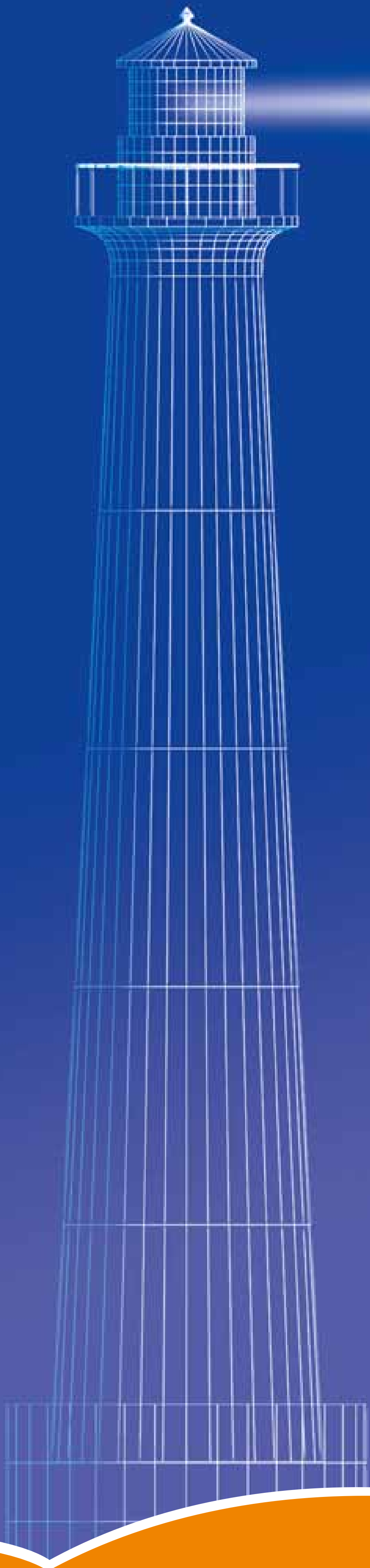
6th Global Symposium for Regulators (Yasmine Hammamet, 2005)

Developing a new regulatory framework to promote broadband deployment and access in developing countries

Discussion Papers

International Telecommunication Union



GSR 2005

DISCUSSION PAPER

BROADBAND PROVISIONING

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Broadband provisioning for developing countries

Prepared by *MICHAEL BEST AND BJORN PEHRSON*

<u>Comments are welcome and should be sent by 5 December 2005 to</u>
<u>http://www.gsr2005@itu.int</u>

TABLE OF CONTENTS

Page

GSR Discussion Paper

Broadband provisioning for developing countries*

Introduction

The purpose of this paper is to facilitate decision-making by regulators, policy makers, and potential broadband providers. This paper identifies and analyzes the key promising technologies that can help promote to broadband access in developing countries, particularly in rural and underserved areas. The range of broadband systems is organized into three broad families of technologies: **broadband wireline networks,** including DSL, cable TV, powerline, Local Area Networks (LAN) over twisted pair copper cables and fibre solutions; **broadband wireless solutions**, including third generation mobile, wireless Local Area Networks and other fixed and mobile wireless access solutions; and **non-terrestrial options,** including VSATs and stratospheric solutions. The paper will analyze the benefits and challenges of all, the types of equipment, infrastructure and software that are needed to deploy each and their viability for rural and underserved areas of developing countries. The viability analysis is based on a series of factors including current levels of infrastructure deployment, power requirements, types of equipment and infrastructure investments required, capacity provided and how different terrains impact deployment. The paper concludes that there is not a significant environment on the planet today in which broadband internet does not make commercial, social, and institutional sense, given the political will to foster an enabling environment to drive demand for broadband by a full range of stakeholders.

1 What Do We Mean When We Say “Broadband”?

Like many terms used in today’s fast moving technology sector, the term “broadband” is not well defined. The word was originally used in the network engineering community to signify transmissions over some medium carrying multiple channels simultaneously. This would be in contrast to “baseband” where a single channel was transmitted at anytime. Today, however, “broadband” is used much more frequently to indicate some form of high-speed internet access.

The decision of which networks provide sufficient capacity to be called “broadband” is a matter open to debate. Many attempts to associate broadband with a particular speed or set of services, but in reality the term “broadband” is like a moving target. Internet speeds are increasing constantly, and at each new advance, marketers eagerly emphasize just how blazingly fast the latest connection speeds are. The speed of a network is usually expressed in term of its underlying data rate and measured in bits per second (the bandwidth). What is not in debate is that today’s dial-up Internet speeds, topping at around 56 Kbp/s, are *not* broadband connections. But beyond that it is a matter of taste. The United States Federal Communication Commission (FCC) has defined broadband as starting at 200 Kbp/s, the OECD at 256 Kbp/s, and the International Telecommunication Union defines broadband as a network whose combined capacity, both up and down, sums to 256 Kbp/s or above.

A good example of the broad range of definitions can be found within Sweden. The Swedish IT Commission (1994-2004) defined broadband as supporting a formidable 5 Mbit/s up and down; the Swedish government as at least 2 Mbit/s up and down while Sweden’s incumbent operator, Telia, defines it as at least 0.5 Mbit/s both up and down. In Swedish metropolitan area networks (MANs), 10-100 Mbit/s, has become the standard.

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* This discussion paper has been prepared by Michael Best and Bjorn Pehrson. The views are those of the authors and may not necessarily reflect the opinions of the ITU or its membership.

While the parameters of definition in the market space are wide, for the purposes of this paper the term broadband refers to data rates that correspond to the ITU definition as outlined above.

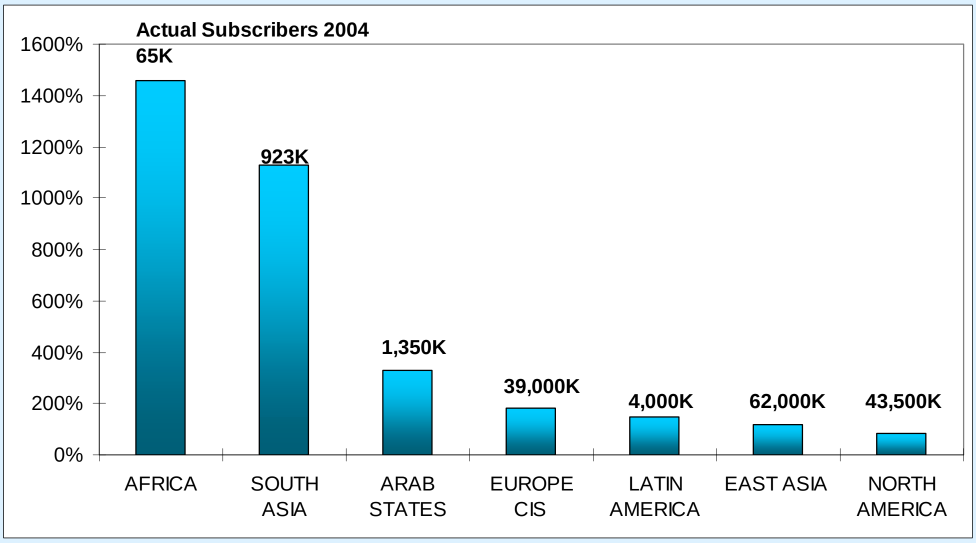
Beyond precise data rate thresholds, perhaps an even more useful way to define broadband – whether it is fixed or wireless - is in terms of what, at a minimum, can be accomplished with it. This certainly includes fast downloads when using the web. But it also should include CD quality streaming audio, fully interactive voice services such as VoIP, some level of interactive video chat services (if not full capability video conferencing), and reasonable quality streaming video services (if not full DVD quality video on demand). Note that realizing this wish list is not simply predicated on available bandwidth. Interactive applications such as VoIP also require small latency (delays), error rates, and jitter (whereupon data arrives out of order).

2 The State of Global Broadband Growth on Wireline Networks

The number of total global internet users continues to increase, reaching around 875 million at the end of 2004[1]. Broadband internet access technologies (e.g. DSL, cable modems, wireless LANs, fibre optics) are changing the quality as well as the purpose of access, and new wireless broadband technologies, such as wireless metropolitan area networks (e.g. WiMAX), offer great promise for countries lacking in physical communication infrastructure.

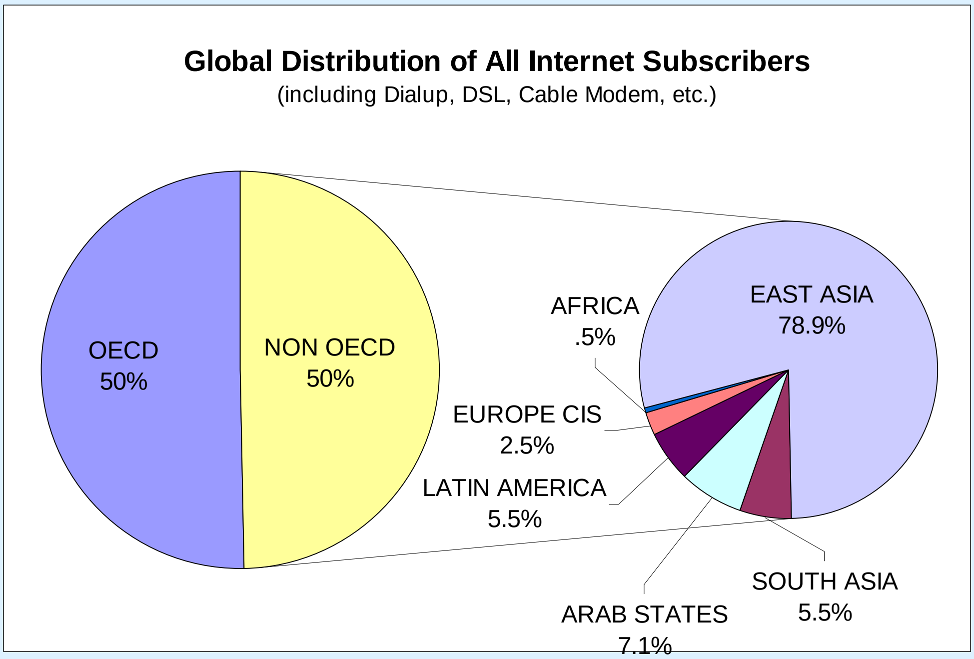
There are over 98 million DSL broadband subscribers in the world today, in addition to over 51 million cable broadband subscribers and a further 9.3 million who are using ‘other’ technologies (this includes technologies such as satellite broadband internet, Fiber-to-the-home internet access, Ethernet LANs, etc.) in the attempt to attain ‘always on’ internet access. This brings total fixed line broadband subscribers to nearly 159 million already at the end of the 2004. While the total number of these subscribers has undoubtedly been increasing around the world, it is notable that the fastest rates of broadband (and specifically, DSL) growth today is occurring in the developing countries of South Asia (notably India and Pakistan) and sub-Saharan Africa. (See Figure 1) Indeed, while there is a general perception that internet growth is limited to the wealthier OECD members, in fact internet subscribership is currently being driven at about equal rates between OECD and non-OECD countries (see Figure 2). About 50 per cent of all general internet subscribership in the world is now accounted for by non-OECD nations.

Figure 1: Rate of Broadband Growth By Region (2002-2004)



Source: ITU World Telecommunications Indicators Database

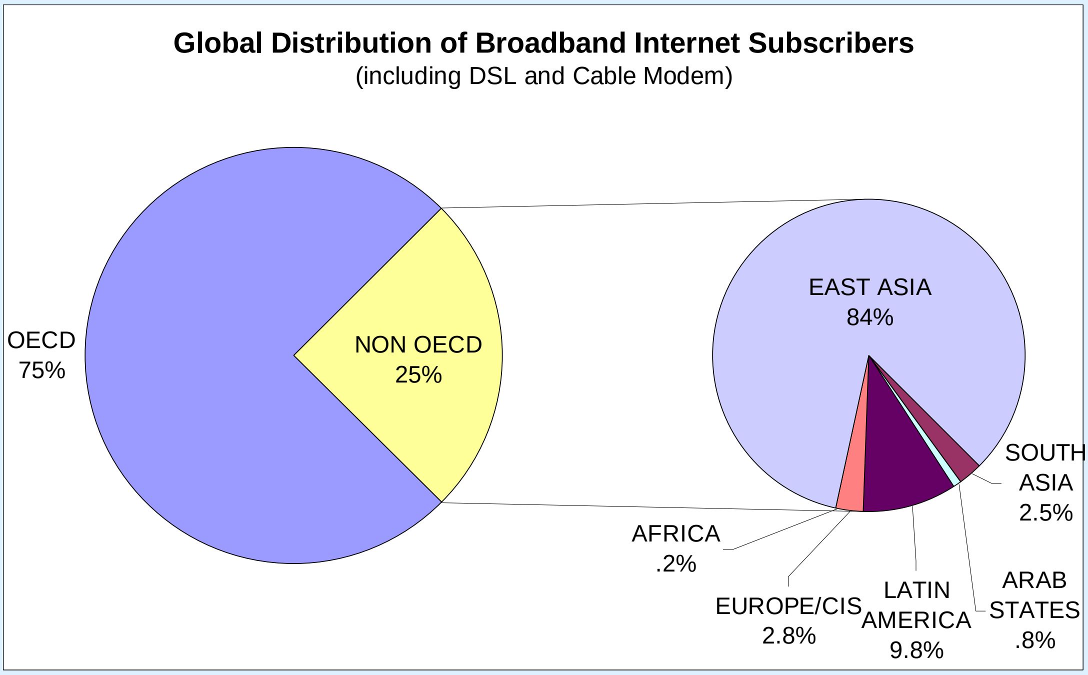
Figure 2: Global Distribution of Internet Subscribership (2004)



Source: ITU World Telecommunications Indicators Database

Non-OECD countries today account for a full 25 per cent of broadband subscribership (see Figure 3). While the growth rate from year to year of total non-OECD country broadband subscribers has been increasing steadily from 71 per cent in 2002-2003 to over 107 per cent between 2003-2004, overall *global* broadband rates of growth show evidence of even year-to-year growth, at around a consistent 49 per cent between 2003 and 2004. This does not mean, however, that there is any decrease in the absolute numbers of subscribers. Rather the fervor of quick and sudden broadband deployments over the past few years are now being tempered and stabilized. China is an exception to this rule, logging steady broadband year-to-year growth rates relative to Canada, Japan, Korea (Rep.) and the United States, who have the highest numbers of broadband subscribers.

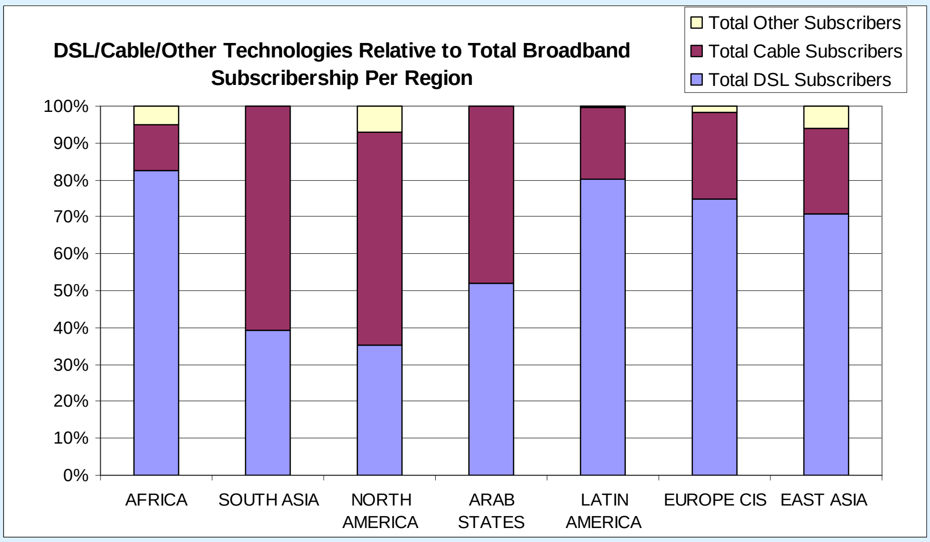
Figure 3: Global Distribution of Broadband Internet Subscribers (2004)



Source: ITU World Telecommunications Indicators Database

Globally, already in 2003 about 30 per cent of all internet use was on broadband. Of the total broadband subscriber base, 32 per cent are using cable modems for access, 62 per cent are using DSL, and 6 per cent are using another technology. Figure 4 below depicts the breakout of broadband access type by region. It is fair to assume that while there may be other ways (i.e., VSAT connection) of achieving 'broadband status', most are connected via DSL or cable modems, and the majority of the remainder—close to 60 per cent of internet subscribers-- is using dial-up. It is clear from the figure that DSL features most prominently in Latin America, Europe/CIS, Africa and East Asia, while South Asia and North America are more dominated by cable modem technology.

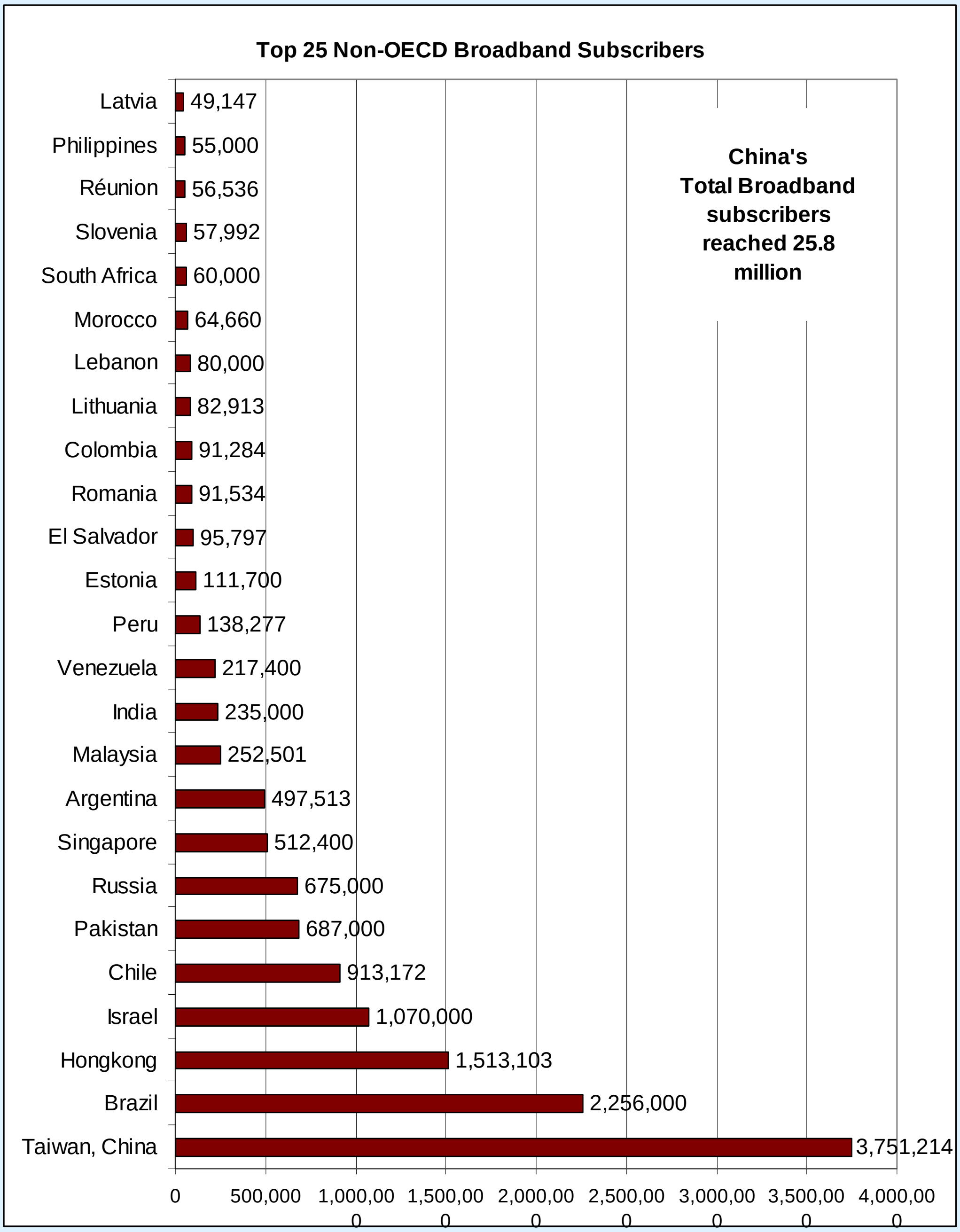
Figure 4: DSL/Cable/Other to Total Broadband Subscribers (by Region) 2003



Source: ITU World Telecommunications Indicators Database

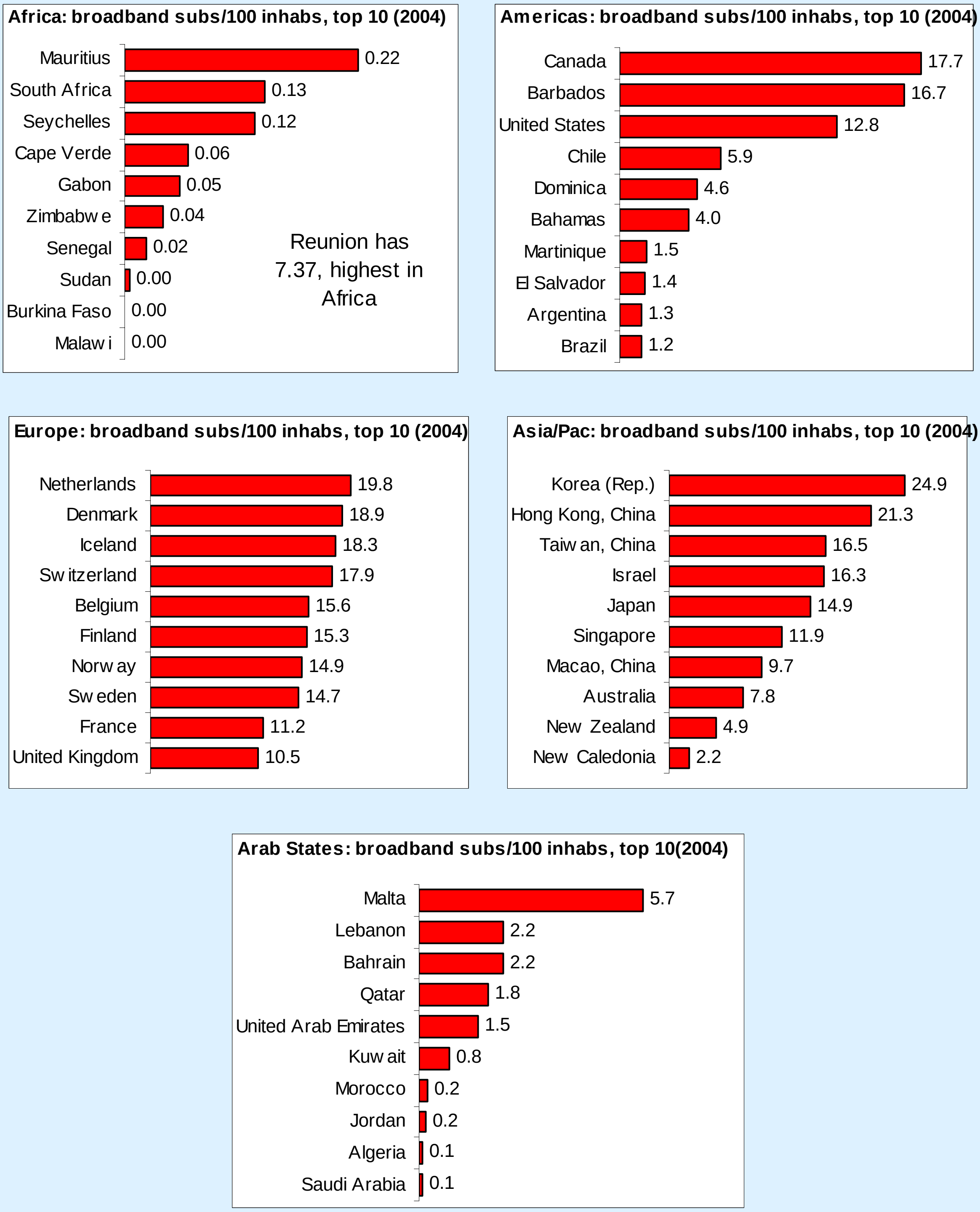
While the growth of DSL subscribers in non-OECD countries contributions was negligible until 2003, suddenly in 2004 non-OECD countries had a 22 per cent higher impact on total global DSL growth. This was mirrored by a corresponding 6 per cent decrease in the predominance of OECD countries as drivers of DSL take-up. This signals a clear recognition by telecommunication operators and investors that developing, non-OECD markets are valuable and hold potential, as they begin to build out new communications infrastructure in places it has not existed before. Figures 5a and 5b below offer a breakout of which countries have what kind of subscriber base.

Figure 5a: Top 25 Broadband Subscribers, Non OECD Countries (2004)



Source: ITU World Telecommunications Indicators Database

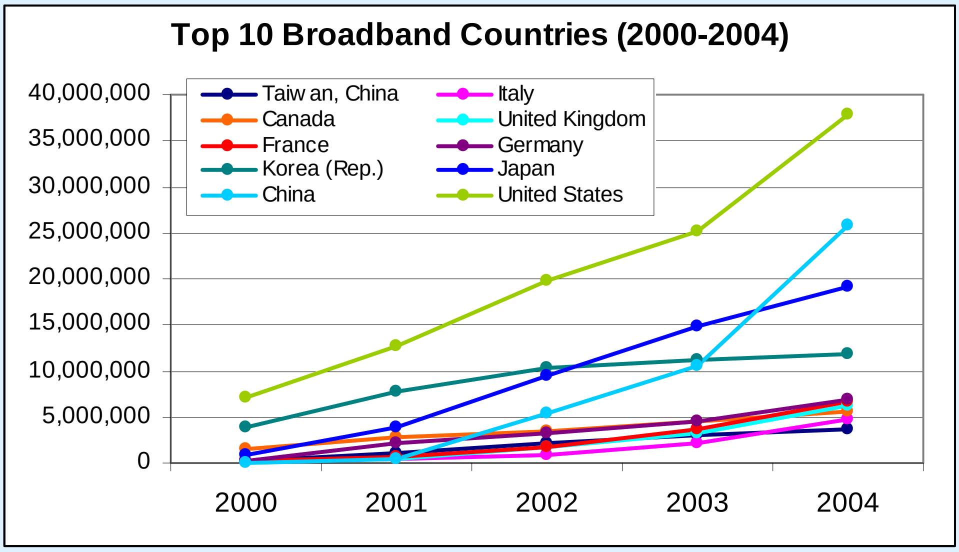
Figure 5b: Top 10 Broadband Countries by Region



Source: ITU World Telecommunications Indicators Database

Growth in terms of absolute fixed line broadband subscriber numbers is abundant. Figure 6 provides a snapshot of some of the most developed countries that have adopted and expanded their broadband subscriber bases successfully.

Figure 6: Top 10 Broadband Subscribers, World (2000-2004)



Source: ITU World Telecommunications Indicators Database

Considerable new broadband deployment activity in nations throughout the developing world, from the Arab States to Southeast Asia, warrants attention. For example, DSL broadband internet lines have been rolled out in Egypt from TE Data, and ISP Nile Online. In Chile, carrier Telsur has initiated an internet/broadband development project, which has seen a total investment of US$20 million in the last five years. Brazil has launched triple play services including broadband, as has the Indian operator MTNL. From Fiji to Oman, the telecommunications industry is evolving to expand in the direction of broadband infrastructure, and most of these are DSL based.

Some transition countries are moving faster than others, jumping straight ahead to providing wireless broadband connectivity; for example, Bulgaria has opened a tender for several decade-long nationwide point-to-multipoint wireless broadband licenses, and seven contenders expressed interest, according to the country's telecoms regulator CRC. Meanwhile, in Saudi Arabia, broadband wireless technology has been deployed to enhance data transfer rates in the kingdom's urban areas. Asian markets have been particularly active; and representatives from China, Japan and Korea (Rep.) have reached an agreement to jointly develop future 3G technologies. These developments have not been driven uniquely by governments and telecommunication operators; large-scale international manufacturers are also doing their part. Intel, for instance, has announced its plans for WiMAX, trials in Malaysia, Philippines and Thailand before the end of 2005, and in Indonesia and Vietnam before the end of 2006.

The challenge today is to extend the promising signs of broadband growth throughout the developing world, and in particular to rural and underserved areas. Technological solutions and innovations like VoIP and broadband applications are providing the means by which broadband connectivity can be used to leverage legacy networks where they exist and to deploy entirely new infrastructure in un-served areas. Some countries are already extending broadband connectivity nationwide. (See Box 1.)

Box 1: Broadband Wireless Nations

A small set of countries has announced plans to become the world’s “first broadband wireless nation”. Who will be the world’s first broadband wireless country? Mauritius and TFYR Macedonia both are deploying fixed wireless broadband networks across the bulk of their countries using technologies that are tracking the emerging 802.16 WiMAX standards.

In Mauritius, the small African island nation of 1.2 million people, the wireless network is reported to already cover 60 percent of the island and 70 percent of the population. By the end of 2005 Mauritius intends coverage to reach a full 90 percent of the country.[2]

In TFYR Macedonia, a country of 2 million people, local network provider On.NET is deploying a broadband wireless network across the country using Motorola Canopy radios. This project is a unique partnership between the donor community, the Government of TFYR Macedonia, and the private sector. The Government of China has donated thousands of personal computers to be used in the nation's primary and secondary schools. Complimenting that donation, USAID is providing broadband internet connectivity to 460 primary and secondary schools and 71 other sites through 2007. This substantial guaranteed countrywide customer base has created the business case for On.NET to make a significant investment in a pervasive countrywide wireless network.

On.NET is free to sell capacity to additional corporate or consumer subscribers throughout the country. Furthermore, in metropolitan areas they are deploying a mesh based (see Box 8) network providing pervasive hotspot connectivity in the country's population centers.

In October 2005 the project partners announced an important milestone, that 95 percent of the country's population is within reach of the broadband wireless signal.

3 The State of 3G Wireless Broadband Deployment3

IMT-2000 technologies, known popularly as 3G, are also starting to grow broadband subscribers. Two of the most popular 3G technologies are W-CDMA, the 3G migration path for GSM networks, and the family of CDMA2000 technologies, including CDMA 20001x and CDMA 1x EV-DO. These 3G technologies are discussed more fully below, in section 5.3 below. There were nearly 134 million IMT-2000 subscribers on 166 networks by year end 2004.

4 The poor pay more for less broadband

The ITU World Telecom Indicators database[4] shows that not only is broadband penetration higher in high-income countries, but that low-income countries pay more for less capacity. Not surprisingly, upper income countries have more broadband subscribers per 100 people than the lower or middle-income countries. Indeed, while the means are not significantly different between low and middle-income countries, with less than one broadband subscriber per 200 people, there is a statistically very strong difference between the case of upper income countries and all other countries.

Given the fewer broadband users per capita in low-income countries, how does the price and capacity of the service vary from country to country? The average fee paid by low-income countries for broadband service is US$291 per month compared to a mean for upper income countries of US$18 per month. While the poor pay more for their broadband service on average they also receive less bandwidth. The average high-speed downlink capacity for upper income countries is 3.8 Mbp/s compared to an average for low-income countries of 712 Kbp/s.

In summary, broadband penetration in low and middle-income countries trails significantly penetration in upper income countries. While penetration is very small in low-income countries broadband subscribers there pay considerably more money for inferior service. As is so often the case, the poor pay more.

5 Promoting Broadband in Developing Countries: A Technology Analysis

Each wave of technological developments offers new promise in the battle to bridge the digital divide. Most new technologies are cheaper to deploy than legacy copper networks, and, at the same time, can deliver a full range of ICT services, from voice to broadband applications and services. Many new technologies can also be deployed incrementally, even locally, rather than on the large scale of traditional telecommunications networks. Not only does this make deployment more affordable to traditional telecommunications operators and service providers, reducing investment strain, it opens the door to a whole new range of possible broadband providers who can drive demand for broadband services. The types of broadband providers enabled by new technological developments include regional or private network operators, small and micro entrepreneurs, as well as public institutions such as universities, schools, libraries, post offices, local government offices, health facilities, and non-governmental organizations active in developing countries. This paper will now identify and analyze the key promising new technologies that can help promote broadband access in developing countries, particularly in rural and underserved areas.

5.1 How are broadband networks designed?

To structure the discussion, two generic concepts describing two different dimensions of networks are useful, layered architecture and network topology. These are important because they help us understand the dynamics that determine incentives, viability and the potential for collaboration between entities that are tasked with the deployment of broadband. In order to help regulators make informed decisions in light of the array of technical options before them, the following sections break out the various aspects and layers of networks, providing definitions, technical specifications, as well as comparisons between DSL, CATV, broadband via powerline solutions, and fibre optical networks as part of a Wireline Broadband Roadmap. These sections also provide detailed explanations of the various link layers (point to point vs. point-to-multipoint access networks), system types, wireless broadband, as well as options for non-terrestrial wireless broadband networks where wireline solutions are not feasible or applicable.

5.1.1 Layered network architecture

The layered network architecture divides a network at any specific point into layers, each of them adding value to the physical medium of communication. A layered architecture based on open standards is useful for several purposes:

– *Technical:* to define physical and logical interfaces required to connect different subsystems.

– *Commercial:* to define the conditions under which a user or a provider of value added services can get access to services provided by a specific provider at a specific level.

– *Regulatory:* to identify the value chains and define the roles of actors providing services in different layers, to regulate where there should be competition and where it should be possible for any service provider to buy services to provide value added services at a higher level. Rights of way, spectrum licensing, access to essential resources and local loop unbundling, are all examples of such regulations at different levels.

The following layers are explained in greater detail:

5.1.1.1 Physical Layer

The physical layer identifies a medium, such as radio spectrum or wires of different sorts (i.e., copper or fibre), and specifies the mechanical and electrical interfaces that connect to the medium for communication purposes.

The most important media include:

Wireless spectrum: This is a scarce natural resource, which is why regulation is necessary to manage the resource. Existing regulations are often more restrictive than technically and economically motivated from a public good perspective, preventing new innovative actors from entering the market. This is clearly illustrated by reliance on license-free spectrum in the dynamic development of Wi-Fi, and is explored more fully in the GSR Discussion Paper on Broadband Spectrum Management.

Wire line infrastructure: This includes fibre, copper cables and coaxial cable, is largely unlimited in supply, and can be deployed and made available at a cost. In some countries, the provisioning of passive infrastructure is an independent business while in others it is an integrated part of vertically integrated operator(s). In many countries, regulations governing ownership of or access to wireline infrastructure may be more restrictive than necessary to promote broadband access. Access to the physical medium is essential for those that have special needs regarding the choice of transmission system or for those that want to compete at the link level and above, e.g. by introducing a new competitive transmission technology. Regulatory measures to promote access to both wireline and wireless broadband infrastructure are explored more fully in the GSR Discussion Paper, The Role of Regulators in Promoting Broadband.

5.1.1.2 Link Layer

Access to link level services is essential to service providers and organisations that need private networks which seek to build their own networks without having to operate their own transmission systems. The link layer adds procedures for digital data transmission over the physical medium, point-to-point or point-to-multipoint. The link layer includes medium access both to wireless spectrum and wire lines, error control, such as automatic repeat request when check sums do not match, forward error correction (FEC) based on the inclusion of redundant information coded in a way that transmission errors can be corrected directly rather than via retransmission requests, etc. Different link level technologies also have different properties that are important for users, such as capacity, performance, security, privacy, etc.

The properties of the discussed link level technologies are different and may be of different significance to operators, users and regulators wanting to strike a balance between producer and consumer interests. Links are implemented using transmission equipment, and the most important ones to be discussed here include the most commonly used Wide Area Network (WAN) technologies; technologies for data access over legacy networks such as digital subscriber lines (DSL) over the Public Switched Telephone Network (PSTN), cable modems over cable TV networks, broadband over power line (BPL) of the electrical power grid, and a range of both wired and wireless local and metropolitan area network (LAN/MAN) technologies, all of which use the Ethernet frame data format according to the IEEE 802.3 standard[5]. An Ethernet frame is the unit of data that is transmitted between network points on an Ethernet network. Examples of such wired networks include Ethernet with data rates from 10 Mbp/s to 100 Gbp/s (IEEE802.3) while examples of wireless link level equipment include: WiFi (IEEE 802.11) that has exploded over the last 5 years and WiMAX (802.16) which is expected to grow as a wireless backbone technology.

5.1.1.3 Network Layer

The network layer provides mechanisms for addressing and forwarding of data. This paper assumes that the Internet Protocol (IP) is used for this purpose. The network layer is implemented by network elements such as routers interfacing to different link level technologies, link level switches and multiplexers, etc, to connect network hosts (servers and terminals). This is the level at which all ISPs provide services.

5.1.1.4 Transport Layer

The transport layer provides end-to-end connections between user applications in network hosts. The central transport protocols include the connection oriented Transport Control Protocol (TCP) and the User Datagram Protocol (UDP).

5.1.1.5 Application Layer

In the application layer, the communication parts of a user application, such as email or file transfer, web access, database access, are implemented.

5.1.2 Network Topology

The network topology divides networks into functional parts, including access, backbone and service networks and traffic exchange points where different service providers exchange traffic. Each of these functional parts is built up by layers according to the previous section.

5.1.2.1 Access networks

Access networks include links between users and the service providers' networks, whether they go the first or last mile or meter. First mile refers to where a user or local service-provider, or perhaps even an apartment building company[6] owns the access network and connects to service providers via their own upstream links. Last mile refers to where a service provider owns the access network and connects to the users downstream via its own links. Different link level technologies used in access networks have different properties with different sets of strengths and weaknesses that can be valued differently by regulators, users, operators and network owners. Depending on the geographical context, the access network could be a LAN or a MAN. As will be discussed in a later section, the technical solutions might be different depending on who owns the access network. In open regulatory environments, it could be owned by anyone, including a service provider, an organization, a municipality, or a user agent or a neutral agent, such as a real estate owner or independent operator.

The physical layer infrastructure available for access networks includes PSTN, cable networks, electrical power networks, radio spectrum, and increasingly fibre to the neighbourhood, office or home (FTTP, i.e. fibre to the premises). On the user premises, the connections to the residential or office gateway could use dedicated wiring, legacy copper telephone wiring, power line communication or wireless. The most common link level technology on user premises is a local area network (IEEE 802), wired Ethernet or wireless (Wi-Fi).

In an environment with more than one operator, local loop unbundling is an important first step towards an open market, however often limited by a dominant owner of the infrastructure competing with its own customers regarding service provision. A more developed market requires independent ownership of the infrastructure and mechanisms for service providers to obtain direct access to users without intermediary gatekeepers in the way.

5.1.2.2 Backbones

Backbones consist mainly of long haul links which ISPs can use to expand their service networks geographically, to get transit to the Internet and to connect to regional traffic exchange points. In some countries, an open backbone market has emerged due to the existence of parallel or complementary fibre infrastructures deployed by different owners, including telecom operators, power utility companies, railways, pipeline companies, municipalities, etc.

5.1.2.3 Service networks

A service network contains the servers of an Internet Service Provider offering services to users via access networks, transit to the next tier ISPs and peering with neighbouring ISPs in the same tier.

5.1.2.4 Traffic exchange points

Traffic exchange points are used by operators to exchange traffic via peering directly between their service networks rather than indirectly via transit through their upstream providers. An Internet exchange point (IXP) consist in its simplest form of a link layer switch over which ISPs peer to exchange IP-traffic. The service provided by an exchange point is to improve the network performance by keeping local traffic local and minimizing transit costs for the connected Internet Service Providers. This is particularly important in areas where the backbone consists mainly of satellite links with long delays, high bandwidth prices and the remote ends on different continents.

This is a particular problem in Africa. To compensate for the fact that Africa is comprised of a large number of VSAT "islands" on the shores of other internet backbone "continents", one solution that has been identified is that IXPs be interconnected, even via satellite links if better alternatives are lacking. This would cut the number of satellite hops by making direct hops between IXPs rather than taking the transit route that would involve at least two hops, sometimes more, plus perhaps a few transcontinental and overseas passages depending on where the different transit links happen to terminate. The main drawback of distributing an IXP geographically by connecting local IXPs is the bundling of the switching function and the long haul link, which could lead to unfair competition in situations where link capacity is expensive.

In communities that only have VSATs available as gateways, it makes sense to have a local IXP keeping local traffic local before sending it upstream via the satellite channel. This is also valid for remote local communities that can take advantage of limited alternative fibre stretches, e.g. used for meter monitoring in pipelines (water, oil, gas) or power lines. IXPs thus start appearing in the local access networks, not only between service networks. The importance of IXPs is explored more fully in the joint ITU-IDRC Report *Via Africa: Creating local and regional IXPs to save money and bandwidth.*

5.2 Wire-line Broadband Roadmap

Internet access has in the early phases of Internet expansion been provided mainly by using legacy infrastructure deployed to provide other services, such as fixed telephony (PSTN) and cable TV (CATV). It has been provided by leveraging existing infrastructure, and in areas where such infrastructure has not existed, has been utilized via satellite (i.e., bi-directional VSATs). In some areas, communication over power lines (PLC) has been considered a viable alternative.

To an increasing extent today, where possible, dedicated broadband networks are being deployed. Such networks are typically based on Ethernet over fibre, in backbones, to the curb, block or neighbourhood, and to the home and/or office premises. They can interface to any other link level technology to take advantage of existing infrastructure.

At the same time, new technologies have been developed to be able to provide broadband services over the legacy networks, such as DSL over PSTN, HFC for cable TV networks and broadband over power line (BPL).

The different link level technologies involved are discussed and analyzed below to provide:

- A description of likely broadband upgrades based on existing infrastructure,
- The differences in quality of service and transmission rates of the various solutions;
- An indication of the kinds of infrastructure investments that are required to deploy each technology (as a proxy for cost); and
- A means of assessing the suitability to different socio-economic and geographical contexts.

5.2.1 Upgrades to PSTN

5.2.1.1 Dial-up and ISDN

Due to high teledensity in developed countries, PSTN has long served as a primary access network to the Internet, through dialup modems or leased telephone lines. Data communication via a dialup telephone connection requires an analogue modem at both ends of the telephone line. Traditional modems encode data in the same frequency band as the one carrying the voice call (up to 4 KHz). The user can either speak or send data. Data rates vary between 2.4 and 56 Kbp/s per connection depending on the quality of the analogue copper telephone line, whether or not the network operator's central office switch is digital, whether the switches are clock synchronized, and whether the switches are connected via modern media like fibre or microwave.

From an economic point of view, user modems are cheap and typically integrated in most new computers. Carrier class dialup servers required at the ISP end are quite expensive, while lower class equipment that can be used by rural entrepreneurs on a small scale is cheap (less than USD 500) and supported by open source software. From the user point of view, the usage includes the telephone call cost to the telecom operator while connected and the ISP fee, which may be flat or connection-time based.

Upgrade from PSTN to ISDN requires a digital network to the user premises, and thus investment in equipment both at the central office and at the user end. If already installed, ISDN is still an alternative for internet access in areas where more advanced services such as DSL, cable networks or fibre networks cannot be used. If ISDN is not already installed, DSL appears to be a better investment since it facilitates cheaper and higher quality broadband service. ISDN and some DSL systems are not designed to be used over the same infrastructure. Users that have upgraded from PSTN to ISDN may have to downgrade again, before upgrading to DSL.

Compared to dialup PSTN, ISDN is an improvement both from a bandwidth and reliability point of view. Operators offer ISDN services including two channels as a basic rate offering (BRI) and 24 or 30 channels (depending on basic PSTN type), as a primary rate offering (PRI). Available user equipment consists of simple routers interfacing to the ISDN modem including 2 or 24/30 channels and an Ethernet interface for a local area network on the customer premises. The equipment supports automatic opening of new channels as needed when the traffic increases, thereby providing from 64 to 1.5/2Mbp/s connections. It is also possible to connect different channels to different destinations. On the operator side, the ISP typically leases a primary rate connection (PRI) from the telecom operator. From the user point of view, the usage includes the call fee to the telecom operator for each channel while connected, and the ISP fee, which may be flat or connection-time based.

Even in the best of circumstances with 56/64 Kbp/s maximum bandwidth per connection at voice tariffs, dialup systems or ISDN systems are not able to offer competitive broadband services.

5.2.1.2 Digital Subscriber Line (DSL)

DSL includes a family of technologies providing a digital connection in an unused part of the frequency spectrum of the copper wire subscriber line in the telephone network (ITU-T G.933.2 and www.dslforum.org). The voice and data connections can thus be used independently of each other.
The DSL technology provides a significant enhancement of the installed PSTN base and protects the value of the copper network. According to the ITU World Telecommunication Indicators database, DSL is used to provide over 60 percent of worldwide home broadband connectivity.

The bandwidth that DSL systems can provide has been increasing and there are now systems installed that can provide 256 Kbp/s - 1.2 Mbp/s upstream and 512Kbp/s -28 Mbp/s downstream. The limits are set by the attenuation of signals at higher frequencies, which depends on the quality of the copper lines and their installation. The distance between the subscriber and the exchange usually has to be in the range 0,3-5 Km, depending on data rates.

To deploy DSL, equipment must be added at both ends of the subscriber line. At the user end, a DSL modem and a cheap passive splitter must be installed. The passive splitter plugs into the existing telephone socket and splits the incoming signal between the telephone and the DSL modem. On the other side of the modem, the user can connect a computer directly, or a LAN via a customer premises gateway for less than USD100. The DSL modem converts between the data format used in the local area network environment, mostly an Ethernet LAN (IEEE802.3), into a digital audio stream. On the operator side, before the subscriber line is connected to the telephone exchange, the DSL circuits are separated and terminated in a digital subscriber line access multiplexer (DSLAM), which aggregates the digital connections from different users and feed them into the ISP network.

ADSL

ADSL (Asymmetric Digital Subscriber Line) is the most widespread DSL-technology. The data channels use one frequency band for a low speed upstream channel (25 KHz to 138 KHz) and another for a high-speed downstream channel (139 KHz to 1.1 MHz).

Data transmission speeds vary mainly based on the distance between the subscriber and the central office. Some users cannot be reached by ADSL due to their distance from the central office. In Denmark in 2004, for example, about 5 per cent of households could not be reached by any ADSL services and only 70 per cent of the population could access a 2 Mbp/s connection. More recent ADSL standards, such as ADSL2 and ADSL2+ promise improved capacity and coverage.

VDSL

VDSL (*Very high-rate Digital Subscriber Line*) is similar to ADSL but optimized for shorter distances, 300-1500m. Existing systems offer capacities up to 52 Mbp/s by including more high frequency bandwidth in the copper cables and by deploying more efficient modulation. To extend the range, VDSL requires deployment of a fibre optical backbone network to the curb, block or neighbourhood (street cabinet), and a power supply for the street cabinet, which is not required by PSTN. This increases deployment costs significantly. It has also other limitations, including interference from ADSL and AM radio services. VDSL2, a standard under development, promises to achieve bit rates of up to 100 Mbp/s.

Uni-DSL

UDSL or UniDSL (One DSL for Universal Service), a new variant of DSL, integrating all earlier DSL variants, promises aggregated bit rates of up to 200 Mbp/s, including 100 Mbp/s symmetrical connections. While Uni-DSL gives operators the flexibility to offer a range of connections, the higher data rates cannot be offered on the existing PSTN infrastructure. Uni-DSL would require a fibre backbone infrastructure and would use only a part of the existing subscriber line closest to the user premises.

5.2.2 Upgrades to CATV networks

5.2.2.1 Broadband communication over cable TV networks

Cable TV (CATV) networks use coaxial cable, initially only for distribution of TV-channels in a tree-structured network created by using passive splitters, to reach all users in a point-to-multipoint topology. Broadband communication over cable TV networks is accomplished by transferring data full duplex via unused bandwidth in the cable, similar to what DSL does over PSTN. The standard is “Data over Cable Service Interface Specification” (DOCSIS)[7]. The basic data rates are 54 Mbp/s downstream and 3 Mbp/s upstream. An Internet service provider connects to the cable company central office (known as the head end by CATV operators) and uses the cable network to connect to users.

Similar to the DSL case, equipment has to be installed both at the head end and at the customer premises. On the operator side, at the head end, a cable modem termination system (CMTS) is installed that separates the digital communication channel from the CATV circuits, aggregates connections from different users and feeds them into the ISP network. On the user side, a splitter and a cable modem (CM) must be installed. The splitter divides the incoming signal between the TV set and the cable modem. On the other side of the modem, the user can connect a computer or a residential gateway via an Ethernet port and a USB telephone connecting to a Voice over IP service, if provided by the ISP.

From an economic point of view, broadband over cable is favourable in areas where there is already an existing cable network. The tree-structured point to multipoint technique has, however, several severe disadvantages compared to point-to-point solutions:

- For the regulator, it is less attractive since it has a lock-in effect by preventing local loop unbundling on the physical and link levels.
- For the operator, it is more complex to plan, manage and upgrade.
- For the user, the performance depends on traffic from other users due to sharing without traffic control of individual connections. Users in a neighbourhood (typically, 100 - 2000 homes) share the available bandwidth provided by a single coaxial cable line. Therefore, connection speed can vary between 10 Mbp/s and a few Kbp/s depending on the traffic from other users. While most networks share a fixed amount of bandwidth between users, cable networks generally spread over larger areas and require more attention to such performance issues. The broadcasting technique also raises concerns regarding security and privacy. To address these concerns, the DOCSIS standard includes encryption and other privacy features that are supported by most cable modems.

5.2.2.2 Hybrid Fibre Coaxial

Hybrid Fibre Coaxial (HFC) is a network integrating a conventional coaxial cable network, and fibre optic cables between the head end and the curb, block or neighbourhood interfaced by converters. An HFC network may carry a variety of signal types, including analogue TV, digital TV, telephone, and data. It increases the competitiveness of the cable operators industry in a similar way as the PON (Passive Optical Network) reinforces the wire line operator industry. PON is discussed in greater detail in section 5.2.4.2.

5.2.3 Broadband via Power line

Power line communication (PLC) systems that use the existing electrical power grid as a local loop for delivery of broadband services are sometimes referred to as Broadband via Power Line (BPL). The typical power grid comprises generators, high voltage lines (155-765 kV), substations, medium voltage lines (1-40kV), transformers and low voltage lines (up to 400 V). High voltage lines are unsuitable for BPL since there are too many electromagnetic disturbances (noise). The need for standards ensuring coexistence and interoperability between technologies, and compliance with Electro Magnetic Compatibility (EMC) regulation, is attended to by several organizations. IEEE has started work towards a "Standard for Broadband over Power Line Hardware (P1675)[8] intended to provide electric utilities with a comprehensive standard for installing the required hardware on distribution lines. The standard is targeted for completion in mid-2006. There are also working groups within the Special International Committee for Radio-Electric Disturbances (CISPR)10, the relevant directives of which include EN55022 (European) and CISPR22 (international).

In Europe, standards include the low power voltage 240-volt and frequencies from 30 kHz to 150 kHz. In North America, corresponding standards include the 120-volt grid and allow use of frequencies above 150 kHz as well. Power utility companies often use frequencies below 490 kHz for their own telemetry and equipment control purposes.

BPL uses medium voltage power distribution lines (Access BPL) and low voltage in-house wiring (In-house BPL).

Access BPL uses modems and couplers, which are inductive injectors wrapped around the power lines. Typically, a fibre optic network connection from an ISP is terminated in an opto-electric converter and connected to a BPL modem at the utility substation where the high-voltage lines are transformed to medium voltage distribution networks. The traffic is fed into and extracted from the distribution lines via couplers.

The Radio Frequency (RF) carrier supporting the communications signals can share the same line with the electrical signals as they operate at different frequencies. This is otherwise known as Frequency Division Multiplexing (FDM) of telecom and electrical power, with the BPL signal using frequencies between 2 MHz and 80 MHz.

Repeaters amplifying the signal and regenerating data have to be installed about every 300 meters from the station towards customer premises. Signals are terminated in a device just before the transformation to low voltage lines (110/220 V) used in-house.

In-House BPL facilitates home networking by enabling devices plugged into wall outlets in a building to communicate with each other over the existing wiring. One formal industrial standard that serves as an industry reference point is HomePlug (www.homeplug.org), offering specifications that operate in the frequency range 4.5 to 21 MHz; some in Europe operate from 10 to 30 MHz. In-House BPL and Access BPL are not dependent on each other, which means that one may be used together with other technologies in exclusion of the other.

Examples of Access BPL systems manufacturers include:

- **Ilevo** [www.ilevo.com] offers products providing 200 Mbit/s and 45 Mbit/s. Each power outlet is an access point to the power line network. The Ilevo systems include a head end connecting the power grid to an upstream ISP via any standard link level technology, different types of repeaters and a modem at the customer premises. The frequency band used is 1-30 MHz.
- **Amperion** [www.amperion.com] offers products that deliver Internet connectivity via a wireless link called PowerWi-Fi (IEEE802.11b) to an Ethernet port, instead of via the in-house wiring. These systems operate over 3-35 kV MV lines, and provide up to 24 Mbp/s of delivered throughput per injection point depending on line quality and equipment spacing.

5.2.4 Fibre networks

The paper thus far has discussed ways to extend networks primarily dedicated to other services to provide broadband internet access. This section takes the opposite perspective: how to take advantage of fibre technology to deploy broadband networks offering data as well as voice and video/TV services? In addition to a technical overview, this section will discuss strategies for deployment of fibre in developing countries particularly in rural and underserved areas where penetration of wired telephone networks is low, and in many cases decreasing due to the introduction of cellular wireless telephone networks. The wireless networks in many developing countries are based on microwave backbones which provide little support for broadband applications. Many, if not most rural and underserved areas thus lack a broadband communication infrastructure as well as other types of infrastructure, such as power, water and sanitation, and even basic transport. Nevertheless, these regions also have users that demand broadband services.

The lack of legacy infrastructure can clearly be turned into strength in the form of leapfrogging by coordinating fibre deployment with other infrastructure programmes, especially extensions of the power grid (as power and ICTs mutually boost each other's market), as well as along railways, pipelines and roads. Many developing countries have in recent years developed such strengths, including political awareness manifested in national ICT policies and National Information and

Communication Infrastructure (NICI) plans. The most striking examples include Laos, Rwanda and Tanzania, but many other countries are developing similar strengths. The availability of infrastructure creates new opportunities, where the regulatory environment allows those who recognize these opportunities to act.

5.2.4.1 Physical layer

An optical fibre is a hair-thin thread of glass that transports light waves with very low diminution over long distances. Fibre is deployed in cables. Standard cables contain 24, 40 or 96 fibres. Cables can be deployed under ground in conduits, under water as submarine cables or hanging in poles or pylons. The cost of deploying fibre is mainly associated with the extent of the civil engineering work involved. The marginal cost of adding more fibre cores in a cable is generally very low compared to the costs associated with deploying other infrastructure.

Power utility companies deploy fibre, primarily for supervision, control and data acquisition (SCADA) of the power grid, but are increasingly adding more fibre at a very low marginal cost to lease to others. These companies normally use a special ground wire with a fibre cable in the core (optical power ground wire, OPGW) in green field installations or wrap fibre around the transmission lines in brown field installations (known as SkyWrap). Thus, every power grid substation, including in rural and underserved areas, becomes a point of presence for access to fibre.

Signalling over optical fibre is accomplished by lasers as transmitters and photo diodes as receivers. Standard data rates are 1, 2.5 10 and 40 Gbps in each stream. A 100 Gbps prototype was presented at the 2005 European Conference on Optical Communication (ECOC). Wavelength Division Multiplexing makes it possible to have up to 96 parallel data streams in one single fibre. The maximum total capacity in one single fibre is currently thus in the 1-10 Tbps range.

Optical networks

When discussing optical fibre, the physical layer consists of two sub-layers, the passive fibre itself, without any signals, and an active purely optical network. In the passive fibre network, passive optical splitters can be installed creating a tree structure infrastructure, similar to what is done with coaxial cable in cable networks. This infrastructure is called a passive optical network (PON) and is used to implement point-to-multipoint links, such as Ethernet over PON (EPON), discussed in the link layer section below. Active optical networks focus on the optical signals, rather than the passive fiber itself, implementing wave-length division multiplexing and optical switching.

A passive optical network (PON) is a tree-structured physical point-to-multipoint infrastructure. PONs are created by introducing passive optical splitters on fibre cables. The design is similar to CATV networks in that they are designed for shared use, providing broadcast to end-users. Passive means that the transmission of signals from the central office to the customer premise equipment does not require power. Instead, PONS use light waves for data transfer. The use of such trees to establish links (PON) is discussed in the link layer section below.

Active optical networks are point-to-point infrastructures and include active (powered) optical components that provide routing, grooming and restoration of signals at the wavelength level, as well as wavelength-based services, by using wavelength division multiplexing.[11] This means creating a purely optical network infrastructure, before involving the electrical or digital domains on the link level.

Not all fibre networks are designed using an optical network sublayer in the physical layer. The main arguments for introducing an optical sublayer on top of the passive fibre, before adding the digital communication link, are:

Better utilization of the installed optical fibre base, including the possibility to resell capacity on a wavelength basis rather than an entire fibre. This argument mainly concerns the already installed fibre base since the marginal cost of adding more fibre cores when deploying a new cable is mostly very low.

– Better network restoration capability after network failures since optical networks can perform protection switching faster and more economically;

– Reduced cost of the entire communication system since the distributed wavelength routing scheme decreases the cost for cross-connects and only wavelengths that inject or tap traffic at a node need an electrical network element at that node.

5.2.4.2 Link layer

The dominant wire line link level technology in fibre ***access networks*** is Ethernet (IEEE802.3). The 10/100 Mbp/s Ethernet is standard in all new computers, including laptops; 1 Gbp/s Ethernet is a standard interface in most networking components used in access networks.

Regarding ***backbones***, 10 Gbp/s Ethernet have been in operation for quite some time in high end network components, a few 40 Gbp/s backbones are in operation, and soon 100 Gbp/s backbones will be deployed. In the backbone, the IEC Synchronous Digital Hierarchy and ANSI Synchronous Optical Network standards (SDH/SONET)[12] still dominate due to more robust and reliable carrier-class equipment being available. The considerably cheaper and less complex Ethernet technology is however making its way into the backbone, reducing both CAPEX and OPEX expenditures. Moreover, ***Internet Exchange Points*** are now Ethernet-based and the 30 year old Ethernet technology is thus expanding to all parts of the network topology.

Point-to-point access networks

Point-to-point access networks establish independent links between user premises and service networks. They offer maximum flexibility to all stakeholders, regardless of who owns and operates the involved links. The operator-neutral model developed by the housing industry, municipalities, service providers and systems manufacturers in Sweden is neutral in the sense that the passive access network infrastructure is often owned by housing companies, condominiums or tenant organisations and in some cases also by municipalities.

Access networks are connected to a shared access network backbone to which any service provider can connect their service network gateway and offer services. The access network backbone is designed so that individual users in a housing area can select service providers independently of each other. Low-cost standard Ethernet multiplexers or switches are used to aggregate links from user premises to the access network gateway while preserving the provider selection.

The operator-neutral model suits rural and underserved areas well since there are few traditional operators that are likely to see a profitable business there. Given an adequate regulatory environment and appropriate technologies, local entrepreneurs that know the local market opportunities can provide local services and connect users to a point of presence of the larger service providers.

Point-to-multipoint access networks

IEEE 802.3ah Ethernet in the First Mile standard and the ITU-T G.984 GPON standard have made Ethernet the preferred protocol also among the traditional vertically integrated telecom operators.

PON, as mentioned earlier, is a point-to-multipoint technology similar to cable networks, but fibre-based. By introducing passive optical splitters and couplers, a tree structure is created from an optical line terminator at the operator central office to optical network terminals (ONT) at a number of customer premises. Downstream data is broadcasted to the terminals, each of them looking for a matching address at the protocol transmission unit header. Upstream traffic is coordinated using a

Time Division, Multiple Access (TDMA) protocol, in which dedicated transmission time slots are granted to each terminal.

The main fibre can operate at 155 Mps, 622 Mbp/s (Broadband PON or BPON managing up to 16 ONTs) and 1.25 Gbp/s or 2.5 Gbp/s (Gigabit PON or GPON managing up to 32 ONTs). Bandwidth allocated to each customer from this aggregate bandwidth can be static or dynamically assigned in order to support voice, data and video applications. The terminal can provide all the appropriate interfaces. A single fibre, meanwhile, can service 16, 32, or more buildings through the use of passive devices to split the optical signal and PON protocols to control the sending and transmission of signals across the shared access facility. From an economic point of view, PON saves the cost for fibre and equipment at the central office/head end, compared to using point-to-point connections.

Any savings should, however, be weighed against the weaknesses vis-a-vis point-to-multipoint technologies, as discussed for broadband in cable networks. For a regulator pushing an open regulatory regime, the lock-in effect of PON is less attractive since the topology of the physical medium makes it impossible to separate users and thus prevents local loop unbundling on the physical and link levels. There is no unique path between the central office and a single user due to the fact that passive splitters are used to build the physical infrastructure, like in a cable network. Active optical networks, on the other hand, use switches, so that end users can be separated.

For the operator, it is more complex to plan, manage and upgrade than point-to-point links. For the user, the performance depends on traffic from other users due to sharing unless traffic control of individual connections is introduced. The broadcasting technique also requires concerns regarding security and privacy to be addressed. Policy makers and regulators seeking to promote green field fibre backbone deployment will wish to weigh carefully the costs and benefits of these two fibre options to best meet the ICT development goals of their country.

5.2.4.3 Cases from development countries

Fibre deployment is taking off in developing countries and has in several cases already occurred. . The technologies exist and are not that expensive. In many of the developing countries deploying fibre, universities are at the forefront, establishing National Research and Education Networks (NRENs). Bangladesh, India and Pakistan all have national fibre backbones:

- The Pakistan Education and Research Network (PERN) connect all public universities in Pakistan.
- Laos has a national fibre infrastructure reaching all province and district capitals. There is an Internet Exchange Point (IXP) to which all ISPs, except the incumbent, are connected. The universities are in the process of setting up an NREN and participate in a European Union (EU) funded regional academic backbone programme TEIN2, connecting NRENs in the ASEAN countries participating in the ASEM (Asia-Europe Meeting) programme. For 1-2 million USD, Laos could have a national link level backbone consisting of four Gbp/s Ethernets, with points of presence in each province capital, using one fibre pair in one of the nationally deployed cables.
- A Kenyan network provider, in an order reported to cost USD 50 million, has commissioned the supply of an optical fibre network with a length of 1,140 kilometres by the end of 2006. The optical fibre technology supplied is to provide mobile operators, ISPs and fixed-line operators with a core network that extends from the Kenyan coastal city of Mombassa in the southeast to the country's borders with its western neighbours.
- In Rwanda, Terracom is in the process of deploying EPON to all schools and other priority groups. Rwanda has an IXP with all ISPs connected. The academic institutions are in the process of organizing an NREN.

- Both Tanzania and Mozambique have a mix of multiple fibre owners. Both have IXPs and are in the process of establishing NRENs.
- Malawi and Zambia rely on power utilities for fibre deployment. Both are in the process of deploying IXPs and the universities are in the process of setting up NRENs in both countries.
- Bolivia has a national fibre backbone, an IXP and an expanding NREN.

Box 2: Radio transmission primer

All wireless networks communicate via electromagnetic energy. Such energy is, to a first order, described by a single figure of merit: its wavelength or frequency. Since electromagnetic energy traces a sine wave, the frequency specifies the number of humps (or troughs) per second of time and this unit is called the Hertz (or just Hz).

Radio waves between 30 MHz (million Hz) and 20 GHz (thousand million Hz) are usually used for data. Lower frequencies are used mostly for broadcast services such as FM and AM broadcast radio (though in some cases these are also used for data). Energy much above 20 GHz is not very suitable for data over long distances as it is easily absorbed by particulated water vapor in the atmosphere. Note that visible light is electromagnetic radiation in the Terahertz range.

Indeed, the frequency of electromagnetic energy does a lot to delineate its propagation properties. Relatively low frequency energy, such as that used for AM radio broadcast, travel as ground waves literally hugging the earth's surface. This allows the radio waves to travel past the horizon dramatically extending its distance. Furthermore, such long waves are not easily absorbed or reflected by objects such as trees, buildings, and the like. Relatively low frequency energy also can be bounced (or duck back and forth) off of the ionosphere, which again can dramatically extend the distance travelled (Figure 7).

Due to their ability to hug the earth, bounce off of the atmosphere, and/or avoid or penetrate obstructing objects, low frequency radio communications can travel long distances with significant reliability and clarity. Furthermore, the engineering of transmitters and receivers at lower frequencies is easier and requires less sophistication resulting in cheaper appliances.

In contrast higher frequencies, in the microwave spectrums, generally require line of site (LOS) and cannot travel much past their horizon. The direct LOS requirement can be mitigated, as seen in some emerging 802.16 technologies, through sophisticated multi-path approaches. In this case the signal reaches the receiver not necessarily in a straight line from the transmitter but instead reflects off one or more bodies creating multiple paths from the sender to the receiver.

Given these propagation properties, and the significant complications that arise from multi-path fading, it would seem that the lower the frequency the easier and better! But when we are thinking about broadband digital data transmission there is one major advantage to higher frequencies – the higher the frequency the more data that can be transmitted. In fact, typically 1 – 4 bits per second of data can be encoded for each cycle-per-sec of the radio wave. Note that this is related to but not equal to the data rate delivered to a user since many of these bits are put to other purposes. Indeed many bits must go to the basics of signalling, error detection and correction, and so forth.

These propagation properties are the physical laws that proscribe the capabilities of wireless networks. Broadband wireless networks are all situated in the microwave spectrum in order to take advantage of much higher signalling rates. However, they all must do battle with the relative difficulties in signal loss and fading.

Figure 7: Low frequencies can either bounce off the atmosphere or hug the earth, travelling past the horizon. Both features extend the range of low frequency transmission

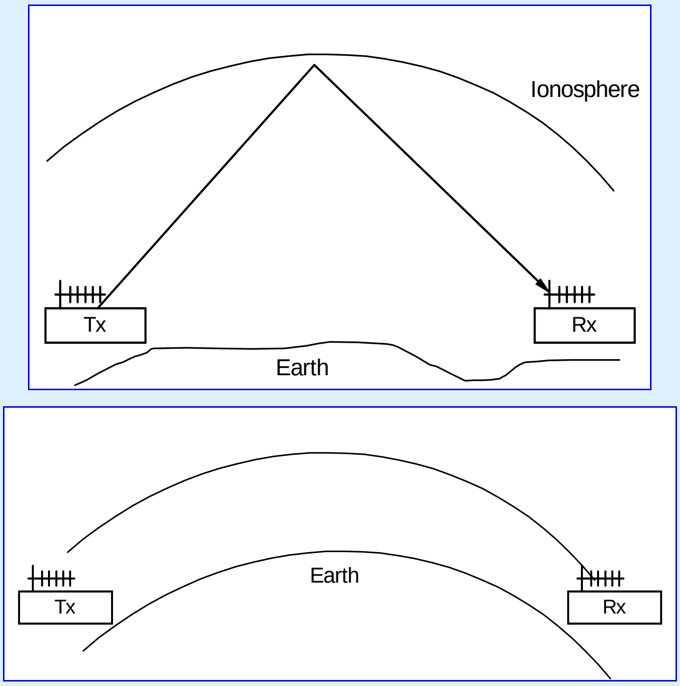
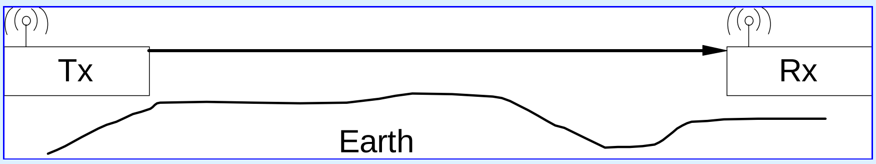


Figure 8: High frequencies require line of site (LOS)

High frequencies require line of site (LOS) between the transmitter and receiver and can be obstructed by foliage, buildings, and the like. Some more complicated systems mitigate somewhat this LOS requirement by allowing the transmitted signal to arrive via multiple paths that have reflected off of surrounding elements.



5.3 Broadband Wireless Access (BWA) Networks

A range of terrestrial wireless solutions are on offer or on the horizon. The development of BWA solutions has been marked both by significant technological progress, as well as substantial industry dropout, as some players forge ahead and others are left behind. BWA solutions can be divided into four primary sub-categories, two of which (GSM and CDMA) are also often labelled as third generation (3G) or IMT-2000 cellular systems. The other two major families, WiMAX and 802.20, are growing in use and maturity in parallel with the development of their standards. While the 3G systems have evolved out of the mobile telephony sector and focused on mobility the other two technologies have emerged from the data networking sectors and often offer fixed wireless solutions (though they too are moving towards mobility).

Box 3: Decoding the 2G cellular acronyms

Second generation (2G) cellular phone systems have seen extraordinary increased levels of penetration worldwide and indeed the number of 2G mobile subscribers surpassed the number of fixed line subscribers from 2002. 2G mobile systems have been implemented using four different classes of technologies each of which is known by it acronym:

Global System for Mobile Communications (GSM). This is the predominant technology worldwide and the predominant system in Europe. It is also used in many nations in Africa, Asia, the Middle East and some countries in the Americas.

Time Division Multiple Access (TDMA). While this term refers to a radio modulation scheme that can be generally applied it also refers specifically to the IS-95B cellular standard, and is the leading technology in the Americas.

Code Division Multiple Access (CDMA). While this term refers to a radio modulation scheme that can be generally applied it also refers specifically to the IS-136 standard. The largest number of CDMA subscribers are in the Americas, followed by the Asia-Pacific region. CDMA has enjoyed less take up in Europe, the Arab States and Africa.

Personal Digital Cellular (PDC). This system is deployed only in Japan.

Source: ITU

5.3.1 GSM

Second generation (2G) GSM networks were initially implemented in Europe and then Asia and have since been installed across much of the world. Original GSM systems support only very limited data capacity (well below that required to be labelled broadband). The next step for GSM-based data services has been 2.5G general packet radio services (GPRS) and the enhanced data GSM environment (EDGE). GPRS offers maximum speeds of 171.2 Kbp/s while EDGE can triple those rates. A typical cell radius for these 2.5G networks is 500-1000 meters, meaning that to achieve complete coverage, every point in the coverage area can be no more than 1Km away from an antenna. GPRS and EDGE technologies allow mobility at vehicular speeds and handle seamless handoff between cells.

The upgrade costs from 2G to 2.5G networks can be extensive since they generally require both soft and hardware upgrades at the base station and may also require upgrades to the backhaul network and increased connectivity at the core network. In addition, in many settings, high costs for spectrum licensing (in the 2GHz band) add to the upgrade costs. Subscriber appliances (e.g. phone handsets) also require upgrades to support 2.5G and handset replacement cycles have often been a central component to system adoption. While estimating the cost is difficult, common implementations have experienced costs per base station above $100,000 or, said another way, upgrade costs per subscriber on the order of $50 or more in low-population density areas.

Third generation W-CMDA systems are an incremental upgrade from GSM's 2.5G networks. These networks, sometimes called UMTS, have seen initial deployments in Europe and Japan. Standard W-CDMA systems can support up to 2 Mbp/s while an enhanced version, called HSDPA, allows downlink rates up to 14 Mbp/s by using a higher modulation rates and other advanced techniques. Given 2.5G base stations and available backhaul networks and spectrum the upgrade from 2.5 to 3G systems can be done incrementally and with relative ease. For instance, 3G services can be offered on a cell-by-cell basis and only in those areas with sufficient subscriber demand. In practice, however, 3G upgrades are done across an entire region in order to provide consistency in service levels for mobile customers and to allow broad marketing and sales plans.

Table 1: Comparative prices for mobile data services
Price per Mbit/s, for selected operators in selected countries, June 2004, in USD, at different monthly usage thresholds, compared with NTT DoCoMo's unlimited usage monthly price

Operator (country)	Technology	1 Mbit/s	10 Mbit/s	100 Mbit/s	1 Gbit/s
Orange (France)	GPRS	1.46	1.22	1.22	1.22
T-Mobile (Germany)	GPRS	10.68	2.62	2.09	0.23
TIM (Italy)	GPRS	1.82	1.82	1.82	1.82
Telefonica (Spain)	GPRS	7.29	7.29	1.46	1.46
Vodafone (UK)	GPRS	13.71	3.86	2.15	2.15
NTT DoCoMo (Japan) (package)	W-CDMA	9.14	3.92	1.35	0.07
NTT DoCoMo (flat-rate)	W-CDMA	35.00	3.50	0.35	0.04

Source: 3G Mobile, ITU Research

Box 4: TD-SCDMA – A Chinese Standard

TD-SCDMA is a 3G standard created by the Chinese Academy of Telecommunications Technology working with equipment vendors such as Siemens. Similar to the WiBRO initiative described below, TD-SCDMA is interesting in the way that the public sector has collaborated with private interests to create a local network standard. In fact, the Chinese have explicitly positioned TD-SCDMA as a way for the country to avoid dependence on "Western technologies". And with China having more mobile subscribers than any other nation in the world, the country has a sufficient market size to support its own standard.

The TD-SCDMA standard (Time Division Synchronous Code Division Multiple Access) is an evolution from the GSM standard in the same way of W-CDMA. Field tests have shown the system to work at vehicular speeds and at a 21 Km distance from the base station. Data rates are published as ranging from 1.2 Kpb/s to 2 Mbp/s.

The fact that the published data rates are so broad is more than a curiosity as technical trials have shown a disappointing delivered capacity. The government has called on an "intensive industry-wide effort" to deliver on the technology and to make it competitive.

5.3.2 CDMA

The second major 2G cellular technologies fall into the CDMA IS-95 family. These systems developed by Qualcomm and used primarily in the United States, do not use the time division multiplexing (TDMA) modulation approach of 2G GSM but, instead, carry multiple transmissions simultaneously by filling the channel with packets encoded for their specific destination device. Note that these CDMA approaches are not compatible with the W-CDMA approach described above; their similar names may be misleading.

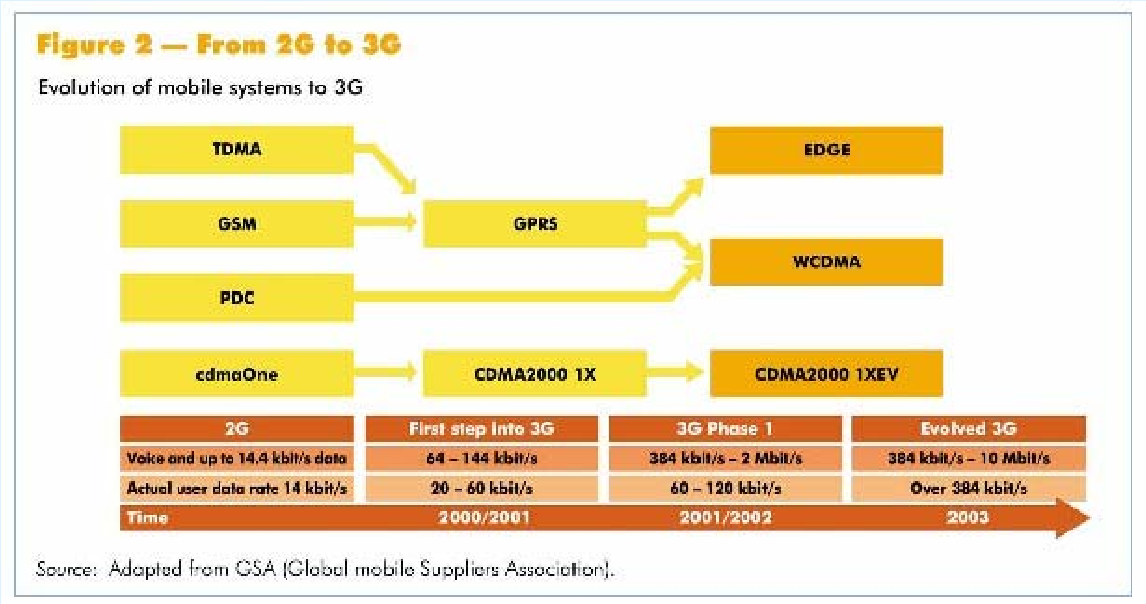
There is a family of 3G upgrades for CDMA networks that are called CDMA2000. This includes the CDMA2000 1x systems which support data rates up to 307 Kbp/s. The CDMA Development Group (CDG) reports their CDMA2000 subscriber numbers as 3G users. This is somewhat clarified by the idea of some operators and equipment manufacturers that the real equivalent to 3G is in fact CDMA2000 1xEV (for Evolution), which is a higher-speed version of 1x. Within this set of technologies are CDMA2000 1xEV-DO (data only) and 1xEV-DV (data/voice). Recent versions of EV-DO and EV-DV support 3.1 Mbp/s downstream and 1.8 Mbp/s upstream theoretical data rates. Real-world rates are about half that speed.

The upgrade paths from a 2G CDMA IS-95 networks to a 3G CDMA2000 network are perhaps like that experienced from GSM to GPRS/EDGE. Certainly they can require similar attention to handset, backhaul, and core network enhancements. However, some industry experts (and many CDMA advocates) have argued that the upgrade requirements on base stations migrating from

CDMA IS-95 to CDMA2000 is easer and cheaper than that required to move from GSM to GPRS/EDGE or W-CDMA.

The performance and market adoption of 3G networks (CDMA2000 and W-CDMA both) has, to date, been disappointing. This has been due in part to the high price associated with network upgrades, the extraordinary rates paid for 3G spectrum in some areas (mostly Europe), and the lack of suitable applications to motivate subscriber adoption and handset upgrades. But the vision is compelling: ubiquitous internet access enjoyed while moving at vehicular speeds with broadband (DSL or cable modem comparable) bandwidths and latencies.

Figure 9



Box 5: Wi-Fi beyond hotspots

The explosive growth of Wi-Fi hotspots that provide wireless local connections in business complexes, homes, and public spaces such as coffee shops and airport lounges has made Wi-Fi a household word. The IEEE 802.11 family of standards was designed by the data networking community for just these contexts: indoor, short range (one hundred meters per access point), nomadic (can support walking speeds), but with weak handoff between access points. But the vision of Wi-Fi networks simply as a replacement technology to the physical cables in the home or office LAN now seems wildly constrained.

The amazing growth of Wi-Fi has driven economies of scale such that the price for access points and end-user systems can be as low as $50 or even less. And this attractive pricing, along with the spectrum license-exemptions that many countries offer to the frequencies used by Wi-Fi radios, has led researchers to explore ways that Wi-Fi chipsets can be used in other networking environments, especially those designed to be served by the WiMAX family of systems described below (as well as mesh networking environments, see Box 8).

A number of university research projects (and probably others) have been exploring modifications to 802.11 systems that would make them better suited to long distance point-to-point backhaul networking. This includes work at the Indian Institutes of Technology campuses in Kanpur and Chennai as well as the University of California, Berkeley in the United States. These projects have attempted long-range (10s of kilometers) point-to-point backhaul hops using 802.11 systems. The principle problem with the 802.11 standard within these contexts lies with the way multiple radios on the network contend for transmission capacity (in technical jargon, the MAC layer uses a Carrier Sense Multiple Access (CSMA) protocol which, while being well suited for local area networks is ill suited for wide-area networks). Research projects have developed new Wi-Fi protocols better suited for long-distance point-to-point networking. What may be emerging is a “rural network” extension to the 802.11 family that could be in direct competition with WiMAX.

More likely, however, is that Wi-Fi networks will compliment WiMAX (and related networks). Wi-Fi hotspots can provide nomadic broadband for the last 100s of meters with WiMAX or other networks backhauling from there to the core head end.

5.3.3 WiMAX

A range of technologies fall under the WiMAX moniker including those that comport to the emerging set of IEEE 802.16 standards. WiMAX systems promise to be very high capacity (up to 134.4 Mbp/s in a 28 MHz channel), travel long distances (50 Km or more), not require line of site, work at vehicular speeds (under the 802.16e extension), enjoy high spectral efficiency (by using OFDM, described below, under the 802.16a/d extension), and be inexpensive (with base stations in the $10,000 range). It sounds like a broadband wireless dream-come-true but for the fact that not all of these extensions have worked yet in the real world and all of these desirable qualities cannot be enjoyed at the same time under the same network (e.g. there is not at present a cheap, efficient, high-capacity system that works at vehicular speeds).

Nonetheless, WiMAX systems show great promise for the provision of broadband internet services especially in remote areas and especially when fully ubiquitous access and vehicular speeds with seamless handoff is not a high priority.

Box 6: 802.16 extensions in the works

802.16a	Works in 2-11 GHz range and supports mesh deployments.
802.16b	Increases the amount of spectrum that can be used in 5 and 6 GHz range. Provides Quality of Service guarantees.
802.16c	Works in a higher frequency range of 10 to 66 GHz.
802.16d	Improvements to 802.16a; this standard supplants 802.16 and 802.16a.
802.16e	Supports mobile devises.

While the 802.16 standard, and its extensions, were still being finalized at the time of publication, a number of vendors have been offering technologies that are designed for the WiMAX metropolitan point-to-point or point-to-multipoint broadband market. Some of these technologies have plans to comport with the 802.16 standard as soon as it is stable. One example of these technologies is the Canopy system from Motorola. Canopy can travel 50 km in a single hop providing 10 Mbp/s shared bandwidth. Outdoor access points can list for $1,000 with customer premises equipment costing $500.

Samsung and LG Electronics of Korea (Rep.) have developed a WiMAX styled technology called WiBro (for wireless broadband). The technology is designed for 2.3GHz and offers 512 – 1024 Kbp/s per user and allows users to travel at near vehicular speeds (around 60 km/h). The system has emerged with assistance from the government of Korea (Rep.) which was eager to see a locally produced technology.

Korea (Rep.) had encouraged WiBro to be used as the basis for the 802.16e mobile WiMAX standard. Other important stakeholders were not supportive of WiBro as a standard setting technology along technical grounds, especially as it relates to the frequency of use. The 802.16e standardization process would have, of course, been weakened if two competing technologies were to emerge. However, at this point, companies from both sides of the argument have agreed to converge on a shared single standard.

The European Telecommunications Standards Institute (ETSI) has also developed broadband metropolitan area network standards under the name HiperMAN. Like WiBro and other related technologies, these systems allow for long-distances (10s of kilometers) and high bandwidth (up to 280 Mbp/s per base station).

The WiMAX Forum has been working with the HiperMAN, WiBro, and IEEE 802.16 standards to try to ensure interoperability amongst these various systems.

5.3.4 802.20 – the newest standard on the block

While WiMAX started as a fixed wireless technology and has since been evolving towards support of mobility (under the .16e extension), the IEEE 802.20 standard originated explicitly as a mobile broadband technology. The fact that its original design requirements included mobility should prove beneficial to the standard (as opposed to trying to add support for mobility onto an existing fixed wireless standard). However, one significant advantage of the 802.16 family of systems is a first-mover advantage and at present stronger industry support from major players.

Through its recent acquisition of Flarion Technologies and their Flash-OFDM technology, Qualcomm, has just demonstrated its support of the emerging 802.20 standard by its. This system plans to comport to the 802.20 standard as it is finalized.

Orthogonal frequency-division multiplexing (OFDM) is emerging as a leading technology for providing very high bandwidth wireless connectivity. As the speed of wireless services increase so does the requirement for more and more radio spectrum. And this spectrum can be hard to acquire and expensive. Thus spectral efficiency, the number of bits that can be encoded into a single radio cycle becomes more and more important. OFDM based technologies, including WiMAX, enjoy spectral efficiencies of around 4 bps/Hz as compared to 802.11d, for instance, which is under 2 bps/Hz.

OFDM works by segmenting available spectrum by frequency and carrying a portion of user data on each of these frequencies. Each of these frequencies is unique and non-overlapping, and thus orthogonal one to the next. This ensures that there is no interference between the various tones. This technique, along with other sophisticated improvements in digital signal processing, has produced an efficient and speedy network technology.

Flash-OFDM can deliver to users capacity of around 1 Mbp/s downstream and .5 Mbp/s upstream while motionless, though while moving at vehicular speeds available bandwidth is diminished. One significant strength of the Flash-OFDM system is its spectral efficiency at about 4 bps per Hz (similar efficiency is planned for the 802.16a OFDM extension). When spectrum is scarce and/or expensive, this is a great advantage. In some rural and underserved areas where the microwave radio bands are relatively underutilized, this advantage need not be so compelling.

Another early system that intended to track the emerging 802.20 standard, iBurst, is based on radio technologies (and in particular smart antenna designs) by the United States based ArrayComm. Early deployments of this mobile broadband system have gone up in Australia and South Africa.[13]

Box 7: The evolution of a "Southern" solution

Broadband corDECT is an important incremental improvement on the corDECT system designed at the Indian Institution of Technology, Madras. The initial DECT system, based on the European standard originally developed for cordless telephones provided LOS connectivity at a maximum of 70 Kbp/s. One significant strength of this system is its relative low cost.

While the benefits of non line-of-sight systems are palpable, there is no immediately available technique to develop a NLOS DECT based system. This is because of the power restrictions placed upon the spectrum used by DECT radios. Broadband corDECT is able to turn this "bug" into a feature by taking advantage of the line-of-sight requirement to enhance capacity. Through spatial reuse of spectrum, enhanced modulation levels, and the use of radio wave polarization techniques, Broadband corDECT delivers 256 and ultimately as much as 512 Kbp/s dedicated bandwidth to each user. Costs are considered affordable at around $150 per subscriber including base station and customer equipment costs.

Source: Midas Communications

Box 8: Mesh networks

A mesh network is an interconnection of communication nodes that are capable of passing messages directly between each other in the absence of a dedicated intermediary. The communication nodes used in a mesh network can be of any type from handheld sensors to web-browsing desktop computers to Wi-Fi routers. The difference between this direct form of communication between clients (also known as multipoint-to-multipoint or peer-to-peer) and traditional networking is that in a traditional network, a dedicated router would be required to pass all messages from one client to another. Mesh networks still frequently make use of dedicated routers, but enjoy the freedom to not rely solely on such infrastructure. The arrangement (topology) of client communication devices (nodes) is also very flexible. The important part is that each node is capable of talking directly to its neighbors within range, whether client (computers, sensors, kiosks) or infrastructure (routers, access points, gateways).

There are a number of reasons that a mesh network might be chosen over a traditional one, and these include scalability, extensibility, resiliency, and consideration of the physical infrastructure. Scalability stems from the flexibility of a mesh network for choosing the path of a message being passed. When an additional node is added to a traditional network, it has to be able to communicate with a dedicated router, which necessarily either increases the load on an existing router or requires a new router to be put into place. On a mesh network, however, the additional node not only consumes routing capacity but also adds its own capacity to the network. This means that the routing capacity and aggregate throughput within the network grows as the network grows rather than starting at some limit and decreasing, which is what happens in a traditional network.

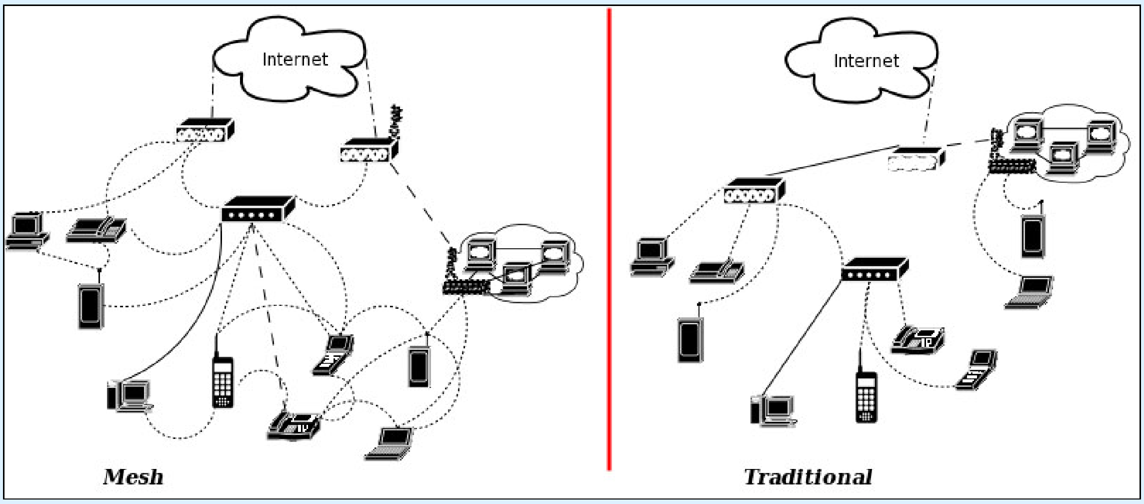
Extensibility is a very important advantage of mesh networks, particularly when referring to wireless mesh networks. Extensibility stems from the fact that any node can have its message hop from one point to another via a peer node. While in a traditional (point-to-multipoint) wireless network being out of range of a dedicated access point would mean loss of connectivity, in a mesh network connectivity can be maintained so long as there is another client node within range which can be used to eventually reach the access point or destination. There is no fundamental limit to the number of hops a message can make before reaching its destination, but implementation details mean that as the network extends farther and farther outward, it will eventually be beneficial to add a new dedicated access point.

Another advantage to mesh networks is in its tolerance of failures. Typically, in a mesh network there will be more than one path available for data to take, in comparison to a traditional network which only offers a single path. If, in a traditional network, a router suffers a failure, the nodes connected to it lose all connectivity. Another benefit of the multipath character of mesh networks is that the network diameter, or minimum number of hops separating any two communicating nodes, can be smaller than in a traditional network. This can result in reduced latency on the network.

There are drawbacks to mesh networking. First and foremost is that each communicating nodes needs to be willing and able to route traffic. This activity requires computational and electric power and thus could slow down the appliance or unduly drain its battery. In addition, mesh networks requires additional preparation and/or setup of each client and may be harder to maintain than a more centralized traditional network.

One area where mesh networking could make significant inroads is rural access. A mesh network provider based in a metropolitan area could offer services in remote areas by "piggybacking" connectivity over a series of subscribers in the direction of the end-user. Data traffic on the outer edge of the network in a remote village would only need a wireless connection strong enough to reach the next, closer subscriber to the metropolitan area. This second subscriber would then pass the traffic to another, closer subscriber and the process would continue until the traffic reached the backbone Internet connection. By using all subscribers as transit points, the mesh network can quickly reach distant areas with relative ease.[14]

Figure 10: A mesh network topology versus a traditional networ



5.3.5 Integrating Heterogeneous BWA Networks

What this roadmap makes clear is that there are a number of complementary and often-competing standards, standard setting institutions, proprietary offerings, and vendors. While considerable effort is being put to interoperability and merging of these various systems, it still is likely that many settings will have installed a heterogeneous collection of wireless networks. (Moreover, the functionality of many of these systems is converging, see Box 9).

Ongoing research work has been studying ways to integrate across these various network technologies. For instance, the Third Generation Partnership Project (3GPP) has been studying systems to inter-network 3G systems with WiMAX or Wi-Fi networks. Issues have included hand-off; authentication, authorization and accounting (AAA); and other considerations.

Box 9: Convergence of WLAN and 3G

There is, to date, not a single optimal broadband technology. Each major family of technologies enjoys some strengths and is hampered by some weaknesses. Below are some preliminary decision matrices that can help develop strategic choices among the technology types. Notwithstanding these technology differences, there is a period of significant convergence among the various offerings towards a similar set of design characteristics for the ideal broadband wireless network, which include:

– High bit-rates in an all-IP environment including IPv6 support
– End-to-end QoS
– Multimedia support
– Mobility at automobile and train speeds
– Seamless session management
– Security, security, security
– Support for flexible and dynamic spectrum and interference management (including software defined radios)
– Advanced authentication, authorization, and accounting protocols.

These goals are more than a pipe-dream. The fixed wireless and 3G families of networks are converging on each other, and beginning to converge on this network design wish list.

Figure 11: Convergence of WLAN and 3G technologies towards each other

Current WLAN Strengths

- Relatively inexpensive
- Data ready and high-bit rates (e.g. mobile WiMAX 802.16e?)
- QoS (e.g. WiFi 802.11e)

VoIP

Emerging WLAN Strengths

- Mobility

Current 2G strengths

- Ubiquitous
- Mobility
- QoS guarantees

High data rates
(e.g. W-CDMA)

Emerging 3G Strengths

- Multimedia support

As the capabilities and purposes of fixed wireless and 3G wireless networks converge, and approach the performance of wireline networks, perhaps it will become easier to make a strategic choice between these families of technologies.

5.4.6 Civil Engineering Costs for Broadband Wireless

According to Moore's law, an amazing pattern of exponential growth in the performance and affordability of computer technology will occur. Regrettably, Moore's law has yet to apply to the performance or cost of steel, cement, or labor. The result is that the "civil engineering" costs for outdoor radio networks, those associated with radio towers, cement foundations, and related requirements, are beginning to outdistance the cost of the solid state radio equipment.

Let's consider the cost for radio masts or towers. Such facilities are required for fixed wireless and 3G radio networks in order to position signals above foliage and buildings that might obstruct them, extend the horizon, or meet other transmission requirements. In most major cities the skyline is littered with these towers. They range from masts on the order of a meter in height that are positioned on the roof of a customer's premises, to 10 meter cellular network towers, to 100 meter (and higher) towers populated with high capacity point-to-point microwave antennas and, perhaps, broadcast TV or radio facilities.

The cost and effort required in constructing a radio tower can be influenced by a number of factors including local weather conditions (i.e. are there high winds or will there be icing) and the intended loading of the tower (i.e. one small antenna or many large ones). Towers are designed with these factors in mind and a choice is made between three principal support strategies: free-standing, bracketed against an existing structure, or supported with guy wires.

However, by far the most important factor in determining the cost and complexity of a tower design is its height. The height requirement dictates to a large degree the type of tower needed, the foundation strength, the requirements for guy wires, and so forth.

An additional cost associated with a tower that is especially critical in many parts of the world is the expenses associated with grounding. In areas that experience seasonal electric storms, tall radio towers are likely to attract lightening strikes. And such an event can spell the death of an antenna and the radio electronics. In order to protect the equipment, lightning attractors can be affixed at the top of the tower. The principal of a lightening attractor is simple: it should be higher than the equipment being protected and it should offer less resistance to the flow of electricity than "competing" local options (such as the radio equipment). Fixing an attractor above the radio and antenna is easy enough. But ensuring low electrical resistance requires careful attention to grounding. Especially in rural and underserved areas, where for instance a relay base station may be positioned, industrial grounds are not available and it is necessary to dig an earth pit which serves to ground the arrestor. This activity can add substantial expense.

The authors' study of five different radio tower vendors shows that three critical expenses – the cost of the tower itself, installation labor costs, and the cost for grounding – all follow strict linear associations with the tower height.

Figure 12 shows empirical data for the tower and labor costs in the United States and Ghana and grounding costs in the United States. A simple regression performed on these data points shows the linear cost models which are depicted visually below. Our results can be summarized this way:

- In Ghana a 3 meter tower with installation and grounding costs just under USD220 and an additional USD 270 for each additional meter.
- In the United States a 3 meter tower with installation and grounding costs nearly USD 1,360 and almost an additional USD770 for each additional meter.

Of course these models are just that, estimates that help to clarify and guide our thinking. As a point of comparison, for instance, Motorola Canopy outdoor access points can list for approximately $1,000 while their subscriber modules can be under $500. Clearly any cost analysis of wireless broadband equipment should consider such civil engineering costs, since they are quick to dominate costs for radio equipment.

Figure 12: Empirical data points for tower, installation, and grounding costs

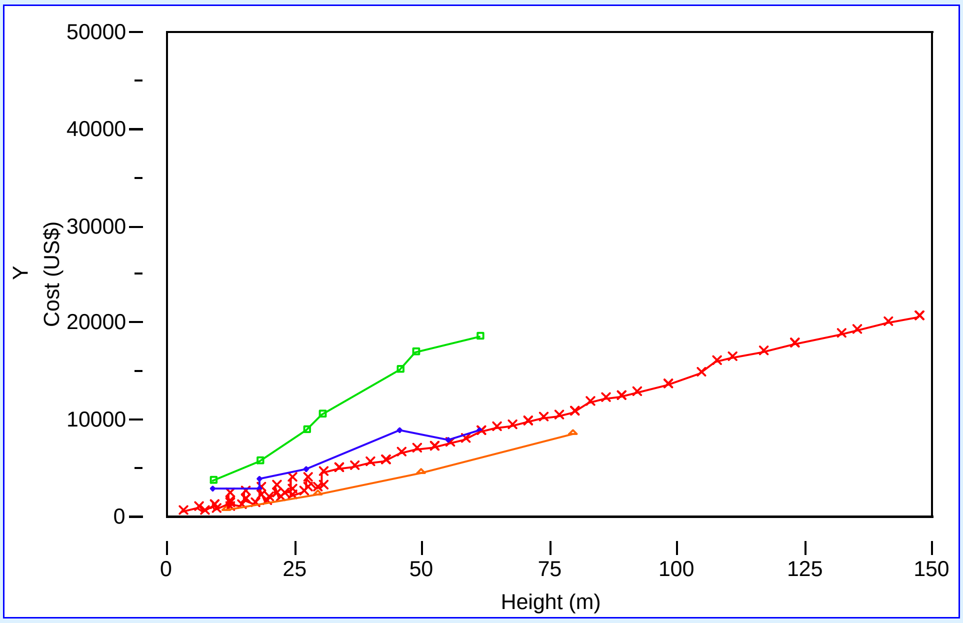
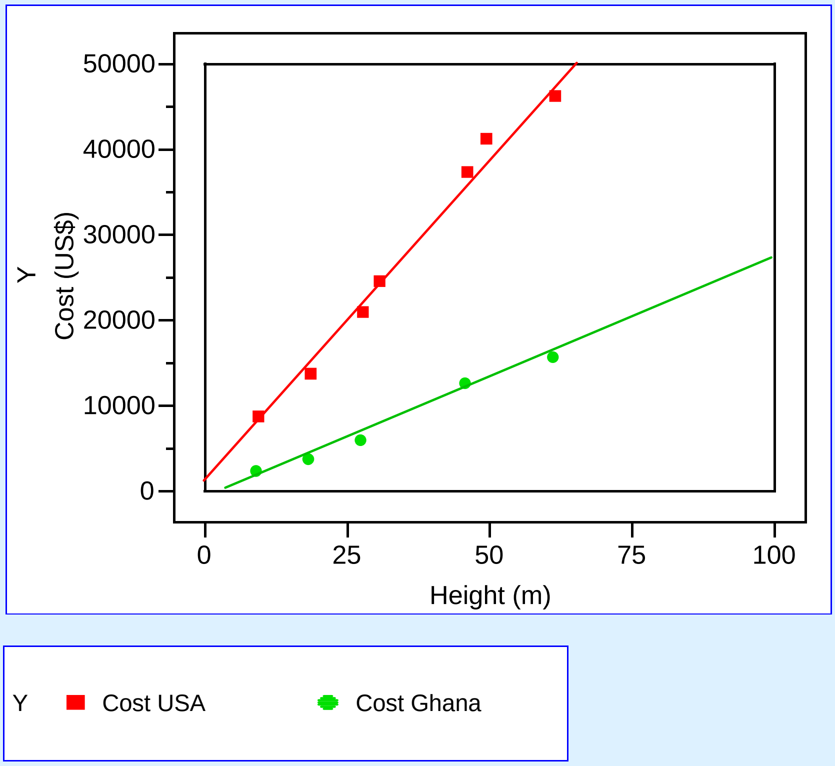


Figure 13: Linear model of tower, installation, and grounding costs in the USA and Ghana



A simple radio pole, perhaps just a few meters high (left); a free-standing radio tower used for a cellular phone network, perhaps 10 meters high (center); a guyed radio tower holding various antenna, perhaps 100 meters high (right).

5.4 Non-terrestrial wireless broadband

From a broadband internet access point of view, non-terrestrial systems are generally regarded as a complement in areas where there are no terrestrial networks. This is mainly due to high cost, limited bandwidth and longer delays. Still, the number of subscribers for internet access services provided by satellite operators is increasing. Besides TV distribution services and telephone connections, the capacity is primarily used to connect Internet service providers (ISPs) to the internet backbone, rather than connecting individual users to an ISP, although the latter is also an increasing market in rural and underserved areas.

Whether broadband internet access via satellite is the right choice in cases where there are alternatives depends on the cost/performance of the alternatives. The cost per megabyte via satellite is decreasing, albeit slowly. While the cost of operating the large low earth orbit constellations limits their margins, regional geostationary systems should be able to reduce their costs significantly. Prices in the order of US$ 0.10 per megabyte have been predicted.

The open standard for digital video broadcasting with return channel via satellite (DVB-RCS) is increasing its market share and is expected to benefit both users and industry through lower costs, customer choice and equipment interoperability. The market is, however, still dominated by a few proprietary vendor solutions.

A satellite terminal consist of two parts, an outdoor unit consisting of a transceiver and an antenna that is placed in direct line of sight to the satellite and an indoor unit interfacing the transceiver with the end user's communications device, such as a computer or a local area network. The aperture of antennas required decreases at higher frequencies due to the reduction in parabolic antenna beam width at higher frequencies. Due to this, terminals operating at higher frequencies are called Very Small Aperture Terminals (VSAT).

The frequency allocation relevant to the system types is being discussed in this section. Most satellite systems for television broadcast and broadband data communication in operation today use portions of the C and Ku-bands. In the C-band antennas are typically 2-4 metres while in the Ku band they can go below 1 metre, which also makes it easier to direct the antenna.

The lower frequency parts of the spectrum that the C and Ku band represent cannot accommodate the data rates and traffic volumes demanded. This has forced commercial satellite system operators to consider the Ka and V-band as well. These higher frequencies offer, however, additional challenges due to blocking of signals by rain, fading and signal scattering.

5.4.1 Stratospheric platforms

Stratospheric platforms operate within the stratosphere under aerodynamic conditions. High and low altitude platform stations (HAPS or LAPS) offer the coverage benefits of satellites at costs close to fixed infrastructure:[15]

HAP: High Altitude Platform, typically an airship soaring in the stratosphere at an altitude about 20km, well above normal aircrafts and below orbiting satellites. There are no commercial services yet but active research and development efforts [www.capanina.com]

LAP: Low Altitude Platform, typically an airship kept stationary at about 3 km. Commercial services are available, especially targeting temporary needs, like emergency response situations, sports activities, etc [www.worldskycat.com/markets/skycom.html]

The key market for LAPS and HAPS will likely be rural and developing areas that are underserved by traditional infrastructure. However, they could also play a key role for newer wireless technologies such as WiMAX. Since LAPS and HAPS are underlying platforms for delivering a range of wireless connectivity, their radio equipment could make use of the most current technologies to provide fast connectivity within line of sight. Since the line of sight requirement could be met for many applications, the frequencies and corresponding transmission speeds could be much higher.[16]

5.4.2 Network topologies

Independently of the system type, non-terrestrial wireless broadband network topologies fall in the following categories:

– **Bent pipe star** topology, characterized by having a large gateway earth station transmitting one or more high data rate forward link broadcasts to a large number of small user terminals. These broadcasts contain address information which allows each user terminal to select those transmissions intended for it. In the return direction, the remote user terminals transmit in bursts at low to medium data rates to the gateway.

– **Bent pipe point-to-point** topology having a dedicated duplex connection set up between a large gateway earth station and a single user terminal.

– **On Board Processor (OBP) Switching** Topology, in which the satellite rather than the gateway is the central node in a star network. The satellite is connected to the gateway by one or more high data rate trunks. The on board processor de-multiplexes the uplink trunk into several downlinks for different geographical areas, usually determined by the footprint pattern. The forward downlinks contain messages for large numbers of user terminals and the destination is identified by message headers. In the return channel, the uplink transmissions from user terminals in one or more cells are multiplexed onto a downlink trunk to the gateway.

The benefits of the “bent pipe” versus OBP are under discussion. In the bent-pipe system, the received signal is retransmitted without processing. While this scheme is less complex and has performed well in the first phase of Internet development via satellite, OBP promises better bandwidth efficiency and true mesh connectivity. OBP trials are being conducted by a number of companies.[17]

6 A Decision Framework for Broadband

Facilities based competition is a desirable element for any nation's broadband market but is a situation that simply may not exist in all parts of all countries. For instance, some high-income metropolitan areas may have multiple wireline broadband providers (the cable provider competing with the DSL operator) along with multiple mobile operators each competing to provide the most cutting-edge data solutions and, finally, local entrepreneurs or even municipalities offering wireless hotspot solutions. But in some low-income areas, and especially rural and sparsely populated areas, this level of competition may not be commercially viable. Initially, policy makers and regulators may succeed in coaxing only one broadband provider to enter rural and sparsely populated markets, while leaving the door open for other entrants once demand for broadband services has been established. In these environments, therefore, strategic choices may have to be made between various network families. In other words, some contexts may commercially support facilities based competition (or, said another way, "complimentary" networks) while other regions may face a choice of one network over the others.

There are currently three dominate technology families for the deployment of broadband Internet connectivity: **broadband wireline networks, (e.g.** DSL, cable TV and fibre solutions), **broadband wireless access (**e.g., third generation mobile and WiMAX), and **non-terrestrial wireless options,** (e.g. VSAT). Each of these solutions is in play today and each have contexts in which they are the most appropriate. In this section we will consider these contexts - the geographic, economic, demographic, and public policy environments – and how they determine the viability of each family of network solutions. **Our conclusion is that there is not a significant environment on the planet today in which broadband Internet does not make commercial, social, and institutional sense**.

These families of technologies under discussion in this report mostly describe the *edge network*, that is, the "last mile" component of the network that connects the base station or central office (or similar) to subscriber premises. The *backhaul network* is the facility that connects the various base stations together. And finally, this traffic is aggregated by the backhaul network and passed on to the Internet "cloud" which we will refer to as the *core network*. This paper has focused mostly on edge networks because, in particular, they are the most expensive and difficult to deploy. However, as stressed in Section 5.2.4 on broadband wireline networks, the availability of core network facilities, and in particular, fibre networks, is vital to promoting broadband deployment.

The next session explains the four main environments for the deployment of edge networks: converged, complementary, competing and exclusive in an effort to facilitate decision making by policy makers and regulators. Different policy and regulatory choices may apply to each environment, and new regulatory frameworks may have to be developed as broadband markets evolve and mature. While the goal of this publication is to identify regulatory practices and procedures to encourage initial broadband deployment, regulators and policy makers will also wish to look toward a future of more widespread broadband access.

6.1 Converged Environments

Converged environments are sprouting up (or currently under test) in areas densely populated with high-value and mobile/portable subscribers such as in metropolitan areas in North America. In a converged environment fixed wireline networks compete or compliment BWA networks. And BWA networks are being integrated such that using single converged appliances (phone handsets, PDA's, laptops) users can move seamlessly between 2.5G or 3G networks and WiFi or WiMAX networks. As these converged environments develop, two approaches to the integration of the wireless networks are being explored. Tightly coupled integration is implemented at a relatively low level within the network. Here, for instance, the WiMAX network will appear to the 3G facility as just another cellular-access network. Thus seamless handoff between cellular and WiMAX networks can be expected. In comparison, another approach, loose coupling, implements integration at the Internet protocol layer. This form of integration will still support some limited handoff between networks. Finally, and more immediately, hybrid appliances can support a limited form of network convergence, for instance today's Wi-Fi and 2.5G enabled handsets.

Converged environments are the most capital and technology intensive requiring significant vertical integration amongst network operators. They also place significant cost burdens on each user since converged handsets and appliances are only now becoming available on the market and are expensive.

6.2 Complimentary Environments

Converged environments are just now emerging and in today's reality, in most areas with multiple broadband networks the networks either compete or compliment each other (or both). In a complimentary environment broadband network providers provision service to specific niche markets. The networks are often broadly pervasive but not wholly ubiquitous. For instance one of the authors subscribes to three different broadband network services provided by three separate operators: a cable based home broadband network; a hotspot WLAN facility available at coffee shop chains, airport terminals, and so forth; and a 2.5G EDGE network provided by a major cell phone operator. None of these networks are integrated as in a converged environment. But they all respond to specific needs of the author: when working at home, when enjoying a cup of coffee or waiting to board an airplane, and when requiring short but immediate connectivity for instance to quickly check email when travelling.

6.3 Competing Environments

In many areas where the number of high-value subscribers per unit area is substantial, but perhaps the organizational and capital environment has not yet been able to support much in the way of converged facilities, multiple broadband networks will be deployed in competition. Indeed this is the case for most metropolitan areas in North America, parts of Asia and Latin America, and Europe.

The example environment of one of the authors described above, with three complimentary broadband networks, also includes a number of competing network facilities. The local dominant cable provider offers home broadband service. Competing with this service is a DSL broadband service provided by the local exchange carrier. Similarly, multiple WLAN hotspot services compete, though not often at the identical physical location.

Indeed, we expect that in those areas which enjoy a large number and high density of high-value broadband users there will exist simultaneously instances of converged, complimenting, and competing broadband networks.

6.4 Exclusive Environments

In marked contrast, much of the developed world has no broadband provider at all. While regulators seek to promote competitive broadband provision, a more likely scenario, at least in the short term, is broadband provision in an "exclusive" environment. It is not that regulators seek to create single provider markets. The problem is they may only succeed, at least in the near future, in attracting one broadband provider. Rural areas that are sparsely populated, low-income areas, and places with challenging physical environments are all candidates for such exclusive broadband providers. It is these environments that are the most important and the most compelling for bridging the digital divide. Since only a single broadband network is likely to be able to be commercially viable, at least initially, picking the technology family, and getting the institutional and policy environments right to support the network, is critical. These contexts will include much of rural and semi-urban areas in low-income countries as well as extremely rural and remote areas the world over.

How can we best conceptualize and support broadband internet in these exclusive environments, especially in those green field cases that currently have no available access?

We wish to consider our three technological families, first the two "extreme" cases of fixed wireline solutions and non-terrestrial wireless, and then the "middle" case of fixed and mobile terrestrial wireless networks.

6.4.1 Wireline Broadband for Exclusive Environments

For conditions which include a large density of stationary users, and sufficient access to capital, public policy support, and organizational integration, wireline broadband solutions will make good sense. Indeed, fixed wire networks are the cheapest per bit, where the goal is to traffic a very large numbers of bits. Researchers have argued that fixed wireline solutions are the most cost effective, compared to available wireless solutions, in environments with more than 40 broadband subscribers per square km.

The choice between the three primary wireline edge technologies (DSL, cable, and fibre) will probably be driven mostly by what the extant networks are made up of. If there is a high-quality copper network already in place then that might suggest broadband DSL service. Similarly, if cable TV is in heavy use then coaxial and fibre networks might be able to support broadband data.

However, it is important to note that our exclusive environments are usually areas that do not include a large density of high-value users nor the necessary capital to support the financially intensive requirements of broadband wired networks. In other words, we expect few if any exclusive environments that would be best served by a fixed wireline broadband network.

6.4.2 Atmospheric Wireless Broadband for Exclusive Environments

VSATs are the clear solution for extremely remote areas and areas with extreme geographic conditions (e.g. severely mountainous). Today every part of the planet is touched by multiple satellite signals providing, for a price, broadband internet services. But, in general, it is this service price which reserves satellite connectivity only for the most remote and difficult settings. It is not uncommon to be confronted with a monthly fee of thousands of dollars for broadband satellite service.

Although this section focuses on various edge network solutions, one possible approach to the use of VSATs, which leverage economies of scale and create opportunities for sharing the expense, is to utilize VSAT technologies as the backhaul network. A local BWA network can then share this connectivity with multiple local subscribers.

6.4.3 WiMAX and Related Networks for Exclusive Environments

It is likely that the majority of exclusive environments, especially in rural and semi-urban areas in low- and middle-income countries, will receive broadband internet via some form of terrestrial wireless technologies. First this section considers the case for WiMAX and related networks in these contexts, trying to understand the business and policy environment that supports these systems, before contrasting these networks with their mobile 3G counterparts.

WiMAX, WiFI, 802.20 and related networks are an attractive solution in many environments, especially if the anticipated number of subscribers per square kilometer is 5 or lower. And because such wireless deployments can be driven bottom-up and can potentialy be deployed quite incrementally these systems can work in environments with relatively weak institutional support and small capital markets. A variety of point-to-multipoint wireless technologies exist that can provide broadband fixed wireless service and some of these technologies have been overviewed in the technology roadmap earlier.

Exclusive BWA networks can be visualized as a series of circles connected by sticks. The circles represent areas of coverage by a point-to-multipoint radio transceiver, representing the edge network. The sticks represent the backhaul network that ultimately aggregates the traffic at a head end and passes it on to a higher tier ISP, the core network. The “circle” of edge connectivity can have a radius that is only 100s of meters by using popular Wi-Fi systems, and the backhaul network can have “sticks” that extend for many 10s of kilometers using WiMAX related technologies. Likewise, the circles could have a radius of 10 or 20 kilometers using significant WiMAX base stations and omni-directional antenna facilities. And they, in turn, can be backhauled with long-distance point-to-point microwave networks or fibre, where it exists.

In an exclusive environment with a very small number of anticipated subscribers per unit area the fixed-wireless approaches of WiMAX and related networks promises to be the most cost effective approach. One reason is that it does not anticipate a ubiquitous signal but instead allows for a focused deployment of signals that connect only those specific areas requiring service. This is a benefit in sparse and low-demand areas but it is a liability where a network that is more universally available across a region is required. Furthermore, as shown in Figure 15 most WiMAX technologies do not support vehicular-speeds (though newer 802.20 and WiMAX technologies are emerging that do handle mobility) nor do they usually support seamless handoff between cells.

As noted above, however, while there are distinctions in mobility, cost, ubiquity, and even capacity between WiMAX, 802.20, and the 3G family of networks, in fact they are rapidly converging on a fairly similar feature set. For instance mesh Wi-Fi and WiMAX systems are available that can provide nearly seamless and ubiquitous coverage (see Box 8 on mesh networks). Similarly WiMAX standards (and 802.20) that support vehicular motion are in the works (see Box 9 on 3G and fixed wireless convergence).

6.4.4 3G for Exclusive Environments

Mobility and ubiquity are key elements to today’s 3G deployments. These may not be of critical singular interest in exclusive environments At first glance, in underserved and remote environments a ubiquitous and mobile broadband connection with seamless handoff at vehicular speeds may be asking for more than the market needs or can bear. Indeed there are many examples of deployed 2G networks that are used mostly as a fixed-mobile voice network. The Grameen Phone network is well known for providing rural voice services in Bangladesh via village “phone ladies”. Providing support for vehicular travel and seamless handoff to these “phone ladies” is, according to the project’s principal, a case of an engineering solution in search of a problem. And if vehicular mobility is generally not needed for voice traffic it probably is even less required for broadband data.

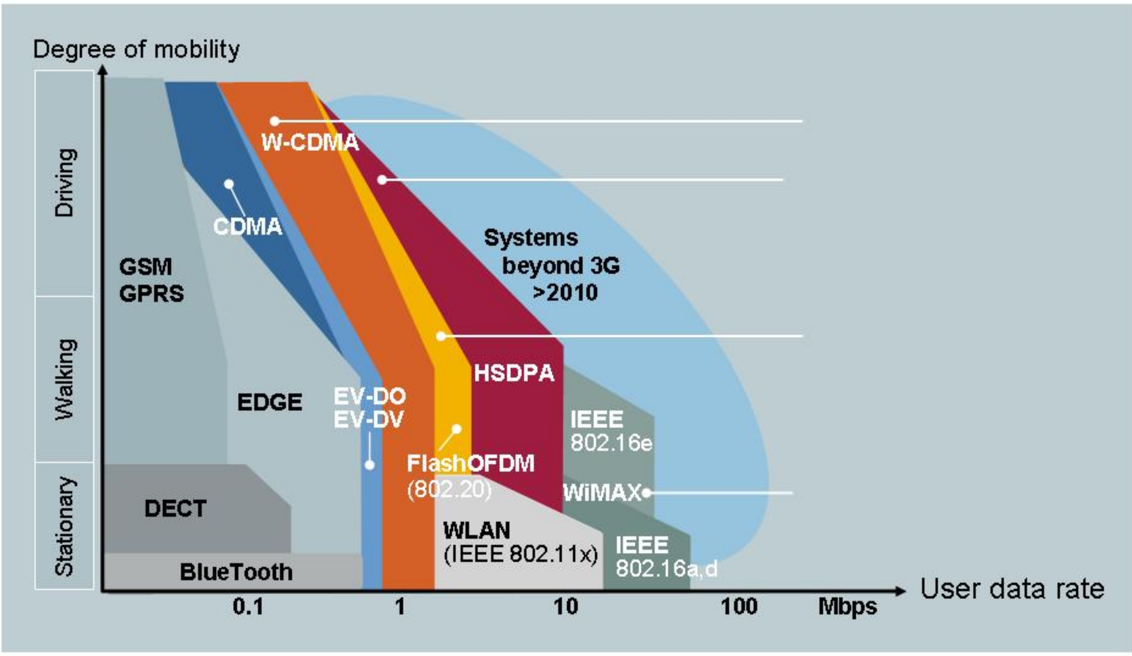
But perhaps there are sufficient markets for ubiquitous and mobile 3G in exclusive environments, including relatively remote and sparsely populated areas. After all, mobile 2G networks enjoy very high levels of world penetration even in some of the most remote and low-income areas in the world.

Moreover, much of the world currently is within the reach of an existing mobile phone network. These networks are mostly 2G (GSM or CMDA) both of which enjoy clear upgrade paths to 2.5 and ultimately 3G systems as summarized earlier in the technology roadmap. Thus, one very viable approach to broadband coverage even in remote exclusive areas is to leverage existing 2G networks (or even building new green field mobile networks) upgraded to 2.5G or 3G support. This may well depend on industry response and the regulatory environment.

While in terms of the consumer experience, both 3G and fixed broadband wireless approaches are converging (as fixed wireless gains mobility and ubiquity and 3G increases capacity), the two technologies come from very different communities. Fixed wireless technologies come from the data networking and computer science crowd and 3G from the telecommunications community. As such, institutionally they generally are structured differently. 3G networks are usually deployed through top-down planning via a vertically integrated large operator who has access to substantial investment capital. The deployments are generally over large regions and announced at a single moment. In other words, while many 2.5G to 3G systems allow incremental deployment (one base station at a time) for marketing and customer adoption purposes this is not usually what is done. Instead a large region with many base stations are upgraded all at once. So in practice, 3G installations have appealed more to large companies with significant start-up capital while fixed wireless networks have appealed more to community driven efforts employing a much more incremental approach.

There are many tradeoffs between the various types of BWA networks that can be deployed within an exclusive environment. In some cases robust 2G networks upgrading to 3G technologies will be the most promising solution. In other similar areas, the 2G base station infrastructure might be suitable for deploying WiMAX (or even 802.20) access points. Alternatively, in some green field settings it may be desirable to abandon the mobile phone market and develop a pin-point fixed wireless solution with connectivity surgically placed just where it is needed. In other green field environments it may be most appropriate to leap-frog straight to a 3G mobile network ready to provide mobile voice and stationary broadband data to an entire region.

Figure 14: Degree of mobility versus user data rate for popular BWA systems



Source: Siemens

7 Power requirements for broadband

An important requirement for pervasive broadband connectivity is reliable and relatively high-quality electric power sources. High-capacity wireless networks, and the multi-media enabled appliances that broadband applications call for, can accelerate the electric power requirements. So any consideration in deploying of broadband networks needs to also consider the availability of power solutions including, but not limited to, grid power.

Today's modern desktop personal computers have a few major sources of power consumption:

– The central processor (now often consuming 80 W)

– The screen (a CRT can consume up to 100 W)

– The hard drive (which can consume 100 W when spinning)

– RAM memory, graphics cards and other on-board devices (can consume up to 40 W)

Low-power consuming versions of these technologies do exist today (for instance as used in laptops). Their main sources of power consumption can be:

– The central processor (consuming as much as 40 W in full operation)

– The screen (an LCD can consume 50 W)

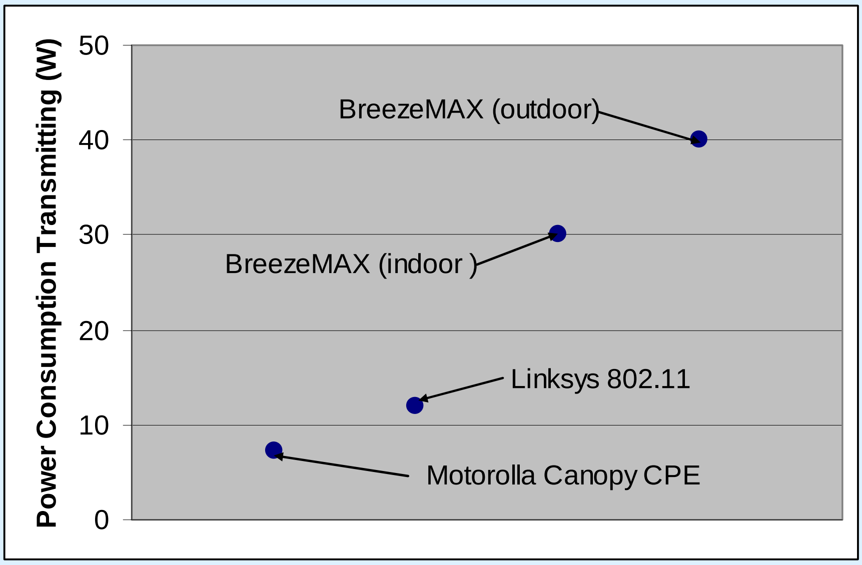
But more power efficient laptops can be engineered to require below 40 watts or less in normal operation. These figures give us points of comparison.

Figure 15 shows the power consumption for a set of popular WLAN radio technologies. BreezeMAX WiMAX technologies can require from 30 to 40 watts when in operation. A subscriber unit for Motorola Canopy consumes under 10W while an indoor wireless router from Links consumes just over 10W on average.

What these figures suggest is that a standard broadband-enabled PC can consume a fairly considerable power load and even low-power consuming laptops require a fair amount. Futhermore, the power load of a PC is nonlinear (it fluxates over time unlike a lightbulb for example) and a PC requires quite high quality power (again unlike a lightbulb). This puts further requirements on the source of the power.

Are there power solutions for broadband in areas that do not have reliable grid electricity? Even harder, is there a way to support mobile broadband without overly restricting the performance and capabilities of internet appliances (e.g. not supporting full screen real-estate)? Major solutions for off-grid powering of ICT systems includes solar PV cells, small wind systems, micro-hydro power technologies, and generator sets (diesel, gas, or other bio-fuels). Each of these solutions has its benefits as well as drawbacks. Below are two case studies which illustrate innovative applications of off-grid power for ICT's.

Figure 15: Power consumption of some wireless radio products



7.1 Two Off-Grid Power Case Studies

7.1.1 Tanzania - Kasulu Teachers Training College

At the Kasulu Teachers Training College (KTTC) in Tanzania, the agrarian "First Wave" and the information technology driven "Third Wave" mingle with each other to create a broadband service that is changing the lives of some of the most impoverished people in Africa. An Internet centre at the KTTC is equipping the next generation of teachers in Tanzania with the tools of an information society despite the fact that Kasulu has no electricity supply and its 15 phone lines have no data capabilities. What is unique about the project is that it is run by an unusual source of power – cow's manure.[18]

Kasulu has a population of 33,668 people[19] and is located in the northwest of Tanzania. Being close to the Burundi border, the region has seen a huge influx of refugees fleeing Burundi, escaping the civil war. In 2000, the Global Catalyst Foundation (GCF) in collaboration with the United Nations High Commissioner for Refugees (UNHCR) and Schools Online decided to explore the feasibility of setting up a Kasulu Internet Project[20] designed to promote cooperation and understanding between refugee Burundians and their neighboring Tanzanians in the Kasulu area. Another objective was to promote economic development and entrepreneurship in these impoverished regions.

GCF is a private foundation established by Kamran Elahian, a successful IT entrepreneur and founder of Global Catalyst Partners, a Silicon Valley venture capital firm. The organization's mission is "empowering people through technology" and it supports projects that "improve education, alleviate poverty, promote social tolerance and celebrate diversity," across the world.[21] Schools Online, another non-profit started by Elahian, has the goal of helping students use the Internet for learning and cross-cultural dialogue. Since 1996, the organization has assisted over 5,700 under-served schools in the United States and over 400 schools in 35 other countries with the equipment and support necessary to get online.[22]

Figure 16: UNHCR refugee camps in Tanzania. Source: Food and Agriculture Organisation

Under the Kasulu Internet Project, GCF, Schools Online and the UNHCR have collaborated in establishing three Internet centers – one located in a nearby UNHCR administered refugee camp called Meatball, the second at the Kasulu Folk Development College and the third at the Kasulu Teacher Training College.

GCF contributed USD120,000 in operational funds for the three centers for three years, and is responsible for the overall management of the project. The local communities have contributed their labor to build computer labs, UNHCR provides logistical and administrative support, and Schools Online provides the hardware and software infrastructure and the funds necessary for professional development and capacity building.[23]

At the KTTC facility, the 800 students enrolled in the teacher-training programme are the main computer-lab users. The labs are open to community members from 7pm–10pm during the week and also open on Saturdays and Sundays on a fee-for-use basis costing approximately USD1 per hour (1,000 Tanzanian Shillings). Members of the local NGO and UNHCR communities are frequent users of this heavily resourced laboratory during these opening hours.

Figure 17: KTTC computer laboratory

Source: Michael L. Best

The teachers and students study for the International Computer Driver's License (ICDL) and CISCO Academy courses. The ICDL has seven skill levels – word processing, file management, Internet etc. The CISCO Academy has seven students who pay approximately USD200 for a six-month course. About 10 students from town are also studying elements from the ICDL curriculum, paying approximately USD200 per course. Another 30 students from the KTTC also attend these classes but pay lower fees. Revenues from these training programs help KTTC pay for the cost of Internet access, maintenance and ongoing operations.

Currently the KTTC students who are enrolled in computer classes do so out of interest. But the Tanzanian Ministry of Education is planning to make IT training compulsory for teacher training and this is expected to put a large demand on facilities since all KTTC students will be requiring instruction.

The school is connected to the Internet through a VSAT service provided by I-way. The I-way connection offers 128 Kbp/s downlink and 30–40 Kbp/s uplink speeds and the Global Catalyst Foundation pays USD500 per month for the connection. The Internet is reasonably reliable though it does fail on occasion.

As mentioned above, the GCF chose to turn to an unusual source of power – cow's manure – to power the KTTC computer lab. The droppings of twelve cows are collected and fed into a 50-cubic-metre biogas plant that generates methane. This methane is then mixed with diesel in a 70:30 ratio and fed into a power generator producing 10 Kilowatts of power and running 15–16 PIII computers for eight hours daily. Six shared UPS systems provide a 30-minute power backup.

Nothing goes to waste in this system. After the methane is extracted, the remaining sludge is removed from the biogas plant to provide fertilizer for crops the college raises to feed its staff and students.

The biogas digester, the dairy cattle, cowshed and the 10-kilowatt generator cost approximately USD18,120. The biogas system was built in late 2001 and the computers arrived at the Kasulu Teacher Training College in early 2002.

Apart from powering computers, the college also wants to use methane for cooking. Currently, the college consumes several tons of timber every year to cook food for its students. Replacing timber with methane would be more eco-friendly and the cooks would also be spared the harmful effects of wood smoke. To do this, the college plans to increase the capacity of the biogas plant from 50 cubic meters to 200 cubic meters. To provide manure for the increased capacity, the college will have to maintain 40–50 cows. The additional methane generated would fuel a 30 Kilowatt generator and allow for a 100 percent methane powered system.

Figure 18: The biogas digester (top left), methane/diesel generator (bottom left), and cow corral (right)

Source: Michael L. Best

The Swedish International Development Agency (SIDA) is considering funding the expansion and would like to replicate the biogas system at the 30 Teacher Training Schools in Tanzania and perhaps scale to 3,000 secondary schools. The organization is also funding a micro-hydro power project in Kasulu where, along with a power micro-grid, fiber-optic cables will also be strung. The fiber-optic cables will be connected to the Internet via VSATs and used for networking NGO's, schools and clinics.

7.1.2 Tanzania - Mtabila Refugee Camp

Over 50,000 Burundian refugees stay at the Mtabila camp. Conditions at the camp are bleak, with very little work to occupy the refugees. The refugees live often in simple houses and mostly survive on food provided by the World Food Programme (WFP). Most of the adults at the camp are women.[24] The refugee camp also has a significant adolescent population that faces an uncertain future.

With no phone access, the ten computers at the Mtabila Internet Centre have the potential to serve as the refugees' main connection to the outside world. When the centre is open to the general population there is often a long wait for Internet access. Daily around 30 refugees use the centre to send email at a charge of approximately USD20 cents per session.[25] The Internet has reduced the refugees' sense of isolation and enables them to communicate with the outside world at a cost that is cheaper than the postal service. News and information downloaded from the web also help the refugees stay abreast of happenings in the outside world. The refugees access web sites, including those in Kirundi and Kiswahili languages.

For the refugees at the Mtabila camp, the Internet Centre is equipping them with skills that will be useful in the reconstruction of Burundi. The Kasulu Online[26] web site reports that around 2000 refugees have been educated in further or higher education and are the ones directly benefited by Internet access. Other refugees benefit through intermediated access that keeps them abreast of news of current events and helps them establish contact with friends and relatives who have email.

Figure 19: Mtabila camp VSAT and PV systems (top)

Mtabila camp VSAT and PV systems (top), refugees waiting outside of the computer lab (bottom left), and inside the computer lab (bottom right)

Source: Michael L. Best

Ten teachers, selected by the refugee community, are being put through training for the International Computer Driving License (ICDL). These same teachers also supervise the centre. The big surprise for these teachers, as well as camp administrators, has been the demand for email. Many of the refugees have friends and family scattered throughout Africa, Europe and North America and email is an affordable way of keeping in touch with their community.[27]

Broadband internet is provided via a VSAT terminal. And the power for the computers and Internet at the refugee camp is generated using photovoltaic cells. The solar setup cost approximately USD37,152 and consists of 48 solar panels of 75 watts each. Solar power was chosen over biogas because this eliminates dependence on fuel supplies and spare parts that a generator-powered system would entail.

Setting up the centers was a trying task due to poor telephone lines that barely supported email, delays in importing essential equipment, and the challenge of liaising between the various governmental, international and non-governmental agencies involved in the project. Despite these challenges, the project is beginning to deliver the intended benefits. Here is an excerpt from an email sent from a refugee at the Mtabila camp: "I'm not able to tell you how happy we are to get connection to the Internet! Before I was connected to the Internet I felt lost. But now that I am connected, I feel saved. The world will not forget us now, because we, the refugees, can speak to the outside." [28]

8 Conclusion

Taking advantage of the opportunity

Broadband Internet means connectivity at speeds that support interactive audio, full motion video, interactive video chat, speedy web searching, and many other valuable applications. While some parts of the world have seen explosive growth in broadband penetration most of the world have low levels of broadband diffusion, and what broadband is present is expensive and relatively low capacity. In an encouraging trend, however, many of these same areas in developing countries are enjoying some of the highest growth rates for broadband service and are clearly important areas for future market expansion.

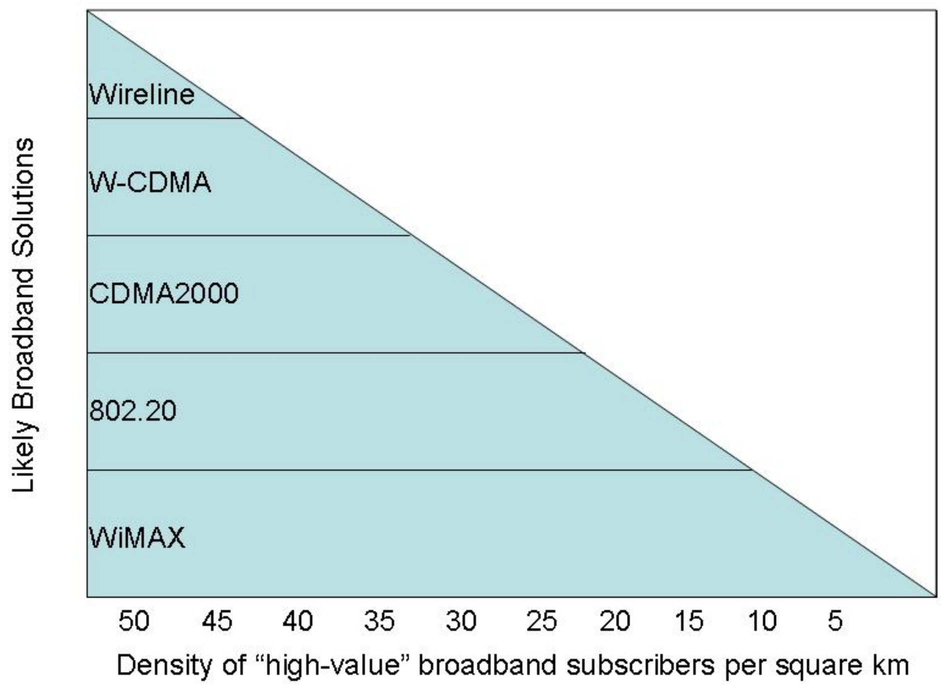
This paper has overviewed three important families of technologies that are instrumental in providing the edge network in a broadband system: broadband wireline services, broadband wireless access, and non-terrerstrial broadband wireless systems. All three of these families of systems have appropriate contexts in which they provide the best solution. In some contexts, such as areas which are densely populated with high-value subscribers, a collection of these systems will converge, compete, or complement each other. In other settings -- those with only limited numbers of potential broadband subscribers -- single network systems are likely to be an exclusive solution and sit in isolation. In cases where the density of potential subscribers is lowest, various wireless broadband solutions are likely to be the most cost effective.

These sets of technologies can be placed on a continuum of the density of high-value subscribers. With densities of 40 people per square kilometre and above wireline solutions are likely to be cost effective. As density declines to just a few people per square kilometre fixed wireless solutions, such as WiMAX, are more likely to be best suited.

Broadband deployment does not depend solely on technological choices. Capacity building to develop local human resources is vital. Education and training, including practical showcases and pilots involving all stakeholders on neutral ground is equally important in the quest to promote broadband access.

Governments can further organize open regional, national and local forums dedicated to identifying and meeting the broadband needs that include all key stakeholders. These stakeholders will include users (both current and potential); national and local development programs on healthcare, education and e-government; other public service institutions such as universities, libraries and local and national government offices; local entrepreneurs, traditional telecom operators, system manufacturers and owners of fibre infrastructure from other sectors, such as transport and utility companies. Together such stakeholder forums can strive to meet their broadband requirements and achieve the UN Millennium Development goals. Once broadband needs are identified, they can be met through the development of open market-based networks, fostered through effective regulatory practices. In conclusion, broadband deployment in rural areas of developing countries is likely to be fuelled both by civil society, including a range of public service actors, and the private sector, including local entrepreneurs building sustainable businesses.

Figure 20: Likely broadband solutions against the expected number of broadband subscribers per sq km



What is needed are regulatory frameworks designed to lower business risks and open markets to a full range of potential broadband providers. These key issues are addressed in the GSR Discussion Paper on the Role of Regulators in Promoting Broadband.

[1] It is important to note that all ITU data pertaining to Total Internet subscribers in 2003-2004 may appear slightly conservative, attributable mainly to slightly lower response (6% decrease) rates on the Annual ITU Telecommunications Indicators Survey compared to previous years, as well as to the fact that some countries have not yet reported their data for 2004.
[2] This is being done using wireless technologies developed by Texas based Navini Networks.
[3] It is important to note that data pertaining to the uptake of 3G services has not been historically collected by the ITU. This year 2005-6 constitutes the first year that the ITU will be collecting 3G specific data for inclusion in its World

Telecommunications Indicators database. Therefore, for the purposes of this paper, we rely on industry (association, news) sources

[4] Figure 8 is based on 2003 data.

[5] See http://standards.ieee.org/getieee802/portfolio.html for more information about the IEEE802 standard.

[6] In Sweden, apartment house companies own their own fibre networks to serve the tenants in their buildings. These networks connect to a point of presence of all operators at a metropolitan area hub. In a departure from the fibre *to* the home model, they outsource the link level of their fibre *from* the home networks to service-providers serving their tenants.

[7] See http://www.cablemodem.com/specifications/ for more information about DOCSIS.

[8] See http://grouper.ieee.org/groups/bop/ for further information about P1675 from the IEEE).

[9] See www.iec.ch/tctools/dashbd-e.htm for further information about the working groups with the CISPR.

[11] For further information about this process, please see http://www.iec.org/online/tutorials/acrobat/opt_net.pdf.

[12] See http://www.iec.org/online/tutorials/sdh/ for more information about SONET.

[13] Commercial acceptance has been disappointing on these systems and it is thought that ArrayComm intends to abandon this technology in order to focus on WiMAX based systems.

[14] ITU Internet Reports: The Portable Internet available via the Internet at http://www.itu.int/publications/bookshop

[15] ITU Internet Reports: The Portable Internet available via the Internet at http://www.itu.int/publications/bookshop

[16] Portable Internet.

[17]These include Astrolink, SpaceWay and EuroSkyWay.

[18] "Cow pats fuel computers" BBC Online. See http://news.bbc.co.uk/2/hi/technology/2957488.stm

[19] See http://www.tanzania.go.tz/census/districts/kasulu.htm

[20] See www.kasuluonline.or.tz

[21] See http://www.global-catalyst.org/pages/who_we_are.htm

[22] See http://www.schoolsonline.org/whoweare/index.htm

[23] See http://www.schoolsonline.org/whatwedo/update_sep_2002.htm

[24] "Rape at the end of the world." See http://www.unfpa.org/focus/tanzania/rape.htm

[25] "Cow pats fuel computers" BBC Online. See http://news.bbc.co.uk/2/hi/technology/2957488.stm

[26] See www.kasuluonline.or.tz

[27] "Tanzanian refugee camp gets wired for Internet" See http://www.hrea.org/lists/huridocs-tech/markup/msg00933.html

[28] "Start. Succeed (or Not). Repeat." *Los Angeles Times*. See http://www.latimes.com/la- tm-sventrepreneur10mar09,0,7991984.story

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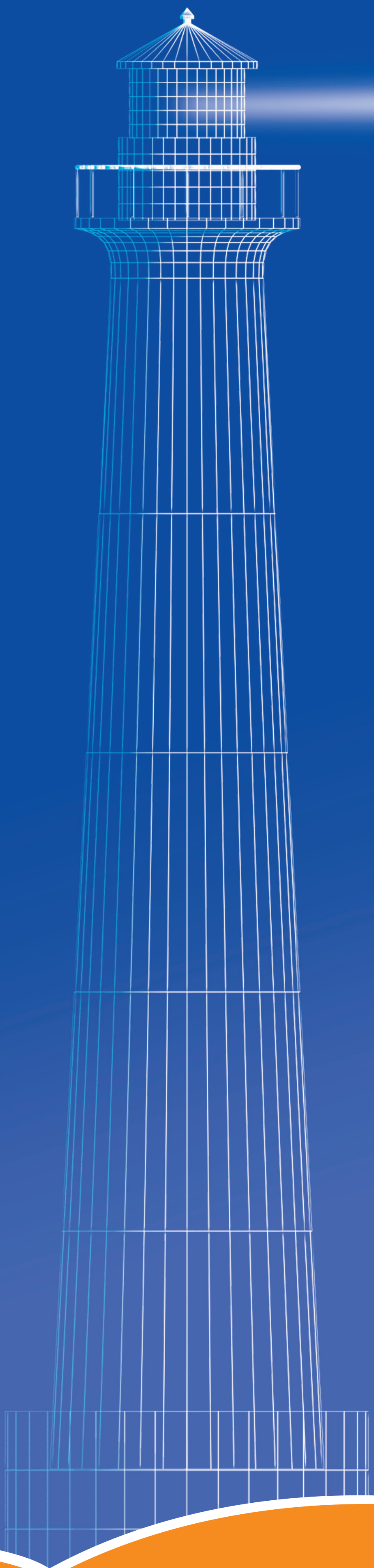

GSR 2005

DISCUSSION PAPER

VoIP AND REGULATION

Comments are welcome and should be sent
by 5 December 2005 to GSR05@itu.int

ITU International Telecommunication Union

GLOBAL SYMPOSIUM FOR REGULATORS

MEDINA CONFERENCE CENTRE
YASMINE HAMMAMET, TUNISIA

14-15 NOVEMBER 2005

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VoIP and regulation

Prepared by *TRACY COHEN, OLLI MATTILA AND RUSSELL SOUTHWOOD*

Comments are welcome and should be sent by
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TABLE OF CONTENTS

Page

GSR Discussion Paper*

VoIP AND REGULATION[1]

Voice over Internet Protocol (VoIP) is generally viewed as a "disruptive technology"[2]. All the current market indications show that IP networks and services like Voice over Internet Protocol (VoIP) will replace traditional PSTN networks and services. ITU estimates that by 2008, at least 50 percent of international minutes will be carried on IP networks and that many carriers will have all-IP networks. Recent trends are certainly headed in this direction. For example, in the United States, residential VoIP subscriber numbers have increased from 150,000 at the end of 2003 to over 2 million in March 2005. It is predicted that subscribers in the US will exceed 4.1 million by 2006, generating over USD 1 billion in gross revenues for the year[3]. In March 2005, the Chilean broadband operator VTR launched the first telecommunication network for residential services based on IP technology. The operator expects to expand its platform and reach 2 million customers in five years. There are approximately 35,000 residential telephones that use IP technology in Chile, either through Chilean operators or through Vonage.

Likewise, ITU expects that much of mobile traffic will become IP-based and that the introduction of mobile VoIP will influence the shape of the mobile business globally. Wireless-enabled mobile VoIP offers the potential for cheaper voice calling. Users of 3G networks can already use mobile phones to make VoIP calls such as Skype to other Skype subscribers at cheaper data rates. The growth of mobile VoIP will particularly affect the high-price international roaming business.

Today, however, VoIP services have been implemented unevenly around the world. Some countries have enabled many legal providers, whilst others have blocked the provision of VoIP providers and others only have grey market operators. These approaches reflect very different perceptions of VoIP in various parts of the world. In some countries, VoIP is seen as an exciting technological development that offers cheaper calling for consumers, whereas in others it is seen as a threat to the existing order. At an international level, VoIP traffic is often described as "by-pass" or "lost" traffic but this traffic has driven the development of new service providers both in the developed and developing world.

In both developed and developing countries however, the advent of VoIP has brought about new challenges for regulators. In developing countries where the entrenched rights of fixed line operators have been protected, the main question has been whether to legalize the introduction of VoIP. In more mature and competitive markets, VoIP has raised new questions for regulators over what aspects of the new services require regulation. Inevitably, it is those countries that have legalised VoIP as part of a broader liberalisation of their markets that have started to accumulate thinking, experience and precedent in this area. But even in these countries, VoIP is a relatively recent development and therefore there is often little consensus about how best it should be regulated.

This paper examines how VoIP services will affect future regulation. Due to the starkly contrasting global perceptions of VoIP however, it is difficult to present a unified approach to regulatory treatment of VoIP and this paper aims to reflect regulatory experiences from a wide range of countries that are grappling with the transition to VoIP. The three sections of this paper are structured to answer both the broad and specific questions raised by VoIP services, including the

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* This discussion paper has been prepared by *Tracy Cohen, Olli Mattila and Russell Southwood*. The views are those of the authors and may not necessarily reflect the opinions of the ITU or its membership.

overall approach to regulating VoIP as a mainstream service; how VoIP has changed voice business models and the various ways of classifying the services it has created; and finally, other related issues frequently raised in connection with VoIP, such as quality of service; network integrity; emergency calling, numbering, communication security and lawful interception.

Box 1: VoIP – A Primer

"Voice over Internet Protocol" (VoIP) is a generic term referring to a technical standard that enables the transmission of voice traffic in whole or in part, over one or more networks, which use the Internet Protocol (IP).

Standards or **'protocols'** for VoIP are still evolving, but two main *open protocols* and proprietary *vendor protocols* enable VoIP: *"H. 323"*- the most widely adopted protocol for the transmission of VoIP. It is an International Telecommunication Union (ITU) legacy standard, which builds on earlier protocols for the transmission of voice and video over analogue PSTN, ISDN and ATM; and *"Session Initiation Protocol"* (SIP) is an application-layer control protocol, which is an end-to-end signalling protocol. SIP facilitates communication between two or more SIP supported devices, but it is not the only protocol required to make VoIP calls, which takes place via additional protocols.[4]

How VoIP technology works: Voice (or data) is compressed and converted into digital packets that travel over the Internet, or a private network utilizing VoIP and are then converted back at the other end compensating for echoes made audible due to the end-to-end delay, for jitter (variability) and for dropped packets. The data packets are non-isochronous and may take many different and independent paths to the intended destination, arriving out of sequence or with different end-to-end delays. VoIP technology makes much more efficient use of bandwidth and voice is transmitted on IP-based networks at considerably lower cost than circuit-switched networks which require a dedicated connection for the entire duration of a 'call'.

VoIP Applications: The first generation VoIP services only allow calls to people using the same service, (PC-to-PC, or Class 3, e.g. Yahoo! Instant Messenger). Here, voice signals transmitted are not switched across a PSTN at all. Second generation VoIP services allow calls to any regular (PSTN) telephone number (PC-to-Phone or Class 2, e.g. Dialpad, Net2Phone, Skype Out) including local, long distance, mobile, and international numbers. A third generation of VoIP services, enable use of a traditional phone (Phone-to-Phone, or Class 1[5], e.g. x-lite and Lipz through an adaptor, at both the originating and terminating ends of a call, but routing the call over an IP packet-switched, rather than traditional circuit switched network. [6]

1 VoIP: Evolution or Revolution in Regulatory approach

1.1 How VoIP is changing voice business models

In more liberalised telecoms environments, it is important to create regulatory frameworks that allow the market to produce sustainable business models. The industry continues to experience rapid change as the underlying business models change shape. A wide variety of technological and service innovations have already come from the introduction of IP networks. VoIP is a powerful service innovation that has the potential to change how existing voice markets operate. Since VoIP is largely enabled by the existence of IP networks, there is inevitably an overlap throughout this paper between these two key concepts which remain inextricably linked. It is not yet clear how IP networks will be implemented and at what speed but it is important to try and identify key elements of the changing business model as a basis for understanding the policy and regulatory dilemmas it poses. This discussion can also be extended to a broader one on Next Generation Networks (NGN) as many of the regulatory issues and challenges identified in this paper will arise as part of the move to NGNs.

Current regulatory practice for telephone service was devised at a time when circuit switched technology was dominant and is therefore historically based on this technology. This approach treats different types of networks differently. Future regulation should, however, be based on a fundamental recognition of the convergence of telecommunications, broadcasting, media and information technology sectors which means that all transmission networks and services should be addressed by a single regulatory framework model. For the remainder of this paper, the term Information and Communications Technologies (ICT) will be used to reflect this forward-looking approach.

For operators, VoIP represents three broad types of commercial opportunities emanating from the specific circumstances identified at the end of this section:

1.1.1 Price Arbitrage

Arbitrage is a term used to describe a situation where one buys at a cheaper price in one market to sell at a higher price in another. The growth of VoIP for international calling has been built on the wide gap between retail and wholesale calling prices in many parts of both the developed and developing world. These differences are a function of the uneven introduction of competition in voice markets around the globe.

In Africa for example, it may cost a caller (at the retail rate) between US50 cents and US$1 to call Washington DC but the same call is bought by the incumbent (at the wholesale rate) for between US1-3 cents. Where this circumstance exists, incumbent operators are able to maintain high margins because they either have monopolies or limited competition. What is often described as "bypass traffic" or the "grey market"– whether defined as illegal in some countries or in a genuinely grey area – is a proxy for competition, particularly on international voice calling. This has already forced incumbent telcos to cut their international rates and, as there is increasingly less regulatory protection of international voice markets, these rates will continue to decrease.[7]

Moreover, many incumbent operators are going through the process of "rebalancing" their tariffs in line with the costs of providing services. In the pre-competition days, high international rates were used to cross-subsidise rates on domestic networks. With competition in the largest voice markets having driven down international rates, and as various operators are mandated by law to ensure that tariffs are rebalanced within a given period, this business model is unlikely to be sustainable.[8]

Box 2: Examples of Grey Market revenues as a per cent of overall international call revenue

Africa	20-30%*
Asia	30%+
Brazil	36%**
Colombia	50%***
Costa Rica	20%****

* Source: Balancing Act
** Source: Abrafix
*** Source: V-P Technology, Orbitel
**** Source: Incumbent telco ICE

The VoIP service market has been fostered by the introduction of IP networks and the proliferation of web based transactions. Grey market operators can simply sign up on a web site and be offered international calling services that they can offer to users. As data, these calls are not recorded as minutes and need not use the international gateway of the historic or incumbent operator for outgoing calls. While quality of service issues do arise, many cost-conscious callers seem willing to make the trade-off between price and quality.

However, as a commercial opportunity this is entirely price dependent, so this arbitrage effect may change or disappear as prices are reduced. The legalisation of VoIP services to a wider range of operators is in effect the introduction of wider competition that will result in a lowering of this price arbitrage gap. Yet, whatever prices are chosen, the future of revenue in telephony, particularly in the international domain, appears to be "low-margin, high volume" rather than "high-margin-low volume" for this type of calling. Where VoIP has been legalised, VoIP providers appear content to work with lower margins than established operators.

1.1.2 Savings from New Network Topologies

Many of the world's larger carriers have been persuaded to consider VoIP because an IP-based network can carry both voice and data in one rather than two networks. In this way, operators will be investing a single network that can be used more efficiently for many different forms of traffic.

IP network deployment costs often come in smaller increments than those required for telco switching facilities and dedicated circuits. It is possible to add capacity incrementally in a manner that will realise return on investment more quickly than the traditional multi-million dollar telecom equipment investments, which require many years to produce the required return. For example, large numbers of traditional switches can be replaced by fewer "soft switches". Smaller investments can often be financed from cash flow rather than requiring major external borrowing. Moreover, some components for the new IP networks are items that can be found in retail electronics outlets rather than being sold as an "integrated solution" by a manufacturer. However, not surprisingly these arguments are hotly contested by some telco managements, traditional telephone network engineers and telephone equipment manufacturers.

The debate tends to centre on both the soundness or integrity and cost of the newer generation of network equipment - including Wi-Fi and Wi-MAX – as part of an IP network roll-out. These new wireless technologies can and are being deployed both to create local loop VoIP access and for backbone links. Again, it is argued that this is being done at prices that are much cheaper than traditional copper or fibre networks. As with arguments about IP networks, the potential cost savings using wireless technologies are not without challenge. However, incumbents worldwide are both deploying these technologies and at the same time, are threatened by them.

Likewise, mobile operators that have invested considerable sums in 3G licences and need to make a return on their investment over five to ten years are also threatened by the potential of VoIP, in particular the effect substitution of mobile VoIP will have on operators' high-price international roaming business. This presents a recurring dilemma for the regulator: should the regulator protect the investment of the mobile operator and delay cost-saving innovations for consumers or should it allow wireless-enabled, mobile VoIP to flourish, which may have the effect of undercutting investment returns of the mobile operators?

These questions are particularly pertinent for regulators and policy-makers in developing countries where the choice is often between defending a government-owned telco incumbent (for financial and social reasons) and the distributive policy aspiration of making cheaper communications available to a wider number of people, particularly in rural areas.

1.1.3 New Products and Services

The convergence of voice, data and images on IP networks allows users to combine these different forms of traffic and significantly expand the range of product and service offerings. For example, call-centre software can include a range of features such as productivity management, real-time database access and cost-effective call routing. Convergence also blurs the line between voice, data and television programming. Many operators in the developed and developing world are now offering the so-called "triple-play" option that combines all three in a single service. Senegal's Sonatel has rolled out a "triple-play" service, offering voice, internet access and television programming and Brazil's TVA[9] is also offering the same service bundle.

This form of delivery has implications for competition as users increasingly seek a single provider and billing option. A single bill for all these services is undoubtedly convenient for consumers but the cost of each service is not transparent, making comparisons between services difficult for users. However, triple play, also has the potential to open up television as a delivery platform for a far wider range of rich, multimedia services, overcoming to some extent, the lack of installed, Internet-connected computers in developing countries. While this may be a solution for the urban poor, it still will not address lack of Internet access for those in rural areas without electricity or television coverage. Yet, while this may not be tomorrow's market, it is certainly going to be relevant in the medium-term.

In addition, there are now a number of VoIP crossover technologies for use with mobiles that are currently in a trial phase, or beginning rollout. For example, "Push-to-talk" is the term used to describe what most people would understand as "walkie-talkies": instantaneous, direct two-way conversations between two individuals based on IP software that sits on a mobile phone. US-based Nextel and others started offering the service in 2003. The product debuted in Europe with Orange's 'Talk Now' offering. Although it requires users to be subscribers to a data service from one of the major carriers and has a number of quality issues, there has been significant take-up. It is seen as sufficiently threatening to the traditional "walkie-talkie" market for Motorola to have produced at the beginning of 2005, specifically designed, rugged "push-to-talk" phones. Two of India's mobile providers – Hutchison Essar and Tata Indicom – also launched "push-to-talk" services in May 2004.

Another area of development will be the current testing of products that integrate cellular and WLAN networks and provide voice from a WLAN device. As with most technical advances, it can go in several directions: it is possible to use fibre and co-axial cable to distribute a wireless signal throughout a large area like a hospital, government ministry or a university. The wireless signal can then deliver VoIP calling and access to the Internet at broadband speeds without the same interference problems that are usually caused by walls. It would then for example, allow doctors and nurses to have conference calls about patients and in more developed versions, offer the opportunity to show video or images for discussion. As part of the EU-project IPv6 Wireless Internet Initiative (6WINIT), Ericsson has trialled a health project, called Guardian Angel, using IPv6 and roaming between 2G, 3G and WLANs.

Mobile carriers in both the United States and Europe are already rolling out networks that offer 11-Mbit/second 802.11 WLAN access. Their fear is that it will eat into their existing data business (and perhaps even undercut the rationale for 3G) but at the same time, these operators are aware that they cannot be in a position where they fail to offer these advantages and they lose out to a competitor. One European UMTS mobile operator has been sufficiently worried by the impact of VoIP that it has threatened to block Skype calling to its subscribers.[10]

These three broad business opportunities have come from a number of key changes in the underlying business model for voice:

The impact of the features of IP networks

With traditional telephony, “intelligence” in the network is located centrally (in the functionalities of the switch) and usually controlled by one organisation. In its historic form, largely “dumb” devices (telephones) were attached to the network and these had a limited set of functions. The traditional telephone network’s root and branch structure means that traffic flows to and from exchanges in ways that reinforce this pattern. For example, traffic for international destinations tends to go via a single international gateway. Telecoms carriers maintain bilateral relationships with other carriers and exchange revenue (to a much more limited extent than previously) through the Accounting Rate System.

By contrast, the IP network is one where no single entity has control, other than over the most basic transport to other networks. The service-providing “intelligence” is deliberately designed out of the network architecture. Indeed, put simply the network is “dumb” and intelligence is at the edge of the network. For example, a computer accessing the network has a far more complex range of service functionality in its application programmes which is not solely related to its size[11].

Traffic on the network is routed via the easiest route and therefore not always via central points. For example, international traffic can as easily flow from an ISP, a cyber-café or a telephone company: each has only to open a network connection and have the required capacity available. In this way, VoIP services do not necessarily need to go through an international gateway. The network design, where an important feature was a decentralised network without a central focus or control point, originated from United States military demands for redundancy and that the network withstand nuclear attack. Also, stemming from its university origins, it was designed to be open to users through publicly available standards, making it easy to access.

Due to their open nature, IP networks pose particular security challenges. The PTSN (and also a mobile network) is a closed network with controlled security and privacy. IP based VoIP is open architecture where vulnerabilities, threats and risks for communication security exist in various network elements. Special measures are required for ensuring communications security (see 5.2 and 5.3 below)

IP networks have introduced novel ways to do business. Broadly speaking, the telecoms sector charges each side of an international call, the cost of a full circuit. By contrast, ISPs bear the full cost of the circuit but have a well-developed set of industry practices known as ‘peering’ arrangements that allow ISPs to swap traffic at no cost. These practices will undoubtedly have an impact on existing interconnection models and this issue is discussed further in 4.7 below.

The separation of retail and wholesale

Historically, a vertically-integrated organization like the telco incumbent carried traffic and offered services, usually from a monopoly position. In a more liberalised market, the same telco incumbent sells international transmission to both external ISP customers and to its own ISP, leading to inevitable accusations of conflicts of interest. For VoIP service providers, the terms under which there is access to broadband therefore becomes a key question.

With liberalisation and more entrants in the market, there has been an emerging separation of retail (services) and wholesale (infrastructure) functions. Alternative infrastructure providers like utility companies have begun to wholesale bandwidth capacity and operators like ISPs, VoIP service providers and mobile virtual network operators (MVNOs) have begun to retail services to end users. The nature of IP networks has enabled this process and indeed encouraged changes in thinking about these two functions.

As a result, many telcos have separated out their wholesale and retail functions in order to better understand the underlying cost structure of different parts of the business. In some instances, this was prompted by regulators seeking to clarify terms of access to either the local loop or the network itself or by the companies themselves wanting answers to questions about costs of delivery.

Charging structures reflecting changes in geography, distance and services

Due to the broad similarity in wholesale rates between the more competitive markets in the world, several VoIP service operators offer the same or broadly similar rates between these countries. For example, Skype sells "Skype Out" minutes to enable its subscribers to call PSTN phones and at the time of publication, for less than two cents a minute, it was possible to call: Australia, Chile, Europe and North America.

Most telco transactions are based on knowing where a call originates and terminates. This is not however, the basis of many VoIP services. Charges per minute are based on where the call terminates. And charges in those countries with less competition reflect the higher international charges. However in a tacit acknowledgement of the impact of competition, even these countries can be called at cheaper rates than are offered directly by their incumbent telcos.

As we discuss in greater detail below (see 4.3), numbering once used be an indicator of geographic location but with VoIP, this is no longer the case and many VoIP service providers will offer users "virtual" numbers. For example, a user may live in London where her dialling code is 207. Her mother may live in Florida and has a 561 dialling code. The VoIP service provider can give the user a 561 dialling code that rings to her 207 line. In this way the user makes a "local" call to her mother. Argentina's PVTEL offers its customers the choice of a Buenos Aires or Miami dialling code.

As fixed line and mobile phones (rather than SIP or soft phones) are still the dominant form of telephony, a hybrid model is emerging where operators offer consumers, part minutes, part bandwidth. The telco or ISP wanting to sell broadband connections will seek to offer an attractive combination of broadband and an adaptor or VoIP-enabled phone; free calling to their other subscribers as a sales incentive; and cheaper domestic and international calls. Again Argentina's PVTEL allows users to make and receive calls using their broadband connection and an adaptor.

2 The Pace of VoIP Market Development

All current market indications show that IP networks and services will replace PSTN networks and services and influence the mobile business as well. Moreover, the introduction of IP networks will affect countries globally, but the timescale for its introduction will vary widely.

A number of major international carriers have committed themselves to making the transition to VoIP including, British Telecom (100% by 2009) MCI (100% of all traffic by the end of 2005); AT&T (100% by the end 2010); and Telecom Italia (80% of all traffic went by VoIP by the end of 2003).

In Europe, the number of market players offering VoIP has increased with astonishing speed during late 2004 and early 2005. According to rough estimates in March 2005, there were over ten VoIP service providers in most Western European countries and in some the number is in excess of 40. Yet, this growth is taking place across the globe. For example there are currently 11 companies in Pakistan using VoIP and more than 80 licensed in Malaysia[12]. Since 1 February 2005, all value added network service providers in South Africa are legally allowed to carry voice on their networks. While there are no specifically licensed VoIP providers, a number of companies are already offering various VoIP solutions.

In less liberalised markets, the impact of VoIP wholesale carriers gives some indication of how the market is changing. In 2004 between a fifth to a quarter of all historic operators in Africa were using VoIP to carry part of their international traffic. As these agreements are politically sensitive, establishing exact numbers is difficult. Telkom Kenya is about to offer a VoIP-based international service. Five African carriers – the Second National Operator (South Africa), BTC (Botswana), Mundo Startel (Angola), Telecom Namibia and UTL (Uganda) – have announced that they will introduce IP-based networks. Mexican incumbent Telmex has already implemented IP for the majority of its core network and various Mexican carriers (Alestra, Avantel, Axtel and Protel) have been conducting initial trials, whilst waiting for changes in legislation, and Marcatel is already offering long-distance services. Oman's incumbent Omantel, has committed itself to creating an end-to-end IP communications services network.

The transition to VoIP is so rapid and far-reaching that it is hard to make definitive statements about its progress. In some countries, legalised VoIP operators are already offering significant cost and service choices for both national and international calls. In others, the process of liberalisation has not yet begun and the only 'choice' for consumers are grey market operators. Irrespective of national regulation, there has been a very rapid growth in VoIP services over the Internet. Providers like Delta Three, Skype and Vonage have increased their subscriber base rapidly over the last three years globally.

Although there is no market data on the progress of this transition, it is useful to differentiate between the different types of VoIP services transitions that are occurring. At the wholesale level, there is a well-developed market for the carriage of international traffic over IP networks. Calls originate from a PSTN phone and are converted to data and then converted back to the PSTN format if required at the call's destination. National calls may even be carried over an IP backbone with the same conversion happening at either end of the call. Such calls may happen in parallel to existing PSTN networks.

At a local level, VoIP service provision is a much more substantial undertaking. Few users have IP-enabled phones or soft-phones[13] on their PCs or mobile phones. Also, the implementation of IP-enabled PABXs that can handle both TDM[14] and IP traffic in corporate markets varies enormously from sector to sector and country to country. Investment both at a personal level (by the individual user) and by the company (at a corporate level) will take time and as with the introduction of digital television, will be driven by an unpredictable mix of drivers including the speed of telco implementation, individual and company choice and government and regulatory policy. As with all technological transitions, the cost of the equipment needed – particularly at a local level – will only begin to come down once there is a sufficient volume of buyers.

The question posed by these developments is whether the transition to VoIP requires a revolution in regulatory thinking or whether it is more prudently handled in an evolutionary way? The best way to approach this question is to differentiate between the short-term changes that are largely evolutionary and the long-term changes are more far-reaching. The transition from short-term to long-term changes is summarised in the box below. From the summary, regulators will be able to look at the different elements of change occurring and locate their market in the transition process. But the changes described in the long-term indicate that VoIP represents a major disruptive force for all telecom service providers and there will be a need for radical changes in all regulatory models when VoIP becomes the primary means of transmission for calls.

One clear certainty is that with the advent of next generation networks and the rapid rise of new technologies regulators will need new knowledge and expertise. The experience of almost all regulatory personnel is based upon knowledge of circuit switched technology and the services it offers. In the future, regulators will need to understand the new IP layered networks, the service concepts based upon them and the influence these will have on the future shape of the market. And because IP networks and VoIP services change rapidly, regulators are under greater pressure to make swift decisions and decide on a course of action.

Box 3: VoIP Transition

Short to medium-term evolution (evolution from PSTN to IP networks)

Technical concepts

- PSTN phone services and VoIP services exist in parallel.
- PSTN – IP network gateways are needed in most cases.
- E.164 numbers are (mainly) used, additionally ENUM use of E.164 numbers is increasing.
- Terminals: Adapter + regular phone, IP-phone or a soft phone.

Transition period for the market

- New type of competition with possible advantages of cost structures and with new innovative services (in particular nomadic use of IP/Internet telephony) and possibly lower level charging models.
- Voice traffic is shifting to IP based traffic and revenues from traditional phone services are decreasing.

Regulatory model

- Changes are required to the current regulatory regimes, need to take into account long-term influences.
- Should balance basic main objectives:
  - to enable the development of new innovative services.
  - to ensure acceptable social and consumer protection.

Long-term change (towards all IP)

Technical concepts

- IP/NGN networks and VoIP services are prevalent.
- Subscribers and services are addressed mainly by different types of Internet addresses;
- however, E.164 numbers are likely to prevail at least in the global context.
- New terminals e.g. combined GSM/UMTS/WLAN phones supporting IP/Internet telephony at home and other WLAN coverage areas.
- VoIP is normally one service inside a large service set.

Market and competition structure is changing:

- Integrated, innovative and personalized services.
- Nomadic use is important, increasing the amount of cross border services.
- Cost and revenue model of service providers has changed radically.
- The separation of the transport network and the services delivered on top of that network.

Regulatory model:

- New legal framework/regulatory model is needed.

3 Regulatory Responses to VoIP – Grappling with Change

Before looking at the detailed issues that VoIP raises for regulators, it is worth looking at the overall policy and regulatory responses of different countries. As regulatory responses are extremely varied, this section groups countries under a series of headings, corresponding to their approach to VoIP as part of their broader liberalisation process, or lack thereof.

It is these countries, both developed and developing, that have started to accumulate thinking, experience and precedent in this area. The outlines of regulatory approaches below concentrate on what might be described as the core philosophy of the regulators involved. Yet even in these countries, VoIP is a relatively recent development and there is not often a consensus about how it should be regulated. Some countries have adopted an incremental, evolutionary approach to VoIP regulatory issues and sought to make modest adjustments to their regulatory frameworks that allow them to grapple with the scale of changes they are facing. For others, VoIP (particularly the impact of the international price arbitrage business) represents a considerable threat to the established order and remains illegal.

In China for example, the deployment of IP technology has been driven by the basic services operators (China Unicom, China Telecom and China TieTong). There is currently no specific VoIP regulation, and VoIP has not been classified as either a value-added network service, or as a basic service. At the present time, basic telecommunications licensees are allowed to offer VoIP services and use IP technology in their core networks. The government is considering whether to ban the use of VoIP services provided by those other than licensed operators.[15] Currently, ISPs can only offer PC-to-PC VoIP services.

3.1 A Liberalised Policy Approach to VoIP

Various countries have legalised VoIP services at different levels. For example, all forms of VoIP service are legal in Canada, the European Union, India and Korea. The following details some specific examples:

Europe: The European Regulators Group (representing regulators from 27 European countries) has agreed a common statement on the regulatory approach to VoIP in their countries. According to the Group, VoIP should be used to enable (for the benefit of consumers) the greatest possible level of innovation and competitive entry in the market, whilst ensuring that consumers are adequately protected. Application and interpretation of rights and obligations in relation to VoIP should be in accordance with the European regulatory framework including the policy goals and regulatory principles existing today. Consumers and service providers should be provided with adequate information and be empowered to make informed choices about services and service provision.

United States: The 1996 Telecommunication Act separates telecommunication services and information services. The FCC has formalised the policy of not imposing traditional telecommunications rules on new Internet applications (information services). Currently the FCC is running proceedings to examine issues for “IP enabled services”, including VoIP. These proceedings are examining various social issues (e.g. Universal Service) and the classification of services for regulatory purposes.[16]

Japan: VoIP is permitted and is subject to minimal regulation. The legal framework distinguishes three types of VoIP services based on the quality of the service. Providers that do not need numbers for their operation (e.g. PC-to-PC communications) do not have to comply with QoS requirements. If the provider can ensure a minimum QoS (in terms of end-to-end voice quality and end-to-end voice delay), the authority can assign it 050-prefix numbers. Only if the quality is as good as traditional telephony, providers can use the same numbers as the PSTN. Tariffs and access charges for VoIP services are not regulated. Only if the VoIP provider is a facility-based operator is interconnection required. VoIP providers have to pay access charges to the PSTN operators when calls are terminated on their networks. It is also worth noting that South Korea adopted a broadly similar approach to VoIP in September 2004.

The allocation of 050-prefix numbers started in September 2002. 050-prefix numbers enable subscribers to receive calls from the PSTN, and they allow the provision of location-free services. In 2003, common PSTN numbers were allocated to VoIP services that offer a quality equivalent to that of the traditional voice services. In addition, emergency calls and direct access must be available from these lines, and numbers must observe location correspondence.

Canada: Following a public consultation process, the Canadian Radio-television and Telecommunications Commission (CRTC), published a decision in May 2005 that it would only regulate VoIP service when it is provided and used as a local telephone service[17]. The CRTC reached its decision based on service neutrality, namely that subscribers use VoIP primarily as a local service and that providers offering VoIP do so with the same core attributes as local exchange services[18].

In subjecting local VoIP services to the same regulatory framework applicable to local competition[19], the CRTC's decision provides for the registration of VoIP resellers; access to numbers and local number portability; directory listings; equal access to interexchange carriers; winback rules; comprehensive assessment by VoIP operators of access for the disabled; message relay service; privacy safeguards; tariff filing requirements; contribution to the national service fund; regulation of non-dominant carriers; the development of IP interconnection interface guidelines and the regulation of VoIP in areas where local competition is not permitted (areas served by small ILECs and the far north of Canada).

In line with its approach to retail Internet services, the CRTC will not regulate computer to computer (peer to peer) VoIP services which reside solely on the Internet.

Tariffs are therefore regulated and incumbent local exchange carriers with market power cannot price their local VoIP services below cost in order to facilitate sustainable competition in local telephone markets- one of the few remaining telecoms markets in Canada that is still regulated.

Singapore: In June 2005, Singapore announced the introduction of a new policy framework for Internet Protocol (IP) Telephony to address the growing trend of consumers increasingly using the Internet and other Internet Protocol (IP)-based networks to make local and international voice calls, together with, or as alternatives to traditional fixed-line telephony. In Singapore, IP Telephony is a form of Voice over IP (VoIP) service, whereby a user's voice during an IP telephony call is digitized, carried over public Internet or private IP networks in IP data packets, then de-digitized back into 'voice' at its destination. With IP Telephony, a user can potentially use any broadband Internet access connection to make and receive local or international voice, data and video calls with a phone number.

The InfoComm Development Authority of Singapore (IDA) will issue licences and phone numbers for the provision of IP telephony services to facilitate the entry of companies interested in offering IP Telephony services in Singapore.

Under the new IP telephony framework, facilities-based operators (FBOs) and services-based operators (SBOs) can be licensed. For the provision of IP Telephony services, FBOs can use 8-digit level "6" numbers. In addition, IDA will issue a new 8-digit number level "3" to both FBOs and SBOs. To encourage adoption in this emerging technology, IDA's framework includes minimal regulatory obligations to address certain public and regulatory concerns. For instance, operators providing IP Telephony services using level '3' numbers, are not required to provide number portability, emergency service connection, directory enquiry and printed directory services, or conform to QoS levels set by IDA. However, operators must provide clear information to their subscribers, for example, whether their service allows access to emergency services and whether it meets the minimum QoS levels set by IDA for local fixed-line services. Also, FBOs are only to assign level '6' numbers to users with valid Singapore addresses. This ensures that Singapore's national numbering plan resources continue to benefit users in Singapore.

IDA’s view is that a proper framework that provides phone numbers for VoIP brings convenience to consumers. Singapore’s regulator expects that the growth in IP Telephony will bring about reduced costs in providing telephone services, and in turn, translate to reduced prices and more service choices for businesses and consumers.

South Africa: As of 1 February 2005, any holder of a value-added network service, or enhanced service licence is allowed to carry voice on their networks. Until this date, all VANS providers were prohibited by legislation from allowing their networks to carry voice. This restriction formed the basis of various regulatory complaints by Telkom, the incumbent operator during its period of exclusivity. In recognition of the removal of the restriction on voice, the terms and conditions for VANS licensees were revised and now include the right of a VANS provider to apply for numbering resources, spectrum and interconnection with any operator. Other restrictions lifted on 1 February 2005, suggest that VANS may also self-provide telecommunications facilities and no longer have to obtain them solely from Telkom and the Second Network Operator, when licensed. However, a media statement by the Minister of Communications in late January 2005, has noted that VANS are still required to obtain facilities from any licensed telecoms operator, including mobile operators, but cannot self-provide such facilities. While some VANS providers and market analysts disagree, to date, the media statement has not been challenged.

Various Internet Service Providers and VANS operators have begun to offer VoIP services on a retail basis and have also begun to advertise aggressively. Internet Solutions, a subsidiary of Dimension Data is offering a “Voice over Internet Solutions (VoIS) over their MPLS[20]network billed as a full portfolio of converged voice and data services, including calling between branches of the same company; calls to customers of other ISPs; national long distance calls; call to cellular phones; and International calling. There is no regulation of rates and tariffs for VoIP services directly, but the regulator is considering quality of service issues and access to emergency services on VoIP networks. It is worth noting that all the Second Network Operator’s traffic will be IP based by virtue of its deployment of a Next Generation Network.

Philippines: In August 2005, the National Telecommunications Commission issued new regulations, treating VoIP as a value-added service, for which only registration, not authorization, is required. Commercial VoIP providers with no network of their own are required to enter into interconnection agreements with network operators. Although such interconnection agreements are to be negotiated between the parties, the NTC will intervene where necessary to ensure interconnection is provided under fair terms. Local exchange and inter-exchange operators and overseas carriers who have previously received authorization, are not required to register with the NTC when providing VoIP services[21].

3.2 An Incremental Approach to VoIP

India has offered Internet telephony legally since April 2002. Internet telephony covers the “following types of connections using the public Internet: (i) PC to PC (both within the country as well as abroad), (ii) PC to Phone (PC in India, Phone abroad), and (iii) IP based H.323/SIP Terminals in India to similar Terminals both in India and abroad, employing IP addressing scheme of the Internet Assigned Numbers Authority (IANA)”

Internet Telephony through PCs or IP based terminals should be available also through India’s Public Tele-Info Centers & Internet Kiosks. Facility based operators can provide Internet telephony and use VoIP technology to manage their networks. Furthermore, the regulator TRAI, has issued regulations on quality for VoIP international long distance calls, differentiating between two quality levels: toll quality and below toll quality. Tariffs of VoIP services offered by ISPs are not regulated.

In *Bolivia*, VoIP is considered to be a telephony service as the Telecommunications Regulations define a telephony service as every real-time voice communication, irrespective of how it is transmitted. In January 2005, a Bolivian ISP (Unete) announced that it was investing US$5 million to launch a national and international long distance voice service.

In *Ecuador*, telephony providers are either required to have a licence for local and long-distance public telephony or to establish resale agreements with licensed operators. In February 2005, the regulator CONATEL published regulations covering cyber-cafes and telecentres. The regulations limit the number of terminals assigned for VoIP services: up to 25 per cent of the total, or one if the cyber-café accommodates only two or three terminals.

In *Honduras*, the regulator has allowed VoIP services provided that operators contract with the monopoly incumbent Hondutel. The organisations doing this are described as “sub-operators” and can have their own networks and use them to sell other licensed services. However, the international traffic must be conveyed through Hondutel, the incumbent operator until 24 December 2005.

3.3 VoIP out to Consultation

Chile: In July 2004 the Chilean regulator SUBTEL launched a public consultation on VoIP that stressed the need to increase the development of new technologies that will allow more and better services for consumers and promote network and infrastructure deployment. According to the consultation document, if voice services are offered through the existing PSTN network, the operator is required to comply with the regulations that apply to PSTN services. Within the framework of technological neutrality and non-discrimination, service providers offering VoIP calling through direct access are subject to the same conditions as for PSTN services. But if services are provided over the Internet, they are not subject to the same conditions. The regulator is suggesting a broadband voice licence (Servicio Público de telecommunicaciones de voz sobre banda ancha – SPTVBA) that allows the provision of voice using the IP protocol. Some operators responding to the consultation document have indicated that the classification is too rigid and potentially problematic in an increasingly converged environment. The Chilean incumbent argued that the introduction of IP telephony will only positively affect a small group of the population but will take income from it, thus reducing the financing of current networks, discouraging investment and therefore harming the access to services for the less well off.

Colombia: In June 2004, the Ministry of Communications issued a consultation document on VoIP services. The consultation has been completed but no action had been taken by August 2005. At present operators require a basic PSTN licence (Telefonia Pública Básica Conmutada – TPBC). The use of a PC to make calls over the Internet is not restricted. The Ministry of Communications is seeking to classify VoIP in the existing telecommunications service categories of public telephony but a number of consultees have suggested that VoIP needs a new service category because it will not fit the old ones. The consultation addressed the following issues: emergency calling; numbering; network availability in event of disaster; services provided from other countries; market definition; the treatment of access to free services and lawful interception.

Some of the stakeholders that have responded to the consultation see the introduction of VoIP services as market skimming and argue that it will be to the detriment of contributions to the Universal Service Fund. The incumbent has argued that VoIP service providers should bear the same regulatory burdens as the existing TPBC operators.

Jordan: In May 2005, the Jordanian regulator issued a consultation document on the delivery of voice services using Internet protocol. This raised a number of issues on which it sought comment including: distinctions between different types of voice services, particularly when they are seen as identical by the consumer; the provision of information to equipment purchasers and potential users; the role of network and service providers in relation to network integrity; geographic and non-geographic numbering; emergency service requirements; interconnection; the requirement for a class licence for VoIP service providers, even if the operator is off-shore, and quality of service issues.

Hong Kong, China: In June 2005, Hong Kong's regulator (OFTA) published its statement on the "Regulation of Internet Protocol (IP) Telephony"[22]. This statement outlines the position of OFTA after having evaluated the comments on a consultation document released in October 2004.

According to the statement, service-based providers should be allowed to compete with facility-based operators (Fixed Telecommunications Network Service (FTNS)/Fixed Carrier (FC) licensees). Moreover, the principle of technological neutrality has to be upheld. Therefore, OFTA decided to introduce two different licenses for VoIP providers: Class 1 services – IP telephony service providers who market their local voice telephony services to customers with service attributes similar to those of conventional telephone services; and Class 2 services - those that do not have the same attributes as conventional telephony. Class 2 services are subject to minimum regulation, although services providers are however, required to inform customers about the limitations of their services. Class 1 services must fulfil FTNS/FC licensing conditions.

In recognizing the multiple modes of IP service provision in the scope of Hong Kong's regulations, OFTA states that "the provision of IP Telephone services by overseas websites will be outside the jurisdiction of the TA (…) unless the provision involving the establishment or maintenance of means of telecommunications, or offering of telecommunications services, takes place within the territory of Hong Kong."

Algeria; Israel; Taiwan, China; and Trinidad and Tobago have all gone out to consultation on VoIP, while Kenya has issued guidelines legalising various categories of VoIP, following public consultation.

3.4 Where VoIP is illegal

There are a considerable number of countries where VoIP remains illegal[23]. Governments and regulators in these countries adopt a number of different strategies to try and eliminate grey market operators. Some countries seek to ban websites that allow users to make international calls. Others periodically confiscate or seize the equipment of grey market operators. Some jurisdictions back up these sanctions with severe jail sentences and in one instance, the owners of several ISPs were jailed for a short period.

Before the ending of the monopoly in Panama in 2003, the Public Services Regulator mandated all ISPs to block IP ports identified with VoIP services. In addition, sometimes telcos filter (stop) VoIP service providers on their own. For example, an ISP in Mexico filters VoIP service providers including Skype and operators in Kenya have also filtered VoIP traffic. Unfortunately such filtering also affects the business of those using the Internet for video conference calls and instant messaging.

In almost all those countries where estimates of the grey market are given by the incumbent operator, the amount of "lost" traffic" is on a scale that would indicate that few of these strategies are successful at completely closing down grey market operators and preventing access by users to some form of VoIP service.

3.5 Classifying VoIP Services for Regulation

As can be seen from examining the current state of VoIP regulation, a key question for regulators is to examine how, if at all, these kinds of services are or should be classified. VoIP technology is being used to provide a variety of market offerings. Any rigid classification is unlikely to be stable given the pace of technological and market-driven change. Any classification used also depends on national policies and legislation. However, the VoIP offerings in the box below roughly divide into three categories, depending on which regulatory regime they fall under:

Box 4: Classification of VoIP Services

Category I

VoIP offerings that do not really require regulation because there is no provision of service. This would cover VoIP communication that is self-provided, such as a software programme downloaded to run on a personal computer (Examples include GIZMO, Yahoo instant messenger and Skype).

Category II

VoIP offerings which are outside the scope of regulation in that there are normally no specific public obligations:

- Corporate private networks, where VoIP is used to provide communications inside companies
- IP technologies used within a public operator's core network, but which do not impinge on the retail services offered to the end-user.

Category III

This category covers publicly available services provided to the end-user using VoIP technology in which the service consists of signals in an electronic communications network. These services do fall into a category of legitimate regulatory concern. However, there are many different kinds of publicly available VoIP service offerings, and the regulatory treatment depends on the nature of the service being offered and relevant national legislation.

Publicly available VoIP services belong in this category, where there is access to and/or from the PSTN (i.e. use of a PSTN-gateway. The services can either be offered by a broadband access provider or by an independent ISP.

This type of service can be divided into at least into three types:

- VoIP services, where there is access to and from PSTN (i.e. use of a PSTN-gateway).
- VoIP services, where there is access to the PSTN, (i.e. use of a PSTN-gateway).
- VoIP services, where there is access from the PSTN, (i.e. use of a PSTN-gateway).

A large number of national regulatory agencies have carried out consultations on VoIP issues but have not reached any final decisions. Many are trying to adapt existing service classifications under existing telecommunications legislation for VoIP services. There appears to be a consensus that VoIP services residing solely on the Internet (PC-to-PC calling) should not be regulated. Global discussion of these issues focuses on approaches to VoIP services that are similar to those described in category III above. The basic regulatory question that hovers over the whole discussion is whether or not VoIP can be regarded as a substitute for PSTN-telephony?

Below are various examples of how different countries have treated these issues:

European Union: the regulatory framework addresses the question of how communication services should be regulated in two ways. The Universal Service Directive defines service classification for purpose of consumer and social protection. For market and competition control purposes the need for regulation is to be assessed through analysing if VoIP services have "Significant Market Power" (dominance) in one or more of the “Relevant Markets” (See section 4.6 below for full explanation).

The services covered by the Universal Service Directive are divided into two categories:

- **Electronic Communication Service (ECS):** If a service is provided for remuneration and consists wholly or mainly in the conveyance of signals on Electronic Communications Networks. ECS is treated with lighter regulation.
- **Publicly Available Telephone Service (PATS)**: If a service includes all the following functions: available to the public; for originating and receiving national and international calls; access to emergency services, through a number or numbers in a national or international telephone numbering plan. PATS attracts more regulation and obligations. The main obligation compared with ECS is the provision of emergency calls.

The EU regulatory framework seeks to be technology-neutral, though some of its rules are built upon traditional telephony technologies. Debate on the classification of VoIP services is still ongoing but as a result, different European countries seem to interpret the regulatory framework for VoIP services in different ways. These vary from a flexible reading of the rules to a strict interpretation of the framework's wording. The following examples reflect these differences:

- There is a flexible classification where providers of communications services or of publicly available telephone services can decide in which regulatory category they want to be classified, rather than a decision being made by the regulator (for example, the UK);
- There is an approach where distinguishing different types of services strictly follows the wording of the PATS definition. PATS obligations are imposed on a voice telephony service only if all four parts of the PATS definition are fulfilled.
- The compromise approach is to apply criteria according to which a service is qualified as PATS if it is available to the public for originating and/or receiving national and/or international calls through an E.164 number. Access to emergency services is then not regarded as being part of the PATS definition and its regulation can be decided separately.

For market control purposes, each national regulator assesses how different VoIP services fit into the EU's Relevant Markets categories. At present, there is very limited practical experience and precedents set from that experience. The EU is currently discussing market analyses that include VoIP services.

Canada: the classification of VoIP services has come out of a discussion of emergency call services. From this perspective, there are currently three different types of VoIP service offered to customers: fixed, nomadic and foreign exchange. Users of **fixed** VoIP service can only place a telephone call from the location where their service is being provided. Users of **nomadic** VoIP service can make calls from any location where users can get access to Internet service. **Foreign exchange** VoIP service allows users in one exchange to receive telephone calls dialed as local calls in another exchange that they have selected (e.g. a customer located in Ottawa with a Halifax local telephone number). These different types of VoIP services have different requirements in respect of emergency calls (see section 4.4).

United States: in the United States there has been substantial debate about how VoIP services should be seen from the regulatory point of view: are they so called 'information services' with no regulation or regulated telecommunication services or are they simply a substitute for traditional telephony services? From the FCC perspective, services that are only provided over the Internet (like MSN Messenger and Skype) are classified as information services. If VoIP services have a gateway to the PSTN, then they should not be regulated except in relation to emergency calls and lawful interception.

4 Regulatory Responses to VoIP

4.1 Balancing different policy needs

The transition to IP networks and VoIP services tends to produce conflicting policy approaches in different countries. The following defines some of these conflicts which tend to emanate from opposing policy goals and sector objectives.

The main challenge is to balance short and long-term policy and regulatory approaches. In some countries VoIP is seen as a major threat to established operators because it undercuts their domestic and international long distance rates and radically reduces their revenues. However, strict regulation in the short-term to protect these revenues (forbidding VoIP usage, strict licensing conditions or heavy obligations for new services/market entrants) may harm the development of the sector in the longer term. Often, this drive to protect the national incumbent may stem from a particular social policy, such as extending universal service. However, regulators need to weigh the impact of short and long-term policy and regulatory approaches not only from the established operator's point of view but from the perspective of end users and potential new market entrants as well. The impact of lower prices brought about by VoIP may benefit users directly and help to increase the number of users and the volume of usage. In these circumstances, it is important that policy decisions are based on trend data and that the regulator analyses different market scenarios.

The regulatory model for VoIP should create a justifiable balance between partly conflicting objectives: regulation is needed but the shape of new markets is far from clear. Therefore regulation may struggle to keep up with new developments. It is a commonly expressed truth among regulators that, "one can establish a regulation in a year but it takes ten years to remove it." Regulation needs to guarantee regulatory certainty for investors but the period over which a rate of return is realised is getting increasingly shorter. Therefore, the tension that emerges is whether to protect those with longer historic investments or encourage newer, cheaper technologies that benefit users. In an ideal world, the regulator should be in a position to protect past operators' investments but as newer technologies become more widespread as part of IP networks, this may become harder to achieve in reality.

New policy and regulation needs to promote competition through innovative, cheaper services in the interest of users, however it also needs to ensure consumer protection and take social concerns into account, including through universal access and service objectives. Regulators may find themselves torn between the need to react quickly to new concerns and stepping back to see the shape and dynamics of the emerging market.

A basic objective of regulation in promoting competition is to ensure a level playing field for similar services. One emerging challenge is how to interpret technological neutrality between services based on technologies with very different attributes. One example is the difficulty in comparing copper cable-based, local loop with a Wi-Fi-based local loop. The former is not designed to promote mobility, whilst the latter has a form of mobility as a primary functional attribute.

Many regulators are guided by the principle of limiting regulatory obligations so they are not so onerous as to discourage market entry or the creation of innovative new services. Thus regulators have adopted "light-touch" regulation particularly in respect of newer technologies so that suppliers are encouraged to find technical solutions. A number of developing country regulators have encouraged the use of free or low-cost spectrum and low or no licence fees for areas where there are little or no voice or data services.

A vital task for regulators and policy makers is to manage the transition to the new world of IP networks. These include:

- how long a PSTN network should be maintained;

- assessing how much time is needed to make changes to existing legislation or rulings to provide legal stability in a time of flux;
- how quickly competition policy should change or adjust to reflect an IP based network rather than a PSTN era;

The pace at which these issues are decided may not necessarily be determined by government or the regulator as the market changes are already underway in many different forms, both for legal operators and currently illegal or grey market service providers.

Moreover, there is no consensus on these issues amongst policy makers and regulators, either at a global or a national level. National approaches vary from fully liberalised policy and regulatory frameworks supporting VoIP services to countries where VoIP is illegal or prohibited. What follows is an examination of a number of these different responses. These are not grouped geographically but according to topic headings that identify key issues.

4.2 Examining the Best Regulatory Approach to Encourage Market Entry

Regulators will face different challenges depending on how advanced the liberalization process in their country is. Regulators in more liberalized countries will simply manage the range of issues that flow directly from the transition of services to an IP network. In countries where the historic operator still has exclusive rights, the task of the regulator is both more complex and challenging. These regulators have to manage two processes in parallel: the transition from a monopoly to liberalized markets and the transition from existing technology to the new IP based technology. So in addition to preparing revised legislation and new regulatory measures that deal with IP-based networks, the regulator will also have to prime the historic operator with exclusive rights to prepare itself for wider competition.

VoIP's innovative services and special characteristics create new types of challenges for regulating markets. In the past, regulators have been used to slower moving and more predictable national telecommunications markets: initially rules were set without reference to experience but were changed slowly, setting precedents for further future rule changes. In the future, regulators will face a rapidly changing market based on a new type of infrastructure. They will need to deal with a large number of new services entering the market that may never have existed before. The policy and regulatory framework may be influenced or changed by international market developments over which they have little or no control. It is therefore becoming increasingly difficult to lay out detailed conditions in advance about how regulation might function and how market entry will be governed.

As stated above, many countries have carried out or are in the process of carrying out national consultations on how VoIP regulation might best be approached. Therefore as with the overall approaches to VoIP regulation, there are widely differing strategies for addressing new market entry.

The approach of the European Union is to facilitate "easy" market entry by only requiring individual licenses for scarce resources like spectrum frequency. For other network or service developments, only a notification or registration is required. It also adopts a "technology-neutral" approach, leaving market players to decide for themselves what technology they use.

South Africa has enhanced the business case and created conditions for easier market entry in value-added (VANS) or enhanced services, but still retains control over the market structure for fixed, mobile and satellite services. Under the current Telecommunications Act, only VANS and Private Telecommunications Network service licenses may be issued on a non-exclusive basis. Fixed line service has been dominated by one incumbent, with a second entrant set to commence operations by 2006. Mobile voice and data services are supplied by three operators.

Until 1 February 2005, the fixed line incumbent, Telkom had a full monopoly on facilities provisioning, and the resale of spare capacity for VANS and PTNs was prohibited. Since then, VANS may obtain alternative facilities supply from other operators. There is some debate about whether the lifting of restrictions on facilities supply has given VANS the right to self-provide facilities or whether they must obtain them solely from other fixed and mobile licensed operators. The resale market has been opened along with the market for providing public pay telephone services.

These policy developments took place in the context of a markedly delayed entry of a second fixed line network operator. In effect, these determinations lifted a number of legislative restrictions in the law and were intended to facilitate growth and competition in the communications sector; create greater choice for operators and service providers in acquiring facilities and managing spare capacity on their networks; liberalize the public payphone market segment and enhance Internet connectivity in schools and tertiary educational institutions across South Africa by mandating a discounted fee for service and connectivity. New regulations for VANS give providers the right to access spectrum, apply for numbering allocations and interconnect with other operators. Numerous VoIP providers are emerging in the South African market as a result, although the regulator has not yet finalized a policy on numbering and spectrum access for VANS.

Other countries restrict entry to the market for new VoIP operators through the use of different approaches to licensing. In many countries, much depends on whether VoIP is defined as a voice or information data service. Where VoIP has not yet been categorized, the issue often leads to extended debate.

ANATEL, the Brazilian regulator, for example, has not defined VoIP as telecommunication service, a value-added-service or a technology. If VoIP is considered a data service, operators need a license for multimedia communication services. However, in order to initiate and terminate calls outside of a private network, operators need a license for public switched fixed telephony. The latter type of license requires certain goals on coverage and QoS, and the application process is more complex.

Some countries, like Colombia, Egypt and Nigeria are pragmatic about certain aspects of VoIP (like PC-to-PC telephony) which is regarded as personal use and would almost certainly be impossible to control. Others, such as Guinea have made legal the use of VoIP over Virtual Private Networks (VPN), something which again is hard to detect and therefore equally hard to control. However, only VPN VoIP could easily be described as a field for new service providers.

In Nigeria, the regulator has stated that VoIP is legal provided operators obtain the appropriate licences. Thus one satellite operator with an international licence is offering a VoIP service to its customers. Yet, other countries completely restrict any form of VoIP market entry and seek to control grey market operators through a variety of strategies.

4.3 Numbering for VoIP Services

Numbers can be used for several different purposes. They can be used to differentiate between services and inform users of tariff categories like premium call services. Numbers can also be used as a tool to control markets by setting restrictions on the use of certain numbers. Thus access to numbers and the use of them potentially becomes a barrier to market entry.

VoIP services can be routed to the user in a number of different ways: IP addresses; SIP addresses; H.323 addresses or E.164 numbers. Traditionally E.164 numbers have been needed to originate and receive voice calls but it may lose its dominant position in the future and become just one of many options.

E.164 numbering ranges are usually divided into several generic types indicating the services that may be offered using these numbers. Geographic numbers or some special number series are regarded as most relevant for VoIP services. Also mobile, personal and corporate numbers can be used to address VoIP subscribers. These are, however, seen as less attractive in many countries because users will associate them with high retail calling prices.

The current position on the availability of geographic numbers for VoIP services varies between countries. The main argument in favour of allocating geographic numbers to VoIP services is that they offer the best support for competition, especially when combined with number portability. The main arguments against this approach have been the need for nomadic use of VoIP and exhaustion of geographic numbering resources. There are three ways to allocate geographic numbers in order to support VoIP services:

- allowing nomadicity in a limited area;
- allowing nomadicity countrywide but requiring some relationship with the geographic area of the number, or
- removing any requirement for a relationship to a geographic location.

Regulators may also open new number ranges for nomadic VoIP services, whether or not existing number ranges are changed. Broadly speaking, there are three types of possible new number ranges: a general-purpose number range; a number range for nomadic services and a number range for ENUM-based or similar software based services. Creating new number ranges seems to have mainly been motivated by a number of factors including the need to avoid giving the impression that these are high tariff numbers like those for mobiles; the need to keep existing number ranges intact and a desire to give service providers the freedom to create their own service description.

In Europe for example, the number ranges open for VoIP use varies due to different numbering policies and the regulations related to them. The geographic number ranges are open for VoIP services in most countries. However, some countries list a number of requirements that have to be fulfilled by VoIP services.

Cost of Numbers: The cost of numbers (national numbering fees) can be a significant barrier to market entry in some countries. Geographical numbers are typically allocated in blocks (normally blocks of 1000 or 10,000) for a certain national geographical area. A country can have a large number of geographic areas. Where geographic numbers are sold with limited nomadicity, VoIP service providers need to get number blocks that cover the whole country. The costs of doing so can be high and act as a market entry barrier for small providers. In Europe, numbering market entry costs vary greatly.

Number Portability: This is a key enabler of competition because it allows users to retain their telephone number when they change service providers. While the implementation of number portability can also be an onerous cost to new entrants and existing market players, it is essential to facilitate a truly competitive arena in both mobile and fixed line markets. Generally, a reasonable implementation period can address some of the cost concerns associated with porting from one network to another.

Call routing: There are various ways to find the IP address when routing a call based on an E.164 number but at the moment ENUM (Electronic Number Mapping) seems to be most practical tool, although there are other software solutions, such as the peer to peer Distributed Universal Number Discovery (DUNDi) system.. ENUM is a protocol developed by the Internet Engineering Taskforce (IETF) that defines a DNS based architecture and protocol aimed at using a telephone number to look up a list of IP based service addresses (e-mail, IP phone address, URL, SMS, etc). The idea of ENUM is to use an E.164 number as the key to identify the available communication services to contact a person. For VoIP, it is used to route a VoIP call to an IP network based on the receiver's

E.164 number. There are different ENUM systems for public service and for operators' internal use. For regulators, the issue is to provide the necessary rulings for the use of ENUM or other solutions that cover as a minimum, non-discriminatory use and protection of privacy issues.

4.4 VoIP and Emergency Calling

The nomadic nature of VoIP services poses a problem for the provision of emergency calls as it creates uncertainties about location informationThe location information from a geographic number of the user calling is used for routing such calls to the nearest "Emergency Centre". With VoIP there may well be a complete separation between the provision of the voice service and the transport of the voice data. There is – at least currently - no way of conveying location information about the user calling an emergency service between ISPs and VoIP providers. However in the future, technical solutions are expected to come out of the current standardisation work that is being undertaken.[24] .

National and International Challenges: The problems of handling emergency calls from VoIP users can be divided into two categories: emergency calls phoned from within a country and cross border emergency calls. The first category is likely to be less problematic due to the likelihood of increased co-operation between service providers covered by national regulation in a single country.

Cross border VoIP emergency calls raise more difficult issues because an emergency call needs to be identified as such. Globally there are more than 60 national emergency call numbers (e.g. 911 in the US; 112 in Europe). For an emergency call to be routed to the right country and the correct emergency centre, intensive international agreement, cooperation and arrangements will be required.

Consumer Issues: From a consumer point of view, the best possible solution would be the possibility of an emergency call from any VoIP device as the very nature of emergencies is likely to preclude a caller from stopping to assess whether the device they are using supports calls to emergency centres. It needs to be recognised that a user making an emergency call is often under severe stress, and it is possible that he or she may attempt to make an emergency call via whatever method appears to be most accessible, even if this would not normally be a natural choice. While various solutions will be required to overcome any technical limitations to the provision of data so as to ensure the adequate routing of emergency calls, two likely scenarios emerge:

1) In the short to medium term, a VoIP service may be the only option for making an emergency call if it is implemented as a primary line residential service or operates across a corporate network. A VoIP service is less likely to be regarded as the only choice for making an emergency call if it is used in a home or office environment in which a PSTN-connected phone or a mobile phone is readily available. Additionally, some industry observers are predicting that VoIP services running over Wi-Fi or Wi-Max, may become a replacement for existing mobile services: in other words, mobile calls will become VoIP-enabled. A key question is what will happen with VoIP connections during electricity outages, especially where VoIP is the only option for making a call in an emergency situation.

2) A VoIP service will, in the short- to medium-term, be a natural choice for making an emergency call if it appears to be identical to a PSTN (or mobile) service, or is used in a similar way to a PSTN (or mobile) service. This would appear to rule out the likelihood of devices such as gaming consoles or applications such as MSN Messenger or Skype being used to make emergency calls.

   Various principles may be considered to address these problems:

- If VoIP terminals are likely to be used for making emergency calls, they should have the capacity to be able to do so;
- An emergency call from a VoIP terminal should reach an emergency centre in the country in which it the call originates;
- Where possible, an emergency call from a VoIP terminal should reach the specific emergency call centre that is responsible for receiving emergency calls for the area in which the caller is located;
- The VoIP call made to an emergency centre should carry Calling Line Identification (CLI) which can be used to call back the person reporting the emergency if the person is cut off or rings off before full information has been provided;
- Where possible, the number provided by CLI for an emergency call from a VoIP terminal should not be linked to location information that is incorrect or misleading.

The following examples of VoIP emergency calling suggest various approaches:

European Union: The EU's Universal Service Directive leaves room for technical feasibility when imposing obligations relating to the provision of location information. It says it must be "*handled in a manner best suited to the national organization of emergency systems and within the technological possibilities of the networks" and "make caller location information available to authorities handling emergencies, to the extent technically feasible, for all calls to the single European emergency call number 112"*.

How the Directive is actually applied varies depending on the national organisation of its emergency systems and the capabilities of the networks involved. Similarly, related legal requirements - like providing caller location information, routing calls to an appropriate emergency centre and providing Calling Line Identification – varies a great deal between countries. Where VoIP services are regulated, some countries have set the same legal requirements for both VoIP and PSTN calls, whilst providing a temporary reprieve from these requirements to VoIP calls. Currently, it seems that nomadic VoIP service providers can only meet national legal requirements for emergency services in a few countries and there are still outstanding issues in the majority of countries. In Gabon, Pakistan and Romania however, VoIP operators have regulatory obligations to provide access to emergency services.

Canada: The Canadian Radio-television and Telecommunications Commission (CRTC) made a decision in April 2005 that requires VoIP service providers who provide fixed VoIP service (users of fixed VoIP service can only place a telephone call from the location where their service is being provided) to provide the same level of 911 emergency service that is provided by the incumbent telephone companies to their existing customers (either Enhanced 911 or Basic 911 service). Implementation was made mandatory 90 days after the decision was made[25].

The CRTC placed obligations on two other types of VoIP service providers: **Nomadic** VoIP services where users can make calls from anywhere they can get access to the Internet or **foreign exchange** VoIP services which allow users in one exchange to receive phone calls dialed as local calls in another exchange. So in the case of the latter it might refer to a user with a Halifax local number receiving calls in Ottawa. The Commission has imposed the obligation to provide an interim solution, the equivalent of a basic 911 service, and that providers in these categories do so within 90 days of the decision.

In addition to the above service requirements, the Commission also required all VoIP service providers to provide customers with notification, both before service commencement and during service provision, regarding any limitations associated with their emergency 911 service. The VoIP service providers must also secure the customer's express acknowledgement that they are aware of these limitations, prior to providing this type of service. VoIP service providers must also notify customers of all limitations on emergency services before commencement of service to them.

Box 5: Existing Enhanced and Basic 911 Services

In Canada and the United States, the existing local telephone networks currently provide two types of 911 service: Enhanced 911 service and Basic 911 service. Enhanced 911 service automatically sends customer location information to an emergency centre where an operator dispatches a response service. Basic 911 service connects the caller to a central call centre which then connects the call to the correct emergency response centre, at which point the caller must identify his or her location in order for an emergency response service to be dispatched.

United States: In May 2005, the Federal Communications Commission (FCC) issued an Order requiring interconnected VoIP providers to provide Enhanced 911 Service. The Order places obligations on interconnected VoIP service providers that are similar to traditional telephone providers. For example, according to the FCC's interpretation, service provider Vonage falls into this category in that they enable customers to receive calls from and terminate calls to the PSTN. It does not place obligations on other IP-based service providers, such as those that provide instant messaging or Internet gaming services, because although these services may contain a voice component, customers of these services cannot receive calls from and place calls to the PSTN. The FCC has also stated its intention to adopt, in a future order, an advanced E911 solution that includes a method for determining the customer's location without the customer having to self-report this information.

Box 6: FCC Enhanced 911 Service Order (FCC 05-116[26])

- Interconnected VoIP providers must deliver all 911 calls to the customer's local emergency operator. This must be a standard, rather than an optional feature of the service.
- Interconnected VoIP providers must provide emergency operators with Calling Line Identification and location information for their customers (an Enhanced 911 service) where the emergency operator is capable of receiving it. Although the customer must provide the location information, the VoIP provider must provide the customer a means of updating this information, whether he or she is at home or away from home.
- Interconnected VoIP providers must inform their customers, both new and existing, of the Enhanced 911 capabilities and limitations of their service.
- The incumbent LECs are required to provide access to their Enhanced 911 networks to any requesting telecommunications carrier. They must continue to provide access to trunks, selective routers, and E911 databases to competing carriers. The Commission will closely monitor this obligation. Interconnected VoIP providers must comply with these requirements, and submit to the Commission a letter detailing such compliance, no later than 120 days after the effective date of the Order.

4.5 VoIP and Universal Service/Access

In developing countries, the term 'universal service' is often used to describe the widespread provision of identified services at affordable rates to users in every part of a country. The concept has two main elements: affordability and accessibility. In developing countries, the term 'universal access' is subsumed by the broader concept of universal service and as a medium term policy option, refers to public access to identified services, which may be defined in terms of distance or time to reach access or the size of communities with access. Funding has traditionally been raised to achieve universal access and service goals through a percentage or specified amount of revenues from traditional telephony providers. With more users switching to VoIP, there is fear that a loss in telecommunications revenues could lead to a subsequent loss in funding for universal service/access. This raises the inevitable question as to whether VoIP providers should be included in universal service/access arrangements and contribute to a national universal service/access fund?

There are two regulatory and policy issues at stake here: the financial contribution VoIP service providers might make to universal service/access funding and the use of VoIP as a tool to deliver cheaper calling to a wider number of consumers. Universal service/access contributions are in effect a form of taxation. Providers are usually charged a percentage of their turnover, paid to the regulator, and in some cases paid over to the national fiscal authority. The regulator may pass the money on to an agency or agencies charged with the task of meeting universal service/access objectives. The difficulty posed by VoIP service providers in this context--and particularly where VoIP is not a formally licensed service--is that they do not usually make contributions of this kind to the regulator and that as VoIP calling increases, the amount of turnover subject to such funding will reduce.

The FCC has issued a public notice that states that the "dramatic decrease in traditional long-distance wireline traffic and the increase in the use of VoIP and the deployment of IP networks has changed the dynamics of USF so irrevocably that immediate attention to the issue is required." If approved, this would mean new taxes on VoIP customers that do not currently pay into the universal service fund. Companies that already pay into the fund indirectly may have to raise their rates because their contribution would likely have to increase. The FCC has suggested that any new regulations should require anyone with a phone number to pay into the fund at the same rate, regardless of whether their phone service comes from a cable provider, VoIP provider, or a wireless or wireline provider. Some VoIP customers already see charges linked to the USF on their bills, because many providers have to pay fees to the telephone companies whose wires they use. Vonage, for instance, imposes what it calls a "regulatory recovery fee" of $1.50 on each phone number it distributes[27].

However, if all calls (or just international calls) are subject to tax, irrespective of what technology they were carried by, government can collect funds to be used to meet its universal service/access objectives. Clearly there is concern that as the cost of calling is reduced, the amount of traffic revenue will also decrease, reducing the amount that can be raised by taxes. However, this concern may well be balanced by greater levels of uptake as call costs become cheaper, thus reducing the scale of any overall universal service/access burden. And there is also a wider market entry point to consider: if the burden of this universal service/access "tax" is too high, it may put off the very innovators who might be able to deliver low-cost, calling services for the less well-off.

As IP delivery of services is arguably cheaper than traditional PSTN services, VoIP can also be seen as a way of encouraging precisely this kind of low-cost innovation. Using the same bandwidth, a VoIP network can carry many times the number of voice calls as a switched circuit network. Therefore transport cost per bit of information is lower on packet switched networks. As such, VoIP can be supported by regulators in developing countries as a means to enhance at least the affordability aspect of universal service/access. The Association of Infocentres of El Salvador (Infotel), for example, is launching a VoIP service for international calls using pre-paid call cards. The service will be available in 41 of the Association's centres and the initiative is supported by the Salvadorian regulator as a means of reducing international call costs. Similarly, state-owned

Telecommunications Office (Telof) in the Philippines plans to launch VoIP services in un-served rural areas.[28]

To address poor teledensity in rural areas, the South African government amended the Telecommunications Act in 2001 to create a class of service licences to provide telecoms service in geographical locations where teledensity is less than 5 per cent. These “under-serviced area licensees” (USALs) are comprised of small businesses and their licences specifically mandate the provision of service using VoIP, fixed mobile services and public pay phones. The first group of USALs were licensed in 2004 and the regulator began the second round of licensing in 2005.

However, VoIP is likely to remain a small percentage of overall voice revenues in South Africa for many years. Analysts predict growth from ZAR 30 million in 2005 to ZAR 630 million in 2009, representing 3 per cent of all fixed line voice revenues or, only 0.8 per cent of total voice, fixed and mobile combined. Moreover, growth patterns are expected to follow that in Australia, where the majority of VoIP services are expected to be in the corporate sector. The low penetration rate of broadband in homes and the high cost of VoIP terminals, may be one of the main drivers of this skewed take up[29].

The European Union’s Universal Service Directive defines universal service as “*the provision of a defined minimum set of services to all end-users at an affordable price*”. The Universal Service Directive states that there are no constraints on the technical means by which the connection is to be provided to the user and therefore there is no reason to exclude VoIP technologies from the set of technologies by which universal service can be provided. However, the Directive does not specify to what level a connection needs to be provided. Indeed, the recent EU Commission Communication on the scope of Universal Service suggests that broadband access need not be included.

Similarly, on the grounds of technological neutrality, non-discrimination and especially proportionality considerations, the Directive propose to exclude service providers (including VoIP) from contributing to any national Universal Access Fund unless they are of a sufficient scale to do so. Therefore the question of VoIP providers making a universal service contribution in European countries is at the moment an open one.

Various other countries that allow VoIP, including the Czech Republic, Mauritius, the Slovak Republic and Venezuela subject operators to universal service/access contributions. In Canada, the CRTC has ruled that if the VoIP service provided allows for access to and/or from the PSTN, the service is considered eligible to make contributions to the national contribution fund, even if the customer uses the service to make peer-to-peer (computer) calls. In South Africa, VoIP providers who offer service by virtue of their VANS license are required to contribute to the universal service fund as a general telecommunications licence holder.

4.6 Competition and VoIP

The question of how to regulate the VoIP service market raises the question of what kind of competition issues might arise specifically in relation to VoIP. A number of issues come to the fore in this regard. For example, the development of VoIP services depends greatly on the availability of broadband access. In order to support greater broadband availability, the challenge for the regulator is to ensure open, non-discriminatory and fair-priced access for ISPs wanting to resell broadband access.

Another challenge experienced by regulators is how to prevent the incumbent operator from stopping or blocking VoIP services, for example, by closing the ports used by VoIP services or refusing facilities to downstream providers dependent on infrastructure. Another concern arises out of whether VoIP services can be regarded as a substitute for traditional telephony, sharing similar product features. As described earlier, regulators in most countries have not yet expressed an opinion on this and where opinion has been expressed, it varies considerably. There is also no consensus about which regulatory tools might be best used to ensure fair competition. It is important that a regulator with oversight on competition issues is effective in preventing anti-competitive behavior emerging with respect to VoIP providers as they apply downward pressure on tariffs.

In the European Union, market control is based on principles of competition law that respond to practical definitions of different markets. Regulation is therefore relative to the level of competition in the market described. The telecommunications market is divided into 18 “Relevant Markets”[30] which can be analyzed by the national regulator in each member country. If robust competition is present, no regulation is applied. If the regulator finds an operator with “significant market power” it will set one or more regulatory requirements (remedies) to that operator in the market concerned.

Several European countries are in process of considering whether VoIP should be seen as part of the services to be included in the “fixed telephony relevant market”. Again results vary considerably but in some countries, those VoIP services with a gateway to the PSTN will be considered part of the fixed telephony market for the purposes of competition analysis. The whole question of where VoIP services will be placed in terms of “relevant markets” will shortly be considered by the European Commission (working with European regulators) in the near future. This discussion underlines the main question posed at various points in this paper as to whether VoIP services are equivalent and equal to, and hence substitutable PSTN voice services?

The Canadian Radio-television and Telecommunications Commission has decided that VoIP should be seen as part of fixed telephony market. However it will only regulate VoIP services when they are provided and used as a local telephone service. The decision is aimed at building sustainable competition in the local telephone market. Under this decision, incumbent local loop carriers – those with market power- cannot price their local services below cost to themselves in order to stifle competition.

4.7 VoIP and Interconnection Models

VoIP services challenge current interconnection models in several respects, both from an economic and structural perspective. Again it is helpful to separate what may happen in the short-term during the transition period and in the longer-term when most networks are IP-based. In the short-term, the main interconnections will be between IP networks and the PSTN. In the long run, the interconnections will mainly occur directly between IP networks.

As already mentioned, VoIP has a number of characteristics that will affect basic interconnection. As an IP-based network service, it can be provided directly with the cheapest provider irrespective of national boundaries. VoIP service provider Skype, for example, allows callers to call PSTN numbers and other Skype customers using its ‘Skype In’ and ‘Skype Out’ features. Calls between competitive, developed countries are charged almost at a flat rate and calls elsewhere to PSTN numbers are charged solely on the basis of where the call terminates, not where it originates.

For developing countries, changes in the interconnection model will be driven by the speed at which they make the transition to VoIP and IP-based network services. The more that transition is accomplished, the greater will be the need to consider the issues raised in this section. Regulators from developing countries can assess where they are in the transition process by referring back to Box 3, VoIP Transition, above.

Short-term interconnection issues: Current interconnection models are increasingly based on cost-based charges. The disruptive factor for current interconnection arrangements introduced by VoIP services is the likely difference of investment scale between IP-based networks and PSTN networks. Although views differ as to the exact scale of difference, the cost of IP networks is significantly lower. There is not likely to be any major conflict when the call comes from an IP-based network to the PSTN as the receiving PSTN operators normally charge the same termination fee regardless of which network the call is coming from. However, when the call originates on the PSTN network and terminates on the IP network, the termination cost is difficult to determine. The relevant elements to assess the actual costs are unclear. Thus PSTN to IP interconnection is likely to create a difficult debate between the different players and may require greater regulatory oversight and intervention.

The cost calculation to define the cost based interconnection pricing is usually based on various FDC (Fully Distributed Cost) or LRIC (Long Run Incremental Model) calculation concepts.

Some countries are planning on using LRIC as a tool to define network termination prices, which usually requires significant resources from regulators, their consultants and industry. Today`s LRIC models are developed for circuit switched networks and their applications to IP networks is not known. With the rapid development of network concepts towards IP, caution about LRIC modelling may be warranted. This depends, however, on the state of transition to IP-based network services a country has reached.

Long-term interconnection issues: In the long term, when IP to IP interconnection is dominant, the application of current telephony interconnection models will create a number of problem areas. These are commented on below, but it should be noted that these comments could apply to all IP services and not just to voice calls.

- **Support of new IP based services:** IP based networks are expected to support new services including third party services over network boundaries. The existing usage-based charging for interconnection would mean that there would need to be interconnection agreements and charging arrangements at each interconnection point for each service carried over that point. However, there is a basic technical problem in that there is no way (at least in the near future) to transmit the charging information between IP networks. These practical problems could constitute a barrier to the roll-out of new services if changes are not made to the interconnection model.
- **Changes to cost structures:** Developments in technology and huge economies of scale have resulted in the costs of core or backbone networks dropping substantially. The existing regulatory and commercial models are built on the assumption of an expensive core or backbone network, hence the focus on competition in long distance and international calls through carrier selection and the development of services such as 'freephone'. As a new cost model has developed, there is need to consider changing charging to capacity instead of usage for basic connectivity. The reduction in core or backbone network costs means that a complex interconnection charging model is no longer justified and that a simpler approach should be sought. A simpler approach could come from a combination of two changes, either the separation of services and connectivity, or the adoption of "bill and keep" for services.
- **Changes to the retail market:** The existing retail market is changing with call prices dropping and some operators starting to offer flat rate tariffs where unlimited call volumes are offered for a fixed subscription. This generates the risk of arbitrage and the operators would benefit from having interconnection arrangements that better match the structure of the retail charges. This change is causing many commentators to say that the days of time-based call charges are rapidly disappearing. However, there are still a number of high price, time-based charging structures (for mobile calls and premium rate services) and these providers will likely seek to continue these revenue streams or find substitutes, such as charges for video or music downloads.

4.8 Possible Approaches for Interconnection for IP Based Networks and Services

These developments suggest that there is need to look for new approaches to interconnection. A variety of ideas are under discussion about how to approach IP/NGN interconnection models. There is lively debate between the "telecom world" and the "internet world" on two basic approaches:

a) an open internet type approach where the separation of service provision and connectivity occurs as it does on the internet. This would require separate consideration of:
   - Interconnection (interoperability) at the service level, where services are charged on the “bill and keep” principle (peer to peer), and
   - Interconnection at the connectivity level, where charging between networks is based on capacity charging or another similar method

b) an NGN architecture approach through which network operators have more control over new services, for example service quality (such as providing different categories of guaranteed bandwidth), security (such as customer ID, authentication and security tunneling) and charging for services by third parties. NGN architecture includes additional software, which is not present on the basic internet network, such as IMS (IP Multimedia Subsystem), which controls the interconnection of services to networks. This means that in NGN architecture, since network and application services are separate, network operators can get a share of revenues from application services.

It is likely that in the future there may be more than one interconnection model and that market players should be able to choose the one that best fits their situation. During the transition period to NGN networks, new interconnection models will naturally work in parallel with existing models as the Internet’s current charging models work alongside those of telephony.

5 Other VoIP Regulatory Issues

5.1 Quality of Service

One of the requirements for the deployment of voice over IP networks is the ability to offer toll-quality service equivalent to the existing PSTN. The quality of service (QoS) for voice transmission over IP can be defined in a number of different ways, depending on whether it is considered from a user or a technical perspective. The users' perceptions of service quality can be measured through subjective quality assessment. The most common consumer-based method to quantify QoS in telecom services is the Mean Opinion Score (MOS) described by the E-model from ITU-T. It is based on a variety of statistical tools and aims to represent the user perceptions of service quality.

5.1.1 End to end quality

Discussions of QoS in relation to VoIP typically highlight the issue of increased end-to-end delay and discuss the effects of this delay in terms of its potential for interfering with the normal cadence of voice conversations. A real-time expectation guides our conversation behaviour and, where this expectation is violated, the back-and-forth nature of the conversation begins to break down as we start to talk over each other (double talk) and consequently become more hesitant about switching between the role of listener and talker. However, this problem is not a new one and has appeared with both satellite latency on international calls and mobile telephony.

The delays that come with the use of mobile technology can be more marked than those of VoIP technology and are apparently well accepted by mobile users. Furthermore, for most developing countries, mobile phones set the level of quality expectation, since the majority of voice subscribers use mobile phones. This may be particularly true for Africa. While VoIP call quality is still inferior to analogue or circuit switched systems, many PSTNs in developing countries offer call quality below that experienced in developed countries. In this light, 'quality' must be seen as a relative concept.

Delay is still a major issue for digital voice transmission, but other parameters need to be included in QoS for voice transmission evaluation. The combination of these parameters will therefore define the end-to-end quality:

– jitter, which is the variation in the time between packets arriving, caused by network congestion, timing drift, or route changes. A jitter buffer can be used to address this;

– packet loss, which introduces audio distortions;

– speech coding and decoding, which generates an approximation of the original signal.

5.1.2 QoS for VoIP in Practice

QoS issues for VoIP seen from the consumer perspective are really about a series of trade-offs between costs and other advantages. If we make the comparison with mobile phones, consumers appear willing to pay more for this service than fixed lines because it offers mobility. Likewise, a consumer using VoIP services are willing to trade call-quality for free or low-cost calls. In developing countries, users in the grey market are making exactly the same trade-off: they want to speak to their relatives or friends overseas as cheaply as possible whilst at the same time still being able to make themselves heard and hold a conversation.

On this basis, quality of service for VoIP seems to self-regulate itself and many operators make great efforts to maintain the QoS at the highest possible level. If consumers are not happy with a service's quality, they will cease to use it. Mission critical voice as required by corporate clients is generally not reliant on VoIP unless service level agreements are in place ensuring the integrity of the network for a percentage of service time. While it does seem unlikely then that QoS questions will be a major problem with VoIP, it still remains an issue that regulators are examining. This is particularly true in developing countries where VoIP is emerging as a low-cost communication solution.

5.2 Regulating Network Integrity

The term 'network integrity' is used to refer to the inherent reliability of a network and its resilience to threats (for example, natural disaster or malicious acts) and measures that might be taken to mitigate threats to the normal operation of the network.

The main regulatory problem in this arises from the fact that a VoIP service can be provided independently of the underlying network access ('network/service independence'). This has a number of implications which include:

- Voice over IP services can be provided over an access network without the provider of that network being aware or having any control over the voice service provided;
- Voice over IP services can be provided over an IP network using any access technology;
- Voice over IP services can be provided over an IP network at any location.

This fundamental change has the potential to raise more complicated issues for regulators. This is because existing network integrity requirements have generally been developed with the assumption that the network and the service are *not* independent. In the case of the PSTN, the access network provider is always the provider of calls over that access network (even if at the retail level those calls are resold by another provider), and would always have direct control over the integrity of the access network used. However, VoIP services have introduced the possibility that calls can be provided independently of the access network provider.

In the EU, the requirements relating to network integrity are set out in the EU's Universal Service Directive. It states that "Member States shall take all necessary steps to ensure the integrity of the public telephone network at fixed locations and, in the event of catastrophic network breakdown or in cases of force majeure, the availability of the public telephone network and publicly available telephone services at fixed locations. Member States shall ensure that undertakings providing publicly available telephone services at fixed locations take all reasonable steps to ensure uninterrupted access to emergency services."

This raises a number of questions in relation to VoIP services. For example, are 'nomadic' VoIP services (ones that can be used over any IP access network) provided at a fixed location? What are the implications of network/service independence? What are "all necessary steps" to ensure the integrity of the public telephone network at fixed locations in a VoIP context? These are all issues that are under discussion in European countries. Thus far there is no common European regulatory approach covering VoIP and network integrity.

Box 7: SPIT: A future issue

An issue that has recently begun to emerge and may require further consideration is "Spam over Internet Telephony, or "SPIT". This is part of the general problem of SPAM and SPIM (Spam over Instant Messenger). SPIT is essentially junk mail in voice form, unsolicited voice messages and unwanted advertising or marketing. This problem has a unique element in that VoIP does have elements of broadcast capability. Views differ on the future potential of the problem: while some security products are being developed to incorporate SPIT-blocking technology in future releases, some operators and analysts are less concerned about such threats as messages would have to be streamed to a network, as opposed to simply being mass emailed. At the same time, others have noted that standard content filters used for spam would be very difficult to implement with voice data because of the variability of phrases and pronunciation, making algorithms difficult to write and that the technology lends itself to extremely cost effective solutions for telemarketers. While SPIT is just barely emerging, it is not in itself a new problem, and needs to be addressed as part of a general approach to voice security in the IP space, including Viruses and Denial of Service attacks (DoS) and vulnerabilities to hackers that have been identified with Session Internet Protocol (SIP).

5.3 Communication Security and VoIP: the Role of the Regulator

Electronic communication security is a broad subject that can be used to address a large variety of issues. It is normally understood (for example, in the ITU X.805 framework) that there are eight dimensions that are designed to address network security:

- Access control;
- User authentication;
- Non repudiation;
- Confidentiality;
- Communication security;
- Data integrity;
- Availability;
- Privacy.

For example on application layers of an IP network, the operation of each application (web browsing, e-mail, domain names, real time communication including VoIP services) brings with it its own security questions and in each case specific actions are taken to minimize risks (like filtering in e-mail services).

Box 8: Current Threats to VoIP Networks and Publicly Available Services

- Distributed Denial of Service (DDoS) attacks against the availability of the VoIP network by flooding the network with unnecessary data or attacking the key network elements of the VoIP network. DDoS attacks are typically launched from a large number of compromised client machines and are difficult to defend against in the light of VOIP QoS requirements;
- Thefts of call information by breaching vulnerable VoIP signalling servers. The call information can be as valuable as the content so it is likely to be a target for attackers;
- Conversation eavesdropping or recording by breaching VoIP network gateways or other key points of the infrastructure. Plug-ins needed for sniffing VoIP traffic are available on many open source web sites for free;
- Call hijacking or man-in-the-middle attacks. These scenarios involve rerouting the connection and modifying call parameters;
- Identity spoofing by caller id manipulation;
- Attacks against the terminal equipment software, devices or network servers themselves. The software on these devices can be vulnerable to same types of vulnerabilities that affect all operating systems software.
- A new issue that has recently developed is “Spam over IP” or “SPIT” (see Box 7 above)

5.3.1 The Nature of VoIP services

The communication security of an IP-based phone service and PSTN phone service differs significantly due to differences in the concepts that underpin how each network operates. The PSTN is by nature a closed network with controlled security and privacy. The IP network is based on open network architecture where vulnerabilities, threats and risks for communication security are present in various network elements.

VoIP services are a specific set of services among a larger set of possible services on IP based networks. Thus VoIP services are largely under the general communication security questions that are common to all IP based communication /application services. The following therefore addresses some basic concerns about IP network communication security, which includes VoIP services:

5.3.2 User provided security/privacy - network provided security/privacy

In traditional PSTN networks, privacy and security have been mainly guaranteed by the network’s operator, whereas in IP networks these have been guaranteed end-to-end by the terminals/users. With the wider use of IP networks, it is clear that there needs to be a greater emphasis on privacy and security before VoIP services can be called “carrier-grade”, particularly with the implementation of Next Generation Networks.[31]

Work is already being done to try and address these privacy and security issues in some of the Internet Engineering Task Force’s specification work. It uses the term ‘trust domain’ (and other trusted entities) which can be used in connection with network asserted identities and their privacy.

5.3.3 Regulatory Authorities

Electronic communication security is managed by various organizations on various levels.

However, it is particularly important that telecommunications regulators follow the development of communication security in IP based services, particularly through organizations like the Internet Engineering Task Force.

In the meantime, regulators and governments can inform consumers of the security and privacy risks related to different types of IP based electronic communication and provide education information on the available protection methods and their effectiveness. Regulators and governments can also help highlight the importance of the issue by requiring reports from relevant service providers on the security incidents and failures.

Box 9: Defense Mechanisms Against Security Attacks Services

The protection of communication security is dependent on both the actions of the terminal equipment user and the security practices of the VoIP service provider/operator. Security is always a compromise between the usability/cost of the services and the protection mechanisms provided. The VoIP operator/service provider needs to consider at least the following points to mitigate security risks:

- VoIP networks should be logically separated from other IP networks of the organization;
- VoIP servers should be hardened and treated using the same security precautions as any other servers that contain confidential information and offer network services;
- VoIP networks should be redundant to ensure the availability of the service. The VoIP network has to be resistant to DoS attacks. This is especially essential for emergency services;
- Encryption of VoIP traffic can be used whenever reasonable. Encryption can be implemented on the application, transport or network level;
- Network devices should be configured properly to restrict unnecessary traffic toward VoIP systems and to ensure the operation of VoIP services.

5.4 Regulation and Lawful Interception

The regulatory aspects of lawful interception in terms of VoIP services are complex. In the future it will be vital for law enforcement agencies to be able to monitor and intercept Internet-based voice traffic. However, because of the way in which VoIP services are provided, the sector is much more fragmented than the large telephony operators. Also, traditional carriers are clearly signalling their intent to move to Next Generation Network architectures**.**

Several countries are examining the possibility of providing their security services with the necessary powers to intercept e-mails and monitor traffic on the Internet. If this comes about, Internet service providers will be required to install a link to the security services. The security services will then be able to monitor Internet traffic or equipment within their network. Increasing pressure is being placed on national regulatory bodies to ensure that operators are obligated to have surveillance-enabled networks and retain call and traffic information. As more voice traffic moves to IP-based networks, the same pressures will be brought to bear on VoIP operators.

For example, in August 2005, the United States FCC ruled that that providers of certain broadband and interconnected VoIP services must be prepared within 18 months, to accommodate law enforcement wiretaps and are thus subject to the Communications Assistance for Law Enforcement Act, or CALEA. The FCC has determined that VoIP services can essentially replace conventional telecoms services currently subject to wiretap rules, including circuit-switched voice service and dial-up Internet access. As such, any voice over Internet Protocol, or VoIP, provider linking with the public telephone network must be wiretap-ready by early 2007[32]. CALEA requires the Commission to preserve the ability of law enforcement agencies to conduct court-ordered wiretaps in the face of technological change.

The FCC Order is limited to facilities-based broadband Internet access service providers and VoIP providers that offer services permitting users to receive calls from, and place calls to, the public switched telephone network.

However, as with other media, there are other pressing and sometimes conflicting concerns to consider with respect to the individual right to privacy. In terms of lawful interception, regulators might play a useful role in helping to determine the balance between the rights of the individual citizen and the requirements of government to monitor this kind of traffic. At a practical level, regulators can also help find a balance between the obligations and requirements of law enforcement agencies and the needs of service providers.

Lawful interception raises a number of difficult issues that are not always easily balanced including: data protection, user privacy and public interest. Therefore it is probably easier to use general authorization regimes and ensure that these are compliant with any lawful interception obligations. A further complicating factor is that VoIP services are frequently provided across borders.

Below are some of the issues that are raised by lawful interception obligations:

Costs: the cost of compliance with such obligations can be significant. In some countries, law enforcement agencies or the government share the costs of lawful interception with smaller operators or service providers. However, where these arrangements are absent, regulators need to be sensitive to the fact that for smaller ISPs or VoIP service providers, the cost of purchasing the necessary equipment to be able to provide access to law enforcement agencies can be prohibitive.

Area of Responsibility: another potential problem area is that of delineation of responsibilities for implementation and compliance between the national regulatory authority and the law enforcement agencies. This can lead to difficulties in establishing technical specifications, determining service provider responsibilities and applying remedies that can be imposed in cases of non-compliance.

Standards: lawful interception, especially of cross-border services, is highly dependent on standardization bodies such as the European Telecommunications Standards Institute. Unfortunately, although standards for Lawful Interception in traditional circuit switched networks are well defined and now becoming mature, there is still a long way to go before interception standards for VoIP are standardized.

Privacy: there is no question that lawful interception plays a crucial role in helping law enforcement agencies combat criminal activity. Lawful interception of public telecommunications systems in each country is based on the national legislation in that country. Regulators may have differing ranges of powers that can be applied when dealing with lawful interception issues. Although it is difficult, it is important to balance the data protection, user privacy and public interest aspects.

6 Conclusion

This paper has attempted to outline the regulatory challenges posed by VoIP technology and uptake. It has highlighted the various different approaches currently being taken globally, informed by different levels of market maturity, competition and social objectives of regulation. While the implementation of regulatory approaches will remain highly uneven for many years, and may in fact, never standardize, there is at least consensus on the fact that IP based technology and networks need to be addressed from a regulatory point of view.

The countries that have begun to address regulation on VoIP are generating precedent and learning opportunities for other countries that are not yet in a position to do so. It appears that minimal additional regulation of VoIP is required, to ensure quality, security, network integrity, interconnection, access to emergency services and further competition in global telecoms markets. VoIP services offer a truly exciting technological development that may yet unlock affordable communication solutions for much of the developing world. Regulators can act to ensure that they assist in this common goal.

VoIP is a particularly important opportunity for developing countries to enable voice and other services more cheaply than over traditional PSTN networks. The increased availability of cheaper services will widen access to a larger number of citizens, providing another avenue for closing the digital divide. VoIP also highlights the powerful role of technology and change in communications and its benefits overall, for incumbent operators and new entrants alike who can harness new business opportunities technological change brings.

References

The views in this discussion paper are based on a wide range of information including: recent VoIP conference papers, internal discussion among various national telecoms regulators and from co-operation work, especially among European regulators. Further information is available for example in the following documents (listed alphabetically by title):

ERG Common Statement for VoIP regulatory approaches, includes a common approach by 27 European regulators, especially for VoIP numbering and emergency services. Annexes include summary of some European countries' current regulations related to these issues.

www.erg.eu.org.int

The Essential Report on IP Telephony by the group of experts on IP telephony / ITU-D

http://web/ITU-D/e-strategy/publications-articles/pdf/IP-tel_report.pdf

Impact of Skype on Telecom Service Providers, an Evalueserve report

A Model for Interconnection in IP-based Networks, ECC draft report, including reasons to move to a new interconnection model and presentation on the new model concept.

www.ero.dk

An Overview of VoIP regulation in Africa: policy responses and proposals by Tracy Cohen and Russell Southwood for the CTO

The policy implications of Voice over Internet protocol, report by OECD DSTI/ICCP/TISP (2005)

Skype-VoIP Win-Win, harnessing the value creating power of Skype while avoiding the value destruction by Merlin Consulting and by Fornebu consulting

World numbering developments by Antelope Consulting

www.antelope.org.uk

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[2] Clayton Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (New York: Harper Business, 1997), coined the term "Disruptive technologies". These technologies are said to satisfy existing

customer needs at a drastically lower cost and are simpler and easier to use than previous ones. Disruptive technologies cannot at the point they are introduced into the market, compete against the traditional products such that they can acquire a large market share.

[3] See http://www.telegeography.com/press/releases/2005-05-31.php

[4] See *Webopedia* at http://www.webopedia.com/TERM/I/Internet_telephony.html

[5] Class 0 is phone-to-phone over the PSTN. This is David Clarke's classification system (MIT).

[6] A VoIP network requires a terminal or communication end-point, which can be a phone, PC or even a software programme. Terminals are identified by at least one IP address (e.g. user101@196.71.47.103) and are registered with a server, which stores IP addresses and can map an address to a terminal. The server might also store locational, identifying and traffic data. Finally, gateways act as bridges between the local PSTN and IP network to allow calls between different networks so that the signalling protocol can be understood between networks and so that IP addresses and regular PSTN numbers are recognizable between networks. Signalling data is exchanged between switched circuit telephone networks and VoIP networks. This information is used to setup, manage and release voice calls, and support telephony services such as caller ID, toll-free calling, and mobile authentication and roaming services.

[7] For example, from May 2005, Senegal's incumbent operator Sonatel cut its international call rates to US19 cents a minute at weekends and US31 cents during office hours. Sonatel was one of early adopters of VoIP for international calling.

[8] In South Africa, as part of its tariff rebalancing licence requirement, the monopoly operator, Telkom, reduced international calls overall by approximately 36% over 2004-2005.

[9] A privately owned Pay TV company.

[10] See http://www.20min.ch/tools/suchen/story/27383201.

[11] It is also noteworthy that the establishment of the World Trade Organization (WTO) and the GATS Framework Agreement, has facilitated a much wider and more complex exchange process, and facilitated a regime change from one typified by a exchange of traffic, to one characterized by (multilateral) trade in services, and a consequent shift away from individual, bilateral country negotiations for market access and network interconnection.

[12] The Pakistan carriers use VoIP as licensed long-distance or local loop carriers.

[13] A soft-phone is a piece of software that sits on the desktop of a computer and mimics the functions of a physical phone.

[14] Time Division Multiplexing, a type of multiplexing that combines data streams by assigning each stream a different time slot in a set. TDM repeatedly transmits a fixed sequence of time slots over a single transmission channel. Within T-Carrier systems, such as T-1 and T-3, TDM combines Pulse Code Modulated (PCM) streams created for each conversation or data stream.

[15] Chinatechnews, "MII: No Plans Soon To Lift Ban Over VoIP", July 22, 2005, online at http://www.chinatechnews.com/index.php?action=show&type=news&id=2813; Chinatechnews, "China Netcom Prepares To Crackdown On Illegal Phone Kiosks", June 20, 2005, online at http://www.chinatechnews.com/index.php?action=show&type=news&id=2716

[16] IP-Enabled Services , WC Docket No. 04-36, Notice of Proposed Rulemaking, 19 FCC Rcd 4863 (2004).

[17] "Regulatory framework for voice communication services using Internet Protocol", Telecom Decision CRTC 2005-28, 12 May 2005.

[18] Local VoIP services are defined as those which use telephone numbers that conform to the North American Numbering Plan and provide universal access to and/or from the Public Switched Telephone Network (PSTN), along with the ability to make or receive calls that originate and terminate within an exchange or local calling area.

[19] "Local Competition", Telecom Decision CRTC 97-8, 1 May 1997.

[20] Multiprotocol Label Switching, an IETF initiative that integrates Layer 2 information about network links (bandwidth, latency, utilization) into Layer 3 (IP) within a particular autonomous system--or ISP--in order to simplify and improve IP-packet exchange. MPLS gives network operators a great deal of flexibility to divert and route traffic around link failures, congestion, and bottlenecks.

[21] Memorandum Circular, No. 05-08-2005, Subject: VOICE OVER INTERNET PROTOCOL (VOIP), National Telecommunications Commission of the Philippines (last visited at http://www.ntc.gov.ph/whatsnew-frame.html).

[22] REGULATION OF INTERNET PROTOCOL (IP) TELEPHONY, Statement of the Telecommunications Authority, 20 June 2005, OFTA http://www.ofta.gov.hk/en/tas/ftn/tas20050620.pdf

[23] China's government is considering banning the use of unregulated VoIP services. Report in Fierce VoIP, 13 September 2005.

[24] Intrado has introduced a new service that will enable wVoIP providers to offer 911 services in compliance with the recent FCC mandate. The company claims that its V911 Mobility Service will let wVoIP providers nationwide position their services as primary line replacements. The solution is designed to accommodate each jurisdiction's 911 regulations while supporting static, mobile and out-of-area phone numbers. Intrado supplies 911 integration by transmitting routing instructions for the local 911 service through the wireless VoIP provider's modem. The service redirects VoIP 911 calls

over the existing wireline service and offers live call-center support 24 hours a day. See http://lists.fiercemarkets.com/c.html?rtr=on&s=69l,f8zf,lcs,bhks,bxd0,jti9,1419

25 "Decision on 9-1-1 Emergency Services for VoIP Service Providers", Telecom Decision CRTC 2005-21.

26 Federal Communications Commission, 911 Services, at http://www.fcc.gov/911/enhanced/

27 Federal Communications Commission, Federal-State Joint Board on Universal Service Seeks Comment on Proposals to modify the Commission's Rules relating to High Cost Universal Service Support", FCC 05J-1, CC Docket No. 96-45, 17 August 2005.

28 Telegeography, "Telof to launch VoIP in unserved areas", May 16, 2005. Available at http://www.telegeography.com/cu/article.php?article_id=7203

29 ITWeb Market Monitor with BMI-TechKnowledge, July 2005.

30 The list is provided in the European Commission's recommendations.

31 For a description of Next Generation Networks, see Keith G. Knightson's presentation of Basic NGN Architecture and Principles: http://www.itu.int/ITU-T/worksem/ngntech/presentations/s1-knightson.pdf

32 Federal Communications Commission, First Report and Order and Further Notice of Proposed Rulemaking, FCC 05-153, ET Docket No. 04-295 RM-10865, 23 September 2005. Available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-153A1.pdf

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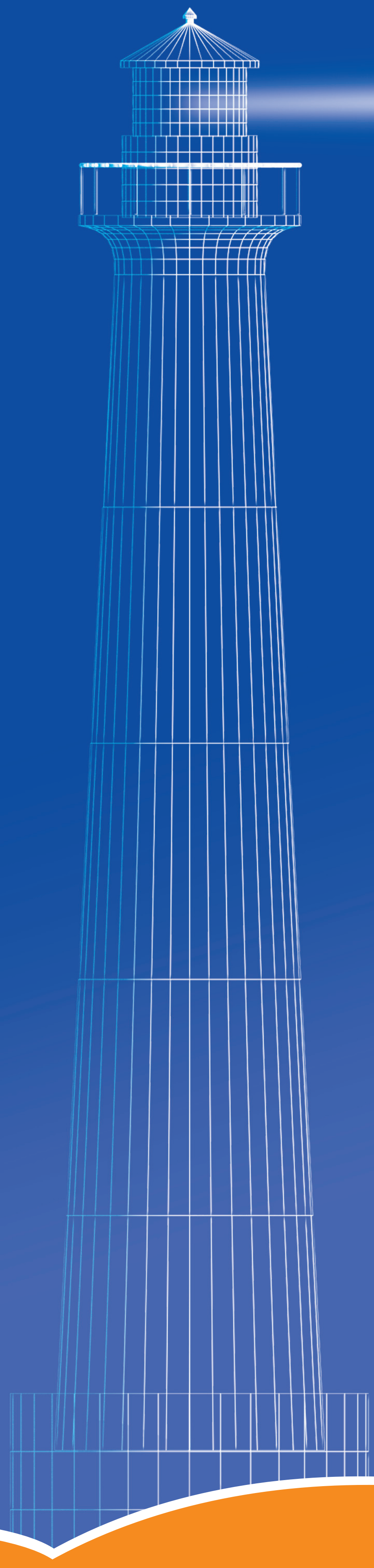

GSR 2005
DISCUSSION PAPER
SPAM

Comments are welcome and should be sent by 5 December 2005 to GSR05@itu.int

International Telecommunication Union

GLOBAL SYMPOSIUM FOR REGULATORS

MEDINA CONFERENCE CENTRE
YASMINE HAMMAMET, TUNISIA

14-15 NOVEMBER 2005

Work-in-progress, for discussion purposes

Stemming the International Tide of Spam:

A Draft Model Law

Prepared by *JOHN PALFREY*

Comments are welcome and should be sent by 5 December 2005 to http://www.gsr2005@itu.int.

TABLE OF CONTENTS

GSR Spam Discussion Paper

"Stemming the International Tide of Spam: A Draft Model Law"*

Executive Summary

Spammers continue to run circles around the anti-spam police. Dozens of countries have anti-spam laws on the books, yet enforcement of the statutes is costly, infrequent, and rarely, if ever, has any meaningful net effect on the amount of spam sent and received the next day. Each enforcement action is complex, frequently involving multiple jurisdictions, and more expensive than most developing countries can afford to undertake. Anti-spam enforcement must take more innovative forms than simply the direct pursuit of individual spammers by over-burdened regulators[1]. Most important, any anti-spam initiative must be pursued in the context of multiple modes of regulation, including law, technology, markets, and social norms. The least-intrusive, least-costly, and ultimately most effective anti-spam measures are relatively simple things that end-users can do to protect themselves, such as spam filters on e-mail clients. But these end-user controls alone have not solved the problem, for a variety of reasons, and, while preferable as a solution, there is no consensus to pursue an aggressive end-user education route as the answer. As the spam problem worsens, it is taking on increasingly troubling dimensions of fraud as well as threatening to undermine efforts in developing countries to provide access to citizens. Legislators and regulators believe that they are compelled to act against spam in the public interest.

This discussion paper primarily takes up the question of what – beyond coordinating with technologists and other countries' enforcement teams and educating consumers – legislators and regulators might consider by way of legal mechanisms. First, the paper takes up the elements that might be included in an anti-spam law. Second, the paper explores one alternative legal mechanism which might be built into an anti-spam strategy, the establishment of enforceable codes of conduct for Internet Service Providers (ISPs). Third, this paper also examines a variant of the legal approach where ISPs are formally encouraged by regulators to develop their own code of conduct. ISPs should be encouraged to establish and enforce narrowly-drawn codes of conduct that prohibit their users from using that ISP as a source for spamming and related bad acts, such as spoofing and phishing, and not to enter into peering arrangements with ISPs that do not uphold similar codes of conduct. Rather than continue to rely upon chasing individual spammers, regulators in the most resource-constrained countries in particular would be more likely to succeed by working with and through the ISPs that are closer to the source of the problem, to their customers, and to the technology in question. The regulator's job would be to ensure that ISPs within their jurisdiction adopt adequate codes of conduct as a condition of their operating license and then to enforce adherence to those codes of conduct. The regulator can also play a role in sharing best practices among ISPs and making consumers aware of the good works of the best ISPs. While effectively just shifting the burden of some of the anti-spam enforcement to ISPs is not without clear drawbacks, and cannot alone succeed in stemming the tide of spam, such a policy has a far higher likelihood of success in the developing countries context than the anti-spam enforcement tactics employed to date.

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* This discussion paper has been prepared by John Palfrey. The views are those of the author and may not necessarily reflect the opinions of the ITU or its membership.

I Introduction

The anti-spam laws enacted around the world to date have so far been largely unsuccessful in stopping spam.[2] Almost in every instance, anti-spam statutes are directed at sanctioning spammers for their bad acts. An increasing number of jurisdictions, often at the country and the state level, have created such laws. Other jurisdictions use existing laws of general application – such as data protection, consumer protection, or anti-fraud legislation – to fight spam. In many cases, these laws miss their target entirely, with no perceptible impact on actual spammers. Often, too, the laws have negative side effects, in the form of transaction costs, administrative costs, and a chilling effect on legitimate senders of e-mail, whether or not in bulk. No matter what kind of law is in use, anti-spam laws require well-conceived, targeted, and coordinated enforcement mechanisms to be effective. The enforcement of anti-spam laws involves investigations that almost invariably become complicated and expensive. This cost and complexity can present challenges for any country seeking to enforce anti-spam laws. Even the United States Federal Trade Commission, with its substantial resources relative to other agencies of its kind around the world, has brought only approximately 70 cases against spammers. For developing countries that have limited human and financial resources for such work, anti-spam laws can be rendered near meaningless because of the enforcement challenge. And while cross-border cooperation and enforcement is not only desirable, but essential to spam-fighting, the variety of spam laws and underlying legal systems on the books of various states makes collaboration extremely difficult. The challenge of fighting spam through law – to be sure only one of the potential modes of regulation – calls both for new thinking and increased emphasis on harmonization and collaboration at an international level. A combination of approaches is likely to be an effective means of combating spam. As noted in the Chairman's report of the ITU 2004 Global Symposium for Regulators[3] (GSR), a multi-pronged approach to dealing with spam is an appropriate measure.

A The Problem

The problem of spam is well established. The extent of the problem is plain to anyone who relies upon electronic messaging as a means of communication and who uses the Internet actively. Electronic mail, along with related forms of messaging such as blogging and SMS, has become an important and popular means of communication in cultures around the world. People and businesses the world over rely upon electronic messaging for a wide range of functions on a daily basis. These services are cheap, have global reach, and have played a key role in the development of e-commerce. The value of the many merits of electronic messaging are rendered obvious by the application's extraordinary global adoption rate, whether in the form of an e-mail client (such as Microsoft's Outlook, Eudora, Thunderbird, or others) or hosted services (such as Microsoft's Hotmail, WebBlaze, Yahoo! Mail, Google's Gmail, Wanadoo or Noos in France, and so forth).

But the openness that has made e-mail and its close cousins such tremendously easy ways to connect is also emerging as their downfall. A combination of economics, technologies, and norms of behavior online has made it such that there is nearly zero incremental cost to send spam, and a more-than-zero return on that investment for senders. The economics seem baffling: how can it possibly be economically worthwhile to send out the grammatically-challenged messages about low-cost VI*%GRA or ripped-off copies of software that most people ignore or never see, as they pile up in "junk mail" folders? Part of the answer is that since the cost of sending the marginal electronic message is so low, the response rate does not need to be very high. It turns out that enough people do respond, either by buying the product marketed illicitly or otherwise acting on the message's information (such as buying a "headed through the roof!" penny stock or giving up your social security number or bank PIN code, in the phishing context), to make the endeavor worthwhile to the spammer. The Business Software Alliance, for example, found that an astonishing 22 per cent of British consumers surveyed purchased software through spam.[4] Rates for the other five countries surveyed by BSA were similarly high. Spam persists because it is a profitable undertaking. Absent a level of consumer education that would result in fewer people falling for the ruse, the risk and cost to the spammer associated with sending spam must rise if the problem is to be solved in a comprehensive manner.

Spammers and those who perpetrate related frauds take advantage of the broadly open network design to render e-mail costly to recipients or even nearly unusable for some businesses and consumers. The "extremely rapid growth" of spam[5] has led to the enactment of more than 75 specific laws,[6] such as the well-regarded Australian law, the United States' CAN-SPAM Act of 2003 and the thirty-seven state laws that it largely pre-empted, and comparable legislation in several dozen countries around the world.[7] These laws have, to date, been unable to stop spam. Each major, credible report on this topic suggests that more than half of the e-mails sent today are spam, and some suggest that spam comprises between 70 and 90 per cent of all e-mails sent.[8] The costs of this scourge are borne not by the spammers, but by those who run the network, those who pay the recipients to work, and those who receive the messages. Accounts vary somewhat in terms of rates of growth, but there is no persuasive evidence that the growth of spam has abated in the wake of anti-spam legislation.[9] In fact, most indicators point in the other direction.[10]

Spam is most profitably viewed not as an isolated nuisance, but in the context of cybersecurity. Spam is bad enough as a drain on productivity in the society at large and as a daily annoyance for many people when they wake up. Spam is enormously costly to Internet Service Providers (ISPs) and others who maintain the network at various levels. Meanwhile, its negative impact is growing by virtue of the bad things it brings with it. Spam is the preferred delivery mechanism for a range of Internet security threats: viruses, phishing, pharming, endless permutations of scams, and advance fee fraud.[11] Spam is also harming the efforts of those in developing countries to persuade new users to begin to rely on digital communications.

The problem is exacerbated by the fact that spam has, to date, defied both extensive lawmaking and concerted efforts on the part of leading technologists and their companies. Arguably the world's most powerful technologist, Bill Gates, promised to lead the charge against spam and to end it within two years of the January 2004 World Economic Forum meeting in Davos, Switzerland, which today seems unlikely to occur.[12] Most major, well-intentioned ISPs and e-mail service providers, along with many technology start-ups, have devoted many millions of dollars to date toward spam-fighting measures. Standards-bodies have sought to improve protocols to snag more spam. User education campaigns have been launched. And governments around the world have come together to enforce their spam laws and to coordinate, periodically, more effectively with one another. The problem continues despite these many efforts, suggesting that new solutions must emerge and that existing efforts must be better pursued and coordinated.

Some of the most effective recent efforts have been those lawsuits undertaken by ISPs under a private right of action in spam legislation. In the United States, the CAN-SPAM Act of 2003 enables ISPs to sue spammers directly. AOL, Microsoft, and Earthlink – very large-scale providers of electronic messaging services – have each brought actions under this statute, as well as under state computer crimes and common law statutes, which have resulted in multi-million-dollar judgments or settlements against "spam king-pins" who abuse their networks.[13] Microsoft's $7 million judgment against Scott Richter may have put an end to one network of spamming that allegedly distributed more than 38 billion unsolicited messages per year.[14] These lawsuits, though few and far between and limited to certain jurisdictions, represent a ray of hope that enforcement by ISPs, with help from customers, might get the job done against spam. The success of these efforts suggests that ISPs could become the most valuable players in the effort to end spam. The challenge for lawmakers is how to create a fair, effective regulatory regime that takes advantage of the abilities and positioning of ISPs to help end spam without placing an undue burden on law-abiding companies.

B A Model Law: One of Several Ways to End Spam

The persistence of the spam problem has led policy-makers, technologists, academics, and many others to come up with a wide range of possible strategies for how to end spam. The least intrusive approach, most consonant with the end-to-end principle of network design, is to leave the work to the end-users, through simple technologies such as spam filters on e-mail clients. Emerging technologies such as authentication, accreditation, and identity management ought to help make user-level controls more effective over time.[15] Mr. Gates, at Davos in 2004, proposed three specific solutions that Microsoft was pursuing that would largely complement these user controls.[16] The most comprehensive of these proposals, in the fashion made famous by Lawrence Lessig of Stanford Law School, call for a combination of law, code, markets, and norms.[17]

The chairman's report of the ITU Thematic Workshop on Countering Spam in 2004 contains a range of such proposals and suggests the intersection of these many methods of spam-fighting.[18] This comprehensive, five-part approach calls for a combination of:

- Strong, enforceable legislation;
- The continued development of technical measures;
- The establishment of meaningful industry partnerships, especially with Internet Service Providers, mobile carriers and direct marketing associations;
- The education of consumers and industry players about anti-spam measures and Internet security practices; and,
- International cooperation at the levels of government, industry, consumer, business and anti-spam groups, to allow a global and coordinated approach to the problem.

Virtually every major report on spam calls for a combination of approaches to end the spam problem, rather than a single "silver-bullet"-style solution. This chapter does not take up in detail each of these anti-spam tools, but rather focuses on legal strategies, with an emphasis on those of relevance to developing countries.

Regardless of which anti-spam strategy, or combination of strategies, one prefers as a primary solution, anti-spam laws are today perceived to be a necessary tool that all countries may wish to consider adopting. If for no other reason, adoption of an anti-spam statute helps to facilitate international cooperation in combating spam. Even the most ardent supporters of user-based, technology, or market solutions to spam tend to agree that governments have a role to play in tracking down and punishing the worst offenders, such as those who use spamming as a means to defraud unsuspecting users. As prominent cyberlaw expert Michael Geist notes, we are in the "third phase" of anti-spam law development, where the anti-spam issue is increasingly viewed as "an enforcement problem that requires significant government involvement at both the national and international level."[19] The existence of interoperable anti-spam laws creates the common baseline essential to coordinated enforcement. While a developing country may not have the necessary resources to enforce its anti-spam legislation alone, there may be anti-spam activities of an international nature in which two or more countries may cooperate to shut down the worst spammers. A country with experience enforcing anti-spam legislation may wish to provide human resources to conduct an anti-spam investigation and enforcement action that leads to another country. In the absence of anti-spam legislation, however, such international cooperation is not possible on a systemic basis. Anti-spam laws are increasingly viewed as one of several necessary tools for most countries.

Spam is arguably a bigger problem in developing countries, where anti-spam infrastructure is infrequently in place, than in wealthier countries, where anti-spam mechanisms are more robust. Many developing countries do not yet have anti-spam legislation.[20] Those that do often are constrained in their ability to devote the necessary resources to enforce these laws.[21] The drain on the technical infrastructure, even if lighter in absolute terms, is relatively more costly in the developing country context. ISPs are frequently deluged by spikes in spam, which lead to network slowdowns and breakdowns.[22] Many sending emails in developing countries do so from shared Internet connections and equipment, such as cyber cafés or other public access centers, and as such ordinarily rely on hosted email services with limits on inbox sizes. These customers complain that spam is tantamount to a denial of service since accessing email becomes too expensive if per-minute charges paid to cyber café owners are consumed by cleaning spam from their inboxes. Even worse, legitimate emails are bounced because the limited space of their inboxes is consumed by spam. Representatives of developing countries point to the fact that most, or at least much, spam still comes from the United States and other wealthy countries and that little support in terms of resources to fight the problem locally have been forthcoming. In addition, representatives of developing countries have argued that the resources of regional bodies such as the OECD are not available to developing countries consistently, leaving developing countries at a comparative disadvantage in terms of being able to do something about spam.

The answer for developing countries is not simply to enact an anti-spam law akin to those passed elsewhere, as such an approach is unlikely to have a perceptible effect. Anti-spam laws aimed at sanctioning spammers, even if codified, may be little used in developing countries. This paper takes up the challenge of introducing the outline of a model anti-spam law that might be tailored to usage in a developing countries context where no anti-spam law yet exists. This paper further takes up the question of whether there are other steps regulators in developing countries could take to combat spam, such as an enforceable code of conduct system related to a country's ISPs.

C An Alternative Mechanism: Enforceable Codes of Conduct

This paper explores the possibility of introducing into anti-spam legislation, particularly in developing countries, the requirement that ISPs establish a code of conduct relative to spam-related activity. The proposal also calls for provisions in the statute that empower the regulator to enforce that code against the ISP in the event of material breach of the code.[23]

Such a proposal cuts – jarringly – across the grain of most Internet regulation to date. ISPs, which are essential players in terms of development of ICT-powered economies, have generally been left alone by legislatures, administrative agencies, and judges. Though licensed and overseen by regulators in some contexts, ISPs have tended to enjoy broad immunity from prosecution related to the bad acts of people on and via their networks. Such a general posture has served development of the global network of networks very well; notwithstanding the proposal set forth here, that posture ought to continue to be the inclination moving forward. The best policy, where possible, is for ISPs not to be in the job of the gatekeeper: they would ideally be in the role of passing all packets from sender to receiver, with decisions about what to send and what to receive determined at the end-points. Any departure from such an approach must be taken up only when serious circumstances warrant; where the regulation is handled with a light touch; and where the new burdens placed on the intermediaries are not viewed as an entry point for more intrusive regulatory hooks.

It is essential to acknowledge the Internet has changed since its inception. We use the network far differently than any of its early architects could possibly have imagined. The community of users is now more far-flung than it ever was; users no longer expect to know one another, as the earliest academics and military users did. The Internet's architecture is a victim of its own success as a matter of design. The conventional wisdom that no intelligence should be built into the heart of the network – the so-called end-to-end principle – is still held dear by many technologists, but is no longer the practice in a meaningful sense, as a large number of points of control have been built into the network, often placed there to deal with massive problems like spam.[24] ISPs still enjoy broad immunities – from copyright and defamation claims based on what others do on their networks – in many jurisdictions, but they are increasingly called upon to play a role in protecting and policing the network. There are substantial risks associated with placing such jobs in the hands of ISPs – particularly to civil liberties – and legislation that supports such regimes must be carefully drafted so as to mitigate these risks.

The suggestion in this paper is that countries establish an industry-led regulatory approach that provides a hook for regulators to step in against the worst actors. The proposal is, explicitly, not meant to presage a wholesale shift in the presumption related to the roles of ISPs; nor is it meant to indicate a shift away from adherence to the end-to-end principle as a preferred design matter. ISPs already bear the brunt of the costs of spam. The role of the law and the regulator should not be to overburden ISPs further, especially given the constraints they already face.[25]

The law should function here as a leveling force. The goal of this regulation should be to reduce spam in a manner that establishes a fair and competitive environment for the protection of responsible ISPs that abide the law. As the Internet has developed into a complex network of networks, ISPs are positioned, for good or ill, as key gatekeepers. ISPs that implement responsible, effective anti-spam measures, while preserving the civil liberties of their users in a manner that is consistent with local law, should be rewarded for their good behavior. One means of rewarding those responsible ISPs is for regulators to hold accountable their competitors who are irresponsible. It is this dynamic of a level playing field for responsible ISPs that the proposal in this paper seeks to establish.

ISPs are no stranger to tussles over spam. ISPs from many countries around the world have taken an active role in fighting spam at the source and, on the receiving end, before it gets to their customers' inboxes. These anti-spam measures undertaken by ISPs cover a wide range. Many ISPs participate in industry-wide working groups, such as the Messaging Anti-Abuse Working Group,[26] and standard-setting organizations working on relevant technical solutions.[27] Initiatives within the ISPs' operations are often geared toward improving security and decreasing the vulnerability of users and of networks – and, in a functioning market with choices of e-mail providers, these measures can take the form of competitive advantage for the ISPs. For example, Google's Gmail, a free web-based e-mail service, removes hyperlinks from messages that the service believes to be "phishing" attempts.[28] The large United States-based ISP Earthlink requires all e-mail messages to route through its mail servers to reduce the impact of zombie networks and mandates that users' e-mail programs submit passwords to transmit messages.[29] While these methods can reduce the burden of spam, their effect is minimal if consumers do not also take steps at the "client" level of the network. Users who do not update virus software and operating systems automatically or regularly, or who download programs that contain "malware" and "spyware" that compromise their computer, pose a risk not only to themselves but to other users worldwide, since their personal computers may be used to relay spam to other unsuspecting customers.

The incentives of law-abiding ISPs are well aligned with the interest of the state in the common desire to end spam.[30] ISPs bear a large amount of the cost of spam and get nothing in return, so long as those same ISPs are not charging a premium to spammers in exchange for sending spam out on their behalf. ISPs also are relatively close to the problem; a spammer needs an ISP to get access to the network to do their nefarious deeds. While spammers are increasingly sophisticated in their actions to evade those who would track them, in most instances, a concerted effort among cooperating ISPs (and possibly law enforcement officials and end-users) can result in finding the worst offenders. The travel of spam can be traced and mapped at a network level.[31] While ISPs are often in very competitive situations where cash-flow is tight, many ISPs do have the financial and human resources to play a key role in the anti-spam fight – and which efforts, at least at the level of collective action, will redound to their own benefit and that of their customers.

Under this proposed approach, the law of a given country would mandate the development of codes of conduct for and by Internet Service Providers (ISPs). The establishment of these codes might be set as a condition of a license, or permission to provide Internet services to citizens. Alternately, this mandate might be implemented through rule-making, via a common set of regulations that applies to ISPs whether licensed or authorized, much as operators are required to provide interconnection, the rules for which are spelled out in interconnection regulations. Such a code of conduct would be developed as part of a light-handed, industry-driven regulatory process. In this scenario, the law would require that regulators grant to ISPs the first opportunity to create a code of conduct outlining appropriate use of its service by its customers (i.e., prohibiting spam, phishing, spoofing, and comparable anti-social behavior on the network), as well as suggestions regarding the best use of spam filters and other technological tools that customers and ISPs themselves can take to fight spam. Under such codes, ISPs would commit themselves to denying service of any kind to spammers, phishers, spoofers and other bad actors who violate these policies. Such codes of conduct would be led by industry and made functionally consistent among all players across the industry, but as part of a process that is grounded in law and provides a role for regulators. The regulator would be empowered to approve the code and to enforce the code if the ISP deviates from its terms in material fashion.

Regulators are better able to do their job under this scenario, as compared to the straight enforcement role against spammers, since the regulators would primarily interact with ISPs. The ISPs are largely running legitimate businesses, are incentivized to help solve the problem (so long as they are not cheating), and are easy to find relative to the spammers, who are often not in the same country and are constantly hiding behind technological smoke and mirrors. The ISPs, in turn, would be responsible to keep tabs on those customers who are engaged in illegal activity and to spurn offers for premium payments to provide spammers with an onramp to the Internet. This paper discusses how such enforceable codes of conduct could be developed such that industry, which best understands technological solutions to the spam problem, takes the lead in drafting the code, while leaving to regulators the job of approving the code and ensuring that ISPs abide by it. This mechanism would empower the regulator to apply a default code of conduct where ISPs fail to develop one or until an acceptable policy is set forth by the ISP. Such a mechanism would also include the regulator's certification of the code which ISPs could use in their advertisements, to ensure customers that the ISP is taking all available steps to protect its customers, and the network at large, from spam. The system would also involve a reporting mechanism so that victims of spam, phishing, spoofing and the like can report such activity either to the ISP or the regulator for follow-up investigation and action.

Such an enforceable ISP Code of Conduct is not without drawbacks. The hazards associated with this approach, explored in greater depth below, must be carefully mitigated. As an enforcement mechanism, its terms must be narrowly tailored to curb spam and related bad acts; it should not be used as a back-door measure to over-regulate ISPs, either by imposing anti-spam obligations where no technical solution has yet been developed (e.g., currently, many anti-spoofing requirements suffer from such a problem) or by using anti-spam measures as a means to limit legitimate political discourse or other protected speech or to infringe upon the privacy interests of citizens. It is essential that such codes be developed by industry and approved, or at a minimum developed together with industry in a collaborative process, and that the codes are frequently updated to take into account new developments in spamming practices and anti-spam technology.

Under a variant of this formal legal approach, the regulator could formally encourage ISPs to develop their own codes of conduct. Many ISPs are taking this step without any encouragement from regulators, which policies are effectively expressed through Acceptable Use Policies for customers and for ISPs with whom the ISPs enter into peering relationships.[32] Under this voluntary scheme, the regulators may assist the industry in developing these codes of conduct. The regulator might also provide assistance to consumers seeking to determine which ISPs have effective codes of conduct and which do not. Though far less likely to be effective than other measures, it is conceivable that a functioning market could emerge, wherein consumers choose ISPs, where there is competition, in part based upon their reputation in terms of fighting spam.

Finally, regardless of whether ISPs are compelled to establish enforceable codes of conduct, regulators have an important role to play in educating and raising awareness among consumers, businesses, ISPs and cyber café operators both on technical solutions such as spam filters, and warning about fraudulent activities like phishing. This chapter will explore in brief the kinds of information regulators can disseminate as well as suggest means of disseminating such information.

II An Outline of a Model Law

A The Context for a Model Anti-Spam Law

Representatives of many countries, particularly in developing areas, have sought a model law for combating spam. The topic of a model law has received considerable attention at two international gatherings hosted by the International Telecommunication Union, one devoted to spam in the summer of 2004 and another on cybersecurity more generally in the summer of 2005. This paper is intended to draw upon the many resources developed to date and to press forward in the process of developing such a model anti-spam law. The outline set forth in this paper is offered with the understanding that the process of refining a model law must also be an inclusive, carefully designed one that is carried out over an appropriate period of time.

An earlier paper, "A Comparative Analysis of Spam Law: The Quest for A Model Law" has made the argument that the benefits of a model anti-spam law are several-fold:

- **Clear guidelines** – Senders who want to comply with applicable legal requirements could more easily learn what rules apply and could follow them more cheaply and consistently, since they would not have to attempt the near-impossible task of tailoring messages for recipients in different jurisdictions.
- **Easy adoption** – Legal systems that do not yet have laws governing spam would have a ready-made model to implement, reducing the burdens of drafting, implementation, and coordination.
- **Enhanced enforcement** – Regulators could enforce laws more effectively and easily since their systems would share harmonized definitions of offenses, burdens of proof, and exceptions. Greater harmonization would make broad-based cooperative arrangements more likely to arise.
- **Stronger norms** – Broad international consensus on the meaning of spam, and what constitutes unlawful communication, would strengthen norms that deprecate such conduct.
- **Fewer havens** for spammers – As more regimes adopt the model law, spammers would have fewer locations friendly to unlawful activity where they could establish operations, increasing their costs and reducing the financial incentives to engage in this behavior. In addition, harmonized legal provisions will increase pressure on systems to adopt meaningful regulations rather than loose ones that facilitate a domestic spam hosting industry. (In particular, the ISP code of conduct notion introduced in this paper is designed to address this substantial concern.)
- **Increased sharing of best practices** – Since legal systems would share harmonized provisions, regulators and enforcers could more easily collaborate upon, develop, and share best practices for implementing spam laws.[33] This issue of spam was, as indicated earlier, addressed at the annual international gathering of the world's regulators, the Global Symposium for Regulators, in 2004 and will be further debated at the 2005 session.

While even a well-crafted anti-spam law in every relevant jurisdiction will never get the job done alone, common anti-spam legislation can be a useful element of a coordinated anti-spam strategy. A good anti-spam law ought to "distinguish between good actors and bad actors and mete out punishment accordingly. If each spam message sent carries with it a credible risk of a fine or other punishment to the spammer, then the effective cost of sending spam will correspond with the volume a spammer produces."[34] The law must be backed by a reasonable expectation that it will be enforced if violated. It is this enforcement mechanism that poses the broadest challenge in the business of anti-spam. That problem is most acute in the developing countries context. An anti-spam law is most likely to be effective in direct proportion to the extent to which it is geared toward being possible to enforce by regulators.[35]

The process for developing a model anti-spam law ought to be pursued collaboratively and inclusively. After such a process, a full model law would be more substantially built-out and include further annotations and options than that which we provide here in this outline. This attempt is to set in place a draft outline, drawing upon the good work of many actors to date, from which a country might work in developing their own statute or as a basis for a full-blown model law, which would need to be extensively vetted. As with any model law, (or, for instance, a directive of the sort passed by the European Union), the proposal must be flexible enough to be able to be integrated with the general types of law in the jurisdiction. Other laws that should be considered, from an integration standpoint, include anti-fraud legislation, consumer protection legislation, and telecommunications and internet-specific legislation (such as computer fraud and e-commerce laws). A relevant process to consider is that which UNCITRAL undertook in establishing its Model Law on Electronic Commerce (1996).[36] UNCITRAL's E-Commerce model includes a number of relevant sections, elements of which have been adopted in dozens of jurisdictions, but it does not address spam *per se*, which did not exist in anywhere near its current form in 1996. Such a model law development process ought also to consider the broad range of laws on the books today, many of which include variations worth considering that are omitted in this report for space purposes only.[37]

Most of the existing anti-spam laws are directed at controlling the behavior of spammers. This emphasis is appropriate at a conceptual level, since spammers themselves cause the problem. In light of the fact that the current slate of laws has failed even to curb the *growth* of spam, much less to eradicate the problem, the core function of these laws is subject to examination.[38] Why have they failed?

There are many reasons that contribute to the lack of success of the current slate of anti-spam laws. Some observers argue that the countries that generate the highest proportional amounts of the world's spam[39] – have done too little at home to stop the problem within their own country and beyond, especially in relying upon opt-out rules and then not enforcing them aggressively enough. This blame can be spread much further than the greatest spam-producing nations, though; no country in the world, including those lauded as the most effective in combating spam, has made terrific inroads through classic enforcement mechanisms. Another problem is that states have not yet been learning from their mistakes by updating anti-spam laws in light of their now-obvious inadequacy. Others point to the fact that anti-spam laws should be focused not on the spammers themselves, but rather those on whose behalf the spam was sent.[40]

The primary issue with these extant laws is that there is too little emphasis placed on investigation, enforcement powers, and resources to carry out the enforcement in a way that is likely to work against such a distributed problem. The issue is not so much that any one case is so hard to build, mount, and win – most spammers or those who commission them to send the mail can ultimately be found, if enough people cooperate – but rather that each investigation is so intensive and complex as to result in an unfavorable (to the enforcer and to the public at large) cost-benefit equation. One of the core tenets of the model law described here is that it emphasizes creating a framework for national enforcement, international coordination in terms of enforcement, and distributed enforcement through the ISP code of conduct provisions.[41]

B Elements of a Model Spam Law

This model law, proposed here as an annotated outline, follows roughly the structure of the Australian anti-spam law, which is widely regarded as one of the most well-conceived statutes of its kind in the world.[42] What follows is an outline of key elements of a model law, a functional description of each segment (not intended to be suitable as the actual legislative language for each jurisdiction, of course), and annotation designed to help the drafter consider important options at each stage of the drafting process. For instance, by way of annotation, a number of important issues are noted that a draftsperson would need to take up at the outset of developing an anti-spam statute.

One such threshold issue is whether the law will be an "opt-in" or an "opt-out" statute at its core. In an opt-in statute, the law states that it is illegal to send spam unless a recipient has affirmatively agreed to receive such an electronic message or otherwise indicated her assent (often through a pre-existing business relationship of some description). In an opt-out statute, the law states that it is illegal to send spam if a recipient has told the sender that the recipient does not wish to receive messages from the sender. The effects of such a decision reverberate through the law thereafter. For instance, if the law is grounded in an opt-out system, the language for a requirement to have an unsubscribe function is, at least conceptually, more essential and takes on a different character than if the system is opt-in, which presumes that the receiver initially exercised an affirmative choice before receiving any messages.

A series of important definitional issues is addressed at the outset of the draft model law. One deficiency of many of the extant spam laws is a lack of clarity at the definitional level and problems that stem from variation among definitions across jurisdictions that might otherwise cooperate to enforce their respective laws.

Draft Model Law

Section 1: Introduction and Definitions

The law ought to clarify that it establishes a scheme for regulating commercial e-mail and other types of commercial electronic messages.

Annotation: The introduction section of the law ought to set forth a series of important definitions. While definitions are always important in legal drafting, they take on special significance in the anti-spam setting. On the one hand, the terms must be broad enough to encompass emerging types of ICT-related spam as they inevitably develop as new technologies become popular; on the other, the provisions must be precise enough to be understood by the governed. In addition, given that anti-spam statutes nudge up against important civil liberties, such as speech and personal privacy (more honored in some jurisdictions than in others), definitions may play a pivotal role in whether the statute is permissible under a country's constitutional framework and/or sufficiently protective of the rights of citizens.

The following are some of the key terms to be included in the definition section of the Model Law, though by no means a complete list:

- **Address-harvesting software.** The law should define the types of computer applications used for the harvesting of e-mail addressed from the Internet which are banned, or the trafficking in or use of which is banned, (if such a provision is included), under the statute.

  Annotation: An important question for any anti-spam law is whether or not to include a prohibition on the use of or trafficking in the technologies that support spamming, such as address-harvesting software. If included in the model law, the term must be carefully *defined so as to avoid banning useful technologies of general applicability that may be used for address-harvesting. Another approach – to some policy advisors, vastly preferable – is not to ban the technology, but rather to bar its use for the prohibited end of gathering e-mail addresses then used in spamming.*

- **Authority, or Regulator.** The law should specify the regulator under whose jurisdiction the anti-spam law resides. Countries vary as to the precise placement of this authority, which might be vested in the telecommunications regulator, the consumer protection authority, the trade regulator, or another regulator of commercial activity.

  Annotation: If multiple regulators are charged with enforcing the anti-spam rules, precise division of responsibility should be established, either in the definitions section or, more likely, below under the enforcement-related provisions.

- **Authorization.** The law should clarify what it means for an individual to authorize a sender to send a message.

  Annotation: This definition may take on greater or lesser significance depending on whether the law is designed as opt-in rather than opt-out. Depending upon the nature of the law adopted and the use and definition of the term "Consent," below, this definition might not be necessary.

- **Commercial.** The law must specify with precision what constitutes a message sent for commercial purposes. Commercial messages among senders and recipients who do not have a previous commercial relationship are likely to serve as the core, prohibited type of content.

  Annotation: One key issue facing development of a useful model law is the variation in the treatment of speech rights in different jurisdictions. In Australia and the United States, for instance, legislators and regulators have stayed clear of regulating unsolicited political messages in light of constitutional protections in both places for political speech.

  Most anti-spam laws focus not on the content of the message, but rather on the intent of the sender. Spam legislation varies as to whether or not the prohibition is circumscribed so as to apply only to commercial messages, but in any event commercial messages most likely must be carefully delineated at the outset. Intent-based statutes suffer from a well-known set of deficiencies, but in this case, it seems to be the consensus that an intent-based rule is necessary. The counter-argument is that the emphasis on intent rather than content might make the statute less likely to harm the rights of free expression of citizens.

- **Consent (or, Affirmative Consent).** The law should clarify what the recipient had to do to indicate her or his willingness to enter into correspondence with an e-mail sender. For instance, the law might state that the term ''affirmative consent'', when used with respect to a commercial electronic mail message, means that (A) the recipient expressly consented to receive the message, either in response to a clear and conspicuous request for such consent or at the recipient's own initiative; and (B) if the message is from a party other than the party to which the recipient communicated such consent, the recipient was given clear and conspicuous notice at the time the consent was communicated that the recipient's electronic mail address could be transferred to such other party for the purpose of initiating commercial electronic mail messages.

  Annotation: As noted above, this definition should be coordinated with the definition of the term "authorization," as needed.

- **Electronic message.** The law must specify, for the purposes of this Act, what constitutes an electronic message. In the Australian example, an electronic message is a message sent: (a) using: (i) an Internet carriage service [the term to be amended depending on local descriptions of ISPs, ESPs, and the like]; or (ii) any other listed carriage service; and (b) to an electronic address in connection with: (i) an e-mail account; or (ii) an instant messaging account; or (iii) a telephone account; or (iv) a similar account.

Annotation: An important area to consider is what applications are covered by the anti-spam statute. The best anti-spam laws will be general enough to cover information and communications technology-based unsolicited messaging in formats that have yet to be devised as well as the range of formats that exist today. Short Messaging Service (SMS) text messages on cellular phones, spam over the instant messaging protocol ("spim"), web blogs (especially in the comments fields), Spam over Internet telephony (SPIT) voice message over Internet telephony and Really Simple Syndication (RSS) are important current variants of traditional e-mail spam that drafters may wish to keep in mind.

- **Evidential (or evidentiary) burden (or, burden of proof).** The law should define carefully, in relation to a matter, which party bears the burden of adducing or pointing to evidence that suggests a reasonable possibility that the matter exists or does not exist.

  Annotation: The relative importance of this provision, of course, will depend upon the nature of the judicial process in a given jurisdiction. It is included here because one of the key problems that enforcement authorities have faced is a high burden of proof placed upon the prosecution in instances where they must show conclusively that a user did not opt-in to communications with the sender. Virtually no individual can prove the negative that they never entered into a commercial relationship, or once hit "OK" in a click-through contract, that permitted a sender to contact them; to place the burden on the regulator to prove this negative is to hamstring her or him in the enforcement process.

- **Internet service provider** (or Internet carriage service; Internet content provider; E-mail service provider; Telecommunications service; or the like depending upon jurisdiction). The law should define what types of service is covered by the statute. The essential part of the definition is that the covered party is one that provides a connection between an end-user and the Internet for a fee.

  Annotation: In many jurisdictions, a wide range of definitions for ISPs are established across various Internet-related laws, so special care should be taken to tie definitions across statutes for clarity's sake. United States law, for instance, has more than 40 potential definitions for terms that resemble "Internet service provider."[43] *The integration of this definition with the rest of the country's law, to limit ambiguity, is important in particular for this model law, which contemplates setting an affirmative requirement for ISPs to develop an enforceable code of conduct.*

- **Send.** The law should clarify that the definition of "send" includes attempts to send.

  [*End of (partial) definition section.*]

Section 2: It is unlawful to send unsolicited commercial electronic messages

Annotation: The scope of what type of message is unlawful to send, combined with the definition of the terms of what is banned, is a crucial element of any spam law. States vary widely in terms of whether messages outside of the core "unsolicited commercial e-mail" is included under the ambit of the law. For instance, non-commercial bulk e-mail is included in the definition of "spam" in some anti-spam legislation and not in others. This is also the juncture where each country must decide whether to join the opt-in or opt-out camps. Virtually all anti-spam laws focus upon the act of sending (or attempting to send) as the core, operative offense. An additional prohibition for this section might be to hone in on the act of paying someone to send unsolicited commercial electronic messages on one's behalf. Some states also bar the sending of unsolicited charitable and issue-

oriented (political) messages, but that step is dangerous and not advocated here, given the importance of political speech to well-functioning government systems.

Section 3: Commercial electronic messages must include accurate sender information

Commercial electronic messages must include information about the individual (or organization) who (or that) authorized the sending of the message.

Annotation: The law might also require that commercial email be identified as an advertisement, with [ADV] or the like in the header, and include the sender's valid physical postal address. Possible terms include stating: "Commercial electronic messages must contain clear and conspicuous notice that the message is an advertisement or solicitation and that the recipient can opt out of receiving more commercial email from you. It also must include the sender's valid physical postal address." Some activists have also called for the requirement that senders label sexually-explicit messages with [SEXUALLY EXPLICIT] in the subject line. The requirement of labeling, such as the added [ADV] or [SEXUALLY EXPLICIT] in the subject line, is hotly contested by e-mail marketers, who fear that all such messages, even if legitimate commercial offers in which individuals are interested, will be filtered into trash folders in e-mail clients and by ISPs.

Section 4: It is unlawful to include false information in any commercial electronic messages

Commercial electronic messages must not include false information. An email's "From," "To," and routing information – including the originating domain name and email address – must be accurate and identify the person who initiated the email. The subject line cannot mislead the recipient about the contents or subject matter of the message.

Annotation: Most experts contend that an anti-spam law ought to contain such a ban on inclusion of false information as a supplement to other provisions, such as the outright bar against sending an unsolicited message. This fourth provision on its own, without the additional hooks, is critiqued as de facto permitting spam that is unwanted but otherwise accurate. Much of the criticism leveled against the US CAN-SPAM Act of 2003 has followed such a line of argument.

Section 5: It is unlawful to send a commercial electronic message without a simple means for recipients to indicate that the recipients do not wish to receive any further commercial electronic messages from the sender

Commercial electronic messages must contain a functional unsubscribe facility. If a recipient exercises his or her right to indicate that he or she does not wish to receive future messages from the sender, the sender must honor those requests. [Or, if the regime is an opt-in regime, such a provision would ensure that a recipient who had previously opted-in could opt-out at any time, after which time the recipient would be treated for legal purposes as not having opted in, from that the time of unsubscription forward.]

Annotation: In the United States, for instance, a sender must provide a return email address or another Internet-based response mechanism that allows a recipient to ask the sender not to send future email messages to that email address. The sender must honor the requests. Any opt-out mechanism a sender includes must be able to process opt-out requests for at least 30 days after commercial email is sent. When a sender receives an opt-out request, the law gives 10 business days to stop sending email to the requestor's email address. A sender may not help another entity send email to that address, or have another entity send email on your behalf to that address. It is illegal for a sender to sell or transfer the email addresses of people who choose not to receive that sender's email, even in the form of a mailing list, unless a sender transfers the addresses so another entity can comply with the law. These provisions, while sensible, are believed to have a very low rate of compliance. Most critics also believe that unsubscribe responses by recipients are *frequently used to add to spamming lists, since the spammers then know that the address reaches a real recipient.*

Section 6: The use of and trafficking in address-harvesting software and the resulting lists of electronic mail addresses are prohibited.

Address-harvesting software must not be supplied, acquired, trafficked in, or used. An electronic address list produced using address-harvesting software must not be supplied, acquired, trafficked in, or used.

Annotation: There is a wise presumption generally against banning technologies that may be general purpose in nature. Any provision of this sort ought to bear in mind, and exempt, the makers of general purpose technologies (for instance, a spreadsheet or software enabling a user to write a simple program that could scrape information from the web) that might be used by spammers to harvest e-mail addresses. The law might also include a prohibition against hacking into databases of e-mail addresses, though in many jurisdictions, such acts would be covered under statutes related to computer crimes, the common law of larceny and/or trespass, or equivalent laws.

Section 7: Remedies include civil penalties, injunctions, and criminal penalties

The main remedies for breaches of this Act are civil penalties and injunctions. Criminal penalties are also sometimes sought, including imprisonment, when false representation, use of another's computer to perpetrate a fraud, or the like is involved.[44]

Annotation: The law might also include a provision making it a criminal offense for an ISP knowingly to accept premium payments from spammers who use the ISP's network to send their spam. Similarly, the law might include a provision that makes the knowing hiring of a spammer to send out unsolicited commercial e-mail a criminal offense.

Section 8: Causes of Action

The law ought to establish a cause of action for regulators against someone who pays a spammer to spam for them (i.e., the owner of a website to whom a spammer is paid to direct traffic, or the party seeking to drive up the value of a certain equity offering, e.g.).[45] The law might also include additional causes of action, such as those that enable an ISP, enforcement officers in lower jurisdictions, and individuals or others who are harmed to initiate a case.

Section 9: International Cooperation

The law ought to create a mechanism for information-sharing internationally and, possibly, formal cross-border enforcement support. These rules would be geared toward the facilitation of cross-border enforcement, simplifying the process for exchange of information among regulators, and encouraging exploration of Memoranda of Understanding and similar means of cross-border cooperation.

Annotation: Much of the emphasis of far-sighted regulators in recent years has been on improving cross-border enforcement efforts. The US FTC has been encouraging the US Congress to pass a law to make such cooperation more likely to succeed. Consider also the work of the International Consumer Protection and Enforcement Network, which joins dozens of countries to conduct "sweep days" to rid the Internet of scams.[46]

Section 10: Jurisdiction

An effective anti-spam law might include provisions designed to assist enforcers by resolving jurisdictional ambiguities.

Annotation: Such a provision could simply clarify what it means for a message to originate or be received within that country and how the regulator will treat such situations. On a more elaborate level, in the United States, the state of Washington's anti-spam law established a database that includes many of the e-mail addresses in that jurisdiction for the purposes of protecting the state's residents.[47] Such an approach bears with it the security concern and hazard that a list of that nature held in one place would be an attractive target for hackers. This concern is mitigated by the fact that spammers apparently do not have much of a problem coming across large swaths of e-mail addresses through other means.

Section 11: Enforceable Codes of Conduct by ISPs.

An effective anti-spam law might include sections related to the development and enforcement by regulatory authorities of industry-derived and implemented Codes of Conduct to be applied to ISPs.[48] Such provisions might include:

a) An introduction, explaining the intention to establish such codes of conduct.

b) A provision granting the regulator, or regulators clearly delineated, to require all ISPs to develop a code of conduct specific to that jurisdiction.

c) A description of the process, involving as many stakeholders as practical, to be involved in the development of codes of conduct, including those who could press the interests of members of the public, consumers, and industry.

d) A provision establishing a registration process for codes of conduct.

e) A provision enabling consumers to access registered codes of conduct.

f) A provision enabling the regulator to develop a code of conduct in the event that industry cannot agree or otherwise fails to enact a code of conduct.

g) A provision enabling the regulator to reject a proposed code of conduct in the event that it lacks appropriate community safeguards.

h) A description of the process for the regulator to issue a warning to an ISP for apparent breach of the code prior to taking an enforcement action.

i) A provision granting power to the regulator to enforce the code in the event of breach by the ISP.

Annotation: A similar structure is set forth in Part 6 of Australia's Telecommunications Act of 1997 covering industry codes of conduct. There are a number of issues to be considered, many of which are set forth in the section that follows. The law would need to establish a timeline for compliance from the enactment of the law and provide for periodic updating of the code. One question is whether, where an industry association exists for all or part of the ISP industry within a given jurisdiction, that industry association ought to be tasked with leading development of the code of conduct. If such an association establishes a code of conduct that is acceptable to the regulator, must all ISPs within the jurisdiction adopt an identical code? The enabling provisions for the code might ensure that an ISP may opt out of a code developed in a group process, and register that separate code with the regulator, provided the ISP's self-developed code is sufficiently protective of the public interest as determined by the regulator.

Australia TELECOMMUNICATIONS ACT 1997 - SECT 117

Registration of industry codes

1) This section applies if:

a) the ACMA is satisfied that a body or association represents a particular section of the telecommunications industry or the e-marketing industry; and

b) that body or association develops an industry code that applies to participants in that section of the industry and deals with one or more matters relating to the telecommunications activities or e-marketing activities, as the case may be, of those participants; and

c) the body or association gives a copy of the code to the ACMA; and

d) the ACMA is satisfied that:

  i) in a case where the code deals with matters of substantial relevance to the community—the code provides appropriate community safeguards for the matters covered by the code; or

  ii) in a case where the code does not deal with matters of substantial relevance to the community—the code deals with the matters covered by the code in an appropriate manner; and

e) the ACMA is satisfied that, before giving the copy of the code to the ACMA:

  i) the body or association published a draft of the code and invited participants in that section of the industry to make submissions to the body or association about the draft within a specified period; and

  ii) the body or association gave consideration to any submissions that were received from participants in that section of the industry within that period; and

f) the ACMA is satisfied that, before giving the copy of the code to the ACMA:

  i) the body or association published a draft of the code and invited members of the public to make submissions to the body or association about the draft within a specified period; and

  ii) the body or association gave consideration to any submissions that were received from members of the public within that period; and

g) the ACMA is satisfied that the ACCC has been consulted about the development of the code; and

h) the ACMA is satisfied that the Telecommunications Industry Ombudsman has been consulted about the development of the code; and

  i) the ACMA is satisfied that at least one body or association that represents the interests of consumers has been consulted about the development of the code; and

j) in a case where the code deals with a matter set out in paragraph 113(3)(f)—the ACMA is satisfied that the Privacy Commissioner has been consulted by the body or association about the development of the code before the body or association gave the copy of the code to the ACMA; and

k) the ACMA has consulted the Privacy Commissioner about the code and consequently believes that he or she is satisfied with the code, if the code deals directly or indirectly with a matter dealt with by:

  i) the National Privacy Principles (as defined in the *Privacy Act 1988*); or

  ii) other provisions of that Act that relate to those Principles; or

  iii) an approved privacy code (as defined in that Act) that binds a participant in that section of the telecommunications industry or the e-marketing industry; or

  iv) provisions of that Act that relate to the approved privacy code.

2) The ACMA must register the code by including it in the Register of industry codes kept under section 136.

3) A period specified under subparagraph 1) e) i) or 1) f) i) must run for at least 30 days.

4) If:

a) an industry code (the *new code*) is registered under this Part; and \(b) the new code is expressed to replace another industry code;

the other code ceases to be registered under this Part when the new code is registered.

Note: An industry code also ceases to be registered when it is removed from the Register of industry codes under section 122A.

http://www.austlii.edu.au/au/legis/cth/consol_act/ta1997214/s117.html

III Codes of Conduct for ISPs, Network Operators, and Other ICT Data Carriers

This paper suggests that countries drafting an anti-spam law, especially developing countries, consider establishing enforceable codes of conduct for ISPs and other entities that might transmit spam. The primary goal of such a set of provisions is to ensure that ISPs that provide a route to the Internet – the source ISP – are taking adequate steps to keep spammers off the network. The net effect of such a set of regulations ought to be to level the playing field for those ISPs that are actively seeking to rid the network of spam, rather than seeking to profit from sourcing it. While there are many risks attendant with regulating ISPs more extensively than they have been in the past, a carefully balanced set of provisions will redound to the benefit not just of customers, but of all well-intentioned ISPs as well.[49]

In virtually all instances, industry is better placed than most regulators to know what technical solutions to spam exist and are likely in the best position to ensure that such technical solutions are implemented.[50] Regulators have a role to play to ensure that industry does all that it can to implement such technical and policy solutions and to share best-practices where industry members do not have visibility into the effective practices of others.

The use of industry codes of conduct is a promising mechanism that has been under-utilized in the anti-spam fight. A similar strategy has been used for a variety of other issues, such as interconnection, number portability, and other technical coordination issues in telecommunications. If combating spam is not in the remit of the telecom regulator, a similar mechanism could be established for consumer protection authorities, data protection authorities or other similar bodies. For the purposes of this chapter, the code of conduct has been included in a model anti-spam law, but such a set of provisions could easily fit within other sections of a country's legislation, such as the telecommunications laws and regulations generally. The code of conduct does rely, however, upon core elements of an anti-spam statute.

A Procedural Steps Toward an Enforceable Code of Conduct

Industry codes of conduct should be developed in the spirit of minimal regulation of the Internet and as a measure of private and public sector cooperation to address the growing problem of spam. The development of such codes of conduct would include several key steps:

- The relevant industry member or members are granted the first chance to develop their own code of conduct, based upon the stated goals of the regulations. The process by which a draft code is established should be set forth in the regulations so as to ensure broad and open participation by key stakeholders.
- Where appropriate, the regulator can help in code development, by way of sharing best practices. Internationally, this can be done, for example, through the use of online fora such the ITU's Global Regulators Exchange (G-REX)[51] or face to face meetings such as the annual ITU's Global Symposium for Regulators. Another useful international resource is the OECD's Spam Toolkit, which is under development (a draft is accessible at www.oecd.org/sti/spam

- The relevant industry member or members present(s) the code to the regulator for its approval.
- A new body, or an existing regulator with relevant expertise, takes responsibility for the administration and registration of the code.
- If industry fails to develop a code, or if the code is not deemed acceptable, the regulator has the power to develop a code for industry or revise the code to ensure sufficient anti-spam measures are being taken by ISPs, network operators and other potential spam carriers.
- The industry members are expected to enforce the code against their customers and those with whom they peer. The enforcement is meant to prohibit the worst acts of spamming, not to encourage an ISP to inquire into the nature of any more messages sent through their networks than they ordinarily do. The expectation is that ISPs would only need to take reasonable measures, such as investigation when the ISP receives an unusually large numbers of complaints against a single customer or when the regulator passes along such complaints.
- The regulator or administrator provides a mechanism for handling complaints from end-users against an ISP for failure to live up the code.
- If industry members fail to enforce the code, the regulator is empowered to take action against non-compliant ISPs. Possible sanctions include fines levied against the ISP, the introduction of harsher licensing requirements, or lawsuit.

  Annotation: One issue to consider is which parties would have a right of action to sue a non-responsive ISP. For instance, consumers who have been damaged by spam or phishing, but who have not been able to convince the regulator to bring an action against an ISP, might gain recourse to go to court to sue the ISP directly for violation of its code of conduct. Another way to achieve the same end might be to require ISPs to include adherence to their code of conduct as a pledge made by the ISP to consumers under their usage contracts, enabling consumers to sue not under the anti-spam law but as a straight breach of contract matter in those jurisdictions with such a cause of action.
- The code might also allow for the creation of a "certification" or "accreditation" system, whereby ISPs that have agreed to comply with the code can advertise to their customers that they are a signatory to such a code. Such an accreditation mechanism might function as other trustmark organizations, such as TrustE, do in a business ecosystem, helping consumers with limited time to make reasonable decisions about which service to choose.[52] Such an accreditation process would be most important in the event that the code of conduct process were encouraged, but not mandated, by the regulator.[53]
- The code should also include a mandatory review or sunset clause provision to ensure that the regulation remains appropriate in a fast-changing technological and legal environment.

These procedural steps ought to be designed with a view toward ensuring that the resulting codes of conduct are optimally designed to address the spam problem as it continues to morph, while limiting the negative externalities to which such provisions might give rise.

B Elements of a Model Industry Code of Conduct

Like a model law, an industry code of conduct ought to be developed through an inclusive, carefully orchestrated process designed to elicit the best thinking from a range of experts and concerned stakeholders.[54] The code should set forth the responsibilities of ISPs and other carriers with regard to spam in a manner that is sensitive to local concerns, yet takes into account the cross-border nature of the problem. Key elements of a model industry code of conduct might include:

- A series of common definitions that tie directly to the definitions set forth in the relevant law.
- A set of suggested procedures to be followed by ISPs in dealing with obvious spam that comes into the ISP's sub-network (including procedures relating to the provision or use of regularly updated software for filtering spam).
- A commitment not to provide services to those who send unsolicited commercial email in bulk and to terminate those clients when complaints, and subsequent investigation, reveals that the client has been spamming through the ISP's network. This commitment also includes agreement to refuse any payment, or premium payment, offered by a known spammer for any services.
- A commitment to giving subscribers to the ISP information about the availability, use and appropriate application of software for filtering spam at the client level. A similar commitment to giving customers plain-language advice on how to prevent their computers from being infected by worms, trojans, or other malware that turn computers into spam "zombies," and provide the appropriate tools and assistance.
- A commitment to taking action to assist in the development and evaluation of software for filtering spam that gives the user maximum levels of control over their decisions of what to accept and to reject.
- A series of suggested best practices, not required by the law but recommended by the code, that may be taken as appropriate in order to minimize or prevent the sending or delivery of spam. At present, such suggested best practices might include some of those set forth in the London Action Plan.[55] The London Action Plan is the result of a meeting in late 2004 of "government and public agencies from 27 countries responsible for enforcing laws concerning spam" who "met in London to discuss international spam enforcement cooperation. At this meeting, a broad range of spam enforcement agencies, including data protection agencies, telecommunications agencies and consumer protection agencies, met to discuss international spam enforcement cooperation. Several private sector representatives also collaborated in parts of the meeting." Recommendations derived from these expert gatherings include:
  - The optimal configuration of servers and other network devices so as to minimize or prevent the sending or delivery of spam;
  - A commitment to taking meaningful zombie-prevention measures;[56] and,
  - A statement of principles relating to entry into peering arrangements only with those ISPs which also abide in full the code of conduct, to establish a virtuous circle.

The draft provisions of a code of conduct will no doubt change rapidly as the nature of the problem changes. Today, as much as 50% of all spam is sent through "zombie" computers, which suggests that emphasis on helping users to avoid their computers becoming zombies ought to be a high priority. Once this loophole is closed to spammers, the way through the network for unwanted e-mail is certain to change, potentially giving rise to the need to amend the code of conduct to head off other problems. The proposed law ought to be flexible enough to accommodate such certain changes in the technological landscape.

C Hazards Associated with Enforceable Codes of Conduct

The adoption of a statute that establishes a regime of enforceable codes of conduct for ISPs is not without hazards. A well-designed scheme should be able to mitigate these hazards, but they are worth considering at the outset.

- Industry Codes of Conduct should be geared toward ensuring that ISPs have the proper incentives to be refusing service to and shutting down outrageous spammers, not to over-regulate ISPs or to encouraging ISPs to block more messages or listen in to more conversations that their users are having. The use of such codes should be strictly limited to requiring ISPs to shut down spammers, and not used for other objectives, such as requiring ISPs to shut down those who use email to send what the government considers as unpalatable political messages, nor for the purpose of surveillance of a country's citizens. This hazard points back to the importance of definitions in the introduction of a model anti-spam law that clarify that only electronic messages of a commercial nature are not to be sent without the appropriate level of permission (contingent upon whether the regime operates on an opt-in or opt-out basis). Overall, the risk of such an approach is that ISPs become more inclined to look into the nature of messages sent across their network. A properly crafted law of this sort should not have this effect, if regulators are certain to focus on the worst, most obvious cases of spamming, rather than pressuring ISPs to shut down legitimate e-mailers for fear of regulatory backlash.
- Enforceable codes of conduct have a key dependency on a well-drafted, basic anti-spam law or provisions in other laws that prohibit the worst acts of spamming. Without such an underlying statute and the threat of direct enforcement against the spammer by a regulator, the ISP, or another affected party, the code approach is less likely to be successful. As referenced above, the provisions that establish a code of conduct might sensibly be placed within telecommunications regulations or otherwise apart from the spam statute, so long as the regulator, and potentially others, has the ability to take direct action against a spammer.
- The political realities in terms of adopting and enforcing such a scheme are likely to be complex in many jurisdictions where ISPs have previously enjoyed broad immunity or where the ISP is a monopoly, state-owned telecommunications provider that actually or prospectively generate important revenues for the government.
- There are costs associated with any new administrative mechanism, even one as simple as the code development, registration, and updating process, which ought to be factored into a country's cost-benefit analysis when considering adopting such a regime.
- There are a variety of downsides related to placing such a large bet on placing ISPs in the role of lead players in the fight against spam. As noted above, adding intelligence to the middle of the network, and encouraging gatekeepers to use this intelligence, is sub-optimal from a network design perspective. Like regulators in developing countries, ISPs may themselves face resource constraints to enforce their code. ISPs may or may not consider themselves properly incentivized to enforce the code (i.e., they may have trouble balancing a desire to attract and retain bad-acting but paying customers v. the cost of transmitting the spam through their network + the regulatory risk/cost of so doing + any loss of other revenues or attendant costs associated with harboring spammers). ISPs may over-enforce the provisions of their own code, resulting in messages not getting delivered to recipients – a far worse outcome, many argue, to dealing with even a deluge of spam. ISPs may also not be as sensitive to the rights of free expression of their users as states are, especially as most speech protections do not extend to non-state action, as in the case of a private actor blocking otherwise protected speech. ISPs would likely pass costs along to end-users, perpetuating the already-vicious cycle of spammers making the rest of the Internet's users pay for their bad acts. In a developing country context, high Internet access costs are already a major barrier to widespread ICT adoption. Such concerns, however, should be seen in the context of the spam problem itself, which is adding to the cost of Internet access and is helping criminals to perpetrate fraud and disseminate destructive code, each of which are bad not only for consumers but also for the ISPs themselves.

Any legal and regulatory approach of this sort should bear in mind and seek to mitigate these drawbacks. On balance, however, many jurisdictions will likely find enforceable codes of conduct to be a sound policy choice, which effectively distributes part of the enforcement burden to those closest to the source of the spam problem – the ISPs and the end-users.

IV The Role of the Regulator in Education and Awareness Raising

The optimal solution to spam would involve no new law whatsoever. If consumers and businesses could take spam-fighting into their own hands, the problem would be solved at the lowest cost and at the quickest rate. Regulators could establish an enforcement backstop against the worst offenders who perpetrate the occasional fraud, rather than being thrust into an active enforcement role on the front lines of the anti-spam battle. The brunt of the anti-spam enforcement work would be carried out at the further edges of the network in the most distributed manner possible, by those who pay the true costs of spamming – the end users – while regulators focused their enforcement resources on the largest, most complex cases.

Regulators could have a very important role to play in educating consumers, businesses and ISPs about the dangers of spam and the steps they can take to protect themselves against spam and its attendant problems.[57] The London Action Plan includes some suggestions for best practices for regulators. Specific ideas include:

- Regulators should consider developing a communications plan relating to consumer and ISP education, such as posting information on their websites and developing print materials for distribution to cyber-café owners, consumers, other businesses and ISPs.
- Regulators should provide a simple means for consumers to make complaints about spam, which, in the aggregate form, in turn will be useful both to ISPs and regulators in stopping spammers.
- Regulators should consider creating a "Combatting Spam" section on their websites that would provide information for consumers, businesses, and ISPs about the best anti-spam practices at any given time. Practical advice regarding spam filters, warnings about phishing attempts and spam that carries viruses, information about recent scams carried out over e-mail, and the like would help to empower end-users to participate in the anti-spam campaign. Examples of web sites in use today include:

  Industry Canada's page on Recommended Best Practices for Internet Service Providers and Other Network Operators:

  http://e-com.ic.gc.ca/epic/internet/inecic-ceac.nsf/en/gv00329e.html

  Recommendations of the Commission nationale de l'informatique and des libertés in France (CNIL Republique Francaise):

  http://www.cnil.fr/index.php?id=1539

  Guidance provided by the Korea Spam Response Center, which "KISA (Korea Information Security Agency), which is an affiliated agency of the Ministry of Information and Communication, on January 24, 2003, to receive and handle civil appeals relating spam issues and to carry out anti-spam activities".

  http://www.spamcop.or.kr/eng/m_3_2.html

  The US FTC's Education Pages related to Spam:

  http://www.ftc.gov/bcp/conline/pubs/buspubs/secureyourserver.htm
  http://www.ftc.gov/bcp/conline/edcams/spam/secureyourserver/index.htm
- Regulators should also consider their ability to play a central role in coordinating the sharing of best practices among ISPs, especially in contexts where political will or

resources do not exist for the regulator to achieve an enforcement role. The regulator can also help educate ISPs about some of the relatively simple technical measures. Specific measures include the latest information related to the blocking of open relays,[58] focus on "botnets,"[59] and slowdowns of traffic on port 25 that might make an enormous difference, particularly in the developing countries context.

Consumer and ISP education is a necessary component of spam-fighting strategies, but efforts of this sort has had little effectiveness to date. The limited effectiveness of these measures, however, is not due to their lack of promise, but rather the limited vigor with which they have been pursued and the challenge of communicating highly technical information to a lay audience. Like the other modes of regulation, consumer and ISP education cannot stand alone, without effective technological and regulatory measures to combat spam, but substantially greater efforts in this area by regulators are warranted and would pay large dividends. But regulators should not lose sight of the fact that end-users, as well as ISPs, are best positioned to make a difference on the front lines of the anti-spam battle.

V Conclusion

Despite the challenges that are bound to lie ahead, regulators ought to encourage the adoption of an anti-spam law that is as consistent as possible with that of other countries. Such an anti-spam law might involve creation of an enforceable code of conduct for ISPs, which will place the responsibility closer to where the technical expertise lies. The problem with anti-spam laws to date is that they have failed to create an enforceable regime and have failed to bridge the divide between the state and the technologists who are closest to the ways to solve the problem. An enforceable code of conduct for ISPs, while imperfect as a remedy, could help to mitigate these shortcomings of most previously-enacted anti-spam laws.

Any model anti-spam law, or specific regulatory recommendation, must be taken in the context, however, that the effort to fight spam is not going to be won by adoption of any single strategy. The only way to be successful will be to ensure broad international cooperation based on a range of shared strategies, including legal and regulatory mechanisms, technical improvements, market forces, and consumer-oriented strategies. The development of ISP codes of conduct and their enforcement by regulators can immediately contribute in terms of stemming the tide of spam and materially reducing costs to ISPs and consumers.

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[1] This discussion paper uses the term "regulators" in the broad sense to include any governmental entity that has been given the mandate to combat spam. Thus, the term "regulators" for this chapter may mean national telecommunications or ICT regulatory authorities, consumer protection authorities or data protection administrations.

[2] Despite passage of many dozens of anti-spam statutes in jurisdictions across the globe, the problem has continued to worsen. *See, e.g.*, David E. Sorkin, Spam Legislation in the United States, The John Marshall Journal of Computer and Information Law, Volume XXII, Number 1, at 4 (2003) ("…it is generally agreed that legislation has failed to solve the spam problem.") *See also*, Matthew Prince, "How to Craft an Effective Anti-Spam Law," WSIS Thematic Meeting on Countering Spam, July 2004, ITU Discussion Paper, at 10, at http://www.itu.int/osg/spu/spam/contributions/Background%20Paper_How%20to%20craft%20and%20effective%20anti-spam%20law.pdf ("Few people would dispute that around the world the first generation of anti-spam laws has been an unqualified failure.").

[3] http://www.itu.int/ITU-D/treg/Events/Seminars/2004/GSR04/index.html

[4] Business Software Alliance, *1 in 5 British Consumers Buy Software from Spam*, Dec. 9, 2004, *at* http://www.bsa.org/uk/press/newsreleases/online-shopping-tips.cfm.

[5] http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=108_cong_public_laws&docid=f:publ187.108.pdf

[6] *See* Matthew Prince, "How to Craft an Effective Anti-Spam Law," *supra* note 1, at 3.

[7] For the most comprehensive resource on the world's anti-spam laws, *see* Christina Bueti, "ITU's Survey on Anti-Spam Legislation Worldwide," July, 2005, at http://www.itu.int/osg/spu/cybersecurity/docs/Background_Paper_ITU_Bueti_Survey.pdf.

[8] For instance, e-mail security provider IronPort Systems asserts that 72% percent of e-mail sent is spam. *See* http://www.ironport.com/company/pp_sci-tech_today_08-10-2005.html.

[9] AOL claims that spam is down 85% from two years ago, based upon consumer complaint information. However, such a claim does not account for the effectiveness that their filters may have achieved on behalf of customers, nor the changing perceptions of consumer about how much spam is acceptable. The same article that reported AOL's claim of less spam concludes, "But statistics show that the amount of spam is still huge – even worse than it was when the federal act [the CAN-SPAM Act of 2003] was introduced two years ago." *See* http://www.crmbuyer.com/story/45413.html. *See also* http://www.washingtonpost.com/wp-dyn/articles/A30433-2004Dec27.html. There is a dearth of reliable industry-wide data, which is not surprising in light of the distributed nature of the problem and the competition between ISPs to provide the best anti-spam services to consumers.

[10] For a review of some of the many recent spam statistics, *see* Bueti, "ITU's Survey on Anti-Spam Legislation Worldwide," *supra* note 5; see Michael Geist, "Untouchable: A Canadian Perspective on the Anti-Spam Battle," June, 2004, at 2, at http://www.michaelgeist.ca/geistspam.pdf; *see also*, Derek Bambauer, John Palfrey, and David Abrams, "A Comparative Analysis of Spam Laws: the Quest for Model Law," June 2005, at 7 – 8, at http://www.itu.int/osg/spu/cybersecurity/docs/Background_Paper_Comparative_Analysis_of_Spam_Laws.pdf.

[11] *See* Chairman's Report, ITU WSIS Thematic Meeting on Cybersecurity, June – July, 2005, p. 2, point 12, at http://www.itu.int/osg/spu/cybersecurity/chairmansreport.pdf (citing a speech by Spamhaus CEO Steve Linford).

[12] http://news.bbc.co.uk/2/hi/business/3426367.stm.

[13] The AOL Legal Department posts Decisions and Litigation to their web site at http://legal.web.aol.com/decisions/dljunk/. *See also* http://www.theregister.co.uk/2005/08/10/aol_spam_sweepstake/ (regarding the AOL gold bars raffle, in which they planned to give away the assets seized from a major spammer).

[14] *See* http://abcnews.go.com/Technology/PCWorld/story?id=1029922.

[15] *See* David R. Johnson, Susan P. Crawford, and John G. Palfrey, Jr., *The Accountable Net: Peer Production of Internet Governance*, 9 VA. J. L. & TECH. 9 (2004)

[16] BBC, *supra* note 10.

[17] The four modes of Internet regulation were popularized in Lawrence Lessig's ground-breaking book, *Code and Other Laws of Cyberspace*, in 1999 (New York: Basic Books).

[18] *See* http://www.itu.int/osg/spu/spam/background.html and, in particular, the Chairman's Report, at http://www.itu.int/osg/spu/spam/chairman-report.pdf.

[19] Geist, "Untouchable," *supra* note 8, at 5.

[20] *Ibid.*, point 24 at 4.

[21] It should be noted that even the United States Federal Trade Commission, which is a relatively well-funded regulatory body, had only brought "over 70 cases" as of July, 2005. In light of the billions of spam messages per day, the notion that such an enforcement effort is unlikely to have much effect undoubtedly is apparent to many governments choosing whether or not to devote resources to fighting spam locally. *Ibid.*, point 19, at 3.

[22] *See* Suresh Ramasubramanian, "OECD Task Force on Spam Report: Spam Issues in Developing Countries," May, 2005, at http://www.oecd.org/dataoecd/5/47/34935342.pdf.

[23] *See* http://www.itu.int/ITU-D/treg/related-links/links-docs/Spam.html for a list of voluntary and enforceable ISP codes of conduct.

[24] *See generally* Jonathan Zittrain, "Internet Points of Control," 43 Boston College Law Review 653 (2003). *See also*, J.H. Saltzer, D.P. Reed, and D.D. Clark, "The End-to-End Argument in Systems Design," at http://www.reed.com/Papers/EndtoEnd.html and "The End of the End-to-End Argument" at http://www.reed.com/dprframeweb/dprframe.asp?section=paper&fn=endofendtoend.html ("But in many areas of the Internet, new chokepoints are being deployed so that anything new not explicitly permitted in advance is systematically blocked.")

[25] *See* John Spence, "Pennsylvania and Pornography: CDT v. Pappert Offers a New Approach to Criminal Liability Online," 23 J. Marshall J. Computer & Info. L. 411 (Winter, 2005) (a good general discussion of the role of ISPs in the network and the difficulties they face).

[26] http://www.maawg.org/about/roster/

[27] Many technical working groups have focused on anti-spam-related standards, technologies, and best practices. The IETF, ISOC, and other groups have supported efforts that have involved representatives of ISPS, including the now-scuttled MARID Project (*see* http://www.internetnews.com/bus-news/article.php/3407431), which was preceded by the Anti-Spam Research Group (at http://asrg.sp.am/).

[28] *See* Renai LeMay, *Gmail Tries Out Antiphishing Tools*, CNET NEWS.COM, Apr. 4, 2005, *at* http://news.com.com/Gmail+tries+out+antiphishing+tools/2100-1029_3-5653794.html.

[29] *See* Anick Jesdanun, *Battle Against Spam Shifts to Containment*, ASSOCIATED PRESS, Apr. 15, 2005, *at* http://finance.lycos.com/qc/news/story.aspx?story=48398343.

[30] Consider the remarks of Randall Boe, executive vice president of AOL, when he said that "Spam has become the single largest customer problem on the Internet." (Quoted in Thomas Claburn, "Four Big ISPs Sue Hundreds of Spammers," 10 March 2004, Information Week, at http://www.informationweek.com/story/showArticle.jhtml?articleID=18311680.)

[31] As one illustration of the fact that spam can be traced, *see* http://www.channelregister.co.uk/2005/09/20/spam_map/.

[32] Consider, for instance, that MAAWG is already promoting industry-wide codes of conduct. *See* http://www.maawg.org/about/.

[33] Bambauer, Palfrey, and Abrams, "A Comparative Analysis of Spam Laws: the Quest for Model Law," *supra* note 8, at 11.

[34] Prince, "How to Craft an Effective Anti-Spam Law," *supra* note 1, at 4.

[35] *Ibid.*, at 6. Mr. Prince argues: "The most effective anti-spam laws are action laws that focus on the problems prosecutors face and work to resolve them. If we want anti-spam laws to be effective, our job must be to identify the costs faced by prosecutors and craft laws to reduce those costs."

[36] Accessible online at http://www.uncitral.org/pdf/english/texts/electcom/ml-ec-e.pdf.

[37] *See* http://www.itu.int/osg/spu/spam/ for a catalog of existing anti-spam laws on the books in jurisdictions around the world.

[38] Many analysts predicted the failure of these laws at the time they were passed. For one example of a United States-based consultancy, consider Gartner's report, Maurene Caplan Grey, Lydia Leong, Arabella Hallawell, Ant Allan, and Adam Sarner, "Spam Will Likely Worsen Despite US Law," 3 December 2003, at http://www.gartner.com/resources/118700/118762/118762.pdf.

[39] *See* BBC News, "US Still Leads Global Spam List," 7 April 2005, at http://news.bbc.co.uk/1/hi/technology/4420161.stm (citing a study by security firm Sophos that the US is responsible for sourcing 35% of the world's spam).

[40] *See* the FAQ page for the Coalition Against Unsolicited Commercial Email, at http://www.cauce.org/about/faq.shtml#offshore.

[41] One interesting, as-yet-theoretical variant to the state-focused enforcement mechanism is the "bounty hunter" system proposed by Prof. Lawrence Lessig of Stanford Law School. Prof. Lessig has "bet [his] job" on the notion that such a distributed system, established by law but pushing out enforcement authority to netizens, would work if enacted. *See* http://www.lessig.org/blog/archives/000787.shtml.

[42] The Australian law, which took effect in 2003, can be found online (in an unofficial version) at http://scaleplus.law.gov.au/html/pasteact/3/3628/0/PA000260.htm

[43] For example, the text of the Communications Decency Act Section 230 in the United States provides immunity to the providers of "interactive computer services" for the content published on their network. These providers are defined as follows: "The term `interactive computer service' means any information service, system, or access software provider that provides or enables computer access by multiple users to a computer server, including specifically a service or system that provides access to the Internet and such systems operated or services offered by libraries or educational institutions." http://www.fcc.gov/Reports/tcom1996.txt. By contrast, the term "Internet access service" in the CAN-SPAM Act of 2003, as stated in the Telecommunications Act of 1934, as amended, reads: "The term 'Internet access service' means a service that enables users to access content, information, electronic mail, or other services offered over the Internet, and may also include access to proprietary content, information, and other services as part of a package of services offered to consumers. Such term does not include telecommunications services." http://www4.law.cornell.edu/uscode/html/uscode47/usc_sec_47_00000231----000-.html.

[44] Geist, "Untouchable," *supra* note 8, at 17 (for a discussion of civil and criminal sanctions common in anti-spam legislation.

[45] For discussion of the effectiveness of such a measure, *see* Prince, "How to Craft an Effective Anti-Spam Law," *supra* note 1, at 9.

[46] http://www.icpen.org/.

[47] For discussion of the effectiveness of the state of Washington's use of such a measure in the United States, *see* Prince, "How to Craft an Effective Anti-Spam Law," *supra* note 1, at 6 and 10.

[48] For the full text of the Australian Telecommunications Act of 1997 that contains such provisions, *see* http://www.austlii.edu.au/au/legis/cth/consol_act/ta1997214/s117.html *et seq*.

[49] The Australian Direct Marketing Association (ADMA) has also established a Code of Conduct. Where such an organization exists, such a code is another logical, parallel step; many countries will not have such an entity in place, in which event a legal provision mandating a parallel process of this sort would not make sense.

[50] Consider the findings of the New Zealand regulators with respect to the most effective mode of enforcement: "A civil penalty regime where the emphasis is on ISPs/carriers taking action in response to customer complaints is considered to be the best approach. This is because most spam in New Zealand originates from overseas and the ISP/carrier will often

best be placed to put in place the appropriate technical measures to deal with it. In addition, if spam is originating from an address/number hosted by another ISP/carrier in New Zealand, then the user's ISP/carrier can approach the sender's ISP/carrier and seek action by that ISP/carrier against the sender. If complaints cannot be satisfactorily resolved in this way then the user's ISP/carrier can forward the matter on to the enforcement agency to consider whether an investigation or further action is appropriate." Ministry of Economic Development (NZ), "Legislating against Unsolicited Electronic Messages Sent for Marketing or Promotional Purposes (Spam) - Enforcement Issues - Cabinet Paper," at http://www.med.govt.nz/pbt/infotech/spam/cabinet/paper-two/paper-two-03.html#P31_3192.

[51] G-REX is an online discussion platform reserved for policy-makers and regulators> For more information, see: http://www.itu.int/ITU-D/grex/index.html.

[52] *See* http://www.truste.org/.

[53] Countries might consider also establishing a scheme for arbitrating disputes between consumers and ISPs that are the source of spam. In a related scheme, some countries have established consumer arbitration mechanisms to resolve disputes between telecom customers and their service providers. Spain's arbitration mechanism also includes a certification. *See* the ITU's 2002 Feedback to Regulators case study at http://www.itu.int/ITU-D/treg/Case_Studies/index.html.

[54] The process underway at the Messaging Anti-Abuse Working Group may well provide extremely useful guidance on this front, both as a matter of process and of substance. *See* http://www.maawg.org/news/maawg050711.

[55] *See* http://www.ftc.gov/os/2004/10/041012londonactionplan.pdf. *See also*, for particular suggestions, http://www.ftc.gov/bcp/conline/edcams/spam/zombie/index.htm. For a letter sent to 3,000 ISPs, as part of this initiative, *see* http://www.ftc.gov/bcp/conline/edcams/spam/zombie/letter_english.htm.

[56] The specific suggestions for such zombie-prevention measures will vary over time. Some initial recommendations, derived as part of the London Action Plan meeting and related efforts, include: 1) blocking port 25 except for the outbound SMTP requirements of users authenticated by the ISP to run mail servers designed for client traffic and other carefully accredited purposes; 2) exploring implementation of Authenticated SMTP on port 587 for clients who must operate outgoing mail servers; 3) applying rate-limiting controls for email relays; 4) identifying computers that are sending atypical amounts of email, and take steps to determine if the computer is acting as a spam zombie. When necessary, quarantining the affected computer until the source of the problem is removed; 5) providing, or pointing customers to, easy-to-use tools to remove zombie code if their computers have been infected, and provide the appropriate assistance; and, 6) the shutdown of open relay servers after appropriate notice and inquiry. Regarding the first of these suggestions, related to port 25, Industry Canada (in a separate context), recommends, "ISPs and other network operators should limit, by default, the use of port 25 by end-users. If necessary, the ability to send or receive mail over port 25 should be restricted to hosts on the provider's network. Use of port 25 by end-users should be permitted on an as-needed basis, or as set out in the provider's end-user agreement / terms of service." http://e-com.ic.gc.ca/epic/internet/inecic-ceac.nsf/en/gv00329e.html.

[57] The New Zealand regulators note: "The enforcement agency would be seen as also having a role in educating users/consumers on how to deal with spam in conjunction with the industry as well as a role in educating business and other organisations on how to comply with the legislation along with the Ministry of Economic Development, which will be responsible for administering the legislation, and organisations such as the Direct Marketing Association." Ministry of Economic Development (NZ), "Legislating against Unsolicited Electronic Messages Sent for Marketing or Promotional Purposes (Spam) - Enforcement Issues - Cabinet Paper," *supra* note 47, at http://www.med.govt.nz/pbt/infotech/spam/cabinet/paper-two/paper-two-03.html#P31_3192.

[58] For a description of open mail relays and their importance to the spam issue, *see* http://en.wikipedia.org/wiki/Open_mail_relay.

[59] For a definition of botnet, *see* http://en.wiktionary.org/wiki/botnet.

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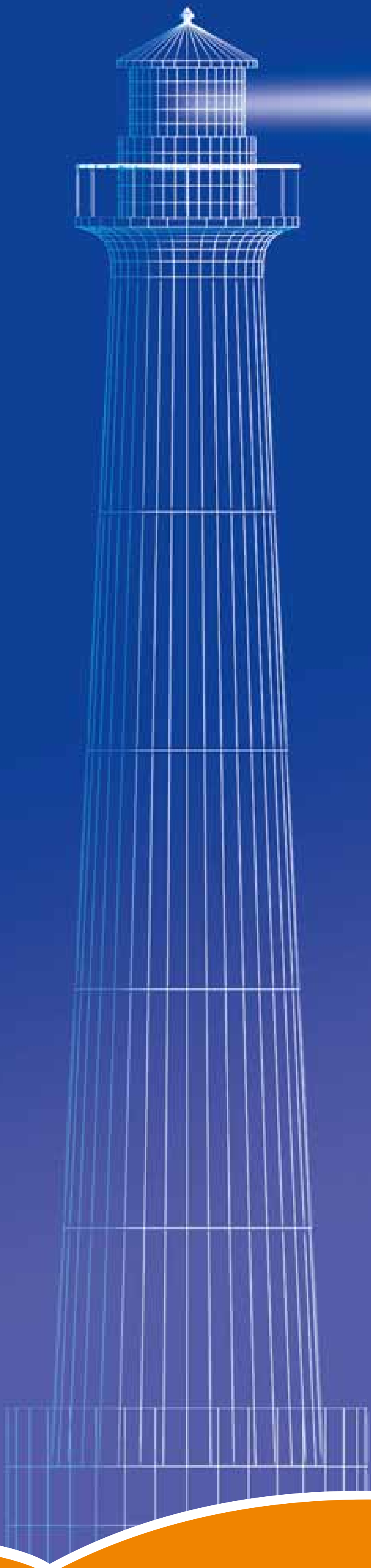

GSR 2005
DISCUSSION PAPER

ROLE OF REGULATORS IN PROMOTING BROADBAND

Comments are welcome and should be sent by 5 December 2005 to GSR05@itu.int

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GLOBAL SYMPOSIUM FOR REGULATORS

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The Role of Regulators in Promoting Broadband in Developing Countries

Prepared by *YANG-SOON LEE, DR WILLIAM BRATTON & WU WEI SHI*

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TABLE OF CONTENTS

GSR Discussion Paper*

The Role of Regulators in Promoting Broadband in Developing Countries

1 Introduction

A promising new landscape of broadband opportunities is emerging as waves of innovation reshape the information and communication technology (ICT) sector. These innovations are occurring across all levels of the industry from technological developments and business models to regulatory and policy frameworks, creating broadband opportunities for end users, large-scale network operators[1], small entrepreneurs, local communities and government alike. These new broadband opportunities require a new vision by potential broadband providers, and a new paradigm by policy makers and regulators. Broadband is completely transforming the ICT sector. Put simply, broadband cannot be treated as business as usual.

Network operators that fail to join the broadband world risk being left behind. The reality is, however, that deployment of broadband access technologies in developing countries is often constrained by a lack of supporting telecommunications infrastructure, especially backbone networks, and concerns over the potential for revenue generation by traditional large-scale network operators. Such large-scale commercial operators are often discouraged from commercially providing broadband access in marginal areas[2], given the costs of deploying broadband networks and the view that associated retail charges in many areas of developing countries may be too high relative to disposable incomes to result in large-scale take-up. At the same time, other potential broadband providers are kept out of the market by regulatory frameworks designed for another era.

A new pro-broadband regulatory paradigm will seek to harness the power of all potential broadband providers, tailoring the regulatory framework as needed. This pro-broadband regulatory paradigm expands on the existing regulatory practices developed following the revolutionary entry of Internet into the life of millions of citizens. Broadband technologies allow the Internet discussion to be taken to a higher level, as it provides for speed in access to the information and extended mobility. Regulators will seek to spur competition at all levels of the broadband value chain, from the link and transport infrastructure layers, to the content required to fuel demand, to the computers needed to access broadband services and applications. This will require regulators to take a comprehensive and coordinated approach, as identified by the world community of regulators participating in the 2004 ITU Global Symposium for Regulators (See box below).

* This discussion paper has been prepared by Yang-Soon Lee, Dr William Bratton & Wu Wei Shi of Spectrum Strategy Consultants. The views expressed in this document are those of the authors and do not reflect the opinion of the ITU or its membership.

Box 1: GSR 2004 Best Practice Guidelines for the Promotion of Low Cost Broadband and Internet Connectivity

We, the regulators participating in the 2004 Global Symposium for Regulators, have identified and proposed best practice guidelines to achieve low cost broadband and Internet connectivity. Our goal is the creation of national regulatory frameworks that are flexible and enable competition between various service providers using multiple transport and technology options. We believe the best practices outlined below will help bring social and economic benefits to the world's citizens.

An enabling regulatory regime that encourages broadband deployment and Internet connectivity

1) We encourage political support at the highest government levels with such support expressed in national or regional policy goals. These include an effective regulator separated from the operator and insulated from political interference, a transparent regulatory process, and adoption and enforcement of clear rules.

2) We believe that competition in as many areas of the value chain as possible provides the strongest basis for ensuring maximum innovation in products and prices and for driving efficiency.

3) We encourage regulators to set policies to stimulate competition among various technologies and industry segments that will lead to the development and deployment of broadband capacity. This includes addressing barriers or bottlenecks that may exist with regard to access to essential facilities on a non-discriminatory basis.

4) We believe that the primary objective of regulation should be to secure fair and reasonable access for competitive broadband services, including Internet connectivity.

5) We encourage the maintenance of transparent, non-discriminatory market policies in order to attract investment.

6) We encourage regulators to adopt policies that are technology neutral and do not favor one technology over another.

7) We encourage regulators to take into consideration the convergence of platforms and services and that they regularly reassess regulatory regimes to ensure consistency and to eliminate unfair market advantages or unnecessary regulatory burdens.

8) We encourage regulators to allocate adequate spectrum to facilitate the use of modern, cost effective broadband radiocommunications technologies. We further encourage innovative approaches to managing the spectrum resource such as the ability to share spectrum or allocating on a license-exempt non-interference basis.

9) We urge regulators to conduct periodic public consultations with stakeholders to inform the regulatory decision-making process.

10) We recommend that regulators carefully consider how to minimize licensing hurdles.

11) We encourage the development of a regulatory framework that permits ISPs and broadband providers to set up their own last mile.

12) We encourage regulators to provide a clear regulatory strategy for the private sector in order to reduce uncertainty and risk, and remove any disincentives to investment.

Innovative Regulatory Policies Must Be Developed To Promote Universal Access

1) We recommend that the promotion of access to low cost broadband interconnectivity should be integrated from "grass-roots" efforts to identify local needs all the way through the "tree-tops" of international law. Governments, business and non-governmental organizations should be involved.

2) We recommend that regulators adopt regulatory frameworks that support applications such as e-education and e-government.

3) We encourage each country to adopt policies to increase access to the Internet and broadband services based on their own market structure and that such policies reflect diversity in culture, language and social interests.

4) We encourage regulators to work with stakeholders to expand coverage and use of broadband through multi-stakeholder partnerships. In addition, complementary government initiatives that promote financially sustainable programs may also be appropriate, especially in filling in the market gap that may exist in some countries.

5) We encourage regulators to adopt regulatory regimes that facilitate the use of all transport mechanisms, whether wireline, power line, cable, wireless, including wi-fi, or satellite.

6) We encourage regulators to explore programs that encourage public access to broadband and Internet services to schools, libraries and other community centers.

7) We encourage regulators to implement harmonized spectrum allocations consistent with the outcome of ITU Radiocommunication Conference process and each country's national interest. Participation in this well-established framework will facilitate low-cost deployment of equipment internationally and promote low-cost broadband and Internet connectivity through economies of scale and competition among broadband vendors and service providers.

Broadband is an Enabler

1) Regulation should be directed at improving the long term interests of citizens. Broadband can contribute to this by improving and enabling education, information, and increased efficiency. It can reduce costs, overcome distance, open up markets, enhance understanding and create employment.

2) We encourage regulators to educate and inform consumers about the services that are available to them and how to utilize them so that the entire population benefits.

3) We urge regulators to work with other government entities, industry, consumer groups, and other stakeholders to ensure consumers have access to the information they need about broadband and Internet services.

Such a regulatory paradigm will require regulators to at the same time do more and to do less than 'regulation as usual.' Regulators will do more in making potential broadband providers such as local communities and non-governmental organizations aware of the technologies and broadband provision opportunities they could seize. Regulators will also do more in coordinating with other organs of government and public institutions such as universities to drive demand for health, education and government services using broadband technologies and applications. Regulators will do less in maintaining outdated regulatory frameworks that restrict market participation

A successful comprehensive policy framework in a developing country with major challenges in rural connectivity is likely to be structured not only to foster long-term appeal to large scale operators, but to encourage public institutions and smaller players looking to deploy broadband to suit their own operational or commercial objectives. As was highlighted in the GSR Discussion Paper on Broadband Provisioning, many broadband technologies can be deployed incrementally. They are not limited to huge, nation-wide deployment plans. Enabled by the ability to deploy broadband on an incremental basis, local community aid and development projects find that providing broadband is an integral part of their work. Likewise, small and micro-entrepreneurs can launch new businesses based on broadband access. The key, therefore, is for regulators to determine which obstacles to their progress may be minimized. Such obstacles may include prohibitive pricing for interconnection with incumbent operators, high access costs to existing untapped infrastructure/resources from parallel utility sectors (i.e., energy/transport), and extensive and onerous licensing processes. Once community providers are able to establish the presence of demand, competitive large scale operators are more likely to see the benefits of market entry, and may be further incentivized with proper rewards schemes (i.e., targeted subsidies from universal service funds or tax exemptions).

It is also important to highlight the importance of programs and content that may serve as initial drivers of broadband take-up in areas where it has been absent. Government in developing countries is often the largest user of information and communication technology. Government can also launch top-down initiatives (i.e., e-government) that will spur the initial interest of the citizenry in getting connected. And this interest will be fueled by the ability to minimize bureaucratic procedures and paperwork and save travel costs while developing the institutional capacity to interface with the citizenry en masse. Most importantly, e-government as a driver of broadband take-up is feasible only if it is sanctioned by a citizenry with its own capacity to demand and use the public information and transactions offered. Once demand is proven, commercial broadband providers will respond with entertainment content designed and priced for developing country users. In short, promoting broadband access and its associated full range of services in urban and rural areas of developing countries requires a new vision characterized by reduced regulatory burdens and conditions conducive to innovation, collaboration and creative incentives.

1.1 A look back

Ten years ago, the predominant model for the provision of telecommunications involved a state-owned incumbent operator deploying a fixed line public switched telecommunication network (PSTN). Over the same period of time, this model has given way to alternative competitive networks such as cable television, fibre optic, satellite, second generation (2G) mobile cellular, and more recently 3G and broadband wireless – all enabled by new technologies. Most telecommunication networks have been provided on a nation-wide, or at least regional basis[3]. Today, most large-scale networks are in private hands, meaning they must be profitable to operate. Even the majority of PSTNs today have been at least partially privatized.[4] The business model adopted by large-scale network operators requires significant infrastructure investment and high subscriber revenues to remain financially viable. Most national regulatory frameworks were designed for such large-scale network operators and service providers.

What has this first wave of sector reforms achieved? Telephone access has quadrupled since 1990, from 10 per cent to 40 per cent of the world population. By the end of 2004, there were an estimated 1.19 billion fixed telephone lines in operation around the world and 1.8 billion mobile subscribers. The rise in mobile subscribers is phenomenal. More than 50 per cent of mobile subscribers today are in developing countries[5]. Still, many of these users are located in urban areas. The challenge for regulators today is to build on this mobile growth to provide an enabling environment that will bring both voice and broadband Internet services to rural areas.

The stage is now set for such a rural renaissance as an entirely new player has appeared on the scene, the community broadband provider, largely enabled by low-cost broadband wireless technologies. Local community initiatives are providing broadband services to users in remote areas currently not served by large-scale networks. These small-scale broadband providers range from public institutions such as libraries, educational institutions, health facilities and local governments, to non-governmental organizations and small and micro-entrepreneurs that can be profitable with margins of only a few dollars a day. Whether private or public, all community broadband providers are concerned by costs. The lower the costs of providing broadband services and applications, the greater the opportunity for community initiatives to succeed in bringing ICTs to rural users. Keeping regulatory costs down will give these local initiatives a better chance of success.

1.2 A look ahead

A new regulatory framework, tailored to the unique circumstances of local community initiatives, is needed to help small-scale broadband providers foster growth in rural areas. This paper explores options for such a new regulatory framework. At the same time, evolution of the regulatory framework designed for large-scale network operators is also taking place. This evolution seeks to provide greater incentives to large-scale network operators to deploy broadband access networks in rural areas. This paper takes a hard-nosed look at the commercial realities of large-scale operators. Commercial operators are profit driven and cannot be expected to provide services that do not yield profits. The success of any regulatory framework targeted to large-scale operators depends on operator profitability and enforcement of regulatory requirements by regulators. Where regulators are unable to require large-scale operators to build broadband networks in rural areas, either due to inability to offer financial incentives or to enforce build-out requirements, regulators could focus efforts on developing new pools of broadband users in rural areas. Enabling small-scale or public service broadband providers to create new pools of broadband users in rural areas is likely to give large-scale operators the incentive to extend their networks out to these new commercially viable areas, offering Internet backhaul and interconnection with urban markets.

The paper begins by identifying the importance of broadband and the potential positive impacts that access to broadband technologies can provide, before discussing the key issues associated with such deployment in developing countries. The paper then highlights the role of competition in accelerating the deployment of supporting networks and reaches a number of conclusions with respect to the appropriate regulatory framework to create an environment conducive for the deployment of broadband enabled networks. The paper concludes by identifying a number of other potential policy measures that regulators can undertake to support the deployment and take-up of broadband access technologies

2 The role and importance of broadband in developing countries

The deployment and take-up of broadband access technologies offers a number of positive impacts for developing countries. These include:

- **Eroding information differentials** resulting from geographical constraints that prevent marginal communities from participating in regional, national or international processes.

These processes may be social (e.g. education and health), political (e.g. involvement in and input to decision-making and consultation) or economic (e.g. access to financial information and advice and markets (both buyers and sellers). Broadband technologies, therefore, can facilitate the integration of marginal communities into wider processes beyond the geographical limitations of their specific areas;

- **Access to regional, national and international resources** through broadband access technologies can substantially improve the living standards of marginal communities.

For example, improving accessibility to e-health systems that allow remote diagnoses and treatment via two-way rich voice and video are particularly useful in marginal areas where access to medical equipment and expertise would otherwise be limited. Similarly, broadband access technologies can be used to provide remote education and training services (for example, the African Virtual University[6] and at a more advanced level, Universitas 21[7]). The provision of such access can have a significant positive impact on living standards.;

- Furthermore, broadband access technologies can enhance the sustainability of marginal communities by **supporting the transfer of knowledge and expertise to marginal communities**.

For example, rural doctors can receive regular training via e-health systems ensuring that they can also remain on-location (rather than leaving an area for training) whilst learning the latest techniques and securing greater understanding of key medical issues. Similarly, broadband access technologies can be used to enable the transfer of agriculture knowledge to improve productivity and to limit desiccation of the environment through unsustainable farming techniques;

- Improved information flows, as a result of broadband access technologies, **increase the range of options available to marginal communities**.

For example, farmers need not be limited to the single buyer who is physically on-site but can use broadband access technologies to fully access geographically remote markets, including auctions. This benefit is particularly pronounced for perishable agricultural products where the physical transfer of produce limits the number of potential buyers to those in a particular location at a particular point. The use of on-line markets, however, allows producers to establish contacts with a far wider range of potential buyers across larger geographies and, therefore, to maximize potential incomes;

- Broadband access technologies will have **positive impact on the productivity of businesses** in developing countries.

Access to greater information sources, e-mail and other supported services, e.g. VoIP, allow businesses to improve their revenue-generating potential and to reduce their costs of conducting business. In India, for example, widespread broadband deployment is also expected to increase labour productivity by 11 per cent and lead to direct employment of 1.8 million and total employment of 62 million by 2020[8]; and

- The deployment of broadband access technologies may **support the growth of regional and national IT industries**.

This growth can impact positively on GDP growth. For instance, in Korea, IT, significantly underpinned by broadband deployment, accounted for approximately 50 per cent of GDP growth rate in 2002[9]. The Confederation of Indian Industry National Broadband Economy Committee estimates that broadband will contribute US$90bn to the Indian economy between 2010 and 2020[10].

Specific examples of how the deployment and take-up of broadband access technologies in marginal communities and developing countries include:

Box 2: The impact of broadband access: Examples in developing countries

In the Reserva Ecologica do Xixuanú of **Brazilian Amazon**, a telemedicine project has been launched where medical information from local communities are transmitted through satellite to the United States for remote diagnosis.

Rural villages in **Bhutan** that were previously not connected by traditional telephone service are now provided with inexpensive basic voice telephone access using wireless broadband technologies.

In **China**, students in rural villages are able to participate in distance-learning courses set up by major universities in Beijing using VSAT satellite broadband access.

In a small remote town located in the mountainous region of north-eastern **Ecuador**, Wi-Fi technology has enabled the local mayor to access online government databases. In addition, broadband access is used to promote ecotourism in the area and to help local SMEs become more competitive.

In **Laos**, Wireless LAN networks have been rolled out to villages, allowing people to make local and international (using VoIP) voice calls, and hence, significantly improving their connectivity. Other activities made possible by the network include accounting, letter writing and e-mails, as well as supporting local business activities.

In **South Africa**, institutions are connected to international institutions using broadband technologies, to advance co-operation in various R&D areas.

In **Uganda**, rural schools are able to gain access to educational tools via broadband access.

Recognizing the benefits of broadband for the agricultural sector, the government in **India** has just announced that it would set up a network of computer kiosks across 25,000 villages to help farmers sell their produce to the highest-paying customers. The national rollout is due to be completed in 2007.

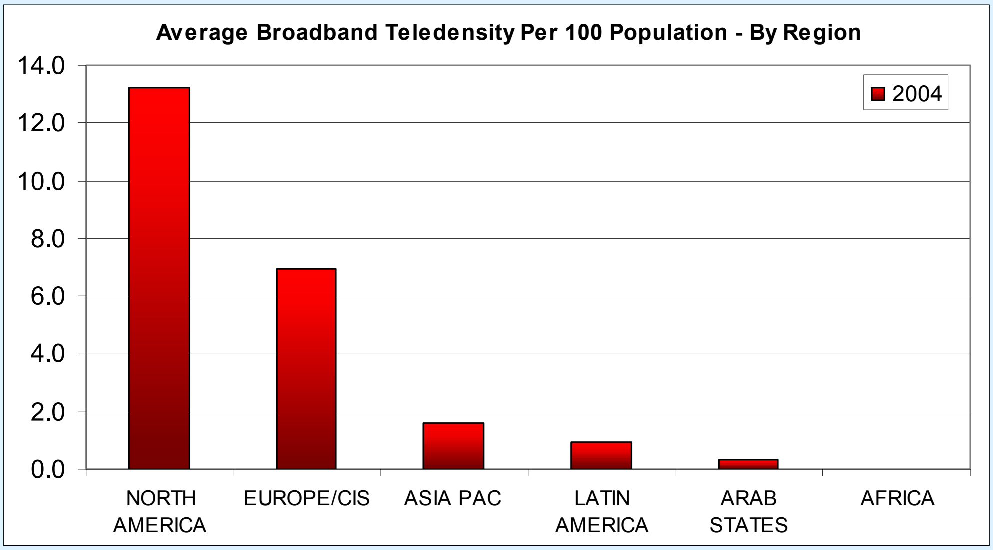
There is no doubt that broadband access technologies can provide substantial benefits to end-users in developing countries and marginal communities if the services subsequently provided over the networks are sufficiently targeted to offer end-users real benefits. Apart from regulations that aim to create a competitive broadband market providing universal and equitable broadband access, governments and regulators are also focusing on developing policy measures that include local communities into the design and implementation of broadband initiatives.

3 Current state of broadband deployment

As seen in the GSR Discussion Paper on Broadband Provisioning, up until 2004, the deployment and subsequent take-up of broadband access technologies remained largely concentrated in the developed world. While many developing countries still have not yet begun commercial deployment of DSL solutions, 2004 witnessed the beginning of broadband growth in developing countries, with some twenty-five per cent of broadband subscribers now located in non-OECD countries.

The graph below details the number of broadband subscribers per 100 population by region. Although it is evident that the total numbers of broadband-connected citizens in Africa, the CIS, the Arab States and Latin America currently comes to less than 1 for every hundred persons, it is important to bear in mind that this does not translate to a lack of growth, or to a lack of technological options for developing viable deployments. In fact, the pace of broadband deployments from year to year has been highest in developing countries over the last two years. (See Figure 1, GSR Discussion Paper on Broadband Provisioning.) This is in part because growth reflects drastic changes from a starting point of zero connectivity, but also because various entities are finding it in their interest to champion broadband.

Figure 1: Broadband penetration by region (year-end 2004)



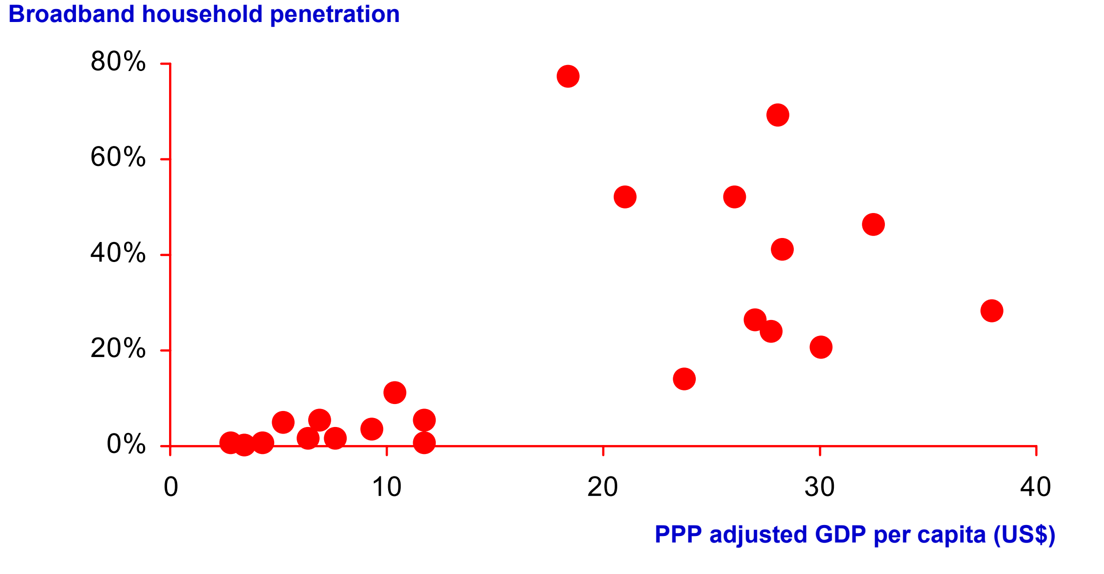
Source: ITU World Telecommunications Indicator Database

Certainly in terms of absolute broadband subscribers, there is a marked variance between the more developed countries in North America and Western Europe and the other regions, including Asia-Pacific. In North America there are more than 10 broadband subscribers per 100 inhabitants – and throughout Europe (including Western, Central and Eastern), there are nearly 7 subscribers per 100 inhabitants, whereas it is estimated that across Africa there is a take-up of less than 0.01 per 100 population. Other regions also record relatively low levels of take-up (e.g. the Arab States with 0.4 broadband subscribers per 100 population and South America with a ratio of 0.9).

Although the Asia-Pacific region has the largest number of broadband subscribers, its relative take-up is just 1.6 per 100 population. This ratio, however, is distorted by the inclusion of China and India as the Asia-Pacific region contains some of the most successful countries in terms of the take-up of broadband access technologies, for example, China, Hong Kong, China, Japan, Singapore and South Korea.

The finding that the take-up of broadband access technologies appears to be significantly higher in developed countries is further demonstrated when the take-up of broadband is compared against purchasing power parity (PPP) adjusted GDP per capita.

Figure 2: Comparison of broadband penetration and GDP for selected countries (year-end 2004)



Source: Telecom Markets (2005), Reuters (2005), IMF (2004), EIU (2004)

While broadband growth is now beginning in developing countries, there remains a large disparity between urban take-up (especially in the primary urban centres) and non-urban areas. In Pakistan, for example, it is believed that the 40,000 broadband subscribers (as of June 2004) were all in Karachi, Lahore and Islamabad. Outside these three major urban areas, broadband networks are virtually non-existent.

Telecommunications networks are increasingly accepted as important as other forms of infrastructure (e.g. transportation and power) in supporting and promoting economic as well as political development. Regulators are thus seeking to address such geographical variations in the take-up of broadband services in their countries range of digital opportunities. Fortunately, there is evidence in the relevant literature to suggest a significant relationship between the deployment of preliminary communication infrastructure, and associated improvements in standards of living, health, education and overall sustainability.

Some developing countries are already demonstrating strong performance with respect to encouraging broadband take-up. Chile, for example, has a reported household penetration rate of greater than 10% driven by a set of policies and approaches detailed below.

Box 3: Promoting broadband in developing countries: Chile

Broadband development has benefited from a competitive telecommunications sector and early privatisation of the incumbent operator. Economic and regulatory policies that foster competition have also contributed.

In addition, the government has actively pursued initiatives to promote broadband deployment and take-up, often in co-operation with the private sector.

The "Digital Agenda" was launched in February 2004 and sets out a plan of action for a national ICT strategy to be completed in 2010. The programme is funded by both public and private funds. Some of the initiatives in the programme include:

Concrete goals in six areas, namely Internet access, education and training, e-government, business digital development, ICT industry development, and legal and regulatory readiness;

Ensuring public access, including connecting more than 8,000 state schools to some form of ICT, providing Internet access to 368 public libraries and launching over 1,300 Internet centres;

Review and amendment of the legal and regulatory framework to facilitate ICT development;

Launch of "National Digital Literacy Programme" which benefits poor communities and rural areas through the opening of school computer laboratories to facilitate public access to the Internet; and

Award of licences for provision of WLL service provision throughout the country.

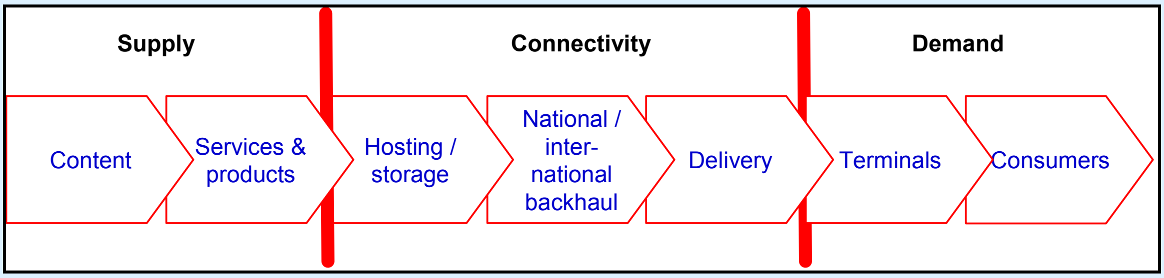
The key issue remains distilling and learning from the lessons of such apparent success stories and successfully implementing appropriate frameworks in other markets.

4 Key issues in promoting broadband in developing countries

Given the stated potential economic and social benefits of broadband access technologies, the need to develop solutions to counter the relatively low levels of broadband take-up in many developing countries is clear.

From a cost-benefit corporate perspective, the fundamental problem is that there are holistic constraints to broadband take-up in developing countries across all the value chain components from the supply of content, services and products through to connectivity and finally, demand. Limited consumer demand, however, is likely related to lack of awareness of the potentials of broadband. Once deployed, it is quite fair that the demand (in terms of content and volume) of consumers in the developing world will not be so different from their counterparts in the developed world. The main difference will lie more simply in the rates they are able to pay, and the portion of their disposable income they are willing to allocate to content.

Figure 3: Simplified broadband value chain



In terms of **supply**, key constraints to deployment of broadband services and products in developing countries are:

- Insufficient compelling content, especially in local languages and with specific reference to local circumstances;
- Lack of understanding on the benefits of broadband;
- Little incentive for fixed line incumbents to offer broadband access technologies and risk cannibalizing PSTN and ISDN revenue streams, especially in the absence of market competition;
- Competing demands for investment funds, for example in developing countries operators perceive that they could generate a better return and payback with deployment of second generation mobile networks than with fixed or broadband networks;
- Lack of market competition to encourage operators to develop and commercially deploy broadband services; and
- Lack of a regulatory framework designed to encourage broadband deployment by a full range of potential broadband providers from large-scale network operators, to universities and other national public institutions to local community initiatives.

In terms of **connectivity**, key constraints to take-up are:

- There is a lack of hosting/storage facilities within many developing countries requiring much content to be stored overseas with resulting strain on international connectivity;
- Often limited international connectivity impacts on the data rates available, the quality of the service and the cost of international bandwidth;
- Lack of backbone connectivity in many areas, with the incumbent often retaining control over many backbone networks where they do exist and, therefore, able to control the costs and quality of offered leased lines to competitors; and
- Concern over the commercial viability of deploying broadband delivery networks by large-scale network operators, especially in non-urban areas where the costs of service provision may be substantially in excess of the point at which it is affordable.

In terms of **demand**, key constraints in developing countries are:

- Lack of consumer demand (resulting from limited consumer purchasing power) and awareness (although linked to the offered pricing points and the above point) and/or lack of coordination by key stakeholders, such as end-users, universities, public institutions and local community initiatives, that could drive demand for broadband;

- Excessive pricing of broadband products and services, especially when compared to average incomes, which necessitates alternative cost modeling and targeting techniques;
- Greater priority on mobile voice communications than data services; and
- Limited availability of affordable end-user terminals. Deploying broadband access networks only makes sense if potential users have the ability to utilize the services and products.

Many of these points are not unique to developing countries but they are accentuated when compared to developed countries, in particular the ability of consumers to afford the services and products at an appropriate pricing point that accurately reflects the underlying costs of service provision. Similarly, the relatively low PC penetration rate (an issue of affordability but also electricity provision since it is difficult to use a personal computer where there is no electricity to power it) significantly reduces the demand for broadband access. The forces of innovation and the intensely competitive environment in developed countries, however, are pushing manufacturers and engineers to develop very low-cost, simple, converged devices expressly tailored for applications and content in developing country contexts. To a large extent, this could even be said to reflect the development of a niche market of low priced, functional products, as service providers consider their interest in catering to potential untapped markets.

The relevance of specific factors varies significantly between developing countries and between geographies within developing countries. However, given the relevance of such supply, connectivity and demand factors in constraining the take-up of broadband in many areas of developing countries, regulators have an important role in seeking to minimize the impact of these factors or developing appropriate solutions.

5 Regulators' role in promoting broadband

Unlike developed countries where the relatively high levels of teledensity allows for a greater focus on the promotion of service based competition, the primary role of most regulators in developing countries is to create a framework that creates and maintains an environment conducive for network investment.

In order to confidently commit to network investment, however, especially in potentially more expensive broadband access technologies and in developing countries where risks are often higher, operators seek a regulatory approach that is consistent and will not experience significant variations from stated positions. Therefore, any regulatory framework (and this covers both the legal framework as well the precedent to which the legal intent is enforced) that creates uncertainty and/or the risk of financial loss will deter market entry and subsequent network investment.

Regulatory agencies that fail to provide this consistency risk deterring investment and, therefore, constraining the development of their telecommunications networks, including the development and deployment of broadband.

Within this context, there are several steps/mechanisms that a regulator can undertake to promote the deployment and take-up of broadband. These are detailed in the following sections.

5.1 New entry and the role of market liberalisation

Market liberalisation remains the most effective mechanism to encourage greater investment in telecommunications networks. Experience shows that market liberalisation through the licensing or authorization of new operators will yield greater benefits than incentive- or obligation-driven approaches targeted at only a monopoly or duopoly. The absence of liberalisation removes a significant incentive for an incumbent to invest in networks, services and QoS and historical precedent demonstrates that network investment is significantly enhanced after the introduction of market competition - both by new entrants and the incumbent (for example, inter alia, Brazil, Hungary and India).

It is clear, however, that after market liberalisation in many developing countries, the incumbent continues to invest significantly more in network deployment than new entrants, especially in marginal areas. As such, the incumbent can often be the most important (and often the largest) source of funds for telecommunications investment in the longer term.

Given this, a number of commentators have argued that excessive market competition may reduce the incentive for incumbents to continue large-scale investment. This may be particularly the case where tariff re-balancing has not been fully undertaken and new entry results in very rapid margin erosion in the more lucrative long distance and international markets while the incumbent continues to provide these services. Such a situation can result in a very rapid deterioration in the financial performance of the incumbent and, therefore, its capability/willingness to undertake investment, unless the incumbent introduces new services and seeks new lines of business.

It is necessary, therefore, that the regulatory framework does not impact adversely on network investment and the diversity of new lines of potential business.

Due to the costs of network deployment, especially of broadband access technologies, there have been some suggestions that network duplication, and hence duplicated investments, could be avoided by the creation of a “super” network operator. While this idea often has immediate appeal for developing countries, due to concerns about the availability of investment funds, implementation raises significant competitive concerns. In particular, incumbent operators tend to advance this argument on a regular basis. This ‘super’ operator would be responsible for the build-out of a comprehensive network to which other service providers would be able to secure access, i.e. a transition to service based rather than infrastructure or network-based competition. Incumbents often raise such arguments in an attempt to limit competition, however. This allows incumbents to retain complete control over infrastructure and, therefore, to a greater or less extent, control the development of competition. In both developing and developed countries, incumbents have proven remarkably effective at controlling access to their infrastructure even when the regulator is relatively strong. It is unlikely, therefore, that a ‘super’ network scheme would be effective in the absence of a very strong regulator that can ensure that service providers have access to the network.

An alternative is perhaps for governments to fund such networks directly and to oversee access to them by both incumbent and new service providers. Such an approach has been used successfully in Singapore where the government funded the roll out of a broadband backbone network in 1997 called SINGAPORE ONE, to which the incumbent and new operators, including the cable TV operator, have access. Furthermore, the potential threat that new entrants may secure access to end-users through deployment of networks encourages network build-out. Of course, not all governments have the resources to build such broadband backbone networks.

A more practical alternative, therefore, may be offered by infrastructure sharing. For example, allowing mobile operators to roam onto each other’s second generation (2G) and 3G networks in rural areas would save significant network costs while enabling greater network coverage. In fact competitors have even started sharing the bulk of their Radio Access Network in non-rural areas as in the example of Telstra’s and Hutchison’s shared 3G network in Australia. Similarly, France has allowed infrastructure sharing among 2G operators to reach un-served rural areas known as “zones blanches”. Such roaming and infrastructure sharing arrangements could also apply to new broadband wireless networks.

Fibre backbone networks are often lacking in developing countries, making broadband deployment more challenging. Fibre backbones can boost the capacity of DSL networks, and extending fibre backbone networks closer to rural areas can facilitate internet backhaul for wireless broadband technologies. Again, rather than resorting to a “super” fibre backbone operator, regulators can promote synergies between different kinds of energy and transport infrastructure projects, such as electricity, highways, railways and pipelines, to deploy fibre as part of their projects, and then encourage open access to such fibre communication resources. Since many infrastructure projects are already deploying fibre as they build energy and transport networks, regulators can launch a high-profile information campaign to create awareness of such fibre resources among key stakeholders driving broadband demand. Regulators could also provide incentives, such as tax breaks, for second-generation mobile operators to build their own backbones using (currently dark) fibre instead of the more commonly used microwave links. The regulatory framework can then make it possible for all owners of such communications resources to lease unused capacity to others for commercial deployment.

In conclusion, therefore, regulators have generally opted to promote the deployment of broadband access technologies through market liberalisation (and a supporting regulatory framework) rather than rely on the good will of incumbents, even if incumbents set ambitious targets. Concerns over the impact of competition on network investment can be mitigated through a series of traditional regulatory tools, such as including investment commitments on large-scale operators through the licensing framework, as well as more innovative measures, such as building synergies between non-traditional telecommunication players to promote investment in fibre networks or providing tax incentives to telecom operators to upgrade their transmission links to fibre.

In addition, countries are introducing new regulatory tools to encourage network investment by smaller market players. Ireland, for example, has found that rather than imposing national broadband rollout and coverage obligations on large-scale operators, it has achieved greater success in encouraging broadband infrastructure deployment by allowing wireless broadband providers to enter small local service areas. Ireland’s practice of licensing small local service areas--defined as a 15-kilometre radius around a base station—has led to a significant rise of new broadband subscribers in non-urban areas.[11]

Encouraging competitive market entry is part of a larger package to promote broadband deployment by a full range of potential broadband providers. Additional elements of this larger package are explored below.

Box 4

A new regulatory framework, tailored to the unique circumstances of local community initiatives, can encourage small-scale broadband providers to provide broadband access in rural areas;

An incentive based regulatory framework, for example, using targeted grants or tax exemptions, can be used to encourage both large and small-scale network operators to deploy broadband networks in rural areas;

Where financially viable, broadband deployment requirements can be made part of the licensing commitments of new market entrants;

The promotion of sufficient supporting network infrastructure to enable the provision of broadband services, e.g. backbone connectivity; and

The development of government driven initiatives that provide an important source of demand for the network facilities and services.

These issues are detailed in the following sections.

5.2 The role of foreign ownership of operators

New market entry and subsequent investment, including in broadband access networks, is likely to be supported if there are no restrictions on foreign ownership of licensees - this is particularly the case in developing countries where capital availability may be limited. Foreign ownership brings the possibility of incremental capital funds as well as managerial expertise and international best practice.

Increasingly, governments and regulators seek to attract foreign ownership, rather than restrict it on the premises of national security, cultural protection and domestic economic development, although these often remain concerns for policy makers.

There are persuasive reasons to facilitate and support foreign ownership of new entrants in many circumstances, even allowing full foreign ownership of new entrants. These reasons include that:

- There is an international trend to ease foreign-ownership restrictions, partially encouraged by World Trade Organization (“WTO”) agreements, but also driven by increasing recognition of the substantial benefits that foreign ownership provide;
- It is possible to address investment requirements through licence commitments; ensuring that these are not so high as to lead to excess capacity; and
- Foreign investors are more likely to view the risk associated with an investment as related to the extent to which it can retain managerial and operational control. Greater financial ownership is likely to be associated with greater managerial control and hence, ability to determine the business behavior of the company.

In addition, there are an increasing number of successful examples of foreign ownership of new entrants resulting in substantially improved telecommunications infrastructure. Foreign ownership will not per se result in greater broadband access network deployment, although foreign ownership may support such deployment through access to greater funds, managerial experience and potentially lower unit costs.

Besides allowing foreign ownership, governments can also tap into the global capital markets and international lending agencies for funds to improve and upgrade their telecommunication networks. This is now less difficult than before because it has been proven that telecommunications infrastructure, when properly deployed and managed, is across the board a commercially viable business.

5.3 Providing a simple and consistent licensing or authorization framework

The deployment of broadband can be expedited through relaxing the licensing conditions for large-scale broadband access providers and by ensuring a consistent framework that is clearly targeted towards a set of defined policy objectives. In addition, regulators are increasingly using general authorizations in lieu of onerous licensing frameworks to ease market entry.[12] Where licenses are used, it is important that:

- An efficient administrative process that is transparent and consistently applied, together with minimal administrative requirements helps attract investment and ensures that potential investment is not delayed;
- Any terms and conditions included in licenses are not financially punitive and allow operators to achieve sufficient financial return over the life-cycle of their investments, this can also be linked to the incentivisation approach detailed in the following section;
- Licence fees charged are commensurate with the required activities of the licensee, i.e., if the licensee is expected to deploy substantial broadband access network infrastructure licensee fees can be reduced to reflect this high level of investment. Increasingly policy

makers and regulators are moving away from the view that telecommunications operators, especially more profitable wireless operators, are to be treated as "cash-cows" and a source of funds for other activities;

- Regulators establish and enforce appropriate monitoring mechanisms that ensure licensees do meet their commitments where specific conditions are included in license agreements;
- It is recognized that re-negotiating licence commitments increases the risk associated with network investment that is required to promote broadband access deployment and take-up.

While licences or general authorizations are usually required for large-scale broadband infrastructure operators, increasingly regulators are lightening such requirements for operators and service providers in small, non-urban areas. Facilitating broadband market entry in small, non-urban areas allows broadband providers to test the business case for broadband provision on a small scale. Some small-scale broadband providers may later decide to commit to more large-scale deployment. Thus, regulators can replace licensing requirements for commercial community broadband providers by a general authorization or registration framework, just as some countries have already established "open entry" policies for Internet service providers (ISPs). Where broadband access will be used exclusively for public services, such as in health facilities or libraries, regulators may question whether licensing should apply at all. It is also particularly important that licence fees for very small broadband providers be kept as low as possible, if not eliminated altogether, and that licensing obligations that may apply to large-scale operators, such as roll-out and coverage obligations, or contributions to universal access funds, be minimized or eliminated in a regulatory framework targeted to community broadband providers.

There is also a case for allowing broadband services to be resold without any licensing requirements in rural areas. For example, broadband subscribers in a rural area could be allowed to use their broadband connection as a public kiosk and resell the service to occasional users who would otherwise not be able to afford it at all. In this way additional economic activities would be generated besides increasing broadband access.

It is important to note that reducing or eliminating licensing requirements is not synonymous with not regulating service providers. In some countries, for example, telecommunication licensing is not widely used as a regulatory instrument. Instead, regulatory rules for market players are enacted through the regulations, codes, decisions or orders made by the regulator. Even with open-entry or simple notification policies, local commercial broadband providers could still be subject to government oversight in areas such as consumer protection and the fight against spam. Again, they could be treated like ISPs, who often come under general business regulation that applies to all commercial entities — or at least a certain group or "class" of companies.

Many of these issues increasingly represent best practice for regulators with respect to all products or services. However, given concerns over the commercial viability of broadband access technologies in developing countries and consequent risks with deployment, it is especially important that the regulator is consistent and minimizes the extent of regulatory burden on such operators.

5.4 Using licensing frameworks to encourage broadband access network deployment

Regulators could use the licensing framework to incentivise network deployment by large-scale operators, especially in early stages of market liberalisation, particularly with respect to the deployment of broadband access technologies13.

The intent of this approach should be to encourage operators to deploy networks that may otherwise not be considered commercially viable or may create less value than other options. It is particularly relevant to highlight the importance of looking at the appeal of such investments in the long-term, as opposed to in the short-term perspective. Such networks may include build-out to more marginal geographies or broadband access networks that would otherwise be considered cost prohibitive (especially in the absence of large-scale commercial demand). The incentives could either be rewards for meeting licence commitments or, where they can be enforced, financial penalties for failing to meet agreed commitments.

Such licensing incentives could take several forms including:

- Extension of licence periods;
- Access to other operators' infrastructure;
- Provision of other more lucrative licences;
- Access to universal access/service funds;
- Reduced licence fees;
- Tax incentives, including reduction of taxes and duties for both operators and end-users; and
- Financial penalties for failing to meet a licence commitment.

For example, rural areas could be packaged with lucrative locations for licence tender by potential operators14. In addition, multiple services may be bundled under one licence or authorization. Brazil, in 2005, for example, announced that it would issue licenses to enable operators to offer the triple play of voice, Internet and broadcast.

Such an incentive framework has been used to encourage network deployment in a number of countries (e.g. Hungary (possible extension of licence period) and in Brazil (possible provision of new licences for more lucrative business activities).

Box 5: Incentivising network deployment: The Hungarian approach

In February 1994, Hungary was divided into 54 franchise areas for local telecommunications access.

The incumbent and new entrants were invited to submit bids for each franchise area to act as the monopoly local access service provider potentially until January 2002.

The licence conditions required each operator to achieve annual growth in local access lines of 15.5% per annum and fulfill 90% of customer demand for new local access lines within 6 months by January 1997.

In 1993, teledensity was 14.5 main telephone lines per 100 inhabitants. This had increased to 26.0 per 100 inhabitants by year-end 1996 and 36.1 by year-end 2002 (over the period teledensity peaked at 38.0 at year-end 2000).

Post 2002, all service providers with significant market power were mandated to provide local loop unbundling to other service providers, including new entrants (including a special RIO for the local loop).

Box 6: Incentivising network deployment: The Brazil licensing model

Following the process of deregulation of the telecommunications sector from 1997, operators that reached their universal service obligations were allowed to acquire additional licences, including mobile and long distance services.

In early 2004, the telecoms regulator, Anatel, certified Brasil Telecom as having met its universal service targets, thereby allowing the operator to roll out mobile and long-distance services in addition to the local-line service that it was already offering in the country's southeast.

Brazil's other two major landline operators, Tele Norte Leste and Spain's Telefonica Internacional, had already met their targets and were offering wireless phone and long-distance services in other regions, prior to 2004.

As mentioned above, the converse of the above incentives is the threat of licence revocation if licence commitments are not met. There is, however, a natural tendency on the part of regulators not to revoke licences especially if the operator under review has achieved a sufficient number of subscribers and withdrawal of the licence would cause disruption to these subscribers.

Besides providing tax incentives for the operator such as tax "holidays" or tax concessions for equipment, reducing the burden of tax and duties for users can also encourage wider adoption and usage. A recent study commissioned by the GSM Association indicated that in many developing countries up to 20% of the total cost of owning and using mobile telephony goes to taxes and duties. If these are reduced or abolished more people would be able to afford the service.

To date, the above incentive mechanisms have been generally applied only to PSTN local access, but there is no reason why they are not also applicable to encouraging deployment of broadband access networks. For example, new entrants or even existing operators could be offered appropriate incentives to deploy all types of broadband access technologies, especially in non-urban areas. Given the relative success of such incentives for PSTN deployment, it is believed that such incentive frameworks could impact positively on broadband deployment, especially if they are available to all industry players.

Exclusivity periods as an incentive mechanism pose the danger of "crowding out" potentially more efficient new entrants and new investment sources. Generally, market liberalisation, as long as the licensing framework is appropriate, will yield greater benefits than the tandem exclusivity-obligations approach adopted in a number of markets (both developing and developed).

5.5 The role of technology neutrality

In principle, broadband regulation should be technologically neutral and the licensing or authorization regime should reflect this position. Increasingly, licensing/authorization frameworks focus on encouraging the provision of and investment in broadband access networks, rather than defining the specific method of delivery. This is particularly relevant when licensing radio spectrum for the provision of broadband wireless services, but it is also potentially applicable in terms of fixed line deployment (for example, allowing such licensees the flexibility to use copper, fibre or satellite (if the spectrum is available).

Technology and service-neutral licenses and authorizations also enable broadband providers the flexibility to offer a full range of services (including the triple play of voice, Internet and broadcast) in rural areas, increasing revenue stream options. In Venezuela, for example, rural licences allow operators to offer mobile and multimedia services in addition to fixed access, long-distance and international services. India and Uganda have allowed operators to provide both fixed and mobile services under the same license, leading to increased competition and subscribers as well as lower prices for consumers. Hong Kong, China is issuing unified licenses for broadband wireless access providers designed to adapt to technological developments. Today, it allows broadband wireless access providers to offer fixed services; as BWA technology develops, the same license will authorize providers to offer mobile broadband wireless services.

It is recognized, however, that total technology neutrality in licensing frameworks may be quite difficult to achieve (for example, some technologies and services are specific to and standardized for certain radio frequencies), but regulators are increasingly providing licensees with the maximum flexibility possible when selecting which technologies they wish to adopt in the provision of broadband access services, within existing standards and international frameworks. Such flexibility may encourage broadband access deployment in marginal areas and developing countries by allowing licensees the ability to select the delivery technology that minimizes costs and accelerates financial return and customize the components of the technological infrastructure that will drive their service offerings to their specific organizational and technical needs. This may allow them to leverage whatever existing economies of scale they have been able to achieve in other, possibly adjacent, markets.

For example, such flexibility has been exhibited by India's unified access service licensing framework that effectively provides operators with the choice of either GSM or CDMA selection within their allocated spectrum blocks.

Box 7: Technology neutral licensing regime: India's unified access service (UASL) licensing framework

In 2004, The Indian regulator, TRAI, established a unified access service licensing regime in response to an increasing overlap between GSM full mobility and CDMA limited mobility operators.

The unified access service licensing framework covers all basic and cellular licences for now. In the next phase, the government plans to implement a fully unified licensing regime covering all telecommunication services.

The financial burden in terms of licence fees and registration charge is lessened for operators wishing to provide multiple services. This represents a significant lowering of entry barriers for new and small players, and may also translate into more affordable prices for end-users.[15].

Box 8: Technology neutral licensing regime: Proposed unified licensing framework in Nigeria

In February 2005, the Nigerian Communications Commission proposed a review of the telecommunications regulatory framework to establish a unified licensing regime.

Under the new regime, new and existing fixed wireless and mobile licensees will be allowed to provide both services, subject to geographical/regional limitations stated in their licences.

With the removal of the fixed-mobile differentiation, licensees will be free to offer voice, data or multimedia services as they deem fit once spectrum is allocated[16].

In contrast, the definition of a specific required technology within a defined spectrum block or for the provision of a defined service, although used in some countries as an industry development tool, may not result in the most efficient allocation of spectrum or the most rapid deployment of that service. For example, if the required technology is not the most appropriate (either in terms of cost or supported functionality) then take-up is likely to be constrained and spectrum usage limited.

This position does not, however, undermine the role of standards, especially international radio frequency allocations and technical standards, since such standards do provide a number of advantages. In particular, they allow for economies of scale (both in terms of network and end-user equipment), large-scale vendor commitment and more consistent development road maps, interoperability, reduced consumer switching costs and international roaming capabilities. They also provide collectively agreed upon best practices that can drive more efficient usage of spectrum and energy/power, two particularly important elements in resource-scarce areas. These advantages have accelerated deployment of telecommunications services above and beyond what could have been expected if technologies had remained fragmented.

Nevertheless, an acceptance of standards does not necessarily mean that regulators should specify which standards should be used with respect to any specific spectrum allocation or defined service. Nor does it necessarily mean that regulators should limit potential operator technology selection to internationally standardized technologies. The regulatory framework could provide licensees with the flexibility to select the appropriate technology for their circumstances in order to encourage the deployment of broadband access infrastructure.

There is, of course, the risk that licensees may choose to deploy non-standard, unique and proprietary technologies, but given the substantial benefits of internationally recognized and adopted technologies, this is considered a relatively low risk possibility.

5.6 The role of wireless technologies in providing local broadband access

Clearly the scope for deploying fixed-line broadband local access technologies (whether cable or xDSL) into non-urban or financially marginal areas is limited due to the costs incurred in laying lines. Consequently, there has been significant interest in the use of wireless technologies to provide broadband access.

The fundamental advantage of wireless technologies compared to wireline alternatives is the avoidance of the investments required to deploy a comprehensive fixed local loop. But due to radio planning requirements, different wireless technologies incur very different capital expenditures and, therefore, exhibit different relative levels of attractiveness as a broadband access technology.

There are in effect a number of generic categories of wireless technology available for deployment that support broadband access:

- Mobile telephony standards and developments, including EDGE, WCDMA (HSDPA/HSUPA), UMTS-TDD and CDMA 1x;
- 802 standards and developments, especially .11 (WiFi), .16 (WiMAX), .15 and .20 (Mobile-Fi); and
- Other standards, generally proprietary although often based on the above standards.

The relative advantages of these different technologies are summarized in the following table:

Figure 4: Relative functionalities/capabilities of alternative wireless broadband access technologies

Technology	Used frequencies	Supported data rates	Cell radius	Notes
EDGE	850 / 900 / 1800 / 1900 MHz	Up to 384 kbps	1 km	Deployed globally; extensive availability of terminals
WCDMA	1900 / 2100 MHz	Up to 2 Mbps	0.4-2 km	Large-scale deployment; widely-supported by vendors
HSDPA	1900 / 2100 MHz	Up to 14 Mbps	2 km	Enhancement to WCDMA; limited deployment in Japan
1xRTT	450 / 850 / 950 / 1800 / 1900 / 2500 MHz	Up to 144 kbps	Up to app. 50 km	Widely used as fixed wireless solution
1xEV-DO	2.3 GHz	Up to 2.4 Mbps	Up to 15 km	Deployment mostly concentrated in North Asia; widely supported by vendors
UMTS-TDD	1.9 / 2 / 3.4-3.5 GHz	Up to 7 Mbps	29 km	Deployed in a few countries, e.g. New Zealand, Australia, Portugal, etc.
WiFi	2.4 GHz	Up to 11 Mbps	100 m	Widely deployed globally; backed by major vendors with range of terminals available
WiMAX	3.5 GHz	Up to 75 Mbps	Up to 50 km with line of sight	Believed to be optimal solution for fixed wireless access and for pushing broadband into rural areas

Source: Selected vendor white papers.

Although Wi-Fi technologies often utilize unlicensed spectrum frequencies, which relieve potential operators of upfront investments in terms of licence fees and, therefore, has scope to improve the financial business case of broadband access provision, they have largely been used for wireless local area networks (WLANs), the use for which they were engineered. There have, however, been several cases where WiFi technology has also been used to provide Wireless Metropolitan Area Networks, and this is explored more fully in the GSR Discussion Paper on Broadband Provisioning. Such longer-range uses require outdoor routers and some form of Internet backhaul, either through cabling or the use of VSATs. From a global perspective, it is interesting to note that by region – including Africa, Asia Pacific, the Americas and Europe/CIS – on average about 67% of countries across these regions are allowing WiFi to remain unlicensed.

WiMAX is increasing being cited not only as a wireless backhaul technology (especially to connect Wi-Fi hotspots) but also as a mechanism for providing broadband connectivity directly to end-user terminals. If WiMAX fulfils its stated potential then the implications for developing countries will be substantial, and this could be the technology that makes an immediate and ready impact. This will be true especially if it can be overlaid on existing mobile network infrastructure (e.g. masts and sites). It is expected that vendors will commercially ship WiMAX equipment in the first half of 2006 and that this could change existing pricing models. Anticipating that WiMAX could become the key driver of broadband deployment, many regulators are already reviewing spectrum plans and allocations in order to make provision for new fixed and mobile wireless access services including WiMAX, e.g. Hong Kong, China, Mauritius and Singapore.

To date, the primary broadband capable wireless technologies deployed and taken-up are in fact the standard dominant mobile technologies comprised of EDGE, WCDMA and CDMA 1x.

GSM and CDMA mobile technologies have, in many developing countries, become the primary form of telecommunications infrastructure and access to telecommunications services. The extent of geographic coverage of these technologies combined with the relative ease of taking mobile services has accelerated their take-up. As such, any discussion over network deployment, including the deployment of broadband access networks, should include a consideration of the role of mobile technologies.

There has been increasing deployment of high-speed mobile data networks in developing countries, primarily CDMA 1x - but also EDGE and in the longer term, WCDMA. Many limited mobility solutions deployed across Asia and Africa, for example, use CDMA 1x in the 450 and 800MHz frequency bands (e.g. Ethiopia, Indonesia, Nigeria, Sri Lanka and Uganda). In Nigeria, for example, private telecommunications operators have focused largely on fixed wireless for rapidly rolling out infrastructure, capturing 25% of the fixed line market in the process.

CDMA 1x, EDGE and potentially WCDMA all have the functionality to potentially act as broadband access networks. A number of CDMA 1x operators in developing countries now provide broadband functionality through, for example, the use of data cards (e.g. Reliance in India). Similarly, an Asian EDGE operator has privately suggested that its traffic performance indicates that some cybercafés in rural areas are using EDGE handsets as modems to provide internet connectivity.

Box 9: Providing broadband data connectivity using 1x: Reliance in India

Reliance launched its 1xRTT network in February 2003 as a limited mobility proposition although Reliance’s licence was subsequently converted to full mobility under India’s unified licensing framework.

As at 1Q05, Reliance had more than 9million subscribers.

There are plans to upgrade the network to one that is 1xEV-DO-enabled.

The operator provides a range of data services across the 1xRTT network to mobile handsets. For example, news video clips, e-commerce, mobile banking, cricket information and receiving of examination results.

The operator also provides data services to corporate customers (especially SMEs) including enterprise related services and data-cards to provide broadband access to PCs and laptops.

However, both 1xRTT and EDGE have limited functionalities when compared to alternative wireless broadband access technologies (e.g. in terms of supported data rates). Furthermore, the development paths for 1xRTT and EDGE (1xEV-DO and WCDMA respectively) may be difficult to justify in developing countries given expected revenue performance. For example, recent modeling exercises undertaken by the authors to determine the viability of large-scale WCDMA deployment in selected North African and Southeast Asian countries suggest that such deployment may make sense only in the main urban centres.

That said WCDMA and 1xEV-DO unit costs are declining rapidly. It has even been suggested that with the deployment of HSDPA, the functionality of WCDMA may be so enhanced as to become an appropriate substitute for fixed-line broadband access (e.g. xDSL or cable) and alternative fixed wireless broadband access technologies (e.g. WiMAX). However the costs of these networks are likely to remain relatively high in the foreseeable future and are therefore unlikely to achieve substantial geographic deployment outside designated core urban areas.

What is apparent, however, is that in the absence of fixed-line infrastructure ,and given the technical constraints (i.e., latency issues, etc.) of satellite broadband access provision (which is expected to remain limited to providing broadband access to targeted company and public organization locations), wireless technologies will remain key in providing broadband to the mass-market in non-urban and even urban areas of developing countries. Regulators that are keen to promote the deployment of broadband networks, therefore, will have to position wireless access as central to any strategy – even if this revolves around promoting the use of higher-speed mobile networks and encouraging their use for internet access. More specific technologies, e.g. UMTS-TDD and in the longer term WiMAX, are available for use if the appropriate spectrum frequencies are made available.

Consequently, regulators could seek to provide appropriate frequencies to licensees, allocating spectrum on a technology neutral basis; they may seek to provide incentives, as detailed above, to increase network investment.

5.7 Role of alternative technologies in providing local broadband access

Alternative broadband access technologies include cable, satellite and potentially power-line communications. These technologies have attracted significant attention, however, while cable delivery has demonstrated its role as a broadband access technology, take-up of satellite broadband access remains limited. It is nevertheless considered to be a viable option for developing countries. Power-line communications is often discussed though the extent of its validity in developing countries where powerline infrastructure may be limited has yet to be proven.

In more developed countries, a primary driver of broadband take-up is competition between PSTN and cable operators (e.g. Hong Kong, South Korea, United Kingdom and the United States). In many of these countries, for example, it was the initial move by cable operators that prompted incumbent PSTN operators to respond with xDSL. Furthermore, in the absence of large-scale local loop unbundling access, the only large-scale competitive threat to PSTN operators still comes from owners of alternative access infrastructure, of which cable operators tend to have the most extensive alternative networks.

Cable infrastructures are more limited in developing countries although they have been deployed in a number of upper middle-income economies (e.g. Hungary), some lower middle-income countries (e.g. Thailand) and even in some low-income economies (e.g. India). In these markets, however, the geography of cable remains limited to urban areas and even within these urban areas, are typically limited to the more prosperous areas. Fundamentally, cable remains more focused on wealthier urban environments. It is also a relatively expensive technology to deploy given the infrastructure requirements and options for reducing incurred costs (e.g. by not digging cable but using poles) further raise associated risks such as theft, etc. In some countries, there are also constraints resulting from the quality of the cable network and its ability to support broadband services. However, where there is existing cable infrastructure a number of operators are offering cable modem services, such as in the case of Thailand.

Reflecting its lower cost structure, satellite broadband delivery has attracted attention although take-up of such platforms remains limited to date, especially compared to other access technologies (DSL and cable) and has been marked by the failures of the Low Earth Orbit (LEO) platforms, e.g. Iridium. This is not to say, however, that such services are not widely offered (including in developed countries, for example, Canada, Ireland, the United Kingdom and United States) especially as many satellite operators (e.g. Eutelsat, Hughes Network Systems and Shin Satellite) have been aggressively promoting satellite broadband solutions.

There are a range of satellite broadband deployments in developing countries (including Chile, Ethiopia, Guatemala, Peru and Thailand), a number of which are highlighted below.

Box 10: Examples of satellite broadband service provision (developing and developed countries)

Algeria: provision of satellite broadband to enterprises and public organisations in rural areas.

Ethiopia: Schoolnet is a UNDP funded programme to provide satellite broadband to 400 schools.

Ireland: Smart Telecom has a contract with Eutelsat to provide satellite broadband access to 530 schools.

Thailand: Commercial deployment of satellite broadband services and delivery to schools.

Uganda: Trial provision of satellite broadband services to number of rural schools.

The primary advantage of satellite service provision is that it avoids the requirement for supporting backbone infrastructure compared to other technologies, both wireline and wireless. Furthermore, the VSAT required to access the satellite broadband service can be powered by batteries or solar-power, thereby removing the requirement for connection to the power-grid. This allows rapid provision of broadband access to all areas of a country (assuming that the satellite footprint is sufficient and that there is sufficient transponder capacity).

The key constraints in the use of satellite platforms, however, remain the issues over capacity (especially as new satellites are relatively expensive) and potential cost (although small VSAT/dishes have declined in cost substantially in recent years, transponder leasing costs can be relatively expensive).

Similarly, although power-line communications that support the delivery of telecommunications services over electrical infrastructure (with only minor modifications) (including broadband) has received much recent attention, it remains for the most part in trials phases. The use of existing electrical power infrastructure reduces the requirement to incur substantial telecoms network investment and consequently has attracted substantial attention as a mechanism for providing an alternative fixed local loop with broadband capabilities.

Powerline is dependent on existing electrical infrastructure that in many areas of developing countries is characterized by a marked absence. As such, powerline communications may be no more appropriate than other forms of fixed-line telecommunications infrastructure..

5.8 Other options for securing access to the local loop: wholesale provision

The deployment of broadband access services has to a certain extent been encouraged in more developed countries through various forms of local loop wholesale products, including full local loop unbundling and line resale. These products allow new entrants to access end-users without incurring the investments necessary to build local loop infrastructure.

There are various forms of local loop wholesale available. The key options are detailed below.

Box 11: Local loop wholesale options

There are three main types of local loop unbundling:

Local loop unbundling allows access seekers to have management control over the copper pairs connecting a subscriber to the incumbent's main distribution frame (MDF). The access seeker can provide both voice and data services on the incumbent's network.

Shared access refers to the arrangement where competitive service providers have access to either voice or data transmission over the incumbent's network. The access seeker leases part of the copper pair spectrum while the incumbent maintains control of the copper pair.

Bit stream (or wholesale) access involves the incumbent installing high-speed access links to its customers and opening these links to competitors. In this case, the access seeker has no management control over the physical line and is not allowed to add any equipment to the network.

The success of providing wholesale local loop products has varied between countries but in Hong Kong, China, the United States and Germany, unbundled local loops (or network elements in the United States) now account for a significant proportion of direct exchange lines. The establishment of LLU access prices, and other local loop wholesale services, at appropriate levels (i.e. levels that permit operators acquiring unbundled local loops an appropriate margin) has encouraged alternative operators to provide broadband services to end-users using unbundled local loops and this has played a role in creating demand for broadband access.

Provision of local loop wholesale services in developing countries, however, is fundamentally different from the provision of such services in more developed countries.

In developed countries, the local loop had often been substantially constructed prior to market liberalisation by an operator that had a significant period of time as a monopolist to recover the costs incurred. As such, there was no need to encourage further network deployments to improve teledensity but there was a requirement to encourage service competition by allowing new entrants access to end-users (especially as the need to encourage competition is often constrained by the incumbent's position in the local loop).

Therefore, when determining the pricing of wholesale products to the local loop in developed countries it is considered appropriate to use methods that incorporate incremental costs, i.e. the incumbent operator should only be able to recover those costs that it incurs in the provision of the wholesale product. The adoption of this pricing methodology has increased the viability of market entry by reducing costs involved in accessing the local loop and thereby encouraging the development of more competitive markets.

The situation in developing countries is fundamentally different for the following reasons:

First, many developing markets are being liberalised in order to achieve higher levels of network investment, i.e. the relative date of liberalisation is earlier than in many developed countries in terms of the state of development of their telecommunications industry. As demonstrated above, if managed correctly within an appropriate policy framework, liberalisation can result in substantial improvements to teledensity and this is the primary intent of the liberalisation process (especially improvements in network deployment to more marginal areas). Service based competition (as facilitated through the provision of wholesale local loop products) is, therefore, less relevant at this development stage.

Many incumbent operators may not have had sufficient time to recover the costs of local loop network deployment. As such the use of incremental pricing methodologies may not be appropriate and fully allocated costs approaches may have greater justification and validity. However, the use of such pricing approaches will result in higher wholesale prices (and may include the inefficiencies and historic network structures of the incumbent) and consequently will reduce the relevance of local loop wholesale access to alternative operators.

There may be concerns over institutional capabilities and resources in many developing countries and their ability to implement a requirement for incumbents to provide local loop wholesale services. Even in developed countries, a number of countries have struggled to establish a local loop wholesale framework that encourages the development of market competition. Many incumbents have successfully impeded such processes through technical limitations (e.g. lack of space in exchanges to permit co-location), slow processes (e.g. limitations on visiting access by other operators to local exchanges) or by agreeing wholesale prices that do not allow other operators to construct a viable business case.

Therefore, few regulatory authorities in developing countries have opted to build their broadband access strategy solely on the provision of wholesale local loop products by incumbent operators. Those that have opted to implement local loop unbundling recognize that its success rests on the ability to enforce the associated requirements.

Although the provision of wholesale local loop products remains very limited in developing countries, a few developing markets are planning to or are implementing mandated local loop requirements.

Box 12: Acquiring access to the local loop: Local loop unbundling in Poland

In February 2005, the Polish Office of Telecommunications and Post Regulation issued a directive requiring the incumbent telecoms operator, Telekomunikacja Polska (TP), to provide other operators with access to its local loop. The move is part of a plan to further liberalize the telecoms market in Poland.

In the first phase of local loop unbundling, TP will provide both full (voice and data) and shared (data) access to competing operators. There are plans to extend the local loop unbundling offer to include bitstream access.

The regulator is still reviewing the cost model submitted by TP. However, it is understood that LLU tariffs will be defined by benchmarking them against other European providers operating in competitive markets.[17]

Likewise, in September 2005 the members of the West African Telecommunication Regulators Assembly (WATRA) agreed to a set of regulatory guidelines to govern regulation in West Africa that includes support for bit stream access.18

The provision of wholesale local loop products, including local loop unbundling, will meet with greater success in promoting the deployment of broadband access networks where certain regulatory and commercial conditions are in place. These success factors include:

- Where the incumbent operator has an extensive and well-developed network;
- The existence of clear and complete regulations that spell out all unbundling requirements to ensure that strong operators do not impede access to their exchanges; and
- The encouragement of continuing investments from both incumbents and new operators in new infrastructure rollouts

Regulators may decide to end wholesale local loop requirements once new operators achieve an appropriate level of commercial scale. Regulators can then place more emphasis on frameworks that encourage network deployment.

5.9 Removing other network bottlenecks, e.g. backbone and international connectivity

There is scope for multiple network bottlenecks in the provision of broadband services, both by incumbents and new entry operators. In particular, bottlenecks can occur both in terms of the presence of actual infrastructure (i.e. a lack of required infrastructure) and/or ownership of the required infrastructure (i.e. all the required infrastructure owned by a single operator – typically the incumbent).

For example, in some markets, incumbents have used their ownership of backbone infrastructure to impose constraints on the ability of new entrants to compete by:

- Imposing excessive access/leasing costs (in some markets, for example, incumbents levy higher leasing charges on competing telecommunications operators than their corporate customers;
- Limiting the amount of bandwidth and the QoS supported; and
- Imposing restrictions on points of interconnection, for example, with respect to access to international switches or technical restrictions.

In a number of markets, control of backbone and international connectivity (whether by incumbents or other monopoly operators) has been used to manipulate and constrain the development of competition. This could lead to artificial shortages of bandwidth and inflated prices, thereby hampering the provision of robust global telecommunications services. Due to such concerns, the regulator in Singapore, for example, has moved towards opening up access to submarine cable landing stations in order to enhance competition in the provision of telecommunications services.

There are two main options available to regulators to remove the adverse consequences of such ownership of backbone infrastructure:

- Impose a tighter regulatory framework on those owners of bottleneck infrastructure to ensure that other operators, especially those providing broadband access services to end-users, can access such infrastructure at an appropriate pricing point; and/or
- Encourage existing licensees or new licensees to deploy alternative infrastructure.

Regulatory intervention to determine the terms and conditions associated with access to an operator's existing infrastructure is often required where the costs and timelines associated with duplicating such infrastructure would be so excessive as to not be commercially viable. It may also be necessary where the ability of new licensees to deploy local access infrastructure (and hence improve teledensity) is constrained by investments in backbone and international networks.

For example, with regard to access to international networks, it may not be expected that a new entrant be able to deploy such networks due to the high costs and advanced technical skills involved. Some countries, however, have permitted new entrants to install VSATs with international access, or are allowing local broadband providers to connect directly with the international backbone, rather than terminating traffic through an incumbent's international gateway. In many developing countries, however, even where international traffic has been opened to competition, the incumbent owns control of access to international network infrastructure and is able to use this control to impose excessive prices on other operators and, thereby, impede their market competitiveness. Thus, regulators are increasingly stepping in to ensure that new entrants gain fair and competitive access to existing backbone infrastructure. This is important to the commercial viability of market entry whether a new entrant relies on interconnection, leased circuits or is required to dig its own networks for trunk carriage of traffic. In addition, regulators are finding that the reliance on international connectivity can be reduced through the development of Internet Exchange Points and local caching, which the government can actively encourage or establish.[19]

Box 13: Removing network bottlenecks: Introducing competition to IPLC in India

The Indian telecommunications regulator, TRAI, is planning to introduce more competition into International Private Leased Circuits (IPLC), which are currently "bottleneck" facilities with implications for international telecom services like International long distance (ILD), internet and broadband.

There is a significant lack of competition in the IPLC market at present, forcing smaller operators out of the market for several services relying on such capacity. The reasons for lack of competition include:

- There are a limited number of landing stations in India, which are owned and controlled by a small number of operators;
- The IPLC providers, who are also Internet Service Providers (ISP), are able to charge other ISPs prices that are significantly above costs, thereby forcing out competition in the ISP space;
- IPLC providers also charge substantial prices to non-facility based ILD operators, with whom they also compete in the ILD space.

In response to this, TRAI has undertaken/is planning the following initiatives:

- TRAI has recently fixed the ceiling tariff for various capacities based on the cost of the incumbent operator. The differentiation in the pricing of IPLC based on usage by ILD operators and ISPs have also been removed.
- TRAI is reviewing the need to permit resale of IPLC to other operators, which was previously disallowed on the grounds that this would delay the setting up of sufficient ILD infrastructure in the country.
- TRAI recognises the need to facilitate the access to cable landing stations by new service providers as well as by the new international cable carriers.
- TRAI is also planning to facilitate mutual sharing of landing station infrastructure as well as international cable capacities amongst the carriers.[20]

It is also necessary to encourage the construction of supporting backbone networks, especially if the intent is to deploy infrastructure into rural areas. However, such requirements are more likely to be effective if they are not so prohibitive as to deter market entry. With respect to encouraging licensees to deploy alternative infrastructure and, furthermore, to deploy infrastructure into areas previously not accessed by telecommunications networks, there are a number of options/approaches for the regulator to consider:

- Facilitating existing operators of telecommunications infrastructure used for alternative activities, e.g. railway signaling or pipeline monitoring, to make excess capacity potentially available in their systems to licensed telecommunications operators (i.e. to become licensed telecommunications operators);
- Ensuring and facilitating access to government land, including railways, electrical grids and road networks (including tunnels). For example, by streamlining and standardising the application process, as well as ensuring just and reasonable fee structures;
- Ensuring that telecommunications networks are incorporated into new infrastructure developments, for example, by providing broadband ducts into new roads or by incorporating cables on to new electrical grids (for example, Chile's ICT project side-stepped difficulties of geographical isolation and infrastructure shortage in rural areas by taking advantage of infrastructure that provide electricity to rural communities); and
- Creating/joining a broadband alliance to pool financial and other resources and to enhance negotiation power with network vendors (for example, the Wireless Broadband Alliance which joins operators in the United States, United Kingdom and the Asia-Pacific region, provides the benefit of scale in areas such as testing of products and services, influencing

development and adoption of technology standards, international roaming agreements amongst member-operators, etc.).

Experience from a number of more developed markets, e.g. Australia and the United Kingdom, shows that backbone networks can be more quickly established by leveraging existing infrastructure. For example, cables can be strung across electrical pylons that can also act as the location of radio antennas for wireless technologies. Other alternative infrastructures include main roads, gas and oil pipelines, and water channels (especially maintained canals).

Box 14: Removing network bottlenecks: Using the Indian rail network for backbone connectivity

Railtel Corporation of India was set up in 2000 to exploit communication assets lying idle commercially along India's rail network. Since then, the company has laid 25,000 km of fibre optic cables along the rail network.

Railtel provides leased lines to telecoms service providers, along with other infrastructure like tower space and co-location services. In addition, it is also an Internet service provider, operating a network of Internet kiosks set up at railway stations.

The company has plans to open an additional 300 cybercafes at railway stations, providing services such as VoIP and video conferencing for local people with otherwise no access to computer equipment and broadband access. Owing to India's extensive railway network, broadband access can be rapidly extended into many marginal areas.[21]

Box 15: Removing network bottlenecks: Using gas pipelines for backbone connectivity in India

Gailtel, the telecoms services arm of the largest gas transmission company in India, operates as an integrated telecom infrastructure provider. The company started leasing bandwidth to telecoms operators like Bharti and Tata in mid-2001. It also operates as an Internet service provider serving corporate and residential customers.

The company has laid an optic fibre co-axial (OFC) network along about 8,000km of natural gas and LPG pipelines, and has plans to extend the network to 18,000km around the country. The network currently serves 73 cities across 8 states.

Due to infrastructural cost-savings derived from overlaying the OFC network on existing pipelines, Gailtel is able to offer broadband services to its customers at substantially lower costs compared to its competitors.[22]

Box 16: Examples of using water ducts for laying of fibre optic cables

Egypt: Egypt is reportedly evaluating the options of providing broadband access by laying fibre optic cables along water conduits.

Japan: Japan is planning to complete 100,000km of fibre optic cables in sewers by 2010.

Sweden: Fibre optic broadband access is provided by running 4,000km of cable along water, sewer and electricity ducts throughout Stockholm. The fibre network provides both "last-mile" and backbone connectivity.

USA: In New York, ducts of an inactive water system originally built for fire fighting is being used for laying of fire optic cables for broadband access. In Atlanta, tests have been conducted on the use of the sewer system as a fibre conduit.

The key issue for discussion remains, however, on circumstances and situations where such supporting infrastructure does not exist. A great deal of basic support infrastructure (e.g. electrical grids, railways and pipelines) may be lacking in some areas of developing countries that are often separated from urban areas by large distances or rugged terrain. In such circumstances, the regulatory framework can facilitate the use of wireless technologies where traffic is not expected to be substantial – via satellite trunking. This can be achieved through the expeditious allocation of unused spectrum with low spectrum utilisation and/or licence fees. Developing countries may also explore the pooling of resources to collectively launch satellites that can provide broader regional service, or to back a commercial satellite operator. Shin Satellite of Thailand, for example, has just launched its Ipstar satellite, which has a wide footprint across Asia-Pacific. Although it is a commercial operator, its satellite has extended broadband access to rural areas of Thailand, Laos, Cambodia and Myanmar.

5.10 Funding network deployment

The need to deploy infrastructure into more marginal geographies is based on the recognition that without such access, the digital divide both between developing and developed countries as well as between urban and rural areas in developing countries would likely to be maintained and exacerbated over time. Given the benefits of broadband deployment, including cheap voice communication, regulators are playing a critical role in seeking to reduce this divide through the promotion of broadband access deployment.

Box 17: GSR 2003 Universal Access Best Practice Guidelines

We, the regulators participating in the 2003 Global Symposium for Regulators, have identified and propose the following best practice guidelines to achieving universal access to information and communication technology (ICT) services.

A An enabling regulatory environment: the role of governments and regulators

The success of any universal access/service policy is dependent upon political support at the highest level that recognizes the role of ICTs as a tool for development.

1) It is essential that Regulators exist or be established where they do not yet exist, and that their key role in implementing universal access policies and promoting competition be recognized and reinforced.

2) A series of policy and regulatory reform measures can be taken to achieve universal access to ICTs. These include:

   a) Formulating a national policy that identifies appropriate and realistic universal access/service objectives that take into account the differences between universal access—public access to ICTs—and universal service—household or private access to ICTs.

   b) Including all citizens, regardless of gender, ethnicity, socio-economic level or geographic location, in national universal access/service objectives.

   c) Reviewing universal access/service policies, regulations and practices periodically to adapt to the evolving nature of ICT services and the needs of end users.

   d) Conducting periodic public consultations to the extent possible with stakeholders to identify their needs and modify accordingly universal access policies, regulation and practices.

   e) Designing universal access policies, regulations and practices in order to create incentives for the private sector to extend universal access to communications services.

   f) Establishing a fair and transparent telecommunication regulatory framework that promotes universal access to ICTs.

   g) Adopting technologically neutral licensing practices enabling service providers to use the most cost-effective technology to provide services for end users.

   h) Adopting a framework of interconnection rates linked to costs.

   i) Reducing regulatory burdens to lower the costs of providing services to end users.

   .

j) Developing an effective regulatory body responsible for implementing policies directed towards assuring the best quality reliable services at the most affordable prices that meet the needs of consumers—existing and future.

k) Promoting competition in the provision of a full range of ICT services to increase access, affordability, availability and use of ICTs.

3) Countries can use regulatory reform as the first step in achieving universal access, recognizing that further steps may be necessary to achieve ubiquitous access to ICTs, e.g., in rural areas or to users with special needs.

4) Appropriate licensing schemes for rural service providers could be granted to meet the needs of un-served and under-served areas.

B Access to information and communication infrastructures

1) The lessons learned from the initial experiences developing countries have achieved with mobile cellular services can be applied to a broader range of ICT services to foster universal access. These lessons include providing services in a competitive framework, using new technologies that offer both innovative services and affordable pricing options (e.g., pay as you go options such as pre paid cards) to a wide range of end users.

2) Other measures to promote affordable ICT equipment could include national manufacturing of ICT equipment, reduced customs tariffs and duties, and end-user loans to foster affordability of ICT equipment.

3) A full range of public access options can be developed, including the creation of public telecentres.

4) Local input (including the content useful for local populations) into projects increases their long-term financial sustainability.

5) Educating local people on the benefits of ICTs and their use increases their long-term financial sustainability

C Guidelines in regard to finance and management of universal access policy

1) Universal service funds can be viewed as an option that complements regulatory reform and developed as a mechanism within a broader market-oriented approach to achieving universal access.

2) Universal service funds can be financed by a broad range of market players, managed by neutral bodies such as regulators, and be used to kick-start public access projects that meet the needs of the local community.

3) Governments may consider a full range of other financing mechanisms, including tax incentives for ICT providers and end users.

4) Competitive minimum subsidy auctions could be used, as an option, to reduce the amount of financing necessary for public access projects financed by a universal service fund.

5) Public access projects can be designed to achieve long-term financial self-sustainability, especially where consideration is given to innovative low-cost technologies

The first step regulators are taking is to develop a regulatory regime conducive to investment and supportive of commercially viable broadband access network deployment. In other words, they are specifically addressing the market access gap in broadband provision. The need to first address the market access gap in promoting ICT development was explored fully in the 2003 edition of the ITU Trends in Telecommunication Reform (Trends). Just as regulators in their attempt to achieve universal access to basic telecommunications first moved to close the "market access" gap in the telecom sector, regulators can also seek to face these challenges by removing regulatory burdens and encouraging market responses to broadband deployment. This includes facilitating market entry of small players, such as small enterprises and micro-entrepreneurs, as well as encouraging the full range of public service players, including NGOs, libraries and local governments, to drive broadband demand. In addition, regulators can encourage large-scale operators to deploy broadband networks in areas viewed as non-commercially viable in return for access to potentially more value creating business activities or other incentives.

It may also be necessary for regulators to establish mechanisms to fund network deployment especially if there is evidence that even an incentive framework and/or the use of alternative lower cost technologies (e.g. wireless) is unlikely to result in the extension of a broadband access network to certain areas. This may be suitable in the event that there is a market failure that is unlikely to be resolved in the short to medium term except through some form of government intervention. As explored more fully in the 2003 edition of Trends, these measures can be maximized — as can governments' ability to afford them — by limiting such measures to addressing the true access gap. Thus, only once governments have moved to eliminate the market efficiency gap, through sector reforms, are they considering the use of targeted and limited "smart" subsidies to spur the deployment of broadband access networks to areas and populations that would otherwise not be reached.

There are various true access gap measures available to regulators, including:

- The licensing of special rural operators whose remit is to deploy broadband access networks in defined geographies (concession areas) with the support of universal access funds or other direct grants. Licensees would be selected on the basis of the minimal required subsidy to achieve specified targets. By licensing such rural operators within specific defined areas, regulators can "leapfrog" the traditional diffusion of new technologies from urban to rural geographies;
- Providing funding for local community initiatives to provide broadband access. While many universal access funding programmes have taken a top-down approach by which fund administrators (often regulators) identify the communities for which targeted subsidies will be made available, a bottom-up approach could also be used. Provided the development of an awareness raising campaign, this could allow communities themselves to apply for funds to deploy broadband access networks. This would help to ensure local community involvement in and demand for broadband access.
- Direct and indirect financial support in return for the deployment of broadband access networks. Governments could provide tax exemptions to operators that rollout telecommunications infrastructure in rural areas. Where this is still commercially unviable, full funding and partial funding may be considered. Alternatively, the government may provide preferential loans to operators with the specific purpose of funding the accelerated deployment of broadband access networks.
- Requiring operators (either the incumbent, a specific operator or all operators) to deploy broadband access networks, to be funded in whole or part by payments made by all operators (either as a flat-rate or as a percentage of qualifying revenues) or by general government revenues. The operator(s) responsible for the provision of universal broadband access would receive financial incentives or payment for each new broadband access line installed but could also be given the freedom to determine in which specific locations it would deploy such infrastructure. Before allocating financial incentives or payments, governments often prefer to calculate the net benefit of operators providing broadband access networks and compensate operators only where the costs of providing broadband access exceed the benefits of doing so.

Any such involvement in financially supporting the deployment of broadband access networks has a number of potential difficulties including ensuring that the allocated funds are used for the expressed purpose of deployment infrastructure in marginal areas. This requires the regulator to have the institutional capability to manage and oversee the allocation process and to provide maximum transparency.

There are examples of such regulatory frameworks, including Korea (Rep.) and a number of South American countries.

Box 18: Encouraging broadband access network deployment: Korea (Rep.)

The **Korea** Information Infrastructure (KII) Project was established in early 1995 as an avenue to promote nationwide broadband usage.

The ultimate aim of the project was to provide broadband networks to 13.5 million subscribers with the average transmission rate of 20Mbps by 2005.

To achieve its objective, the government supplied public funding to facilities providers for partially easing the burden of investment in access networks, with greater funding reserved for remote areas. In addition, some enterprises were offered tax exemption on deployment of broadband infrastructure.

The government provided loans at preferential rates worth US$77million to facilities service providers in 1999 and committed an additional US$77million in 2000 for the purpose of deploying infrastructure in less densely populated areas. Subsequently, public funding was extended to include infrastructure build-out in rural areas, with additional investments amounting to approximately US$900million.[23]

Box 19: Encouraging broadband access network deployment: Use of universal access funds

In 1995, the **Chilean** government established a Universal Access Fund to provide public telephone systems to isolated rural areas, through a competitive "bidding for subsidies" programme. The fund managed to secure approximately US$160m in investments, of which about 85% came from private companies. With support from the fund, public telephones were provided to about 6,000 rural localities, reaching 2.2m inhabitants within 7 years. Reliance on market forces and minimal regulation, amongst others, has been credited for the success of the scheme.

In **Peru**, universal access funds for the Fondo de Inversión en Telecommunicaciones (FITEL) are collected through a one percent tax on the gross revenues of all public telecommunications companies. The funds are then allocated through public competitive bidding to operators deploying infrastructure in locations of priority social interest.

Deployment of broadband access networks by large scale network operators, even wireless based, may only be commercially viable in many areas of developing countries (and even a number of areas in developed countries) if an incentive framework is incorporated into the licensing approach, coupled with government funding and initiatives that generate customer demand. Targeting such large-scale operators for broadband deployment, consequently, may require the use of regulatory incentives or funding, either directly or indirectly, to support and promote broadband access network deployment. Another approach is to encourage small-scale players to serve local communities by removing regulatory burdens that often apply to large-scale operators, and allowing small players to test the business case for broadband access and build demand. The key issue is deciding which approach has the best fit with the underlying regulatory and institutional capabilities, and which approach minimizes the extent of government involvement while maximizing the commitments of private investors.

5.11 Enforcing competition

To ensure a reasonable level of competition in an emerging broadband market, a regulatory framework that prevents anti-competitive behavior by operators (especially dominant operators, i.e. those operators that are capable of acting independently of competitors, buyers and sellers) is a pre-requisite. Such regulation should not be onerous and excessively restrict the business conduct of dominant operators but should be designed rather to prohibit conduct which has the potential of preventing or constraining the development of market competition.

Examples of potential business conduct by dominant operators that should be prohibited include:

- Predatory pricing (i.e. providing services at less than cost);
- Mandatory product bundling (i.e. requiring end-users to take products in which the operator is not dominant in order to access products in which the operator is dominant);
- Price discrimination (i.e. applying different prices and terms and conditions according to end-user); and
- Cross-subsidisation (i.e. using profits generated in a market in which an operator is dominant to subsidize its operations in a market in which the operator is not dominant).

In addition, associated obligations typically applied to dominant operators include:

- Requirements to provide interconnection to competing operators on appropriate terms and conditions; and
- Obligations to ensure that tariff structures comply with regulatory requirements including price controls as appropriate.

All of these issues are relevant to the broadband access market. A dominant operator, i.e. the incumbent, could distort the development of broadband access market competition by undertaking the above business conduct in order to impede the business of new entrants, e.g. by undertaking predation or cross-subsidisation in order to force smaller broadband access providers from the market.

In addition, reflecting the regulation of other telecommunications products and given the dominant position of the incumbent in the provision of broadband access networks, as well as other required network components, the broadband access market could be subject to *ex-ante* rather than *ex-post* regulation. *Ex-post* tends to be applicable when there is sufficient evidence that competitive market forces will function properly and that no operator has an apparent dominant market position. Given the structure of telecommunications markets, including broadband access networks, there is no reason to suggest that such circumstances exist.

Even within an asymmetric regulatory framework, however, it remains important to avoid excessive regulatory burdens. Regulations can be carefully tailored and minimized to address key concerns, including the prevention of anti-competitive business conduct, compliance by operators with their licence commitments and the protection of end-users. This may include relaxing price regulation practices, for example, by replacing regulation of all tariffs levied by a dominant operator by a general price cap regime, with the goal of ending price regulation when the market is genuinely competitive. Even with such goals, however, new services may hasten the end of price regulation. While some regulators may prefer to give dominant operators pricing flexibility only once tariff rebalancing has been undertaken, the rise of new services, such as VoIP, whose prices are not regulated, may force dominant operators to lower their prices to retain market share.

Finally, section 5.7 of this paper has already detailed the role of competition between cable and telecommunications companies in driving competition in the broadband access market and hence, take-up. Therefore, cross-ownership of telecommunications and cable network companies can serve as an impediment to broadband development. This is because such an integrated provider is unlikely to deploy both DSL and cable modem networks as the two businesses would cannibalize on each other. As a result, only one of the two technologies would be deployed, leading to high retail prices.

Box 20: Enforcing competition in the telecoms and cable markets: Limiting cross-ownership in the EU

In 1999, the EU issued a directive requiring the separation of telecommunications and cable TV operations into distinct legal entities.

It is believed that cross-ownership of telecommunications and cable operations prevent cable companies from providing low-price voice telephony services in competition to those offered over telecoms networks. In addition, there is little incentive for telecoms operators to upgrade their existing telephony networks to full-scale broadband capability via xDSL.

Hence, under the new directive, dominant public telecoms network operators are required to run their cable operations as separate legal entities. It is thought that this would prevent emergence of new anti-competitive gatekeeper positions or bottlenecks and would encourage competition and innovation in both the telecoms and cable markets.

This is an issue for developing countries as well and could be incorporated into regulatory frameworks.

5.12 End-user terminals / equipment

Promoting broadband access requires more than access to broadband networks. People in developing countries also require access to personal computers or other end-user terminals. Are there low cost devices that can enable users in developing countries to receive broadband enabled services, products and content? What role can regulators play in improving PC and low cost devices penetration in the developing world? Without a solution to the problem of low PC penetration rates, the provision of broadband access networks will have little impact.

It is important that any policy to encourage the deployment of broadband access networks also considers appropriate policies that encourage the promulgation of end-user terminals, especially PCs, in order to achieve the full potential of broadband access networks.

There is of course a significant constraint to encouraging the take-up of PCs in terms of the incurred entry costs. One option relevant for most developing countries is the development of single access points where users can access PCs at a single location whether it is a cyber-café (often the primary mode of accessing the internet in many developing countries) or a community centre (including schools and public offices). For example, in Sud Mennucci, a town in southern Brazil, plans are underway to set up Internet centres to reach out to low-income rural communities.

Box 21: Extending broadband access to rural communities: Installing Internet centres in Southern Brazil

Sud Mennucci is a town with 7,500 inhabitants, located 700km southeast of Sao Paulo.

There is a plan to install two Internet access centres with 10 computers by end of 2005, to provide Internet access to low income inhabitants.

Three solutions have been proposed to realize this plan:

Have the federal government donate the computers for the centre;

Incorporate the plan into the state government's Acessa Sao Paulo programme, which aims to provide free Internet access to dozens of municipalities in Sao Paulo state, or

Engage private companies to set up the centre and provide training in the use of technology.[24]

There are, however, many alternative options for encouraging PC take-up, some of which are detailed below:

Box 22: Encouraging PC penetration: Selected examples

In **India**, the government has launched an "Indian PC Programme", which aims to improve PC penetration from the current 14 per 1,000 to 65 per 1,000 by 2008. Some of the initiatives include: launching Rs 9,999 (US$230) "no compromise" PCs, subsidized by software vendors and chipmakers; encouraging all incumbent operators to move towards a subscription model for broadband and PC as a package; setting up loan schemes, employee provident funds and other saving funds to encourage PC adoption amongst government employees; and amending the Income Tax Act to include deduction of home PC purchase price.

In **India**, cybercafe kiosks have been set up along railway tracks around the country to provide computer access to rural villages. As a result, rural communities now have access to e-Government, tele-education and telemedicine services.

In **Mexico**, under the e-Mexico project, community plazas equipped with public Internet kiosks were set up in 3,200 municipalities around the country. Each community plaza has an average of 10 computers and has Internet access via satellite technologies.

In **Sri Lanka**, in co-operation with the World Bank, the Sri Lankan government is planning to set up telecentres in rural areas around the country to improve community access to ICTs. The target groups for these include farmers, students, SMEs and other marginalized groups.

In **Thailand**, a "Computer ICT Programme" was launched in 2003 to provide low-cost computers. In addition, there is plan to establish a nationwide network of 751 tele-centres located at various post offices throughout the country.

In **Tunisia**, the World Bank is working with the Tunisian government to subsidize 6,000 Publinets and 10,000 PCs under the "PC Familial" programme. There is also an investment plan to increase the number of PCs in schools.

In **Uganda**, Uconnect, an NGO based in Uganda, imports used computers from Europe and the United States, revamps them and supplies them to schools and organizations. About 100 mostly rural-based schools have benefited from this project.

5.13 Increasing the awareness of broadband

This paper has thus far focused on the role of regulators in stimulating the supply side of the broadband access market, i.e. encouraging network build-out. There are, however, significant opportunities for regulators to promote usage of broadband through the expansion and improvement of applications and services available to end-users, especially in terms of relevance, as well as improving end-user and other agency awareness.

Given scarce capital resources in many developing countries, there is a requirement by regulators (and appropriate ministries) to demonstrate the relevance and necessity of promoting the deployment of broadband access networks, especially if funding is required in some form. This requires a clear demonstration of the benefits of broadband access and the preparation of a holistic ICT strategy of which broadband access is but one component.

In particular, a number of countries have used e-government projects to initiate and support information and communication technology (ICT) and, specifically, broadband development. Such projects have a number of objectives including:

- To enhance the efficiency of government through more rapid and structured information and workflows, i.e. manual transactions to online transactions (e.g. more simplified procurement processes);
- To improve government linkages with the population (i.e. to allow more ready access to government services , officials, and information);
- To expand the reach, awareness and understanding of broadband access (especially important as governments are often one of the largest employers in many developing countries); and
- To provide a framework to attract local and foreign investments.

For example, the ITU is working on a Global E-Government Project to enhance government services through the use of secure and trusted Internet infrastructures and applications in selected developing countries[25].

The Vietnamese government, in co-operation with the World Bank, is currently working on implementing an e-government plan, which aims to promote and sustain extensive take-up of broadband.

Box 23: Increasing awareness of broadband: E-government project in Vietnam

The Ministry of Posts and Telematics (MPT) in Vietnam has recently drafted a National ICT Master Plan for 2006-2010 and an E-Government Master Plan to 2010. These initiatives will be implemented in co-operation with the World Bank.

The ICT Master Plan aims to achieve:

a wide diffusion of ICT through Vietnam's economy and society, such that ICT accounts for a higher percentage of GDP;

establishment of a nationwide information and communications network;

a comprehensive ICT skills development;

As part of the process to improve e-readiness in Vietnam, the ICT project will address the following issues:

- strengthen technical and managerial capacity of the MPT in implementing the ICT initiatives;
- facilitate increased access to telecommunications in the context of a gradual move towards a more competitive market environment and private sector participation;
- promote greater awareness of ICT and e-applications in the business community, with the view to encourage businesses to adopt e-commerce;
- support enhanced government online presence and content at the national and municipal level, through interactive and dynamic portals;
- roll out e-government services to businesses in areas such as e-procurement and business/land registration; and
- support extensive training and awareness-raising efforts to encourage diffusion of ICT in the private sector.

Within such projects, the provision of broadband access networks is just one component of a broader strategy to improve Vietnam's ICT positioning and, hence, provide substantive positive impacts across the economy.

Within the country, telecommunications regulators are in a good position to initiate greater collaboration and co-operation with other government agencies to promote broadband take-up. Apart from e-government projects, which allow other government agencies to be directly involved in the promotion and usage of broadband, inter-government-agency working groups could be established to facilitate the development of broadband infrastructure, particularly in commercially less viable areas where resources can be shared. For instance, the Singapore ONE initiative, which was officially launched in 1997, was designed to be a collaborative effort between government and industry to implement a nationwide broadband network. It was jointly supported and driven by a number of government agencies, including the telecommunications regulator, the Economic Development Board, Media Development Authority and a government research agency.

Regulators and government agencies could take the lead by actually building a broadband backbone network. The success of the Singapore ONE initiative was largely driven by its building and operating of a core Asynchronous Transfer Mode (ATM) backbone network, which enabled broadband access to be provided extensively to public libraries, schools and training centres across the island. This served to raise awareness of broadband and drove broadband take-up across various communities.

Importantly, however, in order to really act as advocates for broadband access, regulators must be able to clearly demonstrate its credible advantages. Indeed the regulator can even take the lead in coordinating the needs of the various government ministries and departments. This is the case in Singapore, where the IDA coordinates all ICT procurement for the government. This paper has already provided a number of such advantages including the ability to support specific applications (e.g. educational or health). As a further example, the Turkish Ministry of Health is partnering with ITU to develop e-healthcare systems. Specific initiatives include providing healthcare providers and professionals, and citizens with access to health-related information via broadband access, and development of Primary Healthcare Information Systems and Electronic Health Records.

Similarly, the deployment of broadband access networks in Chile was supported by defined positive impacts on the educational system, especially in more marginal areas.

Box 24: Involving local communities: The Rural-Enlaces project in Chile

The Rural-Enlaces is part of an ICT policy to improve education in 3,600 rural schools around Chile, with an estimated reach of 130,000 students.

The project involves the provision of learning aids, such as computers, as well as telecommunication access, including broadband.

The proponents of Rural-Enlaces are convinced that technology should be seen as a means to support existing pedagogical approaches to rural education, rather than as a cultural invasion of the dominant group. Hence, the project aims to involve various segments of the local communities in the implementation process.

For instance, the project is positioned as an opportunity for professional development for local teachers. Apart from benefiting from technological knowledge transfer, teachers are also directly involved in the selection of educational software and nature of content information. In addition, they are consulted on the design of learning practices that are most appropriate and relevant to everyday reality.

Parents are also involved in helping out with various aspects of project implementation at the local schools.

The relevance and potential impact of broadband access networks can also be increased by providing content that is relevant to local communities, particularly in local languages. Morocco, for example, is in the early stages of developing Arabic content for both mobile and Internet services. In Laos, one of the least developed countries in the world, a Lao-language version of Linux-based graphical desktop and Lao-language office tools have been developed and provided to villages as part of a plan to promote wireless LAN.

Fundamentally, in order to be able to increase awareness of broadband access networks and to successfully advocate positioning broadband access at the forefront of a country’s telecommunication strategy, regulators need to be able articulate the potential benefits, both direct and indirect within a cost-justified framework. Furthermore, the rationale for broadband is likely to be stronger when contained within a broader and holistic ICT strategy (including policies to improve the rate of PC penetration). This is the challenge for regulators, especially when there are so many other demands on a country’s telecommunications infrastructure and on a country’s scarce resources.

5.14 Other regulatory concerns

This paper has thus far focused on the promotion of broadband access as an information delivery platform. As broadband take-up and usage widens, regulation of broadband services and applications will become an increasing concern for regulators.

In view of the potential and growing demand for IP telephony, regulators in several countries have begun developing a regulatory framework to address associated issues with the service. These key concerns are examined in greater details in the GSR discussion paper on VoIP:

- Numbering
- Emergency services

- consumer-protection
- Quality of service

In addition to the above, regulators will also need to consider regulatory measures pertinent to any content delivery platform as broadband deployment takes off. Given the superior functionalities of broadband access, some of these concerns are arguably more pressing for regulating broadband than other telecommunications services. These include:

- Having an appropriate framework that can be used effectively against intellectual property infringement;
- Setting in place content regulation guidelines to protect consumers, especially minors; and
- Setting up appropriate and suitably non-invasive regulatory mechanisms over the broadband Internet to ensure that national security is not compromised.

6 Conclusions

Although basic PSTN teledensity is extremely low in many countries at the moment, the rapid development of technologies, especially wireless technologies, provides opportunities for these countries to plan beyond increasing basic teledensity and into broadband.

This should be viewed in the context of the following:

- First, broadband is rapidly taking off across the developed world and is beginning to be deployed in developing countries. Still, deployment in developing countries needs to grow in terms of real numbers and distribution throughout all regions of the world, and between urban and rural areas. In the absence of greater broadband deployment, developing countries will be left behind;
- Second, broadband access networks are able to support applications, services and products which can have substantial positive impacts, including cheap voice communication, and health and educational related services;
- Third, new wireless technologies are rapidly changing the underlying costs of the provision of broadband access and if these technologies meet all their expectations (in terms of unit costs and functionality), then the impact could be substantial; and
- Fourth, deployment of broadband access networks allows developing countries to effectively “leapfrog” the development road map, i.e. not to have to deploy circuit-switched PSTN local loops but to advance straight to IP based local loops with all the consequent advantages.

There are clearly a large number of challenges to be faced. In particular and amongst others, this paper recognizes that the current perceived lack of local demand and available revenue streams could prevent the commercial deployment of broadband access networks in many areas of developing countries, especially non-urban areas, at least by large-scale network operators. Furthermore, continued low PC penetration rates in many developing countries could effectively negate any potential positive impacts that may arise from broadband network deployment.

In response to these challenges, this paper has reached the following conclusions/recommendations:

- Regulators could seek to maximize investment flows into their industries by liberalizing markets and permitting foreign ownership. This includes allowing broadband providers to offer a full range of services and applications, such as the triple play of voice, internet access and broadcasting;

- Regulators can encourage the deployment of wireless broadband access networks by freeing up the requisite spectrum and linked to this recommendation, could adopt a technology neutral approach;
- Regulators can create a regulatory framework that encourages a full range of potential broadband providers, from large-scale national network operators, to universities and government offices to local community initiatives, to deploy broadband access networks. This may include tailoring regulatory frameworks to each group of potential broadband providers.
  - A regulatory framework tailored to small broadband providers will enable and encourage local community providers to harness the potential of broadband technologies and enable greater broadband access in rural areas;
  - Competitive large-scale operators can be encouraged to extend their networks to rural areas through infrastructure sharing arrangements that guarantee open access to all competitive operators;
  - Competitive large-scale operators can be incentivised to deploy non-commercially viable networks in return for appropriate rewards;
  - Regulators could seek to encourage the deployment of broadband access networks by providing direct (e.g. targeted smart subsidies from universal access fund contributions/grants) or indirect (e.g. tax exemptions) financial support to the full range of broadband providers;
- An asymmetric regulatory regime could be defined, implemented and enforced to prevent the dominant (often the incumbent) operator from constraining the development of competition in the broadband access market;
- Regulators could work with other government agencies or ministries to develop initiatives such as e-government programmes (provided that this is supported by appropriate levels of institutional capacity to support large-scale automated transactions) that generate demand for broadband services;
- Regulators can take a number of steps to encourage the build-out of fibre backbone networks to boost the capability of both wireline and wireless broadband technologies. These steps include forging synergies with transport and energy infrastructure projects and providing incentives for 2G mobile operators to replace their microwave links with fibre networks and then make it possible for all owners of such communications resources to lease unused capacity to others for commercial deployment;
- Any broadband access development strategy could be linked to efforts to support and promote PC take-up, including government-sponsored PC kiosks and other access terminals, especially in areas where broadband networks are to be deployed.

Promoting broadband access in developing countries, both in urban and non-urban areas, requires a new vision of reduced regulatory burdens, innovative incentives, and coordinated efforts by all links in the broadband value chain. It requires concerted political will to achieve, treating ICT and broadband as a tool for development, and an end to a ‘business as usual’ approach. Commercial deployment opportunities can be unleashed where unnecessary regulatory burdens are removed so that all potential providers can freely offer broadband access and a full range of broadband-enabled services. Many small players stand ready to respond if their market entry is authorized. For other potential small players, an awareness raising campaign related to broadband technologies and facilitated market entry, may be all that it takes. Public service institutions like libraries, universities and government offices can be tapped to drive demand for broadband access in rural areas. Some larger commercial players will be spurred to action when they see new local markets driving demand. Commercial players can then continue to drive demand with entertainment content to complement public service content. Other large commercial players may require incentives and targeted government support in order to extend broadband network to rural areas. Moreover, untapped communications resources such as fibre in electrical grids and railways can be made available to boost broadband capacity and support the ease and viability of deployment. There are many challenges in the road ahead. Strategic and creative thinking to overcome these challenges through concerted efforts on all fronts promise to enable developing countries to join the broadband world.

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[1] Large-scale operators include main national operators, new entrants and mobile operators.

[2] Marginal areas include remote, rural and under served areas.

[3] While some private companies have also deployed private networks, these remain largely in urban areas.

[4] By year-end 2004, some 112 countries had at least partially privatized their State-owned incumbent operator. *Source:* ITU World Telecommunication Regulatory Database.

[5] ITU World Telecommunication Indicators Database.

[6] The African Virtual University was established in 1996 as part of a World Bank project. It was founded as a technology-based distance education network to bridge the digital divide in Africa. www.avu.org

[7] Universitas 21 is an international network of leading research-intensive universities, with the objective of facilitating collaboration and co-operation between member countries, as well as to create entrepreneurial opportunities for them. Established in 1997, it now has 17 member universities in 9 countries. www.universitas21.com

[8] TRAI, 2004, Recommendations on Internet and Broadband. www.trai.gov.in/Recommendations%20on%20Internet%20and%20Broadband%202004-04-29%20FINAL.pdf

[9] Yun *et al.*, 2002, The Growth of Broadband Internet Connections in South Korea: contributing factors. http://www.ciaonet.org/wps/yuk01/

[10] TRAI, 2004, Recommendations on Internet and Broadband. www.trai.gov.in/Recommendations%20on%20Internet%20and%20Broadband%202004-04-29%20FINAL.pdf

[11] Contribution of Ireland to GSR Consultation to identify best practice guidelines for spectrum management to promote broadband access (http://www.itu.int/ITU-D/treg/Events/Seminars/2005/GSR05/consultation.html).

[12] The trend away from onerous licensing practices toward more flexible market-entry authorization approaches, including technology and service-neutral licensing and authorizations, was explored fully in the 2004/05 edition of Trends in Telecommunication Reform: Licensing in an Era of Convergence (http://www.itu.int/publications/).

[13] See ITU Trends in Telecommunication Reform 2004: Licensing in an era of convergence.

[14] For a detailed discussion on this issue, See ITU Trends in Telecommunication Reform 2003: promoting universal access to ICTs.

[15] See ITU Trends 2004, Chapter 5. TRAI press release August 2004. www.trai.gov.in/Newpressrelease.pdf

[16] The Nigerian Communications Commission, 2005. www.ncc.gov.ng/Headlines/REPORT%20ON%20POST%20EXCLUSIVITY.doc

[17] See http://europa.eu.int/information_society/topics/telecoms/implementation/annual_report/7report/slides281101.

[18] The full set of regulatory guidelines agreed by WATRA are available at http://www.itu.int/ITU-D/treg/Events/Seminars/ITU-EC-Project/Ghana/modules/Guidelines-e.pdf

[19] The role of regulators in promoting IXPs is explored in the ITU-IDRC report Via Africa: Creating local and regional IXPs to save money and bandwidth, available at http://www.itu.int/ITU-D/treg/

[20] TRAI, 2004, Fixation of Ceiling Tariff for International Leased Line Circuit (Half Circuit). http://www.trai.gov.in/consultation%20paper-30th%20april%202004.pdf

[21] http://www.railtelindia.com/

[22] http://www.convergenceplus.com/apr03%20expert%20view%2002.html

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[24] LatinCom, 2005.

[25] For more information on this project see: http://web.itu.int/ITU-D/e-strategy/projects/E-Government/Executive-summary11.pdf

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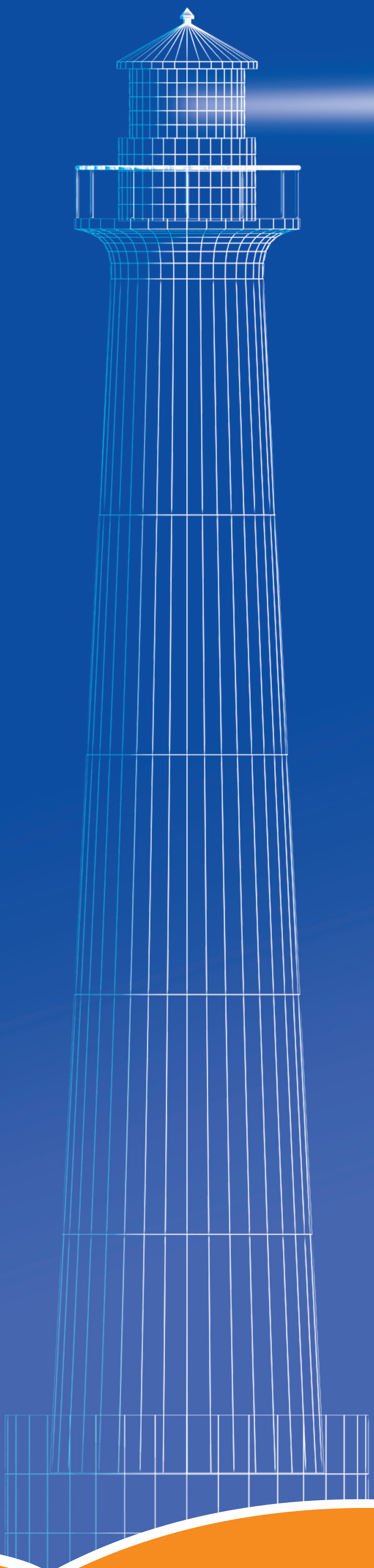

GSR 2005
DISCUSSION PAPER

BROADBAND SPECTRUM MANAGEMENT

Comments are welcome and should be sent by 5 December 2005 to GSR05@itu.int

International Telecommunication Union

GLOBAL SYMPOSIUM FOR REGULATORS

MEDINA CONFERENCE CENTRE
YASMINE HAMMAMET, TUNISIA

14-15 NOVEMBER 2005

Work-in-progress, for discussion purposes

Broadband Spectrum Management

Pragmatic Tradeoffs for Enabling Broadband Wireless Access

Prepared by *JOHN B. MULETA*

Comments are welcome and should be sent by 5 December 2005 to http://www.gsr2005@itu.int.

TABLE OF CONTENTS

GSR Spam Discussion Paper

Broadband Spectrum Management

*Pragmatic Tradeoffs for Enabling Broadband Wireless Access**

1 Executive Summary

This chapter discusses the dawn of broadband wireless access (BWA). It does so from the perspective of the challenges faced by global spectrum regulators on how to allocate and assign spectrum rights in a manner that encourages the rapid and widespread deployment of BWA systems for the ultimate benefit and welfare of consumers. The spectrum regulator's main challenge is to provide for flexible, market oriented spectrum license rights---which theoretically create a positive investment climate for BWA services---while at the same time avoiding uneconomic hoarding and speculation in spectrum that could have the detrimental effect of delaying the availability of these services to consumers. The key point of this paper is that grants of increasingly flexible spectrum rights should be favored so long as the spectrum licensees' meet two absolute preconditions critical to the development of communications markets. The first precondition is that the grant of these new rights to the spectrum licensee, or in the case of unlicensed spectrum – the service enabler, must in some form or shape increase the competition for the benefit of consumers. The second precondition is the requirement that the licensee, or in the case of unlicensed spectrum---the service enabler, to experience the opportunity cost of using its spectrum allocation as a way of ensuring effective and efficient use of the spectrum.

This paper is not intended as an academic overview of spectrum issues; instead, it is designed to stimulate thinking on how to make effective and pragmatic spectrum management decisions without falling into dogmatic and theological approaches that have become the standard discourse on this issue.[1]

The paper begins by articulating the primary goals of broadband spectrum regulators and seeking to understand some fundamentals about the economics of wireless access systems based on the past 20 years of experience in mobile wireless markets. It follows with a review the fundamental technological advances that are making it possible for new spectrum resources to be available for broadband wireless services and applications. The traditional regulatory spectrum management models are then examined to determine whether they adequately address the challenges presented by these new advances in BWA technologies. After concluding that the current regulatory models are by themselves insufficient to address these changes, the paper outlines a more pragmatic framework for managing BWA spectrum resources to achieve the end goals. The paper continues on to discuss certain key spectrum management best practices that could be incorporated into this pragmatic approach to accelerate the rate at which BWA networks could be deployed. The final section of the paper reviews recent spectrum decisions demonstrating how best practices and a pragmatic outcome oriented spectrum policy framework can help encourage the rapid deployment of BWA systems.

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* This discussion paper has been prepared by John Muleta. The views are those of the author and may not necessarily reflect the opinions of the ITU or its membership.

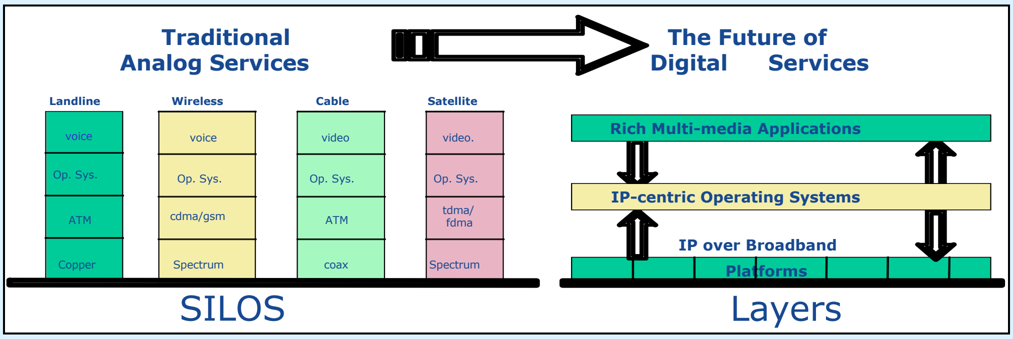
2 Introduction

In our modern world, broadband wireless services are poised to bring significant benefits to all parts of the world by bringing the Internet's power to educate and inform literally into the hands of billions of people around the globe. Unlike the past, these new services are likely to be uniform in that they will ultimately be providing "access" to the Internet and to Internet Protocol enabled services. Henceforth, the phrase "Broadband Wireless Access" or BWA will be used to describe the arrival of an era where it is possible to have the "Internet Everywhere All the Time." As the intent here is to find ways of increasing the rate of consumer adoption of BWA, the discussion of BWA addresses spectrum bands below 6 GHz where the physical characteristics of the spectrum are more conducive to consumer applications.

In this new era, the power of the Information Age to affect our lives will be exponentially multiplied by the freedom brought about by BWA networks. Wireless broadband technologies such as those defining BWA will fuel the engines of our global economies by enabling consumers to:

- freely access the Internet from the farm, the city, kiosks, cyber cafés, coffee shops, on moving trains, and in their own communities and backyards, in developed and developing countries alike.
- connect to the Internet seamlessly using a single device – to make phone calls, to access information, to vote, to access government services, pay taxes, pay bills electronically, and access entertainment.
- live in enlightened communities that are connected to broadband using spectrum based services – gaining access to a wealth of resources and opportunities not previously available.

Figure 1: The ultimate consumer broadband experience will be based on a multi platform IP network with BWA as its core



BWA networks' impact on consumers is even more heightened when it is combined with the advances made in other telecommunications platforms including wireline, cable, broadband-over-powerline (BPL) and satellites. *Ultimately, the broadband world is one where BWA networks, because they enable mobility and* portability*, are at the core of a variety of useful combination of broadband technologies that result in a rich multi-media consumer experience at nearly all times and all places.*

Of course, the opportunity for BWA services to improve our lives ultimately relies on the amount of spectrum rights made available by regulators. However, for the first time in spectrum's short history, it appears that advances in technology, independent of the action of the regulators, can increase spectrum capabilities and resources (i.e., allowing licensees to do more with the same spectrum or enabling new uses for spectrum not previously possible). As these advances become more widely adopted and new spectrum resources become available even more rapidly, regulators must consider whether traditional approaches to spectrum management are sufficient to address the resulting challenges and opportunities.

While contemplating the appropriate regulatory model for the evolving state of spectrum technology, broadband spectrum regulators must also be mindful of a number of key best practice concepts that have developed around spectrum management over the last two or three decades. The best practices listed below have, in varying circumstances, fostered the widespread adoption and deployment of an earlier generation of wireless services including cellular mobile radio, broadcast television, paging, and satellite services. They have also led to significant reduction to the cost of providing services and created the opportunity for entrepreneurs to develop innovative applications that have benefited consumers.

2.1 Spectrum Management Best Practices

Regulators participating in the 2005 Global Symposium have identified the following set of best practice guidelines for spectrum management to promote broadband access:

2.1.1 Facilitate deployment of innovative broadband technologies.

Regulators are encouraged to adopt policies to promote innovative services and technologies. Such polices may include:

a) Managing spectrum in the public interest.

b) Promoting innovation and the introduction of new radio applications and technologies.

c) Reducing or removing unnecessary restrictions on spectrum use.

d) Embracing the principle of minimum necessary regulation to reduce or eliminate regulatory barriers to spectrum access, including simplified license and authorization procedures for the use of spectrum resources

e) Allocating frequencies in a manner to facilitate entry into the market of new competitors.

f) Ensuring that broadband wireless operators have as wide a choice as possible of the spectrum they may access, and releasing spectrum to the market as soon as possible.

2.1.2 Promote transparency

Regulators are encouraged to adopt transparent and non-discriminatory spectrum management policies to ensure adequate availability of spectrum, provide regulatory certainty and to promote investment. These policies may include:

- Carrying out public consultations on spectrum management policies and procedures to allow interested parties to participate in the decision-making process, such as:
  - public consultations before changing national frequency allocation plans; and
  - public consultations on spectrum management decisions likely to affect service providers.
- Implementing a stable decision-making process that provides certainty that the grant of radio spectrum is done in accordance with principles of openness, transparency, objectivity--based on a clear and publicly available set of criterion which is published on the regulator's website--and non-discrimination and that such grants will not be changed by the regulator without good cause.

– Publication of forecasts of spectrum usage and allocation needs, in particular on the regulator's website.
– Publication of frequency allocation plans, including frequencies available for wireless broadband access, in particular on the regulator's website.
– Publication of a web-based register that gives a complete overview of assigned spectrum rights, vacant spectrum, and license-free spectrum.
– Clearly defining and publishing radio frequency spectrum users' rights and obligations, including on the regulator's website.
– Clearly defining and publishing licensing and authorization rules and procedures, including on the regulator's website.
– Publication of legal requirements for imported equipment and foreign investment, in particular on the relevant government agency website.

2.1.3 Embrace technology and service neutrality

To maximize innovation, create conditions for the development of broadband services, reduce investment risks and stimulate competition among different technologies, regulators can give industry the freedom and flexibility to deploy their choice of technologies and decide on the most appropriate technology in their commercial interest rather than regulators specifying the types of technologies to be deployed, or making spectrum available for a preferred broadband application.

• Regulators can take into consideration technological convergence, facilitating spectrum use for both fixed and mobile services.
• Regulators can provide technical guidelines on ways to mitigate inter-operator interference.
• Regulators can ensure that bands are not allocated for the exclusive use of particular services and those spectrum allocations are free of technology and usage constraints as much as possible.

2.1.4 Adopt flexible use measures

Regulators are encouraged to adopt flexible measures for the use of spectrum for wireless broadband services. Such measures may include recognizing that:

• minimizing barriers to entry and providing incentives for small market players by allowing broadband suppliers to begin operations on a small scale at very low cost, without imposing onerous rollout and coverage conditions, to enable small market players to gain experience in broadband provision and to test market demand for various broadband services.
• wireless broadband services can be used for both commercial and non-commercial uses (e.g., for community initiatives or public and social purposes) and that broadband wireless spectrum can be allocated for non-commercial uses with lower regulatory burdens, such as reduced, minimal or no spectrum fees; regulators can also allocate and assign spectrum for community or non-commercial use of broadband wireless services.
• flexible licensing mechanisms of wireless broadband technologies can provide a full range of converged services.
• adopting lighter regulatory approaches in rural and less congested areas, such as flexible regulation of power levels, the use of specialized antennas, the use of simple authorizations, the use of geographic licensing areas, lower spectrum fees and secondary markets in rural areas.
• in markets where spectrum scarcity is an issue, the introduction of mechanisms such as secondary markets (e.g., spectrum trading) can foster innovation and free-up spectrum for

broadband use. If spectrum users can trade spectrum rights and change the use made of the spectrum, this will enable new broadband services to be introduced more speedily than if the regulator first revokes existing licenses and re-awards them for broadband applications.

- the role that both unlicensed (e.g. license-exempt) and licensed spectrum can play in the promotion of broadband services, balancing the desire to foster innovation with the need to control congestion and interference. One measure is to allow small operators to start operations using license-exempt spectrum, and then moved to licensed spectrum when the business case is proved.
- the promotion of shared-use bands, as long as interference is controlled. Spectrum sharing can be implemented on the basis of geography, time or frequency separation.
- Developing strategies for clearing bands for new services as appropriate.
- the need for cost-effective backhaul infrastructure from rural and semi-rural areas, regulators can consider the use of point-to-point links within other bands, including any bands for broadband wireless access

2.1.5 Ensure affordability

Regulators can apply reasonable spectrum fees for wireless broadband technologies to foster the provision of innovative broadband services at affordable prices, and minimize unreasonable costs that are barriers to entry. Increasing the direct and indirect costs of accessing spectrum further reduces the economic viability in rural and under-served areas. Auctions and tender processes can be managed to better meet these goals.

2.1.6 Optimize spectrum availability on a timely basis

Regulators are encouraged to provide effective and timely spectrum use and equipment authorizations to facilitate the deployment and interoperability of infrastructure for wireless broadband networks. Regulators are also encouraged to make all available spectrum bands for offer, subject to overall national ICT master-plans, in order that prices are not pushed up due to restrictive supply and limited amount of spectrum made available and so that opportunities to use new and emerging technologies can be accommodated in a timely manner. In addition, special research or test authorizations could be issued to promote the development of innovative wireless technologies.

2.1.7 Manage spectrum efficiently

Spectrum planning is necessary to achieve efficient and effective spectrum management on both a short-term and long-term basis. Spectrum can be allocated in an economic and efficient manner, and by relying to the greatest extent possible on market forces and economic incentives. Regulators can promote advanced spectrum efficient technologies that allow co-existence with other radio communications services, using interference mitigation techniques like dynamic frequency selection and spread spectrum technology. Regulators can provide swift and effective enforcement of spectrum management policies and regulations.

2.1.8 Ensure a level playing field

To prevent spectrum hoarding, especially by incumbents, regulators can set a limit on the maximum amount of spectrum that each operator can obtain, which would be no higher than the optimum amount of spectrum required for nationwide deployment.

2.1.9 Harmonize international and regional practices and standards

Regulators can, as far as practicable, harmonize effective domestic and international spectrum practices and utilize regional and international standards whenever possible, and where appropriate, reflect them in national standards, balancing harmonization goals with flexibility measures. This could include harmonization of spectrum for broadband wireless access that could generate economies of scale in the production and manufacture of equipment and network infrastructure. Likewise, global harmonization of standards to ensure interoperability between different vendor's user terminals and network equipment can be promoted. The use of open, interoperable, non-discriminatory and demand-driven standards meets the needs of users and consumers. Developing coordination agreements with neighbors, whether bilateral or multilateral in nature, can help speed licensing and facilitate network planning.

2.1.10 Adopt a broad approach to promoting broadband access

Spectrum management alone is inadequate to promote wireless broadband access. A broad approach, including other regulatory instruments; such as effective competitive safeguards, open access to infrastructure, universal access/service measures, the promotion of supply and demand, licensing, roll-out and market entry measures; the introduction of data security and users' rights, where appropriate; lowering or removing import duties on wireless broadband equipment; as well as development of backbone and distribution networks is necessary.

2.2 Key Emerging Global BWA Technologies

Technology is delivering innovation at an unheralded rate and its effect is being realized in wireless access technologies where a myriad of choices are presenting themselves. It is important to note that with the increasing harmonization of services across the globe, regulators should encourage the build-out of as many of these technological alternatives in order to maximize the options to the end-users. Some of the key emerging technologies are described below.

2.2.1 WiFI and HiperLan (Radio Local Area Network) Standards

The ITU's harmonization of the 5 GHz band in 2003 through the World Radio Conference has substantially increased the spectrum available for wireless local area networks (WLANs) worldwide. In addition to adding to the gross level of spectrum available, the ITU's consensus also permit the use of the IEEE standard 802.11 and ETSI Hiperlan standards, both widely deployed RLAN standards that have already achieved significant economies of scale in manufacturing and end-user distribution systems throughout the globe. The latest 802.11a standard has achieved maximum data rate of 54 Mbp/s, and many types of laptops and PDAs are now equipped to use the 802.11a standard. In the coming months and years, many new wireless mobile handsets will be incorporating dual chipsets (known as Unified Mobile Access "UMA" devices) that enable the handsets to seamlessly switch between wide area systems such as CDMA and GSM and radio local area networks such as those enabled by Wi-Fi networks. Similarly, the ETSI standard called HiperLAN2 has also been designed as a short range access mechanism that specifically complements UMTS networks (see below) and can also used for private wireless LAN system. HiperLAN2 is designed to offer high-speed (up to 54 Mbp/s) access to a variety of networks including the UMTS core networks, ATM networks and IP based networks. Both types RLAN systems provide competing benefits to the market and represent an opportunity for greater consumer choice.

2.2.2 UMTS & W-CDMA

Global system for mobile communications (GSM) is the largest mobile technology in the world, with 1.5 billion subscribers is evolving into a new high-speed standard known as Universal Mobile Telecommunication System (UMTS). This is the most subscribed to standard for third generation mobile networks. UMTS was launched in 2002 and is just now being fully implemented across developed country markets. UMTS is expected to deliver permanent internet access throughput of at least 384 kbp/s and up to about 2 Mbp/s. Wideband Code Division Multiplexing Access (W-

CDMA) and its related standard linked to UMTS, the High-Speed Downlink Packet Access (HSDPA), are mobile telephony protocols that permit data transmission downlinks ranging up to 2-8 Mbp/s using standardized 5 MHz bandwidth channels. These standards were created to enable a uniform global standard for real time multimedia services that enable seamless international roaming.

2.2.3 WiMAX

WiMAX utilizes the IEEE standard 802.16, has a data rate of between 10 and 100 Mbp/s, and provides large coverage areas of up to several kilometers. Wireless broadband networks that involve point-to-point or point-to-multipoint networks with individual network links that can provide last mile connectivity in metropolitan environments or can span distances of up to 30 miles are often referenced as WiMax systems. The IEEE currently is working to finalize the 802.16e standard which extends the WiMax standards to mobile applications. The WiMax 802.16 standard holds great promise for future developments in wireless broadband because it can be used for applications in both licensed and unlicensed spectrum, allows communications without the need for line-of-site connections, enables interoperability with different equipment using the same standard, and, in the near future, will encompass both fixed and mobile wireless applications. The developing world, much of which is not wired, is likely to embrace WiMAX as a substitute for cable or DSL broadband service. Although the WiMax standards can operate on both license and unlicensed spectrum, consensus appears to be in favor of a licensed approach with most countries allocating 2.5 GHz and 3.5 GHz bands for WiMax deployments.

2.2.4 WiBro

Wireless Broadband (WiBro) was developed by the Korean telecommunications industry, to operate on the 2.3-2.4 GHz frequency band. WiBro has a data rate of 30-50 Mbp/s and can cover a radius of up to five kilometers. This technology utilizes OFDMA, which allows signals to be divided into many lower-speed sub-channels to increase resistance to multi-path interference. Additionally, consistent with the ITU’s IMT-2000 allocations, WiBro systems under development emphasize hybrid satellite and terrestrial networks that are designed to optimize the delivery of new mobile applications such as mobile video and mobile broadband access.

2.2.5 Digital Television Broadcasting Standards

Digital Video Broadcasting on Terrestrial Networks (DVB-T) is a suite of internationally accepted, open standards for digital television maintained by an industry consortium supported by the European Telecommunications Standards Institute (ETSI), the European Committee for Electrotechnical Standardization (CENELEC) and European Broadcasting Union (EBU). Adoption has been widespread as these digital transmissions use the MPEG standard and are integrated in all set-top boxes commercially available in Europe.

In contrast, Qualcomm has developed a proprietary broadcast system designed to be complementary to CDMA and W-CDMA systems. Its Mediaflow chipsets are designed to use “forward link only” technology for multicasting video content to mobile handsets. This standard offloads high throughput applications onto a separate broadcast spectrum while seamlessly integrating the user experience to avoid latency and packet loss. Given its proprietary nature, it is unclear whether this approach will be able to provide significant advantages to end-user BWA experience in the short term outside of the few markets like the United States where CDMA has achieved significant market penetration.

2.2.6 UltrawideBand (UWB)

UWB is a wireless radio technology designed to transmit data within short ranges (up to 10 meters). It transmits at very high bandwidths (up to 480 Mbp/s) while using little power. UWB is ideal for exchanging data between consumer electronics (CE), PCs, PC peripherals, and mobile devices at very high speeds over short distances. For instance, it could transfer all the pictures on a digital camera's memory card to a computer in a few seconds. There are two standards competing for dominance currently leading to some level of uncertainty for end-users until UWB enabled devices are introduced into the market place in 2006 and thereafter.

Unlike conventional radio systems, UWB systems broadcast over very short distances using a broad spectrum band. Thus, instead of concentrating a powerful signal in a narrow band, the signal is spread over a very wide spectrum range at very low power levels. Of course the challenge of this approach to creating a new spectrum resource is that it encroaches on the rights of other licensees operating in the band. UWB supporters argue that the power levels and the distance limitations are such that the overlay of this technology will not result in harmful interference. Complicating this issue is also the different regimes adopted in Europe and the United States as to which bands UWB can be utilized. In the United States, UWB is limited to operate between 3.1 GHz and 10.6 GHz while in Europe the permitted range is above 4 GHz. Given the size of the United States market, European operators, especially those planning to use 3.5 GHz as the BWA platform, are concerned that UWB overlay systems could interfere with their systems in unexpected ways. Clearly, a more harmonized approach could avert a potentially protracted process of certifying UWB systems for use in different countries.

3 Goals for Broadband Spectrum Regulators

Outside of the political context of regulatory policy- making, spectrum regulators in the new broadband world should be advancing three separate but interrelated goals simultaneously. One primary goal should be to provide the proper incentives for spectrum licensees, both existing and new, to invest in broadband services. The second goal should be expanding consumer choices and welfare by enabling sustainable competition for similarly situated (e.g., "broadband") services irrespective of the underlying transport platform. Finally, the regulators' should consider implementing policies that discourage wasteful and potentially anti-competitive behavior resulting from uneconomic speculation and hoarding of the new spectrum capabilities and resources that result from the explosion of technological advances taking place in radio system design.

There are three conventional spectrum management methods. The first is a "command and control" model where strict operating parameters and service definitions provide the basis for defining licensees spectrum rights. An alternative licensing model is the "exclusive use" model where a licensee is afforded exclusive and, within limits, transferable and flexible use rights for a specified spectrum band within a defined geographic area and a fixed period of time. In the current understanding of the exclusive rights model, spectrum use rights and the supporting rules are primarily technical (as opposed to service based) in nature and are designed to protect the spectrum licensee from generating or receiving harmful interference.

The third regulatory model is the "commons or unlicensed" model which allows unlimited numbers of users to share a defined set of frequencies without having any defined set of individual spectrum use right. As such, permitted uses are defined by technical criteria that specify bandwidth and emitted power and provide no enforceable rights to protect against interference. A popular form of commons approach has been the deployment of wireless local area networks using the IEEE 802.11 standard (known as Wireless Fidelity or Wi-Fi).

These models do not sufficiently address today's rapidly evolving world of broadband spectrum. In the case of command and control approach, the spectrum rights are granted on such narrow grounds that they are of limited utility for broadband opportunities and also require constant government intervention, with its attendant time lag, to change the operating parameter of licenses. The exclusive use model, despite having compelling arguments for providing market incentives to new entrants unfortunately also creates counter-incentives for incumbent licensees to engage in speculative or anti-competitive hoarding of spectrum as a way of thwarting real or perceived competition. Finally, the commons approach, which today provides low entry barriers for service providers to launch services and can result in significant scaling in terms of consumer adoption, also unfortunately becomes self-limited by the lack of enforcement mechanisms to manage and prevent overcrowding and overuse.

An alternative to these models is for the regulator to adapt these models in various combinations that permit him or her to condition the grant new spectrum resources or rights to licensees that demonstrate they will use these rights and resources to increase overall competition for broadband services across all platforms and that they will experience the real and quantifiable opportunity cost of using these spectrum rights. This pragmatic approach insures that a market-based approach is utilized to achieve a public policy goal of deploying BWA systems as rapidly and as efficiently as possible.

4 Defining Broadband Wireless Access

Although wireless services are redefining the limits of our world, there is still no universal definition of wireless broadband. Some countries have defined wireless broadband as the ability of the consumer to have a set of devices that seamlessly interconnect various messaging and communications platforms, including voice and data, and while using inexpensive, high speed connections while at a fixed location or on the road.

Box 1 :

Singapore's regulatory authority describes wireless broadband as "an access technology that offers high-speed data access over the air. A wireless broadband network, typically operating at frequency bands less than 6 GHz, provides broadband speeds ranging from 256 kbps to tens of Mbps. Each base station generally serves an area of up to several square kilometers. Wireless broadband networks can deliver network connectivity to fixed locations using standards like IEEE 802.16d, and in the near future, to mobile users using standards like IEEE 802.16e and IEEE 802.20."

Kenya's Communications Commission defines broadband fixed wireless access "as intentional radiators that use wideband digital modulation techniques and provide a wide array of high data rate fixed communications for individuals, businesses, and institutions."

Mauritius uses a three-part definition for BWA, in accordance with ITU-R Recommendations:

- Wireless Access systems are broadband radio systems that may be deployed either indoors or outdoors. These systems include:
- Fixed wireless access which may be defined as *"Wireless access application in which the location of the end-user termination and the network access point to be connected to the end-user are fixed"*.
- *Mobile Wireless Access* which may be defined as *"Wireless access application in which the location of the end-user termination is mobile"*
- *Nomadic Wireless Access* which may be defined as *"Wireless access application in which the location of the end-user termination may be in different places but it must be stationary while in use*

There is even less agreement as to what constitutes the proper throughput of wireless broadband technologies. For some countries, 200 kilo bits per second ("Kbp/s") generally defines broadband. Other countries embrace 1000 Kbp/s as the minimum throughput required to meet the definition of broadband.

Internationally, the ITU considers broadband wireless access (BWA) to encompass mobile or fixed access technologies that provide connections at speeds higher than the primary rate (e.g.

2 Mbp/s), encompassing technologies falling within the IMT-2000 family as well as newer technologies such as WiMax and WiBro.

Nonetheless, it is likely that each country will continue to make its own decision about the definition of BWA given its technological and economic development stage. In that context, a pragmatic definition of BWA would be to equate the minimum throughput for a BWA system to be one that lends to a seamless “look and feel” with the minimum throughput of a fixed wireline broadband alternative available in that particular country. Defining BWA to be the minimum throughput of the competitive wireline systems has the sensible benefit of setting the market’s competitive dynamics so BWA systems have increasing incentives to add throughput in order to match, as closely as possible, wireline systems. This approach emphasizes the coming reality where broadband access is not a single platform but an amalgamation of platforms, with BWA systems at the core, that work together to deliver a set of relevant broadband features to the consumer.

4.1 The Economics of BWA

After two decades of wireless mobility, the economics of wireless access is now much better understood. The principal economic drivers of wireless systems are the availability and cost of spectrum, the cost of the end-user device, and the acquisition and maintenance of the end-user subscriber (ranging from network management to billing and customer service operations). For a BWA system to be successful, it must be competitive across each of these categories demonstrating to operators and end-users alike that it represents a viable value in the broadband marketplace, particularly when compared to the wireline or satellite alternatives which require significant capital expenditure to increase capacity or reach to the next available increment.

4.2 Spectrum as an Input

Spectrum, as discussed later on, is defined by the four parameters of which only two, power and bandwidth, are usually defined by regulators. These parameters determine the capacity and coverage that a particular spectrum band can deliver to an operator so the operator can deliver valued services to end-users. System capacity and coverage essentially determine the number, the size and the cost of the transmitters (including the supporting backhaul network) that an operator needs to deploy in order to deliver the desired set of services. These factors establish the return threshold of the operator wishing to deploy a competitive BWA network.

Box 2: Millimetre Bands

In comparison to spectrum below 3 GHz, millimetre wave spectrum bands (generally ranging above 20 GHz) represent the other extreme where the licensed bandwidth can generally provide significant throughput and data rates. For example, Mauritius has allocated 40 GHz spectrum for use in point-to-point and point-to-multipoint services. There are new developments in the marketplace expanding the throughput of these millimetre systems in excess of 80 Mbp/s which is competitive on a unit basis with fiber networks. However, the poor propagation characteristics of these spectrum bands limit coverage since base stations can only be deployed within unobstructed sight of each other. The economic effect of these line-of-sight limits means more base stations to cover more end-users devices thereby increasing overall operator costs. These bands are not effective for consumer applications and services on a standalone basis, but can provide complementary enabling backhaul services to consumer services deployed using non line-of-sight spectrum.

Spectrum in the range below 3GHz has propagation characteristics that enable wide coverage areas and can more easily overcome interference conditions including foliage, buildings and other obstructions using non line-of-sight technologies such as beam forming. The ability to provide non line-of-slight services reduces the number of base stations required to provide coverage in these bands. However, as we have learned from the experience with mobility services, the increasing the density of customers that comes from successful adoption of the service in the marketplace requires more base stations to meet the need for capacity. Ultimately, any viable BWA service will need to enhance both coverage and capacity but, in the first instance, it is more important to have greater coverage. It is unlikely that a new service category such as BWA that is just coming on in the market will have the necessary consumer adoption justifying a cost of a system designed solely for throughput and system capacity instead of reach and coverage. Over time, as consumer adoption increases, BWA systems will begin to emphasize throughput and capacity by reducing cell sizes and increasing the number of base stations.

There are a number of spectrum bands operating above 0.4 GHz and 5.5 GHz that could help foster the growth of BWA although each band represents necessary tradeoffs between capacity and coverage. In identifying these bands for new uses such as BWA, the general trend across the globe has been to reclaim the bands from incumbent licensees who have or will have the ability to deploy more spectrally efficient equipment that reduces their need for spectrum. One category of reclaimed spectrum comes from government and military operations (1.5-2.4 GHz as well as 5.1-5.8 GHz). In the commercial context, satellite (2.0-2.3 GHz) and fixed microwave systems (3.1-3.7 GHz and 2.1-2.2 GHz) provide an avenue for reclaiming spectrum since the increasing spectral efficiency of the latest technology for these systems and the widespread availability of substitute technology and services (e.g., submarine cables and fiber-optic networks) has reduced the demand for spectrum needed to deploy these services. The broadcast television bands including the UHF (400-700 MHz) and MMDS (2.5 -2.7 GHz) bands have also been the source for new BWA spectrum in various markets given the advent of spectrally efficient digital television broadcast standards.

Box 3: Spectrum Bands for BWA

- 450 – 500 MHz (Regions 2&3) and 600-1000 MHz (Region 1) could be used for broadband mobile access services given the significantly enhanced propagation characteristics of the band[1]; These bands are also under discussion as a candidate to be included as IMT-2000 bands during the 2007 ITU World Radiocommunication Conference (WRC).
- 1.5-2.5 GHz. Many of the bands in this range are currently identified as IMT-2000 bands as shown in Figure 3. They are also under discussion across all regions as part of the 2007 WRC harmonization process to be used for both fixed BWA and broadband mobile, meaning IMT-2000 and beyond (i.e., 3.5 and 4G). These bands are also identified for hybrid satellite and terrestrial wireless systems that permit seamless continental roaming for BWA operators;
- 3.4-3.7 GHz across all regions for licensed BWA services;
- 5.1-5.7 GHz across all regions as part of the WRC for license exempt BWA uses.

The process of identifying bands for new uses such as BWA can be achieved relatively easily, especially in the context of the global harmonization efforts that can provide guidance to the regulator about the most effective future use of a spectrum band. The difficulty lies in transferring these bands from an incumbent licensee to a new one. This paper seeks to help address these transitional issues in a pragmatic fashion by creating marketplace incentives that encourage licensees to transfer spectrum to its best and highest use while at the same time offering services that are competitive for the particular dynamics and context of each country (whether rural or urban, developed or developing markets).

4.3 End User Costs and Devices

End user adoption of wireless systems is largely a function of the cost of the end-user device and applications that work on the devices. Although it is common sense, it bears noting that the lower the cost of the end user device the greater the likelihood for significant adoption of the underlying service by consumers.

Over the last 20 years but increasingly over the last 5 years, the mobile marketplace has demonstrated that consumer adoption in developed markets has accelerated when device costs have been below the US$200 barrier. Although this threshold amount might not be practical for developing markets, it is important to understand that that mass adoption of end-user devices in developed countries has the positive scale effects that can easily translate to lower costs for end user devices distributed in developing economies. Additionally, wireless equipment manufacturers have also learned from the mobile market and are now offering end-user devices with limited functionality to developing country markets in order to further accelerate the manufacturing scale effect that reduces overall cost of making these devices.

4.4 Service Delivery and Management

Reducing the cost and complexity of applications and the associated service delivery mechanisms that work on wireless devices has a significant effect on consumer adoption and leads to accelerating the scale economies of manufacturing the devices. In all geographic markets, the advent of flat rate voice services and the use of prepaid services have increased the rate of adoption of wireless mobile devices thereby leading to significant scale of economies in manufacturing these devices. Additionally, the movement enabling internet protocol services on wireless devices will increase the rate of consumer adoption by making wireless access at the service layer indistinguishable from wired alternatives thereby increasing the value of these services to consumers.

The impact of the internet protocol mindset on BWA service delivery can be best understood by looking at the IEEE 802.16 WiMax standards development process currently underway. The key innovation of the 802.16 standards process has been to simplify the communications protocol stack so that economies of scale can take place in developing radios and the associated chipsets---the most expensive elements---while providing greater freedom for developing applications at the service layer.

5 The Technology Revolution Creating New Spectrum Capabilities

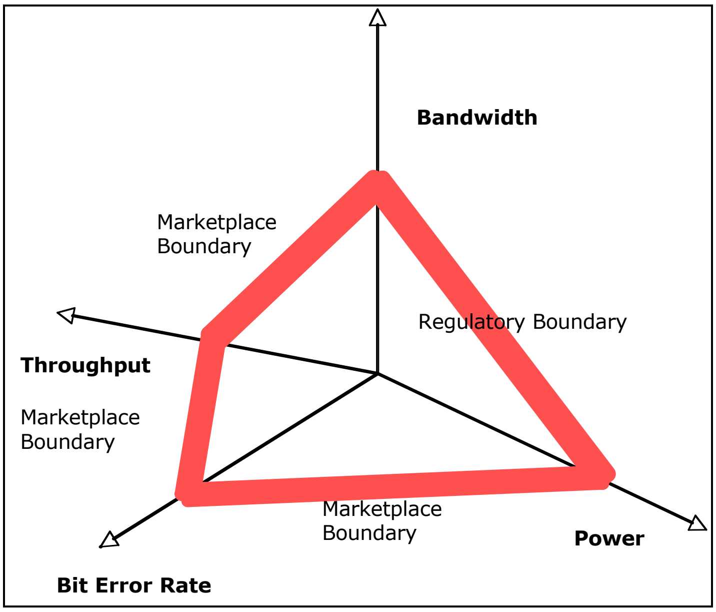
5.1 Applied Information Theory in Radio System Design

Spectrum represents the temporal and spatial opportunities to transmit information using the electromagnetic spectrum. The range of frequencies in the electromagnetic spectrum is typically divided into eight bands spanning from 3 Hertz to 300 GHz.

Frequency Range	Description
3 to 30 Khz	Very low frequency band (VLF)
30-300 KHz	Low frequency band (LF)
300-3 MHz	Medium frequency band (MF)
3 MHz-30 MHz	High frequency band (HF)
30 MHz-300 MHz	Very high frequency band (VHF)
300 MHz-3 GHz	Ultra high frequency band (UHF)
3 GHz-30 GHz	Super high frequency band (SHF)
> 30 GHz	Extremely high frequency band (EHF)

The characteristics of signal propagation depend on the frequency band on which the signal is transmitted and these signals are typically transmitted by an antenna device that transmits energy in one or multiple directions.

Shannon's capacity theorem, the fundamental theorem of radio communications design, establishes that the rate of information transfer by a radio is limited physically by the available spectral bandwidth and ratio of signal to noise within the band. Within this physical limit, the spectrum resources available to a radio are determined by four factors including specified bandwidth, the allowable power or energy emission within the band, the bit error rate acceptable to the end user and the throughput desired by the consumer. Most regulators have hereto only defined the power limits and the bandwidth and left the other two factors to be determined by the marketplace.

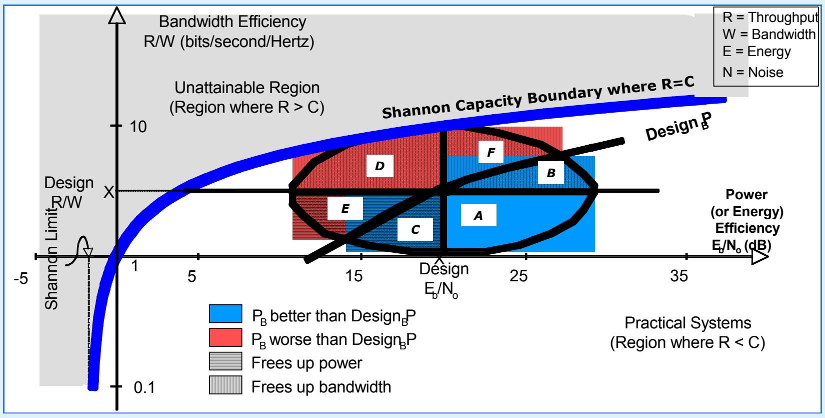


Traditional radio systems were designed using analog equipment and had limited computational power available to them. The results were radios that operated using very narrow throughput and bit error rate (i.e., quality of service demands) parameters and that were highly sensitive to the operating environment. Traditional radios were not flexible and could not be used to take on new tasks or operate in new environments making them unsuitable for broadband networks.

5.2 Advances in Microprocessor Technology and their Effect on Radio Designs

The advent of miniaturized and powerful computing resources available through digital signal processors (DSPs), non-programmable hardware computing components (ASICs) and field programmable gate arrays (FPGAs) has made it possible to create radio systems that can dynamically change along all four vectors (bandwidth, power, throughput, and bit error rate) that define spectrum. By using powerful microprocessors to dynamically change the four variables, radio system designers can now create new spectrum capabilities where none had previously existed. Figure 2 graphically describes the effect of applying these fundamental technologies as enlarging the operating parameters of the radio system from a single point on the design line to a much wider set of permutations among the four variables. By incorporating digital and microprocessor technologies into the design fabric of radio systems, engineers are now creating radios that can dynamically operate outside the constraint of a particular intersection of bandwidth and power limits normally set by regulators.

Figure 2: New technologies permit new spectrum uses to be created by trading off power or bandwidth with throughput and bit error rate dynamically on the same radio



For example, a radio designed to optimally perform at design P_B (in the middle of the circle) can now be redesigned on the fly to operate within any of the 5 possible regions surrounding the optimal point. Each of the 5 regions represent a tradeoff between power, bandwidth and throughput and bit error rate with the blue areas (those below the design line) representing increased performance in the form of either throughput or bit error rate in exchange for reduced power and bandwidth. In contrast, the red areas above the design line provide for increased power and bandwidth utilization but poorer performance in terms of throughput and bit error rate. Computing resources enable radios to make these tradeoffs virtually on the fly thereby increasing the flexibility of these systems to handle different types of market environments without the user having to have a different radio.

The net result of these advances is consumer radios that are becoming more flexible and highly adaptable. From a spectrum regulator's perspective, the additional flexibility and adaptability of the technologies means that new spectrum resources must be accounted for and usage rights eventually be assigned.

Box 4: Software Defined Radios, Adaptive Array Systems and Mesh Networks

Three exciting advances in radio technology have been made possible by the availability of computing resources to radio signal processing. These are software defined radios (SDRs), Adaptive Array Systems (AAS) and Mesh Networks.

Software defined radios (SDRs) describe an approach that uses both ASIC and FPGAs and other new technology to allow a re-configurable radio, which can be adapted at the point of use and for different applications. Software radio technology is a way of providing a multi-band, multipurpose radio. In the ideal software radio scenario, the radio signal is directly converted to digital signals at the antenna and all other radio functions are performed in the digital domain by software on the host platform which might be a flexible digital signal processing (DSP) chip, a computer or even a mobile telephone.

Unlike conventional antennas, where the energy is diffuse, AAS systems use computational algorithms to direct energy to a number of parallel and simultaneous channels within the same frequency bands. This exciting technology uses computing technology to combine a set of antennas (antenna arrays) and radio frequency energy in order to detect and calculate radio signals on a highly refined basis thereby suppressing interfering signals and automatically track desired signals leading to a significant increase in overall system capacity by enabling greater re-use of the same radio frequencies.

Mesh networks, developed through military communications technology research, and which are also known as ad-hoc and infrastructure free networks, are designed to maintain network quality of service in unstructured and/or harsh spectrum environments. Mesh networks eliminate the need for a spoke and hub radio network whereas traditional radios require remote units to constantly communicate with base stations using "big iron" infrastructure and control signals. Infrastructure free networks allow one subscriber to communicate with another while using the available spectrum without requiring synchronization from the base station. Ad-hoc networks rely less on device-to-device communication but on sharing messaging protocols so messages from one device can be passed on by another and so on without use of any public switched infrastructure. The ability to have sufficient computing resources to sample frequencies and process large amounts of data packets are key elements to making these types of mesh networks a commercial reality. Because mesh networks lack any common infrastructure, they represent new spectrum capabilities that are ungovernable from a central point and represent the latest challenge to regulators' ability to manage and allocate spectrum use rights

6 Can Conventional Regulatory Models Meet the Challenges of Broadband Spectrum?

6.1 Command and Control Model

The traditional process of spectrum management is referred to as the "command-and-control" model because of the strict definition of operating parameters applied to the use of spectrum. Some define the command and control model as a form of government control but a more honest assessment would consider the command and control approach to originate from the limits of conventional radio design during the last century. Ordinarily, the command-and-control regulatory model usually involves four, potentially bureaucratic, steps: allocation, adoption of service rules, assignment, and enforcement of rights.

In a command and control model, the regulator's task is never done. He or she must continually revisit and referee the radio environment as new radios are introduced into the marketplace. In order for a new radio system to enter the market, the regulator must address a wide variety of questions ranging from system configuration, co-channel and adjacent channel, power flux density, coding, out-of-band emissions, and innumerable other technical criteria relevant at any discrete point in time. *Of course, the cost of the regulator's involvement is the time it takes to transfer spectrum rights to their highest uses. Given the rapid rate of technological change, the time lag associated with government processes for allocating spectrum rights amounts to a significant cost to the ability of licensees to rapidly deploy new competitive BWA systems.*

6.2 Exclusive Use Model

The "exclusive use" model grants a licensee spectrum use rights that are generally exclusive, flexible, and transferable. These rights are bounded by interference related responsibilities and technical rules that are designed to protect the licensee from causing or receiving interference from out-of-band emissions. Under an exclusive use model in its purest form, licensees acquire an interest in a frequency band that is similar to a fee simple interest in the spectrum, with the right granted being exclusive for a set period of time. Few or no restrictions exist on the alienability of the spectrum including secondary market trading of the usage rights.

Proponents of the exclusive licensing approach tout the benefits of well-defined rights as providing licensees economic incentives for making the highest and best use of their spectrum rights. Detractors of this approach fear that it is quite possible that exclusive licensing models could lead to market failure in the form of hoarding or underinvestment by incumbent providers as a form of strategic behavior placing spectrum capacity out of reach of new entrants and/or competitive providers. *Furthermore, in the situation where technology continuously increases spectrum resources available to a licensee, it is not readily apparent that, absent significant competition, incumbents would be highly motivated to harness these new resources for the benefit of consumers. Left to its own devices, the exclusive model does not guarantee that licensees will use their spectrum rights to advance new innovative and competitive systems like BWA into the marketplace.*

6.3 The Spectrum Commons Model

In a spectrum commons model, spectrum is available to all users that comply with established technical standards for power limits and other criteria for operating spectrum devices with limited potential interference. Outside of equipment certification requirements, this regulatory regime requires no licenses and usually operates on a first in time sequence. The benefits of the commons model are that it provides users greater economic scale by reducing equipment costs and removing any direct cost of accessing spectrum.

The commons approach that provides for unlicensed spectrum significantly reduces a major barrier to entry for providing wireless services. Regulators wanting to jumpstart BWA deployment might choose to provide unlicensed spectrum, especially in rural and underdeveloped areas where other factors such as low population density and backhaul infrastructure might be limited. Of course, regulators must be careful to consider the inherent long term risks associated with this approach. In the long term, the limits to the spectrum commons model derive from its very success when increasing numbers of competing and interfering radios crowd out the available spectrum leading to an unstable environment for useful wireless services. This overcrowding phenomenon is more commonly known as the "tragedy of the commons" and can be mitigated by putting in place rules on power levels, modulation, back-off schemes, and other techniques. *Of course, the imposition of new technical rules by regulatory fiat to address these problems would effectively convert the commons approach into the more classical command and control model thereby defeating the very basis for establishing a commons model.*

Some regulators are using a mix of licensed and unlicensed spectrum to address the need for low cost broadband services in rural areas. Ireland, for example, allows small operators to launch services in rural areas using unlicensed spectrum. When such broadband providers establish a business case, they can migrate to licensed spectrum. See Box 5 below.

Box 5: Ireland's Contribution to the 2005 GSR Best Practice Guidelines on Spectrum Management to Promote Broadband Access

Principle Two: Balancing the Use of Licensed and Licence-exempt Spectrum.

A number of local initiatives have taken effect to provide broadband access using licence-exempt spectrum. In Ireland, from July 2002, wideband data transmission systems for the provision of fixed wireless access networks/metropolitan area networks (FWA/MAN) have been permitted in the 5.8 GHz (5725 – 5875 MHz) band on a licence-exempt basis, provided that the maximum radiated power does not exceed 2W eirp. This higher power level, over and above the current European harmonised standard, has increased the coverage achievable and hence the utility of the 5.8 GHz band.

This initiative provided some impetus for small market players to enter the market at very low cost, to gain some experience of broadband provision and to test market demand for various broadband services. A number of successful operations using the licence-exempt spectrum, having proved their business case, have now moved to licensed spectrum. ComReg has committed itself to continue to identify appropriate spectrum allocations, both licensed and licence-exempt, for Wireless Access Services which are supported by choice and availability of equipment.

Principle Three: Access to Cost Effective Backhaul Infrastructure.

Just as consumers in semi-rural or rural areas may not have access to ADSL, the providers of wireless broadband are hampered by the lack of cost-effective backhaul infrastructure, e.g., fibre. The alternatives such as satellite or point-to-point wireless fixed links are significantly more expensive compared to the costs of providing a wireless base station for broadband access.

In Ireland consideration is being given to permitting the use of point-to-point links within the broadband access spectrum to provide a cost effective backhaul operation. While this is difficult to accomplish from a spectrum management viewpoint, it is seen as a viable alternative to the traditional and more expensive alternatives.

Ireland's contribution to the 2005 GSR Best Practice Guidelines is available at http://www.itu.int/ITU-D/treg/Events/Seminars/2005/GSR05/consultation.html

7 A New Approach for New Times: A Pragmatic Approach for Managing Broadband Spectrum

In the broadband context, the fundamental future challenge for spectrum regulators is how to efficiently and effectively distribute new spectrum resources that technology is making available. A pragmatic model, unencumbered by having to subscribe to any particular spectrum theology--but still able to use any and all--to achieve the underlying policy goal-- seems to be the optimal way to meet this complex challenge. This secular approach takes into account the fact that technology is creating new spectrum capabilities and resources faster than most regulators' ability to redistribute these new rights using traditional means. The modern spectrum regulator needs a practical, outcome oriented policy framework that achieves results---in this case, the rapid deployment of broadband services---rather than seeking to resolve the grand theorem about the rights involved in spectrum use. The traditional spectrum management models---command and control versus exclusive rights versus commons---essentially focus on defining usage rights of spectrum licensees without articulating how these goals help achieve the underlying policy goals of the regulator.

High levels of spectrum license incumbency and limited level of inter-modal competition existing in most of today's broadband markets make the political and economic consequences of spectrum decisions significant. A pragmatic approach focusing on outcomes can make these factors more transparent thereby lending more authority to the regulator's decision-making process. A pragmatic approach which also rewards economic risk taking by spectrum licensees by offering market based incentives to deploy BWA mitigates the likelihood that licensees will occupy spectrum rights simply for its perceived scarcity value. *So what is a pragmatic approach? A pragmatic regulatory approach for increasing the affordability and availability of BWA services starts by offering to grant spectrum licensees maximum flexibility for their spectrum rights on the condition they meet two threshold obligations. First, licensees must demonstrate, a priori to the grant of their new spectrum rights, their commitment to increasing inter-modal broadband competition. Second, the licensees must agree to license conditions that positively enforce the opportunity cost of their newly allocated spectrum rights.*

7.1 Defining Flexible Spectrum Rights

Flexibility is defined herein as providing licensees significant degrees of freedom to manage the technical parameters of the spectrum within a boundary set of only having to avoid harmful interference with adjacent licensees. As the universe of wireless services expand, licensees must use these new found capabilities to address a set of service capabilities required to achieve broadband wireless services including:

- providing either portable or mobile services to increase the personalization of communication services and enhance societal and individual productivity,
- achieving spectral efficiency and overall network efficiency to create economic returns commensurate with the scale of investment
- reducing the form factor and cost of the customer premise and terminal end unit in order to encourage rapid and widespread consumer acceptance
- enabling and integration and convergence with other platforms to provide universal experience

With the advent of new technologies, licensees can make tradeoffs between power, bandwidth, throughput and bit error rate in order to enable each of these required features in the context of the broadband marketplace. Furthermore, flexible spectrum rights would allow the licensee the right to apportion and share those rights with others in order to facilitate the availability of BWA services and increased modal competition.

7.2 Flexible Spectrum Rights Necessary for Creating Competitive Broadband Markets

A practical approach to BWA spectrum licensing would call for granting spectrum licensees' unlimited (within the bound of avoiding harmful interference to adjacent licensees) technical flexibility to create more spectrum capabilities and resources and to have operational autonomy to enter new lines of service (as enabled by the current state of technology). The regulator would grant these additional rights to licensees so long as the licensees' meet two absolute preconditions. The first is that the grant of these new rights to the spectrum licensee, or in the case of unlicensed spectrum – the service enabler, must increase both inter and intra-modal competition for broadband communication services available to consumers. The second precondition is the requirement that the licensee, or in the case of unlicensed spectrum -- the service enabler, to experience the opportunity cost of using its spectrum allocation and assignment.

7.3 Preconditions for Providing Flexible Spectrum Rights

If the spectrum regulator simply granted technical and operational flexibility, he or she is providing the licensees significantly enhanced spectrum rights---unfortunately, it will not guarantee that the licensee will choose to deploy the most competitive services such as BWA (for example, choosing to invest in mobile voice as opposed to mobile broadband services). However, granting such rights with a concomitant obligation to provide competitive inter-modal broadband services would encourage spectrum licensees the positive incentives to enter and aggressively compete in the emerging markets like the one for broadband services.

The second absolute condition on the grant of flexibility as defined here is for the regulator to enforce the opportunity cost of using spectrum on the licensees. Generally, the goal here is to provide licensees price signals about the value of their spectrum holdings that discourage them from engaging in uneconomic hoarding of spectrum capabilities. Although this condition can be enforced by the regulator's right to recapture spectrum, there are other more positive mechanisms for enforcing the opportunity cost of spectrum. One of the more popular methods for enforcing opportunity cost of using spectrum in the last decade has been the use of auctions. Unfortunately, the effectiveness of auctions has diminished as a result of the growth of the wireless industry and the availability of large amounts of capital to the industry making the industry highly desensitized to price signals coming from standard auctions. Furthermore, the limited instances where auctions have been used to increase sovereign liquidity instead of a limited tool for enforcing market discipline has lead to unsustainable auction results creating uncertainty in the markets. Nonetheless, adjusting for these two factors, transparent auction processes are a viable method of enforcing the opportunity cost of using spectrum.

The Infocomm Development Authority (IDA) of Singapore, for example, successfully auctioned spectrum in the 2.3 GHz and 2.5 GHz frequency bands for broadband wireless access services in May 2005 in an effort to enhance competition in the island nation's broadband market. The starting price for each of the spectrum lots was Singapore Dollars 1,000 and the highest closing price bid was SD 550,000. IDA noted that it decided to grant successful bidders a ten-year spectrum right to provide investment certainty. Singapore's allocation of spectrum for BWA services was conducted in open and transparent fashion. IDA indicated that it had earmarked the 2.3 and 2.5GHz bands for wireless broadband services in February 2004. Then in April 2004, IDA launched a public consultation on spectrum allocation and the licensing framework for wireless broadband services. The regulators released licensing details for broadband wireless services in February 2005, notifying interested parties that it would hold an auction if demand exceeded the supply of available spectrum lots. In a similarly transparent fashion, Bulgaria's Communications Regulation Commission announced plans to auction BWA spectrum in July 2005.Similarly, enabling secondary markets for trading spectrum rights also has the effect of enforcing the opportunity cost of spectrum. By allowing for the rapid transfer of spectrum rights between private parties that value these rights differently with minimal governmental involvement, creates the price signals that encourage licensees to use the spectrum to provide competitive BWA services as they are the most valued in the current marketplace. Again, it is important to remember that BWA services are the core component of a general set of broadband services that consumers would utilize and providing the marketplace the flexibility to combine BWA services with other platforms increases the consumer welfare than by restricting such combinations.

Additionally, with the secondary markets for spectrum rights gaining greater acceptance with licensees and regulators, leading thinkers in the field are now considering how to combine auctions and secondary markets to create new mechanisms that rapidly drive spectrum to its highest and best use. Two-sided auctions, where the regulator and spectrum incumbents combine their spectrum resources into a simultaneous auction that transparently recalibrates both the geographic and technical limits on spectrum rights, are being developed as a way of smoothly restructuring bands to more useful purposes for providing new, innovative services like BWA.

Another more traditional but equally efficient method of enforcing opportunity cost would be to impose build-out and/or construction obligations on the licensees. Although these build-out obligations are effective in imposing costs, they tend to be blunt regulatory instruments because they are conditioned on ex-ante assumptions about marketplace conditions. However, combined with secondary markets for spectrum, these requirements become a valuable method of disciplining licensees from hoarding spectrum rights.

In shared license bands, the sharing rules developed by the regulators are the best method of enforcing the opportunity cost of using the spectrum. These rules generally determine the level of barriers to entering the shared bands, the level of interference permitted between and among users of the band and the power level permitted (and therefore the coverage range). These key parameters all help define the opportunity cost of using the spectrum. In the case of unlicensed bands, low power limits combined with the lack of interference management circumscribe the use of the bands and encourage a high degree of efficiency.

8 Complementary Best Practices

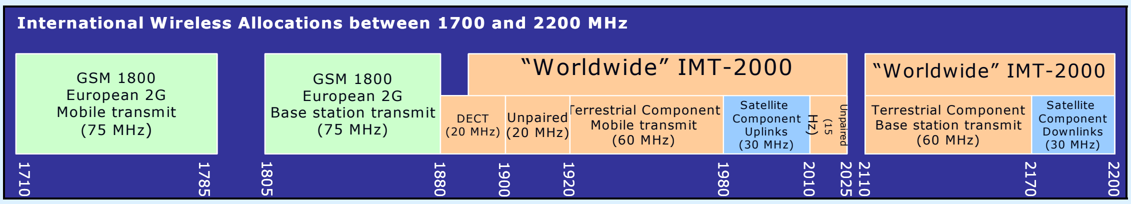
Spectrum regulators need also to look at a number of spectrum management best practices developed over the last two or three decades as tools that can be used to encourage BWA deployment. Earlier in this chapter, a summary of the Draft GSR Best Practice Guidelines on Spectrum Management to Promote Broadband were highlighted. This list has been narrowed down to a smaller set that the author believes are the most critical to implementing BWA services. Generally, these best practices reduce the cost of spectrum devices by reducing interference within spectrum bands. These best practices also permit for large economies of scale in the design and manufacturing of the end user devices and the development associated applications. In the spirit of pragmatism, each of these best practices will be reviewed to identify their benefit as well as their potential limitations in advancing the cause of consumer broadband services.

- Harmonizing spectrum allocation on a global basis to increase economies of scale at product and the service layers and reduce cost to the end-user.
- Fostering the use of standards based technology to increase economies of scale that reduce cost to the end-user.
- Allocating spectrum and develop technical rules that encourage adjacent spectrum users to have compatible technical characteristics as a way of limiting interference and maximize use of spectrum ("good neighbor" policies)
- For shared spectrum bands, encourage or mandate technical standards fostering cooperative systems designed to reduce harmful interference
- Develop efficient and transparent licensing rules and processes that allow for restructuring of incumbent spectrum bands in order to implement harmonization goals.

8.1 Global Harmonization of Spectrum Allocation

Broadband spectrum regulators can significantly drive down the cost of broadband wireless services and thereby increase the rate of adoption of these services by harmonizing their spectrum allocations globally. Global harmonization allows equipment manufacturers to benefit from significant positive scale effects associated for building radios that can operate across a large pool of users located in multiple countries.

Figure 3: Globally Harmonized Spectrum



Of course, harmonization to a global ideal as in the case of IMT 2000 described in the chart above will lead to a significant amount of incumbent dislocation with the attendant political cost to the regulator. This is especially true in developed countries that have a high level of incumbencies and more established exclusive model spectrum regimes. Harmonization is ideal although the efforts require transparent licensing systems and significant political will. Needless to say, participation in the ITU and other regional regulatory organizations can help provide the economic and political support enabling such transitions. For example, ITU-R Study Group 8 and its Working Party 8F are currently looking into BWA technologies including the IEEE's 802.16 family of standards (more commonly known as WiMax). Participation in these ITU groups as well as in the more commercial efforts at harmonizing this spectrum such as the WiMax forum enable regulators to learn about the global direction of these technological developments and put in place the appropriate spectrum regulations in anticipation of these standards becoming widely deployed.

Because manufacturing and services are increasingly global in scale, spectrum harmonization should be a goal for any allocation decision in order to lower costs for equipment manufacturers, software developers, and off-the-shelf solutions based on the potential of global deployment of these services.

8.2 Fostering Standards Based Technologies

In order to effectuate and magnify the results of their global spectrum allocation decisions, spectrum regulators must also closely follow and support the norms and recommendations of the following standards setting organizations: (a) Institute for Electrical and Electronics (IEEE); (b) European Telecommunications Standards Institute (ETSI); (c) Wi-Fi Alliance (for 802.11 products); and (d) WiMAX Forum (for 802.16 products).

Similar to global harmonization, the effect of embracing standards-based technology development is to significantly reduce the cost of the devices by reducing the number of proprietary components. This will lead to faster adoption of the devices and the associated services. *Although the benefits of a standards-based approach are many, it is also important to remember that it is a consensus driven process. If not managed carefully, the standards process essentially commoditizes innovation and could ultimately, especially if regulators embed the standards into their regulatory systems, become a benign form of economic regulation. Broadband regulators must be mindful that a standards-based approach, with its natural tendency towards compromise, could potentially lead to suboptimal results and therefore must understand that these unintended "costs" must be part of a broader policy tradeoff in embracing a particular standard into the regulatory scheme.* Generally, regulators should avoid embedding of standards unless there is a compelling policy goal to support such a move.

8.3 Operational Spectrum Best Practices

8.3.1 Good Neighbor Allocations

This best practice generally involves grouping spectrum allocations based on interference and other technical compatibility characteristics. Generally, this "good neighbor" practice would enhance the zoning of spectrum of uses including power and bandwidth limits, in order to maximize overall capacity and reduce transaction costs. In a similar fashion to the global harmonization of spectrum allocation, this practice also raises significant transitional costs and dislocation which must be accounted for in the regulator's decisional processes.

8.3.2 Voluntary Sharing Guidelines for Unlicensed Bands

For shared spectrum users such as those found in the unlicensed bands, a relevant best practice would be to encourage voluntary coordination among the end-users in order to better manage the interference and capacity issues. Users of these bands should be made to understand that the alternative to self-regulation would be a command and control model that is not only cumbersome but time consuming.

8.3.3 Infrastructure Sharing

Regulators can also enhance wireless broadband adoption by inducing licensees to share infrastructure such as towers and backhaul facilities. Infrastructure sharing between wireless systems to promote efficiency, reduce deployment costs and increase environmental sensitivity by avoiding the construction of duplicative facilities.

8.3.4 Different Power Limits for Rural Areas

Regulators should attempt to differentiate the rules for spectrum based on market types. In lower density environments such as rural areas or underserved communities, there is less opportunity for interference and it therefore makes sense to allow for increased spectral power. Similarly, regulators can increase the size of the bandwidth allocated to broadband services in these areas in order to increase capacity since there would be limited competition for the spectrum in these areas and granting this flexibility might provide better economic incentives for the licensee to deploy a BWA network. Ireland's efforts to grant rural BWA operators greater flexibility with regard to spectral power limits has enabled the country to meet the broadband demands of its rural population. (See Box 5.) In addition, Ireland has endeavored to keep licensing obligations as low as possible to reduce barriers to entry. See Box 6 below.

Box 6: Ireland's Contribution to the 2005 GSR Best Practice Guidelines on Spectrum Management to Promote Broadband Access

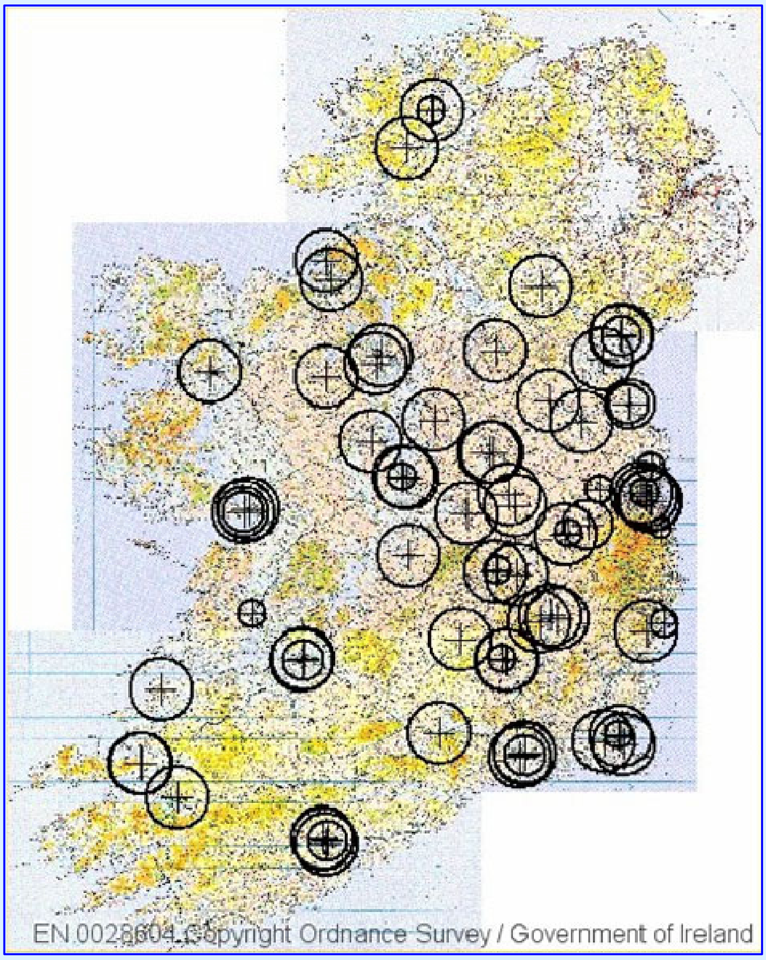
Principle One: Barriers to entry should be as low as possible

Our experience indicates that regulators should minimise barriers to entry in this area by allowing broadband suppliers to begin operations on a small scale, and not imposing onerous rollout and coverage conditions. Ireland has awarded national licences in the past for broadband wireless access that incorporated rollout and coverage obligations, however, none of the licencees were able to make a viable business case and consequently roll out of services was less than satisfactory.

In 2004 ComReg announced a new scheme for the licensing of broadband fixed wireless access services in local areas. Each local service area was defined by a 15km radius circle from a base station, with an interference zone extending to 30 km radius, at the perimeter of which a certain field strength should not be exceeded in order to limit interference into adjacent areas. Since its inception, 110 licences have been granted on a first-come, first-served basis. The success of this approach, compared with the earlier attempt at national licences, is reflected in an increase of 43% of customers in the last 6 months.

One of the key reasons for the success is that operators only take out licences for areas in which they are able to develop a viable business case and, as there is no national network rollout obligation, all attention is focused on the local area. Initial concerns that rollout would only occur in urban areas (due to high population) have proved to be unfounded as small entrepreneurs and local community groups have taken up the challenge to supply broadband access to many rural areas where ADSL is not available. Current rollout is shown in the following map.

Figure 4: Coverage area (Circles) of individually licensed broadband access services across Ireland



8.3.5 Transparent Licensing Systems and Processes

Establishing transparent and automated licensing procedures and records to reduce transaction costs associated with facilitating the highest and best use of spectrum rights. As part of the licensing efforts, regulators must also conduct periodic testing, analysis, and auditing of spectrum resources to measure the efficiency of the incumbent licensees use as well as the interference issues emanating from the use of the spectrum by the licensees. Regulators can use the collected information to form improved sharing and interference rules and regulations as well as expand the "spectrum" capabilities of that band to permit new forms of uses within the band for either the incumbent licensees or new licensees.

8.4 A Short Discourse on Technology Neutrality (as it applies the other Best Practices)

The last best practice concept to relate in this chapter is the confusing notion of technology neutrality as it applies to spectrum management. Technology neutrality is usually understood to be the concept where the regulators apply rules and regulations in a way that does not favor one type of technology over another. Clearly, when described in this manner, this particular concept is at odds with the other best practices such as harmonizing spectrum globally, adopting standards based technologies and applying good neighbor rules which by their very nature tend to favor particular technological choices.

From the perspective of the regulator as a resource manager, technological neutrality is an impossible goal since the desire to effectuate efficiency and rapid utilization of the spectrum resource ultimately requires a decision set that leads to a particular technology path. Promoting a standard or a particular spectrum band or its configuration, directly or indirectly, also obviates the notion of neutrality. Similarly, creating a harmonized spectrum band and associated service rules will also tend to favor particular technologies. Thus, there is an inherent conflict and contradiction between the goal of technological neutrality and the function of the spectrum regulator as a resource manager.

Fortunately, pragmatism once again comes to the rescue by understanding that a spectrum regulator has to play different roles that lead to different conclusions about technological neutrality. In the one case, the spectrum regulator is a resource manager concerned with optimizing the efficient use of a scarce resource. In the other case, the spectrum regulator is a policy advocate charged with enabling social policy goals such as universal access/service and reducing the digital divide among the myriad of other social goals required by modern society. A practical solution to the conundrum would apply technological neutrality only to the means used to achieve macro policy goals as opposed to the means for managing the spectrum resource.

Technological neutrality is paramount only to the means applied to achieve broad social policies. In achieving broad social policies such as providing universal broadband access to consumers, the regulator should use any combination of available technologies and resources to achieve the desired outcome in order to more rapidly deliver on the social compact that he has been charged with achieving.

One example of effective balancing between the goal of technology neutrality and pragmatism can be found in the public consultation process of the Office of Telecommunications Authority (OFTA) in Hong Kong, China, described in Box X.

Box 7: OFTA Consultation on Broadband Wireless Access Licensing

In August 2005, the Office of Telecommunications Authority (OFTA) in Hong Kong, China, issued its “analysis of comments received, preliminary conclusions and further consultation on a licensing framework for deployment of broadband wireless access.” Comments on the further consultation were invited through 31 October 2005. The August consultation followed an initial BWA consultation launched in December 2004 on whether BWA should be licensed in Hong Kong, and if so, when. All contributions received have been published on OFTA’s website.

In the August consultation, OFTA expressed the view that BWA spectrum should be assigned in 2006 on a technology-neutral basis:

Consistent with the technology neutrality principle and having considered the respondents’ views, the TA is prepared to allow the deployment of any technology which conforms to recognised open standards, for the delivery of BWA services. Because BWA devices and equipment will be supplied competitively and only technology conforming to recognised open standards will be allowed, the TA considers it unlikely that end users will have insufficient choice in the selection of BWA devices.

OFTA also expressed the view that although BWA is currently being deployed as a fixed service, it should also be allowed for both fixed and mobile services once the technology is developed and cost-effective. Thus:the TA proposes that the scope of permitted services of the future BWA licences should be restricted to fixed telecommunications services initially and be expanded to include full mobility services after 1 January 2008. Fixed telecommunications service will include the conventional fixed services and telecommunications service of “limited mobility” nature. “Limited mobility” means no cell handoff capability will be permitted before 1 January 2008.

OFTA also expressed the view that it would issue unified carrier licences in order to accommodate the trend toward fixed-mobile convergence, since BWA can offer both.

It is therefore proposed that a new Unified Carrier Licence will be introduced. The validity period of this new licence will be fifteen (15) years, which is the same as that for the existing fixed/mobile carrier licences. Any interested party, including existing fixed/mobile carriers and new entrants, may bid for the BWA spectrum and, if successful, will be licensed under the Unified Carrier Licence which will permit the licensee to provide fixed telecommunications service using the BWA spectrum from the start of the licence and to provide both fixed and mobile telecommunications service starting from 1 January 2008.

OFTA has made clear that BWA licensees will be expected to invest in and rollout infrastructure to provide public services; they will not be allowed to enter the market solely as services-based operators. The consultation document may be accessed at http://www.ofta.gov.hk/en/report-paper-guide/paper/consultation/20050831.pdf

9 Spectrum Allocation Demonstrating A Pragmatic Approach

A Spanish proverb holds that "**experience** is not always the kindest of teachers, but it is surely the best." Thus, regulators that have yet to establish a comprehensive spectrum management plan embracing BWA networks should take the pragmatic opportunity to learn from the experience of their brethren that have already done so. To help with this process, this paper concludes by undertaking a comprehensive review of a major BWA allocation decision by the Mauritius Information and Communication Technologies Authority to advance different technologies and standards in support of rapid deployment.

9.1 Enabling BWA in Mauritius

In the first half of 2005, the Information and Communication Technologies Authority (ICTA) of Mauritius made the regulatory decisions establishing the future course of BWA on this fast growing island economy. Although it is too early to predict the success or failure of its allocation decisions, a brief review of the ICTA's processes and methodology shows a regulator that has adopted key best practices and made pragmatic tradeoffs that enable BWA to take root rapidly.

In the first instance, it is useful to note that unlike many regulatory bodies, the ICTA mission is more broadly defined by its name and its charter developed in 2001. Clearly, the goals of the ICTA are not simply to "manage" spectrum but to effectuate a broader goal of increasing the reach of information and communication services throughout the country. In considering BWA services, it is important to note that the ICTA also undertook a transparent public consultation process and arrived at its final decision within a commendable 180 days of its initial report.

In starting the process, ICTA identified the demand for BWA while also recognizing the need for its decision to be aligned with the global harmonization efforts in order to provide scale economies that would not be otherwise available to its economy. It also identified key market conditions that have had a deleterious effect on past BWA attempts such as the congestion in the "license exempt" 2.4 GHz band on the islands. According to its study, ICTA found that operators in this band were exceeding the designated power limits to use these license exempt systems for long-range systems contrary to their design and purpose. It also noted the continuing and significant demand from Internet Service Providers (ISPs) for wireless spectrum for deploying their services. Additionally, ICTA took note of other countries' decisions to define certain bands for BWA uses including 2.5-2.7 GHz, 3.3-3.5 GHz, 5.1-5.3 GHz and higher powered unlicensed use of 5.4-5.9 GHz. It also noted the advent of new standards such as WiMax, among others, for deploying BWA services integrated with computers and other ICT devices. The ICTA's ultimate decisions in each of these bands demonstrates a practical approach to resolving the various tradeoffs required to advance deployment of BWA networks in face of competing demands among operators and given a history of spectrum incumbencies.

9.1.1 Mauritius BWA in 5.4-5.8 GHz

ICTA determined that radar incumbencies in the 5.4-5.9 GHz band required it to postpone that decision until a later time although this band has been globally harmonized for higher powered unlicensed operations through the WRC 2003 multilateral negotiations process. It is likely that the complexity of the radar system operations coupled with their public defense mission requires a more deliberate transition for this band as demonstrated with the difficulty that the United States has experienced in implementing the necessary dynamic frequency selection (DFS) systems needed to protect sensitive military operations in that band in the United States.

9.1.2 Mauritius 2.4 GHz BWA License Exempt Band

In reviewing the status of the 2.4-2.483 GHz unlicensed band, ICTA came to the conclusion that the previous "commons" model had led to overuse and overcrowding. It found that existing operators in the band tended to exceed their power limits of 23 dam EIRP in order to extend for interference. Additionally, one can surmise that from ICTA's decision to define the distance limitation for this band that incumbent operators were increasing the power of their devices in this band in order to use it for longer distance applications than the radio local area networks it was originally intended for. In its decision, ICTA took some pragmatic steps to improve the functionality and longevity of the band:

- Mandated use of the bands for applications not to exceed 500 meters
- Mandated the emitted power to 20 dam while giving some transitory leeway for incumbent operators to stay at the 23 dam until 2010; and
- Required new systems to register thereby allowing ICTA to track the level of usage in the band and identify potential interference prone uses

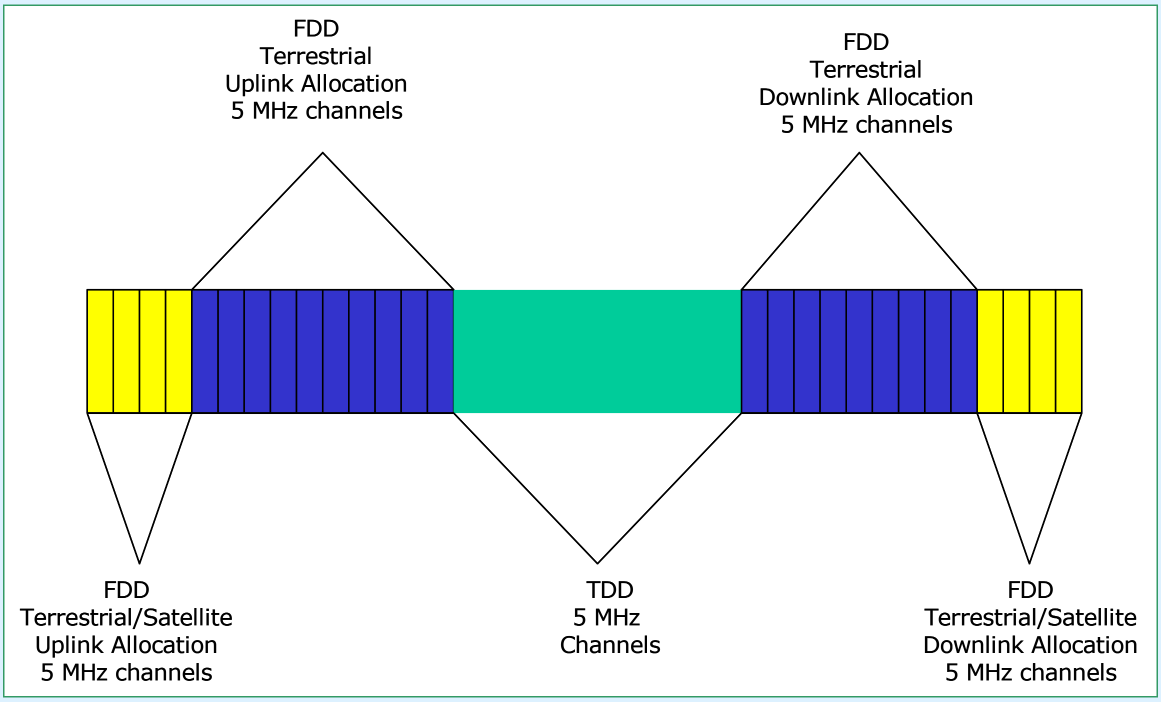
This set of decisions will certainly have the effect of extending the useful life of the 2.4 GHz license exempt band. Of course, these decisions also highlight the pitfalls associated with the commons approach as discussed earlier in the paper.

9.1.3 Mauritius 2.5-2.7 GHz BWA Band

This band was previously allocated for multi-channel, multi-point distribution service (MMDS). ICTA's decision harmonized the band with the IMT 2000 allocation enabling three distinct types of BWA systems to eventually operate in the band. Implicit in the decision was the determination that the incumbent MMDS use was not as relevant as the future potential of BWA systems to be offered in the band. In reviewing the decision and the supporting analysis, there was not an explicit determination about the value of MMDS relative to BWA. ICTA seemingly relied on the lack of input from market participants---where only one respondent to its public notice advocated the continued use of the band for MMDS---as indicating the relative utility of the two services.

Other aspects of the ICTA's decision about this band were significant. First, it determined that only licensed operators could provide BWA services in this band. Second, it made sure to create a channelization plan for the band that permitted the grouping of like systems together---instead of the interleaving familiar to broadcast bands---so both TDD and FDD wideband systems could be deployed to deliver BWA (the channel sizes were also changed to 5 MHz from 8 MHz segments better suited for wideband systems like those being developed by the IEEE 802.16 groups). ICTA also allocated 40 MHz---20 MHz for uplink operations and 20 for downlink operations---to be used for hybrid satellite and terrestrial services. Finally, ICTA also allocated a significant transitional period for incumbent operators by making the band available for BWA services described above in January 2010. It leaves open for voluntary transition with language suggestion that the timeline for transition might be accelerated based on "market conditions."

Figure 5: Mauritius 2.5-2.690 GHz BWA Allocation



9.1.4 Mauritius 3.4-3.6 GHz BWA Band

The ICTA reallocated this band from primarily a fixed satellite service band to co-primary as a terrestrial BWA band deploying point to point and point to multipoint links in harmony with other global allocation decisions. Fixed link services were favored in this band in order to provide protection for incumbent VSAT operators. Despite this limitation, BWA advocates such as the WISPs (wireless internet service providers) were able to obtain the benefit of higher powered use since ICTA allowed for 15 W EIRP systems to operate in the bandICTA also decided that in assigning frequency channels in these bands it would giver priority to public operators (although not conclusively); that licenses were mandatory and the permitted point-to-point and point to multipoint links must be registered. Finally, ICTA allowed the aggregation of multiple 25 kilohertz channels while requiring a minimum of 100 MHz separation for avoiding interference of duplex operations in the band.

9.1.5 Mauritius 5.150-5.350 GHz BWAS Band

Consistent with WRC 2003 agreements, Mauritius ICT Authority has opened up this band for mobile license exempt use using equipment specifications consistent with IEEE 802.11 standards. Given the challenges presented by radar incumbencies in this band, the ICTA determined that the use shall be limited to indoor use only. Additionally, in order to prevent overcrowding and overuse and to stop potential interference with incumbent operations, the ICTA requires the equipment in this band to use dynamic frequency selection (DFS)--- an automated mechanism detecting the presence of signals from other systems, notably radar systems, and avoids co-channel operation---- and transmit power control (TPC)----an automated mechanism that regulates a device's transmit power in response to an input signal or a condition---features as part of the equipment registration and approval process that it plans to put in place for this band.

The limitations imposed on the use of this band reflect the tradeoffs ICTA believed necessary to advance BWA while accommodating the sensitive operations already incumbent in the band. Both DFC and TPC systems are early in their development and have not yet fully demonstrated their ability to protect incumbent operations. Nonetheless, they are clearly part of the technological advances taking place enabling the rapid deployment of BWA services.

10 Conclusion

The ability of broadband wireless access networks to improve our lives ultimately relies on the amount of spectrum rights made available by regulators for BWA. However, for the first time in spectrum's short history, it appears that advances in technology, independent of the action of the regulators, can increase spectrum capabilities and resources (i.e., allowing licensees to do more with the same spectrum or enabling new uses for spectrum not previously possible). As these advances become more widely adopted and new spectrum resources become available ever more rapidly, regulators must consider whether traditional approaches to spectrum management are sufficient to address the resulting challenges and opportunities.

A sensible approach for BWA spectrum licensing calls for granting spectrum licensees' unlimited (within the bound of avoiding harmful interference to adjacent licensees) technical flexibility to create more spectrum capabilities and resources and to have operational autonomy to enter new lines of service (as enabled by the current state of technology). The pragmatic regulator sgrants these additional rights to licensees so long as the licensees meet two absolute preconditions important to the development of communications markets. The first is that the grant of these new rights to the spectrum licensee, or in the case of unlicensed spectrum – the service enabler, must increase both inter and intra-modal competition for broadband communication services available to consumers. The second precondition is the requirement that the licensee, or in the case of unlicensed spectrum -- the service enabler, to experience the opportunity cost of using its spectrum allocation and assignment.

While contemplating the appropriate regulatory model for the evolving state of spectrum technology, broadband spectrum regulators must also be mindful of a number of key best practice concepts that have developed around spectrum management over the last two or three decades. These best practices fostered the widespread adoption and deployment of an earlier generation of wireless services leading to the significant reduction in the cost of providing services and the creation of innovative applications. The same best practices could be used to help deploy BWA networks thereby increasing the potential significantly increase the welfare of consumers in the modern information society.

In reviewing a recent comprehensive BWA allocations in Mauritius, one traces the outlines of the practical tradeoffs necessary for using BWA spectrum in order to achieve the broader policy goals of the regulators. The lessons one should draw from these types of complex allocation decisions is not in the particular merit of any particular allocation decision or outcome. The lessons come from having a better understanding the challenges required to properly balance the demands of effectively and efficiently allocating the new spectrum rights and capabilities brought about by rapid changes in technology while simultaneously advancing the broader social goals of increasing consumer welfare and economic productivity which have been entrusted to the modern spectrum regulator.

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[i] The thoughts outlined herein are based on the author's experiences as the chief of the United States Federal Communications Commission Wireless Telecommunications Bureau between 2003 and 2005.

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