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Twenty years of measuring the missing link

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In 1985, through the Report of the Independent Commission for Worldwide Telecommunications Development: The Missing Link, Sir Donald Maitland and his team reported on the lack of telephones worldwide that was impeding the world's economic and social development.

Some 20 years later, in its 16 September 2005 edition, *The Economist* reported on the "death" of the phone business, supposedly killed by the rise of voice over Internet protocol (VoIP). The capacity of the Internet, which is optimised for data, is so great that telephone calls can be carried at a marginal cost which begins to approach zero.

What happened in the 20 intervening years to convert a global shortage of phones into a glut of over-capacity? How has the world changed in those two decades? How has the science of measuring the "missing link" – or the "digital divide" as we are more likely to call it today – affected our understanding of the problem?

What a difference 20 years makes

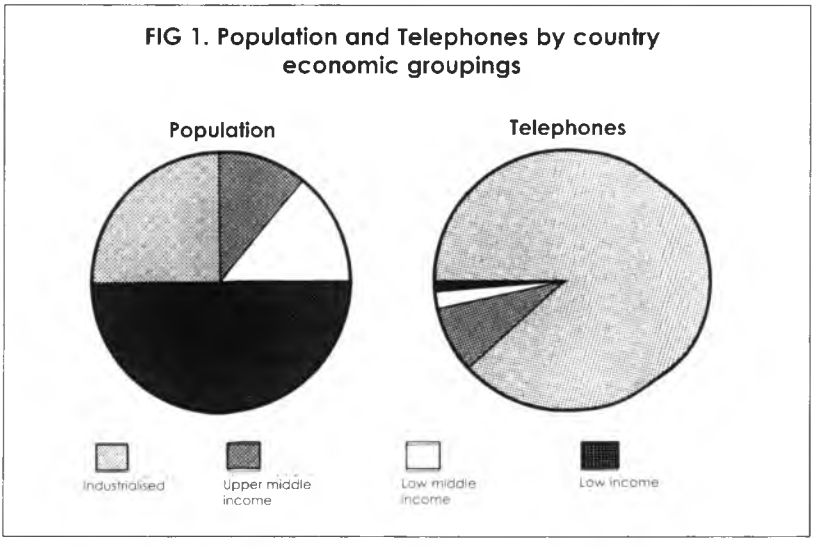
The Missing Link is probably best remembered for its aphorisms, some of which do not even appear in the report (see box on page 26). It also contained some memorable charts and graphs, based on data from the ITU, which had been collecting telecommunication indicators since the 19th century. This process was formalised in the 1960s with first publication of the Yearbook of Statistics[1]. More recently, in 1994, on the 10th anniversary of *The Missing Link*, the ITU launched the World Telecommunication Development Report series, and a couple of years later the World Telecommunication Indicators Database. These reports provide a much richer range of statistical data than was available to the Worldwide Commission, but nevertheless, comparisons between the Maitland Report and more recent data make for fascinating reading.

The Maitland Report showed a chart on the breakdown of telephones compared with the breakdown of the world's population, by income group of countries (See Figure 1, overleaf, top chart). The Maitland data was

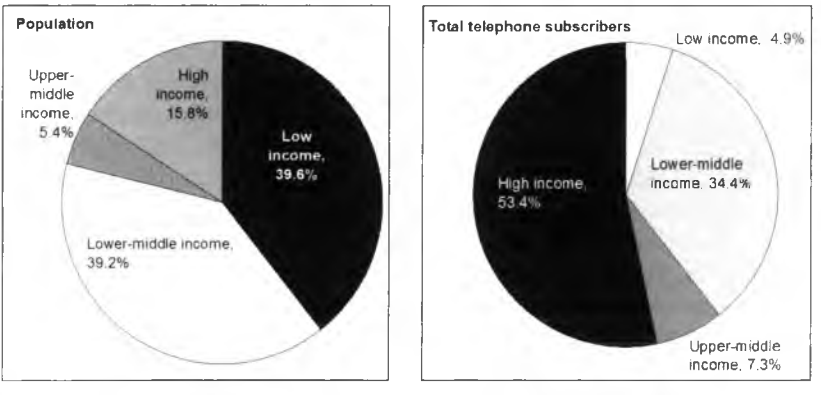
based on around 110 economies for which telecommunication indicators were available at the time. They showed that some 96% of telephones were located in high-income or upper-middle income countries. Twenty years on, ITU tracks data for some 206 economies. Those same two categories still account for the majority of the world's phone subscribers (fixed-line

Figure 1: Distribution of the world's telephone users, 1982 and 2002.

Breakdown of population and telephones – chart from the original Maitland Report



Breakdown of population and fixed telephone lines as it stood in 2002



Note: The original diagrams in the Maitland Report were hand-drawn. The examples shown here have been scanned. The countries that fit into the categories "industrialised" (now called "high income"), upper-middle, lower-middle and low income have changed over time as countries have "graduated" from one to another. Source: The Maitland Report 1985 and the ITU World Telecommunication Indicators Database.

telephones and mobile phones combined), but now their share is down to just 61%. The category of "lower-middle income countries", which today includes India and China, today accounts for around one third of the world's telephone users compared with just 3% in 1982.

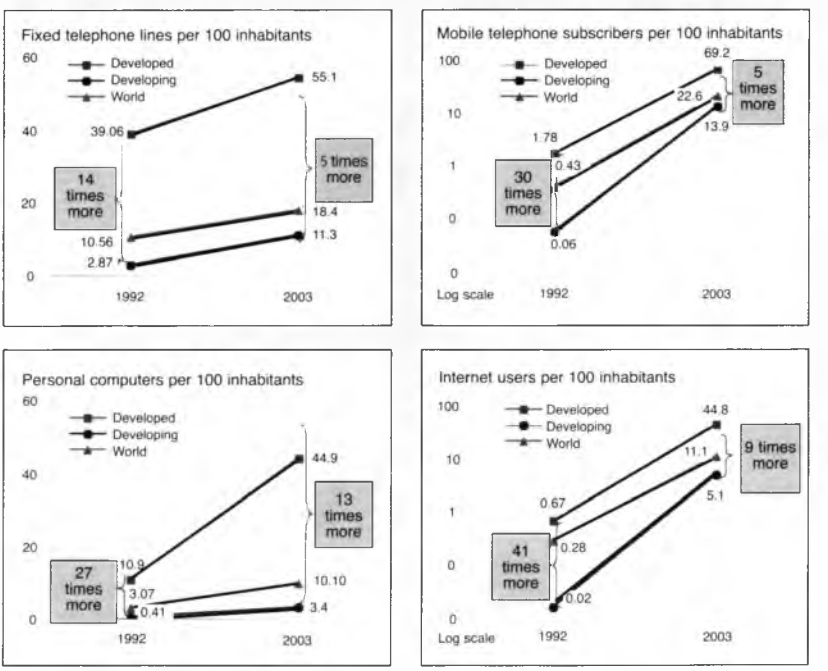
Measuring the digital divide

In assessing the extent of the digital divide, it is useful to look at those networks, services and hardware that provide a platform for the development of other information and communication services. The Maitland Report focused on the fixed-line telephone network and, to a lesser extent, telex. Today, as Figure 2 shows, it is worth focusing on the progress in reducing the digital divide among four key information and communication technologies (ICTs):

- For fixed line telephone networks, which still form the main

Figure 2: The digital divide is narrowing, but faster for some than others

The pace of reduction in the digital divide between developed and developing countries 1992-2002, for fixed telephone lines, mobile phones, personal computers and Internet users, per 100 inhabitants.



Note: A logarithmic scale is used in the right-hand charts. "Developed" includes Western Europe, Australia, Canada, Japan, New Zeakland and the United States. "developing" refers to all other countries. Source: ITU World Telecommunication Development Report 2003: Access Indicators for the Information Society.

Some telecom myths and near misses

In trying to characterise the digital divide, it is still common to cite from the Maitland Report, even though it is now 20 years old. But many of these aphorisms are no longer true. For instance:

- *"There are more telephones in Tokyo than in the whole of Africa"*. WRONG. Although this was true at the time the Maitland Report was written, it was already false by the late 1990s. As of the start of 2004, there were around 25 million fixed lines and more than 50 million mobile phones in Africa, which is several times more than the total population of Tokyo.
- *"Half of the world's population have never made a telephone call"*. WRONG[2]. This particular soundbite, which is still repeated by some of those who should know better, is frozen in time. It does not appear in the Maitland Report, although it may have been correct at the time. Now it is almost certainly false. While there are still large segments of the world's population that do not have access to a telephone, and probably could not afford to make a call, this is far less than half the world's population. ITU estimates, based on the number of households and villages that have telephone access, suggest that close to one-fifth of the world's population currently have no telephone access.
- *"There are more Internet users in Iceland than in Africa"*. WRONG. This particular soundbite came from the ITU's 1999 report Internet for Development, and again was true at the time, but has long since been overtaken by technological progress. At the start of 2004, there were an estimated 12.4 million Internet users in Africa, which exceeds by around 40 times the total population of Iceland.

Source: ITU (2005) "Multi-stakeholder partnerships for bridging the digital divide", available at: www.itu.int/wsisbridges.

telecommunication infrastructure, the digital gap fell from 14 times to 5 times greater, in the decade between 1992 and 2003, as economies such as China and Vietnam greatly expanded their fixed-line networks.

- For mobile telephones, the reduction is even more dramatic. Mobile phones began in commercial service in the early 1980s, and took around twenty years to reach their first billion users. But the second billion was reached in just four years, between 2002 and 2005. During the decade, the digital gap was reduced from 30 times to five times. Since 2002, mobile phones have outnumbered fixed-lines and will soon be more diffused than them. Indeed several developing countries – including Cambodia, Morocco, South Africa and Uganda – already have many times more mobile phones than fixed line telephones.
- Personal computers are one area where the digital divide is not narrowing quite so quickly. Although the level of penetration in developing countries has risen from one PC for every 243 inhabitants in 1992 to one for every 29 in 2003, this is still a long way behind the rate of one PC for every 2.2 inhabitants in developed economies. The digital divide is wider in PC ownership than any of the other indicators tracked

here. One reason for this is the high cost of acquisition and ownership (e.g. upgrading memory, software etc) of a personal computer. The advent of low-cost computers and laptops, together with the widespread adoption of free and open-source software, may help to reduce the digital divide for PCs[3].

- But the most dramatic reduction of all in narrowing the digital divide has come in Internet use, where, between 1992 and 2003, the gap between developed and developing narrowed from 41 times more to 9 times more. Interestingly, although there are fewer estimated Internet users than PCs in developed countries (44.8 and 44.9 per 100 inhabitants respectively), in developing countries there are more Internet users than PCs (5.1 and 3.4 per 100 inhabitants). This suggests the significance of Internet access from cybercafes, post-offices, schools, universities and other public Internet access centres (PIACs) in the developing world.

As the evidence shows, for the main bearer networks the digital divide is narrowing as diffusion spreads, and in most cases at an accelerating pace. Nevertheless, because technological change is also accelerating, and ICT innovations are being introduced on an almost daily basis, the popular impression is that the digital divide is expanding, because each succeeding ICT innovation starts the diffusion process all over again. Innovations tend to start in the richer countries and spread to the poorer ones.

Visualising the digital divide

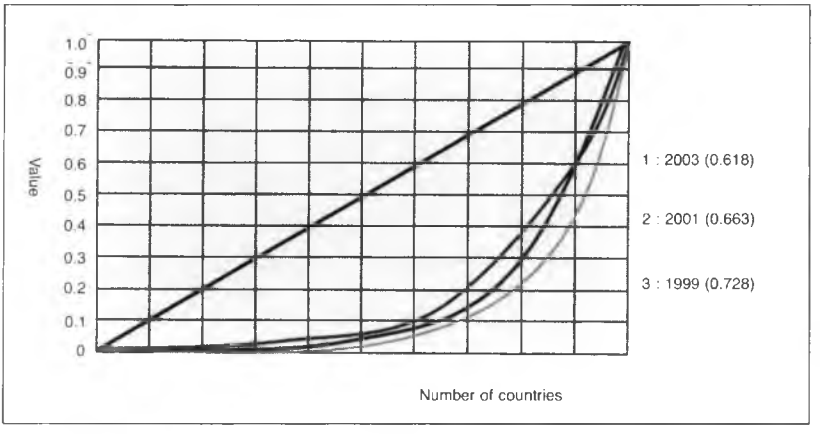
One way of visualising this process of diffusion is to use a Lorenz curve, which is a measure of how closely a distribution of a particular innovation or service resembles an idealised one. The Lorenz curve is typically used alongside a Gini coefficient, which is a statistical measure of the gap between the ideal curve (total equality) and the actual Lorenz curve for a particular distribution. By measuring the transition in the Gini coefficient over time, it is possible to gauge the extent to which the digital divide is being reduced.

For instance, as Figure 3 shows (overleaf), the Gini coefficient for the global divide in Internet users has been reduced from 0.728 in 1999 to 0.618 in 2003[4]. However, other evidence suggests that the progress in reducing the digital divide has occurred mainly as a result of middle-income countries catching up, whereas some of the least developed countries (LDCs) have actually been falling behind[5]. This can be seen, for instance, in the lower chart in Figure 3 where the progress at the high and middle end of the scale is much greater than at the bottom end of the scale in those countries ranked at 150 and below.

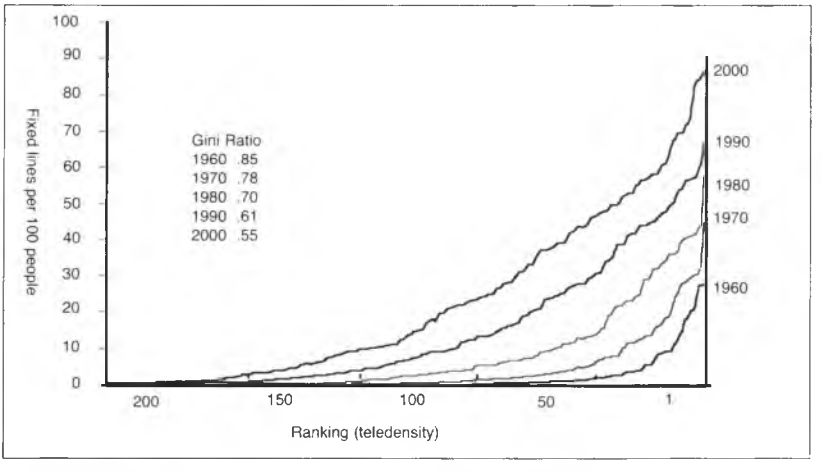
Because of this problem of the long "tail" of the teledensity curve (in other words, countries with the lowest teledensity exhibiting the slowest growth),

Figure 3: Using Gini coefficients to show progress in reducing the digital divide

A. For Internet users 1999-2003



B. For fixed-line teledensity 1960-2000



Note: The Gini coefficient varies between 01 and 1 where 0 reflects absolute equality.

Source: Upper chart – Cheong-Moon CHO (KADO), based on data from ITU World Telecommunication Indicators Database. Lower chart – ITU.

it can sometimes be more meaningful to look at progress in crossing particular thresholds. Consider the following:

- At the time of publication of the Maitland Report, in 1985, some three billion people, or around half of the world's population, lived in economies with a teledensity (telephone lines per 100 inhabitants) of less than one. Global average teledensity was around seven. There were fewer than one million mobile phones worldwide and only a few tens of

thousands of Internet users (the World Wide Web did not yet exist).

- Now, in mid-2005, only eight economies*, with a population of less than 160 million, or around 2.5% of the world's population, have a total teledensity (fixed and mobile combined) of less than one. The global average total teledensity is around 50. There are some two billion mobile phones worldwide and around 750 million Internet users.

The examples of the two most populous economies, China and India, illustrate the progress that has been made since 1985:

- In China, where, in 1985, the fixed-line teledensity was just 0.3%, it reached 20.9% in 2003, while mobile density had reached 21.5%.
- In India too, fixed-line teledensity increased significantly, from 0.4% in 1990 to 4.6% in 2003, while mobile teledensity reached 2.5%.

In reality, it is often more politically correct and convenient to stress the downside of the digital divide rather than reflect the reality of rapid growth and diffusion of ICTs that is currently going on in the developing world. Furthermore, to focus on the extent of the digital gap downplays the excellent efforts that are going on across the globe to bridge the digital divide, efforts that are the focus of this report.

Different experiences in different regions

One of the features evident in comparing the average level of Internet penetration and mobile phone penetration in the developing world, as shown in Figure 2, is that the level of development is broadly equivalent to that reached in the developed countries around five years earlier. By contrast, the average level of fixed-line penetration in developing countries at the end of 2003 (just over one for every ten inhabitants), was reached in the developed world as long ago as the 1960s.

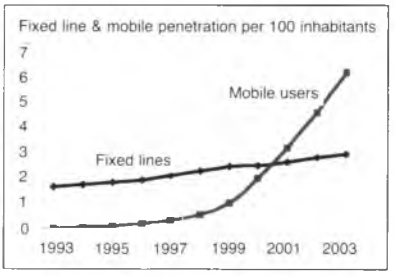
This suggests that the process of "catch-up" is occurring much more rapidly among newer services than for older ones. But it also suggests that the developing world's strongly expressed preference for mobile phones over fixed-line systems is likely to put the brakes on Internet development in the near future. That is because the vast majority of the world's Internet users still use copper-based fixed-line technologies (e.g. dial-up, ISDN, DSL, cable modems) to access the Internet. Internet access from wireless devices is certainly possible (e.g. through so-called "third generation" mobile or through wireless LANs), but it is still quite expensive and, in the case of wireless LANs, has only limited range. These constraints are solvable, but there may well be a period of years during which the further development of the Internet in some developing regions of the world is slowed by the absence of a dense copper-based network.

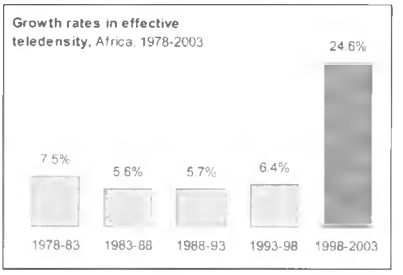
The converging trends in ICTs worldwide have come about in large part

* The eight economies with a total teledensity of less than one at the start of 2005 were: Central African Republic, Chad, Eritrea, Ethiopia, Guinea-Bissau, Liberia, Myanmar and Niger.

Figure 4: Africa's mobile revolution

Mobile users overtaking fixed in Africa 1993-2003 (chart at left) and changes in growth rates of effective teledensity 1978-1993 (chart at right).

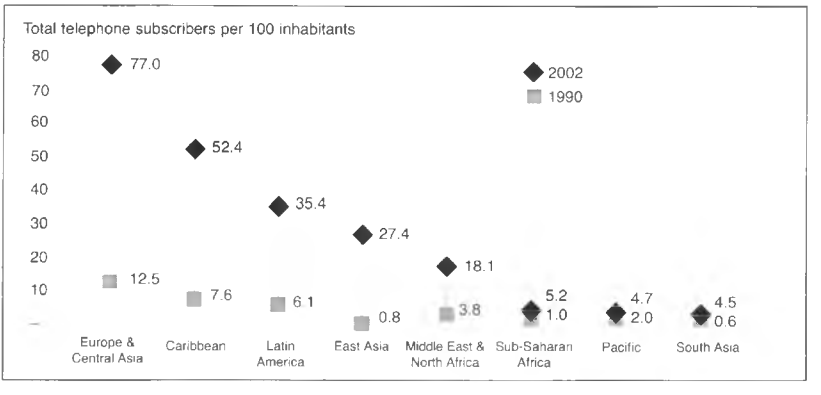




due to changes within the last few years. 2002 was the first year in which the number of mobile phones overtook fixed-lines worldwide. Africa was the first region where this took place and the impact has been most profound in Sub-Saharan Africa. Several countries of the region, including Cameroun, Congo, DR Congo, Mauritania and Uganda have levels of mobile phone penetration that are more than eight times higher than fixed-line penetration. As Figure 4 (above) shows, 2000 was a turning point in Africa's telecommunications history as it crossed the psychological threshold of one user per 100 inhabitants. In the first few years of the new century, more Africans have become telecommunication users than in the hundred years of the previous century.

Figure 5: A decade of ICT progress

Total teledensity (main telephone lines and mobile users per 100 inhabitants) in 1990 and in 2002, in developing regions.



Note: Developed countries excluded. For region definitions: www.worldbank.org/data/countryclass/classgroups.htm.
Source: ITU World Telecommunication Indicators Database.

The right chart in Figure 4 demonstrates the extent to which this marks a step change in Africa's telecommunications history. Africa's recent growth rates have been more than four times higher than anything achieved in the recent past. The period of the Maitland Report actually marked the nadir of slowest growth.

As shown in Figure 5 (left), all of the developing sub-regions of the world have grown their fixed and mobile telephone networks at a faster rate since 1990 than before that date. In the exceptional case of East Asia (which includes China), the total number of fixed and mobile subscribers per 100 inhabitants (i.e. total teledensity) in 2002 was more than 35 times higher than in 1990. In all cases except in the developing Pacific, total teledensity was at least five times higher in 2002 than it was in 1990.

In the 1990s, Africa was the main focus of UN system-wide attempts to eradicate poverty and to raise living standards. The problems of that region continue to dominate the development agenda. But there is a danger that other parts of the world may be overlooked. As Figure 5 shows, the problems of the digital divide are also evident in South Asia and especially among the small island developing states of the Pacific, which have so far failed to benefit from the information age. The Pacific has slipped from fifth place to seventh place in terms of total teledensity. Part of the problem is that, with small domestic markets, the introduction of competing mobile operators has not always been viable. These countries have also suffered from the decrease in settlement payments from international voice traffic that helped them overcome the problems of isolation and lack of economies of scale.

Using composite indices to measure the digital divide

As shown above, there is not a single digital divide, but rather a plurality of divides, related to factors like wealth, development, age, gender, education, etc. Furthermore, for each of the different bearer ICTs, which are at different stages of their product life-cycle, there are different degrees of digital divide. For these reasons, it is appropriate to use a composite index, or "basket" approach, to measure the extent of the digital divide. This is specifically called for in the WSIS Plan of Action (para 28a):

> *"In cooperation with each country concerned, develop and launch a composite ICT Development (Digital Opportunity) Index. It could be published annually, or every two years, in an ICT Development Report. The index could show the statistics while the report would present analytical work on policies and their implementation, depending on national circumstances, including gender analysis."*

In order to initiate this work, consultations were launched at the WSIS Thematic Meeting on Measuring ICT for Development, held in Geneva from

7-9 February 2005. Although several composite indices already exist, notably those from Orbicom, ITU, UNCTAD, GITR and others, it was felt necessary to take a fresh approach, based on the core list of indicators adopted at the WSIS Thematic Meeting. Accordingly, a "straw-man" document on a possible methodology was developed (see background paper at www.itu.int/osg/spu/statistics/DOI/index.phtml) and applied to 40 leading economies. It was presented at the WSIS Thematic Meeting on multi-stakeholder partnerships for bridging the digital divide in Seoul on 23-24 June 2005, and subsequently revised.

The initial results from the "straw-man" document are encouraging, in that the new digital opportunity index appears to be:

- relatively robust: for instance, adding in new factors likely to affect the digital divide, such as variations in knowledge, does not appear to change the rankings greatly;
- flexible and modular: because of the design principles used, new indicators, or groups of indicators can be added relatively easily, meaning, for instance, that it could be combined with existing composite indices (like the UNDP Human Development Index), or extended or adapted for specific purposes;
- easily disaggregated into its component parts, for instance to distinguish between mobile and fixed-line networks and services;
- easily adapted for use within countries (e.g. between regions or between urban and rural areas), as well as between countries;
- strongly-correlated with the main factor underlying the digital divide, namely wealth. This means that further policy analysis can be carried out to exclude wealth as a predictive variable, and to focus on other variables more amenable to policy change.

It is hoped that the digital opportunity index will be one of the lasting legacies of the WSIS process, and will provide a useful tool in measuring national and international progress towards bridging the digital divide.

The digital divide is shifting, and the focus of development efforts must change with it. The successful conclusion to the first phase of the World Summit on the Information Society, held in Geneva 10-12 December 2003, provided a fresh impetus for international efforts to address the digital divide. Those efforts must concentrate on those areas of the world that are not yet benefiting from growth (such as the Pacific) and on those technologies where the catch-up process is proving slow (principally the fixed-line network). In those areas where the digital divide is already narrowing (such as in East Asia) and where developing countries are already leapfrogging ahead (for instance, in mobile communications) successful policies can be studied and copied. As the Maitland Report correctly identified, the digital divide is primarily a problem of geography, not of economics or technology.

References

1. The most recent edition is entitled *Yearbook of Statistics: Chronological time-series 1993-2002*, available at: www.itu.int/ITU-D/ict/publications/yb/index.html.

2. This particular factoid was effectively debunked by Clay Shirky in his 2002 article "Sorry, wrong number" which appeared in *Wired* magazine, see: www.wired.com/wired/archive/10.10/view.html?pg=2.

3. A number of efforts have been launched to bridge the digital divide by developing low-cost, "thin-client" equipment to substitute for personal computers. These include the Nivo and the Simputer. One recent project is the "US$100 laptop" announced by the MIT Media Lab and United Nations University during the WSIS Thematic Meeting on Ubiquitous Network Societies (see: www.unu.edu/hq/rector_office/press2005/mre12-05.doc).
The partnership aims to have working prototypes available for demonstration at the Tunis Phase of the World Summit on the Information Society (WSIS), from 16-18 November 2005. Initial specifications for the laptops are 500 MHz processor, 1Gb hard drive, wi-fi enabled, and running LINUX. Over time, it is planned that the laptops would become more powerful, but not more expensive.

4. See Cheong-Moon CHO (2004) "How to measure the digital divide?" Paper presented at ITU/MIC/KADO "Digital Bridges Symposium", 10-11 September 2004, Busan, Republic of Korea, available at: www.itu.int/digitalbridges/docs/presentations/02-Cho-Background.pdf.

5. See, for instance, Sciadas, George (ed. 2003) "Monitoring the digital divide ...and beyond", available at: www.orbicom.uqam.ca/projects/ddi2002/2003_dd_pdf_en.pdf. See also the analysis presented in ITU (2002) "World Telecommunication Development Report: Reinventing Telecoms".

6. This is an important methodological step, because the alternative approach (beginning with the index and then deciding upon the component indicators) lays itself open to the criticism that the indicators are chosen to achieve certain results.

7. For more details on the proposed Digital Opportunity Index, see: www.itu.int/osg/spu/statistics/DOI/index.phtml.

Dr Tim Kelly is Head of the Strategy and Policy Unit of the International Telecommunication Union (ITU), where he has worked since 1993. Before joining ITU he spent five years as a Communications Policy Analyst with the Organisation for Economic Co-operation and Development (OECD) and three years with Logica Consultancy Ltd. He has an MA (Hons) degree in Geography and a Ph.D in industrial economics from Cambridge University.
Over the last twenty years, Dr Kelly has specialised in the economics of the telecommunications industry. He has written or co-authored more than 20 books on the subject including the ITU's World Telecommunication Development Report, Direction of Traffic and ITU Internet Reports. He is currently in charge of the "content team" for the World Summit on the Information Society (WSIS).

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