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From radiotelegraphy to worldwide wireless

How ITU processes and regulations have helped shape the modern world of radiocommunications

By Valery Timofeev

A century's wave of progress

Experiments with radio transmissions started in the late nineteenth century. Then in May 1895, a Russian professor, Alexander Popov, reported sending and receiving a wireless signal across a distance of some 600 metres. In the same year, Guglielmo Marconi managed to transmit and receive radio signals at his parents' home in Italy. Two years later, Popov equipped a land station at Kronstadt and the Russian navy cruiser *Africa* with his wireless apparatus for ship-to-shore communications. In 1901, Marconi is reputed to have sent the first transatlantic radio signal from south-western England to Newfoundland.

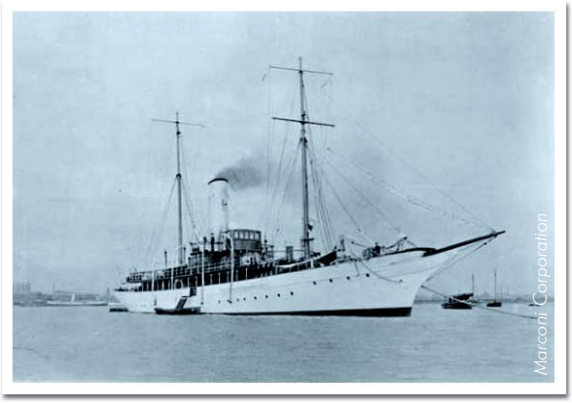
Radiotelegraphy soon came to be used extensively, and its various applications started to be developed quickly. For example, wireless signals proved to be effective in communications for ships in distress. By the early 1900s, a number of ocean liners had already installed wireless equipment.

As a consequence, in 1906 the first **International Radiotelegraph Conference** gathered 29 maritime States in Berlin to sign the *International Radiotelegraph Convention*, establishing the principle of compulsory intercommunication between land and vessels at sea. The annex to this Convention contained the first regulations governing wireless telegraphy. These regulations have since been expanded and revised by numerous radio conferences, and are now known as the *Radio Regulations*. Coincidentally, 1906 was also the year in which the Canadian, Reginald Fessenden, made the first radio broadcast of the human voice (see *ITU News* of December 2005).

A hundred years later, we are again witnessing another spectacular growth in the use of wireless communications. Innovative technological solutions using radio transmission are laying the foundations for a truly *wireless world*. Radio has become pervasive in our lives, from personal devices such as mobile phones, radio-controlled watches, radio headsets to equipment for home and office networking, radio positioning systems for navigation, intelligent transport systems (for example, toll control and collision avoidance), broadcasting through radio and television, and emergency communications and disaster warning systems.

Valery Timofeev, Director, ITU Radiocommunication Bureau

Poldhu wireless station in 1901 with the fan-shaped aerial which sent the first wireless signal across the Atlantic to Signal Hill, Newfoundland



Initial experiments on board Elettra

We are also seeing the development of such important new technologies as radio-frequency identification (RFID), which, for instance, uses tags that can be attached to almost any object and report back on its whereabouts.

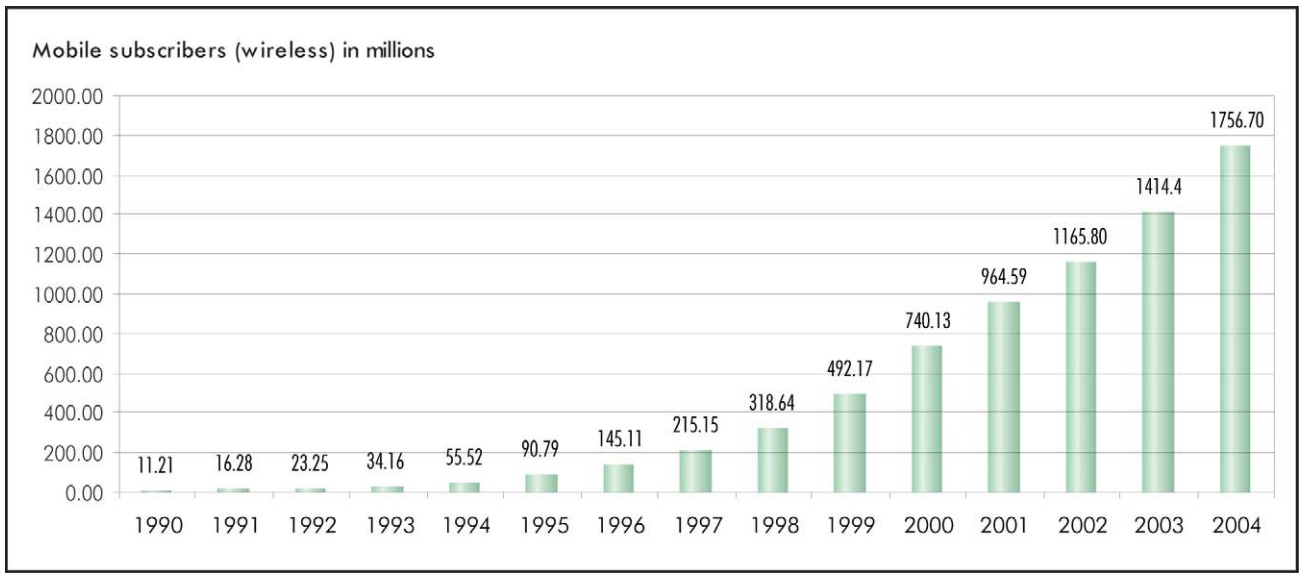
One striking example in the wireless revolution is the astounding growth of mobile communications since the service was initially deployed. In 1990, there were only about 11 million mobile subscribers worldwide. This number increased to over 300 million by the end of 1998, and at the end of 2004 it had boomed to 1.75 billion, according to ITU statistics (see Figure 1).

We are now witnessing the full deployment of third-generation (3G) mobile systems, based on ITU standards known as IMT-2000. According to industry data, more than 250 million users are enjoying the benefits of IMT-2000 services, and the number could rise to 1 billion by the end of this decade. The framework for the development of 3G was established in 1992 at ITU's World Administrative Radio Conference (WARC-92), where, among other regulatory provisions, the radio-frequency spectrum bands were identified on a global basis for use by countries when deploying IMT-2000 systems.

The international dimension

In order to function properly, all radiocommunication systems make use of appropriate radio frequencies. However, the propagation properties of radio waves ruled by laws of

Figure 1 – Growth of mobile communications



Source: *ITU World Telecommunication Indicators Database, 2005.*

physics mean that radio frequencies do not respect national borders. Sometimes, this is done intentionally in order to provide international radiocommunication services, for example, in the case of high-frequency broadcasting and satellite systems, or aeronautical and maritime communications. Consequently, as radio technology developed, the international community established a structure for coordinating activities related to the use of spectrum and preventing radio interference.

The **first Radiotelegraph Conference** (Berlin, 1906) established the international *Table of Frequency Allocations*, which allocated frequencies from 500 to 1000 kHz for public use in the maritime service, a frequency band (below 188 kHz) for long-distance communication by coast stations, and another band (188–500 kHz) for military and naval stations not open to public use. In order to facilitate and strengthen this international cooperation, organizational structures and procedures were developed.

In 1927, the Washington Radiotelegraph Conference established the **International Radio Consultative Committee (CCIR)** to study technical radio problems. In Madrid in 1932, the Plenipotentiary Conference decided to change the name of the International Telegraph Union to *International Telecommunication Union*. It also decided that ITU should be governed by a single *International Telecommunication Convention* and supplemented by *Telegraph Regulations*, *Telephone Regulations* and *Radio Regulations*. The new name, which came into effect on 1 January 1934, was chosen to better reflect the full scope of the Union's activities, which by then covered all forms of wireline and wireless communications.

Radio has become pervasive in our lives — for listening to the news, making phone calls, or networking the office and home with the latest wireless equipment. Radio is also an essential element of emergency communications, as well as systems for navigation and intelligent transport

The results of the Madrid Conference had several implications for radiocommunications. One was the division of the world into two Regions (Europe and other regions) for the purposes of frequency allocation. Another was the establishment of two technical tables (one for frequency tolerances and the other for acceptable emission bandwidths). The third was the setting of standards for the registration of new stations.

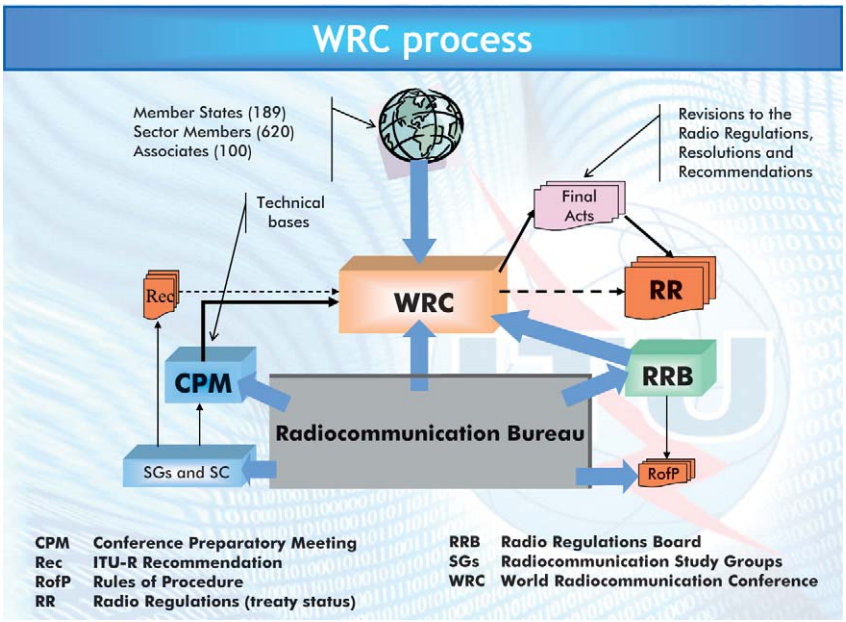
The **Plenipotentiary Conference** that followed in 1947 in Atlantic City (United States) had the aim of developing and modernizing ITU. Under an agreement with the United Nations, ITU became a UN specialized agency on 15 October 1947, with its headquarters in Geneva. ITU has continued ever since to play a vital role in the overall management of the radio-frequency spectrum and its activities have a significant impact on national spectrum management.

The WRC process

The dramatic rise in demand for frequency assignments from the 1940s onwards caused severe congestion in the lower frequency bands to the point where utilization of the upper frequency bands began to be explored in earnest. As far back as 1979, the need for additional frequency availability was recognized. As a consequence, the *ITU Table of Frequency Allocations* was thoroughly revised by the **World Administrative Radio Conference of 1979 (WARC-79)** — a diplomatic marathon, which lasted more than three months with the object, among others, of stimulating development of the upper frequency bands, especially above 20 GHz.

Since WARC-79, in view of the enormous demand for spectrum, the *Radio Regulations*, and particularly the *ITU Table of Frequency Allocations*,

Figure 2 – The WRC process



have been revised and updated almost regularly, in order to keep pace with the rapid expansion of existing systems and new, spectrum-hungry advanced wireless technologies. The **ITU World Radiocommunication Conferences (WRC)** are at the heart of this updating process, which constitutes the starting point for national spectrum management (see Figure 2).

In the 1980s, concern arose about ensuring equitable access to spectrum and orbital resources, particularly given the uneven needs of developed and developing countries in terms of quantity and timely access to those resources. As a consequence, the principle of *a-priori* planning of spectrum and orbit resources was introduced in ITU at a series of planning conferences that took place during that decade and involved mainly space radiocommunication services.

According to its Constitution, ITU is responsible for the allocation of spectrum and registration of frequency assignments, and of orbital positions and other parameters of satellites "in order to avoid harmful interference between radio stations of different countries". The international spectrum management system is therefore based on regulatory procedures for frequency notification, coordination and registration. This is an essential task for administrations to ensure their services obtain international recognition and are coordinated with the services of other administrations. ■

World radiocommunication conferences at a glance

The next conference

World Radiocommunication Conference 2007 (WRC-07) (Geneva, 15 October–9 November 2007)

This conference will consider some 30 agenda items, covering almost all terrestrial and space radiocommunication services. Many applications will also be discussed, including those of the third-generation International Mobile Telecommunications (IMT-2000) and systems beyond IMT-2000, high-altitude platform stations (HAPS), high-frequency broadcasting, and Global Maritime Distress and Safety Systems (GMDSS).

Notable achievements between 1995 and 2003

World Radiocommunication Conference 2003 (WRC-03) *(Geneva, 9 June–4 July 2003)*

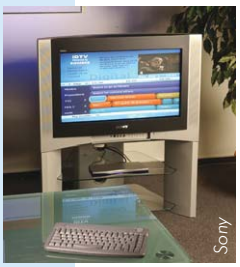
• New frequency allocations were made to the mobile service in the bands 5 150–5 350 MHz and 5 470–5 725 MHz for wireless access systems, including radio local area networks (RLAN).

• ITU reaffirmed its support for the continuing deployment of mobile wireless communications by recognizing the need to provide a global vision for the future development of IMT-2000 and systems beyond IMT-2000. These include 3G systems and their enhancements, as well as WLAN-type, short-range connectivity, and broadcast systems. As part of its commitment, ITU is conducting technical and operational studies to develop Recommendations for the future development of these systems. The studies will take into account the particular needs of developing countries, including use of the satellite component of IMT-2000 for suitable coverage of these countries.

• A resolution was approved that paves the way for the deployment of new technologies for wideband and broadband **public protection and disaster relief communication applications**. The resolution lists specific frequency bands and ranges, which the conference identified for use in each region for advanced solutions for public protection and disaster relief. It strongly recommends that countries use these regionally harmonized bands to the maximum extent possible. The benefits of spectrum harmonization include increased potential for interoperability during disasters or emergencies (see article on page 16).

• A new resolution on the use of the band 108–117.975 MHz by **aeronautical services** was also approved. It recognizes the need for the aeronautical community to provide additional services in order to enhance navigation and surveillance systems as well as passenger access to e-mail and internet services through telecommunication data links. It also takes account of the need for the broadcasting community to provide digital terrestrial sound broadcasting.

World Radiocommunication Conference 2000 (WRC-2000) *(Istanbul, 8 May–2 June 2000)*



• The results of this conference have enabled the industry to develop and deploy a host of sophisticated new radio-based communication systems**.** The conference was hailed as a success because of its ability to come to grips with ever more complex issues; in particular, how to share the radio-frequency spectrum (a limited resource) amidst the rapid growth of radio-based systems worldwide.

• An agreement was reached on **additional spectrum for IMT-2000**, effectively giving the green light to the mobile industry worldwide to deploy 3G networks and services. The decision provided for three common bands, available on a global basis for countries wishing to implement the terrestrial component of IMT-2000.

• A new **broadcasting-satellite plan** for Europe, Africa and Asia-Pacific was adopted to enable the delivery of direct satellite television broadcasting signals to a growing customer base.

World Radiocommunication Conference 1997 (WRC-97) *(Geneva, 27 October–21 November 1997)*

• One major milestone was the replanning of the broadcasting-satellite service, which was experiencing rapid growth worldwide in delivering direct-to-home television services.

• An agreement was also reached between new mobile satellite service operators, paving the way for the development of new, global broadband satellite systems that can deliver internet and multimedia applications to homes and businesses anywhere in the world.

World Radiocommunication Conference 1995 (WRC-95) *(Geneva, 23 October–17 November 1995)*

• Additional spectrum was allocated to the **mobile-satellite service (MSS)** for "little LEO" systems (operating below 1GHz). These systems will be used to provide mobile data services.

• The debate over the approval of non-geostationary orbit fixed-satellite service systems, such as "Teledesic", ended with the agreement to allocate the system 400 MHz of spectrum in the 19 GHz and 29 GHz bands. The "Teledesic issue" was considered to have a potentially huge impact on the development of new "fibre-in-the-sky" systems.