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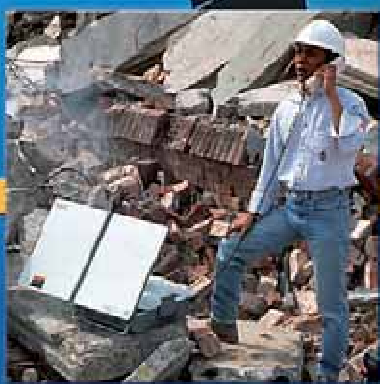
World Radiocommunication Conference 2007

RA WRC07

Bringing all radio services together



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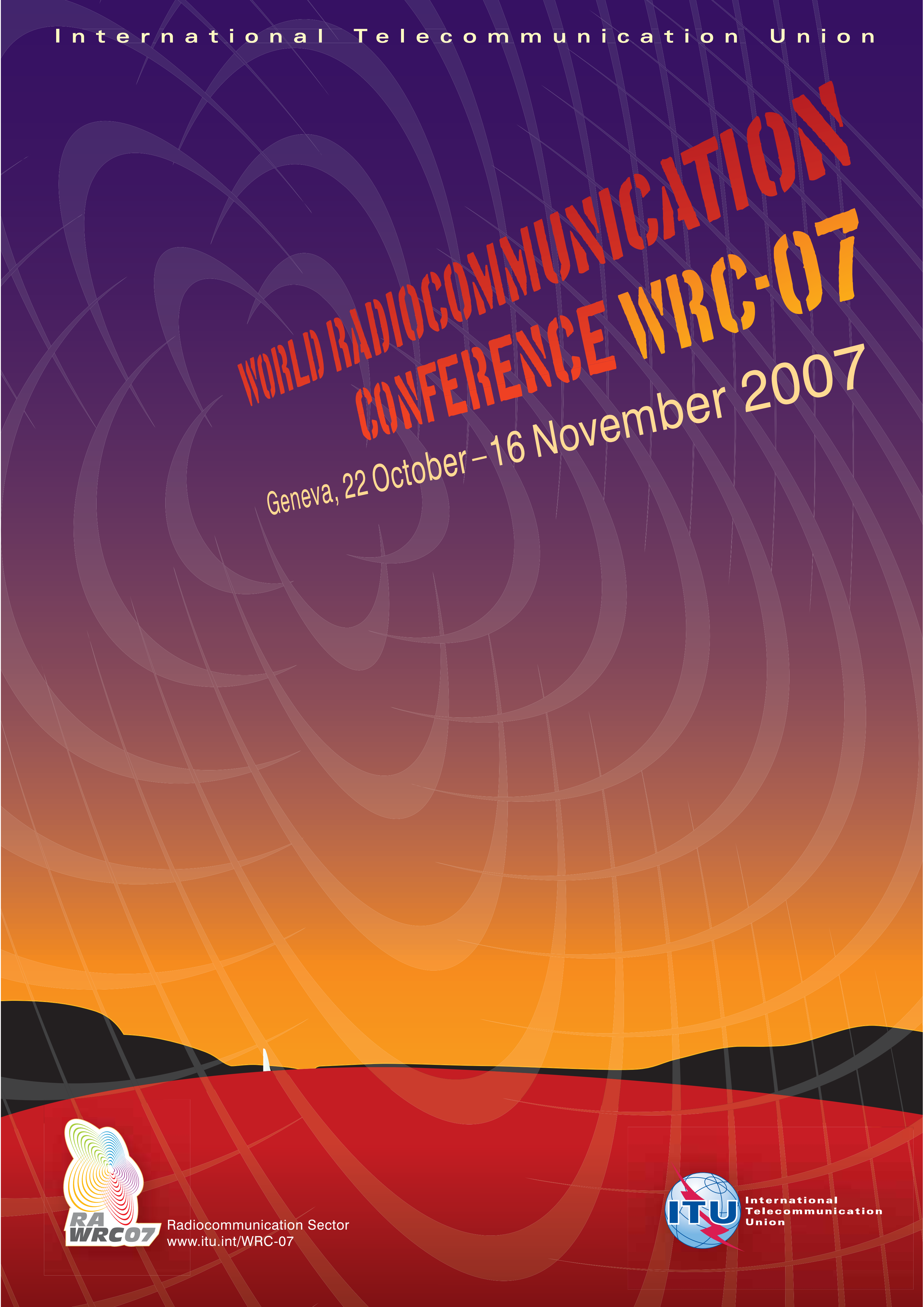
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CONFERENCE WRC-07
Geneva, 22 October – 16 November 2007
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Special Edition — WRC-07

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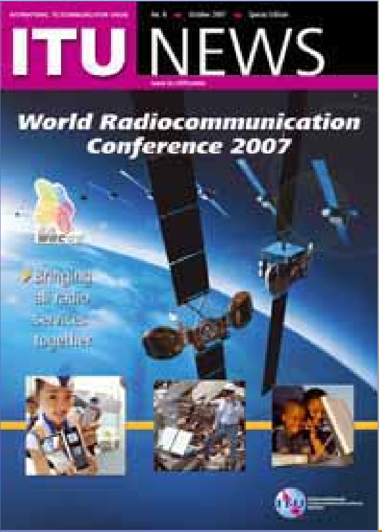

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Sharing finite resources

Dr Hamadoun I. Touré, ITU Secretary-General

The radio-frequency spectrum and satellite orbits are finite natural resources that are increasingly in demand from a large and ever-growing number of services. How to organize equitable access to these resources is an essential and challenging task of world radiocommunication conferences.

So important are these conferences, and because they now normally take place every four years, some call them the "wireless Olympics". As at a sporting event, there will be hot competition at the World Radiocommunication Conference (WRC-07), which ITU hosts in Geneva from 22 October to 16 November. The many vital services that use the radio-frequency spectrum will compete to ensure that they maintain — and perhaps expand — their access to it. Also looking for a slice of the pie will be new technologies, some of which will provide communications anywhere and at any time.

As parts of the spectrum become crowded, WRC-07 must ensure that all users can share it without causing harmful interference. The articles in this edition of *ITU News* indicate some of the issues that will be debated. Calls will be heard from the aviation sector, amateur radio, space sciences, emergency telecommunications, and electronic news gathering. And one of the most fundamental issues will be reconciling the needs of satellite operators with those of mobile personal communications and broadcasting.

As mobile markets approach saturation in developed countries, IMT-2000 (or 3G) systems and those beyond (known as IMT-Advanced) are expected to generate further growth opportunities. And broadband wireless access technologies, such as Wi-Fi and WiMAX, promise new ways of bridging the digital divide. We need flexibility in spectrum allocation and management for these technologies to really take off. Meanwhile, analogue television will be replaced by digital broadcasting over the next ten years, as envisaged, for example, in the plan adopted at the ITU Regional Radiocommunication Conference in June 2006. New digital techniques are expected to make broadcasters' use of spectrum six times more efficient. As well as giving viewers more channels, this opens the door for new services after analogue broadcasting is switched off. We must act now for the benefits of this "digital dividend" to be shared globally.

With its 191 Member States and 700 Sector Members and Associates, ITU has the noble mission of connecting all the word's inhabitants. Access to spectrum and orbit resources is critical in providing the infrastructure needed to achieve this mission and the connectivity goals of the World Summit on the Information Society. I am confident that WRC-07 will take the decisions needed to meet these goals.

WRC-07 will review and update the Radio Regulations, which have the force of an international treaty. And although there will be competition at these "Olympics", there will also be compromise. As the global manager of radiocommunication resources, ITU will (as it says in our Constitution) seek "to harmonize the actions of Member States and promote fruitful and constructive cooperation and partnership". I am sure that this spirit of consensus that has characterized our membership over the last 142 years will prevail at WRC-07.

Overview of the conference

Valery Timofeev

Director, ITU Radiocommunication Bureau

Updating the Radio Regulations

On 30 October 2006, the Radiocommunication Bureau (BR) proudly celebrated the centenary of ITU radiocommunication conferences. At the International Radiotelegraph Conference held in 1906 in Berlin, the first International Radiotelegraph Convention was signed, with its annex containing the first regulations governing wireless telegraphy. Since expanded and revised by numerous radiocommunication conferences, these are now known as the *Radio Regulations* — the international treaty governing the use of the radio-frequency spectrum and satellite orbits.

Currently, the *Radio Regulations* apply to frequencies ranging from 9 kHz to 400 GHz, and incorporate over 1000 pages of information describing how the spectrum and satellite orbits may be used and shared around the globe. In an increasingly wireless world, some 40 different radio services now compete for spectrum allocations to provide the bandwidth needed to extend services or support larger numbers of users.

The ITU Constitution (CS89) states that "a world radiocommunication conference may partially or, in exceptional cases, completely, revise the *Radio Regulations* and may deal with any question of a worldwide character within its competence and related to its agenda". The process of convening a world radiocommunication conference (WRC) is described in ITU Plenipotentiary Conference Resolution 80 (Rev. Marrakesh, 2002). This framework is based on the principles that:

- preparations and administration, including budgetary appropriations, should be planned on the basis of two consecutive WRCs;
- the regional harmonization of common proposals for submission to WRCs should be supported;
- formal and informal collaboration in the interval between WRCs should be encouraged.

The dawn of a new radio century

The World Radiocommunication Conference (WRC-07), scheduled from 22 October to 16 November 2007 in Geneva, inaugurates a new century of activities in the ITU Radiocommunication Sector (ITU–R) relating to the process of updating the *Radio Regulations*. Its agenda, established by the 2004 session of the ITU Council, contains about 30 items, concerning almost all terrestrial and space radio services and applications. It includes, for example, aeronautical telemetry and telecommand systems, satellite services, mobile communications, maritime distress and safety signals, digital broadcasting, satellites for meteorology, and the prediction and detection of natural disasters.

Building solid bases

The technical, operational and regulatory bases for the work of WRC-07 were prepared by the Conference Preparatory Meeting (CPM) held in two sessions: the first in 2003 set up the work programme of several ITU–R study groups and prepared the structure for the CPM Report. As a result of work on technical, operational and regulatory matters undertaken by these study groups and the Special Committee, on the basis of contributions by the ITU–R membership, the second session of the CPM prepared a consolidated report to support the work of WRC-07. Nearly 1100 participants from over 100 countries attended the CPM, which took place in February–March 2007.

The Final Report, published in the six official languages of ITU, contains about 600 pages structured in seven chapters addressing the various issues included in the conference agenda items (see box on page 6).

Rodolfo Clix

Structure of the CPM Report to WRC-07

Issues	WRC-07 Agenda item	CPM Report (WRC-07 Doc. 3)
Mobile, aeronautical mobile, radionavigation and radiolocation services	1.3, 1.4, 1.5, 1.6	Chapter 1
Space science services	1.2, 1.20, 1.21	Chapter 2
FSS, MSS and BSS below 3 GHz	1.7, 1.9, 1.11, 1.17	Chapter 3
Fixed service including HAPS and FSS above 3 GHz	1.8, 1.18, 1.19	Chapter 4
Services in LF, MF and HF bands, and maritime mobile service	1.13, 1.14, 1.15, 1.16	Chapter 5
Regulatory procedures and associated technical criteria applicable to satellite networks	1.10, 1.12, 7.1	Chapter 6
Future WRC programmes and other issues	2, 4, 5, 6, 7.1, 7.2	Chapter 7

Abbreviations:
FSS fixed-satellite service
MSS mobile-satellite service
BSS broadcasting-satellite service
HAPS high altitude platform stations

The Informal Group

Following the practice of previous radiocommunication conferences, the WRC-07 Informal Group was created. This has met six times since its first meeting on 26 November 2004, with the main purpose of facilitating regional preparations for WRC-07 as well as developing consolidated proposals for the conference structure and the chairmanships of the conference, its committees and working groups. The Informal Group also provided a forum for collaboration among Member States and regional groups with a view to resolving differences over items on the agenda of the conference, or to review new items for a future conference.

Information Meeting for African countries

Based on the instructions of Resolution 72 of WRC-2000 and on the advice of the 13th meeting of the Radiocommunication Advisory Group in 2005, BR, in collaboration with the African Telecommunications Union (ATU), organized a WRC-07 Information Meeting for African countries, held in Geneva on 28–31 August 2007. The meeting was chaired by Ernest Ndukwe, Chief Executive Officer of the Nigerian Communications Commission. Participants were able to review the common positions and proposals of the regional groups on the most difficult agenda items. The last day was devoted to the African countries' finalizing their draft common proposals, under the coordination of ATU, for submission to ITU.


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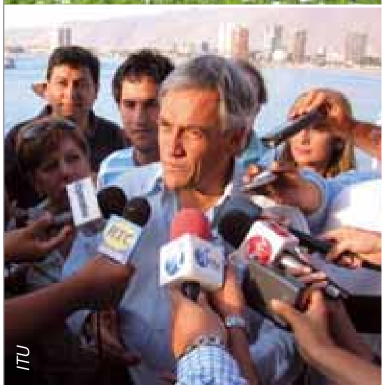
Steve Woods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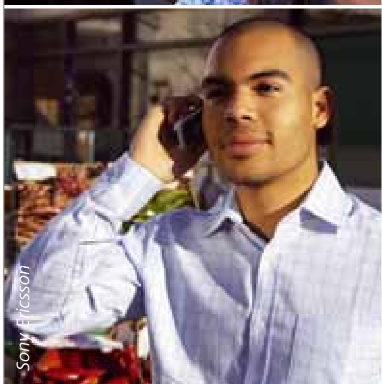

Sony Ericsson

Regional preparations

Regional activities have become one of the key factors for the successful preparation of radiocommunication conferences. In the context of WRC-07, six regional and sub-regional organizations and groups have been active in the establishment of common coordinated positions and proposals for the consideration of the conference (see box below). These entities organized meetings where draft proposals for each conference agenda item were developed for approval of the participating governments and further submission to ITU. Meetings between two different regional groups were held to coordinate matters of common interest.

Resolution 72 of WRC-2000 (on the regional preparations for world radiocommunication conferences) instructs BR to provide the necessary support to these regional preparatory activities.

Regional groups' preparations for WRC-07

European Conference of Postal and Telecommunications Administrations	Working Group "Conference Preparatory Group" for WRC-07 (CPG07), divided into four Project Teams (PT1-4): Final meeting: 10–13 July 2007, Gothenburg, Sweden European Common Proposals (ECPs): WRC-07 Doc. 10 Website: www.ero.dk/cpg
CITEL Inter-American Telecommunication Commission	Permanent Communications Commission II (Radio) (PCCII) Working Group for the Preparations of CITEL for WRC-07: Final meeting: 31 July–3 August 2007, Orlando, United States Inter-American Common Proposals (IAPs): WRC-07 Doc. 14 Website: citel.oas.org/ccp2-radio/WRC.asp
APT Asia-Pacific Telecommunity	APT Conference Preparatory Group for WRC-07 (APG2007): Final meeting: 16–21 July 2007, Busan, Republic of Korea Website: www.aptsec.org/Program/APG/papg.html
African Telecommunications Union	Final Meetings: 25–28 June, Abuja, Nigeria, and 28–31 August 2007, Geneva. Website: www.atu-uat.org
RCC Regional Commonwealth in the Field of Communications	Final Meeting: 17–20 September 2007, Chisinau, Moldova. RCC common proposals: WRC-07 Doc. 16 Website: www.rcc.org.ru/en/
ASMG Arab Spectrum Management Group	Final Meeting: 22–27 July, Damascus, Syrian Arab Republic. Website: www.aspg.org.ae/


Troy Newell


VisMedia

The secretariat behind the scenes

The ITU Secretary-General acts as the secretary of a WRC. Overall responsibility for conference preparation lies with BR, which provides staff for the substantive conference committees and other groups. BR also coordinates the activities of the ITU General Secretariat, which is deeply involved with WRC-07 before, during and after the conference.

With an expected attendance of nearly 2500 delegates and a budget of about CHF 2.5 million, the logistics and administrative preparations for the conference require the work of various departments of the secretariat, notably Information Services, Conferences and Publications, Security, Legal Affairs, Protocol, and Administration and Finance. BR is responsible for delegates' registration and the control of documents. The preparation of the provisional Final Acts, based on documents approved during the conference, is the result of teamwork led by the Secretary of the Editorial Committee. The final version of the Final Acts is prepared by BR a few months after the conference.

WRC-07 represents a challenge in two support service areas. First, maintaining the online delegates' registration system that has been developed in ITU, which provides special facilities for delegations and participants. Second, the need for ITU to equip the conference venue (the Geneva International Conference Centre) with a technologically advanced, high-capacity wireless local area network (WLAN) to allow delegates to work electronically for most of the time. This should result in substantial savings in the conference budget.

BR Director's report

Under item 7.1 of the conference agenda, as Director of the Radiocommunication Bureau I have prepared a report (WRC-07 Document 4) on the activities of the Radiocommunication Sector since the last conference. To facilitate consideration of the many subjects dealt with, the report is structured in sections, including a detailed account of the activities of the Radio Regulations Board.

The document is of crucial importance to the work of the conference and identifies several issues that require decisions by WRC-07. In particular, the section on experiences in applying the radio regulatory procedures includes accounts of difficulties or inconsistencies in the application of the Radio Regulations.

Special edition

Meanwhile, this special edition of *ITU News* contains articles contributed on various issues to be considered at WRC-07. In addition to the reports produced by the Radiocommunication Sector and the proposals and information documents submitted to the conference, these articles will give readers a chance to see issues from the perspective of active players and highly regarded experts in radiocommunications or broadcasting.


Sony Ericsson

More frequencies needed for mobiles

José Costa, Senior Manager, Nortel Networks, and **mib** Coordinator

The background to the issue of mobile telecommunications' growing requirement for radio-frequency spectrum was covered in an article in the April 2007 edition of *ITU News*. Four years of intense preparations are now about to culminate at the World Radiocommunication Conference 2007 (WRC-07), which will "consider frequency-related matters for the future development of IMT-2000 and systems beyond IMT-2000" (agenda item 1.4).

The needs of IMT-2000 and more

To support the development of faster mobile services that are compatible worldwide, in 2000 ITU introduced a set of radio access interfaces known as International Mobile Telecommunications-2000 (IMT-2000), which is a global standard. Currently, there are five IMT-2000 terrestrial radio interfaces: IMT-2000 CDMA Direct Spread, IMT-2000 CDMA Multi-Carrier, IMT-2000 CDMA TDD, IMT-2000 TDMA Single-Carrier, and IMT-2000 FDMA/TDMA, which are specified in Recommendation M.1457-6 of ITU's Radiocommunication Sector (ITU–R). There is also a proposal for a sixth terrestrial radio interface for IMT-2000, referred to as OFDMA TDD WMAN. This, along with the evolution of the existing radio interfaces, will be considered by the Radiocommunication Assembly that takes place in Geneva on 15–19 October, just before WRC-07.

The IMT-2000 radio technologies are expected to converge towards IMT-Advanced, supported by a common packet core network. This should be able to carry up to 100 Mbit/s for high-mobility services (such as mobile access) and up to approximately 1 Gbit/s for low-mobility services, such as nomadic/local wireless access, for deployment after 2010.


ITU

José Costa, Nortel Networks and ***mib***

To be able to operate these systems and deliver such bandwidth-intensive applications, sufficient spectrum will be needed. Existing, identified spectrum bands will not be able to carry the predicted traffic for IMT services after 2015.

Decisions needed now

The preparation process for world radiocommunication conferences involves all parties concerned, including the users of the spectrum, national administrations and regional groups. Since a conference results in updates to the ITU Radio Regulations that are treaty binding, there is a well-coordinated international effort to achieve the best results for everyone concerned. However, it can be a long process from the time of entry into force of a new edition of the Radio Regulations until the spectrum can actually be used.

The regional groups, such as the European Conference of Postal and Telecommunications Administrations (CEPT), the Inter-American Telecommunication Commission (CITEL) and the Asia-Pacific Telecommunity (APT), issue mandates and recommendations for use of the newly allocated spectrum, possibly following frequency arrangement Recommendations that need to be developed in ITU–R. After that, national administrations still need to issue the necessary regulatory standards and spectrum licences, relocating other users if necessary. Eventually, operators and end users are able to use the spectrum for wireless systems and applications.

Thus, from the time spectrum is allocated or identified at a conference, it may take up to 10 years to make it available to users. For that reason, it is important that spectrum be allocated or identified well in advance of when it will be needed.

The perspective of mib

The Mobile Industry Backing Terrestrial Spectrum for IMT (known for short as "**mib**") is an industry group that has been preparing for WRC-07 agenda item 1.4, in collaboration with other industry forums and in support of work in ITU–R. Members of **mib** include Alcatel-Lucent, Ericsson, Fujitsu, Huawei, Motorola, NEC, Nokia, Nokia Siemens Networks, Nortel, Panasonic, Qualcomm, Samsung, Siemens, and ZTE.

A **mib** objective for WRC-07 is that, not only should sufficient spectrum be allocated to the mobile radiocommunication service, but also that it be identified for IMT in order to facilitate economies of scale and global roaming of mobile stations.

Another important issue for mib is that spectrum is identified at WRC-07 and a decision is not postponed to a future conference. This is critical, given the years it takes for spectrum to be made available following a WRC. Also, by providing a harmonized spectrum solution for IMT at WRC-07, unnecessary regional divergence can be avoided. As John Hoadley, Nortel Vice President of 4G Business and Ecosystem Development, has commented: "Early identification of spectrum enables wireless operators to plan an orderly growth of their networks with global roaming capabilities, resulting in significant benefits to the end users, including lower cost and advanced capabilities."

An ITU report (ITU–R M.2078) estimates that total spectrum bandwidth requirements will be up to 720 MHz by 2020, including the bands currently in use for terrestrial wireless systems, and it will be a challenge to identify such spectrum. "ITU has laid a solid groundwork through its efforts to identify the spectrum requirements that will help bridge the digital divide and bring the benefits of mobile broadband to all," says Hank Menkes, CTO for Alcatel-Lucent's wireless business. "To ensure that all communities have sufficient access to mobile broadband services, there needs to be a consistent approach to spectrum allocation around the world to deliver the economies of scale needed to make broadband truly affordable. It is essential that WRC-07 balance the interests of new and incumbent users of spectrum with the need to support widespread availability of broadband services in every part of the world."

Connecting the unconnected by 2015

The Conference Preparatory Meeting (CPM) retained for consideration at WRC-07 the candidate bands identified by ITU–R:

410–430 MHz	2 300–2 400 MHz
450–470 MHz	2 700–2 900 MHz
470–806/862 MHz	3 400–4 200 MHz
	4 400–4 990 MHz.

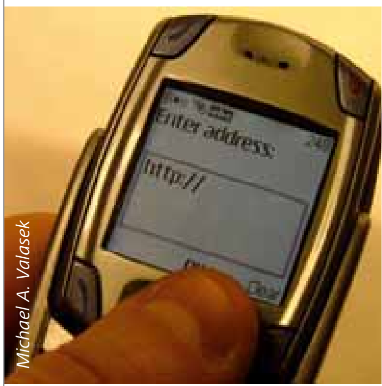
The advantages and disadvantages of each of these bands were described in the CPM-07 Report. This also outlines the methods for allocating spectrum for the future development of IMT-2000 and IMT-Advanced, which were highlighted in the article in the April edition of *ITU News*.

Spectrum-sharing studies are important and have resulted in various ITU–R reports, including those on sharing with geostationary satellite networks in the fixed-satellite service in the 3 400–4 200 MHz and 4 500–4 800 MHz bands (ITU–R M.1209); radiocommunication services in the 450–470 MHz band (ITU–R M.2110); radiocommunication services in the 3 400–3 700 MHz band (ITU–R M.2111), and airport surveillance radar and meteorological radar within the 2 700–2 900 MHz band (ITU–R M.2112).

New bands for IMT-Advanced should be globally common, wide enough to support carriers up to 100 MHz in bandwidth, and low enough in the spectrum (preferably below 5 GHz). A decision at WRC-07 would enable deployment within the 2015–2020 timeframe. "ITU has made world-changing, forward-looking decisions in the past… We look to WRC-07 to again provide that leadership and the positive decisions on IMT candidate bands, which are needed to facilitate the global development of the mobile Internet into the next decade," says Tero Ojanperä, CTO of Nokia.

According to **mib**, spectrum requirements for mobile communications will need to be met if ITU's vision of connecting the unconnected by 2015 is to be achieved.

Meanwhile, **mib** has conducted seminars and presentations in Asia, Africa, Europe and the Americas to elaborate in detail the rationale and needs for terrestrial spectrum for mobile services. These presentations, as well as further information, can be found on the **mib** website at: http://standards.nortel.com/spectrum4IMT/.

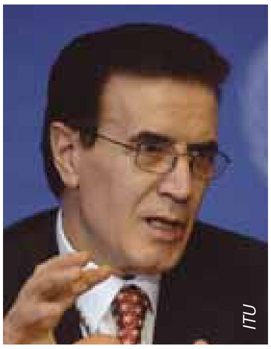


Michael A. Valasek

Nokia

IMT: finding solutions that satisfy everyone

Kavouss Arasteh, Chairman of the Conference Preparatory Meeting for WRC-07



Kavouss Arasteh, Chairman, Conference Preparatory Meeting for WRC-07

Mobile communications are advancing rapidly across the globe. In developing countries, for example, the penetration rate is rising dramatically and already exceeds that of fixed lines. To support progress in mobile wireless communications, ITU adopted radio access interfaces at its Radiocommunication Assembly in May 2000. Known as International Mobile Telecommunications-2000 (IMT-2000), this global standard was born after years of collaborative work between ITU and the mobile industry.

The first frequency bands for IMT-2000 were identified at the World Administrative Radio Conference in 1992, with additional bands identified at the 2000 World Radiocommunication Conference (WRC-2000).

WRC-03 recognized the need for a global vision for the development of IMT-2000 systems, and those beyond known as IMT-Advanced. It asked ITU to study the technical and operational aspects of how these systems will evolve and report to WRC-07. So under agenda item 1.4, WRC-07 will *"consider frequency-related matters for the future development of IMT-2000 and systems beyond IMT-2000 taking into account the results of ITU–R studies in accordance with Resolution 228 (Rev. WRC-03)."*

What ITU studies say

A report (M.2074) from ITU's Radiocommunication Sector (ITU–R) says that there may be a need for new wireless access technologies to be developed around the year 2010 and be widely deployed around 2015 in some countries. The capabilities of IMT-Advanced (mobile access and new nomadic/local area wireless access) are envisaged to handle a wide range of supported data rates. The target is peak data rates of up to approximately 100 Mbit/s for high mobility (such as mobile access) and up to around 1 Gbit/s for low mobility (such as nomadic/local wireless access). Research work on these rates and the new technology is being conducted in Europe and elsewhere.

ITU market and technology predictions show that further spectrum will be needed for IMT within the next decade, in addition to the spectrum identified for IMT-2000 in 1992 and 2000. To meet the demand of advanced IMT beyond 2010, globally harmonized frequency bands are expected to remain important in facilitating economies of scale and global roaming of terminals. Therefore, from the industry perspective, the preference is to identify the frequency bands that can be made available globally as far as possible. This globally harmonized spectrum could be complemented by spectrum harmonized regionally, as far as possible.

IMT: finding solutions that satisfy everyone

Spectrum requirements for IMT-Advanced

The report (ITU–R M.2074) indicates that the spectrum needed for new technologies that can fulfil all the ITU requirements for IMT-Advanced (including "new mobile access" and "new nomadic/local area wireless access"), should be identified below 6 GHz — preferably as low as possible.

Bands below 6 GHz allow sufficient mobility and there is an acceptable trade-off between cost and wide area coverage. Also, it is seen as feasible that the hardware components needed will be available within the required timeframe, while the complexity and power consumption of mobile terminals could stay at an acceptable level.

For mobility objectives and in order to achieve an acceptable trade-off between cost and coverage, it is clearly preferable to use spectrum below 5 GHz. Radio interfaces specific to nomadic applications may need to be identified in the bands above 5 GHz. Some countries however, believe that such requirements can be accommodated in frequency bands above 5 GHz that were allocated to the mobile service at WRC-03.

Improving IMT coverage in developing countries

Recommendation ITU–R M.1645 states that IMT services can best be provided at low cost to rural areas and to low-income populations by using globally harmonized frequencies. This would cut the cost of systems by minimizing the complexity of terminals and maximizing economies of scale. The Recommendation also says that geographical coverage could be increased for the terrestrial component of IMT by using lower frequency ranges than those identified today for IMT-2000, or by using the satellite component of IMT-2000, subject to market conditions and such limitations as handset size, power consumption and indoor coverage. These frequency bands would be below 1 GHz.

The pros and cons of candidate bands for IMT

410–430 MHz

In this band there are public safety and emergency networks in many countries. The band presents complex interlacing between professional mobile radio (PMR), public access mobile radio (PAMR) and civilian/governmental usage. Considerable difficulties could arise if it is identified for IMT applications.

450–470 MHz

Cellular networks use this band in some countries, and in others it is used for public safety and emergency networks. Nevertheless, WRC-07 could identify the 450–470 MHz band for IMT-2000 and systems beyond. However, it should be emphasized that the continued use of this band for PMR/PAMR needs to be taken into account.

470–806/862 MHz

In some countries, aeronautical radionavigation uses the band 645–862 MHz, and in several others the primary allocation for mobile services lies in the upper part of the band, especially for defence.

A digital broadcasting plan, covering some 116 countries (mainly in Africa and Europe), was agreed for the frequency bands 174–230 MHz and 470–862 MHz at the ITU Regional Radiocommunication Conference (RRC-06) in June 2006. According to this plan, almost all analogue broadcasts should switch to digital in June 2015 in Region 1 (Africa and Europe) and in one country in Region 3 (Asia and Australasia). It is to be expected that broadcasting technology will develop in the coming decades as it did in the past, so the digital plan has a modification procedure for taking account of new developments. Such a procedure is part of all broadcasting agreements. In the case of the new plan, the modification procedure provides flexibility to administrations to use the spectrum freed by the switch-over to satisfy new requirements. It allows broadcasting assignments or allotments to be used for other applications, provided that this causes no more interference and that no more protection is claimed than what is foreseen in the plan.

Whether the digital dividend in Europe will include mobile systems such as IMT-2000 may not be known before WRC-07 and will not be implemented before the switch-over expected to


Intelsat

occur in Europe and some other parts of Region 1 around 2012, and in the rest of Region 1 and one country in Region 3 in June 2015. A certain level of harmonization would be desirable to facilitate the market development of such applications, including a harmonized common channelling arrangement, taking into account compatibility issues, economies of scale and the development of pan-European services.

Bands between 2 000 and 3 000 MHz

In many regions, IMT deployment within the band could impose serious constraints on radar operations and future radar installations. Studies show that interference between radars operating in the band 2 700–2 900 MHz and IMT systems will occur to the aeronautical radionavigation service (ARNS) and meteorological radars on a co-channel basis. Separation distances of more than 100 km between the radar and the nearest macro, micro, and pico IMT networks are necessary in order to protect radar operations.

3 400–4 200 MHz and 4 500–4 800 MHZ

Fixed-satellite services (FSS) provide essential connectivity in the band 3 400–4 200 MHz (C-band). These include strategic links for governments, safety-of-life services for maritime and air travellers, weather warnings and commercial services, as well as the trunking and rural connectivity that are necessary for sustainable economic development. In addition, new broadband satellite services are being brought on-line in the C-band, which will therefore remain the band of choice for countries located in tropical and sub-tropical parts of the world, especially those with significant seasonal rainfall. As if to demonstrate this point, use of the C-band has increased significantly over the past 40 years in all parts of the world and continues to grow, such that there are now over 160 satellites in geostationary orbit providing C-band services.

The band 4 500–4 800 MHz is covered by the provisions of Appendix 30B of the Radio Regulations (the FSS Plan) and was developed to "guarantee in practice, for all countries, equitable access to the geostationary-satellite orbit". In order for the FSS Plan to retain any value to administrations, they must be certain that the satellite capacity guaranteed in the plan can be implemented, and that it will not suffer from harmful interference.

Sharing studies have been conducted to assess the technical feasibility of deploying IMT-Advanced systems in the 3 400–4 200 MHz and 4 500–4 800 MHz bands that are used by FSS (amongst other services). To provide protection of the FSS receive Earth stations, they must be separated from the stations of the mobile terrestrial network. The distance between the stations depends on the parameters of the networks and the deployment of the two services. Studies of these separation distances also took into account the need to meet both short-term and long-term interference criteria. These were based on three interference mechanisms:

- If FSS is deployed in a ubiquitous manner and/or with no individual licensing of Earth stations, sharing is not feasible in the same geographical area, since a minimum separation distance cannot be guaranteed.
- There have been studies of how the use of terrain information, including clutter losses, might reduce the necessary separation distance. The degree of such reduction will depend on specific circumstances. However, the reliability of local terrain information has not been proved for all countries.
- Site shielding of FSS Earth stations, where possible, would mitigate interference from IMT-Advanced systems. Other mitigation techniques, such as narrow-beam transmission based on sectorized or adaptive-beam forming antennas, sector disabling and antenna down-tilting, could also reduce the required minimum separation distance.

The deployment scenarios of FSS Earth stations and IMT-Advanced systems may be considered in order to take full advantage of the mitigation techniques. The impact of the various mitigation and spectrum management techniques on the operation of existing and/or planned FSS receive stations has not been fully studied.

IMT and integrated MSS and terrestrial systems

In recent years, there has been interest in systems that integrate the mobile-satellite service (MSS) and terrestrial systems. This approach allows

Nokia


Siemens

MSS frequencies to be re-used in a ground-based network, improving the MSS coverage.

With regard to the satellite component of IMT-2000 and IMT-Advanced, the bands 1 518–1 525 MHz and 1 668–1 675 MHz are the only ones that have been proposed by ITU. WRC-07 may consider identifying the 1 518–1 525 and 1 668–1 675 MHz bands to be used by administrations wishing to implement the satellite component of IMT. This could be accomplished by adding these bands to provision No. 5.351A of the Radio Regulations and by amending Resolution 225 (Rev. WRC-03).

Band(s) between 6 and 10.6 GHZ, and above

Some countries are of the opinion that WRC-07 should adopt an agenda item for the following conference in 2011 (WRC-11) to consider the spectrum requirement for the IMT-Advanced nomadic component, and the identification of bands between 6 GHz and 10.6 GHz or higher to meet this requirement. Other countries believe that these requirements can be met by using the current mobile allocation below 5 GHz.

What action will WRC-07 take?

Taking into account the draft common proposals which ITU is receiving from regional organizations, one could envisage that WRC-07 might take the following steps regarding spectrum for IMT-2000 and systems beyond:

- There may be a high probability that the frequency bands 450–470 MHz and 2.3–2.4 GHz will be identified for IMT.
- There may also be a high probability that an agenda item for WRC-11 will be adopted asking ITU–R to study the feasibility of identifying part or parts of the frequency band 470–806/862 MHz for IMT — if the results of the study support such identification.
- There is almost no possibility of the frequency bands 2.7–2.9 GHz being identified for IMT applications.
- It is less likely that a decision will be made to include an agenda item for WRC-11 to consider frequency-related matters for new nomadic applications of IMT in bands between 6 GHz and 10.6 GHz or higher.
- There is almost no possibility that the frequency band 4.4–4.990 GHz (and in particular, the band 4.5–4.8 GHz) will be identified for IMT.
- The conference might need to examine the possible identification for IMT of a portion or sub-band of the 3.4–3.8 GHz band.

A way forward

Clearly, there are conflicts of interest between various users in different frequency bands. The important issue is how to find solutions which satisfy everyone.

The issue is complex, since, on one hand, incumbent services must be assured that the frequency bands currently used for telecommunication infrastructure, networks and systems can continue in use until there are other ways and means to meet their needs. On the other hand, there needs to be timely design, development, deployment and enhancement of modern mobile communications that are capable of providing systems and networks with high-speed data rates and high mobility.

In the past, there have been occasions and circumstances when a frequency band has been identified and allocated for a given service or application, but the date of implementation came later. At WRC-07, with respect to the possible identification for IMT of a sub-band in the 3.4–3.8 GHz band, the whole picture must be taken into consideration in order to arrive at a satisfactory solution. Consideration of other possible allocations for IMT, such as within the band 470–806/862 MHz, might need to be postponed until the conference in 2011, following further study in ITU.

Solutions will be different for the various frequency bands requested for IMT. However, when we look back at the agreements achieved at previous world radiocommunication conferences, it is clear that success is possible.

Satellite operators challenge mobiles' use of C-band

José Albuquerque, Senior Director, Spectrum Engineering, Intelsat

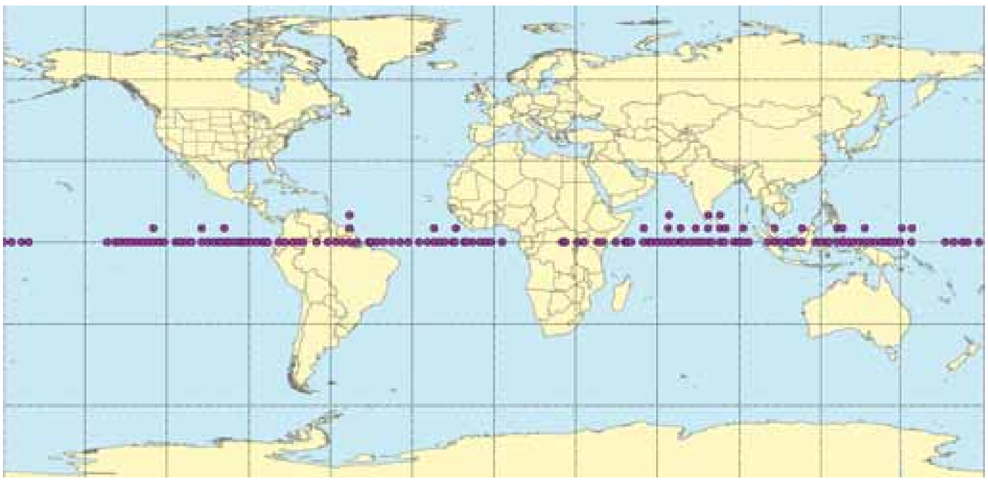
José Albuquerque, Intelsat

The World Radiocommunication Conference (WRC-07) will address matters related to the identification of radio-frequency spectrum for IMT-2000 and systems beyond. (International Mobile Telecommunications-2000, or IMT-2000, is ITU's global standard for third generation — 3G — wireless communications). In the opinion of many satellite operators, the frequency bands 3 400–4 200 MHz and 4 500–4 800 MHz (known as C-band) are not suitable for this purpose.

The frequency ranges 3 400–4 200 MHz and 4 500–4 800 MHz are in the list of candidate bands that emerged from studies conducted within the ITU Radiocommunication Sector (ITU–R) in connection with this conference agenda item. Most existing C-band satellites use the first of these ranges for their downlink transmissions. The band 4 500–4 800 MHz is associated with the downlinks of the fixed-satellite service (FSS) Plan, and is intended to preserve orbit and spectrum resources for future use on an equitable basis by all countries.

Currently, there are some 160 satellites in the geostationary orbit using C-band frequencies for their downlink transmissions (see Figure 1). This is the equivalent of more than 3000 satellite transponders with a 36 MHz bandwidth with the potential for transmitting about 180 Gbit/s at any given instant. This infrastructure represents an investment in excess of USD 30 billion

Figure 1 — Geostationary satellites currently in orbit using the band 3 400–4 200 MHz



in spacecraft and launch costs alone, without taking into account investment in the ground segment made by users and satellite operators.

Deployment of IMT systems in these frequencies would drastically reduce the benefits that these resources have brought to users around the world, because fixed-satellite services and IMT systems cannot share frequencies in the same geographic area.

Critical services delivered via C-band

C-band frequencies are used for downlink satellite transmissions that provide a wide range of services in developed and developing countries, including critical applications such as distance learning, telemedicine and universal access services; backhaul services (telephony, Internet); very small aperture terminal (VSAT) data links such as bank transactions or corporate networks; distribution of television programmes; mobile-satellite service feeder links, and emergency links, including disaster recovery services and meteorological tracking. These services require the high reliability and broad geographic coverage that can only be delivered in the C-band.

C-band is effective for smaller markets

The satellite beams in C-band cover large geographic areas and facilitate intercontinental and global communications. In higher frequencies, such as around 12 GHz (Ku-band) or 20 GHz (Ka-band), beams are more focused towards smaller areas to overcome the more severe signal attenuation due to atmospheric effects. This is illustrated by the downlink footprints of a satellite currently operating at 180°E, which are shown in Figure 2 for C-band and in Figure 3 for Ku-band.

Due to their broad geographic reach, C-band beams allow for economically viable coverage of smaller markets and regions

Figure 2 — C-band footprints of a satellite at 180°E

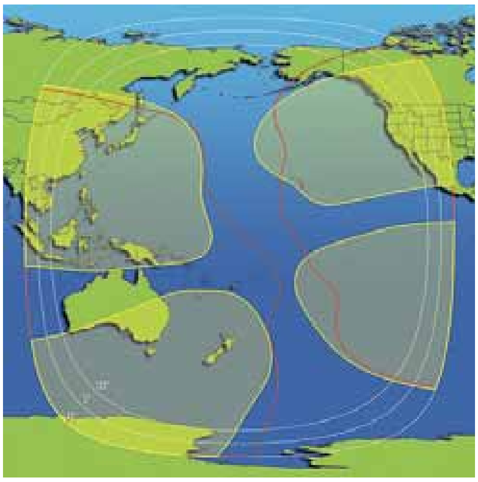
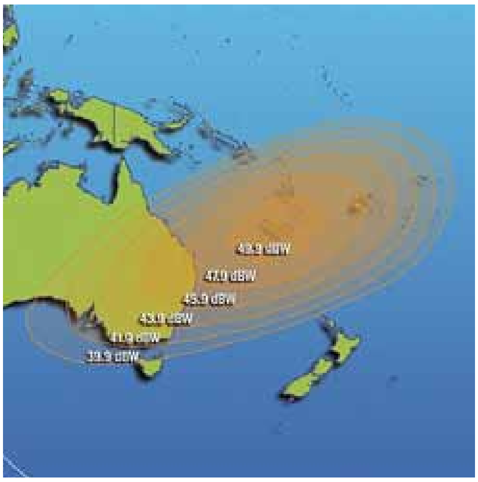


Figure 3 — Ku-band spot beam of a satellite at 180°E



with low population density. In C-band, region-wide coverage can be provided with high availability, irrespective of rain zones, because rain fade effects are almost negligible in these frequencies. On the other hand, the severe rain fading effects on Ku-band or Ka-band signals require operators to create smaller beams focused on areas of high demand and population density, in order to maintain the required quality of service in an economically viable manner.

IMT cannot share with FSS

It is not feasible to undertake co-frequency operation of FSS receiving Earth stations and transmitting fixed or mobile stations in IMT systems. ITU–R studies have concluded that separation distances of between tens of kilometres and a few hundred are required to ensure protection of FSS Earth stations. Considering that a typical city covers an area with radius of between 15 and 30 km, sharing between IMT systems and FSS receiving Earth stations is not realistic.

In addition, IMT transmitters can also interfere with FSS Earth stations operating in adjacent bands. Unwanted emissions generated by IMT transmitters falling within the FSS desired signal cannot be filtered and will therefore generate interference. Furthermore, signals generated by an IMT transmitter can be strong enough to saturate the low-noise amplifier (LNA) of the FSS receiver. In view of the significant difference between the levels of the desired signal (originating at the satellite transmitter about 36 000 km away) and the interfering signal (originating at the IMT transmitter only a few kilometres away), filtering the IMT signal to the required levels might become unfeasible.

The adjacent-band interference effects described above highlight the fact that identification of a portion of C-band frequencies for IMT systems, while keeping another contiguous portion for FSS use, is not free of interference problems and does not constitute a desirable approach.

Mitigation techniques have been proposed in this context. However, given the order of magnitude of the separation distances required to reduce interference to acceptable values and the location of Earth stations in high density areas, application of mitigation techniques is not a realistic option.

In particular, spectrum management techniques are not feasible because the weak signal coming from the satellite cannot be monitored by the IMT transmitter, and development of a database with information on the signals received by FSS Earth stations is unrealistic. For much the same reasons, site shielding is not practical either. The number of Earth stations involved is too large and such a solution, even if it could be implemented, would become too expensive.

Number of Earth stations

It is very difficult to make an accurate estimate of the number of C-band Earth stations around the world. Only a small fraction of those operating are individually notified to ITU. At the national level, data are also incomplete, especially because, in the vast majority of cases, receive-only (RO) Earth stations are not required to be registered (and actually are not registered) with the telecommunication authorities of each country.

As an example of this situation, in August 2006, approximately 6500 Earth stations deployed in the United States were in the database of its Federal Communications Commission (FCC), while it was known that there were more than 11 000 RO Earth stations operating in that country as cable head-ends.

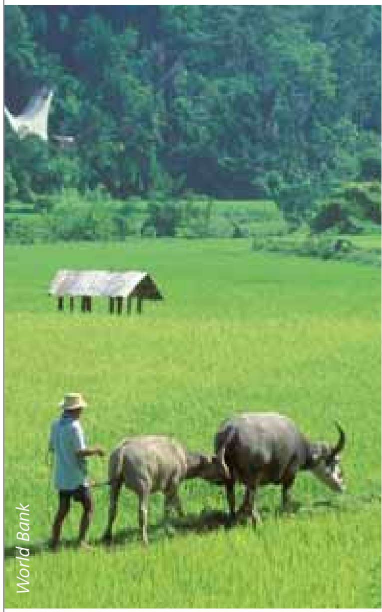
Another illustration is seen in Figure 4, which presents a map of Earth station locations of a single satellite operator. As explained, even for this single operator the map represents a substantial undercount of the actual deployment.

C-band is not suitable for IMT systems

It should be noted that C-band frequencies are not the most appropriate for IMT systems. In areas where population density is high, cell diameters will be based on usage requirements. In areas where population density is low, however, cell diameters depend on how far signals can reach. The characteristics of C-band will significantly increase costs as compared to deployment in lower frequency bands, because C-band signals, in addition to not being able to penetrate buildings, lose energy over distance much more than lower frequency bands. This would mean that IMT deployment to rural areas using C-band would be much more expensive.

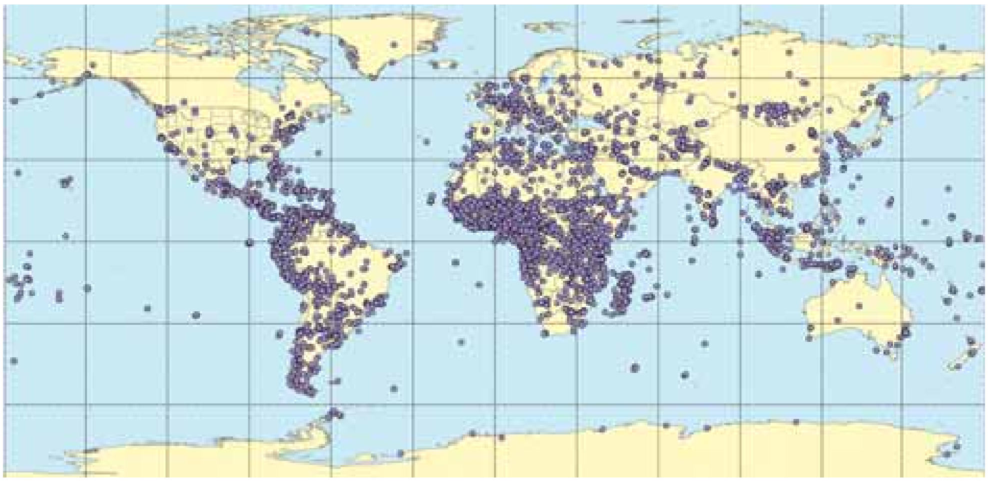
Furthermore, alternative bands are available for IMT. The World Administrative Radio Conference (WARC) in 1992 and the World Radiocommunication Conference in 2000 identified a band of around 750 MHz for IMT systems. Several other IMT candidate bands will be considered by WRC-07, mostly below 3 GHz.

Given all the above circumstances, satellite operators are of the view that the frequency bands 3 400–4 200 MHz and 4 500–4 800 MHz (C-band) should not be identified for use by IMT systems, either globally or regionally.



Due to their broad geographic reach, C-band beams allow for economically viable coverage of smaller markets and regions with low population density

Figure 4 — C-band Earth stations: Incomplete count from a single satellite operator



Spectrum requirements for international civil aviation

Robert Witzen, Technical Officer, International Civil Aviation Organization (ICAO)

The International Civil Aviation Organization was founded in 1944 to promote the safe and orderly development of civil aviation worldwide.
It is a specialized agency of the United Nations.

As more and more flights cross the skies and new communication technologies are introduced, the International Civil Aviation Organization (ICAO) would like to see the allocation of radio-frequency spectrum keep pace. Spectrum allocation for aviation is an important topic for WRC-07.

The position of ICAO, which will be presented at WRC-07, addresses the global needs and concerns of the international civil aviation community, with the view to securing spectrum that will support and satisfy developments in aviation in the medium and longer term. At the same time, current aircraft operations, for which requirements differ among the seven ICAO Regions mainly depending on the density of these operations, need to be supported by improved communication, navigation and surveillance systems — all of which require radio-frequency spectrum.

While fully recognizing that the use of radio-frequency spectrum needs to conform to the framework set by the ITU Radio Regulations and Recommendations of the Radiocommunication Sector (ITU–R), ICAO wants to see radio allocations and regulatory provisions agreed at WRC-07 that will provide the necessary conditions for operating in overcrowded spectrum in a manner that is compatible with other radio services. At the same time, the aviation industry needs maximum flexibility in developing and implementing systems required for the safe and efficient operation of aircraft, as and when necessary. In this regard, the aviation industry is working within the framework set by ICAO Standards and Recommended Practices (SARPs).

Since 2000, spectrum available for satellite radionavigation systems has been increased significantly, meeting long-term requirements for these systems in aviation. Spectrum allocations for terrestrial-based aeronautical navigation systems have not been changed. At present, they are expected to meet aviation's requirements, although it is of paramount importance that the spectrum for these terrestrial systems remains available until the role of satellite navigation vis-à-vis terrestrial radionavigation systems in aviation has been firmly established, and on a global basis.

Air-ground communication needs more spectrum

In contrast to the spectrum available for aeronautical radionavigation, since 1959 there has been little increase in the spectrum available for air-ground communication systems. The band 117.975–137 MHz is the only one available to aviation for line-of-sight air-ground communications. Increased capacity in this band has been achieved over the years by reducing channel separation, from 50 kHz to 25 kHz in 1973 and to

8.33 kHz in 1996. Also, in 1996 air-ground data link systems were introduced, primarily in the sub-band 136–137 MHz. Saturation of the band 117.975–137 MHz, which is now used for both voice and data communications, is expected in Europe around 2015 and there are predictions for heavy congestion in North America around 2020. No further technological improvements are available to date that might alleviate this situation. Clearly, additional allocations will be needed to meet future requirements.

Future air-ground communications will be based increasingly on the exchange of (automated) data messages between air traffic control and aircraft, compared to the exchange of voice messages today. These communications include tactical controller-to-pilot data, automatic dependent surveillance (a technique whereby the aircraft transmits its position, primarily derived from the Global Positioning System (GPS), to other aircraft and/or air traffic control units), and flight information messages, including meteorology reports. This is why ICAO's primary aim at WRC-07 will be to increase the amount of spectrum that can be used for air-ground data communications.

ICAO has studied the potential for introducing allocations to the aeronautical mobile (route) service, or AM(R)S, in the frequency bands 108–117.975 MHz, 960–1 124 MHz and 5 091–5 150 MHz. ICAO's studies have raised concern that the use of these bands for aeronautical mobile communications will, in general, reduce their availability for the aeronautical radionavigation systems to which the bands have already been allocated. In the development of future communication systems in these bands, ICAO recognizes the need to secure sufficient spectrum for radionavigation systems.

Safety-of-life communications — future systems

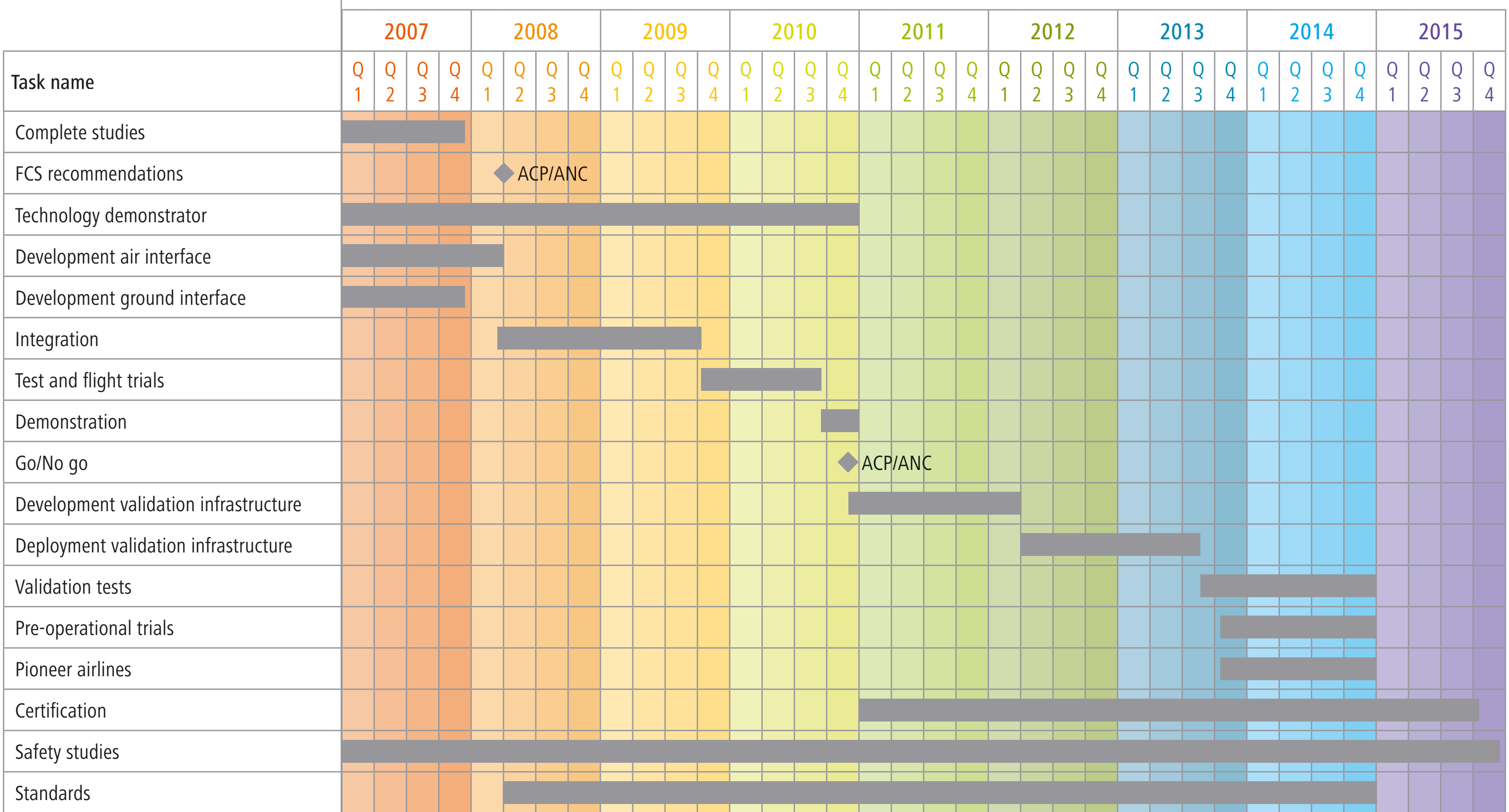
Since 2003, ICAO has also been investigating operational concepts and architecture for future aeronautical safety-of-life communications. This activity is expected to be completed in early 2008 and to be followed by the identification of technologies and the development of ICAO standards for future systems. While still preliminary, the following main principles for satisfying spectrum requirements for future communication systems are the basis of the ICAO position for WRC-07:

- The 117.975–137 MHz band should be used as long as possible, if necessary through introducing reduced channel spacing (8.33 kHz) for air-ground voice communications. If this band can no longer satisfy requirements in certain high-density traffic areas, expansion into the 112–117.975 MHz band would be necessary.

- The 960–1 124 MHz band should be used primarily for broadband air-ground data communication systems, for which ICAO is primarily considering the use of the sub-bands 960–977 MHz and 1 143–1 164 MHz.
- The 5 091–5 150 MHz band should be used primarily for airport surface safety-of-life applications, using IEEE 802.16 technology. This band is also seen as capable of initially accommodating spectrum requirements for unmanned aerial systems. (This usage could also, partly, be accommodated in the 5 000–5 030 MHz band.)

When developing standards for new systems operating in these bands, ICAO will, as usual, cooperate with ITU–R to secure compatibility with other radio services. This is particularly necessary with regard to the FM-broadcasting service operating in the band 87–108 MHz, and the fixed-satellite service operating in the band 5 091–5 150 MHz. Also, compatibility with ICAO standardized systems operating in these bands will be ensured when developing ICAO standards for these new systems. It should be noted that, given the safety-of-life aspects, the development, implementation and operational use of new systems in aviation takes a long time and can easily exceed a decade.

Figure 1 — Target plan



Q Quarter — ACP Aeronautical Communications Panel — ANC Air Navigation Commission

Compatibility with systems that have not been standardized by ICAO will be addressed, either on a bilateral basis with relevant administrations or in ITU–R. For some of these systems that are used for national security purposes, reviewing the details necessary to establish compatibility criteria may not always be possible in ITU–R. A target plan for ICAO's activities on future communication systems is depicted in Figure 1.

As identified in the Report of the Conference Preparatory Meeting for WRC-07, and supported by ICAO, other frequency bands that can be allocated to AM(R)S are 5 000–5 010 MHz and 5 010–5 030 MHz. However, significant work still needs to be undertaken before compatibility can be established between the radionavigation-satellite service (RNSS), planned to operate in these bands, and AM(R)S.

Future world radiocommunication conferences

ICAO supports the inclusion of an agenda item at the WRC to be held in 2011 to address the long-term availability for AMS(R)S spectrum in the 1.5/1.6 GHz bands, currently allocated to the mobile-satellite service (MSS). Exclusive allocations for aeronautical mobile safety-of-life satellite communications in the 1.5/1.6 GHz bands were removed in 1997 from the Radio Regulations, creating serious concern about the practicality of making satellite spectrum available for aeronautical safety-of-life communications. A footnote stipulated that AMS(R)S communications would have priority access and immediate availability, by pre-emption if necessary, over all other communications operating within a network. This was intended to provide protection to aeronautical requirements for AMS(R)S communications and did not address ICAO's more serious concern about coordination of aeronautical spectrum requirements between different satellite networks.

In 2005, an ITU–R Report was approved on the "Feasibility and practicality of prioritization and real-time pre-emptive access between different networks of mobile satellite services in the bands 1 525–1 559 MHz and 1 626.5–1 660.5 MHz". This report concluded that "prioritization and intersystem real-time pre-emption is not practical and, without significant advances in technology, is unlikely to be feasible for operational and technical reasons". In addition, allotment of spectrum in these bands to specific mobile-satellite service providers has been organized under various regional memoranda of understanding (MoU), whose provisions are not in the public domain. This makes it virtually impossible for the aviation community to develop long-term planning for the use of this spectrum, essential for supporting long-distance (over the radio horizon) communications to and from aircraft.

Modernizing systems in developing countries

Another issue to be considered by WRC-07 relates to the current satellite frequency allocations that will support the modernization of civil aviation communication systems. Very small aperture satellite terminal (VSAT) networks form part of the

Sharlene Jackson

global aeronautical fixed telecommunication network and provide a means for voice and data communications between adjacent air traffic control centres, especially in remote and oceanic areas which lack terrestrial infrastructure. ICAO supports the incorporation of a Recommendation in the Radio Regulations which recognizes that VSAT networks can also be used for aeronautical safety-of-life communications. This will help administrations to implement VSAT networks in a manner compatible with aeronautical requirements. There is no need for the Recommendation to place any obligation or constraint on VSAT operators. These are addressed in the direct arrangements between VSAT operators and civil aviation authorities.

Telecommand and telemetry

WRC-07 will consider spectrum requirements for aeronautical telecommand and high-bit rate aeronautical telemetry. Through various footnotes in the Radio Regulations, spectrum for aeronautical telemetry is already available in the 1.5 GHz and 2.3 GHz bands. However, additional spectrum is required to support flight testing more efficiently through broadband high-speed data links capable of transmitting high volumes of data. This will mean faster development programmes for new aircraft and fewer test flights, thus achieving significant cost savings.

In addition, spectrum is required to support unmanned aerial systems. Although aeronautical telemetry is not a safety-of-life service, ICAO supports these requirements. ICAO also favours a generic allocation for aeronautical telemetry, which would enable the use of aeronautical telemetry spectrum in a flexible and efficient manner. Alternatively, on the basis of more detailed work being undertaken, WRC-11 could consider an allocation for use by unmanned aerial systems. As for proposals for using the frequency band 5 091–5 150 MHz for aeronautical telemetry, ICAO is of the view that priority should be given to the protection of aeronautical safety-of-life services that are being considered for this band.

In summary, ICAO considers WRC-07 to be an important opportunity to increase the spectrum for air-ground communications and secure the protection of aeronautical radionavigation bands. Moreover, the organization looks forward to a review of the allocations for aeronautical satellite communications in 2011.

ICAO policy statements on radio-frequency issues important to international civil aviation, as well as a description of the use of spectrum by aviation, can be found in the ICAO "Handbook on radio-frequency spectrum requirements for civil aviation", Fourth Edition (2007). Information on ICAO activities related to the use of the radio-frequency spectrum is available at www.icao.int/anb/panels/acp (under "Working Group F").

Broadcasters face growing complexity

Sharad Sadhu, Head of Transmission Technology and Spectrum, Asia-Pacific Broadcasting Union (ABU)*

Sharad Sadhu, ABU

ABU Preparatory Seminar on WRC-07, Kuala Lumpur (Malaysia), June 2007

The number and complexity of issues that affect broadcasting services' use of the radio-frequency spectrum have been growing in recent world radiocommunication conferences (WRC). At world administrative radio conferences (WARC) of the 1980s and 1990s, the broadcasting community had to deal with just one or two basic spectrum matters. For example, WARC-85 and WARC-88 addressed the broadcasting satellite service (BSS), while the WRC of 1995 and 1997 dealt with shortwave radio and revision of the BSS Plan.

With WRC-2000, there was a paradigm shift as several agenda items had a potential impact on the spectrum used or planned for broadcasting services, including an omnibus item on IMT-2000 involving several critical broadcasting bands. WRC-03 continued this trend.

As David Astley, Secretary-General of the Asia-Pacific Broadcasting Union, said at the ABU Preparatory Seminar on WRC-07 in June in Kuala Lumpur, Malaysia: "Broadcasting services have multiplied, both in sheer numbers and in genres. However, the requirements of other spectrum users, such as mobile phone providers and broadband wireless access providers, have considerably increased the pressure on the available spectrum resources. It is no coincidence that most often the piece of spectrum preferred by such services overlaps or lies close to the broadcasting bands."

At WRC-07, besides the shortwave broadcasting allocation issue, there are eight items which address sharing of broadcasting spectrum by a host of other services, ranging from IMT-Advanced, to High Altitude Platform Stations or HAPS, and radio astronomy. This reflects the range of expertise now required of broadcasters in preparing for world radiocommunication conferences.

HFBC allocation — a rough road ahead

Allocation of spectrum for the high-frequency broadcasting service (HFBC), an issue that has been carried forward from WRC-03, seeks additional spectrum for shortwave radio services, from as little as 300–800 kHz. Presenting strong evidence based on monitored data from the three regional coordination groups — the High-Frequency Coordination Conference (HFCC), the Arab States Broadcasting Union (ASBU), and the Asia-Pacific Broadcasting Union

* *This article does not necessarily reflect the views of ABU on all the issues raised.*

Broadcasters face growing complexity

High-Frequency Coordination Group (ABU-HFC) — broadcasters say they are unable to find clear frequency channels for a large number of their services. Hence, the radio transmissions overlap each other, resulting in unintelligible quality and grossly inadequate returns on resources invested in such services. A recent ABU study, for example, estimated that the money spent on such radio transmissions by a sample of broadcasters in 22 countries amounted to some USD 164 million in 2005.

While most countries in Europe are strongly in favour of the allocation, countries in the Asia-Pacific and Americas have adopted a cautious approach, mainly to safeguard the interests of the fixed and mobile communication sector. Understandably, international broadcasting industry organizations, such as the ABU, are in solid support. As a way forward, a compromise proposal was mooted recently. It aims to have an HFBC allocation made to the broadcasting service at WRC-07, and to postpone usage regulations to a subsequent conference.

It is amazing that such a small amount of spectrum is causing so much debate and giving rise to highly polarised positions, while extensive studies have failed to lead to any consensus. This seemingly straightforward matter has become entangled with the most complex issue of the conference; the review of 4–10 MHz spectrum. Interestingly, radio amateurs have taken this opportunity to seek additional allocations in a couple of bands, including the highly congested 7 MHz band.

Worldwide call to protect television broadcasting

Another crucial item at WRC-07 is protection of television broadcasting in the 620–790 MHz band from the proposed highly elliptical orbit broadcasting-satellite service (HEO-BSS). As the Asia-Pacific has a particular interest in broadcasting-satellite services, broadcasters in the region initially considered adopting a balanced approach to facilitate operation of HEO-BSS while providing full protection to terrestrial television services. However, the situation changed when it became known that a number of HEO-BSS systems had been filed in this band in the last four years. Additionally, many concerns remain about the efficacy of suggested measures to protect television broadcasting. The broadcasters have, therefore, decided not to support introduction of any new HEOs, while asking for measures to effectively protect television broadcasting in this band.

A similar position has been taken by many countries in the Asia-Pacific Telecommunity (APT), the Inter-American Telecommunication Commission (CITEL), and the Regional Commonwealth in the Field of Communications (RCC). The European Conference of Postal and Telecommunications Administrations (CEPT) concurs, as it is keen to protect the Geneva-06 digital broadcasting plan. This means that most of the world has a common position on the issue.

470–960 MHz: why broadcasters are worried

If there is one piece of spectrum that broadcasters want left alone, it is the 470–960 MHz band, at least its most operative part. It is a particularly vulnerable piece of spectrum for broadcasters, as it is widely used for television, an industry that involves several hundred billion dollars, perhaps much more. It is, therefore, essential to ensure that no harmful interference is caused to television services. This band is also subject to the Geneva-06 Agreement in more than a hundred countries, a plan that needs to be protected.

Because of superior propagation characteristics offered by this band, many services eye it all the time for new applications. At WRC-07, two agenda items deal with this piece of spectrum directly. Previously, it was the subject of a major allocation exercise at WRC-2000, and already, several prospective agenda items are being floated for WRC-11. Thus, broadcasting interests are hard pressed to defend against repeated incursions into this band.

WRC-07 also aims to identify spectrum for IMT-Advanced communication systems and 470–806/862 MHz is a candidate band. However, at present there appears to be no support for any fresh allocations in this range to IMT-Advanced or generic "IMT" in most of the world, including in the APT, CEPT, RCC and CITEL regional groups.

But WRC-11 is another matter. The CEPT countries are proposing that WRC-11 identify some part of the 470–862 MHz spectrum for IMT in Region 1 (Africa and Europe), citing the transition from analogue to digital television as a driver for this. Some APT countries are also mooting a similar proposal.

The broadcasting industry will face immense problems, maybe total loss of its satellite service, if IMT services are permitted in the 3.4–4.2 GHz band. There appear to be no sharing options left. In high rain intensity countries, this band is widely used by satellite operators for highly reliable television distribution and other services. In the APT, RCC and CITEL groups, there is no support for any allocation to IMT in this band. However, the CEPT group supports part of this spectrum being allocated to IMT.

A companion item on the WRC-07 agenda aims to use 2 500–2 690 MHz spectrum for terrestrial services such as IMT, through sharing with satellite services, such as BSS-TV, that are intended for community television reception. This is expected to significantly constrain implementation of new satellite services, including BSS. Region 3 (Asia and Australasia) is the only one where satellite systems are deployed and operate successfully in this band. These include India's GSAT and INSAT; Indonesia's INDOSTAR, and Japan's N-Star, ETS, and MBSAT which Japan jointly owns with the Republic of Korea.

Other issues that affect broadcasting

Reflecting the growing complexity of conference issues for broadcasters, several agenda items either imply sharing broadcasting spectrum or restricting broadcasting services. For example, it is proposed that the 18 GHz band be shared with MetSat services, and the 10.6–10.68 GHz band with the Earth exploration satellite service (passive),

Samsung

Handset for receiving multimedia programming broadcasts via satellite

Sergio Savarese

Philips

and radio astronomy and space research (passive) services. However, this would affect BSS feeder-links and electronic news gathering (ENG) and electronic field production (EFP) systems.

Spectrum sharing is also implied with HAPS in the 27.5–28.35 GHz, 47.2–47.5 GHz and 47.9–48.2 GHz bands (a portion of these bands is for feeder-links to BSS), and power-flux density limits are to be established for highly inclined orbit (HIO) satellites for spectrum sharing in the band 17.7–19.7 GHz. This may affect the operation and location of the 12 GHz BSS feeder-links which share a part of this band. In addition, broadcasting bands of 21.4–22.0 GHz and 620–790 MHz will be involved in discussions pertaining to protection of the radio astronomy service.

New items for WRC-11

The gathering momentum on two new agenda items for WRC-11 is a positive development. Originally mooted by the broadcasters, these address spectrum harmonization and identification for ENG-EFP television and radio links, and spectrum usage of 21.4–22 GHz BSS-TV band.

Television has emerged as the primary delivery method of live news coverage, including events affecting public safety. Audiences have increased considerably since spectrum was allocated for ENG and all services ancillary to broadcasting, while the growth in spectrum usage for mobile, satellite and other applications makes it hard to meet ENG demand. Broadcasters hope that WRC-11 will establish viable worldwide and regional harmonization of spectrum usage for ENG links.

ITU has asked all countries to ensure flexibility in the use of the 21 GHz BSS bands. To achieve this, methods need to be developed that avoid rigid allotment structures and that safeguard the interests of all countries. Studies in ITU's Radiocommunication Sector have already established basic operating parameters of BSS systems in this band. It is proposed that WRC-11 should decide an appropriate spectrum usage methodology for BSS in the 21.4–22 GHz band and associated feeder link bands in Regions 1 and 3.

Both these agenda items have received support in the APT group. The RCC group supports an agenda item on the 21.4–22 GHz issue. Indications are that CEPT may not support the BSS agenda item, if rigid planning procedures are involved.

Careful planning needed

Recognizing that continued growth in the radiocommunication industry depends on adequate spectrum, future use of this resource must be planned carefully. Speaking at the ABU Seminar in June, the Chairman of the Malaysian Communications and Multimedia Commission, Dr Datuk Halim Shafie, put it aptly: "As services and market demand develop, it will become a necessity for regulators to move along with the market emphasis on new and expanding services, such as mobile and high-definition television, while balancing the need to fuel economic and social goals."

Amateur radio

Dr Larry Price, President of the International Amateur Radio Union (IARU)

A worldwide community

Thousands of telecommunication professionals trace the beginnings of their careers to the exploration of the radio spectrum that was made possible by their early involvement in amateur radio. Many continue to pursue their passion for radio communication as a hobby, as well as a vocation. The amateur radio service and the related amateur-satellite service (collectively called the "amateur services") are unique, in that they are defined in the Radio Regulations as being open to those whose interest in radio is "solely with a personal aim and without pecuniary interest."

The operational and technical standards of the amateur services are as high as any other radiocommunication service. A total of some three million individuals in nearly every country of the world, from the very young to the very old, have demonstrated their qualifications and have been issued amateur radio licences by their administrations. These individuals constitute the global amateur radio community. They have formed radio clubs at the local level, and technical educational organizations at the national level, for the purpose of increasing the understanding of telecommunication technology and extending the benefits of radio communication to the wider community.

Participating in ITU

In ITU, the amateur radio community is represented by the International Amateur Radio Union (IARU), a worldwide federation of national societies in 159 countries and territories. The IARU is an active Sector Member of the ITU Radiocommunication Sector (ITU–R) and Telecommunication Development Sector (ITU–D), and is a regular participant in world radiocommunication conferences (WRC).

The "self-training, intercommunication and technical investigations" that constitute the defined purposes of the amateur services are made possible by providing access to the radio spectrum by means of allocations of frequency bands. The principal objective of the amateur radio community at any WRC is to preserve this access to spectrum.

At the present time, allocations to the amateur service begin in the vicinity of 1.8 MHz (in the case of the amateur-satellite service, at 7 MHz) and appear at intervals throughout the Radio Regulations' "Table of Frequency Allocations" up to 250 GHz. Use of these bands is managed through a combination of national regulations by telecommunication administrations and through self-management by the amateur radio community itself.

Dr Larry Price, IARU

Some 3 million people, from the very young to the very old, have gained amateur radio licences. The boys from left are Esko Mattila and Tarmo Wahlstrom from Finland

An early interest in amateur radio can lead to an exciting career. For Dr Joseph H. Taylor, Jr., it led to the 1993 Nobel Prize in Physics for the discovery of binary pulsars

IARU Secretary David Sumner has observed that "the specific service rules for the amateur and amateur-satellite services, Article 25, were reviewed and modified at WRC-03. These modifications increased the emphasis on the use of amateur stations in providing communications in support of disaster relief and eliminated a long-standing requirement that amateur operators using frequencies below 30 MHz must demonstrate ability in Morse code. As a result, since 2003 the number of amateur stations equipped to operate below 30 MHz has risen sharply."

Items at WRC-07

While most of the agenda items under consideration at WRC-07 do not directly affect the amateur and amateur-satellite services, there are four that are of particular interest to radio amateurs:

Harmonization of frequency allocations

As befits radio services that are global in scope, most of the frequency allocations to the amateur services are on a worldwide basis, with a few regional variations. Some country footnotes provide for alternative or additional allocations in some of these frequency bands. The amateur radio community seeks increased harmonization of frequency allocations, through the reduction and avoidance of country footnotes that reduce the availability of bands that are allocated internationally to radio amateurs.

Maintaining and extending allocations

WRC-07 will review the allocations to all services in the high frequency (HF) bands between 4 and 10 MHz, with certain bands excepted. At present, the only allocation to the amateur service in this frequency range is at 7 MHz. WRC-03 expanded the amateur allocation in Regions 1 (Africa and Europe) and 3 (Asia and Australasia) from 7 000–7 100 kHz to 7 000–7 200 kHz, effective in March 2009, and maintained the allocation of 7 000–7 300 kHz in Region 2 (the Americas). The band 7 000–7 200 kHz is excluded from consideration at WRC-07.

To fulfill a longstanding requirement that was only partially met at WRC-03, the amateur service seeks to maintain its allocation of 7 200–7 300 kHz in Region 2 and to extend this allocation to Regions 1 and 3, as outlined in the Report of the Conference Preparatory Meeting (CPM) for WRC-07.

With only one allocated frequency band between 4 and 10 MHz, stations in the amateur service are unable to be as flexible as those in other HF services in adjusting their operating frequency to suit varying propagation conditions. To improve the reliability of communication at any time of day and to facilitate the role of the amateur service in support of disaster mitigation and relief, a worldwide secondary allocation of 150 kHz is sought in the frequency range just above 5 MHz, as proposed in the CPM Report for WRC-07.

Modern amateur radio equipment is very compact and integrates easily with computers

Amateur radio offers young people opportunities to gain hands-on experience with telecommunications technology. The girls from left are Fanny Winstén and Cecilia Ekholm from Finland

Secondary allocation in the low-frequency range

A more straightforward issue is the conference's consideration of a secondary allocation to the amateur service in the frequency band 135.7–137.8 kHz. At present, the amateur service has no frequency allocations lower than about 1.8 MHz. While the radiation efficiency of practical antennas has limited the effectiveness of communications at this order of frequency, digital processing now makes it possible to recover weak signals that previously would have been obscured by atmospheric noise. This opens a window of opportunity for amateurs to conduct technical investigations in the low-frequency range.

More than 20 administrations have permitted private individuals, virtually all of them licensed radio amateurs, to experiment with transmission and reception on various frequencies between 73 kHz and 200 kHz. A regulation from the European Conference of Postal and Telecommunications Administrations (CEPT) on the use of the band 135.7–137.8 kHz by the amateur service has been implemented in 15 European administrations. An international allocation will harmonize these national arrangements, and a secondary allocation will provide regulatory protection for the primary services.

Proposals for the WRC in 2011

The amateur radio community wishes to see the following issues considered for inclusion on the agenda of WRC-11:

- an allocation to the amateur service in the range 50–54 MHz in Region 1, in order to harmonize this allocation among the three Regions;
- allocation of the band 495–510 kHz to the amateur service on a secondary or primary basis;permitting the development of reliable groundwave systems for disaster relief and providing spectrum for digital signal processing experimentation;
- continued access for amateurs to frequencies at regular intervals above 275 GHz as allocations and protections for other services. (One option is to provide specific allocations to the amateur services of relatively narrow, primary bands adjacent to wider, secondary bands);
- in any review of HF allocations, consideration of the expansion of the amateur bands near 10, 14 and 18 MHz, in order to better accommodate increased activity.

As always, several observers will be present at WRC-07 on behalf of the IARU. During the conference, members of the IARU team will be pleased to answer questions and provide information about the amateur services.

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Space science issues

Vincent Meens, Head, Frequency Bureau, National Centre for Space Studies (CNES), France

ITU

Vincent Meens, CNES

The study of space beyond the realm of Earth might seem to have little connection with our daily preoccupations. But in fact, space science is important in our everyday lives. Without its help, the essential services of weather mapping and forecasting, for instance, could not have reached their degree of reliability. In this period of great meteorological disturbances, space science also plays a major role in the prediction and detection of natural disasters.

The World Radiocommunication Conference 2007 (WRC-2007) will address several topics related to space science issues. Four agenda items focus directly on frequency bands used by the space science community. These are the use of active and passive sensors, meteorological-satellite services, and radio astronomy.

Monitoring Earth — and beyond

Active sensors are mainly radar systems transmitting from orbiting satellites; however, unlike their terrestrial counterparts, they are not aimed at detecting targets or flying aircraft. Their purpose is to analyse the reflection of a radar signal sent to the surface of the Earth. Depending on the frequency band, the nature of the signal or the type of antenna, the reflecting signal will give information on the altitude of the Earth's surface, the nature of cloud cover or ice sheets, for example, or may even be used to create imagery. This information has tremendous potential for monitoring our planet and has a direct application to our knowledge of geological and meteorological processes.

The European Space Agency plans a Soil Moisture and Ocean Salinity (SMOS) mission to collect data via a satellite due for launch in 2008

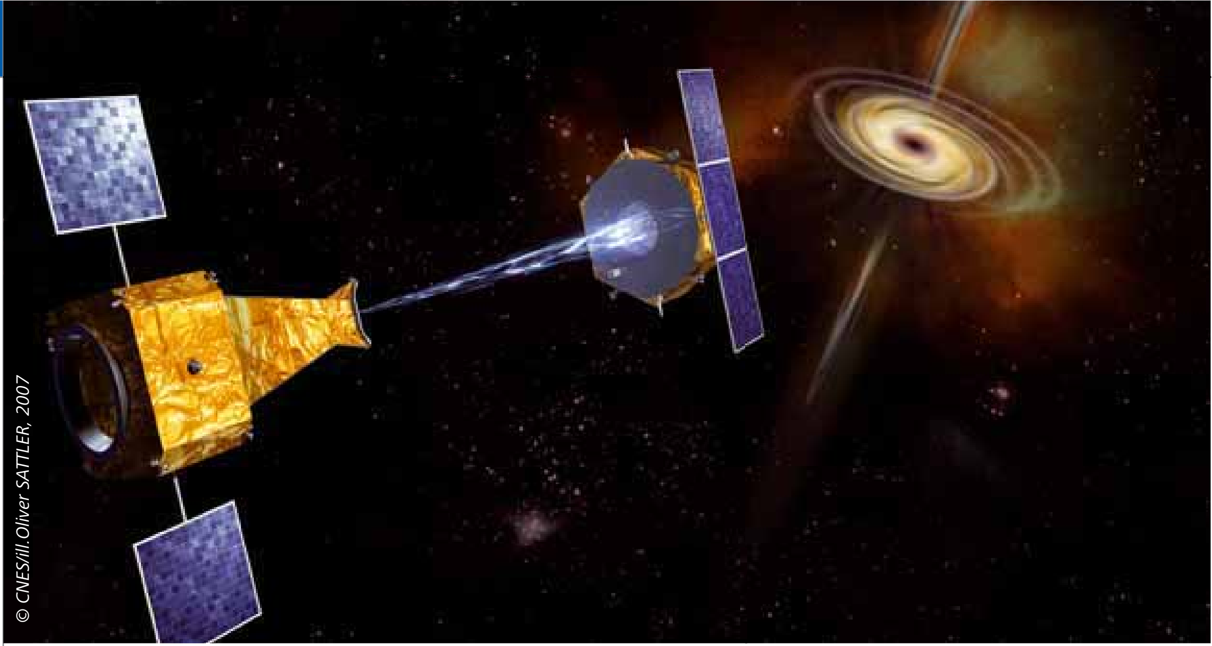
WRC-07 will consider whether to increase the bandwidth for Earth-exploration satellite and space research services around the band 9 500–9 800 MHz. A larger bandwidth would mainly be used by synthetic aperture radar to create high-resolution imagery. This would give a level of detail comparable to satellite photography, with the possibility of "seeing" through clouds or during the night. The use of a larger bandwidth also has a direct application in space research, allowing planets and their moons to be mapped even though they lie beneath a heavy cloud system, such as Venus or Titan. Extending the frequency band will also mean protecting the existing services. In the band below 9 500 MHz, current services are no different from the ones used in the present operating band and it is expected that sharing will not create difficulties.

Less noise means better predictions

All celestial bodies transmit radio waves, as do chemical elements in the Earth's atmosphere. The level of the radio signal is weak in the case of the atmosphere, and, although starting out strong, the signal from a celestial body is weak after crossing very long distances through space. Passive sensors on board satellites are used to measure natural radiation from the Earth's atmosphere, while radio-astronomy telescopes measure the signals coming from distant stars, galaxies or stellar gas clouds. Both technologies are confronted with the same difficulty: interference from man-made radio emissions.

In passive sensing, the sensor measures the radiation emitted by constituents of the Earth's atmosphere or oceans. Additional, man-made signals are seen as noise and cannot be differentiated easily from natural emissions. Only when interference repeatedly occurs over very specific areas can we be sure that we are confronted with man-made interference; in all other cases, interference adds errors to the measured frequencies. Wrong data injected into models of the atmosphere, or ocean currents, have an adverse effect on the validity of weather forecasts.

WRC-07 will consider studies that have been performed on the protection of passive bands from man-made radio emissions. In two bands shared with active services (10 and 36 GHz), these studies have shown that applying constraints on terrestrial transmitters, such as power limits and elevation angles, can satisfactorily allow sharing on an equitable burden basis between the two services. In other bands where an exclusive allocation exists for passive sensors, interference comes from unwanted emissions from man-made emitters in nearby or adjacent bands and falling within the passive sensor bands. Studies concerning the bands 1.4, 24, 31 and 50 GHz have shown that unwanted emission limits could be applied to active services, so as to ensure that the level of man-made emissions within the bands used by passive sensors remains acceptable.



A joint French-Italian project is producing Simbol-X, a telescope to observe X-ray radiation from black holes and other objects. The necessary long focal length is formed by two satellites flying in formation, giving more precise readings than ever before

It will be up to the conference to decide whether these limits can be included in the Radio Regulations. The use of passive sensors is extremely important for weather and disaster prediction, not only short-term, but also over the long term. A better knowledge of the Earth's atmosphere and ocean water circulation is the key to better understanding the climatic changes we are witnessing. The protection and the availability of several passive bands to differentiate between all constituents of the atmosphere is essential.

Radio astronomy — the big picture

Many passive and radio-astronomy bands are exclusive to these applications; however, some are shared with terrestrial and active space services. In the case of radio astronomy, a variety of techniques (such as filtering, power limits or exclusion zones) may be used to avoid excess interference from terrestrial systems. However, for interference originating from satellites, in particular non-geostationary satellites, sharing is more difficult and requires a complete analysis of the behaviour of the satellite constellation. WRC-07 will consider the compatibility of radio astronomy with active space services, while reviewing threshold levels that are used in the consultation process.

The consultation process was adopted during the 2003 World Radiocommunication Conference to help administrations reach mutually acceptable solutions when unwanted emissions from active space services fall within radio-astronomy bands. A consultation process can be initiated if unwanted emissions from a new system exceeds the previously agreed threshold.

Radio astronomy is a very important tool to help us better understand the evolution of our universe. By looking at very distant objects of various sizes we can comprehend the life and death processes of multiple stars or galaxies. Not only is this important for the advancement of humanity's knowledge of the universe, but it also provides information on the future of our own solar system.

Space science issues will be an important part of the discussions during WRC-07. Establishing rules that satisfy both the telecommunication and the science communities will ensure the continued availability of scientific knowledge and better comprehension of climatic changes. This is critically important for our day-to-day life, and for the future of everyone on Earth.

Radio telescopes track and collect data from satellites, as well as astronomical radio sources

Improving the Fixed-Satellite Service Plan

Kavouss Arasteh, Space Communication Expert

Satellites are used extensively nowadays for television, radio, telephony, and data communication networks. Most of the applications of satellite communications belong to the fixed-satellite service, or FSS, where a satellite relays communications between Earth stations at fixed positions.

At the World Administrative Radio Conference in 1979 (WARC-79), it was decided that a plan should be made for allocating radio-frequency bands to the fixed-satellite service. These bands are: 4.5–4.8 GHz (space-to-Earth) and 6 725–7 025 MHz (Earth-to-space), 10.7–10.95 GHz (space-to-Earth), 11.20–11.45 GHz (space-to-Earth) and 12.75–13.25 GHz (Earth-to-space). Responding to this decision, the World Administrative Radio Conference on the use of the geostationary satellite orbit in 1985 (WARC-ORB–85) established the principles, criteria, parameters and method for the plan. This led to the development and adoption of the FSS Plan in 1988. It is contained in Appendix 30B of the Radio Regulations and has been in force since 1990.

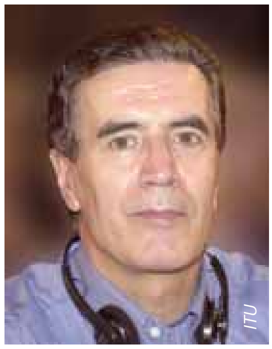
After 17 years of application, the FSS Plan still shows some shortcomings with regard to regulatory procedures. Moreover, the technical parameters on which the FSS Plan was established in 1988 are obsolete in some areas, have been drastically improved in others, and thus need to be updated.

To remedy this situation, the World Radiocommunication Conference in 2003 (WRC-03) tasked WRC-07 "to review the regulatory procedures and associated technical criteria of Appendix 30B without any action on the allotments, the existing systems or the assignments in the List of Appendix 30B".

Details of the FSS Plan

The World Administrative Radio Conference of 1977 planned the broadcasting-satellite service (BSS) downlink for Regions 1 (Africa and Europe) and 3 (Asia and Australasia). And in 1983, a similar conference planned the BSS downlink and feeder link for Region 2 (the Americas). A method known as *a priori* planning was applied to the broadcasting-satellite service. This approach establishes a plan in advance of service operation for a specific service type. The BSS *a priori* plans were established by these two conferences, recognizing the technologies that were considered feasible at that time.

Based on the experience gained from BSS planning, administrations were not in favour of establishing an *a priori* frequency assignment plan for FSS, because of its perceived lack of flexibility to respond to technological developments and to the needs of the ITU membership. WARC-ORB-85 thus



Kavouss Arasteh,
Space Communication Expert


Jenny W. Emsago

decided to use allotment planning, an approach which provides some degree of flexibility, a feature considered necessary if the fixed-satellite service is not to be constrained in terms of future applications.

WARC-ORB-85 also envisaged that every ITU Member State would be given a national allotment of 800 MHz (300 MHz in the 4/6 GHz band and 500 MHz in the 10–11/13 GHz band) with one or several orbital positions. The allotment was to be based on the size and conditions of each Member State, and associated with ±20° of the orbital arc (pre-determined arc, or PDA) at the pre-design stage, ±10° of the orbital arc at the design stage and 0° of the orbital arc at the operational stage. The definitions of these three stages were determined in the output document of WARC-ORB-85.

The Allotment Plan and the regulatory procedures with which the plan was associated were drawn up by WARC-ORB-88. This plan consists of Part A, on the allotment of frequencies, and Part B, on the networks of "existing systems". Both the plan and the List of Assignments are contained in Appendix 30B of the Radio Regulations and entered into force on 16 March 1990. (The "existing systems" may continue to operate until 16 March 2010.)

In order to satisfy the requirement of each ITU Member State, the antenna diameters were chosen to be seven and three metres for the 4/6 GHz band and the 10–11/13 GHz bands, respectively. Most allotments have interference limits that meet the criteria established by WARC-ORB-88.

The plan allows administrations to establish a more economically viable service by pooling their resources and establishing sub-regional systems, preferably using the orbital position of one of the participating members. This implies that other members' national allotments would be suspended during the operational lifetime of the sub-regional system.

Currently, however, all applications submitted to ITU's Radiocommunication Bureau (BR) for the modification of the plan use orbital positions other than those planned for the Member States participating in a sub-regional system. This means that it has not been necessary to suspend the national allotment of the participating members in a sub-regional system.

Appendix 30B also contains provisions for the establishment, under certain conditions, of additional use other than the initial allotment as contained in Part A of the plan. However, the service area of the additional use must be limited to the national territory of the notifying administration, unless otherwise agreed by the administrations concerned. Also, the lifetime of the additional use is limited to 15 years from the submission date, and it cannot use the concept of PDA to resolve incompatibility.

Problems in practice

At WRC-03, a group of European countries argued that: "A number of difficulties have been raised by administrations in applying the procedures currently contained in Appendix 30B [of the Radio Regulations], some of these procedures being not fully transparent vis-à-vis administrations. Moreover, a considerable amount of Rules of Procedure has been developed to overcome the deficiencies and/or ambiguities of the current procedures. The technical criteria have been established in the light of the existing technology in the mid-1980s and need to be reviewed in the light of the technology available nowadays. There is therefore a need to improve the technical and regulatory efficiency of Appendix 30B, as well as its usability."

Based on this argument, European countries proposed an agenda item for WRC-07 to discuss this issue (agenda item 1.10). Its main objectives are:

- to update the technical parameters to be used in applying provisions of the plan for forming sub-regional groups and for additional use (Articles 6 and 7 of Appendix 30B); and
- to resolve the difficulties and deficiencies that administrations and BR face when applying the procedures of Appendix 30B (the FSS Plan).

There is no doubt that the technical elements of the plan, which are based on the technologies of 1980–1985, need to be fully revisited and modernized. A similar course of action was

Miranda Technologies

taken with respect to the BSS Plan for Regions 1 and 3, which was partially revised at WRC 97 and fully revised at WRC-2000.

However, the second set of problems is more complex, and three approaches to solving them have emerged. These are sequential processing and non-sequential processing of submissions, described in the Report of the Conference Preparatory Meeting for WRC-07, or a hybrid of the two.

Sequential processing of submissions (Approach 1)

The current procedures of Appendix 30B of the Radio Regulations are based on sequential processing of administrations' submissions for access to the geostationary-satellite orbit in the FSS frequency bands. This means that submissions are examined in order of receipt by BR. Then, BR either registers the submission in the "List of Assignments", or returns it to the notifying administration and gives time (currently 30 days) for the administration to obtain compatibility with the FSS Plan and the list.

One of the main difficulties of sequential processing is that BR cannot begin examination of the second submission until the expiry of either the 30-day "adjustment period", or both the "adjustment period" and the "commenting period". This has limited the processing rate of submissions to an average of 12 per year.

Non sequential processing of submissions (Approach 2)

Under this approach, submissions by administrations are also examined in order of receipt by BR, which determines the coordination requirements and publishes them in a Special Section of its fortnightly Circular (BRIFIC). Then, without waiting for the results of the coordination, BR starts examining the second submission. The notifying administration has until the end of the submission's regulatory period (eight years) to complete bilateral coordination with all identified administrations, or to modify its technical parameters so that other administrations are unaffected.

A major difficulty of one of the alternatives currently under consideration in non-sequential processing is that only the effect of the single entry interference is taken into account and the cumulative effect of the aggregate interference is not considered at all. In the second alternative, while the effects of both single entry and aggregate interference are taken into account, a tolerance of exceeding interference is also allowed which does not exist in the current plan. There is also an inconsistency between the initially calculated levels of incompatibility and the final ones. This is due to the processing of submissions in two steps on different dates.

Combined sequential and Non Sequential /Hybrid Approach (Approach 3)

An initiative has been proposed that is mid-way between these two approaches. It is a hybrid that combines the sequential and non-sequential processing methods, and attempts to preserve the advantages of both while resolving the disadvantages. Its main elements and principles are as follows:

The predetermined arc concept

The PDA concept is maintained, to a great extent, in conjunction with the concept of the coordination arc, with some limitations.

The coordination arc concept

The use of this concept reduced unnecessary coordination requirements outside a particular arc (±9° or ±10°, according to the frequency bands). The hybrid approach proposes the use of a common coordination arc of ±10° for both the 13/10–11 GHz and the 6/4 GHz bands. However, for creating "packets" (see below) for submissions of orbital positions which are back-to-back (0° separation), or close to each other (less than 10° separation), a separation of ±20° has been proposed. This will provide more flexibility to displace the submissions' orbital position as well as the allotments' orbital positions during the 30-day adjustment period.


ESA

Creation of packets

Consecutive submissions from different administrations, which are not part of a "multiple submission" from the same administration, and the orbital positions of which are more than ±20° apart, will be contained in a single packet and processed in a non-sequential manner.

Other submissions will either be included in different packets, or will be considered as stand-alone submissions. These, along with submissions received from new Member States will be processed in a sequential manner.

Speeding up the process

WRC-07 could be invited to adopt a resolution as an additional measure to increase the processing rate of submissions. Through such a resolution, administrations could be urged to review their submissions that are in the queue for processing, with a view to reducing the number of multiple submissions to the minimum necessary to satisfy their actual requirements. Their review should bear in mind the principle of efficient, economic and rational use of orbital and spectrum resources. This course of action has been taken before, and is expected to speed up things significantly if taken in the case of the FSS Plan. The overall processing time of a submission would fall from the current four to five years to about two years or less.

And with the use of a hybrid approach, the current long period of up to eight years to complete coordination under the non-sequential processing approach would be reduced to between 18–24 months. In other words, instead of waiting for up to eight years to finalize a given case, it would take less than 2 years.

Looking at the issues at WRC-07

Once the principles on which the initial FSS Plan was established have been discussed and confirmed, the conference needs to decide on a number of issues:

- Consider the basic issues of Appendix 30B of the Radio Regulations that are not associated with, or depend on, any of the three approaches outlined above.
- Consider the approaches submitted by administrations and select the most appropriate.

WRC-07 then needs to decide the appropriate regulatory procedures compatible with the selected approach. It also needs to decide on the technical parts of Appendix 30B and to finalize them.

Once these issues are resolved, the allotments of all ITU Member States (including those stemming from new geographical situations) could be recalculated, based on the new parameters. Administrations will then be in a position to convert their allotments in the FSS Plan into assignments in an appropriate and consistent manner.

Spectrum management and communications in disaster relief

Bruce Emirali, Radio Frequency Manager, Directorate of CIS Strategy, New Zealand

Bruce Emirali, Directorate of CIS Strategy, New Zealand

We have already seen a number of natural disasters in 2007, ranging from floods in Africa to major earthquakes in Peru and Indonesia, typhoons in East Asia and hurricanes in the Caribbean. These events grab the media headlines, dominate the international news and capture the attention of the public.

Large-scale catastrophes create human misery, confusion, chaos and widespread economic harm. They happen all too often and they can happen at any time. When disasters occur it is of critical importance that first responders, from both local and international relief agencies, are on the ground and operational in the disaster area as quickly as possible. Speed of effective response is vital in minimizing the human misery and turmoil that always accompany these events.

The importance of coordination

Communications technology has a vital role in ensuring that relief teams can go about their activities as effectively as possible for the benefit of disaster victims. In particular, these teams are heavily reliant on radiocommunication systems. However, getting the best out of high technology-based systems and infrastructure requires national, regional and international cooperation.

Responses to large-scale events are likely to involve a large number of relief agencies and relief teams, both national and international, from which arises the critical requirement for interoperability and cooperation, including frequency coordination of radiocommunication systems. In many cases, due to the severity of a disaster and its impact on the local infrastructure, international relief agencies will generally be forced to rely on radiocommunication systems that they bring with them, in order for them to meet the immediate needs of victims.

Relief teams coming into a disaster area not only need reliable communications for their own activities to be effective, but also often require the capability of working with personnel from other teams. Harmonized frequency use has been seen as one approach that leads to improved interoperability.

Spectrum management is key

Without proper spectrum management, it is difficult for any organization to use its radio equipment to provide support critical to life, without interfering with local users and any other organization already deployed in the devastated area.

It is vital that people at risk receive disaster alerts as fast as possible

Although the critical importance of telecommunications in support of relief operations is well recognized by the United Nations and its Member States, work still needs to be done to ensure reliable communications in support of disaster relief operations. In particular, methods to achieve improved communications within the first 48 hours of a major disaster need urgent attention.

Much work has been carried out by the United Nations and by many countries on improving early warning systems, such as for tsunami. While these improvements help to reduce the loss of lives when a disaster strikes, they do not prevent the destruction of local infrastructure and the humanitarian impact that results from this.

The immediate requirement for relief operations following disasters generates high demand for reliable communications, which in turn need effective spectrum coordination. The challenge in recent times for ITU, and in particular for world radiocommunication conferences (WRC), has been to put in place regulatory provisions, supported by relevant technical studies, that provide the framework within which the radiocommunication needs of public protection and disaster relief agencies can be satisfied. Following the WRC in 2003, it was strongly recommended that administrations use regionally harmonized radio-frequency bands for public protection and disaster relief to the maximum extent possible, in order to facilitate interoperability between relief agencies.

Response of ITU

ITU's Radiocommunication Sector (ITU–R), Telecommunication Standardization Sector (ITU–T) and Telecommunication Development Sector (ITU–D) have all worked on disaster communications and their list of accomplishments speaks for itself. These are just a few of them:

- Handbook on Emergency Telecommunications (ITU–D)
- Follow-up to the Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations;
- Establishment of a Partnership Coordination Panel on Telecommunications for Disaster Relief (ITU–T)
- Q-Series Recommendations (ITU–T)
- ITU–R Special Supplement on Emergency and Disaster Relief
- Resolution 646 (WRC-03) and Recommendations on the global circulation of equipment (ITU–R M.1637, ITU–R M.1579);
- Recommendation ITU–R M.2033 on the needs of future systems for Public Protection and Disaster Relief (PPDR), and Recommendation ITU–R M.1042-2 on disaster communications in the amateur and amateur-satellite services.

In addition, the United Nations Working Group on Emergency Telecommunications (WGET) of the Office for the Coordination of Humanitarian Affairs (OCHA) plays a key role in improving the coordination of emergency telecommunications in support of disaster relief operations. WGET assists in applying the ITU Resolutions and Recommendations related to telecommunications for disaster relief, and is an active facilitator of the promotion and implementation of the Tampere Convention.

Lessons of the tsunami

The tsunami that hit South-East Asia on 26 December 2004 brought into sharp focus the significance of the work of ITU. It also highlighted some deficiencies in the area of communications support, especially in the initial stages of the relief operations.

The follow-up work after the tsunami resulted in a number of regional workshops being held, to share experience and the lessons learnt from coping with the aftermath of this tragic event. Most workshops focused on disaster risk reduction and improving early warning systems. Associated with this was the recognition of the need to enhance communication systems that disseminate early warning information, and to improve the methods used to get this information as quickly as possible to people at risk. However, many of the national debriefing sessions conducted by the operational agencies also highlighted a number of issues related to radio-frequency spectrum in the provision of communications to support disaster relief teams.

In examining communication operations after the tsunami in 2004, a number of issues emerged. Although the United Nations established communication networks, these took some time to set up after the tsunami struck. The first 48 hours were critical and considerable communication difficulties were experienced as many international agencies and national teams converged on the area to offer much-needed relief and assistance. The lack, or perceived lack, of a lead agency in planning and implementing spectrum use for communications became clear as various safety-of-life and air traffic communications experienced unavoidable interference. This in turn caused delays in delivering the humanitarian aid that the survivors of the tsunami desperately and urgently required.

An initiative by government agencies from Australia, Canada, New Zealand, the United Kingdom and the United States resulted in a discussion paper on this topic being introduced at a meeting chaired by OCHA in May 2007. The meeting concluded that the development of standard operating procedures for spectrum management in the event of disasters would further improve communications, and hence improve coordination amongst humanitarian agencies that are part of the initial response teams.

It was also considered that the Director of ITU's Radiocommunication Bureau could assist Member States with their preparedness for emergency communications. One such activity would be to identify available frequencies for use in emergencies, for inclusion in a database to be developed and maintained by the Bureau. These considerations are currently being studied and are expected to result in concrete actions to be undertaken by ITU and OCHA.

The occurrence of disasters cannot be prevented, but their impact can be reduced by preparing appropriate advance operational plans, establishing warning systems, training emergency response personnel, educating citizens about potential dangers and risks, and testing emergency procedures.


NOAA

Data transmitted via satellite from an ocean buoy can give warnings of tsunami disasters


David Rydevik

Breaking news can be reported live through electronic news gathering

Radio microphones: an important part of electronic news gathering

Roger Bunch, ITU–R Rapporteur for ENG

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When watching news programmes on television, or listening on the radio, we seldom think about the equipment being used. But without modern wireless microphones — more commonly known as radio microphones — reporters would find their work much more difficult. Use of these microphones is steadily raising demand for radio-frequency spectrum, and this issue will be discussed at the World Radiocommunication Conference 2007 (WRC-07).

Radio microphones first appeared in the early 1950s. They are becoming ubiquitous pieces of equipment used in services ancillary to programme-making (SAP) and services ancillary to broadcasting (SAB). SAP and SAB comprise the professional collection of video and/or audio material without the use of film or tape recorders. Instead, small, often handheld, electronic cameras are used, and/or microphones with radio links to the news room or to portable tape or other recorders. Television news providers use radio microphones to offer rapid coverage of developing stories through live and recorded news reports "from the scene". Radio microphones normally use wideband frequency modulation to achieve the necessary audio performance for professional use. For the majority of applications, the transmitted signal requires a channel bandwidth of up to 200 kHz.

It is estimated that the terrestrial SAP and SAB operators providing news coverage within a major conurbation with a high density of newsworthy events could require a total allocation of up to 30 wideband channels for radio microphones. Radio and television studio productions also use professional radio microphones. European studies show that currently, spectrum demand by studios might be as high as 15 wideband channels.

Theatres, concert halls and other venues of all sizes, both amateur and professional, use radio microphones too. The same European studies show that the peak spectrum demand for a single theatre production can be as high as 55 wideband channels.

Spectrum bands

The current recommended frequency ranges for professional radio microphones are the VHF and UHF television bands 174–216 MHz, 470–862 MHz, and 1 785–1 800 MHz. In these bands, radio microphone operations have been managed by using the so-called "white spaces" between the assigned television channels in any specific location.

The 174–216 MHz band (Television Band III) is identified by many administrations as a tuning range for radio microphones, where a large number are in operation. This band is also used by many administrations for terrestrial television and digital audio broadcasting transmissions, which places restrictions on the widespread use of radio microphones. In addition, some administrations are increasingly using the band for land mobile services and, as a result, do not allow radio microphones to use it too.

The 470–862 MHz band (Television Bands IV and V) is also identified as a tuning range for professional radio microphones by many administrations, and very few countries do not allow radio microphones in this band. There appears to be a high level of interest among manufacturers in exploiting the band 470–862 MHz for radio microphones. However, there needs to be further consideration of solutions for ensuring the continued coexistence of radio microphones with broadcasting after and during the move from analogue to digital television.

The band 1 785–1 800 MHz has been identified by some administrations as a candidate for harmonized allocation for future (digital) radio microphones. This band is positioned between GSM-1800 operating in the lower adjacent band, 1 710–1 785 MHz, and the terrestrial flight telecommunication systems (TFTS) allocation in the upper adjacent band at 1 800–1 805 MHz. Compatibility studies show that an upper and lower guard band is necessary in those countries using GSM-1800 and TFTS. The upper guard band is required to protect radio microphones from the airborne transmission leg of TFTS, and the lower guard band to protect GSM-1800 from radio microphones. These guard bands limit radio microphones to 1 785.7–1 799.4 MHz. However, this band still presents a challenge to manufacturers of professional radio microphones in designing and developing new equipment to the common harmonized standard.

Study Group 6 in ITU's Radiocommunication Sector (ITU–R) is looking at Question 121/6 on *Spectrum usage and user requirements for wireless microphones*. This study includes:

- operating characteristics for broadcast wireless microphone systems;
- optimum arrangements for frequency selection in wireless microphone systems for broadcast and non-broadcast applications;
- steps to be taken for frequency management;
- methods for frequency selectivity;


Bartlomiej Stroinski

Components of a radio microphone system

- transmission artifacts to be avoided;
- optimum bandwidth requirements, and
- unified standards.

Studies of digitization

A major trend which may affect changing demand for spectrum is the introduction of digital radio microphones. In many countries where radio microphones are deployed in densely populated areas, the number of channels has become insufficient. To solve this problem, standardization of the digital radio microphone is being discussed. Experimental systems have been developed and tested inside and outside studios.

There has been uncertainty with regard to the future prospects of digital technology for professional radio microphones. Of the few models produced and tested in ISM bands (2.4 GHz), all were found to be unsatisfactory for professional use because of audio delay and poor sound quality. It was not until recently that professional digital radio microphones were developed in the band 1 785–1 800 MHz and in the Television Bands IV and V.

Initial studies focused on the potential benefits of digital technology for radio microphone applications, expectations of current manufacturers, and comparisons of the expected spectral efficiency of digital versus conventional analogue radio microphones. It was estimated that the necessary spectral bandwidth of the digital radio microphones required a potential channel spacing of 500 kHz. While this is larger than the 200 kHz currently used by analogue equipment, studies indicated that adjacent channel operation of digital radio microphones might be feasible and so digital radio microphones might be more spectrum efficient.

Studies have also shown that the problem of noticeable audio delay resulting from digital signal processing is a major limiting factor in the adoption of digital radio microphones, particularly for use at live events. It has been found that the most important specification is keeping an optimized balance between the transmission delay and transmission bandwidth.

Recent studies in Japan have been conducted with the aim of increasing the efficiency of frequency usage, while maintaining sound quality. One of the intended applications of this type of wireless microphone is for the transmission of performances in theatres and concert halls.

Future spectrum demand

European studies suggest that predictions of future demand by SAP and SAB users depend heavily on the success of digital technology as a major means of sound and television electronic news gathering. If digital technology does not deliver the promised advantages, then there will only be modest growth over the next decade in spectrum demand for SAP and SAB operations. However, if digital technology does provide advantages of resilience, quality and ruggedness, then it could mean not only the replacement of analogue radio microphones with digital radio microphones, but also an overall boost to SAP and SAB coverage.

A report by ITU–R (BT.2069) predicts that, whether or not digitization is successful, within ten years the channel demand for SAP and SAB will be 25 to 50 wideband radio microphone channels for professional television electronic news gathering and 10–15 for coverage of routine outside broadcasts. For local and national radio stations the demand will be 5–10 radio microphone channels, plus 5–10 wideband channels for other outside broadcasts.

It appears that most manufacturers intend producing digital radio microphones for the band 470–862 MHz. Few indicated a wish to produce professional digital radio microphones in the band 174–216 MHz.

Conclusion

A wide variety of radio microphone applications are deployed in the relevant tuning ranges, of which the band 174–216 MHz seems likely to lose its importance for future SAP and SAB applications. However, because of the large base of existing equipment, its identification as an SAP/SAB tuning range should be maintained for the time being.

The band 470–862 MHz appears to be the vital tuning range for audio SAP and SAB applications, where most existing and future use is concentrating. Even with exploitation of the 1 800 MHz band for radio microphones, the pressure on the 470–862 MHz band is not likely to decrease significantly, as the 1 785–1 800 MHz band will satisfy only part of the overall SAP and SAB demand in the UHF range. Therefore, identification of the 470–862 MHz band as a tuning range for audio SAP and SAB applications should be reinforced. In particular, further measures should be considered for ensuring long-term coexistence with television transmissions during and after conversion to digital systems. One such measure — widening of the switching range of equipment — already seems technically feasible.

The band 1 785–1 800 MHz is another solution for long-term uniform use by radio microphones. Most administrations in the European Union have already declared their commitment to allow radio microphones to use this band.

The ITU–R Seminar on Electronic News Gathering in March 2006 heard that some administrations consider that radio microphones are the most sensitive devices used and deployed in SAP and SAB. It was also reported that high levels of congestion are occurring. WRC-07 will be asked to consider approving a resolution calling for studies on whether it is feasible to harmonize worldwide user requirements and spectrum usage for electronic news gathering, in terms of frequency bands used for such applications, including the identification of a specific band or bands.

Within some countries, proposals are emerging for the assignment of one television channel in the 470–862 MHz range for radio microphones. However, electronic news gathering is one of the most frequent and high-profile applications of the radio-frequency spectrum. This makes it essential for administrations to agree that harmonization of tuning ranges is feasible, in order to alleviate the frequency coordination problems being faced by broadcasters, programme makers and journalists around the world in their use of radio microphones.

A vehicle equipped for outside broadcasting, using dedicated radio-frequency spectrum

Pioneers' Page


Steven Reyer

In 1954, the Regency TR-1 transistor radio was launched as the world's first mass-produced, mobile communication device

The transistor turns sixty

As described in last month's *Pioneers' Page*, an early method for amplifying electric signals to produce sound was the carbon microphone. By the start of the 20th century, thermionic valves (or vacuum tubes) were being used for amplification in many types of equipment, from telephone systems to radio sets.

Some readers might remember how, in the first half of the last century, radios containing valves took a while to warm up before sound could be heard. The glow of these sets may have created a cozy atmosphere, but they were hardly portable. And vacuum tubes not only gave off heat: they were also bulky and fragile. It was not until the 1940s that a breakthrough came. It made possible today's digital world.

Semiconductor research

Some materials can both conduct electricity and resist its flow. Called semiconductors, they include the elements germanium and silicon. Under the influence of electrical fields they can either amplify a signal or close a circuit. The use of crystals to receive radio waves goes back to the late 19th century, and research into using such "solid-state" materials was carried out in the 1920s and 1930s. However, there was incomplete understanding of how these worked.

In 1945, a team of physicists at Bell Telephone Laboratories, in New Jersey, United States, was asked to investigate the topic. The team was led by William Shockley, with John Bardeen and Walter Brattain. After two years, Bardeen and Brattain discovered how to make an amplifying circuit using germanium, which they showed to Bell executives in December 1947. It later became known as the transistor — and 2007 sees the 60th birthday of one of the most important pieces of technology ever invented.

How it worked

In 1956, Bardeen, Brattain and Shockley shared the Nobel Prize for physics "for their researches on semiconductors and their discovery of the transistor effect." It works because pure germanium or silicon are good insulators. But if contaminated, or "doped", with other substances, they produce either a surplus of negatively charged electrons, or steal electrons from the semiconductor to produce "holes" that can carry a positive charge. If you place a negative electrode against a semiconductor with negative carriers, the current is blocked. The insulating property can be removed by electrically injecting positive "holes" that attract the negative carriers.

Origin of the name

Bell Telephone Laboratories asked staff to name the new invention, and accepted the proposal of John R. Pierce. So, the transistor was described as "an abbreviated combination of the words transconductance (or transfer) and varistor".

Question for next time

What is the connection between computers and an automaton called "The Digesting Duck"?

The world's first transistor was a "point-contact" type. It was overtaken by the "junction transistor" invented by Shockley in 1948, which comprised a "sandwich" of three regions of germanium. This blocked the flow of electricity both ways until a small current was applied to the middle region to let a much larger current flow through the whole device. Thus, the transistor could act as either a switch or an amplifier. The new technology could produce controllable conductivity — at low cost, little power, small size and good durability.

A mass-market, mobile device

Hearing aids were the first application for transistors. Then, in 1953, the first ever radio using a transistor was demonstrated by the German company Intermetall at the Düsseldorf Radio Fair. In fact, it used four "transistrons" developed independently by German physicists Herbert F. Mataré and Heinrich Welker.

In the United States the following year, two companies, Texas Instruments and Industrial Development Engineering Associates, cooperated to make the "Regency TR-1" that was advertised as "the world's first pocket radio".

This portability began a revolution. No longer was a radio a piece of living-room furniture; now, it was a personal accessory. The TR-1 was small but expensive (USD 49.95, or about USD 400 today), and it was soon overtaken by transistor radios manufactured in Japan. Nevertheless, with parts that were specially designed to fit its size, the TR-1 had heralded the development of miniature electronic components.

Transistor technology had other, far-reaching effects. An expert on the first transistor radios, Dr Steven Reyer, Professor in the Electrical Engineering and Computer Science Department at the Milwaukee School of Engineering, United States, has described the TR-1 as "in some ways, really ushering in the beginnings of the information age. That is, many of the electronic devices that we have today are based on the transistor in one form or another — either individual transistors, as appeared in this radio, or, in the case of personal computers, many millions of transistors embedded in integrated circuits".

Heading for Silicon Valley

Using transistors based on silicon, those integrated circuits (or microchips) revolutionized the world of computing. They were spearheaded by William Shockley. After leaving Bell Labs in 1955, he directed a semiconductor research and manufacturing company at Mountain View, California, United States. Colleagues went on to form Fairchild Semiconductor Corporation, which developed some of the first integrated circuits at a location that became part of "Silicon Valley".

Shockley later became a professor at nearby Stanford University. A meeting was held there in 2002 to remember those days. It confirmed (and to answer the question posed in last month's *Pioneers' Page*) that "Shockley is the man who brought silicon to Silicon Valley."

Alcatel-Lucent/Bell Labs

William Shockley (seated), John Bardeen (centre) and Walter Brattain (right)

Alcatel-Lucent/Bell Labs

The first point-contact transistor comprised two very closely spaced gold contacts held against a block of germanium, which had a surface layer with an excess of electrons. When an electric signal arrived through the gold foil, it injected "holes" into the block. A small change in a current applied to the metal base below the germanium caused a greater change in the current flowing between the two contacts.

From official sources

Final Acts of the Regional Radiocommunication Conference for planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3, in the frequency bands 174–230 MHz and 470–862 MHz (RRC-06) (Geneva, 2006)

The Government of the **Republic of Cyprus** has ratified the above Final Acts. The instrument of ratification was deposited with the Secretary-General on 1 June 2007. The Government of Cyprus confirmed Reservations made at the time of signature.

Structural changes

Islamic Republic of Mauritania

The Ministry of Hydraulics, Energy and Information and Communication Technologies has been created.

Republic of the Philippines

The Department of Transportation and Communications (DOTC) is now responsible for the control and supervision of all telecommunications-related functions, in lieu of the Commission on Information and Communications Technology (CICT).

Czech Republic

The Ministry of Industry and Trade is responsible, since 1 June 2007, for all rights and responsibilities in the field of electronic communications, in lieu of the Ministry of Informatics, which was dissolved on 31 May 2007.

Republic of Serbia

The new Ministry for Telecommunication and Information Society has taken over the functions of the former Ministry of Capital Investments in the field of telecommunications and the information society.

Change of status

Yokogawa Electric Corporation (Tokyo, Japan), formerly an Associate, is now a Sector Member of ITU–T.

Change of name

Alcatel SEL AG, a Sector Member of ITU–T, has changed its name to *Alcatel-Lucent Deutschland AG (Stuttgart, Germany)*. MTN Networks (Pvt) Ltd, a Sector Member of ITU–D, has changed its name to *Dialog Telekom Limited (Colombo, Democratic Socialist Republic of Sri Lanka)*.

New Associate

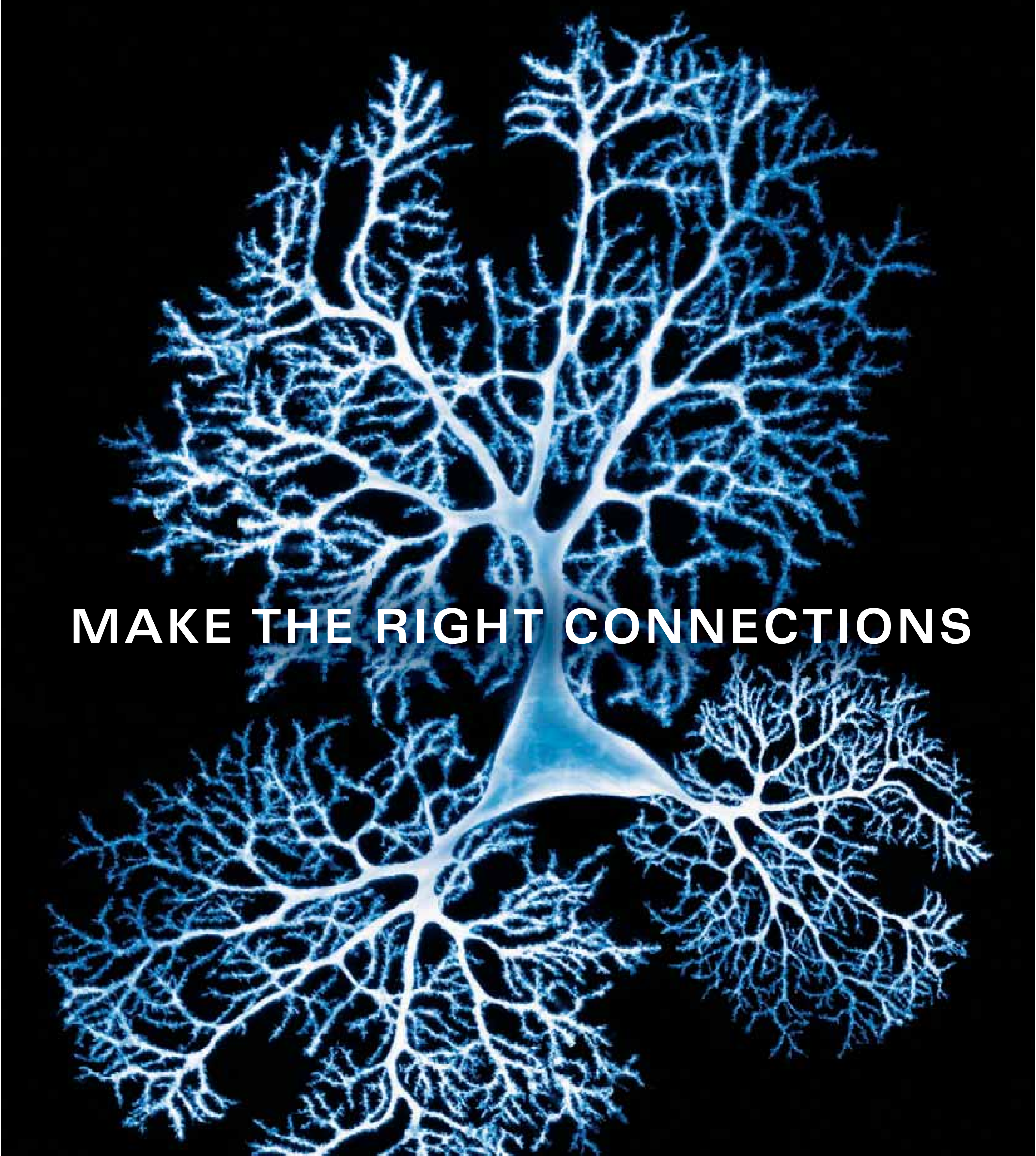
Telecommunication Standardization Sector

OnAir (Geneva, Switzerland) has been admitted to take part in the work of Study Group 2.

Diary of ITU events

Up-to-date details of forthcoming ITU meetings and conferences can be viewed on the ITU website at

www.itu.int/events/index.asp


MAKE THE RIGHT CONNECTIONS