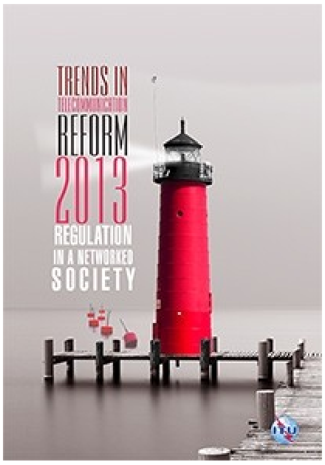
INTERNATIONAL TELECOMMUNICATION UNION

GSR 2012 Discussion Paper

Spectrum Policy in a Hyperconnected Digital Mobile World



Work in progress, for discussion purposes

Comments are welcome!

Please send your comments on this paper at: gsr@itu.int by 19 October 2012.

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1. *The Forces of Change*

1.1 Introduction

In the ICT sector, there are many forces at work which may cause governments to rethink spectrum policy. These include convergence, globalization, use of the Internet, the increasing demand for broadband and mobility, competitive conditions, much broader availability of wireless and the trend toward integrated national broadband policies. These have created a greater complexity in which policy-makers face the challenge of how to best utilize the limited resource of spectrum.

Within this context, a well-designed spectrum policy is essential in a digital world. In this digital world, advances in broadband have put a strain on wireless capacity compared to an age when the Internet was not easily accessible through mobile devices. In turn, this has caused a re-evaluation of the different options in bringing spectrum to market and the regulatory basis for this to happen in an efficient, cost-effective way, while also allowing continuing innovation to occur.

Therefore, as a prelude to examining the modern practices in spectrum policy and its implementation, it is necessary to review this broader scope of developments as background to succeeding sections of this paper. This paper firstly addresses the general evolving nature of the wireless industry, and with this the changes for regulators over the past two decades. Bourgeoning demand for data has emphasized the critical nature of the limited resource of spectrum and the need to accommodate foreshadowed demand for spectrum. These considerations have a particular relevance to considerations of national spectrum policy and planning which should be regarded as a key component in evolving national broadband policies.

In the second section of the paper, high level policy principles are examined, along with the beginnings of an approach to discovering best practice in spectrum policy.

The third section moves into the most important elements which comprise best practice in contemporary spectrum policy and its implementation to satisfy today's needs, including the need for a National Spectrum Plan and periodic consultation to maintain an up to date Plan. Also needed is a well understood, market-based plan for making spectrum available. This section includes "pathfinding" examples from several countries and regions which aim to achieve the sought after efficiencies and objectives of spectrum policy in a world that is experiencing exploding demand for mobile broadband services.

1.2 Digitization effects and convergence

Whilst networks used to be built vertically around specific applications (e.g., the public switched telephone network for voice or broadcasting systems for television), digitization and the advent of the Next Generation Network (NGN) has 'de-layered' networks so that content or applications are no longer network specific. Thus, an IP network can easily transmit all forms of voice, data, and video. This, in turn, is paving the way for 'over the top' (OTT) content and service providers. The impact of such convergence for regulation is profound, as formerly distinct regulatory regimes become less suited to today's converged networks and services. Determining how wireless networks fit into this world, and how spectrum policy can be designed to maximize the potential of wireless broadband will be an important issue for regulators going forward.

1.3 Data serves up a new date with destiny

The digitization of communications networks is a phenomenon which is not new and is no longer unexpected. It has been occurring for decades. However, digitization, in combination with the development of the Internet protocol (IP) and the rapid deployment of IP-based networks, has accelerated convergence and enhanced the immediacy of all types of communications which were at one time comparmentalized and self-contained.

The explosive global growth of mobile data has swamped voice traffic. Demand for new broadband applications and services is a game changing development for carriers and service providers. In combination with the arrival of smart phones and tablets, these developments have created the beginnings of a seismic shift in industry structure and relationships. For example, emerging machine-to-machine (m2m) communications, cloud services, and other OTT services are giving rise to a new breed of service provider. Many of these new services and providers are in their infancy, but the evidence of greater things to come is overwhelming.

As a result of these new technologies and services, traditional business models and concepts of regulation are now being challenged. The implications of these changes for wireless regulation are especially relevant to developing countries, where wireless is likely to be the primary vehicle for broadband service delivery.

Both fixed and mobile voice services have been the bedrock business for carriers until recent times. Margins in the past have been significant and the augmented service of SMS tied to mobile voice services has been a digital addition which has been highly lucrative on a per character basis.

The advent of faster, more advanced technologies, however, has begun to radically change the wireless industry. With smartphones and tablets, mobile broadband users are now able to take advantage of a wide range of wireless services and applications, including mobile VOIP (e.g., Skype) and other WiFi or on-net applications. Networks will require some degree of re-design and dimensioning for the future to meet the demands of new consumer and business applications. Looking ahead, several trends can be identified that will put even more pressure on wireless networks—heightening the need to plan for and manage/regulate the spectrum resource.

The introduction of smart phones/tablets has allowed third-party service providers to treat carriers as simply providing "dumb pipes," with the service providers taking increasing charge of applications/services and users.

In a recent report, Google provided current penetration rates for smartphones in selected countries around the world.[2] This is reproduced in Figure 1. Of particular interest are comparisons between developed and developing countries, where penetration rates do not appear to reflect the status of development. ITU data also confirms the rapid take-up of broadband-enabled mobile phones.[3] A recent report from Pyramid Research indicates that by 2017 emerging markets will account for 63 per cent of all smartphone sales, compared with 42 per cent in 2011.[4] This again points to mobile service developments being the vehicle for breaking down barriers to advancement and helping to reduce the digital divide. The implication is that the foundation for future IP service development is much more promising for all countries.

Figure 1: Penetration of smartphones in selected countries (May 2012)

Penetration	%	Penetration	%
USA	44	JAPAN	20
UK	51	GERMANY	29
UAE	61	EGYPT	26
SWEDEN	51	CANADA	33
SAUDI ARABIA	60	BRAZIL	14
NZ	44	AUSTRALIA	52
MEXICO	20	ARGENTINA	24

Source : Google/IPSOS

m2m communications and similar transactional scenarios

The impressive forecasts of 50billion communicating (m2m) devices by 2020[5] will demand a greater relative signalling capacity, and indeed signalling congestion may pose a threat for networks if they continue as they are currently dimensioned. This is a consequence of "hyperconnectivity" as distinct from the simpler connectivity between persons (Metcalfe's Law) or social networks (Reed's Law).

Such applications will see the transmission of only a small amount of data per transaction but done on a more frequent basis. This might be from interactions to alleviate battery drain, or applications such as interactive gaming, patient monitoring, meter reading, intelligent transport systems etc. Smartphones also contribute to this situation by making constant queries to the network as they move amongst cell sites to convey email, to access social networking and to conduct repetitive actions. Always-on applications rely on constant signalling messages to and from the network. Consequently, whilst end-user data traffic is growing quickly, signalling traffic (which is overhead data for networking purposes) is outpacing it by 30 to 50 per cent.[6]

Cloud communications

Cloud communications is another growing trend, whereby information is stored in remote servers and then accessed by consumers and business users on an as-needed basis. For consumers, this can be a way to securely store music, photos and other information, with the advantage of being able to access that information from anywhere there is a broadband connection. For businesses, the cloud can store all types of information that workers in the field can access when they need it. This, however, adds to the growing needs for data carriage capacity for the bulk transfer of data amongst data sites and destinations and ultimately for the spectrum to make wireless access and carriage solutions possible.

1.4 A closer focus on mobile developments: traffic is increasing rapidly

Reflecting these growth trends, at the end of 2011, there were close to 6 billion mobile-cellular subscriptions with global penetration reaching 86 per cent, with 78 per cent in the developing world.[7] Mobile-broadband subscriptions have grown 45 per cent annually over the last four years, and there are now twice as many mobile-broadband subscriptions as there are fixed-broadband subscriptions. While people in developed countries use mobile-broadband networks in addition to fixed-broadband connections, mobile broadband is often the only access method available to people in developing countries, especially outside urban areas.

In its studies of the future, Cisco predicts that global mobile data traffic will grow 18-fold from 2011 to 2016 with a compound growth rate of 78 per cent.[8] This is three times faster than fixed broadband traffic. Mobile data traffic in 2016 is expected to reach 10.8 exabytes per month.

The implications of this growth for carriers are serious. A study by Tellabs[9] suggests that profitability could be extremely challenging for some mobile operators within three years. This is a result of the mobile Internet forcing operators to transform their networks and business plans. Without rethinking the design and capabilities of their networks, the study claims that costs will surpass revenue for many operators throughout North America, the developed Asia-Pacific countries, and Western Europe in this three-year time frame. Since users have embraced the mobile Internet, traditional ways of handling traffic growth (e.g., cell splitting) have become expensive, and competition has increased pressure on revenues. Box 1 discusses the changes that result from demographic shifts and their potential to increase demand for services, particularly in urban areas of developing countries.

Box 1: The Impact of Demographic Shifts on Mobile Demand in Africa

By 2050 the market in Africa for telecommunications services (and for many other goods and services) will grow by an additional 1.5 billion people, representing almost half of the total market expansion worldwide.[10] The majority of this region's population will be living in urban areas, where telecommunications infrastructure is relatively easier to roll out and upgrade. An additional 800 million people will be living in Africa's cities by 2050 (taking the total to 1.2 billion), compared to 500 million in India and 340 million in China. This represents 300 per cent growth in urbanisation in Africa compared to 70 per cent in Asia.

With mobile market penetration currently standing at about 65 per cent, this huge growth will undoubtedly bring a range of challenges to Africa but the opportunities for the telecommunications industry are unparalleled.

The demographic challenge of significant urbanization will make ICT and education key enablers to allow the citizen of the metropolis to fully participate in and derive a living from the information age. This is not an issue which is unique to Africa, though it is more poignant. It is not an issue that is even unique to developing countries, but equally applies to developed countries and hence unites the world in a common cause. Wireless infrastructure is highly important in this scenario and probably more critical to developing countries. Ergo good spectrum management is a future centrepiece of economic and social cohesion in society.

Source: Author.

Future regulation needs to reflect these important developments, and the industry challenges which have arisen.

2. *Spectrum policy: high level principles*

2.1 Introduction

The changes in the wireless communications environment described in Section 1 have prompted consideration of the effects of these changes on regulation in a number of the ITU's areas of activity.[11]

Regulators rely on a combination of administrative and market-oriented approaches to managing spectrum. In addition, there are pioneering considerations of new approaches to aspects of spectrum allocation and assignment within some regulatory bodies, such as in the areas of spectrum sharing, greater use of unlicensed spectrum, incentive pricing, etc. A question is whether traditional regulatory approaches and principles (and implementation) of spectrum policy are sufficient and appropriate to carry forward into the future – or whether there is a need for a re-assessment of parts of the regulatory approach to deployment of spectrum.

Best practice in the fully digital era with national regulation is influenced more than ever by externalities such as links to other domestic imperatives like a national broadband plan and NGN expectations, the achievement of universal access and service, support for industry, and political concerns for privacy, security, a degree of control, and social ambitions. Regional influence and interaction is now more evident than ever, and the voice of regional bodies is far more effective in international fora such as the ITU. Manufacturers significantly define the boundaries of what is possible, and they prefer production on a global (rather than a country- or region-specific) basis. Consequently, international harmonization is particularly important and a leading factor in spectrum policy decisions.

Some differences have also emerged in the past between developed and developing countries, and these differences may be holding back progress in some cases. The differences can be traced to a lack of confidence or involvement in change, and tardiness in regulatory reform. However, mobile broadband does enable a narrowing of the broadband gap because of the adaptability of the technology to different environments and needs. In order to realize this goal, however, one of the biggest issues for policy and regulation going forward is making spectrum available to support the growth of broadband services. Other major companion challenges are dealt with elsewhere in GSR12 discussion papers.

2.2 Approaching best practice

A number of attempts have been made in the past to capture the important constituents of best practice in spectrum policy.[12] Some conclusions – such as the applicability of high level principles - are still valid today. Other implementation considerations need refreshing and re-casting in the developing environment. It is therefore useful to subdivide "best practice" into high level principles and then their achievement.

With regard to high level spectrum policy principles, there are some durable factors that still remain as valid as they were seven years ago at GSR05[13] and will likely still remain valid for years to come (see section 2.3). Thus, the focus of best practice lies with developing new implementation approaches that flow from these enduring principles.

The main influence in re-assessing best practice is the broadened scope of consideration. In the past, attention has been closely focused on the unique and narrow issues associated with radiocommunications. Today, a greater influence of wireless services in society and mainstream economics causes a need to examine policies for their suitability. It is, however, worthwhile to analyze existing views on best practice and to then address those areas which could be updated to better fit today's circumstances.

For example, mobile networks have made universal access to voice services feasible in most countries, and most markets have been able to support at least limited facilities-based mobile competition, which makes regulation less necessary than for fixed networks (which historically have been provided by a monopoly incumbent). In addition, in recent years, wireless technology has advanced to the point that it can now also support (increasingly capable) broadband.

2.3 High level policy principles and their implementation

GSR05 in Tunisia produced high level Best Practice Guidelines for Spectrum Management to Promote Broadband Access.[14] The Guidelines focused on 10 key areas that demand consideration in the quest for best practice:

- Facilitate broadband deployment;
- Promote transparency;
- Support technology neutrality;
- Enhance flexible use measures;
- Ensure affordability;
- Make spectrum available in a time fashion;;
- Manage spectrum efficiently;
- Level the competitive playing field;
- Harmonize (International and Regional) policies; and
- Take a broad approach to promoting broadband access.

These formed a durable set of high level principles that are still relevant today. They provide a baseline for first principles consultation by policy makers with stakeholders, especially industry, and they provide a starting point for the implementation of other elements of a National Spectrum Policy. The output statement from the ITU's 2011 Global Symposium for Regulators (GSR11) is worth repeating for completeness. At that meeting, participants drew attention to the challenges of making spectrum - which is a cornerstone of growth in the digital information age - available for mobile broadband.[15] Regulators and policy makers were urged to address a host of issues in order to ensure that spectrum is used in the most efficient manner.

GSR11 participants expressed a preference for implementing incentive-based, market-driven approaches to making more spectrum available (where scarcity of spectrum exists).[16] For example, a number of auction techniques were cited as having the potential to extend broadband to underserved areas. Furthermore, allowing flexible use of spectrum, including spectrum refarming and secondary markets was seen as key to ensuring that with market maturity and evolution, spectrum moves to more productive uses. The Guidelines also envisage leveraging the "digital dividend" spectrum, and the use of TV "white spaces" for unlicensed broadband device use.

To implement such principles, many countries are now developing national spectrum plans to guide their wireless sector development. To support the development of such a National Spectrum Plan, other implementation and policy considerations deriving from the high level principles involve the conduct of an inventory of national spectrum needs, comprehensive public consultation on a national basis, and the development of a spectrum program that is market-based and brings transparency and certainty to prospective investors in wireless applications. These national implementation efforts are often complemented by and dependent on an engagement strategy with regional and international bodies in order to achieve the full benefits of harmonization and standardization.

2.4 The changed regulatory model – *'Third Generation Regulation'*

To address such issues, a new model for spectrum regulation is coming into practice. In step with evolving regulatory approaches in telecommunications as a whole, the strategy of dealing with the allocation and assignment of spectrum has also matured through three phases during the last two decades, irrespective of whether the regulatory function in any particular country has been associated closely in an organizational sense with telecommunications regulation or not. The evolution of wireless regulatory models has changed in accordance with policy priorities at the time and shifting market and industry structures. Each of these shifts in approach has been heavily influenced by advances in technology, the opportunities afforded through convergence, and socio-economic needs.

Since the days of the traditional Post Telephone and Telegraph (PTT) organizations, in which regulation and operations were entwined within a single government body (or "Administration", there have been three clearly distinguishable generations of regulation, as shown in **Table 1**.

Table 1: Generational changes in regulation

Regulatory Phase	Policy Priorities	Regulation Focus	Spectrum Management
1st Generation	Regulation of a monopoly	Independent regulation, correcting monopolistic behaviour, price regulation (ROR[17] or price caps)	Separate administrative methods of spectrum allocation and assignment
2nd Generation	Infrastructure Competition	Resale, pricing, access, call selection, unbundling, bit-stream access, cross-subsidised universal access	Increasing use of market methods for allocation of spectrum. Some merging of regulatory bodies
3rd Generation	Service Provider Competition	Network and spectrum sharing, net neutrality, more focus on regulation of content and applications, bitstream access, universal access no longer cross subsidy.	Broader integrated spectrum policies. Affordable new spectrum. Re-use of existing spectrum. Sharing and flexibility. Alternatives in using spectrum

Source: Author.

Across these three generations, because of quickly growing demand and a realization of spectrum scarcity, administrative methods of assignment have increasingly been replaced by market approaches that seek to apply economic criteria for achieving the highest-valued use of the spectrum where appropriate. More recently, questions have been posed over how spectrum should be valued and the disconnect between socio-political and economic descriptions of value.

The transition from the second generation to third generation regulatory models has been led by convergence, spectrum scarcity and a pervasiveness of broadband communications throughout the world's economy. From the point of view of spectrum and its management, wireless is now seen as part of a broader scheme within the communications field largely brought about by the growing importance and visibility of mobile broadband. Because of the pressure on spectrum and its availability, the focus of the spectrum regulator is moving to evaluation of alternative uses of spectrum, re-use, re-farming, liberalization and a renewed scrutiny of the efficiency of current spectrum uses. This broader ambit, for example, has led to more in-depth consideration in many countries of how broadcast spectrum is used and how that spectrum could be used to create a "digital dividend" that would benefit wireless broadband users..

Today, such matters require resolution by the 'third generation regulator." The underlying principles in the model apply whether the spectrum regulatory function is managed by a converged ICT regulator or a more narrowly constituted body. Thus, it is not necessary to converge the regulatory functions in an organizational sense, but to recognize the increased interdependence and interworking which is now necessary. The third generation will take us into the future.

3. *Creating a national spectrum policy*

3.1 Introduction

Accounting for the bourgeoning need for data delivery and the spectrum to support it, as well as providing for many other users of the spectrum creates a considerable challenge for the regulation of spectrum. The massive uptake foreseen for mobile data and video applications and services, short range devices, m2m communications, fixed/mobile cloud services, m commerce, etc. provide the genesis of much greater demand.

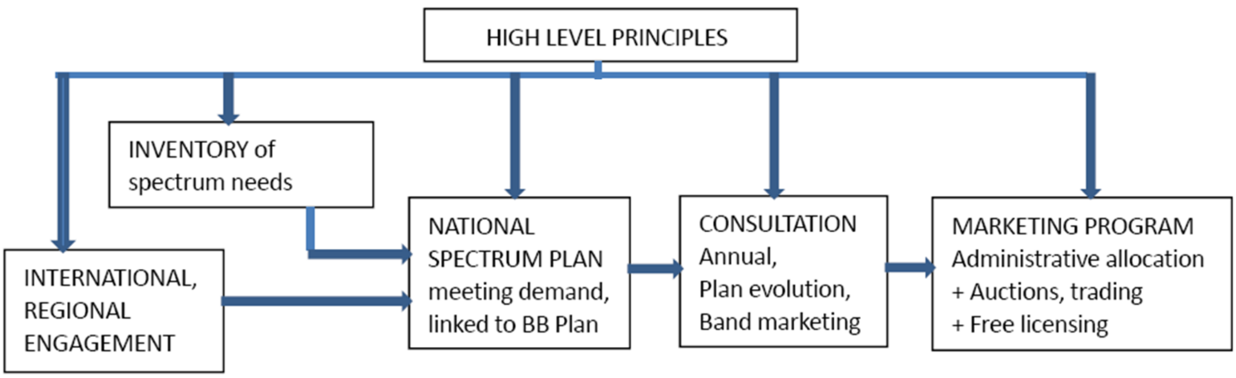
In seeking to meet that demand, operators know that optimum technical efficiency is extremely important in emerging network and system developments. Regulators and policy-makers also have tools at their disposal when it comes to making sure that the supply of spectrum is sufficient to meet rising demands. These include re-farming existing allocations or assignments for to allow new services, using the digital dividend that comes from the migration of broadcasting services, as well as new or re-purposed bands for mobile services (such as in unlicensed applications). For such approaches to be most successful, they should be considered as elements in an overall National Spectrum Policy that starts with clear goals and can serve as a blueprint for managing spectrum over time.

This Section addresses the elements needed in a National Spectrum Policy, introduces some contemporary best practice and provides relevant examples of how some countries have addressed spectrum management issues. The elements are:

- wider recognition, visibility and accountability of the spectrum function;
- an inventory of spectrum needs;
- a National Spectrum Plan and rolling annual consultation;
- a Market-based approach for assignment of spectrum; and
- a strategy of international and regional engagement.

These elements are summarized in Figure 2 as five implementation elements flowing from the high level principles, and which have the aim of achieving spectral efficiency while meeting demand. Each element is discussed in detail in the following sections.

Figure 2: Elements of a National Spectrum Policy



Source: Author.

3.2 Wider recognition of the spectrum function

Historically, the function of spectrum management has been concealed behind high technical barriers to understanding. The job of allocating spectrum has largely been left to specialists and engineers who are responsible for allocating wireless services within particular bands and providing for acceptable interference arrangements between licensees.

Some of the factors that have given spectrum management a higher profile include –

- significant returns to treasuries from the auction of commercial services;
- convergence (the ability of wireless to deliver voice, data and video services); and
- increasing demand for spectrum to support emerging broadband applications.

As a result, spectrum policy now needs to be factored into the wider canvas of national broadband policies, and should be widely consulted as part of the development of a national broadband plan. Interdependencies of converging industries and services affect the implementation of spectrum policies and vice versa. In addition, there is an increasing need to consider how wireless services can assist the goals of universal service. As a result of these interrelated considerations, governments are also considering the further integration or convergence in an organizational sense of the regulator where this has not already taken place.

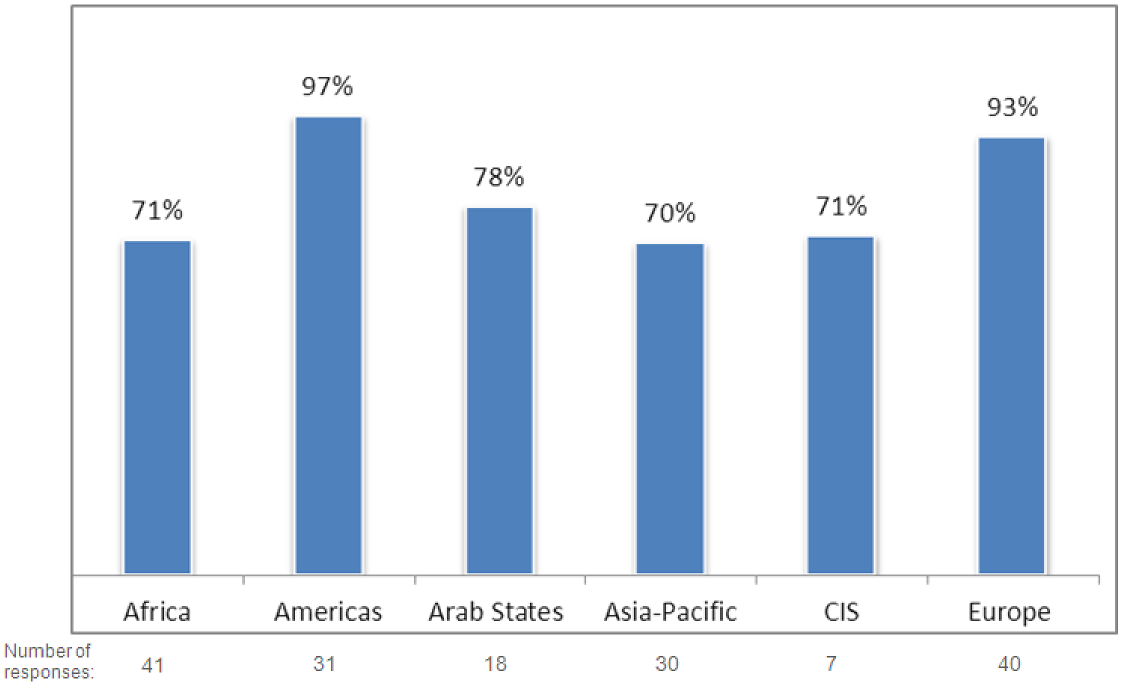
In the United States**,** 2010 saw a landmark report from the FCC in its *National Broadband Plan.*[18] Issues discussed in the Plan included the need for: greater transparency in spectrum allocations; incentive mechanisms to reallocate or repurpose spectrum; more spectrum made available within the next 10 years; and expanded opportunities for innovative spectrum access models such as unlicensed use. Efforts in spectrum reform took on greater significance in June 2010 with a Presidential Memorandum entitled "*Unleashing the Wireless Broadband Revolution.*"[19]

The United States example is instructive for several reasons. First, it shows that spectrum matters in the United States have been raised to a higher level of visibility and significance in the context of planning for the future.. Second, the time context to consider for planning and regulatory activity was recognized to be over a long term—a period of 10 years. Third, the demand for spectrum for new wireless services is very significant (estimated at an extra 500 MHz) and calls into question existing allocations and the justification and efficiencies of current approaches to fulfilling spectrum needs. Fourth, the demands for commercial and Government use of spectrum need to be comparatively assessed and prioritized, given the limited availability of spectrum.

As part of the U.S. initiatives, the Department of Commerce's National Telecommunications and Information Administration (NTIA) has released a number of reports.[20] The most report recent addresses the repurposing of government spectrum in one of the bands entitled "*An Assessment of the Viability of Accommodating Wireless Broadband in the 1755 – 1850 MHz Band*".[21] Here, the NTIA concludes that a repurposing of all 95 MHz is possible. However, the extent to which the spectrum can be made exclusively available to commercial interests—and in what timeframe—requires further discussions between agencies and the industry. Possible solutions include partial clearing scenarios and a phased approach to commercial auctions and entry. Some federal systems might need to remain in the band indefinitely. Thus, negotiation is the favored way forward, rather than fiat. This has also been the favored way in the United Kingdom for many years**.**

As the previous examples illustrate, transparent access to relevant information by all stakeholders is an important way to ensure greater recognition of the importance of spectrum. A general measure of transparency amongst countries is provided by the ITU as a result of a questionnaire over whether a country makes publicly available information on spectrum (e.g. regulations, a spectrum management table, and spectrum fees).[22] The responses are shown in Table 2 in regional summary and these indicate an encouraging situation.

Table 2: Spectrum information made available, percentage of country responses by region, 2011



Source : ITU World Telecommunication/ICT Regulatory Database

3.3 An inventory of spectrum needs

An inventory provides substantive evidence of spectrum needs and should involve demand and supply considerations and most likely an active database to track spectrum use. The inventory allows for a review and justification of spectrum needs for individual radiocommunication services: which will involve metrics covering the technical, economic and social efficiency of the use of spectrum. As such, inventories can also be useful in determining where spectrum is underutilized or where it might be possible to reallocate spectrum for new uses. This aggregation of potential demand for spectrum is an exercise which is now common amongst many countries as they try to dimension the challenge of spectrum into the future.

Spectrum needs cover many industries and user communities. The ITU-R considers spectrum usage and demand for different services in its work within the Study Groups leading up to World Radiocommunication Conferences (WRCs) and Radiocommunication Assemblies (RAs). This work can also serve as a useful reference for services that need to be accounted for in a National Spectrum Plan, helping to lay out uses and allocations, on a primary and secondary basis.

In the United States, the FCC's National Broadband Plan also gives consideration to methods for ongoing measurement of spectrum utilization and a triennial assessment of spectrum allocations. In Australia**,** the regulator - ACMA[23] - provides an annual rolling 5-year forecast of spectrum demand drivers, the top spectrum projects over the 5-year period and specific work plan priorities over 2012-2016 in the current version. These are followed up with open consultative processes on the itemized projects as the year proceeds.

Europe is currently in the process of conducting an inventory of spectrum uses over the range 400 MHz to 6 GHz, with a view to putting focus on the *supply side* of spectrum provision and efficiency of spectrum use.[24] Functional characteristics will be matched by efficiency metrics, and the program will depend critically on a transparent and compatible pan-European ECO Frequency and Information System database.[25] Spectrum management agencies throughout Europe will cooperate and improve national databases and inventories, which currently exist in Denmark, Finland, France, the Netherlands and the UK.

Canada has also implemented a stocktake of the current use of spectrum across the range of services in Canada, and commissioned a study of future demand up to 2015 for radio spectrum in Canada.[26] One interesting feature of the study from Canada is its categorization of Scenarios. One scenario is a *wireless only* solution to broadband demand, which, whilst it may be of more academic interest to Canada, could well be the scenario of greatest interest to developing countries where wireless solutions will prevail. In this scenario, there is rapid progression to higher levels of wireless communications. The range of demand across the scenarios is 300 – 500 MHz by 2015. The other two scenarios comprise a more balanced fixed and wireless provision with the differences being the rates of uptake.

3.4 The importance of a National Spectrum Plan

Organizing spectrum to be available in a timely fashion to meet developing needs involves long term thinking as part of the national strategy. As mentioned, a National Spectrum Plan should be a widely consulted document with a horizon of at least 5 or 10 years. Once established it can be publicly “rolled over” through forecasts and consultation on an annual basis for updates as technology and markets evolve. This assists transparency and orderly spectrum allocation by the regulator, and allows spectrum marketing proposals to be discussed progressively. Longer timeframes allow appropriate and meaningful milestones to be built in.

Sweden has a well-designed Spectrum Strategy proposal[27] summarized in Box 2.

Box 2: Spectrum Strategy Proposal: Sweden

- **Inventory phase**: demand and supply (today and out to 2022), followed by
- **Analysis phase**: a review of frequency bands and evaluation of current and potential usage of spectrum, followed by
- **Implementation phase**: involving review or phasing out of current usage of spectrum; together with license conditions; assignment options; and finally assignment

Source: NPTA Sweden

These efforts will be supported by principles and tools to optimise the public welfare, together with efficient instruments for spectrum management, and efficient technical rules for licensees. The consultation referred to in Figure 2 has a number of considerations and is not confined to just the National Spectrum Plan. It also refers to other separate consultations over the market proposals for spectrum, and even further to the broadest of consultation on spectrum in a wider policy environment.

For regulators and policy makers seeking to develop a National Spectrum Plan that will allow them to better match spectrum supply and demand—and make more spectrum available for broadband uses—a number of policies can be implemented. For example, a Report to the United States Congress[28] notes that there are currently three key policy tools for increasing the availability of spectrum for wireless broadband:

- allocation of additional spectrum
- re-assigning spectrum to other users (with compensation)
- opening up spectrum for unlicensed use

Other policy options considered include:

- sharing of network infrastructure
- changing the cost structure of spectrum access
- more spectrum efficient technologies, and
- sharing spectrum.

Box 3: Categories of future spectrum needs

Aeronautical Mobile : voice and data communications necessary for the safety and efficiency of aviation

Broadcasting : intended for direct reception by the general public on AM, FM and digital systems

Fixed Services: between a fixed transmitter and one or more fixed receivers

Land Mobile: terrestrial services between base stations and mobile stations, or directly between mobiles

Maritime : communications for safety and efficiency of maritime military, civilian, and search and rescue

Radiodetermination: to obtain position, velocity or other characteristics of an object

Satellites : enabling international communications or large coverage areas or rapid deployment

Science Services: for Earth and space station data transfer for processing

Wireless Access Services : terrestrial connections for a user to a core network Internet or other provider

Emerging Technologies : adoption of future developments

Source : ACMA Australia 5-year Spectrum Outlook

A dynamic concept of spectrum sharing arises from a progression from static channel allocation approaches to those for network-centric technologies typical of responding to the instantaneous character of Internet-type services. Spectrum-sharing techniques include geolocation databases, smart antennas and cognitive radio and may lead to dramatically different ways of managing a nation's spectrum resources.[29]

A comprehensive National Spectrum Plan should account for all required services – for example – as summarized in Box 3. Specific applications are contained within these categories of service (i.e., public safety systems are provided under the Land Mobile service). Areas of spectrum scarcity and how to place a value on the quite different uses of spectrum (commercial vs non-commercial and emerging vs. existing services) is an increasing challenge which confronts both the policy-maker and the regulator who must manage spectrum allocation in practice. This is a delicate balancing act.

In the United States, for example, the FCC National Broadband Plan sees the need to make spectrum available for the development and evolution of new technologies. This need is foreseen to be met partly by freeing up a new, contiguous nationwide band for unlicensed use. Also, finalization of rules for the use of TV white space spectrum[30] was made possible by innovative databases and cognitive radio techniques, and on a licensed or unlicensed basis. "Opportunistic" or "cognitive" technologies - which generally do not require a license and which are at a pre-commercial stage - may significantly increase the capacity of spectrum in the future by sharing available spectrum dynamically without disrupting incumbent, licensed users.

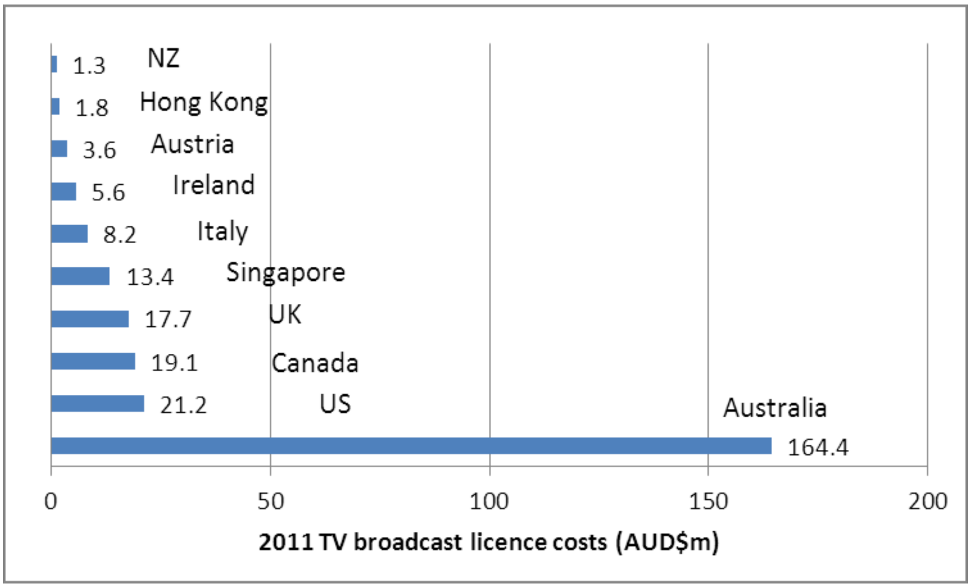
As policy-makers and regulators seek to promote radio services and manage spectrum efficiently, it will be important to recognize the international context within which decisions are made. A National Spectrum Plan should be consistent with agreements reached at WRCs and RAs as those agreements provide the certainty to implement radiocommunication services in a harmonized and standardized way. To accommodate special circumstances, countries can insert footnotes to the regulations allowing differing national allocations.

Importantly, the ITU has begun a significant work programme that is designed to identify additional spectrum that could be used for mobile broadband services. The agenda for the 2015 WRC, which guides much of the Study Groups' activities, includes Agenda Item 1.1 in the Land Mobile category which is –

'to consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) and related regulatory provisions, to facilitate the development of terrestrial mobile broadband applications in accordance with Resolution **233 (COM6/8)WRC-12**'

A recent Inquiry into Convergence[31] in Australia examines the fundamental change brought about by convergence and puts forward recommendations for a new principles-based policy framework that should reduce compliance costs and increase certainty and flexibility whilst ensuring that services continue to meet expectations. The Inquiry was partly informed by reports from the ACMA on "broken concepts" and "enduring concepts."[32] One issue that arose during the Inquiry was the matter of charging for the use of broadcasting spectrum. It was shown that commercial TV and radio broadcasters in the broadcasting services bands are subject to licence fees calculated as a percentage of gross earnings, with 9 per cent for television and 3.25 per cent for radio in 2011. Four other countries have a similar approach to TV broadcast license costs: New Zealand, Singapore, Austria and Italy, whilst New Zealand (which has a dual fee structure), Canada and the United Kingdom have charges determined by a market-based mechanism. Licence cost comparisons are as follows in Figure 3.[33]

Figure 3: Comparisons of TV Broadcast License Costs



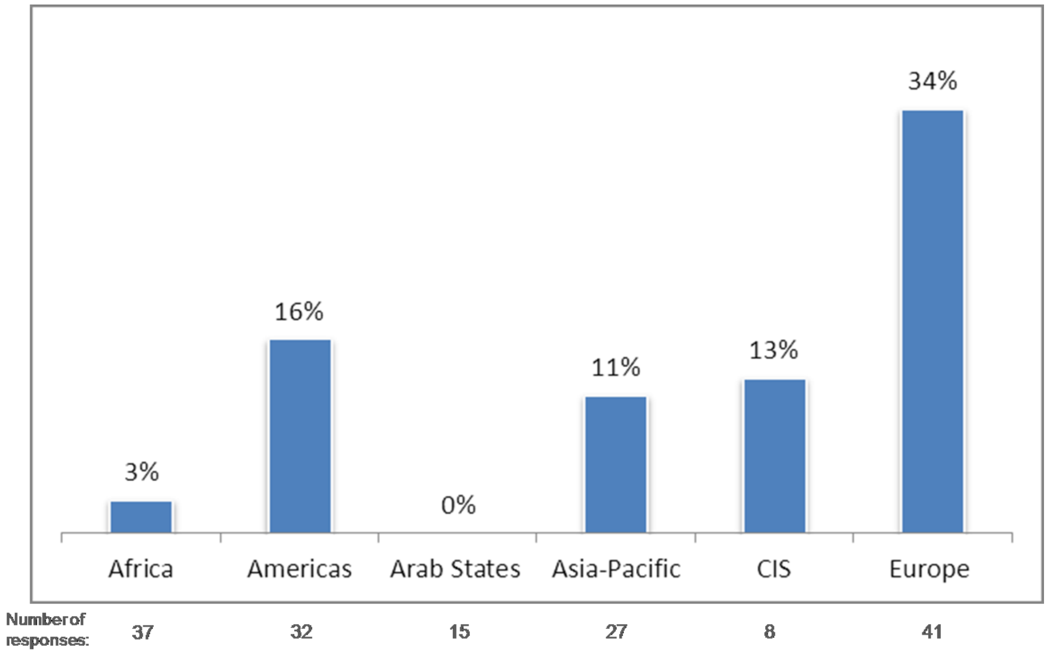
Source: 20. Australian Government. "Convergence Review : Final Report". March 2012. www.dbcde.gov.au

The recommendation to the Australian government on this particular matter tracks the initiative of the UK, noting that, because convergence is eroding the boundaries between broadcasting, voice communications and data transmission, spectrum allocation should as far as possible be based on spectrum management resources, not content. In addition, the regulator should develop methods to value spectrum (see below) and derive an appropriate license fee in consultation with existing broadcasters. This would allow a non-discriminatory and affordable approach to licensing.

As policy makers and regulators seek to develop a National Spectrum Plan, one area that shows a division of thinking in spectrum policy amongst countries is the licence-exempt model. Whilst somewhat dated, the World Bank's InfoDev program in 2003 estimated that only 41 per cent of developing countries had rules for licence-exempt bands compared with 96 per cent of developed countries.[34] This may have undesirable consequences by dissuading new technologies from coming to market in developing countries, especially considering the leap-frogging potential they may offer to those countries.

Secondary trading of spectrum is another area of contrast, as shown in ITU statistics and data on which countries allow this.[35] This information is summarized by region in Table 3. It shows that countries in Europe are much more involved in secondary trading of spectrum, and are reaping the benefits that this brings in administering spectrum, whilst other regions have generally not adopted such approaches.

Table 3: Spectrum (secondary) Trading, percentage of country responses, 2012



Source : ITU World Telecommunication/ICT Regulatory Database

3.4 A market-based approach for assignment of spectrum

In an effort to speed up spectrum decision-making and ensure that spectrum is put to its most efficient and highest-valued use, policy makers and regulators have begun to develop market-based policies to supplement or even supplant slow, bureaucratic processes. Such approaches, which include market-oriented and flexible-use policies are increasingly viewed as an important means to promote convergence and increase broadband diffusion.

A recently released ITU report addresses market-based spectrum management policies and identifies a framework based on market-oriented and flexible-use policies as an important means to promote convergence and broadband diffusion.[36] In designing auction and tender rules for IMT spectrum, for example, the report recognizes that regulators can achieve various public policy goals such as enhancing coverage, and providing service to rural areas, as well as generating revenues for the government. However, the latter should not result in the creation of barriers for spectrum assignment via excessive pricing. The report also notes some best practices for market-based and flexible-use spectrum management, as summarized in **Error! Reference source not found.**.

Box 4: Best practices for market-based and flexible-use spectrum management

- Adopt auctions as the mechanism to award spectrum use rights for commercial mobile services and set out transparent rules for the award and licensing process, including a clear understanding of what rights and obligations winners will be subject to (e.g. coverage obligations).
- Auction a wide range of frequency bands, in both higher and lower bands (i.e. above and below 1 GHz) since higher bands tend to be suited more for urban areas, while lower bands allow for more efficient coverage of rural areas.
- Initiate and complete spectrum auctions as quickly as possible, with the potential of conducting multi-band auctions, in order to allow license winners to speed up the deployment of mobile services, particularly mobile broadband.
- Ensure that new and existing spectrum licenses are technology - and service-neutral by setting minimal technical usage conditions on licenses, and consider adopting rules for unlicensed use and/or expanding spectrum available for unlicensed use.

Source: ITU, "Regulatory Impact of Convergence and Broadband for the Americas". Connect Americas Summit, Final Draft, 2012

Flexible-use policies include technology neutrality—which allows an operator to use any technology (or wireless standard) to provide a given service. This allows the operators to evolve and adapt their networks using the latest technology to best meet their customers' needs (i.e., the market helps drive technology choices). Overly prescriptive requirements that mandate the use of a particular technology in a particular spectrum band are increasingly seen as harmful to innovation and stifling increases in efficiency.

A growing number of regulators are introducing market-based mechanisms such as in-band migration, spectrum sharing and spectrum trading to distribute spectrum in an effort to meet the demand for fresh spectrum both for 3G and 4G services quickly and efficiently.[37] A substantial number of regulators, however, still rely heavily on administrative assignment and beauty contests to award spectrum licenses. In the African continent this approach is quite common. Uganda, for example, has made several bands available for mobile services using a first come - first served approach. It did not conduct an auction, even though auctions are allowed, because policy-makers felt that an auction was unnecessary in the circumstances. In South Africa, ICASA created a hybrid assignment system involving a first stage "beauty contest" to pre-qualify bidders. But the regulator had some difficulty designing an auction system and finding a qualified auctioneer to run it. Cameroon, Ghana, and Nigeria are looking to develop "4G" service provision through turnkey arrangements with operators.

With respect to spectrum used for commercial purposes, the last two decades have seen many countries move from a prescriptive form of spectrum management to greater reliance on market forces and a lighter form of regulation of industry.[38] This has occurred for example in the United States, Canada, Europe, Australia, New Zealand etc. Market-based mechanisms include auctions, public tenders, and subsequent trading of licenses after award. Currently, nearly one half of countries worldwide use auctions as a primary way of assigning spectrum for the most popular mobile broadband services.[39]

In the United States, which has been using auctions for more than a decade, a major new element of policy is the (eventual) use of voluntary "incentive auctions"[40] for which the FCC now has legislated authority. This type of auction is intended to facilitate the movement of spectrum currently dedicated to one commercial purpose (such as TV broadcasting) to another, higher-valued use (e.g., mobile broadband).

An essential part of an auction process is a well consulted and comprehensive auction manual, which provides transparency to potential bidders. The manual also provides the vehicle for clearly explaining government objectives such as competition expectations, or spectrum caps, rollout obligations, or requirements, including infrastruc-infrastructure sharing.

Canada provides a typical example of a spectrum policy framework built around these concepts.[41] Canada will generally apply an auction mechanism when demand for spectrum is expected to exceed the available supply and government policy objectives can be met fully through use of an auction. An auction will generally not be used in bands designated for priority service (such as where systems are vital to national sovereignty and defence, law enforcement, public safety and emergency services).

Auction licensees are usually given the maximum flexibility to adapt to changing consumer demands, and the technologies they may offer. Spectrum policies are also pro-competitive, following two guiding principles :

- restricting market participation, based on existing market power and potential anti-competitive effects, and
- spectrum aggregation limits, again based on competition concerns.

New Zealand has also been a leader in moving its commercial spectrum management approach from its historical administrative assignment process under the radio licence regime to the management rights regime. The central guiding document summarizing policy in New Zealand,[42] whilst dated 2005, was somewhat prescient in the opportunities and tensions foreseen in commercial mobile and broadcasting technology developments in the future. The document contained observations on convergence, and the potential need for a comprehensive audit (equivalent to the inventory concept introduced earlier) to identify inefficient utilization to resolve a perceived shortage of commercial spectrum, and for achieving social and cultural objectives. As these examples show, a market-based approach is a common, even necessary element of a National Spectrum Policy. In practice this would comprise a combination of techniques involving administrative allocation methods, market-oriented assignment methods, and license-free operation in proportions which reflect national needs and priorities. Table 4 provides some insight into the popularity of the various techniques used to achieve public policy goals in a recent study of the Americas.[43]

Table 4: Various spectrum management techniques from the Americas

SPECTRUM MANAGEMENT TECHNIQUES	COUNTRIES
Specific coverage obligations	Colombia, Chile, Brazil, Costa Rica, Peru
Use of spectrum caps	Argentina, Brazil, Chile, Colombia, Mexico, Peru
Spectrum trading rights	USA, Mexico, Chile, Uruguay
Flexible use spectrum policies	Argentina, Brazil, Chile, Colombia, Peru, Uruguay, USA, Venezuela
Development of incentive auctions	USA
Development of “Unlicensed” or “license-exempt” rules	USA, Canada, Brazil, Argentina, Chile, Colombia, Costa Rica, Panama, Paraguay, Uruguay, Venezuela.

Source: Regulatory Impact of Convergence and Broadband for the Americas”. Connect Americas Summit, July 2012, **ITU**

The role of economics: efficient management of spectrum

As policy-makers and regulators seek to balance competing interests, it will be important to clearly indicate how the different uses of spectrum will be evaluated in the context of larger national communications and economic goals. Many governments are turning to market-based valuation methods to help them manage spectrum more efficiently.

The terms "highest value use" and "total welfare standard" have gained traction in economic evaluation of spectrum. However, whilst conceptually straightforward, this is a very difficult issue. A problem lies in establishing "value" on a comparable basis in a diverse user environment. Spectrum that will be used purely for commercial activity is relatively straightforward; comparisons can be made to past auctions, for example. The question often asked, though, is whether and how value should be ascribed to safety of life services, or the use of spectrum for scientific pursuit, or for experimentation with new technology, or the use of spectrum in defence of a country, etc.

With regard to repurposing spectrum, the United Kingdom has employed Administrative Incentive Pricing (AIP) for commercial and government spectrum to signal market value to spectrum users so that they have the incentive to ensure optimal use of their spectrum.[44] This approach has had its intended impact on government spectrum holders – the military in particular. Here, spectrum costs are now included in business cases for major programs, long term spectrum need plans are developed, and some unneeded spectrum has been transferred to other uses.

Significant effort has been expended to develop an economic estimation of the value of spectrum, and this still remains the most viable approach for commercial applications of spectrum pricing and marketing. An economic base of thought also provides the best starting point for comparable valuation of non-commercial applications of spectrum. It is extremely unlikely, for example, that any other methodology other than market forces (or a proxy such as AIP) will be used to distribute 3G and 4G spectrum, at least in countries where spectrum access is constrained and the marketing processes allow contemporary auction techniques for doing this.

However, as indicated in an ITU report on valuation of the spectrum, there are still no easy answers for comparing values among spectrum bands that continue to be used by different kinds of (commercial and non-commercial) users.[45]

It is suggested that a broader perspective may need to be taken into consideration for evaluating the social value of spectrum – the value of spectrum used for non-profit-making enterprises such as weather prediction, scientific inquiry, emergency responses or national defence. Proxies may, however, exist indirectly, for instance in unlicensed bands through observing input costs to service development.

In general, governments have no mechanism (other than general taxation) to "charge" citizens for spectrum used in the interests of the common good. Until this disconnect is resolved, spectrum value will continue to have multiple meanings - one for making money, and one for making policy.

Despite this, some progress is being made. In the United Kingdom, the use of AIP by Ofcom may widen to applications beyond Defence. Tools involve a gradual introduction of taxation, coupled with starting points assisted where possible by intrinsic and extrinsic factor analysis, and using the concepts of opportunity costs and marginal costs where feasible. Moreover, current work by Marcus[46] and Marks[47] addresses the different forms of efficiency and metrics in the use of spectrum. This is part of a European spectrum inventory exercise, and should lead on to better solutions for comparing dissimilar users.

According to the studies, the different forms of efficiency involve:

- technical efficiency
- economic efficiency, and
- social efficiency

No single metric can fully capture efficiency (in the use of spectrum) in any of these dimensions, and an efficiency metric must be understood in the context of the application for which it was designed.

The EC vision is that data on economic and social values will be evaluated for all bands (in the range 400MHz to 6GHz) using metrics for economic *and* social efficiency. In this way, bands under significant pressure will be identified and policy options proposed to improve spectrum efficiency.

Marks points out that there are no precedents for the metrics approach envisaged and data may be incomplete. However, she expects indications of opportunities for significant improvement in the efficiency of use resulting from the analysis undertaken, and this should assist regulators with the difficult exercise of meeting demand for spectrum.

3.5 A strategy of international and regional engagement

The enormous changes occurring in mobile broadband and the accompanying evolution of spectrum policy are international in scope. It is therefore critical to have a strategy of engagement in regional and international considerations to the greatest extent possible.

At the international level, the ITU provides a common venue where all Member States can participate in the work of allocating spectrum for new uses and developing standards and plans that maximize the harmonized use of the spectrum resource. As the top level of the spectrum allocation process, the ITU thus plays a critical role in promoting harmonization among the regions of the world—ensuring that services can coexist with each other, while minimizing interference.

The work of the ITU-R sets much of the stage for international harmonization and collective guidance on regulatory and technical matters, ranging from the WRCs to the Working Parties within individual Study Groups that pursue the technical basis for the evolving wireless world - both terrestrial and satellite. The ITU has been particularly active in addressing mobile broadband issues. More information on ITU-R IMT mobile broadband studies is given in Box 6.[48] The ability to efficiently accommodate demand for spectrum and contain interference to acceptable levels depends critically on these studies, which were set in motion by WRC-12. The ensuing ITU-R Reports and Recommendations will form an essential basis for the development of national regulations.

Box 5: IMT work plans in ITU-R resulting from WRC12 decisions

Many of the spectrum regulatory tools and techniques (such as sharing criteria, antenna technology advances, software defined and cognitive radio, radio network architectures), to efficiently accommodate new technology and service advances will be studied in ITU-R Study Groups during the next 4 years, culminating in inputs to the ITU World Radiocommunication Conference to be held in 2015 (WRC-15). At WRC-15, new spectrum allocations will be considered with a view to incorporating agreements into the Radio Regulations (which have treaty status), and attendant Resolutions and Recommendations. Back-to-back with this will be the Radiocommunications Assembly (RA-15) which deals with non-treaty technical matters from Study Groups, and which may produce technical output documents of a voluntary nature. Some of these considerations may flow into WRC-15.

In association with these meetings is the Conference Preparatory Meeting (CPM) which meets twice between each WRC. CPM-15 first met immediately following WRC-12 and amongst other things organized the detail and timing of the work activity of the ITU-R Study Groups with regard to WRC-15 Agenda Items. The second meeting of CPM-15 will meet approximately 7 months ahead of WRC-15 in order to evaluate and catalogue the alternative solutions (or methods) to satisfying each agenda item. These alternatives come from the Study Groups, and are then presented to the WRC for its consideration.

WRC-12 (and the following CPM-15) was instrumental in setting up an additional and important activity on "IMT-Advanced" through a Joint Task Group (JTG4-5-6-7) which will progress its work on identifying spectrum for broadband applications and sharing studies towards the next CPM-15 Meeting.

JTG 4-5-6-7 is important because it captures much of the intersecting interest (and conflict) in the spectrum needs of the bourgeoning terrestrial mobile broadband sector and the existing services. The elements for study by the JTG are contained under Agenda Items 1.1 (see Section 2.2 earlier) and accompanying Item 1.2 for WRC-15, which are explained in an ITU-R Circular Letter.

The IMT studies to be conducted before WRC-15 should assist regulators in identifying the spectral efficiencies (and hence the actual spectrum needed) that should be expected as a result of advances in modulation techniques, antenna designs, offloading between different radio networks, coding efficiencies etc. These studies will also indicate potential candidate bands that may be used for the next generation of broadband services.

Source : ITU.

Engagement at the regional level is also critical for ensuring that spectrum is most efficiently utilized. Regional organizations are important venues for developing policies that will promote harmonization among neighboring countries. In addition, regional preparations for the WRC and RA Meetings provide a convenient way for many countries to stay abreast of developments in efficient use of spectrum. A series of preparatory meetings hosted by regional bodies also allows neighboring countries the opportunity to dialogue on border issues and to share similar experiences and promote harmonization. These opportunities also create a context for the ongoing refreshment of the National Spectrum Plan and associated forecasts.

Border coordination between individual countries addresses geographic overlaps and potential interference scenarios. Agreed signal/power levels need to be coordinated. These levels should reflect ITU-R outputs, which represent an agreed international technical basis and which can be drawn on during negotiations.

Further development of national policies and regulatory solutions that encompass the broad social, economic and technical considerations are benefitting from regional cooperation. The significance of this work has been pointed out from within Europe in pathfinding efforts there.

Box 6: Wireless Broadband Master Plan Pilot Project

A recent ITU presentation points out a key assumption that shared wireless access permits lowering of the costs of access in an easier way than fixed networks. Upgrades to WBB are also simpler, and consumers can buy services on an incremental (often pre-paid) basis. The presentation also stated that it is unlikely that for many emerging markets there will ever be fixed network deployment at a level comparable to developed countries. The WBB Master Plans are intended to address these issues and provide guidance.

Based on a survey of the circumstances in 18 countries in the Asia Pacific, four countries were chosen for a WBB Master Plan pilot project: Myanmar, Nepal, Samoa, and Vietnam. Important observations have been made based on the pilot projects (see Reference 30). The goals of affordable universal WBB services that address the "digital divide" in emerging countries, and the effective use of regulatory tools to achieve a key policy objective, will be met if:

- competition and market structure is optimised ahead of revenue raising;
- ample spectrum is made available and its use is flexible;
- technology innovations are able to be deployed;
- infrastructure is not duplicated and there is service competition on that infrastructure;
- prices (if regulated) should take into account the market and changes driving that market; and
- universal service schemes are efficiently delivered and well targeted.

Source: Sameer Sharma. ITU Regional Office for Asia and the Pacific, International Training Program. "Wireless Broadband Master Plan : Introduction, Survey Results and Outcomes". 2-4 April 2012, Hyderabad, India.

Pathfinding efforts are not restricted to developed countries. Solutions are also being developed to meet the specific circumstances of developing countries. Under the joint partnership of the ITU and the Korean Communication Commission, for example, the *Wireless Broadband Master Plan* project was launched in Q2 2011 (see Box 7). The aim is to assist selected developing countries in the Asia Pacific region to develop their own wireless broadband master plan in order to provide for broadband supported services and applications that are affordable and comparable to those in developed countries. In essence, the goal is to address the "digital divide" by utilizing wireless broadband (WBB) technologies.

On a broader harmonization front, the GSMA has released a report on the importance of harmonized allocation of spectrum on a regional basis in the 700 MHz bands a result of the digital dividend.[49] The report estimates that the adoption of harmonized spectrum for mobile broadband in the Asia-Pacific region could generate up to US$1 trillion in GDP growth between 2014 and 2020. The GSMA reports that Japan and Papua New Guinea are likely to be the first countries to hold spectrum auctions in the band, while Australia and New Zealand are expected to be the next batch of countries to open the spectrum to mobile operators. Within the Asia-Pacific region, most countries have heeded the harmonization lesson, and only Malaysia and China remain currently undecided on the 700 MHz band.

The consequences of a non-harmonized approach can be significant. The United Kingdom and Spain, for example, were early movers in digitizing their broadcast services in order to free up 800 MHz digital dividend spectrum. This was accomplished in advance of regional harmonization. Both countries were subsequently faced with the need to redeploy some channels so as to harmonize with the rest of Europe. In the United Kingdom, this resulted in up to 350million pounds in redeployment and interference mitigation costs.

4. Conclusions

The first section of this paper set the scene for an assessment of spectrum policy making and regulation in an environment in which there is increased pressure on the scarce resource of spectrum, arising especially from the need to service mobile broadband and the phenomenal increase in data traffic expected in the future. The greater inclusiveness of spectrum management in broader industry and economic activity, including being an integral part of national broadband planning means that the modern spectrum regulator needs to be more broadly aware of the industry and market atmosphere and developing issues which are outlined in the section 1. This leads to the notion of the "third generation regulator".

Spectrum policy has high-level principles that are durable in nature. Section 2 summarizes these principles as :

- Facilitate broadband deployment.
- Promote transparency.
- Ensure technology neutrality.
- Apply flexible use measures.
- Ensure affordability.
- Make spectrum available on a timely basis.
- Manage spectrum efficiently.
- Level the competitive playing field.
- Harmonize (International and Regional) policies.
- Take a comprehensive approach to promoting broadband access

More dynamic change with time is associated with implementation of these principles. This leads to contemporary best practice, the elements of which include:

- wider recognition, visibility and accountability of the spectrum function;
- a taxonomy of spectrum needs;
- a National Spectrum Plan and rolling annual consultation;
- a Marketing Program for allocation of spectrum; and
- a strategy of international and regional engagement.

Best practice is expressed in implementation of stable high-level principles, and is demonstrated through pathfinding examples that are embedded within this report.

Regarding whether National Spectrum Policy measures up to best practice, this can be evaluated with a series of considerations or tests. For example, do the initiatives –

- Encourage regional and international harmonization of spectrum?
- Promote efficient use of spectrum?
- Balance public and commercial interests?
- Promote greater competition?
- Provide flexibility in use of spectrum for different users and needs?
- Encourage and reward use of new and efficient technologies?
- Utilize the latest spectrum management principles?
- Demonstrate international cooperation?

REFERENCES

1. 4G Americas : White Paper "New Wireless Broadband Applications and Devices: Understanding the Impact on Networks". May 2012.
2. The World in 2011. ITU ICT Facts and Figures.
3. Gary Schwartz. "the Impulse Economy : Understanding Mobile Shoppers and What Makes Them". Atria Books. October 2011.
4. Cisco : VNI Mobile Forecast Highlights, 2011 – 2016. www.cisco.com/web/solutions/sp/vni/vni_mobile_forecast_highlights/index.html.
5. Guillermo Escofet, Informa Telecoms & Media. "Mobile Content and Applications Report". May 15 2012.
6. Tellabs Study. "Mobile Operators Profitability Challenged within Three Years". Feb 2011. http://www.tellabs.com/news/2011/index.cfm/nr/142.cfm
7. Google/Ipsos. "Our Mobile Planet : Understanding the Mobile Consumer". May 2012. www.thinkwithgoogle.com/insights/tools/our-mobile-planet-tool.
8. ict regulation toolkit. ITU infoDev. Module 2 : "Competition and Price Regulation". www.ictregulationtoolkit.org
9. Administrative Circular CA/201. ITU Radiocommunication Bureau. 19 March 2012. "Results of the first session of the Conference Preparatory Meeting for WRC-15 (CPM-1).
10. GSR11 "Best Practice Guidelines on Regulatory Approaches to Advance the Deployment of Broadband, Encourage Innovation and Enable Digital Inclusion for All". Colombia October 2011.
11. GSR5 "Best Practice Guidelines for Spectrum Management to Promote Broadband Access". Yasmine Hammanet, Tunisia. November 2005. See also http://www.itu.int/ITU-D/treg/Events/Seminars/2003/GSR/WSIS-Statement.html for broader ramifications.
12. Spectrum Policy in the Age of Broadband :Issues for Congress. Linda K. Moore, Congressional Research Service. 21 June 2012.
13. FCC National Broadband Plan, Chapter 5: Spectrum. March 2010 http://www.broadband.gov/download-plan/
14. Presidential Memorandum, USA, June 2010. "Unleashing the Wireless Broadband Revolution". http://www.whitehouse.gov/the-press-office/presidential-memorandum-unleashing-wireless-broadband-revolution
15. U.S.Department of Commerce. March 2012. "An Assessment of the Viability of Accommodating Wireless Broadband in the 1755 – 1850 MHz Band" http://www.ntia.doc.gov/files/ntia/publications/ntia_1755_1850_mhz_report_march2012.pdf.
16. FCC Order on unlicensed operation in the broadcast TV bands. November 2008. http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-260A1.pdf
17. John Alden, Freedom Technologies. Report to ITU-D, April 2012. "Exploring the value and economic valuation of spectrum". www.itu.int/broadband.
18. World Bank InfoDev Report. November 2003. "The Wireless Internet Opportunity for Developing Countries". www.infodev.org/en/Publications.24.html
19. Five Year Spectrum Outlook 2012-2016 : *The ACMA's spectrum demand analysis and strategic direction for the next five years.* Australia 2012. www.acma.gov.au
20. Australian Government. "Convergence Review : Final Report". March 2012. www.dbcde.gov.au
21. ACMA. "Broken Concepts : *The Australian communications legislative landscape*" August 2011 and "Enduring Concepts : *Communications and media in Australia*" November 2011. www.acma.gov.au
22. European Commission Workshop. "Inventory and review of spectrum use : Assessment of the EU potential for improving spectrum efficiency". Brussels, May 2012.

23. J.Scott Marcus, WIK Consult-GmbH. “Inventory review of spectrum use : Preliminary Findings”. Ibid.
24. Philippa Marks, Plum Consulting Ltd. “Inventory review of spectrum use : Evaluating the Economic and Social Efficiency of Spectrum Use”. Ibid.
25. Lena Liman, Swedish Post and Telecom Authority. “Spectrum strategy work in Sweden”. Ibid.
26. Government of Canada. “SPFC – Spectrum Policy Framework for Canada”. June 2007. www.ic.gc.ca/spectrum
27. Red Mobile/PA Consulting, 2012. “Study of Future Demand for Radio Spectrum in Canada 2011-2015. www.ic.gc.ca/spectrum
28. ict regulation toolkit. ITU infoDev. Module 5 : “Radio Spectrum Management”. www.ictregulationtoolkit.org
29. Sameer Sharma. ITU Regional Office for Asia and the Pacific, International Training Program. “Wireless Broadband Master Plan : Introduction, Survey Results and Outcomes”. 2-4 April 2012, Hyderabad, India.
30. Scott Minehane. Ibid. “Wireless Broadband Master Plan – II”.
31. Ministry of Economic Development, New Zealand. “Review of Radio Spectrum Policy in New Zealand”. 2005.
32. Marianne Treschow. “Spectrum Policy in Sweden”. Private communication.
33. KCC Annual Report. March 2011. See http://eng.kcc.go.kr
34. KCC Plan for 2011.
35. Ofcom “Spectrum Review Framework : A consultation on Ofcom’s views as to how radio spectrum should be managed”. November 2004. http://stakeholders.ofcom.org.uk/consultations/sfr
36. Ofcom “SRSP: The revised Framework for Spectrum Pricing: Our policy and practice of setting AIP spectrum fees”. December 2010. http://stakeholders.ofcom.org.uk/spectrum/spectrum-pricing/
37. Ofcom “Appendix A (to SRSP consultation document): Our current practice in setting AIP fees”. Ibid. March 2010.
38. Regulatory Impact of Convergence and Broadband for the Americas”. Connect Americas Summit, July 2012. ITU.
39. Main Characteristics of a National Spectrum Policy. Mercy Wanjau, Kenya Communications Commission. Private Communication.

[1] The paper was edited by David Wye, TMG.

[2] See Reference 7.

[3] Trends in Telecommunications Reform 2012. ITU-D.

[4] www.pyr.com. June 2012.

[5] http://www.ericsson.com/au/res/region_RASO/docs/2010/ericsson_50_billion_paper.pdf

[6] See Reference 1.

[7] See Reference 2 and www.http://www.itu.int//ITU-D/ict/statistics/index.html

[8] See Reference 4.

[9] See Reference 6.

[10] See pbc@budde.com.au Newsletter 31/7/2012.

[11] An important source of regulatory advice comes from the ITU's *Telecommunications Regulation Handbook,* which is divided into several modules. Module 2 (Competition and Pricing – Reference 8) was significantly re-written in 2011 and this section summarises some of the new lessons. Module 5 is also important.

[12] These attempts include considerations in GSR05 of best practice guidelines, the ITU Handbook of Spectrum Management, Module 5 of the ITU infoDev ICT Regulation Toolkit,and the work of ITU-R Study Groups (see for instance current work in ITU-R SG1 WP1B, Temp Docs 3, 5 and 6).

[13] When they were last examined in detail within the GSR community.

[14] See Reference 11.

[15] See Reference 10.

[16] See the GSR11 Best Practice Guidelines on regulatory approaches to advance the deployment of broadband, encourage innovation and enable digital inclusion for all, www.itu.int/bestpractices

[17] Rate of return (regulation)

[18] See Reference 13.

[19] See Reference 14.

[20] The NTIA administers federal government- used spectrum, whilst the FCC has responsibility for commercial and other uses.

[21] See Reference 15.

[22] ITU ICT Eye : http://www.itu.int/icteye

[23] ACMA is the Australian Communications and Media Authority

[24] See Reference 22.

[25] EFIS(ECO Frequency Information System) is the tool to provide harmonised availability of information regarding spectrum use in Europe. 42 CEPT countries are represented in EFIS.

[26] See Reference 26.

[27] See Reference 25.

[28] See Reference 12.

[29] See also ITU Trends 2008.

[30] See Reference 16.

[31] See Reference 20.

[32] See Reference 21.

[33] As at the time of writing the USD and AUD were almost on a par.

[34] See Reference 18.

[35] Spectrum (secondary) Trading. ITU ICT Eye : http://www.itu.int/icteye

[36] See Reference 38.

[37] As presented in ITU Trends 2012.

[38] See http://www.itu.int/itu-D/treg/publications/bbreports.html

[39] ITU Telecommunication/ICT Regulatory Database, www.itu.int/icteye

[40] These involve compensation to an incumbent for relocation or displacement in order to allow higher value use of the spectrum.

[41] See Reference 26.

[42] See Reference 31.

[43] See Reference 38.

[44] See http://www.itu.int/itu-D/treg/publications/bbreports.html

[45] See Reference 17.

[46] See Reference 23.

[47] See Reference 24.

[48] http://www.itu.int/ITU-R/index.asp?category=information&rlink=rhome&lang=en

[49] www.mobilebusinessbriefing.com/articles/apac-spectrum