UMTS Forum

A White Paper from the UMTS Forum

Spectrum for future development of IMT-2000 and IMT-Advanced

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Executive Summary

Data traffic on mobile networks continues to grow, demonstrating the immense global importance of mobile broadband as a key socio-economic enabler. Meeting this unabated growth in demand urgently requires the identification by the International Telecommunication Union (ITU) of additional spectrum for International Mobile Telecommunications (IMT) networks.

Drawing on previous studies, industry association the UMTS Forum (www.umts-forum.org) argues in this paper that:

- The World Radiocommunication Conference 2012 (WRC-12) should adopt an Agenda Item for WRC-15, allowing the identification of additional IMT spectrum;
- The ITU Radiocommunication Sector (ITU-R) should conduct during the next study period (between WRC-12 and WRC-15) thorough studies on future IMT spectrum requirements;
- The ITU should urge countries to co-ordinate their actions in order to harmonise IMT spectrum both before and during WRC-15.

Introduction: facing up to the mobile data explosion

Mobile broadband (MBB) has become the most important enabling platform for innovative services and user applications. Triggering significant and lasting socio-economic growth, these services and applications are changing the way we live.

The benefits of mobile broadband services are not limited to a fortunate few. On the contrary, they extend to a significant proportion of the world's population. Today there are more than 1 billion 3rd Generation (3G)/Universal Mobile Telecommunications System (UMTS) subscriptions (January 2012), and more than 5 billion mobile subscriptions leveraging the Third Generation Partnership Project (3GPP) technology family. Mobile broadband has become the all-inclusive platform of progress.

Given the fast-growing relevance of mobile broadband, it is little surprise that data traffic on mobile networks is exploding. This traffic growth illustrates powerfully the importance of MBB to individual citizens and economies. However, it is also a challenge to mobile operators. There is unrelenting pressure on mobile networks to become more efficient and more densely deployed in response to this organic traffic growth. While these two strategies have already been extensively applied, they are today becoming increasingly constrained by technical and practical boundaries.

UMTS Forum: supporting UMTS/IMT and mobile broadband development

An industry expertise in traffic prediction and spectrum requirements

Previous UMTS Forum studies played a key role in the preparations for WRC-2000, which identified the 2.6 GHz band for IMT-2000. For WRC-07 preparations, the UMTS Forum played an active role by providing administrations with the best possible information on the development of mobile networks. In 2005, UMTS Forum Report 37 (Magic Mobile Future 2010-2020) [1] concluded that mobile traffic would increase by a factor of 23 between the years 2012 and 2020. As such, this study provided an early warning about the huge volume of data that is already starting to flood the mobile networks. Following this call to action, in 2006 UMTS Forum Report 40 (Development of spectrum requirement forecasts for IMT-2000 and systems beyond IMT-2000 (IMT-Advanced)) [2] analysed spectrum demand, concluding that a total of around 1600 MHz of spectrum is required for IMT networks by 2020, including the spectrum already allocated at WARC-92 and WRC-2000.

Reports 37 and 40 were provided respectively as inputs to the 2005 ITU-R Report M.2072 on world mobile telecommunication market forecast [3] and 2006 ITU-R Report M.2078 on estimated spectrum bandwidth requirements for the future development of IMT-2000 and IMT-Advanced [4]. ITU-R Reports M.2072 [3] and M.2078 [4] were drafted in preparation for WRC-07. Most significantly, ITU-R Report M.2078 [4] concluded that between 1280 MHz and 1720 MHz of spectrum are required for IMT by year 2020.

During WRC-07, countries and administrations recognised the need for additional IMT spectrum and identified new bands for IMT. Though significant progress has been achieved since WRC-07, the spectrum currently identified for IMT networks is still far below the amount recommended in ITU-R Report M.2078 [4]. The identified amount of IMT spectrum varies between 664 MHz and 947 MHz depending on the Region, when the calculated minimum spectrum demand is 1280 MHz.

The UMTS Forum not only supports the discussion on the amount of IMT spectrum required, but also provides its best support to administrations in order to identify such new IMT spectrum.

In 2007, the UMTS Forum commissioned a study (ATDI Study, [5]) that was distributed during WRC-07, showing the technical feasibility of creating a 112 MHz sub-band in several countries in the upper part of the UHF band (between 750 and 862 MHz). The aim of such a sub-band was to promote advanced mobile broadband services while ensuring that national digital terrestrial television broadcasting requirements were still fulfilled (i.e. that the possibility of rolling out 7 national Digital Terrestrial TV layers per country was maintained, in line with the Geneva 06 Agreement [6]).

The concept of such a sub-band was adopted by ITU Region 1, which allocated the 790-862 MHz range to mobile on a co-primary basis. The European Conference of Postal and Telecommunications Administrations (CEPT) then adopted a harmonised frequency arrangement for mobile, the so-called 800 MHz band [7].

Daily mobile traffic per subscription	2010	2015	2020
Mobile Broadband (MB per day)	10	155	294
Dongles (MB per day)	26.7	265	503

Table 1: Daily mobile traffic per mobile broadband and dongle subscriptions – representative European country
Source: IDATE

Finally, we anticipate total worldwide mobile traffic of 351 EB in 2025 representing a 174% increase compared to 2020."

ITU-R study on IMT forecasts

Given the rapid evolution of mobile broadband traffic, the ITU decided to conduct an assessment of the global mobile broadband deployments and forecasts for IMT, published as ITU-R M.2243 Report [10].

This report not only stresses the importance of the growth of the traffic in the past few years, but also provides an overview of consolidated forecasts of mobile broadband traffic on a worldwide basis.

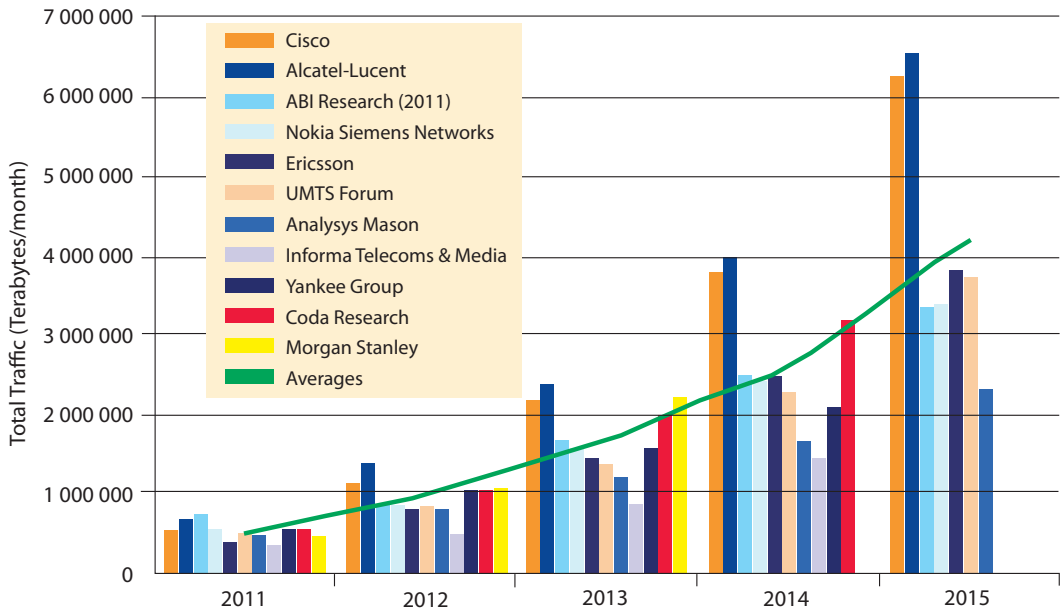

Figure 3: Mobile global data traffic estimates 2011-2015 based on multiple sources
Source: ITU-R M.2243 Report [10]

The commercial success of 3G around the world is unarguable, with 3GPP/UMTS representing the leading standard. This appetite for mobile broadband is illustrated by a global total of more than 1 billion subscriptions (January 2012) to the 3GPP family of IMT-2000 mobile systems.

Spanning Wideband CDMA (WCDMA), High Speed Packet Access (HSPA)/HSPA+ and Long Term Evolution (LTE) networks, this 1 billion figure represents almost a fifth of the global total of all mobile connections, numbering over 5 billion GSM/3GPP family subscriptions plus an estimated 0.5 billion CDMA2000 subscriptions.

Of almost 400 3GPP-family networks worldwide[5], the vast majority have now implemented HSPA that gives data speeds in the 2-14 Megabits per second (Mbps) range. Furthermore, around 140 networks are using HSPA+ technology to deliver even higher peak theoretical speeds of up to 42 Mbps for their customers.

After the first LTE networks launched commercially in December 2009, commercial LTE deployments now number over 50 networks, with over 150 operators committed to launch the technology. In a second step, Fourth Generation (4G)/LTE-Advanced was standardised by the end of 2011 and will be commercialised by 2015, promising peak data rates in the range of 1 Gigabit per second (Gbps).

Taking the end of 2009 as "Year Zero" for commercial LTE deployments, there are fast approaching 10 million LTE subscriptions. And while forecasts vary, some observers predict that LTE subscriptions will ramp up faster than the birth of 3G a decade ago. As the classical constraints on consumer uptake are removed – notably terminal availability and pricing – it is widely anticipated that demand for LTE will hit mass-market volumes from 2013.

Looking further ahead, market analyst IDATE forecasts that by the end of 2015 there will be around 400 million LTE subscribers worldwide, which confirms the figure already forecast in 2008 by UMTS Forum/Analysys Mason in the report, Market potential for LTE. Asia-Pacific will be the leading market with some 180 million subscribers, followed by North America (95 million), Western Europe (85 million) and Eastern Europe (20 million).

This insatiable demand for mobile broadband is further underlined by changing user behaviours. The smartphone has become a focal point for many people's digital lives, displacing the PC as the primary means of accessing the Internet. Facebook claimed in October 2011 that 350 million of its 800 million worldwide users are accessing the social networking site via their mobile device.

As these figures amply demonstrate, mobile has become the largest and most sociologically significant technological platform in the history of mankind, ahead of even PC adoption and fixed-line telephone networks. Mobile devices are, quite simply, our entry point to the digital world and the centre of our digital lives.

[5] Source: Wireless Intelligence

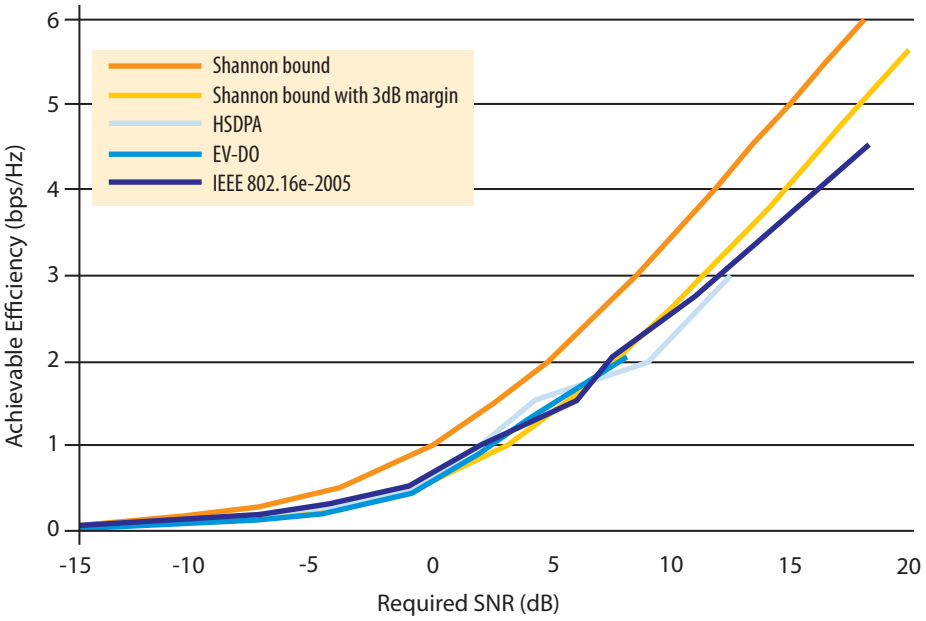

Figure 7: System performance and theoretical limits
Source: 4G Americas, September 2010

Since the latest IMT air interfaces are operating very close to the capacity of given channels, the only possibility to introduce systems with higher performance is to operate on channels with higher capacities. The Shannon capacity of a channel depends on three basic parameters:

- The number of antennas at both the transmitter and the receiver and the geometry of the transmission channel;
- The Signal on Noise and Interference Ratio (SINR) at the receiver;
- The bandwidth of the channel.

LTE is already leveraging the use of several antennas at both the transmitter and the receiver through the so-called Multiple Input Multiple Output (MIMO) technologies. However, the gain obtained through MIMO is limited by several factors. The number of antennas that can be deployed at base station sites and inside terminals is obviously limited. Furthermore, the geometry of the transmission channels is also important, leading to a situation where antennas that would be located too close to one another would not benefit from the MIMO effect anyway.

The SINR at the receiver is influenced by two main factors: the radiated power at the transmitter and the channel loss between the transmitter and the receiver. Since the radiated power at transmitters is limited, the only way to improve the SINR is actually to place the transmitter closer to the receiver, i.e. to increase the density of base stations in mobile network deployments. While technically sound, such an approach requires massive investment in order to improve the capacity significantly. It is therefore likely that the operator would be unable to respond to the challenge of the explosion of mobile broadband traffic only through increasing the density of mobile broadband networks.

Finally, the capacity of mobile broadband channels increases with the channel bandwidth, at constant emitted power spectrum density. This path is clearly favoured by the ITU as the requirement for 4G systems such as LTE-Advanced corresponds to transmissions over channels with 100 MHz bandwidth, compared with the 5 MHz typical bandwidth of 3G systems.

It is unlikely that the explosion of traffic can be addressed through a single solution. It is likely that MIMO technologies (i.e. new technologies), increased network density (i.e. increased investments) and larger bandwidth must be combined in order to properly address this challenge. However, it is clear that mobile broadband networks will not be able to address the rise of traffic without allocating the adequate amount of spectrum required by IMT networks.

Mobile broadband traffic growth: a unique opportunity

As detailed in the section above, mobile broadband will grow significantly in the next decade. Such rapid growth will pose significant challenges to operators and will require large resources to respond to it.

While these challenges can be daunting, it is important to remember that they only mirror the opportunities offered by mobile broadband. Quite simply, mobile broadband services and applications are changing the way we live and triggering socially responsible economic growth. For each answered challenge, the cost in terms of missed opportunities is likely to be several fold.

This explains why governments all over the world are adopting mobile broadband plans, in order to ensure that all hurdles are removed and that mobile broadband will not be artificially limited. For example, the USA's national broadband plan[8], the EU's Digital Agenda[9] and Radio Spectrum Policy Program (RSPP)[10] or Australia's National Broadband Network demonstrate the commitment of government all over the world to secure the benefits of mobile broadband services for their respective countries.

8 www.broadband.gov/

9 http://ec.europa.eu/information_society/digital-agenda/index_en.htm

10 http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/eu_policy/rspp/index_en.htm

Turning the IMT/mobile broadband potential into reality

Governments and regulators across the world understand the potential of mobile broadband and are working to allocate additional spectrum to IMT. So isn't the future secure? In reality, the ITU leadership must demonstrate that its positive actions will result in benefits for all mobile broadband users. New spectrum allocations will only bring the benefits of additional and improved services if solutions are not fragmented, but harmonised at international level.

Ensuring full availability of IMT identified spectrum
Mobile broadband users can gain immediate benefits through access to well-established terminal and user equipment ecosystems, i.e. the pre-existence of a large and diversified terminals and User Equipment (UE) commercial offering. The use of spectrum in other regions also provides immediate opportunities in terms of international roaming opportunities. As such, it is clear that the most benefits are derived through ensuring that the currently identified IMT spectrum bands are made available to commercial services to the largest possible extent.

The amount of available spectrum per region is documented in Table 2.

Region	Total spectrum available for IMT (Typical country)
APT	Between 330 MHz and 510 MHz
ASMG	Between 340 MHz and 630 MHz
ATU	370 MHz
CEPT	590 MHz
North America (CITEL)	478 MHz
Latin America (CITEL)	Between 270 MHz and 360 MHz

Table 2: Typical regional spectrum availability
It should be noted that some specific countries may be different from a typical approach in their region and may have more or less spectrum available for IMT.

An ITU study of IMT future spectrum requirements
Following the concerning report about the unexpectedly rapid growth of mobile broadband traffic and in light of the exploding number of applications, it is undeniable that the mobile broadband landscape has evolved in strides since the last World Radio Conference.

To adopt the most appropriate solutions, it is critical to base any reasoning on renewed and updated analyses of future IMT spectrum requirements. The most urgent task for the ITU to complete is an update of ITU-R Report M.2078. This will provide a clear common framework and understanding of future IMT spectrum requirements at worldwide level.

Support spectrum harmonisation at ITU level
Harmonisation of IMT frequency bands is more important than ever. While terminals are supporting more frequency bands than in the past, hardware progress is only on track with the number of bands in any given region, but fails to keep the pace of the worldwide growth of the number of bands. During the 2G era, a terminal could typically support 2 to 3 different bands, when any region would have 2 mobile bands and a world phone would only need 4 bands.

Conclusion

Mobile networks have become the largest and most sociologically significant technological platform in the history of mankind, ahead of even PC adoption and fixed-line telephone networks. Mobile devices are, quite simply, our entry point to the digital world and the centre of our digital lives. Mobile services and applications are changing the way we live, and triggering socially and ecologically responsible economic growth.

The development of these services has led to the unexpectedly rapid growth of mobile broadband traffic. The mobile data traffic in 2010 was more than 5 times greater than some of the estimates for Report ITU-R M.2072 [3]. Moreover, the data traffic being experienced by some operators today (year 2011) is even greater than some of the 2020 forecasts given in Report ITU-R M.2072 [3]. This very rapid mobile broadband traffic growth is a challenge not only to mobile network operators, but to the entire mobile broadband community: will we be able to carry the traffic and provide all the services that users are craving?

Given the extent of the challenge, it is unrealistic to expect that one single solution will solve all problems. Current mobile networks have to become always more efficient[11] and always more densely deployed[12] to respond to this growth of traffic. However, these two solutions have already been extensively applied and are more and more constrained by technical and practical boundaries. First and foremost, the identified IMT spectrum should be made fully available as soon as possible in all countries.

More generally, there is currently just not enough IMT spectrum to support the projected growth of mobile data. Additional IMT spectrum must become available to complement these early solutions. This explains why governments all over the world have been adopting mobile broadband plans, in order to ensure that all hurdles are removed and that mobile broadband will not be artificially limited.

The ITU has a unique leadership role to play in the process of identifying additional IMT spectrum. The ITU is the only body that can secure harmonisation to the largest extent possible and ensure that any new IMT spectrum is identified in a co-ordinated manner, both from a geographic and timing standpoint. The ITU should endorse the following tasks in order to ensure the continuous growth of mobile broadband services:

- WRC-12 should adopt an Agenda Item for WRC-15 allowing the identification of additional IMT spectrum;
- The ITU-R should conduct during the next study period (between WRC-12 and WRC-15) thorough studies on the future IMT spectrum requirements;
- And finally the ITU should urge countries to co-ordinate their actions in order to harmonise IMT spectrum both before and during WRC-15.

As the time interval between WRC-12 and WRC-15 is quite short, it is critical for the ITU to adopt an extremely efficient organisation to conduct the studies. Clear management, ideally relying on existing study structure, would provide the biggest chance of success for this ambitious task.

11 Through adoption of more efficient air-interface technologies.
12 Through network densification for improving capacity and offloading of the traffic.

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