UMTS Forum Report No. 38

Coverage Extension Bands for UMTS/IMT-2000 in the bands between 470-600 MHz

UMTS Forum, January 2005

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Executive summary

This Report presents the results of work that has been undertaken in the UMTS Forum on the interest to find additional harmonised spectrum for UMTS in order to provide better geographical or services coverage for UMTS/IMT-2000 in large areas of low population density, but also providing the opportunity for new and improved services. These may include such services specifically requested by subscribers in sparsely populated areas and in less developed regions.

Lower frequency bands, called here 'Coverage Extension Bands', could provide better geographical or service coverage in a more cost effective way than those bands now used for UMTS/IMT-2000. Capacity limitations, which are typically drivers for additional bandwidth or new spectrum, are usually not a problem in large areas of low population density.

In parallel, the ITU Regional Radiocommunication Conference (RRC), 2nd session to be held in May-June 2006, will establish an all-digital frequency plan for terrestrial TV broadcasting in Europe and other areas of ITU Region 1. Due to the higher spectrum efficiency of digital technology the transition from analogue to digital broadcasting is expected to set free some spectrum, suitable for coverage extension, in the band 470-600 MHz. It is expected that this released spectrum resource, the so called 'digital dividend', would present a significant amount of spectrum. This digital dividend, or parts of it, could then be allocated to Mobile Service and identified and harmonised for IMT-2000 in the next ITU World Radiocommunication Conference, taking place in 2007 (WRC-07). In some ITU Regions this band is already co-allocated to Mobile Service, therefore such an initiative would also better harmonise the allocations on a global basis.

The additional spectrum for the future development of IMT-2000 and systems beyond IMT-2000 will be decided by ITU WRC-07. In addition to the frequency requirements for the future capacity needs, the Conference preparatory work also includes the issue of lower frequency bands, i.e. the usage of frequencies below those identified for IMT-2000, for a better coverage implementation of IMT-2000 thus meeting the need in many developing countries and countries with large areas of low population density.

Results of the studies undertaken by the UMTS Forum confirm the clear benefit in terms of lower number of base station sites when providing UMTS/IMT-2000 coverage at 470-600 MHz compared to 2 GHz bands in large areas of low population density. Concerning 900 MHz bands, some benefit in terms of lower number of base station sites can still be achieved by providing UMTS/IMT-2000 coverage at 470-600 MHz compared to 900 MHz bands. The economic impact of the possible band 470-600 MHz on UMTS operators' investments makes it possible to forward benefits also for the end-users.

On the basis of studies mentioned above, the UMTS Forum has developed views and recommendations concerning the need for Coverage Extension Bands i.e. harmonised mobile spectrum in the band between 470 MHz and 600 MHz.

The UMTS Forum believes that there is a need for harmonised mobile spectrum in the band 470-600 MHz in order to provide better coverage for UMTS/IMT-2000 services in a cost effective way, particularly in large areas of low population density where revenues are typically low, too.

The UMTS Forum is interested in the possibly freed spectrum in the band 470-600 MHz for UMTS/IMT-2000 services, resulting from switchover to digital TV broadcasting. Actions would be necessary at the 2nd session of the ITU RRC to develop an appropriate broadcast frequency plan and at the ITU World Radiocommunication Conference (WRC-07) to modify allocations to include the mobile services in these bands, where such an allocation does not currently exist.

Recommendation 1

ITU RRC should develop the new digital broadcasting plan so that the digital dividend, resulting from digital switchover, is harmonised within the band 470-600 MHz. The UMTS Forum supports to use this harmonised digital dividend, or parts of it, for Mobile Service.

The additional spectrum for the future development of IMT-2000 and systems beyond IMT-2000 will be decided in the next ITU WRC that is scheduled to take place in 2007. In preparation for the WRC-07 under Agenda Item 1.4 and its related Resolution 228, the preparatory work also includes the issue of the lower frequency bands.

Recommendation 2

The UMTS Forum supports identification of a new Coverage Extension Band on lower frequency bands for IMT-2000, to cover part of WRC-07 Agenda Item 1.4 and its related Resolution 228. This new Coverage Extension Band should be allocated on a primary basis to Mobile Service in all three ITU Regions and identified for terrestrial IMT-2000.

The amount of spectrum to be identified for UMTS/IMT-2000, as a Coverage Extension Band, should have the potential to satisfy coverage needs of large areas of low population density. The minimum amount of spectrum needed by each operator – and the minimum spectrum that would be needed globally to offer fair, competitive conditions between mobile operators and fulfilling the particular needs of developing countries – needs to be studied.

With 2x30 MHz and based on existing 5 MHz channelling, it could be possible to have three UMTS operators each having 2x10 MHz. This would provide a viable business case for operators and balanced competition. Also with 2x30 MHz, the band can be considered wide enough to be interesting from vendors' point of view. This spectrum amount can also facilitate 'greenfield' operators in some emerging markets, such as Africa.

Recommendation 3

The UMTS Forum considers that 2x30 MHz of paired spectrum would provide a viable minimum Coverage Extension Band for UMTS/IMT-2000.

1. INTRODUCTION

Current mobile services have been, and still are being, very successfully deployed in many countries and their use is growing at a rapid pace in many regions. Continued standardisation and service development provide users with new capabilities. Due to lack of lower frequency bands, large geographical areas with low population density are, however, every so often deprived of advanced mobile communication services. The following shows how coverage and services can be extended to these under-served areas in a cost efficient way by utilizing the 'digital dividend' resulting from switchover to digital broadcasting (TV).

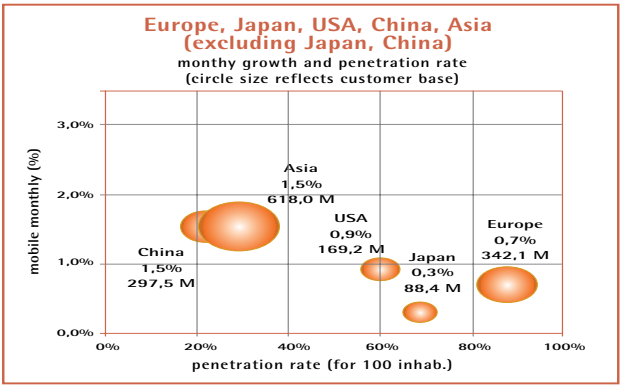
1.1 GSM is a world-wide deployment success – lack of lower bands hinders covering the whole of the population

More than one billion people (September 2004), almost one in six of the world's population, are now using GSM mobile phones. This has been reached only 12 years after the commercial launch of the first GSM networks. Now adopted by more than 200 countries and territories, GSM has become the main global standard for mobile communications. For 80 % of all new mobile customers, GSM has driven wireless take-up to the extent that mobile phones now outnumber fixed telephone lines globally (ref. Feldmann V., Mobile overtakes fixed: Implications for policy and regulation, ITU, year 2003).

GSM is rapidly approaching market maturity in more established mobile markets where significant penetration levels (85 – 95 %) have been reached. In these markets, the focus is now on the introduction of richer end-user services. The biggest share of the GSM market growth is now in the still emerging markets, primarily China, but also in some other Asian Countries, such as India, as well as in Russia, Africa and South America.

For example, in China operators attract 4 to 5 million new customers per month and the GSM user base has passed 290 million, exceeding that of the United States (see Figure 1). And in Russia, every month a million Russians acquire a mobile phone, driving up the penetration rate from 14% in year 2002 to 21% in year 2003. Now Russia has in excess of 50 million GSM users.

Figure 1 – Mobile monthly growth and penetration rate



Ref.: October 2004 Source: EMC

The graph above shows the size of the market of each zone (mobile customers in millions), its maturity (SIM penetration rate in the population) and its monthly growth rate (%).

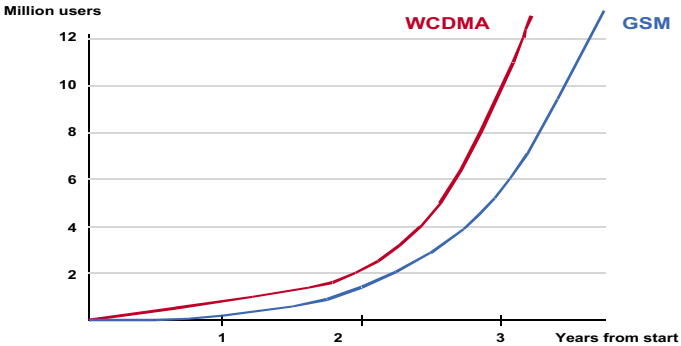
With the GSM subscriber base growing at nearly a 100% per year in the Americas in year 2003, the region will continue to power the GSM market beyond the one billion customer mark. The benefits of GSM now reach every country in Latin America, North America, and nearly all of the Caribbean. GSM is the number one choice of new customers in the Americas.

The same strengths that took GSM to the first billion - open global standards, choice and innovation - are propelling it towards further growth in mobile multimedia as well as voice, spawning new business models that will bring new uses and new users together.
However, there still are rural and sparsely populated areas in all the ITU Regions, including parts of Europe, without mobile service coverage, especially for offering mobile multimedia services. This is mainly due to the high cost of providing such coverage using the frequencies currently assigned to 2G and 3G networks.

1.2 Global UMTS/WCDMA deployment

UMTS service launches in the 2 GHz band (1920-1980 MHz/2110-2170 MHz) started in the year 2001. There are some 125 operators with UMTS/IMT-2000 license and plans to launch a network. Over 60 commercial UMTS/IMT-2000 networks, based on WCDMA technology, have already been launched serving over 16 million users worldwide (January 2005) with accelerating growth in Europe and Asia. It is worth noting, that in a relative comparison, the initial take-off of UMTS/WCDMA has been stronger than the take-off of GSM at its introduction, see Figure 2.

Figure 2 - Comparison of UMTS/WCDMA and GSM growth



Indeed, globally an important milestone to note is the growth the number of UMTS/IMT-2000 users, which was over one million in one month for the first time in June 2004.

There is a need to extend the coverage of UMTS/IMT-2000 services also to large areas of low population density. Experience shows that coverage must be comparable to that of 2G services, at least. Yet covering large areas of low population density using 2 GHz bands currently allocated to UMTS/IMT-2000 is a real challenge for network operators in terms of a viable business case, because of high investment costs and also taking into account the fact that revenues are typically low in these geographical areas.

For this reason it is in the interest of the UMTS Forum to find additional spectrum in lower frequency bands, which then could provide better geographical or service coverage in a more economical way.

1.3 Extension of UMTS/IMT-2000 services coverage in large areas of low population density

Solutions to provide coverage extension for UMTS/IMT-2000 are lower frequency bands with suitable propagation characteristics, e.g. bands below those currently identified for UMTS/IMT-2000.

According to the ITU Radiocommunication sector (ITU-R) Study Group 1 (SG1) "Digital television is approximately four times more efficient than analogue television in the broadcasting service." As a consequence, the UMTS Forum expects that the "spectrum dividend" from analogue television switch-off will represent a significant amount of spectrum, and that this spectrum or parts of it could be allocated to other (mobile) electronic communications services.

The following sections review possible coverage extension frequency bands and also the international bodies where these bands are now under discussion.

1.3.1 CEPT context

ECC activities

The European Communications Committee (ECC) has two areas where the issue of additional spectrum for UMTS/IMT-2000 is under study:

- In preparation for the WRC-07 Agenda Item 1.4 the ECC Project Team 1 (PT1) is developing a CEPT Brief and the European Common Proposals. Two areas of spectrum issues have been identified in the ECC PT1. One is the spectrum requirements for high data rate mobile applications below 6 GHz. The second is spectrum for coverage extension of UMTS/IMT-2000 networks in lower bands than those currently identified for UMTS/IMT-2000.
- The newly established Working Group RRC-06 is responsible for the CEPT preparations for the second session of ITU Regional Radiocommunication Conference (RRC). For the first meeting of the group, the UMTS Forum provided an input document (ref: WG RRC06-23) highlighting the initial view that RRC-06 should identify the spectrum dividend resulting from the switchover to digital broadcasting and that the new digital broadcasting plan should be developed by RRC-06 in such a way that the digital dividend or parts of it could be used for mobile services.

The UMTS Forum expressed its opinion to the ECC Working Group FM meeting held in April 2004 when the meeting discussed the RRC issues including proposals for a harmonised digital dividend. The Forum presented its contribution "Possible use of part of the 'digital dividend' for complementary UMTS/IMT-2000 coverage for large areas of low population density".

1.3.2 EU Context

The UMTS Forum took the opportunity to express its opinion[1] on the 'digital dividend' through the consultation concerning the spectrum implications of switchover to digital TV broadcasting. The Forum's opinions are concerning the EU Commission's objectives to retain maximum flexibility to be able to match technical and commercial development in anticipation of the second session of Regional Radiocommunication Conference (RRC). Also, according the Forum, its is important to define a frequency plan for the digital terrestrial broadcasting (TV) service that allows the introduction not only of conventional broadcasting (TV) in the new digital format, but also of other electronic communications services as a results of the 'digital dividend'.

The European Commission Radio Spectrum Policy Group (RSPG) is developing an Opinion on spectrum implications of switchover to digital broadcasting (TV). Several issues are to be covered by the Opinion, including how large the spectrum dividend from switch-off will be and how it could be allocated to various electronic communication services. Also the issues related to the simulcast period and the date for final close down of analogue transmissions are expected to be highlighted in the Opinion.

This EU initiative through the RSPG consultation process is an important step in Europe to develop a strategic regulatory approach in addition to technical considerations. A related on-going issue in the EU context is the European Commission's request for a Coordinated EU Spectrum Policy Approach concerning Wireless Access Platforms for Electronic Communications Services (WAPECS).

1.3.4 ITU context

Regional Radiocommunication Conference year 2006

Switchover to digital TV broadcasting is challenging in terms of spectrum management and calls for a revision of the existing international framework (i.e. the '1961 Stockholm plan' and its revisions). The International Telecommunication Union's (ITU) Regional Radiocommunication Conference, 1st session held in May 2004 and 2nd session to be held in May-June 2006, will establish an all-digital frequency plan for terrestrial TV broadcasting in Europe and other areas of ITU Region 1.

This is a prerequisite to facilitate the digital transition and prepare the post-switch off scenario. Decisions on spectrum aspects relating to switchover and switch-off require international co-ordination to deal mainly with interference, the efficient use of spectrum and the timing and duration of the switchover period, especially for regions where the spectrum is heavily used.

[1] UMTS Forum Response to the RSPG Consultation 'Opinion on the spectrum implications of switchover to digital broadcasting', 15th March 2004

World Radiocommunication Conference year 2007

The issue of lower frequency bands for cost efficient coverage through larger cells, initiated in year 1999 (ref: UMTS Forum Report No. 7), was supported by many developing countries at WRC-03. After an intensive debate the issue was recognised in Resolution 228 which:

- "invites ITU-R to conduct regulatory and technical studies on the usage of frequencies below those identified for IMT-2000 in No. 5.317A for the future development of IMT-2000 and systems beyond IMT-2000" and;
- recognises "the need, in many developing countries and countries with large areas of low-population density, for the cost-effective implementation of IMT-2000, the future development of IMT-2000 and systems beyond IMT-2000."

The additional spectrum for the future development of IMT-2000 and systems beyond IMT-2000 will be decided by the next WRC scheduled for year 2007. Within the Radiocommunication Sector of ITU, Working Party 8F has the responsibility for preparation of Agenda Item 1. 4 (to consider frequency-related matters for the future development of IMT-2000 and systems beyond IMT-2000, taking into account the results of ITU-R studies in accordance with Resolution 228 (Rev.WRC-03)). This preparatory work also includes the issue of the lower frequency bands.

2. THE OPPORTUNITY FOR COST EFFICIENT COVERAGE THROUGH LARGER CELLS IN LOWER FREQUENCY BANDS

The provision of UMTS/IMT-2000 services to large areas of low population density is in the interest of public mobile network operators due to customer expectations. Wide coverage is important also for society to be able to benefit from the new services on equal geographical basis. Lower frequency bands with better radio wave propagation provide better geographical or service coverage in a more cost effective way through larger radio network cells, but also offer the opportunity for new and improved services, perhaps such services specifically requested by subscribers in sparsely populated areas and in less developed regions.

2.1 The band 450-470 MHz

The band 450-470 MHz is to some extent outside of the scope of this report, but will here be addressed in brief as this band is harmonised in CEPT for PMR/PAMR services and most of it is currently in use. In many European countries this band has earlier been used for analogue cellular communications and some countries have now assigned the band for digital cellular networks (e.g. Norway, Romania, Russia, Sweden).

However, the available band within 450-470 MHz is not wide enough to support more than one UMTS network using the current 5 MHz channel width and also the band assignments for PMR/PAMR or cellular are fragmented between countries. Therefore, this band is not appropriate as a UMTS band in a competitive environment. Also, in this narrow band it is not possible to deploy all wide band technologies to provide high bit rate services.

Moreover, it is the opinion of the UMTS Forum that, if a network operator is able to address the same market as other existing operators, all operators should face the same spectrum supply conditions, regardless of the standard used. Also, the mobile market and consumers would suffer if the standards and frequency allocations are fragmented.

2.2 The band 470-600 MHz

The transition from analogue to digital TV broadcasting is expected to release a substantial amount of spectrum in the band 470-600 MHz, due to the higher spectrum efficiency of digital technology (ref. ITU-R SG1). This spectrum, the 'digital dividend', or parts of it could be allocated to e.g. public mobile communication services and harmonised for UMTS/IMT-2000 by the ITU World Radiocommunications Conference in year 2007 (WRC-07).

When establishing the new digital frequency plan for terrestrial TV broadcasting, a new approach may emerge to reflect market and technology evolution through the 'digital dividend'. The framework for spectrum assignment must therefore be set up with greater transparency and technological neutrality. This is particularly relevant in the context of convergence, where broadcasting content is delivered by broadcasting companies, as well as by fixed and mobile operators.

The mobile allocation in this band could in particular benefit developing countries, rural areas and larger areas of low population density along with its potential for long-range coverage. In addition this band has the potential for a global mobile allocation.

With an allocation of 2x30 MHz and based on existing 5 MHz channelling, it could be possible to have three UMTS/IMT-2000 operators each having 2x10 MHz. This would provide a viable business case for operators and balanced competition. Also with 2x30 MHz, the band can be considered wide enough to be interesting from vendors' point of view. This spectrum amount could also facilitate greenfield operators in some emerging markets, like Africa.

Based on the above, the UMTS Forum is recommending 2x30 MHz as a viable minimum band needed.

In Europe, the current time schedule for analogue to digital switchover varies from the years 2007 to 2015. In emerging markets like Africa, the use of this band for mobile services is not so dependent on analogue to digital switchover, since according to the information currently available, this band is less used than elsewhere (see Annex 2).

2.3 The band 900 MHz

The band 806-960 MHz was identified in ITU WRC-2000 on a worldwide basis for the terrestrial component of IMT-2000 to provide administrations with an opportunity to migrate those parts of this band that are for mobile use to IMT-2000 in the longer term.

In CEPT and the EU the band 880-915 MHz / 925-960 MHz is harmonised for GSM900. Concerning the so called extended GSM band at 880-890 MHz / 925-935 MHz, in most of European countries this extended frequency band is not in GSM usage yet, for different reasons.

In many countries on a global basis the so called primary GSM band 890-915 MHz / 935-960 MHz is intensively used by GSM systems with 3 to 4 operators in the band and typically with all available channels already in use. For the GSM operators the 900 MHz band is exceptionally important. Because of the better radio wave propagation properties in the band 900 MHz compared to the higher GSM frequency band 1710 – 1880 MHz but also compared to the higher UMTS/IMT-2000 frequency band 1920 – 1980 MHz / 2110 – 2170 MHz, it is the band enabling the operators to deploy and offer nationwide services in the most cost effective way.

It is foreseen that this primary GSM band will continue to be heavily used by GSM operators over an extended period of time, because of the positive development now going on with an increasing number of operators rolling out EDGE enhancements to their networks. Already 106 operators in some 64 countries (August 2004) are committed to deploy EDGE for delivery of data rates 3 times higher than that of GSM/GPRS. In conclusion GSM will, with its ongoing developments, continue to use the 900 MHz band for a very long time. For this reason the GSM900 band is not expected to provide an immediate and simple solution for UMTS/IMT-2000.

When considering the whole 2x35 MHz GSM900 band, it seems difficult to refarm the band for UMTS/IMT-2000 without causing difficulties for existing GSM operators and their customers.

In conclusion, refarming parts of the band 806-960 MHz, identified in ITU WRC-2000 on a worldwide basis for the terrestrial component of IMT-2000, is foreseen to take too long in most European countries in order to meet the needs to provide better coverage for UMTS/IMT2000 in large areas of low population density.

3. DETAILED ANALYSIS OF THE BAND 470-600 MHz FOR THE PROVISIONING OF UMTS/IMT-2000 SERVICE COVERAGE IN LARGE AREAS OF LOW POPULATION DENSITY

3.1 Comparison of the extension of UMTS/IMT-2000 service coverage at 470-600 MHz band compared to 900 MHz and 2 GHz bands in large areas of low population density

Mobile service provisioning in rural areas is an interesting challenge for network operators in terms of business viability. The deployment of UMTS/IMT-2000 networks in rural and low density populated areas is driven by the need to extend the geographical network service coverage and not primarily by the need to extend the network capacity needs. Capacity or capacity limitation is typically not a problem in sparsely populated areas due to low user density and typically lower traffic per user.

Lower frequency bands offer longer-range radio wave propagation characteristics than higher frequency bands and therefore would allow operators to extend UMTS/IMT-2000 network coverage to large areas with a reduced number of base station sites. This leads to lower network investment costs, especially in areas with low user density where the revenues are low.

Experience shows that in a rural large area environment, radio base station subsystem and transmission costs count for more than half of all the typical CAPEX (capitalised expenditure) of the mobile network subsystem (network switching subsystem, transmission and base station subsystem). The actual cost of a radio base station is typically only one third of total investments in base station site infrastructure, while most expenditure relates to site material and services (land, housing, mast, electricity etc.). This means that when covering large areas of low population density it is the total base station site costs that dominate, not the cost of radio base station equipment.

Basic analysis of number of base station sites on different bands

In order to estimate the benefit of the band 470-600 MHz compared to the 900 MHz and 2 GHz bands on the extension of UMTS/IMT-2000 network coverage, a study has been made to ascertain the number of base station sites needed in each band to cover the same area. The results of the study are shown in Table 1. Details of these calculations, based on radio wave propagation and link budgets, can be found in Annex 1 A.

Table 1.
Number of Base Station Sites to cover an area of 10 000 square km in different bands

Frequency Band	AMR UL/DL	64 kbps UL/DL	64 kbps UL/384 kbps DL
2000 MHz	454 sites	887 sites	1980 sites
1000 MHz	174 sites	340 sites	665 sites
500 MHz	91 sites	178 sites	304 sites

Table 1 shows that at 1000 MHz band compared to 2000 MHz band network operators could save some two radio base station sites out of every three sites (i.e. cost saving 66%) in their network deployment when covering areas of suburban and rural nature. On 500 MHz band compared to 2000 MHz band network operators could save some four base station sites out of every five sites (i.e. cost saving 80%). This results in remarkable cost savings in network investments, also because base stations subsystem and transmission costs play a vital role in determining up-front and downstream capital costs (CAPEX) as well as ongoing operating costs (OPEX) for mobile network operators.

Detailed analysis of number of base station sites on different bands

In order to analyse further the benefit of the band 470-600 MHz compared to the 900 MHz and 2 GHz bands for the extension of UMTS/IMT-2000 network services coverage in large areas of low population density, simulations of UMTS/IMT-2000 network deployment at 500 MHz, 900 MHz and 2 GHz have been performed in a rural area in France, namely in the Massif Central area. The area of the Massif Central is 63 883 km², it is located in the centre of France and it is characterised by a predominantly rural environment (see Figure 3).

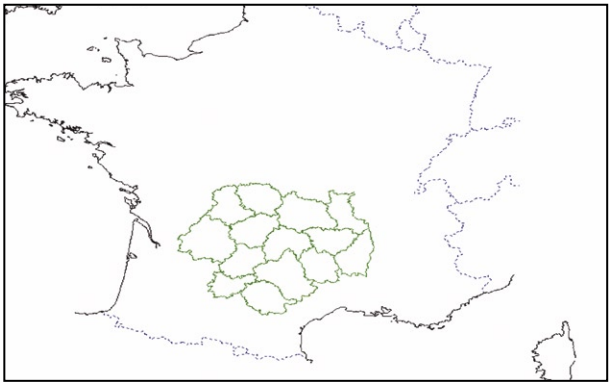


Figure 3 – Massif Central, France

The Massif Central area is also characterised by a mixed terrain profile including mountains, forest and plains (see Figure 4).

The UMTS/IMT-2000 network deployment simulations at 500 MHz, 900 MHz and 2 GHz take into account the terrain profile characteristics as well as the offered services requirements (speech, 64 kbps CSD, 144 kbps PSD and 384 kbps PSD).

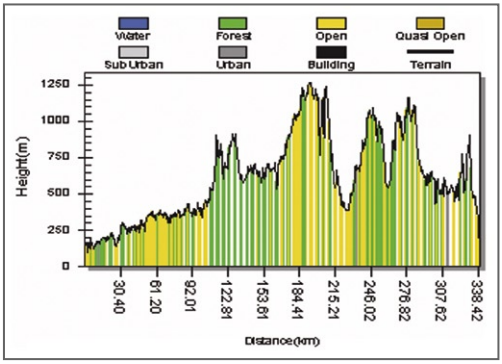
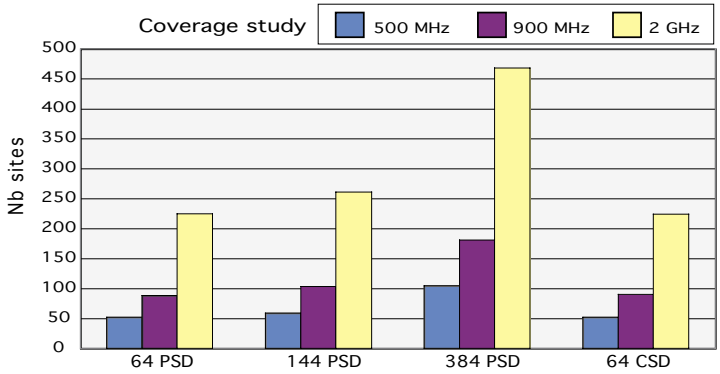


Figure 4 – Massif Central, a typical terrain profile

The technical details used in the simulations (e.g. propagation model, cell loading, various UMTS services) are detailed in Annex 1 B.

Based on the simulations made, the number of UMTS/IMT-2000 base station sites that would be needed for the coverage of the Massif Central for various services are provided below in Figure 5.

Figure 5 – Comparison of number of base stations sites at 500 MHz, 900 MHz and 2 GHz for various 3G services



The analysis performed above on the benefit of the band 470-600 MHz compared to the bands 900 MHz and 2 GHz for the deployment of UMTS/IMT-2000 in low density populated areas particularly in rural areas shows that the band 470-600 MHz allows UMTS/IMT-2000 operators to extend the coverage of their network in rural areas at significantly lower cost. UMTS/IMT-2000 operators would need to deploy some five times more base station sites at 2 GHz compared to 500 MHz and more than two times more base stations sites at 900 MHz compared to 500 MHz. This simulation result is thus consistent with the calculations in the basic analysis presented earlier.

Overall, considering the cost of UMTS/IMT-2000 base stations equipments and base stations sites (CAPEX) and the cost of the deployment and the maintenance (OPEX) of UMTS/IMT-2000 base stations sites and equipment, it could be concluded that the band 470-600 MHz would allow UMTS/IMT-2000 operators to considerably reduce their CAPEX and OPEX investments related to extension of their UMTS/IMT-2000 networks coverage in large areas of low population density.

3.2 Regional and country level information on the usage of the band 470-600 MHz

The introduction of digital terrestrial TV broadcasting (e.g. DVB-T) has started recently in some countries. Yet there are concerns that the introduction of DVB-T and the replacing of analogue TV may be delayed due to lower than expected acceptance by the users and that the date for the final close down of analogue transmissions varies between countries. This impacts on the timely availability of the expected 'digital divided'.

The ITU Regional Radiocommunication Conference (RRC) will establish a digital frequency plan for terrestrial TV broadcasting in Europe and other areas of ITU Region 1 and potentially also for the harmonised use of the 'digital dividend'.

This new plan is a prerequisite to facilitate the digital switchover and prepare for the post-switch-off scenario. Decisions on spectrum aspects relating to switchover and switch-off require coordination efforts. They are likely to be necessary both between a country using analogue television and/or using digital television in the band and another country possibly using UMTS/IMT-2000.

Concerning the ITU Radio Regulations and its frequency allocations in all three ITU Regions of the band 470-600 MHz to different category of services, especially to mobile service in addition to broadcasting, the situation is as follows:

ITU Region 1:

470-790 MHz

- Allocation to broadcasting service on a primary basis.
- Additional allocation to land mobile service, intended for applications ancillary to broadcasting, on a secondary basis in several European and in some African countries (footnote 5.296)
- Additional allocation of the band 582-790 MHz to fixed and mobile, except aeronautical mobile, services on secondary basis in Israel, Libya, Syria and Sudan. (footnote 5.300)

Case Africa

When analysing the usage of the bands 470 – 790 MHz, according to the information currently available, it appears that this band is sparsely used for broadcasting stations in most African countries, see Table 2. As an example in Cameroon only three TV channels are in use. More country level information on Africa can be found in Annex 2.

Table 2. Usage of the broadcasting bands for Television in Africa

Country	TV stations / channels
Algeria	2 TV stations including one via satellite
Angola	2 TV channels operated by Televisao Popular de Angola (TPA)
Benin	3 TV channels: Television Nationale, LC2, Golfe TV
Burkina Faso	1 TV station: Television Nationale du Burkina
Burundi	1 TV station: La Radiodiffusion et Television Nationale de Burundi (RTNB)
Cameroon	3 TV channels: Cameroon Radio Television, TV Max and ATV
Central African Republic	1 TV station: Television Centrafricaine (TVCA)
Ivory Coast	2 TV channels operated by Radiodiffusion Television Ivoirienne (RTI)
Kenya	- 3 TV channels operated by Kenya Broadcasting Corporation (KBC) - Kenya Television Network - TV station available in Nairobi, Mombasa, Nakuru, Eldoret, Kisumu - Nation TV - Nairobi-based station - Citizen TV - Nairobi-based station - Stella TV (STV) - privately-owned station - Family TV - Christian station
Mauritius	3 TV channels operated by Mauritius Broadcasting Corporation (MBC)
Mozambique	- Televisao de Mozambique (TVM) - Radio-Televisao Klint (RTK)
Namibia	- Namibian Broadcasting Corporation (NBC) - national state broadcaster - Desert TV - private station in Windhoek
Niger	- Tele-Sahel - state-run - Tenere TV - private, Niamey-based - Telestar - Niamey, subscription service
Senegal	- 1 TV channel operated by Radiodiffusion Television Senegalaise (RTS) - 3 private television channels
Seychelles	1 TV station operated by Seychelles Broadcasting Corporation (SBC)
Sierra Leone	Sierra Leone Broadcasting Service (SLBS) - terrestrial network with limited coverage
South Africa	- SABC - state broadcaster, operates three national TV networks, two pay-TV channels - e.tv - free-to-air commercial network - M-Net - pay-TV
Swaziland	1 TV channel operated by Swaziland Television Authority
Togo	2 TV stations: Television Togolaise (TVT) and Media Plus
Zimbabwe	1 TV station: Zimbabwe Broadcasting Corporation (ZBC)

ITU Region 2:
470-512 MHz

- Allocation to broadcasting service on a primary basis and to fixed and mobile service on a secondary basis.
- Different category of service to fixed and mobile service in Mexico and Venezuela and to the mobile service in Argentina and Uruguay on a primary basis. (footnote 5.292)
- Different category of service to fixed and mobile service on a primary basis in several countries e.g. the US and Canada. (footnote 5.293)

512-608 MHz

- Allocation to broadcasting service on a primary basis.
- Additional allocation to fixed and mobile services on a primary basis in several countries, e.g. the US.

Case USA

Broadcast television in the US has begun the transition from analogue to digital television (DTV). Once the digital television transition is completed, DTV stations will operate only on channels 2-51. Channels 52-69 (700 MHz Upper and Lower bands) have already been reallocated for other uses, e.g. Mobile Broadband IP services. The FCC proposed (May 2004) to allow unlicensed radio transmitters to operate in the spectrum at locations where that spectrum is not being used by television stations and has sought (August 2003) comment on rules for digital low power television ("LPTV") and television translator stations, and issues related to digital television booster stations (see Annex 2).

For more country level information of the Americas see Annex 2.

ITU Region 3:

470-585 MHz
- Allocation to fixed, mobile and broadcasting services on primary basis.

585-610 MHz
- Allocation to fixed, mobile, broadcasting and radionavigation services on primary basis.

Case Japan

Japan could be taken as a representative country for Asia. Currently the band 470-806 MHz is used for broadcasting services. However, Japan plans that the band 470-710 MHz may be used for land mobile service on and after 25th July 2012 (see Annex 2).

Case India

India is another representative country where there is possibility to consider the use of the band 470-585 MHz for mobile service already now. Requirements for fixed and mobile services will be considered in the band 470-520 MHz and may be considered in the band 520-585 MHz on case-by-case basis.

For more country level information of Asia see Annex 2.

When considering 'Coverage Extension Bands' for UMTS/IMT-2000 in the band 470-600 MHz from above it can be concluded that there is a need for global spectrum harmonisation on a primary basis to Mobile Service.

3.3. Related issues on global spectrum harmonisation

Harmonisation and resulting economies of scale are beneficial to both end-users and industry. Harmonisation facilitates the timely availability of equipment at reasonable cost.

Country or operator specific, non-harmonised solutions will require higher investments from operators and larger R&D efforts from equipment manufacturers. Multi-mode/multi-band user terminals in low volumes due to the non-harmonisation have a negative impact not only on the end-user but on the viability of the business as a whole.

Adding a new band class at 470-600 MHz to UMTS/IMT-2000 terminals increases terminal complexity and cost to some extent. If harmonisation is achieved, adding this band class is just like any other IMT-2000 band and it is up to the market to take it or not. If the new band is not harmonised the issue is more complex and costly.

A coordinated European approach to the 'digital dividend' issue, including an agreed switchover schedule, is essential. This would provide equal benefits to all European parties by contributing to global harmonisation, easy introduction of new services, economies of scale for equipment and services and increased global spectrum efficiency. It would also allow an improved frequency co-ordination in border areas between the countries in question.

The UMTS Forum strongly supports wide frequency harmonisation, preferably on a global or at least on a regional level. Spectrum at 470-600 MHz possibly released as 'coverage extension bands' for UMTS/IMT-2000 should be large enough to allow fair competitive conditions.

4. CONCLUSIONS AND RECOMMENDATIONS

End-user expectations for 3rd generation UMTS/IMT-2000 high bit-rate services include good service quality and wide geographical coverage comparable to existing mobile services. In a competitive environment network operators must deploy their networks cost effectively. In these terms covering large areas of low population density with UMTS/IMT-2000 at 2 GHz is a real challenge for network operators in terms of a viable business case, also taking into account the fact that revenues are typically low in these geographical areas.

Experience shows that for rural large area environments the base station subsystem and transmission costs account for more than half of the typical capital costs of the mobile network subsystem. The price of radio base station equipment is only a part of the total base station site cost. Actual cost of the radio base station equipment is typically only one third of total investments in the infrastructure, with most expenditures relating to base station site material and construction services.

The results of this study undertaken by the UMTS Forum confirm the clear benefit of providing UMTS/IMT-2000 coverage at 470-600MHz compared to 2GHz band and also to 900 MHz band in large areas of low population density. The benefit comes in terms of lower number of base station sites and is of the order of saving two out of three, even three out of every four base station sites to be deployed (i.e. cost savings 66...75%). The economical impact on UMTS operators' investments makes it possible to forward benefits for the end-users, too.

The UMTS Forum believes that there is a need for harmonised mobile spectrum in the band 470- 600 MHz in order to provide better coverage for UMTS/IMT-2000 services in a more cost effective way, particularly in large areas of low population density.

The ITU's Regional Radiocommunication Conference will establish an all-digital frequency plan for TV broadcasting. The digital switchover is expected to free some spectrum in the band 470-600 MHz due to higher spectrum efficiency of digital technology. It is expected that the 'spectrum dividend' resulting from analogue television switch-off would represent a significant amount of spectrum and that this spectrum or parts of it could, in particular, be allocated to other electronic communications services such as UMTS/IMT-2000.

Action would be necessary at the Regional Radiocommunication Conference and World Radiocommunication Conference (WRC-07) to modify allocations to include the Mobile service in these bands, where such an allocation does not currently exist.

Recommendation 1:

ITU RRC should develop the new digital broadcasting plan so that the digital dividend, resulting from digital switchover, is harmonised within the band 470-600 MHz. The UMTS Forum supports to use this harmonised digital dividend, or parts of it, for Mobile Service.

The issue of lower frequency bands for cost efficient coverage through larger cells was supported by many developing countries at ITU WRC-03. The issue received recognition through Resolution 228 which "invites ITU-R to conduct regulatory and technical studies on the usage of frequencies below those identified for IMT-2000 in No. 5.317A for the future development of IMT-2000 and systems beyond IMT-2000". It also recognises the need, in many developing countries and countries with large areas of low-population density, for the cost-effective implementation of IMT-2000.

The additional spectrum for the future development of IMT-2000 and systems beyond IMT-2000 will be decided by the next ITU WRC-07. In preparation for WRC-07 Agenda Item 1.4 and its related Resolution 228, the preparatory work also includes the issue of the lower frequency bands.

Recommendation 2:

The UMTS Forum supports identification of a new Coverage Extension Band on lower frequency bands for IMT-2000, to cover part of WRC-07 Agenda Item 1.4 and its related Resolution 228. This new Coverage Extension Band should be allocated on a primary basis to Mobile Service in all three ITU Regions and identified for terrestrial IMT-2000.

The Coverage Extension Band should be made available as soon as possible after analogue switch-off and subject to market demand. The time frame of the requirement for Coverage Extension Bands within individual countries may differ and will depend on the development of the market in those countries.

The amount of spectrum to be identified for UMTS/IMT-2000, as 'Coverage Extension Bands', should have the potential to satisfy coverage needs of large areas of low population density. The minimum amount of spectrum needed by each operator and the minimum spectrum that would be needed globally to offer fair competitive conditions between mobile operators and fulfilling the particular needs of developing countries needs to be studied.

The UMTS Forum believes that the spectrum dividend from analogue TV switch-off would be significant enough to fulfil coverage needs of UMTS/IMT-2000 in large areas of low population density and enable an appropriate level of competition.

With 2x30 MHz and based on existing 5 MHz channelling, it could be possible to have three UMTS operators each having 2x10 MHz. This would provide viable business case for operators and balanced competition. Also with 2x30 MHz, the band can be considered wide enough to be interesting from the vendors' point of view. This spectrum amount can also facilitate green-field operators in some emerging markets, such as Africa. Based on the above, the UMTS Forum is recommending 2x30 MHz as a viable minimum band needed

Recommendation 3:

The UMTS Forum considers that 2x30 MHz of paired spectrum would provide a viable minimum Coverage Extension Band for UMTS/IMT-2000.

5. REFERENCES

UMTS Forum Report No. 7: Report on Candidate Extension Bands for UMTS/IMT-2000 Terrestrial Component, 1999

Annex 1

Calculations and simulations made in order to analyse the benefit of lower frequency bands for extension of UMTS/IMT-2000 service coverage

Annex 1 A
Link budgets used in the calculations of number of base station sites

Annex 1 B
Simulations for coverage of the Massif Central in France

Link budgets used in the calculations of number of base station sites

NB. Man-made noise is known to be higher in the lower bands, however, it is seen here not an issue in rural coverage, where the impact of man-made noise is generally minor.

500 MHz band

SERVICE INFORMATION	Unit	AMR		384 kbps	
		UPLINK	DOWNLINK	UPLINK	DOWNLINK
Load	%	50 %	50 %	50 %	50 %
Bit rate	kbps	12.2	12.2	64.0	384.0
RECEIVING END	**Unit**	**UPLINK**	**DOWNLINK**	**UPLINK**	**DOWNLINK**
Receiver noise figure	dB	3.00	6.00	3.00	6.00
Receiver noise power	dBm	-105.09	-102.09	-105.09	-102.09
Interference margin	dB	3.01	3.01	3.01	3.01
Total effective noise + interference	dBm	-102.08	-99.08	-102.08	-99.08
Processing gain	dB	24.98	24.98	17.78	10.00
Required E_b/N_0	dB	5.00	7.00	2.00	4.00
Receiver sensitivity	dBm	-122.06	-117.06	-117.86	-105.08
RX antenna gain	dBi	12.00	0.00	12.00	0.00
Cable loss	dB	2.00	0.00	2.00	0.00
Mast head amplifier gain	dB	2.00	0.00	2.00	0.00
Antenna diversity gain	dB	3.00	0.00	3.00	0.00
Soft handover gain	dB	1.00	2.00	1.00	2.00
Required signal power	dBm	-138.06	-119.06	-133.86	-107.08
TRANSMITTING END	**Unit**	**UPLINK**	**DOWNLINK**	**UPLINK**	**DOWNLINK**
Tx power per connection	W	0.126	2.00	0.126	2.00
Tx power per connection	dBm	21.00	33.00	21.00	33.00
Cable loss	dB	0.00	2.00	0.00	2.00
Tx antenna gain	dBi	0.00	12.00	0.00	12.00
Peak EIRP	dBm	21.00	43.00	21.00	43.00
Maximum path loss	**dB**	159.06	162.06	154.86	150.08

CELL SIZES	Unit	AMR		384 kbps	
MS antenna height	m	1.5		1.5	
BS antenna height	m	40.0		40.0	
Standard deviation	dB	7.0		7.0	
Building penetration loss (BPL)	dB	12.0		12.0	
Std. of building penetration loss	dB	8.0		8.0	
OKUMURA-HATA	**Unit**	**AMR**		**384 kbps**	
Correction factor	dB	-6.5		-6.5	
INDOOR COVERAGE	**Unit**	**AMR**		**384 kbps**	
Location probability over a cell	%	90.0%		90.0%	
Slow fading margin + BPL	dB	17.6		17.6	
		UPLINK	DOWNLINK	UPLINK	DOWNLINK
Cell size	km	7.43	9.08	5.61	4.08
CELL SIZE		Indoor Uplink	7.43 km	Indoor Downlink	4.08 km

1 GHz band

SERVICE INFORMATION	Unit	AMR		384 kbps	
		UPLINK	DOWNLINK	UPLINK	DOWNLINK
Load	%	50 %	50 %	50 %	50 %
Bit rate	kbps	12.2	12.2	64.0	384.0
RECEIVING END	**Unit**	**UPLINK**	**DOWNLINK**	**UPLINK**	**DOWNLINK**
Receiver noise figure	dB	3.00	6.00	3.00	6.00
Receiver noise power	dBm	-105.09	-102.09	-105.09	-102.09
Interference margin	dB	3.01	3.01	3.01	3.01
Total effective noise + interference	dBm	-102.08	-99.08	-102.08	-99.08
Processing gain	dB	24.98	24.98	17.78	10.00
Required E_b/N_0	dB	5.00	7.00	2.00	4.00
Receiver sensitivity	dBm	-122.06	-117.06	-117.86	-105.08
RX antenna gain	dBi	15.00	0.00	15.00	0.00
Cable loss	dB	3.00	0.00	3.00	0.00
Mast head amplifier gain	dB	3.00	0.00	3.00	0.00
Antenna diversity gain	dB	3.00	0.00	3.00	0.00
Soft handover gain	dB	1.00	2.00	1.00	2.00
Required signal power	dBm	-141.06	-119.06	-136.86	-107.08
TRANSMITTING END	**Unit**	**UPLINK**	**DOWNLINK**	**UPLINK**	**DOWNLINK**
Tx power per connection	W	0.126	2.00	0.126	2.00
Tx power per connection	dBm	21.00	33.00	21.00	33.00
Cable loss	dB	0.00	3.00	0.00	3.00
Tx antenna gain	dBi	0.00	15.00	0.00	15.00
Peak EIRP	dBm	21.00	45.00	21.00	45.00
Maximum path loss	**dB**	162.06	164.06	157.86	152.08

CELL SIZES	Unit	AMR		384 kbps	
MS antenna height	m	1.5		1.5	
BS antenna height	m	40.0		40.0	
Standard deviation	dB	7.0		7.0	
Building penetration loss (BPL)	dB	12.0		12.0	
Std. of building penetration loss	dB	8.0		8.0	
OKUMURA-HATA	**Unit**	**AMR**		**384 kbps**	
Correction factor	dB	-6.5		-6.5	
INDOOR COVERAGE	**Unit**	**AMR**		**384 kbps**	
Location probability over a cell	%	90.0%		90.0%	
Slow fading margin + BPL	dB	17.6		17.6	
		UPLINK	DOWNLINK	UPLINK	DOWNLINK
Cell size	km	5.37	6.14	4.06	2.76
CELL SIZE		Indoor Uplink	5.37 km	Indoor Downlink	2.76 km

2 GHz band

SERVICE INFORMATION	Unit	AMR		384 kbps	
		UPLINK	DOWNLINK	UPLINK	DOWNLINK
Load	%	50 %	50 %	50 %	50 %
Bit rate	kbps	12.2	12.2	64.0	384.0
RECEIVING END	**Unit**	**UPLINK**	**DOWNLINK**	**UPLINK**	**DOWNLINK**
Receiver noise figure	dB	3.00	6.00	3.00	6.00
Receiver noise power	dBm	-105.09	-102.09	-105.09	-102.09
Interference margin	dB	3.01	3.01	3.01	3.01
Total effective noise + interference	dBm	-102.08	-99.08	-102.08	-99.08
Processing gain	dB	24.98	24.98	17.78	10.00
Required E_b/N_0	dB	5.00	7.00	2.00	4.00
Receiver sensitivity	dBm	-122.06	-117.06	-117.86	-105.08
RX antenna gain	dBi	18.00	0.00	18.00	0.00
Cable loss	dB	4.00	0.00	4.00	0.00
Mast head amplifier gain	dB	4.00	0.00	4.00	0.00
Antenna diversity gain	dB	3.00	0.00	3.00	0.00
Soft handover gain	dB	1.00	2.00	1.00	2.00
Required signal power	dBm	-144.06	-119.06	-139.86	-107.08
TRANSMITTING END	**Unit**	**UPLINK**	**DOWNLINK**	**UPLINK**	**DOWNLINK**
Tx power per connection	W	0.126	2.00	0.126	2.00
Tx power per connection	dBm	21.00	33.00	21.00	33.00
Cable loss	dB	0.00	4.00	0.00	4.00
Tx antenna gain	dBi	0.00	18.00	0.00	18.00
Peak EIRP	dBm	21.00	47.00	21.00	47.00
Maximum path loss	**dB**	165.06	166.06	160.86	154.08

CELL SIZES	Unit	AMR		384 kbps	
MS antenna height	m	1.5		1.5	
BS antenna height	m	40.0		40.0	
Standard deviation	dB	7.0		7.0	
Building penetration loss (BPL)	dB	12.0		12.0	
Std. of building penetration loss	dB	8.0		8.0	
OKUMURA-HATA	**Unit**	**AMR**		**384 kbps**	
Correction factor	dB	-6.5		-6.5	
INDOOR COVERAGE	**Unit**	**AMR**		**384 kbps**	
Location probability over a cell	%	90.0%		90.0%	
Slow fading margin + BPL	dB	17.6		17.6	
		UPLINK	DOWNLINK	UPLINK	DOWNLINK
Cell size	km	3.33	3.56	2.51	1.60
CELL SIZE		Indoor Uplink	3.33 km	Indoor Downlink	1.6 km

Simulations for the coverage of the Massif Central in France

In order to analyse further the benefit of the band 470-600 MHz compared to the 900 MHz and 2 GHz bands on the extension of UMTS/IMT-2000 networks coverage in low density populated large areas, simulations of UMTS/IMT-2000 network deployment at 500 MHz, 900 MHz and 2 GHz have been performed in a rural area in France, namely in the Massif Central area. The surface area of the Massif Central is 63 883 km². It is located in the centre of France and it is characterised by a predominantly rural environment (see Figure 1).

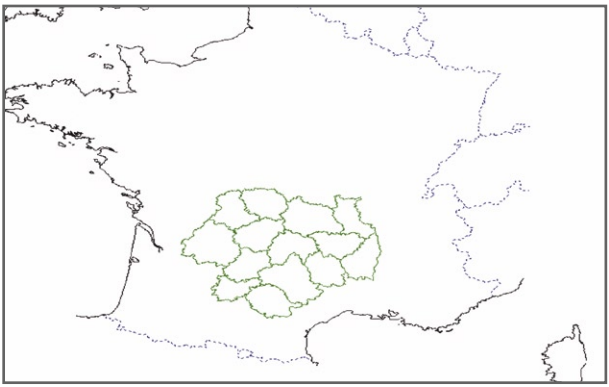


Figure 1 – Massif Central, France

The Massif Central area is also characterised by a mixed terrain profile including mountains, forest and plains (see Figure 2).

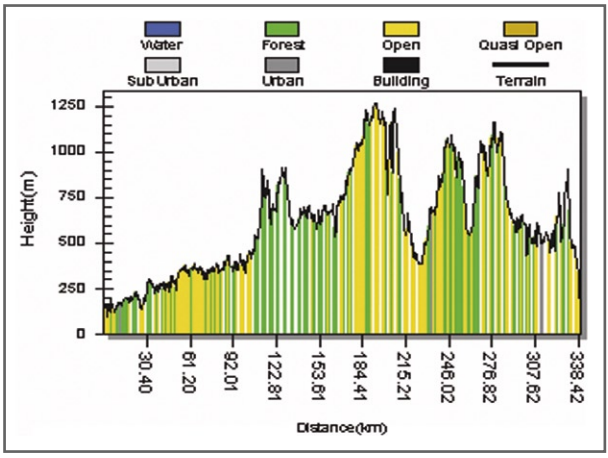


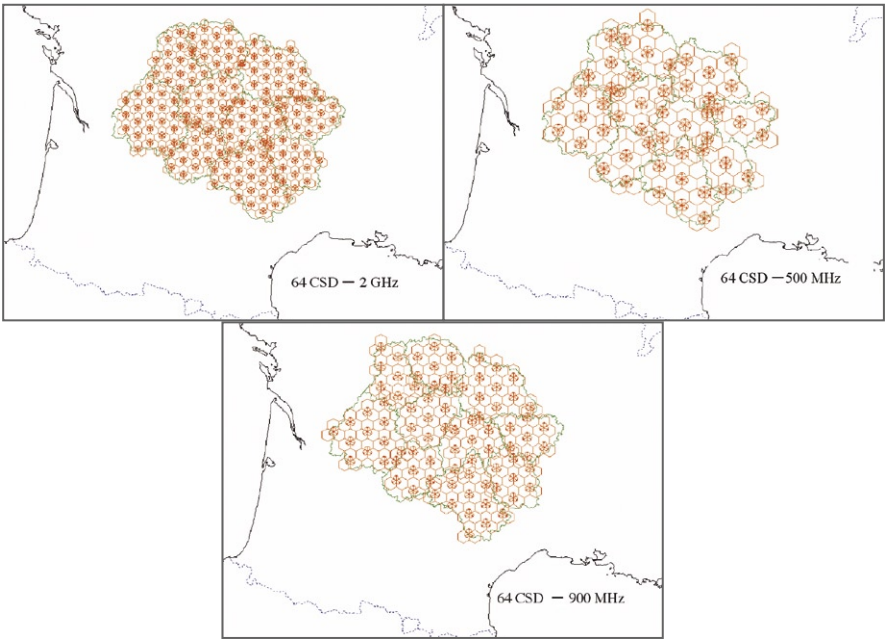
Figure 2 – Massif Central, a typical terrain profile

An analysis of the deployment of a UMTS/IMT-2000 network to cover the Massif Central has been performed at 500 MHz, 900 MHz and 2 GHz in order to offer several 3G services including speech, 64 kbps CSD (Circuit Switched Data, e.g. visiophony), 144 kbps PSD (Packet Switched Data), and 384 kbps PSD (Packet Switched Data).

The UMTS/IMT-2000 network deployment simulations at 500 MHz, 900 MHz and 2 GHz take into account the terrain profile characteristics as well as the offered services requirements (speech, 64 kbps CSD, 144 kbps PSD and 384 kbps PSD).

Figure 3 illustrates UMTS/IMT-2000 network deployment at 500 MHz in order to offer a 64 kbps PSD service compared to a network deployment at 900 MHz and 2 GHz in order to offer the same service. It highlights the number of base stations needed for the coverage of the Massif Central at 500 MHz, 900 MHz and 2 GHz. The simulations results shows that 224 UMTS/IMT-2000 base stations sites would be necessary to cover the Massif Central for a 64 kbps (CSD) visiophony service at 2 GHz and 90 UMTS/IMT-2000 case stations sites at 900 MHz whereas 52 UMTS/IMT-2000 base stations would be sufficient to offer the same service at 500 MHz, see Figure 4.

Figure 3 – UMTS network dimensioning for 64 kbps CSD at 500 MHz, 900 MHz and 2 GHz



Taking into account the network deployment showed in Figure 3, the coverage maps of the UMTS/IMT-2000 network deployment at 500 MHz (52 base stations), 900 MHz (90 base stations) and 2 GHz (224 base stations) were simulated and are presented in Figure 4.

Figure 4 - Coverage map for 64 kbps CSD at 500 at 500 MHz, 900 MHz and 2 GHz

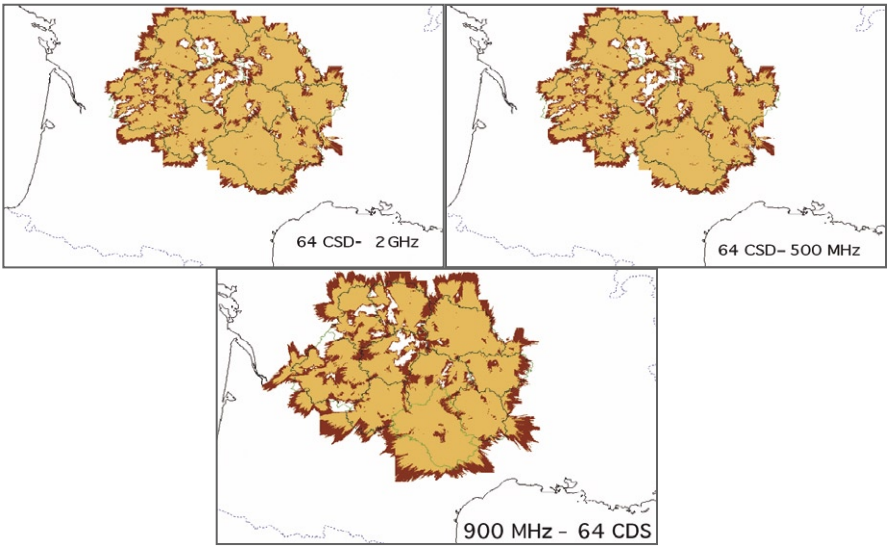
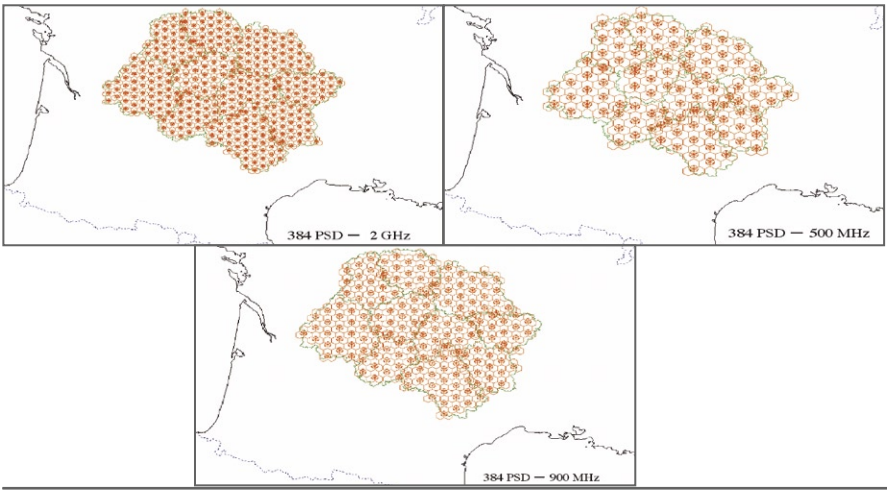


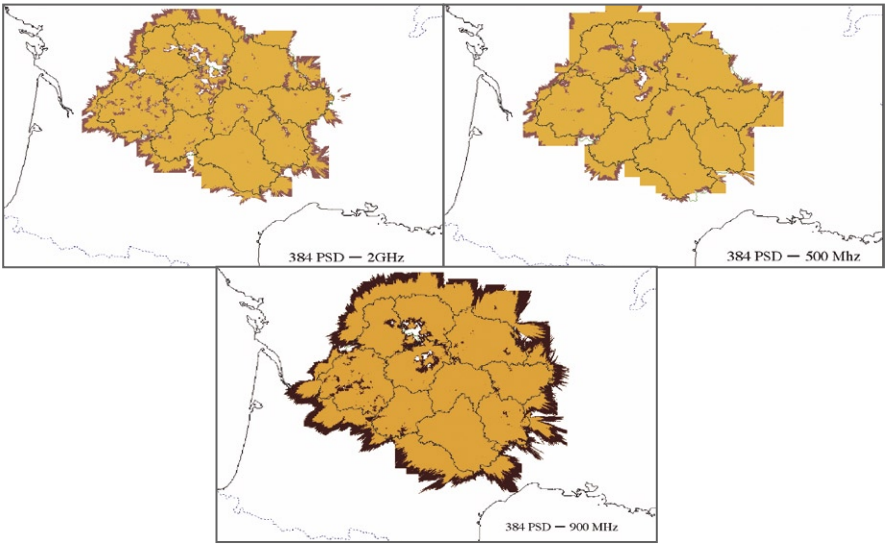
Figure 5 illustrates UMTS/IMT-2000 network deployment at 500 MHz in order to offer a 384 kbps PSD service compared to a network deployment at 900 MHz and 2 GHz in order to offer the same service. It highlights the number of base stations needed for the coverage of the Massif Central at 500 MHz, 900 MHz and 2 GHz. The simulations results show that 468 UMTS/IMT-2000 base stations would be necessary to cover the Massif Central for a 384 kbps (PSD) service at 2 GHz and 181 UMTS/IMT-2000 base stations at 900 MHz whereas 104 UMTS/IMT-2000 base stations would be sufficient to offer the same service at 500 MHz.

Figure 5 – UMTS network dimensioning for 384 kbps PSD at 500 MHz, 900 MHz and 2 GHz



Taking into account the network deployment showed in Figure 5, the coverage maps of UMTS/IMT-2000 network deployment at 500 MHz (104 base stations), at 900 MHz (181 base stations) and 2 GHz (468 base stations) were simulated and are presented in Figure 6.

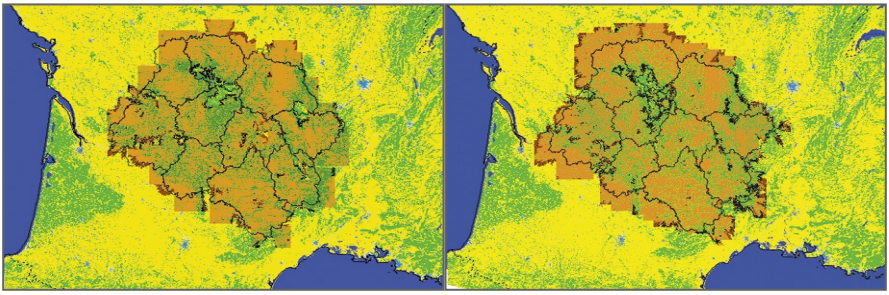
Figure 6 – Coverage map for 384 kbps PSD at 500 MHz, 900 MHz and 2 GHz



Equivalent simulations and analysis have been performed for UMTS/IMT-2000 coverage of the Massif Central in the case of voice services at 12.2 kbps as well as in the case of data services at 64 kbps PSD and 144 kbps PSD.

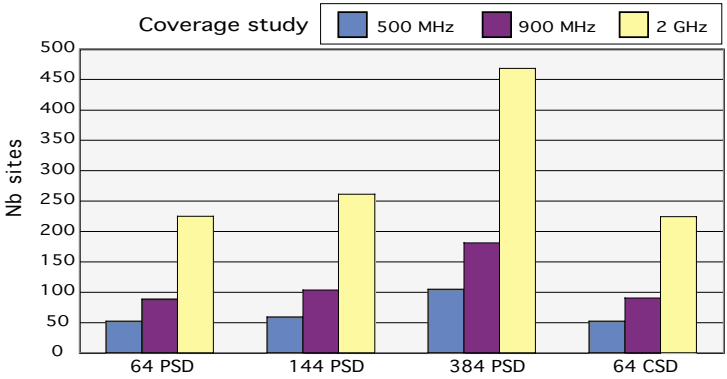
Figure 7 presents the UMTS coverage of the Massif Central at 500 MHz and 2 GHz for the provision of 144 kbps PSD service. There would be a need to deploy 59 UMTS base stations to ensure this coverage at 500 MHz whereas 261 UMTS base stations would be needed at 2 GHz. Additionally, Figure 7 provides an overview of the terrain profile.

Figure 7 – Massif Central terrain profile coverage map for 144 kbps PSD at 500 and 2 GHz



The number of UMTS/IMT-2000 base stations that would be needed for the coverage of the Massif Central for various services (speech, 64 kbps PSD, 64 kbps CSD, 144 kbps PSD, 384 kbps PSD) are provided below in Figure 8.

Figure 8 – Comparison of number of base stations sites at 500 MHz, 900 MHz and 2 GHz for various 3G services



The analysis performed above on the benefit of the band 470-600 MHz compared to the bands 900 MHz and 2 GHz for the deployment of UMTS/IMT-2000 in low density populated areas particularly in rural areas has shown that the band 470-600 MHz would allow UMTS/IMT-2000 operators to extend the coverage of their network in rural areas at lower number of base stations. Indeed, simulations of the UMTS/IMT-2000 network deployment in a typical large low density populated area (the Massif Central area in France) to offer 3G services (speech, 64 kbps, 144 kbps and 384 kbps) have shown that UMTS/IMT-2000 operators would need to deploy some five times more base stations at 2 GHz compared to 500 MHz and more than two times more base stations at 900 MHz than at 500 MHz.

Overall, considering the cost of UMTS/IMT-2000 base stations equipments and sites (CAPEX) and the cost of the deployment and the maintenance (OPEX) of UMTS/IMT-2000 base stations sites, it could be concluded that the band 470-600 MHz would allow UMTS/IMT-2000 operators to considerably reduce their CAPEX and OPEX investments related to extension of their UMTS/IMT-2000 networks coverage in large areas of low population density.

Propagation model

The propagation model used in the simulations above at 500 MHz and 900 MHz is the Okumura model for rural areas and is given by the following formulas:

$Lp = K1 + K2 \log (d)$

Where:

- K1 = 69.55 + 26.16 log f – 13.82 log (hb)
- K2 = [44.9 – 6.55 log (hb)]
- d = distance, f = frequency, hb = antenna height

with terrain correction:

- Lp' = Lp – A
- A = 4.78 [log(F)]^2 + 18.33 log (F) – A'

A' depends on the environment, in rural areas A' is equal to 35.94 dB.

The propagation model used in the simulations at 2 GHz is the COST-Hata propagation model for rural areas and is given by the following formulas:

Lp = K'1 + K2 log (d)

Where:

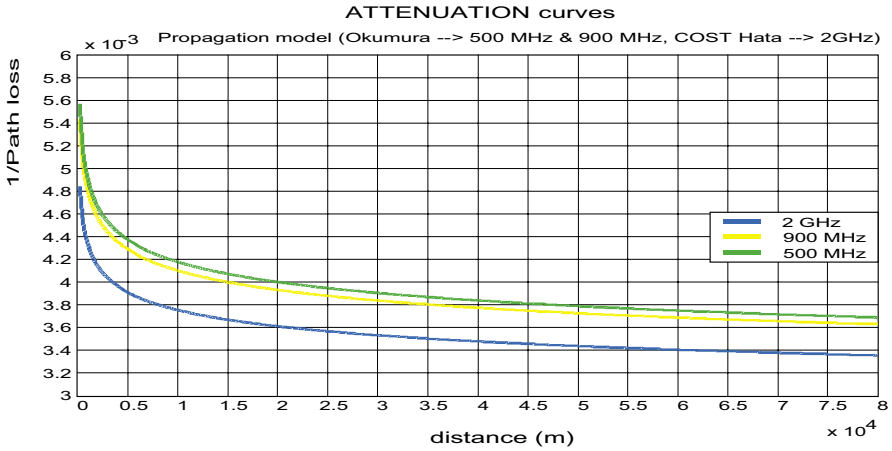
- K'1 = = 46.3 + 33.9 log f – 13.82 log (hb))
- K2 = [44.9 – 6.55 log (hb)]
- d = distance, f = frequency, hb = antenna height

with terrain correction :

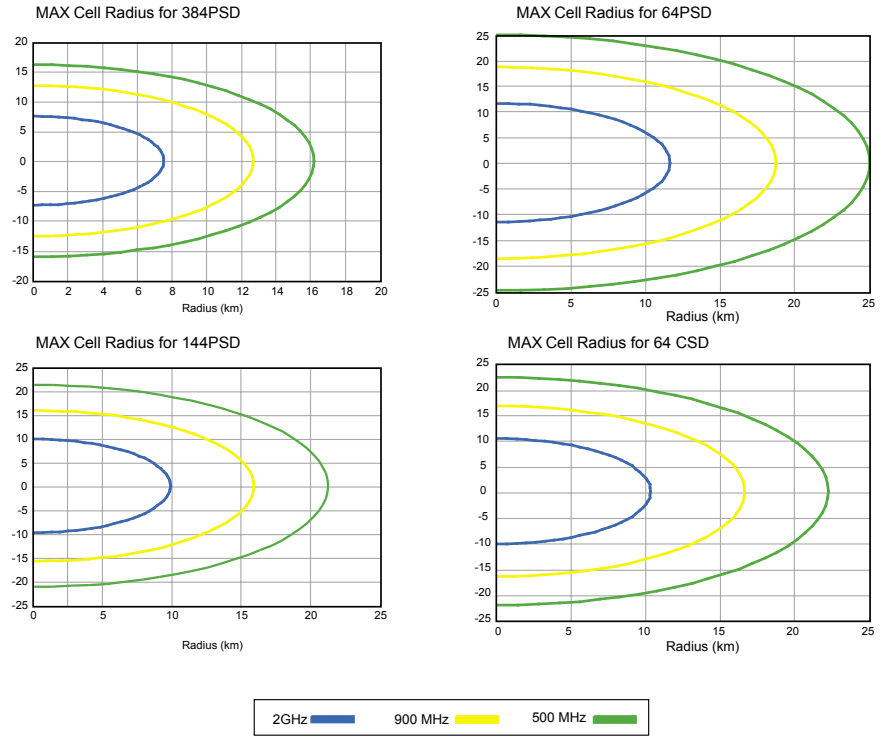
- Lp' = Lp – A
- A = 4.78 [log(F)]^2 + 18.33 log (F) – A'

A' depends on the environment, in rural areas A' is equal to 35.94 dB.

The figure below provides the variation of the attenuation as the function of the distance for the propagation models Okumura 500 MHz and 900 MHz and COST-Hata at 2 GHz



A comparison of the maximum cell radius of the various 3G services (64 kbps, 144 kbps and 384 kbps) at 500 MHz, 900 MHz and 2 GHz are presented in the figure below.



Country level information on the usage of the band 470-600 MHz

NB. In this Annex some examples are collected on a per country basis in order to give a general picture of the actual country level spectrum usage of the band in question. The material is based on the information currently available and is not comprehensive.
The footnotes in the tables below refer to the frequency allocation table of the country in question and are not provided here in more detail.

AFRICA

470 – 790 MHz

Country	Broadcast TV	Broadcast Radio
Algeria	1 state-run	1 state-run
Angola	1 state-run, operates two channels	1 state-run, operates 5 channels 1 Roman catholic FM station 2 private radio stations
Benin	1 state-run 2 commercial	1 national state-run 1commercial 1 catholic
Botswana	1 state-run 1 private 1 pay-tv	1 state-run 3 commercial
Burkina Faso	1 state-run 1 private	1 state-run About a dozen private
Burundi	1 state-run, broadcasts in Kirundi, Swahili, French and in English	1 state-run which broadcasts in Kirundi, Swahili, French and in English 3 private 1 European Union funded station to promote reconciliation BBC World Service and Radio France Internationale
Cameroon	1 state-run 2 private, broadcasting "culture-oriented" programmes to the capital and western areas of the country	1 state-run 1 catholic Around a dozen were created after 2000 but most of them were closed in late 2003
Cape Verde	1 state-run	1 state-run Some commercial Portuguese radio and Radio France Internationale
Central African Republic	1 state-run	1 state-run 1 roman catholic in Bangui 1 private 1 UN-backed in Bangui

Chad	1 state-run	1 state-run which operates nationally and regionally 1 private 1 catholic
Comoros	1 state-run	1 state-run RFO
Republic of Congo	1 state-run	2 state-run 1 private 1 community RFI, BBC and Voice of America
Djibouti	1 state-run	1 state-run RFI, BBC and Voice of America
Egypt	2 state-run 6 regional 2 satellite	1 state-run 2 private
Equatorial Guinea	1 state-run	1 state-run 1 private owned by president's son RFI
Eritrea	1 state-run	2 state-run (around a dozen programmes in 11 languages)
Ethiopia	1 state-run (applications have been delivered in 2004)	1 state-run 1 regional in Tigray Regional State 1 private 1 Unicef founded station broadcasting to Somalia
Gabon	1 state-run 1 private 1 TV Sat – pay TV operator	1 state-run which operates 2 networks Africa n°1 – pan-African broadcaster based in Gabon, heard across Africa on shortwave and on FM relays in many cities
The Gambia	1 state-run 1 private satellite channel	1 state-run 4 private
Ghana	1 state-run 2 private	1 state-run which operates 2 radios in English and in Ghanaian vernaculars 7 private BBC and RFI
Guinea	1 state-run	1 state-run operates in French, English, and vernacular languages and operates several Radio Rurale community stations
Guinea-Bissau	1 state-run RTP Africa	1 state-run 3 private
Ivory Coast	1 state-run operates 2 channels	1 state-run operates 2 stations 1 private 2 catholic Africa n°1 Local FM relays of the BBC and RFI were taken off
Kenya	1 state-run 6 private	1 state-run 9 private

Lesotho	South Africans channels	South Africans stations 5 private
Liberia	No TV service	1 state-run radio station which does not have national coverage 4 private in Monrovia
Libya	1 state-run, available terrestrially and via satellite	1 state-run Voice of Africa - state-run external service
Madagascar	1 state-run 3 private	1 state-run 7 private
Malawi	1 state-run	1 state-run 3 private 1 catholic BBC World Service on FM in Blatyre, Lilongwe and Mzuzu
Mali	1 state-run 2 multi-channel operators	1 state-run of national and regional stations 11 private networks in Bamako
Mauritania	1 state-run in Arabic, French and other languages	1 state-run
Mauritius	3 TV channels	
Mozambique	1 state-run 1 private RTP BBC Word service in Maputo, Beira, Xai Xai, Nampula and Quelimane	1 state-run Private operates in most urban areas
Namibia	1 state-run 1 private in Windhoek	1 state-run 6 private
Niger	1 state-run 2 private	1 state-run 5 private Africa n°1 BBC and RFI in Niamey, Maradi and Zinder
Nigeria	1 state-run (national and regional) 5 private	1 state-run (national and regional) 2 private
Senegal	1 state-run 3 private	1 state-run 5 private
Sierra Leone	1 state-run with limited coverage	1 state-run 6 private BBC and RFI in Freetown
Somalia	4 private Qatar re-broadcasters	9 private
South Africa	1 state-run which operates 3 national networks and 3 pay-TV channels 2 private	1 state-run 20 national and regional in 11 languages 3 private (40 radio services in Johannesburg)
Swaziland	1 state-run	1 state-run operates 3 stations 1 private
Tanzania	1 state-run has yet to achieve its national coverage 4 private	2 state-run 1 state-run in Zanzibar 6 private
Togo	1 state-run 1 pay-TV	1 state-run operates 3 stations 3 private 1 private in Lome RFI operates in Lome and Kara

Uganda	1 state-run 2 private	1 state-run operates 5 stations 5 private 1 private operates in Kampala and regional centres
Zambia	1 state-run multi-channel pay-TV services	1 state-run 3 private 3 private in Lusaka or Chipata BBC and RFI in Lusaka and Kitwe
Zimbabwe	1 state-run operates 2 channels	1 state-run operates 4 networks 2 privates which operates from shortwave transmitter in Madagascar

THE AMERICAS

USA

	Federal Government	Non-Federal Government	FCC Rule Part(s)
USA	470-608 MHz	470-512 MHz FIXED LAND MOBILE BROADCASTING NG66 NG115 NG128 NG149	Public Mobile (22) Broadcast Radio (TV) (73) Auxiliary Broadcasting (74) Private Land Mobile (90)
USA	470-608 MHz	512-608 MHz BROADCASTING NG115 NG128 NG149	Broadcast Radio (TV) (73) Auxiliary Broadcasting (74)

Broadcast television in the US has begun the transition from analogue to digital television (DTV). Once the digital television transition is completed, DTV stations will operate only on channels 2-51. Channels 52-69 (700 MHz Upper and Lower bands) have already been reallocated for other uses, E.G. Mobile Broadband services.

- In May 2004, the Commission proposed to allow unlicensed radio transmitters to operate in the broadcast television spectrum at locations where that spectrum is not being used by television stations. Comments on the NPRM are due November 30. In principle TV channels 5-36 and 38-51 would be generally available for unlicensed operation
- In August 2003, the Commission, by a Notice of Proposed Rule Making, sought comment on rules for digital low power television ("LPTV") and television translator stations, and issues related to digital television booster stations. Comment was sought on the impact of these proposals on television broadcast and other primary services, particularly those in the 470-512 MHz band and the new services in the 698-806 MHz (Upper and Lower 700 MHz) bands. No ruling yet.

ARG	470-471	MHz	LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.35 ARG.42
ARG	471-473.5	MHz	FIXED LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.42
ARG	473.5-473.875	MHz	BROADCASTING ARG.11 ARG.42
ARG	473.875-474.125	MHz	FIXED LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.42
ARG	474.125-474.425	MHz	BROADCASTING ARG.11 ARG.42
ARG	474.425-475	MHz	FIXED LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.42
ARG	475-476	MHz	LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.35 ARG.42
ARG	476-478.5	MHz	FIXED LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.42
ARG	478.5-478.875	MHz	BROADCASTING ARG.11 ARG.42
ARG	478.875-479.125	MHz	FIXED LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.42
ARG	479.125-480	MHz	BROADCASTING ARG.11 ARG.42
ARG	479.125-479.425	MHz	BROADCASTING ARG.11 ARG.42
ARG	479.425-479.125	MHz	FIXED LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.42
ARG	479.425-480	MHz	FIXED LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.42
ARG	480-480.5	MHz	LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.28 ARG.42
ARG	480-480.5	MHz	LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.28 ARG.42
ARG	480.5-481	MHz	FIXED LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.42

ARGENTINA (Suite)

ARG	481-484	MHz	FIXED LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.42
ARG	484-487.5	MHz	BROADCASTING ARG.11 ARG.42
ARG	487.5-488	MHz	FIXED LAND MOBILE BROADCASTING ARG.11 ARG.42
ARG	488-492	MHz	FIXED LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.42
ARG	492-492.5	MHz	BROADCASTING ARG.11 ARG.42
ARG	492.5-493	MHz	FIXED LAND MOBILE BROADCASTING ARG.11 ARG.42
ARG	493-493.25	MHz	BROADCASTING ARG.11 ARG.42
ARG	493.25-495.5	MHz	FIXED LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.42
ARG	495.5-501	MHz	FIXED BROADCASTING ARG.4 ARG.24 ARG.42
ARG	501-502	MHz	FIXED BROADCASTING ARG.11 ARG.42
ARG	502-503.25	MHz	BROADCASTING ARG.11 ARG.42
ARG	503.25-505.5	MHz	FIXED LAND MOBILE BROADCASTING ARG.4 ARG.24 ARG.42
ARG	505.5-512	MHz	FIXED BROADCASTING ARG.4 ARG.24 ARG.42
ARG	512-608	MHz	BROADCASTING Fixed ARG.20 ARG.25

ANTIGUA

ATG	470-512	MHz	BROADCASTING Fixed Mobile
ATG	512-608	MHz	BROADCASTING

BRAZIL

B	470-608	MHz	BROADCASTING
B	470-608	MHz	BROADCASTING

BOLIVIA

BOL	470-512	MHz	FIXED MOBILE BOL.56
BOL	512-608	MHz	Broadcasting (Televisiva digital) BOL.56B FIXED BOL.56A

BARBADOS

BRB	470-806	MHz	BROADCASTING BRB.32

CANADA

CAN	470-512	MHz	BROADCASTING
CAN	512-608	MHz	BROADCASTING

CHILE

CHL	470-512	MHz	FIXED MOBILE CHL.56
CHL	512-608	MHz	BROADCASTING (television digital) FIXED CHL.56B

COLOMBIA

CLM	470-482	MHz	Fixed MOBILE (Enlaces nacionales, Broadcasting sonora) CLM.36 CLM 40
CLM	482-512	MHz	Fixed MOBILE (Radiotelefonía Mobile, Radiomensajes, Transmisión de datos) CLM.28 CLM.42 CLM 43
CLM	512-608	MHz	BROADCASTING TELEVISION (Canales UHF de televisión) CLM.44

COSTARICA

CTR	470-512	MHz	BROADCASTING (TELEVISION) Fixed Mobile CTR.2.40 CTR.2.41
CTR	512-608	MHz	FIXED BROADCASTING (TELEVISION) CTR.2.40 CTR.2.41

DOMINICAN REP.

DOM	470-512	MHz	BROADCASTING Fixed Mobile
DOM	512-608	MHz	BROADCASTING DOM.33

EQUADOR

EQA	470-512	MHz	Fixed MOBILE EQA.55 EQA.60 EQA.115
EQA	512-608	MHz	BROADCASTING EQA.120

GUATEMALA

GTM	470-500	MHz	BROADCASTING FIXED MOBILE
GTM	500-512	MHz	BROADCASTING (TV CANALES 19-20)
GTM	512-806	MHz	BROADCASTING (TV CANALES 21-69) FIXED MOBILE

GUYANA-NG

GUY-NG	470-512	MHz	BROADCASTING
GUY-NG	512-608	MHz	BROADCASTING

HONDURAS

HND	470-512	MHz	BROADCASTING Fixed Mobile HND.33
HND	512-608	MHz	BROADCASTING HND.34

JAMAICA

JMC	470-476	MHz	FIXED MOBILE
JMC	476-806	MHz	BROADCASTING JMC.6

MEXICO

MEX	470-512	MHz	BROADCASTING FIXED LAND MOBILE MEX.68 MEX.69 MEX.109 MEX.111 MEX.114 MEX.115MEX.116 MEX.149
MEX	512-608	MHz	FIXED LAND MOBILE BROADCASTING MEX.68 MEX.69 MEX.114

NICARAGUA

NCG	470-512	MHz	BROADCASTING Fixed Mobile NCG.95 NCG.96
NCG	512-608	MHz	BROADCASTING NCG.95

ORGANISATION OF EASTERN CARIBBEAN STATES

OECS	470-512	MHz	BROADCASTING OECS.12
OECS	512-608	MHz	BROADCASTING OECS.12

PANAMA

PNR	470-512	MHz	FIXED MOBILE PNR.202
PNR	512-626	MHz	BROADCASTING PNR.210 PNR.220 PNR.802 PNR.902

PARAGUAY

PRG	470-512	MHz	BROADCASTING Fixed Mobile PRG.34 PRG.35
PRG	512-608	MHz	BROADCASTING PRG.34 PRG.35

PERU

PRU	470-512	MHz	BROADCASTING Fixed Mobile PRU.41
PRU	512-608	MHz	BROADCASTING Fixed Mobile PRU.41

SEN

SEN	470-512	MHz	BROADCASTING Fixed Mobile 5.292 5.293
SEN	512-608	MHz	BROADCASTING 5.297

SALVADOR

SLV	470-512	MHz	BROADCASTING Fixed Mobile
SLV	512-608	MHz	BROADCASTING, FIXED, MOBILE

TRINIDAD

TRD	470-512	MHz	BROADCASTING Fixed Mobile
TRD	512-608	MHz	BROADCASTING

URUGUAY

URG	470-512	MHz	FIXED MOBILE
URG	512-608	MHz	BROADCASTING

VENEZUELA

VEN	470-512	MHz	FIXED MOBILE VEN.32 VEN.33
VEN	512-608	MHz	BROADCASTING TV CANALES 21 al 69 VEN.34

ASIA

CHINA

CHN	470-485MHz	BROADCAST SPACE RESEARCH SPACE OPERATION Radio location Fixed Mobile
CHN	485-566MHz	BROADCAST Radio location Fixed Mobile
CHN	566-606MHz	FIXED BROADCAST RADIO LOCATION RADIO NAVIGATION

INDIA

Specific remark about India on the Allocation table: IND33 Requirements of fixed and mobile services will be considered in the frequency band 470-520 MHz on case-by-case basis. Requirements of fixed and mobile services may be considered in the frequency band 520-585 MHz on case-by-case basis.

JAPAN

J	470-585 MHz	BROADCASTING LAND MOBILE J46, J73A
J	585-710 MHz	BROADCASTING LAND MOBILE J32, J73A, J74, J75

J46 This band can be used for both mobile services except land mobile services closely related to land mobile services and fixed services.

J73A This band can be used by land mobile services from July 25, 2012.

The conclusions and recommendations in the report are supported by all members of the UMTS Forum. However, the views expressed do not necessarily represent the views of National Administrations. These Administrations cannot therefore be bound by the detailed recommendations contained in this report.

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