THE USE OF ANALOGUE TELEVISION SPECTRUM AFTER THE DIGITAL SWITCHOVER

Contents

1 Summary

With the switchover to digital television, spectrum will be freed up because digital transmission requires less bandwidth than analogue to carry the same amount of content. In practice this means that when analogue transmitters are shut down, bandwidth will remain unused. There has been much interest and discussion within the European Union and elsewhere on how to use this digital dividend. Suggested uses include the expansion of 'conventional' television broadcasting (including pay TV), high definition television (HDTV), mobile television (e.g. DVB-H), or completely different types of radio traffic, such as mobile networks and other wireless broadband. The wider propagation range and better indoor reception of the frequencies that are released from analogue television mean that they could also be used to provide more cost-effective wireless broadband services in sparsely populated areas.

Finland currently has four national analogue television networks plus one regional (SVT Europe) and one local analogue network. There are three digital television networks (DVB-T), and one mobile television network (DVB-H) has also started up. In addition, an operating licence has been granted to one nationwide digital network, which will be starting operations on 1 September 2007.

In spring 2006, the ITU[1] Regional Radiocommunication Conference in Geneva (RRC-06) revised and updated the existing international agreement on television spectrum use and the accompanying plan of spectrum use. That plan (GE06) allocated to Finland nine nationwide digital networks. Planning was based on the needs of digital television and partly on the needs of digital radio, but on certain conditions the frequencies allocated can also be used for other radio systems. According to the agreement, the right of analogue television networks to claim protection against interference caused by new digital networks will expire in 2015. Until then, the deployment of frequencies in accordance with the digital spectrum plan requires separate agreement with neighbouring countries.

Five of the nine networks allocated to Finland in the GE06 framework have already been allocated to licensed operators; bandwidth equivalent to the requirements of four digital television networks still remains free. Two of these networks are in the UHF range and two in the VHF range. The different technical characteristics of these frequency bands have some impact on the choice of services for implementation in the networks. Part of these frequencies will be available as soon as analogue television shuts down, part of them later. As the digital dividend frequencies are scattered both geographically and across the spectrum, it is not possible to allocate a single slice of bandwidth to a certain radio service in accordance with the GE06 plan.

In addition to the digital dividend frequencies, it will also be possible to make use of some of the bandwidth that remains in-between the frequencies used by television broadcasting but that because of interference problems are not suitable for use on high-power and large-cell transmission networks. However, the use of these 'white areas' requires careful network planning and the use of new, smarter technologies in terminal devices.

[1] International Telecommunication Union

Digital television distribution is currently based on MPEG-2 compression and the DVB-T standard. These technologies allow for the distribution of about six normal-quality digital television services in one multiplex (television network). With the introduction of MPEG-4 and the DVB-T2 standard, it will be possible to achieve a fourfold increase in the number of standard-quality (SDTV) services per network, or to deliver a high-definition quality (HDTV) service in the same bandwidth currently required by SDTV.

As there are such large numbers of MPEG-2 receivers in use, this technology will not be replaced over the next few years. However, it is possible and feasible to adopt new and more efficient technologies when new services are implemented. Later on it may also be possible to compress existing services by the partial adoption of new technology, but it makes sense to continue to deliver basic services using current technology for some time to come, because consumers do not want to be forced into buying new receivers unless absolutely necessary.

The RRC-06 conference only dealt with the television and radio frequencies in the VHF III and UHF bands (174–230 MHz and 470–862 MHz), but other frequencies are also used for television and radio broadcasting.

Television channels 2–4 are located in the VHF I band (47–68 MHz). The use of this bandwidth for television transmission is very limited (only two transmitters in operation), and it will end altogether when analogue broadcasts cease. Reception on these frequencies requires large antennas, and therefore they are poorly suited for portable terminals.

The VHF II band (87.5–108 MHz) is still reserved for FM radio use.

The VHF III band (174–230 MHz, television channels 5–12) is reserved in the future for both digital television and radio. Within this band, several European countries applied at the RRC conference primarily for frequencies suitable for digital radio use (DAB[2], DMB[3]). Finland came away with two nationwide networks that are suitable for digital television use as well. In this frequency band, too, required antenna sizes are fairly large, and therefore it is best suited for services that mainly use fixed antennas, e.g. high definition television. In some countries the VHF-III band is also used for the delivery of DAB and DMB services. These services are not available in Finland.

Immediately above the VHF III range is a 10 MHz band (230–240 MHz) in which Finland and some other countries have long had frequency reservations for digital radio.

In the UHF band (470–862 MHz, television channels 21–69), the RRC conference allocated altogether seven national networks and some regional frequencies to Finland. In addition to the networks allocated to Finland under the GE06 framework, there are certain other frequencies in this band that can be deployed on condition that they do not interfere with uses conforming to the GE06 Agreement. These uses must

[2] Digital Audio Broadcasting
[3] Digital Multimedia Broadcasting

be agreed upon separately with neighbouring countries. In Finland, some frequencies from the upper end of the UHF band have been allocated to military use (790–822 MHz and 838–862 MHz or channels 61–64 and 67–69), which limits their potential use for other radio services. In addition, channel 21[4] and partly channel 23 are used for purposes of radio programme production, and it would be very difficult in the short term to replace them. In addition, Russia uses television channels 45, 54, 55 and 58–69 for other than television broadcasting purposes, which restricts the television use of these channels in Finland, too.[5]

In Europe, frequencies have also been allocated to digital radio in the L band (1452–1492 MHz). The European Union is looking into the possibility of extending the use of this frequency band for multimedia purposes. In Finland, the availability of this frequency band is restricted by its use for other purposes in Russia.

Although international agreements on the use of the digital dividend spectrum mainly allocate these frequencies for television and radio uses, they can in principle be allocated for use by other radio systems as well. This requires that agreement is reached with any countries whose frequencies may be affected, and that these uses are compatible with the primary uses of these frequencies. The following potential uses have been raised in discussions within the European Union:

- increasing conventional television services,
- high definition television (HDTV),
- local and regional television broadcasting,
- multimedia (including DVB-H),
- digital radio,
- mobile networks,
- wireless broadband.

2 Working group proposals

2.1 Criteria

In line with European Union terminology, the concept of ‘digital dividend’ refers here to the spectrum that will be freed up in connection with the switchover from analogue to digital television. Since all four existing national analogue television channels in Finland could be loaded into one digital multiplex, the digital dividend accruing from the nine multiplexes allocated to Finland in the GE06 Agreement is equivalent to the spectrum requirements of eight national multiplexes. The wider propagation range and better indoor reception of the frequencies that are released from analogue television mean that they could also be used to provide more cost-effective wireless broadband services in sparsely populated areas.

When analogue broadcasting is discontinued, Finland will have access not only to the multiplexes already reserved, but also to frequencies corresponding to four digital television networks. Furthermore, frequencies will be available in the ‘white spaces’ that remain in-between television broadcast channels.

[4] In the GE06 frequency plan, Finland has not been allocated frequencies for channel 21.
[5] In the GE06 frequency plan, Finland has not been allocated frequencies for channels 66–69.

In addition to traditional, free-access terrestrial television broadcasting, Finland has also issued licences for DVB-H mobile television and pay-TV operations. Analysis of the development of business in these new services will provide valuable information to assist in future decision-making.

Over the next two years the European Union will be making several decisions and recommendations concerning the use of frequency bands 174–230 MHz and 470–862 MHz. These decisions and recommendations may have a major influence both directly on the use of these bandwidths and indirectly on decision-making about their use.

High definition broadcasting via a terrestrial network requires more efficient coding and distribution technologies than are currently available. Receivers for the reception of MPEG-4 video coding are already available, albeit in limited supply. It is expected that the first DVB-T2 receivers will be available in 2009 and that they will reach commercial production one or two years later.

The distribution of television services is increasingly via other than the terrestrial network. More than half of Finnish households today have cable television. Satellite reception continues to remain at a low level. The same goes for the distribution of television services via broadband, although that is expected to increase sharply over the next few years. In practice the only way to reach nationwide television coverage today is either via terrestrial network or satellite. Satellite distribution effectively precludes regional television broadcasting and advertising.

It is unlikely that it will be possible in the immediate future to provide cable or broadband television distribution to all of Finland’s 500,000 summer cottages, for instance. Mobile reception (e.g. trains, boats, mobile homes) requires a wireless distribution network anyway.

Digital television distribution allows for local and regional broadcasting at a lower cost than analogue television. Indeed decision-making on frequency allocations should also be sensitive to the need for regional and local origination programming and for a strong diversity of television and multimedia content by making sure that a sufficient range of regional and local UHF frequencies are available in the country’s main economic areas.

Furthermore, it is important to bear in mind that as transfer speeds on digital mobile networks continue to accelerate, this will pave the way to completely new kinds of broadband television services, including interactive television.

2.2 Proposals

The working group proposes that

1. Decisions made on the allocation of the digital dividend take account of European Union decisions, recommendations and timetables concerning spectrum use and regulation, the decisions reached at the World Radiocommunication Conference 2007 (WRC-07), and other international agreements.

2. Decision-making supports the development, implementation and use of existing and new services.

3. Decisions made shall consider the development of television broadcasting over the next few years, including the advances in and proliferation of high definition television, mobile television, pay television and on-demand television, cable television, broadband distribution (broadband television and Internet television) and satellite transmission. User needs must also be considered.

4. Decisions made on the digital dividend are flexible in view of potential changes in the market situation. For example, spectrum capacity requirements in television broadcasting will change with the switchover from MPEG-2 to MPEG-4 coding, DVB-T2 and possibly to high definition television.

5. Studies are conducted to assess the impacts on consumers and users as regards
    a. the feasibility, benefits, drawbacks and costs of different radio networks (mobile networks or other wireless broadband) on digital dividend frequencies allocated to television broadcasting after the discontinuation of analogue broadcasts
    b. the feasibility, benefits, drawbacks and costs of different radio networks on digital dividend frequencies released from television broadcasting;
    c. the benefits, drawbacks and costs of allocating a single, nationwide spectrum for purposes other than television broadcasting.

6. Studies are conducted on the feasibility and need to allocate frequencies to DVB-T or DVB-H networks for local or regional use either by using frequencies allocated for nationwide distribution or by separately allocating frequencies for this use.

3 International agreements on television and radio spectrum use

In Europe, the frequency bands 47–68 MHz (VHF-I band), 87.5–108 MHz (VHF-II band), 174–230 MHz (VHF-III band) and 470–862 MHz (UHF bands IV and V) are allocated to television and radio broadcasting. [6] The VHF-II band is assigned to FM broadcasting, the other bands to television. The VHF-III band has frequencies for both television and DAB radio. Furthermore, a European agreement was reached in Wiesbaden in 1995 on the use of the bandwidths 230–240 MHz and 1452–1492 MHz (the so-called L band) for digital radio.[7] This agreement and especially its provisions concerning L band frequencies were revised in Maastricht in 2002.[8] In Finland the use of L band frequencies is problematic because Russia uses them for aviation radio traffic, which is highly sensitive to interference.

Apart from television broadcasting, Finland and other countries have allocated the frequency band 47–68 MHz to mobile land traffic (primary allocation) and to radio positioning (secondary allocation). The frequency band 223–230 MHz is additionally allocated to fixed and land mobile services (secondary allocation), and the frequency band 790–862 MHz to both fixed and broadcasting services, and in several European countries (including Finland) also to land mobile services with corresponding (primary) rights.

The ITU Radio Regulations also provide the framework for regional, more specific agreements on spectrum use. Agreements on the frequencies available for analogue television distribution have been made on the basis of the Stockholm Agreement of 1961.[9] The provisions in this agreement concerning VHF-III and UHF frequency bands have been superseded by the Geneva Agreement 2006 (GE06)[10] on digital television distribution. GE06 also provides for the protection of analogue television use as set out in the Stockholm Agreement through to 17 June 2015. In addition, it largely supersedes the 1995 DAB agreement, which remains relevant for the part of frequency bands 230–240 MHz and 1452–1492 MHz. A decision on the suspension or revision of the DAB agreement is expected during 2007.

In the GE06 Agreement, Finland (like most other countries) has been allocated frequencies for seven national networks (multiplexes) suitable for digital television distribution in the UHF band and for two networks in the VHF band. Furthermore, regional UHF frequencies are allocated among others for the Helsinki metropolitan area. The distribution of UHF bands by region is presented in Appendix 1, Figure 1.

In a communication attached to the Geneva Agreement, the European signatories[11] have declared that the frequencies allocated may also be used for other than television and radio broadcasting purposes, provided that those uses do not cause interference

[6] ITU Radio Regulations
[7] Special Arrangement of the European Conference of Postal and Telecommunications Administrations (CEPT) relating to the use of bands 47–68 MHz, 87.5–108 MHz, 174–230 MHz, 230-–240 MHz and 1452–1492 MHz for the introduction of Terrestrial Digital Audio Broadcasting (T-DAB), Wiesbaden 1995.
[8] Final Acts of the CEPT T-DAB Planning Meeting, Maastricht 2002.
[9] Final Acts of the European VHF/UHF Broadcasting Conference, Stockholm 1961.
[10] Final Acts of the Regional Radiocommunication Conference for planning the digital terrestrial broadcasting service in parts of regions 1 and 3, in the frequency bands 174–230 MHz and 470–862 MHz (RRC-06), Geneva 2006
[11] Among Finland's neighbours, Russia is not party to this communication, but the corresponding issues have to be agreed upon separately in bilateral negotiations.

and that they do not require higher interference protection than television and radio broadcasting. Other harmonisation criteria may also be agreed upon bilaterally or multilaterally.

In Finland, the use of spectrum allocated to television and radio broadcasting is governed by the radio frequency regulation issued by the Finnish Communications Regulatory Authority[12]. More detailed rules on the use of frequency bands allocated to telecommunications operations and television and radio broadcasting for which an operating licence is required are set out in a Government Decree (1159/2002, latest amendment by Government Decree 6/2006).

4 Spectrum used by television networks

In Finland, analogue television broadcasting uses the VHF-III and UHF bands. In addition, there are two transmitters in the VHF-I band. Frequencies are in use for four national networks (YLE TV1, YLE TV2, MTV3 and Channel Four Finland) and for one regional network (6 transmitters) that broadcasts a compilation of Swedish Television programming (SVT Europe). The VHF frequencies are used only by YLE TV1 and to some extent by YLE TV2; all other networks operate in the UHF band. In the frequency range below 1 GHz, a total of 469 MHz has been reserved for television broadcasting; 448 MHz of this is within the VHF III and UHF bands.

One transmitter that is shared by two operators at the Pyhävuori television and radio station is in local use.

Digital television broadcasting uses three national networks (multiplexes A, B and C). One of them (multiplex C) does not use all the frequencies reserved for the network because it does not cover the whole country. The network's sports channel currently reaches 85 per cent, its other channels 78 per cent of the population. The current licence allows the operator to expand the network for nationwide coverage, and in practice all the frequencies allocated to network C are reserved. The network licence holder has the right independently to decide on bringing these frequencies into use. With the exception of the sports channel, the programming companies using the network have no obligation under the operating licence to increase the network coverage to more than 70 per cent of the population. The operating licence for the sports channels requires nationwide coverage.

One national network's worth of spectrum (multiplex D) has been allocated to mobile television (DVB-H). However, some of the frequencies will only be available after the cessation of analogue television services. The DVB-H network was launched on 1 December 2006 in Helsinki, Turku and Oulu.

In addition to the networks currently in use, one national network (multiplex E) has been set aside for television broadcasting that can be taken into use after the cessation of analogue broadcasts. In the Vaasa area, a licence has also been granted to build a regional network. Once completed, this network will serve the current users of the Pyhävuori analogue local transmitter.[13]

[12] Finnish Communications Regulatory Authority's Regulation No. 4
[13] This analogue local transmitter will also be shut down on 31 August 2007.

The Table below shows the channels that are currently carried on digital networks in Finland (situation as at February 2007). Subscription channels are indicated with an asterisk.

Multiplex A	**TV:** YLE TV1, YLE TV2, YLE FST5, YLE EXTRA, YLE Teema, **Radio:** Ylen Klassinen,YLE Radio Peili, YLE FSR+, YLE Mondo and YLE Radio Extrem
Multiplex B	**TV:** MTV3, MTV3 MAX (*), Subtv, Subtv Juniori (*), Channel Four Finland, Jim
Multiplex C	**TV:** CANAL+ FILM 1 (*), CANAL+ FILM 2 (*), CANAL+ SPORT 1 (*), CANAL+ SPORT 2 (*), Disney Channel (*), Sports channel, The Voice, Digiviihde, IskelmäTV Harju & Pöntinen; in the Turku area the regional channel Turku TV. **Radio:** KISS and Iskelmä.
Multiplex D	Mobile television (DVB-H)
Multiplex E	YLE/SVT Europe, Discovery (*), Eurosport SA (*); MTV3 documentary (*), Swelcom (*), MTV Europe/Nickelodeon (*)

Table 1: *Operating licences issued by the Government by multiplex. Multiplex A and B operators are under obligation to provide nationwide coverage (in the case of YLE this obligation is imposed by law), for multiplex C operators the requirement is to reach 70% coverage of population and for multiplex E operators 59% coverage as from 1 September 2007 and 80% coverage as from 1 December 2007.*

Based on the Finnish area classification used in the Geneva frequency plan, the allocation of frequencies for one television network requires 56 MHz of spectrum in the UHF band. This means that mathematically, Finnish networks with current operating licences have a total of 280 MHz bandwidth in their use. If all seven multiplexes in Finland were in use, the total amount of spectrum available in one geographical area would be 7x8 MHz or 56MHz. The width of a whole frequency band is 392 MHz. International surveys and measures will be needed to find additional capacity and to step up frequency efficiency.

In the VHF area, two national television networks are accommodated in the frequency band 56 MHz.

5 Other use of spectrum allocated to television and radio broadcasting

5.1 Broadcasting production

Two UHF channels (21 and 23) are currently in reporter transmitter use for outdoor radio broadcasting. This wireless transmission method is used particularly in YLE's regional programming operations, but the two channels in question are also available to others for radio microphone use. Channel 21 is reserved exclusively for wireless transmission use, channel 23 also carries television transmitters.

The transmission system is entirely independent of other national telesystems. It has excellent coverage and reliability, and no alternatives have as yet been found.

5.2 Radio microphones

Among the frequencies reserved for television use, some bands have also been allocated to radio microphones. Microphone use is currently allowed on frequencies 790–822 MHz (TV channels 61–64) and 854–862 MHz (TV channel 69). However, microphone use must not interfere with television use.[14]

5.3 Military use

In Finland frequency bands 790–822 MHz (TV channels 61–64) and 838–862 MHz (TV channels 67–69) are also reserved for military use.

[14] At present there are no television transmitters on these channels. With the exception of channel 69, however, some reservations are included in the GE06 frequency plan.

6 Spectrum released from analogue television networks

6.1 Digital dividend

Digital dividend refers to the frequencies that will be freed up with the switchover from analogue to digital television. Since all four existing national analogue television channels in Finland could be loaded into one digital multiplex, the digital dividend accruing from the nine multiplexes allocated to Finland in the GE06 Agreement is equivalent to the frequency requirements of eight national multiplexes. However, Government operating licences have already been issued for five digital networks, which means that four multiplexes out of the total digital dividend have been reserved for television use (one for mobile television). On both VHF and UHF frequencies, therefore, two nationwide multiplexes remain free.

In addition to the networks specified in the Geneva framework, unused frequencies will remain in the buffer zones required by television broadcasting. These will be available depending on intended uses and the technical characteristics of proposed television networks.

6.2 National networks

The Table below shows the current situation with regard to the use of digital broadcasting frequencies allocated to Finland in the Geneva Agreement. The agreement does not cover the VHF-I band (47–68 MHz), which in Finland will be de-allocated from television use with the shutdown of analogue television broadcasting. Problems within this frequency band include the propagation of radio interference and the relatively large antennas required by terminal devices, which make these frequencies less useful and less interesting.

UHF 470–862 MHz	**A** DVB-T	**B** DVB-T	**C** DVB-T	**D** DVB-H	**E** DVB-T FROM 1 Sept 2007	**F** *RELEASED FROM ANALOGUE TV USE*	**G** *RELEASED FROM ANALOGUE TV USE*
VHF III 174–230 MHz	**H** *RELEASED FROM ANALOGUE TV USE*	**I** *RELEASED FROM ANALOGUE TV USE*					
VHF I 47–68 MHz	*TO BE DE-ALLOCATED FROM TELEVISION USE*						

Table 2: *Multiplex use, situation as at 1 September 2007*

6.3 Regional networks

A number of regional networks are also available. Some of these have already been allocated to Finland under the Geneva Agreement (e.g. the frequency band for the Helsinki metropolitan area), but in most cases further discussions are still needed with our neighbours because the use of a certain frequency in one country limits its use elsewhere. One of the main principles of spectrum agreements is to allocate the capacity available as equally as possible among the countries concerned. This means that Finland cannot expect to have the free use of the whole frequency band currently available, but it will have to reach agreement with its neighbours on its equal allocation.

Figure 2 in Appendix 1 illustrates the maximum possible number and location of regional networks as assessed on the basis of planning principles for television use. It is expected that this number will be almost halved in connection with the forthcoming round of international negotiations. The calculation is based on technical requirements corresponding to television use (in terms of radio frequency interference and protection needs).

6.4 Additional networks

There still remains the possibility to implement other radio networks, either in addition to or instead of those described above. Rather than based on high-performance transmitters, these networks are designed around a cell concept with low-performance transmitters and use buffer bands[15] or the 'white areas' required by television distribution, within which high-performance uses are not possible because of interference. As a rule this kind of frequency use also requires agreement with neighbouring countries. In addition, it requires very careful network planning and the use of new, smarter technologies in terminal devices. This is because the purpose is to tie together radio networks implemented in very different ways.

6.5 Summary

In the UHF area, the digital dividend corresponds to two national digital television networks, or a total of 112 MHz (based on the Geneva planning parameters, one television network or multiplex in Finland occupies 56 MHz of bandwidth). One geographical area can use 8 MHz for one television-type network.

In the VHF-III area (174–230 MHz), possibly the whole bandwidth or 56 MHz will be freed up. Because of differences in the regional division used and in radio technology characteristics compared to UHF frequencies, this frequency band can accommodate two national television networks. As the bandwidth of one VHF television channel is 7 MHz, one geographical area can use 7 MHz for one television-type network.

In the VHF-I area (47–68 MHz), 21 MHz will be completely released from television use with the cessation of analogue broadcasts.

[15] This is sometimes referred to as interleaved spectrum.

A total of 280 MHz (5x56 MHz) is reserved for the five national multiplexes already licensed. As one multiplex takes up 8 MHz of bandwidth in the UHF area, the television use of these five multiplexes amounts to a total of 40 MHz per geographical region; in principle, 240 MHz will thus remain unused. Part of this capacity will be needed to implement gapfillers for already licensed television networks in cases where the frequency of the main transmitter cannot be used, part of it will be taken up by the interference effect and the protection of television use in Finland and its neighbouring countries.

Even licensed television networks will not necessarily use all the spectrum allocated to them, especially in sparsely populated areas. This will create further leeway in some parts of Finland.

As far as timing is concerned, the release of spectrum is dependent not only on decisions taken in Finland; the timetables for the digital switchover in neighbouring countries also come into play. The Geneva Agreement stipulates that analogue television broadcasts be granted interference protection until 2015, unless otherwise agreed between individual countries. Sweden will be shutting down its last analogue transmitters in November 2007, but based on current knowledge analogue broadcasts in Estonia will continue through to the end of 2012. Information on the situation in Russia is variable, but one realistic assessment suggests that analogue transmitters there will shut down in 2015.

Whenever frequencies are brought into use that are not specified in the Geneva Agreement, all the countries potentially affected shall agree on this separately.

6.6 Factors restricting the use of the digital dividend

Even though it is in principle possible to implement digital television networks regionally on a single frequency basis, with both the main transmitter and gapfillers operating on the same frequency, this has proven rather problematic. In practice, the distance between the transmitters needed in a single frequency network is shorter than assumed, and most gapfillers have to be assigned a different frequency. This costs some of the free capacity available, depending on the network coverage targets (network reach and the targeted service level in shadow areas). However, the three networks that are now in operation have already made at least most of these reservations, and therefore the figures indicated here of the amount of capacity to be released are not affected. The DVB-H network will be implemented using shorter transmitter distances than with DVB-T networks, and therefore there will be no similar problems.

As for DVB-H networks, it has to be borne in mind that a buffer band is needed between the GSM transmission frequency and the DVB-H reception frequency. In practice this restricts the frequencies available for DVB-H distribution to under 750 MHz. Consequently the highest numbered television channel is 55.

One major restriction to the use of freed-up spectrum follows from the fact that in the GE06 plan, frequencies are scattered both geographically and across the spectrum. The release of an even moderately uniform frequency band would require a re-arrangement of frequencies both on transmitters already in use and in neighbouring countries. Even

in the best case this would incur additional costs to both operators and large numbers of consumers, because frequency changes would require adjustments to both transmission and reception equipment. Overall, however, the harmonisation of spectrum use is useful and beneficial.

Any other spectrum uses must not interfere with digital television and digital radio use either in Finland or in its neighbouring countries, and levels of interference tolerance must be equally high as in television and radio broadcasting. Non-interference with radio broadcasting in neighbouring countries is guaranteed by the ITU Radio Regulations and the coordination procedure described in spectrum use agreements. In practice, this means that the decision to launch a new radio network outside of the scope of earlier agreements must be approved by the countries within the area affected by radio interference.

Radio networks that are structured in different ways, i.e. that use different mast locations and transmitter distances, for instance, are liable to cause mutual interference. There is practical experience of this with DVB-H distribution. From a network planning point of view the introduction of new services among existing television networks is extremely challenging. Before any decisions are made to allocate spectrum to networks that differ significantly in terms of their radio-technical characteristics or in terms of the way in which they are implemented, it is crucial to establish the mutual compatibility of those networks.

In Russia, television channels 45, 54, 55 and 58–69 have other than television uses. This restricts the television use of these channels in Finland, too. Furthermore, the use of certain other television channels is affected by restrictions due to international agreements.

7 International situation

7.1 European Union and CEPT measures

In February 2007, the European Union's Radio Spectrum Policy Group (RSPG) adopted an opinion concerning the use of spectrum that will be released with the switch-off of analogue television broadcasting ('EU Spectrum Policy Implications of the Digital Dividend'). The document is a follow-up to the RSPG statement 'Spectrum implications of the switchover to digital broadcasting' (adopted in 2004) and the opinion 'Spectrum for mobile multimedia services in the field of broadcasting' (November 2006).

The EU Radio Spectrum Committee has mandated CEPT to prepare a survey of both one-way multimedia use in the television frequency band and the use of spectrum that will be released through the digital dividend ('digital dividend mandate'). A major concern with regard to multimedia use will be to enhance the flexibility of the European Maastricht Agreement and other instruments. The Maastricht Agreement covers the frequency range 1462–1479.5 MHz, and the expectation is to be able to use that range not only for T-DAB but also for mobile television broadcasting and other uses. The final report is due for completion in summer 2007. The CEPT working group FM45 is preparing a response to the Commission mandate. The EU Commission's decision on the issue is expected in late 2007.

CEPT (task group ECC TG4) is preparing a response to the digital dividend mandate. The first part of the mandate includes a survey of one-way multimedia services in the UHF area (470–862 MHz) and the second part a technical feasibility study of a harmonised sub-band in the UHF area for two-way mobile networks. The deadline for the survey is July 2007. The third part of the mandate involves a study of the feasibility of new applications and services in the unharmonised 'digital dividend' band ('white areas'). The final report is deadlined for December 2007. The EU Commission expects to reach a decision on this issue as well.

In November 2005 the EU Radio Spectrum Policy Group has drafted a communication on the WAPECS procedure (Wireless Access Policy for Electronic Communications), endorsing the objective of a more flexible spectrum use.

In summer 2006 the EU Radio Spectrum Committee mandated CEPT to identify the requirements for flexible spectrum use with a view to protecting different types of services against interference and the obligations emerging from international agreements. In addition, CEPT is to look into ways of increasing flexible frequency use with a view to enhancing the harmonisation of different services in adjacent frequency bands and different applications sharing the same bands. The deadline is set for 29 July 2007.

CEPT (project group ECC PT1) is also preparing European opinions on the allocation of frequencies below 1 GHz to IMT-2000 systems.

In a communication published in February 2007, the Commission has expressed its views on the practical measures that will be needed by 2010 in order to introduce a more flexible system for the administration of the rights of spectrum use. Electronic

communications directives will change the legal basis of spectrum management in the ways described in this communication. The reform of the regulatory framework will be completed by 2010.

In its communication, the Commission explains why the reform was grounded in the principles of technology and service neutrality. The Commission also sets out the measures it will be taking before 2010 in order to further the goals of the anticipated legislation. By the end of 2007, the Commission says it will issue recommendations on the minimum conditions and restrictions relating to the rights of spectrum use. It is expected that the Commission's forthcoming recommendation will ease the conditions of spectrum use, particularly so that they no longer restrict the intended use of a frequency without special reason.

Appendices 2 and 3 provide Internet links and additional information on EU communications, CEPT mandates and CEPT agendas.

7.2 Sweden

Sweden has been shutting down its analogue television transmitters region by region since autumn 2005. The latest plans are that analogue broadcasts over the terrestrial network will be discontinued in November 2007.

PTS (Post- och Telestyrelsen), the authority that monitors the electronic communications and postal sectors in Sweden, commissioned surveys in 2006 on the possible technical uses[16] of spectrum released from analogue television broadcasting and on the implications from a consumer, market and social point of view.[17] The latter survey also includes a summary of the technical report. The purpose of these reports is not to make recommendations, but rather to provide background material for decision-making.

The Swedish situation is in many ways similar to that in Finland. Sweden, too, has issued operating licences for five of the seven nationwide UHF networks specified in the Geneva Agreement. All VHF frequencies have been reserved for digital radio (T-DAB). The services competing for the freed-up spectrum are thought to be the same as in Finland. It is not considered impossible that different types of services could operate in parallel with one another, but the report says that conclusions cannot be drawn without a more detailed investigation.

The technical report is based on an analysis of three different scenarios. In the first scenario, the existing television network infrastructure remains in place; in the second minor changes are allowed; and the third scenario portrays a completely new infrastructure for television broadcasting. The starting-point for all three scenarios is that the five DVB-T networks in the UHF area cover at least 70 per cent of Swedish households and that the VHF frequencies accommodate two DAB networks.

[16] Teknisk utredning av användning av frigjort frekvensutrymme vid övergång till marksänd digital-tv [Technical review of the use of released spectrum following the switchover to terrestrial digital television], HiQ Data AB, Stockholm 2006.
[17] Utredning av användning av frigjort frekvensutrymme i samband med övergången till marksänd digital-tv, [Review of the use of released spectrum in connection with the switchover to terrestrial digital television], Netlight Consulting AB, Stockholm 2006.

The review includes high definition television (DVB-T/HDTV), mobile television and multimedia (DVB-H, MediaFLO, T-DAB/T-DMB and UMTS/MBMS) and WiMAX broadband networks. The main difference in the spectrum use of these systems is that in fixed rooftop antenna reception, reception capacity is restricted by interference caused by other networks. In mobile reception networks, on the other hand, reception capacity is restricted by measures to curtail the interference caused by others to other networks.

As well as providing a general overview, the report looks into the detailed analyses carried out on four geographical areas.

One of the scenarios starts from a completely clean table. It includes a detailed examination of the impact of increased network density, i.e. reducing cell size, antenna height and transmission power. In DVB-T distribution, network capacity could be increased in one of the three areas analysed, where it was not necessary to consider interference with neighbouring countries' networks.[18] In this area the bandwidth available could be increased by 32 MHz (from 10 television channels to 14). For mobile television (DVB-H and MediaFLO) the capacity could be increased by 8 MHz, again in one area (although not in the same area as in the case of DVB-T).

In the latter report that focuses chiefly on marketing and demand, perhaps the main conclusion is that either because the technologies concerned are not yet mature or because it is not clear how demand for those technologies will develop, it would be prudent to take a slow-go approach, or at least to allocate spectrum in a manner that still allows for flexibility later on. However, the report also points out that there are cases where it is beneficial to be in the vanguard, citing the examples of Finland, Nokia and mobile television.

7.3 United Kingdom

The UK will switch off analogue television broadcasts region by region between 2008 and 2012. A total of 368 MHz will be released from UHF frequencies (the whole bandwidth 470–862 MHz is not in television use), but the British government has already decided to allocate 256 MHz to terrestrial digital television. In the UK, this means six multiplexes. The digital dividend is exactly the same as in Finland and Sweden, i.e. 112 MHz. For geographical reasons the UK can accommodate more services in one and the same frequency band than Finland, for example: it has fewer neighbours and therefore significantly less radio traffic to avoid.

In the UK, the Office of Communication (OFCOM) has produced an almost 200-page report on the use of the digital dividend.[19] The main emphasis is on the social benefits –the added value deriving from different alternative services to people both as citizens and consumers – but economic values are given prominent consideration as well. In addition to the alternatives brought up in Finland and Sweden, the OFCOM report deals with very low-power applications (e.g. home networks), satellite services and public security services (e.g. applications used in emergency situations). Other areas that are given focal attention include radio microphones and local television. In

[18] This was possible in the centre of the country, in the region of Örebro.
[19] Digital Dividend Review, OFCOM, 2006.

addition, OFCOM wants to open debate on whether it is necessary to leave an ‘innovation reserve’ for allocation to completely new services.

OFCOM’s definition of the digital dividend extends to the ‘white areas’ in-between television networks that are not suitable for television use. To be precise, these are not released frequencies, but they are merely used in a new way. Corresponding uses have been possible even with analogue television broadcasting, but digitalization makes it easier to integrate different kinds of networks.

The report provides a technical overview of the potential uses of the spectrum released and examines consumer behaviour and the demand for different services. It also looks into the possibilities of defining the monetary value of spectrum from both a consumer and business point of view, and more generally from the viewpoint of society at large. For example, the transmission of standard definition television, local television and mobile broadband services are considered to have societal value, whereas high definition television and mobile television are not. However, the way in which different services are valued may change over time.

The UK plans to allocate the digital dividend frequencies as soon as the shutdown of analogue broadcasts begins in 2008. Licences will be issued for at least 18 years.

OFCOM also addresses the question of how the regulation of spectrum use should be organised in the digital era. The report concludes that in most cases, the spectrum should be auctioned off and users should pay the going market price. The resale of spectrum should also be made easier. However, non-profit uses in the public sector must not be ignored.

8 Potential uses of the digital dividend

8.1 Overview of potential uses and needs

The spectrum released from analogue television broadcasting may be used either for mass communication purposes (television and radio broadcasting) or for other radio services. Mass communication is one-way, other services are typically two-way processes.

Potential mass communication uses include
- increasing the number of television programme services (including pay TV)
- local or regional television broadcasting
- additional television services, e.g. surround sound
- improving quality without increasing image resolution
- high definition television (HDTV)
- national, regional and local mobile television/multimedia; and
- digital radio

Other potential uses include:
- mobile communication,
- wireless access networks; and
- licence-free radio devices.

The latter networks and devices have traditionally been used for two-way targeted communication such as telephone and data network services (Internet), but as from 2008 they will also incorporate mass communication characteristics.

When a new technology is launched for the delivery of consumer services, the transition usually needs to be smoothed over by means of simulcasting. During this period when both the existing and more advanced technologies are used, the need for frequencies is significantly higher than normal. Examples are provided by NMT and GSM and by analogue and digital television.[20]

The distribution of mass communication services uses not only terrestrial networks, but also cable television networks, satellites and other data networks (broadband television and Internet television). For more on these, see Appendix 4.

[20] In some cases, however, different generations of radio technology are compatible backwards, i.e. terminals can operate on the same radio frequencies regardless of whether they use the older or newer technology. Examples include GSM and EDGE and basic 3G/UMTS and HSPA.

8.2 Mass communication

8.2.1 Development of television and radio broadcasting technology and distribution networks

In Finland, digital television signals are currently transmitted via the terrestrial network using MPEG-2 compression technology. The new, more efficient standard, MPEG-4[21], is almost ready for launch, but in practice it is not yet possible to take advantage of its maximum theoretical efficiency. It is expected that by 2009, MPEG-4 technology will provide around twice the efficiency of the present system, and later possibly even more.

MPEG-4 reception requires new receivers (either digital set-top boxes or integrated receivers), although all terminals that can process MPEG-4 code will probably be able to receive MPEG-2 broadcasts, too. Since there are large numbers of MPEG-2 receivers in use, it makes sense to restrict the use of MPEG-4 compression to new services such as high definition television.

Work is also underway to develop a new, more powerful standard for terrestrial network distribution (from DVB-T to DVB-T2). Among the main aims of this development effort are to increase the frequency efficiency by 30–100 per cent and to optimise DVB-T distribution for high definition television. It is expected that the technical standards for reception will be established by 2009. Receivers will not be available before 2010. DVB-T2 technology also requires new receivers. Appendix 5 provides further information on the DVB-T2 standard.

Only part of the digital television receivers currently on the market operate at both UHF and VHF frequencies. In most European countries VHF frequencies are reserved for digital radio or multimedia (DAB/DMB).[22] Therefore much uncertainty surrounds the proliferation of VHF compatible receivers in the future.

8.2.2 Standard definition television

At current quality standards, using modulation that conforms to the DVB-T standard and MPEG-2 coding, one digital multiplex can accommodate about six television services (programme channels). The exact number depends on the technical demands of the content: the greater the proportion of the image that changes before the next screen is displayed, the higher the transmission capacity required. The transmission of demanding content – e.g. a sports event – at high quality requires speeds of about 4 Mbit/s, a news broadcast can normally make do with 2 Mbit/s. A poor-quality source also puts a drain on capacity, because the system is unable to distinguish noise from variable picture content. If too many channels are forced into one multiplex, image quality will deteriorate. Other services (radio, MHP) crammed into the multiplex also detract from capacity.

As the screen size of television receivers continues to grow, increasing attention has to be paid to image quality even in standard definition services. Large LCD screens are particularly critical – the current image quality is only just acceptable. Improved

[21] Specifically, its profile 10 or H.264/AVC.
[22] In Germany, for example, DVB-T services are also transmitted on VHF frequencies.

image quality, then, will require either more compact coding or increasing the capacity reserved for one programme.

8.2.3 High definition television

High definition television (HDTV) refers to television broadcasts with significantly higher resolutions than in Standard Definition Television (SDTV).

It does not make sense to transmit high definition video over a terrestrial network with MPEG-2 compression, because one single content channel would take up the capacity of the whole multiplex. Indeed large-scale HDTV distribution over terrestrial networks requires more effective compression and modulation methods. This has been one of the aims of ongoing DVB-T2 development projects. Together with MPEG-4 compression technology, the DVB-T2 standard provides a reasonably sound platform for high definition broadcasts over a terrestrial network.

The number of HDTV households worldwide is rising very sharply, but this growth is concentrated in just a handful of countries. Europe is not yet part of this area of rapid growth. More than 90 per cent of the world's HDTV households are in the United States and Japan. Other countries of strong growth include Canada, Australia and South Korea. Most HDTV broadcasts today are via satellites and cable television networks. Broadcasts over fixed broadband networks are just starting up.

In a report by the market research firm In-Stat in summer 2006,[23] it is estimated that by the end of 2009, the number of households viewing HDTV programmes will climb to 55 million. According to figures released by the Finnish Association of Electronics Wholesalers, 80 per cent of television receivers sold in Finland in 2006 were high definition ready. Sales of flat-screen televisions in 2007 are projected to rise to 300,000 units, of which more than 90 per cent are HDTV ready.

To date, more than seven million HDTV sets have been sold in Europe. According to Euroconsult, the figure will rise to over 30 million by 2010. However, In-Sat suggests that there is an imbalance at least in the United States between the number of HDTV televisions purchased and the number of households watching HDTV programmes: no more than one in three HDTV households actually watch high definition broadcasts.

As HDTV reception requires a new receiver anyway, one option could be to allocate multiplexes in the VHF area for this use and set VHF readiness as a basic device requirement from the start. VHF is not suitable for mobile use because of the large antenna size required, but in rooftop HDTV applications antenna size is not a problem.

8.2.4 Mobile television (DVB-H)

Television, radio and multimedia in general can be distributed to portable or mobile media by various different technologies. Distribution can be based on either mobile networks or separate networks optimised for mass communication. Here, mobile television refers to systems based on the latter method of distribution.

[23] HDTV Service Expands: Over 15 Million Households Now Watch High-Def TV (In-Stat, August 2006).

Mobile television systems are optimised for the reception of television services on small, portable, battery-powered terminals. Mobile phones are well suited to this purpose because they are by far the most ubiquitous portable personal device. Furthermore, as the mobile phone is connected to the mobile network, it will also be possible to develop various interactive services and billing systems, for instance.

The mobile television network that was launched in Finland on 1 December 2006 is based on the DVB-H standard; see Appendix 6 for further details. Other standards developed for mobile television broadcasting include the Korean DAB-based T-DMB for terrestrial networks and S-DMB, which is based on satellite distribution; another example is MediaFLO, which has been developed by the American company Qualcomm. In addition to S-DMB, other satellite-based mobile television systems are under development. T-DMB currently operates on VHF-III frequencies; S-DMB in Japan and Korea operates on 2630–2655 MHz; and MediaFLO, like DVB-H, on UHF frequencies.

Various calculations have been done on the cost implications of the choice of frequency band for mobile television networks. Most comparisons have been between the VHF III (174–230 MHz), UHF (470–862 MHz) and L bands (1452–1477 MHz), all of which have been suggested for mobile television use in Europe. In Finland the use of the L band is somewhat problematic because Russia uses these frequencies for aviation radio traffic, which is highly sensitive to interference.

The utility of different frequency ranges is determined not only by the direct relationship between frequency and path loss, but also by the dependence of the terminal device’s antenna gain on the frequency. The lower the frequency, the larger the antenna needed. This very much restricts antenna options with small DVB-H terminals, particularly in the VHF area. In the L band, antenna gain is clearly better than in the UHF area, but path loss is accordingly much higher. Comparisons show that the costs of a network implemented in the VHF III area are about twice as high as those for a comparable UHF network. A network built in the L band, then, is three times more expensive than a comparable UHF network. For purposes of implementing a mobile television network, therefore, UHF is the optimum bandwidth range.

DVB-H use in the UHF range is not unrestricted either. The only frequency range that allows for the simultaneous use of a GSM-900 mobile system connected to a terminal and DVB-H reception is 470–750 MHz. Since GSM frequencies are almost immediately above the band reserved for television, it is necessary to leave a sufficient buffer band.

8.2.5 Digital radio

Several systems are available for digital radio distribution. The strongest contenders are T-DMB and DVB-H, which were already mentioned in connection with mobile television, and Digital Radio Mondiale (DRM), which has been designed primarily for current AM frequencies. The DVB-T system can also be used for radio distribution, but this requires a digital converter designed for television reception. DRM is the only standard specifically designed for audio content, the other two are also capable of transmitting multimedia, including mobile television. Both T-DMB and DVB-H

operate on television frequencies, the former in the VHF band and the latter in the UHF band.

In Finland digital radio broadcasts are currently transmitted on both DVB-H and DVB-T networks. DVB-T, however, is not suitable for mobile reception.

8.3 Mobile communication

8.3.1 Development of mobile communications network technology

High-speed downlink packet access (HSDPA) technology was deployed in the Finnish 3G/UMTS network in summer 2006. HSDPA will initially deliver mobile downlink speeds of about 1 Mbit/s. As well as offering higher speeds for e-mail connections, this will pave the way for new multimedia services, such as video streaming, downloading music onto phones, and higher quality mobile television. HSDPA data transfer capacity will be multiplied during 2007, when the transfer speed will be increased to several megabits per second. HSDPA offers maximum speeds of about 14 Mbit/s.

The efficiency of the 3G/UMTS system will be further improved over the next few years. As from 2009, the aim is to offer 100 Mbit/s downlink and 50 Mbit/s uplink speeds.[24] In February 2007, several manufacturers were already demonstrating 150 Mbit/s connections.

Another promising line of development is the so-called Extended Range, which can be used to increase the range of the radio cell by a factor of four. This will extend the coverage of a single transmitter even more. Australia has demonstrated ranges of up to 200 kilometres, while the typical range at the 850 MHz frequencies used in Australia is 50 kilometres.

Mobile networks also accommodate television programming as well as other video and multimedia services. For the time being distribution is still via user-specific (i.e. unicast) radio channels,[25] but multicast or broadcast-type distribution technology will be launched in the near future. Video-on-demand services are also possible. Appendix 7 looks in closer detail at the potential mobile television uses of the 3G/UMTS network.

8.3.2 Spectrum used by mobile networks and future spectrum requirements

In Finland, 3G mobile networks have been deployed in the 2 GHz frequency area allocated to them in the 1992 World Radio Conference. More than 40 per cent of the Finnish population is now covered by these networks (almost 50 towns and cities and about 15 holiday resorts[26]). Finland may be deploying 3G networks in the 900 MHz frequency band (which are currently used by GSM networks) as soon as 2007.

[24] These speeds are based on the long term evolution (LTE) standard, which is in its final stages of development.
[25] Although unicast channels are user-specific in 3G, they can be carried on the same radio frequency channel (5 MHz carrier wave) whose bit capacity they are using.
[26] December 2006

A total of 585 MHz of bandwidth is currently reserved for mobile networks. 70 MHz of this is in the frequency band below 1 GHz, 515 MHz is in the range of 1–3 GHz.

It is estimated that the frequencies currently in use plus those reserved for mobile networks will last until 2015. Unless the spectrum available is increased, a dramatic shortage looms large from 2015 onwards. By the end of the 2010s, the need for frequencies will be more than double the number of frequencies currently available. The additional frequencies required by mobile networks cannot be found in the bandwidths that are available for this purpose.

The ITU-R Report M.2079 lists the following candidate new frequency bands for mobile communications (the same bands appear in the ITU CPM-07 report):

- 410–430 MHz, 450–470 MHz, 470–862 MHz,
- 2300–2400 MHz, 2700–2900 MHz and
- 3400–4200 MHz, 4400–4990 MHz.

A base station operating in the frequency range of 2 GHz has a significantly smaller geographical coverage than a station with the same transmission power operating in the frequency range of 900 MHz, for example. As lower frequencies are far more cost-effective in building mobile networks, there is a strong global drive now to make these low frequencies available for the needs of fast mobile networks.

The UMTS Forum, a European body promoting the development of 3G mobile communications, has assessed the economic implications to operators of allocating spectrum from the lower end of the UHF band, i.e. the frequency range 470–600 MHz to 3G mobile networks. Their study compares the costs incurred from the same proposed coverage area (10,000 km^2) and a certain minimum data transfer speed. In the 2 GHz frequency range, downlink speeds of 384 kbit/s and uplink speeds of 64 kbit/s require a total of 1,980 base stations; in the 1000 MHz frequency range, the required number of base stations is 665; and in the 500 MHz frequency range 304. The operator's savings in investment costs increase at almost the same rate. Furthermore, because of the smaller number of base stations, significant savings are gained in overheads. In the 500 MHz area savings of up to 70–80 per cent can be made compared to the 2 GHz area.

For more background information on the spectrum requirements in mobile networks, see Appendix 8.

8.3.3 International regulation of the frequency band 470–862 MHz and its possible use for mobile communication

The possible uses identified by the Radio Regulations for the frequency band 470–862 MHz vary in different parts of the world, but one of its universal uses is for broadcasting. In addition, the United States and some other countries have allocated certain bandwidths in this range to mobile uses (including mobile networks),[27] in Asian countries the whole frequency band is allocated to mobile use. In the United States, Japan and some other Asian countries, the frequencies in this band have already been allocated to mobile networks.

[27] 470–512 MHz and 614–806 MHz.

European countries have not allocated any of these frequencies to mobile services, although the Geneva Agreement does under certain conditions allow for other than broadcasting uses. To eliminate any misunderstandings with respect to possible and permissible uses, it has been suggested that mobile services be added to the Radio Regulations as a co-primary use alongside broadcasting. This would also make it possible to enter mobile services in the ITU frequency register and establish the same rights for mobile services as for television and radio use.

Any amendments to the Radio Regulations require a decision by the World Radiocommunication Conference (WRC). The next conference (WRC-07) will be held in 2007, thereafter in 2011.

Several European countries are committed to the aim of incorporating mobile services in the Radio Regulations. There are two main approaches. Some countries have suggested that allocations for mobile services should be increased as soon as possible in WRC-07 and that a footnote should be added to the Radio Regulations that would allow for the allocation of at least part of the 470–862 MHz bandwidth for mobile networks. The second approach suggests that WRC-07 issue a resolution commissioning the ITU to look into the digital dividend and the possibility of allocating bandwidth to mobile services. The results of these inquiries would then be submitted to the 2011 conference, which would proceed to take decisions both on the allocation of bandwidth to mobile services and on the Radio Regulations footnote allowing for mobile communications operations in this frequency band.

Based on the agreements reached by the working group preparing for WRC-07 under the chairmanship of the Finnish Communications Regulatory Authority, Finland will be voting at the conference for the allocation of mobile services to the 470–862 MHz frequency band. This is in line with the communication concerning the flexible frequency use attached to the Geneva Agreement as signed by Finland and most other CEPT countries.

8.4 Wireless broadband networks

The past few years have seen a sharp increase in interest in wireless broadband connections and related needs. As technologies continue to develop and consumer habits to change, mobile networks have assumed an increasingly important role in the delivery of broadband services. In the next few years, mobile networks will be able to deliver transfer speeds of up to 10–50 Mbit/s.

In response to the growing demand, European countries have now begun to look into the possibility of creating wireless systems that specialise exclusively in the delivery of broadband connections e.g. in the frequency band 3400–3600 MHz. Surveys have also been undertaken to see where one could find additional frequencies for these systems.

Finland has taken the decision to deploy the 450 MHz frequency band for broadband use. Released from the NMT mobile phone system, this band is ideally suited in terms of its radio-technical characteristics for building broadband connections in this sparsely populated country.

In the future, wireless broadband terminals may use either fixed wireless access, moving or nomadic wireless access, or mobile wireless access.

In principle the 470–862 MHz frequency band can also be used for fixed wireless broadband systems, but with current trends in development it seems it will not be possible to allocate enough frequencies within this band so that the capacity demand for broadband can be met. Other frequency bands or systems will need to be used in order to satisfy this demand.

8.5 Needs of authorities

The security authorities and defence forces in particular also have their own needs in the VHF-I and III bands. The VHF-I band lies in the middle of a frequency band allocated for use by the authorities, and as in Central Europe the sub-band 225–230 MHz in the VHF-III range is part of an area that will be harmonised for use by the authorities.

9 Weighing the alternatives

The re-allocation of digital dividend frequencies is a matter that calls for careful consideration: the decisions concern frequencies that are highly usable in terms of their radio-technical characteristics, and they will have far-reaching financial implications.

Finland is a sparsely populated country. For this reason terrestrial wireless television and radio networks have much greater significance here than they do elsewhere in Europe, where many densely populated countries are heavily cabled. For the same reason, Finland stands to reap significant economic benefits from the implementation of mobile networks in frequencies that because of their longer propagation range and better indoor coverage allow for a fairly sparse network of base stations.

Finland's geopolitical position differs from that of most other European countries. One of the factors that places restrictions on the use of certain frequencies is the proximity of Russia, which has adopted different solutions to EU countries.

Some of the services that will be using digital dividend frequencies can be launched within the next few years, others cannot be started up until several years later, depending for instance on advances in technology. Another timetable factor is the speed at which Finland's neighbouring countries will be moving to shut down their analogue television transmitters.

It is obviously easier to forecast developments over the next few years than to project the uses of television and mobile services and related business developments that lie over 10 years ahead in the future. However, services that are still in their infancy today may later evolve into the most sought-after uses with the strongest potential.

Key among the factors influencing the re-allocation of digital dividend frequencies are the continuing development and increasing diversity of television in the near future (e.g. Internet television, broadband television, high definition television and the personal use of television-type services) and the growing demand for various mobile and wireless media services that require increasing transmission capacity (e.g. wireless Internet and community-based services).

Decision-making on frequency use may be based on several different approaches. If the aim is to achieve the greatest possible benefit for the greatest number of people, the first step is to define that benefit – for example, is it having access to a large number of high-quality wireless radio and television programmes, or is it having access to mobile two-way broadband (fast) communication independent of time and place?

Decision-making on frequency use and related planning must also take account of the European Union's opinions. There is a clear trend towards an insistence on greater flexibility in spectrum use and on greater freedom of choice with regard to the technology used and services offered. There is a strong body of opinion that commercial factors should have greater influence on spectrum use. Similarly, there is growing support for the allocation of spectrum by auction and for allowing the resale of spectrum.

10 Concepts

Multiplex (MUX)
Frequency band in which a service provider delivers television services or other image or audio material in a television network.

Broadband television (IPTV)
Cable television type service offered in a broadband network and typically viewed on television and requiring a separate device (cf. Internet television).

Wireless broadband
A wireless broadband network can provide fixed services (wireless access network) or mobile services (mobile access network). Transfer speeds may be several or several tens of Mbit/s.

Mobile television
A system in which television, multimedia or radio services are transmitted to a mobile media type terminal either via a separate distribution network or a mobile network.

Internet television
Television-type service transmitted over the Internet network and typically viewed on computer (cf. broadband television). Viewing does not require a separate device, only dedicated software. For the time being, full-quality reception requires a very broadband, closed network, but inferior-quality images at smaller sizes can also be transmitted via the public Internet network. Broadband data transfer speeds are increasing all the time, which means that ever better quality images can be transmitted over the Internet.

Radio cell
Term used in mobile networks for the geographical area covered by one base station transmitter in the network.

Television network
Transmitter network for broadcasting one analogue television channel or one digital multiplex either throughout the country or in a smaller region.

11 Abbreviations

AM	Amplitude Modulation
CBMS	Convergence of Broadcast and Mobile Services
CEPT	European Conference of Postal and Telecommunications Administrations
DAB	Digital Audio Broadcasting
DECT	Digital Enhanced Cordless Telecommunications
DMB	Digital Multimedia Broadcasting
DRM	Digital Radio Mondiale
DVB-H	Digital Video Broadcasting - Handheld
DVB-T	Digital Video Broadcasting - Terrestrial
ECC	European Radiocommunications Office
FDD	Frequency Division Duplex
FWA	Fixed Wireless Access
HDTV	High Definition Television
HSDPA	High-Speed Downlink Packet Access
HSPA	High-Speed Packet Access
IPDC	Internet Protocol Datacast
IPTV	Internet Protocol Television
ITU	International Telecommunication Union
LTE	Long Term Evolution
MBMS	Multimedia Broadcast Multicast Service
MHP	Multimedia Home Platform
MIMO	Multiple-input multiple-output
MPEG	Moving Picture Experts Group
NWA	Nomadic Wireless Access
RRC	Regional Radiocommunication Conference (ITU)
RSPG	Radio Spectrum Policy Group
SDTV	Standard Definition Television
SFN	Single Frequency Network
T-DAB	Terrestrial DAB
S-DMB	Satellite DMB
T-DMB	Terrestrial DMB
TDD	Time Division Duplex
UHF	Ultra High Frequency
VHF	Very High Frequency
UMTS	Universal Mobile Telecommunications System
WRC	World Radiocommunication Conference (ITU)

APPENDIX 1: Regional distribution of television networks available or potentially available

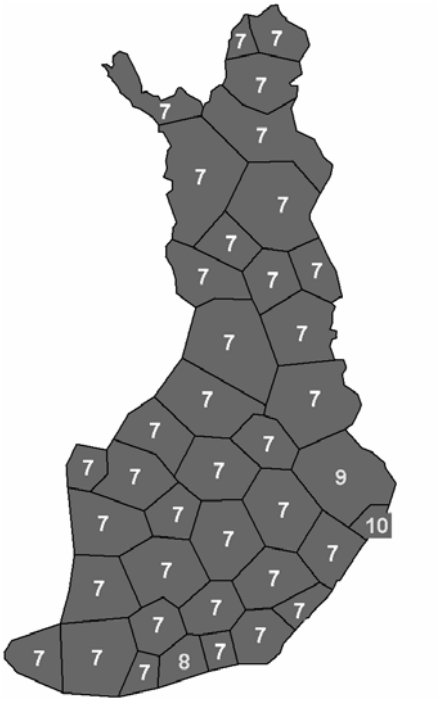

Figure 1: *Number of television networks allocated to Finland in the Geneva Agreement 2006 by region*

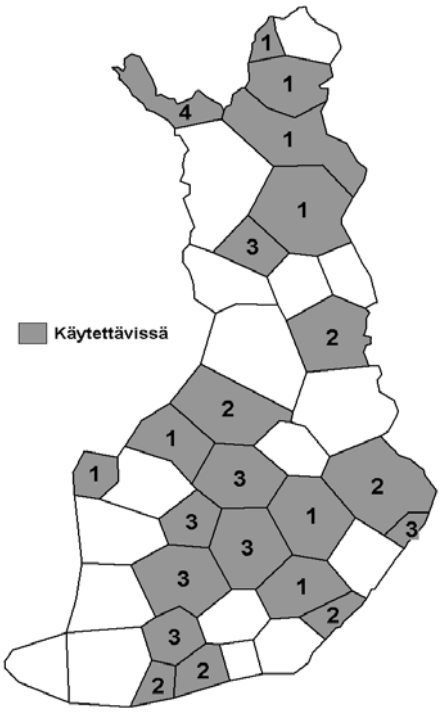

Figure 2: *Number and location of regional networks available in addition to those shown in Figure 1, not considering the possible future uses of neighbouring countries. The analysis is based on the technical characteristics of networks suitable for television distribution.*

[Käytettävissä = Available]

APPENDIX 2: WAPECS - Digital Dividend - Multimedia - flexible spectrum use: background and current situation, web links

1. EU Radio Spectrum Policy Group (RSPG): 'Opinion on spectrum implications of switchover to digital broadcasting' (2004):

http://rspg.groups.eu.int/doc/documents/opinions/rspg04_55_op_dig_switch.pdf

2. Commission Communication on the switchover from analogue to digital television 29 September 2005:

29 September 2005 - Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions - EU spectrum policy priorities for the digital switchover in the context of the upcoming ITU Regional Radiocommunication Conference 2006 (RRC-06)

http://eur-lex.europa.eu/LexUriServ/site/en/com/2005/com2005_0461en01.pdf

3. Radio Spectrum Policy Group Opinion on Wireless Access Policy for Electronic Communications Services (WAPECS) endorsing the objective of a more flexible spectrum use 23 November 2005:

http://rspg.groups.eu.int/doc/documents/opinions/rspg05_102_op_wapecs.pdf

4. ITU Regional Radiocommunication Conference (RRC-06) 15 May–16 June 2006

5. WAPECS Mandate issued by the EU Radio Spectrum Committee (RSC) to the European Conference of Postal and Telecommunications Administrations (CEPT) and the Communications Committee (COCOM) 5 July 2006

http://ec.europa.eu/information_society/policy/radio_spectrum/docs/current/mandates/ec_to_cept_wapecs_06_06.pdf

http://forum.europa.eu.int/Public/irc/infso/cocom1/library?l=/public_documents_2006/cocom06-18_authorisation/_EN_1.0_&a=d

6. EU Radio Spectrum Policy Group Opinion on the Introduction of Multimedia Services 5 October 2006 and Mandate given by the EU Radio Spectrum Committee (RSC) to the European Conference of Postal and Telecommunications Administrations (CEPT) 12 October 2006

Opinion:

http://rspg.groups.eu.int/doc/documents/opinions/rspg06_143_final_rspg_opinion_multimedia_services.pdf

Mandate:

http://ec.europa.eu/information_society/policy/radio_spectrum/docs/current/mandates/EC%20Mandate%20to%20CEPT%20on%20L_Band%20Oct%202006.pdf

7. Commission Communication on flexible spectrum use 8 February 2007:

8 February 2007 - Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions - Rapid access to spectrum for wireless electronic communications services through more flexibility

http://ec.europa.eu/information_society/policy/radio_spectrum/docs/ref_docs/com/com_50_en.pdf

8. EU Radio Spectrum Policy Group (RSPG): Opinion on the Digital Dividend (adopted 14 February 2007)

http://rspg.groups.eu.int/doc/documents/opinions/rspg07_161_final_op_digdiv.pdf

9. Digital Dividend Mandate issued by EU Radio Spectrum Committee (RSC) to the European Conference of Postal and Telecommunications Administrations (CEPT) March 2007

http://ec.europa.eu/information_society/policy/radio_spectrum/docs/ref_docs/mandate_dig_div.pdf

10. Forthcoming: Commission's WAPECS recommendation concerning the rights of use for radio frequencies in April 2007; under preparation by the Cocom committee

Link to page with a full list of all mandates:

http://ec.europa.eu/information_society/policy/radio_spectrum/activities/rsc_work/mandates/index_en.htm

All RSPG opinions are available at:

http://rspg.groups.eu.int/rspg_opinions/index_en.htm

APPENDIX 3: CEPT working groups

SE42*: Flexible spectrum use and WAPECS mandate issued by the RSC. By 29 July 2007, the working group is to draft reports on*

- the technical requirements of WAPECS frequencies with a view to ensuring the protection of different radio services and the obligations emerging from relevant international agreements;
- possible ways of increasing flexible spectrum use with a view to enhancing the harmonisation of different services in adjacent frequency bands and different applications sharing the same bands.

ECC/TG4*: assigned to draft three CEPT reports*

- Report A on compatibility issues between cellular/low-power transmitter networks and traditional, larger coverage networks and on the possibility of harmonising a sub-band in the UHF range 470–862 MHz for multimedia applications. The draft report deadline is March 2007.
- Report B on the technical feasibility of harmonising a sub-band in the UHF range 470–862 MHz for mobile applications (including uplinks). The draft report deadline is in July 2007.
- Report C on the feasibility of fitting new applications/services into non-harmonised spectrum of the digital dividend. The draft report deadline is in December 2007.

ECC/FM PT45: *assigned to*

- compile a draft report in response to the EU Commission mandate on the harmonisation of the frequency band 1452-1479.5 MHz to enable flexible use by mobile multimedia technologies; the draft report deadline is March 2007;
- explore the possibilities of using mobile multimedia technologies in the frequency band 1479.5–1492 MHz;
- identify the necessary measures and establish the timetable for the cessation/revision of the 1995 Wiesbaden Agreement that was revised in Maastricht in 2002; this shall be completed by June 2007;
- investigate the feasibility of and requirements for the direct conversion of DVB-T allotments to T-DAB assignments in the VHF III band;
- determine the necessary regulatory measures for the launch of DRM broadcasting on LF/MF frequencies.

ECC PT1: *to draft ECPs (pan-European proposal) on agenda item 1.4 and Briefs (background data) for WRC-07.*

The working groups' documents are public and available at the European Radiocommunications Office's (ERO) website at www.ero.dk. Open the drop menu 'ECC Activities', select the working group, and click on the relevant document under 'Related Documents' on the right hand side of the page.

APPENDIX 4: Different television distribution systems

In addition to terrestrial distribution, television broadcasting in Finland uses cable and satellite distribution systems. The latest newcomer is broadband television distribution. The most common mode of television reception today is via cable. The breakdown of television reception modes in Finnish households in 2006 was as follows:

Terrestrial households (other than cable TV)	42%[28]
Cable TV households	51%
No television	7%
Satellite TV households	5% (estimate)
Broadband TV households	0+% (estimate)

In satellite households, television services are received not only via satellite, but in most cases also via the terrestrial antenna network. Satellite reception does therefore not detract from the number of terrestrial or cable households. Figures for broadband television reception, on the other hand, are still so small at this stage (counted in no more than a few thousand) that statistics inevitably are somewhat unreliable.

Cable television

In recent years cable television operators have invested heavily in increasing their network coverage and frequency range and in developing two-way networks.

The total number of cable television subscribers in Finland currently stands at 1,274,820;[29] the number with access to a two-way network is 955,605. All in all more than 78 per cent of all Finnish homes are now passed by a cable system.

Cable television networks transmit in the frequency bands 5–400/450 MHz, 5–606 MHz or 5–862 MHz, depending on the technology used and the design parameters. The frequency band is divided into upstream frequencies (5-65 MHz) for cable modem and interactive television, and downstream frequencies, which cover the whole range from 87 MHz through to the cable network's upper corner frequency. Cable networks can use almost the whole frequency band available, and for instance in the UHF band it is quite commonplace to use adjacent television channels. The use of the whole downstream capacity is restricted by antenna network channels that broadcast on the same television channels and by frequency bands reserved for certain other uses. Effective use of the upstream band 5-30 MHz is partly restricted by general interference in this frequency band.

The high existing channel capacity (65 channels with 8 MHz of bandwidth in the 606 MHz system and 97 channels in the 862 MHz system) is sufficient for the distribution of virtually all foreseeable television services – including high definition television – and other cable television services. The programming of cable television networks

[28] Finnpanel Oy: Television households in Finland (8 Feb 2007)
[29] Finnish Cable Television Association (FCTA) statistics 31 Dec 2006

consists mainly of terrestrial television services and a larger number of other television programmes that are transmitted via satellite.

Satellite television

Households that watch satellite programmes either using their own receivers or via a communal antenna system have access to a variable number of satellite programmes and in most cases also to services transmitted via the terrestrial network. Commercial HDTV broadcasts are also available via satellite. The reception of most satellites is technically possible in the whole of Finland, provided there is 'eye contact' with the satellite. Having said that there are regions where this may be problematic because the angle of elevation of antennas is at best no more than some 20 degrees, in the northernmost parts of the country just ten degrees. However, even with this restriction, satellite coverage is better than the coverage of cable and broadband television, which are only available in larger population centres and their immediate vicinity.

At year-end 2006, it was estimated that about 71,000 households[30] in Finland received television broadcasts via satellite.

During 2007, the Nordic countries are planning to launch a new satellite with the capacity to broadcast several dozens of HDTV programmes across their area.

Broadband television and Internet television

Television programmes can be distributed via broadband in two different ways. Broadband television (IPTV) refers to a service delivered to subscribers over a broadband network and typically viewed on television; reception of the service requires a separate device. Internet television, then, is a service distributed over the Internet network and typically viewed on computer; reception does not require a separate device, only dedicated software. For the time being, full-quality reception requires a very broadband, closed network, but inferior-quality images at smaller sizes can also be transmitted via the public Internet network.

Broadband television distribution has already been started up in Finland, but as yet it remains fairly insignificant. Broadband television services are currently offered by three service operators. The proliferation of broadband television is being held back by the high transfer speeds required. Reception of standard definition television programmes with MPEG-2 compression requires a minimum speed of 8 Mbit/s, but 24 Mbit/s is recommended. With an 8 Mbit/s connection, reception is restricted to one television programme per connection (household) at a time. Higher speeds enable the reception of more programmes at a time and also the reception of HDTV standard. With the adoption of MPEG-4 coding, it will be possible either roughly to double the number of standard-quality broadband television services or to improve image quality. The aim is that HDTV programmes will be transmitted at speeds of no more than 8 Mbit/s. Manufacturers have introduced the first prototypes, but it will probable be some years before this target is reached.

[30] Kaapeli-tv-toimialaraportti [Cable television report], Markab Oy 2006

Standard definition (SDTV) Internet television services have also been launched in Finland. Broadband speed requirements are roughly the same as for broadband television.

Broadband speed and capacity is increasing all the time. In Finland the first 100 Mbit/s connections for household subscribers were opened in 2007. Even faster fibre optics based networks have also been launched. As yet, however, the fastest networks are only available in the most densely populated areas.

Broadband television distribution in Finland is very much hampered by copyright problems and the lack of legislative coherence. In several other European countries including France, Italy and Sweden, broadband television is already in use, and it is expected to gain ground in Finland as well.

With the advent of Internet television there has also been increasing discussion on so-called on-demand services (television and video on-demand), which allow users to download programmes or other contents via a broadband connection independently of other users. With on-demand television, users can control their own viewing in the same way as with a personal hard disk recorder, allowing them for instance to time-shift or view the same programme several times. Broadband transfer speed presents no restrictions because in principle it is possible to spend more time downloading a programme than viewing it. Even HDTV quality content can be downloaded from the Internet.

APPENDIX 5: DVB-T2 standard

The DVB-T standard was finalised in 1996. It has gained a very strong position globally, and in Europe is the only standard used for terrestrial digital television distribution. Overall there has been a high level of satisfaction with the DVB standard and its performance, as it has marked a significant improvement compared to analogue transmission.

With the arrival and increasing penetration of high definition television (HDTV), the implications to terrestrial distribution have also received growing attention. The receivers currently in use will not provide high enough image quality because HDTV video coding will probably use MPEG-4-based AVC rather MPEG-2. Updating is not an option because video decoders are not software-based. Therefore, as it will be necessary to change the receivers anyway, the physical data link layer, i.e. DVB-T could be upgraded at the same time. HDTV requires a high bit speed even with MPEG-4 coding, reducing by half the number of television programmes that can be accommodated on one channel of 8 MHz bandwidth. This puts terrestrial operators in a very difficult position with respect to spectrum availability and possibly pricing when compared to satellite and cable operators.

In January 2006 the DVB Organisation launched a research project (*Study Mission*) on the DVB standard: the purpose was to look into updating the standard and related technological feasibilities. The project submitted its report to the Technical and Commercial Modules of the DVB Organisation in June 2006. The Modules decided to continue the development effort and founded the CM-AMT to draft commercial claims and the technical group TM-T2. Various technological solutions have been put forward during the course of the survey that would allow for an increased spectrum efficiency in the new system. One of the solutions that has received prominent attention is multiple antenna technology MIMO, which is already used in many new radio systems, including various WLAN standards. At best, ‘2x2 MIMO’ allows for a doubling of spectrum efficiency, but on the downside, a more complex antenna system is needed at the receiving end. The timetables are such that the technical details of the new standard can be finalised no sooner than late 2007 or early 2008. In this case the standard would be ready for launch in mid-2009, with commercial devices available some 18 months later.

APPENDIX 6: DVB-H system

The development of digital mobile television systems has been grounded, on the one hand, in the digitalisation of television distribution in general; and on the other hand, in the development of terminal screens and processing power to a level that allows for good enough image quality. Digital television systems such as DVB-T are poorly suited for mobile television distribution, because terminal power consumption is too high on account of high transmission speeds and MPEG-2 compression. Based on the DVB-T standard, the DVB Consortium has therefore developed the DVB-H (Handheld) standard, in which services broadcast are bundled together using time-slicing technology. Here, one service uses the whole channel capacity for a fairly short burst, other services then follow one after another; the cycle is completed within 1–2 seconds and starts over from the first service again. This allows the receiver to shut down in-between bursts, which brings considerable savings in power consumption. DVB-H also includes an additional error correction which helps to improve reception especially in mobile applications such as in cars.

Mobile television is based on a DVB-H platform using IP-datacasting technology in which IP-based video services are coded with the highly efficient H.264 compression technology.

The DVB-H standard was completed in autumn 2004 and DVB-CBMS, which determines the higher levels of the IP-datacasting system, during 2006. The first DVB-H-based commercial services started up in Italy in summer 2006.

Mobile television services are designed for indoor or vehicle use on small portable terminals, which is why network coverage targets differ from those of traditional television networks based on fixed rooftop antenna reception. Here, cost efficiency is achieved by long transmitter distances and by high transmitter power. Mobile television reception requires higher field strength uniformly across the whole reception area, even indoors. As the amount of interference from the network is restricted, mobile television networks are usually implemented with a larger number of low-power transmitters than DVB-T networks.

A DVB-H network can be implemented on frequencies reserved for digital television networks under the 2006 Geneva spectrum plan (GE06). In this case 6–7 frequencies are needed to achieve one national coverage. In theory, DVB-H networks could be implemented with a smaller number of frequencies (3–5), because the signal interference ratio required by the networks is lower than in DVB-T networks designed for fixed rooftop antenna reception, but this would be difficult to fit together with the frequency plans of other networks. It is also unclear whether this would have any real benefits. It has even been shown that it is, in principle, possible to build an indefinite DVB-H network using one single frequency, provided that transmitter powers and mast heights are low enough. However, this is an expensive solution. Furthermore, the services would be the same across the whole network, which would be a significant drawback.

DVB-H is also extremely well suited for radio distribution. In DVB-H radio distribution, the sound coding method can be chosen as required. The minimum is 24

kbit/s. DAB-quality sound requires 96 kbit/s. Sound can also be combined with image (so-called visual radio).

APPENDIX 7: Mobile television in mobile communications networks

The situation today

Today's third generation (3G/UMTS) mobile networks carry a unicast-type mobile television service in which a streaming connection ('channel') is opened for each viewer when they tune in. The broadcast may be either a real-time television programme or a recorded programme (television/video-on-demand). The number of programmes available is indefinite, but the number of viewers that can be online at any one time is limited by the capacity of the local mobile network (radio cell size and number of carrier waves).

However, capacity has so far not proved to be a problem, especially if other network users (e.g. telephone service users) can be switched to the GSM network – after all most terminals work on both networks. As the capacity of the UMTS radio network is set to increase significantly over the next few years with the advent of HSPA and LTE technologies and with steps to increase that capacity by increasing the density of the cellular network, it is expected that there will be sufficient unicast capacity for a significant increase in the number of UMTS users.

It is estimated that worldwide, 3G/UMTS mobile television services are offered by about 100 operators, two of which are currently based in Finland. Virtually all 3G/UMTS phones have unicast television readiness. User surveys suggest that real-time television viewing is approximately equally popular as on-demand television viewing.

The future: Multicast/Broadcast (MBMS)

MBMS is an expansion of the UMTS mobile radio standard as defined by the UMTS standardisation organisation 3GPP. It allows for the flexible and dynamic use of the UMTS carrier wave both for traditional services (telephone, IP access and unicast) and for mass communication. MBMS allocates within the UMTS carrier wave a common radio channel to all users watching the same television programme: compared to unicast, therefore, it takes up only a fraction of the radio channel's capacity. Capacity savings are also achieved in the transmission network. A carrier wave can locally accommodate up to 12 multicast channels (at 128 kbit/s each). In practice, one carrier wave could accommodate 4–6 multicast channels when the same wave is additionally reserved for other unicast services such as on-demand video or other communication. HSPA and LTE technologies will also provide additional capacity in the future.

An important feature of MBMS is dynamic channel allocation between multicast and unicast: depending on demand at any moment in time, multicast channels can be formed for a few television programmes that have the largest number of viewers, while programmes that are less in demand are allocated to unicast channels. As this can be done cell-specifically, it will be possible simultaneously to deliver both mass communication services to large numbers of users and a virtually indefinite number of individual television programmes to a limited number of users.

MBMS will be introduced in 2008. The service will also enable interactive uses via the same UMTS network as well as various combinations of services. For example, it

will be possible to deliver tailored advertisements or other messages to viewers of the same television programme. Furthermore, a push TV service will be available in which programming specifically chosen by the user is sent to the user’s terminal for later viewing to (for example, the breakfast news can be transmitted in the early hours when a lot of free capacity is available in the network).

APPENDIX 8: Mobile spectrum requirements

Questions of frequency allocation for mobile networks have long been the subject of investigation by several international working groups that have involved not only teleoperators and equipment suppliers but also radio administration officials. Their work has been based on periodic market surveys, the development of the markets, and the dramatic increase in radio traffic. According to ITU reports /1/, total daily traffic volumes in 2010 are expected to rise to 249 terabytes (4.8 Mbytes/user/day). In a typical western European country, projections for the period from 2010 to 2020 are for an increase in daily traffic volumes from 250 to 5750 terabytes.

ITU figures indicate that by 2020, the global demand for additional spectrum on mobile networks will amount to 1280–1720 MHz (low market / high market demand) /1/. The corresponding estimate in the latest UMTS Forum survey is 1600 MHz /2/. For Europe, CEPT (ECC PT1) has settled on the ITU figure of 1720 MHz, based on the higher than average mobile penetration rate and higher use. This is supported by European forecasts by ITU-R working groups /1/. The estimate of 1720 MHz applies to the situation where there is one teleoperator; in a multioperator environment the frequency need is higher. This value represents the total need, i.e. it includes both current and projected spectrum, which in Europe adds up to 585 MHz (GSM, DECT, IMT2000). The actual estimated need for additional spectrum in 2020 is thus 1135 MHz.

Work to identify the frequencies that are suitable for additional bandwidth use is underway. The focus is on the frequency bands 470–862 MHz, 2.7–2.9 GHz, 3.4–4.2 GHz and 4.40–4.99 GHz. Broadband frequencies above 3 GHz are mainly suited for fast data transfer with high transmission requirements, whereas the frequency band below 1 GHz is best suited for purposes of cost-effectively increasing coverage area. In the bandwidth 470–862 MHz, the UMTS Forum estimates mobile spectrum needs at 60 MHz–95 MHz /4, 5/.

In principle, Finland can also take over the 900 MHz frequencies for 3G/UMTS use. At the moment this frequency band is exclusively in GSM900 use, and it is expected that GSM services will still be offered for some time to come. In addition, because the 900 MHz frequency has a narrow bandwidth, a wider scale adoption of UMTS technology would be difficult (the width of one UMTS channel corresponds to 21–27 GSM channels). The 900 MHz band can thus only provide a partial solution to acute problems of cost-effectively extending UMTS coverage in remote areas.

/1/ ITU-R Report M.2078 and M.2072
/2/ UMTS Forum Report 37 Mobile magic future 2010-2020, April 2005
/3/ UMTS Forum Report 40 Development of spectral requirements for IMT-2000 and systems beyond IMT-A
/4/ UMTS Forum contribution to the ECC PT1 meeting in December 2006
/5/ UMTS Forum Report 38 Coverage extension bands for UMTS/IMT-2000 in the bands between 470-600 MHz, January 2005
/6/ UMTS Forum Report 40 Development of spectrum requirement forecasts for IMT-2000 and systems beyond IMT-2000 (IMT-Advanced), December 2005