# Spectrum war

*The battle for the digital dividend*

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# Spectrum war – The battle for the digital dividend spectrum

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## Abstract

The digital dividend discussion represents an obvious conflict of interest between on the one hand the traditional broadcasters and market players from other mobile communication sectors and on the other hand between the stake holders within the mobile communication sector. The first one being a conflict in accessing to the valuable spectrum resources allocated to TV broadcast that has been there for many years and which has been intensified in different phases of technological development and the second being an obvious conflict of interest between the different stake holders within the mobile communications sector, including commercial mobile operators and the stake holders representing specific uses like Public Safety and Emergency (PSE), Intelligent Traffic System (ITS), etc in getting access to these resources. The paper gives an analysis of the digital dividend and discusses relevant new applications, technology and the policy/regulatory issues at European and international level.

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# Spectrum war – The battle for the digital dividend spectrum

## 1. Introduction

The objective of this paper is to identify the relevant uses of digital dividend spectrum. The digital dividend discussion represents an obvious conflict of interest between on the one hand the traditional broadcasters and market players from other mobile communication sectors and on the other hand between the stake holders within the mobile communication sector. The first one being a conflict in accessing to the valuable spectrum resources allocated to TV broadcast that has been there for many years and which has been intensified in different phases of technological development and the second being an obvious conflict of interest between the different stake holders within the mobile communications sector, including commercial mobile operators and the stake holders representing specific uses like Public Safety and Emergency (PSE), Intelligent Traffic System (ITS), etc in getting access to these resources. The paper gives an analysis of the digital dividend and discusses relevant new applications, technology and the policy/regulatory issues at European and international level.

The market organisation of radio and TV broadcast services has historically been dominated by either monopoly organisation (national or local) or in few cases by markets having few competing broadcasters. The spectrum scarcity argument has been used as one of the reasons for this market organisation model and for not giving resources to other communication sectors. However, the scarcity argument was challenged from the beginning[1].

In the US, for example, the strong broadcasters began to market HDTV at the end of 1980s to replace NTSC[2] trying to hold on the extra TV channels allotted for television services in every city[3]. This resulted in FCC's provision of spectrum without cost to virtually all of the current television broadcasters to provide for parallel transmission of 'advanced television services'[4] in the 1996 Telecommunication Act. This raised huge resistance from other market actors who were interested in the spectrum, especially, the actors from the "land mobile" and computer industry. In the recent years substantial part of the 'TV spectrum' is released for other uses[5].

[1] See among others Coase R. :"The federal Communication Commission", The journal of Law & Economics, October 1959 and (Noam 1991)
[2] This was a lobbying strategy against Land Mobile. By the end of the 1980s, actors from "Land Mobile" industries applied for these resources to use them for mobile communication systems. Broadcasters, led by the National Association of Broadcasters (NAB), came up with the argument that they needed these resources to introduce HDTV.
[3] In Washington, e.g., networks and independent stations broadcast on channels 4, 5, 7, and 9 on the VHF and 20, 26, 32 and 50 on UHF. The rest of the designated broadcast TV channels, 2 through 69, were vacant and the situation was similar in every city
[4] Later Digital HDTV services
[5] Se more more details later in this paper.

So the spectrum war and the battle between broadcasters and other market players on the allocated broadcast spectrum is not a new thing. The new thing is, as mentioned, the implications of the transition from analogue to digital and the determined deadlines for 'analogue shut down' in virtually all advanced markets.

The digital transition radically changes the spectrum situation. Depending on different technological parameters a spectrum efficiency of 6 to 8 times can be achieved when we go from analogue to digital. The question is then if all the new spectrum resources should go to TV broadcast or we should use part of it for other services, e.g., mobile broadband services.

While Digital Dividend may have a broader meaning in ICT for development relating to developing economies, the term refers to the radio frequencies that are being set free in relation to the switch-over from analog to digital broadcasting in the developed economies (Europe, etc.). The EU defines the Digital Dividend as 'the spectrum over and above the frequencies required to support existing broadcasting services in a fully digital environment, including current public service obligations' (COM/2007) 700 final).

The issues relating to the Digital Dividend are dealt with in a range of different international and national organizations and settings. ITU and its Radio Conferences are crucial events. There is often reference to ITU's Regional Radiocommunication Conference in Geneva in 2006 (RE-06), which took some decisions regarding the distribution of the Digital Dividend between the different applications, primarily broadcasting and interactive communications (e.g. mobile broadband). These decisions have become subject to some criticism especially by the EU Commission as they somehow run counter to manner in which the EU plans to 'clean up' the Digital Dividend by dividing it up into three clusters (high-powered broadcasting, lower-powered broadcasting, for instance mobile TV, and low-powered interactive mobile communications). Furthermore, RE-06 gave more emphasis to broadcasting than the present policies of the EU Commission.

The EU is, as mentioned, also very active in influencing the use of the Digital Dividend. The document mentioned (COM(2007) 700 final) is a crucial policy statement in this context, and the EU is very active in the field with its Radio Spectrum Policy Group (RSPG) and its political foundation in the Wireless Access Policy for Electronic Communications Services (WAPECS). The EU ambitions are basically to promote a harmonized market in the EU and, therefore, harmonized decisions with respect to spectrum usage, and to implement a technology and service neutral policy and spectrum trading. These general policy directions heavily influence the decisions taken by the different Member States. And, the EU is still working very much on the matter. The EU commissioned a major work to Analysys Mason (Mason 2009). This work is a centerpiece in the future directions for EU policies.

The main controversy or dividing line runs between broadcast use and mobile communications. The broadcasters of Europe and especially the public service broadcasters are very active in promoting the use of the freed resources for new broadcast applications, e.g. new channels and High Definition TV. Examples of these activities can be seen in EBU's view on 'How should the digital dividend be used?' (EBU, 2008) and 'Nordic public service broadcasters comments to the RSPG opinion on EU

spectrum policy implications of the digital dividend' (Nordic PSB, 2006). Their focus is on media pluralism and cultural diversity and they believe that this can best be promoted by allocating a large part of the frequencies to new broadcasting possibilities. A characteristic statement is the one on the front page of the abovementioned EBU documents, where it reads 'Long-term Public interest versus short-term profit'. An organization where the broadcasters' point of view have found following is, for instance, the Council of Europe (2008).

On the other side, one finds the mobile operators wanting to use the frequencies for extended and improved mobile broadband. There is presently a huge demand for mobile broadband. This is one of the growth areas of the telecommunications industry, and there are also sound economic arguments for allocating a large part of the frequencies for mobile broadband. This is, for instance, substantiated in a report written by Forge, Blackman and Bohlin (2007) – a report commissioned by T-mobile International. There are surely vested interests at play in this context, but the results are not much different from what we arrived at some years ago when making a similar comparison of the economic value of mobile communications as opposed to broadcasting (see amongst others (Falch & Tadayoni 2004). The economic value added of mobile (broadband) communications is larger than for broadcasting. This is probably also recognized by the broadcasting community, as their emphasis and arguments relate to cultural long-term interests as opposed to 'short-term profits'.

The above mentioned Masson analysis gives the most comprehensive discussion of the issue and points to a number of different deployment scenarios. Also on la-rete.net (http://www.la-rete.net) – an Italian site/organization dealing with the Digital Dividend, there is a comprehensive overview. On this site, Martin Cave (2008) has a small piece on the situation in the UK, where he lists the following uses and applications:

- mobile television and other types of mobile video and multimedia;
- extending existing DTT coverage;
- new DTT channels aimed at a UK market in either SD or HD;
- new DTT channels aimed at local markets (i.e. local television);
- wireless microphones and applications for PMSE;
- other low power applications, like hubs to distribute content around the home or using ultra wideband (UWB) technologies;
- broadband wireless applications, which could be mobile, and other mobile voice and data services;
- services using satellite communications;
- emergency and public safety services;
- community radio;
- digital radio;
- communication with medical professionals and educational institutions;
- amateur and/or university use;
- new services for people with disabilities;
- international and cross border uses (e.g. an international emergency channel);

- digital public service teletext to match the analogue service; and
- user created networks (e.g. employing mesh technology).

One of the most promising new applications could be in the Public Safety and Emergency (PSE) area. WIK and Aegis has made a larger report in this area – commissioned by EADS and Motorola: 'Safety First – Reinventing the Digital Divide in Safeguarding Citizens (WIK & Aegis, 2008). The PSE is further discussed in details in the case studies in this paper

### *Background*

In summer 2008 the Strategic research council funded a research project (FUSE) to identify the relevant innovative services and applications to be used in the digital dividend spectrum. The aim was to come up with ideas for applications for the digital dividend spectrum in the 800 MHz band (792MHz – 862 MHz) as well as the VHF band.

The aim of this research is to point at and analyze alternative applications of the freed frequencies especially with respect to the frequencies in the so-called innovation reserve (MUX 7 and 8). The fact that we cannot escape the controversies between broadcasters and the communication sector has become very clear with the recent Danish decision by the ministers of culture and science and the policy partners in Parliament that the frequencies in the 790-862 band. i.e. basically MUX 7, should be allocated for mobile broadband. The primary reasons stated are that this will facilitate broadband coverage to all parts of the country and provide more frequencies for a high-demand area, but the basis is also that this is the way, for instance, Sweden has gone, and this is also in line with EU decisions on the matter. The EU policy is to allocate frequencies in the 790-862 MHz area to mobile broadband on a technology and service neutral basis, i.e. without any foregone policy decisions on the use, including 'alternative use'.

### *Methodology*

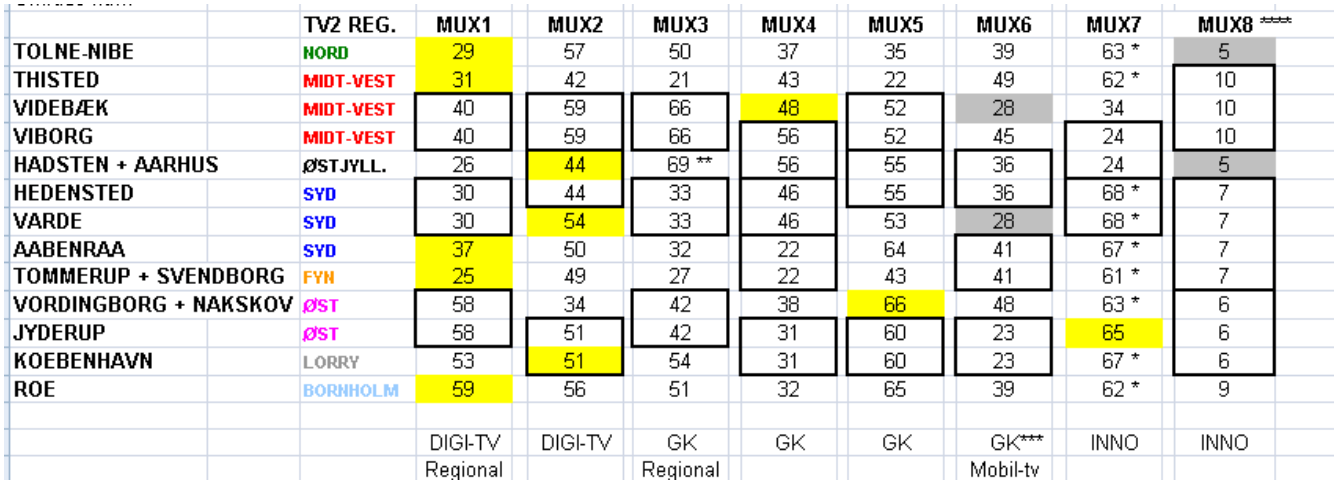
The analysis is based on review of 'research projects' and 'political documents' and country case studies. Furthermore a number of interviews with the relevant stakeholders in Denmark are conducted.

## 2. Country case studies

### *3.1 Denmark*

Today, after analogue shut down there are 8 Multiplexes available in Denmark (MUX1 – MUX8). The allocations are depicted in figure 1. MUX1 and MUX2 are assigned to the public service stations DR and TV2. The administration of MUX3- MUX6 has for a 12 year period (until 2020) been given to a commercial company, Boxer. The use of MUX7 and MUX8 is not yet decided, and will be investigated in this paper.

**Figure 1. Allocation of MUX1-MUX8 in Denmark**



| | TV2 REG. | MUX1 | MUX2 | MUX3 | MUX4 | MUX5 | MUX6 | MUX7 | MUX8 **** |
|---|---|---|---|---|---|---|---|---|---|
| TOLNE-NIBE | NORD | 29 | 57 | 50 | 37 | 35 | 39 | 63 * | 5 |
| THISTED | MIDT-VEST | 31 | 42 | 21 | 43 | 22 | 49 | 62 * | 10 |
| VIDEBÆK | MIDT-VEST | 40 | 59 | 66 | 48 | 52 | 28 | 34 | 10 |
| VIBORG | MIDT-VEST | 40 | 59 | 66 | 56 | 52 | 45 | 24 | 10 |
| HADSTEN + AARHUS | ØSTJYLL. | 26 | 44 | 69 ** | 56 | 55 | 36 | 24 | 5 |
| HEDENSTED | SYD | 30 | 44 | 33 | 46 | 55 | 36 | 68 * | 7 |
| VARDE | SYD | 30 | 54 | 33 | 46 | 53 | 28 | 68 * | 7 |
| AABENRAA | SYD | 37 | 50 | 32 | 22 | 64 | 41 | 67 * | 7 |
| TOMMERUP + SVENDBORG | FYN | 25 | 49 | 27 | 22 | 43 | 41 | 61 * | 7 |
| VORDINGBORG + NAKSKOV | ØST | 58 | 34 | 42 | 38 | 66 | 48 | 63 * | 6 |
| JYDERUP | ØST | 58 | 51 | 42 | 31 | 60 | 23 | 65 | 6 |
| KOEBENHAVN | LORRY | 53 | 51 | 54 | 31 | 60 | 23 | 67 * | 6 |
| ROE | BORNHOLM | 59 | 56 | 51 | 32 | 65 | 39 | 62 * | 9 |
| | | DIGI-TV Regional | DIGI-TV | GK Regional | GK | GK | GK*** Mobil-tv | INNO | INNO |

**MUX1**

DR and TV 2/DANMARK have established mutual cooperation and provide their main TV channels in this platform are 1) DR 1, 2) DR 2, 3) TV 2/DENMARK and 4) Non commercial local TV

**MUX2**

MUX2 is allocated to DR and contains the following programs:

- DR Ramasjang: Children channel
- DR K: Culture channel
- DR HD: DR's HDTV channel
- DR Update: News channel
- Folketing: A channel transmitting live from the parliament

**MUX3 – MUX6**

BOXERTV which is the commercial operator and the "gatekeeper" for the digital terrestrial TV in Denmark provides a number of TV services in MUX3-5. These services are bundled in different packages and offered to the users in a model similar to other multi channel platforms like satellite and Cable TV. At the moment BOXERTV provides 31 national and international TV channels in MUX3-5. Apart from these commercial channels all the public service channels (MUX1-2) are available in the BOXERTV's different packages

Between the 1st November 2009 and the 31st October 2010 MUX6 will be used for research purposes. On the1st November 2010 Boxer will take over and MUX6 will be used for mobile TV services using DVB-H standard.

**MUX7 – MUX8**

MUX7 and MUX 8 are not assigned yet, however, there is a decision that MUX7 will be assigned to commercial mobile broadband services. The use of these MUX'es is the focus of the following interviews with relevant Danish stake holders.

***Interviews with selected stake holders in Denmark***

In a two months period in the beginning of 2010 a number of interviews with relevant experts and stake holders in Denmark was conducted. The aim was to identify the most optimal applications for the digital dividend spectrum seen from interests of market players and knowledge of the experts. The aim was further to identify if part of the spectrum should be allocated for societal relevant applications.

The interviewees where selected carefully to reflect the different interests from mobile industry, broadcast sector, industry association, and some of the other possible users like public safety and emergency.

### Motorola Denmark

On the question about the strategy of the mobile sector related to the digital dividend discussion the answer was that the strategy from mobile industry will be to get access to more spectrums from the 'TV spectrum', this being the 800 MHz spectrum and also the spectrum below 790 MHz.

In the interview the Intelligent Traffic Systems (ITS) and Public Safety and Emergency (PSE) were mentioned as relevant and societal important services that can use the 800 MHz spectrum. However the most important use was identified to be PSE. The sectors like PSE can also have their own spectrum and network within the digital dividend band; however, it was emphasized that this is not so likely any more in the EU setting.

With regards to the technology choice there was no doubt that the technology for the 800 MHz band in Denmark will be LTE. It was, however, emphasized that seen from public safety point of view the Mobile broadband will be considered as add on to mission critical TETRA systems for high bandwidth services. The strength of Tetra is that it has harmonized spectrum in Europe and this will also be the case for the 800 MHz band

The spectrum should be used for mobile broadband and be driven by the commercial operators. The societal relevant services such as PSE can be provided by these networks by putting specific QoS, security and availability requirements on some of the commercial networks. Relevant security level can, e.g., be obtained by IPSEC in the LTE networks.

Another important point raised was that we see a convergence between the requirements from commercial market and the requirements from public safety, enabling both of them to use the same technology with different configurations

With regards to the VHF band (MUX8) the attitude was clear: Mobile industry is not interested in this spectrum. This is both because the technology is 'clumsy' with telescopic antennas but also because many mobile services need to control the service areas in a geographic manner, and here VHF with its large coverage areas is not appropriate

### Motorola Tetra Unit

The interview was focused on the PSE and the results of the interview are given in the following:

There is no doubt that PSE needs more spectrums and that the 800 MHz spectrum is perfectly suited to the requirements of the industry. There has been used many resources for lobbying at European and national levels to get part in this spectrum. But the battle is lost and there is no hope that PSE will get share in this spectrum.

The requirements from PSE has been to get access to 2 X 10 MHz European wide harmonized spectrum in the 800 MHz band, however, now the target is to get 2 X 10 MHz in the area below 1GHz.

The technology to be deployed in this spectrum will with no doubt be LTE, which also will be deployed in the US.

LTE will not replace TETRA and will complement TETRA, which is dimensioned for mission critical voice traffic.

VHF is not of interest for PSE mainly because of the external antennas

### Independent consultant

We discussed both the 800 MHz band and the use if VHF spectrum, and the answers were:
We should have a roadmap for spectrum needs for societal services. 800 MHz spectrum must be used for mobile broadband and operated by commercial actors. Different user groups like PSE can then get access to these networks and come up with their requirements with regards to QoS, Security, privacy etc.

Nobody from mobile industry has shown interest in VHF band and probably the best application will be for broadcast services.

### Molex Denmark

The interview with Molex Denmark, which has focus on research and development within antenna technologies, was primarily focused on the VHF spectrum. The attitude was again that mobile industry is not interested in this spectrum:
VHF is not interesting for mobile industry. The cells in the VHF band become too big for most mobile services and the size of the antenna makes it irrelevant for mobile uses.

Another drawback of this technology for communicative services is that there are a number of health issues with the external antennas. This aspect was however difficult to qualify further.

### Danish confederation of IT industry

The representative from the Danish confederation of IT industry had a much broader view on the subject:
Mobile broadband and in particular access to mobile broadband using dongles connected to laptops will increase dramatically and there will be need for more spectrum resources. The 800MHz spectrum will be used for mobile broadband in Denmark and the attitude from the market is that LTE will be the technological platform deployed in this spectrum.

The societal services that will be important in the future are:

- Mobile health technologies, including remote monitoring of patients
- The intelligent/smart home solutions
- Mobile digital signature
- Public Safety and Emergency (PSE)
- Intelligent Traffic Systems (ITS)
- Education and teaching

The solution is not to allocate spectrum to specific services but to allocate services to mobile broadband driven by commercial operators. Then the specific user groups must get guaranteed access to the resources in these networks and also they must come up with their specific requirements on QoS etc.

Denmark has the world's largest public sector. This must be utilized in developing new services and here the 800 MHz band can be important.

With regards to the VHF band the attitude from mobile industry is that it is not relevant spectrum for mobile services because of the coverage and the external antenna issues. The most probable use could be for broadcast services. Here we could experiment in deploying DVB-T2 and offering some HDTV services.

### The digital Gatekeeper (Boxer)

Boxer was the only representative amongst the interviewees, which represented the interests of the broadcast sector. Here the attitude was clearly that the digital dividend resources should be used for broadcast purposes:

The role of Boxer is to expand the competition on the Danish TV market. One of the important elements of the DTT was the number of TV services and the offered price regimes. Both the 800 MHz and the VHF band should be used for broadcast TV purposes on technology neutral basis.

Today Boxer has 30 TV services and this is enough for now but when HDTV becomes more popular then Boxer will have shortage of resources.

With regards to the use of the VHF band for broadcast purposes some specific issues are important in the discussion:

- 40% to 50% of household do not own VHF antennas
- It would be important to have a pilot in using DVB-T2 technology in this band. The experiences about using DVB-T2 in the VHF band are limited today
- In Sweden, where boxer's mother company operates there is a push for using the VHF spectrum for broadcasting using DVB-T2 technology

### *3.2 UK*

The decision to release a digital dividend in UK was taken by the Government already in 2003. The first plan implied releasing two distinct bands of spectrum, one of which comprised 48 MHz between 806-854 MHz.

In 2009, Ofcom has announced proposals to align more of the spectrum released as part of the UK's digital dividend with other European countries (790-862 MHz).[6]

Government decided that 256MHz (32 channels) of the 368MHz (49 channels) should be used for digital terrestrial television (DTT) from digital switchover. This digital broadcasting will be provided by six multiplexes. The remaining spectrum of 112MHz will be released for new uses. This 112MHz comprises 14 channels of 8MHz, which is presently used for analogue television, and on a secondary basis for uses such as wireless microphones. Both primary and secondary uses will cease at switchover.

Digital dividend spectrum available for release in UK consists of the three sorts of spectrum:

- **the 112 MHz** mentioned above (these channels are numbered 31-35, 37, 39-40 and 63-68)
- **channel 36 and channel 69** (two blocks of spectrum that fall within the spectrum bands currently used by terrestrial television across Europe). Channel 69 is currently use for wireless microphones and will become unavailable for PMSE use during 2012. Channel 36 was used for airport radar until 2009 and presently is cleared.
- **interleaved spectrum** the "white space" that exists geographically between television transmitters to prevent interference. Ofcom estimates that around 208 MHz of interleaved spectrum may become available. At present, interleaved spectrum in the analogue television bands is used by services known as Programme-Making and Special Events (PMSE). PMSE services include outside broadcasts and televised sporting events such as football matches as well as radio microphones used in theatres and other public venues. Ofcom will consider

[6] At the World Radio Conference (WRC) held in Geneva in 2007 mobile services were granted co-primary status with broadcast services in UHF channels 61 to 69, the 800MHz Band. The European Commission has also been considering the matter.

these existing services carefully in planning for the use of this spectrum after digital switch-over

In 2009 Ofcom made proposals to clear channels 61 and 62 to align the 790 – 862 MHz band with other countries in Europe whilst maintaining the existing DTT coverage obligations UK analogue switchover[7].

**Figure 2. UK proposal to clear the 800 MHz band**

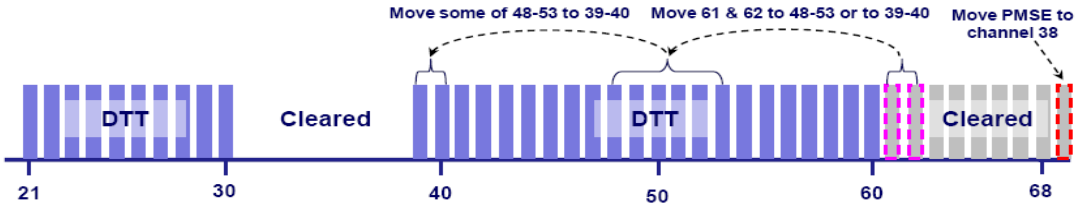
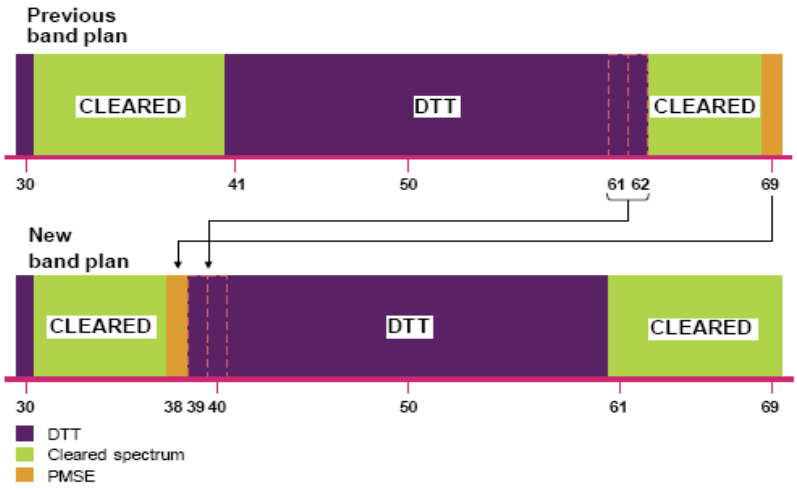



Figure 3 illustrates the changes that will need to be made to the configuration of the UK's digital dividend. In effect, DTT in channels 61 and 62 will be moved into channels 39 and 40, and PMSE in channel 69 will be moved into channel 38. This means the cleared spectrum in the digital dividend will comprise 550-606 MHz (channels 31-37, the 600 MHz band) and 790-862 MHz (channels 61-69, the 800 MHz band)[8]

**Figure 3. Changing the configuration of the UK's digital dividend**




Source: Digital dividend, Clearing the 800MHz band, Ofcom, June 2009

[7] European Commission Hearings on the Digital DividendBrussels, 6 March 2009, UK Broadcasters' perspective on the Digital Dividend, Nigel Laflin, (nigel.laflin@bbc.co.uk) BBC Distribution,

[8] Clearing the 800MHz band, Ofcom

The **790-862 MHz** band will be auctioned to the International Mobile Telecommunications industry (IMT) for the provision of **wireless broadband Internet services.** The suitability of this spectrum for mobile broadband has led an increasing number of European countries to identify the 800 MHz band as their digital dividend.

Ofcom expects to agree revised interference arrangements for two-way mobile use of the 800 MHz band with Belgium, France, Ireland and the Netherlands through MOUs by mid 2010. This will allow for the deployment of services other than broadcasting. These MOUs will be effective when both administrations make the band available for new services.

Ofcom plan to award all of the spectrum on a UK-wide basis, except for packages in the interleaved spectrum that would be suitable for a variety of local or regional services (e.g. local television).

Ofcom proposes to hold three distinct awards of interleaved spectrum:

- a beauty contest for a package with PMSE obligations;
- an auction for geographic packages suitable but not reserved for local television in about 25 locations throughout the UK; and
- an auction for channels 61 and 62 where they are not being used for DTT.

Similar services could be accommodated in other spectrum, including the 600 MHz band and geographic interleaved spectrum[9]. However, Ofcom pointed out that there is no any immediate prospect of this beyond the UK, and this may affect the commercial case for mobile-broadband use of these bands.

**VHF Band III**

In the UK, the current primary use of sub-band 3 is for Terrestrial Digital Audio Broadcasting (T-DAB). The UK government in 1994 allocated spectrum for **T-DAB in the range 217.5 to 230.0 MHz**. The band is also used for **Programme-Making and Special Events (PMSE) and short-range devices (SRDs)** on a secondary basis.

### *3.3 Sweden*

Sweden completed digital switchover in October 2007. The 790-862 MHZ frequency band had previously been used for terrestrial television broadcasting, but has been released from TV broadcasting and will be use for wireless services. In December 2007, the Government decided that:

- 790-862 MHz (the 800 MHz band) should be vacate

[9] The operation of mobile-broadband services in geographic interleaved spectrum is uncertain. But if it is feasible – particularly for downlinks (i.e. from base stations to mobile receivers) – geographic interleaved lots could provide new or extended access on a sub-UK basis (e.g. in areas not served by fixed lines or existing wireless networks using higher frequencies). Ofcom has done some work on how mobile communications networks might use the 600 MHz band. This has looked at systems using FDD and time-division duplexing (TDD) and a mixture of the two. Examples of some possibilities are presented in the consultation document ”Digital dividend: 600 MHz band and geographic interleaved spectrum, Consultation on potential uses” Ofcom, February 2010

- a six nation multiplexer for digital TV should be established under 790 MHz
- a new multiplex should be established in band III (VHF)

Allocation of the digital dividend has been completed in Sweden. A minimum of 6 multiplexes in the UHF frequency bands and 1 multiplex in the VHF band will be available for broadcast services while the UHF Band V spectrum located above 790 MHz is planned to be auctioned and allocated for other services[10].

The following frequency bands for terrestrial television broadcasting were used prior to the switch-off of analogue terrestrial television broadcasting in Sweden:

**Table 1.** Frequency bands for terrestrial television broadcasting prior to the switch-off of analogue terrestrial television broadcasting

| **Frequency bands for terrestrial television broadcasting prior to the switch-off of analogue terrestrial television broadcasting** | | | |
|---|---|---|---|
| ***Frequency range*** | *Designation* | *Amount of frequencies* | *Channel number* |
| **47–68 MHz** | Band I | 21 MHz | 2–4 |
| **174–230 MHz** | Band III (VHF) | 56 MHz | 5–12 |
| **470–862 MHz** | Band IV/V (UHF) | 392 MHz | 21–69 |
| **'Channel number' refers to the generally accepted numbering of the 7 MHz and 8 MHz channels respectively in Bands I, III, IV and V.** | | | |

Sources: The 800 MHz band, Planning and assignment proposals, PTS, 09.2009

In Sweden, the band **790-862 MHz** is already allocated to the **mobile service**, except aeronautical mobile, on a primary basis through footnote RR 5.316[11].

Existing licenses in 790-862 MHz for applications of PMSE (program making and special events) are granted until the end of 2009. The 800 MHz-band is therefore expected to be available for new uses in the time frame 2009-2010.

Conditions for use of spectrum are formulated in a way that is as **technology and service neutral** as possible. This enables licence holders to choose the technology that they wish to deploy and the services that they want to offer. That means that only the technical requirements that are required to ensure coexistence between different users should be imposed (such as, for instance, emission limits within and outside the frequency band and geographical area to which the licence applies) in order to avoid the occurrence of harmful interference.

[10] Allocation of the digital dividend in Sweden, DigiTAG 2009

[11] WRC-07 allocated the band 790-862 MHz to the mobile, except aeronautical mobile, service on a primary basis in Region 1 and identified this band for IMT in Regions 1 and 3. The primary allocation of the whole band 790 - 862 MHz in the entire Region 1, for mobile except aeronautical mobile service will come into effect from 17 June 2015.

In Sweden the **VHF** band will be used by **T-DAB and by DVB-T** (a nationwide coverage).

The Swedish Armed Forces have expressed to PTS their interest in the use of the frequency band 230 – 240 MHz, which forms part of Band III, but which may be affected by possible future decisions on the development of digital sound broadcasting (T-DAB).

### *3.4 US*

In 2003, the FCC ordered analog television broadcasters in channels 52-69 (698-806 MHz) to vacate and to only operate DTV in channels 2-51(500-600 MHz). In 2006, the DTV Act set a firm deadline for the end of the DTV transition of February 17, 2009, at which time the spectrum in the 700 MHz Band, occupied by television broadcasters in TV Channels 52-69, would become available for wireless services, including public safety and commercial services. As part of the transition of TV services to digital television (DTV), broadcasters are being moved from Channels 60-69 and Channels 52-59 to assignments below Channel 52. These actions will make this spectrum – 60 MHz of spectrum referred to as the "Upper 700 MHz Band" and 48 MHz referred to as the "Lower 700 MHz Band" – available for new services. Congress has mandated that 24 MHz of the Upper 700 MHz Band be reallocated to public safety services, and that the remaining 700 MHz spectrum be auctioned[12].

On February 11, 2009, with enactment of the DTV Delay Act, the DTV transition deadline was extended from February 17, 2009, to June 12, 2009.

The final switchover to digital TV occurred on 12 June 2009 but the regulator completed the auction of spectrum in the 700 MHz band already in March 2008, and distributed the spectrum to a variety of providers mainly via a technology-neutral approach. Therefore it is expected that the winning operators will launch commercial services on the released spectrum in 2010.

**700 MHz Band.**

According to FCC, the 700 MHz band is a critical resource for wireless broadband services in particular because of its superior propagation characteristics, building penetration capability, and suitability for mobile applications. In orders adopted in December 2001 and October 2003, the Commission completed rulemakings to reallocate the non-public safety portion of the "upper" 700 MHz Band and the entire "lower" 700 MHz Band to new fixed and mobile services for a broad range of flexible uses.[13] As these channels are cleared of incumbent broadcasters, prime spectrum

[12] 700 MHz First Report and Order, 22 FCC Rcd at 8066 ¶ 2.

[13] *See* Service Rules for 746-764 and 776-794 MHz Bands, and Revisions to Part 27 of the Commission's Rules, Carriage of the Transmissions of Digital Television Broadcast Stations, Review of the Commission's Rules and Policies Affecting the Conversion to Digital Television, *Third Report and Order*, 16 FCC Rcd 2703 (2001); Service Rules for 746-764 and 776-794 MHz Bands, and Revisions to Part 27 of the Commission's Rules, Carriage of the Transmissions of Digital Television Broadcast Stations, Review of the Commission's Rules and Policies Affecting the Conversion to Digital Television, *Order on Reconsideration of the Third Report and Order*, 16 FCC Rcd 21633 (2001); Reallocation

becomes available for uses ranging from the implementation of next generation applications and extensions of existing mobile and fixed networks to the implementation of various innovative stand-alone technologies and services. Also, because the band is situated near spectrum currently licensed to cellular and other CMRS services, this allocation creates efficiencies for carriers and manufacturers in designing new products and networks that would benefit consumers.

The blocks are paired up to facilitate better cellular communications by allocating a bandwidth per block. Pairing the blocks gives cellular network companies the ability to utilize separate frequencies for up-linking and down-linking, which better utilizes the limited frequency spectrum and provides more reliable communications. The exception to this is block C, which is unpaired because it uses the largest bandwidth range, 22 MHz, and is able to support robust frequency engineering and frequency reuse on its own.

**Lower 700 MHz[14] (698-746 MHz)**

Lower 700 MHZ has 5 blocks (38 MHz): A - E. The A, B, and C blocks are paired, which makes them useful for services that require two-way transmission. The D and E blocks are unpaired, thus they only support one-way transmission (ideal for one-way broadcasting – Qualcomm MediaFLO).

A licensee on the Lower 700 MHz Band is permitted to provide fixed, mobile, and broadcast services. Possible uses of this spectrum include digital mobile and other new broadcast operations, fixed and mobile wireless commercial services (including FDD- and TDD-based services), as well as fixed and mobile wireless uses for private, and internal radio needs.

The rules governing the Lower 700 MHz Band are generally found in the 47 CFR Part 1 and Part 27. (http://wireless.fcc.gov/services/index.htm?job=about&id=lower700)

**Upper 700 MHz (746-806 MHz)**

The upper band is divided into five paired blocks; with A through D being auctioned for commercial use and the fifth being devoted to communication related to public safety.

**Blocks A and B** were originally guard bands on either side of the public safety blocks, which meant that they had to conform to strict standards on reducing interference on neighboring frequencies. They were also not allowed to use a cell-based architecture. After a restructuring, however, only the B block is subject to these requirements[15]. Both of these blocks are licensed by Major Economic

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and Service Rules for the 698-746 MHz Spectrum Band (Television Channels 52-59), *Report and Order*, 17 FCC Rcd 1022 (2001); Service Rules for 746-764 and 776-794 MHz Bands, and Revisions to Part 27 of the Commission's Rules, Carriage of the Transmissions of Digital Television Broadcast Stations, Review of the Commission's Rules and Policies Affecting the Conversion to Digital Television, *Second Order on Reconsideration of the Third Report and Order*, 18 FCC Rcd 23308 (2003).

[14] http://wireless.fcc.gov/services/index.htm?job=about&id=lower700

[15] Adam LaMore, The 700 MHz Band: Recent Developments and Future Plans, April 2008

Areas (MEAs), of which there are 51[16]. 700 MHz Guard Bands spectrum can be used for fixed and mobile services. Spectrum can be leased to commercial service providers or directly to end users. [17]

**Block C** consists of paired 11 MHz blocks, giving it the largest bandwidth of any group up for auction. In addition, it is licensed as only twelve Regional Economic Area Groupings (REAGs), six of which combine to cover the entire continental United States; the other six are for Alaska, Hawaii, and outlying U.S. territories. For the C Block, the FCC created special open access provisions:

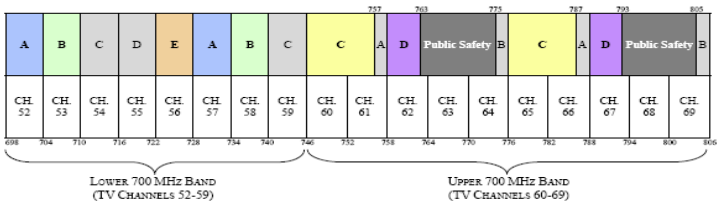
- ✓ Open devices so consumers can use a handset with any wireless network operator
- ✓ Open applications so consumers can download and use any software applications, content, or services they desire without "walled gardens,"[18]

Licensees may not "lock" handsets to prevent their transfer from one system to another, or to other services that compete with wireless service providers' own offerings.

**Block D** consists of paired 5 MHz blocks and only one nationwide license is being given for the entire block. All devices on this part of the band must support spectrum sharing with the public safety devices, as part of the 700 MHz Public/Private Partnership. In this sense, Block D acts somewhat as a guard between itself and the frequencies devoted solely to public safety[19].

### Figure 4. Revised 700 MHz Band Plan for Commercial Services

**Revised 700 MHz Band Plan for Commercial Services**




| Block | Frequencies (MHz) | Bandwidth | Pairing | Area Type | Licenses |
|---|---|---|---|---|---|
| A | 698-704, 728-734 | 12 MHz | 2 x 6 MHz | EA | 176 |
| B | 704-710, 734-740 | 12 MHz | 2 x 6 MHz | CMA | 734 |
| C | 710-716, 740-746 | 12 MHz | 2 x 6 MHz | CMA | 734 |
| D | 716-722 | 6 MHz | unpaired | EAG | 6 |
| E | 722-728 | 6 MHz | unpaired | EA | 176 |
| C | 746-757, 776-787 | 22 MHz | 2 x 11 MHz | REAG | 12 |
| A | 757-758, 787-788 | 2 MHz | 2 x 1 MHz | MEA | 52 |
| D | 758-763, 788-793 | 10 MHz | 2 x 5 MHz | Nationwide | 1 * |
| B | 775-776, 805-806 | 2 MHz | 2 x 1 MHz | MEA | 52 |

* Subject to conditions respecting a public/private partnership.

The blocks shaded above in gray (Lower 700 MHz Band C and D Blocks and Upper 700 MHz Band A and B Blocks) were auctioned prior to Auction 73.

Source: FCC, Band Plans, updated 9/5/2007, http://wireless.fcc.gov/auctions/default.htm?job=bandplans

[16] http://wireless.fcc.gov/auctions/data/maps/mea_basic.pdf

[17] http://wireless.fcc.gov/services/index.htm?job=service_home&id=700_guard

[18] but not the open services and open networks principles.

[19] "Second Report and Order, FCC 07-132", 10 August 2007, http://wireless.fcc.gov/auctions/default.htm?job=release&id=3457&y=2007.

## Public Safety Spectrum[20]

VHF high band is by far the most deployed public safety band in the US and most of the agencies would like to continue its use in low density rural population areas where better propagation supports lower cost deployments. 700 MHz and 800 MHz are needed for more densely populated urban areas requiring more capacity and less range and coverage per site.

Historically, the total amount of spectrum for public safety in the U.S. has been 23.1 MHz in the VHF, UHF, and the 800 MHz bands plus a few other little used bands. The 800 MHz band has experienced significant interference problems and is being re-banded to move public safety users from fragmented assignments to frequencies better separated from other users[21].

New public safety 700 MHz band allocations (shown in Figure 5) that total 24 MHz will almost double public safety allocations.

The FCC reorganized the public safety spectrum to establish one narrowband block and one broadband block. The broadband block will be licensed on a nationwide basis to a non-commercial, not-for-profit entity that would manage an interoperable network for all public safety users nationwide. Commercial Upper 700 MHz Block D (with 10 MHz of paired spectrum) will be adjacent to the public safety broadband block.

Block D will be licensed on a nationwide basis, with the auction winner being required to enter into a partnership with the public safety broadband licensee to build out a network to be shared by the public safety licensee and the Block D auction winner.[22]

The FCC has mandated that the D-Block licensee will be responsible for building out a national public safety network with 75% population coverage within four years of getting the license, and 95% of the U.S. population by the end of the seventh year, and 99.3% of the U.S. population by the end of the tenth year[23]. D Block licensee(s) also must develop and offer devices that operate both on the D Block and the neighboring public safety broadband block, with a path toward scale production of components and devices that can utilize both blocks, in order to stimulate the public safety broadband equipment "ecosystem."

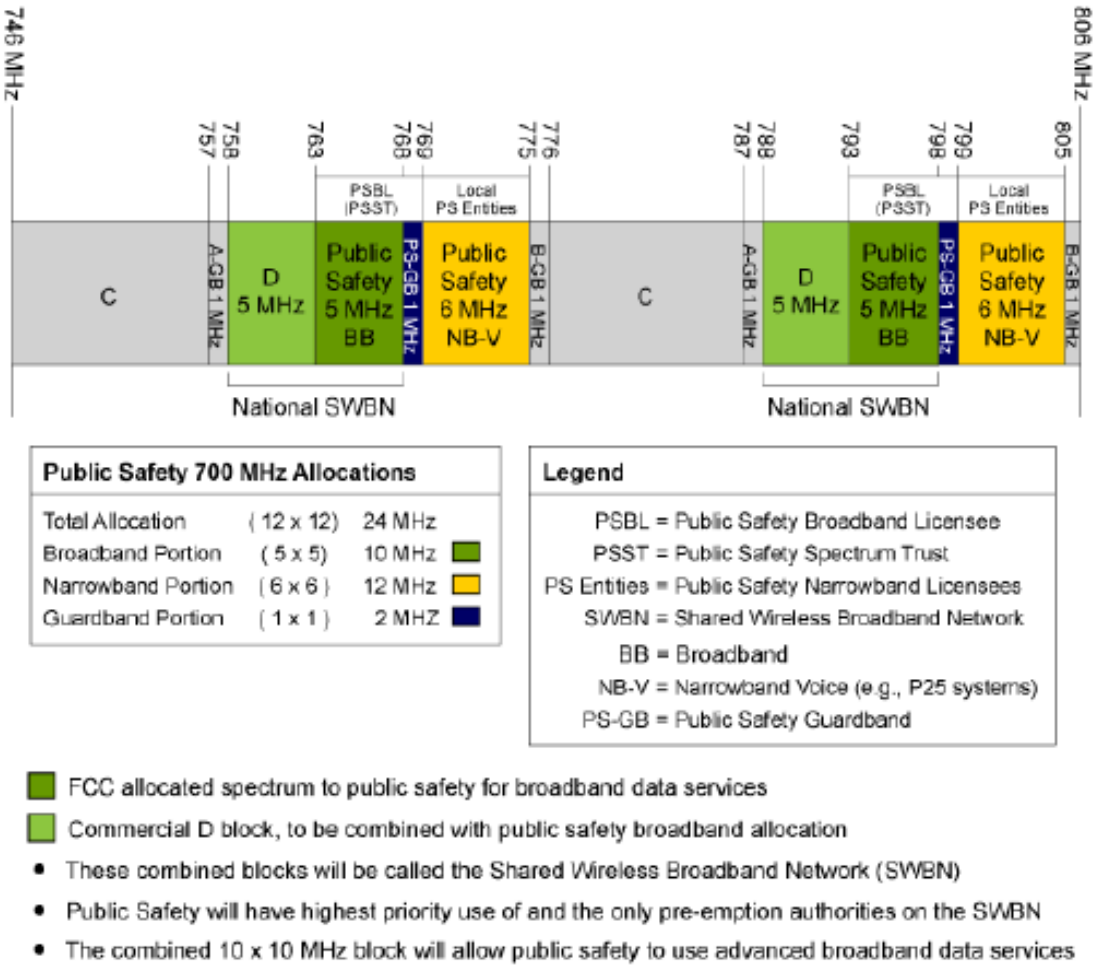
[20] The data in this section is mainly taken from http://www.fcc.gov/pshs/public-safety-spectrum/700-MHz/

[21] Public Safety Spectrum Allocation Bandwidth and Density of Re-Use, Ron Haraseth, Director, Automated Frequency Coordination, APCO International

[22] http://www.bingham.com/Media.aspx?MediaID=5425

[23] Frontline estimated that the network would cost roughly $10 billion to build out, in addition to the $1.3 billion or more the company would have to pay for the spectrum rights. The high build-out costs combined with the FCC's stringent time requirements make it difficult for any company to feel enthused about bidding for the block.

**Figure 5. Public Safety Spectrum Allocation in the 700 MHz Band**




*Source: Public Safety/Commercial Shared Network, http://www.psst.org/networkbenefits.jsp, February 09, 2010*

The D-Block failed to attract any qualifying bids of $1.3 billion and on March 20, 2008, the FCC issued an order delaying further D Block action until further notice[24].

In 2010, Federal regulators are proposing that Congress devote up to $16 billion over 10 years to pay for a nationwide wireless broadband network: $6 billion grant program to build the public safety network, plus a $6 billion to $10 billion grant program to operate and upgrade the network[25].

There are currently no standards being developed to provide such a service. The public safety community has endorsed **Long Term Evolution (LTE)** as the **preferred broadband standard for public safety.**

[24] The absence of meaningful bidding activity indicated that the public safety obligations as designed were not commercially viable.

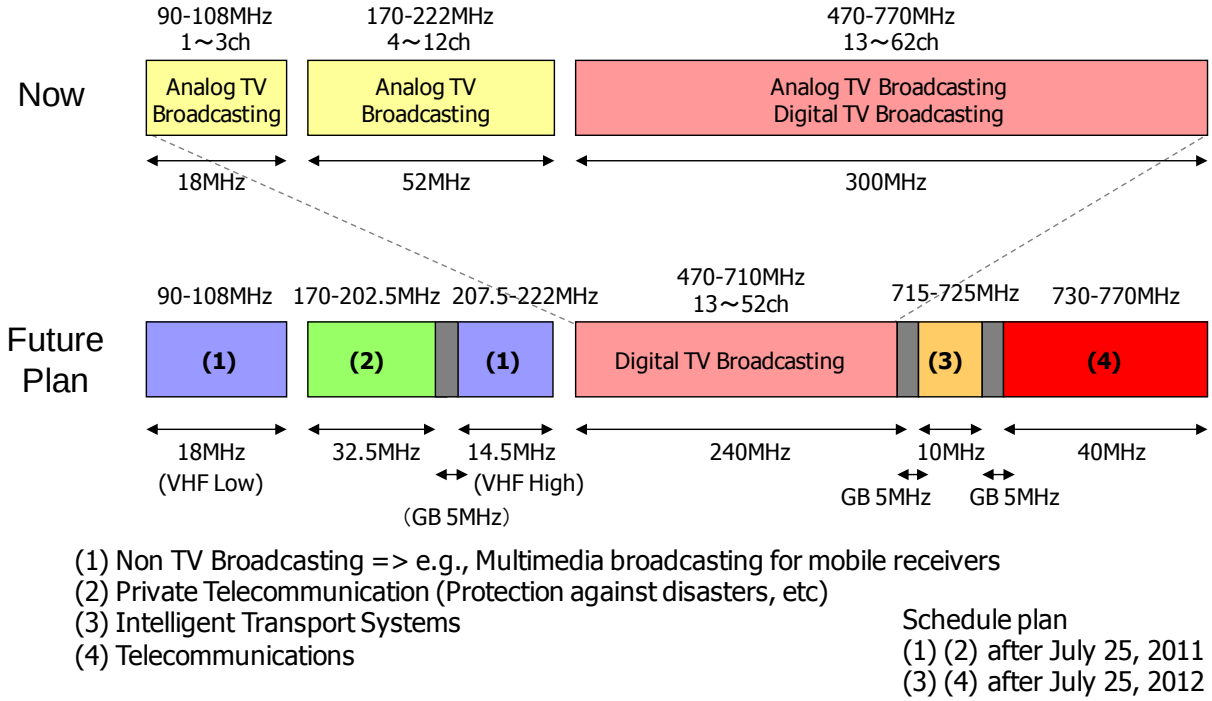
[25]Regulators Propose A Nationwide Wireless Broadband Network For Public Safety, 02.2010, http://news.smh.com.au/breaking-news-technology/regulators-propose-grant-program-for-public-safety-20100226-p684.html

### *3.5 Japan*

In Japan, analog terrestrial TV broadcasting is scheduled to be terminated on July 24, 2011. At present, 370MHz bandwidth in VHF/UHF frequency bands are used by analog TV broadcasting and 300MHz bandwidth in UHF band within these bands is used by digital TV broadcasting. Due to the termination, a wide spectrum of 1-12 channels in VHF band (70 MHz bandwidth) and 53-62 channels in UHF band (60 MHz bandwidth) will be vacant by 2011 and 2012, respectively.

Frequency bandwidth for terrestrial television will be reduced from 370MHz to 240MHz.

**Figure 6. Digital dividend in Japan**




(1) Non TV Broadcasting => e.g., Multimedia broadcasting for mobile receivers
(2) Private Telecommunication (Protection against disasters, etc)
(3) Intelligent Transport Systems
(4) Telecommunications

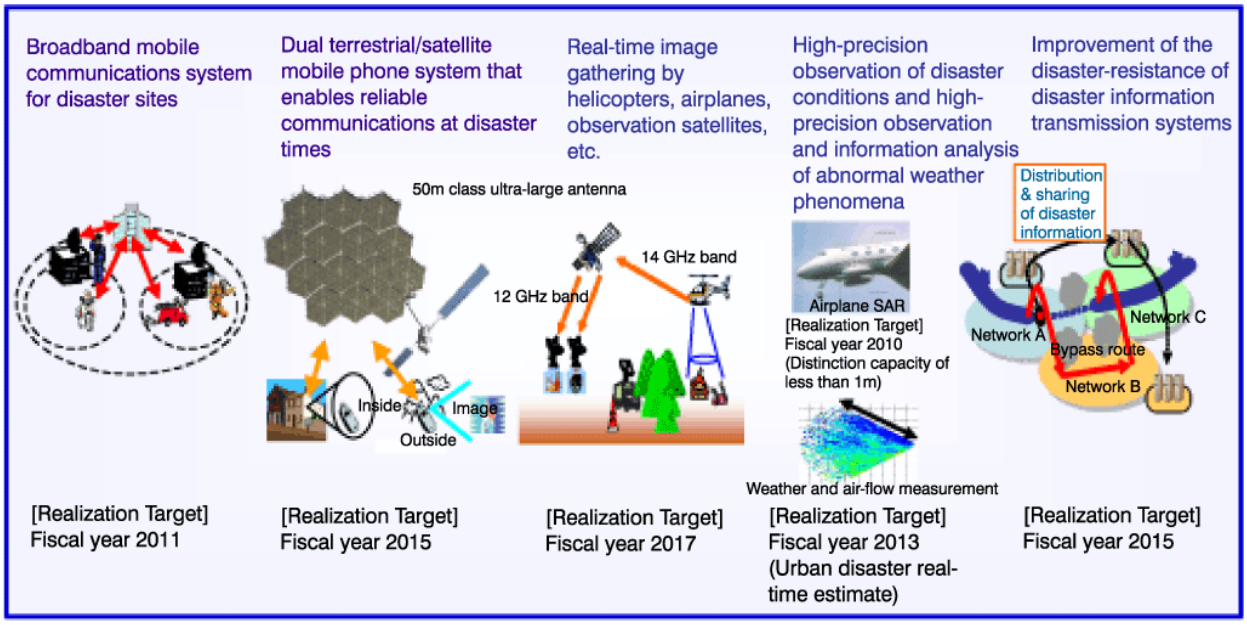
Schedule plan
(1) (2) after July 25, 2011
(3) (4) after July 25, 2012

*Source: One-Seg & Mobile broadcasting, Masami Fujita, Japan Broadcasting Corporation (NHK), July 8, 2008*

**VHF - 170-202,5 MHz – Private Telecommunications (protection against disasters, etc.)**

Secure frequencies for broadband mobile communication systems used for safety and security applications - system mainly for public bodies (local governments, police, and fire departments) which enable to transmit detailed information to enhance public safety and security.

**Figure 7. The 5 core technologies that should be strategically promoted**




*Source: An ICT for Realizing a Safe and Secure Society, Ministry of Internal Affairs and Communication (MIC), Japan, June 2007*

*http://warp.ndl.go.jp/info:ndljp/pid/258151/www.soumu.go.jp/joho_tsusin/eng/Releases/NewsLetter/Vol18/Vol18_05/Vol18_05.html*

The UHF band except those used for digital TV will be used for mobile communications after 2012

**UHF - 470-710MHz Digital TV Broadcasting (240MHz)**

The band may be used for land mobile service on and after 25 July 2012

**UHF - 715-725MHz Intelligent Transport System (ITS) – 10 MHz**

ITS realize vehicle-to-vehicle communication, providing safety assistance to prevent accidents.

The 700 MHz band is suitable for supplying information on hazards that are not visible to the driver, and function that is expected to vehicle to vehicle communication.

Nine Areas of ITS:

1. Advances in Navigation Systems
2. Electronic Toll Collection
3. Assistance for Safe Driving
4. Optimization of Traffic Management
5. Increasing Efficiency in Road Management
6. Support for Public Transport

7. Increasing Efficiency in Commercial
8. Support for Pedestrians
9. Support for Emergency Vehicle Operations

MIC has prepared preferential scheme for flexible spectrum use

**Figure 8. ITS Radio Systems in Japan**

| System | Service | Spectrum | Technical Regulation |
|---|---|---|---|
| VICS: Vehicle Information and Communications System | · Provide traffic information (Broadcast type) | 76-90MHz (FM multiplex broadcasting) | Enacted in 1994 |
| | | 2.5GHz [5.8GHz] (Radio beacon) | |
| ETC: Electronic Toll Collection | · Collect highway fee (Communication type) | 5.8GHz | Enacted in 1997 |
| DSRC: Dedicated Short Range Communication | · Collect highway fee<br>· Provide various applications (Communication & Broadcast type) | | Enacted in 2001 (Revised 2007) |
| Millimeter Wave Radars | · Detect obstacles (Sensor type) | 24/26GHz | Will enact in 2010 |
| | | 60/76GHz | Enacted in 1997 |
| | | 79GHz | Consideration has been started since Nov. 2009 |
| Safety Driving Support System | · Send safety information (Communication type) | 700MHz | Consideration has been started since Jul. 2009 |

*Source: Yasushi Sakanaka, Director for Land Mobile Communications Radio Department, Telecommunications Bureau Ministry of Internal Affairs and Communications, Japan, 2nd ETSI TC ITS Workshop, 10-12 February 2010 - ETSI, Sophia Antipolis, France, February 2010.*

**UHF - 730 – 770 MHz Telecommunications – commercial services (40MHz)**

Secure frequencies to address frequency demand caused by growing numbers of mobile phones and other portable devices (demand from current mobile-phone carriers, cellular phones, etc.)

## 3. Conclusion

The main question of this paper was to address the alternative use of digital dividend spectrum and more specifically to investigate which applications and technologies can be foreseen to be used in the 800 MHz band and in the VHF band. These two bands are identified as digital dividend in

Denmark. The focus has been very much on alternative uses, including societal communication services like Public Safety and Emergency.

With regards to the 800 MHz band there is a European decision to use the spectrum for mobile broadband on a technology neutral basis. The spectrum will be harmonized at European level and because of its good propagation characteristics will be suited for covering rural areas with mobile broadband. In Denmark also there is a decision to assign the spectrum to mobile broadband.

The conclusion is then that when it comes to the 800 MHz band the other uses, including the societal services will not get specific allocations of the spectrum in EU. Huge lobbying activities has been there to get access to part of the spectrum, e.g., for Public Service and Emergency services, without positive results. The solution for getting access to the spectrum for alternative uses is identified by the experts and relevant stake holders to put specific QoS and availability requirements on some of the commercial networks and use the capacity of these networks for other uses, including the societal services.

In other countries, e.g., in the US and Japan we see specific allocations of the spectrum for specific uses.

With regards to the technology choice there is a consensus that LTE will be the preferred technology in the 800 MHz band.

The broadcasting community has still the attitude that this spectrum should be used for TV broadcasting purposes, mainly to develop new services and have the possibility to compete with the multi channel TV providers in other infrastructures, including satellite and cable TV. However, also the broadcast sector has also realized that the battle is lost and part of the TV spectrum will be given to other communication services, including the mobile services.

When it comes to the VHF we could not find any interest neither from the mobile industry and nor from the other communication services like the PSE. The argument was mainly connected to the technical characteristics of the VHF devices and the characteristics of the spectrum: The devices are ‘clumsy’ with external telescopic antennas and the large extend coverage areas of VHF are not suited to the mobile services of today.

The broadcasters are interested in the spectrum as the large extent coverage is a positive parameter for broadcast services, however also here there are some technical challenges, e.g., the fact that more than 50% of the Danish households must upgrade their terrestrial antennas to be able to get access to these services.

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