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THE ALLOCATION OF THE DIGITAL DIVIDEND IN AUSTRIA

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Zusammenfassung/ Abstract

The digital dividend is the amount of spectrum that is freed up by the switch over from analogue TV to digital terrestrial TV in the UHF band. Drawing from a research project (Braulke et al. 2010) commissioned by the Austrian regulator RTR, this article prioritizes, analyses and evaluates the options of use of the 790 – 862 MHz frequency band - the so-called "upper digital dividend" in Austria.

The underlying economic considerations are based on an analysis of the incremental value. The two main options are the use of the spectrum for digital television (DVB-T) and the use for mobile broadband (MBB). The economic analysis clearly shows that the use of the upper digital dividend for MBB would generate the highest economic value.

The Austrian government has, based on this analysis, decided to assign the upper digital dividend for MBB use from 2012 onwards. An auction of the spectrum will take place in 2011.

JEL-Klassifikation / JEL-Classification: L96, L98, L82

Schlagworte / Keywords: Digital dividend, spectrum policy, Austria, digital TV, mobile broadband

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1 Context and goals of the allocation of the digital dividend in Austria

The digitalization of terrestrial TV in Austria started in 2006. At this point in time Austria had about 3.35 million TV households with a share of 52% satellite TV (half of it digital), 38% cable TV (4% digital) and 10% analogue terrestrial TV (RTR 2006: 117 et seq.). The digitalization of terrestrial TV was publicly supported by a digitalization fund with an annual budget of € 6.75 million and it has been nearly completed in 2010. One of the effects of digitalization of the broadcasting system was that the percentage of people using terrestrial TV only, declined from 10 per cent in 2006 to 6 per cent in 2009 (RTR 2009: 5 et seq.). Many of the former terrestrial TV households switched to other platforms in order to avoid the purchase of additional or new TV equipment. As in many other countries, digitalization triggered a highly controversial debate between broadcasters and the mobile industry about the allocation of the "digital dividend". In order to establish a scientific basis for the political decision on the use of this freed-up spectrum, the Austrian regulatory body RTR commissioned a research project to assess different usage scenarios from a public interest perspective in 2010 (see Braulke et al. 2010). This article builds, in essence, on the results of this research project.

The digital dividend refers to the part of the frequency spectrum that is released as a result of the digitalization of previously analogue television services. This is made possible by novel and more efficient broadcasting and coding techniques in the 470 to 862 MHz frequency band (channel 21 to 69). One frequency previously used by analogue services can now be used for multiple digital services. The transmission capacity rises with an unchanged frequency spectrum – the shortage of frequencies is reduced considerably.

Subsequently about eighty per cent of the spectrum is freed up (comparing the frequency spectrum required for the transmission of analogue TV channels in Austria in 2006 to the frequency spectrum necessary for digital transmission of the same number of channels today). As such only one fifth of the spectrum used previously is required for the same services. This trend is accentuated by technological advance (e.g. by DVB-T2 and MPEG4). On the other hand disturbances and incompatibilities caused by the usage of the same frequencies in neighbouring countries, of which Austria has eight, reduce the actually useable digital dividend.

In accordance with coordination efforts at EU level, the digital dividend in Austria is restricted to the "upper" digital dividend (see figure 1), from 790 to 862 MHz, also denoted as channels 61 to 69. The "total" digital dividend also includes the "lower" digital dividend (the frequencies from 470 to 790 MHz, or channels 21 to 60), which is excluded from the current EU harmonization policies regarding the allocation of the digital dividend in Europe.

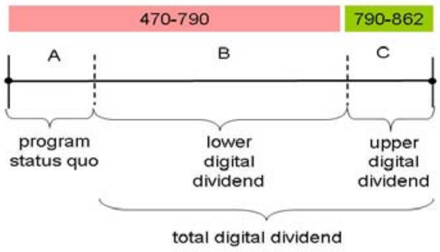

Figure 1: Lower and upper digital dividend.

Due to the very favourable diffusion characteristics, the upper digital dividend is especially suitable for both broadcasting and broadband mobile communications. It is particularly attractive for mobile broadband coverage of sparsely populated rural areas and for the "deep indoor coverage" in urban areas.

Consequently, both telecommunications and media policy objectives can be targeted depending on the allocation of the digital dividend. The public policy goals aspired for include the strengthening of media diversity; securing the future of public service broadcasting, Austrian programme-production and free-to-air services; securing the future of terrestrial broadcasting (incl. High Definition Television - HDTV); full coverage of rural areas with broadband access for economic and democratic reasons; and the maximization of economic benefits. Further goals discussed are the protection of secondary users (professional wireless microphone technology, as well as the growing events or PMSE business - Programme Making and Special Events); and the minimization of possible interferences between cable television and broadband/mobile communications.

The Austrian stakeholders, both from the broadcasting and the mobile sector, agree on the public policy objectives in general. Not surprisingly, they sharply disagree in their assessment of how the diverse usage options for the digital dividend would support the achievement of these objectives and on the prioritisation of certain public goals.

The context and scope of action for allocating the digital dividend in Austria is further framed by international stakeholders and developments. This occurs predominately via specifications and recommendations provided by international and supranational organizations, but it is also affected by the frequency strategies of Austria's neighbours. Among the major cornerstones are:

- The compulsory opening of the upper digital dividend for the optional (co-primary) usage for broadcasting- and mobile communication from middle of June 2015 (according to the World Radio Communications Conference 2007, WRC-07).
- The latest date for the analogue switch-off recommended by the European Commission is early 2012 (Commission 2009/848/EC).

In its Communication (Commission 2009/586/2), the European Commission emphasizes the macroeconomic benefits of allocating the digital dividend to mobile communications. It further recommends (Commission 2009/848/EC) supporting the harmonization of the conditions of use in the European Community in the 790-862 MHz sub-band for services other than or additional to broadcasting, as well as refraining from any actions that might hinder the deployment of these services.

The European economic stimulus package enacted by the Council in 2008 stipulates the objective of achieving full broadband coverage in Europe between 2010 and 2013. This aim is reaffirmed in the consultation process concerning the "post i2010" strategy of the European Union (see Commission 2009).

Currently broadcasting services enjoy a special protection. According to the Geneva 06 frequency plan, existing or planned broadcasting services are to be protected from interference (see O'Leary et al 2006). This is of particular importance in areas close to the border, e.g. for constructing mobile communications networks.

Secondary users do not enjoy any special protection and must not interfere with the primary services of broadcasting. PMSE usage of frequencies is marked by low transmission power in otherwise sparsely used frequency areas. They are scattered over the whole UHF spectrum and have to be reallocated according to the new frequency plans.

The Austrian scope for action is limited by the strategies of neighbouring countries, especially their schedules for digitalizing the terrestrial broadcasting systems as well as their concepts of how they want to use the digital dividend themselves. Major constraints exist in the eastern part of Austria, especially in the metropolitan area of Vienna. The relevant neighbouring countries (Slovakia, the Czech Republic and Hungary) plan to switch-off their analogue network post the Austrian switch off (generally in 2012 although the time line may be postponed further because of the negative effects of the economic and financial crisis in Eastern Europe).

Last but not least the six European countries that already have reached a decision (among them Austria's neighbouring countries Germany and Switzerland), have all opted to act in line with the recommendation of the European Commission to use the upper digital dividend for broadband mobile communications suggesting a certain pressure to "comply or explain".

2 Analytical framework

Allocating any single part of the digital dividend is, in economic terms, a problem of "direct rivalry" between digital terrestrial television, also known as "Digital Video Broadcasting – Terrestrial" (DVB-T), and mobile broadband services (MBB). Direct rivalry means that any frequency can only be used by either MBB or DVB-T, whereas a use by both of them would result in interferences and would make that part of the spectrum worthless.

Any part of the spectrum should be allocated to that specific use where it creates the most incremental social value, which includes private as well as external value. "Value" is used synonymously with "welfare". Incremental (synonymous with marginal) value is shown by the vertical axes in figure 2 for television and broadband, respectively, where both axes use identical scales.

Incremental private value is theoretically exhibited by the respective demand function of the potential users, regardless of whether they would actually have to pay for the use of the spectrum. "External value" includes all additional benefits accruing to the rest of the society, which are not included in the the spectrum users willingness to pay. This includes public service aspects as well as any kind of political goals. The sum of the private and the external value is the social value.

The quantitative amount of spectrum is represented by the segment O_FO_M in figure 2. The amount of spectrum which could be potentially used for television is conventionally outlined from O_F to the right. In order to directly exhibit the rivalry between MBB and DVB-T (Kruse, 2004, 189 ff), the spectrum, which is potentially used for mobile broadband is, other than usually done, shown by distances from O_M to the left.

The private demand function for spectrum of the mobile network operators is denoted by N_{MK} (Z_MZ_A, which is the whole line from Z_M to Z_A). The incremental private value declines from O_M to the left, since the amount of spectrum for broadband increases from O_M to the left. If, for example, the segment O_MQ_R were (by exogenous decisions) available for mobile broadband and the spectrum were allocated by competitive auctions, the price per megahertz

(MHz) would be P_A. The consumers' rent would be shown by the triangle $P_AR_AZ_M$. The producers' rent (quadrangle $O_MQ_RR_AP_A$) equals the government's revenue from the spectrum auction. The total private welfare of the use of O_MQ_R by mobile broadband is equal to the area $O_MQ_RR_AZ_M$.

It is assumed that MBB might have external value for the society, which is not internalized by the market mechanism. External value may include the development and the enhancement of quality of life in rural areas and may have positive effects on culture and democracy. The amount of the external value of O_MQ_R, for example, is represented by the area in the quadrangle $Z_MR_AR_MY_M$ in figure 2.

The social welfare is the sum of private and external value. The social marginal welfare function N_{MG} shows for any given amount of spectrum the incremental value (marginal value) that is derived from an additional unit of spectrum for mobile broadband. For Q_R the incremental social value of mobile broadband is Q_RR_M. If the amount of spectrum for mobile broadband were increased beyond O_MQ_R , the private as well as the external total value of spectrum use by mobile broadband would grow, while incremental value decreases, since by N_{MG} is decreasing.

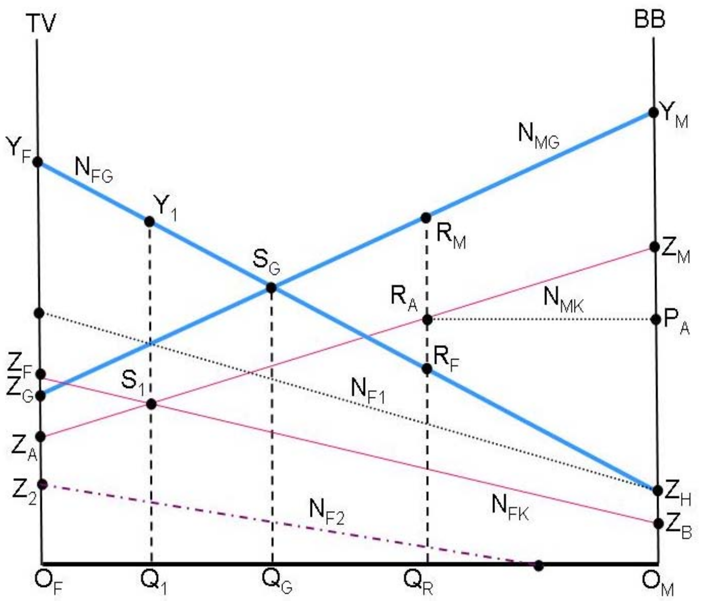

Figure 2: Incremental social value of television and mobile broadband.

The digital television's private demand function for spectrum is theoretically represented by N_{FK} ($Z_F Z_B$). For television, in particular public television, this is only hypothetical since television stations have never had to pay for spectrum and have always used more than the efficient amount. If the external value of additional spectrum for DVB-T is included, the social marginal welfare function N_{FG} is derived. Assuming the amount of $O_F Q_1$ is used for digital television, the incremental social value of an additional unit of spectrum would be $Q_1 Y_1$. The total social value of $O_F Q_1$ would be represented by the area $O_F Q_1 Y_1 Y_F$.

As mentioned above, the main objective is to allocate the available extra amount of spectrum $O_F O_M$ in a way that the sum of the social values of television and mobile broadband is maximized (optimal spectrum allocation). The optimal use for the situation in figure 2 with additional spectrum $O_F O_M$ would be achieved when the incremental spectrum value for use in television and broadband is equal. This is the case for the spectrum split given by the intersection S_G where both incremental values are $Q_G S_G$. This solution allocates an amount of spectrum $O_F Q_G$ to television and $O_M Q_G$ to broadband. The additional social welfare from television would be $O_F Q_G S_G Y_F$ and from mobile broadband $Q_G O_M Y_M S_G$. The sum of both would be $O_F O_M Y_M S_G Y_F$.

If, instead, the government would decide to split spectrum at Q_R (with $O_F Q_R$ und $O_M Q_R$, respectively), the welfare from television would be represented by $O_F Q_R R_F Y_F$, that from broadband would be $Q_R O_M Y_M R_M$, and in total $Y_F O_F O_M Y_M R_M R_F$. The welfare loss (allocative inefficiency - difference to the optimal solution Q_G with value be $O_F O_M Y_M S_G Y_F$) created by this is equal to,$S_G R_F R_M$.

Obviously, the optimal solution mainly depends on where the social incremental value functions, N_{MG} and N_{FG}, are actually located. This will be considered in sections 3.2 and 3.3.

If, for example, most Austrian households would receive their television signals by SAT-TV or CATV, DVB-T's social demand function for spectrum might not be N_{FG} but instead N_{F1} (where $O_M Q_1$ of spectrum is for broadband) or even N_{F2} (where all of the extra spectrum would be for broadband).

3 Assessment of options

The prevailing economic conditions, the current situation within the Austrian market and predictable future developments are key parameters in the estimation of the social incremental value functions N_{MG} and N_{FG}. In order to estimate the position of the social incremental value functions N_{MG} and N_{FG}, specific Austrian facts from both television and mobile broadband have been considered. It is important to note again that not the total value of television and mobile broadband have to be compared, but only the incremental value accruing from additional spectrum with all other activities assumed as given. Also, not only the present situation is relevant, but also the predictable development for the future.

3.1 Definition of options for use

Based on the GE06 (Geneva 06) and WRC07 (World Radiocommunication Conference 2007) agreements the co-primary use of the frequency spectrum 790-862 MHz for DVB-T as well as MBB is decided. The respective frequencies shall be allocated until 2015. However, the exact timing of the allocation depends on the analogue switch-off in the individual EU member states as well as their EU and non-EU neighbour states.

Therefore two options for the use of the digital dividend are already predefined:

1) Use of the digital dividend for *digital terrestrial TV*
2) Use of the digital dividend for *mobile broadband*

Two other options, both of which are in accordance with the GE06 and WRC07 agreements, were widely discussed in Austrian politics and public:

3) *Divided use* of the digital dividend for both DVB-T and MBB
4) *Deferment of the decision* on the use of the digital dividend

The assessment of the *divided use* of the digital dividend in Austria clearly shows the inefficiency of spectrum use due to further fragmentation of the sub-band and cross border interference issues with at least Switzerland and Germany, which already allocated the respective spectrum to mobile broadband use only. On top of this the overall economic value is lower than the economic value that could be derived by using the digital dividend for MBB only (see Braulke et al. 2010: 107 et seq.)

The *deferment of the decision* on the use of the digital dividend is an economically inefficient use of the scarce resource of frequencies as it represents de-facto a non-use of the respective spectrum for the next five years (i.e. until 2015).

Two other options of use were discussed during the decision process in Austria, namely a *regional allocation of spectrum* and an *additional exploitation of the lower digital dividend*. Both options were rejected at the very beginning of the process. The *regional allocation of* *spectrum* would theoretically allow for different usages of spectrum in different geographical regions. This option was rejected because of its obviously economic inefficiency.

The *additional exploitation of the lower digital dividend* on the other hand would permit the usage of spectrum below 790 MHz. This usage scenario is simply not in-line with current EU recommendations and the above-mentioned international agreements.

3.1.1 Scenario: Use of the digital dividend for DVB-T

In this scenario the 790-862 MHz sub-band shall be used for DVB-T only and in addition to the 470-790 MHz band. The extra capacity of the 790-862 MHz sub-band could therefore be used for offering additional free to air TV channels, additional TV content and/or for introducing terrestrial HDTV.

Short description of scenarios

- Use of channels 61-69 of the 790-862 MHz sub-band for DVB-T
- Free of charge allocation during a tendering process (beauty contest)
- Timeframe:
  - Decision on allocation process in 2010
  - Tendering process in 2011
  - Commencement of frequency use in 2012
- Further permission of secondary use of the sub-band by PMSE applications
- Re-farming of cellular radio frequencies in order to optimize frequency use

3.1.2 Scenario: Use of the digital dividend for MBB

In this scenario the 790-862 MHz sub-band shall be used for MBB only in accordance with EU recommendations (see RSCCOM09-59). The frequencies shall be used for improvement of the nation wide broadband coverage especially in rural areas.

Short description of scenario

- Use 790-862 MHz sub-band for MBB in accordance with EU recommendations
- Technology agnostic allocation via an auction process following a technical and economical reliability check of bidders
- Potential additional requirements:
  - Broadband provisioning in rural areas and roll-out timeframe
  - Spectrum limits per operator in order to sustain competition

- Timeframe:
    - Decision on allocation process in 2010
    - Tendering process in 2011
    - Commencement of frequency use in 2012
- Further permission of secondary use of sub-band or duplex gap at least by PMSE applications
- Permission and support of non competition limiting co-operation between network operators

3.2 Analysis: Use of the digital dividend for DVB-T

To evaluate the use of the digital dividend for DVB-T, three primary aspects should be considered, (1) consumer choice of distribution channels, (2) the need for additional television channels and services, and (3) the efficiency of spectrum use.

3.2.1 Consumer choice of distribution channels

Television households in Austria can choose between three general and well-established distribution channels (terrestrial, cable, satellite) as well as two other modes of transmission (television via mobile phone and internet), which are listed in figure 3. It is their own choice depending on price (costs for the consumers), diversity (number and type of carried channels) and a limited number of local restrictions.

	Technical Reach Potential Usage	*Actual Usage*	*Remarks*
Terrestrial digital television (DVB-T)	*93%*	*6% primary users, plus 3% hybrid users*	*free, limited number of programmes*
Cable TV (CATV)	*Homes passed 75%*	*39%*	*monthly costs*
Satellite (SAT TV)	*available almost everywhere*	*55%*	*free, initial cost for antenna*
Television via mobile phone (DVB-H)	*n.a.*	*20.000 users*	*future unclear*
Television via internet (IP-TV)	*depends on DSL penetration (78% for 8 Mbps)*	*1,5%*	*expensive*

Figure 3: Technical reach and actual usage of television distribution channels in Austria, 2009 (sources: RTR 2009; own research).

Satellite television signals are available almost everywhere, including all rural areas, and with only a few restrictions in urban areas (some large buildings, historic city centres listed for preservation). Satellite television offers a diverse portfolio of channels from Austria and abroad. The service is free, except for the initial cost for the antenna (ca. 100 €), and is the most common form of TV transmission in Austria (55% of households actually use satellite reception).

Three out of four Austrian households (homes passed 75%) could opt for CATV and 39% actually do. There is a large number of channels available for a monthly fee.

Television via mobile phones (Digital Video Broadcasting-Handy DVB-H) is a minority technology whose future is unclear. Television via Internet (Internet Protocol-Television - IP-TV) is dependent on DSL (Digital Subscriber Line) penetration. So far it is relatively expensive and actual usage is limited although it is expected to grow in the future.

Finally DVB-T, also known as over-the-air television, is available almost everywhere (93%) and carries a limited number of channels. The service is free to the customer.

Despite being free of charge and widely available only 6% of Austrian households use the terrestrial infrastructure as their primary way of getting television signals (plus 3% hybrid users of analogue satellite TV who receive Austrian channels only via terrestrial infrastructure). This clearly indicates that DVB-T is relevant for only a limited number of Austrians. Since the terrestrial infrastructure has to cover the whole country and the number of users is small, average distribution costs per user are rather high (even without the cost of spectrum).

Terrestrial users derive a low individual incremental value from over-the-air reception, since SAT-TV and/or CATV is generally available and superior with respect to the number of channels. As such the incremental value of DVB-T for this household would be close to zero (assuming that the DVB-T household would be almost indifferent with respect to satellite and/or CATV)

Historically, terrestrial television has received a large part of the spectrum ex ante. Technological advance will allow broadcasters to continue to provide their historical portfolio while at the same time helping them to launch improved services such as high definition television (HDTV). As a consequence, the consumer choice argument alone would inhibit to allocate additional spectrum to DVB-T and keep it away from MBB.

3.2.2 Need for additional TV channels?

The Austrian households enjoy being able to choose between a considerable number of public and private television channels. The number of channels available is much higher than would normally be expected for a country with a population of only eight million people. Such an expectation concerning the number of channels in a specific television market is based on high costs for a qualitatively competitive channel (first-copy-costs), which are independent of the number of viewers. Thus, for a country with only a small television audience, average cost per viewer would be high and/or the number of channels would be small.

The larger number of television channels in Austria is due to the fact that there are two neighbouring countries with same-language programming (Germany and Switzerland). Some German channels have Austrian specific programming windows (Pro7, SAT1 and RTL) or Austrian production shares due to cooperative agreements (arte und 3SAT). Austrian content is broadcasted by three Austrian full programmes (ORF 1, ORF 2, ATV) and several regional channels (among them Puls4, ServusTV, oktoTV).

These (and other) channels are getting enough spectrum, regardless of the upper digital dividend, even for HDTV. For political reasons, they do not have to justify their economic and/or social value in order to receive part of the scarce and valuable spectrum. Thus, if private or public television companies claim additional spectrum this would only make sense for additional channels.

It is highly doubtful whether additional channels would even be able to cover their production and content costs in the small Austrian market – except with the x^{th} repetition of old movies and television series from abroad. Cost coverage is very unlikely for Austrian content with merit value that could contribute to the variety of public opinion and cultural values.

For reasons mentioned above, minority channels would infer not only very high average content costs but also high average distribution costs. It is unlikely (and also would be another severe distortion of competition in the Austrian media market) that the Austrian politicians would be willing to raise the public funds in order to finance even more public channels than already exist. Even if they were to, this would not justify additional spectrum for the six per cent market share distribution channel of terrestrial transmission.

3.2.3 Efficiency of spectrum use

Spectrum has always been a no-cost resource for broadcasters and was abundantly available for a very long time. Economic theory and empirical evidence suggest that such a resource will be used wastefully. This specifically applies if the respective resource may be partly substituted by another, which is expensive. This is the case for spectrum and transmission sites where spectrum is wasted in order to save infrastructure costs by reducing transmission sites (high power - high tower).

In contrast, spectrum was scarce and valuable for the mobile network operators from the very beginning. Sophisticated technologies were developed by the telecommunications equipment industry and installed by the mobile networks (cell splitting) in order to make the most out of limited spectrum and still allow roaming and handover during usage. As such it is fair to assume that the mobile industry uses the available spectrum more efficiently than broadcasters do.

In television, the efficiency of spectrum use could be enhanced significantly, if appropriate incentives would prevail. From an economic point of view it would lead to an efficient use of spectrum, if all users, including television, had to pay a competitive intermodal market price for spectrum. If, for political reasons, television is exempted from spectrum prices, only spectrum scarcity would force them to be more efficient. Or vice versa: If they wanted to broadcast more programmes or do this in higher quality, they would be able to do this with even less spectrum.

Last but not least, this scenario does not support the objective of improving nation wide broadband coverage, as broadband infrastructure upgrades would only occur in areas where effective infrastructure competition already exists. This would not be the case in the rural areas. In addition this scenario has a detrimental impact on the case for fibre rollouts in rural areas. Without MBB radio towers there is no need for fibre based backhaul infrastructure as far as the mobile operators are concerned. As such they will not be willing to co-finance the rollout of fibre.

Due to the introduction of HDTV the packing of channels would further increase, thus displacing PMSE applications to other frequency bands.

3.3 Analysis: Use of the digital dividend for MBB

In order to assess the current broadband situation in Austria and the prospective development based on the potential use of the digital dividend for MBB the authors propose a differentiated broadband definition. This definition is forward-looking and based on the current experts' opinions on the bandwidth that is required as minimum broadband requirement in 2011. In the context of this article this minimum requirement for real broadband is set at 6 Mbps (symmetric) knowing that this requirement will grow over the next few years to 10 Mbps and above.

To reflect the current status of broadband coverage in metropolitan as well as rural areas and to be able to analyse the situation in a differentiated manner the broadband definition is subdivided into three categories:

- *α-Broadband: more than 144 kbps* (based on current definition in Austria used for official statistics, see RTR 2010)
- *β- Broadband: 1 to 6 Mbps* (based on current standard Telco and Internet Service Provider offerings throughout Europe)
- *γ- Broadband: above 6 Mbps* (based on expected demand until 2015)

Here we can assess that all three broadband categories can be provided based on currently available 4G mobile broadband technologies under real world conditions. (see Braulke et al. 2010, pp. 24-26)

Fixed-line broadband infrastructures (DSL and television broadband cable) have significant problems to cover rural areas, since there are no economies of density. Wireless technologies provide the most promising alternatives to service these regions. From a technical and economic point of view (especially related to wave propagation characteristics), the spectrum of the upper digital dividend is very well suited for covering rural areas. Also, most of the GSM networks operate in the adjacent spectrum such that their base station sites may also be used for LTE (long term evolution), which is the respective standard for MBB.

Using the digital dividend for MBB helps to (1) close rural gaps, 1 per cent of all residents for α-broadband, 4 per cent for β-broadband, and even more for γ-broadband, (2) enhance the individual and collective data rate, (3) allow mobile and nomadic internet access for residents, tourists, and businessmen, and (4) intensifies intermodal competition to DSL, television broadband cable, and UMTS in order to enhance their qualities and prices. (see Braulke et al. 2010)

With the use of the digital dividend for MBB the target of improving the broadband coverage can be achieved efficiently and quickly. In rural areas with inadequate or even non-existing broadband supply MBB could provide broadband for the first time. In other regions MBB would enhance the broadband supply in terms of both bandwidth and quality of service. Furthermore, the co-financing portion of the mobile sector would support the roll-out of fibre based broadband infrastructures in these areas.

Television broadcasting can continue in the 220 MHz available for DVB-T in the lower dividend. In the medium term DVB-T2 and HDTV are also feasible within this spectrum, assuming that the necessary technical and operational optimization measures are implemented.

As discussed within the DVB-T scenario the channel density increases with the introduction of MBB in the 790-862 MHz sub-band leading to PMSE applications being relocated to other frequency bands.

In the border region with Italy the frequency coordination effort would increase as it is expected that Italy will use the respective spectrum for broadcasting services at least on a medium term perspective. But due to a favourable topology as well as the location and the direction of TV-transmitters in Italy only minor limitation of frequency use for MBB in the Austrian border areas are expected.

3.4 Results

The economic analyses suggest that the use of the digital dividend for mobile broadband has a high incremental value for Austria. Let's assume that O_FO_M in figure 2 represents the upper digital dividend, which is on stake. The incremental value function for MBB is N_{MG}. The incremental value function for DVB-T is, as a result of the analysis in section 3.2, assumed to be N_{F2}. The evidence shows that even the lowest incremental value for MBB throughout the considered amount of spectrum Z_G is higher than the highest point Z_2 of N_{F2}. Thus, economic analysis postulates that the whole amount of the upper digital dividend should be allocated to MBB.

4 Accompanying measures

In order to achieve the highest economical value for Austria from allocating the upper digital dividend for MBB use, some accompanying measures should be implemented. These measures concern MBB itself, other potentially disturbed technologies (DVB-T, CATV and PMSE), international coordination as well as spectrum policy.

4.1 Aspects of the allocation concerning MBB

The spectrum of the upper digital dividend is to be allocated in form of an auction due to the market environment described above, EU recommendations and recommendations of Austria’s most important neighbouring countries (Germany and Switzerland), which argued for MBB. If the auction is to take place in 2011 it must be prepared for the most part in 2010.

The aforementioned study (see Braulke et al. 2010) recommended organizing the auction for the 800 MHz spectrum as well as for the 2.6 GHz spectrum in order to optimize the value of the spectrum for both the bidder and the Austrian society. This recommendation was overturned by the decision of the Austrian Regulatory Authority for Broadcasting and Telecommunications (RTR) to prepare the auction for the 2.6 GHz spectrum in August of 2010 already, without considering the 800 MHz spectrum.

Another recommendation of the study aims at the necessity of re-farming the 900 MHz spectrum, used for GSM-voice services. Current information indicates that re-farming will not be in effect before 2017 since the spectrum will be needed for voice services until then.

Due to the current high utilization of mobile broadband services in Austria – 90 per cent of the population have access to MBB of up to one to three Mbps – special conditions for the utilization of the upper digital dividend are reasonable only when the operators’ interest and willingness to supply the whole population can be increased thereby. This would, besides improving the broadband access conditions for the resident population in rural areas, also enhance the broadband coverage for seasonal guests in touristic regions.

The usage of the respective frequencies in urban areas should be allowed only after the operators deliver on coverage for the rural areas. Nevertheless, detailed requirements e.g. on population coverage in specific rural areas should be avoided, requirements on achievable bandwidth must be handled flexibly if necessary at all. Generally, requirements must be orientated at the **γ**-bandwidth.

4.2 Aspects of the allocation concerning DVB-T

HD quality television will be achieved by implementing DVB-T2 and MPEG4. Technological developments will, in the medium term, restrict the need for additional spectrum. As such SD television will not require additional spectrum. Since additional technical developments for HDTV are expected in the medium term, no more spectrum will be needed for SD television, especially when utilising the spectrum at 200 MHz.

Simulcast services, offering HD and SD qualities within a limited time will be possible in the spectrum between 470 and 790 MHz with the exception of the metropolitan area of Vienna in case that the usage of one multiplex for DVB-H will be brought to an end, due to low demand. For the area of Vienna and possibly in some neighbouring regions band III, which is qualified for DVB-T2, could be used. This spectrum may be used either for TV or for digital radio programmes.

In summary the interests of broadcasting services will be respected, assuming that alternative spectrum of band III (174 - 230 MHz) can be used. The rights of broadcasters will not be violated when using the upper digital dividend for MBB.

4.3 Aspects of the allocation concerning PMSE, especially wireless microphones

Concerning the distribution of usage of wireless microphones (about 80 per cent below 790 MHz and 20 per cent between 790 and 862 MHz), the situation in Austria is less dramatic than it is in other neighbouring countries as for example in Germany.

Alternative spectrum for the 20 per cent wireless microphones, used where MBB shall be offered in the future, will be the L-band (at 1500 MHz) and the 1800 MHz frequency range. These frequencies can be used for broadcasting radio. The frequencies are currently being harmonized Europe-wide at CEPT.

In addition the duplex band between 820 and 832 MHz will be reserved especially for PMSE. Whether this spectrum will be usable for PMSE depends on the possible interferences within this guard band and will only be known after mobile operators have started using LTE in the respective frequency range.

For professional and variable usage of wireless microphones co-primary utilization of the broadband spectrum of the channels 51 to 60 is recommended in the medium term. In addition it is recommended to support the secondary usage of the spectrum for the short-term.

The frequencies of the channels 21 to 50 will be primarily reserved for broadcasting and can be used for wireless microphones in cooperation with broadcasting corporations.

A European harmonization will be a basic requirement for medium and long term usage of wireless microphones within the broadcasting spectrum and to assure planning and investment reliability for operators and producers of wireless microphones.

Some manufacturers (among them Bosch and Sennheiser) are developing cognitive PMSE-systems. This is necessary because the allocation of the spectrum between 470 and 790 MHz will probably change over the next ten years. The increase in spectrum demand from various users, such as broadcasters or public safety institutions and the concentration within the 470-790 MHz spectrum will continue and the situation for PMSE as secondary user will even get worse.

4.4 Aspects of the allocation concerning CATV

Interferences between usages of MBB terminals and CATV-systems are demonstrated in very different manors regarding the different reports. Apart from this the disturbances caused by CATV-systems on mobile terminals are usually neglected.

Cable network operators basically are allowed to use each other’s frequencies as long as they regard technical engineering standards and legal regulations, although they do not have any legal rights of use. Therefore, cable network operators have to make sure that there are no interferences caused by cable networks on other usages. The rights of new operators after auctioning spectrum therefore will be overruling those of cable network operators.

According to a recent study by mobile operators, cable network operators and the responsible German Regulatory Authority (Bundesnetzagentur) in Germany in 2009, the interferences can be disregarded when the cable network is protected as necessary. If not, re-fittings are needed but feasible. The maximum distance between cable network and mobile terminal is 4.7 meters without network protection (without walls). Similar results are published by a study from Switzerland, which is based on statistical methods with statements about the probability and frequency of interferences. (see Dolder/Siedler 2009)

Final measurements and results will only be possible when LTE-terminals are commercialized. But today one can safely say that interferences between mobile terminals and TV-cable networks in the 790–862 MHz spectrum will be manageable. This is confirmed by identical tests and measurements from BAKOM in Switzerland (see Tschannen 2010).

In addition it will be possible to avoid disturbances via customary filters, which have to be installed between TV-terminal and antenna. This method is already practiced with interferences between terrestrial broadcasting and TV-cable networks.

Additionally to the mentioned measurements and reports the CEPT decided in 2010 that cable network operators have to make sure that their networks do not disturb others.

4.5 Measures to improve international cooperation

The success of harmonization at a European and global level, as well as an improved regional coordination of frequency policy among neighbouring countries will co-determine the size of incremental benefits that can be reaped by the recommended allocation of the digital dividend to MBB in Austria.

There are starting points for international cooperative measures in various subject areas: At a bilateral level among neighbouring countries, the cooperation is currently mainly at the expert level. Hence, the strengthening of political spectrum initiatives – and not only on a bilateral basis – should be considered. By having a regional spectrum initiative, especially with neighbouring countries where the greatest interferences occur, a concerted political decision-making process at ministerial level could be promoted and prove helpful.

Interference scenarios along national borders will also be a topic for discussion at the World Radio Communication Conference 2012 (WRC-12). Until then it is necessary to work on a joint European opinion.

To enlarge the usage of the recommended allocation, endeavours of the European Commission concerning a harmonized allocation and usage of the digital dividend should be supported politically as well as in specific think tanks (CEPT, ECC, ETSI).

A pan-European initiative could be launched to improve the situation of secondary spectrum users (PMSE) of which the events business is of great importance in Austria. The support of other nation states would be necessary for such an initiative of “preferential secondary usage” through PMSE.

Another starting point for improving the situation of spectrum usage through PMSE would be to promote international coordination concerning the usage of the frequencies from 1785 to 1800 MHz in the relevant CEPT-panels.

4.6 Improving spectrum policy

A fundamental legacy problem concerning efficient spectrum allocation is that frequencies have historically been allocated for free. This has led to inefficient technical production and inefficient utilisation of the frequencies available. Currently there is a problematic co-existence of different financial models, with individual industries required to pay for spectrum (e.g. mobile communications) and others receiving spectrum for free (e.g. broadcasting). In the long run a common regime that guarantees an economically efficient frequency allocation is required. This could be based on a market regime for the respective spectrum, potentially with some adjustments for broadcasting.

Broadcasting generates value for society. This value needs to be defined and included in the evaluation and allocation. In the medium-term frequencies in the lower digital dividend could be purchased by broadcasters in competition with other potential users. It would be possible to allocate frequencies according to their market price and to subsidize broadcasters for their frequencies costs according to their public value. This would be a cost-neutral solution since frequency usage fees appear to be revenues for the government. It would lead to an economically more efficient usage of frequencies.

If, for political reasons, it should be decided that broadcasters should not have to pay and to compete for frequencies, imposing sanctions on inadequate utilization of already-allocated frequencies would be needed to increase efficiency. Corresponding regulations may be found in the Austrian Telecommunication Act (see TKG 2003) as well as in the Austrian Private-Broadcasting Act (see PrTV-G 2006). In this case it needs to be considered which potential sanctions (fines, withdrawal, partial withdrawal) would be sufficiently effective to provide adequate incentives to use the allocated frequencies efficiently. Taking the convergence trend between telecommunications and broadcasting into account, there is a need for comparable regulatory arrangements for frequencies to be able to create a level playing field.

5 Projected schedule of the allocation

The auction of the 800 MHz spectrum is scheduled for the end of 2011 or beginning 2012. The auction for 2.6 GHz frequencies has already taken place in September 2010.

The main reason for this time schedule (not combining the auctions) is due to the situation of the Eastern European neighbouring states, which still use analogue frequencies for terrestrial TV, especially the channels 60 and 61 in Slovakia, the Czech Republic and Hungary.

Another political reason for the hold-up may be found in the critical relations between the Austrian government and the Austrian public broadcaster ORF, who is still arguing for a compromise between broadcasting and mobile operators. For the next three to five years the ORF wants to use the frequencies for implementing DVB-T2 in the urban areas of the eastern parts of Austria while simultaneously upholding DVB-T-supply (simulcast operation). At the same time channels 61 to 69 should already be used for MBB in rural areas.

Broadcasting and mobile services simultaneously in the same spectrum will not be possible. It would be necessary to have a distance of approximately 100 to 150 km between different operators, which is not economically viable. These facts are not mentioned in the current discussion. It is only referred that the amount of the auction could be smaller if operators are only allowed to use the spectrum later.

Summing up, the decision of the Austrian Government to allocate the digital dividend to MBB could support the economic development of the country. But the risk remains that the relatively long period between today and the potential auction date (end of 2011 / beginning of 2012) could lead to negative lobbying by some stakeholders trying to double guess the optimal solution.

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