Digital dividend in Southeast Europe

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Executive summary

Revolutionary communication and interactive content based on ever advancing digital technology are envisioned to dominate our close future. Information and communication technologies deliver economic and social benefits, which is also why the World Radiocommunication Conference in 2007 (WRC-07 organised by ITU[1]) allocated the digital dividend to mobile services on a co-primary basis with digital television. Covering the entire EU with broadband is the number one goal of the Digital Agenda for Europe, the first Europe 2020 flagship initiative.[2]

Experts consider the digital dividend as a prime driver of the ongoing digitalisation across the world. The digital dividend is a term referring to the highly valuable frequency spectrum which becomes available after switching from analogue terrestrial television to digital terrestrial broadcasting.[3] The digital dividend has the potential of enhancing electronic communications via its capability of providing broadband access in urban and rural regions across Europe. On top of the positive economic and social effects in the medium and long term, the auctioning of the digital dividend would also have instant positive fiscal effects among European countries.

International organisations and national governments expect to increase the output of national economies by allocating the digital dividend to mobile services, especially to mobile broadband. These efforts are based on the assumption, supported by a number of empirical studies, that access to broadband services contributes significantly to economic growth.

With the emergence of UMTS, 3G, and LTE technologies the mobile industry became able to provide data services which are effectively comparable to fixed broadband services based on their potential contribution to information society development. The wireless nature of mobile broadband ensures that the positive productivity and growth impact of these services is on a par with that of fixed services. The value of the DD1 band is assumed to lie in that it is necessary for maintaining the current trend of mobile broadband take-up by providing radio spectrum for gearing the capabilities of the mobile networks to the ever increasing subscriber data requirement, and in its potential for introducing broadband services in rural areas.

In this study we analyse the status of the digital dividend in Southeast Europe[4] with a focus on two EU Member States, Bulgaria and Greece, and two non-EU countries, Serbia and Turkey, as requested by GSM Association.

Our calculations show that the growing take-up of mobile broadband services – promoted by the allocation of the 800 MHz band to mobile networks – has a measurable potential to increase the GDP of national economies. Within the focus countries of this study, our estimations show that the incremental effect of mobile broadband services on GDP growth varies between 0.1 to 0.6 percentage points cumulated from 2014 to 2016. We also found that the assumed rural effect was limited in the region due to a nearly complete broadband coverage in several countries.

Southeast Europe could further expect revenue from auctioning the 2x30 MHz in the 800 MHz band. So far the 800 MHz band has been auctioned in ten European countries, with frequency prices varying from EUR 0.23/MHz/person in Croatia to EUR 0.8/MHz/person in Italy.[5] These limited observations suggest that license prices in the SEE region could be near the lower end of the range, as the size of the internet market appears to positively influence license prices. Here we need to stress that prices in the auctions are also significantly affected by a number of country-specific factors. Such factors derive from the specifics of the auction process – like the frequency band to be auctioned, the obligations and requirements which come with the license, or the length of the licenses – and further aspects such as current band usage patterns or the proximity of previous frequency auctions.

Many international organisations around the world have realised the potential of mobile service provision in the DD1 band. EU Member States are obliged to discontinue using the digital dividend for analogue television

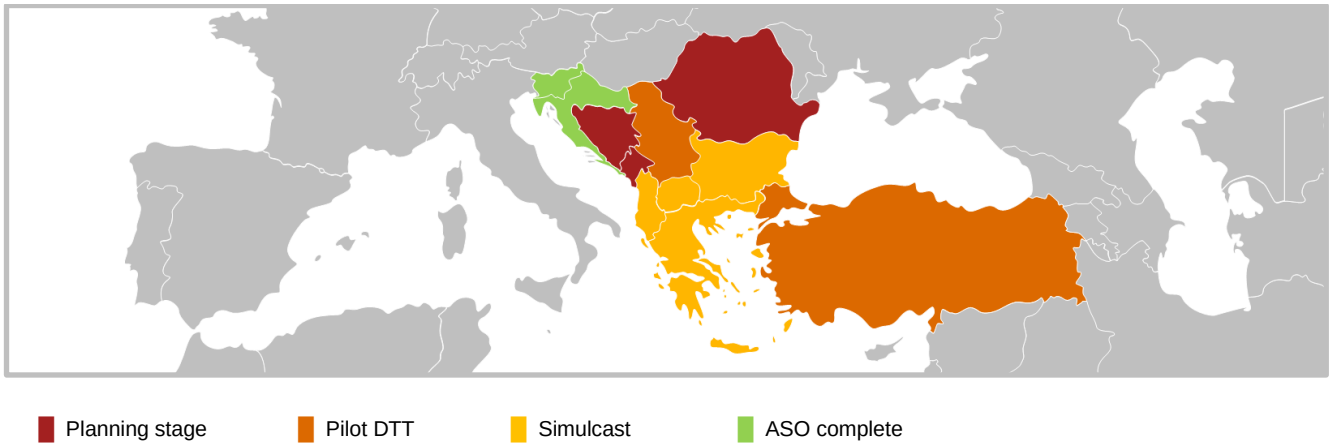
[1] ITU (International Telecommunication Union) is the United Nations specialised agency for information and communication technologies.
[2] Europe 2020, European Commission
[3] The frequencies in the first digital dividend (DD1, frequencies 790 to 862 MHz) are ideal for mobile broadband use due to the physical characteristics of this radio frequency. In the 800 MHz frequencies optimal data transmission rate can be achieved along with good propagation characteristics, thus offering an efficient solution for widespread rural and good indoors urban coverage.
[4] In our study we define the SEE region as Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Montenegro, Romania, Serbia, Slovenia, and Turkey.
[5] Nine European countries have concluded the auctioning of the 800 MHz band to date, namely Denmark, France, Germany, Italy, Portugal, Spain, Sweden, Switzerland, and most recently Croatia and Romania.

by 31 December 2012, and are obliged to use these frequencies for electronic communication services. The RRC-06 (Regional Radiocommunication Conference, organised by ITU) set a June 2015 deadline for switching off the incumbent analogue terrestrial TV signals in the 800 MHz band in Europe, and at the WRC-07 countries agreed to make the DD1 frequencies available primarily for mobile services and digital television.

All EU member states have a strategy for the digital switchover, and some states across Europe have already switched off analogue terrestrial television. The digital dividend has been successfully auctioned to mobile network operators in nine member states. However, a few states needed to revise their end-2012 switchover deadlines citing military use and cross-border frequency coordination issues with other member and non-member states, which prevents them from making the DD1 available for mobile service use. Some adjacent non-member countries in Southeast Europe also find it challenging to keep their respective deadlines.

Figure 1 **Current status of the digital switchover in the SEE region**

Sources: PwC, Digi.TV



Nearly all countries in Southeast Europe have a pilot DTT in operation or currently in the simulcasting phase, though most countries do not have full DTT coverage and network construction is underway. The actual status of countries in the simulcast period also moves on a wide scale – for instance, Greece has already switched off analogue broadcasts in some of its most densely populated areas. The speed of the transition can also be different country by country, as some states introduced pilot broadcasts as early as 2006 but experienced severe delays in implementing consecutive steps.

Bulgaria revised its DSO strategy in mid 2012, postponing the deadline for analogue switch-off to September 2013. Seven national TV broadcasting multiplexes are already licensed in the country and simulcast digital television broadcasts are available, though multiplex licenses are currently being challenged by the European Commission. The major obstacle which prolongs the transition period in Bulgaria is the extensive military presence in the DD1 band – the Ministry of Defence has rights over eight out of the nine channels in the band, rolling a tough challenge in the way of television frequency refarming and the release of the digital dividend. Bulgarian authorities have yet to develop a plan to clear the DD1 band from military use.

Greece successfully switched off analogue terrestrial television broadcasts in one of its most populated areas in August 2012. The planned timeline for the final ASO and the utilisation of the digital dividend is agreed upon in the Second Economic Adjustment Programme for Greece and other agreements with the IMF and the EU. Agreements adopted by the Greek parliament set the ASO deadline for June 2013, followed by the auctioning of the digital dividend. The major obstacles which prolong the utilisation of the digital dividend in Greece apart from the current economic situation are as follows. The Greek military has the right to three out of the nine DD1 channels. Digital television broadcasts are also present in the band, which need to be relocated to other frequencies. Finally, mobile network operators were recently awarded additional frequencies, reducing their immediate need for additional frequencies.

The DSO strategy of Serbia underwent a revision in 2012, moving the ASO deadline from 2012 to June 2015. A pilot digital broadcasting network funded by the EU has been realised, and network completion is set by the end of 2014. The pilot network covers 40% of Serbia's population, but has no effective viewers. In Serbia's case the major obstacles in the way of a speedy utilisation of the digital dividend come from the slow network construction paired with a low public awareness of the digital switchover. However, Serbia, which is not a

member of the EU yet, has more room to manoeuvre as the December 2012 EU deadline is only optional for the country.

Finally, in Turkey the digital switchover is set for 2015, in accordance with the GE06 agreement. Simulcast is planned to commence in 2013, following the pilot digital terrestrial broadcasts back in 2006. The three organisations involved in the digital switchover process and the utilisation of the digital dividend (RTÜK,[6] Anten A.Ş.,[7] and BTK[8]) are in place and operating. Among the four focus countries Turkey is the only one where the DSO process is not delayed, though it is also the only country of the four which initially set its ASO to be completed by 2015. In Turkey we do not see any issues yet which would cause severe delays in the DSO process, and authorities have the resources and responsibilities required to successfully manage the processes.

We found that three key factors prove to play a major role in delaying the switchover in Southeast Europe. These administrative, technology-related, and social factors are briefly described below, along with our recommendations and suggestions which aim to promote the DSO process and accelerate the utilisation of the DD1 band.

1. Administrative issues. After analysing the switchover processes of Southeast Europe we found that every country in the region has at least a strategic document regarding the digital switchover. In some cases the national strategy has been revised due to delays in implementing the strategy. There are no countries that would schedule their analogue switch-off date to after the June 2015 deadline set by ITU at the RRC-06 (Regional Radiocommunication Conference 2006).

We found that a sound and comprehensive legislation with specific mandates and responsibilities is necessary to prevent delays caused by lengthy coordination within public and private organisations. Examples show that cross-border coordination, public awareness raising, state support and subsidy schemes could be successfully managed by an organisation which has clear mandates and the necessary resources. Therefore, we suggest that national regulators and authorities specify such organisations in order to advance the DSO process and the utilisation of the digital dividend.

2. Technology-related issues. Most Southeast European countries already have commercial digital television broadcasts, and nearly all countries have a pilot digital terrestrial TV broadcast (DTT). Most countries, however, do not have full DTT coverage, and network construction is underway. In some cases the radio frequencies in the 800 MHz band are unavailable due to cross-border interferences, or conflicting technologies such as military or digital television broadcasting in the relevant bands. The process of introducing the receiving technology to consumers might also not be flawless. DTT network construction is more advanced in countries where the private sector is better involved, while it is generally slower in countries where the state has financing or other responsibilities regarding digital network operation.

We strongly recommend public consultations to be held to discuss the future utilisation of the digital dividend in countries where the DD1 band has not yet been cleared from its various former uses. Such public consultations would allow affected parties to align their interests, yielding gains to both national governments and the future users of the digital dividend. The consultations could also set out the priorities of the digital switchover and DD1 utilisation processes via exploring the special interests of governments and mobile network operators.

Military use is often an obstacle to releasing the DD1 band for greater value-added use such as mobile broadband. In these cases we suggest a thorough assessment of military usage, similar to the ones done in Poland and Hungary. In some former Warsaw Pact countries[9] a large amount of valuable frequency assigned to military and ARNS[10] use turned out to be effectively unused after measuring radio emissions of the military equipment in question.

The release of the 800 MHz band can be hindered by digital television channels in the band. Relocating these digital multiplexes can be challenging and/or costly if multiplexes are licensed for specific frequencies. Therefore, we suggest a capacity-based multiplex licensing, which allows multiplexes to be relocated whenever required by the regulator.

[6] Radio and Television Supreme Council
[7] National Broadcasting Equipment Operator and Management Company
[8] Frequency Regulating Authority
[9] Such as the Czech Republic, Hungary, Poland, and Slovakia
[10] Aeronautical Radionavigation Service

3. Social issues. All affected countries in Southeast Europe realise the need for support schemes targeting economically or socially vulnerable societal groups. Support schemes are usually set to subsidise the acquisition of the necessary receiving equipment (set-top boxes). However, only few plans go into details about subsidies, as set-top box subsidies are perceived to put a heavy burden on the state budget. Without the necessary public awareness and amidst uncertainty about subsidy policies, households often wait out with equipment purchases until subsidy plans are finalised.

Therefore, we suggest that countries specify eligibility for the set-top box subsidy comprehensively. Any definition that is too general requires further elaboration and could delay the switchover and increase subsidy costs. Clear and reliable subsidy plans could activate business incentives and market mechanisms, and increase the number of households that do not require subsidies. In this case too, set-top box subsidies could be co-financed from immediate revenues realised from auctioning national frequency licenses in advance, where mobile market conditions allow.

In summary, we found that the digital dividend holds a great potential for the Southeast European region in enhancing both economic growth and employment in the medium term. We believe that the challenges which countries currently face can be successfully met, and that accelerating the process towards utilising the digital dividend is in the best interest of every Southeast European country.

Table of contents

Digital dividend in Southeast Europe

In this study we present a comprehensive analysis on the digital dividend in Southeast Europe. In the first section we define the digital dividend and present its most relevant details, along with information about the most recent plans regarding its future utilisation.

In the second section we present the key factors which could influence license fees which mobile network operators are willing to pay for utilising the frequencies of the digital dividend, citing international benchmarks.

Thirdly, we present our macroeconomic model and parameter estimations which we applied when estimating the macroeconomic effects of broadband access on gross domestic product and employment.

In the subsequent section we narrow the focus on Southeast Europe and present an overview on the region, followed by our recommendations which we believe could accelerate the digital switchover process and the future utilisation of the digital dividend.

We close our study with a comprehensive analysis of each of the four focus countries. The country studies are designed to function as standalone studies if necessary, and include both analysis, valuation, and our relevant recommendations.

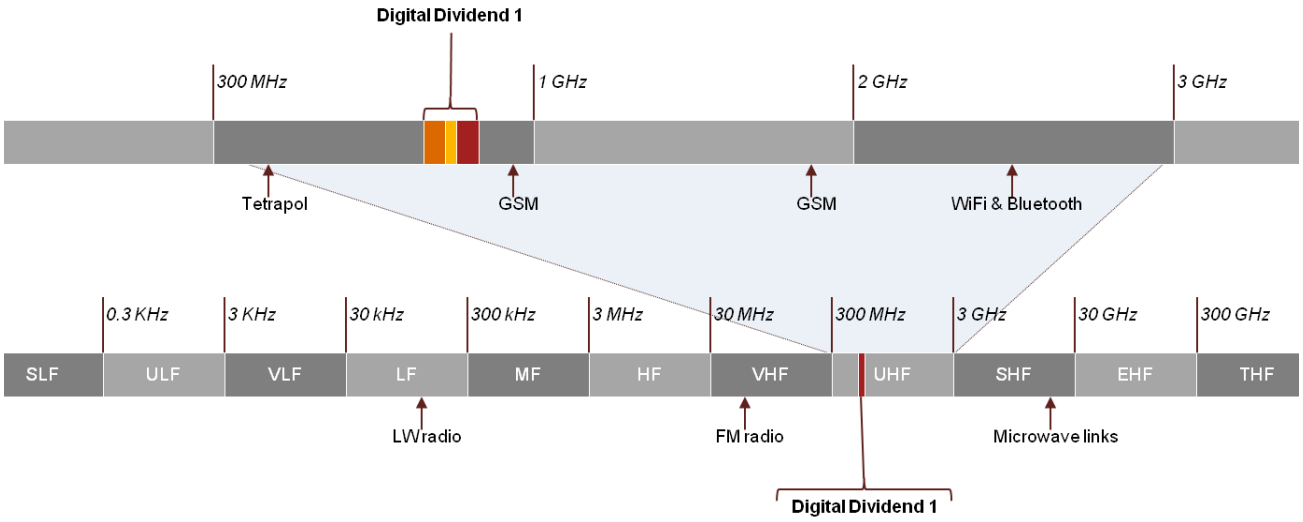
Introducing the digital dividend

This section offers a comprehensive summary of the accessibility of the Digital Dividend 1 (DD1) in Southeast Europe. It introduces plans and decisions shaping the future utilisation of the DD1 band, along with the necessary steps towards releasing the 800 MHz band (frequencies 790-862 MHz) for further use.

The term 'Digital Dividend' is commonly used for referring to a radio spectrum being freed up as a consequence of the Digital Switchover (DSO) process in terrestrial broadcasting. DD1 specifically refers to the Digital Dividend in the UHF 800 MHz band, whereas the term DD2 refers to the released radio spectrum in the 700 MHz band. DD1 is located near the lower end of the UHF band, as displayed in Figure 2 below. In the current Study the term 'Digital Dividend' (DD) will be used interchangeably with DD1, ITU will likely only discuss details regarding DD2 at the 2015 World Radiocommunication Conference.

Figure 2 Locating the digital dividend 1

Sources: ITU; Analysys Mason, DotEcon, and Hogan & Hartson, 2009



The current Study focuses on the DD1 band, which is the digital dividend that would become available in the 790 MHz to 862 MHz (UHF channels 61-69) frequency spectrum, as it is also illustrated in Figure 4 below. The DD1 band has been historically utilised for a number of uses. Most prominently it has been used for Analogue Terrestrial Television broadcast (ATT) in most of Europe, hence the name "channel" which refers to the 8 MHz

bandwidth that has been assigned to one analogue television program channel.[11] Other possible uses include digital television broadcast, radio broadcast, fixed and land mobile broadcast, PMSE (Program Making and Special Events) use, or radar uses. A European Common Allocation (ECA) Table has been developed in which specific utilisation of frequency bands is recorded. According to the ECA, DD1 may currently be utilised by military systems, PMSE devices, SAP/SAB[12] radio microphones, TRA-ECS[13] appliances, and for television broadcasting applications.

Mobile potential in the DD1 band

The DD1 band frequencies are considered to be highly valuable for the next generation 4G/LTE mobile services. In fact, the next generation LTE data transmission technology is designated to be used in the 800 MHz band.

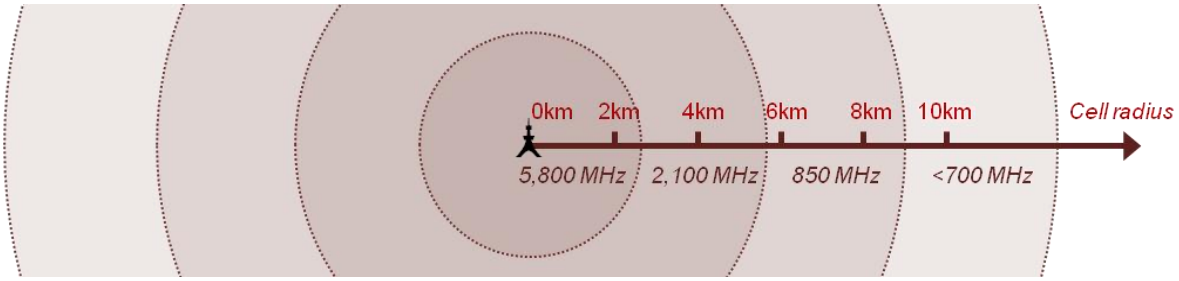
Physical capacities of the lower UHF band (790 MHz to 862 MHz) offer an optimal data transmission rate along with good signal propagation capabilities. Benefits can be best realised when used for mobile services both in urban and rural areas. Other proposed utilisations for the released frequency band can be, amongst others, wireless broadband, terrestrial and mobile TV broadcast, or further various broadband services such as services for public safety and disaster relief (PPDR), or Services Ancillary to Broadcasting/Program making (SAB/SAP).

Mobile service provision in the 800 MHz frequencies provides better in-building coverage under urban conditions, as compared to the 1.8 GHz and 2.6 GHz bands. While the latter are also considered suitable for LTE services, the higher frequencies yield generally poor indoor performance on their own.

Under rural conditions mobile service provision in the DD1 band benefits from the larger cell radius[14] which requires a reduced number of base stations for transmission, as illustrated in Figure 3 below. Good coverage in the generally poorly covered rural areas could therefore be realised at a relatively low CAPEX by mobile broadband providers.

Figure 3 Approximate propagation characteristics of the DD1 spectrum

Source: ITU, 2012



The DD1 band is planned to be allocated for mobile services[15] effective from 17/6/2015 in Europe and other parts of the world[16], according to the results of the 2007 World Radiocommunication Conference (WRC-07) organized by ITU (International Telecommunication Union).[17] The EU has drawn a stricter deadline of 1/1/2013, stating that the 800 MHz band "should in principle be made available for electronic communications services in the Union"[18] by this date. Award mechanisms are to be developed and managed individually by the participating countries.

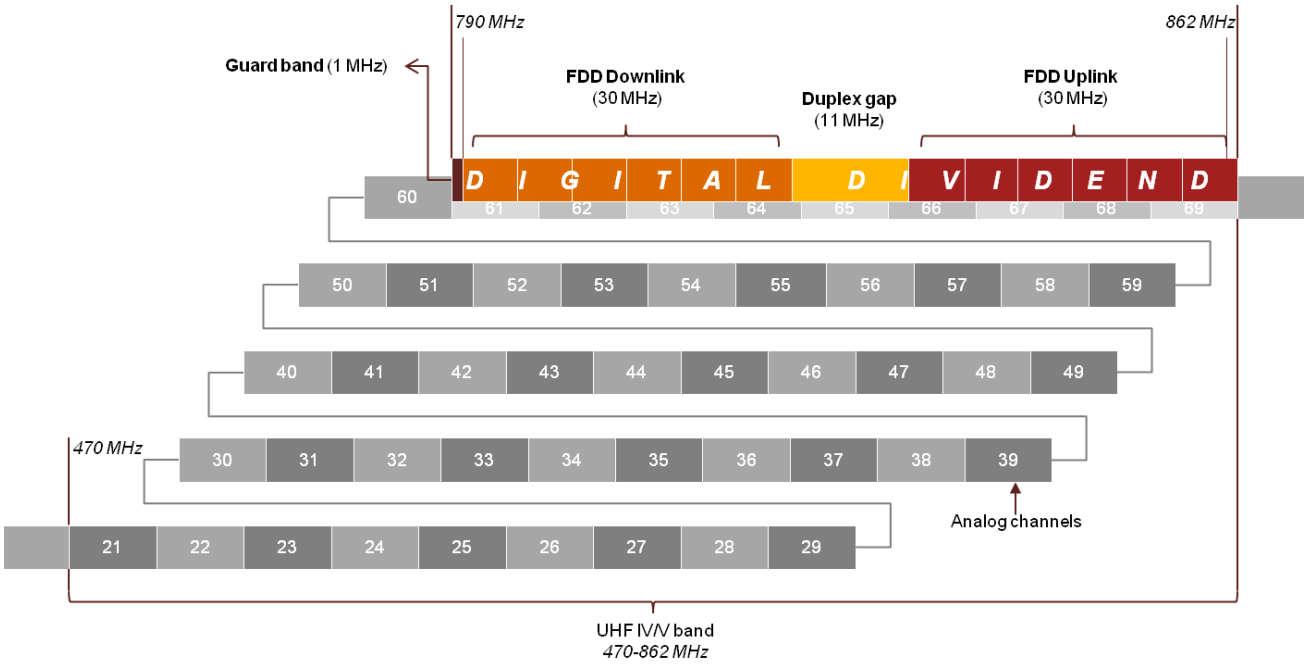
General parameters of the frequency arrangement in the 790 to 862 MHz band are proposed in the 2010/267/EU decision as follows. "The assigned block sizes shall be in multiples of 5 MHz"[19], and the duplex

[11] Depending on country-specific regulations. Authorities around the world generally assigned 6, 7, or 8 MHz bands to one analogue channel
[12] Services Ancillary to Broadcasting/Program Making
[13] Terrestrial radio applications capable of providing electronic communications services
[14] Radius in which the signal can be received and utilised
[15] Except aeronautical mobile services
[16] ITU Region 1 includes Europe, states of the Middle East, and Africa
[17] Source: WRC-07 presentation by the Chairman of the Conference Preparatory Group, CEPT-ECC
[18] Decision No 243/2012/EU of the European Parliament and of the Council of 14 March 2012 establishing a multiannual radio spectrum policy programme Text with EEA relevance. Official Journal L 081 , 21/03/2012 P. 0007 - 0017
[19] Decision no. 2010/267/EU

mode of operation shall be Frequency Division Duplex[20]. The detailed frequency arrangement is displayed on Figure 4 below.

Figure 4 A summary of the FDD frequency arrangement in the 790-862 MHz (DD1) band[21]

Sources: Decision 2010/267/EU; ITU



Releasing the 800 MHz band for mobile services

Most countries need to adjust their current radio frequency allocation in order to make the 800 MHz band available for mobile use, as required by international frequency coordination agreements and recommendations by the ITU and the EU. Existing users of the DD1 band need to be relocated to other (usually lower) regions of the UHF band, a process which in most countries does not come without difficulties. Countries are considered to have both economic and social interest in releasing the 790-862 MHz band to mobile services, at the same time the rearrangement of national radio frequency allocation tables and the relocation of frequency users to match internationally harmonized standards can come at various costs.

The Digital Switchover (DSO) is widely considered to be a prime condition for releasing free frequencies in the UHF band, as Digital Video Broadcasting (DVB-T) standards make it possible to group and broadcast up to twelve SD quality[22] program channels via a single 8 MHz band using Code Division Multiplexing (CDM). In contrast, the analogue broadcasting of twelve program channels would require a total of 12x8 MHz frequency band. The DSO process often includes a simulcast period in which analogue and digital terrestrial television broadcast is available simultaneously. Available free frequency bands would finally be yielded from switching off analogue video broadcasting (Analogue Switch-off or ASO).

The Digital Switchover entails a technology change in the entire terrestrial video broadcasting market. Authorities of each country are required to define their respective national standards for the new technology in order to ensure a smooth transition. In many cases the transition requires applying targeted public policy measures, as the technology change requires significant efforts and investments both on the broadcasters' and the receivers' side. The transition can also come with political implications, especially in countries where the ratio of terrestrial only (AVB-T-only) households is high, and/or in the case of AVB-T-only households from a lower socio-economic status.

[20] The duplex spacing shall be 41 MHz with base station transmission (down link) located in the lower part of the band starting at 791 MHz and finishing at 821 MHz and terminal station transmission (up link) located in the upper part of the band starting at 832 MHz and finishing at 862 MHz.
[21] Applicable to Europe – other frequency bands are defined for the US or Asia Pacific. Source: ITU
[22] This value is valid for MPEG-4 encoded video with the DVB-T standard, which offers a 24 Mbit/s typical data flow rate (maximum data rate is higher) via one Multiplex (MUX); and where an SD channel has a 2 Mbit/s data rate requirement, and an HD channel 5 Mbit/s. In comparison the DVB-T2 standard offers a much faster 40 Mbit/s typical data rate (maximum data rate is higher). Source: dvb.org, 2012

PMSE and military use

Other radio frequency users in the DD1 band, some of which traditionally operate using the frequency gaps between channels, might also be required to discontinue using the 800 MHz band. Regulators need to prevent harmful interference caused by local radio frequency uses such as SAP/SAB (Services Ancillary to Program making/Broadcasting) or PMSE (Program Making and Special Events). The CEPT Report no.32 notes that the "co-location [and] co-existence of PMSE and mobile systems [is] not practicable"[23].

As an alternative the CEPT Report suggests maintaining the use of PMSE appliances in the 470-790 MHz band on a temporary basis. The study also notes that some use of PMSE devices would still be possible within the CDM duplex gap, or in the guard band at the lower end of the CDM. The report suggests controlled access and individual licensing of these devices on a state level.

PMSE usage in certain frequencies is already disallowed in some countries of Europe due to possible interference with Russia's ARNS (Aeronautical Radar Navigation Systems, see Figure 5 below). The ARNS zone reaches out as far as 420 km from the Russian border. Though Russia is reported to allow the co-primary use of the DD1 band by the 2015 ITU deadline[24], in some cases further bi-lateral agreements would be needed in order to ensure successful DD1 utilisation.

Figure 5 Borders of the Russian ARNS interference zone in Europe

Source: Europe Economics, 2010

Regulators and authorities might also need to assign new frequency bands to military uses, as in many European countries parts of the 800 MHz band are assigned for military purposes. Exemptions from the release obligation could be issued by the EU, while some experts suggest that military bands should be relocated to the 300-400 MHz band, one which most European countries already utilise for PPDR (Public Protection and Disaster Relief) purposes.[25]

Further interference issues

The WRC-07 has given equal protection rights via a co-primary status of mobile services and DTT (Digital Terrestrial Television) in the 800 MHz band. Meanwhile, the relevant EU regulation allows Member States to "implement alternative frequency arrangements" if necessary.[26] The relevant international GE06 Agreement[27]

[23] ECC, 2009
[24] Europe Economics, 2010
[25] Analysys Mason, 2009
[26] „(…) with the aim of (a) achieving general interest objectives, (b) ensuring greater efficiency through market-based spectrum management, (c) ensuring greater efficiency when sharing with existing rights of use during a coexistence period, or (d) avoiding interference. Source: Annex A2 of Commission Decision 2010/267/EU
[27] Geneva 2006 Agreement at the Regional Radiocommunication Conference 2006, organized by ITU

also provides significant flexibility to participating countries in the utilisation of frequencies, provided that "other services [do not] cause more interference to neighbours than the corresponding (…) transmission would have caused."[28]

Radio signal interference is possible both in adjacent frequencies and within the same frequency. Inter-frequency interference, such as the interference between DTT and the proposed FDD uplink, can be mitigated via compliance with internationally promoted standards – such as the planned FDD arrangement plan which separates DTT channels from the FDD uplink channels by placing the FDD downlink in between, as displayed in Figure 4 above. Further interference outside the 800 MHz band can be mitigated by the authorities in a manner similar to the common pre-DSO practice.

Cross-border coordination

Intra-frequency interference is especially relevant in border areas, as different systems using the same frequencies might interfere near the administrative borders. This risk is considered manageable by authorities complying with international and/or bi-lateral coordination agreements, just as they did in other cases pre-DSO.[29] The *CEPT Report no.29 on cross border coordination issues between mobile services in one country and broadcasting services in another country* notes that there is no need for special measures when coordinating broadcast/broadcast or mobile/mobile interference, as these procedures have already been a common practice among countries. The CEPT report also notes that a further detailed coordination methodology may need to be developed in the case of possible cross-border broadcast/mobile interference.

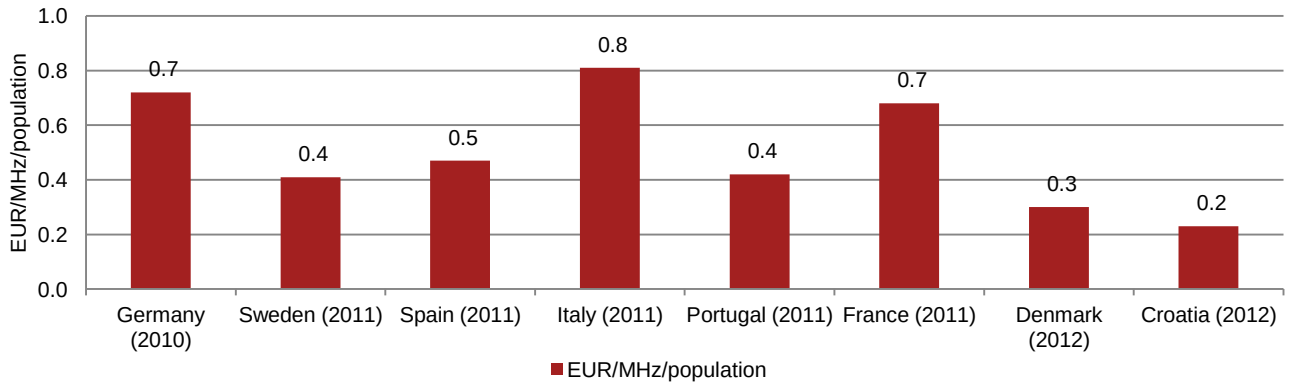
[28] Analysys Mason, 2009
[29] Analysys Mason, 2009

Valuing the 800 MHz band

The auctioning of the digital dividend would have instant positive fiscal effects among countries of Southeast Europe. Ten European countries have concluded the auctions to date, namely Denmark, France, Germany, Italy, Portugal, Spain, Sweden, Switzerland, and most recently Romania and Croatia. License fees paid per one megahertz per person vary on a wide scale from EUR 0.23/MHz/person in Croatia to EUR 0.8/MHz/person in Italy, as it is shown on Figure 6. While the per person price of a megahertz is published for most of the countries, we had to exclude license price results of Switzerland and Romania, as these countries opted for a bundled auction where multiple frequencies in the 800/900/1800/2600 MHz were auctioned, making the specific price of the 800 MHz frequencies incomparable.

Figure 6 License fees in the 800 MHz band in eight selected European countries (in order of switch-off dates)

Source: ITU, PwC



The above numbers suggest that the mobile industry considers the 800 MHz band frequencies valuable. However, we need to stress that prices in the auctions are driven by a number of factors, including industry-specific factors which apply to frequency auctioning in general, and also country-specific factors which derive from local regulation and other economic characteristics of the country.

The achievable license fees in the SEE region could differ from the ones experienced in Western Europe. A comprehensive introduction detailing the key factors which drive per MHz per person license prices is presented in the following sections.

Industry-specific factors

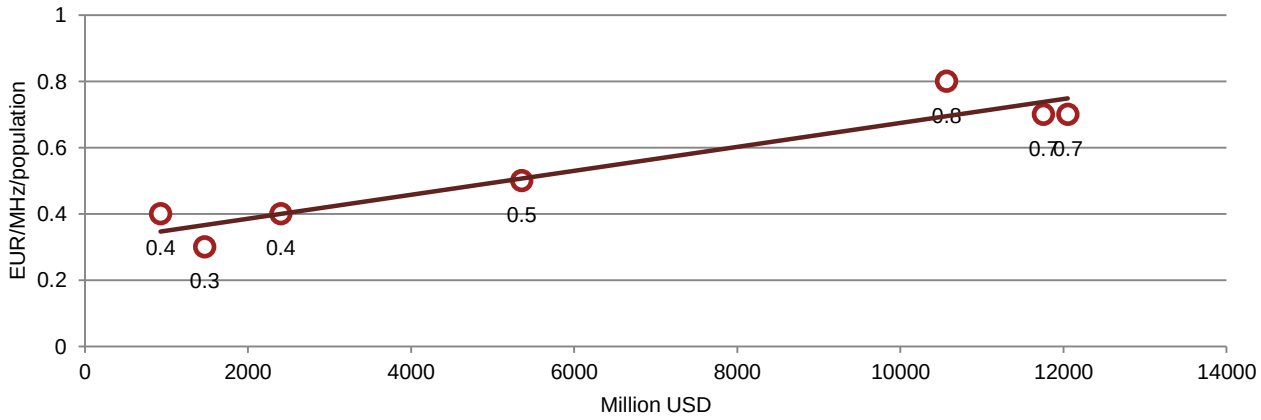
The value of license fees which mobile service providers are willing to pay partially depend on industry-specific factors such as the average revenue per user (ARPU) or the market concentration.[30] Some studies also suggest that a downward trend can be experienced in the market of the 800 MHz band across Europe, as in some countries other-than-800 MHz technology could penetrate the market .[31]

The per megahertz per user value of the DD1 band shows a correlation with the internet access market size of the country in question, according to our findings. This would be counterintuitive, as one would suggest that the per user price should level among countries with the same ARPU value. We understand that any conclusion derived from a limited sample size of only seven countries in Europe can be indicative only. However, this finding suggests that the larger the population of the region which the license is valid for, the larger per megahertz per user price could be expected, as displayed in Figure 7.

[30] Source: PwC
[31] Analysys Mason, 2012

Figure 7 **Internet access (wired and mobile) market size (million USD) and EUR/MHz/person price of the 800 MHz band in selected European countries**[32]

Source: PwC, ITU



The level of competition is another factor which can significantly influence auction results. Recent market consolidation trends in Denmark or Sweden show that mobile network operators increasingly realise the potential in the co-use of frequencies. The joint bidding for frequencies limits competition, and can have a significant effect on the outcome price of the licenses.

Country-specific factors

Numerous country-specific factors can add up significant effects on bidding prices at a frequency auction. Licenses are generally granted for a fixed number of years after which licensees need to renew licenses, which generally comes with the related costs. Therefore regulators can influence bidding outcomes via manipulating the length of licenses.

Regulators can also significantly influence license prices through setting the requirements and obligations which mobile network operators (MNOs) need to fulfil. The German example shows that it is possible to regulate the sequence in which MNOs cover the population. Further coverage ratio obligations and other restrictions can be set by authorities, which could enhance benefits to the country. At the same time regulators need to be aware that these restrictions also get built in the bidding price.

A third significant regulator-specific factor identified is the combination of frequency bands in the licensing procedure. Depending on the current frequency licenses some bands which fit into the frequency strategies of MNOs could be more valuable and generate a larger income to the state. Countries like France or Sweden decided to auction the 800 MHz band in a separate process, Germany or Spain offered frequencies in multiple frequencies in the same auction, while the example of Switzerland shows that authorities have the option to auction bundled frequencies of different bands. There are insufficient examples at this time to identify one best method, though an extensive public consultation with stakeholders could have a positive effect on the outcome of a licensing procedure.

The value of bands including the 800, 900, 1800 MHz and 2.1 and 2.6 GHz bands, depend on the actual frequency utilisation and band usage patterns within a country. The Danish example shows that the price offered for the 800 MHz band could be lower if MNOs already covered most of the country with mobile broadband using other frequencies. However, in other countries the valuation of the 800 MHz band can depend significantly on further country-specific characteristics such as population, infrastructure, topography, or the scarcity of radio frequencies in the 900 MHz band.

Finally, regulators need to be aware of the proximity of any previous frequency auctions. Such auctions usually entail significant investments into frequency licenses which temporarily decrease financial resources of the mobile operators. Also, after a successful auction the immediate demand of operators for additional spectrum will be comparably lower until the newly acquired frequencies again start to fill up. Regulators need to consider both of these factors in order to maximise operators' interest in bidding for spectrum and consequently the amount of state incomes from the auctions.

[32] Croatian figures are not included due to lack of sufficient data

Economic impact of the digital dividend

Broadband makes a significant contribution to economic growth. Several international organisations and national governments expect to increase the output of national economies by allocating the digital dividend to mobile services, especially to mobile broadband. Meanwhile, mobile industry experts suggest that networks can only keep up with growing data traffic if they are supported by access to additional radio frequencies.

Within this study we have estimated the effect of the growing mobile broadband take-up on the performance of national economies. In order to estimate the macroeconomic impacts of allocating DD1 to mobile services, the following assumptions have been made.

- With the emergence of UMTS, 3G, and LTE technologies the mobile industry is able to provide data services comparable to fixed broadband services with regard to services really relevant from the point of view of information society development.
- The ubiquity of mobile services, stemming from its wireless nature, ensures that the positive impact of these services on productivity and growth is at least the same as of fixed services.
- DD1 is necessary for maintaining the current trend of mobile broadband take-up, as it provides spectrum for gearing the capabilities of the mobile network to the ever-increasing subscriber data requirement.
- DD1 has potential for offering broadband connections in rural areas where there had been no broadband coverage before, as fixed or higher frequency mobile broadband network roll-out was uneconomical or the 900 MHz band unavailable for 3G service.

Therefore the allocation of the digital dividend to mobile services would affect the economy, beyond its initial positive impacts of frequency auctioning, through increasing broadband quality and availability.

The following section describes the methodology according to which we estimated the macroeconomic effect of growing mobile broadband take-up. Our country-specific calculations are presented in the respective country reports.

GDP impact of broadband penetration

The importance of broadband in economic productivity and growth triggered a few empirical studies aiming to quantify these impacts.[33] Studies on this topic concluded that household internet access has a positive impact on a country's economic growth. These studies also established an association – mostly through econometrical calculations – between broadband penetration growth and the increase in job creation and productivity by traceable percentage points. Their conclusions are as follows:

- Increasing broadband penetration has a traceable positive effect on both GDP and employment.
- The extent of this macroeconomic effect differs depending on the current broadband penetration of the country.

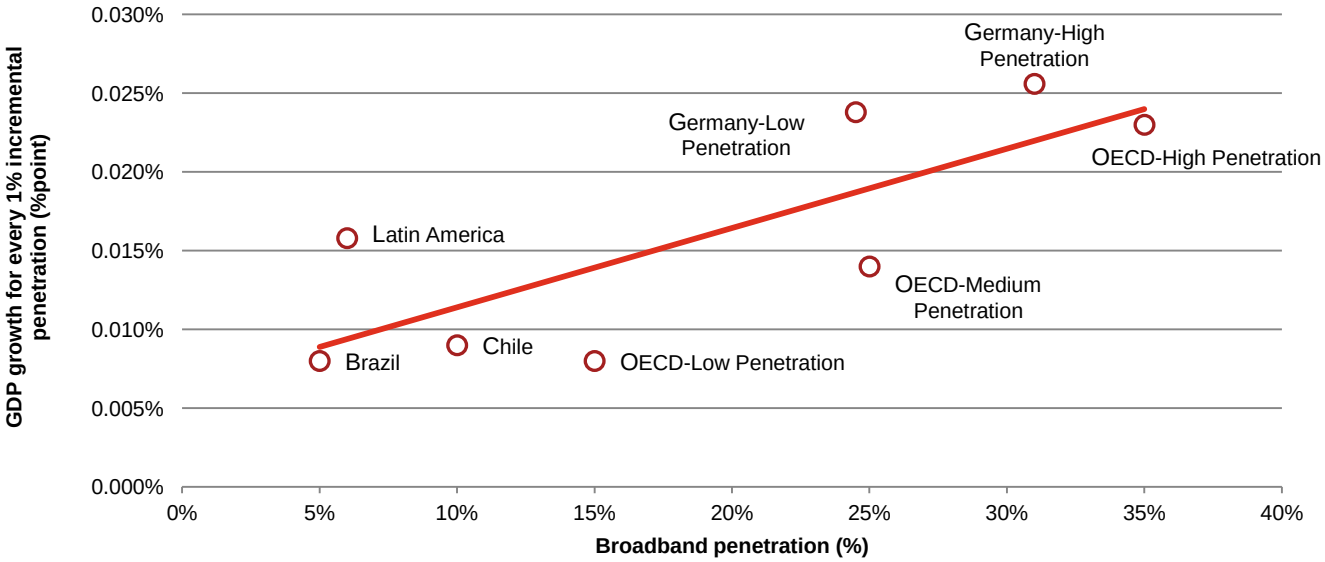
Independent studies conclude that there is a basic relationship between broadband penetration growth and GDP growth. They also suggest that countries with higher initial broadband penetration may expect a higher incremental impact of broadband penetration growth on the GDP than countries with lower initial rates of broadband take-up. That is, the higher the broadband penetration, the more intensive its effect will be on GDP growth.

The results of these researches are plotted in the graph below. Points in the chart represent the empirical relationship between the initial broadband penetration and the consecutive incremental GDP growth for every percentage of broadband penetration growth in different regions of the world. We fitted a trend line on the data points to generate an equation we use to estimate the GDP effects of broadband penetration change at different initial penetration levels.

[33] ITU, 2012

Figure 8 Relationship between broadband penetration and its impact on GDP growth

Sources: ITU, PwC analysis



Based on the trend line we present in the graph, the link between actual broadband penetration and estimated incremental GDP growth in the consecutive year can be described as follows.

$$y_{t+1} = 0.0005x_t + 0.0065$$

This equation, if inputted with the actual broadband penetration (x_t), yields the incremental increase of next year's GDP growth (y_{t+1}). This incremental increase will be higher in countries with higher initial broadband penetration. Using this method we are able to calculate the actual incremental GDP increase by multiplying the results from the equation with the expected broadband penetration growth. To state an example from Figure 8, a 1 per cent increase in Brazil's broadband penetration would result in an increase of 0.008 percentage points in GDP.

Effects on employment

The statistical relationship between employment and the rate of broadband service take-up was also examined in various studies, however, only a few of those found statistically significant results. The coefficient for further calculations in this study was defined according to the econometrical model prepared by Katz et al.[34] They analysed how broadband penetration growth contributed to job creation in German counties with different broadband penetration levels. The research distinguishes between high penetration (around 30% of population) and low penetration (around 20% of population) counties. Our current study uses the result for the low penetration areas, as they show similar characteristics to our focus countries. The research came to the conclusion that employment growth, just like GDP growth, can also be calculated from the previous year's broadband penetration growth using the following equation.

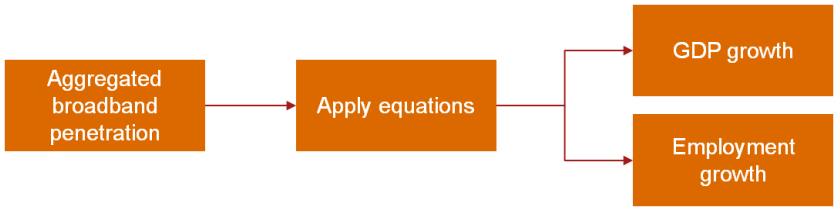
$$y_{t+1} = 0.0027x_t$$

According to this figure, one percentage increase in broadband penetration results in 0.0027 percentage point increase in employment. Multiplied by previous year's broadband penetration growth this coefficient provides the expected employment growth as result. It is assumed that an increase in broadband penetration only has an effect in next year's employment, and the same assumption applies to GDP growth as well.

[34] Katz et al., 2010

Figure 9 Process of macroeconomic parameter calculation

Source: PwC



Effects on productivity

Studies so far have usually not attempted to calculate productivity growth from broadband penetration. However, changes in productivity can be calculated if the GDP and employment estimates are available. Productivity can be expected to increase whenever GDP growth is forecasted to be higher than employment growth, and vice versa. Our calculations show that GDP generally grows faster than employment does as a result of broadband penetration growth, in the SEE region. Therefore we can assume that productivity will also show a positive trend over time. This result also underscores the efficiency-enhancing effect of mobile broadband.

Estimating effective broadband penetration and effect of DD1

We needed to estimate the effective broadband penetration growth – as a result of allocating DD1 for mobile use – to estimate its effects on GDP and employment growth. Effective broadband penetration growth refers to the increase in broadband user numbers, less non-applicable broadband subscriptions.

There are some mobile broadband subscription types which we had to exclude from our estimates to receive the effective broadband penetration. First, we excluded duplicate subscriptions, as any dedicated mobile broadband subscription (activated on USB mobile sticks, laptops or tablets) which is additional to the existing fixed subscription of the same user does not increase effective broadband penetration. Secondly, we excluded confined or secondary subscriptions, as mobile broadband subscriptions which are secondary to voice services on the same device (e.g. mobile broadband access on a smartphone) have different usage patterns and different economic effects.

Therefore we first compiled the fixed and dedicated mobile broadband subscription time series data. Then we estimated the proportion of complementary subscriptions to the total dedicated mobile broadband subscriptions and filtered them out to receive the number of substitute mobile subscriptions. In our estimation we paid attention to generally higher substitute usage in the SEE region that implicates greater importance of mobile broadband service, as compared to that in Western Europe. Finally, we divided the number of broadband subscriptions by the total population to get the final aggregated broadband penetration figure.

Fixed and dedicated mobile broadband penetrations have been forecasted based on available historic data and estimations of future market conditions. Having set up the “organic broadband development scenario”, we made the following assumptions as regards the additional effect of DD1:

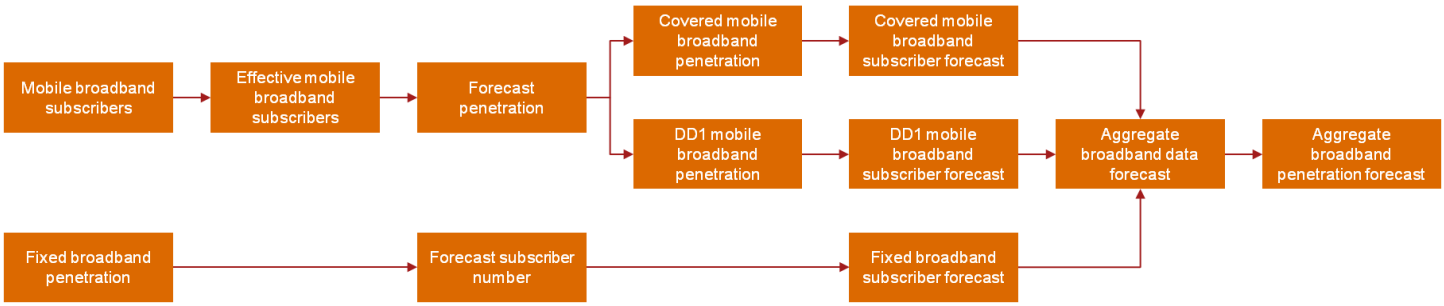
- In the case of territories currently underserved by broadband mobile networks, we assumed network roll-out to be continuous after the allocation of the DD1 band for mobile broadband services. With regards to mobile broadband penetration in these areas, we assumed similar trends to that of the rest of the country, but with a significant delay.
- Our other assumption was that the allocation of the digital dividend will increase broadband penetration by making mobile broadband services accessible to people in such rural territories where incumbent technologies and frequencies made mobile broadband network roll-out uneconomical. By estimating the dedicated mobile service penetration trend in such areas, the incremental effect of allocating the 800 MHz band to broadband services can be calculated.

The effect of the digital dividend can finally be calculated by inputting penetration trends in the macroeconomic model.

Our methodology also has its limitations. In countries where operators have already achieved near full coverage (around 98% of the population) the calculation will show a less significant incremental macroeconomic effect, as in such cases the allocation of the digital dividend has a lesser role in increasing broadband penetration.

Figure 10 Overall process of forecasting the aggregated broadband penetration

Source: PwC



Digital dividend in the SEE region

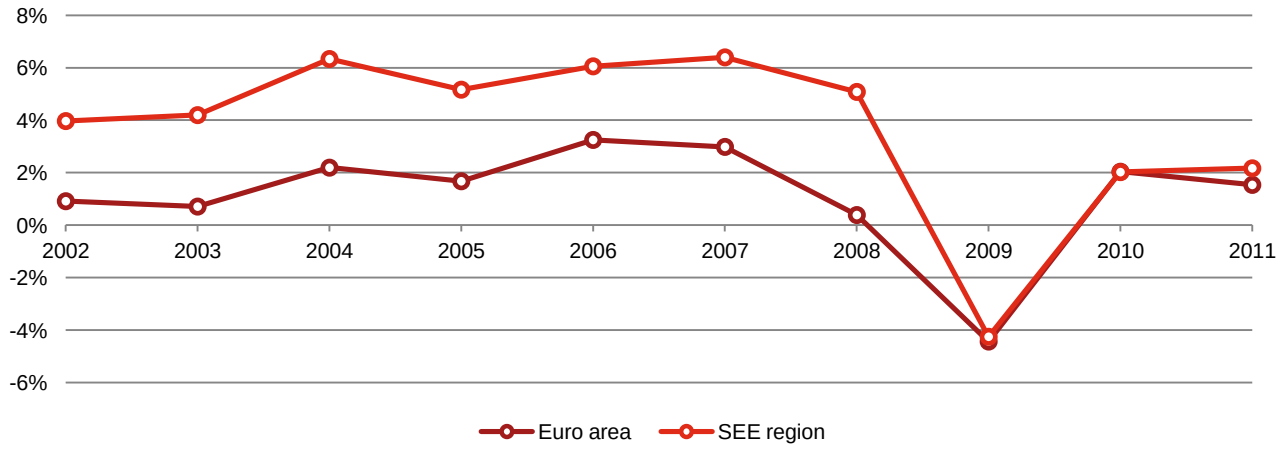
The Southeast European (SEE) region is generally defined to include the Balkan states and some adjacent countries. The SEE region could be defined along political, geographic, cultural, or economic lines. In our study we define the SEE region to include Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Montenegro, Romania, Serbia, Slovenia, and Turkey.

The economic weight of this emerging region has grown significantly in the course of the past decade. The aggregated GDP of the SEE region tripled to reach USD 1,509 billion over the last decade to 2011, thereby returning to the pre-crisis levels of 2008. To put this number in context, the combined GDP of the region is less than half of Germany's gross domestic product. On the brighter side, the region performed a 3.51% CAGR in the period from 2000 to 2011, in contrast with the 1.41% CAGR of the Euro zone in the same period.[35]

The impact of the economic crisis on the region was somewhat delayed compared to the advanced economies, as illustrated in Figure 11. Time to recover from the crisis appears to be longer and lag behind the average of the Euro zone economies, though medium- and long term expectations are generally higher for developing countries.[36]

Figure 11 Average economic growth of the SEE region in the past decade

Sources: IMF, World Bank



The SEE region is a considerable-sized market with a population of nearly 140 million, roughly comparable to the combined population of France and Germany. Still, only around 59% of the Southeast European population is urbanised, which is significantly behind the nearly 80% average of the Euro zone.[37]

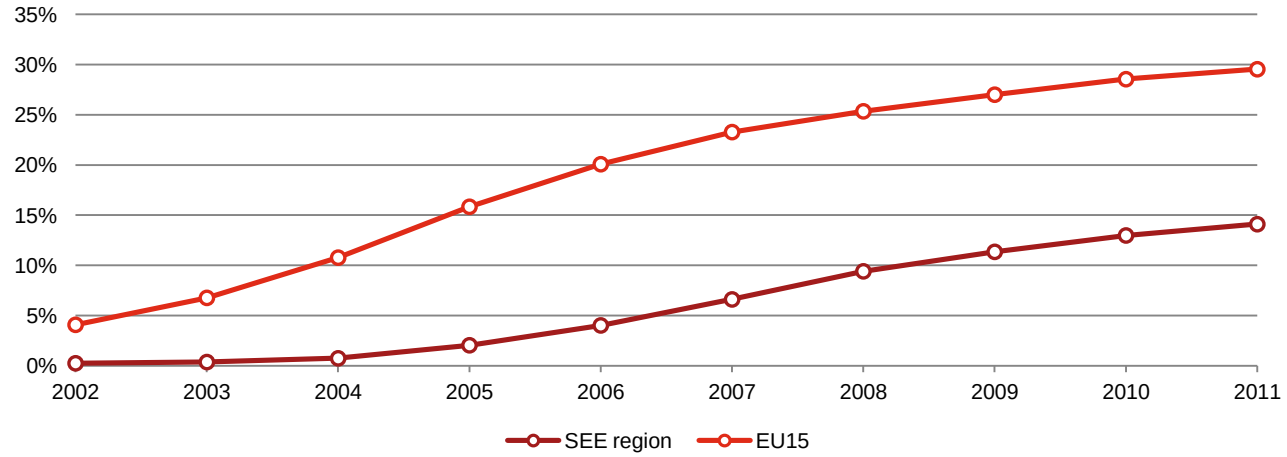
Potential of the digital dividend in Southeast Europe

The digital dividend has a number of benefits to offer in the Southeast European region. The average fixed broadband penetration reached a regional average of around 14% in 2011, less than half of the nearly 30% EU15 average in the same year. In 2006 it appeared that the EU15 countries were given a five-year head start in fixed internet penetration. However, the SEE region could not outperform the penetration expansion experienced in the selected developed countries of the EU. The differences can be attributed to a number of factors including demographic and economic differences, as well as advancements in technology.

[35] World Bank
[36] IMF, World Bank
[37] World Bank

Figure 12 Fixed broadband internet subscribers per 100 inhabitants in Southeast Europe and the EU15

Source: World Bank, Eurostat, PwC estimations



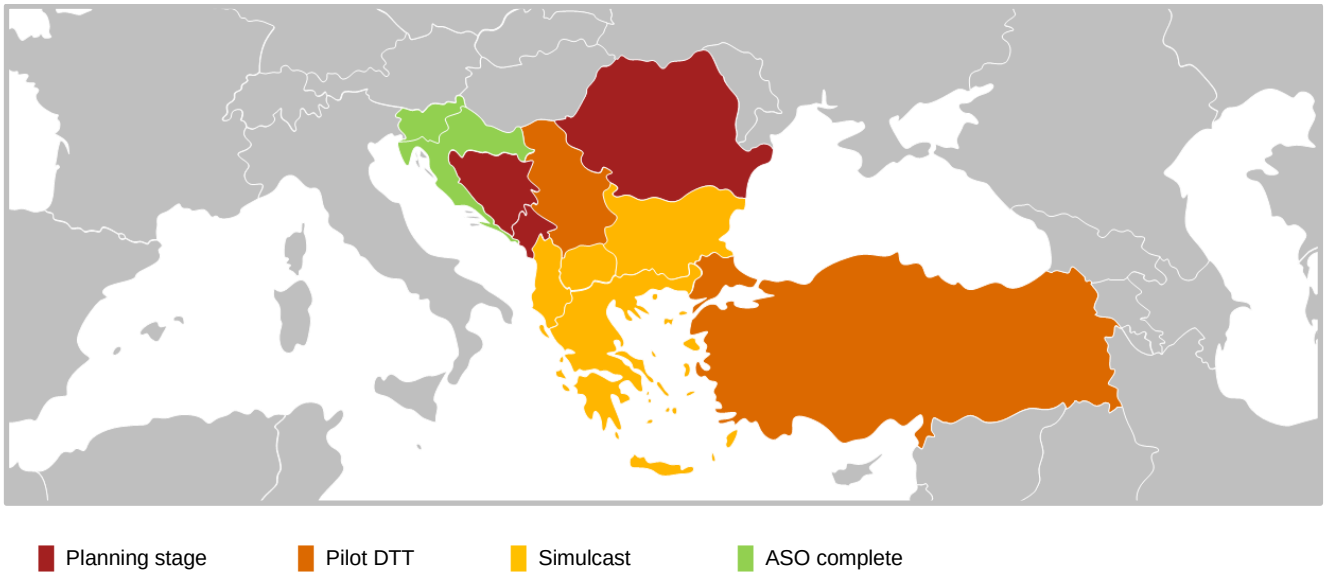
Mobile broadband has got a great potential in the SEE region, as there is comparably lower penetration in the fixed broadband market. Users could therefore jump the fixed platform and move to the mobile platform directly. Mobile broadband could be the platform which would introduce most of the society to the extensive use of online services. Consequently, connecting consumers to various markets through mobile broadband could drive up the economic performance of the entire region.

Digital dividend in Southeast Europe

The digital switchover commenced in all countries of the region, and the current state of the DSO varies widely among Southeast European states. In fact, some SEE countries have already switched off analogue broadcasting while others are still devising their strategy, as is displayed in Figure 13. Nearly all countries have a pilot DTT in operation or currently in the simulcasting phase, though most countries do not have full DTT coverage and network construction is underway. Actual status of countries in the simulcast period is also moving on a wide scale, for instance Greece has already switched off analogue broadcasts in some of its most densely populated areas. The speed of the transition can also be different country by country, as some states introduced pilot broadcasts as early as 2006 but experienced severe delays in implementing consecutive steps.

Figure 13 Current status of the digital switchover in the SEE region

Source: Digi.TV



Most countries in the SEE region are EU member or candidate countries, with only a few exceptions. Most candidate and member states in the region initially aimed to switch off analogue broadcasts before or by the EU

deadline in January 2013 at the latest. However, most member and candidate states revised their switch-off plans as deadlines approached. The delays in implementation can be attributed to a number of legislative, social, and technical factors requiring administrative, coordination, and financial actions. Non-EU member countries generally aimed for the 2015 ITU deadline agreed upon at RRC-06.

Every country in the region introduced their strategic documents serving as a roadmap for their respective digital switchover. Some strategies went well into details on implementation, identified responsible authorities and key milestones and applicable deadlines, some even defined the sanctions and exact sums payable if regulators and public organisations failed to deliver. However, in many cases regulators and authorities failed to implement their tasks for various reasons such as the lack of clearly defined sub-tasks, the lack of financing, or coordination issues.

Figure 14 Assessment of DSO issues in Southeast Europe

Source: PwC analysis

Legislative and Regulatory	Social	Technology	Action required
Adoption and implementation of legislation			**Administrative**
	DSO awareness		**Administrative, Financial**
	STB subsidy program		**Administrative, Financial**
		Cross-border coordination	**Coordination**
		Military interference	**Administrative, Coordination**
		Network construction	**Coordination, Financial**

Public awareness of the DSO is quite low in many countries of the region. The low awareness can be attributed to two factors. One, that information campaigns are planned to be executed only later in the DSO process. Low awareness can also stem from the delays in adopting detailed legislation regarding state subsidy programmes, as consumers wait to invest into new receiving equipment until it is clearly communicated who will be able to apply for state subsidies. In some cases a clear subsidy policy is still missing because some regulators find it challenging to create a platform-neutral subsidy plan, which would be compatible with EU competition law.

State subsidy programs in most of Southeast Europe appear to be a more relevant issue as compared to their Western European peers. All countries have vulnerable households which only receive analogue terrestrial TV broadcasts, and governments in the region, similar to governments all over the world, recognise the need for supporting schemes which would guide vulnerable households through the digital transition. In the SEE region subsidy programmes are faced with critical societal problems of poverty at levels that are more severe than what could be experienced in Western Europe. Furthermore, set-top box subsidy programmes are perceived to put a heavy burden on the state budget.

Budget constraints also delay network construction in some countries where the state is to take part in the task of securing the digital terrestrial network. DTT network construction is generally more advanced in countries where the private sector is involved, while it is generally slower in countries where the state has a larger share in network construction tasks other than coordination.

Some delays also arise when clearing the DD1 band of other uses like military radios within country borders. Clearing and rearranging channels in the UHF band can also be challenging in countries where the UHF frequencies are highly utilised. In many cases the switchover deadlines are delayed due to the common perception that the utilisation of the DD1 band can be blocked by neighbouring countries which do not discontinue analogue broadcasts and other activities in the 800 MHz band. This perception is not entirely baseless, and in such cases governments often decide to wait out the international ITU deadline in 2015 for the ASO, rather than striving for a faster switch-off.

In the following section we introduce selected issues which, we find, delay the utilisation of the digital dividend, and provide suggestions on how to overcome these obstacles.

Regional suggestions and recommendations

Allocating the digital dividend to mobile services would yield economic and social benefits in countries of Southeast Europe. However, a number of risks surround the DSO process in each of the affected countries, including regulatory, technological, financial, political, and cross-border coordination challenges. That is why a co-ordinated public policy action is needed in the region to harvest the potential benefits of the digital dividend. To enhance the effectiveness of these efforts, numerous real-life examples are available, and a wealth of detailed studies have been published to date which provide roadmaps and guidelines towards successful DSO implementation and DD1 utilisation.[38]

All countries in the region have taken the first steps towards benefiting from the digital dividend since they have all initiated their DSO process. The current status of the process ranges from completion of the DSO strategy to setting a concrete deadline for assignment of the 800 MHz band for mobile use. Realising yields from the digital dividend can also be hindered by cross-border interference, as the digital dividend can only realise its full potential in any country once neighbouring countries have also cleared the DD1 band.

We realise that the release of the DD1 band hits hard walls in many of the countries in the region. We believe that the causes of most delays in the region can be traced back to a number of common attributes which most countries from the SEE region share. Such attributes can be: the lack of sufficient frequency spectrum needed to rearrange analogue and digital channels; military activity in the relevant UHF frequencies; cross-border interference issues; etc. In the following sections we will briefly describe the common challenges which were identified, followed by our suggestions and recommendations which outline one way these issues could be successfully mitigated.

We also present suggestions and recommendations concerning issues which do not specifically hinder the DD1 process, but which we believe the countries of the region could benefit from. These suggestions and recommendations could enhance the positive effects of the digital switchover and the utilisation of the digital dividend. As an example, a transparent and reliable DD1 allocation and assignment process would be beneficial in any country, as it would enhance the value of the DD1 band.

Use recent technology standards

The digital switchover and the consecutive utilisation of the digital dividend for mobile broadband services could yield economic and social benefits in the SEE region, according to our calculations. Therefore it is preferable that governments and authorities support the advancement of the digital switchover by creating and adopting a sound regulation.

The digital switchover requires a technology upgrade from analogue to digital terrestrial broadcasting. The transmitter equipment must be replaced with equipment compatible with the new technology, and the consumers also need to be equipped with the necessary technology to receive the signal.

Digital broadcasting technology came a long way in evolving to its current form, hence the various digital standards for signal transmission (DVB-T, DVB-T2) or image encoding (MPEG-2, MPEG-4, H.264, AVC, etc). These standards are too often incompatible with one another, resulting in DVB-T receiving television sets being unable to receive DVB-T2 signals, MPEG-2 set-top boxes being unable to decode MPEG-4 broadcasting, and so on.

Without a regulation it can take a longer trial and error period until the broadcasting market concludes one standard. Network operators would most likely wait with investing in expensive broadcasting equipment until a critical mass of households have the necessary technology. In return, most consumers would not invest in new TV or set-top box devices unless they are assured that they will be able to use it.

Regulation regarding the technology standard to be used for digital television is of high importance, as the markets fail to conclude a standard in a timely manner, which then delays the digital switchover. The commercial viability of digital terrestrial broadcasting depends on a sound regulation.

Therefore, we recommend that the regulators in the region strive to introduce the recent DVB-T2 MPEG-4 standard. We do not advise regulators to choose the older standard, as most countries that introduced digital

[38] See DigiTAG, Digi.TV, ITU, and further EU ECC, CEPT, etc. studies and recommendations

television with an older DVB-T standard are now required to upgrade their outdated technology to the recent DVB-T2 standard.

Doing so, further gains could be realised from a well-articulated preference for the recently developed broadcasting standard. The new standard provides greater transmission capacity, which means that more channels can be transmitted to the user with a more efficient frequency utilisation. TV users could receive a greater variety of TV channels, while the country could clear more frequencies to auction. Meanwhile, countries which opted for the recent technology standard could avoid the situation of many European countries which now must co-finance a second wave of technology swap, predominantly from DVB-T to DVB-T2 and from MPEG-2 to MPEG-4.

Finally, a sound regulation could speed up the DSO process towards releasing the DD1 band to be utilised for higher value-added services such as mobile broadband.

Define set-top box subsidy details early in the process

Digital television broadcasting uses an advanced technology which requires upgrades of both broadcasting and receiving equipment. The technology upgrade necessitates that users purchase a set-top box used to decode the digital signal and transmit it to the TV set, or an integrated (DVB-T/2 ready) TV set. Yet, some vulnerable households are not in a financial or social position that would allow them to make this investment.

Therefore public funding and/or co-financing are often needed to keep these households from being left without access to television after the ASO. Various practices, studies, and recommendations are available which provide guidelines and suggestions to authorities on how to design a set-top box subsidy scheme.[39] Further research should be carried out in order to adjust these solutions to local circumstances in each country.

However, countries should decide early in the DSO process which households should be supported. This could prevent costly and time consuming coordination and negotiation later. Well prepared and accepted eligibility criteria could also limit the cost of such subsidies well ahead of the ASO. The preferred solution is to define eligibility based on well established and objective criteria, as this would prevent unwanted biases in subsidy policy.

International experience provides a wealth of examples for how countries could select which households require some level of subsidy. Certain countries provide financial and/or other support to households that pay: a radio and television (RTV) subscription fee[40]; subsidy for users exempt from paying RTV subscription fee[41]; subsidy for households who receive state support for other utilities[42]; subsidy for households which only receive analogue terrestrial television[43]; etc.

We do encourage countries to specify eligibility comprehensively. Any definition that is too general requires further elaboration. Such definitions as 'households which are socially or economically vulnerable,' in the lack of a clear definition regarding 'economic vulnerability,' provide room for a fair amount of uncertainty and further prolonged debates. In such cases there is a high likelihood that households wait out technology upgrades until it becomes clear if they will or will not be provided financial or other support. This way an unclear definition could easily turn into increasing the burden on the state budget.

Capacity-based multiplex licensing

The digital switchover yields available frequencies in the highly valuable 800 MHz band which can then be used for various services, most prominently mobile broadband (next generation LTE) services. Notably, the DSO achieves this efficiency gain by not decreasing, but enhancing the television experience of consumers. In digital terrestrial television, analogue TV channels are grouped into multiplexes, each of which can shrink up to 8-10 TV channels into the radio signal of one analogue TV channel.[44]

Each multiplex-carrying multiple TV channel requires a frequency channel through which it can be transmitted to the receivers. Most often these channels are given a frequency license by the respective national frequency authority. Two main practices exist for licensing/permitting multiplexes. A multiplex, and in fact any other

[39] Digi.TV, 2011
[40] E.g. Croatian DSO strategy
[41] E.g. Slovenian DSO strategy
[42] E.g. Bulgarian DSO strategy
[43] E.g. Serbian DSO strategy
[44] The exact amount depends on the technology standard in use.

frequency user, can be either awarded specific frequencies (e.g. the right to use frequencies 790-798 MHz specifically), or it can receive the right for the frequency capacity without a specified channel (e.g. the right to use 8 MHz of frequency capacity wherever the authority finds it suitable).

Both license types have their benefits, and regulators are free to choose the one they deem to be better suited for their country. Specific frequency licenses among others have the benefit of assuring the licensee that it will be able to use that frequency as long as the license is pending. This can enhance the value of the frequencies, as the licensee is incentivised to pay more for a greater value. Licenses for frequency capacity among others have the benefit of that the regulator can relocate the frequency user whenever deemed necessary.[45]

Some frequency users necessarily need to be relocated in the DSO process, as the DD1 band eventually needs to be cleared of all uses before it can be assigned to mobile broadband or other uses. This is especially true in countries where frequency capacity is scarce, and the only solution is to place the first digital television multiplexes in the DD1 band for further relocation at a later time. Future rearrangement of the frequencies is expected, as a second digital dividend (DD2) band is currently being evaluated, according to the resolution of the latest World Radiocommunication Conference.

Therefore we recommend that countries in the SEE region consider the capacity based licensing for multiplexes, as this would provide greater flexibility for frequency refarming in the future. Flexibility can be a valuable asset if multiplexes need to be relocated in order to clear the DD1 band to be used for mobile services, as the administrative process would be simplified this way. An ex ante impact assessment of such a decision should focus on the potential positive effects deriving from greater flexibility in frequency planning and the lack of compensation requests for refarming from the side of network operators, and the potential decrease of value of the multiplex licence.

Utilisation of the DD1 frequencies

The utilisation of the digital dividend for broadband services yields additional economic growth according to our calculations and economic modelling. These benefits can be fully realised once the analogue switch-off (ASO) is completed, and the frequencies in the DD1 band (frequencies 790-862 MHz, also referred to as channels 61-69) can be assigned to mobile uses.

However, a number of factors can prolong the DSO/ASO process. Most countries in the region need to find a solution for making sure vulnerable consumer groups are not left behind in the process to digital television, and they also need to tackle the task of relocating military use from the DD1 band and manage cross-border interference with neighbouring countries. Any complication in only one of the mentioned areas can cause a delay in clearing one or more of the channels in the DD1 band. Gains from the digital switchover can be delayed even if just one channel in the DD1 band remains to be used, as many countries in the region plan to allocate and assign the valuable frequencies in the DD1 band only after the complete band has been cleared.

Any delay in the assignment of the DD1 band could cause missed state income and delay additional economic growth related to broadband penetration growth. At the same time it is now evident that most countries in Southeast Europe will not be able to clear the DD1 band and assign it to mobile broadband services by January 2013, based on their current status in the DSO process.

Therefore we suggest that national authorities in Southeast Europe focus on clearing and then auctioning the DD1 band as soon as it is possible. At the same time, we suggest that national authorities hold public consultations with industry players regarding DD1 utilisation schedule. Such public consultations would enhance the value of the frequencies, as regulators could tailor the DD1 assignment process to the needs of mobile broadband market players. This in turn has the potential of increasing frequency license prices.

Scenario analysis for priorities in utilising the digital dividend

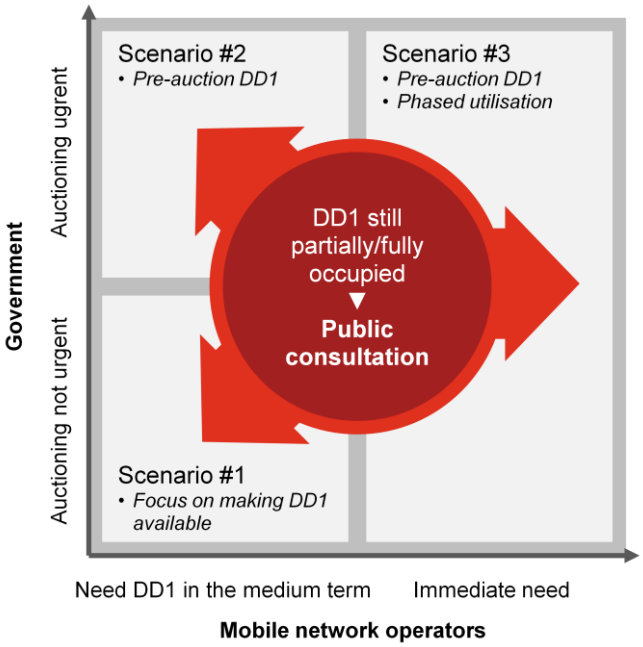
We strongly recommend public consultations to be held to discuss the future utilisation of the digital dividend in countries where the DD1 band has not yet been cleared from its various former uses. Such public consultations would allow affected parties to align their interests, yielding gains to both national governments and the future users of the digital dividend. The consultations could also set out the priorities of the digital switchover and DD1 utilisation processes via exploring the special interests of governments and mobile network operators.

[45] Specifics need to be laid down in the agreement.

In Figure 15 the three basic priority scenarios for DD1 utilisation are illustrated, and a brief description of each scenario is provided following the graph. Scenarios are functions of the interests of the main stakeholders in utilising the digital dividend –mobile network operators and national governments.

Figure 15 Scenario analysis on possible priorities of the DD1 utilisation process based on public consultations

Source: PwC analysis



Each of the scenarios illustrated in Figure 15 are based on the level of interest which prominent stakeholders show in auctioning/utilising the digital dividend. In the following three sections we provide a basic and non-comprehensive description of the scenarios which we identified. We need to stress that further research must be done in order to explore the full effects of each scenario. Our descriptions below stress the necessity of holding industry-wide public consultations.

Scenario #1 – Focus on clearing the DD1 band

Circumstances where mobile network operators only need the 800 MHz frequencies in the medium term (in the course of the upcoming 2-3 years) and auctioning the digital dividend is not urgent for the government mark Scenario #1, or bottom left outcome of the scenario space.

In this case we recommend that countries follow their existing strategies and focus on clearing the DD1 band from its former occupants as scheduled and according to the respective EU and ITU deadlines. Auctioning the digital dividend can be scheduled to after the DD1 band has been completely cleared.

On the upside, this scenario allows mobile network operators to leverage receiving fully utilisable national network licenses. This option could also prevent governments from receiving lower than expected bids in an immediate auction.

Scenario #2 – Immediate income with risks

A limited interest from the mobile network operators' side along with the government's interest in an immediate auction marks Scenario #2, or top left corner in the graph. In this case national authorities could opt for an early auctioning of DD1 frequencies.

On the upside this scenario could generate immediate income to the state. At the same time an early auctioning paired with no immediate need for the DD1 frequencies on the mobile network operator's side bears the risk of a reduced willingness to bid for new frequencies, and uncertainty in the DD1 release schedule could drive bidding prices down.

In case of a frequency auction before the spectrum is cleared, all related processes must be transparent, and reliable guarantees must be provided by the state, strong enough to assure national license holders that the future timeline of the frequency utilisation will be kept.

Scenario #3 – Fast track utilisation

Special need of mobile network operators could render the utilisation of the DD1 band necessary, and drive authorities to auction complete national DD1 frequencies before they are completely cleared from other use. The analogue switch-off and the clearing of the DD1 band are usually done in a phased manner, radio region by radio region. As soon as the DD1 band in one radio region is cleared, mobile services could be provided in the cleared region, when specific technology based circumstances allow. Clearing the DD1 band in the rest of the radio regions could be done in a phased manner, and according to a pre-agreed schedule.

The radio region-based utilisation is viable only if mobile operators confirm the solution, as this approach has such technology related constraints which could block network utilisation. Therefore this method can only be applied if national mobile network operators confirm that the related technology constraints can be mitigated. We believe that in this case it is further required that full national frequency licenses are auctioned which then can be fully utilised according to the pre-agreed schedule; and the state is capable of providing guarantees which are strong enough to ensure bidders that the schedule will be kept.

On the upside, mobile network operators could receive necessary frequencies and could commence network expansion and service provision in regions where the frequency environment allows. This way a region based utilisation has the benefit of facilitating additional GDP growth and productivity increase, as illustrated by our modelling, though to a limited extent only.

In case of a frequency auction before the spectrum is cleared all related processes must be transparent, and reliable guarantees must be provided by the state, strong enough to assure national license holders that the future timeline of the frequency utilisation will be kept. The value of the radio frequency licenses would most likely greatly deteriorate if any uncertainty remained regarding that the state might not be able to free up the scheduled radio regions in time. A better understanding of market needs could then enhance the value of the DD1 for both the state and the mobile service providers.

Country report – Bulgaria

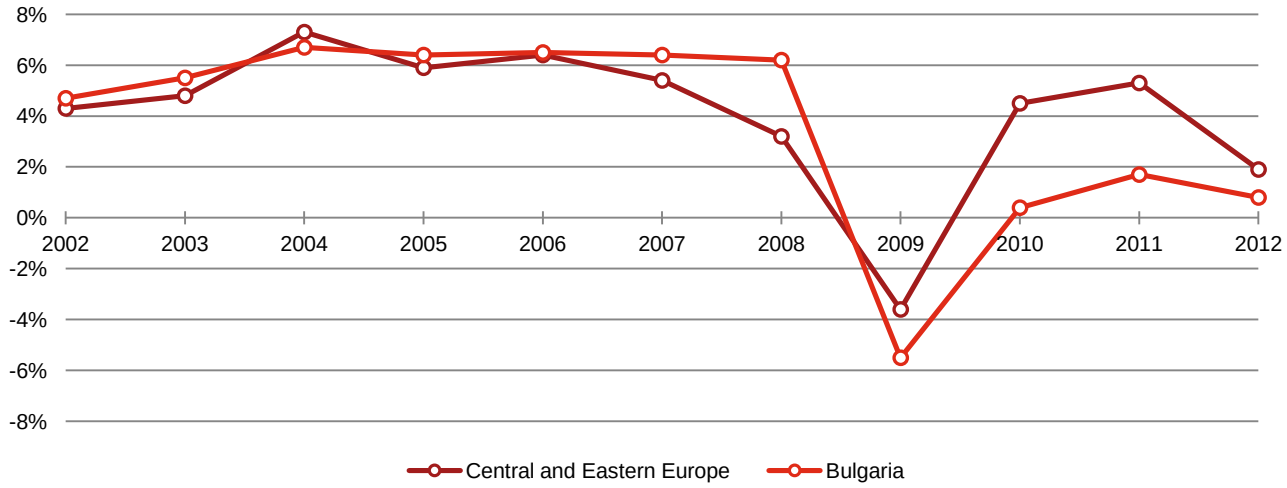
This country report is an integral part of the *Digital dividend in Southeast Europe* study, but it is designed to function as standalone study if necessary. First we introduce the fundamental macro indicators of the Bulgarian economy, followed by a concise overview of the telecommunication sector. We then estimate the macroeconomic impact of allocating the digital dividend for mobile broadband services. We provide insight into the current state of Bulgaria regarding the digital switchover process and the future utilisation of the digital dividend. The country report concludes with recommendations for accelerating the DSO process and for the future utilisation of the digital dividend.

Country overview

Bulgaria was an agricultural economy under the former Communist regime, but since the early 1990s, the country has undergone a major transition to become an industrialized free market economy. Bulgaria joined the EU in 2007, averaged over 6% annual GDP growth from 2004 to 2008 (paired with high inflation) and now is among the upper middle-income economies with a gross net income per capita of USD 7,158 as of 2011. Real GDP growth figures of Bulgaria is comparable with the growth in the CEE region, showing a decline in 2008, but recovering fast in the last three years.

Figure 16 Historical real GDP growth in Bulgaria and in the CEE region (%)

Source: IMF



The government implemented strict fiscal policies, thereby reducing its public debt from over 70% to 16.3% in just a decade by 2010, reaching one of the lowest debt levels in the EU. However, the country could not avert the economic crisis. Annual GDP growth reached a negative 5.50% in 2008, and after foreign direct investment peaked in 2007 at almost USD 13 billion, FDI declined significantly to only USD 1.4 billion as investors were discouraged after the crisis hit the region.

The strict fiscal discipline proved to be a crucial feat in the current economic situation. The Bulgarian economy quickly began its journey to recovery and continued to grow – albeit at a much slower pace than in the 2000s. The unemployment rate declined y-o-y from the early 2000s up until 2008-2009, when unemployment started to grow again. The Bulgarian population (7.36 million) is predominantly urbanised, with more than 70% living in the main administrative centres.

DD1 potential of Bulgaria

The ultimate goal of the transition to spectrally more efficient digital broadcasting is to gain frequencies for various further usages for the benefit of the public. The following dataset describing the telecommunications sector in Bulgaria paints a clear picture of a growing industry with great potential for the Bulgarian economy to benefit from the release of the digital dividend.

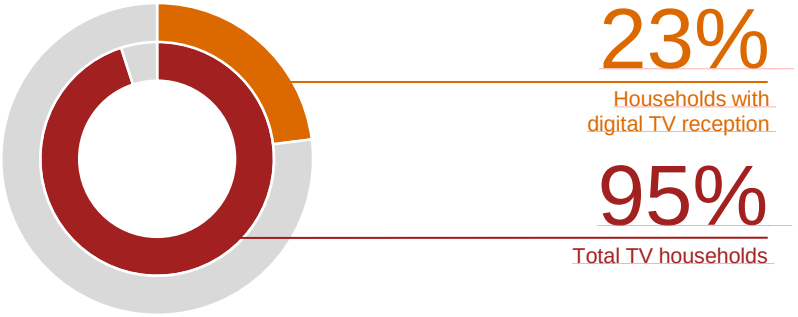
Broadcasting market in Bulgaria

Television is one of the main sources of information for the Bulgarian population with almost 95% television penetration as of 2009. 55% of the total advertising budget was spent on television advertisements in 2009, underscoring the significance of the television market in Bulgaria.

TV programming is accessible through a variety of broadcasting platforms including terrestrial TV, cable TV, satellite TV and broadband TV (IPTV). Digital TV penetration was 23% as of 2009, mainly consisting of digital satellite subscriptions coupled with a significantly smaller proportion of IPTV and DTT households. Data regarding the number of households with DTT receivers is unavailable, calling for instant monitoring of the situation in light of the upcoming digital transition.

Figure 17 Television penetration in Bulgaria (2009)

Source: MAVISE



There are three permits for broadcasting of analogue terrestrial television programs with nationwide coverage and 118 permits for broadcasting of analogue terrestrial television programs with regional and local coverage as of the end of 2011. The three operators with nationwide coverage are Bulgarian National Television (BNT), Btv Media Group EAD and Nova Broadcasting Group EAD. The achieved coverage of the networks is 98% for BNT, 97.7% for Btv and 94% for Nova.[46]

Broadcast transmission infrastructure is provided by National Unit Radio and TV Systems (NURTS) which operates a network of 800 sites providing nearly 100% geographical coverage. In early 2010 BTC (traded as Vivacom), the former Bulgarian fixed line monopoly sold a 50% stake in NURTS to Mancelord Limited. In 2012 BTC announced in a note on the website of the local stock exchange that it had signed an agreement to sell the remaining 50% stake in its radio and television broadcasting unit NURTS to Bluesat Partners Ltd.

The pay-TV landscape experienced a 9% decrease in the overall number of subscribers from 2010 to 2011. Cable TV has lost 328,000 subscribers (27%), but the data suggest that the CATV subscribers are likely to switch to satellite or IPTV services as satellite TV users have increased by 35%, while the number of IPTV users showed the highest percentage increase – 265% in just one year. This shows that despite the currently low DTT penetration, consumers are interested in the rollout of new technologies, indicating the potential that lies ahead for the Bulgarian telecom sector.

Bulgaria's broadcasting law has allowed foreign legal entities to apply directly for broadcasting licences since early 2007, following significant amendments made to the law originally adopted in 1996 in order to comply with EU directives.

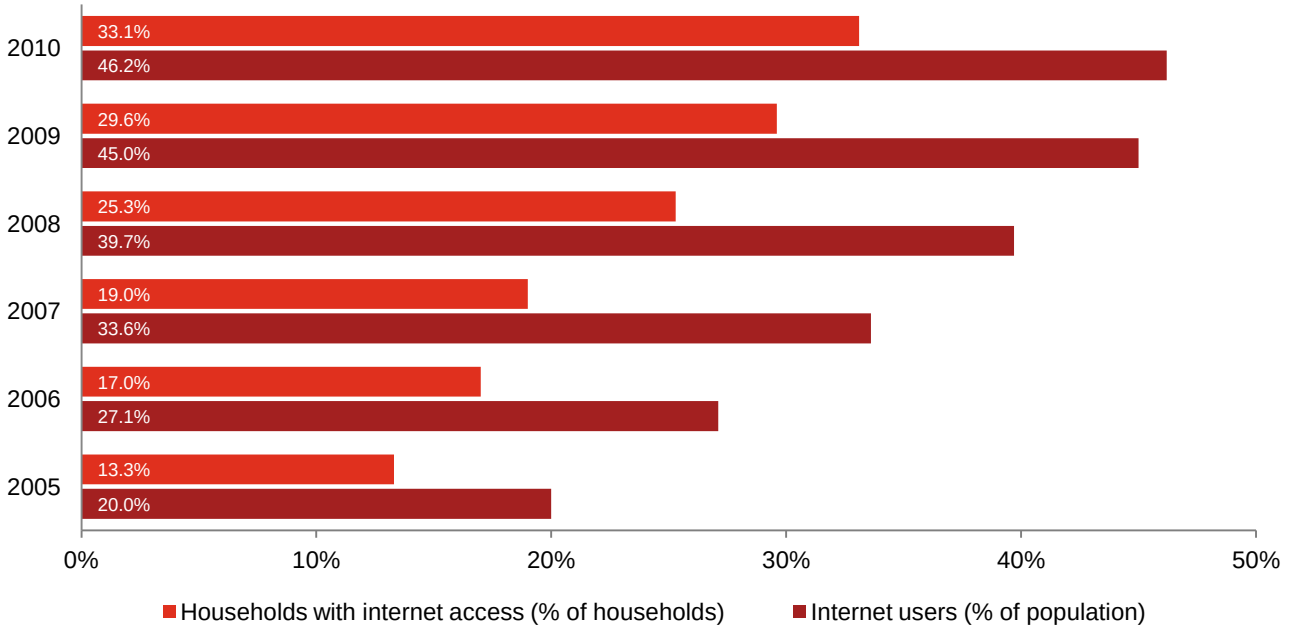
Bulgaria's internet statistics

The rate of internet penetration – along with PC penetration – shows continuous growth in Bulgaria. According to the EC[47], Bulgaria's broadband penetration is the second lowest in the EU, mostly due to the divide between urban areas with cable connections and the uncovered rural areas. The number of households with modem or ISDN stagnated, but the broadband penetration has risen significantly over recent years.[48] Data shown in Figure 18 underscores the assumption that, despite the currently low penetration, a further rise in broadband internet penetration can be anticipated in the near future.

[46] CRC
[47] EC, 2012
[48] Eurostat

Figure 18 Internet penetration in Bulgaria

Source: ITU, 2011

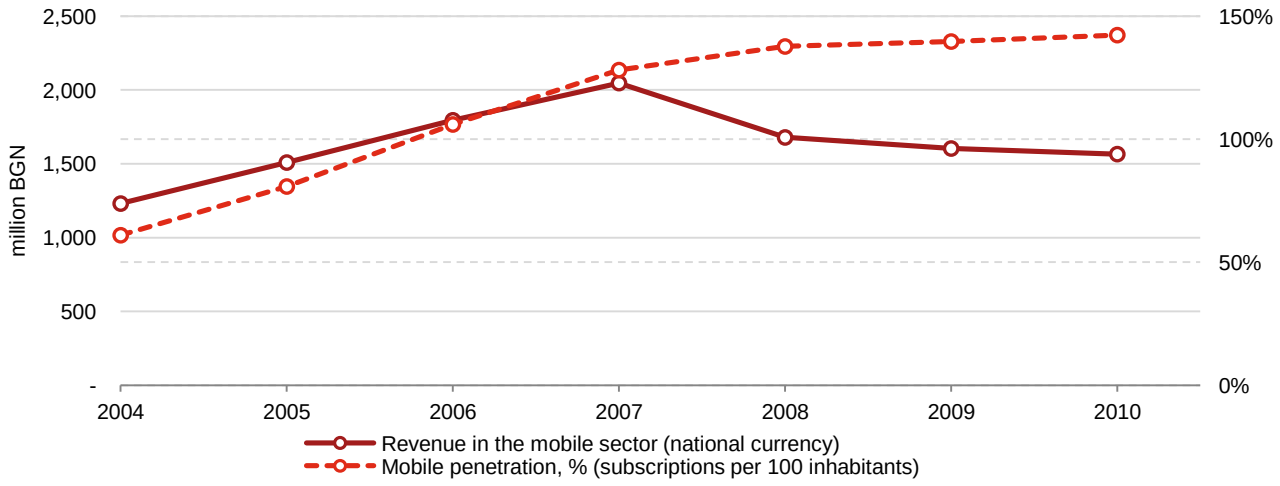


The mobile industry in Bulgaria

The Bulgarian mobile sector is experiencing declining revenues, rising mobile subscriptions and a booming 3G market segment, while the ARPU continues on a downtrend – from BGN 17.61 market average in 2009 to BGN 13.72 in just two years. The declining revenues of the key market players can be attributed to the competition in the voice and data segments, and the EU enforced cuts to mobile termination rates.[49]

Figure 19 Mobile penetration and revenues in the mobile industry in Bulgaria

Sources: BMI, ITU



Mobile penetration in Bulgaria had already surpassed 100% by 2006, and in five years the penetration reached 157.3% in 2011. The substantial growth in the mobile sector is mainly attributed to the "pick-up in Bulgaria's economy in 2011 [...] and a strong focus on subscriber acquisition by the operators".[50]

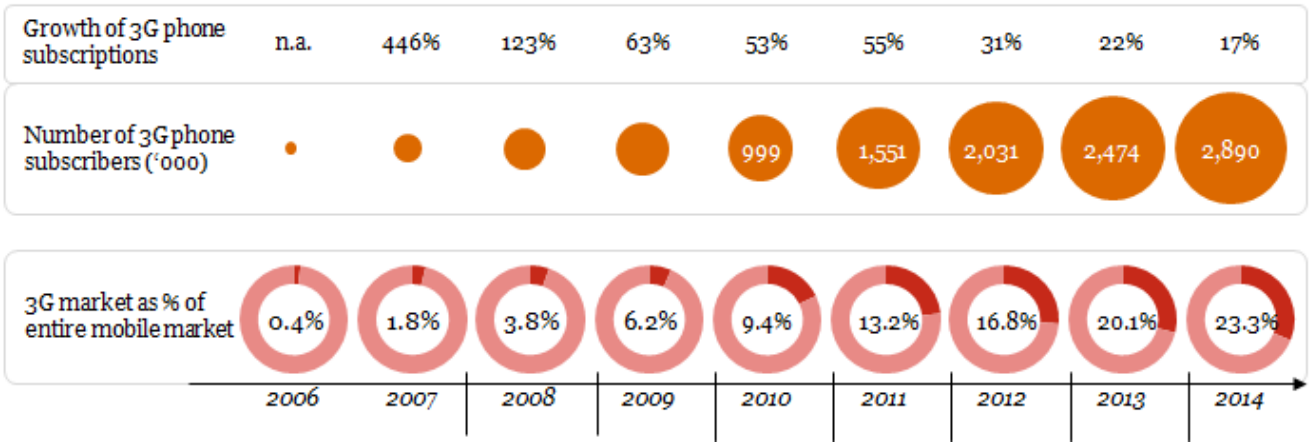
[49] Market leaders are more significantly affected by cuts to mobile termination rates as a greater number of calls are terminated on their networks.
[50] ISI

Mobile broadband penetration also shows growth, but still lags behind the EU average. According to the EC report[51], Bulgaria's mobile broadband penetration was 14.4% in January 2012, while the EU average surpassed 43%.

The trend for 3G phone subscriptions is rising: from only 33,000 subscribers in the early years of 3G (2006), the number of subscribers equipped with 3G phones is expected to reach almost 40% of the total population by 2014. From 2006 to 2011, the market averaged a 148% CAGR.

Figure 20 Mobile internet services in Bulgaria

Source: BMI, 2012



Despite the declining revenues and ARPU and the relatively low mobile broadband penetration, its year-on-year growth in both 3G mobile subscriptions and mobile internet services shows the Bulgarian telecommunications sector's great potential.

[51] EC, 2012

The value of the digital dividend for Bulgaria

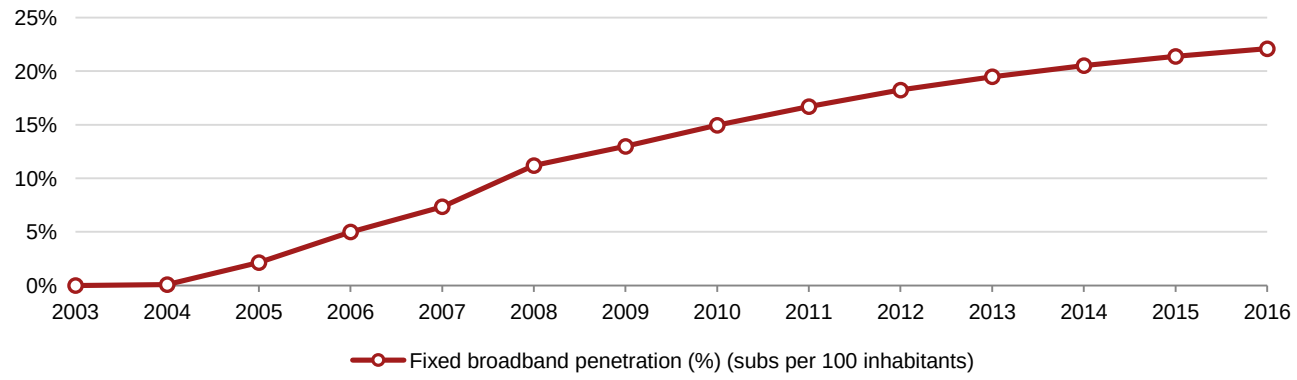
International studies show that households' growing internet access in a specific country has positive impacts on economic growth.[52] They also established an association – mostly through econometrical calculations – between broadband penetration growth and increase in job creation and productivity by traceable percentage points. Through the emergence of UMTS networks, the mobile industry is able to provide data services to subscribers that increase the accessibility of broadband services in the economy. The ubiquity of mobile services, stemming from its wireless nature, ensures that these services will have significant impact on internet penetration. In this section we describe the Bulgarian broadband market and analyse the economic impact of different access technologies among them 3G mobile service. We assume that the allocation of the digital dividend involves an increase in broadband penetration, and following this hypothesis, we calculate a forecasted growth in GDP, employment and productivity.

In 2011 fixed broadband penetration was around 16.7% in Bulgaria. Although mobile operators report very strong growth in broadband subscriptions, the majority of internet access services are still provided by fixed operators. DSL-based lines represent around one third of all fixed broadband connections. As the incumbent operator is upgrading its access network to accommodate higher bit rate services, we expect growth in this segment. With market share over 40% in the fixed market, LAN and CATV network-based connections are also in a strong position. The transition of cable networks to EuroDOCSIS 3.0 standard will give further stimulus to increasing the number of subscriptions in this segment. The most advanced fibre optic-based access technologies gained a 20% share by the end of 2011. We expect a gradually slowing growth of fixed broadband penetration despite the intensifying competition that is due to the advance in technologies and the existence of several platforms.

Competition is intensifying due to the advance in technology and the existence of several platforms, however, we expect the growth of fixed broadband gradually slowing.

Figure 21 Fixed broadband subscriptions per 100 inhabitants in Bulgaria (%)

Source: PwC

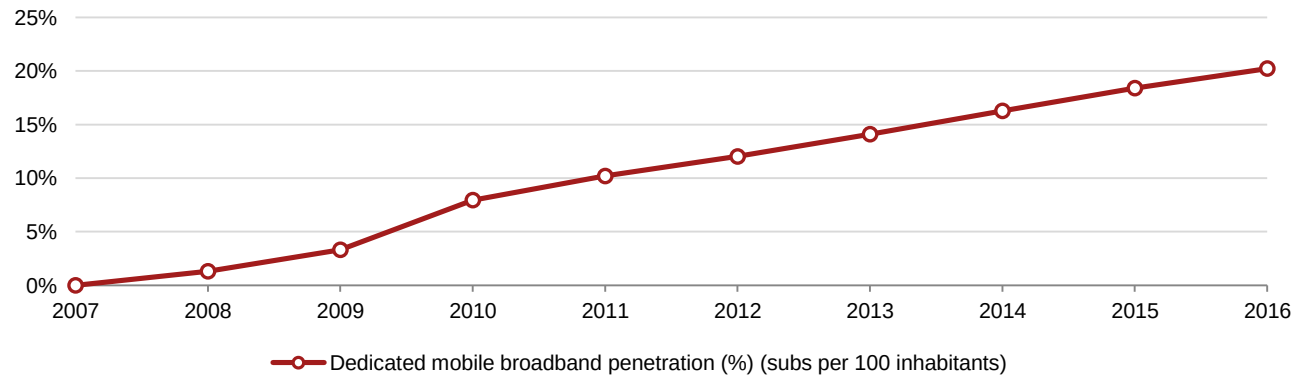


The share of mobile broadband services has experienced rapid growth in recent years. The relatively low fixed broadband penetration of Bulgaria is expected to generate a significant increase in dedicated mobile data service, especially in rural areas. The growth of dedicated mobile broadband is also fuelled by the rapid spread of internet enabled devices such as notebooks or tablets. As the penetration of mobile broadband service in Bulgaria is significantly lower than the EU average, we estimate rapid growth in this segment.

[52] ITU, 2012

Figure 22 Dedicated mobile broadband subscriptions per 100 inhabitants in Bulgaria (%)

Source: PwC



In order to calculate the effect of increasing mobile data subscriptions on the economy, we estimated the percentage of those subscriptions that would actually give rise to household penetration. A majority of new mobile broadband subscription activations is connected to SIM cards placed in smart phones and used by subscribers who also have internet access from a computer. Also, many subscriptions are bought in order to achieve mobility while also having a supplementary fixed broadband service. We consider that those subscriptions which act as a substitute for fixed service will increase the actual household penetration. We estimate that 50% percent of the mobile broadband services activated would increase the household penetration of broadband internet services.

Table 23 Broadband penetration in Bulgaria, 2010-2016

Source: PwC

	2010	2011	2012	2013	2014	2015	2016
Penetration	22.9%	26.9%	30.3%	33.6%	36.8%	39.8%	42.3%
Penetration without mobile	15%	16.7%	18.2%	19.5%	20.5%	21.4%	22.1%

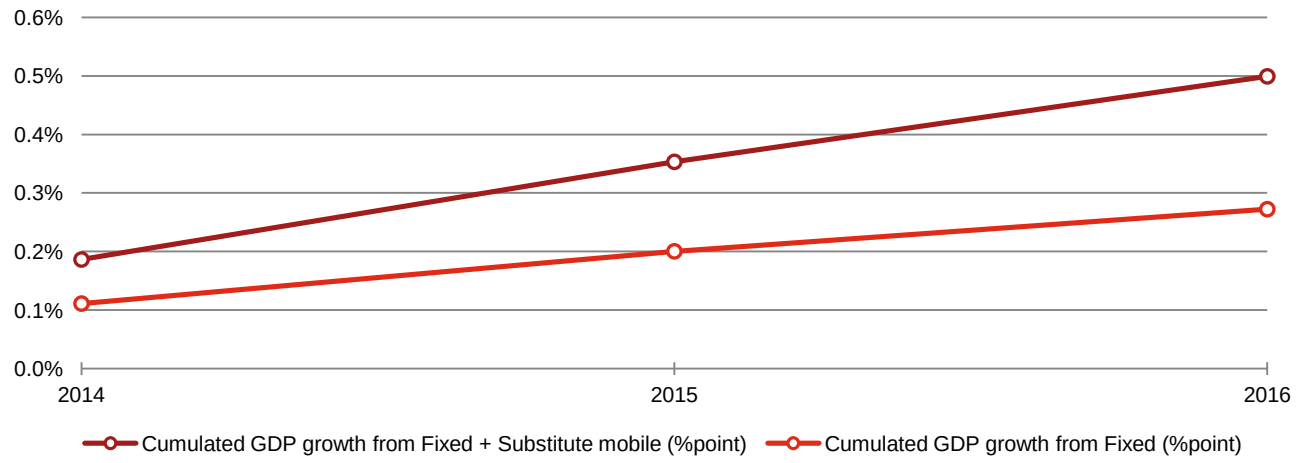
The allocation of the digital dividend to mobile services would have its effect on the economy through increasing the broadband mobile network's coverage and the quality of the data services in terms of speed and reliability. Bulgarian Telecommunications Company AD reports through its website that coverage of its 3G network achieved 98.5% of the population. The other two incumbent operators, Cosmo Bulgaria Mobile EAD and Mobiltel EAD have not published such figures, but their 3G coverage maps suggest that at least one of them has reached a similar level.

In our macroeconomic model, we calculated and forecasted the impact of the broadband effect on the growth of GDP, employment and productivity. Our original hypothesis stated that the allocation of the digital dividend will affect the growth of household broadband penetration by making the service accessible in rural areas where higher frequencies made the network roll-out uneconomical. As mobile broadband coverage is already around 100% in the country, we cannot assume that the allocation of the digital dividend could significantly affect broadband penetration growth in any region. However, one must note that the allocation of the 800 MHz band is also necessary for maintaining the current trend of mobile broadband take-up, as it provides spectrum for gearing the capabilities of the mobile network to the ever-increasing subscriber data rate requirement.

The following chart demonstrates how the current broadband penetration trend is estimated to impact GDP growth up until 2016.

Figure 24 Cumulated GDP effect of broadband access services (percentage points)

Source: PwC



According to the international analysis referred to earlier, broadband penetration also has a positive effect on the employment and productivity of the economy in question. This effect derives from the characteristics of Bulgarian market conditions, and our estimations are presented in Figure 25.

Figure 25 Cumulated employment effect of broadband access services (percentage points)

Source: PwC

The digital dividend in Bulgaria

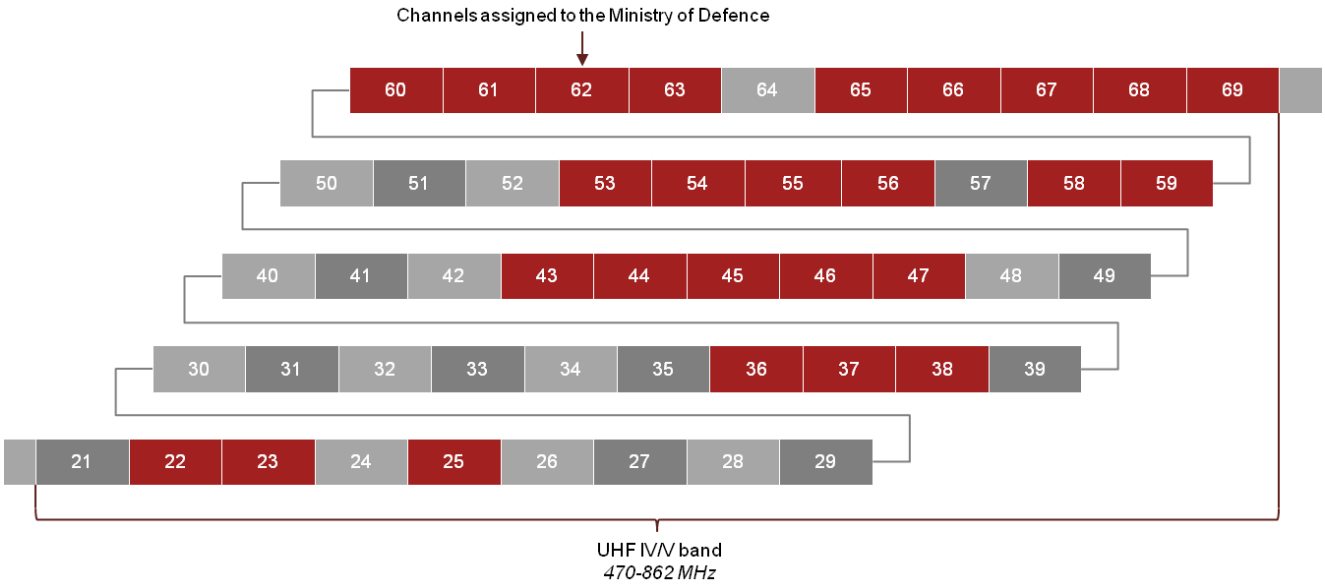
Bulgaria's DSO strategy

The first digital switchover plan was published in 2008 as Decision 24/5 of the Council of Ministers, setting specific steps to be undertaken for the digital transition.[53] The plan included a frequency plan adhering to the RRC-06 guidelines, the date of analogue switch-off and the deadlines for relocating the frequencies used by the Ministry of Defence.

As per the Geneva 2006 agreement Bulgaria received frequency rights for the creation of 10 national, 31 regional and 26 local networks. However, the Ministry of Defence is using a total of 26 channels in the IV and V UHF spectrum from the available 49 channels.[54] This creates a major obstacle for the switchover process as the frequencies to be assigned to digital terrestrial broadcasting should be made available in the III, IV and V bands. While the strategy ordered the licensing of the national, regional and local multiplexes (MUXs), it was made dependent on the ASO and on the Ministry of Defence vacating the currently used frequencies.

Figure 26 Frequencies occupied by the Ministry of Defence in the UHF IV/V band

Source: PwC



Due to the limited digital capacity available, the DSO strategy envisioned the construction of 12 Single-Frequency Networks (SFN), which would allow more efficient utilisation of the spectrum. The combination of the 12 SFNs results in 1 Multi-Frequency Network (MFN). The multiplex operators have the option to broadcast via the 12 SFNs or via the MFN.

The 2008 DSO plan was amended as of 13 July 2012 by Decision 604 of the Council of Ministers as it became evident that the deadline for ASO (December 2012) will not be met. The reason behind the postponement was partly financial: the Ministry of Finance was unable to provide the necessary funding for the relocation of frequencies currently used by the Ministry of Defence, thus creating a major obstacle for the digital switchover process as the Communication Regulation Commission was not able to provide frequencies for the envisioned regional and local MUXs. As a consequence, digital capacity of Bulgaria has been limited to seven nationwide networks, and there is no capacity for regional and local broadcasting of digital terrestrial television channels.[55]

Besides defining a new timetable for the digital switchover process, the 2012 strategy also regulates the following aspects of the transition:

- Simulcast period
- Organisation responsible for managing the DSO process

[53] CRC, 2008
[54] Namely channels 22, 23, 25, 36-38, 43-47, 53-56, 58-63, and 65-69.
[55] According to the Head of Department of Spectrum Regulation and Coordination / Authorization and Frequency Planning Directorate

- Technical details of digital transmission
- Subsidising of consumer set-top boxes
- Information campaign

Key public organisations responsible for the DSO in Bulgaria

The key government organisations responsible for the DSO process are also defined in the 2012 DSO plan. According to the plan, a working group should be formed for managing the switchover process. The working group would include representatives of the Communications Regulation Commission (CRC), the Council on Electronic Media (CEM), the Commission on Protection of Competition, public broadcasters Bulgarian National Television and Bulgarian National Radio, content providers and companies holding broadcasting licences, as well as six ministries – transport and communications, finance, defence, interior, labour and social policy, culture.[56]

The working group will be established under the supervision of the Council of Ministers. The Council of Ministers will determine the composition, timing and manner of work, decision-making powers of the working group and its tasks. The working group representatives will meet once per month and will report on the progress of the implementation of the 2012 DSO plan to the Council of Ministers. The Group will discuss and take a position regarding any questions and issues identified in the digitalisation process, and will take necessary measures to overcome them.

As of this writing, the group has not been formed. Also, the Council of Ministers has not determined the responsibilities of each of the members of the working group.

Timeframe and modularity of the DSO in Bulgaria

The planned phases of the DSO process were also amended by the 2012 DSO plan. The amendments extended the deadlines and removed the initially planned regional networks. The new deadlines have been defined as described below.

Phase 1

- *Implementation of two networks for broadcasting commercial TV channels with nationwide coverage*
    - 95% coverage to be achieved by 1 March 2013 (beginning of the simulcast period) for MUX1
    - 85% coverage to be achieved by 1 September 2013 (end of the simulcast period) for MUX2
- *Implementation of one network for broadcasting public TV channels with nationwide coverage*
    - 95% coverage to be achieved by 1 March 2013 (beginning of the simulcast period)

The conditions for the start of the second phase of the DSO process are the successful completion of phase 1, the release of the spectrum currently used for analogue terrestrial television broadcasting and vacating the channels currently used by the military.

Phase 2

- *Implementation of three networks for broadcasting commercial TV channels with nationwide coverage*
    - 65% coverage to be achieved in nine months following the release
    - 85% coverage to be achieved in 18 months following the release
- *Implementation of one network for broadcasting commercial TV channels with nationwide coverage (tender not announced yet):*
    - Up to nine months from the date of entitlement for the use of the assigned spectrum – provide coverage of 65% of the population of Bulgaria.
    - Up to 18 months from the date of entitlement for the use of the assigned spectrum – provide coverage of 85% of the population of Bulgaria.

[56] CRC, 2012

No exact date has been determined yet for Phase 2, mainly due to the lack of financial resources needed for the release of the currently used spectrum by the Ministry of Defence.

The simulcast period is set to begin on 1 March 2013 and to end on 1 September 2013, when the analogue broadcasting will be switched off in all "digital islands". The 2012 DSO plan stipulates that the simulcast period could not be shorter than 3 months and could not be longer than 6 months. The switch-off will be executed simultaneously countrywide in less than 45 days. The comparably short timeframe of the planned simulcast period is due to limited spectrum availability. The MUXs of phase 1 (MUX1 and MUX2 of NURTS Digital EAD and MUX3 of Hanu Pro Bulgaria) will be broadcasted during the simulcast period.

Technical details of digital transmission in Bulgaria

The technical configuration described in the 2012 DSO plan has been approved by the multiplex operators. The preferred broadcasting technology therefore is the international DVB-T standard with MPEG-4 compression method for the digital broadcast. This way, one multiplex will be able to carry up to a maximum of 8 SD channels, limited by the maximum data transmission capacity of the DVB-T standard.

In accordance with the strategy, the licensed multiplex operators are responsible for the development and construction of the networks that they would also operate.

Business model and state financing

The state subsidy for set-top boxes and an information campaign was approved by the Council of Ministers in early 2012. The total state STB financing budget for 2013 amounts to approximately EUR 9 million (17.5 million lev). The Council has issued an ordinance in the matter to the Minister of Finance to transfer the sum to the Ministry of Transportation, Information Technology, and Communications.

The criteria for persons to be eligible to receive free set-top boxes are defined by Ordinance RD-07-5 of 2008, in the *Terms and Conditions for the Award of Heat Assistance* section. The Agency for Social Assistance will supply the Ministry of Transportation, Information Technology and Communication and the working group with updated lists of those citizens who are eligible for state-subsidies as per the 2012 DSO plan. 96% of the costs will be borne by the government, whereas the remaining 4% of the cost of the receiver will be paid by the network operators.

Bulgaria's DVB-T Plan estimates that around 10-11% of households in Bulgaria will require a set-top box subsidy.

Information campaign

The DVB-T 2012 plan acknowledges that conducting a large-scale information campaign is a key factor for the successful implementation of the digital switchover. The plan regarding the information campaign aims to unite the efforts of all the participants in the transition: governmental bodies, public and commercial media, multiplex operators, and the producers and distributors of digital television equipments. The plan outlines four steps for providing an effective and comprehensive information campaign to the public. The plan includes:

- creating and distributing electronic material highlighting the benefits of DVB-T,
- creating and distributing informational materials (preparation for change),
- developing a website dedicated to DSO and promoting the digital transition through social websites, and
- signing a Memorandum between the government and the retailers of digital television equipment.

By providing plain and easily accessible information, Bulgarians would be aware of how they can receive terrestrial digital television, what the advantages are of DTT in comparison to the analogue terrestrial TV, what the ways of receiving television signals (terrestrial, satellite, cable, mobile access, etc..) are and what the deadline for the analogue broadcasting switch-off is.

The information campaign has not yet started, and there is no exact date or strict plan for its initiation. A conference organised by the Ministry of Transport, Information Technologies and Communications will be held on 3 October 2012, at which all the institutions interested in the project will participate. The plan for the digital switchover, including the information campaign, is expected to be revealed by the Minister of the Ministry of Transport, Information Technologies and Communications. The conference is organised under the auspices of the President of Bulgaria.

Realisation of the DSO strategy in Bulgaria

The digital switchover process was hampered by both financial constraints and the lack of sufficient digital capacity, leading to a delayed process in which the original ASO deadline set for December 2012 could not be met. However, Bulgaria made headway in other aspects of the DSO process by auctioning the MUXs.

In pursuance of legal obligations and in accordance with legal provisions as described in the DVB-T Plan, three competitive contest procedures were organized, conducted and completed during 2009 and 2010. Three licences for the use of a spectrum of six networks (multiplexes) with nationwide coverage were issued as follows:

- Two licenses were granted to the MUX operator Towercom Bulgaria EAD for the broadcast of commercial television channels under Phase 1 of the 2012 DSO plan. The license was transferred to NURTS Digital EAD later in 2010.
- One license was granted to the multiplex operator Hannu Pro Bulgaria EAD for the broadcast of public television channels under Phase 1 of the DVB-T plan.
- Three licenses were granted to the MUX operator Hannu Pro Bulgaria EAD for the broadcast of commercial television channels under Phase 2 of the DVB-T plan (the right to commence service in the spectrum will be granted following the release of frequencies currently being used either for analogue broadcasts or for military purposes). The license of Hannu Pro Bulgaria EAD was transferred to HD Media Services in 2012.

A tender for the seventh MUX for broadcasting commercial television channels is scheduled to late 2012. A summary of MUX operators is presented in the table below.

Figure 27 MUX operators in Bulgaria

Source: PwC

#	MUX Operator	Type	Phase
1	NURTS Digital EAD	Commercial	1
2	NURTS Digital EAD	Commercial	1
3	Hannu Pro Bulgaria EAD	Public	1
4	HD Media Services EAD	Commercial	2
5	HD Media Services EAD	Commercial	2
6	HD Media Services EAD	Commercial	2
7	To be determined	Commercial	2

A tender procedure for two licences to develop and operate commercial digital television networks (multiplexes) was organised in 2009.[57] The tenders were organized by the Communication Regulation Commission (CRC). CRC launched the procedures in accordance with its authority under the Law on Electronic Communications and the commitments of the Republic of Bulgaria for the introduction of digital television.[58]

Experimental transmission of television broadcasting in digital format was also launched in Sofia in 2004 on channel 64 by NURTS, Bulgaria's main transmission network owner and operator. NURTS provides DVB-T for Sofia on a free-to-air basis in MPEG-4 compression method. According to its website[59], NURTS Bulgaria has been airing DVB-T in the whole country since 2010.

The physical network roll-out is the responsibility of the multiplex operators. The Communication Regulation Commission is not aware of the progress of the construction of the networks.

[57] Digital Economy and Digital Media Market, September 2011 Report
[58] CRC
[59] NURTS, 2012

In May 2011 the European Commission started infringement proceedings over the DTT licenses awarded in 2009. Meanwhile, Austria's transmission company, ORS filed complaints following the lost bid for DTT licenses. The company was also not allowed to acquire NURTS by the Anti-Monopoly Office.

As a result, the European Commission asked Bulgaria to ensure open and non-discriminatory access to the digital terrestrial broadcasting infrastructure market. The European Commission claims that Bulgaria did not comply with the requirements of the Competition Directive when it assigned the five spectrum lots available for digital terrestrial broadcasting via two tender procedures, unjustifiably limiting the number of undertakings that could enter the market. Moreover, the selection criteria of the tender procedures were disproportionate and therefore not in line with the requirements of the Competition, Authorisation and Framework Directives. Applicants were not allowed to have links with content providers (TV channel operators), including operators active only outside Bulgaria, or with broadcasting network operators.

Despite the issues brought to light, CRC has recently announced it would call a tender for the country's last DTT multiplex (MUX 7).

Licensing – TV broadcasters

The Commission for Electronic Media is responsible for granting permits for all television broadcasting. The broadcasters may apply for licenses, and the Commission reviews and authorizes the applicants based on the television programming they offer.

Currently 22 suppliers of audiovisual media services hold licenses for the broadcasting of 27 television programs via terrestrial digital broadcasting. Twenty-five channels have national, and two have regional distribution licenses.

The Council for Electronic Media has also authorized "must-carry" television channels in accordance with the Radio and Television Act. According to the Act, television channel may apply for a must-carry license if it meets three criteria:

- the TV operator must possess a valid license for broadcasting channels with nationwide coverage,
- currently the channel must be broadcasted via analogue terrestrial network, and
- the analogue terrestrial network that broadcasts the channel has achieved more than 50% coverage.

The seven must-carry channels are to be broadcasted by the multiplexes on a free-to-air basis. The television operators of the must-carry channels (commercial and public) are required by the Communication Regulation Commission to sign an agreement for the broadcasting of these channels with the multiplexes no later than 31 January 2013. The deadline for signing agreements between the television operators and the multiplexes for the other channels to broadcast is set as 30 June 2013.

Multiplex operators and television operators are to negotiate terms for the broadcast of the licensed channels that do not fall into the "must carry" category on commercial basis.

Conflicting spectrum uses – releasing the 800 MHz band

Currently, eight channels of the DD1 spectrum are occupied by the Ministry of Defence, and one channel (channel 64) has been allocated for digital television broadcasting, although only in certain regions. Despite this frequency allocation, the Communication Regulation Commission has stated that it intends to free up the DD1 spectrum for mobile services. As a first step of this clearance, the military services will be relocated outside of the UHF IV/V bands, and then digital broadcasting service transferred from channel 64 to a frequency band below 790 MHz.

According to government plans, the relocation of frequencies used by the Ministry of Defence is to be financed by the state. Once the Ministry of Finance has approved a budget to be specifically allocated for this purpose, the Ministry of Defence should prepare a schedule for the migration, in accordance with the 2012 DSO plan. In practice, the Ministry of Defence should purchase new radio equipment appropriate for the frequencies to which the services would be relocated.

According to the Communication Regulation Commission, the cost of the transition has already been estimated by the Ministry of Defence, but the data is not publicly available. Also, as stated before, the necessary resources for the transfer is yet to be provided by the Ministry of Finance.

Recommendations

Recommendations concerning the DSO process

Identify authority with the necessary mandates to govern DSO process

Key governmental organisations responsible for the DSO process in Bulgaria are clearly identified in the DSO Plan of 2012. According to the Plan, a working group shall be set up to manage the switchover process. The Plan also notes that the working group shall consist of a number of regulators, public and commercial broadcasters, as well as a number of ministers of relevant fields. The Council of Ministers is identified as the responsible body for determining the specific responsibilities of each of the members of the working group.

However, the decision on the responsibilities of the members of the working group has suffered delays. Our analysis indicates that the DSO process in Bulgaria could be boosted by an efficient authority which is in possession of the necessary responsibilities, mandates, and professional and administrative capacities.

Therefore, we suggest that the Council of Ministers identify the specific mandates and responsibilities of the respective members of the working group. Alternatively, the Government could adopt an amendment to the DSO Plan, in which a specific authority with the necessary responsibilities and licenses to govern the DSO process is identified. International experience indicates that more established public players have better chances to successfully manage the DSO process than newly launched organisations.

Create scenario analysis for the possible outcomes of the EU procedure

The CRC (Communication Regulation Commission) of Bulgaria has assigned six frequency lots so far. Five of the six MUXs were assigned to two commercial MUX operators via two tendering procedures in 2009. Two frequency licenses were assigned to Towercom Bulgaria, while another three were assigned to Hannu Pro Bulgaria. The contest procedures were conducted in accordance with Bulgaria's Law on Electronic Communications.

However the EU Commission decided that the tenders did not comply with the respective EU regulations, and published its reasoned opinion on the matter on 22/3/2012. The decision warns that the Commission may send Bulgaria's case to the Court of Justice, which could, in turn, result in the annulment of the tender results.

Therefore we suggest that the Government of Bulgaria adopt an amendment to its DSO Plan in which action plans for both outcomes of the current situation are elaborated. This detailed scenario analysis would enable Bulgaria to act promptly on every potential outcome.

Mitigate the costs of raising public awareness through a phased ASO

A sum equivalent to around EUR 9 million is currently reserved in the 2013 budget of Bulgaria for set-top box subsidies and for an information campaign concerning the digital transition.

However, the effectiveness of an information campaign has not been firmly proven. Also, it is in the financial interest of Bulgaria that only those ATT-only households receive state subsidy which are indeed socially vulnerable and in need for state subsidies.

In answer to these concerns, we recommend a phased switch-off by broadcasters in order to reduce the costs needed for raising public awareness. Under the first phase of the broadcaster-based switch-off scheme, commercial analogue broadcasters would be switched off, leaving the national public broadcaster the only available broadcaster in Bulgaria. This would then serve as a prime incentive for ATT-only households to switch technology platforms. This type of incentive would also be technology neutral, thus complying with the relevant EC recommendations. The number of households eligible for set-top box subsidies could also be narrowed down this way.

A further means of cost management is that only those ATT-only households should receive state subsidy which are indeed socially vulnerable. This set-top box subsidy program should be supplemented with an effective help scheme (help desk, assistance at set-top box installation, aerial adjustment, etc.) to offer as smooth migration as possible for the targeted households.

Recommendations concerning the release and assignment of the DD1 band

Inspect actual DD1 and E/P-GSM utilisation

The DSO process in Bulgaria is severely hindered by the fact that the Bulgarian military claims to use 26 of the 49 available channels in the UHF IV/V bands. This prevents an efficient transition to digital terrestrial broadcasting, as simulcast becomes difficult to achieve due to the lack of available frequencies. The DD1 band (frequencies 790-862 MHz) is planned to be allocated to mobile services, according to the CRC, once the frequencies become available. The release of the DD1 band also proves to be a hard nut to crack, as the Bulgarian Ministry of Defence claims compensation in return for migrating from the eight channels occupied. Finally, the room for mobile services is also limited above the 800 MHz band, as a proportion of the P-GSM band along with the complete E-GSM band is also claimed to be in use by the Ministry of Defence.

However, examples of countries such as Germany show that the migration of military frequencies is indeed a feasible option. Furthermore, frequencies allocated to ARNS (aeronautical radionavigation services) on a primary basis may actually be unused, as the case of several former member states of the Warsaw Pact, including the Czech Republic, Hungary, and Poland, exemplify. The release of many of the frequencies below 862 MHz has been proven to be possible despite these states having also received protection for ARNS in the same frequencies at the WRC-03 and WRC-07 under footnotes 5.312 and 5.323.

Therefore we suggest that Bulgaria follow the practices of Germany and strive to migrate the military channels to other, preferably lower sections of the UHF band. Bulgaria could also follow the example of Hungary and Poland in thoroughly inspecting the actual frequency utilisation of the military by conducting comprehensive measurements on radio systems operated by the Bulgarian military.

Utilisation of the DD1 frequencies

The allocation of the digital dividend yields additional economic growth according to our calculations and economic modelling. These benefits can be fully realised once the analogue switch-off (ASO) is completed, and the frequencies in the DD1 band (frequencies 790-862 MHz, also referred to as channels 61-69) can be assigned to mobile uses.

However, a number of factors can prolong the DSO/ASO process. Bulgaria needs to find a solution relocating military use from the DD1 band and manage cross-border interference issues. Any delay in the assignment of the DD1 band could cause missed state income and delay additional economic growth related to broadband penetration growth.

Therefore we suggest that Bulgarian national authorities focus on clearing and then auctioning the DD1 band as soon as it is possible. Also, we suggest that national authorities hold public consultations with industry players regarding the future utilisation of the DD1 band. Such public consultations would enhance the value of the frequencies, as authorities could tailor the DD1 assignment process to the needs of mobile broadband market players, as illustrated in the *Regional suggestions and recommendations* section of this study. This in turn has the potential of increasing frequency license prices.

Country report – Greece

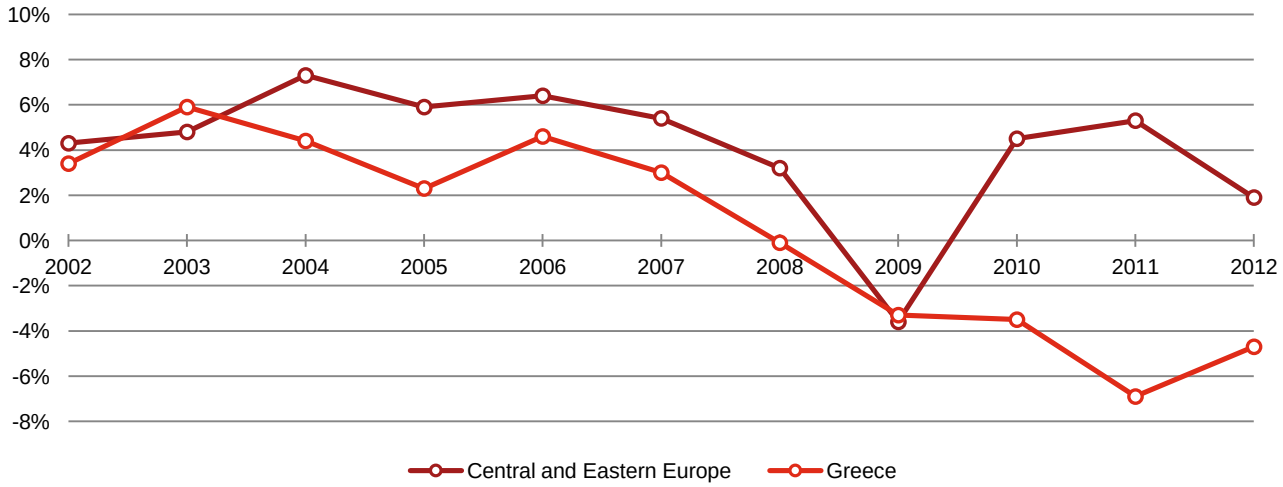
This country report is an integral part of the *Digital dividend in Southeast Europe* study, but it is designed to function as standalone study if necessary. First we introduce the fundamental macro indicators of the Greek economy, followed by a concise overview of the telecommunication sector. We then estimate the macroeconomic impact of allocating the digital dividend for mobile broadband services. We provide insight into the current state of Greece regarding the digital switchover process and the future utilisation of the digital dividend. The report is concluded with recommendations for clearing up the 800 MHz band.

Country overview

Greece's population surpassed 11 million in 2012, with more than 3 million people living in the greater Athens area. 61.4% of the population is concentrated in urban areas and 38.6% live in rural areas, according to the World Bank.[60] Following a period of considerable real GDP growth, the country's gross domestic output declined as the economic crisis hit Europe. Entangled in the debt crisis, the Greek economy was unable to overcome its structural problems, resulting in a staggering 165.3% public debt-to-GDP ratio and a continuing fall in GDP. Greece agreed on an immediate bail-out loan with the IMF and the EU in the heat of the crisis, and Greece was required to implement austerity measures to bring its deficit under control, resulting in social unrest. However, the next years hold a good promise for the country, as real GDP growth is expected to return in 2014 and analysts hope for 2.5% growth[61], as the result of a close monitoring of the implementation of the austerity packages by the EU and the IMF. Greece's USD 26,294 per capita GDP is well below EU average of USD 31,607 per capita.[62]

Figure 28 Historical real GDP growth in Greece and in the CEE region (%)

Source: IMF



DD1 potential of Greece

The digital switchover aims to free up the 790 MHz to 862 MHz band in order to allocate the newly gained spectrum for mobile services and digital television broadcasting. In the following section the study will explore the current television, internet and mobile markets in Greece, demonstrating the consumers' growing attraction to the rollout of new technologies. Our findings underscore the assumption that the digital dividend holds great potential for Greece – both for the consumers and the telecommunications sector.

Television market in Greece

Greece had almost full television penetration: more than 4.2 million households were equipped with at least one television set in 2009. The market is dominated by the incumbent terrestrial broadcasters. The Greek consumers' interest in the new digital era is indicated by the rising trends in broadband penetration; however, their television market is not yet able to follow the pace of the internet hype. The number of digital households was only 879,000 or 20.4% of total in 2009, and only half of digital households were equipped with a DTT receiver, as displayed in Figure 29 below.[63]

[60] World Bank
[61] IMF
[62] Eurostat
[63] MAVISE, 2012

Figure 29 Television penetration in Greece (2009)

Source: MAVISE

Analogue terrestrial TV had been the primary platform in Greece prior to the DSO. The share of terrestrial-only households for television sets was over 80%, followed at a distance by digital terrestrial and satellite TV: 8.5% and 7.8% respectively as of the first quarter of 2012. The publicly owned broadcaster (ERT) offered three channels with national coverage, along with some regionally transmitted channels. The analogue terrestrial television market had eight commercial broadcasters with national coverage each broadcasting one channel in the beginning of 2012. The analogue terrestrial television landscape had 126 regional and local broadcasters, in addition to two terrestrial pay-TV platforms.

Greece had two DTH (satellite) and three IPTV operators, according to the Hellenic Telecommunications & Post Commission (EETT).[64] IPTV has not seen a substantial increase in its penetration and remained at 2% as of 2009.

The TV subscription and license fee market has an expected 5.5% CAGR between 2011 and 2015, showing robust growth lying ahead of the market.[65] At this pace the value of market which currently worth USD 558 million is expected to reach USD 689 million in three years. Despite the considerable growth, subscription TV household penetration (excluding free-to-air DTT and free-satellite households) peaked at 8.6% in 2006 and showed no major increase of numbers in the following years; its penetration reached only 11% by 2010 and is expected to expand to around 16% by 2015.

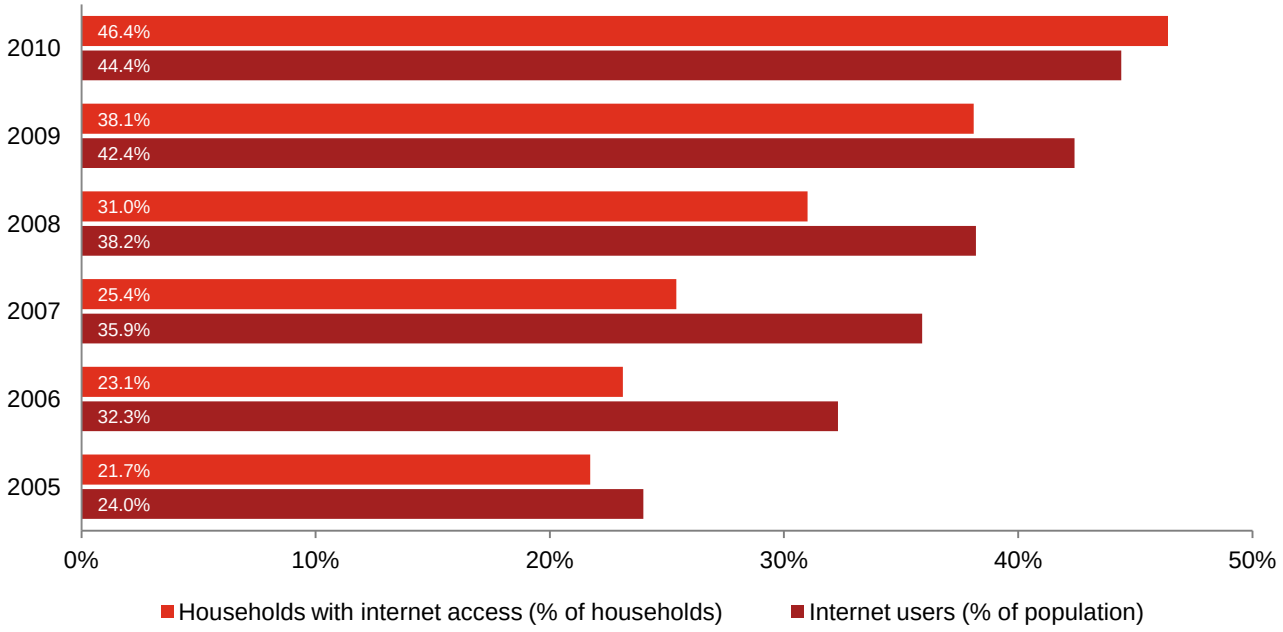
Internet in Greece

The rate of internet penetration in Greece has shown considerable growth in the last couple of years. Nearly 50% of all households had internet access in 2010, and over 44% of the total population have actually used the internet in the last 12 months, according to statistical data.[66] The modernisation of the Greek internet market is marked by both the decline in modem and ISDN use and the quick rise in broadband connections.[67] Broadband penetration still lags behind the EU27 average by 22 percentage points, but it is still considerable in the light of that internet penetration in Greece doubled between 2005 and 2010.

[64] EETT, 2012
[65] PwC, 2012
[66] ITU, 2011
[67] Eurostat

Figure 30 Internet penetration in Greece

Source: ITU, 2011



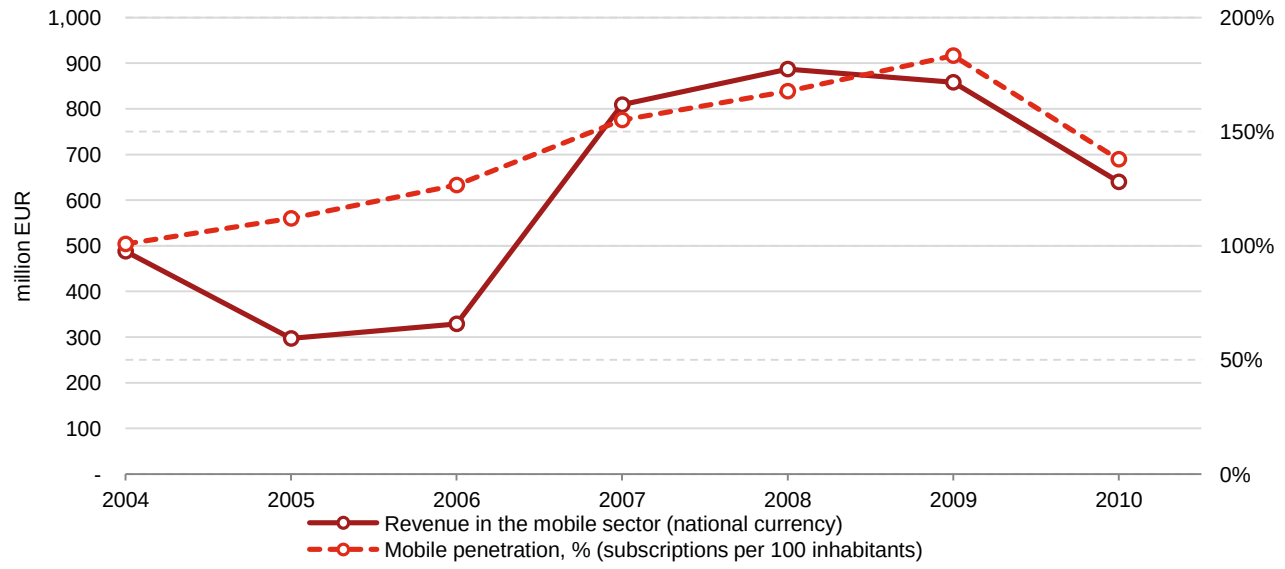
Mobile market of Greece

The mobile subscription rate surpassed 100% in 2007, providing irrefutable evidence for the growth of mobile telephony in Greece. However, the Greek mobile industry hardly showed considerable growth in its revenue between 2005 and 2010 (see Figure 31 below), despite the robust growth in the number of mobile telephone subscriptions. Experts note that the decline in revenues can be attributed to the ongoing price wars between the three telecom providers, Cosmote, Vodafone Hellas and Wind Hellas.[68]

On par with the rise of mobile subscribers, the market segment for prepaid mobile phones also experienced growth, with an annual average above five percent. Regarding the potential mobile use of the digital dividend, it is important to note that mobile penetration is more than twice as high as fixed broadband penetration. Thus it is expected that the developments in mobile broadband could also foster broadband penetration.

Figure 31 Mobile penetration and revenues in the mobile industry in Greece

Sources: BMI, ITU



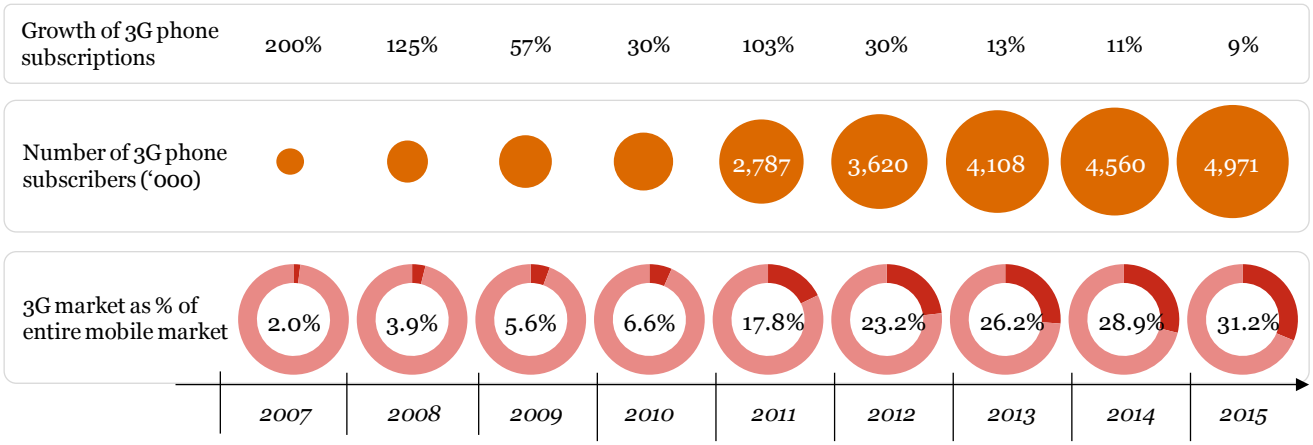
[68] Hontzeas, 2010

The number of 3G phone subscriptions grew more than tenfold between 2006 and 2011, indicating a vast potential for mobile broadband services. The increase in 3G subscription numbers is expected to continue in the following years, but at a slower pace. Currently the 3G market constitutes around 26% of the entire mobile market and is expected to expand during the coming years.

Mobile data traffic also grew significantly between 2006 and 2010. The volume of voice calls originating from mobile telephones averaged an over 18% growth, whereas the total number of text messages sent increased from 3.6 billion to 9.8 billion between 2006 and 2010, according to the Hellenic Telecommunications & Post Commission.[69] The accumulated data traffic via mobile broadband increased by over 80% in only one year's time from 2009 to 2010.

Figure 32 Mobile 3G internet services in Greece

Source: ITU, 2011



[69] Hellenic Telecommunications & Post Commission, 2010

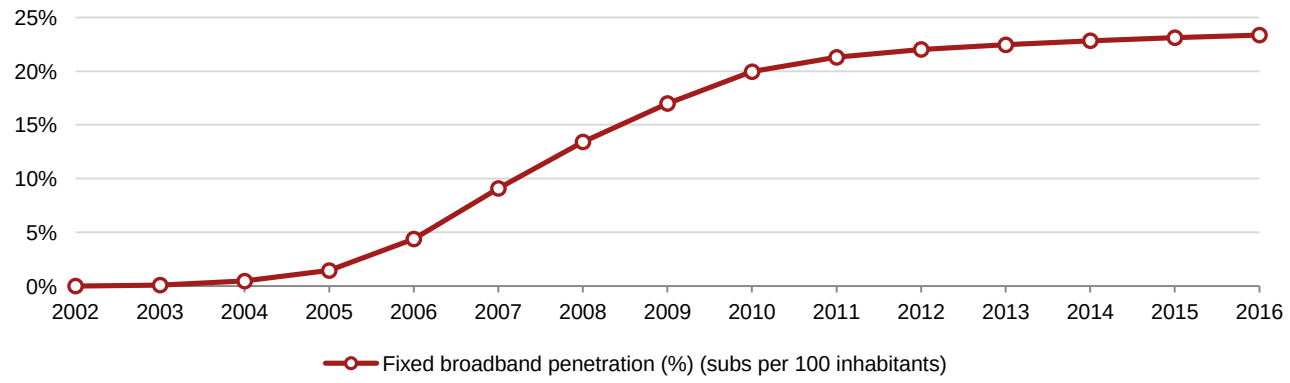
The value of the digital dividend in Greece

International studies show that households' growing internet access in a specific country has positive impacts on economic growth.[70] They also established an association – mostly through econometrical calculations – between broadband penetration growth and increase in job creation and productivity by traceable percentage points. Through the emergence of UMTS networks, the mobile industry is able to provide data services to subscribers that increase the accessibility of broadband services in the economy. The ubiquity of mobile services, stemming from its wireless nature, ensures that these services will have significant impact on internet penetration. In this section we describe the Greek broadband market and analyse the economic impact of different access technologies among them 3G mobile service. We assume that the allocation of the digital dividend involves an increase in broadband penetration, and following this hypothesis, we calculate a forecasted growth in GDP, employment and productivity.

In 2011 fixed broadband penetration was 21.3% in Greece. Annual average growth of penetration has been 2.65 percentage points over the last eight years, but steadily slowing down. And our forecasts show that this slowing trend will be typical for the upcoming years. We estimate that penetration of fixed broadband services will pass 23% by 2016.

Figure 33 Fixed broadband subscriptions per 100 inhabitants in Greece (%)

Source: PwC

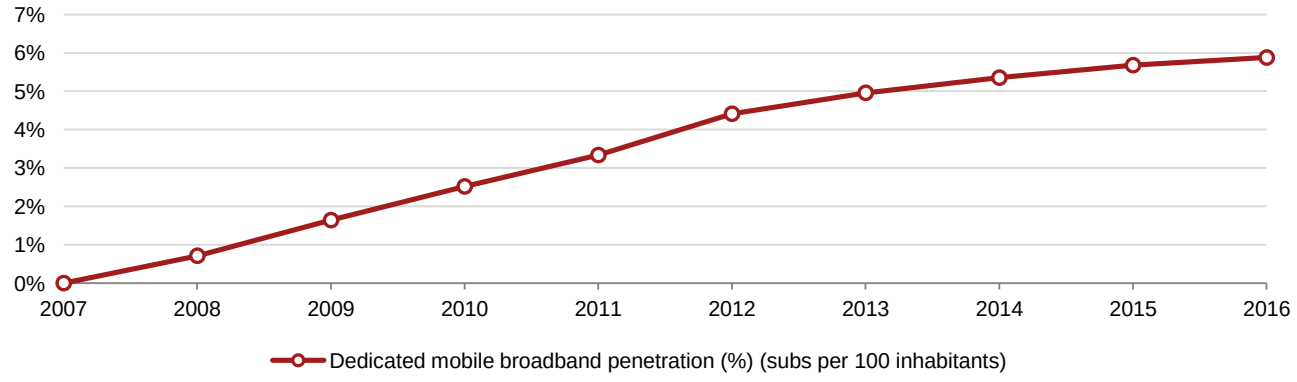


Greece's fixed broadband market is dominated by ADSL service. Although cable operators are upgrading their networks to accommodate developed internet services, the footprint of these networks does not allow them to have any significant impact on market conditions. Also, Greece's wire line operators have just started rolling out fibre optic networks, and the market share of these services was well below 1% in 2011.

Since the first appearance of dedicated mobile broadband in 2007, its penetration has already reached 3.3% in 2011. According to the European Commission, this rate is still below the EU average. We forecast 5.9% penetration by 2016.

Figure 34 Dedicated mobile broadband subscriptions per 100 inhabitants in Greece (%)

Source: PwC



[70] ITU, 2012

In order to calculate the effect of increasing mobile data subscriptions on the economy, we estimated the percentage of those subscriptions that would actually give rise to household penetration. A majority of new mobile broadband subscription activations is connected to SIM cards placed in smart phones and used by subscribers who have other internet access from a computer. Also, many subscriptions are bought in order to achieve mobility while also having a supplementary fixed broadband service. We consider that those subscriptions which act as a substitute of the fixed service will increase the actual household penetration. In countries such as Greece, where CATV has a low penetration, we observe that mobile broadband subscriptions are relatively more substitutes for, than complementary to fixed broadband as in countries with intense fixed broadband competition. Based on the characteristics of the Greek broadband market, we estimated that 50 percent of the mobile broadband services activated in Greece would increase the household penetration of broadband internet services.

Figure 35 Broadband penetration in Greece, 2010-2016

Source: PwC

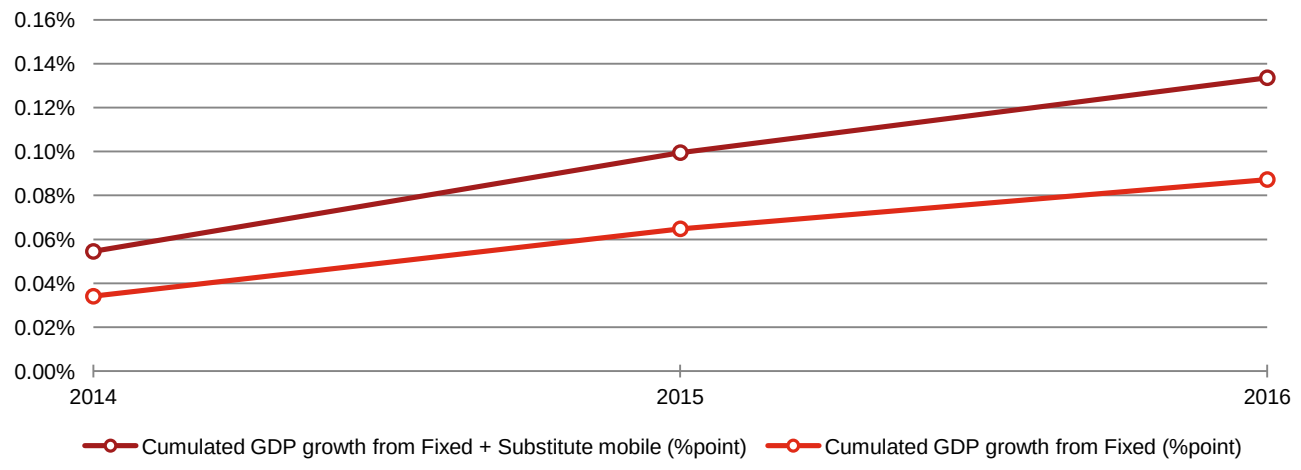
	2010	2011	2012	2013	2014	2015	2016
Penetration	22.5%	24.6%	26.4%	27.4%	28.2%	28.8%	29.2%
Penetration without mobile	20%	21.3%	22%	22.5%	22.8%	23.1%	23.4%

In our macroeconomic model, we calculated and forecasted the impact of the broadband effect on the growth of GDP, employment and productivity. Our original hypothesis stated that the allocation of digital dividend will affect the growth of household broadband penetration by making the service accessible in such rural areas where higher frequencies made the network roll-out uneconomical. As mobile broadband coverage is already around 100% in the country, we cannot assume that the allocation of digital dividend could significantly affect the broadband penetration growth in any region. However, one must note that the allocation of 800 MHz band is also necessary for maintaining the current trend of mobile broadband take-up as it provides spectrum for gearing the capabilities of the mobile network to the ever increasing subscriber data rate requirement.

The following chart demonstrates how the current broadband penetration trend will impact GDP after 2014.

Figure 36 Cumulated GDP effect of broadband access services (percentage points)

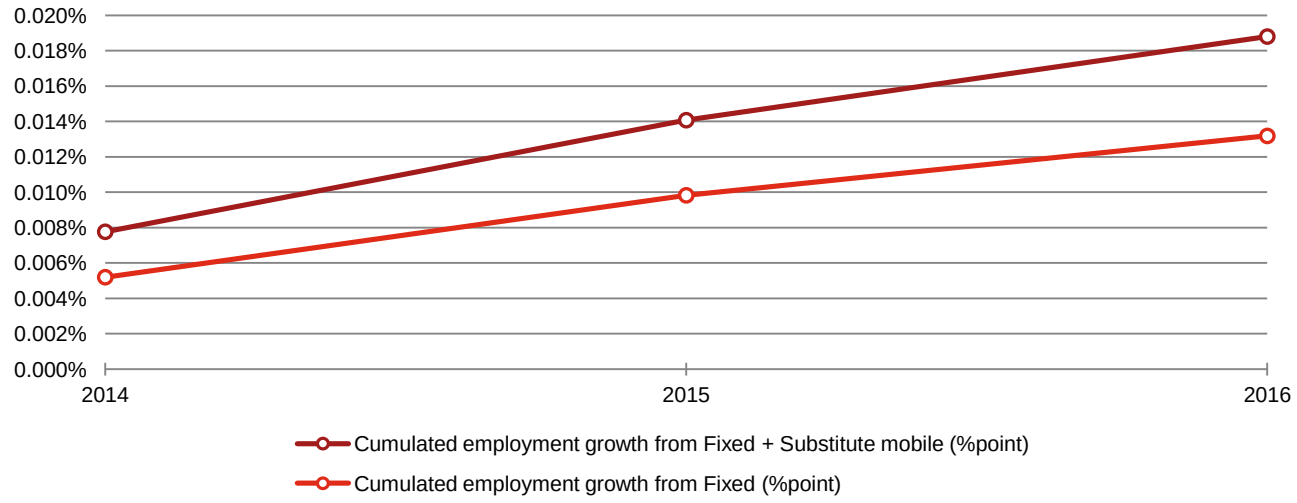
Source: PwC



According to the international analysis referred to earlier, broadband penetration also has a positive effect on the employment and productivity of the economy in question. This effect derives from the characteristics of the Greek market. Our estimations are presented in Figure 37 below.

Figure 37 Cumulated employment effect of broadband access services (percentage points)

Source: PwC



The digital dividend in Greece

The status of the DSO in Greece

In the following sections we first present the current status of the DSO process in Greece, as the switchover is currently underway. Second, the past experiences of the transition from analogue television to digital broadcasting are presented in order to point out how Greece has arrived at its current situation.

The digital switchover is currently underway in Greece. After a phased ASO, the majority of the greater Athens area now receives digital transmissions through eight digital multiplexes, with some analogue transmission sites still in place. The complete ASO is scheduled to 30 June 2013, and the auction of the digital dividend is scheduled to the second quarter of 2013. The DSO in Greece is in a delay compared with the initial plans of the government. However, in comparison to our focus countries in Southeast Europe (Bulgaria, Serbia and Turkey), the Hellenic Republic is still far ahead in the digital transition.

Analogue switch-off in Greece

The two major broadcasters started the analogue switch-off process in the most densely populated areas, ending their simulcast period by the end of August 2012. The phased switch-off started in July 2012, when the leading commercial broadcasters switched off their key transmitter in Athens, affecting approximately 150,000 households. Following that, the national broadcaster switched off its main transmitter covering 65% of the 1.8 million households in the most densely populated Attica region, marking a substantial step toward the digital switchover.[71] In the greater Athens area, only a smaller transmission site covering 25% of households is currently transmitting an analogue signal, and is expected to continue the analogue broadcast at least till the first half of 2013.

The deadline for the completion of analogue switch off is set to 30 June 2013 as part of the *Memorandum of Understanding on Specific Economic Policy Conditionality* from *The Second Economic Adjustment Programme for Greece* document, a mutual agreement between the EU, the IMF and the Hellenic Republic.

Greece's multiplexes

Three major multiplex (MUX) operators currently possess digital frequency rights: the state owned ERT operates two MUXs, the private consortium Digea broadcasts through five and the Digital Union S.A's two MUXs are the most recent developments in the Greek digital television platform.

ERT's MUXs represent a weak model, as the government controls both the content and the broadcasting technology through its own broadcasting company. On the other hand, the commercial broadcasters represent a strong multiplex model, as both Digea's and the Digital Union's channels were selected by a market-driven approach.

Athenians with DTT receivers have access to all nine digital MUXs, offering around 30 digital channels. These channels are all free, with the exception of two channels operated by Nova and carried on one of ERT's multiplexes. Additionally, there are a number of independent stations that broadcast in DVB-T in various regional areas in Greece, mostly using the Digea consortium's multiplexes. The national broadcaster has taken the lead in HD broadcasting through launching Greece's first HD channel, ERT HD, but the competing commercial broadcasters are also planning to launch HD channels in the near future.

Most of the MUXs use MPEG-4 compression method, broadcasted through a single-frequency network (SFN) architecture. Figure 38 presents the complete list of multiplexes in Greece as of 2012.

[71] Papavassilopoulos, 2012

Figure 38 Multiplexes in Greece

Source: media.net.gr

#	MUX owner	MUX Type	Business model	Localization	Compression method
1	Digea	private	free	national	MPEG-4
2	Digea	private	free	national	MPEG-4
3	Digea	private	free/pay	regional	MPEG-4
4	Digea	private	free/pay	regional	MPEG-4
5	Digea	private	free	regional	MPEG-4
6	ERT	public	free	national	MPEG-2
7	ERT	public	n/a	national	MPEG-4
8	Digital Union SA	private	n/a	regional	MPEG-2
9	Digital Union SA	private	n/a	regional	MPEG-2

Current regulatory framework

Act 3592/2007 and Act 4038/2012

Two laws shape the digital switchover process in Greece. These are *Act 3592/2007 on the Concentration and Authorisation of Mass Media Enterprises and Other Provisions* and its subsequent amendments, and *Act 4038/2012 on the structural reforms of Greece* which among others contains specific details regarding the switchover process.

Act 3592/2007 specifies a roadmap for the transition to digital television and describes the licensing procedures for digital terrestrial TV. On the one hand multiplex operators are under a general license regime, provided that they are registered by the Hellenic Telecommunications & Post Commission (EETT). On the other hand content providers are allowed to transmit their programmes both via analogue and digital platforms, making a clear distinction between operators and content providers.

Amendments to Act 3592/2007 contain the following specifications regarding the switchover process: the allocation of frequencies to multiplexes will be based on the auction procedure supervised by EETT; the licensing of content providers will be based on criteria defined by law; ERT is no longer allowed to carry private content providers on its networks.

The initial frequency plan was based on co-ministerial decision no. 21161/2008, with the provisional specification of the number of multiplexes and the number of channels each multiplex can carry.

The digital switchover process is not yet complete as it was planned in the aforementioned acts. The parliament adopted a new regulatory framework in response to comments by the EU concerning the licensing procedure and in accordance with the recommendations made by the IMF. The new roadmap of Act 4038/2012 set the following timetable for the digital transition.[72] After the determination of the analogue switch-off date and the elaboration of the regulatory text, ESR should carry out a tender for content providers by October 2012. Licenses are to be issued by March 2013.[73]

Key administrative bodies – separation of network and content

Following the ongoing discussions and work for a clear separation between network and content providers, the following division of responsibilities has been determined: the Ministry of Infrastructure, Transport and Networks will provide the available frequencies for DTT in accordance with the RRC-06 plan; the Hellenic Telecommunications and Post Commission (EETT) will be in charge of the auction procedure for assigning

[72] Economou, 2012
[73] Articles of Act 4038/2012 regarding the DD1 allocation will be discussed later.

frequency rights to network operators; and the National Broadcasting Council (NBC) will license the content providers.[74]

The selection of broadcasters for TV licenses is based on a kind of "beauty contest", supervised by the National Broadcasting Council (NBC). The frequencies and specific sites of transmission will be defined later in a finalised frequency plan[75], in accordance with the GE06 Agreement of the RRC-06 conference. The administrative body in charge of the licensing procedure is the Greek National Council for Radio and Television (ESR or NCRT). The broadcasting regulatory authority has two committees that deal with digital broadcasting. The Licensing Committee "examines license applications by TV stations and requests for certificates of legitimate operation by radio stations, as well as network permits for radio and TV stations" and the Frequency Committee "examines applications for the allocation of frequencies for digital transmission of programs by TV stations of regional and local coverage".[76] Figure 39 compares the key administration bodies in charge of regulating the broadcasting sector as of 2006[77] and as per the current regulatory framework.

Figure 39 National Regulatory Authorities for Broadcasting

Source: PwC

Authority	Responsibilities as of 2006	Responsibilities as of 2012
Ministry of Infrastructure, Transport, and Networks	• Setting policies for the broadcasting sector, including drafting legislation and frequency management	• Establishing the regulatory framework for the [finalised] licensing procedure • Creating the frequency map and establishing technical requirements • Licensing
Hellenic Telecommunications and Post Commission (EETT)	• Analysis of the market • Management of interferences, including supervision and control of broadcasters, seizure of installations, and imposition of penalties	• Supervising technological compliance
Greek National Council for Radio and Television	• Licensing frequency and content • Supervision and control of broadcasters, including dispute resolution, hearings, and the imposition of penalties • Decisions concerning must-carry obligation • Competition rules for the broadcasting sector, cross ownership and media concentration in particular	• Initiating tender procedures for licensing and content compliance

Conflicting spectrum usages

Preventing the allocation of the total digital dividend spectrum, certain parts of the 800 MHz band are currently being utilised by one of Digea's regional MUXs, Programme Making and Special Events services (PMSE), and by the Greek military.

DTT

Channels 63 and 65 are currently being used for regional DVB-T services by Digea, transmitting from the island of Aegina and covering a large part of the Attica region. Mad TV, 0-6 TV, MTV Greece, and Sport TV programmes are digitally transmitted through channel 63, whereas BlueSky, Channel 9, Kontra Channel, and Teleasty are currently using channel 65 in the 800 MHz band. Regional digital broadcasting must cease in order for the government to be able to allocate the entire digital dividend spectrum.

[74] Plans regarding the auction procedure will be discussed later.
[75] To date, only a provisional frequency map has been presented.
[76] Greek National Council for Radio and Television.
[77] European Commission: Database of regulatory information for the broadcasting sector.

PMSE

During the 2004 Olympics in Athens, Greece had first-hand experience with the vast demand for PMSE services during major events. Until recently, the band appointed for PSME services included the UHF IV/V band and accordingly PMSE equipments used the DD1 band as well.

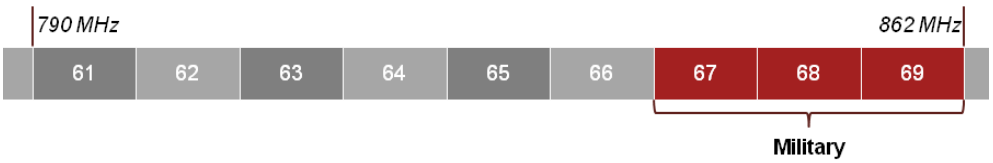
The Hellenic Government decided that PMSE services shall be migrated to the 470-758 MHz band as per Common Ministerial Decision no. 45258/1288/, in order to clear the DD1 band and at the same time ensure the continuous operation of PMSE systems.

Military

Military systems currently occupy the 838-862 MHz band in Greece, posing a considerable challenge for the utilisation of the harmonised digital dividend spectrum.

Figure 40 Military systems in the 800 MHz band

Source: Aegis, 2009



In this case the Government also ordered the migration of military systems to the 758-790 MHz band in order to make the 800 MHz band available (Common Ministerial Decision no. 45258/1288/). While the regulation sets the path for the migration, the technical details of the transition, as well as cross border coordination still needs to be carried out before the decommissioning of military equipment can happen.

Cross-border coordination

The GE06 Plan states that once the deadline for the analogue switch off has passed (17 June 2015), there is no requirement to coordinate any of the channels that are allocated to Greece with other countries as the protection of the analogue signals will terminate. However, during the switchover period, and in the case of DTT even after ASO, Greece will need to coordinate with its neighbouring countries. Moreover, if some of the neighbouring countries miss the ASO deadline of 2015, it is the primary interest of mobile service providers to coordinate spectrum usage, as mobile base stations can be much more sensitive to interference from high power terrestrial transmission than the other way around.

The data regarding the ASO statuses in the neighbouring countries indicate that the switchover process is far from complete. As in case of other countries, it is suggested that cross-border interference issues will be nonexistent if surrounding countries also comply with the ITU resolutions. It is argued that since cross-border agreements have already been established for mobile services in other frequency bands, it should be feasible to do the same for the 790 to 862 MHz band. Italy may decide not to adopt the harmonisation proposal by retaining high power broadcasts in the band, but in practice, the interference would be limited predominantly to mountainous areas with relatively sparse population. The only exception is Corfu, for which experts suggest a close monitoring exercise in order to assess the potential problem in detail.

Greece's DSO so far

The following overview of the events of the DSO process will present an explanation to how Greece arrived at its current state in the transition.

Greece first announced its digital switchover strategy in 2008, after the Geneva 2006 Agreement set 17 June 2015 as the deadline for the completion of the digital switchover. The broadcasting sites were selected targeting full territory coverage (more than 90% of national population). The digital broadcasting plan named 158 broadcasting sites, corresponding to 23 SFNs, in 11 defined service areas. However, it should be noted that the strategy was not detailed: the responsibility for selecting the geographic areas and setting the timeframe for analogue switch off rests entirely with the network operators. The final number of operating MUXs was not clearly defined – plans ranged from 7 to 12 multiplexes. The strategy was not made available to the European

Commission in English, and the switchover process was shaped by market forces (Digea) and by Act 3592/2007.

Key Players Shaping the Process

Initially, the Hellenic Broadcasting Corporation (ERT) and the private consortium DIGEA were the two key players shaping the DSO process.

The Hellenic Broadcasting Corporation is a state owned public radio and television broadcasting corporation with over seventy years of experience in television. The company is supervised by the Ministry for Culture and Tourism, at present broadcasts six channels and manages a considerable technical infrastructure all over the country. ERT's nationwide transmitter network comprises 20 main transmission centres, 40 secondary centres and 2,000 transponders in over 1,200 transmission sites.

The public broadcaster gained considerable competitive advantage over its private counterparts due to two factors. First, the licensing procedure for DTT differentiated between public and private broadcasters, thus allowing ERT to start its operations with a head start. Second, the private players were unable to launch their own DTT programmes as the digital technology requires high upfront investments from the broadcasters. That is especially relevant to the Greek situation, since its mountainous surface can only be covered with as many broadcast relays as much larger countries – e.g. Germany or France – need. Given these conditions, ERT was the first to start its own free-to-view DTT operation in January 2006, under the project name ERT Digital.

With no legislative framework regarding digital broadcasting in place, ERT's DVB-T broadcast featured three channels: Cine+, Prisma+ and Sport[78]. The digital channels were broadcasted in MPEG-2 format using five transmitters across Greece. Initial transmissions were planned to be extended to cover 65% of the Greek population by March 2006. To support this, an SFN network has been put into operation covering Athens as part of ERT's pilot projects for introducing nationwide DTT. ERT officials estimated that more than 500,000 DTT set-top MPEG-2 boxes were purchased by the public; however, these devices soon became obsolete as digital broadcasting later switched to the MPEG-4 compression standard. The Digital boxes were available from around EUR 50, but for people with special needs the state provided the boxes for free.[79]

The next step for ERT was the launch of its second MUX in September 2010, broadcasting ET1, ET2, ET3 and the Greek Parliament's channel. The introduction of ERT HD in April 2011 led to the merger of Cine+ and Sport+ in order to free up bandwidth in ERT's second multiplex. With its new digital package, ERT realised the arrival of the new technology and thus began using DVB-T/MPEG-4 format with a 1440x1080 resolution. To date, the initial digital channels have ceased broadcasting.

ERT Digital was initially funded through ERT SA's budget. A state fee, amounting to EUR 50.88 annually per households is the basic source of income for ERT S.A. The state fee is collected through the bimonthly electricity bill.

Despite pioneering in digital broadcasting, ERT did not consider it to be its responsibility to inform the public regarding the digital switchover. The national broadcaster did not offer interactive services with its DTT programmes, thus failing to incentivise the public to take the necessary steps to follow the transition. In August 2010, in response to shrinking revenues, ERT announced the closing down of ET1, reduced the number of local radio stations and staff cutbacks were carried out as well.

The second phase of the digital switchover in Greece started three years after ERT's pilot DTT broadcasts, when the seven leading national commercial broadcasters jointly set up a single company to manage their DTT platform. The consortium was allowed to operate, as Act 3592/2007 failed to mandate the content providers' legal separation from digital terrestrial network operators. For that purpose, a licensing procedure carried out by the ESR was needed. However, additional issues arose: whereas national broadcasters were only required to register at the ESR for frequencies, regional and local operators were to submit their programmes for approval by the competent authority.[80]

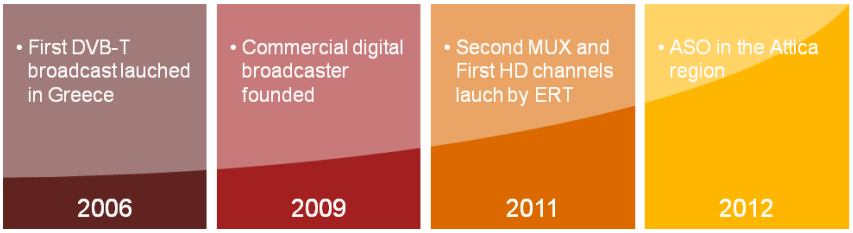
The new company, DIGEA Digital Provider S.A. was founded in September 2009 for the purpose of providing broadcast network and multiplexing services for content providers. The Digea DTT platform covers the majority of the Greek population through its five multiplexes, broadcasting all of its 21 channels in MPEG-4 AVC

[78] Info+ news channel was later added to ERT's DTT platform.
[79] Informa, 2007
[80] Hellenic Foundation for European and Foreign Policy, 2011

compression format. The consortium has taken the responsibility to educate the public about the digital switchover as part of their information campaign. The company's revenue stream comes mainly from the license fees paid by content providers in exchange for multiplexing services. In an attempt to extend its network, DIGEA signed a five-year agreement with NEC Corporation to supply 300 DVB-T transmitters in 2010.

Figure 41 Key events of the DSO in Greece

Source: PwC



The EC envisioned full ASO by January 2012, in order to transform the digital dividend into social benefits and economic growth. However, the Greek DSO did not follow that roadmap. During the first transitional phase TV channels were simulcasted to the majority of households via both digital and analogue signals. It was only by July 2012 that Greece finally began its phased switchover. On 20 July, the leading commercial broadcasters switched off the analogue signal from Mount Imittos in Attica. However, the national networks (ERT) kept running on simulcast due to the ongoing Olympic Games. A month later, at the end of August 2012, the key analogue transmitter serving Athens was switched off as well.

Assigning the digital dividend in Greece

The assignment of the DD1 band is accelerated by the agreement between the EU, the IMF and the Hellenic Government, ratified under Act 4046/2012.[81] According to the agreement, under section *Growth Enhancing Structural Reforms*, a number of obligations and the corresponding timeframes are set for the Government and the relevant governing body, the Hellenic Telecommunications & Post Commission (EETT) regarding the digital dividend.

- EETT is to define a legal framework in primary law to set the mandatory date for the completion of ASO for 30 June 2013, accompanied by a technologically neutral utilisation of the 800 MHz band after the switch-off. Neutrality means that the digital dividend may be shared between broadcasting and mobile services. Furthermore, the utilisation plan must comply with the provisions of the draft Radio Spectrum Policy Programme (RSPP). As of 29 March 2012, the legal framework is being adopted by the Parliament, providing legal separation between network and content providers.[82]

- EETT is under obligation to evaluate the value of DD1 and to complete the strategy for the granting of the freed-up 800 MHz band.

- The Memorandum of Understanding (MoU) requires the Greek administration to resolve cross-border coordination issues with its neighbouring countries by the second quarter of 2012. As international difficulties made this deadline unfeasible, the advisor to the General Secretary for Telecommunications and Post indicated that the issue will not be resolved before the third quarter of 2012.

- The MoU set the second quarter for the launch of the consultation for the amendment of the frequency and broadcasting plans.

- Another crucial deadline set by the Act is the launch of the public consultation on the tender procedure for the assignment of the digital dividend to broadband set to the last quarter of 2012.

- Following the public consultation, the actual auction of the digital dividend is to be held in the second quarter of 2013.

[81] Act 4046/2012 is the written and approved memorandum of the new loan agreement between the EU, the IMF and the Greek Parliament. Published as The Second Economic Adjustment Programme for Greece (March 2012).
[82] Ministry of Infrastructure, Transport and Networks, 2012

Challenging the feasibility of the timeframe, a number of issues must be resolved before holding the auction. Other than completing the digital frequency plan and remedying the international coordination issues with Greece's neighbouring countries, the 800 MHz spectrum must be vacated before the award procedure. Despite the Government's dedication and the recent Common Ministerial Decision on releasing the DD1 band, vacating the 61-69 channels still present considerable challenges for three reasons.

First, the armed forces currently use the upper part of the future DD1 spectrum: channels 66-69 (24 MHz) were until recently assigned to the military. To clear the road before the auction process and to allow the aforementioned spectrum for mobile broadband use, the armed forces must migrate to the 758-790 MHz frequency band, as stipulated by the new frequency allocation table.

Second, PMSE also needs to be relocated from the DD1 band to the 470-758 MHz band as per the regulation.

Third, channels 63 and 65 in the Attica region have already been assigned to two MUXs, carrying regional channels. For the awarding procedure to start, the regional channels currently using channels 63 and 65 will "have to vacate those frequencies, barely 12 months after the time they were awarded them".[83]

After the following issues are resolved, the digital dividend frequencies can be allocated to mobile broadband services. The auction procedure will be carried out by EETT, based on a tendering in which all interested parties will be allowed to bid for the frequency rights. In order to avoid monopolies, EETT will set a maximum limit in spectrum assigned to a single operator. The assignment procedure will demonstrate technology and service neutrality, in accordance with Act 4046/2012.

Digital dividend 2

The harmonised use of the DD2 band (694-790 MHz, the second digital dividend) for wireless broadband is still a long way ahead: the Commission assessment is due before January 2015. It should, among other issues, take into account the possible future spectrum needs of terrestrial radio and TV. The possible use of the 700 MHz band for wireless broadband requires an international agreement.

There are several reasons why the 700 and 800 MHz bands are considered the best spectrum for rural and suburban areas in the lower frequency bands: these frequencies have very good propagation characteristics; operators need fewer cells at lower frequencies; 3G at 700 MHz needs about 30% of cells to offer the same coverage as 3G at 2100 MHz; approximately 70% cheaper to provide mobile broadband coverage over a given geographic area using UHF spectrum than with the 2100 spectrum; and finally it supports wide geographic coverage as it can allow mobile operators to more efficiently reuse their existing 2G base stations. These factors call attention to the potential benefits of allocating the second digital dividend for additional mobile broadband services.

[83] Papavassilopoulos, 2012

Suggestions and recommendations

The Hellenic Republic has made considerable headway in the digital transition and the only remaining crucial task is now to clear the 800 MHz band before the DD1 spectrum can be offered to the market players. Based on the insight gained about the current status of the digital switchover process in Greece, we identified four critical issues that need to be resolved in order to utilise the total digital dividend spectrum.

Current regional DTT channels, the military and the assumed PMSE services in the 800 MHz band should be encouraged to either migrate to spectrum outside the digital dividend or to switch to more spectrally efficient equipment. Resolving these issues, while abiding the general guidelines of transparency, effective coordination among key players, and maintaining public involvement, could lead to the successful utilisation of the freed-up 800 MHz band. Our recommendations are detailed below.

Recommendations regarding DTT utilisation

Channels 63 and 65 are currently used for regional DVB-T services by Digea, covering a large part of the Attica region.

Channels 63 and 65 should be vacated in advance of the award auction if EETT intends to license the total DD1 spectrum. The release of additional spectrum beyond the harmonised digital dividend might be an option. However, when opting for this solution frequency allocations should be in line with the respective ITU and EU frequency layout recommendations.

Recommendations regarding the DD1 frequency auctioning

The utilisation of the digital dividend for broadband services yields additional economic growth according to our calculations and economic modelling. These benefits can be fully realised once the analogue switch-off (ASO) is completed, and the frequencies in the DD1 band (frequencies 790-862 MHz, also referred to as channels 61-69) can be assigned to mobile uses.

However, the recent mobile network license renewals and the recent refarming of radio frequencies as well as the pending implementation of some relevant legislative framework regarding base stations suggest that incomes from DD1 frequency auctions could be lower than expected if auctioned in the close future.

Therefore we suggest that Greek national authorities at this time prioritise clearing the DD1 band. Also, we suggest that national authorities hold public consultations with Greek mobile industry players regarding the future utilisation of the DD1 band. Such public consultations would enhance the possible income of the state by promoting a better understanding of the needs of mobile broadband market players. Transparent processes allow operators to plan in advance and to implement their network structure accordingly, which in turn could help to increase the value and state incomes related to the digital dividend.

Country report – Serbia

This country report is an integral part of the *Digital dividend in Southeast Europe* study, but it is designed to function as standalone study if necessary. First we introduce the fundamental macro indicators of the Serbian economy, followed by a concise overview of the telecommunication sector. We then estimate the macroeconomic impact of allocating the digital dividend for mobile broadband services. We provide insight into the current state of Serbia regarding the digital switchover process and the future utilisation of the digital dividend. The report concludes with recommendations for accelerating the DSO process and for the future utilisation of the digital dividend.

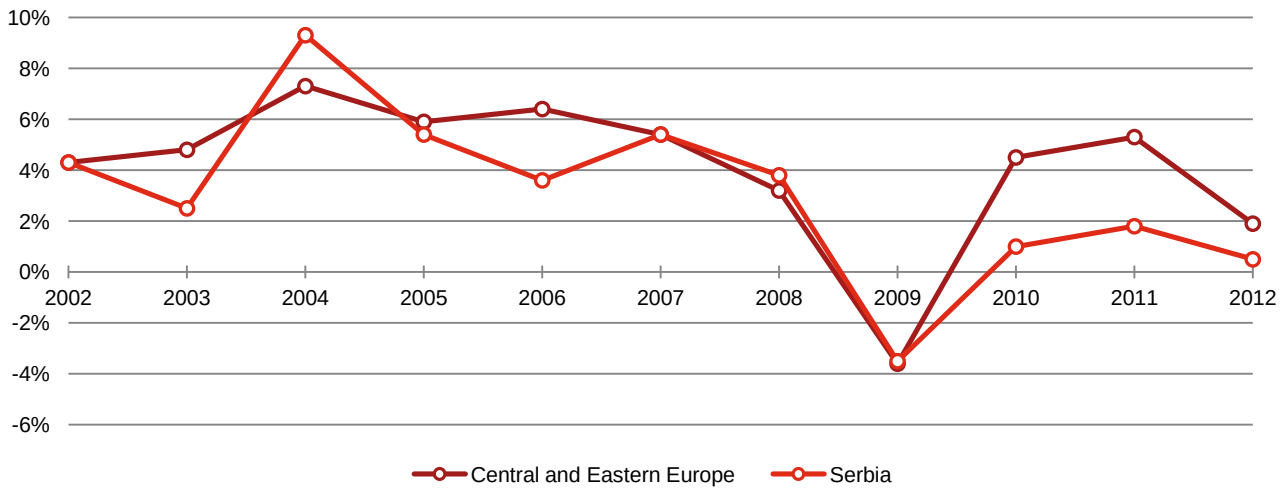
Country overview

Real economic growth in Serbia has been generally on a par with the respective data of the Central and Eastern European (CEE) region. The emerging country is still under the effects of the 2008 crisis, showing a similar but well below regional average recovery in real terms, as shown in Figure 42 below. Despite the current economic environment Serbia has a total external debt ranging up to 79% of the GDP[84], and a 4% long term year-on-year real growth outlook, according to the IMF[85]. However, growth is largely dependent on the state which accounts for around 55% of the GDP.[86]

The country has close economic ties with the EU, as the EU27 countries account for nearly 64% of Serbia's total trade[87]. Although EU accession of the country is still far ahead, the Digital Switchover Strategy of Serbia was originally planned to be executed as close as possible to the EU recommended deadline. Furthermore, the initial digital broadcasting equipment worth over EUR 10.5 million that is currently in use in Serbia is funded from EU pre-accession funds.

Figure 42 Historical real GDP growth in Serbia and in the CEE region

Source: IMF



The population of Serbia was around 7.3 million[88] in 2011, while the total number of households amounts to nearly 2.5 million.[89] More than half of the population (52.4%) is urbanised, well below the EU27 average of around 74%[90]. Private consumption is forecasted to shrink in the upcoming years mainly due to constrained disposable incomes caused by "a low real wage growth rate and a further reduction in employment", a 2012 report[91] by the European Commission expects.

DD1 potential of Serbia

The digital switchover in Serbia aims to free up the 790 to 862 MHz band with the goal of utilising the released spectrum primarily for mobile services. The following sections describing the Serbian telecom sector underscore the assumption that the digital dividend has a great potential in Serbia.

Broadcasting market in Serbia

Television plays a crucial role in the Serbian media content distribution sector as it remained a primary source of information for the Serbian population (with TV being the primary source of information for 71% of Serbians in 2011, down from 77% in 2010)[92]. Nearly all households are equipped with at least one television set,[93] and

[84] National Bank of Serbia, 2012
[85] IMF
[86] BMI, 2012
[87] European Commission, 2012
[88] World Bank
[89] SORS, 2012
[90] World Bank
[91] European Commission, 2012
[92] IPSOS, 2012
[93] OSF, 2011

82% of Serbia's population watched television on a daily basis in 2011. The average Serbian spends 5 hours watching the television each day, the highest value in Europe.[94]

It is estimated that 50% of all TV households were ATT-only broadcast receivers in 2010, which is one of the highest in the region.[95] On the one hand this offers a good starting point for digital terrestrial business models, but on the other hand it provides some social concerns too, as around 300,000 ATT-only households are considered socially vulnerable by the Government. This is an issue to be resolved by state subsidies as per the Strategy.

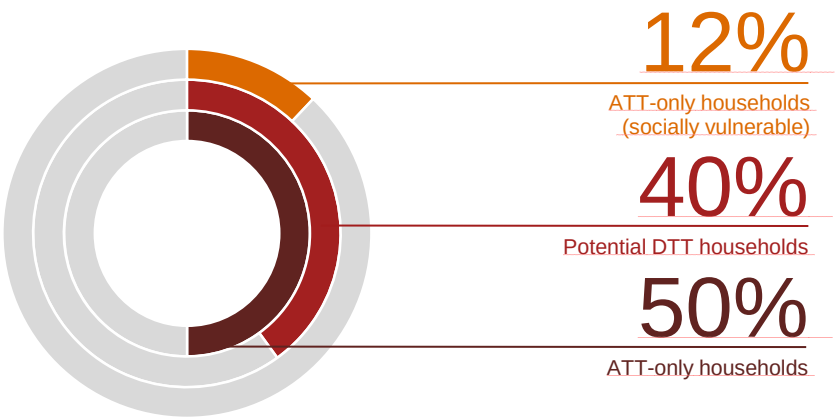
CATV penetration (dominated by analogue subscribers) is around 40% of all households. The platform experienced a 14% increase in subscriber numbers from 2010 to 2011.

Nearly 8.5% of all households are equipped with DTH (Direct-to-Home) broadcast access. IPTV is gaining popularity with a 37% y-o-y increase, and was received by nearly 5% of all households in 2011, according to a report by the Republic Agency for Electronic Communications (RATEL).[96]

The broadcast of a pilot DVB-T2 digital terrestrial television (DTT) commenced in 2012 in Serbia.[97] The network currently covers around 40% of all population, though DVB-T2 compatible receiving equipment is still practically unavailable in the country.

Figure 43 Overview on terrestrial television market penetration of Serbia in 2011

Sources: RATEL, DSO Strategy of Serbia



Two public and five commercial broadcasters are available nationwide through the ATT network of Serbia. Program channels broadcasted by public broadcaster RTS and commercial broadcasters PINK and B92 accounted for over 75% of audience and advertising revenues in 2009, while the remaining small broadcasters share the remaining 25%. There are 121 licensed broadcasters in Serbia[98]. The total number of all program channels broadcasted is currently unknown, as some illegal program channels without a valid broadcasting license or frequency usage permit are still being operated by various local and regional broadcasters throughout Serbia, including channels such as RTS Digital or RTS HD operated by the public broadcaster.

A free-to-air (FTA) business model is being used by broadcasters on the ATT platform, as analogue radio signals are freely receivable within the range of transmission. The roughly estimated cost of operating a national analogue program channel is EUR 1.8 million, around half of which is the cost of the broadcasting license payable to RBA (Republic Broadcasting Agency), while the other half is the cost of the radio frequency usage permit and is payable to RATEL. Program channels are financed with revenues from the sale of advertising airtime and subscription fees where applicable. Public broadcasters are allowed 6 minutes per hour advertising time, while commercial broadcasters are allowed 12 minutes. Subscription fees are as low as EUR 5 per month

[94] AGB Nielsen, 2009
[95] COWI, 2010
[96] RATEL, 2012
[97] A DVB-T pilot trial commenced broadcasting as early as 2005, broadcasting channels RTS1, RTS2, TV Avala, and three years later RTS Culture and Arts channel. The DVB-T2 trial broadcast which complies with the current DTT specifications of Serbia commenced in 2012.
[98] 7 national (including 2 puiblic and 5 commercial), 29 regional (including 2 public and 27 commercial), and 85 local commercial channels

per household, with collection rates as low as 45% in 2010.[99] State aids to public broadcaster RTV are to be maintained in the future, as expressed in the Media Strategy of Serbia.

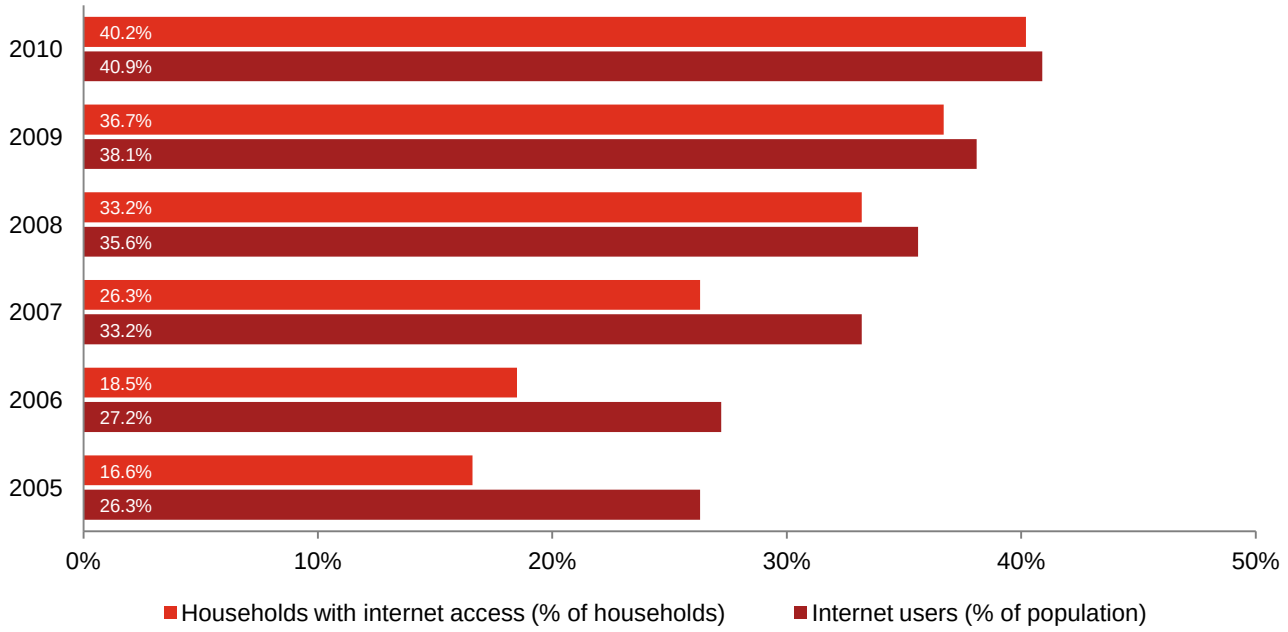
Television advertising expenditures amounted to EUR 90 million in 2009, accounting for nearly 60% of all advertising expenditures in Serbia.[100] Europe Economics reports a slightly lower total amount,[101] noting that the total spending is considered to be insufficient to support such a large number of broadcasters. Television advertising revenues are concentrated, dominated by public service broadcaster RTS (Radio Televizija Srbije) with EUR 35 million, leaving the remaining EUR 60 million advertising revenue for the five national commercial and other regional and local broadcasters in 2009.

Serbia's internet statistics

Internet statistics of Serbia show significant increase in internet usage. 56% of the Serbian population used internet in 2011, with 41% using the internet every day.[102] This means a 36% y-o-y growth from 2010 to 2011. The younger generations have a prominent role in internet usage, as 43% of all Serbians aged 12-29 use the internet as their main information source. The growth of the Serbian internet penetration is also supported by the growth in the number of households with a computer.

Figure 44 Internet penetration in Serbia

Source: ITU



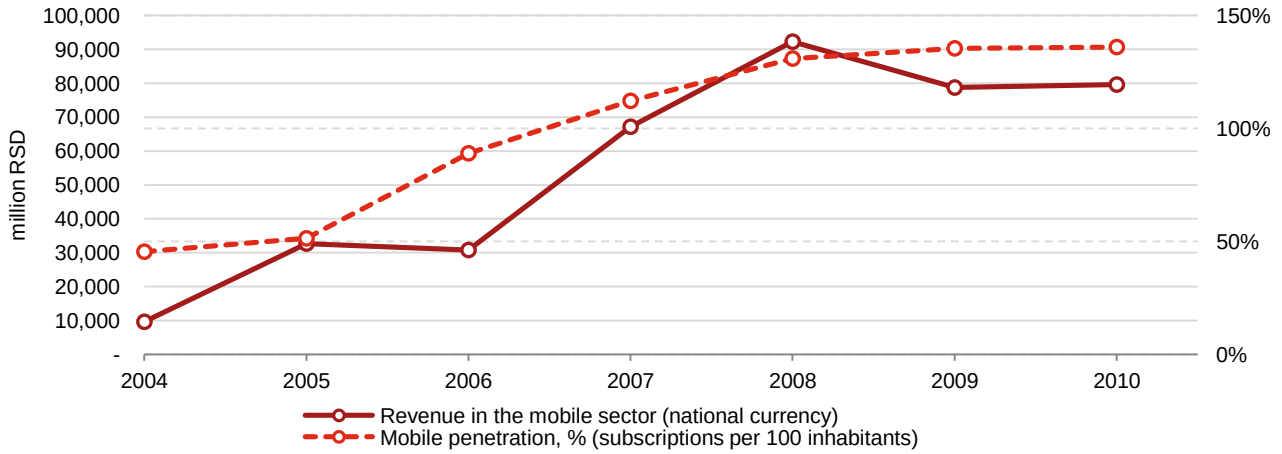
The mobile industry in Serbia

The mobile industry is the main engine of Serbian electronic communication services: 57% of all investments and nearly 53% of all revenues in the telecommunications sector of Serbia were realised in the mobile segment in 2011, as reported by RATEL.[103] Two of the three mobile operators licensed by RATEL are owned by foreign companies, Telenor[104] and Vip mobile[105]. Local provider MTS is 100% owned by the state, and can boast with the most geographically widespread UMTS coverage of around 70%, thereby reaching nearly 85% of Serbia's population. In contrast, Telenor and VIP mobile UMTS services reach 60-65% of the population with a 20-30% geographic coverage. These numbers also indicate the fairly high concentration of Serbian mobile subscribers. Increase in sector revenues was over twofold in the 2005-2010 period, as it is indicated below.

[99] Media Strategy of Serbia, 2011
[100] AGB Nielsen, 2012
[101] Europe Economics, 2010
[102] IPSOS, 2011
[103] RATEL, 2012
[104] 100% owned by Telenor A/S, Denmark
[105] 100% owned by Mobilkom CEE Beteiligungsverwaltung GmbH, (Mobilkom Austria Group)

Figure 45 Mobile penetration and revenues in the mobile industry in Serbia

Sources: BMI, ITU

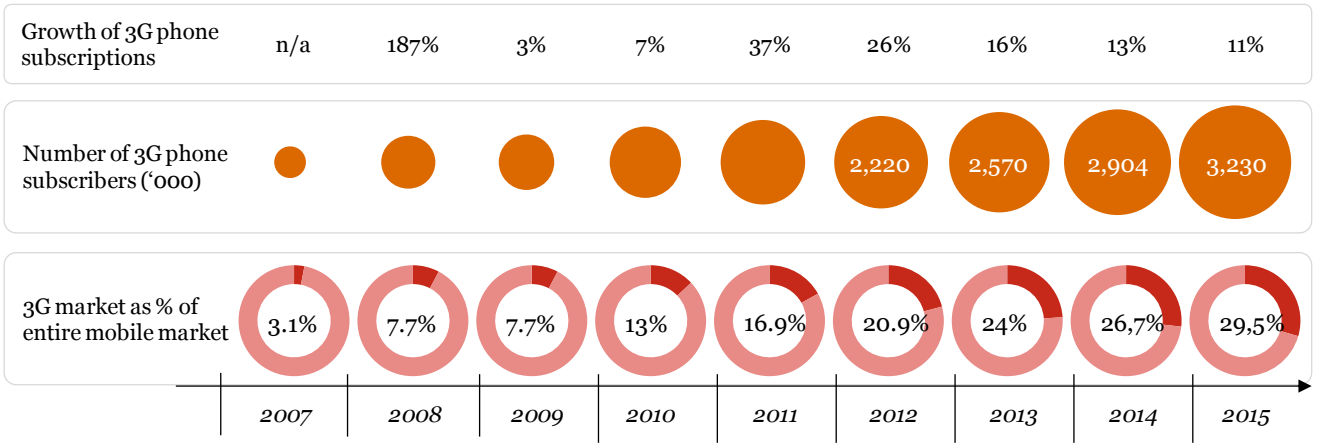


Mobile network operators (MNOs) are currently active in the 890-914/935-959 MHz (P-GSM) frequencies of the 900 MHz band, with license renewals pending in 2016.[106] Telephone service in this band is evenly exploited throughout the country, but RATEL claims that new frequencies in the lower bands would be required to ensure a sufficient 3G/4G coverage in rural areas. Frequencies 410-420/420-430 MHz are currently allocated to CDMA mobile broadband communications. The 880-890 MHz/925-935 MHz (E-GSM) bands are currently allocated to the military, with plans to free up the spectrum for mobile services, according to RATEL.

Mobile penetration appears to be reaching its saturation point at nearly 143% in 2011, after a CAGR of around 15% in the past eight years. The nearly 11% increase of last year can partially be explained with statistical corrections, as the results of the 2011 census indicated a decrease in the country's population. Yet the total number of 3G network subscribers has increased nearly tenfold during the five year period until 2011.[107] The numbers summarized briefly in the following tables indicate the large potential that exists for mobile broadband services in Serbia.

Figure 46 Mobile 3G internet services in Serbia

Source: ITU



[106] An automatic extension is applicable given the service provider fulfilled its obligations
[107] RATEL, 2012

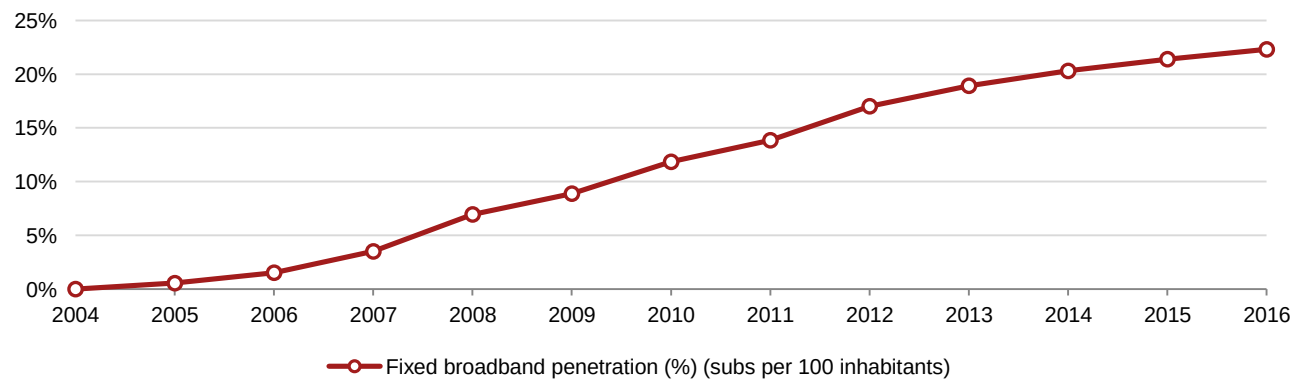
The value of the digital dividend in Serbia

International studies show that households' growing internet access in a specific country has positive impacts on economic growth.[108] They also established an association – mostly through econometrical calculations – between broadband penetration growth and increase in job creation and productivity by traceable percentage points. Through the emergence of UMTS networks, the mobile industry is able to provide data services to subscribers that increase the accessibility of broadband services in the economy. The ubiquity of mobile services, stemming from its wireless nature, ensures that these services will have significant impact on internet penetration. In this section we describe the Serbian broadband market and analyse the economic impact of different broadband technologies among them 3G mobile service. We assume that the allocation of the digital dividend involves an increase in broadband penetration, based on which we can estimate future GDP growth, employment and productivity trends.

Serbia's residential internet market is currently determined by fixed broadband access services. Fixed services had more than one million subscribers at the end of 2011 and we expect this figure to grow steadily. Besides the penetration of personal computers this growth is also stipulated by the competition in the segment. The penetration of CATV services is above 40%, and the upgrade of these networks from analogue transmission to euroDOCSIS 3.0 standard presents ever increasing competition to the currently dominant ADSL service. Due to these factors we estimated a dynamic growth in the sector in the upcoming periods.

Figure 47 Fixed broadband subscriptions per 100 inhabitants in Serbia (%)

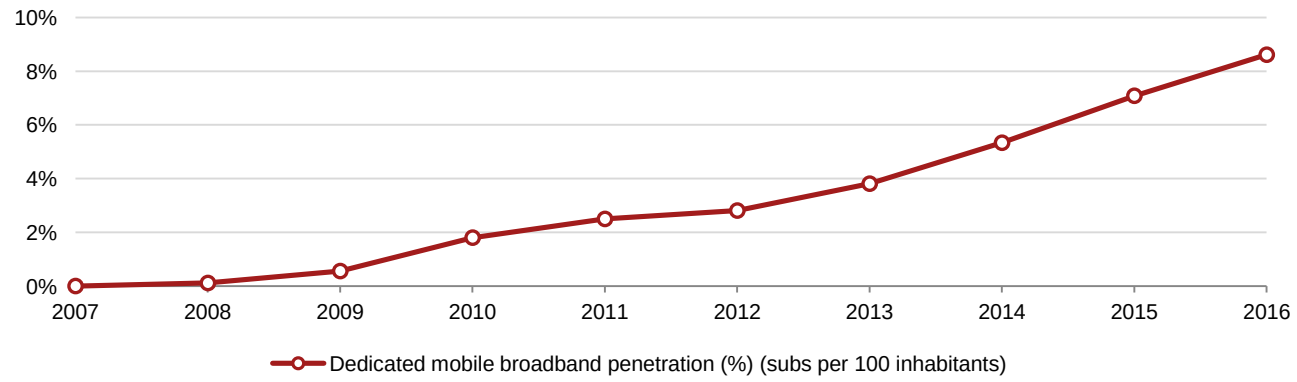
Source: PwC



The penetration of mobile broadband services is also growing dynamically in Serbia. Our estimations on the penetration of dedicated mobile broadband services excluding broadband services supplementary to mobile voice services are displayed in Figure 48 below.

Figure 48 Dedicated mobile broadband subscriptions per 100 inhabitants in Serbia (%)

Source: PwC



In order to calculate the effect of increasing mobile data subscriptions on the economy, we estimated the percentage of those subscriptions that would actually increase household penetration. Many subscriptions are

[108] ITU, 2012

purchased in order to achieve mobility while the user also subscribes to a supplementary fixed broadband service. We consider that those subscriptions which act as a substitute of the fixed service will increase the actual household penetration. We estimated that 50% of dedicated mobile broadband services activated in Serbia would increase the household penetration of broadband internet services.

Figure 49 Broadband penetration in Serbia, 2010-2016

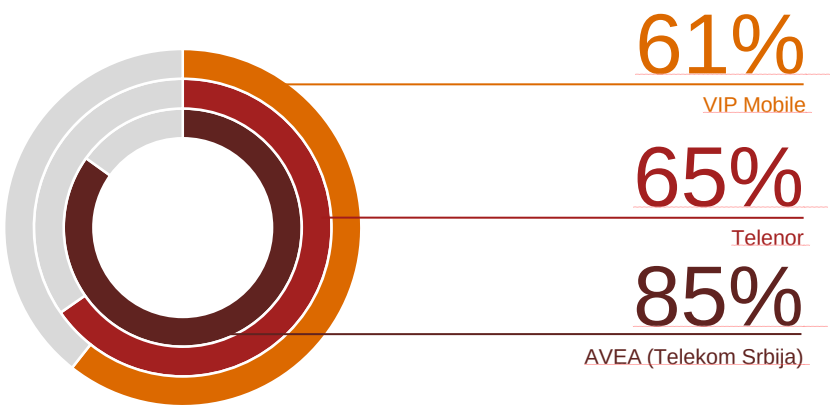
Source: PwC

	2010	2011	2012	2013	2014	2015	2016
Penetration	13.6%	16.4%	19.8%	22.7%	25.6%	28.5%	30.1%
Penetration without mobile	11.9%	13.9%	17%	18.9%	20.3%	21.4%	22.3%

In our macroeconomic model, we calculated and forecasted the impact of the broadband effect on the growth of GDP, employment and productivity.[109] Our original hypothesis stated that the allocation of digital dividend will affect the growth of household broadband penetration by making the service accessible in such rural areas where higher frequencies made the network roll-out uneconomical. RATEL published the following figures on the coverage of Serbia's population by UMTS networks.

Figure 50 UMTS network coverage by population

Sources: VIP Mobile, Telenor, AVEA



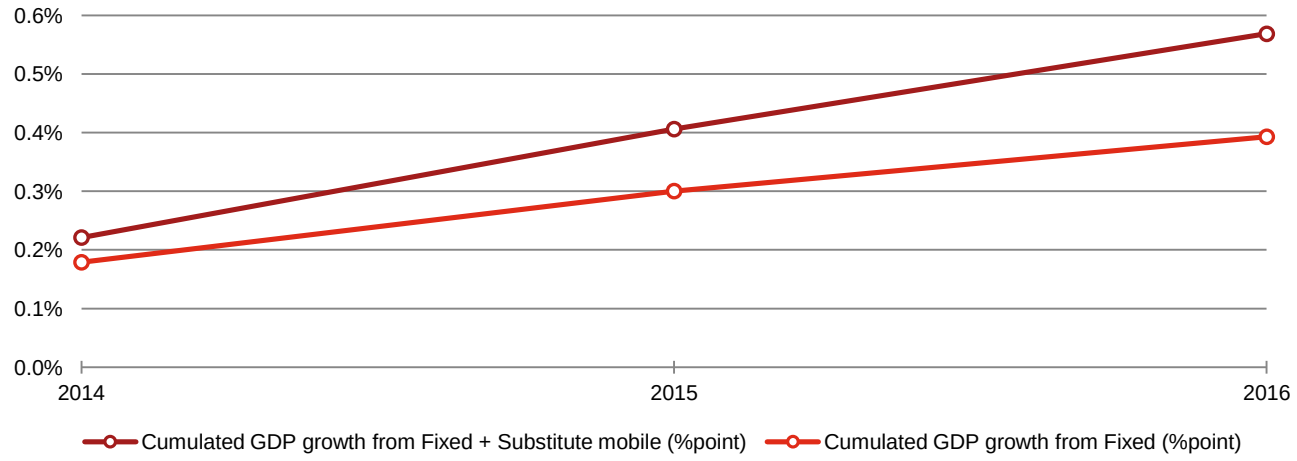
By allocating the 800 MHz band to the mobile operators, the latter would receive a frequency by which they would be able to cover rural territories with broadband service at a relatively low CAPEX. This way, mobile operators could not only supply communities that currently fall outside of 3G coverage, but could also increase the possibility of choice in other areas. We must note, however, that the allocation of 800 MHz band is also necessary for maintaining the current trend of mobile broadband take-up as it provides spectrum for gearing the capabilities of the mobile network to the ever increasing subscriber data rate requirement.

Figure 51 below shows the cumulated positive effect of increasing the coverage of broadband mobile networks by allocating the 800 MHz band to them. Overall, the growing number of mobile subscriptions will have a positive effect on the GDP, as it increases the number of households equipped with mobile subscription. By increasing the territory reach of the mobile networks, DD1 allocation would further raise the positive effect on GDP by making mobile broadband service accessible to households that otherwise fall outside of 3G coverage.

[109] ITU, 2012

Figure 51 Cumulated GDP effect of broadband access services (percentage points)

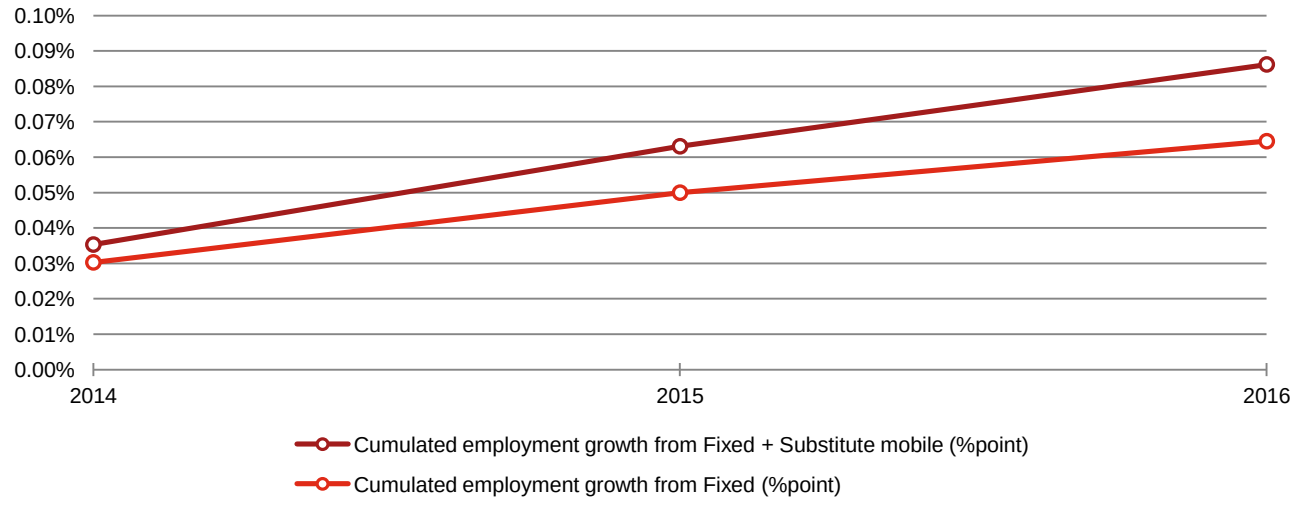
Source: PwC



According to the international analysis referred to earlier, broadband penetration also has a positive effect on the employment of the respective country. This effect derives from the characteristics of the Serbian market conditions. Our estimations are presented in the figure below.

Figure 52 Cumulated employment effect of broadband access services (percentage points)

Source: PwC



The digital dividend in Serbia

Frequency release process – Serbia's DSO strategy

The current DSO Strategy of Serbia is defined by a number of documents and laws. The *Strategy for the transition from analogue to digital radio and televisions programs in the Republic Serbia*[110] (Strategy) has been published in 2009 with the goal of defining the framework for the DSO process in the Republic of Serbia. The document has been amended in March 2012 after it became evident that the April 2012 deadline for ASO will not be met. The *Decision on amendments to the Strategy for Switchover from Analogue to Digital Broadcasting of Radio and Television Programs in the Republic of Serbia*, (Amendment)[111] published in 2012 does not specifically define a new deadline for the DSO to be completed by, but refers to the 17/6/2015 deadline set by the Geneva 2006 Regional Radiocommunication Conference (RCC-06) organized by International Telecommunication Union (ITU).

The Strategy and later the Amendment did not provide all the details necessary for the DSO, but the latter specifies the laws that would govern the DSO process. The Amendment also includes an update to the detailed action plan which assigns developing further details of the regulatory framework, technical and economic issues of the DSO process to the respective governmental bodies and regulators. A comparison of selected key milestones set in the action plans of the 2009 and the 2012 strategic documents can be found in Figure 53 below. Key elements of the resulting Serbian DSO strategy are outlined in the following sections.

Serbia has developed its Digital Switchover Strategy in 2009, parts of which later have been modified in 2012. The strategic documents indicate that the country is open to make the DD1 frequencies available for mobile services, in compliance with the EU and ITU agreements and suggestions. The strategic documents clearly point to that in order to make the 800 MHz frequencies available for further utilisation, the digital switchover (DSO) has to be completed, as Serbia currently lacks the sufficient amount of free frequencies to make the required 72 MHz band available by channel relocations only.

Figure 53 Selected key milestones in the Strategy of 2009 and the 2012 Amendment of the DSO Strategy

Source: DSO Strategy of Serbia

Selected key milestones	Deadline as of 2009	Deadline as of 2012
Rules on switchover from analogue to digital broadcasting and multiplex access in digital terrestrial broadcasting	Q2 2010	Realised in 2012
Realisation of distribution network	Q3 2011	Q4 2014
Decision of the allocation of digital dividend	Q1 2012	Q1 2015
ASO	April 2012	June 2015

Key public organisations responsible for the DSO process

The key government organisations responsible for the DSO process are defined in the revised action plan of the Strategy, published along with the Amendment in 2012. The action plan assigns specific tasks to public organisations, ministries, and regulators. Each action defined in the action plan has a distinct proposer, adopter, executer, and supervisor body assigned, with the respective – and updated – deadlines as well as the expected results.

[110] Official Gazette of the Republic Serbia no. 52/2009
[111] Official Gazette of the Republic Serbia no. 18/2012

Most propositions concerning the further elaboration of the regulatory framework[112] are assigned to the Ministry for Foreign and Internal Trade and Telecommunications (MTT or MCMIS),[113] while the Republic Agency for Electronic Communications (RATEL) and the Republic Broadcasting Agency (RBA) are made responsible for elaborating the regulation concerning the existing broadcasting licenses. Compliance with the respective EU regulation is assigned to the Ministerial Council (hereinafter: MC).[114]

Technical issues related to Serbia's DSO are generally planned to be addressed by RATEL, while the actions concerning the physical infrastructure for digital broadcasting are assigned to the network operator National Broadcasting Operator (Emisiona Tehnika i Veze – ETV).

Remaining questions concerning the financial aspect of the DSO are to be managed by the MTT, while the "financial plan for realisation of digital broadcasting network of the Republic of Serbia and the implementation dynamics of the investments" is assigned to the public enterprise ETV which operates the broadcasting equipment.

Finally, most tasks concerning the information and promotion of the DSO (such as operating a dedicated website, TV advertisement, direct mail, print media, retailers, dedicated call centre) are to be managed by the MTT and ETV. The campaign has partially commenced by Q1 2012 according to RATEL, around two years late from the deadlines defined in the country's original DSO action plan.

Timeframe and modularity of the DSO & ASO processes

Fundamental changes were applied to the Strategy with the March 2012 Amendment regarding the timeframe and modularity of the DSO process in Serbia. The 2012 Amendment introduces a more realistic, geographically phased DSO approach, based on a timetable to be adopted and communicated by the Government in due course. The Amendment specifies the 17/6/2015 deadline for the ASO, in compliance with the Geneva 2006 Agreement (GE06).

Switch-off phasing is driven mainly by the limited amount of frequency available, rendering long term simulcast periods unfeasible. Regional ASO dates are to be communicated to the public by the Government as early as 9 months ahead, while the specific DSO amendment which sets the deadline shall prescribe a maximum of 6 months wide local simulcast window for analogue broadcasters.

The ASO is planned to be realised through a phased 'digital island' approach. Separate DTT regions are to be defined by the Government with a specific timetable for DSO and ASO in each.[115] The ASO in the selected region has to be completed within a 6 month period from the commencement of simulcast DTT in the respective region. Once the ASO has been realised, a public DTT license holder will have covered no less than 90% of the population, or 60% in case of commercial channels, as per the Broadcasting Law.

Technical details of the DSO in Serbia

Once complete, the nationwide digital terrestrial broadcast will be transmitted from 250 locations throughout the country,[116] whereas the current initial digital network is being transmitted from only 13 transmitters and 2 gap filler stations.[117] Further 25 site preparations are currently underway. Experts warn about the seasonal and topographical difficulties in upgrading the existing analogue transmitters which were formerly owned by the state television RTS (Radio Televizija Srbije). Total cost of the upgrade is expected to range up to EUR 75 million, according to the DSO Strategy of Serbia, and the broadcasting network is planned to be operated by public enterprise ETV. The transition can be further hindered by the unpreparedness on the receiving side, as DVB-T2 capable receiving equipment is at this time practically unavailable on the retail market.

As a result of the DSO, frequencies 790 to 862 MHz (channels 61 to 69) are planned to become available as a digital dividend (DD1) for future utilisation after the DSO/ASO process, in compliance with the EU and ITU agreements and recommendations. While analogue broadcasting currently spans across frequencies 174-230

[112] In practice some additional technical issues such as DTT network planning, site renovation, certain financial aspects and information campaign duties are also the responsibility of the Ministry, according to Telenor Serbia.
[113] Formerly: Ministry of Telecommunications and Information Society (MTIS)
[114] According to the action plan. Responsible Ministries and regulatory bodies have full responsibilities for implementation of EU regulatory framework, while Ministerial Council is meeting occasionally and does not have any greater influence in this process, according to Telenor Serbia.
[115] Amendment to the DSO Strategy of Serbia, 2012
[116] Total number of analogue transmitters in UHF band is around 850
[117] Digital TV signal broadcast to 15 sites listed in Annex 4 of the Plan allocation of frequencies / locations for terrestrial analogue FM and TV broadcasting stations in the territory of the Republic of Serbia

MHz and 470-862 MHz, digital terrestrial television is planned to occupy a limited amount of frequencies in the lower UHF band[118] (frequencies 470-790MHz, equivalent to channels 21-60).

DVB-T2 with a single frequency network (SFN) structure is identified as the preferred broadcasting technology, as per the current DSO Strategy of Serbia. This means an increased network capacity and fewer transmitter sites required, as compared to the DVB-T standard. An MPEG-4.10 (H.264/AVC) compression method is to be used for encoding the DTT broadcast. Currently there is no obligation imposed for the introduction of mobile TV (DVB-H) in Serbia.

A maximum of five multiplexes[119] (hereinafter: MUXs) are envisioned to operate in the current DSO Strategy of Serbia. The sole MUX operator in Serbia is the network operator ETV with a permit to commission and operate MUX1 and MUX2 in the specified UHF channels during the DSO period. The Strategy allows the operation of further multiplexes by the private sector "provided there is a market need and it is financially feasible to do so".[120] One MUX will have a channel within each of the 15 distribution zones specified by the Strategy.

Access to the MUXs will be granted via a weak multiplex model, initially to all broadcasters which already own a license for analogue broadcasting, as defined in the *Rules on Transition from Analogue to Digital TV broadcasting and Access to the Multiplex in Terrestrial Digital Broadcasting*.[121] Specifically, broadcasters with a national and/or regional license will have access to MUX1, while local coverage broadcasters will be provided access to MUX2 free of charge for the time of the DSO period, by the Republic Broadcasting Agency (RBA). To date a total of 10 TV channels in SD quality and one in HD quality have been[122] authorised by RATEL.

Changes in licensing and permitting

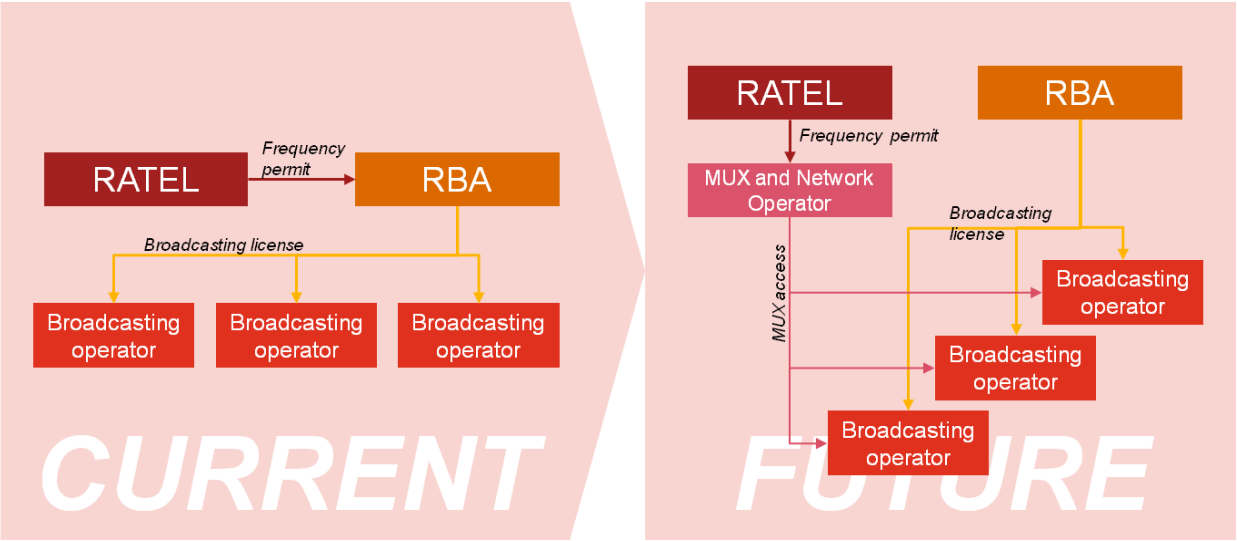
Existing broadcasting licenses issued by the RBA will expire from 2014 to 2018[123], until which period the broadcasting companies need to secure new licenses in order to continue their operations. All frequency usage permits issued for analogue broadcasting in the 174-230 MHz and 470-862 MHz frequency spectrums by RATEL expire on the ITU deadline for ASO in 2015.

None of the broadcasters with existing broadcasting licenses will be required to pay any fees (including additional license fees) for the time of the DSO process. Existing radio frequency permits expire by 16/6/2015 the latest, the day before the RRC-06 final deadline for ASO, also applicable in Serbia. Changes in the licensing and permitting model are illustrated in Figure 54 below.

[118] This is planned so in order to minimise interference with the digital dividend band and thereby maximize its utilisation capability
[119] "The bit rate in the multiplex is at least 2 Mb/s for individual television program that is broadcasted in standard resolution (SDTV) and 5 Mb/s in high resolution (HDTV) [when coded with a constant bit rate. In case of variable encoding, the] required quality of signal [must be ensured]". Source: Amendment to the DSO Strategy of Serbia, 2012
[120] Amendment to the DSO Strategy, 2012
[121] Official Gazette of the Republic Serbia no. 55/2012
[122] RTS 1, RTS 2, RTS Digital, Pink, B92, Prva TV, Avala, Happy TV, RTV 1, STB, and RTS HD
[123] According to RATEL. Licenses expire in a period up to 2019, according to Telenor Serbia.

Figure 54 Current and planned licensing and permitting models in Serbia

Sources: DSO Strategy of Serbia, Media Law



The current licensing framework is suitable for the digital switchover process, according to the answers to the *Questionnaire the Decision on amendments to the Strategy for Switchover from Analogue to Digital Broadcasting of Radio and Television Programs in the Republic of Serbia (Amendment)*[124] and other relevant bylaw provides for the minimum licence conversion requirements for the transition from analogue to digital broadcasting. However, the final legal and regulatory framework (e.g. the new Law on Electronic Media) has to be elaborated.

Broadcasting licenses are to be awarded by a public tender called for by RBA.[125] Frequency assignment and allocation will continue to remain the responsibility of RATEL, similarly to current regulation. Frequency fees determined by the regulator RATEL are subject to Government approval. Further regulation will be required regarding the legal process of allocating broadcasting operators to MUXs once the ASO is complete and current broadcasting licenses expire between 2014 and 2018. The lack of comprehensive regulation remains to be a risk for the period between the ASO and the expiry of the remaining analogue broadcasting licenses.

Business model and state financing

Both public and commercial television channels are planned to be broadcasted on the MUXs in a free-to-air business model, similarly to the current analogue transmission.

A state subsidy of up to a planned EUR 75 million would be available for the physical network development, to be secured from international loans with payback periods starting in 2015, as per the Strategy.[126] To date EUR 10.5 million EU pre-accession funds were spent on digital broadcasting equipment, the necessary regulatory framework analysis, procedural changes within regulators procedures, as well as for the information campaign; while the cost of related site preparations funded by the State was not made public.

The complete digital switchover process is expected to cost between EUR 87 million to EUR 115 million, depending on the scenarios set in the Strategy. Subsidies are not planned to be available for multiplex operators, broadcasting companies, or TV channels, as per the DSO Strategy of Serbia. Finally, the Strategy discusses three set-top box (STB) subsidy scenarios in the range of EUR 15 million to EUR 40 million; thereby enabling end users to purchase appliances at reduced prices or, according to some scenarios, even at no cost.

- Scenario #1: Subsidy for purchasing one STB per household for all users that receive television programs solely by terrestrial reception (subvention of EUR 25 per household, totalling around EUR 37.5 million);

[124] Official Gazette of the Republic Serbia no. 18/2012
[125] Details of the public tendering process are defined in Article 49 of the Broadcasting Law
[126] Serbia to invest up to EUR 115 million into the DSO

- Scenario #2: Subsidy for purchasing one STB per household for all users (approximately 1,6 million units) that pay subscription fee (the subvention is EUR 25 per household, totalling around EUR 40 million);
- Scenario #3: Subsidy for purchasing STBs for the socially endangered persons (around 300,000 units), totalling an overall cost of EUR 15 million.

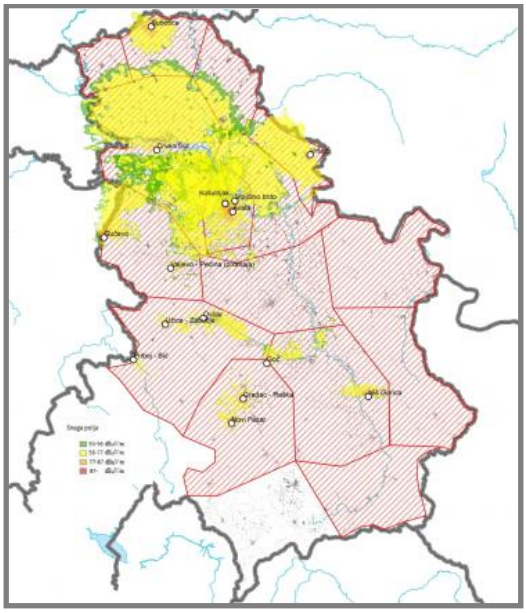
Realisation of the DSO strategy

The digital switchover appears to be hindered by various factors in Serbia. The initial DVB-T2 digital network which is currently in operation has been launched for test purposes on 21/3/2012 by ETV[127]. The test signal is accessible to around 40% of the Serbian population, as it currently operates in a reduced power mode in order to prevent unwanted interferences. Public information campaign has partially commenced in 2012.

The installation of digital broadcasting equipment commenced in February 2011, and has been co-funded from a EUR 10.5 million EU IPA (Instrument for Pre-Accession Assistance) grant. The grant was provided in the form of physical equipment, while site preparation works were done by the state. Experts expect that the initial digital broadcast will serve as an incentive for the introduction of DVB-T2 compatible[128] equipment, such as STBs and TV sets, on the retail market.

Figure 55 Geographic coverage of the initial DVB-T2 broadcast in Serbia, 2012

Image adopted from: digitalnaagenda.gov.rs



Other conflicting spectrum uses – releasing the 800 MHz band

The radio frequency rearrangement in Serbia is planned to result in a new frequency layout that is in accordance with the RRC-06 harmonised recommendations. The risk of harmful interferences in the DD1 frequency band following the 2015 ASO deadline still remains, as studies[129] note the presence of unlicensed local analogue radio and television broadcasts. Authorities so far proved to be ineffective in closing down these illegal services.

The 880-890 MHz and 925-935 MHz (E-GSM) band is currently allocated to the military and mobile (IMT) services, and RATEL claims that there is no further military radio usage in the DD1 band. RATEL and Telenor Serbia also claim that there are plans to free up the band for mobile services upon the finalisation of the auctioning process. With regard to PMSE activity in the 800 MHz band, RATEL indicated that only temporary permits are being issued in Serbia. Still, to date the impact of mobile use of the DD1 frequency blocks on PMSE devices currently in use has not been assessed.

[127] A DVB-T trial broadcast commenced as early as 2005 in Serbia, while the DVB-T2 broadcast which complies with current standards commenced in 2012. Source: DVB.org
[128] See specifications under the section on technical details of the DSO
[129] Europe Economics, 2010

The Strategy expects that there will be no cross-border coordination issues, as surrounding countries will also have completed the DSO process by 2015 and they also claim to have adopted the recommendations of the ITU. In any coordination issues, GE06 harmonisation mechanisms would apply, as per the Strategy. However, some coordination will probably be necessary, especially in the northern areas where interference issues arise at border areas due to the flat topography of the region.

Allocation and assignment of the DD1

The decision on the allocation of the digital dividend is scheduled for Q1 2015 in the Amendment to the DSO Strategy of Serbia. The Media Strategy of 2011 envisages the DD1 frequencies to be used for mobile broadband services, in order to facilitate the "social progress, particularly for citizens from rural environments who, due to the lack of a fixed cable network, are unable to even access contemporary internet services".[130]

The Strategy does deliberately not provide a detailed plan for the DD1 allocation or the award mechanism after the ASO, though RATEL considers auctioning to be the best way to assign the frequencies. Assignment can commence once a new national radiofrequency band allocation plan has been adopted. Technical conditions of the DD1 allocation are planned to be in compliance with the EU recommendation no. 2010/267/EU. Any further frequency allocations for mobile services below 790 MHz would be possible upon a revision of GE06, according to RATEL.

[130] Media Strategy of Serbia, 2011

Recommendations

Recommendations concerning the DSO process

Schedule DD1 allocation and assignment process ahead of current deadline

Serbia currently has a well developed strategy governing the DSO process. The DSO Strategy also lays down the foundations for the future utilisation of the DD1 band. The DSO Strategy of Serbia was updated in 2012, and now offers an up to date and clear roadmap for the DSO process with a modified switch-off date set to 17/6/2015. The Strategy also includes a detailed action plan with clear institutional mandates and deadlines.

However the Strategy does not provide specific details regarding the future utilisation and/or the allocation process of the DD1 band which is to be released after the DSO/ASO processes. Economic and social benefits could be realised and the DSO/ASO process could be fostered by the broadcasting and mobile services market players, under clear regulatory conditions regarding the DD1 allocation and assignment process. A fair amount of uncertainty exists among market players due to the current approach taken in the Strategy which refrains from laying down the necessary rules. The example of the US digital dividend policy and GSM program shows that an early decision could accelerate the process.

The scope of the DSO Strategy of Serbia does not allow a detailed plan on allocating and assigning the DD1 band. Instead the Strategy assigns the proposition, adoption, execution and supervision of the decision on the allocation of the DD1, to the respective authority and/or regulator with a Q1 2015 final deadline for execution. This approach is appropriate as the decision requires a detailed elaboration. At the same time the Government of Serbia would be able to realise its goals more efficiently by creating the rules of the allocation and assignment processes, as in return these regulations would allow broadcasters and mobile service companies to anticipate future market trends and foster the realisation of the Strategy.

Therefore we recommend that the Government of Serbia take the necessary steps towards identifying the specific authority responsible for the DD1 allocation and assignment processes. We also recommend that the Government of Serbia take the necessary steps towards creating the specific regulatory background under which the allocation and assignment procedures would be carried out. The dates and conditions of the ASO should be communicated effectively to the public and the awareness of the ASO should be monitored, once they are finalised.

Implement regulation concerning outstanding analogue license conversion

The current licensing framework is suitable for the digital switchover process, according to the answers to the *Questionnaire the Decision on amendments to the Strategy for Switchover from Analogue to Digital Broadcasting of Radio and Television Programs in the Republic of Serbia (Amendment)*[131] and other relevant bylaw provides for the minimum licence conversion requirements for the transition from analogue to digital broadcasting. Broadcasting licenses are to be awarded via a public tender called for by RBA.

The amended DSO Strategy and the relevant bylaws[132] already provide for the necessary procedures for converting the valid analogue broadcasting licenses to digital ones. Frequency allotment and allocation will continue to remain the responsibility of RATEL, similarly to current regulation. Frequency fees determined by the regulator RATEL are subject to Government approval.

However a number of analogue broadcasting licenses are set to expire only by 2018, well after the 2015 deadline for ASO. The ASO and DD1 allocation processes could be hindered in case the analogue broadcasting license conversion process experiences delays in execution. The final legal and regulatory framework (e.g. the new Law on Electronic Media) also has to be elaborated.

Therefore we recommend that the responsible authorities elaborate and implement the necessary framework until the ASO deadline the latest. Also, the necessary administrative capacity has to be made available in the Government.

Clarification required regarding state funding and subsidies

Broadcasting equipment for the digital terrestrial network is planned to be financed from international loans. Serbia already uses broadcasting equipment worth around EUR 8 million which is completely funded from EU

[131] Official Gazette of the Republic Serbia no. 18/2012
[132] Rulebook on the Switchover from Analogue to Digital Broadcasting of Television Programmes and Access to the Multiplex in Terrestrial Digital Broadcasting

pre-accession funds. The current digital terrestrial broadcasting infrastructure consists of 15 stations, whereas the planned network is to count a total of 250 transmitters, once it is ready. Total cost of the DVB-T2 capable broadcasting equipment is expected to around EUR 115 million, according to the strategy. The equipment is planned to be financed from international loans, as per the DSO Strategy of Serbia.

However, it is still not clear whether the country will be able to access such loans, an uncertainty which puts the success of the DSO process at risk. Further uncertainty exists regarding the plans concerning the households which currently are only capable of receiving analogue terrestrial television broadcast. The DSO Strategy of Serbia outlines three distinct scenarios with the respective costs ranging from EUR 15 million to EUR 40 million. With 300,000 socially or economically vulnerable ATT-only users the political and financial support has to be maintained.

Therefore we suggest that the Government of Serbia keep the financial burden of the set-top boxes at minimum, while ensuring that vulnerable households do get access to the necessary equipment. At the same time any state aid should be carefully designed so as not to give undue preference to one commercial operator, broadcaster, or technology platform over the other. The best option for the time being could be to subsidize the vulnerable ATT-only users only supplemented with an effective help scheme (help desk, assistance at set top box installation, aerial adjustment etc.).

Broadcaster based phased ASO preferred

The current test digital terrestrial broadcast is widely believed to incentivise retailers to supply and consumers to buy DVB-T2 compatible receiving equipment. Also, the DSO Strategy of Serbia identifies a regionally phased approach for the DSO/ASO processes, which would also have an incentivising effect on retailers and ATT-only households.

However experiences indicate that there is still practically no DVB-T2 capable receiving equipment available on the retail market in Serbia.

Therefore we recommend a phased switch-off based on broadcasters. Under the first phase of the scheme commercial analogue broadcasters would be switched off, leaving only the national public channels available in the country. This would then serve as a better and more efficient incentive for ATT-only households to switch technology platforms. This approach would also be technology neutral.

Recommendations concerning the allocation and assignment of the DD1 band

Investigate E-GSM utilisation

The E-GSM band (frequencies 880-890/925-935 MHz) is currently allocated to the military according to the current frequency allocation table of Serbia. However, without an actual testing and detailed investigation the possibility of the E-GSM band being unused, cannot be ruled out.

Therefore, while we have no reason to believe that there is no military usage of the E-GSM band, we would still suggest an investigation conducted by an independent third party into the utilisation of the band. The Serbian allocation strategy then should be reconsidered, may the frequencies prove to be partially unused.

Utilisation of the DD1 frequencies

The allocation of the digital dividend could yield additional economic growth according to our calculations and economic modelling. These benefits can be fully realised once the analogue switch-off (ASO) is completed, and the frequencies in the DD1 band (frequencies 790-862 MHz, also referred to as channels 61-69) can be assigned to mobile uses.

However, a number of factors can prolong the DSO/ASO process. Serbia needs to find a solution for making sure vulnerable consumer groups are not left behind in the process to digital television, and the country also needs to tackle and manage cross-border interferences. Any complication in only one of the mentioned areas can cause a delay in clearing one or more of the channels in the DD1 band. Any delay in the assignment of the DD1 band could result in missed state income and delay additional economic growth related to broadband penetration in Serbia.

Therefore we suggest that Serbian national authorities focus on clearing and then auctioning the DD1 band as soon as it is possible. Also, we suggest that national authorities hold public consultations with industry players regarding the future utilisation of the DD1 band. Such public consultations would enhance the value of the

frequencies, as authorities could tailor the DD1 assignment process to the needs of mobile broadband market players, as illustrated in the *Regional suggestions and recommendations* section of this study. This in turn has the potential of increasing frequency license prices.

Country report – Turkey

This country report is an integral part of the *Digital dividend in Southeast Europe* study, but it is designed to function as standalone study if necessary. First we introduce the fundamental macro indicators of the Turkish economy, followed by a concise overview of the telecommunication sector in the country. We then estimate the macroeconomic impact of allocating the digital dividend for mobile broadband services. We provide insight into the current state of Turkey regarding the digital switchover process and the future utilisation of the digital dividend. The report concludes with recommendations for accelerating the DSO process and for the future utilisation of the digital dividend.

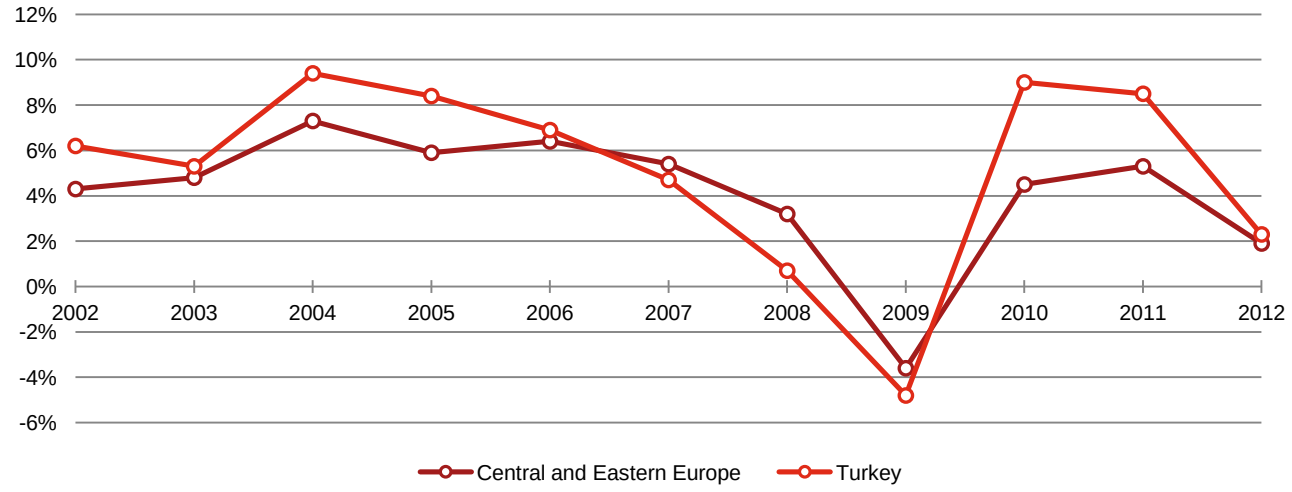
Country overview

The emerging country of Turkey is considered to be the sixth largest economy in Europe, and 18th largest in the world, based on its GDP amounting to around EUR 548 billion in 2011.[133] The Turkish economy also has outstanding outlook for the future, as the OECD predicts that the country will become the second largest economy in Europe by 2050. Turkey's real economic growth has so far followed the patterns of Central and Eastern Europe in a slightly more volatile manner, and the Turkish economy has a real growth outlook of over 4.5% year-on-year according to the IMF.[134]

Turkey has a close trade relationship with the EU, which is currently based on a limited free trade agreement. The EU27 countries rank no.1 in Turkish trade, both in terms of Turkey's imports (39%) from and exports (46%) to the EU.[135] With a trade-to-GDP ratio of around 40% the country has considerable domestic economic power. Government debt reached 35% to GDP in 2011.

Figure 56 Historical real GDP growth in Turkey and in the CEE region

Source: IMF



The population of Turkey reached around 73.6 million in 2011,[136] the third largest in Europe after Russia and Germany. Total number of households ranges up to over 18 million, based on a 4.1 person per household estimate by OECD. Over 71% of Turks are urbanised, nearly as high as the EU27 average of around 74%. Despite considerable GDP growth rates, GDP per capita is still less than half of the EU27 average of around USD 14.5 thousand. Unemployment rate of Turkey shows a declining trend in the recent years, after reaching its historic height of over 14% in 2009.

DD1 potential of Turkey

With over 66.1 million mobile telephone subscriptions the digital dividend has outstanding potential in Turkey. One option for utilising the digital dividend is to allocate the frequencies for mobile services. In the following sections the study briefly introduces the current television, internet, and mobile markets. Market trends underscore the assumption that the digital dividend holds great potential for Turkey.

Broadcasting market in Turkey

The vast broadcasting landscape of Turkey comprises nearly 18 million households equipped with a television. Television remained the primary source of information for most Turks in 2012, and the average Turkish person spends over five hours watching television every day, according to the national media authority RTÜK.[137]

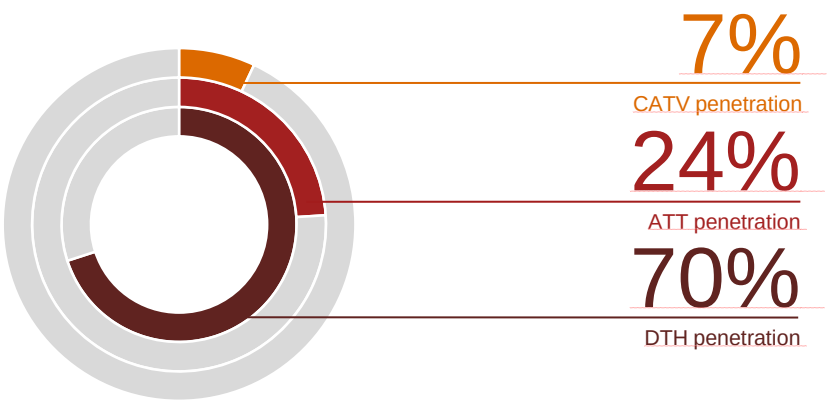
Some statistics indicate that all of Turkish households are equipped with a TV set, while other estimates conclude that two out of every 100 household does not own a TV. Around 70% of all households receive digital

[133] IMF
[134] IMF
[135] EC, 2010
[136] World Bank
[137] Euromonitor

television broadcasts through satellite, while subscription satellite household penetration does not come near 10%. With regard to other platforms, CATV penetration ranges up to over 7%, and IPTV penetration is still marginal in Turkey.[138]

Figure 57 Broadcasting technology platform penetration in Turkey

Source: OSF, and RTÜK



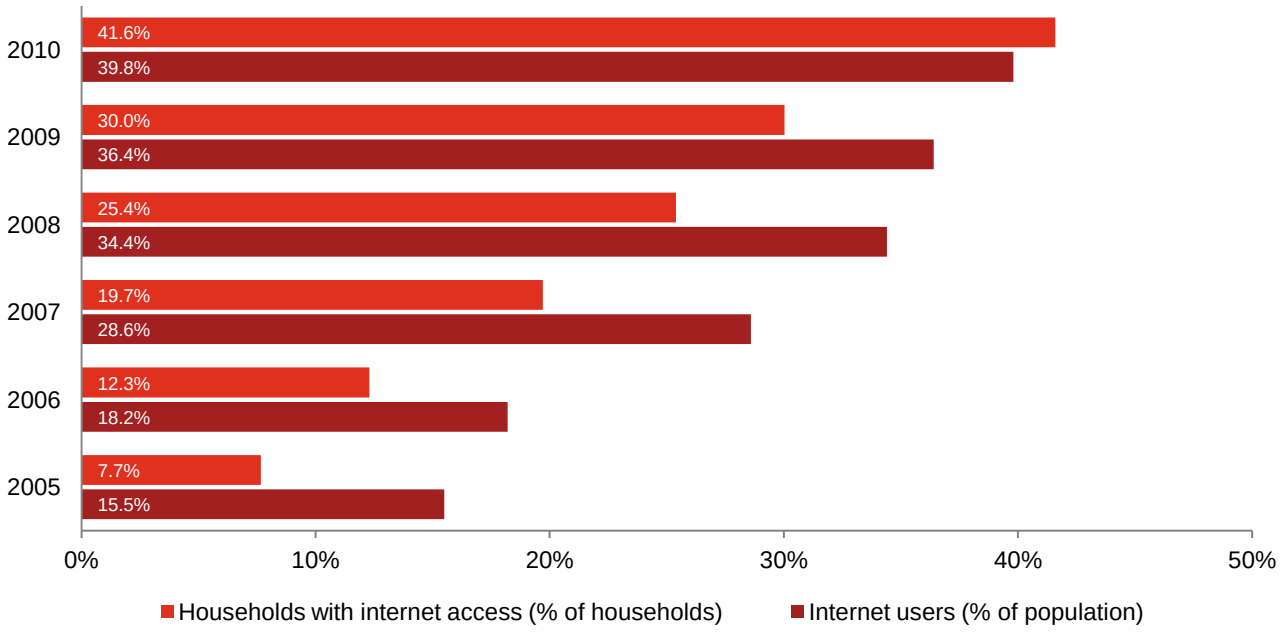
A significant amount, 23.6% of all households receive television broadcasts through a terrestrial platform. Trends indicate that terrestrial receivers are being replaced with DTH (satellite) platform since the beginning of the 2000s.[139] Digital terrestrial broadcasts have been available since 2006, after national broadcaster TRT (Turkish Radio and Television Corporation) launched its pilot DTT service from Istanbul and two further locations.

Turkey's internet statistics

Internet penetration shows a considerable growth in the last decade in Turkey. 47.2%[140] of all households had access to the internet. Nearly four out of ten people used the internet in 2010, following an over 260% growth from 2005 to 2010.[141] Most internet users use a broadband connection, according to ITU data.

Figure 58 Internet penetration in Turkey

Source: ITU



[138] PwC, 2011 and OSF, 2012
[139] OSF, 2012
[140] 2012 data, Source: Turkish Statistics Agency
[141] ITU, 2011

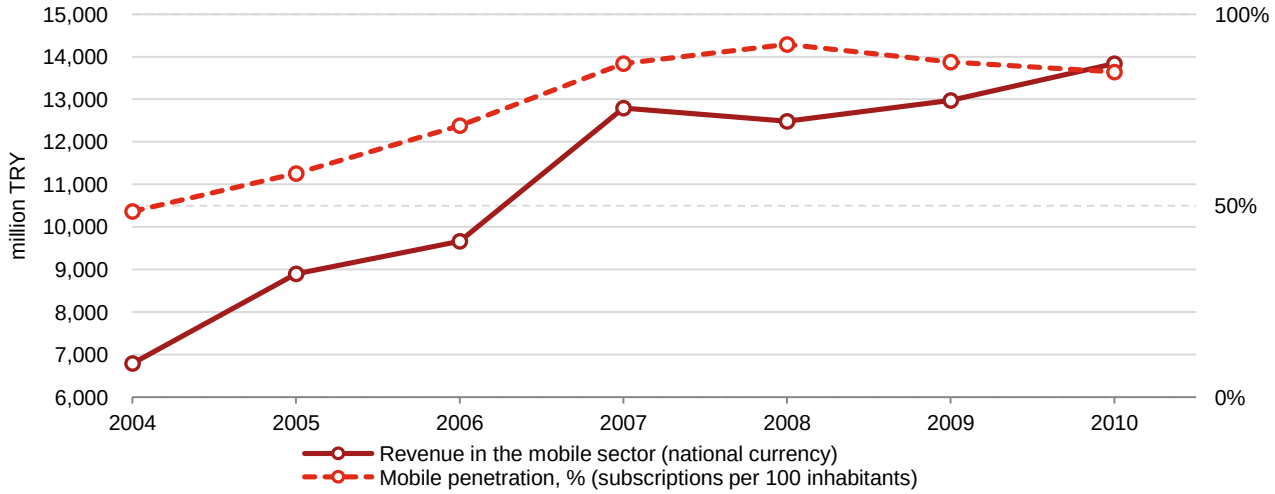
Mobile industry in Turkey

Three mobile network operators are available on the Turkish market. Turkcell is the dominant player with over 53% market share, followed by Vodafone and Avea with 28% and 20% market shares, respectively. The popularity of mobile telecommunications among users is indicated by the significant fall in fixed line telephone subscriptions, arriving at 16 million in 2010 from 19 million in 2004, according to BTK.

Total revenue in the mobile sector increased by over 50% in the five year period from 2005 to 2010. Revenues showed a slight decrease due to the economic downturn only in 2008. Growth has since recovered to levels of the years before the crisis. The number of mobile phone subscriptions peaked in 2008, and experienced a decline in the following years. However, recently published data of mobile service operators indicates that mobile line penetration recovered to nearly 90% in Turkey.[142] The growth in mobile penetration and the increasing demand for mobile broadband confirms the need for the allocation of the digital dividend to mobile services.

Figure 59 Mobile penetration and revenues in the mobile industry in Turkey

Sources: BMI, ITU



The P-GSM band (890-915/935-960 MHz) is allocated for GSM use by mobile network operators in the 900 MHz band, with licenses pending 2023 for Turkcell and Vodafone, and 2026 for Avea. However, frequencies are distributed unevenly among mobile network operators. The newcomer Avea has access to only a limited amount of frequencies in the 900 MHz band, at the same time the company has a considerable amount of spectrum assigned in the 1800 MHz band unlike its competitors which have none.

The E-GSM band (880-890/925-935 MHz) is not yet allocated to mobile services, which contributes to the scarcity of frequencies in the mobile services industry. BTK published its plan on new frequency assignments in the 900 MHz and 1800 MHz bands in July 2012. According to the decision, one block of 2x8.6 MHz E-GSM spectrum may be subject to tender for GSM operators that have less than 2x10 MHz of the 900 MHz band (applicable to Avea), and two blocks of 2x15 MHz of the 1800 MHz band may be subject to tender for GSM operators that have no 1800 MHz frequencies (applicable to Turkcell and Vodafone). Mobile operators in Turkey claim that further frequencies from the digital dividend would be required for realising an efficient 3G/4G coverage in the country.

Currently there are no mobile services allocated in the 450 MHz band, but the release of this spectrum is currently underway. The band is to be emptied by the end of 2013, according to BTK.

[142] Turkcell

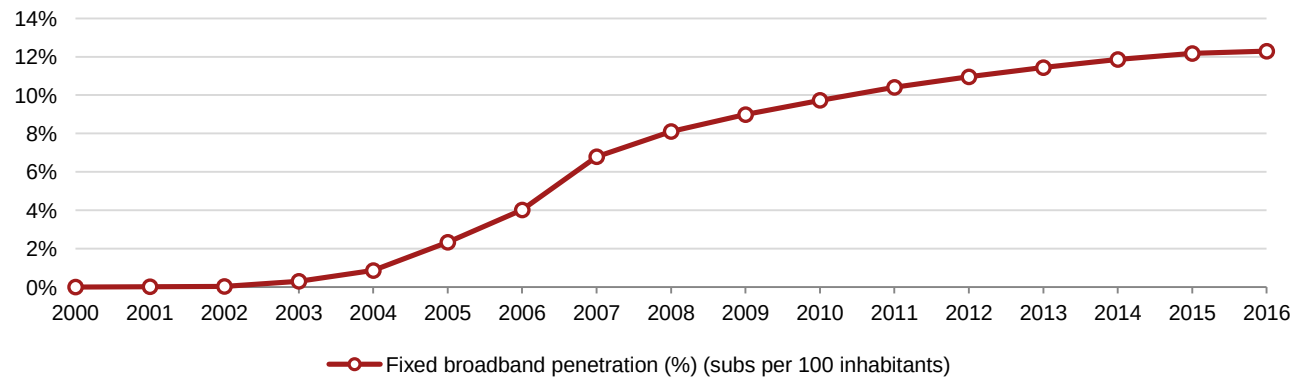
The value of the digital dividend in Turkey

Growth in the rate of household internet access has a positive impact on the economic growth of a country, international studies show.[143] Studies established an association – mostly through econometrical calculations – between the growth of broadband penetration and the increase in job creation and productivity by traceable percentage points. The mobile industry is able to provide data services to subscribers with the emergence of UMTS networks, which increase the accessibility of broadband services in the economy. The ubiquity of mobile services, which stems from its wireless nature, ensures that these services will have significant impact on internet penetration. In this section of the study we describe the Turkish broadband market and analyse the economic impact of different broadband access technologies among them 3G mobile services. Our assumption is that the allocation of the digital dividend involves an increase in broadband penetration, based on which we could estimate a forecasted growth in GDP, employment and productivity.

Fixed broadband penetration was 10.4% at the end of 2011 in Turkey. This figure is low in European comparison; however, we estimate further decrease in the pace of growth due to the rapid emergence of dedicated mobile subscriptions.

Figure 60 Fixed broadband subscriptions per 100 inhabitants in Turkey (%)

Source: PwC

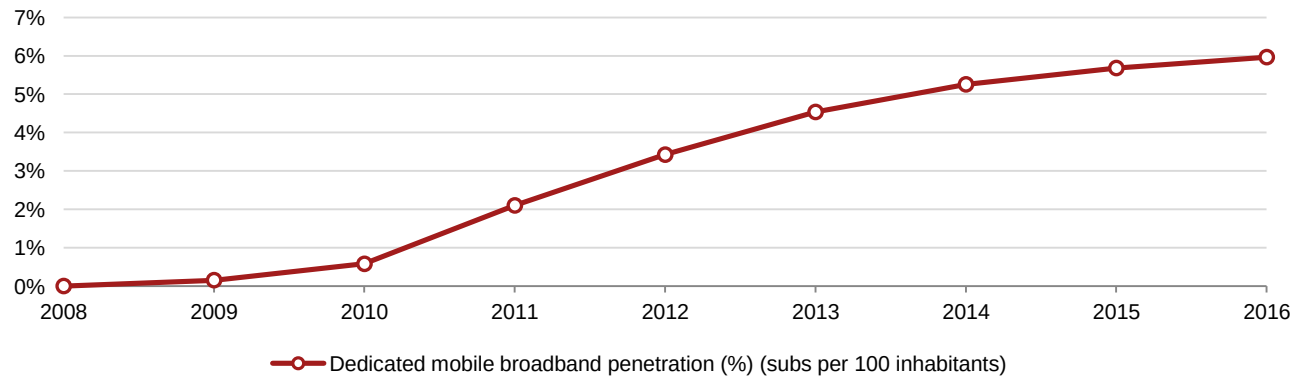


Turkey's fixed broadband market is dominated by ADSL service. Other technologies like cable or LAN networks play minor role on the market.

By the end of 2011 the number of dedicated mobile subscriptions passed 1.5 million. Although we do not expect dedicated mobile service to take over fixed broadband as the major internet access platform until 2016 we estimate further rapid growth in the segment.

Figure 61 Dedicated mobile broadband subscriptions per 100 inhabitants in Turkey (%)

Source: PwC



In order to calculate the effect of increasing mobile data subscriptions on the economy, we estimated the percentage of those subscriptions that would actually increase household penetration. Many subscriptions are

[143] ITU, 2012

purchased in order to achieve mobility while also having a supplementary fixed broadband service. We consider that those subscriptions which act as a substitute of the fixed service will increase the actual household penetration. We estimated that 50 percent of dedicated mobile broadband services activated in Turkey would increase the household penetration of broadband internet services.

In our macroeconomic model, we calculated and forecasted the impact of the broadband effect on the growth of GDP, employment and productivity.[144] Our original hypothesis stated that the allocation of digital dividend will affect the growth of household broadband penetration by making the service accessible in such rural areas where higher frequencies made the network roll-out uneconomical. Turkcell reported 88% 3G population coverage, while Avea reported 79% 3G population coverage, according to BMI data (Q4 2011). Vodafone didn't reveal data for its UMTS network infrastructure.

By allocating the 800 MHz band to the mobile operators, the latter would receive a frequency by which they would be able to cover rural territories with mobile broadband service in a cost efficient way. This way, mobile operators could not only supply communities that currently fall outside of 3G coverage, but could also increase the possibility of choice in other areas. One must note, however, that the allocation of 800 MHz band is also necessary for maintaining the current trend of mobile broadband take-up as it provides spectrum for gearing the capabilities of the mobile network to the ever increasing subscriber data rate requirement.

Figure 62 Broadband penetration in Turkey, 2010-2016

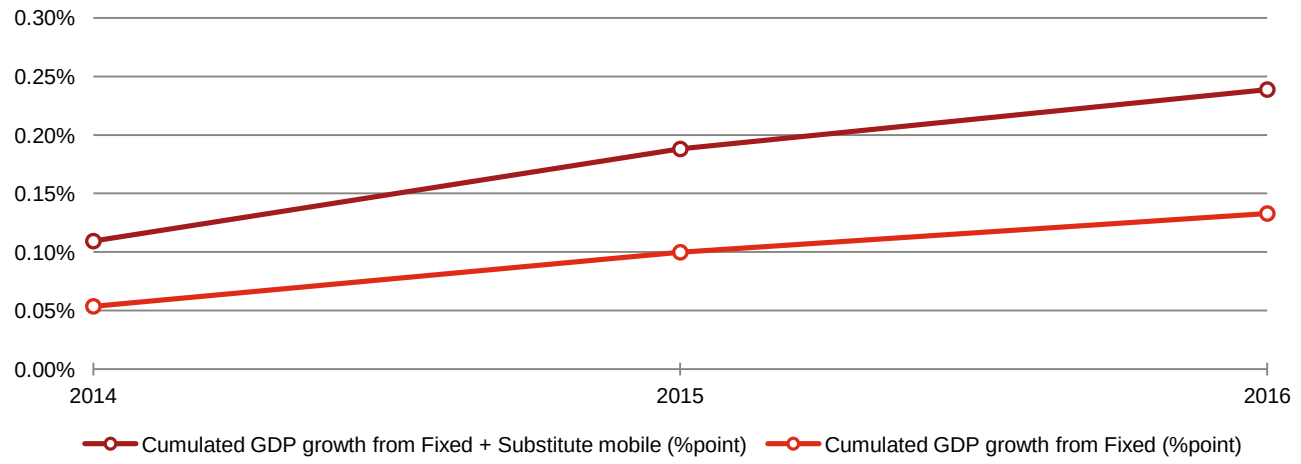
Source: PwC

	2010	2011	2012	2013	2014	2015	2016
Penetration	10.3%	12.5%	14.4%	16%	17.1%	17.9%	18.3%
Penetration without mobile	9.7%	10.4%	11%	11.4%	11.9%	12.2%	12.3%

Figure 63 below represents the cumulated positive effect of increasing the coverage of broadband mobile networks by allocating the 800 MHz band to these purposes. Overall, the growing number of mobile subscriptions will have a positive effect on the GDP, as it is increasing the number of households equipped with mobile subscription. By increasing the territory reach of the mobile networks, DD1 allocation would further raise the positive effect on GDP by making mobile broadband service accessible to households that otherwise fall outside of 3G coverage.

Figure 63 Cumulated GDP effect of broadband access services (percentage points)

Source: PwC



According to the international analysis referred to earlier, broadband penetration also has a positive effect on the employment and productivity of the country. This effect derives from the characteristics of the Turkish market, and it is displayed in Figure 64 below.

[144] ITU, 2012

Figure 64 Cumulated employment effect of broadband access services (percentage points)

Source: PwC

The digital dividend in Turkey

Frequency release process – Turkey's DSO strategy

Act No. 6112 on the Establishment of Radio and Television Enterprises and Their Media Services[145] lays down the legal and regulatory basis for the DSO in Turkey. Over 14 bylaws are also claimed to be adopted, based on Act no. 6112 of 2011. Although no official strategic documents have been published, Act No. 6112 gives a detailed guideline on the necessary procedures which need to be completed in the DSO process. Deadlines for the DSO and ASO, as well as the DD1 allocation are defined in the Act as follows. A frequency plan and an implementation schedule are due to be adopted one year after the Act coming into force (2012). DSO shall commence following a 'ranking tender' called by national media regulator RTÜK by March 2013 at the latest, two years from the Act coming into force. The DSO is to be completed in another two years time by 2015, after which the ASO shall be completed. The Act also orders the release of the DD1 band along with the DSO process. Further details regarding the frequency release process in Turkey are introduced in the following sections.

Key public organisations responsible for the DSO process

National media regulator Radio and Television Supreme Council (hereinafter: RTÜK or Supreme Council), is the key organisation involved in the DSO process in Turkey, as per Act No. 6112. The Supreme Council is involved in most tasks related to the DSO process, and has practically exclusive legislative, regulatory, and licensing responsibilities. In fact, the draft Act No. 6112 was prepared by RTÜK, and the Supreme Council was the organisation responsible for the stakeholder consultations which preceded the Act.

The Act also calls for a single transmitter installation and operating company to be established, "which is jointly established by the enterprises that hold national terrestrial broadcast licences".[146] Technical Services and Transmitting Antenna Facility Management Joint Stock Company[147] (usually shortened as Anten Corporation) was founded in 2012 according to the Act. The company is owned 20% by public broadcasting company TRT (Turkish Radio and Television Company), 70% by commercial broadcasters with national coverage, and 10% by commercial broadcasters with regional or local coverage. The establishment of a new transmitter installation and operating company became necessary after the operation of the former Anten Corporation was blocked by the constitutional court of Turkey.

National telecommunications regulatory authority BTK (Information Technologies and Communication Authority) is responsible for the allocation of radio frequencies in Turkey. BTK is mandated to allocate the DD1 band once the ASO is completed in 2015, in compliance with the ITU recommendations. Mandates of BTK are not clearly defined, but are limited by Act No. 6112. Among others, BTK is required to obtain the opinion of RTÜK when amending the national frequency plan.

Timeframe and modularity of the DSO & ASO processes

DSO shall be completed and analogue signals shall be switched off by 2015, according to the Act, and in compliance with the ITU recommendation. The Act calls for a 'ranking tender' for distributing multiplex capacities by March 2013, at the latest. The Act provides a limited possibility for continuing analogue broadcasts up to another two years for broadcasters who were awarded digital terrestrial broadcasting rights. Broadcasting companies which have been awarded a multiplex capacity are required to commence digital broadcasts in two years the latest, from receiving their licenses.

Technical details of the DSO in Turkey

A new frequency allocation plan was commissioned by RTÜK in 2012. With regards to the existing analogue broadcasting equipment, owners have two options defined in the Act, as follows. Analogue transmitting equipment shall either be removed or transferred to the digital transmitter installation and operating company.

As a result of the DSO/ASO, frequencies 790 to 862 MHz (channels 61 to 69) are planned to become available as a digital dividend (DD1) for future utilisation, in compliance with the EU and ITU agreements and recommendations. While analogue broadcasting currently spans across frequencies 174-230 MHz and 470-862 MHz, digital terrestrial television (DTT) is planned to occupy a limited amount of frequencies in the lower UHF band (frequencies 470-790MHz, equivalent to channels 21-60).

[145] The Law came into force after its publication in the Official Gazette no. 27863 dated 3/3/2011
[146] Law No. 6112.
[147] Anten Teknik Hizmetler Ve Verici Tesis İşletme Anonim Şirketi or Anten A.Ş. in Turkish.

The ASO process in Turkey is both deadline- and coverage driven. Consumers will be able to watch both analogue and digital transmissions until 70% of the audience has been provided with the means to receive digital terrestrial broadcasting, according to RTÜK.

There is sufficient frequency capacity available in Turkey to enable a simulcast period, according to the Act. A draft plan currently underway by RTÜK suggests that the simulcast period would last 6 months, though the Act allows a longer timeframe. The maximum time for the simulcast period is constrained by the 2015 deadline provided in the Act, which is in accordance with the ITU agreement.

Eight multiplexes are planned to be established by Anten Corporation in Turkey. Six national and one regional and local MUX add up the eight commercial multiplexes, while one MUX is to be used by public broadcaster TRT. Multiplex licenses are planned to be not transferable, while broadcasters are to receive multiplex capacity via a tendering, according to RTÜK.

DVB-T2 standard with MPEG-4 encoding is to be used by the multiplexes for encoding the DTT broadcast, and the Act also contains provisions that retail receiver equipment must comply with detailed standards for the protection of consumers. Broadcasting networks are planned to be operated in a SFN model.

Licensing and permitting

Television licensing and permitting is exclusively controlled by RTÜK. Broadcasting licenses as well as multiplex capacities are awarded by the Supreme Council under a weak multiplex model, where multiplex operators have the responsibility to conclude the transmission of all broadcasters which received a broadcasting license from RTÜK. Provisions apply to the prospective broadcasters, as only those with at least one year of broadcasting history are allowed to participate in the 'ranking tender'.

Special licensing rules apply to public broadcaster TRT, which is entitled one multiplex (Multiplex no.1) through which TRT is obliged to transmit at least four terrestrial television broadcasts. Three commercial channels were also transmitted along with TRT's channel in the pilot DTT signal in 2006. Frequency licenses are planned to expire in 10 years starting from 2013, while the right would be not transferable, according to RTÜK.

Special restrictions apply to broadcasting companies under foreign ownership. Direct foreign paid-in capital of any broadcaster may not exceed 50%, a ratio considered to be highly liberal in the light of the pre-2009 regulation allowing a maximum share of only 25%. Further restrictions limit foreign ownership in the Turkish broadcasting service market, such as the provision stating that "a foreign real or legal person can directly become a partner in a maximum of two media service providers".[148]

Business model and state financing

All multiplexes are planned to be operated in a free-to-air (FTA) business model, in which broadcasts are receivable free of charge using the necessary receiving equipment (set-top box).

A set-top box subsidy for consumers is planned, but further details are not provided in the Act. Details of the planned subsidy are currently being discussed by the authorities, according to RTÜK.

Total costs of the DSO in Turkey are still not known, as Anten Corporation currently evaluates these values. However, some 450-500 transmitter sites are estimated to be necessary in order to cover the necessary 70% of Turkey's population. Such investment could cost up to an approximate USD 20 million, according to RTÜK.

Realisation of the DSO strategy

Fourteen bylaws have been adopted following Act No. 6112 of 2011, which created the legal framework for the digital switchover in Turkey.

An initial pilot broadcast commenced in 2006 at three locations throughout Turkey. The test signals were transmitted by national broadcaster TRT from Istanbul, Ankara, and Izmir locations. A new company was formed in 2012 with the goal of developing and operating the digital transmission network, following several court rulings against its predecessor Anten Corporation.

[148] Law No. 6112

The pilot broadcast proved to be ineffective in incentivising the public to change technology platforms, as no digital terrestrial reception was indicated in Turkey by 2009, three years into the pilot broadcast.[149]

New simulcast DVB-T2 broadcasts from larger cities such as Istanbul, Ankara, or Izmir, are planned to commence in 2013, according to RTÜK.

Other conflicting spectrum uses – releasing the 800 MHz band

Frequencies 790 MHz to 862 MHz are currently allocated to multiple uses, including analogue broadcasting, PMSE services, mobile services, and radiolocation (military) services as per the national allocation table of Turkey.

PMSE use is currently license exempt[150] in the DD1 band in Turkey until 1 January 2015. After this date PMSE will not be allowed in the 800 MHz band, according to BTK.

The presence of radiolocation services in the 800 MHz band provides some basis for concerns. Mobile services could interfere with radiolocation services in the band once it is assigned to mobile operators. It is also unclear whether the aeronautical radionavigation service (ARNS) used throughout Russia could cause unwanted interference in Turkey, as the ARNS interference zone reaches out into the eastern half of Turkey. BTK, the authority responsible for cross-border frequency issues trusts that any coordination regarding Russia's ARNS will be resolved as both countries accepted the respective ITU resolutions.

A cross-border coordination agreement was signed with Azerbaijan regarding the 900/1800/2100 MHz bands, marking the commitment of Turkey to resolving interference issues at border areas.

Allocation and assignment of the digital dividend

Turkey is committed to allocating the DD1 band to next generation mobile services, in accordance with the results of the WRC-07 (World Radiocommunication Conference in 2007). No detailed plans have been publicly announced to date regarding the non-broadcasting utilisation of the DD1 band. The DD1 band might also be used for PPDR (Public Protection and Disaster Relief) purposes along mobile broadband usage, according to BTK.

BTK, along with the Ministry of Transport, Maritime Affairs and Communications, is the authority responsible for the allocation and assignment of the frequencies in the DD1 band; the Council of Ministers will be responsible for fixing auction fees.

Suggestions and recommendations

Turkey is just at the beginning of the digital switchover process, and the country is making a good progress towards the analogue switch-off. Therefore we believe that Turkey does not require further country specific recommendations above the ones we formulated in the regional section of the study *Digital dividend in Southeast Europe*.

[149] MAVISE
[150] License exemption applies up to maximum 50 mW power.

Appendix

Abbreviations

2G	Second generation mobile telecommunications technology
3G	Third generation mobile telecommunications technology
4G	Fourth generation mobile telecommunications technology
ADSL	Asymmetric digital subscriber line
ARNS	Aeronautical radionavigation service
ARPU	Average revenue per user
ASO	Analogue switch-off
ATT	Analogue terrestrial TV
AVB-T	Analogue Video Broadcasting – Terrestrial
AVC	Advanced video coding standard
BNT	Bulgarian National Television
BTC	Bulgarian Telecommunications Company
BTK	Information Technologies and Communication Authority of Turkey
bTV	Privately owned national television channel in Bulgaria
CAGR	Compound average growth rate
CAPEX	Capital expenditure
CATV	Cable Television
CDM	Code Division Multiplex
CDMA	Code division multiple access
CEE	Central and Eastern Europe
CEM	Council on Electronic Media in Bulgaria
CEPT	European Conference of Postal and Telecommunications Administrations
CEPT-ECC	European Conference of Postal and Telecommunications Administrations – Electronic Communications Committee
CRC	Communications Regulation Commission of Bulgaria
DD	Digital dividend
DD1	First digital dividend
DD2	Second digital dividend
DSO	Digital switchover
DTH	Direct-to-Home (satellite)
DTT	Digital terrestrial TV
DVB-H	Digital Video Broadcasting – Handheld
DVB-T	Digital Video Broadcasting – Terrestrial
DVB-T2	Digital Video Broadcasting – Second Generation Terrestrial
EC	European Commission
EC	European Commission
ECA	European Common Allocation
EETT	Hellenic Telecommunications & Post Commission
E-GSM	Extended GSM (880.0-915.0/925.0-960 MHz)
EHF	Extreme high frequency band
ERT	Public broadcaster in Greece
ESR	See NCRT
ETV	Emisiona Tehnika i Veze – National Broadcasting Operator in Serbia
EU	European Union
EU15	EU 15 countries, namely Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom
EU27	European Union, namely Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.
EUR	Euro
EuroDOCSIS	Data Over Cable Service Interface Specification modified for European use
FDD	Frequency division multiplex
FM radio	Frequency modulation radio
FTA	Free-to-Air television channel
GDP	Gross domestic product
GE06	Geneva 2006 agreement
GHz	Gigahertz
GSM	Global System for Mobile Communications, originally Groupe Spécial Mobile
GSMA	GSM Association
H.264	An advanced video codec standard
HD	High Definition
HF	High frequency band
IMF	International Monetary Fund
IMT	International Mobile Telecommunications
IPA	Instrument for Pre-Accession Assistance, an EU fund
IPTV	Internet protocol TV
ISDN	Integrated Surface Data Network
ITU	International Telecommunication Union, a United Nations specialised agency
kHz	Kilohertz

LAN	Local Area Network
LF	Low frequency band
LTE	Long Term Evolution mobile telecommunications technology
LW radio	Long wave radio
MAVISE	Database on television channels and television companies in the European Union
MC	Ministerial Council in Serbia
MCMIS	Ministry for Foreign and Home Trade and Telecommunications in Serbia. See also: MTT
MF	Medium frequency band
MFN	Multi Frequency Network
MHz	Megahertz
MNO	Mobile Network Operator
MoU	Memorandum of understanding
MPEG-2	Moving Pictures Expert Group 2 standard
MPEG-4	Moving Pictures Expert Group 4 standard
MPEG-4.10	Moving Pictures Expert Group 4 part 10 standard
MTT	Ministry for Foreign and Home Trade and Telecommunications in Serbia. See also: MCMIS
MUX	Multiplex
NBC	National Broadcasting Council of Greece
NCRT	Greek National Council for Radio and Television. Also ESR
NURTS	National Unit Radio and TV Systems
OECD	Organisation for Economic Co-operation and Development
PC	Personal Computer
P-GSM	Primary GSM (890-915/935-960 MHz)
PMSE	Programme making and special events
PPDR	Public Protection and Disaster Relief
PwC	PricewaterhouseCoopers
RATEL	Republic Agency for Electronic Communications
RBA	Republic Broadcasting Agency of Serbia
rGDP	Real GDP
RRC-06	Regional Radiocommunication Conference in 2006 organised by ITU
RSPP	Radio Spectrum Policy Programme
RTS	Radio Televizija Srbije – Public Broadcaster in Serbia
RTÜK	Radio and Television Supreme Council of Turkey
RTV	Radio and Television
SAP/SAB	Services Ancillary to Broadcasting/Program Making
SD	Standard Definition
SEE	Southeast Europe
SFN	Single Frequency Network
SHF	Super high frequency band
SIM	Subscriber identity module
SLF	Super low frequency
STB	Set-top box
Tetrapol	Digital professional mobile radio standard
THF	Tremendously high frequency band
TRA-ECS	Terrestrial radio applications capable of providing electronic communications services
TRT	Turkish Radio and Television Corporation
TV	Television
UHF	Ultra high frequency
UHF	Ultra high frequency band
UHF IV/V	4th and 5th bands of UHF
ULF	Ultra low frequency
UMTS	Universal mobile telecommunications system
USB	Universal Serial Bus
USD	United States Dollar
VHF	Very high frequency band
VLF	Very low frequency
WiFi	Wireless fidelity
WRC-07	World Radiocommunication Conference in 2007 organised by ITU
WRC-15	World Radiocommunication Conference in 2015 organised by ITU

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