Property rights in UHF and 2.6GHz spectrum

Summary report • 23 February 2012

1 Introduction

This is a summary of the final report of a study prepared by Analysys Mason Limited (Analysys Mason) on behalf of the Greek Ministry of Infrastructure, Transport and Networks (YME) to consider the allocation of property rights in UHF (470–862MHz) and 2.6GHz spectrum in Greece. In particular, the study considered the potential value of the 'digital dividend' from the release of UHF spectrum, and whether this should be allocated for mobile broadband use, or for digital terrestrial television (DTT). It also considered assignment options for UHF and the 2.6GHz band, and licensing options for assignment of spectrum to mobile and DTT use.

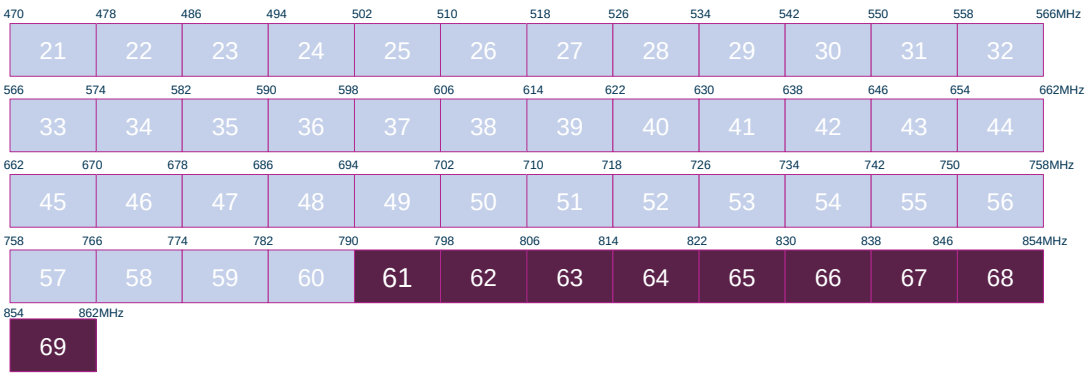
2 Background

Until 2007, spectrum in UHF Bands IV and V was allocated internationally to digital TV services and in Europe, was being planned in line with the International Telecommunications Union (ITU-R) GE-06 agreement for DTT.

However, in 2007, the ITU World Radio Conference (WRC-07) allocated the 790–862MHz band (or parts of it in some countries) on a primary basis to mobile services in selected countries in Europe, Africa and the Middle East, including all European Union countries. This is in accordance with footnote number 5.316A of the ITU Radio Regulations.

The identified spectrum for mobile services within ITU Region 1, from 790–862MHz, comprises the top eight channels of the UHF band, as illustrated below in Figure 1.

Figure 1: UHF Bands IV and V – 800MHz band [Source: Analysys Mason, 2012]



The European Commission (EC) subsequently put forward a decision 2010/267/EC to harmonise use of the 790–862MHz band (referred to as the 800MHz sub-band) for electronic communications systems such as mobile broadband services[1].

Consequently, many European countries have now re-planned – or are in the process of re-planning – their DTT frequency assignments to enable the release of the 790–862MHz band for use by mobile services. This release of spectrum is often referred to as the 'digital dividend'.

In the context of this study, digital dividend broadly refers to spectrum released from switchover from analogue to digital terrestrial television.

Decisions regarding analogue to digital terrestrial television switchover (DSO) and the assignment of digital dividend frequencies have not been formalised in Greece; one of the key objectives of this study is therefore to confirm the future use of the UHF bands IV and V in Greece. Considerations include whether the 800MHz band should be used for mobile services, in line with the EC's decision 2010/267/EC, or for DTT. According to YME, it is considered to be technically and operationally feasible for DSO to be completed in Greece by the end of 2013. However, the Hellenic Government has yet to formalise its decisions relating to licensing of DTT services, and the assignment of UHF spectrum, including the digital dividend.

We have also been asked to consider whether the adjacent spectrum (698–790MHz, referred to as the 700MHz band) should be retained for DTT use, or reserved for other future uses such as 3G/4G mobile services. This is because, although not confirmed at this stage, it is possible that a further UHF spectrum allocation for mobile use might be implemented in Europe in future. This might be in the 700MHz range (e.g. 698–790MHz), which would harmonise Europe's UHF mobile allocations with those of other ITU world regions[2].

Finally, we have been asked to identify award options for the 2.6GHz band (2500–2690MHz), which is a frequency band which, similar to the 800MHz band, has been harmonised for mobile broadband use in Europe according to EC Decision 2008/4776/EC.

In order to provide a an assessment of the impact of different assignments of UHF spectrum in the Greek market, we have described within our report the results of modelling we have undertaken to assess the economic value, also referred to as welfare from the service, of assigning different amounts of UHF spectrum for different uses – specifically mobile broadband and DTT. A summary of the main findings from this modelling is presented in the remainder of this summary report.

1 Commission Decision of 6 May 2010 on harmonised technical conditions of use in the 790-862 MHz frequency band.

2 ITU WRC-07 allocated 790-862MHz to mobile services in Europe, but allocated 698-862MHz to mobile in some other world Regions.

3 Digital television switchover

The terrestrial TV market in Greece comprises a mix of public service and private (commercial) broadcasters, which is also the case in many other European countries. There are eight private television broadcasters with notional coverage (Antenna, Mega, Star, Alpha, Alter, Skai, Makedonia and 902). At present, the channel 902 does not broadcast digitally, but it is authorised to do so. In addition, there are 74 regional coverage television stations, and 52 local television stations.

In line with other European countries, Greece intends to replace analogue terrestrial television services with DTT, in accordance with the frequency and co-ordination arrangements for DTT as defined in the ITU-R Geneva-06 agreement and plan (GE-06). The public service broadcaster, ERT, commenced trials of DTT during 2006 and this trial was subsequently transformed to a commercial service.

A ministerial decision on digital switchover, on the basis of national law 3592/2007, describes the planned transition from analogue to digital terrestrial television, proposing that the DTT network will be based on 23 sites for digital transmissions. Information provided by YME for this study confirmed that, at present, 12 of the 23 sites are currently broadcasting digital transmissions; of these, two are broadcasting digital signals of analogue programmes in 'simulcast' with analogue transmissions of the same programme. Within the transmission area of one, there is analogue switch-off and for the other areas, some television channels that are being broadcast with analogue signals will cease when the digital transmissions of these channels starts at these sites[3]. We understand that the intention is for the remaining sites to be transferred to digital transmission ahead of analogue switch-off (ASO) and that it is technically and operationally possible for this migration to be completed by the end of 2013.

In August 2008, the Common Ministerial Decision (CMD) 21161 was issued based on the national law 3592, in order to describe the transition from analogue to digital TV. The transition plan also assumes the following digital capacity is provided:

- eight MUX available for the areas of Athens and Thessalonika
- seven MUX for the rest of Greece
- four programmes per MUX.

The digital MUX are to be broadcast using 23 sites that make use of frequency/area allotments that have been granted to Greece within the GE-06 plan. In total, Greece has been allocated 34 allotments within the GE-06 plan, and has 357 plan assignments (across VHF and UHF bands), which use frequencies distributed across UHF Bands IV and V (up to UHF channel 66, since the channels above this are used by the military)[4].

[3] Appendix III of the Common Ministerial Decision (CMD) 21161 for the transition period lists the analogue channels that could cease transmission once digital transmissions of these channels is commenced.

[4] If the 800MHz band is to be used for mobile services, 316 plan assignments will remain, since the remainder are in DTT channels 61 to 66, which would not be available for DTT if the 800MHz is used for mobile services.

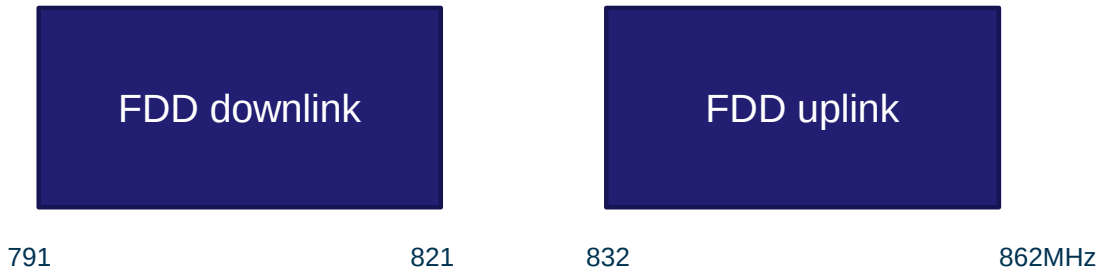
It is noted that a decision by the Hellenic Government to award frequencies in the 800MHz sub-band for mobile use will impact those allotments to Greece in the GE-06 plan that use DTT channels 61 to 66 (which will no longer be available as a result of the 800MHz band being made available for mobile use). This will potentially affect 20 of the 34 allotment areas in the GE-06 plan. .

Although digital services have now commenced in Greece and broadcast licences are in place, we understand that the frequency licensing of those services is still to be confirmed.

4 The 700MHz and 800MHz bands

The EC's decision 2010/267/EC recommends that the 800MHz band be allocated to mobile services in a harmonised band plan, comprising 60MHz of spectrum divided into two 30MHz paired block, as illustrated below in Figure 2.

Figure 2: Harmonised European band plan for the 800MHz band [Source: Analysys Mason, 2012]



It is possible that a future WRC might make further changes to allocations in UHF spectrum. In particular, there is a possibility that a decision might be taken to align the mobile allocation in ITU Region 1 with the rest of the world, which would result in a wider sub-band, from 698–862MHz band, being allocated for mobile use. This would introduce the possibility of a further sub-band for mobile use: the 700MHz band, from 698–790MHz. However, since this decision has not been taken yet, there is no 700MHz mobile allocation within the European frequency allocation table at present, and no harmonised European band plan for mobile use of the 700MHz band.

It is noted that decisions to allocate 700MHz and 800MHz for mobile services will preclude those parts of the UHF band being used by secondary users that currently use UHF frequencies, such as programme making and special events (PMSE). However, within our model, we have not considered the economic impact of PMSE not having access to the full amount of spectrum that it has access to currently.

It is expected that, if a decision is taken at a future WRC to create a 700MHz sub-band for mobile use in Europe, further detailed study will follow in CEPT to develop a suitable harmonised band plan.

In the absence of this, and for the purposes of this study in order to estimate the value of 700MHz spectrum, we have needed to make assumptions on how much paired bandwidth might be available in the 700MHz band. The assumption we have therefore made is it might be configured in a similar way to the 800MHz band i.e. two blocks paired spectrum with an 11MHz duplex gap.

Whilst not confirmed at this stage, a possible configuration might be:

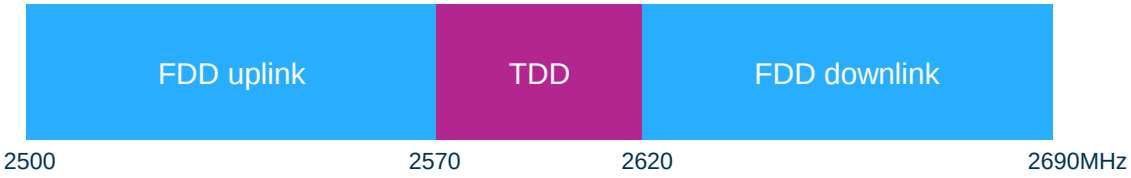
- uplink 698–738 and downlink 749–789MHz
- duplex gap 738–749MHz
- guard band 789–790MHz.

5 The 2.6GHz band

The 2.6GHz band comprises 190MHz of spectrum between 2500MHz and 2690MHz. At an international level, the band is allocated to mobile services in all three ITU regions, and was identified for use by IMT systems – the ITU's definition of 3G/4G technologies – at the WRC in 2000 (WRC-2000). The band sits alongside the 2.4GHz Industrial, Scientific and Medical (ISM) spectrum, used extensively around the world for licence-exempt wireless systems such as WiFi; at 2690MHz, it is adjacent to an international radio astronomy band. At a European level, CEPT and EC decisions on the harmonised utilisation of spectrum within the band 2500–2690MHz have been published as ECC Decision (05)05 and EC Decision 2008/477/EC,[5] respectively.

EC Decision 2008/477/EC recommends that Member States issue licences in the 2.6GHz band in accordance with the harmonised band plan described in ECC Decision (05)05. This band plan divides the spectrum into 14 paired blocks of 5MHz, separated by 120MHz, with the sub-band 2570–2620MHz divided into ten 5MHz blocks of unpaired spectrum. This is illustrated below.

Figure 3: Harmonised European band plan for allocation of the 2.6GHz band [Source: Analysys Mason, 2012]



In accordance with the European band plan, the 2.6GHz band is suitable for both FDD and TDD technologies, since the band plan comprises of combination of paired and unpaired spectrum.

Although spectrum is nominally divided as paired and unpaired 5MHz blocks, the EC Decision allows regulators to award spectrum in lots of 5MHz multiples, which has resulted in some regulators in Europe deciding to offer 2.6GHz spectrum in 10MHz, or larger, blocks.

6 Approach to modelling the value of UHF spectrum for different uses

A number of studies (including other studies by Analysys Mason) have been conducted into the relative benefits to Europe's economy of different allocation options for the UHF spectrum released from switchover from analogue to digital TV. These options have tended to consider a variety of possible configurations of spectrum being assigned to mobile and DTT networks. In

[5] Commission Decision of 13 June 2008 on the harmonisation of the 2500–2690MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community ((2008/477/EC), available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:163:0037:0041:EN:PDF.

each of these studies, the objective has been to identify the appropriate apportioning of spectrum between mobile and DTT in the UHF band in order to maximise overall welfare[6].

We have followed a similar approach in this study for YME, and within the study we have developed models to assess the economic value, also referred to as welfare from the service, of assigning different amounts of UHF spectrum for different uses - specifically mobile broadband and DTT.

In calculating the costs and benefits of assigning UHF spectrum to different services, we have considered the private value, defined as the benefits that users gain from a service, minus what the service costs to produce, plus any externalities[7]. Private value is therefore often split between consumer surplus (benefit to consumers minus the price they pay) and producer surplus (revenue of the producers minus the costs to provide the service). Figure 4 illustrates the standard approach to calculating the consumer and producer surplus.

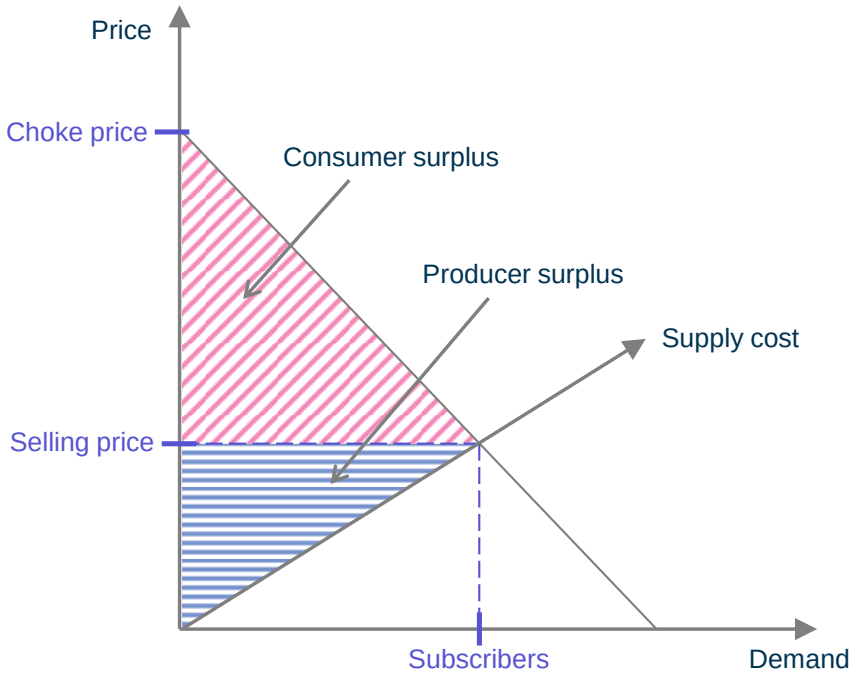


Figure 4: Private value calculation illustration [Source: Analysys Mason, 2012]

Consumer surplus

The consumer surplus represents the direct value to the consumer over and above what they pay for the service. Figure 5 below illustrates, at a high level, how our mobile model calculates the consumer surplus for each service under each scenario. To begin with, we have projected demand, in terms of subscribers and average spend per user, in addition to the 'choke price' (the price at which demand is zero), in every year of the model.

6 In other words, economic benefits that can be expected to be generated by increased availability and use of mobile broadband networks and/or DTT

7 The economic value of using spectrum to provide a particular service is also referred to as welfare from the service, which is the sum of consumer and producer surplus, plus externalities (positive or negative). The calculation does not include taxes and licence fees that the producers might incur.

Consumer surplus is then calculated using the formula:

Consumer surplus = (Annual choke price – annual ASPU)(year average subscribers)/2*

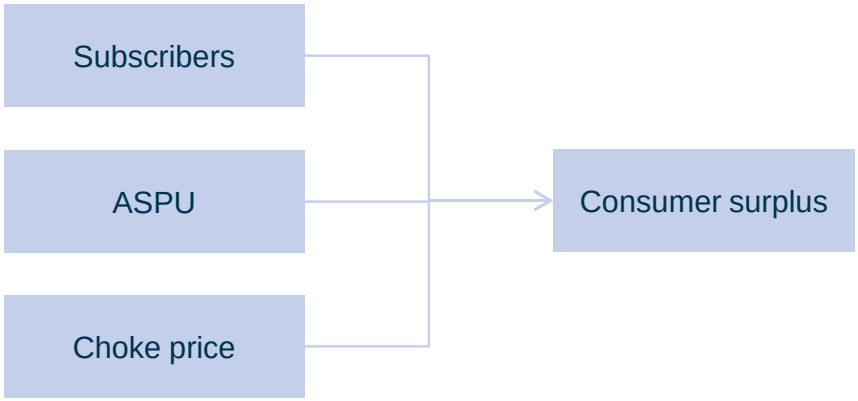


Figure 5: Consumer surplus calculation overview, mobile model [Source: Analysys Mason, 2012]

Detailed inputs and calculations for the consumer surplus for each service are presented in our full report.

Producer surplus

The producer surplus represents the direct value to the consumer of receiving a service (reflected in what they pay) netted off against the cost to provide the service. The producer surplus also includes any additional economic value to the industry, but not to the consumers, for example advertising revenues. This additional economic value is sometimes referred to as an indirect benefit.

Figure 6 below, illustrates how our mobile model estimates the producer surplus, at a high level, for each service and scenario. The subscribers and ARPU forecasts established to calculate consumer surplus are used to derive the producers' revenues, from which the costs of production (i.e. cost of goods sold (COGS), capital and operational expenditure) are subtracted. The resulting free cash flow forms the producer surplus in each year.

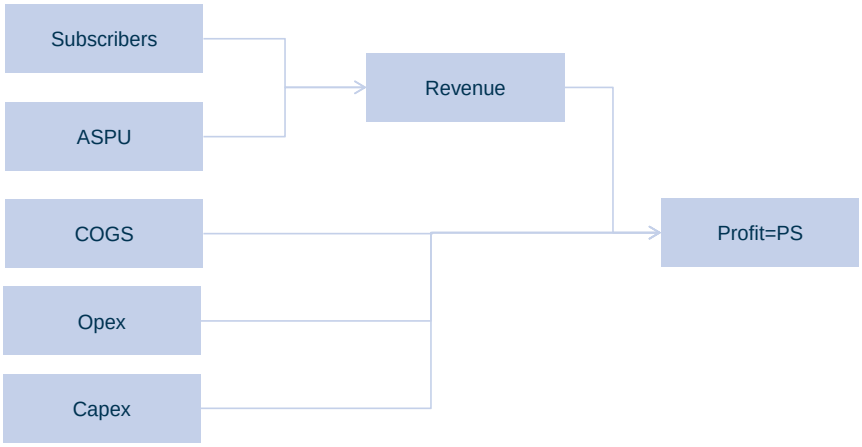


Figure 6: Producer surplus calculation overview, mobile model [Source: Analysys Mason, 2012]

Detailed inputs and calculations for the producer surplus for each service are presented our full report.

Externalities

In addition to the private value of a service, wider societal and economic benefits may result that should be taken into consideration. These benefits may include information dissemination, diversity, access and inclusion.

Benchmarks for the level of external benefits that can be assumed from mobile broadband and television services vary between 5% and 10%.[8] For the purposes of this study, we have applied an additional 10% in external benefits to both the television and broadband revenues.

Scenarios modelled

In order to calculate the relative value of different spectrum allocations, we designed a series of scenarios each of which assumed a different split of spectrum between DTT and mobile broadband services. For DTT services, we have assumed that MUX can either be used to accommodate standard-definition programmes (SD), or high-definition programmes (HD). Although in practice a MUX can accommodate a mix of SD and HD channels, to simplify our model we have compared value from MUXes being used either for SD, or for HD. Within our base case we have assumed 6 SD programmes can be delivered per MUX or 3 HD programmes.

These scenarios are outlined below. The underlying assumptions within each scenario in relation to the spectrum allocated to mobile and to DTT use are described in our full report.

Figure 7: Modelling scenario descriptions [Source: Analysys Mason, 2012]

Scenario	Option	DTT	Mobile
1 – Base case: 470–830MHz is used for DTT[9]	1a – DTT MUX broadcasting in SD	1a – 10 MUX, SD programmes	In the absence of available 800MHz spectrum, 900MHz re-farming is accelerated
	1b – DTT MUX broadcasting in HD	1b – 10 MUX, HD programmes	
2 – Mobile uses the 800MHz sub-band	2a – Three mobile operators are each assigned 2×5MHz of 800MHz spectrum; (remaining spectrum is used by the military)	2a – 8 MUX, SD programmes	2a – 2×5MHz per operator
	2b – Three mobile operators are each assigned 2×10MHz of 800MHz spectrum; (military is transferred to other spectrum) [10]	2b – 8 MUX, Mix of SD and HD programmes	2b – 2×10MHz per operator

8 UK Office of Communications, 2006, Digital Dividend Review – Annexes, p.134-5.

9 Military systems currently use 32 MHz of UHF spectrum from 830-862MHz in Greece (i.e. four 8MHz channels).

10 From our discussions with YME as part of this study we have noted that Greek military systems are likely to be migrated from using the 800MHz band to using spectrum in the 600–700MHz range, at no additional cost. We have therefore performed a sensitivity analysis on Scenario 2b to assess the impact on DTT of military systems using the 600–700MHz range, in view of the resultant loss in capacity to DTT. We have also considered the impact on the DTT results in Scenario 2b DTT of a mix of SD and HD programmes being broadcast, rather than all SD. This is described in Section 5.4.4 of our main report

Scenario	Option	DTT	Mobile
3 – Mobile uses the 700MHz and 800MHz sub-bands	3a – Three mobile operators are each assigned 2×10MHz of spectrum in 2013 (800MHz band), and 2×5MHz of spectrum in 2016 (700MHz band); in addition, a fourth mobile operator enters the market with 2×20MHz of 700MHz spectrum in 2016 [11][12]	3a – 5 MUX, SD programmes	3a – 2×10MHz per operator (three operators) in 2013 (800MHz band), an additional 2×5MHz of spectrum in 2016 (700MHz band); plus 2×20MHz of spectrum for a new entrant in 2016
	3b – Three current mobile operators are each assigned 2×10MHz of spectrum in the 800MHz band, and subsequently (in 2016), 2×5MHz of spectrum in the 700MHz band. Military systems are also migrated from the 800MHz to the 700MHz band to use the remaining 700MHz spectrum	3b – 5 MUX, HD programmes	3b – 2×10MHz per operator (three operators) in 2013; an additional 2×5MHz per operator in 2016

7 Modelling results

Mobile results

The table below shows the results of our mobile model scenarios, split between the consumer surplus and producer surplus, creating the total direct and indirect private value. Further to this, we have considered the additional external benefits to find the total economic value of each spectrum scenario.

The annual figures for each of these values have been calculated for the period 2013–2032 and discounted back to 2013 at a social discount rate of 5% (applied to the consumer surplus) and a commercial discount rate of 12% (applied to the producer surplus). The figures below represent the net present value (NPV) of the values in 2013.

11 In this scenario, military systems could use duplex gaps in the 700MHz and 800MHz bands, plus a further 2×5MHz that is not assigned in the 700MHz band, assuming it is possible for the military systems to use non-contiguous spectrum (which has not been confirmed within this study).

12 It is noted that the result of an auction of 700MHz and/or 800MHz spectrum could result in a spectrum distribution that is different to our scenarios i.e. there is no guarantee that existing operators would acquire the same additional spectrum and they could each acquire different amounts. Our model has assumed an equal distribution for the purposes of estimating the welfare benefit.

Figure 8: Value generated by mobile broadband services (3G and 4G) between 2013 and 2032, taking into account the loss to the fixed market, all figures are in EUR (million) [Source: Analysys Mason, 2012]

	Consumer surplus	Producer surplus	Total private value	Total economic value (incl. external benefits)	Increment on base case
Scenario 1a	10,180	484	10,664	11,730	-
Scenario 1b	10,180	484	10,664	11,730	-
Scenario 2a	13,797	656	14,453	15,898	4,168
Scenario 2b	14,806	733	15,539	17,093	5,362
Scenario 3a[13]	16,532	335	16,867	18,553	6,823
Scenario 3b	15,600	764	16,364	18,001	6,270

Scenario 3a provides the highest total economic value, driven by a high consumer surplus resulting from a reduction in ARPU owing to the presence of a fourth operator in the market, and an elevated mobile broadband penetration resulting from the increased competition and lower ARPU.

The highest producer surplus is produced by Scenario 3a. Take-up of mobile broadband is slightly lower than Scenario 3a, however, the costs of building and operating an additional network are not incurred, and ARPU erosion is not assumed to be as rapid.

DTT results

As for the mobile model, the table below shows the results of our DTT model scenarios, split between the consumer surplus and producer surplus, creating the total direct and indirect private value. Further to this, we have considered the additional external benefits to find the total economic value of each spectrum scenario.

The annual figures for each of these values have been calculated for the period 2013–2032 and discounted back to 2013 at a social discount rate of 5% (applied to the consumer surplus) and a commercial discount rate of 12% (applied to the producer surplus). The figures below represent the NPV of the values in 2013.

13 Scenario 3a and 3b assume that the 700MHz band is harmonised for availability from 2016 onwards. Should the spectrum not be available until 2017, the increment on the base case would drop by around 0.2% for Scenarios 3a and 3b.

Figure 9: Value generated by DTT services between 2013 and 2032, taking into account the loss to the pay TV market, all figures are in EUR (million) [Source: Analysys Mason, 2012]

	Consumer surplus	Producer surplus	Total private value	Total economic value (incl. external benefits)	Increment on base case
Scenario 1a	8,482	1,487	9,969	10,966	-
Scenario 1b	7,098	1,906	9,004	9,904	-1,062
Scenario 2a	7,735	1,657	9,393	10,332	-634
Scenario 2b	6,343	1,961	8,304	9,134	-1,831
Scenario 3a	6,124	1,795	7,919	8,711	-2,255
Scenario 3b	4,905	1,964	6,869	7,556	-3,410

The highest overall economic value is provided by Scenario 1a (with 10 SD MUXs). This high value is driven largely by the consumer surplus, which itself is driven by the 60 SD channels that are available in this scenario. However, the producer surplus is correspondingly lower owing to the additional programming costs of supporting all of these channels, and costs of additional MUXs being deployed within the network.

Conversely, the highest producer surplus can be found in Scenario 3b, which offers only 15 HD channels, and as such bears a lower programming cost[14] and also a lower MUX cost (only 5 MUXs in total).

The DTT producer surplus is primarily driven by network cost, owing to the fact that the revenue streams for DTT are largely uniform across scenarios. The impact on share of advertising is assumed to be relatively minimal, with a slight increase in the non-DTT pay TV share when the total number of DTT channels is reduced. An increase in the pay DTT market share with an increase in total channels, also contributes to a slight elevation in overall revenues.

The HD scenarios generate consistently lower surplus than their SD counterparts, despite an assumed higher relative value per channel for HD against SD. This is due to the reduction in the overall number of channels that can be accommodated per MUX in HD rather than in SD. Whilst we understand that the Hellenic Government has not taken a final decision on the number of SD and HD programmes that will be broadcast per MUX, it is assumed that in practice one MUX might accommodate a mixture of SD and HD channels. In our model we have predominantly considered 'all SD' or 'all HD' for ease of presentation of the results. However, we have modelled a combined SD and HD scenario in the sensitivity analysis contained within our full report. As an additional sensitivity within our full report, we have also considered the impact of the use of DVBT-2 for HD channels, which provides an increase in programming capacity compared to DVB-T.

14 We have assumed the cost of producing content in HD is higher than the cost of producing in SD, but the smaller number of channels for HD means that less programming content overall is required.

Combined results

The mobile and DTT results alone, however, do not provide a view on the total impact to the Greek mobile and television markets of assigning UHF spectrum between the two. In order to do so, it is necessary to match the two sets of scenarios according to the spectrum assignments between the two industries.

The figure below presents the combined results of all of the UHF scenarios.

Figure 10: Value generated by mobile and DTT services by scenario between 2013 and 2032, all figures are in EUR (million) [Source: Analysys Mason, 2012]

	Consumer surplus	Producer surplus	Total private value	Total economic value (incl. external benefits)	Increment on base case
Scenario 1a	18,662	1,970	20,633	22,696	-
Scenario 1b	17,278	2,389	19,667	21,634	-1,062
Scenario 2a	21,532	2,313	23,845	26,230	3,534
Scenario 2b	21,149	2,694	23,843	26,227	3,531
Scenario 3a	22,656	2,130	24,786	27,264	4,568
Scenario 3b	20,505	2,728	23,233	25,556	2,861

The combined results reflect the trends in the mobile broadband model, with Scenario 3a (three mobile operators are assigned 2×15MHz of spectrum each, and 5 SD MUXs are deployed) producing the highest overall economic value. This is because the largest welfare impact from use of spectrum derives from the mobile, rather than the DTT, market.

8 Conclusions and recommendations

The key finding from the modelling we have undertaken concerning economic impact of different assignments of UHF spectrum is that there is a significant benefit to the Greek economy of around EUR3.5 billion if part of the UHF band is awarded for mobile use, rather than for DTT. Specifically, we have estimated that the incremental value of assigning the 800MHz sub-band from within the UHF band for mobile use is around EUR3.5 billion.

The key results from our modelling are as follows:

- If the 800MHz band were to be awarded for mobile use in Greece, the combined value of DTT and mobile broadband services in the UHF band – which represents the total economic or welfare impact of the award of UHF spectrum – would be around EUR26.2 billion, over a period of 20 years. The majority of this value – around EUR15.9 billion – is value generated from mobile services, whilst the remaining EUR10.3 billion is derived from the switchover of analogue to DTT.

- The value generated if all available UHF spectrum is awarded for DTT use is EUR11.0 billion; the assignment of only 470–790MHz results in a small reduction in value, to EUR10.3 billion.

- The value generated from the migration of the mobile market from 3G to 4G mobile broadband services equates to EUR11.7 billion, if services are deployed using the existing 2G/3G spectrum and in the 2.6GHz band (our base case). If the 800MHz band is also available for mobile use, we estimate that the total value generated by the mobile market increases to EUR15.9 billion, primarily as a result of a faster roll-out of 4G services such that mobile broadband penetration levels increase more rapidly than in our base case.[15]

- The economic value for DTT is slightly higher if DVB-T2 is used to accommodate HD programmes in one multiplex than if DVB-T is used. The contribution of DTT to the total economic value also increases if we assume a mixed SD/HD use of DTT multiplex capacity, rather than assuming all multiplexes are used just for SD.

- If the 700MHz and the 800MHz band were to be allocated for mobile use in Greece, a further EUR1.0 billion of economic benefit is derived[16], assuming the entry of a fourth operator in the Greek market.

- We note that military systems currently occupy part of the 800MHz band in Greece. One possibility to release spectrum in the 800MHz band for mobile use might be to migrate military systems to the 700MHz band. However, this may preclude the 700MHz band being used for mobile services in the future. We estimate that the impact of the 700MHz not being available for mobile use (i.e. the loss of value from the entire 700MHz band not being available for mobile services, as a result of military systems occupying part of this band) is around EUR1.6 billion.[17] The reduction in value from the DTT model if the 700MHz band is not available (e.g. if 700MHz is used for military or other systems) is smaller, at around EUR326 million, or 1.2% of the total value already shown in Scenario 2b (EUR26.3 billion).

We therefore conclude that the optimal configuration would be mixed use of the UHF spectrum, with the 800MHz band being allocated for mobile use. We also recommend the 2.6GHz band should be awarded for mobile use, in line with the EC's decision.

As well as assessing the economic impact of different UHF spectrum assignments within this study, we have also considered the potential market value of 800MHz and 2.6GHz mobile licences in Greece, based upon benchmarking against auction results from other European countries where similar spectrum has been awarded.

15 This requires that military use is vacated from the 800MHz band and the band is assigned in Greece in accordance with the EC's harmonised plan set out in Decision 2010/267/EU.

16 Allocating the 698–790MHz spectrum to mobile results in only five multiplexes being deployed, but the mobile use benefit increase offsets the loss associated with the reduction in the amount of spectrum assigned to DTT. (overall DTT value is EUR8.7 billion).

17 This is the difference in economic impact between Scenarios 3a and 3b, as described in Section **Error! Reference source not found.**.

From this, we have estimated the following market value for the 800MHz and 2.6GHz bands in Greece.

Figure 11: Market prices for 800MHz and 2.6GHz licences in Greece, based upon European benchmarks [Source: Analysys Mason, 2012]

Frequency band	Market value per licence (2×10MHz for 800MHz and 2×20MHz for 2.6GHz) (EUR million)	Annualised licence value (EUR million)	Total value if all spectrum is sold in each band (EUR million)
800MHz	Up to 135.6 based on the average of European auction prices, or up to 97.2 using Portugal as a benchmark	6.5	Up to 406.8 based on the average of European auction prices, or up to 291.5 using Portugal as a benchmark
2.6GHz	Up to 20.8 based on the average of European auction prices, or up to 11.3 using Portugal as a benchmark	0.7	Up to 85.5 based on the average of European auction prices, or up to 39.5 using Portugal as a benchmark (licence duration 20 years)

However, whilst we have indicated a market value for the entire 2.6GHz band above, we consider it unlikely that there will be sufficient demand for spectrum within the current Greek mobile market for the entire 2.6GHz band to be required. This is because of the relatively limited competition in the Greek mobile market and because, with a total of 2×70MHz of paired spectrum available in the 2.6GHz band, all of the spectrum would be sold only if individual operators demand more than 2×20MHz of spectrum each. Based upon demand exhibited in other European auctions, this level of demand appears unlikely in Greece.

Our overall recommendations regarding mobile and DTT licensing in Greece in the UHF and 2.6GHz bands are as follows:

- The Hellenic Government should proceed with planning for the award of the 800MHz sub-band for mobile use, in line with the European Commission Decision of 6 May 2010 on harmonised technical conditions of use in the 790–862 MHz frequency band for terrestrial systems capable of providing electronic communications services in the European Union (2010/267/EU).[18] This will necessitate the migration of military systems from the upper part of the 800MHz band, to alternative spectrum. We understand that the Hellenic Government is considering alternative options for this, including the possibility of migrating military systems from the 800MHz to the 700MHz band.

[18] Commission Decision of 6 May 2010 on harmonised technical conditions of use in the 790-862 MHz frequency band for terrestrial systems capable of providing electronic communications services in the European Union (notified under document C(2010) 2923). Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32010D0267:EN:HTML.

- The Hellenic Government should also proceed with planning for the award of the 2.6GHz band for mobile use, in line with the harmonised European plan set out in the Commission Decision of 13 June 2008 on the harmonisation of the 2500–2690MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community (2008/477/EC).[19] However, it is not clear that sufficient demand exists in the market for the entire 2.6GHz band to be sold given the current market conditions in Greece. Therefore, we recommend that consideration be given to awarding only part of the 2.6GHz band at the current time, with the remaining spectrum reserved for future use. We note that award of 2.6GHz spectrum is contingent on the current legal matters regarding existing usage of the band in Greece for multi-point video distribution systems (MVDS) being resolved.

- Spectrum for mobile use in the 800MHz and 2.6GHz bands should be awarded via an auction.

- The Hellenic Government should proceed as soon as is practically possible with the award of rights to access and use spectrum in the 470–698MHz band for DTT, to accelerate the migration from analogue to digital terrestrial television and in the ASO process.

- In terms of the approach to licensing DTT, our analysis shows that assigning frequencies by multiplex is the method most commonly used, rather than assigning frequencies by individual DTT programming channel, or by DTT transmitter. The former approach enables multiplex operators to plan the DTT network within the available frequencies assigned to the multiplex, in accordance with the agreed co-ordination parameters (i.e. as defined within the ITU-R GE-06 Agreement and Plan[20] and the associated bilateral agreements with neighbouring countries).

19 Commission Decision of 13 June 2008 on the harmonisation of the 2500–2690MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community (2008/477/EC). Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:163:0037:0041:EN:PDF

20 Results of the ITU Regional Radio Conference 2006: http://www.itu.int/ITU-R/terrestrial/broadcast/plans/ge06/index.html.