FINAL REPORT

BROADCAST MIGRATION STUDY

OPTIMISING DTT DELIVERY IN EUROPE TO MAXIMISE THE GAINS FROM THE DIGITAL DIVIDEND

London, October 2008

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1 Executive Summary

1.1 Introduction

European countries are migrating to digital TV platforms, which offer consumers both a wider range of television and radio services than analogue, as well as a newfound ability to access numerous data and interactive services. The digital switch-over offers broadcasters a way to deliver these services more efficiently and effectively: in the case of digital terrestrial television (DTT), the space currently occupied by one analogue channel can accommodate a multiplex of between four and twelve digital channels.

This process could free up an important amount of spectrum in the UHF band, known as the "digital dividend" with many different potential uses. Spectrum Value Partners published an earlier report – 'Getting the most out of the digital dividend' – which was intended to help policymakers address how they might best allocate spectrum between broadcasting and mobile uses.

For the current study, we have been tasked by Ericsson, Nokia, Orange, T-Mobile and Vodafone to consider how broadcasters can migrate from analogue to DTT in the most efficient way possible and then later to upgrade to the most up-to-date digital television technologies. This will maximise the other opportunities available from the spectrum – whether for broadcasting or for other uses.

The study is intended to be both a record of the current position of DTT in each European country and a set of recommendations showing how DTT networks across Europe could be optimised in the future. For regulators, we aim to highlight the actions that each could consider to aid the broadcast migration process; for the broadcast community, we hope to illustrate best practice examples from other countries in Europe, on which they may draw when developing their own technology roadmap; and, for other digital dividend stakeholders (e.g. competitors for spectrum, government etc.), we aim to illustrate the barriers to achieving this migration and how they may be able to support the transition.

1.2 Key findings

Although countries vary greatly in their ability to implement changes, our analysis suggests that some general principles could be implemented across all of them:

- **Seeing digital broadcast technology improvements as an extension of moving from analogue to digital**. Updating broadcast technology continues this trend
- **Understanding the technology upgrades fully, including** what each upgrade means for broadcasters, consumers and regulators and the trade-offs between costs and benefits
- **Involving all stakeholders in setting priorities and goals** on the path of broadcast migration by establishing realistic timescales
- **Looking to other countries for examples of best practice**

1.2.1 Phased changes

Beyond the general points, some specific changes could be made at different stages in the migration from analogue to DTT. Our analysis suggests that broadcast migration upgrades can be split into three levels of implementation.

- **Level I** upgrades involve neither a large consumer impact nor a necessity to re-plan the network and, therefore, can be implemented relatively easily and cheaply for the benefit of consumers and broadcasters. These upgrades are possible over the short to medium-term and should be implemented

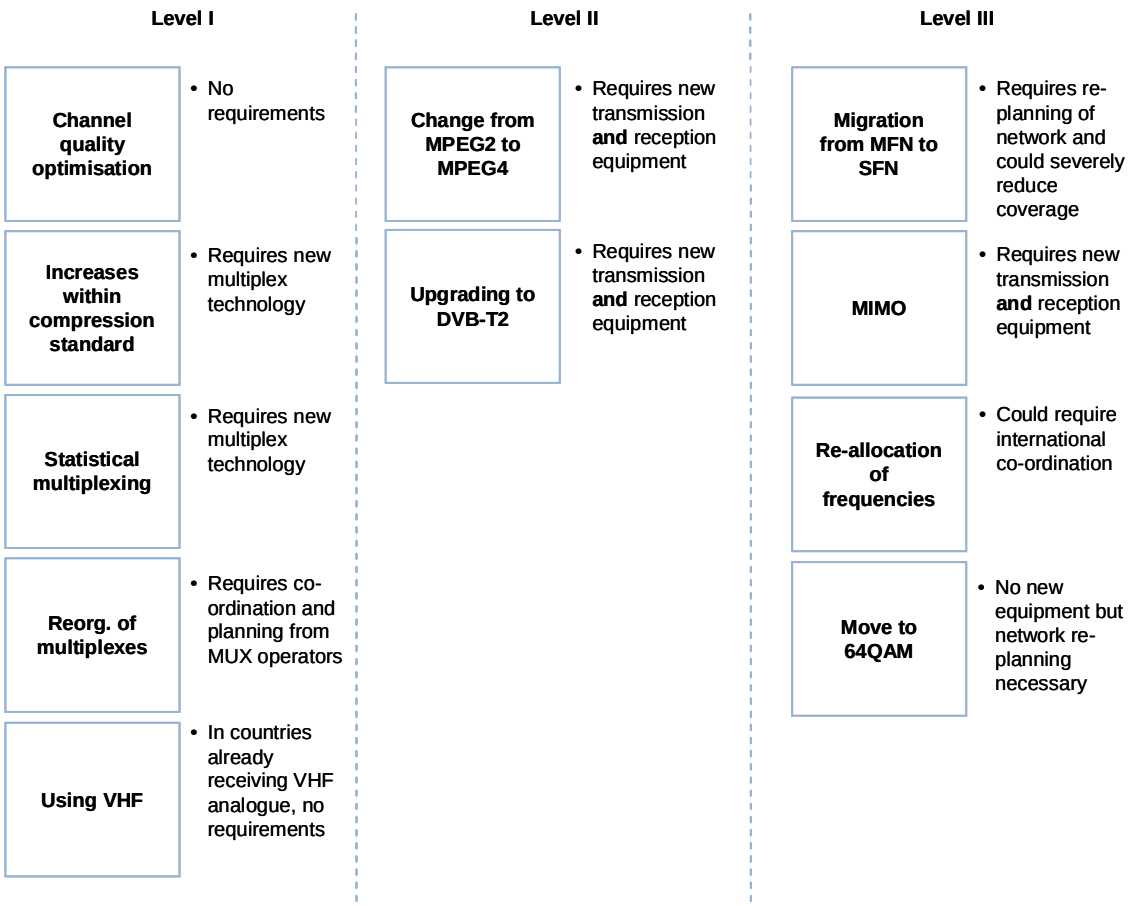
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wherever possible, providing they are commercially viable. They include ensuring that existing multiplex capacity is used efficiently, both in terms of channel bit-rates and the organisation of the multiplexes.

- **Level II** upgrades involve the purchase of new set-top boxes or iDTVs. These changes are not likely to be wholesale swap-outs but a gradual migration, on a multiplex by multiplex basis, which will reduce the installed base of legacy equipment over time. Level II upgrades, we believe, will be possible in the long-term.
- **Level III** involves some element of national and/or international re-planning. These upgrades have great potential to increase the capacity of the network but would involve a level of political and commercial negotiations and, most likely, a costly network improvement.

We consider Level I and Level II upgrades to be possible in the timeframe of this study (ten years) and that these changes should be co-ordinated and implemented as soon as operationally and commercial possible.[1]

Exhibit 1: Levels of broadcast migration for this study



1.2.2 Country-specific principles

Taking into account the commercial, regulatory and technical DTT environments, European countries can be broadly divided into five categories:

[1] We have considered Level III changes only where regulators have considered - or are already implementing - these changes (e.g. Italy moving to an SFN).

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- **Strong terrestrial, with proactive converged regulation** – the UK
- **Strong terrestrial, with media-specific regulation** – France, Italy, Spain
- **Strong cabsats with high portability requirements** – Austria, Belgium, Germany
- **Post-ASO pay-dominated countries** – Finland, the Netherlands, Sweden
- **Late-to-launch DTT territories** – Denmark, Ireland, Hungary, Portugal, Romania, Slovakia

1.2.3 Strong terrestrial, with proactive converged regulation

Market characteristics

The UK is characterised by:

- Proactive, converged regulator
- Technology-neutral stance

Despite being in the midst of an ASO plan, Ofcom has understood the requirement for spectrum to be used as efficiently as possible and that non-broadcast services could contribute to the economy by being offered part of the UHF band. Technology upgrades are underway; however, those involving CPE changes will be phased in.

Potential paths of action

- Explore the possibilities of undertaking level III activities.

1.2.4 Strong terrestrial, with media specific regulation

Market characteristics

The strong terrestrials, with media specific regulation – France, Italy, Spain – are characterised by:

- Pre-allocation of spectrum to DTT by regulators
- High installed base of DTT technologies, rendering upgrade of consumer equipment difficult
- Drive to make sure large analogue base of customers are converted to digital

Upgrading technology in these territories is generally a second priority to getting customers transitioned to digital. In addition, broadcasting is expected to remain strong, aiding the move to HD services and reducing possible spectrum allocation elsewhere. To this end, however, some “quick wins” are captured by migrating to more efficient technology where possible.

Potential paths of action

- The most important course of action for countries with a large installed base of STBs is to maximise spectrum efficiency within each multiplex
- Continue to explore avenues to technology upgrades on a MUX by MXU basis to seed new technology in the marketplace and reduce the impacts of future swap-outs
- Fully understand the implications around timings of migrations that involve consumer equipment – in particular, implications of different implementation timetables of DVB-T2 and MPEG4
- Finally, undertake unilateral decisions on the requirements of the platform and the availability of multiplexes rather than, perhaps, allocating spectrum to one service as a default

1.2.5 Strong cabsats with high portability requirements

Market characteristics

Strong cabsats with high portability requirements – Austria, Belgium, Germany - characterised by:

- DTT development being a low priority due to high cable/DTH penetration
- Low channel capacity due to portability requirements

Technology upgrades are not at the forefront of platform development as channel capacity is considered less important than availability. In these territories, upgrades are limited to those that do not interfere with the network.

Potential paths of action

- Given the limited throughput afforded by the portability and coverage requirements, maximising efficient of each multiplex is even more important. This could be achieved through:
  - reducing or keeping non-TV content to a minimum to ensure maximum pay back for consumers
  - considering maximum optimisation of bit-rates by regularly updating equipment and, potentially optimising quality necessary
- Beyond these, considerations should be made regarding the move to MPEG4 and DVB-T2 to increase capacity
- Finally, continue to discuss the opportunities to migrate to modulation with higher throughput without losing coverage (such as increasing transmitter power or density)

1.2.6 Post-ASO pay-dominated countries

Market characteristics

Post-ASO, pay-dominated countries – Finland, the Netherlands, Sweden - characterised by the fact that:

- ASO already achieved
- Technology decisions taken by predominantly pay operator on commercial basis

With ASO achieved, the focus of these territories is on developing a viable platform. Some of this may involve technology upgrades, where possible, but only if it makes sense commercially. Pay-DTT operators, in general, will be at the forefront of developing efficient multiplexes as this maximises their content offering. This is particularly true as stagnation of growth is evident now that ASO has occurred: easy acquisition of customers enjoyed during migration from analogue to digital now over (Boxer in Sweden has seen its first fall in quarterly subscriber numbers this year).

Potential paths of action

- Continue to monitor the need and feasibility of migrating to MPEG4 and DVB-T2 where appropriate. Rental models should aid the swap-out of boxes
- Regulators and winner of tenders need to work closely together to establish a platform that is attractive to consumers as well as spectrum efficient

Late-to-market territories

Market characteristics

Late-to-market territories – Denmark, Ireland, Hungary, Portugal, Slovakia - characterised by:

- Yet to launch (or in process of launching a new platform)
- Use of latest technology
- Technology decisions being taken by predominantly pay operator on commercial basis

Greenfield sites tend to mean the latest technology is employed; upgrades involving consumer change beyond this may be delayed, however, because of consumer confusion.

Potential paths of action

- The most important aspect is to lead the market in the most up to date technology. It is understandable that late to market territories aim for short swap-out timetables, aided by cheaper technology, but this should not be done, necessarily, on a low-cost entry level option. This option could prove more costly in the long-term (particularly technology premiums continue to be eroded, e.g. MPEG4 over MPEG2)
- Regulators could mandate technology to ensure this occurs – Ireland is the leader having mandated and recommended a significant number of different solutions
- Key decisions must be made around timing of launch with MPEG4 and DVB-T2. A successful DVB-T launch could mean a delay in DVB-T2
- Employing a rental model will be helpful in swapping out boxes gradually

Overall, whilst we have outlined some principles, Spectrum Value Partners believes that the approach to broadcast technology migration needs to be carefully considered on a country-by-country basis. Essential, also, for the successful functioning of any migration strategy, is an understanding of what is possible in the short, medium and long-term, as well as the barriers to achieving each step.

2 Introduction

2.1 Background to this report

Across Europe, markets are moving to digital TV platforms. Digital platforms offer consumers a wider choice of television and radio services, as well as the ability to access numerous data and interactive services. In addition, digital technology offers broadcasters a way to deliver these services more efficiently and effectively: in the case of digital terrestrial television (DTT), the space currently occupied by one analogue channel can accommodate a multiplex of between four and twelve digital channels, depending on various technology factors.

Once digital terrestrial services are up and running, and after a period of analogue and digital simulcasting, analogue transmissions can be switched off. This process could free up a considerable portion of spectrum in the UHF band, known as the "digital dividend",[2] with many different potential uses. There is currently a debate about how best to allocate the freed spectrum, with focus divided between national broadcasters, who want to launch more digital channels and move to High Definition (HD)[3], and mobile operators, who want to launch faster mobile broadband services with wide geographic coverage. The World Radio Conference 2007 decided that the upper portion of the UHF band should be identified for mobile services – although decisions on specific allocation still need to be taken by most Member States.

In 2007, Spectrum Value Partners ("Spectrum") was asked by Ericsson, Nokia, Orange, Telefónica and Vodafone, to analyse the benefits to Europe's economy which would arise if the UHF spectrum released by digital switchover (DSO) was allocated optimally between broadcasters and mobile operators. The report ("Getting the most out of the digital dividend"[4]) was completed earlier this year and its results suggested that allocating approximately 25% of the UHF band to mobile broadband would maximise the value to the European economy – generating between €63bn and €165bn (net of any loss derived from reduced broadcasting capability).

The study has contributed to the debate at the highest levels of European decision making – executive (European Commission), political (the European Parliament) and technical (the European Communications Committee).

Having identified the economic value added, it is clear that a practical implementation plan needs to be developed to unlock this value. In our report, Spectrum outlined three recommendations:

- **An early allocation of spectrum**. An early analogue switch-off and allocation of spectrum would facilitate the swift launch of advanced broadcast and mobile services, such as HDTV and high-speed mobile broadband by removing uncertainty and allowing broadcasters and operators to plan for the future – we estimate that delaying allocation to 2015 would cost €20bn for Europe
- **Regional harmonisation of the released spectrum**. Regional harmonisation of the released spectrum, wherever possible, would allow consumers to benefit from co-ordinated pan-European mobile and TV markets (aided by producers being able to build scale)
- **Migration of broadcast platforms to more efficient broadcast technology**. The migration of DTT networks to MPEG4 and DVB-T2 technologies, for example, would help achieve the spectrum efficiency necessary to sustain high definition on the terrestrial broadcast platform and release spectrum in

[2] The size of the Digital Dividend will vary by market – for example in Sweden 72MHz is estimated to be freed up and in the UK 112MHz.
[3] High definition services are more capacity hungry because of the requirement to broadcast a greater number of pixels per second than standard definition.
[4] Link: http://www.spectrumstrategy.com/Pages/GB/perspectives/Spectrum-Getting-the-most-out-of-the-digita-dividend-2008.pdf

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capacity-constrained markets, such as the Netherlands and Germany. In addition, countries yet to launch DTT should be encouraged to use the most efficient technologies (e.g. MPEG4, 64QAM) where feasible.

Although none of these options are easy, we believe that the benefits of the UHF spectrum can be realised by regulators, broadcasters, operators and others working together.

2.2 The report's principal objectives

As a follow-up to "Getting the most out of the digital dividend", Spectrum was asked by our sponsor group[5], to analyse the third of these value-generating activities – migrating broadcasting platforms to more efficient technologies.

The migration to more spectrum-efficient technologies is important because, as countries move towards an all-digital environment, the demands placed on the UHF spectrum continue to grow. Many broadcasters are demanding additional capacity for HD services, whilst mobile operators are looking to develop their broadband networks. Regardless of the potential uses of the UHF spectrum, a strategy of broadcast technology upgrades – although not always simple – is in the interests of all stakeholders in the long term.

This study is intended to be both a factual record of the current position of DTT in each European country and a set of recommendations showing how DTT networks across Europe can be optimised in the future. For regulators, we aim to highlight the actions that each could consider to aid the broadcast migration process; for the broadcast community, we hope to illustrate best practice examples from other countries in Europe, on which they may draw when developing their own technology roadmap; and, for other digital dividend stakeholders (e.g. competitors for spectrum, government etc.), we aim to illustrate the barriers to achieving this migration and how they may be able to support the transition.

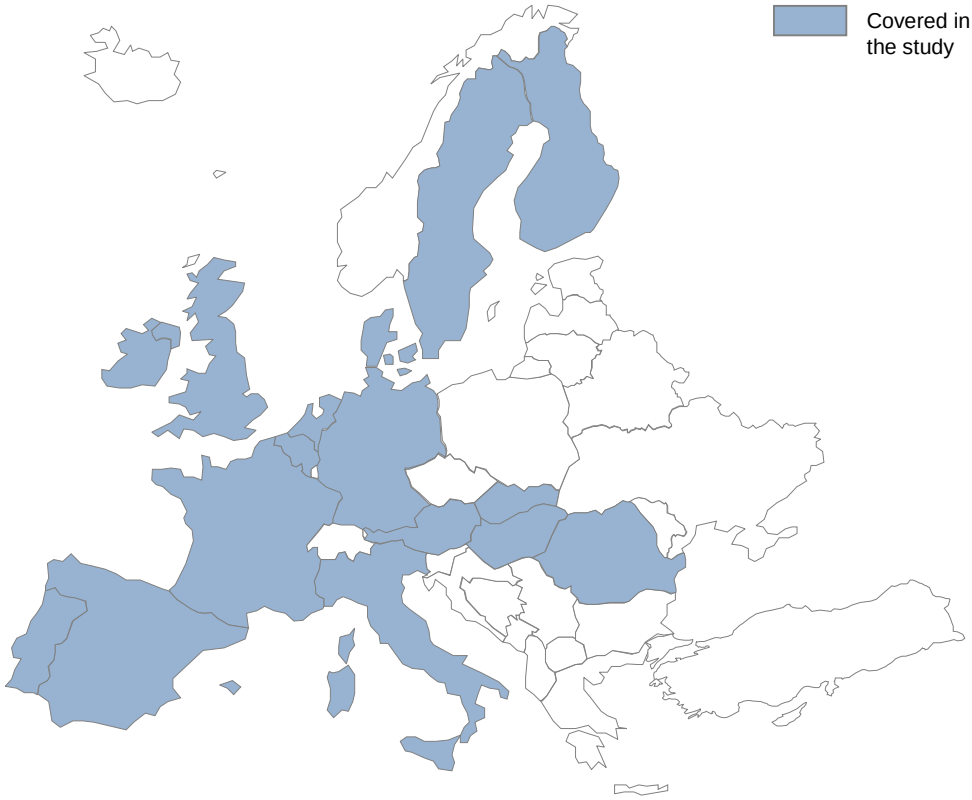
This report details the possible migration pathways for 16 countries across Europe.[6] We did so by considering three modules:

- **Detailing the current DTT environments across Europe**, from a technical, regulatory, and commercial perspective
- **Assessing what the DTT platform of the future may look like** based on technological improvements[7]
- **Understanding what barriers exist**, for both the broadcast community and their consumers, in making these transitions.

[5] T-Mobile now replacing Telefonica
[6] Time constraints and access to key individuals has meant that the scope of the project could not accommodate all 27 Member States.
[7] We have based this study on known technology improvements. We are aware that there will be new improvements that will continue to generate additional benefits for the platform in the future, but over the very long term.

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Exhibit 2: Countries analysed in the study



2.3 The future of the DTT platform

2.3.1 The role of Digital Terrestrial Television

The future of the DTT platform is central to this debate. In many countries, a large proportion of television households primarily watch TV through a terrestrial aerial rather than satellite, cable or other fixed line solution (such as ADSL and fibre-to-the-home).

In others, where cable and satellite platforms dominate the TV landscape, it can act as the preferred delivery mechanism for secondary sets, both in and out of the home. The latter can be particularly important as satellite, cable and other solutions are less suited to delivering TV away from the home.

In all countries it is necessary to have a mixed ecology of platforms, which, taken together, will deliver, post-ASO, universality of service, access to free-to-air programming, and ensure, through regulatory control, provision of public service programmes. Each platform technology delivers these aspects to a varying extent:

- Cable, satellite and IPTV are predominantly pay-TV platforms. Although satellite is, from a technical and economic viewpoint, a more efficient means of HD services-delivery, its predominance as a pay-TV service, in many countries, limits free-to-air access.
- Cable and IPTV does not offer universal coverage, and there is a high cost of roll-out in rural areas
- Satellite is not regulated at an individual country level and so cannot ensure provision of public service programming

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DTT is important because it helps to ensure the broadcast ecology delivers the 3 important aspects (universality of service, access to FTA programming and, through regulatory control, the provision of public service programmes), which in its absence, would not be sufficiently provided.

2.3.2 Operating a commercially viable platform

For DTT to continue to operate successfully, the platform must be commercially viable.

In countries where pay DTT models exist, operators must compete with other pay-TV offerings. Given the relative paucity of capacity afforded by terrestrial spectrum, DTT will, almost certainly, be unable to match other platforms in terms of quantity of channels. It, therefore, must compete by offering quality and/or value for money. We believe that a commercially-viable level of quality would involve capturing between 80% and 90% of audience viewing share. In most markets, this is achievable with between 30 to 40 channels.

For platforms that operate a FTA model, the requirement for a successful platform has to be more carefully considered. PSBs and, in particular, commercial PSBs, need to remain relevant and deliver audiences to their advertisers – as DTT is necessarily a narrower channel proposition than other delivery platforms, PSBs tend to achieve higher viewing shares. However, going forward, as the platform is optimised and the number of channels increases, there will be a consequent increase in audience fragmentation and a reduction in PSB viewing and advertising revenues. In many Western European countries, where TV's share of advertising is declining, this would compound an already-deepening problem. Thus, for these broadcasters, there is a trade-off between a strong and technically optimal platform and the prospect of a more diluted audience.

Any changes to the DTT platform must ensure its ongoing commercial viability as a priority.

2.3.3 Offering HD services

Although DTT is not - and will never lead the transition to - HD (as witnessed by the decision of the BBC and ITV to launch their first free HD services on Freesat), many in the broadcast community consider the transition to HD as inevitable – as much so as the transition from black and white to colour and from analogue to digital. We have made no judgment on whether a platform needs to be fully HD to be commercially viable although common consideration from the broadcast community is that it may well be.

To receive HD services, consumers are either required to purchase a new HD set-top box and/or an HD-ready TV. Most broadcasters considering launching HD services on DTT will do so over newer technology standards (such as MPEG4). Unfortunately, this renders the current crop of HD-ready TVs – which is primarily reliant on sub-optimal technology (such as MPEG2) – redundant. An additional set-top box or the acquisition of a new HD-ready TV would still be required.

2.3.4 Migrating to new technology

In the current transition to digital, regulators and broadcasters have placed an emphasis on getting the service up and running. As we move towards an all-digital environment, the emphasis will shift to ensuring that the platform is using capacity efficiently – squeezing in more channels and offering better quality (and, in some cases, HD quality).

This shift to capacity efficiency will be facilitated by a series of broadcast technology upgrades. Regardless of the potential uses of the freed up UHF spectrum, this focus on the use of the most efficient broadcast technologies – although not always simple or easy to implement – is in the interests of all the stakeholders in the long term.

2.4 Report methodology

2.4.1 Research and sources

To assess the likely future configuration of Europe's DTT platforms, we first gathered inputs from a range of sources:

- Benchmarks from previous Spectrum Value Partners broadcasting projects
- Models and data published by regulators and industry bodies
- Reports published by third parties, such as the EBU
- Outputs of the GE/RRC06 conference

We then developed an Excel broadcast model which allowed us to calculate the impact of individual technology changes on a country's DTT system and the resultant number of channels it was possible to accommodate.

In addition, we also carried out an extensive programme of interviews with regulators and ministry officials across all markets studies. These interviews provided clarification on the current DTT structure as well as giving an indication regarding future technology mandates and the availability of additional capacity. Interview contacts were sent a copy of the first draft of the relevant national chapters so that we could incorporate their comments and ensure that we were accurately reporting the facts of the DTT market in each nation.

Exhibit 3: Interviews carried out in each country

Country	Interview source	Contacted with draft version of national chapter	Received and incorporated comments from interview contacts
Austria	Komm Austria	✓	✓
Belgium	BIPT	✓	✓
Denmark	Media Secretariat	✓	✓
Finland	FICORA	✓	✘
France	CSA	✓	✓
	ARCEP	✓	✓
Germany	BNetzA	✓	✘
Hungary	Advisor to the Cabinet Office	✓	✓
Ireland	Comreg	✓	✓
	BCI	✓	✓
Italy	Agcom	✓	✓
Netherlands	Ministry of Economic Affairs	✓	✓
	RCA	✓	✓
Portugal	ANACOM	✓	✓
Romania	National Authority for Communication and Information Technology	✓	✓
Slovak Republic[8]	Research Institute of ministry of Telecommunications and Posts Telecoms Minister	✘	✘

[8] Interview carried out as part of the previous phase of work.

Country	Interview source	Contacted with draft version of national chapter	Received and incorporated comments from interview contacts
Spain[9]	Ministry of Industry, Tourism and Commerce	✘	✘
Sweden	RTVV	✓	✓
UK	Ofcom	✓	✓

In addition, we interviewed several broadcast technology experts and equipment manufacturers, to test our hypotheses on future capacity gains. Where new technologies, e.g. MIMO, are yet to be deployed, we have estimated the likely impact based on the consensus of our interviews.

2.4.2 *Analysis and document structure*

Our analysis is presented below in three main sections:

- A Europe-wide **overview of commercial operations; regulatory considerations and broadcast technology**. Here, we illustrate how these different factors affect the DTT platform and the possible implications each may have for broadcast technology migration
- **Country-by-country analysis**. For each country, the DTT landscape is considered, the likely technology changes explored and recommendations to optimise the network identified.
- **Conclusions**. Given the outcome of the country analysis, we highlight the conclusions and recommendations on a European level.

[9] Informal discussions only

3 Commercial operations

3.1 Introduction

DTT is an integral platform for the future of television in Europe, as it is, often, the only platform which is able to offer national coverage of FTA public service channels in an economically viable manner. Consequently, regardless of household penetration by incumbent multi-channel services, in each European country governments and broadcast regulators have planned, or are in the process of planning, a DTT network to replace the analogue terrestrial platform post-ASO.

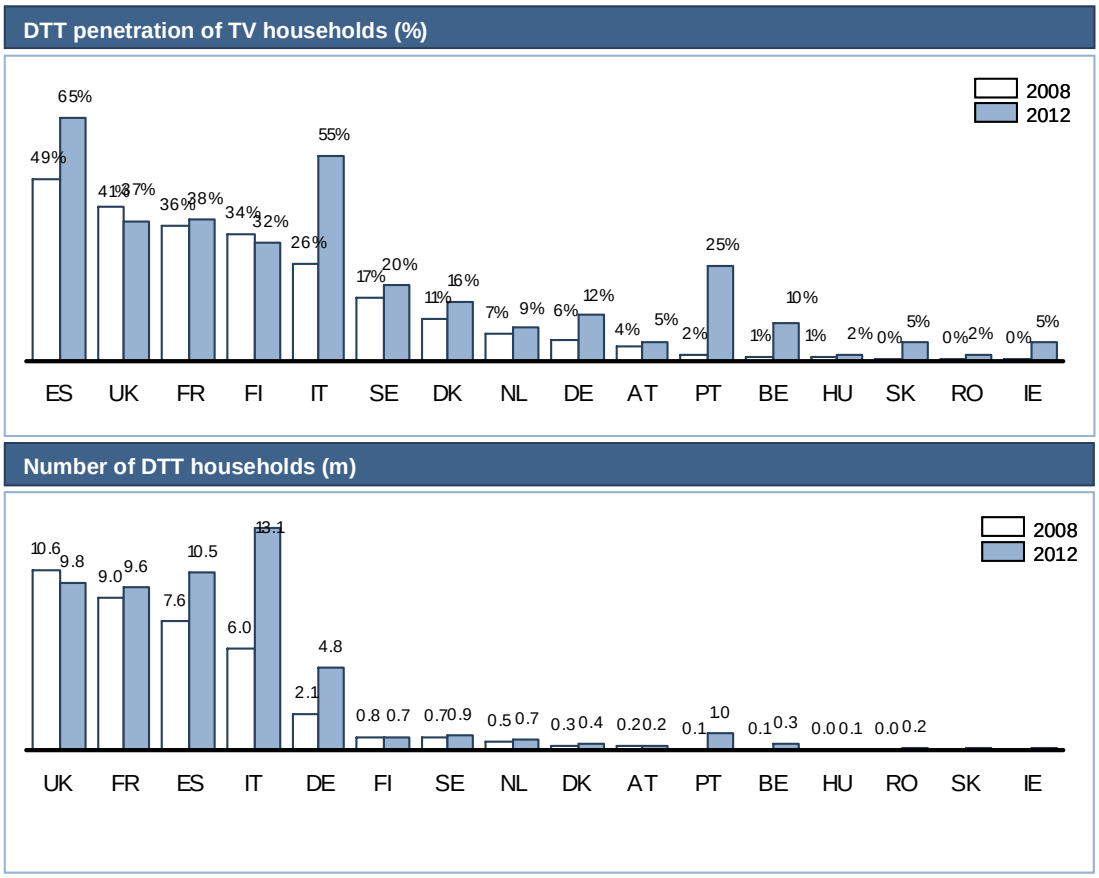
Below we outline some of the key commercial dimensions for the DTT platform – the DTT value chain, DTT business model and the current & forecast platform take-up - and the impact these factors have on any future broadcast migration plans. These three factors are important in shaping the broadcast technology roadmap for the future as they illustrate the commercial decision-makers and reasons behind strategies that they may follow:

- The platform take-up exemplifies the importance of DTT in each country, as well as an indication of the size of the installed base of set-top boxes. Both indicate the consumer disruption which may occur if technical upgrades are required
- The DTT value chain illustrates the stakeholders involved in DTT and, therefore, those that may be involved in upgrading the broadcast technology
- The business model (pay or free-to-air) can identify specific commercial issues that may affect some countries more than others.

3.2 Platform take-up

The take-up of DTT varies greatly across the European nations from above 30% of primary television households in France, Spain, Italy and the UK to below 10% in Belgium, the Netherlands and Austria (not including countries in which the platform is still to launch).

Exhibit 4: DTT penetration



Source: Screen Digest

The success of a DTT platform is primarily dependent on the penetration of cable and satellite platforms. In some countries, cable is seen as a utility by consumers; in others, the satellite platform has had particular success, usually due to the presence of exclusive content. For example, in Belgium, where there is 90% cable and satellite television household penetration, the DTT service has had low-take up (2% in 2008) and has been used mainly for secondary set viewing. In the UK, where analogue terrestrial is a stronger platform, the take-up of DTT has been greater (41% in 2008).

Future success will be determined by DTT's ability to capture consumers migrating from analogue to digital. The run-up to ASO is an uncertain time for analogue customers as they are forced to make a decision on TV service. In the case of FTA DTT platforms, terrestrial is often best-placed as many customers not already paying for a cable or other pay TV proposition, are unlikely to do so in the future. For pay DTT services, prices are generally cheaper than other platforms and so are expected to fair well, also.

Post-ASO, with no major commercial and technological intervention, we would expect to see some stability of take-up between platforms.

3.3 The DTT value chain

In considering broadcast technology migration, two aspects of the DTT value chain are important:

- Control of transmission and multiplex management

- Channel selection

Having control over these factors enables multiplex operators to harness new technology more effectively.

a) Control of transmission and multiplex management

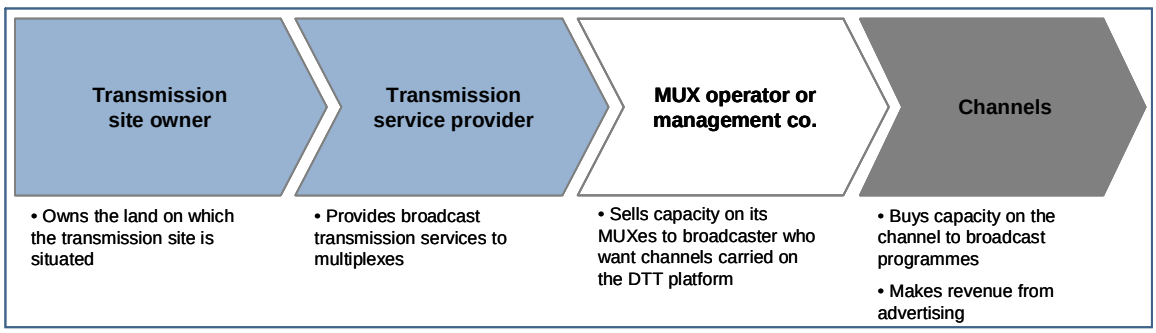
The DTT value chain has four operational positions:

- Transmission site owner
- Transmission service provider
- Multiplex operator
- Channel provider

Companies involved in the DTT platform operate in either one of these or multiple positions

- Boxer in Ireland will be purely a MUX operator
- National Grid Wireless in the UK is a transmission service provider and a MUX operator
- The BBC in the UK is a MUX operator and a channel provider

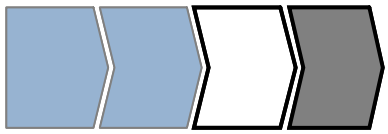
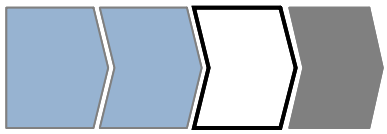
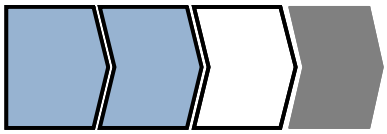
Exhibit 5: DTT value chain



Depending on government regulation, network operators can be just transmission providers or both transmission providers and multiplex operators.

In some instances, such as the aforementioned BBC case, one entity can be both a MUX provider and provide channels on their MUXes.

Exhibit 6: DTT value chain business models[10]

	Illustration	Description
MUX operated by broadcaster		• Broadcaster, rather than a specific MUX operator, e.g. Boxer, is awarded licence • Broadcaster places its channels on the MUX, and awards remaining capacity to third party channels
MUX operator in charge of channel mix		• MUX operator has choice over which channels it awards capacity to on the MUXes • Operator can decide on technology standards for the MUX
MUX operator is also the transmission service provider		• Transmission provider also has licence to operate a MUX, e.g. NGW in the UK • In some cases, transmission provider will also have the right to allocate capacity to channels

As different players across the value chain benefit to varying extents from technology improvements, the structure of the value chain in each market will be an important determinant of the broadcast migration plan.

b) Allocating channels

Traditionally, Government regulation influences the method through which MUX capacity is allocated to channels. In some markets, such as Finland, the government allocates capacity to channels and so the MUX operator does not have control over the specific channels that it accommodates. In others, government intervention extends to the business model (FTA/Pay).

Sometimes channels themselves can decide which channels are allocated capacity. For example, in the UK, MUX operator SDN (owned by broadcaster ITV) has the ability to sell capacity on its MUX to channels at a market rate. A third model of capacity allocation is that operated in Italy, where a proportion of capacity is reserved for independent channels rather than those owned by the major operators, such as Mediaset and RAI.

Exhibit 7: Ability to select channels on DTT MUXes

	Austria	Belgium	Denmark	Finland	France	Germany	Hungary	Ireland	Italy	Netherlands	Portugal	Romania	Slovakia	Spain	Sweden	UK
Regulator	×	×	×	✓	✓	×	×	×	×	×	×	?	×	×	✓	×
Operator	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	?	✓	✓	✓	✓

[10] The system in Sweden is the exception to this diagram. In Sweden, Teracom is both the transmission service provider and muitiplex operator. However, it licenses the ability to operate a pay broadcast service across its multiplexes (to Boxer). Unlike most other pay-DTT platforms, the pay channels are inter-dispersed with FTA channels across multiplexes.

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3.4 DTT business models

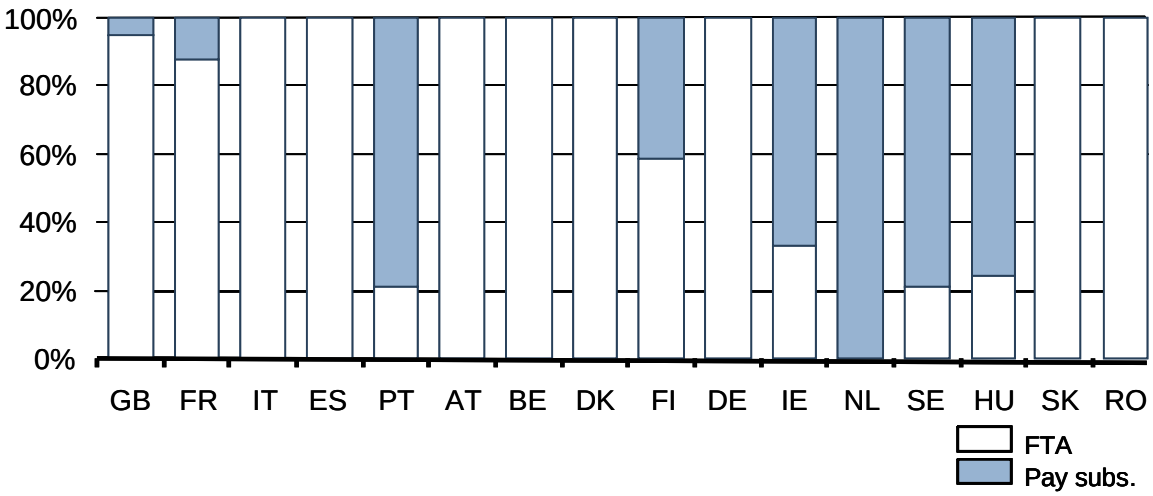
Both FTA and pay-DTT business models are employed across Europe. In all markets where a pay-DTT service operates, it does so alongside at least one FTA MUX, ensuring that terrestrial television continues to have universal FTA access.

Initially, pay-DTT struggled to be successful and early services, ITV Digital and Quiero TV in the UK and Spain, respectively, failed to attract subscribers and went out of business. These services failed as they were launched with poor coverage and an inferior package of channels relative to the incumbent DTH and cable operators. For example, in the UK, ITV Digital invested heavily in the exclusive rights to show live Football League matches, but its content offer still compared poorly to Sky which owned the exclusive rights to show Premier League football matches.

Exhibit 8: DTT Business models (current or anticipated)

	Austria	Belgium	Denmark	Finland	France	Germany	Hungary	Ireland	Italy	Netherlands	Portugal	Romania	Slovakia	Spain	Sweden	UK
FTA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pay-DTT	×	×	×	✓	✓	×	✓	✓	✓	✓	✓	×	✓	×	✓	✓

Exhibit 9: Projected mix in 2012[11]



On pay-DTT platforms where the MUX operator has control over the channels (and technology standards) they have to decide on the trade-off between accommodating a high number of SD channels or a lower number of HD channels. Whilst HD channels arguably provide a higher quality of content, by offering capacity

[11] Source: Screen Digest. The Netherlands does have one free-to-air multiplex but take-up is forecast to be driven by subscription services.

for an increased number of SD channels, MUX operators can maximise carriage fees they receive from channels.

3.5 Summary

Broadcast migration plans must take into account a range of commercial factors, including:

- Platform take-up
- The structure of the DTT value chain
- The DTT business model

For example, in markets with high terrestrial penetration, the importance of the DTT network is likely to be higher and there will be a large installed base of DTT set-top-boxes which must be considered in any technology migration. An effective set-top-box swap-out strategy will be essential.

In markets where there is a pay DTT business model, the migration is likely to be easier as a result of the predominance of rental set-top-box models, which can be more easily replaced, and increased demand for HD services (to accommodate sports and movie content) which necessitates a rapid migration to efficient MPEG4 technology.

In markets where the broadcaster and multiplex owner are vertically integrated and once broadcasters have sufficient capacity to support their own channels, they have little incentive to invest in additional technology upgrades which will further increase the capacity of the network. In fact, the probability that an increase in the number of channels will further exacerbate audience fragmentation may act as a disincentive to optimise the network.

4 Regulatory considerations

4.1 Introduction

Whilst most regulators have set deadlines for the launch of the digital terrestrial platform and the termination of the transmission of analogue signals, the actual implementation of platform technology is typically agnostic from a regulator's point of view. Although generally indicating a market-led approach to technology standards, each country operates with a varying degree of regulatory intervention.

Regulators are principally concerned with three goals for the DTT platform:

- Ensuring the universal availability of existing analogue PSB services (and the plurality of these services)
- Ensuring that no citizen is disenfranchised by the switch-off of analogue signals
- Delivering the conditions for a commercially viable platform

Below we examine several aspects of regulatory intervention and the extent to which they are applied in countries across Europe:

- The digital switchover process provides an overview of the progress – and, most importantly, timing – of the launch and take-up of DTT in each country
- Coverage and portability requirements help to determine the parameters of feasible network upgrades are possible for broadcasters
- Service obligations determine what is possible from a programming perspective
- Finally, technology obligations illustrate the extent to which each regulator is willing to mandate new broadcast standards, and why

All these regulatory areas could impact future decisions on broadcast technology upgrades.

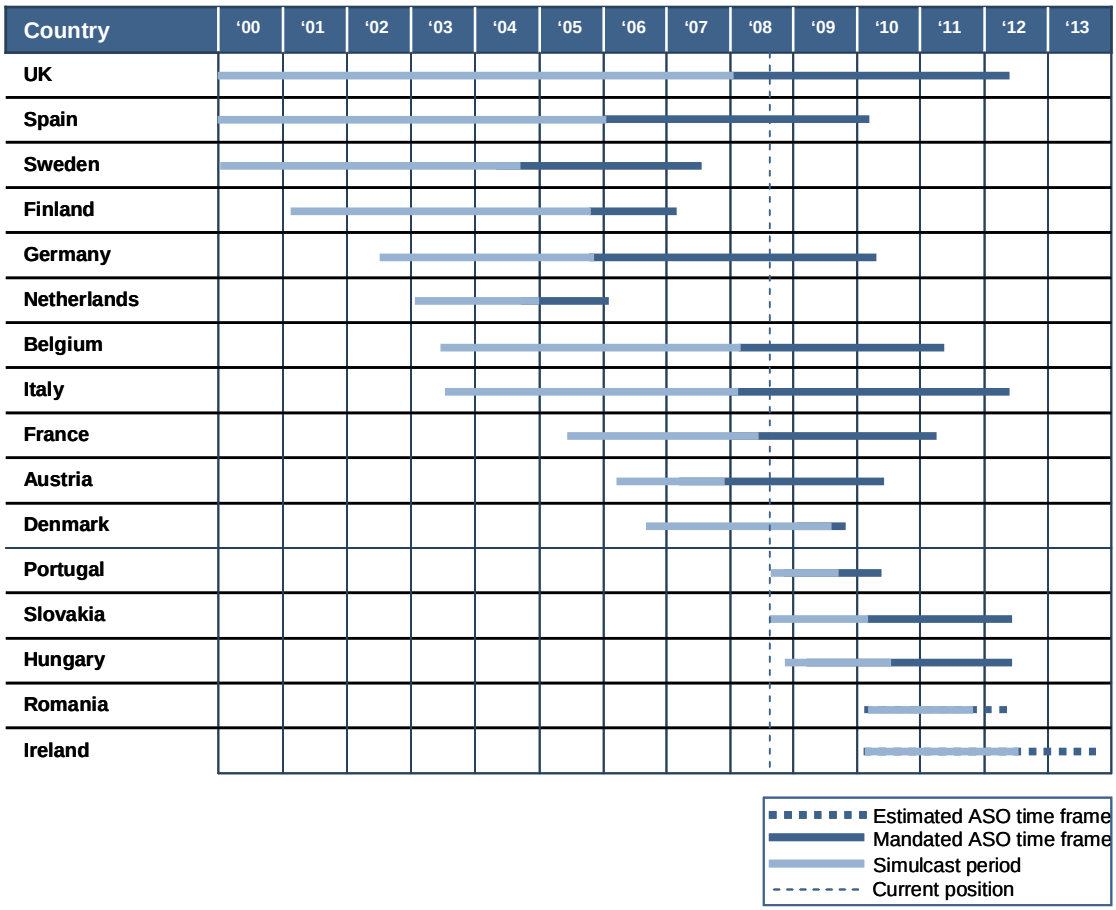
4.2 Digital switchover process

The launch of the digital platform and the cessation of the transmission of analogue signals is the key consideration for regulators. In order to maximise the value of available spectrum, regulators are keen to switch off analogue signals as soon as possible, but only when digital television penetration is sufficient to ensure minimum disruption to consumers.

As broadcasting environments differ from country to country there is no set date for ASO for the whole of Europe and each country has a different digital switchover process which has been mandated by its governments and regulators.

It has been typical, in Europe, for countries to undergo ASO region by region. For example, in the UK, ASO began in 2007 in Whitehaven and will continue region by region until all regions have switched-off in 2012. Some countries, for example Spain and Italy, have delayed their ASO date due to slower roll-out and lower take-up of DTT than expected. Other countries, such as Austria, have been able to bring their ASO date forward. To date, three countries studied have undergone the full transition to digital – the Netherlands (switching off in 2006), Sweden and Finland (both in 2007) – due to a low analogue dependent household base.

Exhibit 10: European Digital Switchover Schedule



N.B. UK began DTT in 1998, and Spain/Sweden began in 1999

Countries can be placed in four broad categories:

- For **platforms that have already undergone full ASO**, the next few years will bring opportunities to enhance the service from both a technology and programming perspective
- **In countries that are yet to switch fully to digital**, this may also be the case although regulators will focus on migrating analogue customers to digital and achieving ASO on time before implementing technology upgrades that could increase consumer disruption
- For **recently launched platforms**, some technological changes could lead to consumer confusion and upheaval and, therefore, are unlikely in the short-term
- **Platforms that are yet to launch** provide greenfield opportunities to implement the latest technologies.

4.3 Coverage

In order to achieve its primary target of universality, regulators typically mandate a certain level of coverage. Our research suggests that there are three broad levels of population coverage obligations:

- Government/Regulator imposed
- Self-imposed (where the MUX operators themselves agree on a level of coverage)

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- No obligations.

It is often the case that regulators will impose different restrictions on different multiplexes – principally, placing heavier conditions on multiplexes that carry PSB channels in order to ensure universality (and match current analogue coverage). As a result, PSB MUXes have stricter obligations than commercial MUXes. This is the certainly the case in all the major western European nations:

- **UK:** the core PSB coverage figure (where all three PSB MUXes are available) is currently at 70% - with MUX1 at 81%. This must be extended to match the current analogue figure of 98.5%, and at minimum must reach 95% of the population by 2010
- **Italy:** at present, coverage is approximately 70% for all multiplexes, Mediaset are obliged to reach 80% by 2006
- **Spain:** the original broadcasters were mandated by the government to reach various milestones, including 95% by 2011
- **France:** the regulator will "chaperone" the roll-out of DTT

In other cases, as DTT rolls out, it is likely that more obligations will be enforced, as governments seek to encourage consumer take-up of the platform. For example, in the UK, industry experts believe that additional coverage obligations are likely to be included as the digital licences are renewed – if the obligations for commercial channels are raised to meet those imposed on the BBC (99+%), 200 new transmitters may have to be built.

In Finland, levels of coverage have been left to the broadcasters to agree rather than being mandated by the Government or regulator. In this instance, broadcasters have agreed, between themselves, that coverage should reach 94%.

In Germany, both public and private broadcasters are actually reducing their proposed coverage due to high costs relative to other platforms and a lack of public subsidies to fund roll-out. As a result, analogue is likely to remain the only terrestrial platform for remote areas until the ASO date.

Exhibit 11: Level and determinant of MUX coverage

Country	PSB MUXes		Commercial MUXes	
	Level of coverage	Mandated by	Level of coverage	Mandated by
Austria	95%	Government	Currently no commercial MUXes	
Belgium	"Regional"	Regional regulators	Currently no commercial MUXes	
Denmark	99.8%	Government	97% once MUXes are launched, mandated by the Government	
Finland	99.9%	FICORA	78%-95%	MUX operator
France	95%	CSA	95%	CSA
Germany	"Regional"	MUX operator	"Regional"	MUX operator
Hungary	94%	Government	94%	Government
Ireland	"Similar to analogue"	Government	90%	BCI
Italy	70%+	Agcom	70%+	Agcom
Netherlands	100%	Government	"National"	MUX operator
Portugal	85%	ANACOM	85%	MUX operator
Romania	98%	Government	No obligation	
Slovakia	N/A	N/A	Currently no commercial MUXes	
Spain	98%	Government	96%	Government
Sweden	99.8%	Government	70+%	Government
UK	98.5%	Ofcom	90%	MUX operator

Coverage requirements will affect any broadcast migration plans as it impacts the cost of technology upgrades and the degree of consumer choice in a given region. Higher coverage targets necessitate the roll-out of a larger number of broadcast towers and, consequently, a higher number of new modulators and encoders when new technologies, such as DVB-T2 are implemented. In countries without DTT coverage targets, consumer choice is likely to be lower, which may be unacceptable to governments and regulators post-ASO.

4.4 Portability

In addition to coverage obligations, regulators can mandate the strength of the transmission signal within an area. This is determined by the level of reception portability required. Portability requirements are political rather than technological decisions – in particular, portability may be mandated to ensure a high quality of reception on secondary sets, without external aerials, for all public service broadcasters.

Three types of portability requirements were proposed at the GE-06 conference, each requiring an increasing amount of spectrum per channel:

1. Spectrum allocated for fixed roof reception
2. Spectrum allocated for portable outdoor / mobile reception
3. Spectrum allocated for portable indoor reception

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The level of portability mandated can significantly impact the number of multiplexes available for digital television. A combination of transmitter power, multiplex modulation and the number of radio channels frequencies required per multiplex to cover the nation may all conspire to reduce the available spectrum. This also means that many countries cannot take advantage of network upgrades such as moving to 64QAM.

Exhibit 12: Level of portability anticipated at GE-06[12]

Country	Level of portability		
	Spectrum allocated for fixed reception	Spectrum allocated for portable outdoor / mobile reception	Spectrum allocated for portable indoor reception
Austria	✓	✓	×
Belgium	✓	✓	×
Denmark	✓	×	×
Finland	✓	✓	×
France	✓	✓	×
Germany	✓	✓	✓
Hungary	✓	✓	×
Ireland	✓	×	×
Italy	✓	×	×
Netherlands	✓	✓	×
Portugal	✓	✓	×
Romania	✓	✓	×
Slovakia	✓	✓	×
Spain	✓	✓	×
Sweden	✓	✓	×
UK	✓	×	×

The outline for this process was considered at GE-06 and our results taken from GE-06 planning documents.

The GE-06 documents show that Germany places significant emphasis on portability. Our interview process highlighted that, in addition, portability is important for Austria, Belgium and the Netherlands – principally because terrestrial is seen as the platform for delivering TV services to secondary TV sets post-ASO.

4.5 Service obligations

Regulators may impose obligations on the services that the multiplex operators offer. These may be for both television and non-television content and can include must-carry of FTA analogue terrestrial channels, allocating a proportion of a MUX to specific channels and placing the restriction on the proportion of MUX capacity allocated to non-TV services. In addition, it is possible in the future that increasing obligations will be placed on the carriage of HD channels in order to increase their availability on the service.

[12] Source: GE-06 digital Plan, "Distribution of DVB-T Assignments/Allotments in Bands IV-V by country" 10 Jan 2007 and series of regulator interviews.

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Whilst technical improvements can be an enabler of higher quality and wider breadth of services, the actual realisation of those benefits can be restricted by service obligations. For example, reserving capacity for must carry channels or data-streams may restrict the platform's ability to carry other channels and services popular with consumers.

4.5.1 Obligations on the delivery of television content

a) Must carry

Regulators place must-carry obligations on FTA PSB channels to ensure that existing analogue terrestrial PSB channels continue to be broadcast in digital following ASO. In some countries, such as France and Spain, the intention is to allocate all the national analogue terrestrial channels their own MUXes. Additionally, in some markets these must carry restrictions require the transmission of selected channels at a higher bit-rate than is deemed necessary elsewhere.

b) Fair, reasonable and non-discriminatory

While many regulators do not go as far as imposing "must carry" obligations, they do expect multiplex operators to operate a "fair, reasonable and non-discriminatory" policy of allocating capacity to channels. This is particularly true for cases in which demand outweighs supply. For example, the recent tender for DTT multiplexes in Ireland states that an FRND policy is essential to the award of the licences.

c) Capacity restrictions

In Italy, 40% of MUX capacity is reserved for independent channels with no affiliation to RAI, Mediaset or Telecom Italia. The intention of this obligation was to ensure that the DTT platform was not dominated by the three major operators. Traditionally, the MUX operators could decide on which channels to award capacity to and the terms on which this capacity was awarded; however following legislation in 2007 the control of capacity for third parties was switched from RAI, Mediaset and Telecom Italia to an independent commission appointed by Agcom and the Ministry of Communications. According to Agcom, the purpose of these new regulations was to create pluralism on the DTT platform.

d) High Definition

Going forward, it is possible that service obligations concerning HD programming will be introduced. Currently, with the exception of the UK and France, which have already allocated specific MUXes for HD services, no MUXes are mandated to carry any HD channels. However, as the penetration of HD-ready television sets increases and improvements in technology become available, it is possible that regulators will create must-carry obligations on HD content.

4.5.2 Obligations on the delivery of non-television content

Some governments place service obligations on non-television content. For example, in the UK, the use of data services is restricted to 10% at most,[13] and in Spain only 20% of individual MUX capacity is permitted for interactive services. The purpose of these service obligations is to ensure that the maximum amount of television channels can be provided on each MUX under current technology standards whilst also giving an allowance for limited non-television content.

[13] Ofcom can reduce this figure, but only the Government can increase it.

Exhibit 13: Service obligations in different countries

	Austria	Belgium	Denmark	Finland	France	Germany	Hungary	Ireland	Italy	Netherlands	Portugal	Romania	Slovakia	Spain	Sweden	UK
FTA must carry	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Capacity reservation	×	×	×	×	×	×	×	×	✓	×	×	×	×	×	×	×
Non-TV restriction	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	×	✓
HD channels	×	×	×	×	✓	×	×	✓	×	×	×	×	×	×	×	✓
DVB-H	✓	×	×	✓	✓	×	×	×	×	✓	×	×	×	✓	×	×

4.6 Technological obligations

Regulators also have it in their power to place obligations on the technology used on the platform – both from a broadcasting perspective (e.g. modulation, compression) and from a customer perspective (the STB and aerial). While it is relatively rare for regulators to place specific technical obligations on MUXes – e.g. Dutch regulators do not take a position regarding DTT technology, instead holding the view that running DTT MUXes should be left to the MUX operators – it is more likely that technological standards will be "encouraged" or "strongly recommended". The influence on technological standards by the regulator differs on a country by country basis and it is possible that, going forward, given the abundance of alternative standards (e.g. MPEG2 and 4, DVB-T and DVB-T2), we may see increased regulation to future proof the platform more effectively.

a) The trade-off between cost and technology

Regulators are, typically, keen to keep initial costs low to encourage platform take-up in the short-term – either directly by keeping CPE costs down or indirectly by reducing the network roll-out costs for operators/broadcasters. Technological obligations placed upon MUXes can lead to increased costs. For example, in countries where portable reception is a requirement on the DTT platforms, such as Germany and Belgium, there is the need for high-powered transmitters and lower modulation, which can increase operating costs whilst not creating additional capacity for the MUX. This may have the effect of disabling the platform in the long term by making it difficult to implement broadcast technology upgrades that would increase the capacity and channel proposition.

b) New launches are not as future-proof as expected

Our research found that, perhaps surprisingly, the majority of imminent DTT launches do not have mandated standards (for compression, modulation and transmission), with the decision reserved for the winning bidders of the MUX licences. For example, in the recently completed Hungarian tender, whilst the regulator supported the use of the most forward compatible technology currently available, i.e. MPEG4, DVB-T, 64QAM, the final decision on which technology standards to use was reserved for the winning bidder. An exception to this is the recent tender process for commercial DTT in Ireland, where MPEG4 is mandated.

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Where regulators do not mandate technology standards, they use language in their public documents to clarify their position regarding technology standards. For example, in the recent Irish DTT tender process the Broadcasting Commission of Ireland (BCI) "strongly recommended" that HD was made available on the platform. In Sweden, RTVV, the broadcast regulator states that the licence for the sixth MUX "*should* contain terms stipulating that MPEG4 technology *should* be used", thus using language that, whilst recommending MPEG4 technology, stops short of mandating it.

Exhibit 14: Technical specifications in different countries

	Channels		Mux Capacity		Set-top box technology
	HD	Compress.	Modulation	DVB standard	STB standards
Austria		✓✓	✓✓	✓✓	
Belgium					
Denmark		✓✓			
Finland	✓	✓	✓		✓
France	✓✓	✓✓		✓	(legislation being amended)
Germany				✓	
Hungary	✓	✓	✓	✓	✓
Ireland	✓	✓✓	✓✓	✓✓	✓✓
Italy		✓		✓	
Netherlands					
Portugal		✓	✓	✓	
Romania	✓ (post ASO)		✓✓		
Slovakia		✓			
Spain					
Sweden	✓	✓✓*			✓
UK		✓✓	✓	✓✓	

* Compression in Sweden has been mandated for the sixth MUX

✓✓ Mandated
✓ Recommended

4.7 Summary

Current regulatory approaches mean that in some markets it will be challenging to optimise the DTT network and free up the digital dividend. This is particularly true for interventions relating to portability, coverage and technology mandates.

Mandatory portability may restrict broadcaster's ability to move to high capacity modulation standards such as 64QAM and thus limit capacity improvements.

Coverage requirements may increase the number of towers required for the network and, consequently, increase the costs of any technology upgrade requiring new modulators for every tower.

Our analysis suggests that regulators are generally technology-agnostic, preferring a market-led approach. For existing platforms, this was understandable at launch; however, we believe that regulators could now take a more involved role to help future-proof the platform. For new launches, only the BCI in Ireland has mandated any level of technology. A process of "encouragement" is in place in other tenders and this opportunity to implement the most up-to-date technology should not be missed.

Going forward, it is important that regulators are more involved in technology decisions in order to ensure that the DTT platform, where yet to launch, uses the most spectrum efficient configuration and, where already in place, continues to upgrade as and when more efficient technology becomes available.

5 Broadcast technology

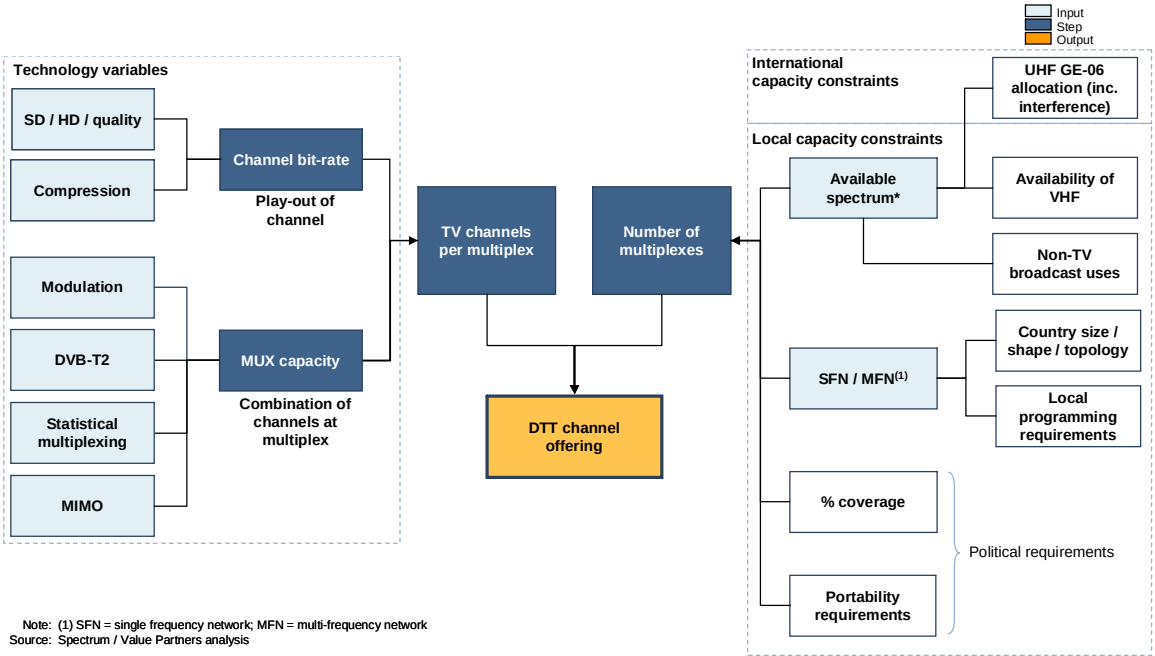
5.1 Introduction

The number and service mix of channels carried over a DTT network is dependent on a range of technological and commercial factors, broadly split into three areas:

- The capacity required to broadcast each channel selected by the broadcasters/multiplex operators
- The capacity of each multiplex and therefore the number of channels each can accommodate, and
- The number of multiplexes available in each country

It is important to note that each Member State has different regulatory, commercial and technical requirements and, therefore, will have different results.

Exhibit 15: General methodology



Note: (1) SFN = single frequency network; MFN = multi-frequency network
Source: Spectrum / Value Partners analysis

Over time, many of these elements will be subject to improvements; but, again, the ability to take advantage of these improvements will vary from country to country.

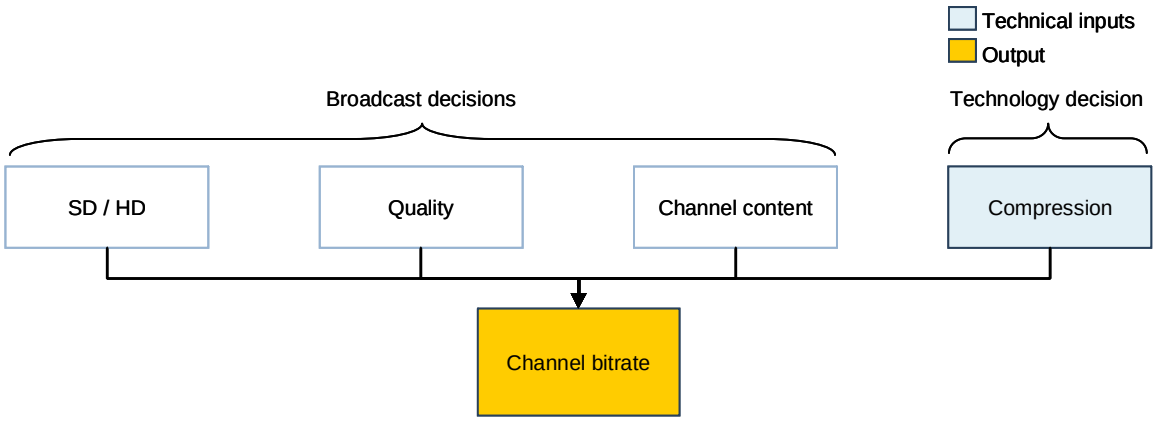
Below, we outline the possible routes to optimise capacity.

5.2 Evaluating channel bit-rate

5.2.1 Channel bit-rate overview

The amount of data that is required to broadcast each television channel depends on: the channel content; the standard to which to the channel is produced and broadcast (standard definition (SD) or high definition (HD)); the chosen quality of broadcasts (given the broadcast standard); and the compression technology used.

Exhibit 16: Factors affecting channel bit-rate



a) Channel content

The channel content is the first factor to consider when delivering digital content. Digital technology requires that only the pixels that alter from frame-to-frame need to be broadcast. Therefore, a studio news programme, in which the shot is often static, can send relatively few pixels after the first frame. However, a sports channel, in which each frame alters very significantly, requires a higher bit-rate and greater capacity.

b) Technical quality of the broadcast picture

The technical quality of the broadcasted picture depends upon the standard of broadcasting. High definition channels have a higher bit-rate, as a greater amount of data is required to deliver the increased number of pixels. Although a fairly simple concept, the availability and use in production of different HD standards complicates the matter slightly – currently 720p/50, 1080i/25 and 1080p/50 are used in HD production. In addition, broadcasters may choose to downgrade the quality of the picture on transmission, i.e. move from 1080i or p to 720p in order to save on spectrum capacity. The trade-off for broadcasters is one of perceived quality vs. capacity.

The EBU have proposed that, if the final quality seen by the modern HDTV viewer is taken into account, 720p/50 should be used as it has the most efficient use of capacity with minimum perceived degradation in quality. Although 1080p/50 is also relatively quality-efficient, it does not enhance the viewing quality over 720p significantly. In the case of 1080i/25, the interlaced nature of the video makes it more difficult to encode and compress[14]. There are, however, practical problems associated with opting for 720p, as, although no technical advantages have been identified with the 1080i/25 format (in the current broadcasting environment), it is currently the dominant format for HDTV content worldwide.

c) Broadcast quality requirements

Even within individual SD and HD standards, broadcasters and/or multiplex operators can opt to modify the level of quality actually delivered to the consumer by decreasing bit-rates. In the UK, for example, the BBC uses higher bit-rates to deliver increased picture quality on BBC1 (typically 4 to 5MBit/s); while many multichannels have reduced bit-rate, and quality, in order to take up less capacity (e.g. between an average of 2.2 and 2.9MBit/s for the channels on commercial multiplexes in the UK).

[14] "When there is motion [in a broadcast], the effect of interlace is to mix the temporal and spatial information. Since digital compression coding works by removing spatial and temporal redundancy, this mixing makes the video much more difficult to encode."

d) Compression

Beyond these broadcast decisions, the compression technology implemented also affects the capacity required per channel.

The two current compression standards used are MPEG2 and MPEG4. MPEG4 is more efficient than MPEG2, although the actual improvement is a matter of some discussion as both technologies continue to improve so that a channel can be compressed into a low bit-rate stream without any loss of quality. At launch in 2002, MUX D, in the UK, only carried 4 TV 24x7 video streams but due to improvements in MPEG2 since then, MUX D now carries 6 TV 24x7 video streams without any change in the standards used or the modulation. This 50% increase in capacity was achieved without any degradation of quality. Today, using the same generation of equipment, MPEG4 offers 30% improvement over MPEG2, but this is expected to improve over time (to perhaps 50%).

Exhibit 17: Current compression rates[15]

	Austria	Belgium	Denmark	Finland	France	Germany	Hungary	Ireland	Italy	Netherlands	Portugal	Romania	Slovakia	Spain	Sweden	UK
MPEG2	✓	✓	✓	✓	✓	✓	×	×	✓	✓	×	×	×	✓	✓	✓
MPEG4	×	×	×	×	✓	×	✓	✓	×	×	✓	✓	✓	×	×	×

Of the countries studied, the about-to-launch or the just-launched channels have all opted for MPEG4. In addition, the pay TV element of the DTT platform is also in MPEG4 in many markets.

e) Examples of current bit-rates

Below we list some of the current assumptions around bit-rates.

[15] Sweden is currently running an HD trial in MPEG4.

Exhibit 18: Examples of SD bit-rates

Country	Status	Year	Compression	Video/All*	MBit/s
France	Active	2005	MPEG2	All	4.00
UK – BBC1	Active	2008	MPEG2	All	4.82
UK – MUX1**	Active	2008	MPEG2	All	3.48
UK – MUX2	Active	2008	MPEG2	All	2.58
UK – MUXA	Active	2008	MPEG2	All	2.24
UK – MUXB	Active	2008	MPEG2	All	2.85
UK – MUXC	Active	2008	MPEG2	All	2.90
UK – MUXD	Active	2008	MPEG2	All	2.62
Germany (PSB)	Active	2008	MPEG2	All	6.00
France	Active	2006	MPEG4	All	3.00
Ireland – MUXA	Advocated	2009	MPEG4	All	1.72
Ireland – MUXB	Advocated	2009	MPEG4	All	1.64

* Bit-rate includes video, audio and SI
** Not including BBC1
Source: Deloitte, December 2007; dtt.me.uk (Mendip transmitter), December 2007; Digitag, 2006

Exhibit 19: Examples of HD bit-rates

Country	Status	Year	Compression	Video/All*	MBit/s
Australia	Introductory	2007	MPEG2	All	13
Japan	Active	2007	MPEG2	All	14
USA	Active	2007	MPEG2	All	19
BBC Trial	Trial	2007-8	MPEG4	All	19.5/14.3
BBC HD	Advocated	2009	MPEG4	All	15, then 12**
Ofcom	Advocated	2009	MPEG4	All	8
France	Advocated	2008	MPEG4	All	12, then 8
Germany	Trial	2007-8	MPEG4	All	6-10
Norway	Advocated	2009	MPEG4	All	12-15

* Bit-rate includes video, audio and SI; service standard (720p, 1080p, 1080i) unknown
** BBC Executive expect s the service to launch at 15MBit/s and then to reduce with technical efficiencies
Source: Sagentia, 23 August, 2007

5.2.2 *Improving the channel bit-rate*

We have identified three areas of improvement in decreasing the bit-rate required per channel: correctly identifying the optimal quality required; harnessing improvements within compression standards; and, upgrading to more efficient compression technology.

a) Optimising the quality required

i) Description and gain

Broadcasters can choose to optimise the capacity used by any individual channel by manipulating the picture resolution (for example, by reducing it from full to three-quarter screen (or less)). To exemplify this, ITV and Channel 4 broadcast only their primary channels at full resolution (ITV1 and Channel 4); whilst BBC broadcasts BBC1, 2, 3, 4 and the News Channel at full resolution.

Public service broadcasters generally place a greater emphasis on delivering quality to the public and, therefore, typically distribute their channels at a higher bit-rate. Moreover, PSBs that do not rely on financial returns from advertising have less incentive to make more efficient use of spectrum and launch more channels.

Potential increases in capacity from optimising individual bit-rates of channels will vary but can be considered to be similar to the current variation in bit-rate between UK PSB and commercial channels (4-5MBit/s to 2-2.5MBit/s).

ii) Impact

This increase comes at limited extra capital cost to the broadcaster, but will impact the consumer through an adjustment in quality.

iii) Likelihood

We have assumed that an optimisation of quality is taken into account in order to come into line with European best practice benchmarks. For example, we estimate that is it possible for all PSBs to broadcast on a standard equivalent to the BBC – 4-5MBit/s (MPEG2) – at maximum. (German PSBs broadcast at 6MBit/s (MPEG2).

b) Improvements within compression standard

i) Description and gain

Compression technology continues to evolve so that a channel can be compressed into a low bit-rate stream without any loss of quality.

Again, any increase within compression standards will vary depending on equipment currently used. Certainly, we are unlikely to see gains in the region of 50% for mature MPEG2 technology again, with improvements of between 5% and 15% more appropriate. However, it should be noted that MPEG4 is still in its infancy and we are experiencing rapid developments in the compression equipment that supports it. In this case, it is not inconceivable for MPEG4 technology to improve by up to 25% to 30% over the next five years. Overall, these benefits can be maintained by refreshing the compression equipment regularly.

ii) Impact

In deciding to upgrade to more sophisticated compression equipment, broadcaster and/or multiplex operators face a trade-off between the cost of the upgrade and the financial return (direct or indirect) from offering more channels.

On the decoder side, existing receivers would not have to be upgraded as the decoder is unaffected by any improvements within the MPEG2 and MPEG4 standards.

iii) Likelihood

Our analysis assumes that all countries can harness improvements within compression standards in the long-term.

c) Upgrading from MPEG2 to MPEG4

i) Description and gain

In addition to improvements within compression standards, broadcasters and/or multiplex operators can choose to upgrade to a more advanced compression standard. As mentioned above, there are two compression standards currently in use – MPEG2 and MPEG4. MPEG4 is more efficient than MPEG2 although the actual improvement is a matter of some discussion. Note that it is important to assess the improvements at any one point in time as both standards themselves are improving (see above) but at different rates, with MPEG4, the newer standard, improving at a greater rate.

ii) Impact

For countries that have already launched MPEG2, swapping all existing multiplexes to the more efficient MPEG4 will require the installed base of set-top boxes to be upgraded.

A feasible alternative, currently under consideration in the UK and France, is to phase the transition to MPEG4 on a multiplex by multiplex basis by reorganising channels between multiplexes and converting an existing multiplex to MPEG4. This process could also take place through the addition of new MPEG4 multiplexes to sit alongside existing MPEG2 ones. Overall, MPEG4 and MPEG2 multiplexes could coincide and, therefore, minimise consumer impact.

A third alternative, only recently becoming a reality, is combining MPEG4 and MPEG2 channels on the same multiplex. This way the latest generation of encoders and multiplexers allow multiplex operators greater flexibility over compression.

For DTT platforms that have not already launched, the MPEG4 standard is likely to be used.

The timing of the phasing-out of older-generation receivers is generally made on a commercial basis – i.e. a pay DTT operator may decide that it is financially viable to swap-out its boxes in order to increase its channel offering and subsequent revenues – although regulators may want to protect customers who rely on existing technologies and are unable or unwilling to change. The swap-out of any reception equipment is dependent on a number of factors:

- The size of the installed base: the larger the installed base of receivers, the more difficult and costly the swap-out. In particular, many customers may use an integrated TV and therefore be required to purchase a box for the first time
- The make-up of the installed base: with two compression standards in use today, several set-top box manufacturers are considering using dual or hybrid MPEG2/MPEG4 boxes. For future sales, this makes the platform more future proof
- The set-top box business model: in countries with a free DTT model, boxes are typically purchased by the consumer, meaning that the onus of any swap-out is on the consumer; in Pay DTT models, boxes may be offered under both a purchase and a rental model. With the latter, the onus of swap-out is with the operators, making it easier and with no additional cost to the customer

- Timing: some countries may opt to wait to implement together with other improvements that require new decoder equipment such as DVB-T2. Although it is likely that a full transition will be made at some point, many countries may only migrate after ASO has occurred.

iii) Likelihood

Our assumption, based on regulator interviews, is that MPEG4 will be phased in on existing platforms as soon as feasible across Europe and that new launches will all be MPEG4.

iv) The future of compression

Given ongoing technology innovation, it is more than likely that over the next few years a new technology will emerge to supersede MPEG4. The EBU noted, in a recent technical report, that the lifetime of a video code is about ten years – i.e. commercial implementation of a new codec is possible ten years after the launch of the existing standard. This suggests that, when many countries are on the brink of a full MPEG2 swap-out, MPEG4 may already have been superseded, and most likely by a technology unrelated to the MPEG family.

5.2.3 Channel bit-rates assumptions

Following our research, we have determined a likely future bit-rate for three types of channels: PSB, commercial (average bit-rate) and commercial (minimum bit-rate). We have applied these future bit-rates in a common manner across the continent. We understand that, currently, average bit-rates differ significantly from country to country; however, we see no reason that future optimal bit-rates cannot be achieved, equally, across Member States. For HD, we have taken 720p going forward.

Exhibit 20: Forecasted SD bit-rates and benchmarks

	Standard	2007	2008	2010	2012	2013	2017	2018	Non-video
MPEG2									
Taken	**PSB**		4.5	4.3		4.1		3.8	0.2-0.3
Taken	**Comm. (average)**		2.5	2.4		2.3		2.1	0.2-0.3
Taken	**Comm. (minimum)**		2.0	1.9		1.8		1.7	0.2-0.3
MPEG4									
Taken	**PSB**		3.2	3.0		2.7		2.4	0.2-0.3
Taken	**Comm. (average)**		1.8	1.7		1.5		1.3	0.2-0.3
Taken	**Comm. (minimum)**		1.4	1.3		1.2		1.1	0.2-0.3

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Exhibit 21: Forecasted HD bit-rates and benchmarks (all MPEG4)

	Standard	2007	2008	2010	2012	2013	2017	2018	Non-video
EBU	720p		9.9						1.9
EBU	720p		9.9						1.9
Zetacast	1080i		16						0.3
Zetacast	1080i 720p			8	7				0.3
Zetacast	1080i/ 1080ip			11	10				0.3
Sagentia	720p	18			13.00		9.25		0.5
Sagentia	720p	18			11.57		7.50		0.5
Sagentia	720p	18			10.79		6.33		0.5
Sagentia	720p	10			7.21		5.13		0.3
Sagentia	720p	10			6.42		4.15		0.3
Sagentia	720p	10			5.99		3.50		0.3
Taken	**720p**					**6.0**		**5.0**	
Taken	**1080p**					**10.0**		**7.0**	

5.3 Evaluating multiplex capacity

5.3.1 Multiplex capacity overview

The ability of a multiplex to carry TV channels is dependent on the throughput of the multiplexes (in MBit/s) and the percentage of this throughput that is reserved for non-TV services, such as the operation of the multiplex or radio and data services.

a) Multiplex throughput

In the first instance, the multiplex operator's ability to carry programming is restricted to the total throughput of the multiplex. This is determined by a number of technical decisions:

Modulation: there are two widely-used modulation standards: 16QAM and 64QAM. 16QAM has a lower throughput but has wider population coverage with a similar transmitter pattern and is a more robust signal (it has a lower tendency to fail in marginal reception areas). In the UK, for example, testing by the BBC suggests that 16QAM gives about 5% more coverage on the existing (low power) system.

Forward error correction and guard band: within the modulation standard, multiplex operators may chose to increase the robustness of signals by increasing the error correction and guard band. One way of offsetting the reduction in robustness through mode change to 64QAM is by increasing these two factors (although this reduces the gain in capacity).

The exhibit below illustrates the capacity of multiplexes under different standards.

Exhibit 22: Throughput of different modulation standards (Mbit/s)[16]

16QAM		Guard band			
		1/4	1/6	1/16	1/32
FEC	1/2	9.95	11.05	11.71	12.06
	2/3	13.27	14.75	15.61	16.09
	3/4	14.93	16.59	17.56	18.10
	5/5	16.59	18.43	19.52	20.11
	7/6	17.42	19.35	20.49	21.11

64QAM		Guard band			
		1/4	1/6	1/16	1/32
FEC	1/2	14.93	16.59	17.56	18.10
	2/3	19.91	22.12	23.42	24.13
	3/4	22.39	24.88	26.35	27.14
	5/5	24.88	27.65	29.27	30.16
	7/6	26.13	29.03	30.74	31.67

Exhibit 23: Current modulation in Europe[17]

	Austria	Belgium	Denmark	Finland	France	Germany	Hungary	Ireland	Italy	Netherlands	Portugal	Romania	Slovakia	Spain	Sweden	UK
16QAM	✓	✓	×	×	×	✓	×	×	×	×	×	×	×	×	×	✓
64QAM	×	×	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note that 16QAM is generally used in countries that have high portability requirements for reception on secondary sets, both in and out of the home. Also, Romania is yet to launch its DTT service.

b) Percentage throughput reserved for non-TV services

The capacity provided by a DTT multiplex can be used to carry a range of digital programming. These include video and audio for TV and radio channels, as well as associated programming services such as subtitling, audio description and signing services.

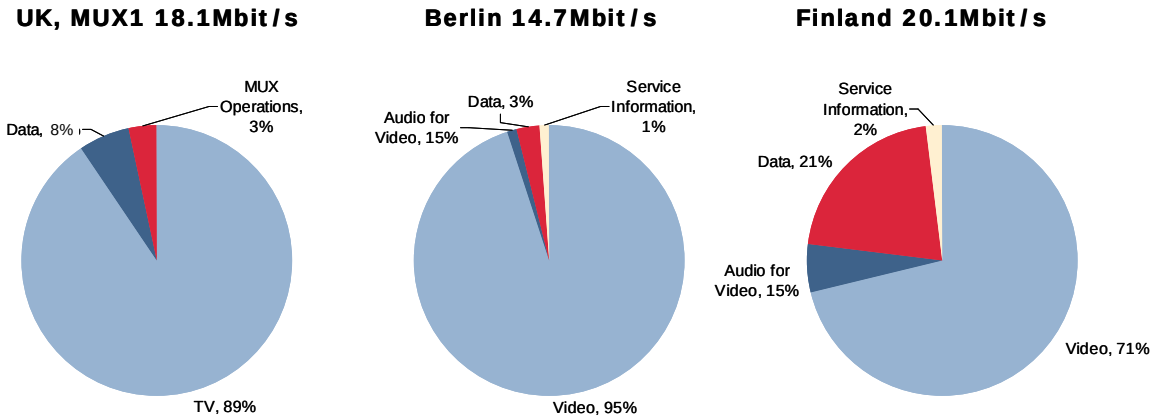
In addition, capacity must remain for technical management of the multiplex. This includes download facilities to enable software changes, system information and, for a Pay DTT multiplex, conditional access systems.

When managing the multiplex, the multiplex operator has a range of trade-offs to make – the principal one is of number vs. quality of services. We have shown above the ability to manipulate channel coding for each channel – the multiplex operator also has to consider how best to organise his content proposition. For a multi-multiplex operator, the ability to organise channels is made easier by being able to co-ordinate over two or more multiplexes.

The exhibit below gives some examples of how multiplexes can be organised.

[16] This table applies to an 8MHz RF channel. Values for a 7MHz RF channel (typically used in VHF) are approximately 10% lower.
[17] Some exceptions for DVB-H may occur, e.g. the Netherlands used 16QAM for the DVB-H multiplex.

Exhibit 24: Multiplex organisation examples



5.3.2 *Improving the capacity of the multiplex*

We have highlighted below five possible broadcast technology improvements that are open to multiplex operators: the first three – upgrading the modulation, implementing DVB-T2 (a new transmission standard) migrating to MIMO – increase the total capacity of the multiplex, whilst the final two – re-organisation of multiplexes and statistical multiplexing – make better use of the available capacity.

a) Moving from 16QAM to 64QAM

i) Description and gain

A 64QAM channel is theoretically capable of transmitting 50% more data than a 16QAM channel, but is more susceptible to interference as the signal is less robust. For this reason, more robust error correction coding is normally used with 64QAM, reducing the gain to approximately 33% (24Mbit/s per multiplex with 64QAM compared to 18Mbit/s with 16QAM).

The loss in robustness can also be offset by increasing the transmission power or transmitter density in most cases. In addition, a loss of coverage is also likely – in the UK, the change (in the remaining multiplexes) from 16QAM to 64QAM at ASO is expected to reduce coverage by 5%.

64QAM is already widely implemented and is likely to be implemented for most future launches of DTT, such as in Ireland.

ii) Impact

In terms of impact: for broadcasters and multiplex operators, there is little cost or difficulty in altering modulation as the alteration is a software change; however, if there is a legislative requirement to keep the coverage as before, an increase in transmission power would be required.

For consumer there is no impact – i.e. no requirement for adjustments to existing equipment or for the purchase of new.

iii) Likelihood

Spectrum believes that, whilst it is possible for all countries to migrate to 64QAM in theory, this may not work in practice. A change in modulation must be considered alongside other network components and is more than likely to necessitate a re-planning of the network. This is principally because, we believe that regulator

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and multiplex operators had to strike a balance between coverage and portability requirements and sustaining a commercially viable platform.

Therefore, in countries where 64QAM has not yet been implemented, we have erred on the side of caution and suggested that it is not like to occur in the short-to-medium term and without significant network re-planning.

The one exception to this is the UK, where 64QAM was considered to be too poor in quality and coverage when the network was planned many years ago. This have proven not to be the case and Ofcom has said that it plans to move to 64QAM on the remaining MUXes (with minimal disruption) soon.

b) Upgrading to DVB-T2

i) Description and gain

In addition, in April 2007, DVB issued a "call for technologies" to develop DVB-T2, an evolution of the current DVB-T standard. The standard has not yet been defined, but is required to offer at least 30% improvement in capacity over DVB-T. A recent EBU report suggests that DVB-T2 may actually offer, in its first profile, a 50% gain.

ii) Impact

The first trial specification should be available later in 2008, with a possible full implementation towards the end of 2009 / early 2010 – Ofcom expects to be able to implement DVB-T2 by the end of 2009 in the UK. For broadcasters, a swap to DVB-T2 would require new modulation equipment on each main transmitter.

Despite the development of the standard from a transmission point of view, equipment manufacturers have suggested that new receivers – which will definitely be required to receive DVB-T2 signals – may not be available until 2011. This means that many countries may not be able to take wholesale advantage of the spectrum efficiency gains in the short-term. It is likely, however, that DVB-T2 will be implemented on a multiplex by multiplex basis, allowing broadcasters to operate specific HD multiplexes (available to the new generation of decoders (which will also be able to receive DVB-T signals)) whilst limiting the effects on the installed base of receivers.

In addition, as suggested previously, a DVB-T2 launch may come together with a shift to MPEG4 technology – offering consumers a mix of DVB-T/MPEG2 and DVB-T2/MPEG4 multiplexes. Again, this reduces the disruption to existing customers but allows purchasers of new hybrid set-top boxes the ability to watch a full service with only one box upgrade/purchase. If DVB-T2 is launched out of sync with MPEG4, this could significantly reduce the likelihood and timescales of its full-scale introduction.

iii) Likelihood

Our view is that converting all multiplexes to DVB-T2 is possible but only in the long term. This needs to be done with a well managed set-top box strategy, most likely involving government mandates for technology components.

c) Implementing MIMO

i) Description and gain

Multiple-Input-Multiple-Output, or MIMO, is the use of multiple antennas at both the transmitter and receiver to improve communication performance. It does so without additional bandwidth or transmitter power.

MIMO effectively doubles the throughput of DTT networks by transmitting two signals via antennas on different polarisations (vertically and horizontally) over the same single 8MHz channel.

ii) Impact

In order to achieve such spectrum efficiency gains, customers would need to buy new dual-polarised antennas and set-top boxes. The horizontal polarisation could be made backward compatible with existing DTT receivers but the coverage footprint might be reduced because of higher interference. In field trials, a MIMO network provided virtually the same coverage footprint as a conventional DVB-T network[18].

Currently, broadcasters seem either not to have considered MIMO or to be reluctant to implement it and therefore timescales for implementation are unclear. As with any network re-planning, it is unlikely to happen in the short to medium term, due to the significant upheaval required and the requirement to replace broadcasting antennas and transmission equipment.

Consumers would have to purchase new antennas as current versions can, typically, only receive one polarisation.

iii) Likelihood

Given that the timescales and full impact of re-planning the network are unclear at this point, we do not consider conversion to MIMO as being feasible in the timeline of this study. However, it is important to reiterate that, if made available, this could double the capacity of the multiplexes.

d) Re-organisation of multiplexes

i) Description and gain

Re-organisation of multiplexes is one of the tactics that multiplex operators in countries such as the UK, France and Italy are currently implementing or looking to implement. In the UK, Ofcom is hoping to introduce HD services without requiring additional capacity. In France, capacity was cleared on MUX 3 to make way for an HD MUX. Existing services were reallocated to MUXes 1 and 2. In Italy, the Government is trying to reallocate the existing MUXes between the existing operators RAI, Mediaset and TI Media as current usage is not spectrum efficient. Some other examples of re-organisation of multiplexes are detailed below.

- **Regional reorganisation**. Relocating regional programmes on one MUX would allow for the use of some SFN for national coverage as in Spain. In the UK, regional variants could be formed in the most cost-effective way if the BBC and ITV regional boundaries where aligned.
- **Moving non-stat-MUX-able streams to one "low efficiency" MUX**. Radio stations cannot be readily multiplexed so all radio services could be grouped on a "low efficiency" multiplex – however, while technologically possible, commercial or regulatory factors may not allow this. For example, in Italy, RAI, Mediaset and TI Media have all been granted multiplexes – this could mean that no one operator is likely to want to operate a lower efficiency multiplex.

The gain is hard to quantify but has the ability to free some existing multiplexes for upgrades.

[18] J Boyer, P G Brown, K Hayler, M Lopez Garcia, J D Mitchell, P N Moss, M J Thorp, "MIMO for broadcast – results from a high power UK trial", BBC white paper, WHP 157, Oct 2007.

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ii) Impact

For broadcasters and multiplex operators, the change would involve co-ordinated effort – depending on the set-up this may be difficult: on FTA multiplexes where channels pay for carriage, negotiations may be necessary; on pay multiplexes, where many multiplexes are operated by one company, this reorganisation is easier (although would have to ensure individual channel quality).

For consumers, the principal impact could be one of channel coverage: if channels are moved between multiplexes with different coverage areas, certain channels would be lost and others gained.

iii) Likelihood

In our assumptions, we have not made any explicit reorganisation of multiplexes.

e) Statistical multiplexing

i) Description and gain

Where several digital video streams are carried in one frequency channel, statistical multiplexing (stat-muxing) can be used in combination with VBR (variable bit rate) coding to dynamically allocate bandwidth across the channels wherever it is required. For example, a lower data rate might be allocated to a news presenter sitting in the studio, whilst a higher rate would be allocated to sports (where the picture changes rapidly – digital technology requires that only the pixels that alter from frame-to-frame need to be broadcast.). This means that rather than allocate a constant bit-rate for each channel, the channels peaks and troughs of bit-rate demand average out requiring less capacity. Within multiplexes a higher statistical multiplex priority can be allocated to certain TV channels.

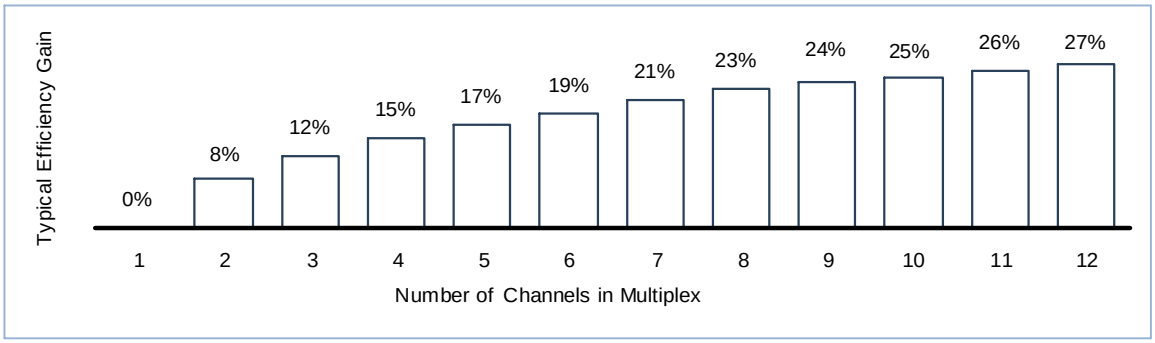
The exact amount of capacity gained depends on:

- **The number of channels**. A greater number of channels better facilitate stat-muxing as there is more room for dynamic allocation. For example, a multiplex with HD content would gain less than one with a greater number of SD channels.
- **The nature of the video content**. There may be a slight reduction in benefit if the maximum threshold differs between channels (as appears to be the case with ITV1 and Channel 4 on MUX 2 in the UK). For example, multiplexing a mixture of HD and SD channels would give less benefit as the demand peak on the HD channel would require several SD channels to reduce bit-rate to compensate. In fact, simulcasting a channel in SD and HD would compound the problem, with both requiring simultaneous bit-rate peaks and troughs.

The savings are, generally, thought to be independent of compression technology. The graph below shows the typical efficiency gain.

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Exhibit 25: Typical statistical multiplexing efficiency gain



For example, Ofcom estimated that if the main services were operated at a higher data rate (3.5 Mbps) and the remaining services at a lower bit rate (2.7 Mbps or lower), up to 8.7 Mbps of capacity could be released. This is a gain of between 15-20%.

In addition to statistically multiplexing video streams, it is possible to include other variable bit rate services, such as subtitles. Note that current audio coding schemes, such as radio, are of fixed data rate and therefore would not benefit from stat-muxing.

ii) Impact

For broadcasters and multiplex operators, encoders with the ability to statistically multiplex would be required in the multiplex centre. The technology that allows for statistical multiplexing is typically a software component which requires a licence to be purchased. This is a decision carried out by the multiplex operator in order to be able to offer more channels per multiplex.

There is no impact on consumers (beyond the possibility of an increase in channels).

iii) Likelihood

In our analysis, we have assumed that all countries employ statistical multiplexing, except for PSB channels that require regional input.

5.3.3 Multiplex capacity assumptions

The table below shows some examples of multiplex enhancements.

Exhibit 26: Example of theoretical benefits of improvements in multiplex capacity[19]

Technical standard	None	T2	64QAM	MIMO	Non-TV	Stat. M.	All
DVB-T	DVB-T	DVB-T2	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T2
Modulation	16QAM	16QAM	64QAM	64QAM	16QAM	16QAM	64QAM
Guard Band	1/32	1/32	1/32	1/32	1/32	1/32	1/32
FEC	3/4	3/4	2/3	3/4	3/4	3/4	3/4
MIMO	No	No	No	No	No	No	No
Total capacity (Mbit/s)	18.1	27.2	24.1	36.2	18.1	18.1	54.3
% reserved for non-TV	15%	15%	15%	15%	5%	15%	5%
Remaining capacity (Mbit/s)	15.4	27.3	20.5	30.8	17.2	15.4	51.6
Statistical multiplexing	No	No	No	No	No	Yes	Yes
Av. bit rate (Mbit/s)	3.5	3.5	3.5	3.5	3.5	3.0	2.5
No. of channels	**4**	**7**	**5**	**8**	**4**	**5**	**20**

5.4 Assessing the number of multiplexes available

5.4.1 Multiplex overview

Each multiplex is broadcast over one radio-frequency channel of 8MHz (in UHF, and 7MHz in VHF). The GE-06 Conference allocated 392MHz of spectrum to broadcasting (between 470-862MHz in UHF, Bands IV/V), with a possible 56 MHz (Band III, 174-230MHz) in VHF. In a perfect world, this would suggest that, overall, 57 multiplexes could be available for broadcasting: 49 in UHF and 8 in VHF. However, several factors reduce this number.

a) Network frequency pattern

First, to avoid inference both within and between territories, more than one channel may be required to broadcast a multiplex across a country. As more than one transmitter is needed to provide widespread coverage of DTT, interference between broadcasts from different masts must be avoided. **This is done in different ways by using either a SFN or a MFN.**

Multi-frequency networks use different frequency channels on adjacent masts to prevent interference, resulting in a higher number of frequencies used per multiplex. In most markets, at least four different frequencies are required, but the actual number varies depending on topography, portability requirements and other factors. For instance, in the UK, the PSB multiplexes use 48 MHz to gain 98.5% coverage post-DSO, whereas the commercial multiplexes use only 40 MHz of spectrum, as they require a lower level of coverage (c.90% post-DSO).

A single frequency network uses the same frequency across the country to broadcast each multiplex, and is therefore more spectrum-efficient than an MFN. This requires synchronisation of the timing of transmissions across all transmitters. In theory, only one frequency channel is required per multiplex on an SFN. However, in markets where content is terrestrially delivered to masts, as relay stations are needed to fill coverage gaps,

[19] Changes from the column on the left are highlight in blue. Except the last column, each column represents one (theoretical) change.

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more frequencies are required. Relay stations use different frequencies to the main transmitters to avoid interference. The actual number required varies, depending on the topography, size and shape of the country.

SFNs require that the same content be broadcast across the whole network, making it unsuitable for multiplexes that need to carry regional programming and ads. To provide regional television networks within a SFN framework, one or two specific multiplexes would need to be set up on MFNs.

b) Portability and coverage requirements

The **coverage** and the **level of portability** required by the multiplex also affect the number of frequencies required per multiplex. For example, a high level of coverage may be required to ensure universal access to public service programming, or portability may be required to ensure DTT reception on secondary sets, without external aerials.

Portable reception and increased land coverage require additional frequencies per multiplex. Portability requires additional frequencies, as a higher-powered signal is required to ensure reception on smaller, indoor aerials. Higher coverage requires greater overlap between adjacent frequencies, to ensure areas on the edge of the range of a mast have adequate reception. Therefore, to ensure there is not interference between adjacent masts, a greater number of different frequencies are required. In addition, a larger number of relay stations are required to cover 'black spots' of coverage caused by topography. These may also need to be on different frequencies to the adjacent masts.

The output of GE-06 has, in essence, readjusted for these factors through complex allocation arrangements. It is likely that 6-8 'layers' or multiplexes, depending on transmission and reception conditions, could be available for digital terrestrial broadcasting, in each European country. These could be used to provide, after analogue switch off, for example, services with near universal digital television coverage - equivalent to today's analogue television - for all multiplexes, but the precise arrangements will be decided by individual national administrations.

c) Sharing the bands with other services

Moreover, broadcasters are required to accommodate TV and radio services with a number of different technologies – DVB-T (terrestrial TV and radio), DVB-H (TV and radio delivered to handheld devices) and T-DAB (digital radio broadcasting). Allocations should allow the delivery of effective and commercially viable propositions of DVB-T, DVB-H and T-DAB services where required.

Beyond broadcasting, some radio-frequency channels are reserved for other primary services, such as radio-astronomy, radar, PMSE and SAB/SAP[20]. These also need to be taken into account when allocating frequencies to DTT in each country.

5.4.2 Increasing the number of multiplexes available

In order to improve the availability of frequency channels to allocate to DTT, we have identified four possible avenues of action. The first two – migrating from MFN to SFN and reducing coverage and portability requirements – aim to decrease the number of frequency channels required for a multiplex, whilst a further two – using VHF and re-allocating frequency channels – aim to increase possible frequencies available to DTT.

[20] Programme Making and Special Events; Services Auxillary to Broadcasting; Services Auxillary to Programming

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a) Migrating the network from an MFN to an SFN

i) Description and gain

Whether to implement a single frequency network (SFN) or a multi frequency network (MFN) is the key technical decision impacting the number of frequencies required per multiplex.

Exhibit 27: Networks in operation

Network	Countries
National MFNs (with some local SFNs)	Denmark, Finland, France, Germany, Netherlands, Ireland, Italy (will move to SFN), Sweden, U.K.
National MFNs and SFNs	Spain (national MUXes will be SFN, local and regional, MFN)
National SFNs	Austria, Belgium, Hungary, Portugal, Slovakia

The gain in spectrum efficiency with the deployment of SFN is dependent on the extent that this can be deployed.

ii) Impact

However, migrating from an MFN to an SFN has many inherent problems.

For broadcasters, this would be a costly network upgrade with more transmitters likely to be required. In addition, co-ordination difficulties may have to be overcome with neighbouring countries.

For consumers, implementation of an SFN could require a swap-out of TV aerials in certain regions. By nature, an SFN delivers content on the same frequency channel nationally; however, in some countries, different regions use aerials with access to different bands of the UHF spectrum. In the UK, aerials are sold by Group (Group A – Channels 21-37, Group B – Channels 35-53, Group C/D – Channels 48-68, Group E – Channels 35-68, Group K – Channels 21-48 and wideband aerials in Group W – Channels 21-68). A Wideband aerial is optimised to receive TV channels anywhere in the UK TV band. In areas of weak signal, a wideband aerial may not be as effective as a high-gain aerial designed for the specific band one is trying to receive (a mast-head amplifier may be needed to help boost the signal).

iii) Likelihood

Our initial assumption is that in countries that have already deployed a combination of the two networks, only limited gains would be possible without significantly re-planning the network incurring potential loss of coverage.

In countries with exclusive MFN coverage, re-planning is possible and has been mooted in both the UK, France and Italy; in France, migrating some multiplexes from MFN to SFN is being used to provide additional capacity for HDTV, whilst in Italy a full SFN is considered likely in the short to medium term (in 2012, at ASO).

b) Reducing the coverage and portability requirements

i) Description and gain

The coverage and the level of portability required by the multiplex also affect the number of frequencies required per multiplex. However, these are political rather than technological decisions. For example, a high level of coverage may be required to ensure universal access to public service programming, or portability may be required to ensure DTT reception on secondary sets, without external aerials.

Portable reception and increased land coverage require additional frequencies per multiplex. Portability requires additional frequencies, as a higher-powered signal is required to ensure reception on smaller, indoor aerials. Higher coverage requires greater overlap between adjacent frequencies, to ensure areas on the edge of the range of a mast have adequate reception. Therefore, to ensure there is not interference between adjacent masts, a greater number of different frequencies are required. In addition, a larger number of relay stations are required to cover 'black spots' of coverage caused by topography. These may also need to be on different frequencies to the adjacent masts.

ii) Impact

For broadcasters/MUX operators, reducing the coverage and/or portability requirements has a commercial rather than technological impact. The reduction in addressable market could impact the economics of channels and pay platforms involved.

For consumers, of course, we would see a reduction in reception.

iii) Gain

In our analysis, we have not accounted for a change in coverage and portability requirements. Again, any network re-planning is considered a detailed and lengthy process.

c) Re-allocating frequency channels

i) Description and gain

Some specific channels may become available over time. However, the release of others in the short-to-medium term is unlikely, as it would involve some sense of reorganising the allocations of GE-06 and co-ordination with neighbouring countries.

ii) Impact

For broadcasters and/or multiplex operators, reusing freed up frequency channels should not pose a problem as these channels are typically within the current transmitter frequency ranges.

For consumers, again, there should be limited barriers as long as the freed channels are within the receiving range of the TV aerials.

iii) Likelihood

For this study, we have not considered re-allocating frequency channels, as we believe that, in most cases, this would bring limited additional capacity and could require significant re-planning. One exception would be Sweden, who are looking at re-planning to facilitate the use of 709-862MHz for other services.

d) Using VHF

i) Description and gain

Traditionally, several European countries have used VHF for TV services. In those that have used this space for radio, VHF has been reserved for T-DAB capacity in the digital switchover process. A VHF multiplex would, typically, use a 7MHz RF channel, although 5MHz can also be used. Using VHF capacity could allow countries to add an additional multiplex. Italy currently operates a VHF multiplex, whilst other countries, such as the Netherlands are planning to launch one in the space.

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In countries where there is no pre-allocation of VHF to DAB or other services, a VHF multiplex would be possible. Otherwise, a swap-out of services would be required.

ii) Impact

For broadcasters and/or multiplex operators, this may involve an upgrade of the transmitters (depending on the transmitter frequency range) and frequency-conscious components such as combining units. It is also possible that an upgrade of the amplifier units may be necessary.

For consumers, a VHF or combined VHF/UHF aerial would be required. The appetite for using VHF is generally dependent on the current use of VHF for analogue TV and varies from country to country.

iii) Likelihood

In this study, we consider the use of VHF in countries that already broadcast analogue in VHF. This means that TV aerials are dual VHF/UHF and would not need to be replaced. However, it should be noted that a spectrum efficiency plan must consider all broadcasting spectrum and its allocation between DVB-T, DVB-H and T-DAB.

Exhibit 28: Countries with analogue TV in VHF

	Austria	Belgium	Denmark	Finland	France	Germany	Hungary	Ireland	Italy	Netherlands	Portugal	Romania	Slovakia	Spain	Sweden	UK
VHF	✓	✓	✓	✓	✓	✓	✓	✓	×	×	✓	×	✓	×	✓	×

5.4.3 Multiplex number assumptions

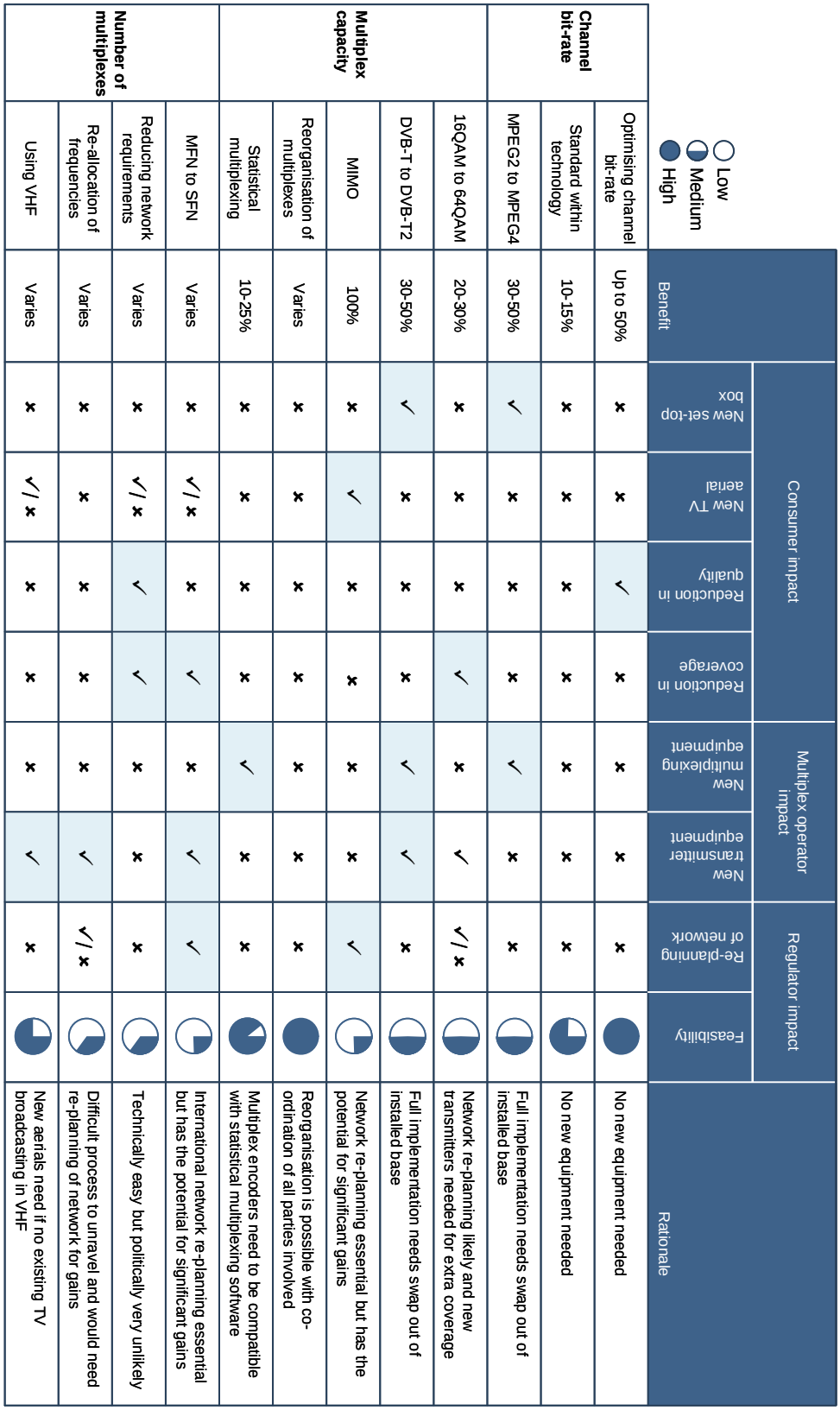
Our multiplex assumptions are derived through interviews with operators and are inclusive of all the factors considered above in each country. We have also considered the impact on multiplexes if a sub-band of 72MHz was allocated to non-broadcast services. Again, we derived our assumptions from regulators (as one cannot always simply prorate the number against the percentage loss of the band because of network frequency planning – i.e. 72MHz is 18% of the UHF broadcasting allocation (392MHz) but this does not always mean that 18% of the multiplexes (i.e. 1 in 5) would be lost).

5.5 Summary

The exhibit overleaf highlights a summary of the possible broadcast migration upgrades that are currently known.

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Exhibit 29: Improved efficiency summary



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Given the analysis on feasibility we consider there to be three levels of broadcast migration.

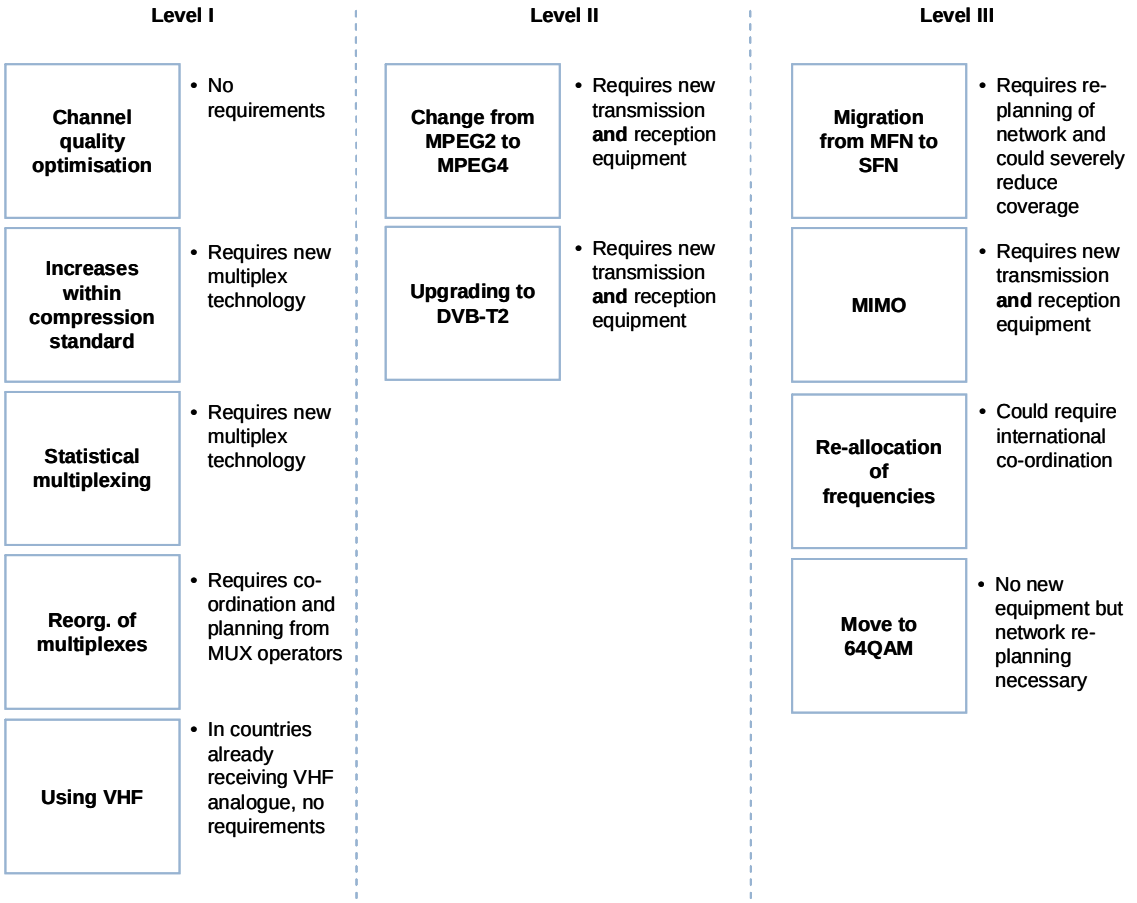
Level I upgrades involve neither a large consumer impact nor a necessity to re-plan the network and, therefore, can be implemented relatively easily and cheaply for broadcasters. These upgrades are possible over the short to medium term and should be implemented wherever possible (and commercially viable).

Level II upgrades involve the purchase of new set-top boxes or iDTVs. These changes are not likely to be wholesale swap-outs but a migration multiplex by multiplex over time – reducing the installed base of legacy equipment. Level II upgrades, we believe, will be possible in the long-term.

Level III involves some element of national and/or international re-planning. These upgrades have great ability to increase the capacity of the network but would involve a level of political and commercial negotiations and, most likely, a costly network improvement.

We consider Level I and Level II upgrades to be possible in the timeframe of this study (ten years) and that these changes should be co-ordinated and implemented as soon as operationally and commercial possible.

Exhibit 30: Levels of broadcast migration for this study



The costs associated with each upgrade are also tabulated below.

Exhibit 31: Upgrade costs

		Multiplexing site equipment			Transmitter site equipment				Consumer equipment	
		Encoder	Multiplexer	Stat. MUX. licence	Transmitter	Modulator	Filters / Amplifiers*	Antenna*	Aerial*	STB
Cost per unit		€30-40k	€20-25k	€2-5k	€50-150k	€20-30k	€5-10k	€50-150k	€20-100	€75-100
No. of units		1 per channel	1 per MUX	1 per MUX	1 per site	1 per site	various	various	1 per home	1 per TV set
Channel bitrate	Reduction in bitrate	✗	✗	✗	✗	✗	✗	✗	✗	✗
	Standard within compression	✗	✓	✗	✗	✗	✗	✗	✗	✗
	MPE2 to MPEG4	✓	✗	✗	✗	✗	✗	✗	✗	✓
MUX capacity	16 to 64QAM	✗	✗	✗	✗	✓	✓/✗	✗	✗	✗
	DVB-T to DVB-T2	✗	✗	✗	✗	✓	✓/✗	✗	✗	✓
	MIMO	✗	✗	✗	✗	✗	✗	✓	✓	✗
	Reorganisation	✗	✗	✗	✗	✗	✗	✗	✗	✗
	Statistical multiplexing	✗	✗	✓	✗	✗	✗	✗	✗	✗
No. of MUXes	MFN to SFN	✗	✗	✗	✗	✗	✓/✗	✓/✗	✓/✗	✗
	Reduce requirements	✗	✗	✗	✗	✗	✗	✗	✗	✗
	Other frequencies	✗	✗	✗	✗	✗	✓/✗	✓/✗	✓/✗	✗
	Using VHF	✗	✗	✗	✗	✗	✓/✗	✓/✗	✓/✗	✗

* Depends on current frequencies and power used

Source: Interviews

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6 Country analysis

In addition to general the trends mentioned above, the following section contains country-specific analysis. This includes the current DTT market and its likely future technological changes, occurring as a result of regulatory intervention and commercial development.

The section detailing the 'likely future changes' to the DTT market takes a long-term view, allowing for the introduction of DVB-T2 technology and the release of additional multiplexes post-ASO.

Some general assumptions for the calculations of channel and multiplex mix are tabulated below.

Exhibit 32: General assumptions[21]

Variables	FTA	Notes
Future long-term channel bit-rate		
PSB (SD/MPEG4)	2.4 MBit/s	• Used for ex-analogue channels • Each channel is located on a specific multiplex so multiplexes with ex-analogue channels may have lower overall channel mix • Number will vary slightly depending on statistical multiplexing effect • Estimated against current best practice and projected forward using proxies from third parties
Com. (SD/MPEG4)	1.2 MBit/s	• Number will vary slightly depending on statistical multiplexing effect • Benchmarked against current best practice (1.65MBit/s in Ireland) and projected forward using proxies from third parties
All HD (MPEG4)	5 MBit/s	• 720p • Benchmarked against third parties
Multiplex throughput		
Original throughput	various	• VHF based on 7MHz channel, UHF on 8MHz
DVB-T2 upgrade	50%	• Based on EBU latest estimations
MIMO upgrade	0%	• MIMO not considered
Additional services		
Other services	various	• Dependent on existing services on multiplexes such as data .radio • Radio assumed at 192kbps
Multiplex operation	0.9MBit/s (free) 1.5MBit/s (pay)	• Additional 600kbps for conditional access system • Benchmarked against UK and Irish multiplexes
Overheads	3%	• Benchmarked against best practice across Europe
No. of multiplexes		
UHF	various	• Dependent on allocation at GE-06 • Confirmation with interviews on actual likely figures
VHF	various	• Likely if currently broadcasting in analogue in VHF • Confirmation with interviews on actual possibility and likelihood

[21] Note that the bit-rate are considered over the long-term.

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7 Austria

7.1 Market context

Exhibit 33: Austrian market summary

Austria	Commercial operations	Regulatory environment	Broadcast technology
Launch	• Television market dominated by cable and satellite • DTT television household penetration currently only 5%	• KommAustria developed a digitisation strategy. Its objectives were: – the development of a high-performance infrastructure – increased basic provision and mobility	• Mobility objective to facilitate second set viewing caused two MUXes broadcast with MPEG2 and 16QAM
2006			
ASO			
2010			

A market dominated by cable and satellite

The Austrian television market is dominated by the cable and satellite platforms. These have a combined television household penetration of 88%.[22][23] Relative to cable and satellite, DTT penetration is forecast as 15% in 2012 and is considered to be a minority platform proposition.

The process for the launch of a DTT service began with broadcast legislation in 2001 creating the Austrian Communications Authority (KommAustria). Responsibility for a DTT launch strategy was given to Digitale Platform Austria (DPA)[24].

Following DPA's recommendations, the government published its timetable for digital switchover and announced ASO for 2010 (earlier than originally expected). The DTT transmission network is being rolled out by ORS, the technical subsidiary of public broadcaster ORF.

DTT launch in 2006 with limited services

DTT launched a single MUX containing three-channels in October 2006, with an initial coverage of 70% (scheduled to increase to 91% before 2009). With only three channels on the platform the government offered subsidies of €40 for set-top boxes to encourage take-up, despite the use of MPEG2 technology decreasing the cost of the box.

A second MUX launched in October 2007 in addition to the original public service broadcaster MUX, commercially operating today with three channels. This multiplex launched following an application process attracting 32 applications earlier in the year.

A third multiplex aiming to accommodate local and regional channels is currently under tender. To-date, there has been high demand for this also – with 29 applications to broadcast received (including three applications from existing analogue terrestrial broadcasters).

[22] Informa TM
[23] A period of consolidation for the cable market in the future is likely. There are approximately 200, mainly local, operators.
[24] DPA was set up by the Federal Chancellery. They worked in conjunction with KommAustria and Rundfunk & Telekom Regulierung (RTR)

16QAM used to ensure portable reception

The existing MUXes use 16QAM modulation to enable portable reception. With low DTT penetration, KommAustria have made mobility an objective so that DTT can be received in various locations and not solely through fixed antenna.

Exhibit 34: Current Austrian MUX structure

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4
UHF/VHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-T	DVB-T	DVB-H
Modulation	16QAM	16QAM	16QAM	
Guard Band	1/4	1/4	1/4	
FEC	3/4	3/4	3/4	
Total capacity	14.9	14.9	14.9	
% reserved for non-TV	16%	16%	16%	
Remaining capacity	12.49	12.49	12.49	
Compression	MPEG-2	MPEG-2	MPEG-2	
No. of channels	3	3	?	

7.2 Likely future changes

7.2.1 Expected changes

Technology mandates fixed until August 2009

Licence conditions currently specify the technology for MUXes A and B. Therefore the earliest expected time for technology improvements is likely to be after August 2009 when the license expires, and the NRA has the ability to alter its mandated technology. However, there is no indication at present if there will be an alteration to the mandated technology standards and its particulars.

An additional three multiplexes available post-ASO

Austria has been allocated 6-7 layers by the Geneva 06 agreement and thus an additional three MUXes are expected to be released after ASO in 2012. This would provide Austria with a total of seven MUXes in the UHF band, six DVB-T and one DVB-H.

HD services are unlikely to play an important role in the short-term

No indication has been given regarding the introduction of HD on the service. However, whilst the majority of Austrian DTT viewing is on secondary sets and 16QAM modulation is used, it is unlikely that HD channels will be introduced. This is due to the low incentive for broadcasters and restricted MUX capacity.

7.2.2 Additional possible changes

MPEG2 and DVB-T2 upgrades possible in the long-term

As NRA has the option to mandate new technology in 2009, there will be an opportunity for existing MUXes to upgrade to MPEG4 compression technology. This will allow greater capacity on the DTT platform whilst not reducing the level of coverage. The low installed base of set-top boxes facilitates a relatively easy migration.

No discussion has taken place in Austria regarding DVB-T2 technology. However, once available it could be introduced into the MUXes to further increase their capacity. It is possible that when the additional MUXes are introduced post-ASO, these MUXes could use MPEG4/DVB-T2. However, if MPEG4 had been introduced in 2009 this would necessitate a further set-top box swap-out.

In the long-term, we foresee Austria operating seven DTT MUXes in UHF, one of which will be DVB-H, plus one in VHF. Assuming that the post-ASO MUXes will be introduced with DVB-T2/MPEG4 and that there will be a migration to DVB-T2 and MPEG4 on the DVB-T MUXes, we estimate that there will be a total of 107 SD channels on the platform (or 21 HD).

Exhibit 35: Possible long-term Austrian DTT platform

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 7	MUX 8
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF	VHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-H	DVB-T2	DVB-T2	DVB-T2	DVB-T2
Modulation	16QAM	16QAM	16QAM		16QAM	16QAM	16QAM	16QAM
Guard Band	1/4	1/4	1/4		1/4	1/4	1/4	1/4
FEC	3/4	3/4	3/4		3/4	3/4	3/4	3/4
Total capacity	22.39	22.39	22.39		22.39	22.39	22.39	19.59
% reserved for non-TV	11%	11%	11%		11%	11%	11%	12%
Remaining capacity	19.95	19.95	19.95		19.95	19.95	19.95	17.15
Compression	MPEG-4	MPEG-4	MPEG-4		MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	13 or 3	16 or 3	16 or 3		16 or 3	16 or 3	16 or 3	14 or 3

7.2.3 Allocating 72MHz to non-broadcast services

If the top 72MHz of the UHF spectrum were to be allocated to mobile broadband rather than to broadcasters for DTT, we believe that Austria would lose between 1 and 2 MUXes without spectrum re-planning. This, in turn, would result in a loss of up to 36 SD channels (or 6 in HD).

7.3 Summary

The opportunity for the NRA to revise its technology mandates in 2009 would be a suitable time to upgrade to MPEG4. However a technology upgrade at this time, with the related box swap-out, could potentially delay the opportunity to introduce DVB-T2, as this would require a further box swap-out. Whilst DVB-T2 could feasibly be introduced with the new MUXes following ASO, it would make sense to integrate DVB-T2 introduction into the set-top box natural replacement cycle to avoid consumer confusion. This would also provide compatible boxes in advance of the technology being introduced. Therefore as people replace their set-top boxes over time, they naturally convert to DVB-T2 in preparation of the upgrade in MUX technology.

Due to reception portability requirements, a migration from 16QAM to 64QAM is not recommended. Moving to 64QAM would necessitate the introduction of new transmitters in order to maintain the level and quality of coverage available with 16QAM. Due to the low penetration of DTT in Austria, the cost of these new transmitters would likely exceed the benefit of 64QAM migration.

Exhibit 36: Summary of Austrian broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	✓	Short	High bitrates on existing PSB to adhere with European standards
	Standard within compression	✓	Short	Improvements in the MPEG2 standard likely to result in further capacity increases
	MPE42 to MPEG4	✓	Long	On a MUX by MUX basis beginning with new MUXes in 2011
MUX capacity	16 to 64QAM	✖	n/a	Portability issues are likely to restrict migration to 64QAM
	DVB-T to DVB-T2	✓	Long	On a MUX by MUX basis beginning with new MUXes in 2011
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✖	n/a	Unlikely to be a major factor
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing already employed
No. of MUXes	MFN to SFN	✓✓	n/a	DTT in Austria already operating over SFN
	Reduce requirements	✖	n/a	Portability and coverage important in Austria
	Other frequencies	✖	n/a	International re-planning with bordering countries likely
	Using VHF	✓	Medium	No confirmation on whether multiplexes will be allocated in VHF but spectrum between 174-216MHz has been allocated for DVB-T

✓✓ In place
✓ Likely
✖ Unlikely

8 Belgium

8.1 Market context

Exhibit 37: Belgian market summary

Belgium	Commercial operations	Regulatory environment	Broadcast technology
Launch	• Television market is divided along linguistic lines with the Flemish and French-speaking regions having their own channels; • The market is dominated by 91% cable penetration; • DTT is primary for secondary set viewing	• ASO date differs between regions of Belgium; • Limited DTT development: only public service MUXes available prior ASO	•MUXes have technological standards enabling portable reception. They are low capacity with 16QAM modulation
2003			
ASO			
2008 (Flemish) 2011 (French)			

Cable-dominance extending to 91% of the population

The Belgian TV market is dominated by cable, with a household penetration of 91%.[25] As a result, DTT is a minority platform and is estimated to be the sole mode of television reception in just 60,000 households.

A market divided along linguistic lines

Belgium's DTT market is divided along its linguistic lines: each region has its own broadcast regulator, plans for ASO and DTT MUXes. The Flemish-speaking area has more immediate transition targets and plans to undergo ASO by the end of 2008 (compared to 2011). The 2008 ASO date is possible because of a low dependency on analogue television. The 2011 ASO date for the French-speaking region of Belgium correlates with France's ASO date. In addition, the eastern border of Belgium is home to the German speaking community; like the Flemish and French speaking regions of Belgium, this area has its own broadcasting regulations.

There are currently two regional MUXes in Belgium. With the exception of Brussels, which has reception of both MUXes, each area of Belgium only has coverage from one of the two MUXes. These FTA MUXes are operated by the public service broadcasters, VRT and RTBF, and have four channels each.

Exhibit 38: Belgian DTT coverage



[25] Informa TM

Portability versus capacity

The low number of channels available on Belgian DTT reflects the position and role of DTT. With cable penetration of over 90%, the majority of DTT viewing is on second sets. As such, reception is considered more important that the volume of content and so portable reception is considered a key requirement. To ensure strong portable reception, the Belgian DTT service uses 16QAM modulation, which, although limits the capacity of the MUXes, allows for greater coverage than would be available under 64QAM.

Exhibit 39: Current Belgian MUX structure

Technical standard	MUX 1	MUX 2
UHF/VHF	UHF	UHF
DVB-T	DVB-T	DVB-T
Modulation	16QAM	16QAM
Guard Band	1/4	1/4
FEC	3/4	3/4
Total capacity	14.93	14.93
% reserved for non-TV	16%	16%
Remaining capacity	12.54	12.54
Compression	MPEG-2	MPEG-2
No. of channels	4	4

8.2 Likely future changes

8.2.1 Expected changes

Limited future government plans for upgrades

At present, the Belgian government has no mandates in place for upgrading technology. DVB-T and MPEG2 are currently used and no decision has been made by the broadcasters to upgrade the standard of technology.

Future multiplexes available but broadcaster demand uncertain

Following ASO in the Flemish-speaking region of Belgium, it is likely that VRT will apply for licences to operate additional MUXes.[26] BIPT, the Belgian Institute for Post and Telecoms, estimates that any one area of Belgium could have up to seven MUXes, excluding Brussels that would have 14 MUXes. The broadcasters' decision to launch more MUXes will be affected by the apparent level of demand for additional DTT services. A similar process is expected in the French-speaking region once ASO takes place in 2011. This area will also have capacity for seven MUXes. At present, it is not clear whether commercial broadcasters in either of these regions will be able to tender for potential availability of additional MUXes.

[26] Interview with BIPT

64QAM migration unlikely

Planned Belgian DTT MUXes are intended to have portable reception. An increase in modulation from 16QAM to 64QAM would decrease the degree of coverage and ease of portable reception. Such a technology change would not benefit the Belgian DTT system and is therefore very unlikely.

VHF multiplexes could be accommodated

Given the outcome of the Geneva 06 Agreement, it is possible for Belgium to have a VHF MUX in both the Flemish and the French-speaking regions. The VHF band could also accommodate one T-DAB MUX, but no decision has as yet been made regarding its use.

No plans for HD yet

As yet, there are no intentions to introduce HD channels on DTT. HDTV channels are instead viewed as a premium offer service for cable operators. Due to the majority of DTT being used on secondary sets, it is unlikely that HD will be integrated onto the platform.

8.2.2 Further recommended changes

Further possible changes to DTT MUXes are to upgrade compression technology from MPEG2 to MPEG4, and transmission technology from DVB-T to DVB-T2. A total of 130 channels on DTT would be in use when all seven MUXes in each of the Flemish and French-speaking areas (Brussels would have access to all 14 MUXes) and when the entirety of the UHF band is exploited for broadcasting. In addition, four MUXes would be receivable in the German speaking area.

We have not predicted there to be any HD channels on Belgian DTT. This is due to the low penetration of terrestrial-only homes limiting the incentive for operators to use up capacity, providing a limited number of HD channels rather than an increased number of SD channels. However, were there to be any, a total of 31 might be possible.

Exhibit 40: Possible long-term Belgian DTT platform

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 7	MUX 8
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF	VHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2
Modulation	16QAM	16QAM	16QAM	16QAM	16QAM	16QAM	16QAM	16QAM
Guard Band	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
FEC	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4
Total capacity	22.39	22.39	22.39	22.39	22.39	22.39	22.39	19.59
% reserved for non-TV	11%	11%	6%	6%	6%	6%	6%	7%
Remaining capacity	20.00	20.00	20.96	20.96	20.96	20.96	20.96	18.17
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	14 or 4	16 or 4	17 or 4	17 or 4	17 or 4	17 or 4	17 or 4	15 or 3

8.2.3 Allocating 72MHz to non-broadcast services

Were the top 72MHz of the UHF spectrum allocated to mobile broadband rather than to broadcasters for DTT, Belgium would lose one or two MUXes in the Flemish-speaking area and up to three MUXes in the French-speaking area. Without spectrum re-planning, this would result in a loss of up to 51 SD channels.

8.3 Summary

Broadcast technology upgrades in Belgium face two main issues:

- The DTT market is divided along linguistic lines, with each region having its own ASO date, multiplex plan and key broadcasters
- The low pressure on increasing channel capacity because of weak take-up and emphasis on portability

Targeting the regions

In the French-speaking region, ASO is scheduled to occur in 2011. It therefore would make sense for MPEG4 and DVB-T2 technology availability for MUXes at this time.

When new MUXes are launched in the Flemish-speaking region, following ASO in 2008, there is the dilemma of whether to adopt MPEG4 at this time or to delay an adoption of this compression technology until DVB-T2 transmission technology also becomes available. Due to the current low installed base, it makes sense to upgrade to MPEG4 boxes and migrate the existing MUX from MPEG2 to MPEG4 as soon as possible and then delay a further swap-out to DVB-T2 set-top boxes.

Portability versus capacity

Given the high portability requirement in Belgium, a migration from 16QAM to 64QAM modulation should not be advocated. The possibility of 64QAM migration, and its requirement to increase the number of transmitters should only be considered if the Government was considering a full re-plan of the DTT spectrum. However, this is unlikely due to the majority of DTT use for secondary rather than primary sets.

Exhibit 41: Summary of Belgian broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	✓	Short	High bit-rates on existing PSB to adhere with European standards
	Standard within compression	✓	Short	Improvements in the MPEG2 standard likely to result in capacity increases
	MPE42 to MPEG4	✓	Long	No decision has been taken regarding an upgrade to MPEG4 but transition could happen on new MUXes when launched Impact of upgrading this MUX is limited with only one existing multiplex per region
MUX capacity	16 to 64QAM	✖	n/a	Portability issues are likely to restrict migration to 64QAM
	DVB-T to DVB-T2	✓	Long	As with MPEG4, expect DVB-T2 to be operational on any new MUXes but unlikely on existing MUXes
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✖	n/a	Only one current MUX per region so unlikely to be a key factor
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing already employed
No. of MUX	MFN to SFN	✓✓	n/a	DTT in Belgium already operating over SFN
	Reduce requirements	✖	n/a	Portability and coverage important in Belgium
	Other frequencies	✖	n/a	International re-planning with bordering countries likely, Belgium is already split on a regional level
	Using VHF	✓	Medium	One multiplex allocated at GE-06 (but no plans in the short-term)

✓✓ In place
✓ Likely
✖ Unlikely

9 Denmark

9.1 Market context

Exhibit 42: Danish market summary

Denmark	Commercial operations	Regulatory environment	Broadcast technology
Launch	• Television market is dominated by cable and satellite services • DTT is currently only at 11% television household penetration	• The tender for four additional MUXes in 2009-10 has recently concluded • Boxer won the licences	• Current MUX uses MPEG2 technology, however tender for new MUXes mandated MPEG4
2006			
ASO			
2012			

High cable and satellite penetration

The Danish television market is dominated by multi-channel platforms as cable and satellite have a combined television household penetration of 80%.[27] A result of this high penetration is multi-channel providers switching their consumer focus from signing up new subscribers to migrating them to digital and providing premium services.

High multi-channel penetration has limited the need for a DTT platform as only a small proportion of television households primarily use terrestrial. Whilst this facilitates a relatively straight-forward ASO process (at the end of 2009), it limits the incentive for broadcasters to appear on the platform as access to the service is possible by other means.

DTT: relatively late to market

The first DTT trials began in 1999; however, plans to launch a four-MUX service failed due to the absence of adequate legislation and concerns over the high penetration of the multi-channel platforms. Further delays caused the four-MUX service to be postponed from 2002 to 2005, and then to March 2006, when it finally launched as a one-MUX service. As a result, Denmark was one of the later territories to launch a DTT service relative to its neighbouring countries.

The single DTT multiplex, operated by Digi-TV, hosts the public broadcaster's channels DR1, DR2 and TV2 Danmark (and Sign language for the deaf).

[27] Informa TM

© Spectrum Value Partners 2008.

Exhibit 43: Current Danish MUX structure

Technical standard	MUX 1
UHF/VHF	UHF
DVB-T	DVB-T
Modulation	64QAM
Guard Band	¼
FEC	2/3
Total capacity	19.91
% reserved for non-TV	8%
Remaining capacity	18.32
Compression	MPEG-2
No. of channels	4

9.2 Likely future changes

9.2.1 Expected changes

Boxer wins the tender for four new commercial multiplexes – available in 2009

In 2008, Boxer won the tender process to provide four new MUXes, three of which will be available in 2009 and a further MUX, which Boxer plan to use for DVB-H, available in 2010.

In the terms of its licences, Boxer must provide 29 channels across its three DVB-T MUXes; any remaining capacity can be used for radio or data services. It was mandated that Boxer use MPEG4 technology.

In the short-term, Boxer chose not to apply to broadcast HD channels on their MUXes. The Media Secretariat believes it is possible that Boxer can introduce HD channels if and when additional MUXes become available on the DTT platform.

In addition, a second PSB MUX (MPEG4) will be launched in November 2009. It is expected that this sixth MUX will be launched using VHF.

Upgrading the existing PSB multiplex unlikely in short-term

Although MPEG4 has been mandated for the commercial multiplexes, the existing PSB multiplex will remain MPEG2 until at least 2012. This is because regulators do not want current consumers to be forced into upgrading their set-top box technology in the near future.

Upgrading the commercial multiplexes dependent on Boxer's necessity for capacity

The decision to migrate to DVB-T2 on the commercial MUXes is Boxer's, based on commercial rationale once the technology becomes available. The view of the Media Secretariat is that a migration is possible; however it will depend on Boxer's willingness to initiate a swap-out of its DTT boxes.

9.2.2 Additional possible changes

Additional multiplexes available both in VHF and UHF

There is also the possibility of two further MUXes in the UHF spectrum. These MUXes will only be available between 2012 and 2015 due to interference with neighbouring countries such as Poland. Referred to as the 'MUXes of innovation', no decision has been made as to whether the MUXes will be used for broadcast or other services such as mobile broadband.

Upgrading to MPEG4 and DVB-T2

In the long-term, we foresee a total of eight MUXes, including one MUX in the VHF band, using MPEG4 and DVB-T2 technology. This would allow for a total of 158 SD channels or 35 HD.

Exhibit 44: Possible long-term Danish DTT platform

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5
UHF/VHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-H
Modulation	64QAM	64QAM	64QAM	64QAM	
Guard Band	1/4	1/4	1/4	1/4	
FEC	2/3	2/3	2/3	2/3	
Total capacity	29.86	29.86	29.86	29.86	
% reserved for non-TV	5%	7%	7%	7%	
Remaining capacity	28.28	27.68	27.68	27.68	
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	
No. of channels	20 or 5	23 or 5	23 or 5	23 or 5	

Technical standard	MUX 6	MUX 7	MUX 8
UHF/VHF	VHF	UHF	UHF
DVB-T	DVB-T2	DVB-T2	DVB-T2
Modulation	64QAM	64QAM	64QAM
Guard Band	1/4	1/4	1/4
FEC	2/3	2/3	2/3
Total capacity	29.86	29.86	29.86
% reserved for non-TV	7%	7%	7%
Remaining capacity	27.68	27.68	27.68
Compression	MPEG-4	MPEG-4	MPEG-4
No. of channels	23 or 5	23 or 5	23 or 5

9.2.3 Allocating 72MHz to non-broadcast services

If 72MHz was taken from UHF, two MUXes could be lost, reducing the SD channel number by 46.

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9.3 Summary

The tender won by Boxer for the next four MUXes on Danish DTT suggests a launch with MPEG4/DVB-T technology. Given the short time until launch it is highly unlikely that DVB-T2 will be implemented. It may be possible for Boxer to upgrade to DVB-T2 using their set-top box rental model, provided that the technology is available and cost-effective. In addition, it may be possible to leverage Boxer's international economies of scale for set top box migration.

At present, an upgrade of the current MUX to MPEG4 requires the set-top boxes in 300,000 homes to be swapped out. However, we do not believe that in the short term, the benefits of the MUX upgrade would outweigh the costs of the box swap-out.

Exhibit 45: Summary of Danish broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	✓	Short	High bitrates on existing PSB to adhere with European standards
	Standard within compression	✓	Short	Improvements in the MPEG2 standard is likely to result in further capacity increases
	MPE42 to MPEG4	✓	Medium	Government would like all MUXes to be on MPEG4 compression by 2012
MUX capacity	16 to 64QAM	✓✓	n/a	MUXes use 64QAM modulation from launch
	DVB-T to DVB-T2	✓	Long	No plan at present to introduce DVB-T2; not been discussed in-line with MPEG4, therefore likely to be introduced post-2012
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✖	n/a	Not considered to have a major impact
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing already employed
No. of MUX	MFN to SFN	✖	n/a	Current MFN unlikely to be transferred
	Reduce requirements	✖	n/a	Not considered to have material impact
	Other frequencies	✖	n/a	International re-planning with bordering countries likely
	Using VHF	✓	Short	One MUX could be introduced in 2009

✓✓ In place
✓ Likely
✖ Unlikely

10 Finland

10.1 Market Context

Exhibit 46: Finnish market summary

Finland	Commercial operations	Regulatory environment	Broadcast technology
Launch	• Cable and satellite are the dominant platforms; • However DTT has a penetration of 34% and is undergoing a period of growth	• Major technical decisions are reserved for MUX operators; • FICORA is supportive of using the most advanced technology possible on the platform • FICORA is encouraging the future introduction of HD	• The current four DTT MUXes use DVB-T and MPEG4 technology with 64QAM modulation
2001			
ASO			
2007			

Cable and satellite dominate but still a positive outlook for DTT

The Finnish television market is dominated by cable and satellite with 60% household penetration; however DTT has shown strong growth with 34% penetration in 2007.[28] Growth in DTT has been driven by a strong pay-TV offering and coverage of areas that could not be reached by cable.

One of the first to launch

Finland was one of the first countries in Europe to launch a DTT service, carrying out tests during the Olympic Games in 2000. Finnish DTT services were launched in 2001 by the transmission company, Digita. Initially, the service was restricted to free-to-air channels provided by the existing public service and commercial broadcasters, YLE, MTV3 and Nelonen, along with eight new digital channels spread over three MUXes. Since then, the service has expanded to offer a combination of free-to-air and pay-TV content from Canal Plus. MUX A is reserved for the public service broadcaster YLE, with the remaining MUXes taken up by commercial programming. Although DTT MUXes were originally operated by the broadcasters, a change in licensing procedure in 2002 passed control to Digita.

A pay-DTT service, Plus TV, was launched in November 2006 by Digi TV Plus. The €38 million rollout was financed by Baker Capital and Provider Venture Partners. Plus TV aims to attract 300,000 subscribers by the end of 2009 and in March 2007 it already had 100,000 subscribers. Competition on the DTT platform has driven development and take-up of the service, and by the end of 2007 it had 34% television household penetration.

Following ASO in December 2007, there are four MUXes for DVB-T and one MUX for DVB-H (in addition there is one local MUX surrounding the city of Vaasa). As a result there are 34 channels available on DTT.

[28] Informa TM

Exhibit 47: Current Finnish MUX structure

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5
UHF/VHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-H
Modulation	64QAM	64QAM	64QAM	64QAM	
Guard Band	1/8	1/8	1/8	1/8	
FEC	2/3	2/3	2/3	2/3	
Total capacity	22.12	22.12	22.12	22.12	
% reserved for non-TV	12%	10%	12%	10%	
Remaining capacity	19.52	19.88	19.49	19.88	
Compression	MPEG-2	MPEG-2	MPEG-2	MPEG-2	
No. of channels	5	7	11	8	

10.2 Likely future changes

10.2.1 Expected changes

Future roadmap uncertain

There are currently no government mandates for technological or capacity changes to DTT and so the future roadmap is uncertain. Technical specifications can be decided upon by broadcasters rather than via mandate from the government, and so decisions regarding technological migration will be driven by commercial rationale. Due to the forecasted strong pay-DTT and primary-set viewing element of DTT predicted in Finland, Digita and Plus TV are likely to want to maximise its channel offering. This could be achieved by migration to MPEG4 and DVB-T2. Regarding DVB-T2 in Finland, it is believed that if the technology becomes available for use in the next few years it would be adopted on to the DTT platform.

With an estimated installed base of 800,000 households in 2012, the cost of upgrading set-top boxes would be lower than would be the case in the UK and Spain, thus reducing the barrier to upgrading to MPEG4 and DVB-T2.

HD on the cards

HD is considered likely in Finland once MPEG4 and DVB-T2 technology becomes available and can be rolled out on set-top boxes. HD could be a way for Plus TV to generate premium content on its pay-DTT service. As yet, no decision has been taken by FICORA or the MUX operators regarding a date for introduction, or the potential scale of HD on DTT.

A pre-allocation of spectrum to mobile

The band 790-862MHz has, just recently, been allocated for broadband mobile services. This leaves room for 6 MUXes in UHF (and two MUXes in VHF with minor modifications to the GE06 Plan).

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10.2.2 Additional possible changes

T2 and MPEG4 for new multiplexes possible

There is the possibility of three additional MUXes (one in UHF and two in VHF). It would be possible for these to be allocated MPEG4 and DVB-T2 technology because this technology will be available by the time these MUXes are introduced.

Migration to national SFN unlikely

We do not view a migration to national SFN as a realistic possibility. Whilst conversion to a national SFN is theoretically possible, it would require significant spectrum re-planning and so it is not a realistic option in the short-to-medium-term. In theory, DVB-T2 would allow larger SFNs, which could lead to a more efficient way of using spectrum. It is also possible that, once DVB-T2 becomes available, Finland could be covered by a single SFN. However, due to the large international impact that this would have, re-planning the network to achieve this is unrealistic for the foreseeable future.

Should the entire UHF band be made available for broadcasting, we believe it possible in the long-term for there to be 8 MUXes, one of which is reserved for DVB-H. Two additional DTT MUX would be available in VHF. This will provide a total of 190 SD channels and 40 HD channels.

Exhibit 48: Possible long-term Finnish DTT platform

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 7	MUX 8
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF	VHF	VHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-H	DVB-T2	DVB-T	DVB-T
Modulation	64QAM	64QAM	64QAM	64QAM		64QAM	64QAM	64QAM
Guard Band	1/8	1/8	1/8	1/8		1/8	1/32	1/32
FEC	2/3	2/3	2/3	2/3		2/3	2/3	2/3
Total capacity	33.15	33.15	33.15	33.15		33.15	29.01	29.01
% reserved for non-TV	8%	7%	8%	7%		7%	8%	8%
Remaining capacity	30.55	30.91	30.52	30.91		30.91	19.39	19.49
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4		MPEG-4	MPEG-2	MPEG-2
No. of channels	23 or 6	23 or 6	25 or 6	25 or 6		25 or 6	22 or 5	22 or 5

10.2.3 Allocating 72MHz to non-broadcast services

The Finnish government have already reserved this sub-band for non-broadcast services resulting in the loss of two multiplexes.

10.3 Summary

Since ASO has already taken place, it is unlikely that the installed base of set-top boxes for primary and secondary sets will grow significantly from their current level. As a result, unlike some other European nations, there is less pressure for an immediate solution to increase the service capacity.

To ensure that the MUX capacity is used efficiently, close coordination between Digita, Canal Digital, Digi Plus and FICORA is essential.

Exhibit 49: Summary of Finnish broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	✓	Short	High bitrates on existing PSB to adhere with European standards
	Standard within compression	✓	Short	Improvements in the MPEG2 standard is likely to result in further capacity increases
	MPE42 to MPEG4	✓	Medium/ Long	New MUXes are encouraged to go MPEG4 from launch in the hope of full swap out in the long-term
MUX capacity	16 to 64QAM	✓✓	n/a	MUXes use 64QAM modulation from launch
	DVB-T to DVB-T2	✓	Medium/ Long	Similarly to MPEG4, encouragement evident for using up-to-date technology
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✓✓	n/a	PayDTT MUXes could be reorganised but unlikely that gain would be significant as MUXes already probably well organised
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing already employed
No. of MUX	MFN to SFN	✖	n/a	A switch to SFN, whilst possible, would necessitate a significant amount of spectrum re-planning and interference issues with other countries
	Reduce requirements	✖	n/a	Not considered to have material impact
	Other frequencies	✖	n/a	International re-planning with bordering countries likely
	Using VHF	✓	Short	Two MUXes could be introduced

✓✓ In place
✓ Likely
✖ Unlikely

11 France

11.1 Market context

Exhibit 50: French market summary

France	Commercial operations	Regulatory environment	Broadcast technology
Launch 2005 **ASO** 2011	• Digital terrestrial platform has a relatively high television household penetration of 41% • Only 40% cable and satellite penetration	• CSA have prioritised DTT and developed the platform with primary set viewing • They have already allocated a MUX for HD content	• Six MUXes at present; FTA SD channels broadcast on MPEG2, all other channels use MPEG4 • All MUXes have 64QAM modulation

Innovation and consolidation

The French television market is characterised by innovation and consolidation. The market has changed significantly in recent years, with all sectors undergoing developments. The rising popularity of IPTV and DTT has triggered mergers in the cable and satellite sectors, and traditional terrestrial channels are relying on thematic channels to drive growth in the increasingly multichannel landscape. The high viewing share of the terrestrial platform in France is similar to that in the UK. In addition, only 40%[29] of households have access to cable or satellite. As such, the French Government and broadcast regulator Conseil Supérieur de l'Audiovisuel (CSA) have prioritised the development of the digital terrestrial platform.

Strong but uneven past growth

The original launch of DTT was uncertain with delays due to disagreements over which compression system to use, and unease about launching a new digital platform into a market that already had two digital DTH providers and an IPTV service. However, following the launch of DTT in 2005, there was strong consumer take-up, with an estimated 6.4m homes, or 26% of television households adopting DTT in 2007 (forecast to increase to 9.6m homes (38% of television households)[30] by 2012). This high level of interest reinforces the government and CSA's support of the service.

The allocation of channels to the individual MUXes was not a straight-forward process. In October 2004, the Conseil d'Etat (State Council) revoked six licences (one FTA, and five pay DTT) previously awarded to the Lagardère Group and Canal Plus. This revocation was based on Canal Plus's ownership interest in Lagardère's content business, Lagardère Thématique. Thus the Lagardère Group's MUXes counted towards Canal Plus' allocation, the sum of which exceeded the limit of MUXes per operator.

As of this autumn, there will be a total of six MUXes in France. The first MUX (R1) is reserved for public broadcasting, whilst the fifth (R5) is being readied for the launch of HD DTT. Unlike a number of other European nations in which the majority or all MUXes are operated by one player, each MUX is operated by a different company.[31] The MUXes have been allocated to the different terrestrial broadcasters. This can make coordination between the two MUXes difficult unless technological standards are mandated by the regulatory authority or government. At present, the six MUXes offer a total of 33 channels, 28 in SD and 5 in HD.

[29] Informa TM
[30] Informa TM
[31] R1 – Société de Gestion du Réseau, R2 – Nouvelles Télévisions Numériques, R3 – Campagnie du Numérque Herzien, R4 – Société Opératrice du Multiplex, R5 – GR5, R6 – SMR6

HD on the route to implementation

In France, DTT is an important mode of primary television reception, which has driven the CSA's development of the capacity of the platform and enthusiasm to introduce HD programming. However, in other countries such as Belgium and Germany, the primary role of the DTT platform is to provide portable reception for use on second sets. French DTT, whilst still a FTA service, is very much a primary set proposition as the quality of content on the service is seen as vital to developing strong consumer proposition.

France offers a mixture of FTA and pay-DTT services. 22 channels are available on the FTA service, comprising of the current analogue terrestrial channels and a number of digital only channels. The remaining eleven channels, including Canal+ and Eurosport are available via a pay-DTT service. HD channels are available both on a FTA and pay-DTT basis.

Exhibit 51: Current French MUX structure

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/32	1/32	1/32	1/32	1/32	1/32
FEC	2/3	2/3	2/3	2/3	2/3	2/3
Total capacity	24.13	24.13	24.13	24.13	24.13	24.13
% reserved for non-TV	12%	12%	15%	12%	15%	12%
Remaining capacity	21.22	21.22	20.62	21.22	20.62	21.22
Compression	MPEG-2	MPEG-2	MPEG-4	MPEG-2/4	MPEG-4	MPEG-2/4
No. of channels	6 SD	6SD	5SD and 1HD	4SD and 1HD	3HD	7SD

11.2 Future likely changes

11.2.1 Expected changes

All regulation concerning ASO in France is based on the 5th March 2007 legislation, which mandates ASO to take place by the end of November 2011. This is seen as challenging as the switchover process had not begun by June 2008 and no fixed transition plan agreed upon. France is therefore left with a shorter DSO window than other major European nations. In addition, France has no agreed long-term plan for the number of DTT MUXes that will be available post-ASO.

Future changes driven by HD

CSA have publicly stated their aspiration for all DTT channels to be available in HD and so are keen to allocate the maximum possible number of MUXes to broadcast in order to identify capacity required for the DTT content. CSA have submitted a plan to the government which would allocate 10 MUXes to broadcast, enable all channels to be in HD. In addition, there would be one MUX for local channels and two DVB-H MUXes.

CSA views HD as a priority on DTT for two main reasons. Firstly, the CSA view HD as the future standard of television broadcasting. It would be offered by all channels rather than as a premium service with limited channels. Secondly, due to the high penetration of DTT and the number of homes that rely on terrestrial as their only mode of broadcasting, there is a desire to make the quality of the platform as forward compatible and competitive as possible.[32]

Migration to HD is being used to drive the evolution of broadcast technology. The CSA has mandated that all HD channels must be broadcast using MPEG4 technology, therefore placing the MPEG4 technology hand-in-hand with HD introduction. The CSA launches a call to tender for HD channels, with licences allocated following a competitive process. Any channels currently broadcasting using MPEG2 transmission technology would then migrate to MPEG4 to enable HD broadcasting.

The first DVB-H MUX is scheduled to be launched later this year, with 16 channels and a capacity of 7.3Mbit/s. There is also the capacity-dependent possibility of an additional MUX for DVB-H. As there were 36 candidate channels for the 16 available slots for the original MUX, it is felt that there is broadcaster demand for an additional MUX. CSA have indicated that they will launch a tender for this second MUX in 2009.

A plethora of multiplexes

At present, based on current regulatory assumptions, France is foreseen to have 13 MUXes post-ASO, comprised of the 10 HD MUXes, two DVB-H MUXes, and a further local MUX. This is based on the assumption that the CSA is granted all MUXes it has requested from the government. Whilst possible, it is unlikely that there will be any broadcasting on the VHF spectrum band. Canal+ currently broadcasts in analogue; however, the spectrum has been reserved for digital radio use.

Government pressure versus broadcaster freedom

Migration to more advanced technological standards and re-organisation of MUXes is difficult in France as technological agreement is required across all the channels. As an example, in order for a MUX to migrate from MPEG2 to MPEG4 it requires cooperation from the MPEG2 channels on the MUX as well as the MUX operator. This system also operates on the DVB-H MUX where the 16 channels need to organise themselves with respect to all the technical specifications of the MUX.

The French government is debating whether to make an amendment to broadcasting law so that all DTT equipment sold should be MPEG4 compatible. Were this amendment made, it would not act as a mandate on broadcasters and MUX operators to upgrade to MPEG4, but it would gradually increase the installed base of MPEG4 compatible set-top boxes and iDTV's. This would, in turn, lower the barrier to a future migration from MPEG2 to MPEG4 compression technology.

11.2.2 Additional possible changes

There has been no regulatory discussion in France regarding the migration from DVB-T to DVB-T2. Like the MPEG2 to MPEG4 migration, this would require an upgrade in set-top boxes. However, if all boxes sold from early in 2009 were MPEG4 and not DVB-T2 compatible, it would realistically be sometime before an additional box swap-out could take place. Therefore, a migration to DVB-T2 should be considered as a long-term rather than medium-term possibility.

[32] Interview with CSA

© Spectrum Value Partners 2008.

SFN move unlikely

It is very unlikely that France will migrate to a full SFN network. Currently, a mixture of MFN and SFN are used, with SFN being used in local areas to boost capacity. A nationwide SFN would require the use of high-powered transmitters that would lead to high transition costs for MUX operators. It is, therefore, unlikely that they will opt to migrate to a nationwide SFN purely for commercial reasons.

In the long-term, we view France as having a total of 14 MUXes, including the local and DVB-H MUXes as described above, and one in VHF, broadcasting using MPEG4 and DVB-T2 technology. This would provide a total of 71 HD channels on the DTT platform.

Exhibit 52: Possible long-term French DTT platform[33]

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 7	MUX 8
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32
FEC	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3
Total capacity	36.19	36.19	36.19	36.19	36.19	36.19	36.19	36.19
% reserved for non-TV	8%	8%	10%	8%	10%	8%	10%	10%
Remaining capacity	33.28	33.28	32.68	33.28	32.68	33.28	32.68	32.68
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	6 HD	6 HD	6 HD	6 HD	6 HD	6 HD	6 HD	6 HD

Technical standard	MUX 9	MUX 10	MUX 11	MUX 12	MUX 13	MUX 14
UHF/VHF	UHF	UHF	UHF	UHF	UHF	VHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-H	DVB-H	DVB-T2
Modulation	64QAM	64QAM	64QAM			64QAM
Guard Band	1/32	1/32	1/32			1/32
FEC	2/3	2/3	2/3			2/3
Total capacity	36.19	36.19	36.19			36.19
% reserved for non-TV	10%	10%	8%			11%
Remaining capacity	32.68	32.68	33.28			28.16
Compression	MPEG-4	MPEG-4	MPEG-4			MPEG-4
No. of channels	6 HD	6 HD	6 HD			5 HD

11.2.3 Allocating 72MHz to non-broadcast services

For the 72MHz digital dividend (which is the probable minimum EU figure) in 790-862MHz, France will probably lose 3 MUXes and therefore 18HD channels.

[33] CSA has expressed the possibility that MUX 5 may use different parameters for the Guardband (1/8) and for the FEC (3/4).

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11.3 Summary

A plethora of multiplexes could allow a swift transition

The large number of MUXes seemingly available in France suggests that not all may be needed for broadcasting if the relevant upgrades were implemented. Therefore, the transition to MPEG4 and DVB-T2 should be encouraged - again, possibly, by the Government mandating set-top box technology (as is currently planned for MPEG4 but which should be extended to DVB-T2 in the near future).

However, in the short-term, HD services should not lead to consumer confusion

In the short term, a conversion to MPEG4 boxes would free up spectrum on the existing MUXes. It is too early, however, for a joint MPEG4/DVB-T2 solution and may make a future migration to DVB-T2 transmission technology difficult. The imminent launch of the R5 HD MUX is likely to complicate any short-term HD DVB-T2 launch as the consumer proposition would be confusing as not all HD channels would be available on original HD-ready set-top boxes. Confusion could best be avoided by delaying a migration to DVB-T2 so that its introduction could be integrated with the set-top box natural replacement cycle.

Reassessing the allocation procedure to release spectrum

Overall, given that the government has made no decisions as to the future plans for UHF spectrum, it would make sense to assess the allocation procedure of future MUXes in order to ensure the best outcome for the consumer, rather than an automatic allocation of the spectrum to broadcast. The optimal situation may be to have platform neutral auctions of UHF capacity, similar to what is planned in the UK.

Exhibit 53: Summary of French broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	✓	Short	High bitrates on existing PSB to adhere with European standards
	Standard within compression	✓	Short	Improvements in the MPEG2 standard is likely to result in further capacity increases
	MPE42 to MPEG4	✓✓/ ✓	Medium/ Long	Some MPEG4 already: full migration expected in the long-term but before then on a MUX by MUX basis
MUX capacity	16 to 64QAM	✓✓	n/a	MUXes use 64QAM modulation from launch
	DVB-T to DVB-T2	✓	Medium/ Long	Will be introduced alongside MPEG4 for new multiplexes
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✓	Long	Allocation of individual multiplexes to individual broadcasters may mean that efficiency is not maximised; however, co-ordination will be difficult
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing already employed
No. of MUX	MFN to SFN	✖	n/a	A large number of multiplex are being co-coordinated without the use of an SFN so migration unlikely
	Reduce requirements	✖	n/a	Not considered to have material impact
	Other frequencies	✖	n/a	International re-planning with bordering countries likely
	Using VHF	✓	Long	Possible for the future but not being consider for the short to medium term: Canal+

✓✓ In place
✓ Likely
✖ Unlikely

12 Germany

12.1 Market context

Exhibit 54: German market summary

Germany	Commercial operations	Regulatory environment	Broadcast technology
Launch 2002 **ASO** 2008	• The television market is dominated by cable, with 60% market share	• Separation of powers and autonomous regional authorities have made DTT a regional proposition: different MUXes are available in different areas	• Low capacity 16QAM MUXes configure with portable reception requirement

Cable-dominance and regional segmentation

The German TV market is dominated by established cable operators, with around two-thirds of the 35 million TV households receiving multichannel services. Cable continues to be the most prominent platform, although subscriber numbers have declined over recent years. The terrestrial sector is dominated by the two public channels (ARD and ZDF), and two commercial channels: RTL and ProSiebenSat.1. There are more than 20 smaller terrestrial channels, the majority of which have an individual viewing share of fewer than 2%.[34]

DTT is characterised by regional segmentation of the market, with different regions having access to a different number of MUXes. Roll-out of DTT began on a region-by-region basis in November 2002 starting in the Berlin-Brandenburg region. Since the original launch, take-up of DTT receivers is increasing as more regions launch the service and by 2007 an estimated 34% of television households (13m) will have DTT receivers. DTT take-up was originally supported by public subsidies, however this was criticised by the cable industry who, itself, was struggling to stimulate take-up of its own digital services. Consequently, the Government no longer provide subsidies to support DTT take-up.

DTT: secondary set viewing

Due to high cable penetration, the primary purpose of the German DTT platform is secondary set viewing. The DTT service has therefore been developed with portable reception as a priority. Historically, discussions about the development of the platform have taken place regarding the trade-off between capacity on the MUXes and good portable reception. The position taken by BNetzA (the National Regulatory Authority) is that reception of the service should be as undemanding as possible for consumers. The portable reception requirement was therefore prioritised over capacity and as a result, capacity of the existing MUXes at 13.3 Mbit/s and 16QAM modulation, which accommodates four SD channels, is low relative to other European countries.

ASO is scheduled for later this year and regulators are confident that they will reach this target for the majority of regions. However, there are some local TV channels whose analogue terrestrial broadcasting licences expire in 2009/10 and will be allowed to continue broadcasting on analogue until the expiry of their licences. In terms of reaching ASO, BNetzA view the DSO process as having gone smoothly with little difficulty promoting take-up amongst consumers.

[34] Screen Digest

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Historical framework to regulation

The regulatory framework for the licensing of DTT MUXes should be considered in the context of German modern history. Following the end of the Second World War it was determined that no one organisation should have complete control over media and communications, resulting in a separation of powers that still exist today. The MUX licences are held by the Federal Government, whilst frequencies are assigned by a separate entity. Programme providers are then allocated a specific amount of spectrum through which to broadcast. As a result, there is a two tier system in Germany, with the media and content providers being vertically separated from the telecommunications and federal agencies.

The result of this regulatory system is that Germany is unique within Europe due to a lack of homogeneous number of MUXes, and so the number of receivable MUXes is entirely dependent upon location. The maximum number of MUXes that can be received in any one area is nine, including one national DVB-H MUX. It is the case that there are more MUXes available in highly populated areas, with only the MUXes containing the major analogue terrestrial channels being available in all parts of the country.

Exhibit 55: Current German MUX structure[35]

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5
UHF/VHF	VHF	VHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T
Modulation	16QAM	16QAM	16QAM	16QAM	16QAM
Guard Band	1/8	1/8	1/4	1/4	1/4
FEC	2/3	2/3	2/3	2/3	2/3
Total capacity	12.90	12.90	13.27	13.27	13.27
% reserved for non-TV	16%	16%	15%	15%	15%
Remaining capacity	10.89	10.89	11.23	11.23	11.23
Compression	MPEG-2	MPEG-2	MPEG-2	MPEG-2	MPEG-2
No. of channels	4	4	4	4	4

Technical standard	MUX 6	MUX 7	MUX 8	MUX 9
UHF/VHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-T	DVB-T	DVB-H
Modulation	16QAM	16QAM	16QAM	
Guard Band	1/4	1/4	1/4	
FEC	2/3	2/3	2/3	
Total capacity	13.27	13.27	13.27	
% reserved for non-TV	15%	15%	15%	
Remaining capacity	11.23	11.23	11.23	
Compression	MPEG-2	MPEG-2	MPEG-2	
No. of channels	4	4	4	

12.2 Likely future changes

12.2.1 Expected changes

Additional multiplexes unlikely

Going forward, it is unlikely that there will be additional MUXes. DTT strategy in Germany is focused on easy access, irrespective of location, rather than volume of content and so additional MUXes are not necessarily required to improve its quality content. In addition, the use of spectrum following digital dividend has not been defined and it will depend on an assessment of the demand for other services. Currently, three services have been highlighted as possible options for the digital dividend spectrum.

- More SD MUXes. This is relatively unlikely as the service is focused on secondary set usage and portable reception. Therefore increasing the amount of content would not necessarily lead to an increase in DTT take-up.

[35] MUX structure detailed is a maximum estimate only, due to the regional complexity and inhomogeneous nature of Germany

- Additional DVB-H MUXes. There is currently one DVB-H MUX, which was allocated by tender last year due to demand from the federal states. According to BNetzA, it is unlikely that there will be additional DVB-H MUXes in the short to medium-term; however, it could be a long-term option dependent on demand from the service by broadcasters and mobile operators.
- High definition. There is currently no agreed view on introducing HD on DTT amongst broadcasters. Additionally, MUX operators question the need for HD DTT, with high penetration cable services already providing DTT channels. If HD were to be introduced then it would be in the form of HD channels being integrated into existing SD MUXes rather than a re-organisation of the MUXes to allow for specific HD MUXes.

Broadcast migration decisions some way away

As yet, there has been no decision about a possible migration of compression technology from MPEG2 to MPEG4. MUX operators want to increase capacity on their existing MUXes, yet due to the high installed base of set-top boxes, a swap-out to MPEG4 compatible boxes would be expensive. The German regulator has taken a liberal position regarding the migration and has left the decision to the MUX operators to decide based on commercial rationale. At present, it appears that a decision to upgrade to MPEG4 is at least two to three years away.

Should compression technology be upgraded to MPEG4 from 2010 onwards, it would be feasible to migrate transmission technology from DVB-T to DVB-T2 at the same time and thus limit consumers to only having to upgrade their set-top box equipment on one occasion. Similarly to the option of an MPEG2 to MPEG4 migration, no decision has been taken regarding an upgrade to DVB-T2, although BNetzA believe that like in other European countries, German MUX operators should make the fullest use of their spectrum capacity as possible.

12.2.2 Additional possible changes

64QAM migration not likely

A migration to 64QAM is not likely due to the portable reception requirement on the platform. However, it does make sense to increase capacity through a migration to MPEG4/DVB-T2 technology as soon as such a migration is feasible. This would allow the DTT platform to maximise the number of channels that are available to consumers, whilst maintaining the high level of coverage and portable reception.

In the long term, we foresee Germany as having nine MUXes broadcasting using MPEG4 and DVB-T2 technology including a nationwide DVB-H. These upgrades in technology are likely as they will allow for greater MUX capacity, whilst not negatively affecting the reception portability. With the upgraded technology and efficiency improvements within standard, we predict that the DTT service will accommodate 160 SD channels. This is based on the assumption that there will be no HD channels.

Exhibit 56: Possible long-term German DTT platform[36]

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5
UHF/VHF	VHF	VHF	UHF	UHF	UHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2
Modulation	16QAM	16QAM	16QAM	16QAM	16QAM
Guard Band	1/8	1/8	1/4	1/4	1/4
FEC	2/3	2/3	2/3	2/3	2/3
Total capacity	19.35	19.35	19.91	19.91	19.91
% reserved for non-TV	10%	10%	10%	10%	10%
Remaining capacity	17.34	17.34	17.86	17.86	17.86
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	14 or 3	13 or 3	14 or 3	13 or 3	14 or 3

Technical standard	MUX 6	MUX 7	MUX 8	MUX 9
UHF/VHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-H
Modulation	16QAM	16QAM	16QAM	
Guard Band	1/4	1/4	1/4	
FEC	2/3	2/3	2/3	
Total capacity	19.91	19.91	19.91	
% reserved for non-TV	10%	10%	10%	
Remaining capacity	17.86	17.86	17.86	
Compression	MPEG-4	MPEG-4	MPEG-4	
No. of channels	14 or 3	14 or 3	14 or 3	

12.2.3 Allocating 72MHz to non-broadcast services

The effect of 72MHz digital dividend (which is the likely minimum EU figure) in 790-862MHz is difficult to accurately account for due to the regional complexity and inhomogeneous nature of the German market; however, currently only 24 MHz is available for broadcasting in that sub-band as the rest is used for tactical radio systems. Therefore, a maximum of 3 MUXes would be lost for broadcast use if taken for mobile broadband systems.

12.3 Summary

Regional autonomy difficult for harmonisation

The regional autonomy in Germany means that the total number of MUXes will vary on location and it is unlikely that there will ever be a homogeneous number of MUXes on the German DTT platform. As a result, any effort towards promoting the need for spectrum re-planning should be discouraged.

[36] MUX structure detailed is a maximum estimate only, due to the regional complexity and inhomogeneous nature of Germany

Whilst not recommending a migration to 64QAM, it would be worthwhile exploring the possibility of increasing the guard band and FEC.

Exhibit 57: Summary of German broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	✓	Short	High bitrates on existing PSB to adhere with European standards
	Standard within compression	✓	Short	Improvements in the MPEG2 standard is likely to result in further capacity increases
	MPE42 to MPEG4	✓	Long	Possible but emphasis on portability/coverage rather than channel capacity so no impetus to upgrade
MUX capacity	16 to 64QAM	✖	n/a	Portability issues are likely to restrict migration to 64QAM
	DVB-T to DVB-T2	✓	Long	Possible but emphasis on portability/coverage rather than channel capacity so no impetus to upgrade
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✓	Long	Co-ordination need by protagonist to better operate multiplexes
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing already employed
No. of MUXes	MFN to SFN	✖	n/a	Regional jurisdictions mean national SFN is unlikely
	Reduce requirements	✖	n/a	Portability and coverage important in Germany
	Other frequencies	✖	n/a	International re-planning with bordering countries likely, Germany already split on a regional level
	Using VHF	✓	Short/ Medium	Band III has been allocated for DVB-T and one multiplex is likely Rest of band is shared with T-DAB which mainly operates in Channel 12 (223-230MHz)

✓✓ In place
✓ Likely
✖ Unlikely

13 Hungary

13.1 Market context

Exhibit 58: Hungarian market summary

Hungary	Commercial operations	Regulatory environment	Broadcast technology
Launch	• High cable and satellite penetration could potentially limit the opportunity for the DTT platform once it is launched in 2008	• The Government has just concluded the tender process for the first three MUXes • The winner, Antenna Hungária ZRt agreed and signed the contract on the 5th Sept. 2008	•Winning bidder will decide on technical specifications of their MUXes, but will use MPEG-4
2008			
ASO			
2012			

Slow launch process only now coming to fruition

The process to launch DTT in Hungary has been slow, with the National Communication Authority in Hungary (NHH) only tendering for the first DTT licences in spring 2008. The tender process for the operator for five DTT MUXes (three of which will be available from the end of 2008, and a further two following ASO in 2011) has just been completed, with the NHH reporting that they had received two bids for the licences: from network operator Antenna Hungaria; and the Slovakian company Digital Broadcasting. Following the valuation, Antenna Hungária ZRt won the licence and National Communication Authority signed the contract on 5 September 2008. Delays had previously been caused by disagreements between the government and the regulator, the National Radio and Television Authority (ORTT). The regulator is keen to retain control over the content broadcast via DTT, while the government wants to liberalise the platform. The outcome of this disagreement is that the winner of the tender process will have complete control over the number of channels they accommodate on each MUX, as well as the technological specifications.

The first three MUXes will be launched at the end of 2008, and are confirmed to use MPEG4 and DVB-T technology over SFN with 8-10 channels per MUX. The second MUX is suitable for DVB-H, and it is confirmed that the winner has decided to use the MUX for this use.

Exhibit 59: Current Hungarian MUX structure (at launch)[37]

Technical standard	MUX 1	MUX 2	MUX 3
UHF/VHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-H	DVB-T
Modulation	64QAM		64QAM
Guard Band	1/32		1/32
FEC	2/3		2/3
Total capacity	24.13		24.13
% reserved for non-TV	20%		20%
Remaining capacity	19.41		19.41
Compression	MPEG-4		MPEG-4
No. of channels	8-10		8-10

13.2 Likely future changes

13.2.1 Expected changes

Control of technology pathway with future multiplex operator

Antenna Hungária ZRt has control over decisions regarding the MUXes and so the likelihood and timescale of any future technical changes is uncertain. In addition, with the MUXes likely to be launched with MPEG4 compression, 64QAM modulation and over SFN, the MUXes are relatively future compatible compared to other European nations such as the UK, and the Netherlands.

The next likely change in DTT technology is an upgrade of transmission technology on the MUXes to DVB-T2. It is considered in Hungary that the MUX operator will be likely to deploy the strongest technology, and therefore it could be expected that DVB-T2 could be introduced at ASO in 2011 when more MUXes are introduced.

Beyond the initial three multiplexes currently under tender, one further multiplex (MUX 4) could become available at the earlier switch-off. A fifth multiplex is also likely at the analogue switch-off of the commercial stations (RTL, TV2). These additional multiplexes would be suitable for HD programming, and whilst the decision on this lies with the operator, it is considered likely that they will be used for this.

13.2.2 Additional possible changes

At GE-06, Hungary was allocated 7 UHF and 1 VHF digital networks. Therefore, although not foreseen by the regulator at this stage, we believe that there will be eight national MUXes broadcasting over SFN using MPEG4 and DVB-T2 technology. Provided that all UHF spectrum is allocated to DTT, 175 SD and 41 HD channels would be able to be offered.

[37] Guard Interval given at interview differs from that given in Hungary Digital document (GI=1/4)

Exhibit 60: Possible long-term Hungarian DTT platform

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 7	MUX 8
VHF/UHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF	VHF
DVB-T	DVB-T2	DVB-H	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2
Modulation	64QAM		64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/32		1/32	1/32	1/32	1/32	1/32	1/32
FEC	2/3		2/3	2/3	2/3	2/3	2/3	2/3
Total capacity	36.19		36.19	36.19	36.19	36.19	36.19	31.67
% reserved for non-TV	13%		13%	13%	13%	13%	13%	15%
Remaining capacity	31.47		31.47	31.47	31.47	31.47	31.47	26.95
Compression	MPEG-4		MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	23 or 6		26 or 6	26 or 6	26 or 6	26 or 6	26 or 6	22 or 5

13.2.3 Allocating 72MHz to non-broadcast services

For 72MHz digital dividend (which appears to be the minimum EU figure) in 790-862MHz, Hungary will probably lose two to three multiplexes.

13.3 Summary

Due to the relatively late launch of the DTT platform, Antenna Hungária ZRt is encouraged to use the most efficient technology available so that it can offer a strong bouquet of channels. Two further MUXes will be available post-ASO and it would make sense that these are with DVB-T2 technology. It is possible that at the launch of the new MUXes, a mandate could force set-top boxes to be sold using DVB-T2 technology, only. A further possible change post-ASO would be to use VHF for a MUX.

Exhibit 61: Summary of Hungarian broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	?	?	Dependant on channels at launch
	Standard within compression	✓✓	n/a	Likely to use latest technology
	MPE42 to MPEG4	✓✓	n/a	MUXes to use MPEG4 compression from launch
MUX capacity	16 to 64QAM	✓✓	n/a	MUXes to use 64QAM modulation from launch
	DVB-T to DVB-T2	✓	Long	Imminent launch in MPEG4 could delay DVB-T2 swap out
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✓✓	n/a	Organisation at launch
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing at launch
No. of MUXes	MFN to SFN	✓✓	n/a	SFN from launch
	Reduce requirements	✖	n/a	Probably optimised at launch
	Other frequencies	✖	n/a	International re-planning with bordering countries likely
	Using VHF	✓	Long	Could offer valuable opportunity in the future

✓✓ In place
✓ Likely
✖ Unlikely

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14 Ireland

14.1 Market context

Exhibit 62: Irish market summary

Ireland	Commercial operations	Regulatory environment	Broadcast technology
Launch	• DTT platform scheduled for launch in 2009; • Analogue terrestrial platform traditionally has a high viewing share	• The BCI has recently awarded the licence for three commercial MUXes to Boxer	• When launched, the four MUXes will use MPEG4 technology and 64QAM modulation
2009			
ASO			
2012			

Delays in the launch of DTT

Historically, the Irish television market has been dominated by cable and satellite, with 78% household penetration.[38] The launch of DTT in Ireland has been significantly delayed from the time of government approval in the late 1990s. Subsequent legislation and a failed licence contest, which only attracted one entrant, were succeeded by several years without progress towards a service launch. Following this period of inactivity, the Broadcasting Amendment Act of 2007 enabled the creation of a national transmission network with four MUXes, and a tender process for three commercial MUXes has now closed. With bids from three consortiums submitted in May 2008, the licence was awarded to Boxer Ireland.

The RTE public service MUX (not part of the tender process) is likely to have six channels with the capacity for at least a further two, whilst the commercial MUXes will accommodate 10-12 channels each. In total, the DTT platform will provide between 36 and 42 channels, of which at least 6-8 will be free to air and the remainder available via pay-DTT.[39]

Strong regulation on broadcast technology

In Ireland regulation has been central to determining the technical specifications, with all MUXes mandated for MPEG4 and 64QAM. In addition, set-top boxes have been mandated to be HD ready. This view contrasts with more liberally-regulated countries such as Finland, Belgium and the Netherlands, in which the operators are allowed to determine the technical specifications of their MUXes. In these cases, the regulators merely provide a framework in which the operators must act.

[38] Screen Digest
[39] BCI tender public information

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Exhibit 63: Current Irish MUX structure (at launch)

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4
UHF/VHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-T	DVB-T	DVB-T
Modulation	64QAM	64QAM	64QAM	64QAM
Guard Band	1/32	1/32	1/32	1/32
FEC	2/3	2/3	2/3	2/3
Total capacity	24.13	24.13	24.13	24.13
% reserved for non-TV	17%	15%	15%	15%
Remaining capacity	20.01	20.62	20.62	20.62
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	6-8	10-12	10-12	10-12

14.2 Likely future changes

14.2.1 Expected changes

Future-proofing the platform

Two more MUXes are likely to be offered in two to three years time, with a possible of two more (a maximum of 8 in total) available at a later date. These additional MUXes will be made available on UHF spectrum. Although it is possible that capacity in the VHF band could be found to accommodate a MUX, it is not thought to be likely.

The relatively late launch of DTT and the prominent role played by Comreg and the Broadcasting Commission of Ireland (BCI) have ensured that the platform is relatively future-compatible. Whereas more mature DTT markets must contend with the issue of how to upgrade a large installed base of MPEG2 compatible set-top boxes to MPEG4 technology, all DTT boxes sold in Ireland will already be MPEG4 compatible.

No stance has been taken by Comreg regarding DVB-T2 at present. However, with the first generation of set-top boxes available from 2009, it will, realistically, be a number of years until the cost of a box swap-out can be justified by either consumers or MUX operators.

It is possible that the introduction of the two new MUXes will have DVB-T2 technology, using the launch as an opportunity to advance compression technology. Whether or not the incumbent MUXes are to upgrade to DVB-T2 at this time would be dependent on the commercial rationale of the MUX operator. If these MUXes are introduced with DVB-T2 transmission technology, it is likely that they will launch HD channels as HD. This is considered important by the BCI. Demand for HD on DTT could encourage regulators to provide additional MUXes for DTT due to the high capacity requirements of HD channels.

Full SFN unlikely

The Irish DTT network is planned to be predominantly MFN, only using local SFN for the two main transmitters in Dublin. Whilst regulators would like there to be as much SFN as possible to increase capacity, the likelihood is that there will be limited further use of SFN above what is currently planned.

14.2.2 Additional possible changes

It is unclear, at present, whether DVB-H MUXes will be introduced in the UHF or VHF spectrum, as it is yet to be formally discussed by the regulators. Were a DVB-H MUX to be introduced, it is most likely that it would only be operated in certain regional areas.

In the long-run, we foresee it possible for Ireland to have nine national DTT MUXes (including one in VHF) broadcasting using MPEG4 and DVB-T2 technology, primarily over MFN networks. Under this scenario the DTT service would be able to offer 234 SD channels and 53 HD channels, based on the assumption that two of the future MUXes will be used for HD programming.

Exhibit 64: Possible long-term Irish DTT platform

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5
UHF/VHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/32	1/32	1/32	1/32	1/32
FEC	2/3	2/3	2/3	2/3	2/3
Total capacity	36.19	36.19	36.19	36.19	36.19
% reserved for non-TV	11%	10%	10%	10%	10%
Remaining capacity	32.07	32.68	32.68	32.68	32.68
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	22 or 6	27 or 6	27 or 6	27 or 6	27 or 6

Technical standard	MUX 6	MUX 7	MUX 8	MUX 9
UHF/VHF	UHF	UHF	UHF	VHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-T
Modulation	64QAM	64QAM	64QAM	64QAM
Guard Band	1/32	1/32	1/32	1/32
FEC	2/3	2/3	2/3	2/3
Total capacity	36.19	36.19	36.19	31.67
% reserved for non-TV	10%	10%	10%	11%
Remaining capacity	32.68	32.68	32.68	28.16
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-2
No. of channels	27 or 6	27 or 6	27 or 6	23 or 5

14.2.3 Allocating 72MHz to non-broadcast services

If there was a 72MHz digital dividend, it is likely that Ireland would lose one to two MUXes, either nationally or at least in part of the country.

14.3 Summary

As a result of the recent DTT tender, the commercial MUXes will be launched with the most advanced technology available, thus providing the highest possible number of channels for the consumer. As the DTT network is to be launched in 2009, no push should be made for network re-organisation. As such, a transition to SFN is not feasible at this time.

Two new MUX licences will be made available in 2011 and will, almost certainly, be used for HD. It therefore makes sense, at their introduction, for these MUXes to use DVB-T2 MUXes. However, the set-top boxes released by the winning consortium for the current tender are likely to be MPEG4/DVB-T HD compatible. This could leave confusion for consumers as some, but not all HD channels, would be available using the original HD boxes released in 2009. To avoid consumer confusion, there should be coordination between all MUX operators so that a migration to DVB-T2 can be managed with consumer interest in mind.

Although a seventh and eighth MUX are likely to be made available post-ASO, they may be allocated via a platform-neutral-auction, similar to those in the UK. This would ensure maximum benefit to the consumer.

Exhibit 65: Summary of Irish broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	?	?	Dependant on channels at launch
	Standard within compression	✓✓	n/a	Likely to use latest technology
	MPE42 to MPEG4	✓✓	n/a	MUXes to use MPEG4 compression from launch
MUX capacity	16 to 64QAM	✓✓	n/a	MUXes to use 64QAM modulation from launch
	DVB-T to DVB-T2	✓	Long	Imminent launch in MPEG4 could delay DVB-T2 swap out
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✓✓	n/a	Organisation at launch
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing at launch
No. of MUXes	MFN to SFN	✖	n/a	MFN planned at launch
	Reduce requirements	✖	n/a	Probably optimised at launch
	Other frequencies	✖	n/a	International re-planning with UK possible but not probable at this stage
	Using VHF	✓	Long	No plans at the moment but could be used in the future (analogue TV currently occupies VHF spectrum)

✓✓ In place
✓ Likely
✖ Unlikely

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15 Italy

15.1 Market context

Exhibit 66: Italian market summary

Italy	Commercial operations	Regulatory environment	Broadcast technology
Launch	• The television market is dominated by terrestrial with the absence of cable and modest DTH penetration; • The terrestrial market is dominated by RAI and Mediaset, with 80% viewing share between them	• Agcom views the principal purpose of DTT as primary set viewing and so is rolling out a high capacity network	• Ten MUXes currently; SFN launched with 24Mbit/s capacity
2003			
ASO			
2012			

Strong terrestrial platform

To date, the Italian television market has been dominated by the terrestrial and DTH platforms, as well as RAI and Mediaset. However, major regulatory and competitive changes are increasing the number of TV players in both the pay TV and free-to-air markets. The television market is dominated by terrestrial television due to an absence of any cable network and modest DTH penetration.

The terrestrial television market has traditionally been a duopoly between state owned operator RAI, who broadcast three channels with a ~40% viewing share, and commercial operator Mediaset who also broadcast three channels with a ~40% share.[40] Additionally, La 7 (owned by Telecom Italia) garners a 2% viewing share, with a large number of regional and local networks accounting for the remaining share.

Historically, all players in the market have been vertically integrated, operating their own transmission towers. However, a law passed in 2001 mandated digital licence separation between "network operators" and "content providers", which created a legal entity separation of the transmission towers business within broadcasting groups.

DTT planning difficult

The process of analogue switch-off has proven chaotic and, as yet, there has been no agreed digital frequency plan. The DTT network, to date, has been created on a piecemeal basis after broadcasters were permitted to buy-up local frequencies in 2001. As a result, there has been uneven progress on infrastructure upgrades. Unlike in the UK, where the public service broadcaster has driven development of the DTT platform, RAI is not driving digitisation and has poor DTT coverage. In addition, where the UK has Digital UK, a consumer-coordination entity to take responsibility and manage the switchover to digital, no such organisation exists in Italy. Regarding the transition to digital, individual regions make the decision when to switch-off and there is no requirement to consult with broadcasters.

Finally, the Italian media market has, arguably, been delayed by the political environment. ASO has become highly politicised process, which has already resulted in the setting of unrealistic targets for switch-off. This

[40] Screen Digest

has resulted in two failed attempts to meet early ASO deadlines and the Communications Minister has already warned that the 2012 deadline may be unrealistic.

Regional ASO is forecast to begin later in 2008 in Sardinia, Val d'Aosta, Piemonte, Turin and Cuneo provinces, with switchover in the remaining regions being decided by the government in September of this year. Agcom, the broadcast regulator, is confident that ASO will go ahead without barriers, provided that the calendar for ASO is decided upon this autumn.[41]

High analogue terrestrial penetration and high levels of primary set viewing mean that content development for DTT is viewed as important. Agcom, therefore, wants to maximise the number of channels available on the service and so is planning to roll out a SFN with a 24.1Mbit/s MUX capacity.

Currently, in Italy, there are 10 MUXes with national coverage (at least 70% population coverage), two of which are DVB-H. As a result, the DTT service now offers 55 channels in total. Due to the incomplete coverage of the majority of the MUXes, not all regions will have access to all channels on the service.

Exhibit 67: Current Italian MUX structure

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 7	MUX 8
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-H	DVB-H	DVB-T
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM			64QAM
Guard Band	1/4	1/4	1/4	1/4	1/4			1/4
FEC	2/3	2/3	2/3	2/3	2/3			2/3
Total capacity	19.91	19.91	19.91	19.91	19.91			19.91
% reserved for non-TV	21%	18%	21%	18%	18%			21%
Remaining capacity	15.74	16.34	15.74	16.34	16.34			15.74
Compression	MPEG-2	MPEG-2	MPEG-2	MPEG-2	MPEG-2			MPEG-2
No. of channels	6	6	6	6	6			6

Technical standard	MUX 9	MUX 10
UHF/VHF	UHF	UHF
DVB-T	DVB-T	DVB-T
Modulation	64QAM	64QAM
Guard Band	1/4	1/4
FEC	2/3	2/3
Total capacity	19.91	19.91
% reserved for non-TV	21%	21%
Remaining capacity	15.74	15.74
Compression	MPEG-2	MPEG-2
No. of channels	6	6

[41] Interview with Agcom

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15.2 Likely future changes

15.2.1 Expected changes

Move to SFN

The Italian DTT plan is to develop a national SFN in order to maximise capacity of the available spectrum. This will place limitations on the network as SFNs require that the same content be broadcast across the whole network, making it unsuitable for multiplexes that need to carry regional programming and ads. In having an SFN network, RAI, therefore, would not be able to broadcast regional news feeds. The Government plans to overcome this by allowing RAI a certain number of small MFN (with the SFN structure).

In addition, a migration from MFN to SFN would require an upgrade in technology by MUX operators and consumers, who would need to purchase new aerials. With a high installed base of five million set-top boxes at present, the cost and coordination of a box swap-out would be expensive.

Based on SFN utilisation, Agcom believe that they can provide between 18-20 MUXes across VHF and UHF, assuming that all available spectrum is used for broadcast. Currently, the concept of reserving UHF spectrum for non-broadcast services such as mobile broadband is possible, but not currently under consideration"[42] and it is therefore unlikely in the short-to-medium-term that any spectrum will be released to these services.

In April 2008, Agcom launched the tender process to award additional DTT capacity on the country's existing MUXes. The tender was launched following the approval of financial conditions for 40% of the transmission capacity of the digital MUXes owned by RAI, Mediaset and Telecom Italia Media to be released.

It is likely post-ASO that there will be further DVB-H MUXes, however at this time the number of DVB-H MUXes to be introduced is unclear.

HD: next step, probably in tandem with MPEG4 and DVB-T2

HDTV on DTT is viewed by Agcom as the next step in DTT technical evolution; however discussions regarding the scale of HD deployment on DTT, and a timetable for its introduction, are unlikely to be started until next year at the earliest. Therefore, at present, it is not possible to estimate the number of HD channels that will be available on DTT. With DTT being a significant mode of primary television reception, it is possible that HD could be introduced as a means of increasing the consumer proposition, especially as there are already a high number of MUXes reserved for DTT relative to other European nations.

An incremental migration to MPEG4 is likely to occur in the medium-term, possibly introduced in conjunction with the launch of HD channels. The high installed base of MPEG2 set-top boxes limits the speed of transition, due to the consumer cost of replacement boxes. An incremental migration would, instead, allow consumers to upgrade to MPEG4 technology as they replace their set-top boxes as part of a natural replacement cycle.

In the long-term, DVB-T2 is forecast to be introduced on DTT, but this is unlikely to occur before 2018. With DVB-T2 technology not likely to be available until 2011, it is probable that consumer migration to DVB-T2 set-top boxes will be part of a second replacement cycle.

[42] Interview with Agcom senior representative

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15.2.2 Additional possible changes

In the long-term, we foresee the Italian DTT market to have 16 MUXes broadcasting using MPEG4 and DVB-T2 technology over SFN. Under this scenario, the DTT platform can accommodate 405 SD channels or 95 HD channels.

Possible long-term Italian DTT platform

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 7	MUX 8
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-H	DVB-H	DVB-T2
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM			64QAM
Guard Band	1/32	1/32	1/32	1/32	1/32			1/32
FEC	2/3	2/3	2/3	2/3	2/3			2/3
Total capacity	36.19	36.19	36.19	36.19	36.19			36.19
% reserved for non-TV	13%	11%	13%	11%	11%			13%
Remaining capacity	31.47	32.07	31.47	32.07	32.07			31.47
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4			MPEG-4
No. of channels	25 or 6	23 or 6	23 or 6	26 or 6	26 or 6			26 or 6

Technical standard	MUX 9	MUX 10	MUX 11	MUX 12	MUX 13	MUX 14	MUX 15	MUX 16
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32
FEC	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3
Total capacity	36.19	36.19	36.19	36.19	36.19	36.19	36.19	36.19
% reserved for non-TV	13%	13%	13%	13%	13%	13%	13%	13%
Remaining capacity	31.47	31.47	31.47	31.47	31.47	31.47	31.47	31.47
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	26 or 6	26 or 6	26 or 6	26 or 6	26 or 6	26 or 6	26 or 6	26 or 6

Technical standard	MUX 17	MUX 18
UHF/VHF	UHF	VHF
DVB-T	DVB-T2	DVB-T2
Modulation	64QAM	64QAM
Guard Band	1/32	1/32
FEC	2/3	2/3
Total capacity	36.19	36.17
% reserved for non-TV	13%	15%
Remaining capacity	31.47	26.95
Compression	MPEG-4	MPEG-4
No. of channels	26 or 6	22 or 5

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15.2.3 Allocating 72MHz to non-broadcast services

For 72MHz digital dividend (which appears the likely minimum EU figure) in 790-862MHz, Italy will likely lose three to four MUXes.

15.3 Summary

We approach Italy with caution. The move to 18 multiplexes on an SFN is a bold one and, if feasible, should be advocated. It may be internally difficult to co-ordinate however, given the number of protagonists involved; externally, allocating 18 SFN multiplexes is very likely to have an impact on neighbouring countries.

In addition, the formation of an SFN is likely to include frequencies within the upper band.

In the short-term, the current re-allocation plan of existing MUXes presents a good opportunity to increase the efficiency of each MUX. However, any possible MUX re-organisation or technological advance would be difficult to coordinate. This is exacerbated by the political nature of the television media in Italy, which, historically, has hindered the progression of DTT.

Given the large installed base of set-top boxes, we think that a swap-out of set-top boxes is unlikely in the short-term. Therefore, a migration to SFN should occur at the same time as a migration to MPEG4 and DVB-T2 technology. Due to the aforementioned coordination issues, the planning for a swap-out of set-top boxes would need to begin well in advance of the proposed swap-out period.

Exhibit 68: Summary of Italian broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	✓	Short	High bitrates on existing PSB to adhere with European standards
	Standard within compression	✓	Short	Improvements in the MPEG2 standard is likely to result in further capacity increases
	MPE42 to MPEG4	✓	Medium/ Long	Similarly to France a large number of multiplexes allocated to broadcasting may delay need to upgrade
MUX capacity	16 to 64QAM	✓✓	n/a	MUXes to use 64QAM modulation from launch
	DVB-T to DVB-T2	✓	Medium/ Long	Similarly to France a large number of multiplexes allocated to broadcasting may delay need to upgrade
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✓✓	n/a	Allocation of individual multiplexes to individual broadcasters may mean that efficiency is not maximised; however, co-ordination will be difficult
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing already employed
No. of MUXes	MFN to SFN	✓	Medium	Move to SFN planned
	Reduce requirements	✖	n/a	Unlikely to yield great benefits
	Other frequencies	✖	n/a	Most frequencies already used
	Using VHF	✓✓	n/a	12 national and 6 regional multiplexes are considered to include VHF

✓✓ In place
✓ Likely
✖ Unlikely

16 The Netherlands

16.1 Market context

Exhibit 69: Dutch market summary

Netherlands	Commercial operations	Regulatory environment	Broadcast technology
Launch 2003 **ASO** 2006	• DTT is viewed, primarily, on second sets, with primary set viewing dominated by the cable and satellite platforms	• Dutch regulators are liberal, leaving operational decisions regarding MUXes to the licence holders	• The portable reception requirement means that the MUXes use 16QAM modulation with a relatively low capacity

The first country to undergo ASO

In December 2006, the Netherlands was the first European country to undergo ASO. The early ASO date was aided by a high dependency on cable, with only 74,000 out of the seven million Dutch TV households relying on analogue terrestrial as their primary means of receiving television.[43]

DTT in the Netherlands was launched by Digitenne (partly owned by telecoms operator KPN) in April 2003 and experienced moderate levels of take-up due to the emphasis on usability. DTT, here, is available for portable and mobile, as well as fixed TV reception.

Currently, there are five DTT MUXes in the Netherlands; one FTA MUX reserved for the public service broadcaster NOS and four pay-TV MUXes. In total, 30 SD channels are currently broadcast on the MUXes, 4 on the FTA MUX, and the remainder on the pay-TV MUXes.

Exhibit 70: Current Dutch MUX structure

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5
UHF/VHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-T /H	DVB-T	DVB-T	DVB-T
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/4	1/4	1/8	1/8	1/4
FEC	1/2	1/2	3/4	3/4	1/2
Total capacity	14.93	14.93	19.91	19.91	14.93
% reserved for non-TV	20%	19%	14%	14%	19%
Remaining capacity	12.01	12.15	17.13	17.13	12.15
Compression	MPEG-2	MPEG-2 / 4	MPEG-2	MPEG-2	MPEG-2
No. of channels	4	5	8	8	5

[43] Informa TM

16.2 Likely future changes

16.2.1 Expected changes

Hands-off regulatory approach

Dutch regulators have a liberal attitude to DTT and so the power to decide technical evolution is left solely to the MUX operators. The broadcast regulator and government do not suggest, encourage or mandate broadcasters to upgrade their technological standards. Therefore, as the MUX operator, Digitenne, can make technological decisions based on commercial reasons, it is not expected to upgrade transmission or compression technology to meet a government-set standard.

Whilst there are currently five MUXes in Holland, it is likely, in two to three years time, that there will be a further two MUXes, taking the total to seven. It is possible that these two additional MUXes will broadcast SD channels. Pay-DTT operator Digitenne will want to maximise its channel offering to DTT-only homes rather than to offer HD channels, which are already offered on the cable platform.

16.2.2 Additional possible changes

Set top boxes in the Netherlands are predominantly rented as part of the subscription to Digitenne's pay-DTT service. Therefore, along with the low installed base of DTT receivers, the cost and difficulty of upgrading set top boxes from MPEG2 to MPEG4, and DVB-T to DVB-T2 technology would be lower than in other countries. For this reason, we see it as possible for DTT in the Netherlands to migrate to both MPEG4 and DVB-T2 in the future, provided that there is a commercial incentive for these changes.

In the long term, should the entire UHF spectrum be utilised for broadcast, we view it possible for there to be 7 DTT MUXes utilizing MPEG4 and DVB-T2 technology over local SFNs. In addition, there is the possibility of using one VHF MUX (although this is not being considered at the moment). This would allow there to be 135 SD channels on DTT.

Exhibit 71: Possible long-term Dutch DTT platform

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 7	MUX 8
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF	VHF
DVB-T	DVB-T2	DVB-T2 / H	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/4	1/4	1/8	1/8	1/4	1/4	1/4	1/4
FEC	1/2	1/2	3/4	3/4	1/2	1/2	1/2	1/2
Total capacity	22.39	22.39	29.87	29.87	22.39	22.39	22.39	19.59
% reserved for non-TV	13%	12%	11%	11%	12%	12%	12%	14%
Remaining capacity	19.47	19.62	26.69	26.69	19.62	19.62	19.62	16.82
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	13 or 3	16 or 3	22 or 3	22 or 3	16 or 3	16 or 3	16 or 3	14 or 3

16.2.3 Allocating 72MHz for non-broadcast services

For 72MHz digital dividend (which appears to be the minimum EU figure) in 790-862MHz, the Netherlands will probably lose two MUXes or, possibly, only one and a half (as the Netherlands will possibly keep a MUX for half of the country). Depending on the possibilities in the future for coordinating extra frequencies, the sixth layer might be able to be repaired (and so only one MUX lost) but it would offer lower quality and/or less coverage.

16.3 Summary

The key priority in the Netherlands is to enable a quick transition to MPEG4 and DVB-T2 technology whilst maintaining a low installed base of DTT set-top boxes. The likely catalyst for this technology migration would be the launch of the next wave of MUXes. Mandating MPEG4 and DVB-T2 boxes at the earliest possible time would ease the transition because the box swap-out could then take place within the natural replacement cycle. The transition is further eased as the majority of set-top boxes are rented from MUX operator KPN, thus limiting the cost to consumers.

Exhibit 72: Summary of Dutch broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	✓	Short	High bitrates on existing PSB to adhere with European standards
	Standard within compression	✓	Short	Improvements in the MPEG2 standard is likely to result in further capacity increases
	MPE42 to MPEG4	✓	Short/ Medium	No current plan to introduce MPEG4 but as it requires a STB upgrade from the consumer, which will be aided by rental model
MUX capacity	16 to 64QAM	✓✓	n/a	MUXes use 64QAM modulation from launch
	DVB-T to DVB-T2	✓	Medium	No current plan to introduce DVB-T2 but as it requires a STB upgrade from the consumer it could be introduced with MPEG4
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✓✓	n/a	PayDTT MUXes could be reorganised but unlikely that gain would be significant as MUXes already probably well organised
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing already employed
No. of MUXes	MFN to SFN	✖	n/a	Coverage already through local SFNs; no allotment with one territory covering the whole territory
	Reduce requirements	✖	n/a	Not considered to have material impact
	Other frequencies	✖	n/a	International re-planning with bordering countries likely
	Using VHF	✖	n/a	No DVB-T reserved in VHF

✓✓ In place
✓ Likely
✖ Unlikely

17 Portugal

17.1 Market context

Exhibit 73: Portuguese market summary

Portugal	Commercial operations	Regulatory environment	Broadcast technology
Launch	• Multi-channel penetration of 52%; • The tender for the DTT service is currently undergoing with a FTA and pay-DTT service due to be launched in 2009	• ANACOM cannot mandate technology for the MUXes but they are supportive of operators using the most advanced technology possible	• With tender currently in process, exact technical specifications for MUXes are not available • It is likely that they will launch using MPEG4 and 64QAM on SFN
2009			
ASO			
2010			

Great potential for the new DTT platform

The Portuguese television market is characterised by a relatively high cable and satellite penetration (52% of TV households[44]) and, up to now, the absence of a DTT service. Unlike many other European markets, terrestrial viewing share has not been significantly eroded by the rise of pay TV, and so a great potential for the DTT service exists once it launches in 2009.

Success over failure

DTT in Portugal originally launched in 2001 when a consortium, Platforma de Televisão Digital Portuguesa (PTDP) was awarded a licence to operate the platform. However, it subsequently lost its licence in 2003 due to its failure to launch. There are two possible reasons to account for PTDP's failure: firstly the technical approach to planning the network was flawed; and, secondly, one of the American partners of the consortium withdrew its financial support following the terrorist attacks of September 2001. This failure could reveal itself as a blessing as it may allow the implementation of more future-proof technology.

The tender for DTT multiplex licences is currently taking place with winners expected to be announced by the end of July 2008. ANACOM has tendered for one FTA and five pay-DTT MUXes. It is possible for companies to bid for all or some of the licences, and it is possible to bid for both pay-DTT licences and the FTA licence. The FTA MUX has must-carry and must-deliver obligations for all four of the current analogue terrestrial channels, but also has space for another five SD channels. It can be decided by the winner of the FTA MUX licence whether to devote the capacity reserved for the non-analogue terrestrial channels to a smaller number of HD broadcasters.

The broadcast regulator ANACOM considers the FTA aspect of DTT to be important as it caters for the proportion of the population that are unable to afford a cable or satellite subscription. Therefore, they want to maximise the quality of service available through the FTA MUX; hence the option to the operator of the FTA MUX to provide HD content.

Technology encouraged but not mandated

ANACOM cannot mandate technology standards, but they have encouraged the DTT licence bidders, who have subsequently agreed to use MPEG4 technology. ANACOM takes the position that, whilst they cannot

[44] Informa TM

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mandate technology for the MUXes, they will encourage the MUX operators to use the most efficient technology available in order to maximise capacity. It is then up to the MUX operators to decide whether it is in their commercial interest to use the encouraged technology standards.

Expected to be one of the most advanced DTT platforms in Europe

Despite MUX operators having the final choice of technical standards, it is expected that when DTT launches in 2009 it will be one of the most advanced DTT services in Europe. In addition to the technical standards, Portuguese DTT is perceived as advanced due to the strategic approach of the platform. With five pay-DTT MUXes, the service is heavily weighted towards the pay-TV, rather than FTA, market. Whilst some previous attempts to integrate pay elements to DTT in Europe have struggled e.g. Quiero TV and ITV Digital, the Portuguese government believe their system will be successful. This belief is based on the high level of importance placed on the pay-DTT aspect, thus creating a strong content-led consumer proposition; and also due to the fact that Portugal currently has relatively low pay-TV penetration, and so there is likely to be sufficient demand for a pay-DTT service.

Exhibit 74: Current Portuguese MUX structure

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/4	1/4	1/4	1/4	1/4	1/4
FEC	2/3	2/3	2/3	2/3	2/3	2/3
Total capacity	19.91	19.91	19.91	19.91	19.91	19.91
% reserved for non-TV	10%	10%	10%	10%	10%	10%
Remaining capacity	17.93	17.93	17.93	17.93	17.93	17.93
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	5	6	6	6	6	6

17.2 Likely future changes

17.2.1 Expected changes

With the DTT platform tender process yet to be finished, and hence the technology standards at launch to be confirmed, it is difficult to forecast with any certainty what changes will occur in the DTT market. All decisions regarding technology standards are reserved for MUX operators and so the choice between SD and HD broadcasts and MPEG2 and MPEG4 will be based on commercial considerations, rather than mandates from the government and regulator. Going forward, regulatory encouragement should be viewed as an indication to likely future changes to technological standards.

Assuming that the MUXes launch with the predicted technology i.e. SD channels broadcasting using MPEG4, DVB-T, 64QAM, and SFN, there are two possible technological changes that are realistic in the medium to long-term: a migration to DVB-T2 and the adoption of HD channels.

Migration to T2 may be difficult given imminent launch

Whilst any migration to DVB-T2 will be the decision of the MUX operator, ANACOM have said that they will not oppose such a migration once the technology becomes available.[45] This would require a swap-out of set-top boxes. Since the majority of pay-DTT boxes will be rented from the MUX operator and also available at a fair price from electrical retailers, it is expected that the cost of a box swap-out to consumers will be limited. It is also likely that the swap to DVB-T2 will occur on a MUX-by-MUX basis, slowing the transition and providing consumers with time to upgrade their set-top boxes.

No current view on HD

There are no regulations or legislation preventing the MUX operators from launching HD channels on the pay-DTT MUXes and so the decision will be made on commercial grounds. For the MUX operators it is a trade-off between offering HD with fewer channels on their MUX, or more channels in SD. It is likely that SD channels will predominantly be favoured so MUX operators can maximise the carriage fees received from channels broadcast on their MUXes. ANACOM foresee HD being introduced on the DTT platform in the second quarter of 2009 with HD-specific MUXes likely to be introduced after ASO.

Following ASO in 2012, frequency channels will be freed as the current analogue channels move to digital. A discussion regarding the use of this spectrum is ongoing and, as yet, ANACOM have taken no public position. As a result, the total number of DTT MUXes in the future is uncertain and no decision has been taken regarding additional MUX availability post-ASO in 2012. Their current position is that they want to monitor the initial success of DTT in Portugal before deciding whether to allocate additional spectrum to the service. One key aspect to monitor is the success of HD channels on the platform, with the possibility of additional spectrum being awarded for the purpose of HD broadcasting in the future.

17.2.2 Additional possible changes

There are plans to allocate spectrum to DVB-H, however this spectrum is not currently available. In the long-term. it is expected that a DVB-H MUX will be launched, but at this point no indication has been given regarding the technical specifications for this MUX.

In the long-term, if all UHF spectrum is reserved for broadcast, we forecast there to be six MUXes. In addition, although Portugal does not plan to use any VHF spectrum for broadcast services now, it could still do so in the future. These would offer a total of 148 SD and 34 HD channels.

[45] Interview with ANACOM

Exhibit 75: Possible long-term Portuguese DTT platform

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 6
VHF/UHF	UHF	UHF	UHF	UHF	UHF	UHF	VHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/4	1/4	1/4	1/4	1/4	1/4	1/4
FEC	2/3	2/3	2/3	2/3	2/3	2/3	2/3
Total capacity	29.86	29.86	29.86	29.86	29.86	29.86	26.13
% reserved for non-TV	7%	9%	9%	9%	9%	9%	10%
Remaining capacity	27.88	27.28	27.28	27.28	27.28	27.28	23.55
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	19 or 5	22 or 5	22 or 5	22 or 5	22 or 5	22 or 5	19 or 4

17.2.3 Allocating 72MHz to non-broadcast services

Were the top 72MHz of the UHF spectrum allocated to mobile broadband rather than to broadcasters for DTT, we believe that the Portugal would lose one to two MUXes.

17.3 Summary

Although already some way down the tender process, the Government would be encouraged to work closely with the winner of the licence to implement the most efficient technology. If DVB-T2 boxes are not available at launch, which is very likely, we foresee a more difficult pathway to DVB-T2, given the first crop of boxes will only be a few years in the market. Therefore, any migration to DVB-T2 boxes should be delayed to avoid the situation where consumers have to replace HD-ready set-top boxes only a year to eighteen months after they were originally purchased. The set-top box model of the winner is still unclear but a swap-out would, of course be aided by a rental model.

Exhibit 76: Summary of Portuguese broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	?	?	Dependant on channels at launch
	Standard within compression	✓✓	n/a	Likely to use latest technology
	MPE42 to MPEG4	✓✓	n/a	MUXes to use MPEG4 compression from launch
MUX capacity	16 to 64QAM	✓✓	n/a	MUXes to use 64QAM modulation from launch
	DVB-T to DVB-T2	✓	Long	Imminent launch in MPEG4 could delay DVB-T2 swap out
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✓✓	n/a	Organisation at launch
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing at launch
No. of MUXes	MFN to SFN	✓✓	n/a	SFN from launch
	Reduce requirements	✖	n/a	Probably optimised at launch
	Other frequencies	✖	n/a	International re-planning with Spain possible but not probable at this stage
	Using VHF	✓	Long	Currently analysing the potential of putting MUXes in VHF; no plans at the moment

✓✓ In place
✓ Likely
✖ Unlikely

18 Romania

18.1 Market context

Exhibit 77: Romanian market summary

Romania	Commercial operations	Regulatory environment	Broadcast technology
Launch 2008 **ASO** 2012	• Television market dominated by pay TV, with cable and a highly competitive DTH sector • DTT yet to launch	• The National Authority for Communication and Information Technology is publishing a DTT strategy document in November of this year	• First two MUXes will launch with MPEG4 technology, with HD being seen as crucial to DTT's differentiation

A cable dominated market

The Romanian television market is dominated by cable, which, along with a recent increase in DTH penetration, has marginalised the position of terrestrial television. The DTH sector is the most competitive, with five services available, however cable continues to be the most popular platform with 64% penetration of television households in 2008.[46] The terrestrial sector has evolved in a similar manner to that of its neighbours, with the state-run public broadcaster facing increasing competition from commercial rivals. PSB channel TVR1 has seen its audience share fall from 37.8% in 2000 to 16.3% in 2006 in the face of competition from Pro TV, Acasa TV, Antena 1, Prima and others.

Late entry into the market

Unlike the majority of its European counterparts, Romania is yet to launch its DTT service. Romania asked for frequency allocations for eight digital multiplexes in June 2006 as part of the digital TV and radio plan set out at the ITU Regional Radiocommunications Conference in Geneva in 2Q06 and a DTT strategy document is scheduled for publication by the National Authority for Communication and Information Technology on November 20th 2008. Following the publication of this document, it is likely that two DTT MUXes will operate from the end of 2008, which will be simulcast with analogue terrestrial television channels until ASO in 2012. Of the first two MUXes one will be PSB and one will be commercial; both will be available on a FTA basis.

The tender to operate MUXes is scheduled to take place during November and December of 2008. The first two MUXes are planned to be launched using MPEG4 and DVB-T technology, however full details of the technical specifications and number of channels available on the MUXes will only be available once the licences have been awarded. It is expected that MUX operators will probably have to invest in the subsidisation of set-top boxes, and it is possible that an operator's ability to do this will account for part of the MUX operator selection process that is due to take place later this year.

It is felt that there are two primary barriers to achieving ASO in Romania: communication and technology. From a communication perspective, the majority of the population are not aware of the DTT platform due to the dominance of cable and so awareness needs to be raised so that all analogue terrestrial television sets can be converted in time. Secondly, there is limited spectrum that will be made available for simulcast. As a result, in the run-up to ASO only two MUXes will be available and this limits the DTT content proposition in the face of strong competition from cable.

[46] Informa TM

Exhibit 78: Current Romanian MUX structure (at launch)

Technical standard	MUX 1	MUX 2
UHF/VHF	UHF	UHF
DVB-T	DVB-T	DVB-T
Modulation	64QAM	64QAM
Guard Band	Operator choice	Operator choice
FEC	N/A	N/A
Total capacity	N/A	N/A
% reserved for non-TV	N/A	N/A
Remaining capacity	N/A	N/A
Compression	MPEG-4	MPEG-4
No. of channels	8-9SD	8-9SD

18.2 Likely future changes

18.2.1 Expected changes

In total, Romania has 8 MUXes, one in VHF and 7 in UHF. In UHF, one MUX has been lost by giving the 690-862MHz band to mobile services. As a result, there is the capacity for 7 MUXes to be used for DTT, two of which will be available through the tender at the end of 2008.

Following ASO, four additional UHF MUXes will be made available one of which is likely to be specifically for HD programming. In addition, following ASO, channels 5-10 in the VHF band will be made available for DTT broadcasting, allowing for an additional MUX. At present it is not certain whether this spectrum will be used for DVB-H or DVB-T. It is expected that, as with the initial two MUXes, additional MUXes will be FTA.

Prior to the November 20th strategy document and in the absence of detailed technology plans it is not possible to cite with certainty any future changes to the Romanian MUX structure bar the increase in number of MUXes. However, due to the stated intention to introduce an HD MUX on DTT, it is likely that, post-ASO, at least one MUX will broadcast using DVB-T2 technology once the technology standard becomes available in order to increase MUX capacity.

18.2.2 Additional possible changes

The stated importance of HD as a content differentiator on the DTT platform suggests that there could be increased HD provision beyond the planned post-ASO MUX. If this were to be the case, it is likely that more MUXes would use DVB-T2 technology. At present, however, a migration to DVB-T2 has not been included in the Romanian DTT strategy document. For a consumer to receive any HD channels broadcast using DVB-T2 they would need to upgrade to a DVB-T2 compatible set-top box, and so once consumers have migrated to these boxes the barrier to migrate additional MUXes to DVB-T2 is lowered due to the fact that there is no additional consumer cost. Regional SFNs are scheduled for use from launch and so increased capacity cannot be found from a migration from MFN to SFN.

We foresee, in the long term, that Romania will be able to use seven MUXes for DTT broadcasting with DVB-T2 technology, with specific MUXes for HD channels and DVB-H.

Exhibit 79: Possible long-term Romania DTT platform

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 7
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF	VHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-H?	DVB-T2
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	Operator Choice	Operator Choice	Operator Choice	Operator Choice	Operator Choice	Operator Choice	Operator Choice
FEC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total capacity	N/A	N/A	N/A	N/A	N/A	N/A	N/A
% reserved for non-TV	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Remaining capacity	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	SD	SD	SD	HD	HD	SD	HD

18.2.3 Allocating 72MHz to non-broadcast services

The top 72MHz (790-862MHz) of spectrum has already been allocated to mobile services.

18.3 Summary

Despite having not yet launched the DTT platform and the existence of fears about significant barriers slowing take-up to ASO, Romania's MUXes are likely to be relatively future-proof thanks to using MPEG4 technology at launch. An upgrade to DVB-T2 at the same time as the introduction of an HD MUX post-ASO is possible once the technology becomes available. To facilitate an ease of transition, coordination between the different MUX operators and regulators should be encouraged. In addition, it would make sense to begin selling DVB-T2 compatible boxes in advance of a change in MUX technology. This would allow consumers to replace set-top boxes as part of a natural cycle rather than being forced to upgrade their set-top boxes over a short time period.

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Exhibit 80: Summary of Romanian broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	?	n/a	Dependent on channels at launch
	Standard within compression	✓	Short	Within standard improvements to MPEG-4 technology
	MPE42 to MPEG4	✓✓	n/a	MUXes scheduled to launch with MPEG-4 technology
MUX capacity	16 to 64QAM	✓✓	n/a	MUXes scheduled to launch with 64QAM
	DVB-T to DVB-T2	✓	Medium/ Long	Potential of being introduced with HD once the technology becomes available
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✓	Short	Plans in place to reorganise certain multiplexes
	Statistical multiplexing	✓	Medium/ long	Commercial MUXes will be from launch, PSB MUXes will be eventually
No. of MUXes	MFN to SFN	✓✓	n/a	Regional SFNs will be used across Romania
	Reduce requirements	✖	n/a	Not considered to have material impact
	Other frequencies	✖	n/a	Not considered to have material impact
	Using VHF	✓	Medium/ Long	Channels 5-10 scheduled for use after DSO; unsure at present whether they will be used for DVB-H or DVB-T

✓✓ In place
✓ Likely
✖ Unlikely

19 Slovakia

19.1 Market context

Exhibit 81: Slovakian market summary

Slovak Republic	Commercial operations	Regulatory environment	Broadcast technology
Launch	• Television market has been, traditionally, dominated by analogue terrestrial, with low multi-channel penetration; • DTT launched in early 2008	• DTT has not been a high priority for Slovakian regulators: only one MUX is to be available at the launch of the service	• The first MUX launched using MPEG4 technology and 64QAM modulation
2008			
ASO			
2012			

An underdeveloped market

The Slovakian television market is relatively under-developed relative to other European countries with regards to multi-channel and digital platform penetration. At the end of 2007 there was 48% multi-channel penetration, however a DTT service had yet to launch and only 2% of television households had digital reception.[47]

A slow launch process

Launching a DTT service has been a slow process. Only in 2007 was Government legislation adopted via the act on Digitalisation of Broadcasting bill which included conditions for the shift from analogue to digital terrestrial broadcasting. This transition is due to be introduced by 2012 at the latest; however it could possibly occur as soon as 2008. The bill outlines the terms for the introduction of digital TV and regulates the freedom of digital transmission provision. In addition, the bill defines a public terrestrial multiplex, with a recommendation for exclusive public broadcasting content.

DTT in Slovakia has launched with one MUX, which will be used to broadcast the analogue terrestrial channels. With only 2% of television households currently able to receive digital it is estimated that there will need to be an annual investment of €7.8m to assist with switching the analogue homes to digital.

[47] Informa TM

Exhibit 82: Current Slovakian MUX structure (at launch)

Technical standard	MUX 1
UHF/VHF	UHF
DVB-T	DVB-T
Modulation	64QAM
Guard Band	1/4
FEC	2/3
Total capacity	19.91
% reserved for non-TV	13%
Remaining capacity	17.34
Compression	MPEG-4
No. of channels	4

19.2 Likely future changes

19.2.1 Expected changes

A strategy for DTT introduction approved by the Government in 2001 suggested that Slovakia could eventually have between five and six multiplexes, two of which would be national, one regional/local, one or two for HD channels, and a final MUX for additional data services. It is foreseen that a pay-DTT service will operate alongside a free service.

19.2.2 Additional possible changes

With the Slovak Republic using MPEG4 technology from launch, the next possible technology upgrade would be an introduction of DVB-T2 technology once it becomes available post-2010. Such an upgrade would require a swap-out of set-top boxes but since the Slovak Republic is already using MPEG4 compression technology, there would only have to be one set-top box update.

In the long-term, we foresee the Slovak Republic having a total of seven DTT MUXes, provided that the entire available UHF band is used for broadcasting. In addition, one MUX could be used in VHF. These MUXes would be able to accommodate 147 SD channels and 25 HD channels as a result of using MPEG4 and DVB-T2 technology.

Exhibit 83: Possible long-term Slovakian DTT platform

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 7	MUX 8
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF	VHF
DVB-T	DVB-T2	DVB-H	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2
Modulation	64QAM		64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/4		1/4	1/4	1/4	1/4	1/4	1/4
FEC	2/3		2/3	2/3	2/3	2/3	2/3	2/3
Total capacity	29.87		29.87	29.87	29.87	29.87	29.87	26.13
% reserved for non-TV	9%		11%	11%	11%	11%	11%	12%
Remaining capacity	27.28		26.68	26.68	26.68	26.68	26.68	22.96
Compression	MPEG-4		MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	18 or 5		22 or 5	22 or 5	22 or 5	22 or 5	22 or 5	19 or 5

19.2.3 Allocating 72MHz to non-broadcast services

Allocating 72MHz at the top of the band would decrease the number of MUXes by one or two.

19.3 Summary

Despite a relatively late launch and slow uptake of the DTT platform, Slovakia's MUXes are relatively future proof from using MPEG4 technology at launch. An upgrade to DVB-T2 could be possible, post ASO, once the technology becomes available. To facilitate an ease of transition, coordination between the different MUX operators and regulators should be encouraged. In addition, it would make sense to begin selling DVB-T2-compatible boxes in advance of a change in MUX technology. This would allow consumers to replace set-top boxes as part of a natural cycle rather than being forced to upgrade their set-top boxes over a short time period.

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Exhibit 84: Summary of Slovakian broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	?	?	Dependant on channels at launch
	Standard within compression	✓✓	n/a	Likely to use latest technology
	MPE42 to MPEG4	✓✓	n/a	MUXes to use MPEG4 compression from launch
MUX capacity	16 to 64QAM	✓✓	n/a	MUXes to use 64QAM modulation from launch
	DVB-T to DVB-T2	✓	Long	Imminent launch in MPEG4 could delay DVB-T2 swap out
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✓✓	n/a	Organisation at launch
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing at launch
No. of MUXes	MFN to SFN	✓✓	n/a	SFN from launch
	Reduce requirements	✖	n/a	Probably optimised at launch
	Other frequencies	✖	n/a	International re-planning unlikely
	Using VHF	✓	Long	DVB-T planned for VHF but primary target is to allow T-DAB to operate Channel 12 once analogue TV has been switched off

✓✓ In place
✓ Likely
✖ Unlikely

20 Spain

20.1 Market context

Exhibit 85: Spanish market summary

Spain	Commercial operations	Regulatory environment	Broadcast technology
Launch	• Three-tier terrestrial system with national, regional, and local channels; • Low cable and satellite penetration	• The Spanish government has been vocal in its support of the DTT platform, but has called for an increased quality of content	• Four national, one regional and one local MUX at present; broadcasting with MPEG2 over a mixture of SFN and MFN
2000/2005			
ASO			
2010			

High terrestrial penetration

Only 23%[48] of homes have access to cable and satellite, thus terrestrial is the strongest platform in the Spanish television market. As a consequence, DTT has become the largest digital TV platform and estimates suggest that there were 5.7m DTT households (29% of TV households) at the end of 2007[49], the majority of which use DTT for primary set viewing. A significant segment of the DTT market is for primary set viewing and so coverage and content are important factors to the present success of DTT in Spain. Currently, DTT MUXes have 88% population coverage, and this is scheduled to increase to 98% for the PSB MUXes and 96% for commercial MUXes following ASO.

The terrestrial market is characterised by a three-tier channel structure comprising of national, regional and local channels. There are three analogue terrestrial channels, 17 autonomous regions with their own broadcasters, and a significant number of local stations in the different regions. As a result the consumer location affects the extent of the terrestrial television service and the number of channels they receive.

False start, 2000

After the UK and Sweden, Spain was the third European country to provide a DTT service, with 'Quiero TV' launching in May 2000. However, despite initial optimism for the success of the service, Quiero TV failed to generate sufficient consumer take-up and was forced to close in 2002 due to mounting debts. The main cause of Quiero TV failing was that it launched as a pay-DTT service with a limited number of channels, and so could not compete with the premium content offering from DTH. As a result, similar to ITV Digital in the UK, Spanish DTT was a weak consumer proposition relative to other platforms. In addition, demand for interactive services, a heavily promoted benefit of DTT, was low and failed to drive take-up.

Re-launch, 2005

Following a period of relative regulatory inactivity, the process of launching a new DTT service began, and in 2005 a new DTT technical plan was approved. The new technical plan had two primary features for DTT; firstly, it moved the analogue switch off date forward by two years to 2010. Secondly, it allocated DTT frequencies to the public broadcaster RTVE, as well as commercial stations Antena 3, Tele 5 and Canal Plus, and digital stations Net TV and Veo TV.

[48] Informa TM
[49] Informa TM

DTT was re-launched in November 2005 and although Spain, through the failure of Quiero TV, has fallen behind many of Europe's major TV markets in terms of DTT take-up, the re-launch and increasing penetration would suggest it has, so far, proved a success. Following the re-launch, the Spanish government has stated that there will be no postponement of the 2010 ASO date. Additionally, to ensure the success of the transition, it is possible that the government will introduce measures to support the digital content industries. Any new measures would be in addition to the €18 million three-phase campaign agreed in June 2006, funded jointly by the government and the Impulsa TDT industry association.

Regulatory criticism

Despite strong growth of DTT and the service achieving 30% penetration of television households in 2007, Spain's largest TV group, Sogecable, asked the Spanish government in May this year to postpone ASO scheduled for April 3rd, 2010. The reason for this request was the perceived "inability" of the market to meet the deadline. The CEO of Sogecable hinted that Spaniards are uninterested in DTT, claiming that DTT penetration was only 30% whilst actual coverage was 85%. He also criticised the lack of clarity regarding pay-TV services' distribution through the DTT network. The government, subsequently, refused to change the ASO date. Since Sogecable made its request, DTT began gaining greater audience share than cable for the first time, displaying the strength of growth in the platform.[50]

There is currently a total of between seven and nine MUXes in Spain, comprising of five national (four SFN and one MFN), one regional and between one and three local MUXes. They broadcast an average of four channels each in SD.

Exhibit 86: Current Spanish MUX structure[51]

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 7	MUX 8
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
FEC	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3
Total capacity	19.91	19.91	19.91	19.91	19.91	19.91	19.91	19.91
% reserved for non-TV	13%	13%	13%	13%	13%	13%	13%	13%
Remaining capacity	17.33	17.33	17.33	17.33	17.33	17.33	17.33	17.33
Compression	MPEG-2	MPEG-2	MPEG-2	MPEG-2	MPEG-2	MPEG-2	MPEG-2	MPEG-2
No. of channels	4	4	4	4	4	4	4	4

[50] DVB.org
[51] An average of eight has been taken.

20.2 Likely future changes

20.2.1 Expected changes

Pre-allocation of spectrum to broadcasting already underway

The Spanish government has already announced its intention to allocate all digital dividends to broadcasting, meaning that there will be no additional spectrum available for services such as mobile broadband. Francisco Ros, Telecommunications General Secretary at the Ministry, stated that "these frequencies would not be given to telecoms operators to be used for wireless telecommunications, but rather all spectrum freed from TV's migration to digital would instead be claimed by broadcasters"[52]. The rationale behind this is that small broadcasters have been given analogue licenses in the past due to the proliferation of TV channels, specifically on a regional and local basis. According to present legislation, these small broadcasters have the right to have enough frequencies to continue broadcasting in digital. With a restricted amount of UHF available, there is not sufficient spectrum for all services. As such, the Spanish government have prioritised broadcasting.

Having announced that the digital dividend will be allocated to broadcasting, the government stated in June 2008 that it views the quality of content on the DTT platform to be insufficient. The government has, subsequently, requested broadcasters to improve their offer or risk facing legal action. It is clear, therefore, that the DTT platform in Spain is intended to act as a competitor with cable and satellite. Thus technological advances to increase capacity and enable HD services can be expected in the medium-term. After ASO, each broadcaster will be allocated a MUX: RTVE will have two MUXes and the 17 regions will have access to two shared MUXes. The current Spanish network plan mandates 12 DTT MUXes post-ASO, 8 of which will be national. Pre-ASO, spectrum was assigned by channel by the Ministry, through a mix of direct award (established players) and 'beauty contest' (new entrants). This system will change, post-ASO, as spectrum will be assigned by MUX for a better use of frequencies, avoiding problems with managing technical aspects and transmissions.

There are, currently, no mandates regarding upgrading technology; however it is likely that there will be an upgrade to MPEG4 once the price of set-top boxes decreases. With a current installed base of over 4.5m DTT receivers, forecast to increase to 10.5m in 2012, the cost of upgrading set-top box equipment will be high, and the price of box swap-out will need to be as low as possible to encourage consumers to buy new set-top boxes.

20.2.2 Additional possible changes

No clear upgrade path

There is no clear indication regarding HD or DVB-T2 technology on the Spanish DTT platform. It is likely that DTT operators will explore the option of HD, with DVB-T2 being introduced simultaneously, when one takes into account the government's call for improved content on DTT. HD tests on the DTT platform were performed in April 2008, but with a demand for local and regional channels as well as the national terrestrial and digital channels, it is unclear how much capacity MUX operators will want to allocate to HD channels

[52] Taken from dvb.org

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(instead of maximising the number of SD channels per MUX). HD content is currently permitted on MUXes but guidelines are likely to be created in the future.

In the long-term, we foresee Spain as having a total of 12 MUXes, eight of which will be for national DTT, two for the 17 regions, one for local channels, and one for DVB-H. These will broadcast using MPEG4 and DVB-T2 technology and will offer a total of 235 SD and 55 HD channels. This is based on the assumption that there will be some HD channels incorporated on the existing SD MUXes rather than there being specific HD MUXes introduced.

Exhibit 87: Possible long-term Spanish DTT platform

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 7	MUX 8
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
FEC	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3
Total capacity	29.86	29.86	29.86	29.86	29.86	29.86	29.86	29.86
% reserved for non-TV	9%	9%	9%	9%	9%	9%	9%	9%
Remaining capacity	27.29	27.29	27.29	27.29	27.29	27.29	27.29	27.29
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	20 or 5	21 or 5	21 or 5	21 or 5	21 or 5	22 or 5	22 or 5	21 or 5

Technical standard	MUX 9	MUX 10	MUX 11	MUX 12
UHF/VHF	UHF	UHF	UHF	UHF
DVB-T	DVB-H	DVB-T	DVB-T	DVB-T
Modulation		64QAM	64QAM	64QAM
Guard Band		1/4	1/4	1/4
FEC		2/3	2/3	2/3
Total capacity		29.86	29.86	29.86
% reserved for non-TV		9%	9%	9%
Remaining capacity		27.29	27.29	27.29
Compression		MPEG-4	MPEG-4	MPEG-4
No. of channels		22 or 5	22 or 5	22 or 5

20.2.3 Allocating 72MHz to non-broadcast services

Given that several national SFN MUXes are expected to be assigned to frequencies towards the top of the UHF band, it is difficult to estimate how many multiplexes would be re-allocated.

20.3 Summary

In the midst of significant DTT transformation, there are aims to assign MUXes to individual broadcasters. These broadcasters will subsequently be allowed to choose channels on their MUX. To ensure that its

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capacity is used as effectively as possible it is essential that coordination exists between the government and broadcasters regarding technical standards and upgrades. Given the large number of broadcasters, there is a significant chance of inefficiency of MUX use, unlike other markets such as Sweden, where the multiplexes are operated by one company.

If a change was at all likely, it would be easier to lobby at the network-planning stage of the post-ASO DTT network rather than once the network plan has been implemented and MUX operators identified.

Due to the fragmented structure of the DTT market, DTT in Spain runs the risk of being uncoordinated and using broadcast spectrum inefficiently in the long-term. In particular, given the MUX allocation to a number of different broadcasters, it is difficult for one broadcaster, alone, to upgrade technology unless a significant part of the installed base is already using hybrid set-top boxes or a coordinated action plan across multiple MUX operators is in place.

Exhibit 88: Summary of Spanish broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	✓	Short	High bitrates on existing PSB to adhere with European standards
	Standard within compression	✓	Short	Improvements in the MPEG2 standard is likely to result in further capacity increases
	MPE42 to MPEG4	✓	Medium/ Long	Not considered an important factor in the short to medium term
MUX capacity	16 to 64QAM	✓✓	n/a	MUXes use 64QAM modulation from launch
	DVB-T to DVB-T2	✓	Long	Not considered an important factor in the short to medium term
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✓	Long	Allocation of individual multiplexes to individual broadcasters may mean that efficiency is not maximised; however, co-ordination will be difficult
	Statistical multiplexing	✓?	Short	Unsure is statistical multiplexing is employed on all multiplexes
No. of MUXes	MFN to SFN	✓	Short	Currently in the process of re-planning national SFN. Local / regional multiplexes will always remain MFN
	Reduce requirements	✖	n/a	Not considered to have material impact
	Other frequencies	✖	n/a	Not considered to have material impact
	Using VHF	✖	n/a	No DVB-T currently considered in VHF

✓✓ In place
✓ Likely
✖ Unlikely

21 Sweden

21.1 Market context

Exhibit 89: Swedish market summary

Sweden	Commercial operations	Regulatory environment	Broadcast technology
Launch	• Despite high cable and satellite penetration, the DTT service has gained 16% penetration, driven primarily through a pay-DTT service	• RTVV provides the framework for the DTT platform, but allows technological decisions to be made by MUX operators	• Five MUXes at present operate with MPEG2 compression and 64QAM
1999			
ASO			
2007			

Strong cable and satellite platforms

The Swedish TV market is characterised by high cable and satellite penetration with the services reaching 73% of TV households, compared with a penetration of 16% of TV households for DTT. Sweden underwent ASO at the end of 2007, a process aided by the relatively low number of households relying on terrestrial as the sole means of television reception as well as the long history of digital terrestrial broadcasting.

An early launch of DTT

Sweden was one of the first countries in Europe to launch a DTT platform in 1999, with Senda, a subsidiary of transmission company Teracom. In August 2002, there was a restructuring process that saw the merger of Senda with Boxer, a set-top box distributor and also subsidiary of Teracom, to form BoxerTV-Access. Now known as Boxer, the company operates all five of Sweden's DTT MUXes.

The current five MUXes offer a total of 35 channels, 4 on the public service MUX and 31 on the commercial MUXes with almost universal coverage.

Exhibit 90: Current Swedish MUX structure

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5
UHF/VHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/8	1/8	1/8	1/8	1/8
FEC	2/3	2/3	2/3	2/3	2/3
Total capacity	22.12	22.12	22.12	22.12	22.12
% reserved for non-TV	11%	10%	11%	15%	10%
Remaining capacity	19.71	19.87	19.68	18.72	19.87
Compression	MPEG-2	MPEG-2	MPEG-2	MPEG-2	MPEG-2
No. of channels	4	8	8	8	7

21.2 Likely future changes

21.2.1 Expected changes

In Sweden, the Government provides the regulatory framework for DTT, it is left to the MUX operator however to make decisions regarding technological standards of its MUXes. The rationale behind this is that whilst the Radio and TV Authority (RTVV) could theoretically mandate new technologies, they want the market to make these decisions based on commercial reasoning.

The RTVV's position on upgrading compression technology from MPEG2 to MPEG4 is that "during the upcoming licence period [an upgrade] would be preferable to ensure that the limited frequency space is used as effectively as possible"[53]. Therefore, whilst they can recommend and encourage migration to new technology, they stop short of mandating its use by a specified date. The RTVV recognise that the reasons supporting a migration to MPEG4 should be balanced against that upgraded technology would require new receiver equipment and that "accessibility to the current offering is thus at risk". The RTVV has suggested that licences for future MUXes should contain terms stipulating MPEG4 technology use, and that during the licence period, licence holders for the incumbent MUXes should aim to switch to MPEG4.

DVB-T2 transmission is likely to be introduced in conjunction with HD programming on DTT, therefore we foresee the possibility of one MUX being used for HD channels from 2010/11. Boxer is already looking into the possibility of introducing HD on DTT and it is reported that several channels have explored the possibility of offering their content via HD as well as, or instead of, in SD.

The RTVV believes that granting licences for HDTV on DTT can be justified as the terrestrial network in Sweden should be included in the services and technological development that is taking place for other programming distribution methods. However, due to the limited frequency available in the current licensing process, the RTVV feel that it is preferable to grant a larger number of licences for SDTV services rather than a limited number of HDTV licences. Therefore it is felt that when broadcasting space in the VHF band is available, a new licensing process should be carried out in which HDTV services can be granted.

Due to the relatively low installed base of set top boxes (710,000 Boxer STBs (June 2008) plus an additional 750,000 FTA), there would be a relatively limited cost to consumers of upgrading to MPEG4/DVB-T2 compatible technology. The cost to consumers would be low as the majority of boxes are included at a low price or even free with Boxer pay-DTT subscriptions.

There is currently no place in Sweden's spectrum plan for a DVB-H MUX, and it is felt that due to low demand from both consumers and broadcasters that introduction of such a MUX is unlikely.

21.2.2 Additional changes

Broadcasting has been limited to the 470-790MHz band of UHF spectrum as well as the possibility of one channel made available in the VHF band. As a result, it is likely that Sweden will launch a further UHF MUX in 2009 and a VHF MUX subsequently. We foresee that in the long-run all seven MUXes will be upgraded to MPEG4 and DVB-T2 technology, with the VHF MUX being used for HDTV. In total, we predict 167 SD or 40HD channels.

[53] RTVV,March 2008

Following legislation in October 2007, which allowed companies to compete with Boxer for pay-DTT services, we understand that future MUXes could be operated by a competitor. However the mode of award/licence has not been determined at this stage.

Exhibit 91: Possible long-term Swedish DTT platform

Technical standard	MUX 1	MUX 2	MUX 3	MUX 4	MUX 5	MUX 6	MUX 7
VHF/UHF	UHF	UHF	UHF	UHF	UHF	UHF	VHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2
Modulation	64 QAM	64 QAM	64 QAM	64 QAM	64 QAM	64 QAM	64 QAM
Guard Band	1/8	1/8	1/8	1/8	1/8	1/8	1/8
FEC	2/3	2/3	2/3	2/3	2/3	2/3	2/3
Total capacity	33.18	33.18	33.18	33.18	33.18	33.18	29.03
% reserved for non-TV	7%	7%	7%	10%	7%	7%	8%
Remaining capacity	30.76	30.93	30.74	29.78	30.93	30.93	26.79
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	23 or 6	24 or 6	24 or 6	24 or 5	25 or 6	25 or 6	22 or 5

21.2.3 Allocating of 72MHz to non-broadcast services

No further multiplexes will be allocated above 790MHz.

21.3 Summary

It makes sense for there to be close coordination with Boxer in order to ensure the most efficient use of spectrum capacity. The introduction of two additional MUXes, which will be partially used for HD, could propagate a transition from MPEG2 to MPEG4 and DVB-T2 technology. Coordination with the government is essential if licences are to be awarded to individual channels and not the MUX operator.

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Exhibit 92: Summary of Swedish broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	✓	Short	High bitrates on existing PSB to adhere with European standards
	Standard within compression	✓	Short	Improvements in the MPEG2 standard is likely to result in further capacity increases
	MPE42 to MPEG4	✓	Short/ Medium	Plans are in place for the broadcasters on MUXes 2-5 to make the transition to MPEG-4 to take place MUX by MUX
MUX capacity	16 to 64QAM	✓✓	n/a	MUXes use 64QAM modulation from launch
	DVB-T to DVB-T2	✓	Medium	Will be introduced simultaneously with HD, possibly in 2010 or 2011
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✓✓	n/a	PayDTT MUXes could be reorganised but unlikely that gain would be significant as MUXes already probably well organised
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing already employed
No. of MUXes	MFN to SFN	✖	n/a	Unlikely due to costs and interference involved (some local SFN already employed)
	Reduce requirements	✖	n/a	Not considered to have material impact
	Other frequencies	✖	n/a	International re-planning with bordering countries likely
	Using VHF	✓	Short	One MUXes could be introduced (analogue TV already switched off)

✓✓ In place
✓ Likely
✖ Unlikely

22 UK

22.1 Market context

Exhibit 93: UK market summary

UK	Commercial operations	Regulatory environment	Broadcast technology
Launch	• Terrestrial platform is strong; previous attempts to launch pay-DTT services proved unsuccessful • However the FTA DTT service has experienced strong take-up	• Forward-looking regulator; consultations regarding technological advances already carried-out • Future plans for MUX re-organisation to provide capacity for HD	• Six MUXes at present • All MUXes currently use MPEG2 technology • Four MUXes are 16QAM, two are 64QAM
1998			
ASO			
2012			

A strong terrestrial sector

Traditionally, the UK television market has had a strong terrestrial sector, and the early launch of DTT relative to the majority of European nations demonstrated the central role that the government and regulator Ofcom want terrestrial television to have in the digital age. Originally launched in November 1998, DTT has developed into a significant digital platform in the UK with a television household penetration of 38% (five years before ASO) compared to cab-sat penetration of 12m households (47%)[54]. The high installed base of DTT receivers is a result of nine years of platform growth and significant promotional investment.

ASO is scheduled to take place according to region-by-region process between 2008 and 2012. The first area in the UK to switch to digital, Whitehaven, underwent ASO in November 2007.

The UK launched the first commercial DTT platform in Europe with ONDigital (latterly ITV Digital) at the end of 1998. From launch, the platform struggled due to the inferiority of its product relative to BskyB's DTH service based on a lack of channels and coverage. In addition, the service greatly overpaid for rights to live Football League matches, which failed to bring additional subscribers to the service. By the time the platform closed in 2002, broadcasters had spent an estimated €1.8bn on the service.

Freeview success

Following the collapse of ITV Digital, the current 12-year DTT licence was awarded to Freeview, which is a joint venture between the BBC, NGW (formerly Crown Castle), BSkyB, ITV, and Channel 4. Freeview is a predominantly FTA service, offering free to view channels to users provided that they have purchased a set-top box. 'Top Up TV' (TUTV), the pay element of Freeview, offers three channels; this was reduced from the original offering of 11 channels and has not experienced significant levels of subscriber take-up. BskyB proposed to launch its own pay-DTT service 'Sky Picnic', using conditional access on its existing channel capacity to launch premium services. However, the launch of Picnic has now been indefinitely delayed whilst Ofcom investigates its potential impact.

DTT in the UK receives a high proportion of primary and secondary set viewing, and so the service has been developed to allow wide coverage and easy reception as well as a significant bouquet of FTA channels. To provide coverage in the areas that DTT does not reach, a FTA satellite service, Freesat, has been launched.

[54] Screen Digest

The Freesat service offers 36 TV channels and 20 radio stations and in addition offers a subscription free HD service, thus making HD available on an FTA basis.

On Freeview, there are currently six MUXes, evenly split between three public broadcasters and three commercial. Two of the public MUXes are operated by the BBC and the third by D3/4. For the commercial MUXes, two are operated by National Grid Wireless and one by SDN (which is owned by independent broadcaster ITV). Currently 31 channels are available on FTA DTT, however in effect the number is higher since many channels share streams and only broadcast for a set portion of the day (for example, the CBBC channel and BBC3 share a stream on MUX A, with CBBC broadcasting during the day until 7pm and BBC3 broadcasting from 7pm onwards for the rest of the evening. Taking into account stream sharing, there are 40 channels available on DTT, including the 3 TUTV channels.

Exhibit 94: Current UK MUX structure

Technical standard	1 - BBC	2 – D3/4	3 - BBC	4 - SDN	5 - NGW	6 - NGW
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T	DVB-T
Modulation	16QAM	64QAM	16QAM	64QAM	16QAM	16QAM
Guard Band	1/32	1/32	1/32	1/32	1/32	1/32
FEC	3/4	2/3	3/4	2/3	3/4	3/4
Total capacity	18.1	24.1	18.1	24.1	18.1	18.1
% reserved for non-TV	10%	10%	10%	10%	10%	10%
Remaining capacity	16.3	21.7	16.3	21.7	16.3	16.3
Compression	MPEG-2	MPEG-2	MPEG-2	MPEG-2	MPEG-2	MPEG-2
No. of channels	4	8	5	9	5	6

22.2 Likely future changes

22.2.1 Expected changes

Focus on efficiency improvements

Ofcom (the UK media regulator) has been proactive regarding the evolution of DTT and has carried out public consultations to develop its thinking concerning migration to advanced technologies. The results from the most recent consultation focusing on efficiency improvements to the DTT platform were published in April 2008. Its outcome was that Ofcom believed that there should be a partial migration to MPEG4 and DVB-T2 technology over time. However, the migration must be managed for a number of key reasons. Firstly, technology migration requires the coordination of a number of different parties including MUX operators, broadcasters, and broadcast infrastructure suppliers (each of whom have their own objectives and incentives). Secondly, Ofcom consider it important that existing MUXes continue to be universally available to subscribers. Finally, Ofcom believe that any further adoption of technical standards should be considered on a case-by-case basis evaluating the benefits to consumers and broadcasters of all proposed changes.

At present, Ofcom has recommended to the government that the four HD channels should be introduced on a single universal coverage MUX, MUX B, which will utilise MPEG4 and DVB-T2 technology to accommodate three HD channels from 2009 and a further channel from 2012[55]. These technological changes are estimated by Ofcom to increase the capacity of the MUX to at least 31.4Mbit/s without any loss of coverage. There are currently no plans for the other MUXes to be upgraded to these technical specifications.

Move to 64QAM

Additionally, at ASO, it has been recommended that the BBC and National Grid Wireless MUXes upgrade from 16QAM to 64QAM which would further increase capacity on the MUXes. This incurs a cost for the MUX operators who will have to build more transmitters in order not to lose coverage when the modulation is changed. Ofcom does not have the ability to mandate upgrading technology on existing MUXes, although it is able to reject changes to the technologies used by these MUXes. For example, NGW and BSkyB have proposed that they should be able to make DVB-T and MPEG4 available on their capacity immediately, but they are unable to do so without agreement from Ofcom.

Following the introduction of the HD MUX and the migration from 16QAM to 64QAM on four of the six MUXes, there will be 38 channels in total available on DTT in the UK, 34 in SD and 4 in HD.

22.2.2 Additional possible changes

We believe that the current proposed changes only reflect a proportion of the total amount of the possible technological changes available on DTT. The creation of an HD MUX using MPEG4 and DVB-T2 technology will require a set top box upgrade by consumers. Once consumers have technology compatible with MPEG4 and DVB-T2, the barrier to upgrading other MUXes to these compression and transmission standards falls, thus increasing the possibility of the other MUXes migrating to this technology. In addition, once Ofcom has seen how the first MPEG4/DVB-T2 MUX has performed, they will be in a position to allow the technology for all existing MUXes.

Dependent on the demand for increased channels on DTT, with HD channels in particular, it is possible that two additional MUXes could be introduced after the conclusion of digital switchover in 2012, using digital dividend spectrum. Ofcom is expected to award this spectrum to bidders through a market-based approach, so whether the spectrum will actually be used for broadcast services is not at present known. However, should they be, we have assumed that these will use the same technical specifications as mandated for MUX B, and so will broadcast 4 HD channels using MPEG4 and DVB-T2 technology.

We have assumed that all channels can be fully statistically multiplexed apart from those on MUX BBC A and D3/4, which broadcast regional feeds of national channels (e.g. BBC1 local news). These regional feeds make statistical multiplexing difficult and therefore we have made the assumption that these two MUXes will not be statistically multiplexed.

We believe that the number of channels available on DTT, following all possible changes, will be 218 SD channels or 48 HD channels.

[55] Ofcom, Digital Television: Enabling New Services – Statement p.6

Exhibit 95: Long-term view of possible UK MUX structure

Technical standard	1 - BBC	2 – D3/4	3 - BBC	4 - SDN	5 - NGW	6 - NGW	7 - *TBD*	8 - *TBD*
UHF/VHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF	UHF
DVB-T	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2	DVB-T2
Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Guard Band	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32
FEC	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3
Total capacity	36.19	36.19	36.19	36.19	36.19	36.19	36.19	36.19
% reserved for non-TV	6%	7%	8%	5%	4%	5%	4%	4%
Remaining capacity	33.95	33.79	33.17	34.52	34.75	34.17	34.65	34.65
Compression	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4	MPEG-4
No. of channels	26 or 6	26 or 6	27 or 6	27 or 6	28 or 6	28 or 6	28 or 6	28 or 6

22.2.3 Allocating 72MHz to alternative services

Allocating 72MHz of UHF spectrum to alternative services would result in the loss of one or two multiplexes, depending on the region, which would result in a loss of 28-56 SD channels or 6-12 HD channels.

22.3 Summary

The UK is currently undergoing the transition from 16 to 64QAM, a technology upgrade at multiplex centres and a reorganisation of the MUXes. These are all positive steps to spectrum efficiency.

The key upgrade pathway in the UK will be the transition to MPEG4 and DVB-T2. We recommend advocating that new set-top boxes are mandated to be forward compatible, as soon as is feasible from a consumer perspective. One expert expects a changeover to be viable four to five years after this point. This will be assisted by the launch of UK's new HD MUX in MPEG4 and DVB-T2.

It would also be optimal to upgrade to MPEG4 and DVB-T2 technology at the same time to restrict the consumer upheaval to one box swap-out rather than two, which would be the case if MPEG4 was introduced before DVB-T2. The effect of this, however, is that an upgrade to MPEG4 may be delayed as it is dependent on the availability of DVB-T2 technology, for which the launch date of which is still uncertain. With a large installed base of set-top boxes it is fundamental that the transition for consumers should be made as simple as possible.

To encourage a smooth transition to improved technology standards, a high level of coordination between the MUX operators and Ofcom is needed. Relative to markets such as Spain and France, where there is a large number of protagonists, the low number of MUX operators in the UK helps facilitate coordination.

Finally, given that Ofcom is one of the most advance regulators in terms of its thinking on digital dividend and spectrum efficiency, it is possible that studies into network re-planning (SFN, MIMO) have already been initiated. These should be encouraged.

Exhibit 96: Summary of UK broadcast technology migration

		Likelihood	Timeline	Rationale
Channel bitrate	Optimisation of bitrate	✓✓	n/a	General bit-rates operating at optimal level
	Standard within compression	✓	Short	Improvements in the MPEG2 standard is likely to result in further capacity increases
	MPE42 to MPEG4	✓	Medium/ Long	Full migration unlikely in the short-term (but on a MUX by MUX basis)
MUX capacity	16 to 64QAM	✓	Medium	16QAM multiplexes to be converted at ASO
	DVB-T to DVB-T2	✓	Medium/ Long	Will be introduced simultaneously with HD, possibly in 2010 or 2011
	MIMO	✖	n/a	Long-term network re-planning unlikely
	Reorganisation	✓	Short	Plans in place to reorganise certain multiplexes
	Statistical multiplexing	✓✓	n/a	Statistical multiplexing already employed
No. of MUXes	MFN to SFN	✖	n/a	SFN is possible but will involve network re-planning
	Reduce requirements	✖	n/a	Not considered to have material impact
	Other frequencies	✖	n/a	Not considered to have material impact
	Using VHF	✖	n/a	No current plans, no analogue TV in VHF

✓✓ In place
✓ Likely
✖ Unlikely

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23 Conclusion

23.1 Need

Across Europe, markets are moving to digital TV platforms. Digital platforms offer consumers a wider choice of television and radio services as well as the ability to access numerous data and interactive services. In addition, digital technology offers broadcasters a way to deliver these services more efficiently and effectively. This process could free up a considerable portion of the UHF band[56] with many potential uses. There is currently a debate about how best to allocate the freed spectrum between broadcasting and other services such as mobile broadband. The World Radio Conference 2007 decided that the upper portion of the UHF band should be identified for mobile services – although decisions on specific allocation still need to be taken by most Member States.

During this process, Spectrum undertook a study to analyse the benefits to Europe's economy if the UHF spectrum released by digital switchover (DSO) was allocated optimally between broadcasters and mobile operators. The report was completed earlier this year and its results suggest that allocating approximately 25% of the UHF band to mobile broadband would maximise the value to the European economy. This would generate between €63bn and €165bn (net of any loss derived from reduced broadcasting capability).

One way to exploit this value would be to upgrade existing broadcast platforms to more efficient technology. As countries move towards an all-digital environment, the demands placed on the UHF spectrum continue to grow. Regardless of the potential uses of the UHF spectrum, however, is the fact that an (admittedly complex) strategy of broadcast technology upgrades is in the interests of all protagonists in the long term

23.2 Feasibility

In our analysis, we identified three levels of broadcast migration.

Level I upgrades involve neither a large consumer impact nor a necessity to re-plan the network and, therefore, can be implemented relatively easily and cheaply for broadcasters. These upgrades are possible over the short to medium-term and should be implemented wherever possible, provided they are commercially viable.

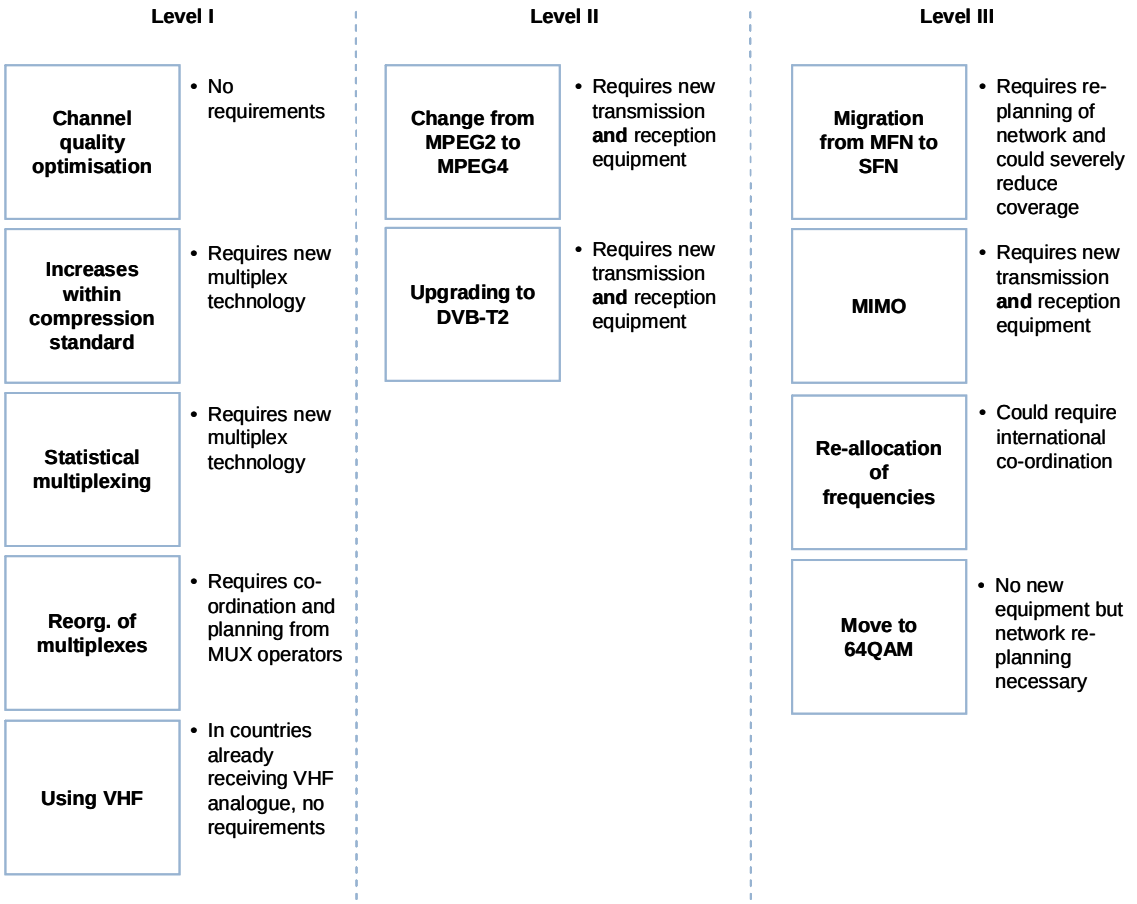
Level II upgrades involve the purchase of new set-top boxes or iDTVs. These changes are not likely to be wholesale swap-outs but a migration, on a multiplex-by-multiplex basis, which will reduce the installed base of legacy equipment over time. Level II upgrades, we believe, will be possible in the long-term.

Level III involves some element of national and/or international re-planning. These upgrades have great ability to increase the capacity of the network but would involve a level of political and commercial negotiations and, most likely, a costly network improvement.

We consider Level I and Level II upgrades to be possible in the timeframe of this study (ten years) and that these changes should be co-ordinated and implemented as soon as operationally and commercial possible.

[56] The size of the Digital Dividend will vary by market e.g. in Sweden 72MHz is estimated to be freed up; UK 112MHz.

Exhibit 97: Levels of broadcast migration for this study



23.3 Benefits

Level I and II upgrades could significantly increase the number of standard definition channels on the DTT platform, allowing DTT to operate as a commercially viable platform (capturing at least 80% of audience viewing share). These upgrades would also allow for an improved HD offering, but the commercial viability of a roll-out of full HD services has not been tested in this report.

Allocating some spectrum to mobile broadband should still allow operators to run a strong DTT platform, with the likely loss of one to two multiplexes but the ability to release spectrum for mobile differs by country. Of particular difficulty will be Italy, Spain and France because of the political and commercial importance of terrestrial platforms.

Taking into account the commercial, regulatory and technical DTT environments, European countries can be broadly divided into five categories:

- **Strong terrestrial, with proactive converged regulation** – the UK
- **Strong terrestrial, with media-specific regulation** – France, Italy, Spain
- **Strong cabsats with high portability requirements** – Austria, Belgium, Germany
- **Post-ASO pay-dominated countries** – Finland, the Netherlands, Sweden
- **Late-to-launch DTT territories** – Denmark, Ireland, Hungary, Portugal, Romania, Slovakia

23.3.1 Strong terrestrial, with proactive converged regulation

Market characteristics

The UK is characterised by:

- Proactive, converged regulator
- Technology-neutral stance

Despite being in the midst of an ASO plan, Ofcom has understood the requirement for spectrum to be used as efficiently as possible and that non-broadcast services could contribute to the economy by being offered part of the UHF band. Technology upgrades are underway; however, those involving CPE changes will be phased in.

Potential paths of action

- Explore the possibilities of undertaking level III activities.

23.3.2 Strong terrestrial, with media specific regulation

Market characteristics

The strong terrestrials, with media specific regulation – France, Italy, Spain – are characterised by:

- Pre-allocation of spectrum to DTT by regulators
- High installed base of DTT technologies, rendering upgrade of consumer equipment difficult
- Drive to make sure large analogue base of customers are converted to digital

Upgrading technology in these territories is generally a second priority to getting customers transitioned to digital. In addition, broadcasting is expected to remain strong, aiding the move to HD services and reducing possible spectrum allocation elsewhere. To this end, however, some “quick wins” are captured by migrating to more efficient technology where possible.

Potential paths of action

- The most important course of action for countries with a large installed base of STBs is to maximise spectrum efficiency within each multiplex
- Continue to explore avenues to technology upgrades on a MUX by MXU basis to seed new technology in the marketplace and reduce the impacts of future swap-outs
- Fully understand the implications around timings of migrations that involve consumer equipment – in particular, implications of different implementation timetables of DVB-T2 and MPEG4
- Finally, undertake unilateral decisions on the requirements of the platform and the availability of multiplexes rather than, perhaps, allocating spectrum to one service as a default

23.3.3 Strong cabsats with high portability requirements

Market characteristics

Strong cabsats with high portability requirements – Austria, Belgium, Germany - characterised by:

- DTT development being a low priority due to high cable/DTH penetration
- Low channel capacity due to portability requirements

Technology upgrades are not at the forefront of platform development as channel capacity is considered less important than availability. In these territories, upgrades are limited to those that do not interfere with the network.

Potential paths of action

- Given the limited throughput afforded by the portability and coverage requirements, maximising efficient of each multiplex is even more important. This could be achieved through:
  - reducing or keeping non-TV content to a minimum to ensure maximum pay back for consumers
  - considering maximum optimisation of bit-rates by regularly updating equipment and, potentially reducing quality necessary
- Beyond these, considerations should be made regarding the move to MPEG4 and DVB-T2 to increase capacity
- Finally, continue to discuss the opportunities to migrate to modulation with higher throughput without losing coverage (such as increasing transmitter power or density)

23.3.4 Post-ASO pay-dominated countries

Market characteristics

Post-ASO, pay-dominated countries – Finland, the Netherlands, Sweden - characterised by the fact that:

- ASO already achieved
- Technology decisions taken by predominantly pay operator on commercial basis

With ASO achieved, the focus of these territories is on developing a viable platform. Some of this may involve technology upgrades, where possible, but only if it makes sense commercially. Pay-DTT operators, in general, will be at the forefront of developing efficient multiplexes as this maximises their content offering. This is particularly true as stagnation of growth is evident now that ASO has occurred: easy acquisition of customers enjoyed during migration from analogue to digital now over (Boxer in Sweden has seen its first fall in quarterly subscriber numbers this year).

Potential paths of action

- Continue to monitor the need and feasibility of migrating to MPEG4 and DVB-T2 where appropriate. Rental models should aid the swap-out of boxes
- Regulators and winner of tenders need to work closely together to establish a platform that is attractive to consumers as well as spectrum efficient

Late-to-market territories

Market characteristics

Late-to-market territories – Denmark, Ireland, Hungary, Portugal, Slovakia - characterised by:

- Yet to launch (or in process of launching a new platform)
- Use of latest technology
- Technology decisions being taken by predominantly pay operator on commercial basis

Greenfield sites tend to mean the latest technology is employed; upgrades involving consumer change beyond this may be delayed, however, because of consumer confusion.

Potential paths of action

- The most important aspect is to lead the market in the most up to date technology. It is understandable that late to market territories aim for short swap-out timetables, aided by cheaper technology, but this should not be done, necessarily, on a low-cost entry level option. This option could prove more costly in the long-term (particularly technology premiums continue to be eroded, e.g. MPEG4 over MPEG2)
- Regulators could mandate technology to ensure this occurs – Ireland is the leader having mandated and recommended a significant number of different solutions
- Key decisions must be made around timing of launch with MPEG4 and DVB-T2. A successful DVB-T launch could mean a delay in DVB-T2
- Employing a rental model will be helpful in swapping out boxes gradually

Overall, whilst we have outlined some principles, Spectrum Value Partners believes that the approach to broadcast technology migration needs to be carefully considered on a country-by-country basis. Essential, also, for the successful functioning of any migration strategy, is an understanding of what is possible in the short, medium and long-term, as well as the barriers to achieving each step.

24 Appendix: Glossary

16 QAM – a modulation format or scheme used to transmit data over a communications medium

64 QAM – an improved modulation scheme over 16 QAM

ASO – Analogue switch-off

Band – a defined range of frequencies that may be allocated for a particular radio service, or shared between radio services

Carrier – in FDD refers to twin spectrum blocks required for uplink and downlink, expressed as 2 x size of required block. For example, 2 x 2.5MHz is required for GSM services (5MHz of spectrum in total); 2 x 5MHz is required for HSDPA (10MHz in total). Spectrum chunks wider than the required size of the carrier are able to support multiple carriers, allowing a doubling up of capacity on that network

Compression – the reduction in size of data in order to save space or transmission time

DSO – Digital switch-over

DTH – Direct to home (satellite TV; TV distributed by satellite to a dish/antenna located on the outside of a home)

DTT – Digital Terrestrial Television, see DVB-T

DTV – Digital Television

DVB – Digital Video Broadcasting: suite of internationally accepted open standards for digital television

DVB-T – Digital Video Broadcasting over Terrestrial networks

DVB-T2 – theoretical new DVB-T standard scoped by Ofcom in 2007

EC – European Commission: one of the five institutions that look after the running of the European Union (EU). It is the main body that handles the day-to-day running of the EU in areas such as Transport and Telecommunications

ERO – European Radiocommunications Office

FTA – Free-to-air

Guard band – band of spectrum that is unused between mobile and broadcasting services and between uplinks and downlinks in the mobile spectrum (in frequency division duplex, the "centre gap").

Handsets – mobile communications terminals (mobile phones, Blackberry™ etc) with UMTS connectivity and data-capable interfaces

HD – see HDTV

HDTV – High definition television

Interference – the effect of unwanted signals upon the reception of a wanted signal in a radio system, resulting in degradation of performance, misinterpretation or loss of information compared with that which would have been received in the absence of the unwanted signal

IPTV – Internet protocol television (television delivered via a broadband connection as an IP stream)

Mbit/s – Megabit per second: a unit of data transfer rate equal to 1,000,000 bits per second. Because there are 8 bits in a byte, a transfer speed of 8 megabits per second (8 Mbps) is equivalent to 1,000,000 bytes per second, not to be confused with Megabyte (a unit of computer data storage)

MFN – Multi-Frequency Network: a type of radio network that operates several transmitters on a number of different frequencies, as opposed to SFN (Single Frequency Network)

MHz – Megahertz: a unit of frequency, represented in millions (1 x 106) of cycles per second, where 1Hz is one cycle per second, e.g. 1MHz = 1,000,000 Hz

MIMO – Multiple-Input and Multiple-Output: the use of multiple antennas at both the transmitter and receiver to improve communication performance. MIMO technology offers significant increases in data throughput and link range without additional bandwidth or transmit power

Modulation – translation of digital data into a carrier signal for broadcast

MPEG2 – the standard for the generic coding of moving pictures and associated audio information: MPEG2 is widely used as the format of digital television signals that are broadcast by terrestrial (over-the-air), cable and direct broadcast satellite TV

MPEG4 – differs from MPEG2 in that it has lower data rates, as well as smaller file sizes due to its improved compression

MUX – Multiplex (block of spectrum used to transmit a number of channels that have been statistically multiplexed: literally the digital transmission streams of each channel have been mixed together)

Ofcom - Office of Communications: the UK's Media and Telecoms regulator with the responsibility for spectrum management

Propagation – the transmission of radio waves. Propagation characteristics depend on frequency and are affected by the environmental conditions, such as terrain and atmospheric conditions encountered on the path

PSB – Public Service Broadcasting: intended to serve the diverse needs of the viewing or listening public, in a system in which radio, television, and potentially other electronic media outlets receive some or all of their funding from the public

SD – Standard definition

SFN – Single Frequency Network: a broadcast network where several transmitters simultaneously send the same signal over the same frequency channel, as opposed to MFN (Multi-Frequency Network)

STB – Set-top box

Terrestrial – on the ground only

UHF – Ultra High Frequency: term used to describe frequencies in the range 300MHz to 3GHz

VOD – Video on Demand: video service that allows the consumer to choose the time of viewing

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