Annexes to Final Report for the European Commission

Public policy treatment of digital terrestrial television (DTT) in communications markets

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Annex A: DTT development in Member States

Annex A provides details of the DTT developments in each EU Member State. The primary research underlying these country profiles took place over November 2004 to February 2005.[1]

A.1 UK

The UK, being in the vanguard of DTT developments, has provided valuable lessons for the development of DTT. Some of the lessons from the experience of ITV Digital are:

- **Competition against Pay TV** – DTT suffers limitations by comparison to DTH in terms of the quantity of content that can be distributed.[2] Furthermore, new entrants cannot easily access premium content already taken by incumbents, who are also more likely to win a content bidding war supported by revenues from their larger customer base.[3]
- **Interactive services** – while of interest to some viewers, the experience of ITV Digital shows that interactive services are an insufficient attraction to drive penetration of DTT. Applications such as Internet and email access promoted from ITV Digital are not provided by Freeview.

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1 Countries are ordered chronologically (launch date) or according to degree of DTT development.

2 Even though the quantity of content that can be broadcast via DTT far exceeds analogue television (with the same spectrum), DTH can provide even greater capacity.

3 Note that where a broadcaster has an established customer base, it is better placed to win a content bidding war. This is due to the fact that content costs are often independent of customer numbers: a new entrant that may not be able to generate significant revenues from acquired content for some time (as it builds its customer base) may find it difficult to compete with a broadcaster that has an established customer base, willing to pay for the content.

- **Network planning –** the UK experience has helped with the understanding of the resilience of the analogue terrestrial signal. In order to ensure minimal interference with the analogue terrestrial signal and thus protect its quality, the power of DTT transmitters was kept to a low level, subsequently found to be unnecessary.

- **Consumer satisfaction –** uneven coverage and installation problems can lead to consumer dissatisfaction, with viewers unable to access all the content that they expect.

The most recent implementation of DTT in the UK in the shape of Freeview has taken into account the key lessons learnt. A head-on Pay TV competition against DTH and cable has been abandoned, and Freeview has focused on the multi-channel benefits of DTT. Modulation parameters have been changed and better reception and coverage have been made possible. This has also addressed the large variance in the coverage of different multiplexes. STB problems have been solved with a large variety of easy-to-use STBs now available through extensive distribution channels.

In turn, a number of lessons may be learnt from the implementation of Freeview:

- **Incumbent broadcasters –** Freeview has benefited from a significant contribution from key analogue terrestrial broadcasters, the BBC, ITV and Channel 4. Their contribution highlights that the DTT platform can be appealing to incumbent broadcasters where the terrestrial platform faces a loss of audience share to DTH and cable platforms. Share of viewing of incumbent broadcasters channels is lower in multi-channel households, and DTT provides them with an opportunity to fight back with another multi-channel offering.

- **Role of enabler/champion –** a significant contributor to the success of Freeview has been the championing of the offering by the BBC. BBC marketing efforts have led to a strong growth in awareness of the Freeview offering amongst UK viewers. Furthermore, a large proportion of Freeview viewers have identified BBC's content available via Freeview as a key factor in their choice.

- **Role of Pay TV** – although limited data is available on the take-up of Top Up TV (launched in 2004), the offering has a reasonable chance of succeeding. This indicates that a role for Pay TV on DTT does exist, not as a match to cable and DTH, but instead as a way of satisfying demand for a few more channels at a lower price than alternative Pay TV offerings.

- **Widescreen development –** the growth in DTT can be used to encourage technology innovations. In the UK, the move to digital television (including DTT) includes a parallel migration to wide screen broadcasts: digital television and widescreen technology have benefited each other. A high penetration of wide-screen televisions in digital households exists (estimated at more than 50%; wide-screen penetration of all TV households in estimated at 27%).

- **Viewing of digital channels –** although simulcasts of analogue terrestrial channels have dominated viewing even in digital TV households, there is evidence of increasing interest in digital-only channels.

Also, contrary to earlier expectations that DTH may be used to complement DTT in the UK in ensuring universal availability of digital television, Ofcom has proposed that the best option for the public service multiplexes is that DTT coverage matches analogue terrestrial coverage.[4] This represents a significant change in approach that may influence DTT policy in other European countries that have a high terrestrial dependence.

Additionally, Ofcom proposes that full analogue switch-off be achieved by 2012, following start of regional switch-off in 2007-08. A significant switch-off period is required in order to minimise disruptions in migrating the large population dependent on analogue terrestrial. While a 4-5 year switch-off period minimises the risk of market disruptions, it also implies higher transmission costs and delays in the use of valuable spectrum (that will become available once the analogue signal is switched off)[5].

The table below shows the key developments in DTT in the UK, including the migration from a Pay TV platform to an FTA platform and, more recently, to a hybrid model.

4 In the UK, multiplexes 1 (BBC) and 2 (Digital 3&4) are at present considered as public service multiplexes.

5 Note that the timings here are indicative, with the final decision to be taken by the Government.

Date	*Development*
October 1996	Licences for multiplexes advertised
December 1997	British Digital Broadcasting (later Ondigital and ITV Digital) granted three licences to broadcast DTT
November 1998	Ondigital launched, becoming the world's first DTT commercial broadcaster
May 1999	STBs free for limited time
November 1999	Ondigital introduced pre-paid digital STPs
May 2000	First digital terrestrial pay-per-view movie
September 2000	Ondigital brings the Internet to the television
December 2000	One million subscribers reached, although annualised churn is at 23%
April 2001	Tesco.com links with Ondigital to provide the world's largest online grocery service
July 2001	Ondigital rebrands as ITV Digital
December 2001	Channels such as Wellbeing, Granada Breeze and TwoWay TV cease service
February 2002	Churn rises to 25% and ITV Digital starts to lay off people to save costs
March 2002	ITV Digital goes into administration. First STB available for retail at below GBP100
April 2002	ITV Digital suspends broadcast
June 2002	Six applications received for the three vacant multiplexes
July 2002	Three vacant multiplex licences were awarded to a consortium of the BBC (who already controlled one multiplex) and Crown Castle
October 2002	Launch of Freeview
March 2004	Launch of Top Up TV

Exhibit A.1: *Key dates in DTT development in the UK [Source: Analysys]*

A.1.1 The TV market context

Five analogue terrestrial channels exist ...

Five analogue terrestrial channels exist in the UK. This includes two channels from the BBC, funded by licence fee revenues, and three channels funded by advertising revenues, ITV, Channel 4 and Five.[6] These channels have some public service obligations in terms of the content they broadcast.

6 Channel 4 is replaced by S4C in Wales.

… and a well developed pay-TV sector

The UK has the strongest DTH operator in the EU, Sky, with more than seven million subscribers by mid 2004. Cable penetration in the UK is limited and has not expanded substantially in the past few years, partly due to the limited increase in cable network coverage.

Analogue terrestrial channels (national)	5
Public service broadcaster (PSB)	BBC
PSB analogue channels (national)	5[7]
TV households	24.5 million
Terrestrial only TV households	14.1 million
Cable TV households	3.4 million
DTH TV households	7 million

Exhibit A.2: *Key features of the TV market in the UK [Source: Analysys, Ofcom, EPRA]*

A.1.2 Assignment of frequencies

The following table highlights the key features of the assignment of DTT multiplexes in the UK:

Number of multiplexes	6
Channels per multiplex	4–8
Assignment mechanism	Per multiplex
Business model	Pay TV originally, FTA since 2002[8]

Exhibit A.3: *Licensing of DTT [Source: Analysys, Ofcom, other]*

The pay-TV platform received three multiplexes…

DTT services were launched in November 1998. The six available multiplexes were distributed in the following manner:

- multiplex 1 was wholly reserved for the public service broadcaster, BBC
- multiplex 2 was reserved for the existing commercial broadcasters (ITV, Channel 4 and the public teletext service)
- multiplex A licence was granted to SDN Ltd [9]
- multiplexes B, C and D were awarded to British Digital Broadcasting to develop a Pay TV platform (Ondigital and then

7 Of which two are from the BBC.

8 Though FTA services have been available from the BBC since the launch of DTT.

9 SDN is partly owned by ntl (other shareholders are S4C and UBM).

ITV Digital).

…that were reassigned in 2002 when it collapsed

Following the collapse of ITV Digital in April 2002, its three multiplex licences were surrendered to the regulator ITC. Immediately, the regulator issued an invitation to apply for the multiplex service licences held by ITV Digital. The former ITV Digital multiplexes were awarded to a consortium of the BBC and Crown Castle, enabling the freed capacity to be put back into service by October 2002.

The following table shows the multiplex operator before and after the collapse of ITV Digital.

Multiplex	*Operator before 1 May 2002*	*Operator after 1 May 2002*
1	BBC	
2	Digital 3 & 4 (for ITV & Channel 4)	
A	SDN (private company with licence for one multiplex)	
B	ITV Digital	BBC
C	ITV Digital	Crown Castle
D	ITV Digital	Crown Castle

Exhibit A.4: *Multiplex operator [Source: Analysys, Ofcom, EPRA]*

Licences for key analogue terrestrial broadcasters are being changed

The UK is in the process of changing the licences for the analogue terrestrial broadcasters Channels 3, 4 and 5 for the digital future.[10] In this respect, Ofcom launched a consultation in September 2004 concerning the terms and conditions of such digital licences. In order to provide more certainty to the timing and process of digital switchover, it has been decided that the licences will include a number of obligations related to digital switchover (see Section 3.6 below for implications on DTT coverage).

10 This represents all the national analogue broadcasters, except the BBC that is also undergoing a review to decide its future shape and strategy.

The following table summarises the DTT industry structure.

Type	*Details*
Channels	Chosen by multiplex operator
Multiplex	Multiplexes assigned to broadcasters by regulator in public process
Network	NTL and Crown Castle are the network operators. Multiplex operators can choose the network they want to be served by

Exhibit A.5: *DTT Structure [Source: EPRA, other]*

A.1.3 The business model

Freeview emerged as a pure FTA offering …

Freeview was launched in late 2002 as a FTA platform, offering a number of channels from a variety of broadcasters (approximately 30 channels).

Crown Castle and ntl are the network operators. ntl's network is used for multiplex A (operated by SDN) and multiplex 2 (operated by Digital 3&4).

Two of the six multiplexes (1 and B) are operated by the BBC, offering BBC content and financed by public funds (annual licence fee).

Of the remaining multiplexes, Crown Castle operates C and D, and Digital 3&4 operates multiplex 2. These multiplexes carry a variety of FTA channels financed by advertising revenues, and they use Crown Castle's network.

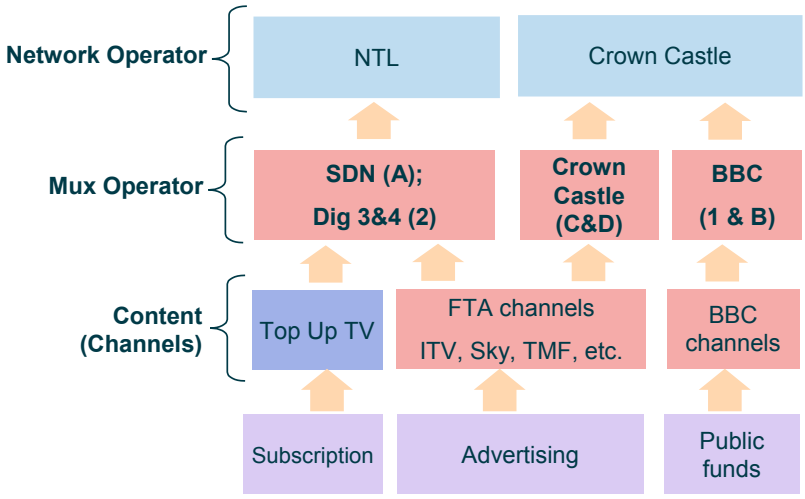

Exhibit A.6:

DTT value chain in the UK [Source: Analysys]

…and Top Up TV has just introduced a Pay TV component

In 2004, the pure FTA model migrated to a hybrid FTA & Pay TV offering with the launch of Top Up TV. The latter offers content from ten channels[11] (listed in Exhibit A.7 below) for an additional monthly fee of GBP7.99 and a one-off connection fee of GBP20[12] (an additional GBP10 per month is required to view The Fantasy Channel – an adult channel). This compares to an average ARPU of GBP33 for DTH subscribers.

11 Top Up TV is primarily broadcast on multiplex A. However, this capacity can allow only four simultaneous channels to be broadcast, and the consumer offer of ten channels uses different time slots on the same broadcast capacity.

12 Subscribers are not tied into the platform, with contracts being monthly.

Offering	*Contents*
Free to Air	BBC1, BBC2, BBC3, BBC4, ITV1, ITV2, Channel 4, Five, ftn, Sky Travel, UKTV Bright Ideas, UKTV History, Cbeebies, CBBC, The Hits, BBC News 24, BBC Parliament, Sky News, Sky Sports News, ITV News, Community Channel QVC, Ideal World, Bid-up TV, Price-Drop TV, Screenshop, ABC1 (since September 2004)
Top Up TV (Pay TV)	E4, UKTV Gold, UKTV Style, Discovery, Discovery Home & Leisure, TCM, Boomerang, Cartoon Network, Bloomberg, Television X: The Fantasy Channel
Planned services	ITV3 (November 2004), More 4 (2005)
Radio	BBC Radio 1, 1Xtra, Radio 2, Radio 3, Radio 4, Five Live, Five Live Sports Extra, Radio 6 Music, Radio 7, BBC Asian Network, BBC World Service, The Hits Radio, Smash Hits Radio, Kiss, Heat, Magic, Q, Oneword, Jazz FM, Mojo, Kerrang!, talkSport, 3c, Premier

Exhibit A.7: *DTT offering in the UK [Source: Freeview, Top Up TV]*

A.1.4 Analysis: the launch of DTT in the UK

Despite a promising start, subscriber growth stagnated

At launch in 1998, consumer interest was highly driven by a strong advertising. The DTT proposition was attractive to consumers as no antenna dish (as with DTH) or cable was required and there was no compulsory telephone connection.

However, by mid 2001, growth slowed down (as shown in Exhibit A.8), and ITV Digital's break-even target of 2 million subscribers was never reached. At its peak, ITV Digital had 1.2 million subscribers.

Technical problems were one of many factors …

Technical problems contributed to the failure of ITV Digital. Besides limited and uneven coverage and installation problems, the picture quality did not match that offered by DTH (Sky) – a survey by the Consumers Association in 2001 indicated that ITV Digital subscribers were significantly more likely to be unhappy with the picture quality than Sky customers.

…but fundamental issues with the business model were key…

- These technical problems only aggravated a situation where the business model was unable to effectively compete against DTH. DTT was unable to offer the same quantity or quality of content available via the DTH platform.
- DTT offered a basic TV package with 15 channels, with the option of 20 additional primary and premium channels.
- DTH's basic offering, by contrast, included around 80 channels, with a overall offering of hundreds of channels and most users subscribing to some premium content.
- the DTT platform was unable to match Sky's offering; 'second tier' sporting events failed to be a sufficient draw to customers in the face of competition from satellite operators showing leading football, cricket and other sporting events, as well as movie content from the major US studios.
- Furthermore, in order to drive take-up of its digital services, Sky offered free STBs. Under competitive pressure, the DTT platform was obliged to match this offer at a very significant cost.

…and heavy advertising was insufficient

In July 2001, Ondigital re-launched as ITV Digital, thus exploiting the highly branded ITV name. ITV Sport was the jewel in ITV Digital's crown and ITV Digital had access to more football hours than any other platform. However, Sky offered more top teams and ITV Digital viewing figures for football matches fell far below forecasts. The advertising failed to increase the flow of new subscribers, whilst churn rose to 25%. By comparison, Sky's churn was below 10%.

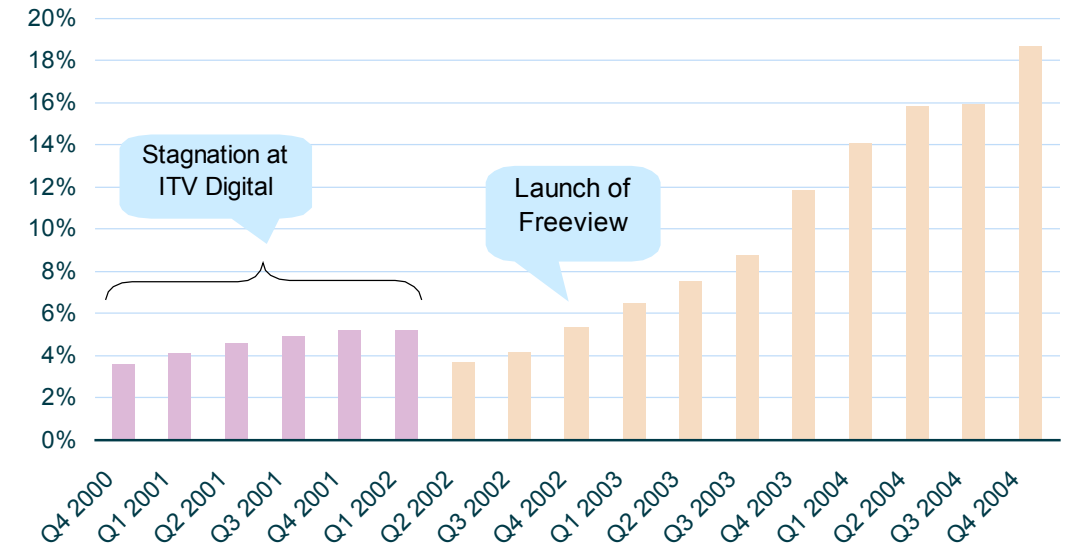

Exhibit A.8: *DTT penetration of TV households in the UK [Source: Ofcom, Analysys]*

Introduction of Freeview has been highly successful…

As shown in Exhibit A.8 above, the introduction of Freeview has seen a strong growth in DTT take-up driven by its FTA multi-channel offering. Ofcom estimated that some 4.4 million DTT receivers had been sold by mid 2004, located in approximately 3.9 million households. This represents nearly 16% of UK TV households.

…demonstrating demand for a FTA multi-channel offering

The success of Freeview can be attributed to the following factors:

- **Free-to-Air offering –** research conducted for the BBC in 2003 indicated that almost two-thirds of Freeview customers said the one-off payment and lack of contract was extremely important to them.[13]
- **STB distribution and prices –** as the number of STB brands available has increased, the prices have fallen, with the cheapest STBs available for as little as GBP40. Also, as demand has grown, STBs are now available from a variety of outlets including supermarkets and from BT.

13 The BBC/Dixons Group Survey, March 2003.

- **Improved coverage –** at launch, all the DTT services reached only 56% of UK households. This has now risen to 74% after changes in the broadcast signal parameters and its power.
- **Investments in channels** – the channels available through Freeview have gained viewers through higher investment and greater promotion. This includes BBC3, which enjoyed a 50% increase in its viewing share compared with its predecessor, BBC Choice. The viewing increase has been driven by a large increase in its budget.

Although simulcasts dominate, interest in new digital channels is increasing

Freeview subscribers still spend the majority of their viewing time watching the simulcasts of the analogue terrestrial channels. However, evidence exists of increased viewing of the digital-only channels in the UK, with their total viewing figures having overtaken that of BBC1's for the first time in Q2 2004. According to Ofcom:

> "*Digital channels account for greater share of viewing than either BBC ONE or ITV1 in Q2 – first time this has happened on a quarter-by-quarter basis.*"

BBC1 and ITV1 have traditionally been the most watched channels in the UK. However, in Q2 2004, the share of audience of the digital-only channels rose to 26%, followed with 24.9% by BBC1. The growth in audience of digital only channels reaffirms that viewers are interested in a wider range of channels, although they may take time in developing loyalty to new broadcasts.

The BBC has significant contribution has included raising DTT awareness

The BBC has played a significant part in the success of the Freeview platform. DTT provides the BBC with a mechanism to compete against the growing take-up of Pay TV platforms (DTH and cable). In addition to the analogue terrestrial broadcasts, the BBC offers a number of additional channels on DTT. The BBC owns a unique and large library of content, and more than 50% of Freeview customers have indicated that BBC digital channels were a significant factor in their purchasing decision.

The BBC has aided the DTT platform with strong market education and advertising. By April 2004, the awareness of Freeview had increased to 80% amongst adults, up from 58% a year before.

Interactive services are available on DTT

ITV Digital offered a variety of interactive services:

- Internet access and email functionality[14]
- sport interactivity, with viewers able to get statistics during football matches, scores from other matches and participate in quizzes and competitions
- entertainment programmes such as E4's Banzai are also accompanied by an interactive betting game.

However, interactive services had limited popularity. An estimated 100 000 subscribers used ITV Active, the platforms interactive service (roughly 8% of total users). On the other hand, Freeview provides a more limited interactive offering, as shown in the table below. It does not contain Internet access.

Service	*Details*
YooPlay	Interactive channel offering games such as Tetris, Darts, Binko, Ring Realms, plus the latest ring tones and java games. Gives the option to listen to JazzFM whilst playing games
Teletext	Teletext offers news, sport and racing, plus weather information and entertainment listings. Teletext Holidays offers a huge range of great value holiday and flight deals
BBCi	Red button on remote control leads to BBCi, which offers news headlines, latest sports updates, weather reports, entertainment and cinema listings and video clips

Exhibit A.9: *Interactive offering from Freeview [Source: Freeview]*

14 Using telephone line return paths.

A.1.5 Analysis: the outlook for DTT in the UK

Continued growth in Freeview take-up expected

Continued growth in the take-up of Freeview is expected in the UK. Ofcom's projections indicate that households with DTT receivers will increase to 6.7 million by the end of 2010.

Ofcom recommends a regional switch-over plan, similar to that implemented in Germany (starting with Berlin). It believes that the announcement of switch-over dates will further drive DTT and DTV penetration. Switch-over will also enable greater DTT coverage by allowing transmitter power levels to be increased without risking interference with the analogue signal.

Top Up TV is expected to break even

The current take-up of Top Up TV is unknown though it gained a reported 20 000 subscribers in its first month of operator. However, based on current projections, the company is expected to be profitable. Given that Top Up TV believes that it can break even at 250 000 subscribers, the BBC estimate that 15% of DTT homes will take Top Up TV by 2010[15], and Ofcom's estimates 6.7 million DTT viewers by 2010, Top Up TV should be profitable.

In the short term, the market for Top Up TV will be limited by the availability of STBs with a conditional access system, as only one new model able to receive Top Up TV (Thomson DTI2300) had been launched by June 2004 (currently retailing at GBP80). However, this is supplemented by an estimated 700 000 ex-ITV Digital STBs still in use. However, a variety of television sets with integrated STBs (iDTV) are available, that have common interfaces for conditional access. Furthermore, a module has been introduced into the market at GBP40 to upgrade STBs without conditional access systems (although the STB have to have a common interface slot).

15 Source: Informa Media.

Key technical issues

The following table presents the key technical parameters chosen for the current implementation of DTT in the UK:

Coverage	*Details*
Actual	Approx. 80% for BBC mux's (1 & 2); 73% for all multiplexes[16]
Target	98.5% DTT core coverage of 3 PSB multiplexes (1, 2 and B)
Modulation type	16QAM for mux's 1, B, C and D 64QAM for mux's 2 and A
Type of national network	MFN
Channel bandwidth	8MHz
FEC (redundancy)	3/4 for 16QAM, 2/3 for 64QAM
Guard interval	1/32

Exhibit A.10: *Key technical parameters [Source: Analysys, DVB, Informa]*

► *DTT coverage*

Significant effort has been devoted in the UK to understanding the appropriate level of coverage that is to be provided by DTT. This section summarises this work, both in terms of the future of DTT in the UK as well as its potential impact on developments across Europe.

Government to ensure universal availability of television

In September 1999, the government announced that switchover would not take place until the following conditions were met:

- everyone who could watch the main public service broadcasting channels in analogue format could receive them on digital systems
- switching to digital was an affordable option for the vast majority of people.

An estimated 98.5% of UK households can receive analogue TV signals for the four main analogue broadcasters. Furthermore, in 1999 the Government stated that a target indicator of affordability could be that 95% of households have digital television (though no such requirement is in place at present).

16 Sourced from Informa Media. 73% refers to households that can receive all DTT multiplexes.

Such availability may be provided via different platforms

Currently, household coverage of the DTT is estimated at 73%. Extending the coverage of DTT to match that of analogue television is likely to require 1154 sites, the same as analogue. Given the considerable cost associated with this further rollout of DTT, other options for ensuring universal television coverage have been considered. DTH is the leading alternative platform, given its ability to cover the whole country from a single satellite.

FreeSat may complete digital coverage …

In its April 2004 report *Driving Digital Switchover*, Ofcom indicated that it would consider whether regulatory intervention would be needed to secure a viable FTA satellite.

… but Ofcom has opted for full DTT rollout

However, Ofcom has proposed that the best option for the PSB multiplexes is that DTT be fully rolled out from 1154 sites, such that coverage matches analogue terrestrial coverage. No dependence on satellite for universal availability is proposed. Ofcom's argument is based on:

- **full availability –** some households cannot receive DTH signal
- **consumer costs –** DTT STBs are cheaper
- **equity** – costs of migration to digital are the same for all consumers, irrespective of location
- **communication** – facilitates market communication if all households can receive DTT.[17]

[17] In the alternative scenario where some households migrate to DTT and others to alternative DTV platforms, it will difficult to explain to consumers the steps they need to take to receive DTV and may result in consumer confusion.

This will imply higher digital transmission fees…[18]

The requirement for full DTT coverage will result in an increase in the transmission fees that broadcasters will need to pay. However, the transmission fees represent only a small proportion of the costs: The following chart shows the order of magnitude of Channel 4's costs in 2003: it can be seen that both analogue and digital transmission accounts for a small proportion of costs.

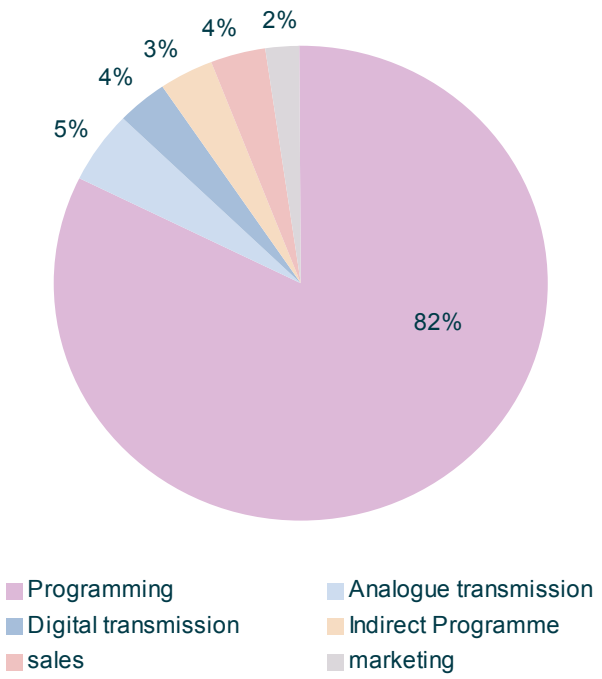

Exhibit A.11: *Breakdown of Channel 4's 2003 costs [Source: Channel 4]* [19]

…but transmission costs are small in comparison to the cost of content

Content is the dominant cost for broadcasters: in the UK, the five main analogue channels earned GBP4.9 billion in 2003, of which GBP2.9 billion was spent on content (source: Ofcom)

Some broadcasters have limited financial resources given the competition for advertising revenues, which may intensify given competition from new DTT channels. However, given the relatively low contribution of transmission to overall costs, broadcasters may struggle to convince policy makers that they cannot bear the cost of full DTT coverage.

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18 Note that full DTT coverage will imply higher digital transmission costs than those currently paid by channels like Channel 4. However, after the simulcast period, these costs will be offset by the disappearance of the analogue transmission costs.

19 Costs for digital and analogue transmission include related regulatory costs. These costs are not only for terrestrial transmission. They also could include elements like satellite transmission costs.

Other technical issues

Exhibit A.10 above also shows that the modulation type varies between multiplexes. Prior to the introduction of Freeview, all multiplexes used 64QAM modulation. The change to 16QAM highlights some technical problems in the previous implementation of DTT in the UK that contributed to the demise of ITV Digital. Some of the key technical difficulties experienced in the UK are outlined below.

► *Poor reception*

Regulatory constraints and optimistic network planning criteria resulted in the quality of transmission received by end users being of insufficient quality. The situation was accentuated by the poor state of many antenna reception systems:

- **Protection of analogue signal –** in order to ensure minimal interference with the analogue terrestrial signal and thus protect its quality, excessively strict protection criteria were adopted, and the power of the digital transmitters was kept to an unnecessarily low level.
- **Antennas –** the chosen technical parameters may have been adequate if antenna reception systems had been of sufficient quality. However, many reception systems (antenna plus distribution cable) suffer from high feeder losses and also allow interference from impulsive noise (produced mainly by electric appliances). It was soon realised that the chosen feeder loss margin was insufficient to compensate for the limitations of the antenna system. This resulted in a very significant variation between theoretical DTT coverage and actual coverage.[20]

The early experience of DTT in the UK highlighted the importance of careful radio planning such that maximum coverage can be achieved. It also highlighted the limitations of focusing solely on maximising the number of channels in planning criteria. Although this was key for Ondigital (later ITV Digital) to compete with cable and satellite, the chosen technical parameters were inappropriate for a high quality service. Lessons were learnt, however, and the implementation of Freeview introduced a number of changes in order to improve reception:

20 Ofcom estimates that even after the power and transmitter number increase, 34% of households require an aerial upgrade at a cost of GBP80–300. The high percentage results from the fact that currently used DTT frequencies are out of group with existing analogue aerials. Following the switchover and the re-assignment of frequencies, Ofcom expects the percentage of households requiring aerial upgrades to drop to 5-10%.

- **Power increases –** in order to address the poor reception of DTT in the UK, a detailed study was undertaken to assess the level to which power output of individual transmitters could be increased, without damaging the analogue terrestrial signal. The implementation of this study has enabled improved coverage of DTT.

- **Modulation change –** the re-launch of DTT in the shape of Freeview also saw a shift from a 64QAM to a 16QAM modulation. This has meant that the same power output can deliver better reception, although this comes at the cost of the number of channels that may be provided.[21]

► *Uneven coverage of multiplexes*

The coverage of the six multiplexes carrying the various channels varied significantly. This resulted in viewer disappointment, who, having installed a STB, expected to receive all the channels advertised by the platform. Subsequent changes (resulting from the equalisation plan of 2000-02 has resulted in a more even coverage.

► *STBs*

Two specific problems arose regarding STBs:

- **Software –** the STB of a particular manufacturer experienced technical problems that resulted in a freezing of the image. This represented a minor problem and was resolved by downloading new software.

- **Installation** – from a consumer perspective, a major challenge was the difficulty encountered in installing the STBs that were marketed as 'plug & play'. This marketing message has pros and cons. While it contributes to diminishing the cost of installation and can work well with minimum technical skills given an adequate working reception system (antenna and distribution cable), if the reception system does not work properly, no corrective action is likely to be taken to correct it and lead to poor reception.

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21 It should be noted that only multiplexes 1 (BBC), B, C and D, (Freeview) underwent the modulation change. In order to ensure that at least four channels may be transmitted per multiplex, the redundancy factor was changed from 2/3 to ¾. Note however that appropriate conditions, good reception is possible with 64QAM.

Given the vanguard development of DTT in the UK, some teething problems with STBs are not surprising and indeed have been experienced in other pioneer countries. The lesson for future DTT roll-outs has been that efforts must be made to ensure STB installation is as simple as possible while still meeting customer expectations. The presence of a large number of competing STBs (as well as network re-planning) has, to a large extent, addressed the issue, with market competition forcing vendors to make their products user friendly. However, the DTT players may contribute by testing and recommending suitable STBs to the market.

A.2 Sweden

DTT was launched in Sweden in April 1999 but a negligible take-up occurred until April 2000. Since then, improvements have been made in the DTT offering leading to a higher take-up.

The lessons learnt from the early experience of DTT are:

- policy and regulatory clarity is essential for development, both in terms of the structure of the DTT environment as well as guidance on analogue switch-off
- a DTT champion is required for promoting the platform, especially for a Pay TV offering competing with cable and DTH
- affordable STBs are required for mass-market adoption.

Since April 2000, the above factors have been addressed. The DTT offering has improved with a migration to a hybrid business model with a significant FTA component. A more conducive policy environment has allowed a merger between DTT players, resulting in a single pay platform (Boxer) that can lead DTT developments. Furthermore, the presence of various low cost STBs has aided market education and affordability.

However, the success of DTT in Sweden is accompanied by an allegation by the satellite operators that the financing of DTT has involved State Aid in contravention of EC Law. An EC investigation is underway to examine whether the transmission fees paid by the PSB (SVT, financed by licence fees) to the network operator Teracom may consist of State Aid. The investigation also covers other measures that the State may have taken in favour of Teracom (i.e. credit guarantees and direct capital injection to Teracom).

Date	*Development*
1997	Parliament decided that DTT should be introduced
1998–9	Licences provided to channels
April 1999	Launch of DTT platform with three multiplexes and approx. 50% coverage However, at least three (out of 11) of the licensed channels (TV3, Kanal 5 and eTV/Cell ICD) did not launched STBs retailed at full price of EUR550 All services encrypted: EUR35 annual fee to receive DTT services
June 1999	Poor take-up, with only a few hundred boxes being sold Regulator decides to award fourth multiplex
September 1999	Boxer established to rent out STBs
December 1999	Fourth multiplex assigned to MTG group
April 2000	Re-launch of the DTT platform with four multiplexes broadcasting 18 channels, and with a STB rental scheme (fourth multiplex carrying popular channels from MTG)
April 2001	Fifth and sixth multiplexes approved
August 2001	41 bidders for Sweden's spare DTT multiplexes
August 2002	Merger between Boxer and Senda[22]
August 2003	Accelerated growth in Boxers' subscribers, driven by new channels
February 2004	Seven more DTT channel licences issued including BBC World and Disney
September 2004	MTG decides to encrypt its channels (TV3, ZTV and TV8)

Exhibit A.12: *Key dates in DTT development in Sweden [Source: Analysys]*

A.2.1 TV market context

Sweden has three terrestrial channels

Sweden has three analogue terrestrial channels, two of which are provided by the Public service broadcaster SVT, as shown in the following table (the third channel is TV4).

22 Originally, Senda was the technical platform in charge of multiplex management, conditional access, etc. Boxer dealt with subscriber acquisition and management.

Number of analogue terrestrial channels	3
Number of DTT multiplexes	5[23]
Public service broadcaster (PSB)	SVT
Number of PSB analogue channels	2
TV households	4.1
Terrestrial only TV households	1.3
Cable TV households	1.8
DTH TV households	1.0

Exhibit A.13: *Key features of TV market in Sweden [Source: Analysys, Informa, other]*

32% penetration of terrestrial…

32% of households use terrestrial means to watch television. Cable has a higher penetration of 43%, with com hem, UPC, Kabelvision/Tele 2 and Canal Digital/Telenor being the leading operators. DTH operators, e.g. Viasat and Canal Digital serve approximately one million households.

…will facilitate switch-off

A regional switchover has been decided upon in order to facilitate distribution of STBs before switch-off. Switchover may start in autumn 2005 in three areas near Stockholm (estimated 200 000 inhabitants), with nationwide switch-off planned for February 2008.

Although terrestrial-only penetration is much higher than in Berlin-Brandenburg, it is significantly lower than in the UK where a regional switchover is also planned. This should make the analogue switch-off easier compared to the UK.

A.2.2 Assignment of frequencies

Exhibit A.14 below highlights key features of the assignment of DTT multiplexes in Sweden.

23 A sixth multiplex is at the planning stage, but has not yet been deployed.

Number of multiplexes	5
Channels per multiplex	4–5
Assignment mechanism	Per channel
Business model	Primarily Pay TV platform (some FTA channels)

Exhibit A.14: *Licensing of DTT in Sweden [Source: Analysys, EPRA, other]*

PSB has a full multiplex, with per-channel assignment for other multiplex

The public service broadcaster (SVT) has been assigned a full multiplex. For the remaining multiplexes, as in Finland, Sweden chose to follow a per-channel assignment regime. This was done to ensure that the freedom of expression, accessibility and variety of choice requirements of Sweden's laws are met.

The first multiplexes were awarded over in 1998, with a fourth multiplex being assigned in 1999. However, some awardees failed to broadcast channels by the deadline of August 2001, and lost their licences. Also in 2001, the government decided to assign channels on a fifth national multiplex. The following table summarises the DTT industry structure.

Type	*Details*
Channels	Licensed in beauty contest
Multiplex	Multiplex and other technical services provided by platform operator, Boxer. It is majority owned by Teracom
Network	Teracom is the authorised network operator. It is 100% state owned

Exhibit A.15: *DTT Structure [Source: EPRA, other]*

A.2.3 The business model

Current DTT structure is hybrid Pay TV plus FTA

The current business model allows for a hybrid Pay TV and FTA offering via DTT. A single network operator, the State owned Teracom serves the various DTT channels. Key elements of the structure are:

- unencrypted channels (SVT, TV4) pay Teracom directly for transmission services
- Boxer pays Teracom for the transmission of the channels its carries
- relationship between Boxer and the channels it carries is based on commercial negotiations.

As shown in Exhibit A.16 below, Boxer receives the revenues from subscribers which include the smart-card fee and the monthly subscription charge. This will include subscription for premium content such as Canal+ or Disney, which will be passed onto the channel under commercially agreed conditions.

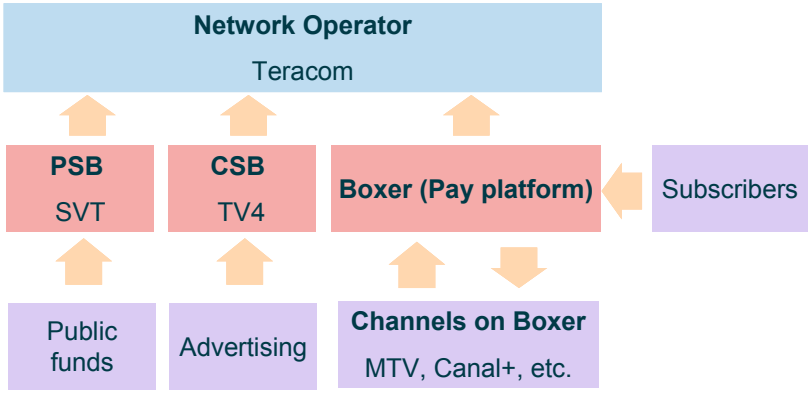

Exhibit A.16: *DTT value chain in Sweden [Source: Analysys]*

This represents an evolution from a pure Pay TV model

The original business model in Sweden was one of Pay TV only. In this model, viewers were required to pay the annual smart-card charge even for access to digital simulcasts of the analogue FTA channels (many licensed channels failed to launch, resulting in a limited channel offering consisting primarily of simulcasts).

As shown in the table below, today viewers can access six FTA channels (three more than analogue terrestrial). Until September 2004, three MTG group channels that now form part of the Basic package were unencrypted: TV8, ZTV and the popular TV3. These three channels have helped drive DTT take-up. Although the impact of their encryption on the take-up of DTT is yet to be seen, it may be limited by the STB subsidy offered by Boxer, offsetting the smart-card cost.[24]

24 Viewers may buy STBs from a variety of retailers. However, on buying a STB with a Boxer smart-card, the cost of the STB is minimal.

FTA	*Basic pay TV package (EUR17.6 month)*	*Premium pay TV content*[25]
SVT1, SVT2, SVT24, TV4, SVT Barnkanalen, Kunskapskanalen	TV4 film, TV400, TV4 Plus, Med I teve, Kanal 5, CNN, Eurosport, Discovery, Animal Planet, MTV, Star, Canal 7, Nickelodeon, VH1, E!, TV3, TV8, ZTV	Canal+ pack of 3 channels for EUR19 per month Disney channel for EUR4.3 per month

Exhibit A.17: *DTT offering in Sweden [Source: Boxer, Informa]*

A.2.4 Analysis: the launch of DTT in Sweden

DTT was launched in April 1999 but the offering was limited

Sweden was the second European country to launch DTT in April 1999, initially with only three multiplexes. However, at least three of licensed channels failed to launch. Thus, the original DTT offering included only the three analogue FTA channels in simulcast, and a few channels new to terrestrial broadcasting. DTT take-up was poor.

Several factors contributed to a lack of confidence

Several factors contributed to a lack of confidence in the future of DTT, and inhibited the broadcasters from launching channels:

- **Multiple decision makers** led to a complexity and uncertainty about future of DTT. DTT decisions were influenced by the Radio and Television Authority (RTTV) as well as the Parliamentary digital TV committee, which was comprised of politicians. Disagreement between the Government and the opposition would imply risks if a change of power were to take place.
- There was no clear **guidance on analogue switch-off** from the government.
- **STBs were expensive**, being sold at their full prices of around EUR400–500.

Complex structure led to a lack of a DTT leader

Different stakeholders promoted their individual concerns, for example, existing Pay TV operators argued for a separation between technical and marketing areas. Compromises resulted in a complex DTT structure:

25 Boxer also offers other content for additional monthly charges. This includes Showtime, BBC World, TCM, Discovery Travel etc.

DTT structure:

- Teracom as network operator
- Boxer in charge of subscriber management
- Senda as a neutral, horizontal, technical platform operator providing services to the channels including multiplex management, conditional access, etc
- individually licensed channels.

Public policy hindered commercial viability and the chosen DTT structure was complex and inflexible. It hindered the creation of a leader for DTT to promote the Pay TV offering. Senda, as platform owner, had limited control on the management of subscribers as well as its content offering.

A.2.5 Analysis: the outlook for DTT in Sweden

Re-launch in 2000 together with a wider content offering and STB rental

Since 2000, sequential improvements have been made in the DTT implementation, that have corrected some of the early mistakes. A re-launch took place in April 2000, with four multiplexes broadcasting 18 channels, and with a STB rental scheme in order to make the STB more affordable.[26]

The following graphic shows how the DTT environment and offering has evolved, enabling a greater uptake of DTT in Sweden.

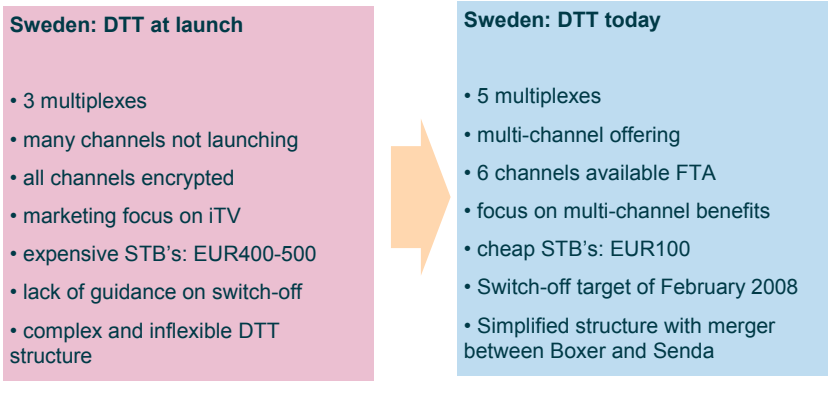

Exhibit A.18: *Change in DTT environment in Sweden [Source: Analysys]*

26 Note that the rental scheme has since been discontinued, in part following the fall in STB prices

2002 saw the creation of a single platform focusing on multi-channel DTT

The development of DTT has been facilitated by the merger of Boxer and Senda, creating a single platform. The resulting unified platform, called Boxer, can promote its offering with greater flexibility, based on being able to negotiate with channels and manage subscribers directly.

The new DTT platform focuses on promoting the multi-channel benefit of DTT. This represents a change from the early phase where interactivity was pushed as a key benefit. At that stage, interactive revenues and usage fell short of expectations, although a variety of interactive services were developed[27] (see Exhibit A.19 below).

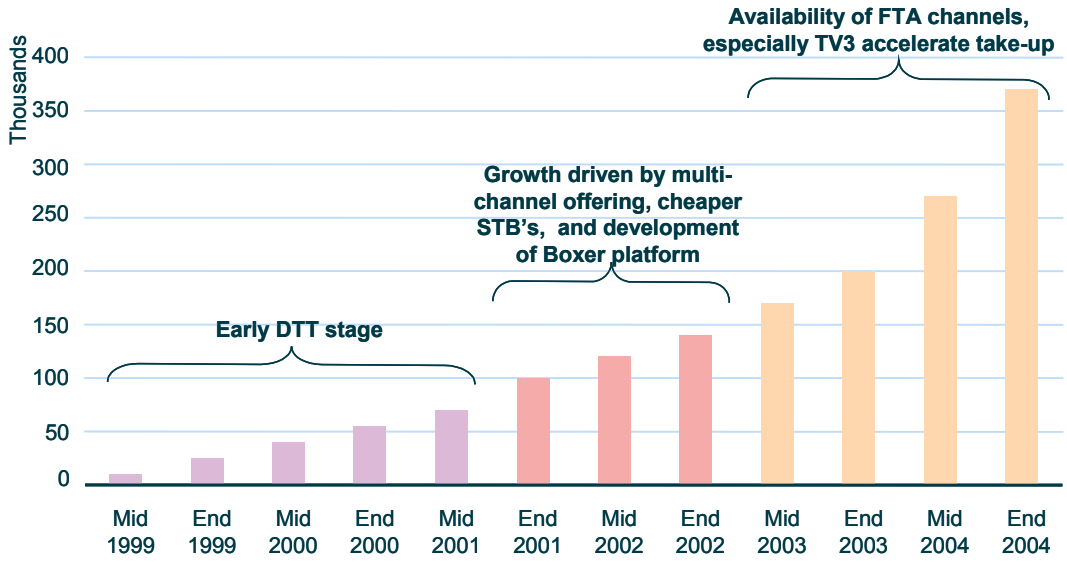

Exhibit A.19: *DTT take-up in Sweden [Source: Analysys, Informa, Teracom][28]*

27 e-TV is an example of interactive services: interactive channel where viewers can shop (for example, CDs, watches, music videos, etc.) and get up to date information (for example, news, weather forecasts. etc).

28 Figure for end 2004 is a forecast, based on progress to date since July 2004. Boxer reported 320 000 subscribers at end of Q3 2004.

FTA was also introduced, boosting DTT take-up

Until 2002, all DTT channels were encrypted in Sweden, requiring users to have a smart-card from Boxer even to view channels available via analogue FTA.

Over 2002–3, the public service broadcaster SVTs channels, TV4 and three channels from the MTG group including the popular TV3 were unencrypted. The impact of these changes has been an acceleration in the take-up of DTT in Sweden, as can be seen from the chart above.[29]

A.2.6 Key technical issues

No specific technical challenges have been encountered in Sweden. Actual DTT coverage in Sweden is high, as shown in the following table.

Exhibit A.20: *Key technical parameters [Source: Analysys, Teracom, DVB]*

Coverage actual	90% of population for multiplexes 1-4, 50% for multiplex 5
Coverage target	99.8% coverage for 1 multiplex, 98% for another multiplex
Number of multiplexes	4
Modulation type	64QAM
Type of network	MFN and SFN
Channel bandwidth	8MHz
FEC (redundancy)	2/3
Guard interval	1/8

The government has set February 2008 as the deadline for analogue switch-off. Some concerns exist that DTH may not be able to fill in the gap between current coverage and universal availability of digital TV as parts of Sweden may not be able are to receive a DTH signal due to low satellite elevation angles. As shown in the table above, the Government requires that one DTT multiplex (carrying PSB content) achieve 99.8% coverage, with 98% coverage for at least another multiplex: this will give the PSB (SVT) the same coverage as the current analogue terrestrial broadcasts. A special Digital TV Commission has been established: one of its objectives is to advise Government on the implementation of the regional switch off process.

29 In September 2004, MTG decided to encrypt its three channels due to the launch of a STB by DTH operator Canal Digital that enabled the viewing of these channels FTA. MTG owns rival DTH platform Viasat that includes some of this content in its Pay TV offering.

A.3 Spain

Spain highlights the fundamental need for a clear DTT policy. A lack of government direction and a failure to reassign the former Quiero multiplexes has meant that no significant developments have taken place since the collapse of Quiero in May 2002.

Spain was of the pioneers of DTT: Quiero TV, a Pay TV platform, was launched as early as May 2000 with a multi-channel and interactive offering. However, the first experiment in DTT was not successful and Quiero was shut down in May 2002. Currently, there are only limited FTA services being broadcast.

There are a number of key lessons that can be drawn from the experience of Quiero:

- **Pay TV –** Pay TV services on DTT will find it hard to compete against other Pay TV platforms (cable and DTH). Customers are drawn primarily by quality and quantity of content. DTT has a natural limitation in number of channels, and premium content is often already owned by competing platforms.

- **Interactivity -** although DTT may be used to provide a variety of interactive services, including Internet access to homes without PCs, interactivity proved to be an insufficient driver for the success of DTT, even when coupled with a multi-channel offering.

- **Antennas -** the technical experience of Spain highlights the substantial cost that may be involved in upgrading or replacing roof-top antennas, especially in multi-dwelling settings.

The lessons from Quiero, together with its UK counterpart ITV Digital, have informed the development of DTT across Europe. Implementations in the UK (Freeview), Germany and other countries have taken into account the difficulty of competing head-on with cable and DTH as a Pay TV operator on DTT. Also, antenna problems have been addressed in different countries, with the UK increasing transmitter power, and other countries such as Germany and The Netherlands opting for portable reception.[30] The table below highlights key dates in DTT development in Spain.

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30 Some antenna upgrades may be inevitable. In the UK, despite having increased the transmitter powers, Ofcom estimates that 34% of households are likely to need aerial upgrades. The cost of this upgrade is estimated at GBP80-300, and is borne by the end user.

Date	*Development*
1997-8	Pilot trials for DTT
October 1998	Legislation in place for DTT
June 1999	Government granted a concession for the provision of 14 national DTT services to the Pay TV broadcaster Quiero TV
May 2000	Quiero TV was launched
July 2000	Quiero paid EUR68million (plus EUR6million per year) for rights to Spanish football league matches on PPV
November 2000	Licences awarded for a channel each to the consortia Net TV and Veo TV
October 2001	49% of Quiero put for sales by shareholder as part of a cost-cutting programme
April 2002	Existing national broadcasters started simulcast of their analogue programmes
May 2002	Quiero ran into severe financial difficulties, and was shut down
July 2002	Net TV and Veo TV started minimal broadcasts
August 2002	Quiero lost its national licences

Exhibit A.21: *Key dates in DTT development in Spain [Source: Analysys]*

The lack of policy direction has meant that virtually no developments have taken place in national DTT since the collapse of Quiero. Although some expectations exist of a new DTT plan being approved by the government in the coming month, which could lead to a free-to-air offering in 2005, the uncertainty continues[31]. Various broadcasters are positioning themselves to gain the maximum DTT capacity possible, and the PSB (RTVE)

[31] The Spanish Government approved on 29th July 2005 the decrees regarding the technical plan for the DTT as well as other issues such as the creation of a new analogue channel, the conversion of the Canal+ channel to an FTA one, and changes on the law of the public radio and television broadcasting operator. The DTT plan grants, for the transition phase, 1 full multiplex (5 nationwide programmes with capacity for regional programming insertion) for RTVE (PSB), plus 14 other nationwide SFN channels, all of them assigned to:

- 1 channel + 2 additional ones (the latter subject to certain conditions) to each of the existing ATV private operators, Antena 3, Telecinco and Canal+
- 1 channel + 1 additional one (the latter subject to certain conditions) to each of the existing DTT operators, Veo TV and Net TV .
- 1 channel to RTVE
- 2 channels to the new ATV operator to be assigned through a beauty contest.

After the Analogue Switch Off, scheduled for 3rd April 2010, RTVE will be granted an additional SFN multiplex and each of the national TV operators at the time (Antena3, Telecinco, Canal Plus, Veo TV, Net TV, as well as the new analogue TV operator) will be granted a full multiplex. An additional multiplex would be assigned to DVB-H services

has asked for it to be granted two DTT multiplexes. However, given the huge debt of the PSB (estimated at EUR6 billion), it is unclear how it may fund such a participation in DTT. At the same time, there is some speculation of the licensing of two new analogue channels, a move that would represent a step away from the benefits of digital technology.

A.3.1 TV market context

Analogue terrestrial is key TV platform ...

The above developments took place in the context of a TV market dominated by FTA analogue services, as shown in Exhibit A.22 below. Cable TV penetration in Spain is low due to limited coverage of cable networks (commercial cable operations started as recently as 1999).

The Pay TV market was very competitive when Quiero was launched, with at least three platforms (four if within CaTV coverage) competing for Pay TV revenues. The two existing DTH platforms, Via Digital and Canal Satélite Digital, have since merged to form Digital+.

Analogue terrestrial channels (national)	5 (of which 1 Pay TV)
Public sector broadcaster (PSB)	RTVE
PSB analogue channels (national)	2
TV households	13.4 million
Terrestrial only TV households	10 million
Cable TV households	0.86 million
DTH TV households	2.6 million

Exhibit A.22: *Key features of the Spanish TV market [Source: Analysys, EPRA, BIPE]*

... creating an opportunity for DTT

The dominance of terrestrial, and the more limited content competition, may provide a strong basis for further developments in DTT in Spain once government policy towards DTT has been clarified.

A.3.2 Assignment of frequencies

The following table highlights the key features of the assignment of DTT multiplexes in Spain.

Number of multiplexes	5 national, 1 regional[32]
Channels per multiplex	5 on mux1, 4 on multiplexes 2-5
Assignment mechanism	Per channel
Business Model	Pay TV + limited FTA channels

Exhibit A.23: *Licensing of DTT in Spain [Source: Analysys, CMT, other]*

Pay TV platform received 14 of the 21 national channels available

The Spanish Government is responsible for granting DTT multiplexes. The five national multiplexes were assigned as follows:

- multiplex 1 was reserved for simulcasting the existing terrestrial broadcasts; the public service broadcaster RTVE received two channels on this multiplex, and three commercial broadcasters (Canal Plus, Antena 3 and Telecinco) one channel each
- assignment of 14 national DTT channels (three and a half multiplexes) to the TV broadcaster Quiero
- one channel each for Net TV and Veo TV on a multiplex to be shared with Quiero.

The DTT multiplexes have not been reassigned since the collapse of Quiero in 2002.

The following table summarises the DTT industry structure.

32 Each of the 17 regions in Spain can use one regional multiplex, based on a regional SFN network and enabling four channels.

Type	*Details*
Channels	Chosen by multiplex operator
Multiplex	Multiplexes assigned to broadcasters [33]
Network	Retevisión (Abertis) authorised network

Exhibit A.24: *DTT Structure [Source: EPRA, other]*

A.3.3 The business model

Pay TV was the primary business model

The original business model for DTT in Spain was Pay TV, Quiero TV, supplemented by two FTA channels and the simulcast of the analogue TV channels. Quiero negotiated with the channels for the Pay TV platform on a commercial basis, and provided a content package to its subscribers in exchange for a monthly subscription charge.

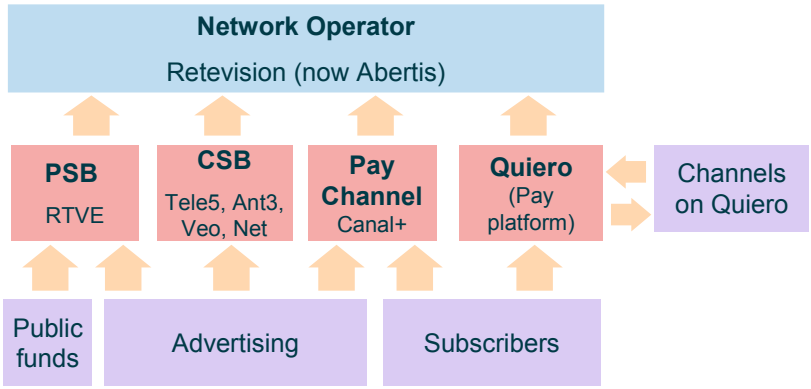

Exhibit A.25: *DTT value chain in Spain [Source: Analysys]*

33 Quiero shared one of its multiplexes with two other broadcasters.

Quiero's offering was designed for head-on competition with other Pay TV platforms

The Pay TV platform Quiero was designed for direct competition with alternative multi-channel pay platforms. Its offering mixed a number of channels with STB rental, PPV and interactive content, including:[34]

- service of 14 channels, at EUR22.6 per month (for comparison, Via Digital offered nearly 50 channels for EUR33.2)[35]
- the STB was rented out at EUR7.2 per month (Quiero sourced STBs from four manufacturers including Sagem and Interisa)
- subscribers could view PPV events, access the Internet and email services via their television, and use other interactive services. PPV events were priced at EUR2.4-3.6 for movies, and up to EUR9.6 for football.

Two new FTA channels and analogue channels simulcasts were also supposed to be available

The public service broadcaster RTVE provided a simulcast of its two analogue channels as did the major commercial broadcasters Telecinco (Tele5) and Antenna 3. Additionally, Veo TV and Net TV started their digital broadcasts (one channel each) in July 2002.

It is worth pointing out that there was virtually no simultaneous transmission of the Quiero TV multiplexes and the above mentioned channels.

A.3.4 Analysis: the launch of DTT in Spain

Quiero was unable to compete in terms of content…

Quiero's strategy was to aggregate the most popular Pay TV content and offer it at a lower price. It acquired expensive premium movie and television content (such as Gran Vía, Gran Hermano, Studio Universal, etc) as well as some sports content (Spanish football league matches on PPV). Nonetheless, Quiero's offering was not as compelling as that of DTH and cable.

The failure of Quiero can be partly ascribed to its relatively

34 Chapter 2 provides a comparison of the generic TV platforms (in contrast to this comparison between two TV offerings in a specific country)

35 Both prices exclude STB rental.

weaknesses compared to the other Pay TV platforms:

- **number of channels** – Quiero's offering was limited by the capacity of the 14 DTT channels that it was licensed
- **lack of prime unique content -** Quiero was unable to match the content offering of DTH, which already possessed the rights to the premium sport and movie content in Spain.

... and suffered from limited demand for interactivity

Quiero emphasised the interactive services available on its platform, which included:

- ability of viewers to browse the Internet without a PC
- programming-related information and participation
- participation in competitions (for example, Oscars 2002)
- chat through the television
- interactive games.

Although some demand existed, Internet access via the television and other interactive services were not sufficient to persuade consumers to opt for Quiero instead of alternative platforms with more channels.

The situation rapidly led to financial trouble

These weaknesses meant that Quiero was unable to attract subscribers to its platform, albeit at a lower monthly cost compared to DTH. Its peak customer base was 200 000, representing less than 2% of the terrestrial viewers in Spain, and less than 10% of the DTH subscribers.

The limited revenue generation, combined with the high costs associated to the aggressive competition for content (meaning high costs and low margins for premium content) and for subscribers (meaning promotions that included subsidised STB and heavy monthly fee discounts), led to very large financial losses.

A.3.5 Analysis: the outlook for DTT in Spain

FTA broadcasts

The five national channels, together with Veo TV and Net TV,

continue ...

continue to offer FTA DTT services. However, these are being broadcast in order to maintain the licences that may otherwise be taken back by the regulator. These broadcasts do not provide any incentive for DTT take-up by viewers, with the majority of the content already available via analogue broadcasts, and minimal attempts being made to develop other content.

... but lack of policy is inhibiting development

Despite much public debate since the fall of Quiero in May 2002, the Spanish Government has not yet defined a new national regime for DTT in Spain. This is negatively impacting the DTT sector:

- existing network investments and spectrum under utilised
- broadcasters spending on transmission for a small audience
- growth in DTH and cable are eating into the DTT addressable market.

Strong interest in DTT remains ...

However, given the high use of terrestrial broadcasts in Spain, a strong interest remains in the future of DTT, and various stakeholders are positioning themselves for prime position in a re-launched DTT environment:

- RTVE has asked the government for a total of two multiplexes (eight channels), using spectrum freed by Quiero
- Sogecable, owner of the analogue Canal+ and the DTH platform, is hoping to add to the single DTT channel it had been assigned.

...and a Freeview-style model is anticipated

It is widely anticipated that the new Spanish Government will support the creation of a Freeview-style FTA offering via DTT. RTVE is expected to play a major role in developing DTT, possibly along the lines of the BBC in the UK.[36]

A.3.6 Key technical issues

Key technical choices made in Spain are detailed by the following table.

36 Before RTVE may invest in DTT, the government will need to take a decision on the massive debt that it has accumulated (approximately EUR6 billion by end 2003).

Coverage	*Details*
Actual	Approximately 80%
Target	95% by 2011[37]
Modulation type	64QAM
Type of national network	SFN, MFN for multiplex 1
Channel bandwidth	8MHz
FEC (redundancy)	2/3
Guard interval	1/4

Exhibit A.26: *Key technical parameters [Source: Digitv, Analysys, Digita, DVB]*

For multiplex 1 carrying the simulcasts of the analogue transmissions, a multi-frequency network (MFN) was chosen to enable regional disconnects.[38] For the remaining multiplexes, a single-frequency network (SFN) was selected. Spain has seen the first implementation of a nationwide SFN for DTT.[39] As a consequence, it has suffered from some teething problems that were solved relatively quickly:

- **Transmitter interference -** the use of the same frequency by neighbouring transmitters meant that viewers in the overlapping areas could receive a signal from more than one transmitter. However, in some cases these signals were out of the guard interval, causing poor reception quality. Such issues were resolved by studying individual transmitters and adjusting the appropriate transmitter delay.
- **STBs -** the first STBs suffered from a hardware problem, which meant that they were unable to cope with pre-echoes when receiving signals from multiple transmitters. In the short term, this was resolved by making changes at the transmitters and subsequent STBs were able to cope with pre-echoes.
- **Antennas -** additionally, a large number of Spanish households (estimated at over 70%) receive their signal via a collective antenna system (MATV). In deploying DTT, Quiero realised that a significant proportion of such antennas were incapable of delivering an adequate DTT signal, requiring consequently a major MATV improvement or, alternatively, a new antenna per individual household, in both cases at a significant cost.[40]

37 According to article 7.4 of the National Technical Plan on DTT (Decree 2169/1998), the public objective is to extend coverage up to at least 95% by the end of 2011.

38 Regional disconnect refers to inserting content into the channels that varies from region to region. Also, the network for multiplex 1 is not a pure MFN network, but rather a cluster of province-wide SFNs. This network, distinct from a small area SFN (with a guard interval of ¼), provides the service facilities of MFN, but keeps the capacity limitations of standard SFN.

39 SFN implies that all the transmitters in an area of coverage use the same frequency. This implies that the signal transmitted must be the same and regional disconnections are not possible.

40 Quiero was required to undertake in-building installations due to competitive pressures, with cable and satellite operators doing the same.

A.4 Finland

Two distinct stages can be identified in DTT development in Finland. June 1999 to Autumn 2002 marked an early but rather slow start to DTT. However, since late 2002 DTT take-up has accelerated and population coverage has been increased substantially.

The first phase highlighted the following issues:

- need to ensure cheap and adequate STBs are widely available
- importance of a clear message to the market, identifying realisable benefits of DTT
- a per channel licensing regime may create inflexibility and can cause delays where individual channels fail to broadcast due to the need to reassign licences.

The second phase of DTT has seen the widespread availability of cheap STBs, leading to interest in DTT from both consumers and broadcasters. It has also benefited from a change in market communication that does not focus on MHP, but instead on the possibility of receiving a broader range of channels and services at high quality.

Exhibit A.27 below highlights the key events in the development of DTT in Finland:

Date	*Development*
May 1996	First European country to introduce legislation on DTT
Feb 1999	27 applications received for channel licences on DTT
June 1999	Licences given to broadcasts (channels). Licences run for ten years from September 2000. Multiplex A reserved for PSB, YLE
September 2000	Digital broadcast starts with four channels in simulcast
February 2001	Channels form multiplex manager, Platco
August 2001	Commercial launch of service (three multiplexes), with 50% coverage
January 2002	Licences taken away from Helsinki Media company and Werner Soderstrom for failing to launch (planned Pay TV channels)
October 2002	Digita granted network operator licence for multiplexes A, B and C
Summer 2002	First MHP compatible STB available in market
March 2003	Licences for national channels to Canal+ (three channels) and a shopping channel
April 2004	Canal+ launched three Pay TV channels

Exhibit A.27: *Key dates in DTT development in Finland [Source: Analysys]*

A.4.1 TV market context

There are four analogue channels in Finland

In Finland, 58% of TV households use terrestrial means to access TV, although, as can be seen from the table below, there are only four analogue terrestrial channels. The introduction of DTT therefore promised more channels and additional services to a substantial base of terrestrial viewers

DTH has a small market share. Finland high latitude means that northern regions suffer from low satellite elevation angles, which can create reception problems. Consequently, DTH may not provide a nationwide alternative to terrestrial reception, even with the use of the DVB-S2 standard (See Annex 1 for more details on the use of DVB-S2).

Number of analogue terrestrial channels	4
Public service broadcaster (PSB)	YLE
Number of PSB analogue channels	2
TV households	2.4m
Terrestrial only TV households	1.1m
Cable TV households	1.1m
DTH TV households	Approx. 170k

Exhibit A.28: *Key features of Finland's TV market [Source: Analysys, Digita, Informa, other]*

A.4.2 Assignment of frequencies

The following table highlights the key features of the assignment of DTT multiplexes in Finland.

Number of multiplexes	3
Channels per multiplex	4–5
Assignment mechanism	Per channel
Business Model	Primarily FTA (some pay channels)

Exhibit A.29: *Licensing of DTT in Finland [Source: Analysys, EPRA, other]*

Multiplexes have been assigned per channel…

A multiplex has been reserved for the public service broadcaster (YLE) on which five channels can be carried. However, in order to ensure plurality, the Finnish Government decided in June 1999 to assign capacity on the other two multiplexes on a per-channel basis. All assignments are for ten years (beginning September 2000).

Reassignment of some channels has been required

Some broadcasters that won licences in 1999 failed to launch channels by the deadline of January 2002.[41] The spectrum remained vacant till April 2004, when Canal+ launched three Pay TV channels.

The following table summarises the DTT industry structure.

Type	*Details*
Channels	Licensed in beauty contest
Multiplex	Shared multiplex management company formed by the channels
Network	Digita is the authorised network operator

Exhibit A.30: *DTT Structure [Source: EPRA, other]*

A.4.3 The business model

Original model was FTA

Exhibit A.31 below shows the current business structure of DTT in Finland. The original business model for DTT in Finland was purely FTA, with the public service broadcaster YLE and commercial channels paying the network operator Digita for transmission.

- In February 2001, the various channels formed a joint venture, Platco, to oversee multiplex management. Platco provides technical services including multiplex management, conditional access and EPG. Platco is paid a fee by the channels.

41 Helsinki Media Company and Werner Soderstrom originally planned Pay TV channels, but failed to launch.

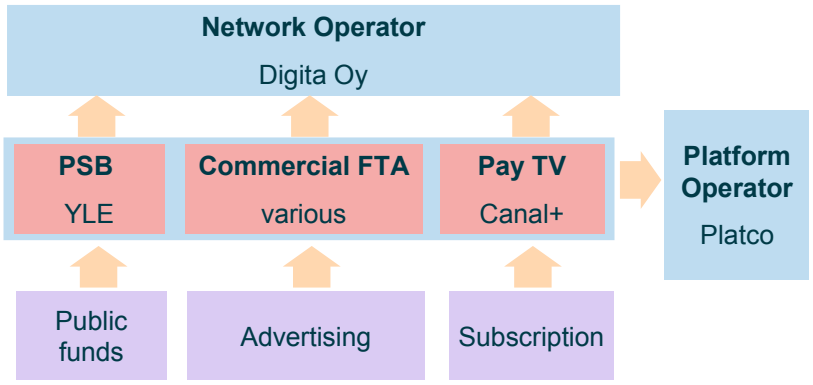

Exhibit A.31: *DTT value chain in Finland [Source: Analysys]*

Pay TV has also been introduced

After a failed start, a Pay TV offering over DTT was introduced by Canal+ in April 2004. The DTH Pay TV platform Canal Digital (owned by Telenor) manages the subscription sales and customer service for Canal+.

Viewers buy STBs direct from retailers

A variety of STBs, including the MHP compatible models ADB iCan and Nokia Mediamaster 301T, are retailed in Finland. No STB subsidies exist. Basic STBs are retailed for as little as EUR59, whereas Finlux's MHP compatible STB (DVB-T 510) retails at EUR299.

A.4.4 Analysis: the launch of DTT in Finland

DTT was commercially launched in 2001…

Finland was one of the earliest European countries to plan the rollout of DTT. However, despite early regulatory moves, commercial DTT services were launched after the UK and Sweden in August 2001, with a 50% national coverage.

…but STB and licensing issues led to no significant developments

The first phase of DTT in Finland from June 1999 to autumn 2002 was uninspiring, with limited take-up of services. This was primarily due to:

- **STB delay** – in order to make advanced interactive services possible, Finland decided early on (October 2000) upon the multi-home platform (MHP) standard for its STBs. However, availability of MHP compatible STBs was limited till mid 2002.

As a result, viewers were unable to buy the appropriate STBs and content providers were slow in offering broadcasts, in view of the lack of market take-up.

- **Market message –** DTT promotion focused on the benefits of MHP. The consequence was that even though basic STBs were available, viewers decided to wait for MHP STBs.
- **Licensing regime –** licences in Finland were issued on a per-channel basis. Three channel licensees had not started broadcasting by January 2002, and lost their licences. When individual channels failed to launch, a lengthy public reassignment process was required, thus causing further delays.

A.4.5 Analysis: the outlook for DTT in Finland

DTT take-up has accelerated…

As Exhibit A.32 below illustrates, since autumn 2002 Finland has experienced a strong growth in the take-up of DTT.

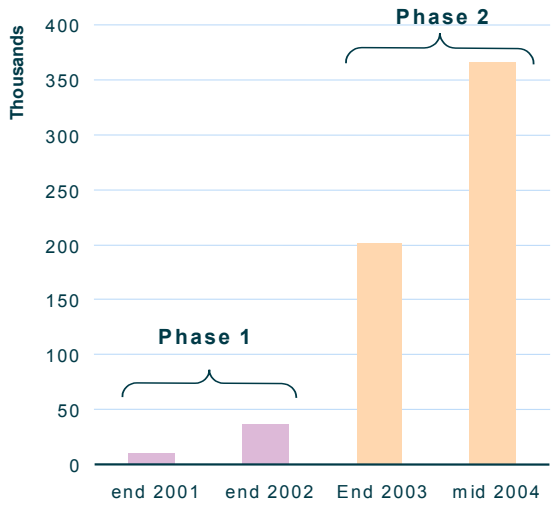

Exhibit A.32: *DTT subscribers in Finland [Source: Analysys, Digita, Informa]*

…driven by emphasis on multi-channel benefit and widespread STB's availability

The new phase has seen DTT promoted on the back of its ability to offer an increase in the channels available to viewers at a high quality. This simpler marketing message has found a greater resonance in the market. Furthermore, the number of STBs available has vastly increased since 2002 – currently STBs are available from at least ten manufacturers, providing both low-cost basic STBs as well as MHP compatible boxes, enabling interactive services. It is estimated, however, that only 5% of the STBs are MHP compatible.

Basic STBs boxes provide access to a variety of content

These STBs provide viewers with access to a broad offering and a significant increase in channels available to terrestrial viewers. Currently, the various multiplexes are carrying the following channels:

Multiplex	*Channels available*
Multiplex A (reserved for PSB, YLE)	TV1-D, TV2-D, FST, YLE24, YLE Teema, radio channels Ylen Klassinen,YLE Radio Peili, YLEQ and Yle Radio Vega+[42]
Multiples B	MTV3, Subtv, MTV3+, Channel Four Finland – Nelonen, Nelonen Plus
Multiplex C	CANAL+ Finland, CANAL+ FILM1, CANAL+ FILM2, Sports Canal, VIISI, Estradi, SEXTV.fi, TurkuTV (regional channel in Turku), Etelä-Suomen Aluetelevisio (regional channel in Lahti) and radio channels KissFM and Iskelmä

Exhibit A.33: *DTT content [Source: Digitv.fi]*

Terrestrial Pay TV has now been introduced in Finland

Since April 2004, Pay TV is also available on DTT from Canal+. The latter benefits from high availability of STBs with conditional access (CA) systems. Pay TV channels via DTT have been planned in Finland since the beginning, but the original channel licensees lost the licences as they failed to deploy on time.

Canal+ offers three pay-TV channels (CANAL+ Finland, CANAL+ FILM1, CANAL+ FILM2) for EUR27 per month. The same offer is available on DTH.

42 TV1 and TV2 are simulcasts.

A.4.6 Key technical issues

No specific technical challenges have been encountered in Finland. Finland is leading developments in fields such as interactive services and mobile DTT that will provide valuable lessons. Current DTT coverage in Finland is high, as shown by the following table.

DTT Coverage	*Details*
Current coverage	94% of population for multiplexes A and B, 72% for C
Target coverage	99.9% for multiplexes A and B by August 2005
Number of multiplexes	3
Modulation type	64QAM
Type of network	MFN
Channel bandwidth	8MHz
FEC (redundancy)	2/3
Guard Interval	1/8

Exhibit A.34: *Key technical parameters [Source: Digitv, Analysys, Digita, DVB]*

As discussed above, low satellite elevation angles imply that DTH reception may be hampered in the northern parts of the country. Furthermore, the low population density in many such areas makes the deployment of cable networks unattractive, and terrestrial is deemed as the most appropriate technology for providing DTT coverage. The licence conditions specify that nationwide coverage should be provided. The target switch-off date is August 2007. The network operator Digita has reached agreement with the Finnish Broadcasting Company, MTV3 and Channel Four Finland on extending coverage to 99.9% of continental Finland. (that is, multiplexes A and B). Current coverage of multiplex C is estimated at 72% and no plans exist to extend this.[43]

Finland's early choice for the MHP standard has led to the development of an array of interactive services, including:

- 'super-teletext' news service from the public service broadcaster YLE, offering round-the-clock updates on news, sports, economy and weather
- Channel Four Finland offers an interactive football service, enabling viewers to display player and club profiles and check the latest results of other matches
- interactive lottery is available from the Finnish National Lottery, via channel MTV3.

43 Multiplex A and B contain simulcasts of the analogue channels. Viewers must have access to these channels before switchover.

Finland is currently undertaking a trial of mobile TV using DVB-H, in which all the major DTT players are participating (including Digita, YLE, MTV3, etc) as well as Nokia and TeliaSonera. A fourth multiplex has been reserved for mobile datacasting using DVB-H – it is believed that the Finnish market is too small to sustain additional advertising-based channels. No results from the trial are out yet, which is aimed at clarifying regulatory and spectrum issues.

A.5 Germany

Berlin-Brandenburg represents one of the most successful cases to date of implementation of DTT in Europe in terms of consumer adoption, albeit at a small scale. Germany has learnt from the UK and Spain that a pure Pay TV offering via DTT is unlikely to succeed in the face of competition from cable and DTH platforms. Furthermore, a strong FTA offering existed in the analogue world. These factors combined to drive Germany towards a FTA model for DTT.

The implementation of DTT in Berlin-Brandenburg consists of a number of salient points, that can educate the development of DTT elsewhere. These include:

- **Regional phased switch-off process** – this is a feasible way of migrating consumers from analogue to digital reception with minimal disruption in the face of spectrum limitations (and the impossibility of full simulcast). The success of the phased switch-off has been noted elsewhere, and Ofcom has proposed a similar approach for the UK. However, it may be more difficult to implement this approach in the UK with a similarly short simulcast period, given the much higher penetration of terrestrial television.[44]
- **Major commercial broadcasters –** the start of DTT in Berlin/Brandenburg was supported by a compelling content offering that included the major analogue terrestrial broadcasters. Financial incentives were put in place to ensure the co-operation of the

[44] It may be noted that the Berlin-Brandenburg area only accounts for just 1.8 million of 36.2 million television households nationwide. Furthermore, only some seven percent of these households depended solely on analogue terrestrial television prior to the switch-off, thus facilitating the process of switch-off.

key commercial broadcasters.[45] Without the participation of RTL/Bertelsmann and ProSiebenSat.1 Groups, it would have been unlikely that the DTT offering had appealed to consumers.[46]

- **Flexible and dynamic policy decisions –** buy-in of all key stakeholders requires a balance in the assignment of spectrum, rollout conditions and other key parameters. This is best achieved where policy decisions are based on dynamic consultations and are able to treat multiple parameters together and reach appropriate trade-offs.

- **Enabler organisation** – the key role played by the Berlin-Brandenburg regulatory authority (MABB) in bringing together key stakeholders and leading the promotion of the platform and education of the market has been crucial in ensuring its success.

- **Strong market communication –** a strong marketing campaign has proven essential to educate viewers as to the benefits of DTT, the need to acquire STBs and the planned schedule. The clear communication of switch-over dates has driven consumer acquisition of STBs.

- **Consumer willingness to buy STBs –** the Berlin example has also shown that consumers are willing to pay for STBs in the range of EUR80–150 if they can perceive benefits (more channels, portable indoor reception).[47]

Additionally, a number of innovations have been made in Berlin, which will inform the development of DTT elsewhere. These include:

- **Portable indoor reception –** successful implementation of portable indoor reception has been a key selling point for DTT.
- **Mobile reception** – trials are currently underway with DVB-H. They have established that data streams transmitted via the DVB-H standard do not impede the quality of parallel TV programme broadcast.

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45 It may be noted that Berlin-Brandenburg represented the first new DTT venture following the collapse of ITV Digital and Quiero (UK and Spain respectively). Following the success of DTT in Berlin-Brandenburg, other regions of Germany have begun DTT broadcasting with the involvement of CSB's, but without the provision of such incentives.

46 Potential impact of such incentives on the competition between different DTV platforms should be considered, with the objective of avoiding market distortions. They are currently being investigated by the European Commission in a State aid procedure (C25/04).

47 STB subsidies have been provided to low income households (see below)

The Berlin example, therefore, serves as a valuable case study in portable indoor reception and further developments in mobile reception that will aid DTT elsewhere. The following table presents an overview of how DTT has developed.

Date	*Development*
August 1997	DTT test operation started in a SFN network as a joint pilot project of Deutsche Telekom, MABB and SFB; other test operations took place in Northern Germany and Bavaria
December 1997	In order to encourage digital development, the 'Digital Broadcasting' Initiative was set up by a Cabinet resolution on 17 December 1997 to elaborate viable strategies for the introduction of digital broadcasting
November 1998	The Berlin-Brandenburg media legislation was amended to allow MABB to specify the details of the switch-over in an MABB statute
July 2001	MABB passed the DTT statute
23 August 2001	MABB presented the DTT launch scenario for the Berlin- Brandenburg area
17 December 2001	MABB's board (media council) decided to financially support the switch-over
13 February 2002	MABB, ARD, ORB, SFB, ZDF, ProSiebenSAT.1 and RTL entered into an agreement on the details of the switch-over to DTT in Berlin-Brandenburg
7 May 2002	MABB filed spectrum applications on behalf of the states of Berlin and Brandenburg with the Regulatory Authority for Telecommunications and Posts (RegTP), which started to co-ordinate the respective frequencies
October 2002	RegTP allocated the frequencies as required by MABB
November 2002	Stage one of the switch-over: two high-power frequencies were switched from analogue to digital transmission; the abandoned two frequencies were used for a digital simulcast
28 February 2003	Analogue transmission of all nationwide commercial television services ended; the high-power public-service frequencies (except for channel 39) were switched to digital operation; the public-services programmes were switched to lower-power analogue channels
4 August 2003	Analogue transmission of terrestrial television in Berlin-Brandenburg came to an end
May 2004	DTT starts in the Cologne Bonn, Bremen/Unterweser and Hannover/Braunschweig regions
November 2004	DTT starts in North Rhine-Westphalia
May 2005	Expected launch in Leipzig/Halle, Erfurt/Weimar and Bavaria (Munich/Nuremberg)
Not before 2006	Launch in Stuttgart Mannheim/Heidelberg/Ludwigshafen

Exhibit A.35: *Key dates in DTT development in Germany [Source: MABB, Analysys, Other]*

A.5.1 TV market context

Cable is the predominant TV platform

As shown in Exhibit A.36 below, cable is the key means of accessing TV in Germany. Historically, the cable infrastructure has been publicly owned and this has contributed to its widespread deployment. However, since 2000 the cable network has been split up and privatised following EC recommendations. Typically, the cable TV service provides 25–30 analogue channels for EUR12–15 per month.

Number of analogue terrestrial channels	3–12 [48]
Public service broadcaster (PSB)	ARD[49], ZDF
Number of PSB analogue channels	2 - 5
TV households	36.2 million
Terrestrial only TV households	2.6 million (DTT estimated 600 000)[50]
Cable TV households	20.6 million
DTH TV households	13 million

Exhibit A.36: *Key features of German TV market [Source: Analysys, DVB, EPRA, MABB, BIPE]*

A.5.2 Assignment of frequencies

The following table highlights the key features of the assignment of DTT multiplexes in Berlin-Brandenburg, Bremen/Unterweser Hannover, and Cologne/Bonn.

	Berlin	*Bremen / Unterweser*	*Hannover*	*Cologne/ Bonn*
Number of multiplexes	7	5 - 7	5	6
Channels per multiplex	4	4 - 5	4	4
Assignment mechanism	Per multiplex and per channel			

Exhibit A.37: *Licensing of DTT in Germany [Source:*

48 Number of channels depends on the region: twelve analogue channels could be received in Berlin-Brandenburg before switch-over.

49 ARD consists of the following independent broadcasting corporations: Bayerischer Rundfunk (BR), Hessischer Rundfunk (HR), Mitteldeutscher Rundfunk (MDR), Norddeutscher Rundfunk (NDR), Ostdeutscher Rundfunk Brandenburg (ORB), Radio Bremen (RB), Saarlaendischer Rundfunk (SR), Sender Freies Berlin (SFB), Sudwestrundfunk (SWR), Westdeutscher Rundfunk (WDR), Deutsche Welle (DW).

50 Source: Frankfurter Allgemeine Zeitung.

Business model	FTA

Analysys, MABB]

Whole multiplexes for incumbent broadcasters…

In order to secure their participation, MABB in Berlin-Brandenburg has assigned the major public and commercial broadcasters one multiplex each:

- the public service broadcasters receive a total of three multiplexes (two for ARD, one for ZDF)
- the two major commercial broadcasters (RTL and the ProSiebenSAT.1) also receive one multiplex each.

…with channels for new entrants

The policy regime in Berlin-Brandenburg requires that, apart from the multiplexes awarded to PSBs and CSBs, a minimum of two multiplexes is available for other broadcasters and for new applications. Individual channels have been awarded to nationwide broadcasters, including BBC World and Eurosport, and to local and regional broadcasters like FAB (Fernsehenausberlin). The actual number of multiplexes available for other broadcasters varies between regions depending on spectrum availability.[51] The following table summarises the DTT industry structure in Berlin-Brandenburg.

Type	*Details*
Channels	Channels assigned individually on two multiplexes. Channels are chosen by the multiplex operator for 5 multiplexes
Multiplex	Some broadcasters (PSB and CSB) have been granted whole multiplexes
Network	T Systems is the authorised network with transmission charges regulated by RegTP

Exhibit A.38: *DTT structure in Berlin [Source: EPRA, other]*

A.5.3 The business model

Pure FTA business model in Berlin

As Exhibit A.39 below illustrates, Berlin has used a pure FTA business model, with channels provided by various broadcasters.

[51] Note that in Cologne/Bonn only one multiplex is open for new entrant channels. Furthermore, most of the new channels in all regions already exist on cable and satellite networks

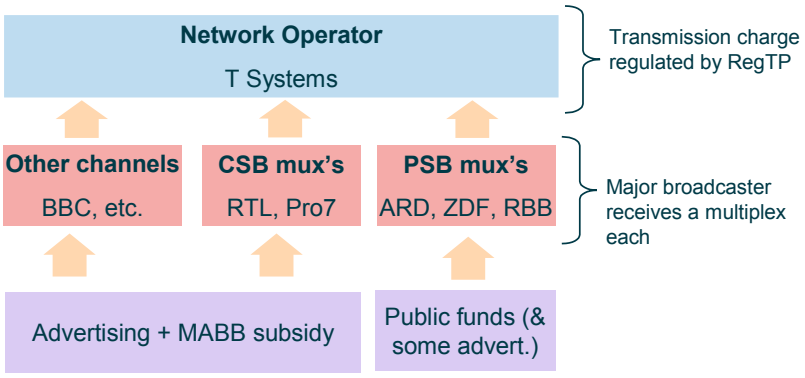

Exhibit A.39:

DTT value chain in Berlin-Brandenburg[52]

[Source: Analysys]

...based on a multi-channel offering with some interactivity

The broadcasters pay transmission fees to the network operator T-Systems, which is a subsidiary of Deutsche Telekom – the former telecoms state monopoly. These fees are subject to regulation by Regulatory Authority for Telecommunications and Posts (RegTP).

As described above, the CSBs' transmission fee is subsidised by MABB[53]. This has resulted in 27 channels being available via the seven multiplexes. One multimedia application, ZDFdigitext, has also been launched.

A.5.4 The original plan for DTT in Germany

In 1998 the future of terrestrial broadcast was in doubt

Since the late 1990s, given the wide availability of alternative platforms and the low terrestrial penetration in Germany, there was a debate about the value obtained from maintaining a terrestrial broadcast network at all.

For public broadcasters, terrestrial transmission costs are borne by all television households, and it was becoming harder to justify that 93% of households paid for a terrestrial system that they did not use. Some commercial broadcasters were considering stopping terrestrial broadcasts and relying solely on satellite and cable.

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52 Note that the value chain may slightly differ between regions of Germany. In former West Germany (including former West Berlin), ARD operates its own transmitter network (whereas ZDF and commercial broadcasters rely on T Systems).

53 In order to incentivise the CSBs to participate in DTT, MABB agreed to subsidise their transmission fees for five years. As a result, major CSB's (RTL and ProSiebenSAT.1) agreed to broadcast for at least five years, thus helping create an attractive DTT offering. Under the Interstate Broadcasting Treaty, MABB is allowed to finance new technical infrastructure with up to 2% of licence fees. However, such subsidies are controversial, with other DTV platforms believing that public funds are being used to develop a rival DTV platform at their expense. An EC investigation is currently underway into the transmission fee subsidy that CSBs receive.

A policy decision to support terrestrial broadcasting was made

In order to ensure universal access to public service television, the government nevertheless decided to support terrestrial broadcasting. However, to justify the cost, a decision was made to deliver an enhanced service to terrestrial viewers and make the platform more attractive for commercial broadcasters. DTT offered broadcasters an alternative multi-channel platform to cable and DTH, and gave them leverage in negotiating the terms of carriage on cable systems.

Basic DTT guidelines were established in 2000…

The 'Launch scenarios 2000' published by the Bundesministerium für Wirtschaft und Technologie (Federal Ministry of Economics and Technology) established basic guidelines toward the implementation of DTT in Germany. These included:

- aim of 12 programme equivalents, and new multimedia services
- the number of programmes offered at the launch is to be capable of expansion to at least 20 television programme equivalents, and a regionalisation of the programmes is to be possible
- portable indoor reception is to be made possible right from the beginning – albeit not necessarily in rural areas.

…leading to a SFN network and a regional approach

The need for portable indoor reception led to a choice of Single Frequency Network (SFN). SFN implies that several transmitters can be deployed in a small area to ensure high indoor reception.[54]

Furthermore, to ensure rapid adoption of STBs and thus access to television, a decision was made for a regional approach, with DTT being introduced in selected areas, so-called 'islands'. The regional approach was also supported by the constitution which hands media regulation authority to the Länders. The islands are identified by the Länder. No decision has yet been made as to how coverage will be extended beyond such islands.

54 In a Single Frequency Network (SFN), portable indoor reception is facilitated as coverage in a specific location can be improved by the installation of small transmitters.

A.5.5 Analysis: the launch of DTT in Berlin-Brandenburg

Berlin enjoyed particularly favourable switch-over conditions

Berlin-Brandenburg enjoyed particularly favorable conditions for DTT: as Berlin had historically been isolated in the former East Germany, there were more frequencies available for digital transmissions by broadcasters than in any other German region. In addition, the area is densely populated and can be covered with few transmitters.

However, Berlin terrestrial viewers already had access to 12 analogue channels. In order to generate greater interest in terrestrial broadcasting, the following new features were proposed:

- multi-media content
- indoor reception
- mobile reception.

DTT was launched in November 2002

DTT was launched in Berlin-Brandenburg on November 2002. This addressed an area with 1.8 million households, of which an estimated 160 000 used analogue terrestrial reception only. A further 90 000 households used analogue terrestrial for second and third televisions.

Three-stage process implemented

A three-stage process was agreed between the Berlin-Brandenburg regulatory authority (MABB), the public broadcasters, and the private commercial broadcasting services:

- **Step 1 –** two high-power analogue channel switched to digital to demonstrate the quality of DTT and to provide guidance to consumers as to the need for new receivers.
- **Step 2 –** all commercial broadcasters switched to digital. Public broadcasters switched high-power transmitters to digital but continued analogue broadcast over lower-power frequencies.
- **Step 3 –** all analogue frequencies were switched off completely.

The success of the Berlin-Brandenburg model has guided the implementation of DTT and analogue switch-off elsewhere, with other regions of Germany having adopted a similar implementation plan.

Exhibit A.40 below illustrates the phased transition, with Channels 5 and 44 switched to digital in November 2002. The displaced public broadcast (ARD or 'Das Erste', respectively) on Channel 5 was placed on Channel 7 till February 2002, when it was switched off and replaced by a bouquet of ARD digital channels (with ARD analogue simulcast continuing in low power on Channel 29).[55]

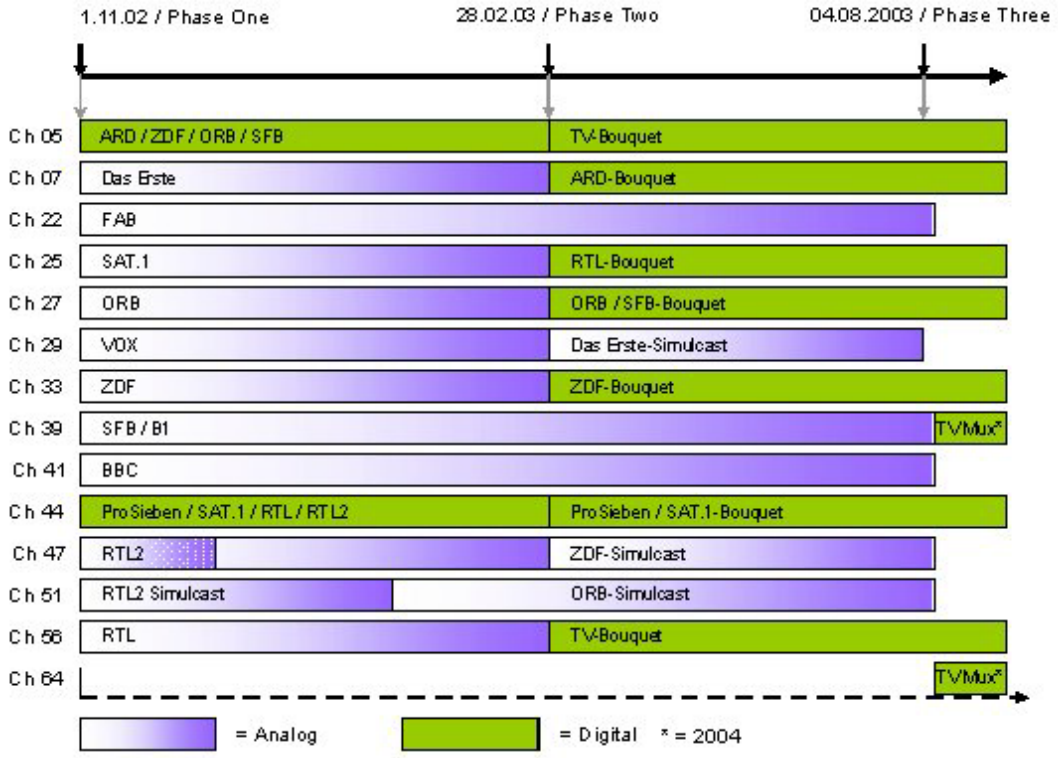

Exhibit A.40: *Transition to DTT in Berlin-Brandenburg [Source: MABB, NCTA]*

Participation of commercial broadcasters has been key …

The phased transition has been successful, experiencing limited technical problems and strong take-up of DTT. By August 2003, 170 000 households had acquired a STB in Berlin-Brandenburg (by the end of 2004, 2.3 million STBs had been sold in Germany).[56] Active participation of the incumbent commercial terrestrial

55 Note that ARD is the same channel as Das Erste.

56 Source: http://www.digitalfernsehen.de/news/news_22488.html.

broadcasters has been an important element in enabling a successful transition, and was secured by:

- **Significant participation** –the most popular commercial broadcasters RTL and ProSiebenSAT.1 were given a significant participation in DTT, with each controlling a multiplex capable of four channels.
- **Subsidy from MABB** – in order to secure the participation of commercial broadcasters, MABB has agreed to pay approximately 30% of the transmission fee for digital television for a period of five years.
- **'Must carry' on cable** – presence on a terrestrial platform provides a channel with 'must carry' status on cable, thus ensuring it to access a wider audience via cable. See Annex E for more details on the cable carriage regulation in Germany.

…and MABB played a crucial role

MABB played a crucial role in ensuring the success of DTT in Berlin-Brandenburg. Its specific contributions include:

- **Flexible and dynamic policy regime** – MABB's policy took into account specific market conditions, and the interests of all relevant stakeholders. Its agreements with the broadcasters were in the form of contracts, thus providing the flexibility to accommodate a variety of issues from capacity assignment, support mechanisms to launch schedules.
- **Co-ordination between stakeholders** – MABB acted as an enabler for DTT, bringing various stakeholders together to achieve buy-in and develop a workable plan.
- **Market communication** – MABB was key in ensuring wide awareness of DTT benefits and scheduled developments. Market communication has been vital, especially with regards to dates of key changes: strong take-up of STBs took place upon the announcement of the main switch-over date (28 February 2003).

Consumers are willing to pay for STBs…

The Berlin experience shows that consumers appear to accept that more services mean more expenditure: the additional cost implied by analogue switch-off did not cause any major public/political controversies. Such additional costs were either in the form of ongoing fees as is the case for cable reception, or in the form of the one-off expense incurred for a satellite dish or a STB for digital terrestrial reception.

It may be noted that DTT presents consumers an opportunity to reduce their TV expenditure by switching away from cable: while cable reception implies a monthly fee, DTT is free-to-air. Thus a decline in cable subscribers is possible, notably where the CaTV networks have not been yet upgraded to digital technology.

…and a scheme for low income families had limited demand

Adoption by consumers was further encouraged by schemes for low-income families:

- **Rental STBs –** for low-income families, the receiver industry provided sets for hire purchase at EUR8.50 per month during the introduction phase.
- **Purchase support –** Germany's social security rules entitle low-income families to a television set. In an agreement with the social security services, MABB decided to support STB purchases with a budget of EUR1 million. Support was strictly limited to the switch-over period and only covered homes that had previously received television via roof antenna only.

However, the rental scheme attracted little interest and only 6000 STBs were distributed via the purchase support scheme at an estimated cost of EUR600 000 (less than the MABB's budget). Given the drop in STB prices, no such measures have been used in regions that have followed Berlin-Brandenburg in deploying DTT.

A.5.6 Analysis: the outlook for DTT in Germany

DTT is being introduced in other regions…

Following the successful model of Berlin-Brandenburg, other regions in Germany have followed by launching DTT. DTT started on 24 May 2004 in Cologne Bonn and Hannover/Bremen with 16 channels being offered. Since then the analogue terrestrial signal has been switched off in these regions, as well as in Bremen/Unterweser and Frankfurt, Wiesbaden and Mainz.

Exhibit A.41: *DTT rollout plans for Germany [Source: Digital TV Group]*

…Pay TV may also be provided via DTT

Pay TV channels via DTT remains a possibility. As early as 2002, PremiereWorld – Germany's DTH platform – was in talks with MABB with regard to the distribution of their Pay content via DTT, but so far no developments have taken place. However, the market for Pay TV via DTT will be limited by the relatively few STBs sold that allow for a conditional access system and the fact that the available DTT spectrum is currently assigned to FTA channels.

Currently, DVB-H for mobile reception is being trailed in Berlin, and includes pay content from suppliers such as Universal Studios.

…though full terrestrial coverage is unlikely

Despite the significant rollout of DTT, full terrestrial coverage is unlikely in Germany. Cities such as Göttingen and Osnabrück are no longer covered by terrestrial broadcasts of commercial broadcasters because these broadcasters left the analogue terrestrial platform around Hannover (because of lack of viewers) and the digital terrestrial platform does not cover these areas. In areas such as Leipzig CSBs are not broadcast over the digital terrestrial platform.

A.5.7 Key technical issues

Upon introduction of DTT in Berlin, there were some minor problems with equipment, as full testing was not possible before DTT rollout. Some indoor antenna receivers were not sufficiently sensitive to the signal. Also, differences in ease of use and the software of the STBs caused a few problems. Future DTT deployment may benefit from more extensive testing of consumer equipment beforehand and the establishment of minimum standards. However, evidence exists of continued teething problems with STBs in areas where DTT has been more recently introduced. In Cologne, the first releases on some STBs had software problems, and caused image freezing and lock-ups. These problems have been addressed by over-the-air downloads of new software and the latest software releases appear to be more stable.[57]

A number of valuable technical innovations from the implementation of DTT in Berlin-Brandenburg may aid implementation of DTT elsewhere:

- **Regional switchover process** – it balances the need for universal availability of the public service broadcast with the costs of simulcast and spectrum availability. Because the German UHF band is intensively used, it has not been possible to simulcast a large number of digital multiplexes.
- **Portable indoor reception** – in 'Launch Scenario 2000', the Federal Government's Digital Broadcasting Initiative recommended:

[57] Image freezing has also been attributed to the "cliff effect", with viewers on the edge of the coverage area receiving DTT signals intermittently.

"For terrestrial television, the Initiative recommends the setting of parameters which represent a commercially acceptable compromise between user data rates, portable receptability and infrastructure costs."

Approximately, 55% of households in Berlin-Brandenburg that can receive DTT are able to use portable indoor reception using small antennas retailing at about EUR80 (antenna only). Technical choices made to deliver this include:

- SFN network to enable more transmitters to be used for the same signal and thus increase the coverage of portable indoor reception
- 16QAM modulation instead of 64QAM – as shown in the table below, enabling indoor portable reception with lower power transmitters.

DTT coverage	*Details*
Coverage actual	Near 100% in Berlin-Brandenburg; 44% of households nationwide (stationary)
Coverage target	100% in Berlin-Brandenburg; 55% of households nationwide in 2005
Number of multiplexes	4 initially
Modulation type	16QAM
Type of network	Small area SFN
Channel bandwidth	8MHz UHF & 7MHz VHF
FEC (redundancy)	2/3 & 3/4
Guard interval	1/8

Exhibit A.42: *Key technical parameters [Source: Analysys, MABB, DVB]*

- **Mobile reception –** the Broadcast Mobile Convergence (BMCO) project in Berlin is amongst the first trials of mobile digital terrestrial reception using DVB-H. The objective of the trial is to examine user requirements and the business, technical and regulatory models applicable. Key details of the project are shown below:

Participants	Network: Vodafone Content: Universal Vendors : Nokia for receiver, Philips for portable TV and conditional access system[58]

Exhibit A.43: *BMCO project in Berlin [Source: BMCO]*

58 The mobile terminal used in the trial is a Nokia 7700 Media Device, equipped with a DVB-H receiver. Philips is contributing prototypes of a portable terminal that can receive both normal TV programs via DVB-T terrestrial standard as well as services via DVB-H. Philips also provides content protection technology via its CryptoWorks conditional access system for DVB-T based services.

Technologies	DVB-T for portable applications DVB-H for mobile applications
Objective	Explore the concept of combining DTT services with a mobile network, which can be received both at home and on the go

During the pilot, new TV content and interactive services are broadcast to portable and mobile end devices using DVB-H. Vodafone's mobile network facilitates billing, interactivity and personalisation. Pay content being trialled includes the channel '13th STREET' from Universal Studios.

Key technical issues are being addressed by the trial; it has already established that data streams transmitted via the new DVB-H standard do not impede the quality of parallel TV programme broadcast. However, before a commercial launch can be made, key issues will need to be worked out, including spectrum requirements and mobile broadcast coverage. Lessons learnt in Berlin may be applied to developing DVB-H around Europe.

A.6 Italy

The low penetration (compared to other EU countries where DTT has been launched) of cable and DTH (see Exhibit A.44 below) makes Italy an attractive market for DTT services. However, the Italian broadcasting market has some significant characteristics, and is dominated by the public service broadcaster RAI and the commercial broadcaster Mediaset. Consequently, the cooperation of these two organisations has been key for DTT development.

Despite a recent start, significant developments have taken place in DTT in Italy. These have been partly driven by a strong marketing campaign by RAI and Mediaset. Also, demand-side intervention by the Italian government has been important: Italy provides the first and only example of government subsidies for the purchase of STBs that meet certain technical criteria by eligible viewers.[59] The start of DTT in Italy yet again shows how commitment from leading broadcasters, combined with affordable STBs, can lead to a rapid take-up.

59 Viewers that have paid television licence fees.

However, such developments have not been free of controversy. The government's STB subsidies have raised questions about their impact on competition between the various DTV platforms, especially in light of the EC investigations in Germany and Sweden. Also, the role played by Mediaset has led to some concerns against the backdrop of the Gasparri Law which overturned an earlier ruling that would force Mediaset to give up one of its three analogue terrestrial channels (in the interest of pluralism), a step that would have led to a fall in Mediaset's advertising revenue. Although the Law has been passed, and thus Mediaset is not required to give up an analogue terrestrial channel, some argue that a successful DTT platform may guard it against similar measures in the future, by creating an arena where Mediaset can offer multiple channels and defend its advertising revenues without pluralism concerns being raised. In any case, the choice of the MHP platform has placed Italy in a strong position to develop advanced interactive services, although few are currently available and a return path is needed. The outlook for further developments of DTT in Italy is favourable, and a further step has been the introduction of a Pay TV offering.

The table below outlines the key developments in DTT that have taken place in Italy since 1998.

Date	*Development*
1998–2000	RAI trialed DTT technology in Rome, Turin and Palermo
August 2001	Italy's Telecommunications Authority published a Consultation Document for DTT regulation
March 2002	Italian Government confirmed the introduction of financial incentives for the purchase of STBs
September 2002	Coverage conditions for RAI were established
February 2003	Approval of frequency allocation for 18 multiplexes, 12 national and 6 regional, allowing between 72 and 90 channels to be transmitted[60]
December 2003	Mediaset launched its first multiplex with five channels
January 2004	RAI launched its two national multiplexes
January 2004	Telecom Italia and TV International launched two channels on fourth multiplex
February 2004	The government confirmed a EUR150 subsidy per STB
February 2004	TF1 and HCS reached an agreement to exploit another multiplex
December 2004	STB subsidy for 2005 cut due to falling price differences between interactive and basic STBs

60 Note that 18 multiplexes will only be possible once switch-off has taken place. Presently, 5 multiplexes are in service in Italy.

Exhibit A.44: *Key dates in DTT development in Italy [Source: Analysys]*

A.6.1 TV market context

Italy has 11 national analogue terrestrial channels…

Italy has a strong existing multi-channel analogue offering, with the Public service broadcaster (RAI) offering three channels, as shown in the table below. The dominant commercial broadcaster Mediaset also offers three channels. The two organisations account for approximately 90% of the TV audience in Italy.

Number of Analogue terrestrial channels	11 national
Public service broadcaster (PSB)	RAI
Number of PSB analogue channels	3
TV Households	21.5 million
Terrestrial only TV Households	18.7 million
Cable TV Households[61]	0.2 million
DTH TV Households	2.6 million

Exhibit A.45: *Key features of the Italian TV market [Source: Analysys, Informa, other]*

...penetration of cable and DTH is low…

The above table also shows that terrestrial remains the dominant means of television viewing in Italy. Penetration of Pay TV is limited, with the DTH platform Sky Italia reporting 2.6 million customers in May 2004. Cable (CATV) hardly exists in Italy, although Fastweb had acquired 138 000 TV customers by March 2004 using a fibre and DSL infrastructure.

…creating an attractive DTT opportunity

The limited penetration of alternative platforms combined with a strong appetite for television creates an attractive opportunity for DTT to flourish in Italy. Italians are strong viewers of television, with an estimated 238 minutes of average daily viewing in 2003.

61 Including Fastweb TV customers.

with an estimated 238 minutes of average daily viewing in 2003.

A.6.2 Assignment of frequencies

The following table highlights key features of the assignment of DTT multiplexes in Italy.

Number of multiplexes	5 national in operation
Channels per multiplex	4–6 capacity
Assignment mechanism	Per multiplex
Business Model	FTA

Exhibit A.46: *Licensing of DTT in Italy [Source: Analysys, Agcom]*

RAI operates two of the five multiplexes

The licensing regime gives a few major players a significant stake in the future of DTT and thus secures their support for the platform:

- the public service broadcaster RAI has two multiplexes
- Mediaset has one multiplex
- Telecom Italia/TV International and D-Free (TF1 and HCS) have one multiplex each.

The following table summarises the DTT industry structure.

Type	*Details*
Channels	Chosen by multiplex operator
Multiplex	Whole multiplexes are granted to broadcasters
Network	RAI is the authorised network operator

Exhibit A.47: *DTT Structure [Source: EPRA, other]*

A.6.3 The business model

The business model is based on advertising

The current business model for DTT in Italy is FTA based on advertising revenues that support the various channels available. The Public service broadcasters' (RAI) two multiplexes are funded both by advertising as well as public funds.

Channels are decided by the multiplex operator

The channels that are broadcast on each multiplex are decided by the multiplex operators. To ensure pluralism, 40% of the channels on each multiplex must be sourced from third parties (except for

multiplex operator

RAI's first multiplex).[62] This rule has meant that two Mediaset channels (Canale 5 and Italia 1) appear on the D Free multiplex. The multiplex operator has to negotiate with such third-party channels, and terms should be non-discriminatory. RAI is currently negotiating with various parties for the two channel slots available on its second multiplex.

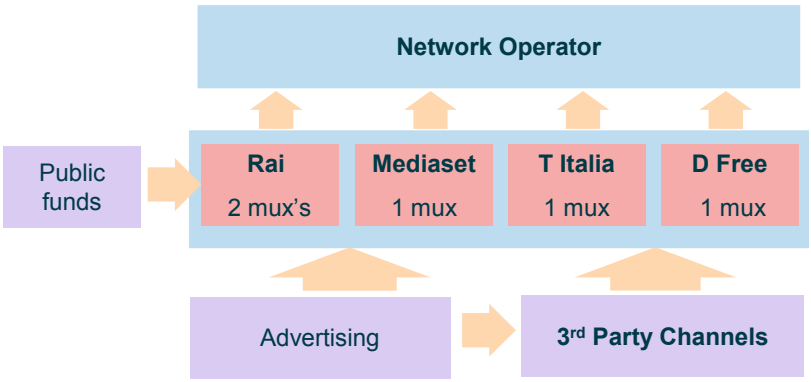

Exhibit A.48: *DTT value chain in Italy [Source: Analysys]*

Twenty channels available via DTT

At present, approximately 20 channels are available via FTA DTT in Italy. This includes the simulcast of the majority of national analogue terrestrial channels.

The following table shows the channels per multiplex; it can be seen that some multiplexes still have capacity for more channels including those owned by RAI, Mediaset and T Italia.

No.	*Multiplex*	*Channels*
1 and 2	RAI	RaiUno, RaiDue, RaiTre, RaiNews 24, RaiUtile, RaiDoc, RaiSport, RaiEdu + 2 third party channels
3	Mediaset	Rete4, BBC World, 24 Ore TV, Class News, and VJ Television + new channel
4	T Italia/TV International	La7, MTV
5	D-Free	Sport Italia, Canale 5, Italia 1 and La Chaine Info, Radio Italia TV

Exhibit A.49*:* *DTT offering in Italy [Source: RAI, Advanced TV, other]*

62 That is, channels not controlled by the multiplex operator

A.6.4 Analysis: the launch of DTT in Italy

DTT has been launched only recently….

DTT was launched as recently as December 2003 in Italy by the leading commercial broadcaster Mediaset. This was followed closely by RAI, launching a DTT service in January 2004 on its two multiplexes. The fourth multiplex (Telecom Italia & TV International) launched two channels in January 2004, with D-Free launching later in 2004.

…and growth has been rapid…

As shown by Exhibit A.50 below, a rapid take-up of DTT has occurred in Italy. By mid-2004, approximately 500 000 DTT STBs were present in the Italian market, representing 2.7% of terrestrial viewers.

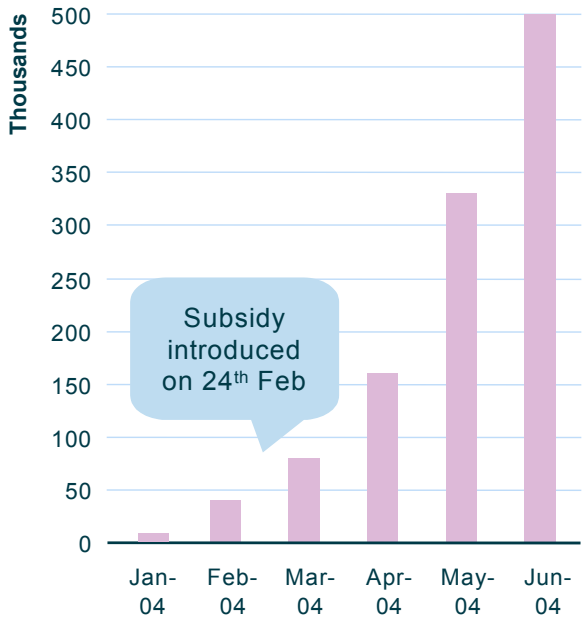

Exhibit A.50:

DTT take-up in Italy

[Source: Analysys]

…aided by government STB subsidies

The take-up of DTT has been strongly aided by a government subsidy of EUR150 (in 2004) for the purchase of interactive STBs.[63] The government had allocated EUR110 million in its budget for 2004, thus providing for 733 000 STB subsidies. For 2005, the subsidy per STB has been reduced to EUR70, reflecting a fall in the retail price of such devices. However, the government has budgeted to subsidise 1.3 million STB in 2005. The rationale of the government's decision has been based on:

63 An STB containing a standardised API and return channel facility, which are typically MHP compatible.

- **Analogue switch-off** is planned for the end of 2006. The government argues that without measures such as the subsidy, take-up would never reach the required levels.
- **Advanced service** including e-government services. The government has been keen to ensure that IP-enabled services are possible. However, without the subsidy, the more costly STBs needed would inhibit market development.

…and a strong marketing campaign

The other key factor in the success of DTT in Italy has been the strong market education by RAI and Mediaset. The two major terrestrial broadcasters have launched a massive advertising campaign in favour of DTT.

Co-operation of commercial broadcasters has been key

The co-operation of the public service and main commercial broadcasters has been key to the development of DTT in Italy. Both parties have been given a significant stake in the future of DTT (two multiplexes for RAI, one for Mediaset) and have thus invested in making it a reality. Mediaset is also motivated by the possibility of offering Pay TV content via DTT and using this platform to challenge Sky Italia in offering premium content.

DTT has developed against the background of Gasparri Law…

In late 2003, a Media Law (Gasparri Law, named after the Communications Minister) was presented in Parliament that introduced a number of changes to the broadcasting sector. Amongst other things, the Law overturned an earlier ruling by a Court that would oblige Mediaset to free one of its analogue terrestrial channels, and move it to satellite transmission. The Court's ruling was based on competition concerns and such a move is likely to have reduced Mediaset's TV advertising revenues.[64]

…and this has caused some controversy

The Law has proved to be controversial and the Italian President refused to sign the Law as it is seen to favour Mediaset. However, the Gasparri Law was passed unchanged in April 2004, after a second reading by the Italian Senate.

64 An article of the Media Law (No.249, July 1997) sets out rules concerning competition and the abuse of dominant position. It establishes that no operator may gain more than 30% of any one of the following three separate markets: terrestrial television, radio, cable and satellite television. In May 2001, AGCOM ruled that Mediaset had exceeded this limit (in the reference year, 1997) for the terrestrial television market.

Possibility of losing analogue channels may have increased Mediaset's interest in DTT

The earlier Court ruling may have contributed to Mediaset's interest in DTT: DTT enables Mediaset to offset the threat of being forced to run fewer analogue terrestrial channels. Although DTT enables other broadcasters to enter the market, Mediaset may believe that the popularity of their content will help them maintain their share of advertising revenues without competition issues being raised.

A.6.5 Analysis: the outlook for DTT in Italy

Mediaset is planning a Pay TV offering, leading to a hybrid DTT offering

Mediaset's activities indicate that a Pay TV offering is likely to emerge soon, leading to a hybrid DTT model. In June 2004, it acquired suitable content rights – a three-year deal with Juventus, Inter Milan and AC Milan football clubs for coverage of Serie A home matches. The rights relate to the digital terrestrial, cable and ADSL platforms and do not include DTH. It is yet unclear in what format Mediaset may offer its premium football content via DTT: premium subscription, pre-paid or pay per view.

Other broadcasters are also considering pay services

Telecom Italia is reported to be planning a 'pre-pay' premium football service on its multiplex in 2005. Access to such content would be controlled by a pre-paid rechargeable card. Telecom Italia is already broadcasting live Serie A and B matches on the Internet, with each match priced at EUR2.50.[65]

At the same time, TF1 – 49% partner in the D-Free broadcaster – has indicated that it may be interested in launching pay channels on its multiplex.

Government's STB subsidies may be reduced

The government indicated (in November 2004) that the amount of subsidies it pays per STB may be reduced following a fall in the retail price of STBs. The government is expected to continue providing STB subsidies, but the State's contribution has fallen from EUR150 to EUR70 per STB due to a significant decrease in equipment prices.

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65 Note that where viewers use low bandwidth internet connections, picture quality will be inferior to that available via broadcast.

A.6.6 Key technical issues

No specific technical challenges have been encountered in Italy. Current DTT coverage in Italy is high, as shown by the following table.

DTT coverage	*Details*
Pop coverage actual	61% for multiplex 1, 55% for 2, 51% for 3 and 5 [66]
Pop coverage target	70% obligation for multiplex 1 & 2 (RAI) by Jan 2005, 50% minimum for other multiplexes
Modulation type	64QAM
Type of network	MFN
Channel bandwidth	8MHz, VHF/7MHz (8MHZ planned for VHF later)
FEC (redundancy)	2/3 for UHF, 3/4 for VHF
Guard interval	1/32

Exhibit A.51: *Key technical parameters [Source: Analysys, DVB]*

For its two multiplexes, RAI is aiming for coverage of 70% by the end of 2004. Mediaset is also planning for 70% coverage for multiplex 3 by end of 2004 and 80% by end of 2005. Expectations are that DTT coverage will approach 90% of the population, and satellite may be used to provide coverage to those areas not receiving DTT.

Other salient technical developments in Italian DTT are:

- **Interactive services** – the choice of MHP STBs places Italy in a strong position to develop interactive content. The government is keen to develop e-government services, including online voting and public administrative processes, although these services have not yet been launched. RAI's interactive offering is to include an enhanced teletext service, 'Supertelevideo', an EPG as well as interactive applications during the European elections and key sporting events. In February 2004, Telecom Italia and Sun Microsystems established the 'DTTLab' to test new interactive DTT services.

- **Return path trials** – advanced interactive services require a return channel for content. Various tests have been made for alternative technologies for the return channel (though details are as yet unavailable).

66 Only the 15 largest cities in Italy could receive all five multiplexes in mid 2004.

Technology	*Details*
GPRS (2.5G mobile technology) ADSL	Multiplex operator Telecom Italia has tested both mobile and fixed telecom return channels
DVB-RCT	Itelco (manufacturer) has tested the DVB wireless return path, DVB-RCT

Exhibit A.52: *Return Path tests in Italy [Source: Analysys, Informa]*

- **Spectrum trading –** the Italian legal system allows for the trading of frequencies. This has been a means of ensuring that spectrum is available to parties interested in using it for DTT services. Greater spectrum availability enables service coverage to be increased cost-effectively by not requiring more transmitter sites. In 2003, Mediaset acquired spectrum from two regional channels.

A.7 The Netherlands

Digitenne, a DTT platform, was launched in the Netherlands in April 2003. Although Digitenne is a Pay TV platform, it is distinct from the first implementations of DTT in the UK and Spain:

- Digitenne does not compete head on with premium Pay TV content offerings, such as those available from DTH operators (Canal Satellite Digital in the Netherlands).
- Although subscribers pay a monthly charge for the service, this is below what the majority of households are accustomed to pay for the widespread analogue cable service. In the Netherlands, such payments are largely considered by consumers as part of the basic household expenditure (and consequently Digitenne is not fighting for the discretionary household spend).[67]
- The focus of Digitenne is not on a multi-channel where DTT has traditionally struggled to compete with the capacity available via DTH and cable.

Instead, the Netherlands provides examples of some digital television market leading innovations:

67 i.e. discretional spend that a household may have, once basic needs are met.

- Digitenne is another leading example of a DTT platform differentiating itself primarily on the basis of a technological innovation: the marketing focus of Digitenne is on its portable reception.[68] (Although portability has long been technically feasible, Digitenne represents one of the first cases where this technology enable feature has been used to differentiate a television offering).
- Digitenne provides the first example of a DTT implementation focused on the second TV set market. In the Netherlands, less than an estimated 100 000 households depend solely on terrestrial means for watching television.[69] An innovate pricing model has also been developed, which benefits from serving multiple television sets in the same household.[70]

In the Netherlands, the vast majority of Dutch households access television via analogue cable. Consequently, Digitenne expects take-up in cable households driven by its portable reception advantage. The example of the Netherlands thus provides a test case for selling DTT on the back of technology innovation. However, some doubt surrounds Digitenne's chances of success, with the value placed by consumers on portability being unclear.

The following table highlights key stages in the development of DTT in the Netherlands:

Date	*Development*
August 2001	Digitenne established
January 2002	Digitenne receives licence to be DTT operator
April 2003	Official launch of DTT on the 23rd of April
January 2004	Estimated 40 000 Digitenne subscribers
May 2004	Coverage increased to 2.7 million households in and around Amsterdam, the Hague and Utrecht
Summer 2004	Coverage increased to 3 million households by inclusion of Rotterdam

Exhibit A.53: *Key dates in DTT development [Source: Analysys]*

Digitenne is owned by the various DTT stakeholders that include: the incumbent telecoms operator KPN, a consortium of broadcasters, a production company (NOB), as well as the broadcast transmission network, Nozema. The involvement of Nozema has been

68 Portable reception has also been highlighted as a key benefit of DTT in Berlin-Brandenburg (Germany).

69 Market reports suggest that the number of terrestrial dependent households could be as low as 65 000.

70 i.e. the per television tariff is lower if multiple television sets are connected.

controversial given that it is still partly state-owned.[71] Furthermore, KPN is helping market Digitenne services with KPN customers being offered discounts on Digitenne. This has also raised some concerns in light of KPN's dominance in the telecoms market. However, KPN do not have a significant presence in the broadcasting market.

A.7.1 TV market context

Cable is dominant in the Netherlands

The Dutch television market is dominated by analogue cable services: an estimated 92% of households take analogue cable. Penetration of digital cable is low, with only an approximate 100 000 digital cable households.

Analogue cable is seen as a utility service, with viewers typically receiving 30 channels for around EUR11. The following table shows key figures for the Dutch television market. The national public service broadcaster is NOS, which is funded by both public sources (State budget) as well as advertising revenues. It maintains three channels, with the majority of the content for these channels coming from eight broadcast associations.

Number of analogue terrestrial channels	3[72]
Public Service Broadcaster (PSB)	NOS
Number of PSB analogue channels	3
TV Households	6.7 million
Terrestrial only TV Households	0.1 million
Cable TV Households	6.2 million
DTH TV Households	0.4 million

Exhibit 54: *Key features of the Dutch TV market [Source: Analysys, Informa, BIPE]*

Terrestrial viewing is very low

Only an estimated 1–2% of TV households depend on terrestrial means to watch television. This is amongst the lowest in Europe.

71 According to the original plan for the funding of DTT, Nozema was expected to exit the consortium mid 2004. However, the lack of a new external shareholder and the government's unwillingness to allow KPN to become the majority shareholder has prevented this from occurring.

72 In the Netherlands, only the Public service broadcaster channels can be received through analogue terrestrial due to the lack of available spectrum (Source: Interview with Ministry of Economic Affairs).

A.7.2 Assignment of frequencies

The following table highlights key features of the assignment of DTT multiplexes in the Netherlands.

Number of multiplexes	5
Channels per multiplex	5-6
Assignment mechanism	Per multiplex
Business Model	Pay TV

Exhibit A.55: *Licensing of DTT [Source: Analysys, EPRA, other]*

Digitenne has been given four multiplexes…

The Pay TV platform Digitenne has developed its offering making use of four multiplexes. Digitenne was granted a 15-year commercial licence by the government in January 2002. The Ministry of Economic Affairs is the licensing authority.

…and one multiplex is reserved for the PSB

One multiplex has been reserved for the PSB NOS. NOS offers simulcasts of its analogue channels Nederland 1, Nederland 2 and Nederland 3.

The following table summarises the DTT industry structure.

Type	*Details*
Channels	Selected by the multiplex operator
Multiplex	4 multiplexes licensed to Digitenne, 1 to PSB
Network	Nozema is the authorised network operator

Exhibit A.56: *DTT Structure [Source: EPRA, other]*

A.7.3 The business model

A Pay TV business model exists…

The business model of Digitenne is one of a Pay TV operator. Subscribers to the platform gain access to approximately 25 channels in return for a monthly subscription fee. The offer is structurally similar to that provided by ITV Digital in the UK and Quiero in Spain. As in the UK and Spain (1998–2002), DTT viewers can access content from a Pay TV platform as well as content from the incumbent terrestrial broadcasters.

…in a context different from ITV

However, the Dutch television market is significantly different, with the majority of viewers used to pay a monthly subscription fee to cable

Digital and Quiero…

operators for analogue television. As a result, consumers view such payments as part of the basic household expenditure. Thus, DTT competes for household spend that is already committed to television (instead of requiring an incremental spend).

…with differentiation based on portability

Digitenne is a leading example of a DTT platform differentiating itself primarily on the basis of a technological innovation: the marketing focus of Digitenne is on its portable reception. Digitenne's subscribers can receive the DTT signal without the need for a cable, at any location in the home, as well as in the garden or on a boat.

Apart from the limited number of terrestrial households, Digitenne's target market consists of the cable households. Given the multi-channel capabilities of cable, DTT has focused upon the technological improvements of portable reception, and expects penetration of cable households to be driven by serving the second television set in such households.

Basic package is supplemented by premium channels

The Digitenne offering consists of a basic pay package that provides approximately 20 channels to viewers, and is designed to compete against the offering of cable operators. A number of FTA channels are included as part of this package, as shown in the table below. Furthermore, Canal+ offers three premium channels (at approximately the same tariff as on cable). In total, 25 channels are currently offered. This is slightly lower than the basic package of a cable operator (typically 30 channels).

Free to Air (FTA)	*Basic Package*	*Premium content*
Nederland 1	Fox Kids	Canal+ Rood
Nederland 2	Nickelodeon	Canal+ Blauw
Nederland 3	Discovery Channel	Canal+ Geel
RTL4	Animal Planet	
RTL5	National Geographic	
SBS6	Eurosport	
Yorin	MTV	
NET5	TMF	
Veronica	CNN	
Regio TV	BBC World	
	Spice Platinum	

***Exhibit A.57**: DTT offering in the Netherlands [Source: Digitenne, Informa]*

An innovative pricing model is used

An innovative pricing model has been developed, that takes into account the number of television sets using the Digitenne service. The subscription fee is EUR8.95 per month for one television set, EUR11.95 for two and EUR14.95 for three (by comparison, a typical cable service is higher than Digitenne's starting price, at EUR11 per month).[73]

Interestingly, Digitenne is benefiting from KPN's marketing facilities. KPN offers Digitenne's services to KPN's customers at discounts. Customers who already have a phone subscription and ADSL Internet connection from KPN pay only EUR7.95 a month (for one television set). This has also raised some concerns in light of KPN's dominance in the telecoms market.

Nozema is the network operator (it is partly State-owned)

As shown in the exhibit below, the DTT network is operated by Nozema, who is paid by Digitenne and the PSB NOS. The transmission fees are based on commercial negotiations between the relevant parties.

73 Pricing information from Informa media. Encryption and Conditional Access is required to protect the Pay TV signal.

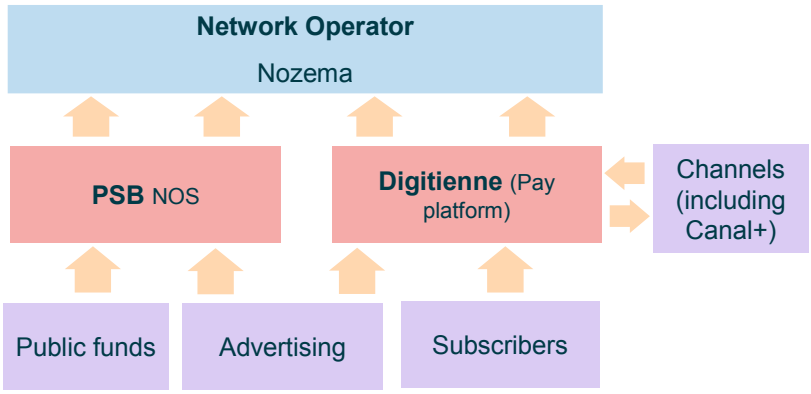

Exhibit A.58:
Analysis: The launch of DTT in The Netherlands [Source: Analysys]

DTT had achieved 40 000 subscribers as of May 2004

DTT was launched in April 2003 in the Netherlands and by May 2004 Digitenne had acquired 40 000 subscribers.

This represents a significant proportion of the terrestrial households in the Netherlands (estimated at a maximum of 100 000). However, Digitenne expects significant take-up for second television sets in cable households, and an estimated 50% of Digitenne's subscribers are taking the services for second TV sets.

It is backed by a wide consortium of stakeholders

A variety of stakeholders have come together in launching the DTT platform in the Netherlands. The shareholders of Digitenne include key members of the DTT value chain:

- **content owner** – production company, NOB
- **broadcasters –** a consortium of commercial broadcasters
- **network operator –** broadcast transmission network, Nozema.

Additionally, the incumbent telecoms operator KPN is a key stakeholder. Digitenne, with the support of key stakeholders, has been able to champion the DTT platform.

Viewers buy STBs direct from retailers

A number of STBs are now available in the Dutch market, which consumers can buy directly from retailers. The price range of STBs is wide, with the cheapest retailing at approximately EUR149 (Brainwave) and more expensive models going up to EUR676. These boxes contain conditional access systems enabling viewers to access the encrypted Digitenne broadcasts, and come with small antennas. This explains the higher prices than those in some other European markets.

STBs are certified by Digitenne

Digitenne certifies that the STBs are compatible with their platform. This has helped avoid some problems as experienced in the UK at the beginning. However, the certification process has also resulted in some delays as only one manufacturer (Rebox) had been certified at Digitenne's launch.

A.7.4 Analysis: the outlook for DTT in the Netherlands

Digitenne represents a test case for the appeal of portable reception

Digitenne is a test cast for take-up based on the appeal of portable reception. To date, although technology improvements have been part of the appeal of other DTT offerings, for example portable reception in Berlin-Brandenburg, no DTT launch has centred around the unique proposition of portability.[74]

The small captive market of DTT in the Netherlands, i.e. households relying on analogue terrestrial for television, implies that the commercial success of Digitenne depends on penetration of cable households.

KPN's marketing and distribution may be a significant help

The recently started distribution and marketing of Digitenne together with KPN products, offering KPN's customers users discounts on Digitenne, may significantly aid Digitenne. Through KPN, Digitenne can access the mass market whilst keeping its marketing costs to a minimum.

Future developments in the shareholder structure may have some impact on support from KPN. KPN has wanted to take majority control of Digitenne but has not been permitted to do so, partly due to regulatory opposition (KPN is considered a dominant operator in the fixed telecoms market).

74 In Berlin, the captive market of analogue terrestrial households was substantially larger. The value proposition for such households centred in large part on multi-channel benefits.

A.7.5 Key technical issues

The following table shows some of the key technical parameters that have been chosen in the Netherlands.

Current coverage	45% of households
Target coverage	100% expected
Modulation type	64QAM
Type of network	SFN's[75]
Maximum transmitter power	10kW
Channel bandwidth	8MHz
FEC (redundancy)	2/3
Guard interval	1/4

Exhibit A.59: *Key Technical Parameters [Source: Analysys, DVB]*

The above table shows that the current population coverage of Digitenne is 45% (2004). At the moment, digital TV from KPN can be viewed throughout the Randstad area, comprising the cities of Amsterdam, Utrecht, The Hague and Rotterdam. It is expected that coverage will be extended across the country, possible by the end of 2006. However, a limitation exists from the perspective of frequency interference. Frequency co-ordination with surrounding countries has not been finalised and this may limit coverage in the meantime.

In line with the extension of coverage, plans have been proposed for digital switchover. A government-appointed commission has proposed that a switchover may begin by 2007. A regional switchover programme may be developed leading to nationwide switch-off over three to four years.

Widespread indoor reception has been a key innovation in the Netherlands. The DTT network has been planned for indoor reception at ground level, for 70% of the covered area (and a higher percentage of covered population). This is likely to rise to 90–95% for main urban centres, given the proximity of key transmitters to such areas. Furthermore, indoor reception at first floor level will be considerably higher. No current plans exist for the

75 Cluster of dense region-wide SFN transmitters. The PSB multiplex includes regional programming: therefore the SFN coverage areas are matched as much as possible to the actual geographical regions

implementation of mobile TV reception, based on the current DTT network or DVB-H. However, some tests have been undertaken for in-car reception using DVB-T.

The certification of STBs by Digitenne has helped avoid significant STB problems and no serious reception problems have been observed. The pre-launch DTT coverage predictions compare well with actual coverage achieved by the transmitters.[76]

A.8 France

France provides an attractive environment for DTT: the TV market is large, broadly comparable to the UK in terms of household numbers, and penetration of non-terrestrial platforms (cable and DTH). However, despite a favourable market environment, the regulatory process may negatively impact development. Although regulatory preparations started in 2002, no DTT services have yet been launched.

Following recent policy decisions, a FTA DTT launch has taken place in March 2005. This is to be followed by a Pay TV offering before March 2006. The following characteristics of the French market should help DTT take-up:

- low multi-channel penetration provides an attractive opportunity for FTA DTT
- France has chosen a hybrid business model, with a significant FTA component that has been successful in other countries.

A strong FTA offering has been key to DTT success elsewhere, and is likely to be replicated in France. However, the regulatory process has hindered developments so far and fears exist that some of the same difficulties experienced in other countries may also curb DTT development in France:

- **Per-channel licensing** – France has opted for a per channel licensing regime. As in the cases of Sweden and Finland, such a licensing regime may prove rigid and is already threatening to delay the launch of DTT in France.

76 Furthermore, no SFN interference nor pre-echo problems have been reported (as occurred in some other countries)

- **Standards –** some uncertainty has surrounded the technical standard for DTT in France. After much debate and over the relative merits of using MPEG2 and MPEG4.10, both have being chosen (for FTA and Pay TV respectively) following the Prime Ministers' intervention. However, the use of two different standards may cause some market confusion and hinder DTT development.

Hybrid business models for DTT have developed in other European countries but the success of its pay TV component is still unproven. Uncertainty regarding Pay TV is even greater in France, given the recent revoking of assigned pay TV licences, the fact no platform operator has been chosen and the lack of clarity on technical standard to be used.

The following table highlights key stages in the development of DTT in France: *Date*	*Development*
March 2002	70 channels apply for DTT licences
October 2002	CSA choose 20 channels for DTT (in addition to existing analogue channels)
June 2004	Legislation for DTT finalised, committing France to analogue switch-off 5 years after the start of DTT
October 2004	Government rules in favour of using MPEG2 technology for FTA DTT
October 2004	Government revokes 6 of the channel licences issued
16 December 2004	CSA issued a new tender for 6 channels
28 February 2005	Closing date for receipt of licence applications (in response to new CSA tender)
17 May 2005	Issue of new licences for 6 channels
March 2005	Launch of FTA DTT in MPEG2
September 2005 - March 2006	Expected launch of Pay DTT in MPEG4.10

Exhibit A.60: *Key dates in DTT development [Source: Analysys, CSA]*

A.8.1 TV market context

A variety of pay TV competitors exist…

In France, pay TV was introduced early with the launch of the single analogue pay channel (Canal+) in 1984. In addition to Canal+, a number of other Pay TV operators exist:

- This includes the two DTH platforms, TPS and Canal Satellite, that collectively have an estimated 4 million subscribers as shown by the table below.
- France has an approximate 3.75 million cable television subscribers (Source: Informa). Of this, less than 1 million are digital: growth in digital cable subscribers is slow and is estimated at around 120 000 per year.
- Furthermore, TV over DSL has been recently launched in France by several companies including Neuf Telecom, Free, and France Telecom that all propose major FTA channels as well as TPS and Canal+ channels.

Number of Analogue terrestrial channels	6[77]
Public Service Broadcaster (PSB)	France Television
Number of PSB analogue channels	3
TV Households	23.5 million
Terrestrial only TV Households	15.7 million
Cable TV Households	3.75 million
DTH TV Households	4 million

Exhibit A.61: *Key features of TV market [Source: Analysys, Informa]*

…though multi-channel penetration is limited

Despite the large variety of Pay TV players offering multi-channel services, the penetration of these services is limited with an estimated 15.7 million households reliant on terrestrial television (Canal+ has an estimate two million analogue terrestrial Pay TV customers). Consequently, its is expected that a FTA multi-channel offering may find a market in France.

A.8.2 Assignment of frequencies

The following table highlights key features of DTT multiplexes in France:

77 Including the Pay channel, Canal+. The other channels are TF1, France 2, France 3, Arte/France 5 and M6.

Number of multiplexes	6, of which 5 have been assigned [78]
Channels per multiplex	5-6
Assignment mechanism	Per channel
Business model	Hybrid FTA and pay TV

Exhibit A.62: *Licensing of DTT [Source: Analysys, EPRA, other]*

Assignment began in 2002, with per channel assignments

The Conseil Supérieur de L'Audiovisuel (CSA) is the broadcast assignment authority in France and ART (Agence de Régulation des Télécommunications) is in charge of DTT network planning. In March 2002, 70 channels applied to launch on DTT. The CSA considered these applications and by October 2002 had chosen channels to launch on the platform (see Exhibit A.64 below).

Combination of FTA and Pay channels licensed

The CSA considered the applications against a range of criteria that included consumer interest, pluralism, experience and the financial resources of the applicants. The licensed channels include:

- **analogue simulcasts** – the existing analogue terrestrial broadcasters have the right to a single DTT channel licence
- **FTA –** six additional FTA channels were licensed
- **Pay-TV channels –** 14 pay-TV channels.

However, some of the licences have since been revoked

On 20th October 2004, the Conseil D'Etat revoked six of the channel licences awarded, on the grounds of pluralism: the law limits to 6 the number of DTT channel licences a single company can possess. The following licences awarded to Canal+/Lagardère have been withdrawn: iMCM, Canal J, Sport+, I-Télé, Ciné-Cinéma Premier et Planète.

One of the cancelled authorisations was for a free channel (MCM), and the remainder for pay channels. The CSA has since launched a public process to reassign (consultation on 21 October 2004; tender on 16 December 2004) the freed channels. The closing date for

78 Channels on multiplex R5 are yet to be assigned.

submitting applications is 28 February 2005, with channel assignments expected to take-place by mid-May. The following table shows the structure of DTT in France:

Type	*Details*
Channels	Selected and licensed by the CSA
Multiplex	Selected by the channels sharing multiplex. Multiplex operator plays technical role
Network	Chosen by multiplex operator. TDF, Antalis and Towercast are the competing network operators[79]

Exhibit A.63: *DTT Structure [Source: CSA, other]*

A.8.3 The business model

A hybrid business model has been chosen

When DTT is launched, it is expected that there will be a basic offering of 15 channels complemented by a Pay TV package (the following table shows the channels that are to be available on DTT).

No pricing information has been released for the pay TV offering. However, an offering in the range of EUR10-15 is expected in order to make the Pay TV component a success.

79 TDF is a key network operator as it is the analogue transmission network operator and owns a significant proportion of the DTT transmission sites (chosen by CSA).

Free to Air (FTA)	*Pay TV channels*
TF1	AB1
M6	Comédie !
Canal+ for its free service	Cuisine TV
France 2	Eurosport France
France 3	LCI
France 5	Match TV
Festival	Paris Première
Arte	TF6
La Chaîne parlementaire	TPS Star
Direct 8	5 channels to be chosen
M6 Music	
NRJ TV	
NT1	
TMC	
1 channel to be chosen	

Exhibit A.64: *DTT offering in France [80] [Source: Informa, CSA, Others]*

Doubts exist regarding the pay offering…

A Pay TV offering requires a platform operator that will promote the cause of pay DTT and undertake subscriber management, marketing, encryption, conditional access and other essential Pay TV activities. The lack of a Pay TV platform operator places in doubt the future of DTT in France. Key commercial broadcasters with a stake in Pay TV have included Canal+ and TPS and the CSA has discussed the provision of platform operator service with both companies, but so far they have not accepted this role.[81]

…with Canal+ and TPS not yet accepting to be platform operators

Canal+ and TPS both have investments in alternative platform and therefore it is unclear how strongly they will invest in a DTT pay platform (TPS is a DTH operator and has also invested in TV over DSL, as is the case for Canal+). The lack of a Pay TV platform can also be attributed to:

80 Following the Conseil d'Etat's decision to cancel the FTA channel MCM's licence, as well as the following Pay TV channel licences: Canal J, Sport+, I-Télévision, Ciné-Cinéma Premier and Planète. Of these, I-Télévision and Ciné-Cinéma Premier belong to the Canal+/Lagadere group. Canal+ retains the following channels on DTT: Canal+, Match TV, Cuisine TV, Comédie.

81 Note that Canal+ Pay TV licences have been withdrawn. These licences will be reassigned to broadcasters by the CSA. Currently therefore, it is unclear whether the Canal+ Pay content will be available on DTT.

- uncertainty about the technical standard to be used for Pay TV, MPEG2 or MPEG4.10 (see Section A.8.4 below)
- following the recent cancellation of the Canal+ Pay TV channels on DTT (Ciné-Cinéma Premier), Canal+ will need to participate in the licensing process to obtain additional Pay TV channels.

Each may have different incentives to take this role

Canal+ and TPS may lead DTT developments for different reasons. Canal+ has an estimated two million analogue terrestrial subscribers.[82] As analogue turn-off approaches, Canal+ will need to find a solution to maintain this customer base It may decide that DTT is a suitable platform for such subscribers, and this may encourage it in leading the DTT Pay offering (as a platform operator). However, TPS may accept the role of Pay TV platform operator and launch services before the expected September 2005 date (using MPEG2) in order to gain a competitive advantage.

It is generally expected that either Canal+ or TPS may eventually become the pay TV platform operator. However, it is still unclear whether if only one of them takes on this role, or two platforms with separate conditional access systems exist in parallel.

Several network operators exist

The exhibit below shows the DTT business model in France. FTA and Pay TV channels exist on several multiplexes, with channels on the same multiplex co-operating to form multiplex operators. In general, the CSA has assigned channels on the basis of 'affinity', i.e. channels from the same broadcaster grouped together on the same multiplex.

The multiplex operators chose the network operator from amongst three competing operators: TDF, Antalis and Towercast. ART has identified the sites to be used for transmission, and TDF (as incumbent national television transmission network) controls a large proportion of such sites. Most multiplexes transmissions sites are

82 Industry estimate. Canal+ does not publish its Pay analogue terrestrial subscribers figures.

used by the various multiplex network operators, reflecting the distribution of the sites between the networks. However, multiplex R6 is planned to be fully transmitted by TDF.[83]

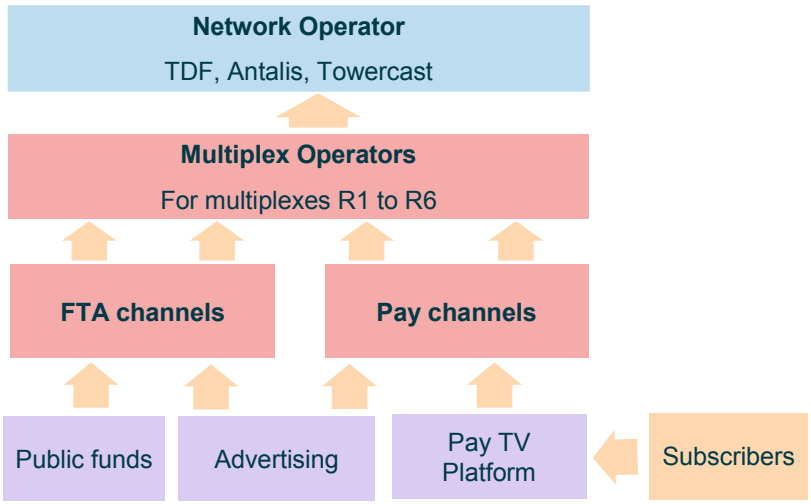

Exhibit A.65: *DTT value chain in France [Source: Analysys]*

A.8.4 Analysis: the outlook for DTT in France

A timetable for DTT deployment has been decided…

The government and the CSA finally took their decision and DTT will be launched in two steps in 2005. FTA channels were launched in March 2005, and are to be followed by the Pay channels over September 2005-March 2006. One of the reason to have this delay for Pay TV is that some pay TV broadcasters want to have a FTA subscriber base before launching pay channels.

83 Note that a wholesale market enabling a particular network operator to use sites owned by other network operators exists, thus permitting a single network operator to provide widespread coverage.

Low cost STBs available in the first quarter of 2005

Customers are to be able to buy the first STBs in the first quarter of 2005, before transmission begins. Industry bodies do not want STBs to be available sooner for fear of disappointing consumers with a lack of service before the official launch date. They are expected to retail at around EUR30, and will be provide only basic functionality (no interactivity). More advanced STB will become available later as the STB market develops. The launch of pay services will be accompanied by STBs that can handle services from different pay broadcasters (likely to be Canal+ and TPS) as such interoperability is a legal requirement.

Much debate over technical standards has taken place…

Much debate has taken place in France regarding the use of MPEG2 or MPEG4.10 coding standards. Although MPEG4.10 is more spectrum efficient enabling more content to be broadcast, it represents a new standard with limited equipment available in the market today.

Various DTT stakeholders have been lobbying the government on this issue. Some broadcasters (TF1 and M6) have been in favour of MPEG4.10, given its greater transmission efficiency. They have argued that DTT should be for HDTV only, with the use of MPEG4.10 providing the required transmission capacity.[84] They represent one of the few proponents of better picture quality as the objective of DTT (instead of more channels or interactive TV). However, TF1's position may be influenced by their existing participation in the pay TV market (via the DTH pay TV platform TPS), making them less keen on a FTA multi-channel offering.

…the government has opted for both MPEG2 and MPEG4.10

Following a period of uncertainty, the government has decided that MPEG2 be used for FTA DTT and MPEG4.10 for Pay DTT. Although this brings the benefit of MPEG4.10's coding efficiency, the decision carries three primary risks:

84 TF1 has not been a key supporter of DTT development. Earlier, TF1 caused some difficulties in DTT network planning as they did not want vacant frequencies required for DTT. However, this was enforced by a court ruling in spring 2003.

- Unavailability of MPEG4.10 capable chip-sets and STBs may cause delays in Pay TV launch.

- Upon launch, STB's price are likely to be higher than MPEG2 STBs, thus potentially reducing the take-up

- Finally, there is a risk that the use of multiple standards may lead to market confusion and subsequent low take-up of DTT

…and the use of a multiplex is yet undecided

The French government had reserved six multiplex for DTT. Of these, channels have been assigned on five multiplexes. A decision regarding the use of the sixth multiplex (R5) is still to be taken and the CSA has been undertaking public consultations.

A.8.5 Key technical issues

Apart from the much-debated issue of whether MPEG2 or MPEG4.10 should be used in France, no significant technical challenges have arisen so far. The following table shows some of the technical parameters that have been adopted:

Current Coverage	0%
Target Coverage	80 - 85%
Modulation Type	64QAM
Type of Network	SFN (whenever possible)
Channel bandwidth	8k
FEC (redundancy)	-
Guard Interval	-

Exhibit A.66: *Key Technical Parameters [Source: Analysys, CSA, DVB]*

In terms of coverage, the new service is expected to broadcast programmes to 35% of the population at launch, rising to 50% by the time pay TV starts. Coverage obligations require that the DTT is deployed at 115 sites by 2007. This is expected to provide an 85% population coverage. It still has not been decided how digital television will be provided to the regions where DTT will not be available. Analogue Switch-off is planned to take place five years after the launch of DTT (i.e. 2010) if penetration of STBs is deemed to be sufficiently high.

A.9 Austria

Although the policy regime for DTT in Austria has been significantly developed, no licensing has taken place yet and actual implementation is currently limited to a trial in the region of Graz. Despite significant penetration of cable and DTH services, terrestrial broadcasting is considered important due to the unavailability of the key PSB channels and ATV, a commercial analogue terrestrial channel, via analogue DTH. The key features of the policy regime that has been defined for DTT are:

- **Four stage process –** migration to DTT and analogue switch-off is planned to be achieved via a four-stage process, which includes regional switch-off and 6-12 month simulcasts. As such, this process benefits from the experience gained from Germany and is in line with thinking in other countries such as the UK and Sweden.

- **Digitalisation fund** – a fund has been created to help the transition to digital, as Austrian policy makers believe that market forces will be insufficient in achieving full digitisation. This fund may be used for developing the terrestrial transmitter infrastructure as well as grants to broadcasters, amongst other things. In the course of 2004, the Austrian government has made a number of modifications in the legal bases of the fund. The fund has been notified to the European Commission for State aid clearance.

The trial in Graz is significant as it will inform the future implementation of DTT in Austria, both in terms of the services to be offered as well as the business model. A key feature of the trial has been the active participation of various stakeholders, something that will facilitate the rollout of commercial services. Such services are expected to be launched in 2006. The following table highlights key DTT events in Austria.

Date	*Development*
2001	Legislation in place
2002	At the end of January Digital Platform Austria (DPA) established
2003	Digital switchover strategy developed
Q2-2004	Pilot trial in Graz
2005	Tender for DTT licence
2006	Expected full launch
2010 onwards	Analogue switch off

Exhibit A.67: *Key dates in DTT development [Source: Analysys]*

A.9.1 TV market context

Cable and DTH widespread…

As can be seen from the table below, cable and DTH services are widespread in Austria. In fact, approximately only 16% of households have terrestrial-only reception, receiving three analogue terrestrial channels of which two are provided by the PSB.

Number of analogue terrestrial channels	3
Public Sector Broadcaster (PSB)	Austrian Broadcasting Corporation (ORF)
Number of PSB analogue channels	2
TV Households	3.3 million
Terrestrial only TV Households	0.5 million
Cable TV Households	1.3 million
DTH TV Households	1.5 million

Exhibit A.68: *Key features of TV market [Source: Analysys, Informa, Regulator]*

...but terrestrial broadcasting is important

Despite the limited dependence on terrestrial means for television viewing in Austria, terrestrial broadcasting remains important. This is because the majority of DTH households have analogue satellite reception and cannot receive the FTA analogue terrestrial channels, including the two PSB ones. For content protection reasons, these channels are only available encrypted via the digital DTH service. Consequently, an estimated 60% of households depend on terrestrial means for viewing these channels.

A.9.2 Assignment of frequencies

No DTT multiplexes have yet been issued in Austria. It is expected that multiplexes will be assigned in a public process in 2005, permitting the launch of full scale DTT services in 2006. However, no details are yet available as to the assignment regime that is to be implemented.

A.9.3 The business model

The business model for DTT in Austria has not been decided yet. Nonetheless, it is expected that an FTA offering may be developed, possibly with a Pay TV component. Results from DTT trials (see below) are expected to feed into deciding the appropriate business model.

A.9.4 Analysis: the launch of DTT in Austria

Digital Platform Austria established, bringing together key stakeholders…

In January 2002, the Digital Platform Austria (DPA), a working group, was established to focus efforts on the implementation of DVB-T in Austria. The DPA brings together a wide range of DTT stakeholders, including broadcasters, network operators, policy makers and consumers. It has approximately 300 members.

The DPA is managed by the regulator (RTR) and was established on the initiative of the Federal Chancellor, following the passing of the Private Television Act (PrTV-G) in 2001, which laid down the legal basis for digitization in Austria.

…and it supports the regulator in planning for DTT

The DPA supports the regulator and plays an important part in developing the plan for the introduction of digital broadcasting in Austria. It is also involved in providing an annual report on digitisation progress.

The regulator body in charge of developing DTT is the Austrian Communications Authority (KommAustria). KommAustria is directly subordinate to the Federal Chancellor, and relies on RTR-GmbH, as supporting body, in the execution of its functions.[85]

Austria places much importance on DTT ...

Despite widespread cable and DTH availability, Austria is placing significant importance on terrestrial broadcasting and DTT. This is partly due to the significant proportion of households that still depend on terrestrial means to watch the PSB channels ORF1 and ORF2 (as well as the commercial channel ATV).

85 KommAustria was established in 2001 to lead broadcasting regulatory activities

… partly from a desire to maintain Austria's cultural identity

Another key motivation of Austria in maintaining a strong terrestrial broadcast is its potential in helping to preserve Austria's cultural identity. Terrestrial broadcasting allows for local and regional distribution of content, unlike DTH where typically larger areas are covered. Consequently, it is seen as a suitable platform for the diffusion of Austrian content.

Trials have been held in Graz, supported by key stakeholders…

A DTT trial has been undertaken in the Graz region of Austria in 2004. The area of Graz was selected as a Regional Agency provided part of the funding for the project.[86]

The three month trial used one DTT multiplex and offered ORF's two channels, the commercial channel, and MHP based interactive television applications. The trial is based on a cooperation between key stakeholders:

- Digital Platform Austria and RTR (policy makers)
- ORF (PSB)
- Telekom Austria (network operator)
- Siemens (equipment manufacturer).

…and has focused on the services to be offered

The trials have focused on developing an understanding of the services and business model that is appropriate for DTT in Austria. In particular, interactive services based on the MHP standard have been tested: approximately 150 households that agreed to take part in market research were provided with MHP STBs.

The data collected from the trials on acceptance and usage of the applications will provide guidance as to relevant service and the business model that may be used for DTT in Austria. The trial was extended into August 2004 in 80 households (originally planned to end in July 2004).

86 Styrian Business Promotion Agency (SFG).

A.9.5 Analysis: the outlook for DTT in Austria

A four-stage digitisation process has been defined

The implementation of DTT is expected to take several years, and the regulator has developed a four-stage plan that aims to achieve widespread DTT coverage (more than 90%). The plan is outlined in the table below.

Stage	*Plans*
Stage 1: 2003 until end 2005	Frequency planning and coordination DVB-T pilot operations like in Graz in 2004 Preparatory surveys and studies Preparation and implementation of the multiplex tender
Stage 2: 2006	Development of network "islands" in densely populated areas by the operator of the multiplex Progressive provision of DTT in densely populated areas: 60% of the population covered in the first year of licence award Review of the digitisation plan
Stage 3: 2007 to 2010	Sequential analogue switch-off in federal provinces Simulcast phase limited from six to twelve months
Stage 4: from 2010	Post-analogue turn-off, 5-6 multiplexes expected Call for tenders and award of further multiplex platforms At least one multiplex of over 90% coverage (stationary) 2-3 channels with 70% stationary and 40% portable indoor reception

Exhibit A.69: *Digitisation plan [Source: Analysys, RTR)*

Full switch-off is forecast for 2010

As shown above, full switch-off is expected by 2010. Current plans may focus on the next two to three years and may change based on technical experience, consumer acceptance and the results of international frequency planning agreements. Nonetheless, Austria currently expects that in the long term there will be 5-6 DTT multiplexes, with some multiplexes providing 90% coverage.

A digitisation fund has been created…

In order to achieve the above digitisation plan, Austria created a digitisation fund in 2004 that will receive annually EUR7.5 million from the state.[87] The fund may be used for the following purposes:

87 In accordance with the Broadcasting Fees Act (RGG).

1	Scientific studies and analyses on technical, economic, programme-related and consumer-oriented issues in connection with the introduction of digital transmission of broadcasting programmes
2	Promotion of pilot trials and research projects on digital transmission of broadcasting programmes
3	Development of programmes and supplementary services, such as electronic programme guides, navigators, interactive and mobile applications, which demonstrate digital added value of digital transmission and go beyond conventional broadcasting applications
4	Measures designed for public information on digital transmission of broadcasting programmes
5	Planning and establishment of the terrestrial transmitter infrastructure for the transmission of digital broadcasting programmes, with the view to optimising the transmitter network and achieving an appropriate degree of coverage in rural areas
6	Promotion of the acquisition of terminal equipment required for the reception of digitally transmitted broadcasting programmes
7	Grants to broadcasting providers to facilitate the transition from analogue to digital transmission
8	Measures designed to create financial incentives for consumers migrating to digital terrestrial reception of broadcasting programmes early
9	Financing of the expenses of KommAustria and RTR-GmbH incurred in the preparation and implementation of the Digitisation Plan

Exhibit A.70: *Uses of the digitisation fund [Source: RTR]*

…and is planned to be technology neutral

Although no details are currently available, the regulator has stated:

> "*Even though grants from the fund will focus on terrestrial broadcasting, where the situation is especially difficult, the Fund takes a technology-neutral approach which is open to supporting all forms of digital broadcasting*"

Furthermore, the guidelines for awards from the digitisation fund have been notified to the European Commission to investigate their compatibility with the State aid rules.

A.9.6 Key technical issues

The following table shows some of the key DTT technical parameters in Austria.

Current Coverage	Limited, only trial in Graz
Target Coverage	Undecided (90% for a minimum of one multiplex expected)
Modulation Type	16QAM
Type of Network	SFN being used for trial
Channel bandwidth	8MHz
FEC (redundancy)	3/4
Guard Interval	1/8

Exhibit A.71: *Key technical parameters [Source: Analysys, DVB]*

The trial in Graz uses an SFN network, transmitting from two sites. Interference with existing analogue TV transmitters was checked before the trial commenced. The trial includes the testing of interactive services. However, results from the trial have not been published yet.

A.10 Poland

Poland is one of the most advanced television markets in Eastern Europe, with a number of broadcasters offering television services via terrestrial, cable and direct-to-the-home (DTH) platforms. In spite of this and the fact that DTT preparations have been underway since 1998, DTT in Poland is still in its early phases of development. A number of trials have already taken place, however, the legal and regulatory structure required for the market launch of DTT has not yet been put in place.[88] A government committee is currently working on a digital media strategy, which is expected to be finalised sometime in 2005.

It is expected that DTT launch in Poland will take place in two stages. Initially, two multiplexes are expected to be assigned to the current analogue terrestrial broadcasters: the public service broadcaster (PSB) TVP and the commercial service broadcasters (CSB)

88 TVP (Telewizja Polska S.A) began DTT trials in Warsaw in 2001 and these have since been extended to several other areas of the country, including Wisla Skrzyczne in January 2005.

Polsat and TVN. Eventually, it is expected that seven multiplexes will be operational. Given the low Internet penetration in Poland, the government would like DTT to contribute to ICT services, although no specific measures have yet been established.

The current analogue terrestrial broadcasters have been in discussions regarding the establishment of a common operator for the first stage of DTT launch. However, the PSB has withdrawn from the consortium leaving the two CSBs, which expect that the launch of services may take place towards the end of 2005. It should be noted that the PSB (TVP) is more advanced in its preparations for DTT launch and may launch independent DTT services if and when it is assigned frequencies.

According to the Polish government, the transition from analogue to digital broadcasting in Poland is likely to be undertaken on a region-by-region basis, starting in Wielkopolska and Warsaw; it is expceted to be completed by 2014. Exhibit A.72 below outlines the key developments that DTT has experienced in Poland.

Date	*Development*
1998	First DTT plan developed
2001	TVP starts DTT trials
2003	Outline DTT plans developed
2005	Polish government likely to approve a plan for DTT
Late 2005-06	Expected launch of DTT platform
2014	Expected analogue switch-off

Exhibit A.72: *Key dates in DTT development in Poland [Source: Analysys]*

A.10.1 TV market context

Approximately 95% of the population has access to terrestrial television

In Poland, only the two channels provided by the PSB are subject to coverage obligations. The Telecommunication Law and Broadcasting Act requires PSB channels to cover 80% of the population; in fact, the main PSB channel provides 95% population coverage and the second PSB channel 93%. There are also two CSBs (Polsat and TVN) with one analogue terrestrial channel each, which provide approximately 95% and 35-40% population coverage.

Number of analogue terrestrial channels	4
PSB	TVP
Number of PSB analogue channels	1
TV households	12.3 million
Terrestrial only TV households	7.5 million
Cable TV households	3.8 million
DTH TV households	1 million

Exhibit A.73: *Key features of TV market in Poland [Source: EPRA, DVB]*

Despite growth in alternative platforms, terrestrial television remains important

Poland represents one of the more developed television markets in Eastern Europe. Two DTH operators compete for pay subscribers (Cyfra+ and Polsat Cyfrowy) against the cable operators, of which UPC is the largest. Cyfra+ was introduced in 1998, and benefited from the migration of Canal+ analogue terrestrial pay subscribers to the DTH platform.

However, despite growth in cable and DTH platforms, terrestrial television remains a key means of accessing television in Poland (as shown in Exhibit A.73 above).

A.10.2 Assignment of frequencies

Two multiplexes are to be assigned to existing broadcasters

To date, no frequencies have been assigned in Poland for DTT. However, as previously noted, it is likely that the launch of DTT in Poland will take place in two stages. Initially, two DTT multiplexes will be assigned to the existing analogue terrestrial broadcasters, public and commercial. It is expected that these broadcasters will provide services using MFN networks that allow regional disconnects (thus enabling regional content to be broadcast).

Beauty contest likely for remaining multiplexes

In the second stage, a further five multiplexes are expected to be available for DTT in Poland. The licensing body is the National Broadcasting Council (NBC), which is the broadcasting regulatory body. It is foreseen that the NBC will allocate multiplexes using a beauty contest. Once multiplexes have been assigned, the NBC will also help determine the channels that are distributed on each multiplex in order to ensure pluralism of content and broadcasters.

Number of multiplexes	7 expected
Channels per multiplex	-
Licensing mechanism	Beauty contest for five multiplexes expected
Business model	FTA for first two multiplexes

Exhibit A.74: *Licensing of DTT in Poland [Source: Analysys, EPRA, other]*

A.10.3 The business model

The broadcasts that are expected to be available in the first stage of DTT launch, via two multiplexes, will be free-to-air (FTA). No decisions have yet been taken with respect to the other five multiplexes.

A.10.4 Analysis – the outlook for DTT in Poland

The key broadcasters have established a DTT operator

The three analogue terrestrial broadcasters (TVP and the two CSBs) have negotiated the creation of a joint-owned company that may serve as the operator of the first two multiplexes. The company named Polski Operator Telewizjny (POT) may lead the launch and market communication of the DTT platform.

CSBs are likely to go ahead with DTT launch in late 2005

However, TVP has decided not to take part in POT, perhaps reflecting its desire to be assigned a DTT multiplex in order to launch independent DTT services. The commercial broadcasters Polsat and TVN have decided to go ahead with the joint DTT project, and services may be introduced by late 2005.

A.10.5 Key technical issues

DTT trials have been taking place in Warsaw since November 2001, and in Lodz and Wroclaw since March 2003, being led by the public broadcaster TVP. Viewers in these areas can receive TVP's two national channels (TVP1 and TVP2), its regional channel TVP3 and its public radio station Radio Rzeszów. Frequency agreements with Slovakia

have allowed these trials to be extended to new areas (Rzeszów, Sucha Góra) and in January 2005 TVP began DTT broadcasts in Wisla Skrzyczne in the south of the country.

Once the necessary legislation is in place and licences have been assigned, it is expected that DTT services will be rolled out on a region-by-region basis, with regional analogue switch-off eventually taking place by 2014. Spectrum occupancy is high in Poland and consequently long simulcast periods will not be possible. Instead, the Berlin model may be used, with progressive switch-off of analogue channels. However, as shown in Exhibit A.75 below, final DTT coverage objectives are yet to be established.

Current coverage	-
Target coverage	-
Modulation type	64QAM fixed & 16QAM portable
Type of network	MFN
Channel bandwidth	8MHz
FEC (redundancy)	2/3 fixed and portable
Guard Interval	1/32

Exhibit A.75: *Key technical parameters for DTT in Poland [Source: Analysys, DVB]*

A.11 Slovenia

A DTT trial has been undertaken in the capital city, led by the PDS, using a single multiplex. However, apart from this, limited developments have taken place in Slovenia and the required legislation for DTT has not yet been established. No assignment of DTT spectrum has yet taken place and the government is still to decide how much spectrum may be used for television channels and how much may be used for data services.

Despite the early stage of DTT development in Slovenia, a number of interesting features may be observed that make Slovenia different from the other countries studied, which have an impact on the DTT policy adopted:

- **limited analogue coverage –** coverage obligation on the public service analogue terrestrial channel is 90% of population. This is significantly lower than in most of the other countries studied: a similar coverage obligation for the public service DTT channels would present an alternative scenario to that being applied in the UK and Sweden and will be easier to achieve

- **focus on ICT development** – policy makers in Slovenia are focused upon information and communications technology (ICT) development in the country and see DTT as another means to achieve this. Consequently, unlike the other countries studied where the focus of DTT is on multi-channel television or indoor portable reception, DTT policy objectives in Slovenia focus on Internet and data services

- **limited capacity of CSBs –** the focus away from multi-channel television in Slovenia in part reflects the limited resources of the country's commercial broadcasters. Only the PSB is believed to have sufficient resources to make a major contribution to DTT.

Exhibit A.76 below shows key DTT developments in Slovenia.

Date	*Development*
2000	DTT trials start
2005	Legislation required for DTT expected
2006	Full launch expected

Exhibit A.76: *Key dates in DTT developments*
Source: Analysys]

A.11.1 TV market context

RTV is the dominant broadcaster in Slovenia

RTV is the dominant broadcaster in Slovenia, having emerged from the Yugoslavian public broadcasting system. It is funded through a mix of revenues streams, with all television households in Slovenia paying a licence fee. In 2003, 73% of revenues came from the licence fee and 17% from advertising.

There are also three commercial broadcasters (Kanal A, Pop TV, and TV3), but these are relatively small organisations with limited resources.

Analogue terrestrial coverage is 90%

RTV has two national analogue terrestrial channels and also owns the network that provides television transmission services, both for its own channels as well as the commercial broadcasters. However, unlike most countries in Western Europe, coverage of the public service analogue terrestrial television in Slovenia is only 90%.

Number of analogue terrestrial channels	5
PSB	RTV Slovenia
Number of PSB analogue channels	2
TV households	0.63 million
Terrestrial only TV households	0.34 million
Cable TV households	0.29 million
DTH TV households	0.00 million[89]

Exhibit A.77: *Key features of TV market [Source: Analysys, EPRA, DVB]*

Cable is the key competitor to terrestrial television

As shown in the above exhibit, there is a significant level of cable penetration in Slovenia. A large number of small cable operators have existed (more than 80) in Slovenia that in recent years have consolidated to a few larger operators. However, technical compatibility between the various cable networks has caused problems.

A.11.2 Assignment of frequencies

No licences have been issued…

No DTT licences have yet been assigned in Slovenia and discussions are still ongoing with respect to how the assignments should be undertaken. It is expected that a significant number of channels will be reserved for the public service broadcaster RTV and a beauty contest used for assigning other channels.

… a per-channel regime is likely

A per channel licensing regime is expected to be implemented in Slovenia. This reflects that the focus on DTT in Slovenia is away from multi-channel television and a large number of DTT channels are not likely to be assigned. Consequently, a per-multiplex licensing regime is not suitable.

Three national multiplexes are expected. Exhibit A.78 below highlights the key features of DTT licensing in Slovenia:

89 EPRA estimate 3000 DTH subscribers in Slovenia

Number of multiplexes	Three national expected
Channels per multiplex	Undecided
Licensing mechanism	Per channel likely
Business model	Undecided

Exhibit A.78: *Licensing of DTT in Slovenia [Source: Analysys, EPRA, other]*

A.11.3 The business model

No decisions have yet been taken regarding the business model likely to be implemented.

A.11.4 Analysis – the outlook for DTT in Slovenia

A DTT trial has been undertaken ...

The PSB started a DTT trial in 2000 using a single multiplex and a medium power transmitter (on channel 37) to cover the capital city (Ljubljana) and its surroundings.

... and commercial services may be available in 2006

The legislation required for the introduction of DTT is expected to be finalised in 2005. This may permit the assignment of DTT licences in 2005 and it is expected that commercial DTT services may start in 2006.

DTT is expected to be led by the PSB…

In Slovenia, the PSB is expected to play a leading role in the development of DTT. It is the largest broadcaster, with greater resources than other broadcasters in Slovenia. Furthermore, it owns the current transmission network and has already undertaken the DTT trial.

... and ICT development is considered important

Slovenian policy makers are focused on the ICT development of the country, and regard DVB-T as an appropriate means for enhancing their ICT objective. As a result, data and Internet services are likely to be developed using DVB-T technology (although the details are still unclear). This marks a different path from that of some of the other countries studied, where such services have either not been developed or have had limited success.

A.11.5 Key technical issues

Exhibit A.79 below shows some of the technical parameters for DTT in Slovenia.

Current coverage	0%
Target coverage	Undecided; 90% analogue coverage
Modulation type	64QAM
Type of network	SFN for trial
Channel bandwidth	8MHz UHF, 7MHz VHF
FEC (redundancy)	-
Guard interval	-

Exhibit A.79: *Key technical parameters for DTT in Slovenia [Source: Analysys, DVB]*

Technical preparations for the launch of DTT are underway in Slovenia. A frequency plan for DVB-T has been prepared and up to seven multiplexes may be used once the analogue signal is switched off. Six of these multiplexes may exist in the 470–862MHz band and an additional multiplex in the VHF Band III may be assigned to DTT.

A.12 Ireland

Commercial DTT service are unlikely in Ireland before 2006 at the earliest. This follows a failed public process to assign DTT multiplexes and concerns about the funding of the DTT network.

Following the publication of the Broadcasting Act in 2001, that established the legal framework for the introduction of DTT, a public process for assigned DTT multiplexes began. However, the only company to apply for multiplex licences withdrew its application after it became clear that the terms of the licence on offer did not include the provision of internet access services. The company had planned to offer a multichannel television offering combined with internet access services.

The public service broadcaster RTE has planned a DTT trial in Dublin, providing services to up to 100 homes. Such a service is expected to consist of simulcasts of the four Irish-terrestrial stations (RTE1, Network2, TV3 and TG4) along with six other channels.

However, the future of DTT in Ireland is still unclear given that it is expected that the Government may have to fund DTT rollout and this may raise competition issues: Cable and DTH penetration combined exceeds 75% of households, with the proportion significantly higher in Dublin.[90]

In the meantime, technical preparations for the introduction of DTT are underway. Planning for 12 main stations and 18 other stations has been completed. ComReg, the regulator published a consultation in November 2004 on the Frequency Spectrum Policy for DTT.

A.13 Lithuania

Lithuania is one of the leading Eastern European countries in terms of preparations for DTT. Four multiplexes are expected to be providing services in the capital city (Vilnius) by mid 2006. Launch in other key cities is scheduled for 2007.

In November 2004 the government adopted a plan for the implementation of DTT (known as the 'Model'), which foresees the use of four multiplexes to deliver DTT services in Lithuania. This is the maximum possible until the analogue switchover begins. Five additional multiplexes may be used for DTT after switch-off.

Frequency assignments have not taken place yet. The government's plan gives the PSB the right to broadcast two TV channels. The multiplex carrying the PSB channels is expected to have the same coverage as the national analogue network (98% of the population). Assignment of the remaining capacity (in the four multiplexes) will be undertaken via a beauty contest, although the criteria for the contest have not yet been decided upon. A hybrid business model is expected, with at least five FTA TV channels.

A DTT trial is currently being undertaken in Vilnius by one of the commercial broadcasters . The trial offers five-to-six TV channels using one multiplex (and QAM64 modulation). Of these, two channels are FTA and three are encrypted.

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90 A 2004 NERA study is reported to have concluded that the Government may have to fund DTT rollout, which may cost at least EUR40 million.

A.14 Hungary

Although DTT trials started in 1999 in Hungary, limited progress has been made toward the commercial deployment of DTT and a full DTT launch is not expected before 2007. The legal framework is not in place and no broadcast licences have yet been granted.

Once the legal framework has been established, upto three DTT multiplexes may be implemented prior to analogue switch-off, with spectrum limitations preventing simulcast of more multiplexes.

The television transmission network operator in Hungary, Antenna Hungária, has been making technical preparations for DTT, having installed the transmission equipment on the Széchenyi Hill (Budapest) and started the trial on 9 July 1999. The trial has been continuously running since its commencement and the company has been testing several kinds of transmitters and receivers. The trial was extended in May 2002, with the first rural DTT station in Kabhegy. Since October 2004, both public service channels have been broadcasting a high quality DTT signal. Set-top-boxes have been distributed among households with the aim of gaining information on the reception. DTT transmitters in Hungary use 64QAM modulation (8k carriers) and FEC 2/3 error correction.

In March 2005, the government made known a decision on the strategic objectives and the priority government-tasks in relation with the transition to the digital terrestrial television broadcasting. As a result, DTT regulatory preparation have started and are expected to be finalised by end 2005. It is planned that the digital broadcasting of two to three multiplexes on “islands” will start in 2007. Analogue switch-off is expected to take place in 2012, though a final decision is yet to be taken by the government. A regional switch-off is likely to be adopted.

A.15 Czech Republic

Although experimental services are available in the Czech Republic, a full DTT launch has not yet taken place. Although the details of any launch are still unclear, it may take place as early as 2006.

The legal and regulatory framework for DTT is still under development and only experimental licences have been provided to broadcasters. Although the existing Electronic Communication Act provides for the assignment of one multiplex to the PSB, a new law in 2005 had been expected to complete the framework for the development of DTT. However, though the new law entered into force on 1 May 2005, it does not provide a complete framework for DTT development. This is due to disputes that arose concerning the balance between content regulation and transmission regulation, resulting in that the required changes in the regulatory environment have not been fully implemented.

Discussions on the required amendments to the law are ongoing and reaching consensus on this is the remaining key step for starting the switchover process. Once this has been achieved, the Czech Broadcasting Council (RRTV) is expected to conduct a public process for two commercial DTT multiplexes. Already three multiplexes are being used for experimental services: the regulator (Czech Telecommunication Office) has authorised Cesky Telecom (the fixed-line telecoms incumbent), the Czech Radiokomunikace (Cra, another telecoms operator) and the Czech Digital Group to develop and operate DTT transmission networks. The final coverage that DTT will provide is still undecided.

A.16 Portugal

In Portugal, frequencies for DTT use have been reserved. However, the public policy for DTT launch is yet to be defined. Consequently, no date for the launch of DTT services has been established. Analogue switch-off is expected to occur between 2010 and 2012

The frequencies reserved for DTT are to allow three national networks (SFN) and three additional networks for regional coverage in the zones of Oporto, Centre and Lisbon. Therefore, in each of these areas, six multiplexes will be available.

Widespread DTT coverage is expected before switching-off the analogue signal. The exact coverage to be achieved is under evaluation, but is expected to at least match the current terrestrial coverage (nearly 95% of the territory).

A.17 Denmark

Plans are underway for the launch of one DTT multiplex by early 2006 in Denmark. Further multiplexes may be possible, though the policy framework does not address such developments yet. No decision regarding the date for analogue switch-off has been taken but discussions are now taking place at the political level, led by the Ministry of Culture.

This follows a political agreement between the Government and the opposition in June 2002 that requires the public service providers in Denmark (DR and TV2) to start digital terrestrial broadcasting in one multiplex. No decisions have yet been taken about the further roll-out. There is a possibility of four multiplexes, and depending on international negotiations, more may be possible.

The two broadcasters share the capacity in the first multiplex, with two-thirds to DR and one-third to TV2. Coverage of the this multiplex is expected to be the same as for the analogue terrestrial channels (i.e. nationwide).

A.18 Estonia

Estonia has only recently started preparations for DTT and plans are at an early stage of development. No launch date has been announced, although technical trials have been conducted. According to a strategy document (dated January 2005), analogue switch-off may occur by 2015.

To date, a single multiplex has been reserved for DTT that allows for a maximum of six channels. The PSB EVT and the network operator Levira are leading the development of DTT in Estonia; the PSB has already been broadcasting a DTT channel (simulcast of its analogue channel) as part of a trial that began in mid 2004. However, for budgetary reasons, the trial has been stopped in 2005.[91] As for the analogue terrestrial services, full (near 100%) population coverage of the PSB's DTT service is expected eventually.

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91 On 27 January 2005, the PSB announced that the trial transmission would be stopped due to insufficient financing. Although the Parliament has approved special funding for digital television, the PSB's 2005 budget does not include funds for DTT.

A.19 Slovakia

Limited developments towards the launch of DTT have taken place in Slovakia to date. Full DTT launch is still some distance away, expected to take place in 2006 at the earliest.

Two government-financed trials are currently ongoing (having started in 2004). These trials are primarily focused in the East (Košice and Prešov) and the North (Banská Bystrica and Zvolen) of the country, and are expected to extend into 2006. However, the legal infrastructure required for DTT has not been established yet.

The government has published a digital strategy paper that foresees analogue switch-off before 2015. However, the strategy for DTT, including the frequency assignment policy, is still under development. Up to seven multiplexes may be used for DTT services. Coverage is expected to approach that obtained by the analogue terrestrial channels (currently, the first analogue terrestrial PSB channel has a 95% population coverage, and the second PSB channel covers 75% of the population).

A.20 Latvia

Significant work has been undertaken in Latvia to investigate the various policy options in the development of DTT. However, no policy for developing DTT has been approved yet and the DTT launch date remains uncertain.

Various public institutions have contributed to policy documents, including a policy paper on the introduction of digital television by the Ministry of Transport and Communications, and more recently a draft concept developed by the regulator, the National Broadcasting Council (NBC), in September 2004. The draft concept developed by the NBC envisages the assignment of frequencies to the PSB and the incumbent terrestrial commercial broadcasters. New channels are also foreseen to deliver greater choice to consumers.

Limited progress has been made in the operational and technical planning for DTT; no date has been established for analogue switch-off and no DTT trials have been undertaken.

A.21 Malta

Malta is currently in the process of defining its policy for the introduction of DTT. Although a public consultation was launched in 2004, no significant steps towards introducing DTT have been taken yet.

The government has received various responses from the public consultation on DTT, and policy makers are currently in the process of developing a DTT plan. The number of multiplexes that will be used for DTT has not been decided yet and will partly depend on international agreements on frequency use. However, it is expected that one or more multiplexes will be assigned to the PSB in order to promote and maintain the local culture and language. Other broadcast licences are expected to be granted via beauty contests. It is expected that establishing a date for analogue switch-off will help the development of DTT, and the consultation foresees analogue switch-off by 2010.

A.22 Cyprus

No significant steps have been taken towards the introduction of DTT in Cyprus to date. A new legal framework is being put into place concerning the provision of digital broadcasting services. The number of multiplexes that will be used for DTT has not been decided yet, and neither have any decisions been taken regarding the assignment of frequencies to existing broadcasters. However, at least two or three multiplexes are expected to be available. No specific date has been set for analogue switch-off.

A.23 Luxembourg

DTT development in Luxembourg is at the stage of policy definition, though some technical tests are ongoing. The Government has financed trials using three transmitters. No date for the launch of DTT or analogue switch-off has been fixed yet.

Cable penetration is very high in Luxembourg and there is only one nationwide analogue terrestrial broadcaster (RTL). All television frequencies have been assigned to RTL until 2010: thus, it will be necessary to coordinate with RTL in creating the appropriate DTT

environment. Eventually, four multiplexes may be made available for DTT. However, before this can happen, the law needs to be modified.

A.24 Greece

No significant DTT developments have taken place in Greece to date. The Ministry of Transport and Communications is currently drawing up the frequency plan for digital television and related services. The legal framework that will underpin DTT development is also under development.

The provisional timetable for transition to digital broadcasting is: pilot broadcast (2005–6) and abandonment of analogue broadcasting after 2010. However, this timetable is expected to be delayed by 1-2 years. Government policy foresees the reservation of DTT multiplex capacity for the national public broadcaster in order to enable it to provide universal service.

A.25 Belgium

No significant steps towards the development of DTT in Belgium have been taken yet. No services have been launched yet, though the PSB (RTBF) is undertaking some test. No launch date has been established, nor has the date for analogue switch-off been decided.

The PSB is expected to lead DTT development, and is allowed to convert one analogue terrestrial channel to DTT. High cable penetration implies that the focus of DTT is likely to be on portability and having a transmission platform competing with cable.

Annex B: HDTV

This annex outlines the development of high-definition television (HDTV) and addresses its relevance for different digital platforms.

B.1 Overview of HDTV

HDTV enhances television broadcasts ...

HDTV was developed as an enhancement to standard definition television (SDTV), delivering a richer viewing experience with the following benefits:

- greater picture detail and sharpness as a result of the higher resolution (4–5 times higher resolution than SDTV resolution)
- wider picture, adapted to the viewer's visual field and thus creating a greater feeling of realism[92]
- improved colour rendering
- improved portrayal of motion
- high-quality surround sound.

... and has also found other applications

Although HDTV development has been intended for broadcast television transmission, HD video technologies have found applications in other related areas. These include film production where high-definition content may be used in film postproduction; conversion of the content for television delivery in various formats, including SDTV; and for cinema

92 In SDTV, the ratio between the width and height of the picture is 4:3. HDTV has a width to height ratio of 16:9. Taken with the increase in resolution, this enables HDTV to offer a viewing angle of 33° (with a viewing distance of three times the picture height), instead of 12.5° for SDTV (with a viewing distance of six times the picture height).

theatre displays. It facilitates film production by reducing the shooting (the need for close-ups and multiple cameras) and postproduction time. Other areas where high-definition can be used include electronic publishing, museum archiving and telemedicine.

The US and Japan are leading the deployment of HDTV

Following slow take-up upon launch, HDTV is currently experiencing rapid development in the US via terrestrial, satellite and cable platforms.[93] Existing US broadcasters have been given a free channel for digital broadcasts (typically in the UHF range) until analogue switch-off. Although the regulator, the FCC, has not mandated that digital broadcasts should be HDTV, the expectation is that HDTV is starting to become the norm, with most terrestrial stations having broadcast free to air (FTA) high-definition content. Furthermore, it is estimated that approximately 10% of television households have a high-definition-ready receiver. Analogue switch-off may occur in 2007, thus leading the US towards becoming the first country with HDTV-only terrestrial delivery.

The HDTV market is well established in Japan, with mainly analogue and digital satellite delivery. Terrestrial HDTV delivery is in an early state of development. In Tokyo (as well as Osaka and Nagoya), approximately 90% of the content broadcast by the PSB NHK is in high-definition format. An estimated 3 million households (6% of all television households) have high-definition receivers.[94]

Terrestrial HDTV has been adopted in Australia and has been in service since July 2003, but take-up is still limited. Other HDTV terrestrial or satellite channels are operated in Canada and Korea.

Various European initiatives are being launched on DTH

The first European HDTV satellite channel (originally named Euro1080, now HD1) was launched on 1 January 2004. Primarily using an Astra satellite, HD1 is run by the Belgian operator, Alfacam, and currently offers a single prepaid channel across Europe.[95] It is to

93 In the US, HDTV broadcasts began in late 1998.

94 Source: Intelligent Life.

95 Astra 19ºE, as well as Sirius 5ºE and Hellas satellites. See www.hd-1.tv for further details.

offer a new channel (HD2) by mid-2005 to deliver live or delayed big events programming to cinema theatres, pubs and households. HD1 is currently using MPEG2, but a simulcast in MPEG4 advanced video coding (AVC) is to start mid-2005, with parallel operation in both standards until 2008. Other European HDTV plans include:

- TPS (French DTH): premium channels in Autumn 2005
- Premiere (German DTH): three channels in November 2005
- BSkyB (UK DTH): premium channels in 2006.

B.2 Brief history of HDTV

HDTV was first developed in the early 1980s

In the early 1980s, NHK in Japan developed the first HDTV system for TV studio production and international exchange of television programmes.[96] The HDTV system was promoted as offering similar detail as 35mm film, but enabled easier recording, editing and storage.

At the same time, NHK also developed a high-definition system for analogue satellite transmission known as MUSE,[97] based on the production standard described above. Services based on this system were launched in 1991 and are still in service, although since 2000 they have been gradually replaced by digital services (based on ISDB-S standard).

Europe opted for its own analogue HDTV system

The NHK system was first demonstrated in Europe to the European Broadcasting Union (EBU) in 1982 at Killarney, Ireland. Its high picture quality led the EBU to launch HDTV studies despite just having started the development of a new SDTV system.[98]

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96 Nippon Hoso Kyokai – Japan Broadcasting Corporation. International exchange of television programmes across regions using different standards was a key objective in the development of HDTV by NHK.

97 Multiple Sub-Nyquist Sampling Encoding. MUSE is suitable for transmission in a 27MHz transponder.

98 The new SDTV system (MAC packet) was intended to overcome the shortcomings of PAL for satellite delivery.

However, the adoption of the NHK HDTV system was rejected by Europe, which opted to develop its own system within the family of MAC standards. The rejection was mainly due to the cost of adapting the Japanese field refresh rate to EU standards.[99] Europe subsequently decided upon a new HDTV production system based on 1250 lines x 50Hz interlaced, and a complementary transmission system.[100]

In 1986, Eureka 95 was launched to develop an analogue HDTV standard …

In October 1986, the Eureka 95 project was launched with the support of the European Commission. Similarly to MUSE, an analogue satellite transmission standard (HD-MAC) was developed. However, unlike MUSE, the new transmission standard was backwards-compatible with existing receivers (using the D2-MAC standard).

… but it was abandoned in 1993 due to lack of interest

However, in January 1993, the European Commission decided to withdraw support to Eureka 95. The standard represented a technology-driven development, for which no clear market demand existed. The Commission felt that broadcasters and manufacturers lacked interest in HDTV and decided to focus instead on the development of digital television and widescreen television.

Furthermore, HD-MAC represented an analogue transmission technology with limited scope for future improvements. The development of HD-MAC ignored the possibility of a migration to digital technology.[101] It was decided that the industry should decide upon the technologies and standards to be used, via the Digital Video Broadcasting Group (DVB).

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99 The NHK production standard used a 60Hz field refresh rate (delivering better motion portrayal and display brightness than 50Hz). However, television receivers in Europe use 50Hz (in order to reduce the visibility of the power supply noise) and at that time conversions were extremely complex.

100 Decision taken at the 1986 CCIR Plenary Assembly in Dubrovnik.

101 In parallel with HD-MAC development, five US analogue HDTV standards were competing. Four of these migrated to digital technology in the second half of 1990, with the exception of the MUSE-based candidate. These four digital standards later merged and formed the basis of the ATSC HDTV system.

Digital HDTV development was prototyped in 1990

In parallel with the HD-MAC development, other European projects (Eureka 256 and Hivits) were launched to develop an SDTV and HDTV digital contribution codec. They offered high-quality picture rendering and the possibility of re-processing the image. In 1990, a Eureka 256 HDTV prototype was demonstrated in the US at the NAB, and the technology was successfully used for satellite HD transmission at the Italia 1990 World Cup and at the 1992 Olympic Games. In 1992, the work of these projects produced ETSI standard ETS 300174: a digital contribution codec for transmission in the range of 34-45Mbit/s.

The high-definition project was abandoned due to the high bit rates required and a lack of broadcaster interest prevented commercial development of HDTV.[102] However, such work has been the precursor of the present HDTV digital delivery systems.

B.3 Requirements for successful HDTV implementation

The introduction of HDTV represents similar challenges as the introduction of colour television in the early 1970s. The broadcasting industry needs to ensure that relevant content is produced in high-definition format, using production systems that are compatible with transmission technologies. The signal needs to be distributed to a large audience in a format that is compatible with the television receivers that end users may use. Finally, end users need to be able to acquire affordable receivers.[103]

Successful HDTV implementation, measured in terms of strong take-up of HDTV services, requires developments across the broadcasting value chain, as shown in Exhibit B.1 below:

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102 Eureka256 was led by RAI, Retevision and Telettra (Italian equipment manufacturer). Hivits was led by BBC, CCETT and Thomson. The first Eureka 256 demonstration required a bit rate of 70Mbit/s. By the 1992 Olympic games, the bit rate required was 45Mbit/s.

103 Note that a key difference exists between the introduction of colour television and HDTV: whereas colour televisions were backwards-compatible with existing black and white receivers, HDTV in Europe is not backwards-compatible with existing SDTV receivers.

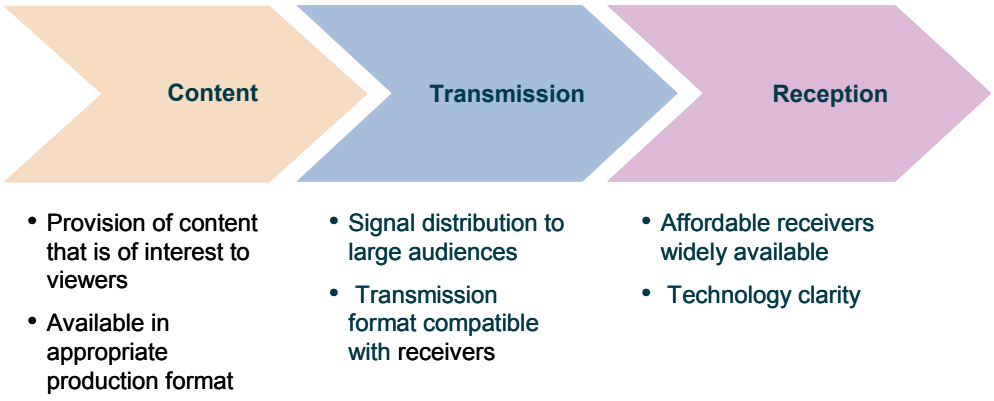

Exhibit B.1: *Value chain requirements for HDTV [Source: Analysys]*

In order to achieve these requirements for success, significant efforts will be needed from broadcasters and manufacturers. Broadcasters and manufacturers need to co-operate extensively to ensure technology compatibility and to develop the market for HDTV services. Such co-operation is an essential condition of market development as the requisites for success are interdependent – without receivers being available for purchase, broadcasters will not invest in transmission; and without broadcasts, manufacturers will not promote the receivers. Furthermore, without attractive content and affordable receivers, consumers may not be interested.

In order to develop HDTV, broadcasters may be required to make substantial investments in HDTV broadcasting over a significant period of time, and during this time penetration of receivers (and therefore benefits to the broadcaster) may be limited. However, many broadcasters which had previously lacked enthusiasm for HDTV are now looking to HDTV in order to generate extra revenues from premium pay TV HDTV services to new and existing clients, and/or to retain existing subscribers in the face of growing multi-platform competition. The development of consumer high-definition devices such as the high-definition DVD facilitate the broadcast of HDTV by driving take-up of receivers.[104]

The issues of content production, transmission and reception of HDTV are further explored in the sections below.

104 High-definition DVD (either HD-DVD or Blue-ray DVD) may see a mass-market launch soon.

B.3.1 HDTV content

HDTV production also allows SDTV broadcasts ...

Content produced in high-definition may be easily adapted for various formats, including SDTV. This has led to many content producers and broadcasters to migrating key content productions (such as drama, TV series, and sports events) to high-definition. Doing so increases the commercial options available to the content owner, even if at present most of the content is converted to SDTV.

... and the higher cost is offset by the benefits

Although production in high-definition format is more expensive than production of content suitable for SDTV only, the difference in cost is limited in comparison to the cost of the content, and is offset by the increased market value of the content. Furthermore, the higher HDTV production costs partly stem from the need for HDTV cameras and other studio equipment. Although this equipment is currently expensive, the unit costs are likely to decline significantly as HDTV production increases.[105]

HDTV content production is taking off ...

A significant amount of HDTV content is already available, covering sport (US sport, European soccer, tennis, etc.), drama and documentaries (natural history, sitcoms, etc.). Furthermore, many broadcasters have developed plans for significant HDTV productions. This includes the BBC, which has announced that all its production will be in HDTV by 2010.

... and movies may be a large source of content for HDTV

Movie production uses 35mm film with an aspect ratio typically close to 16/9. The full natural frame format for 35mm is 4:3. As the resolution is so high, it is possible to shoot in a letterbox wide-screen format without degrading quality, standard practice for many decades. The 35mm prints provide to broadcasters a similar or superior quality to content produced in high-definition. As a consequence, broadcasters may find the large movie libraries to be a key source of content for HDTV transmission.[106]

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105 Some other contributors to the higher cost of HDTV production may not be affected by scale: indeed, with HDTV, wider and more detailed set construction is needed, operation requires greater effort to achieve very precise focusing and ensure that both widescreen (16:9) and standard screen (4:3) windows are protected, and lighting needs higher intensity to ensure greater depth of focus.

106 Conversion of 35mm content to digital format usually takes place in post-production. Thus movie libraries may be easily available in HDTV format. Furthermore, some film production is now taking place in HDTV (though at present special HDTV formats – 4:2:2, 4:4:4 and 10–12 bits per pixel – are required).

Sport events may aid HDTV take-up

Major sporting events, such as the Olympic Games or the athletics World Championships, are also key television broadcasting events. HDTV can significantly enhance the viewing experience and as a result, television production for the majority of major events uses high-definition production. The football World Cup, which is due to take place in Germany in 2006, and the 2008 Olympic Games in Beijing, are expected to help drive HDTV take-up.

B.3.2 Transmission

HDTV will benefit from AVC ...

At present, HDTV services are encoded using MPEG2, which is also used by SDTV. However, improvements in coding technology have led to the introduction of AVC.[107] AVC is a sophisticated technology that enables approximately twice the content to be broadcast using the same bit rate (by comparison to MPEG2).[108]

AVC may facilitate HDTV services, especially where spectrum resources, and consequently the bit rate available, are limited. Instead of the 18–20Mbit/s required by an MPEG2 coded HDTV service, AVC allows a bit rate of 9–10Mbit/s to provide the same picture quality.[109] For DTT, this implies that a standard multiplex may be used to provide a minimum of two HDTV channels and, depending on the modulation parameters used, an additional SDTV channel as well.

European HDTV is not backwards-compatible, thus raising investment requirements

In Europe, a DVB HDTV signal cannot be received by an DTT SDTV receiver. For the same content to be available in both HDTV and SDTV in DVB systems, at present transmission of two streams with the same content is required (one for HDTV and one MPEG2 encoded for SDTV) [110]The dual broadcast requirement raises the transmission capacity needs and also the cost of HDTV for the

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107 AVC was a joint development of the ITU and MPEG. It is know as ITU-T H264 or ISO/IEC 14496-10 (MPEG4-Part10).

108 The gain may be even higher for low bit rate applications.

109 In parallel with AVC, the developments in the encoding technology for audio led to advanced audio coding (AAC). As with AVC, AAC can double the transmission efficiency (i.e. carry twice the content in the same bit rate by comparison to MPEG2). However, given the much greater bit rate requirements of video content, AVC provides the greater overall efficiency gain.

110 Note that in the US (where ATSC is used), the dual broadcast is not required. The same signal can be received by HDTV as well as 525-line HDTV-compatible receivers.

broadcaster. Thus, European broadcasters may be less willing to invest before significant end-user demand is evident. One solution to overcome this limited in the short-medium term may be an integrated HDTV-to-SDTV down-converter, thus enabling a single signal to be used for HDTV and SDTV reception. However, this may not occur: instead, integrated AVC-MPEG2 decoders may become common (thus bringing the benefits of AVC).

However, this favours AVC ...

Although the lack of backward compatibility may represent a drawback for HDTV adoption by broadcasters, it favours the adoption of AVC. Looking towards a post switch-off scenario, there will be no need for the HDTV stream to be encoded in an MPEG2-compatible system, thus facilitating the introduction of AVC as an encoding system for HDTV.

... although the first implementations are based on MPEG2

The first European HDTV satellite channel (Euro1080 or HD1) uses MPEG2 for encoding. The introduction of AVC for HDTV in Euro1080 will require a scheduled migration approach in order to ensure minimal service disruption.

B.3.3 Reception

Growth in flat screen displays is driven by falling prices

Two alternative flat panel display technologies exist: plasma displays (PDP) and liquid crystal displays (TFT-LCD). Strong take-up of flat screen displays, driven by falling prices, has helped to generate interest in HDTV. Astra estimated that LCD prices fell by 43% in Europe in 2004.

LCDs are likely to dominate the HDTV display market

PDPs use UV radiation to light discharge cells in the colours red, green and blue. The colour intensity depends on the number and width of the radiated pulse. PDPs have been available for many years, although they have suffered from some limitations with regard to motion portrayal, brightness and burnt-in problems.

TFT-LCDs make use of the properties of a layer of liquid crystal filled between two glass plates, combined with two polarising filters at 90° to each other. The back light is polarised by the first filter, twisted by the liquid crystals and allowed to pass through the second filter. By

changing the voltage between the glass plates, the back light can be intensity modulated in each cell, according to the TV signal applied.

Following recent developments, LCDs can provide higher resolution displays with wider viewing angles, a longer lifespan and less cost than PDPs. Consequently, over the next few years, the majority of the HDTVs are expected to be based on LCD technology.[111]

Analogue interfaces need to be replaced by digital ones

At present, most interfaces between the display and the receiving device are analogue. However, this represents an outdated technology that results in a loss of quality in the conversion from digital to analogue and back to digital again. For such a quality loss to be avoided, a digital interface is required, and the digital high-definition multimedia interface (HDMI) has been available since 2003. This interface enables a connection between the television display and the high-definition signal-receiving device over a single cable.

However, a lack of clarity exists in the display market …

Significant confusion exists in the market at present, with consumers unable to understand the various HDTV options available. Consumers have the following options when buying a HD receiver:

- **HDTV receiver** – this includes a display and an integrated receiver-decoder (IRD). It usually has a 16:9 aspect ratio, a format of either 720P, 1080I or higher. This type of receiver is common in the US and Japan though not in Europe.
- **HDTV ready receiver** – same as above though without the IRD. Thus, it consists only of the display and is also called a HDTV monitor. The key issue is the interface to connection to the IRD (or DVD player): although HDMI is the most appropriate, various analogue interfaces are common in the market. This approach has the advantage that IRDs have a lifespan significantly shorter than displays. It is the approach

111 New LCD displays with a 1920 x 1080 HDTV format have already been presented at the NAB 2005 by Sharp (45") and Samsung (46").

used at present in Europe.

- **HDTV IRD (HDTV STB)** – an IRD may be bought to complement a HDTV ready receiver. It usually has a 16:9 aspect ratio, a format of either 720P, 1080I or higher.

- **HDTV compatible –** this refers to a TV set that may receive an HDTV signal, but may not display it with HD resolution. This approach is common in the US and Japan.

The situation is further complicated by potential confusion with widescreen television, which is also known as enhanced definition TV (EDTV).[112] Note that current limitations of many HDTV displays mean that some consumers may appreciate the benefits of widescreen more than HDTV: this is discussed in Section B.4 below.

The European Commission is also undertaking an initiative to ensure that multiple technical options do not lead to market fragmentation (and confuse consumers): it is developing a 'Roadmap on HDTV Technical Interoperability'.

… that may hinder HDTV development

The lack of clarity may confuse the consumer, and cause disruptions in the take-up of HDTV. To overcome this potential barrier, the industry needs to work together to develop a simple, comprehensive means of communicating HDTV to consumers.

Recognising the need for this, a high-definition forum has been formed, comprising the major flat panel display manufacturers, as well as key broadcasters. The forum has developed plans for clear labelling of displays.

112 Widescreen television has a 960 x 576 pixel format. However, the same format as conventional SDTV is often used (720 x 576 pixel), with the pixel width stretched and thus the horizontal resolution reduced.

B.4 Widescreen versus HDTV

Widescreen[113] and HDTV share the same wide aspect ratio of 16/9, but they have quite different resolution implementations. The advantage of the wide aspect ratio (compared with a standard 4/3 picture) is the enveloping feeling that it may provide when a sufficiently large widescreen receiver is used.

In terms of resolution, in Europe, a widescreen picture is understood to have 576 active lines and 960 pixels per active line (960 x 576). This compares with 576 active lines and 720 pixels for a standard television.[114] Most common HDTV displays are 'wideXGA' that have a resolution of 1366 active lines and 768 pixels per active line. As a result, such displays are unable to show the full resolution of the HDTV picture (1920 x 1080).[115]

When comparing the picture quality experience with a true widescreen receiver (960 x 576) against an HDTV picture using a wideXGA display, HDTV using wideXGA delivers at least an increase in resolution of 4/3 horizontally and 5/4 vertically. For many observers, such a difference is clearly noticeable. Nevertheless, it is possible that, for many users, the enveloping effect of the wide aspect ratio (from both widescreen and HDTV) is more appreciated than the increase in resolution (possible with HDTV).

It may be noted that HDTV display resolutions are increasing: the trend for the next HDTV display generation is 1920 x 1080 and the first models have already been presented at NAB 2005. Furthermore, the size of displays is also increasing, another factor that may currently constrain viewers' appreciation of HDTV: driven by rapidly advancing LCD technology, the flat-screen television market is increasingly offering larger size displays.[116] The increase in resolution and display sizes together are likely to aid viewer interest in HDTV.

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113 Also known as enhanced resolution TV or simply as enhanced TV.

114 In practice widescreen a significant number of widescreen receivers in the market have 720 pixels per active line, just as conventional receivers. This means that the pixel is distorted anamorphically and the horizontal resolution is decreased by a factor 4/3.

115 WideXGA displays better match the HDTV intermediate format (1280x720P).

116 Note that traditionally plasma screens have dominated the large size display market as LCDs screens are more expensive than plasma or a per-inch basis. However, rapid LCD technology development is narrowing the plasma advantage in the large screen market.

B.5 Technical issues surrounding HDTV

Production and transmission have different requirements

Production and transmission have different requirements and consequently the standards that are most suitable for each may differ. In the 1980s, limited progress was made in harmonising HDTV production and transmission standards, largely due to the dual 50Hz and 60Hz field refresh rates used in different parts of the world.

Digital allows co-existence of different systems

However, digital production technology, combined with developments in digital transmission, have enabled separate production and transmission systems to co-exist, as frame conversion is much easier with digital technology.

The most common production format is 1920 horizontal pixels x 1080 active lines (square pixel approach). This is typically used with interlaced scanning, though no decision has been taken regarding the type of scanning to be used. However, some content producers prefer to use an intermediate format: 1280 horizontal pixels x 720 active lines with progressive scanning.[117]

Progressive scanning has advantages for transmission …

Interlacing scanning has been used in television since its introduction. Interlacing scanning helps to minimise the impact of the scanning rate limitation of cathode ray tube receivers (CRT) and cameras, thereby maximising the picture quality given this constraint.[118] Furthermore, it reduces the bandwidth required for transmission. However, progressive scanning has certain advantages over interlaced scanning: interlaced scanning may suffer from picture distortion when for images with rapid motion. Its higher temporal resolution makes it better for sport.

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117 The EBU is considering what production format and scanning type to recommend. The trend is towards 1920x1080 with progressive scanning for TV productions: currently it is the most commonly used format and is the preferred format for sports. 1920x1080 with progressive scanning (and refresh rate of 25/30Hz instead of 50/60Hz) is used for some film and series intended only for TV delivery. Use of 1280x720 with progressive scanning is limited, mainly because it is not future-proof.

118 A CRT TV is made up of 576 horizontal lines known as scan lines. Interlacing divides the lines into odd and even lines and alternately refreshes them with a new field of your picture. Progressive scanning on the other hand refreshes the entire picture in one go.

Modern imaging devices (LCD and PDP displays) are inherently progressive and almost all PC displays use progressive scanning.[119] If interlaced scanning is used for transmission, the signal needs to be converted to interlaced scanning for transmission, and the receiver needs to de-interlace the signal. Conversion to interlaced scanning is easily achieved. However, de-interlacing is a complex and difficult task that must be carried out at each receiver. Thus progressive transmission may be preferred, as no such conversions are needed, though it requires approximately twice the bit rate, or the use of an intermediate format. Thus, in principle, progressive scanning may be preferred by some broadcasters, but others may find the intermediate format not acceptable. The EBU recommends that transmission standards for HDTV in Europe should be based on progressive scanning but does not mention whether it could be based on the intermediate format.

... though the format is currently undecided

Despite the advantages of progressive scanning, different views exist with respect to the transmission format to be adopted. The two principle candidates are:

- 1080I: 1920 pixels x 1080 active lines with interlaced scanning
- 720P: 1280 pixels x 720 active lines intermediate format with progressive scanning.

The greater number of pixels of 1080I leads to higher static resolution, while the progressive scanning of 720P leads to better motion portrayal. It should be noted that 1080P (1920 pixels x 1080 active lines with progressive scanning) is currently not practical as it requires approximately twice the bit rate.[120]

1080I also suffers from the currently common wideXGA displays (1366x768P) not being able to display the higher resolution. However, a few manufacturers have announced that the next generation of displays will be based on 1920 x 1080, with the first retail models expected in 2005.[121]

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119 Liquid Crystal Display (LCD) and Plasma Display Panel (PDP) displays do not suffers from the scanning constraints of CRT screens and are based on progressive scanning technology. Also CRT's used as PC displays are progressive.

120 However, in the medium term, 1080P may become feasible. 1080P with AVC coding currently requires 15–18Mbit/s per channel. Expected progress in AVC coding technology may lower this to 10–12Mbit/s within 3-4 years.

121 The first true 1920 x 1080 LCD displays were presented at NAB 2005 by Sharp and Samsung.

Uncertainty may be addressed by dual mode receivers

Despite developments to the 1080I receiver, it is unlikely that broadcasters and manufacturers will adopt this format universally. Such uncertainty may limit market developments, with consumers unable to decide what format receivers to buy. The only reasonable solution to address this uncertainty may be to allow broadcasters to choose either format and require the receiver to be able to decode both formats.[122]

B.6 HDTV relevance for different digital platforms

Various platforms can deliver HDTV ...

The bandwidth required for analogue HDTV services means that only satellite delivery was possible. However, digital HDTV allows any platform to be used. Currently, services are being provided across several platforms in different countries:

- satellite: US, Japan, Korea and Europe
- terrestrial: US, Canada, Australia and Japan
- cable: primarily US.

... though spectrum availability favours some platforms

However, spectrum availability favours some platforms over others. Despite the benefits that AVC encoding may bring, the satellite platform has the following advantages in HDTV delivery:

- spectrum resources are available in Europe
- channelling is wide enough to accommodate several high-definition channels in a single transponder[123]
- new DVB-S2 uses an advanced channel coding and modulation scheme that provides approximately 30% more capacity when compared to DVB-S.[124]

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122 A similar approach has been adopted in the US, where 6 HDTV formats have been mandated by ATSC, and receivers are required to be able to decode them all (though only 1920x1080 and 1280x720 are currently being used). However, such an approach may lead to marginally higher receiver unit cost.

123 4 HDTV channels may co-exist in a standard 36MHz transponder (using AVC). If DVB-S2 is used, this may rise up to 5-6 channels. This figure is expected to increase in the medium term, as a result of improvements in the AVC coding technology.

124 This is in additional to the efficiency gain of AVC. DVB-S2 is not compatible with DVB-S. However, for provision of HDTV services in Europe this is acceptable given that separate HDTV and SDTV broadcast streams may be required. In terms of compatibility with existing receivers, again this should not pose a significant problem. Although the current Euro 1080 HDTV service uses DVB-S, the service is currently limited in usage, and a migration to DVB-S2 may occur (in parallel with a migration to AVC).

Cable platforms may deliver high-definition VOD (HD-VOD)

Cable platforms also have certain advantages in HDTV delivery:

- unlike terrestrial networks, cable operators control the cable spectrum and network resources, and can integrate HDTV services with maximum flexibility
- the capacity of cable networks can be increased by changing modulation parameters.[125]

Cable networks may also provide high-definition video-on-demand (HD-VOD) services, although this may suffer from bandwidth limitation in the last mile.[126]

The terrestrial platform suffers from scarcity of spectrum resources

Before the analogue switch-off occurs, the terrestrial platform suffers from scarcity of spectrum resources. In Europe, among Member States where DTT services have been launched, a maximum of six multiplexes are available. Given demand for multi-channel television, it may be difficult to spare the capacity for HDTV, which will require approximately one-half of a multiplex. This is further complicated by the fact that many multiplexes are split between various broadcasters. After the analogue switch-off, HDTV may be introduced in some Member States.[127] However, even then, terrestrial may be unable to compete against satellite and cable platforms in the number of HDTV channels it can offer.

IPTV may also deliver HDTV

ADSL may also facilitate HDTV delivery, including HD-VOD. The improved modulation techniques of ADSL2+ provide a theoretical limit of up to 25Mbit/s (with typically 10–15Mbit/s available), in networks with a maximum copper loop distance of about 3.5km. VDSL2 goes even further, enabling up to 100Mbit/s with a maximum copper loop distance of about 1.8km. This provides ample capacity for HDTV broadcasts.

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125 Cable networks currently use 64QAM modulation, thus approximating the bit rate capacity (38.1Mbit/s per 8MHz channel) of a satellite transponder. However, cable networks may be operated using 128QAM or 256QAM modulation. The use of 256QAM will increase the bit rate capacity by 41%. However, use of 256QAM requires that the cable infrastructure be in excellent condition.

126 In cable (HFC) networks, a group of households share the last mile bandwidth available. This may significantly limit the number of HD-VOD services that can be offered simultaneously. For this reason, VOD services are in an early stage of development, and only available in the US (US cable operators have made significant network investments in recent years).

127 It is expected that RRC06 will allocate some channels specifically for HDTV usage (post analogue switch-off).

Annex C: DVB-H

This annex provides on overview of DVB-H, outlining the issues that play a key role in DVB-H development. It covers the different terminals that may be used for DVB-H and highlights the specific requirements of a service in a mobile environment. It also provides an overview of the technological developments that have made DVB-H possible, as well as the key DVB-H trials that have been carried out. Finally, it provides a description of alternative technologies to DVB-H.

C.1.1 Terminals

Several types of terminals are expected to be used for DVB-H services which may differ from each other in terms of reception mode (mobile at high speed, mobile at low speed, portable outdoors, portable indoors, etc.) and format (picture definition, number of pixels). The following terminals are envisaged:

- **Handheld portable terminals** – Such terminals are expected to combine DVB-H and mobile telephony services and will be capable of mobile reception at high speed (for example, in a car). The terminal needs to incorporate a low gain omni directional antenna, as well as an antenna for mobile telephony. Different picture formats may be used – QCIF (176x144 pixels) may be the most common, but higher quality CIF (352x288 pixels) may also be used.

- **Integrated car terminals –** These terminals may only provide DVB-H services, and are intended for high picture quality mobile reception at high speeds. They will be powered by the car power generator and connected to an external antenna. Picture formats used may include CIF as well as standard definition TV (SDTV).

- **Portable TV –** Small TV sets with an integrated antenna may be used. Battery operated, such terminals are intended for stationary or quasi-stationary reception, indoors or outdoors. The most common format is likely to be CIF but SDTV may also be used.
- **Laptop PCs –** Laptop PCs may provide similar functionality as portable TVs. The key difference is that the screen size is likely to be larger. Antennas may be integrated within the PC, or external antennas may be used.

Handheld terminals are expected to be the main reception device for DVB-H. However, the presence of multiple terminal types with different picture formats may constrain delivery of the same content to all terminals. Multi-format reception or format conversion may need to be provided on the terminal.

C.1.2 Mobile environment

Mobile reception introduces certain challenges

Mobility is a key benefit of DVB-H services. However, services in a mobile environment are more challenging and there are a number of hurdles that need to be overcome. The terminals are required to operate with very small antennas and must achieve imperceptible handover between different transmitters (cells). For reception at high speeds (for example, trains or cars), implementation conditions are even more demanding, particularly for cell handover and Doppler shift susceptibility.

Additional error correction is required

In order to reliably deliver services in the more challenging mobile environment, an additional forward error correction (FEC)[128] code is implemented known as MPE-FEC.[129] This introduces a significant degree of redundancy (typical code rate of ¾ implies a 25% redundant overhead) and ensures better reception in the hostile mobile environment.

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128 An FEC code is a system of error control for data transmission wherein the receiving device has the capability to detect and correct up to a certain number of bits corrupted by noise or transmission errors. FEC is accomplished by adding redundancy to the transmitted information using a predetermined algorithm. Each redundant bit is invariably a complex function of many original information bits.

129 MPE stands for multi-protocol encapsulator. The MPE is an element of the link layer that performs basic DVB-H functions such as implementing the MPE-FEC code and the time-slicing mechanism. It also maps the IP data to MPEG2 packets.

Both time-slicing and MPE-FEC procedures ensure fully backwards compatibility with DTT services. Decoding of the MPE-FEC is optional depending on the performance requirements.

C.1.3 Technology developments

This section presents some of the technological developments that make DVB-H services possible. It includes the development of the DVB-H specification, the adoption of AVC coding and the extensions to the physical layer.

DVB-H's basic specification has been completed…

The DVB-H specification (EN 302 304) was developed in June 2004, following several years of research. The specification brings together broadcasting technology (current DVB-T standard) and telecom protocols (an IP data transmission system). It also takes into account the specific requirements of handheld devices.

In order to deliver DVB-H services, a number of changes have been made to the physical layer of DVB-T (DTT) transmission[130]. These include the introduction of a 4k mode in the orthogonal frequency division multiplex (OFDM) modulation scheme.[131] This facilitates mobile reception, particularly at high speed. Other changes include the use of in-depth interleaving and the provision of additional transmission parameter signalling (TPS) information.

…and extensions for Pay TV are to be introduced

Specifications for some extensions to the DVB-H service are currently under development. Many future DVB-H services are likely to be pay services. Consequently, encryption, digital rights management (DRM) and other security issues are key for the provision of commercial DVB-H services. These issues are currently under study by the DVB and a specification is expected shortly.

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130 Physical Layer refers to Layer 1 of the OSI Reference model which defines seven layers that describe how applications running upon network-aware devices may communicate with each other (the model is generic and applies to all network types).

131 This modulation system is the core of the DVB-T system.

AVC coding enables more efficient broadcasts ...

The adoption of advanced video coding (AVC) for DVB-H can help address the spectrum limitation, by reducing the bit rate required for the service. AVC technology (H264, also known as MPEG4 part10) is well suited to the low bit rate of DVB-H services and the small picture size of the handheld terminals. For low bit-rate applications, AVC can typically deliver the same picture quality with half the bit rate.[132]

...however, AVC chipsets are under development

However, AVC also implies greater complexity in decoding the signal and decoder chips that will include AVC decoding are presently under development. These chips are expected to be ready by the time DVB-H services are commercially launched (with the first products being launched in 2005-06).

C.1.4 DVB-H trials

A number of trials of DVB-H are taking place or have been planned. Such trials serve to test the validity of established technical parameters as well as consumer interest. The trials that are taking place in Europe include:[133]

- **Germany (Berlin) –** The Broadcast Mobile Convergence (BMCO) project in Berlin (which started in 2004) is one of the first trials of DVB-H. The objective of the trial is to examine user requirements and the business, technical and regulatory models applicable. Key details of the project are shown in Exhibit C.1 below:

132 AVC produces a significant bit-rate reduction for the same picture quality when used for low bit-rate applications (by comparison to other coding systems such as MPEG4 part2 or H263).

133 A trial is also planned in Sydney, Australia. Plans exist for a trial in which 15-30 TV channels are broadcast to a test sample of 1000 mobile phone users using DVB-H.

Participants	Network: Vodafone Content: Universal Vendors: Nokia for receiver, Philips for portable TV and conditional access system[134]
Technologies	DVB-T for portable applications DVB-H for mobile applications
Objective	Explore the concept of combining DTT services with a mobile network, which can be received both at home and on the go

Exhibit C.1: *BMCO project in Berlin [Source: BMCO]*

During the pilot, new TV content and interactive services are broadcast to portable and mobile-end devices using DVB-H. Vodafone's mobile network facilitates billing, interactivity and personalisation. Pay content being trialled includes the channel '13th STREET' from Universal Studios.

- **Finland –** Finland is currently undertaking a trial of mobile TV (which started in 2004) using DVB-H, in which all the major DTT players are participating (including Digita, YLE, MTV3, etc.) as well as Nokia and TeliaSonera. The four-month trial covers 500 users in Helsinki. Trial participants are able to watch real-time television, with access to Finnish Broadcasters YLE and MTV, as well as international channels such as the BBC and CNN. No results from the trial are out yet, which is aimed at clarifying regulatory and spectrum issues.

- **UK –** In the UK, Mm02 and ntl are starting a trial (due in September 2005) using DVB-H with 500 of their customers in Oxfordshire. The trial is to determine which TV services are preferred by consumers. A total of 16 channels will be made available, including music, sports, news, comedy, soaps, documentary, drama, cartoons, as well as specialist channels including interactive gaming and shopping.

To date, the DVB-H technology validation is primarily based on the Berlin tests and Metz field trials that began in the last quarter of 2004. These tests proved that the DVB-H system works and that data streams transmitted via DVB-H standard do not impede the quality of parallel TV broadcast. It has also provided positive results on the use of the MPE-FEC code, a key feature of the DVB-H system (see Section C.1.2 above).

134 The mobile terminal used in the trial is a Nokia 7700 media device, equipped with a DVB-H receiver. Philips is contributing prototypes of a portable terminal that can receive both normal TV programs via DVB-T terrestrial standard as well as services via DVB-H. Philips also provides content protection technology via its CryptoWorks conditional access system for DVB-T based services.

C.2 Key issues in DVB-H development

A number of key issues lie in the path of DVB-H development. This issues are described in the following section, outlining the solutions that are currently being developed.

C.2.1 DVB-T compatibility requirements

DVB-H needs to be compatible with DTT

Given the expected widespread deployment of DTT, DVB-H services are required to be compatible with DTT. DVB-H needs to ensure compatibility in the following areas:

- ensure a spectral response compatible with DTT, such that it does not interfere with the DTT services
- allow the use of both DVB-H and DTT in the same multiplex, without requiring changes to the existing DTT receivers. This is important given spectrum limitations
- allow the use of existing DTT network infrastructure (including DTT implementation options such as small single frequency networks (SFN), SFN clusters, multiple frequency networks (MFN), etc.)

The solution has been validated by the Berlin trial

Compatibility has been ensured by changing technical parameters for the DVB-H service; these changes do not affect the DTT service.[135] The successful coexistence of DVB-H and DTT services in the same multiplex has been validated by the Berlin tests and the Metz field trial. Consequently, it is likely that in some countries DVB-H services will be launched on the same multiplex as DTT.

Indoor portable reception and DVB-H make suitable multiplex partners

The DTT portable reception service and DVB-H service are appropriate for sharing multiplexes, as there are similarities in the technical parameters that they require: similar network typology, modulation parameters, and even signal level. Where DVB-H requirements are more challenging, these may be addressed by a higher error correction (MPE-FEC).

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135 DVB-H signals are embedding in the MPEG2 transport stream of the DVB-T system (encoded as IP datagrams) through a multi-protocol encapsulation procedure. Also, other features are added at the physical layer (for example, 4k OFDM mode, in-depth interleaving).

Sharing with standard DTT may require hierarchical modulation

The DTT roof-top antenna reception service has significantly different requirements from DVB-H services. Nonetheless, they may also share the same multiplex with DVB-H services if hierarchical modulation[136] is used and the DVB-H service is given a higher priority. Each of the streams then allows the use of most convenient modulation parameters.

However, this faces a legacy STB issue

However, hierarchical modulation may suffer from a legacy set top box (STB) problem. Most current STBs do not fully decode hierarchical modulation. Consequently, this approach may be unpractical to implement in Member States that already have a significant penetration of DTT services.

C.2.2 Power consumption

Low power consumption is required

As discussed above, DVB-H is mainly intended to provide services to handheld and other mobile multimedia terminals (personal digital assistants, laptop PCs and small portable TV sets). With the exception of integrated car terminals, all of these terminals are battery operated. Consequently, a low power consumption is essential. Power consumption at the DVB-H front-end (tuner and demodulator) should have a maximum of around 100mw, approximately 10% of a present day DTT front-end.[137]

This is achieved via 'time slicing'...

The requirement of low-power consumption is met by using a time division mechanism, called *time-slicing*. Using this mechanism, data is transmitted in periodic bursts. The receiver is also provided with indications of the respective burst (on-time) and interruption (off-time) duration, thus allowing the receiver front-end (tuner and demodulator) to be switched to a stand-by status during the off-time. The receiver front-end is restarted about 250 milliseconds before the next burst.

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136 Hierarchical modulation is a modulation system where two streams with different modulation and channel coding are combined. The stream with a lower protection and less coverage requires a higher signal level and has a relatively higher capacity, and is called the low priority stream. The stream with higher protection and more coverage is called the high priority stream.

137 Other functions of DVB-H receiver also require some energy, though in small quantities. Such functions include decoding the DVB-H protection codes in a subset of the received bursts: this may require 2mW. Neighbouring cells monitoring during off-time for handover also requires a small quantity of power.

…and multiplexing of several DVB-H broadcasts

In order to maintain power consumption below the threshold mentioned above, the on-time is required to be approximately ten times longer than the duration of a single burst. This requires that each DVB-H broadcast be multiplexed with other time-sliced services to fill the on-time.

This introduces some constraints on multiplex sharing

In a multiplex shared with DTT (non time-sliced) services, the bit rate assigned to the ensemble of time-sliced services must be about ten times the bit rate of a standard DVB-H service (approximately 200-300kbit/s, maximum 384kbit/s) in order to apply effectively the low power consumption mechanism.

This constraints the bit rate available for DTT services. However, it should be noted that even after having provided for ten DVB-H services at the maximum bit rate, there is sufficient capacity in a multiplex for four/five standard definition channels, as shown in Exhibit C.2 below.

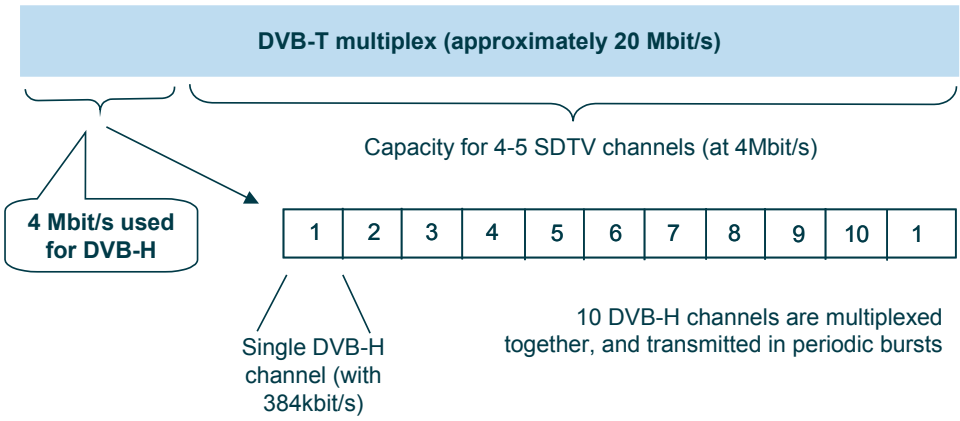

Exhibit C.2: *Time-slicing [Source: Analysys]*

C.2.3 GSM900 incompatibility

GSM900 terminals are incompatible with DVB-H

GSM900 terminals are incompatible with DVB-H reception due to the significantly different power levels used.[138]

GSM900 terminals operate at a relatively high-signal level (+33dBm) in the 880-915MHz frequency band. By comparison, DVB-H receivers require a very low maximum signal level (-28dBm) in the UHF band (470MHz-862MHz). De-coupling the DVB-H signal is extremely difficult and prevents the use of the upper UHF channels (that operate in frequencies approaching that of GSM900).

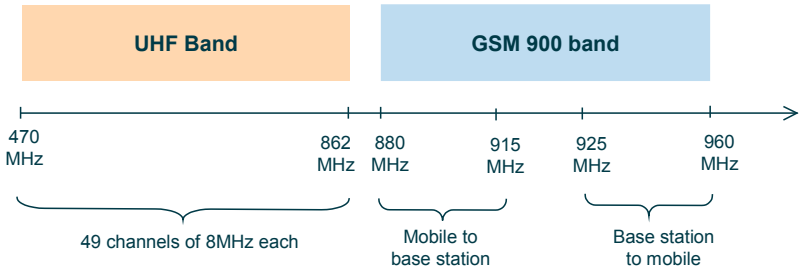

Exhibit C.3: *UHF and GSM 900 frequency bands [Source: Analysys]*[139]

This places a significant constraint on DVB-H

Manufactures have agreed to solve this issue by limiting the highest channel for DVB-H services to channel 49 (702MHz). However, this is a serious constraint for DVB-H as the most commonly used frequencies for digital services are in the upper part of the UHF band. This problem does not only affect GSM (and GPRS and EDGE) terminals, but also UMTS terminals because they are typically backwards compatible with GSM services.

Industry effort is required to find a solution

This problem requires significant industry effort to try to find an alternative to the band limitation. One solution may be to restrict simultaneous usage of GSM900 and DVB-H services. Although switching off the GSM900 services when using DVB-H may not be acceptable, a solution involving a limited GSM service (SMS

138 All GSM900 backwards compatible terminals are affected.

139 The extended GSM band (E-GSM) is shown in the exhibit.

reception, call announcement, interactivity, etc.) may be possible.[140]

C.2.4 Network issues

Hybrid networks are required for DVB-H

DVB-H requires a hybrid network made up of a DTT network (based on high power transmitters) complemented in urban areas by a dense cellular SFN network (comprised of a large number of small overlapping cells).[141]

For shared multiplexes, the network will have a DTT topology with a complementary cellular topology

The network will depend on whether DVB-H shares a multiplex or not. If a multiplex is shared, the network used in urban areas will resemble more a mobile network than a DTT network. By comparison to a DTT-only network, the number of repeaters will significantly increase, and in urban areas the network may approach a cellular topology.

A stand-alone DVB-H network may resemble a cellular topology, complemented by a DTT network

Where DVB-H services are stand-alone in a multiplex and a significant population and area coverage is required, a DTT network type with fewer (high power) transmitter sites than a cellular network may suffice in open areas. However, urban areas and hilly areas may still require a typical cellular approach (with a number of small overlapping cells).[142]

C.2.5 Spectrum

Stand alone DVB-H multiplexes have

As described above, a shared multiplex approach has a number of limitations as it does permit the use of the optimal parameter for

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140 The time-sliced structure of DVB-H operation may allow message reception and call announcement during the off-time without disturbing DVB-H reception.

141 GSM mobile networks typically have five-ten times more cells than transmitters in a terrestrial television network (for nationwide coverage).

142 Note that due to spectrum constraints, an MFN network is not possible. A number of SFN deployment options exist: firstly, a nationwide SFN network may be used, though this will not allow for regional content to be included. Regional SFNs may be used instead.

advantages

either service. However, due to spectrum scarcity, it may be the only option implementable before switch-off. After switch-off, stand-alone DVB-H services in a multiplex may be the preferred option provided UHF frequencies are available. Where such spectrum is available, 30-40 DVB-H services may be exist in a single multiplex.

However, spectrum resources are scarce. Mobile spectrum is not likely to be used

Spectrum resources in the UHF band are limited, and in most (though not all) Member States, spectrum for stand-alone DVB-H multiplexes is unlikely to be available before analogue switch-off.

Stand-alone DVB-H services may be implemented in mobile telecoms bands.[143] However, it is unlikely that mobile operators will use spectrum assigned to them for DVB-H services. They have recently made large 3G investments and will be focusing on achieving a return on these: they may be unwilling to invest in another technology, such as DVB-H, before the potential of their current investment is realised, despite DVB-H providing a much cheaper implementation for point–to-multipoint content delivery than a 3G network. Indeed, mobile TV via 3G may help operators achieve greater 3G penetration and the introduction of mobile TV via DVB-H may put this 3G growth at risk.

RRC06 may not plan for DVB-H, thus restricting spectrum availability

The ITU Regional Radio-communications Conference 2006 (RRC06), scheduled for June 2006, will plan for a minimum of six DTT multiplexes per country in Europe and neighbouring areas (based on planning criteria agreed at RRC04). However, no mandate for planning DVB-H channels is in the RRC06 agenda and given the lack of previously agreed planning criteria for DVB-H, it is very unlikely that the conference will address DVB-H spectrum planning.[144]

Shared multiplexes most likely before

It is likely that DVB-H will be introduced using multiplexes shared with DTT prior to analogue switch-off. However, as mentioned

143 The DVB-H specification permits the 5MHz channelling used in these bands, but reduces the maximum number of services per multiplex to between 15 and 20.

144 Note that RRC06 will is to consider planning for DTT portable reception multiplexes. Given that planning and coverage requirements for DVB-H services are similar, a multiplex planned for DTT portable reception may later be used for DVB-H services.

switch-off

above, at present there is a usage limitation for DVB-H in UHF channels above 49, significantly restricting the multiplexes that may be shared. If this limitation is not solved in the short term, it may significantly restrict DVB-H deployment prior to switch-off.

C.3 Alternatives to DVB-H

This section briefly highlights the key competitors to DVB-H in the provision of portable and mobile reception on handheld terminals.

C.3.1 Digital audio broadcasting

Primarily for audio, DAB also allows multimedia content

Digital audio broadcasting (DAB) was primarily developed (in the late 80s) for high quality mobile reception of audio service. However, the technology may also be used for multimedia delivery and can provide high quality still pictures and some video content (of low frame-rate) to moving vehicles.[145]

DAB is less costly and easier to implement

By comparison with DVB-H, DAB requires much less transmitted power for mobile reception. This implies cheaper networks and easier SFN implementation.[146]

Power savings also exist at the receiver end. DAB uses differential quadrature phase shift keying (DQPSK)[147] modulation that requires approximately one-third of the receiver power consumption as compared to DVB-H. The low receiver power consumption, and the DAB burst structure, make time-slicing unnecessary.

DAB also provides greater flexibility than DVB-H

Four to six multimedia channels (using AVC coding and 250-300kbit/s per channel) may be accommodated on a single multiplex. This allows for a multiplex to be used by a single operator, and thus

145 DAB is based on OFDM modulation (spread spectrum modulation system first developed for DAB) with a 1.5MHz channelling, allowing for a bit rate of 1.2–1.5Mbit/s per multiplex.

146 Note that SFN networks are more spectrum efficient than alternative MFN networks.

147 DVB-H may use QPSK or 16QAM.

than DVB-H

provides greater flexibility (compared to DVB-H where a multiplex may enable 30-40 channels and thus multiplex sharing between operators may be required).

However, DAB suffers from indoor reception problems

DAB has been designed for high quality mobile reception. The signal is designed to be robust (using time interleaving and an unequal error protection (UEP)), enabling reception in fast moving vehicles, for example.[148] However, DAB has not been designed for indoor portable reception. A much greater field strength is required for portable indoor audio and multimedia reception (estimated required increase of 9-15 dB).[149] Increasing the field strength requires higher transmitter power planning; it is expected that these issues will be addressed at RRC06.

Also, VHF spectrum availability is limited

Different spectrum bands may be used for DAB, and thus no significant spectrum constraints exist. The VHF band III (170-226MHz) is well suited for DAB deployments, allowing wide coverage and relatively low cost network implementation. However, in many countries availability of VHF spectrum is limited.[150]

Spectrum in the L-band is available, though networks are expensive

Spectrum in the L-band (1452-1477MHz) may also be used for DAB multimedia services. Although the band has already been assigned to DAB, it is largely unused for DAB audio services. Note that the L-band implies a more costly network (requiring many more transmitters that networks using VHF spectrum). Furthermore, it will not be able to make use of the already existing VHF infrastructure (thus resulting in even higher costs).

Also, further changes will be required for data transmission

Although DAB integrates a data transmission structure, this has been designed as a complement to the audio services and does not provide adequate robustness (error correction) required for video and multimedia services. Although greater robustness of the data

148 UEP provides greater protection to bits of data that are more important for good reception.

149 Figures obtained at tests carried out in Germany and the UK by respectively the IRT and ntl.

150 The VHF band III is saturated with DAB audio channels (and some DTT services) in some countries

transmission

transmission may be achieved by inserting an additional forward error-correction (similar to MPE-FEC), it is unclear if this will substantially improve mobile reception at high speed. A more elaborated data transmission structure may be needed for multimedia services.

DAB is unlikely to substitute DVB-H but may complement it

DAB has some advantages over DVB-H that include low power consumption at receivers, cheaper networks where VHF frequencies are available, easier network implementation and greater flexibility in spectrum assignment to operators. However, despite these, it is unlikely to be a major competitor to DVB-H. This stems from indoor reception problems, limited availability of VHF frequencies and the high cost of alternative L-band networks, as well as a lack of robust data transmissions.

DAB may emerge as a stronger competitor if RRC06 assigns new channels for T-DAB and permits more transmitter power.[151] In this case interoperable DVB-H and DAB services can be envisaged.

C.3.2 Other alternative technologies

Three other technologies exist that may compete with DVB-H: digital multimedia broadcasting (DMB), terrestrial mobile multimedia multicast (TMMM) and integrated services digital broadcasting-terrestrial (ISDB-T). However, these technologies are being developed outside Europe and are not fully compatible with the European DVB standard. As a result, they are unlikely to substitute DVB-H.

Digital multimedia broadcasting (DMB)

DMB is being developed in Korea

The DMB technology was developed in Korea by Samsung in 2002. It is based on DAB technology and enables multimedia content including television broadcasts. Like DAB, it is intended for portable and mobile reception by handheld terminals.

It is largely similar

As with DAB, DMB may be used for terrestrial broadcasts (T-DMB)

151 This will also require for some DAB features to be rapidly develop. These include adequate outer FEC, appropriate encapsulation of IP datagrams on the DAB physical layer, and adoption of same video format as DVB-H.

to DAB

in the VHF band.[152] Similar bit rates are required per video broadcast as DAB (200-300kbit/s), thus allowing four to six broadcasts per multiplex.

DMB differs from DVB-H in the use of transmission protocols: unlike DAB, it uses direct encapsulation of MPEG4 over MPEG2 packets.[153]

DMB has some advantages over DAB (for example, DMB overcomes the indoor reception and data transmission issues of DAB).

The DMB technology has been submitted to the ITU for standardisation.

It is currently being trialled

The first DMB pilot was launched at the beginning of 2005: three transmitters operating in the VHF band provide services in Seoul, offering a variety of video and audio broadcasts. Six DMB multiplexes are being licensed in Korea and commercial services are expected later in 2005.

In Europe, DMB will face the same challenges are DAB

In Europe, DMB will face a lack of available VHF frequency, which is the same challenge faced by DAB. However, unlike DAB, DMB is not fully interoperable with DVB-H. Nevertheless, DMB will be trialled in Europe.

Terrestrial mobile multimedia multicast (TMMM)

TMMM is being developed in the US

TMMM, formerly known as forward link only (FLO), is being developed by Qualcomm in the US. It is intended for mobile multimedia reception by handheld devices. TMMM has been

152 Note that satellite broadcasts are also possible, using the UHF band (S-DMB).

153 DMB is based on H264 AVC coding for video, also expected to be used for DVB-H.

submitted to the ITU for standardisation.

It represents an efficient new technology

TMMM is highly spectrum efficient as it has been developed without backwards compatibility, thus allowing optimal design choices. It is well suited for the upper UHF band, using hybrid SFN networks. In the US, eight channels with higher emission power have been assigned for mobile services. TMMM uses H264 AVC coding for video at an average bit rate of 360kbit/s.

However, it is US specific and is unlikely in Europe

TMMM is unlikely to be deployed in Europe where DVB technology has gained acceptance. Furthermore, TMMM is very new, and it is not yet known whether its performance has not been fully tested.

Integrated services digital broadcasting-terrestrial (ISDBT)

ISDB-T has been piloted in Japan

The ISDB-T technology has been developed in Japan, and the first pilots were conducted in Tokyo and Osaka in 2003. ISDB enables delivery of multimedia services to portable and mobile terminals. It has been specified in Japan as ARIB STD-B24.

Despite technical strength, ISDB-T will not be adopted in Europe

ISDB-T provides highly robust broadcasts of video and audio content to handheld devices. In addition to handheld reception, the technology is fully compatible with fixed antenna reception. However, in spite of its technical strengths, ISDB is not likely to be used in Europe given the existing use and high acceptance of DVB.

Annex D: AVC

This annex outlines the developments in video coding technology, and addresses their relevance to digital television development in Europe.

D.1 Overview of AVC

When the DVB project was formed in 1993, MPEG2 represented the most advanced video coding technology. As a result, it was adopted as the base for DVB video coding standards and up to now it has been used in all DTT services. However, after a series of enhancements, little room remains for further improvements in MPEG2.

A new coding technology has recently emerged that can deliver greater compression efficiency, namely ITU-T H264 or MPEG4 part 10, also known as advanced video coding (AVC).[154] AVC is a non-proprietary standard which has been adopted by the DVB. In addition to a much higher coding efficiency, it offers a wide range of benefits compared to other coding algorithms:

- unlike MPEG2, the picture is encoded independent of the transport or storage mechanism to be used. This enables the encoded picture to easily adapt to the most convenient format for transport in the network[155]

- AVC is highly flexible, making it suitable for a range of applications. It can therefore be used for low bit rate applications such as DVB-H and videoconferencing, medium

[154] AVC was developed by a Joint Video Team from the ITU and MPEG, and standardised by the ITU and the ISO/IEC.

[155] For example, AVC may map to the MPEG2 transport stream packets, 3GPP, IP datagrams for IP networks or file formats for storage.

bit rate applications such as high definition television (HDTV) and DVD, as well as high bit rate applications such as film production and processing[156]

- as with MPEG2, AVC has various defined profiles which vary in implementation complexity. The various profiles are adapted to specific applications. For example, the extended profile provides high resilience and is recommended for wireless applications (DVB-H), whereas the high HP profile is recommended for standard definition television (SDTV) and HDTV.

However, AVC is considerably more complex than MPEG2; its higher efficiency has only been made affordable by rapid developments in processing power and memory capacity. As with MPEG2, the AVC specification only defines the format of the data stream and the decoding process. The development of the encoder is left to the manufacturers, allowing enhancements in performance over the life of the standard.

D.2 Efficiency gain of using AVC compared to MPEG2

The coding efficiency gain that may be obtained by using AVC depends on the application being used (for example, DVB-H or HDTV), as well as on the content that is being transmitted. For example, content with fast moving pictures may result in a lower efficiency gain. For SDTV, the following table shows the evolution in video coding performance over the past decade, assuming average content (in terms of bit rate demand).

Year	*Encoding technology*	*Bit rate*
1995	MPEG2	6Mbit/s
2000	MPEG2	3Mbit/s
2001	MPEG4p2	2.5Mbit/s
2005	MPEG2	2.5Mbit/s
2005	MPEG4p2	2.1Mbit/s
2005	AVC high profile	1.2-1.4Mbit/s

***Exhibit D. 1**: Bit rate required for SDTV channel [Source: DVB]*[157]

156 As with MPEG2, use of AVC results in a net loss, with some information not being retrieved upon decoding. As a result, the bit rate for each application should be kept over a certain threshold to avoid perceivable picture impairment.

As shown in Exhibit D. 1 above, for standard SDTV (as well as HDTV)[158] AVC currently delivers a coding efficiency gain factor of approximately 2 by comparison to MPEG2 (requiring only 50% of the MPEG2 bit rate). However, unlike MPEG2, which is close to its theoretical efficiency limit, there is plenty of room for enhancements to AVC. As a result, it is likely that in five years AVC may approach twice its present coding efficiency (representing a 10-15% bit-rate saving per year).

D.3 Competitive video coding technologies

Microsoft has recently developed a separate technology that may also be used for video encoding. It is based on Windows Media 9 (WM9), a member of the Windows Media family of standards, and was originally intended for video streaming over the Internet.[159]

At present, the technology is proprietary to Microsoft. However, it has been presented to the Society of Motion Picture and Television Engineers (SMPTE) for standardisation as VC1 (Video Codec 1).[160] Once accepted (due in 2005), VC1 will be an open standard.[161]

D.3.1 VC1 versus AVC

Although VC1 uses many of the same coding techniques as AVC, it is a much simpler coding system. However, its simplicity is offset by lower encoding efficiency: although, VC1 provides a bit rate saving of approximately 30% by comparison to MPEG2, this represents a significantly lower efficiency gain than AVC (see Section D.2 above).

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157 This assumes the use of latest technology and statistical multiplexing. It excludes the bandwidth required for the audio stream, multiplexing requirements, etc.

158 Figures based on software implementations of AVC coders. There are some reports that the first hardware implementations show a slightly smaller gain. However, these preliminary results need further verification.

159 Microsoft chaired the Joint Video Team of the ITU and MPEG that developed AVC. However, in parallel it has developed a competing technology. Note that VC1 represents a reduced version of WM9, excluding features such as digital rights management (DRM), metadata, play list and the user interface.

160 SMPTE was founded in 1916 to develop standards in the motion picture industry.

161 VC1 was submitted for standardisation in 2003. However, the unavailability of reference encoder and decoder to test interoperability and multiple licensing issues have delayed the process. It is expected to be finalised during 2005.

Also, whereas VC1 is optimally designed for 1Mbit/s streaming applications, AVC can deliver a high efficiency gain at low as well as high bit rates. Furthermore, VC1 is designed for progressive scanning and its encoding performance falls significantly for interlace scanning (used in all present SDTV television services and it may be used for HDTV).

D.3.2 Co-existence of VC1 and AVC

VC1 provides good coding efficiency compared with MPEG2 and is simpler to implement than AVC. Consequently, it may find a wide use for less demanding applications such as Internet streaming. AVC, on the other hand, provides greater encoding efficiency than VC1, and its flexibility enables it to be used with a wide range of applications (of different bit rates). As a result, given specific AVC profiles, applications such as film production, post-production or digital cinema are likely to use AVC. Furthermore, AVC may also be adopted where spectrum constraints limit transmission capacity; this is highlighted by the recent DVB decision to adopt AVC for IP delivery, including DVB-H.

In addition to the above-mentioned issues, other factors will have an impact on which technology will succeed in the long term:

- **adoption by key consumer devices –** both blue-ray DVDs and HD-DVDs will be compatible with both coding technologies. However, a decision by either of these groups to opt for only one of the coding technologies would have a significant impact

- **rights protection –** protection of digital media assets is a key concern of content owners. The incorporation of rights management and copy protection techniques may significantly enhance the competitiveness of the coding technologies

- **future technology development –** both AVC and VC1 allow for significant improvements in coding efficiency. Industry confidence in which technology may develop further may also have an impact on their success. There are some concerns regarding dependence on Microsoft for VC1 development.

D.4 AVC implementation issues

Although VC1 is easier to implement than AVC, it is less bit rate efficient. Additionally, given industry concerns about the dependence on Microsoft, AVC is likely to become the standard for the next generation of broadcasting, though VC1 may retain an edge for specific applications such as Internet streaming. However, equipment manufacturers are likely to enable both AVC and VC1 coding technology in their equipment, leaving the choice of which system to adopt by content producers and broadcasters.

AVC is gaining acceptance

AVC is being promoted by the AVC Alliance, a group of manufacturers and service providers that are leading the development of hardware and services that use AVC.[162] It has already been adopted for key applications, including DVB-H services as well as HD-DVD and Blue-Ray DVD.

The DVB has already specified the use of AVC for IP delivery, which includes DVB-H, and for SDTV and HDTV, irrespective of the delivery platform.

Some organisations are adopting both AVC and VC1

As mentioned above, HD-DVD and Blue-Ray DVD have adopted both AVC and VC1 technologies. This minimises the technology risk for the next generation of DVDs, gives content producers the freedom to use either technology, and allows manufacturers to implement either a dual decoder or the decoder of its preference.

In spite of the DVB recommendation in favour of AVC, the use of VC1 with some DVB delivery standards may not be excluded.

162 www.avc-alliance.org.

New Pay-TV platforms are likely to prefer AVC

Given that manufacturers are likely to enable both AVC and VC1 in their equipment, the success of coding technologies will depend on their adoption by content owners and broadcasters.

New Pay-TV platforms may find AVC an appropriate platform, especially where broadcast bandwidth is costly or limited, as in the case of Pay DTT in France. Video Networks (an IPTV operator in the UK) has also adopted AVC for its ADSL platform.[163]

Equipment development is underway

Although the AVC specification was ready in 2003, extensions to its specification have taken place as recently as late 2004. As a result, there are currently only a few AVC equipment or integrated chips available in the market. However, most manufacturers that have committed to AVC have projects underway.

As mentioned above, various AVC profiles have been designed for different applications. Equipment for less complex profiles may be developed first if demand exists for the applications. The first hardware for DVB-H services using AVC encoding was released at beginning of 2005. Equipment for SDTV and HDTV using AVC encoding in also expected to be commercially available over 2005–06.

D.5 Relevance to digital television platforms

The developments in video coding technology may facilitate the migration to digital television.

AVC helps overcome DTT spectrum limitations

The coding efficiency of AVC facilitates digital television where broadcasting spectrum is constrained, as is the case with DTT in many Member States. However, in spite of its efficiency, AVC suffers from backward compatibility with MPEG2 that is used in present existing receivers. As a result, the implementation of AVC for DTT in countries that have already achieved significant penetration, especially the UK, will require a challenging STB migration process.

163 Other relevant international organisations that are considering AVC are ISMA (Internet Streaming Media Alliance), IMTC (International Multimedia Telecommunications Consortium), and 3GPP (3rd Generation Partnership Project).

However, backward incompatibility may limit deployment

In general, AVC suits applications that require a new terminal (such as DVB-H or HDTV), with no need for backward compatibility with existing terminals. AVC is also well suited to the implementation of a new TV platform (where a new terminal is required), irrespective of the type of delivery network: DTT, satellite, cable or ADSL. In France, AVC has been adopted for the new Pay DTT platform that is expected to be launched in the coming months.

AVC is well suited to DVB-S2 and DVB-H…

AVC may be successfully employed in new transmission systems such as DVB-S2 for satellite. Using both DVB-S2 and AVC may deliver three times the coding efficiency of a standard satellite service.

AVC is also particularly well suited for DVB-H and other low bit-rate applications, given the higher coding efficiency it may deliver. It may be noted that MPEG2 does not perform well for such applications, and is typically replaced by H263 or MPEG4 part2.[164]

[164] MPEG2 was designed for applications with a bit rate of between 2 and 30Mbit/s. Also, as mentioned above, AVC has a number of profiles, suited for different applications. The AVC High Profile has several features specifically developed for film production, film post-processing, digital cinema, HDTV contribution links, etc. This makes AVC the best choice for such demanding applications.

Annex E: Cable carriage regulation in Germany

Unlike satellite transmissions, channel carriage on cable networks is subject to detailed regulation as there is are more channels requesting carriage than there is analogue transmission capacity. German cable regulation strictly distinguishes between analogue and digital cable networks. Analogue networks are governed by rules specific to each Federal State whereas digital cable are regulated under the Interstate Treaty on Broadcasting.

E.1 Analogue cable

The vast majority of cable networks in Germany still use analogue transmission standards. On such networks, approximately fifty licenced broadcasters compete for transmission capacity of about 35 channels. Consequently, it has to be decided which broadcasters actually receive a cable channel and which do not.

The Federal Constitutional Court has repeatedly ruled that the range of television channels available to the public has to reflect a broad range of interests. As a consequence, regional media authorities (LMAs) decide the broadcaster that can transmit via the analogue cable networks. In implementing this approach, the Federal States use two different regulatory concepts:

Priority Approach

The majority of the Federal States use an approach that defines **three types of channels**:

- The law gives the public service channels (ARD, ZDF plus the regional public service broadcaster of the particular area) must-carry status on the cable network.
- Legislators believe that a similar range of channels should be available to terrestrial and cable households. Consequently, second priority is given to channels that can be 'typically received' by means of terrestrial reception (principally the major commercial channels such as RTL, SAT.1, and ProSieben). In Berlin/Brandenburg and North-Rhine Westfalia this covers all DTT channels.
- The majority of channels fall beyond the above two categories. The LMAs decide which of these channels are assigned a transmission slot based on the principle of diversity of opinion. LMAs have developed a number of criteria to select channels: generally full service programs are preferred to special interest offerings and news channels to entertainment channels.

Selection Approach

In Berlin/Brandenburg and Bavaria a different regulatory approach is used to select channels for cable transmission that is based on the guiding principle of pluralism. Unlike the Priority Approach, **only a small number of must-carry channels** (mainly those of public service broadcasters) **are defined** by law and LMA have responsibility for selecting the other channels. This approach provides a more significant role to LMAs as they are not bound by the categorisation of channels.

Both regulatory concepts create a market environment that overwhelmingly does not allow the cable operator to decide freely upon the usage of its (analogue) network. In particular, must-carry obligations under the Laws of Berlin/Brandenburg, North-Rhine Westfalian and Lower Saxony apply to all DTT channels, i.e. each DTT channel must be granted analogue cable carriage. This specific must carry right on cable acts as an incentive to participate in DTT, for some commercial broadcasters that may otherwise have difficulty in obtaining cable transmission.

LMA decisions are binding, although in many cases they have been legally challenged by broadcasters that were not selected for cable transmission. In most cases, however, these lawsuits have not been successful.

E.2 Digital cable

Digital cable networks are regulated differently. The Interstate Treaty on Broadcasting provides a regulatory model that is implemented by the LMAs. This model divides cable transmission capacity into three types, to each of which different rules apply:

- **Must carry –** *four transmission channels of 8 MHz each are reserved* for the carriage of three public service broadcasting bouquets (two for ARD and one for ZDF) and one bouquet composed of regional and local services.
- **Can carry –** an *additional third of the transmission capacity* is reserved for channels that enjoy 'can carry' status. This typically refers to channels that have been carried on an analogue network as a result of the LMAs selection process. However, digital cable operators are not obliged to carry all of these channels: they can apply the relevant pluralism criteria themselves. Thus, DTT channels which enjoy must carry status on analogue cable may not necessarily be carried as 'can carry' channels on digital cable, even though in practice digital cable network operators will chose to carry these channels. Where the cable operator is seen not to offer a diverse selection 'can carry' channels the LMA may intervene.
- **Non must carry –** for the *remainder* of the digital transmission capacity, cable operators are free to base its choice on economic preferences and carry communications services of any kind, including digital television services, voice telephony or fast internet access offerings.

Where an operator uses both analogue and digital technologies, it will be subject to two different kinds of regulation.

Annex F: Universal terrestrial coverage in Germany

The PSB's in Germany are not required to provide nationwide terrestrial coverage. This represents a change from the past that is reflected in a ruling by the Federal Constitutional Court. This ruling has led to a revised understanding of the universal access obligation. The PSB are no longer obliged to provide terrestrial coverage where the region is covered by cable or DTH.

Previously the Constitutional Court (Case BVerfGE 73, 118) had established that the PSB's are obliged to provide technical television coverage of all television households in Germany. Furthermore, in 1987 (Case 74, 297), the Court ruled that "for now" (i.e. for the foreseeable future), such universal coverage obligation shall mean an obligation to broadcast via (analogue) terrestrial networks as at the time terrestrial broadcasting was by far the predominant means of television distribution in Germany.

The requirement for universal coverage via terrestrial networks has since been withdrawn for the following reasons:

- A dramatic change has taken place in the television market since 1987 with more than 90% of households receiving television via cable or satellite, and less than 10% of households depending on the terrestrial platform.

- PSB's are bound by the principle of economic efficiency in the use of their financial resources. The use of resources to provide terrestrial coverage where lower cost alternatives may be available would go against this principle that has been stated in specific Constitutional Court cases (BVerfGE 90, 60 and 108, 108).

Legislators have taken the above factors into account and justify the switch-off of the analogue terrestrial broadcasts on this basis.