

A HIGHER DEFINITION: THE DIGITAL TERRESTRIAL HD TRIAL

BBC

itv



five



Executive Summary

High definition (HD) broadcasting is potentially one of the biggest changes in television technology since the introduction of colour in the 1960s. It is the latest in a long line of major improvements to TV services, which have moved from black-and-white analogue to widescreen colour digital over the last 50 years. It offers a step change in picture resolution, leading to a clearer, more life-like image. It also offers the ability to broadcast in cinema-style surround sound.

HD arrived in the UK in 2006 with both the first service launches and strong sales of HD Ready TV sets. Around two million of these sets are expected to be sold in the UK in 2006 alone, and forecasts suggest that around 10 million UK homes will have HD Ready TV sets by the end of the decade.

In parallel to this, digital terrestrial television, or DTT, has shown very healthy growth since the launch of Freeview in 2002, with 6.4 million households now using it as their main TV platform. Making DTT universally available is a key part of the government's plans for achieving full digital switchover by 2012, and there has been a huge public and private investment commitment made to the platform.

However, while HD services are now available on cable and satellite, the prospects for HD being available on DTT have been unclear. The BBC, ITV, Channel 4 and Five therefore came together earlier this year, in a ground-breaking

collaborative partnership, to discuss how best to investigate the potential for HD on DTT. These discussions culminated in the trial described in this report.

The trial had two main objectives:

- To test the technical viability and implications of delivering HD signals over the DTT platform
- To gauge consumer reactions to such a service.

Using temporary spectrum licensed by Ofcom, a free-to-air HD service has been broadcasting on the DTT platform in the London area to 450 trialist homes since early June 2006. The trial has showcased a wide range of HD content from each of the public service broadcasters, from a range of key genres.

The trial has successfully demonstrated the technical feasibility of HD on DTT. Consumer reactions have been positive, and the HD content shown has exceeded the already high expectations of the majority of trialists. A number of genres, including wildlife, sport and films, were seen to benefit particularly from being in HD, satisfying viewers' expectations of a quality viewing experience.

"I am totally blown away. The quality of the image is fantastic."

"I just couldn't believe that the picture that we were getting

could be any better than that which we were getting on digital broadcasts, however...I am astounded with the difference."

However, the trial has also raised a number of key issues. Trialists expect HD to be delivered on DTT in the near future, though spectrum restrictions make this unlikely to happen until digital switchover and only then if further spectrum becomes available for the platform. Trialists expect the public service broadcasters to be at the forefront of HD content delivery, though currently there is no clear free-to-air path for the public service broadcasters to do this. They also believe that they should be able to receive HD content for free, with half of trialists unwilling to pay any extra despite the importance they place on HD.

Several important questions are therefore raised:

- Is it inevitable that HD will become the standard TV format of the future, and if so, when?
- Would the lack of availability of HD on DTT have implications for the overall prospects for DTT, consumer satisfaction with digital television more generally, and the development of the HD market?
- What are the potential routes to ensuring HD is available on the DTT platform?

Introduction and background

2006 has seen the arrival of high definition (HD) broadcasting in the UK, in the wake of strong sales of HD Ready TV sets, the first HD service launches, and widespread commentary on the technology in the media. Until now, the UK has been somewhat behind other international markets such as the US, Japan and Australia in delivering HD television, though is widely predicted to have some of the highest rates of penetration and usage in Europe in future years. With the introduction of satellite and cable HD services earlier this year, all eyes are now on how the UK public will take to this new technology, potentially one of the biggest changes to hit television since the introduction of colour in the 1960s.

In parallel to this, digital terrestrial television, or DTT¹, has shown very healthy growth in recent years, with 6.4 million homes already having made the switch from analogue reception. The main public service broadcasters – the BBC, ITV, Channel 4 and Five – collectively have been committed to driving digital growth in order to meet the government's 2012 digital switchover target, with DTT a key platform for achieving this target.

However, the prospects for HD being available on DTT have been unclear, and the purpose of the trial described in this report has been to investigate how DTT can accommodate HD services in the future. We believe viewers will want to keep DTT in the first tier of digital platforms for many years to come, and we believe that HD will be an important element in ensuring this happens.

The BBC, ITV, Channel 4 and Five therefore came together earlier this year to discuss how best to investigate the potential for HD on DTT. These discussions culminated in the trial described in this report.

The trial had two main objectives:

- To test the technical viability and implications of delivering HD signals over the DTT platform
- To gauge consumer reactions to such a service

The trial has now been successfully broadcasting HD content to 450 London homes for over five months, and we believe that these objectives have been met, though there is more learning to be gathered over the coming months. This report describes our key findings to date.

¹ The free television service currently provided on the DTT platform is better known to consumers as Freeview



Tim Marlowa, Museum of Modern Art, Five

Overview of HD and recent market developments

What is High Definition (HD) TV?

HDTV represents the next generation of TV broadcasting. It is the latest in a long line of major improvements to TV services, which have moved from black-and-white analogue to widescreen colour digital over the last 50 years. It offers a step change in picture resolution, together with the ability to broadcast in cinema-style surround sound.

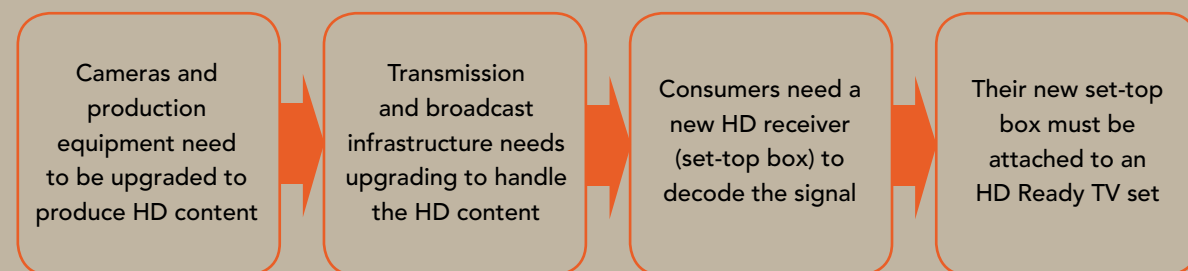
The improvement in picture resolution lies in an increase in the number of pixels used to construct TV images. HD offers up to four times more pixels on screen than standard definition (SD) pictures, leading to a clearer, more life-like image. Edges look sharper and more detail can be seen on screen.

Although the move to digital television platforms has led to an improvement in picture quality for many households, it has been accompanied by a growth in the size of TV sets being sold in the market. This means that the improvement in picture quality is, to some extent, offset by the bigger screens chosen by consumers. The benefits of HD are best seen on larger TV sets of 28 inches and above.

The increased resolution offered by HD means that increased bandwidth is required to broadcast it. Distribution of HD services requires a substantial amount of capacity which, despite expected improvements in compression technologies over time, still provides challenges to its delivery across different platforms. Delivery of a substantial HD service on DTT – where bandwidth availability is much more constrained than on satellite or cable – would currently require additional spectrum to become available on the platform, or the removal of existing channels. High definition requires the upgrading of technology along the length of the TV production, transmission and reception chain, as the illustration below shows. To receive the full benefits of HD, all parts of the chain must be upgraded.

Consumers can also expect to experience HD quality images through the next generation of DVD players and games consoles. The Xbox 360 already allows gamers with an HD Ready set to play their games in high definition, and the long-awaited PS3 console will do the same. High definition DVD systems – of which there are two rival formats: HD DVD and Blu-Ray – are just beginning to hit the market.

Illustration of HD delivery chain from content creation to consumer



HD market developments

HD Ready TV set sales have shown strong growth in 2006. According to GfK, around 1.8m HD Ready sets had been sold in the UK by the end of September, with 2.4m expected to be in the market by the end of the year. The UK HD market is expected to continue to grow strongly, with estimates from Screen Digest suggesting that more than 10m households will have HD Ready sets by the end of the decade.

Sales of HD sets have been boosted by the natural digital TV set replacement cycle. Consumer purchases have been driven primarily by a desire for flat screen LCD and plasma sets which have strong aesthetics and are far less bulky than traditional CRT (cathode-ray tube) sets. The majority of LCD and plasma sets being sold on the high street are now HD Ready, meaning that the purchase of HD equipment often happens by default.

Consumer awareness of high definition is still nascent, but is likely to increase with the promotion of the 'HD Ready' logo and manufacturers' plans to phase out non-HD Ready flat screens altogether. Similarly, the growing availability of HD content and services available in the market is likely to increase demand and awareness over time.

Currently, consumers wishing to receive HD TV services in their homes can do so only via cable and satellite platforms. Telewest were the first to market with a limited video-on-demand (VOD) HD offer at the end of 2005, and Sky's broadcast HD service went live in May of this year. Receiving either service requires a new HD set-top box and an additional monthly subscription fee. The BBC's HD trial stream was available from launch on both cable and satellite without extra subscription costs. ITV has also provided a trial HDTV service to HD cable viewers.

In the US and Japan, HD is considerably more widespread and services have been available for several years. The adoption rates of HD in these markets have benefited from the poorer NSTC standard used for standard definition (SD) TV, compared to the PAL standard used in Europe (including the UK). This makes the difference in quality between SD and HD in these markets even more pronounced. In Europe, broadcasters in several countries started to deliver HD services over the last 12 months. Countries like Germany are at a similarly early stage to the UK, with the 2006 World Cup providing a focus for HD activities across the continent.

The UK production sector, the world's second largest exporter of TV programmes, has already started moving to HD production as it becomes clear that there is an international market for programmes in this format. Currently, commissioning content in HD is more expensive, and can add around 10-15% to production costs, due to the need to upgrade cameras and other equipment, as well as the extra attention to detail needed in set design, costume and make-up. However, these incremental costs are likely to fall substantially over the next few years as the market develops.

Making the trial happen

Delivering this trial required several different elements to be put in place:

- Terrestrial spectrum to enable the service to be broadcast
- HD broadcast technology to distribute the service
- Content to broadcast
- Consumers to view the service with the necessary equipment.

Spectrum for use in the trial was secured through two temporary licences from Ofcom. Due to the limited spectrum available nationally, it was necessary to limit the trial to a small geographical area. London was chosen as the location for the service, and the trial was set up to broadcast from the transmitter in Crystal Palace.

Ofcom issued a one-year licence for the trial, which allowed the creation of two temporary digital terrestrial multiplexes, in addition to the six which are already licensed for the broadcast of DTT services. The terms of the temporary licence required this to be a closed trial, limited to a maximum of 450 trialist homes. The broadcasters worked together to ensure that HD DTT boxes were not made available on the open market. This was achieved by liaising with the manufacturing industry and retailers, and through talking to the technical press. Communication with industry was managed with the assistance of the Digital Television Group (DTG).

Four HD channels were created for the trial. These channels were broadcast on the two multiplexes described above: one operated by the BBC, and broadcasting the BBC's HD stream; the other operated by the commercial PSBs and broadcasting HD streams from ITV, Channel 4 and Five. HD Broadcast technology was provided by the broadcasters' technology partners (see Appendices).

Due to capacity restrictions and current immature compression technology, each multiplex could carry only one live HD stream (channel) at any time. This meant that, although the BBC's HD stream could be broadcast continuously, broadcast time on the commercial PSB multiplex had to be shared between the three commercial PSBs.

Content for use in the trial was sourced by each of the participating broadcasters, in conjunction with their content partners. A limited but varied selection of programming was made available for use in the trial, reflecting some of the best existing HD content across a wide range of genres.

Four hundred and fifty households were recruited to take part in the trial, as described in more detail below. HD set-top boxes were specifically commissioned and developed for the trial by Humax and ADB. These operated using the MPEG-4 compression standard rather than the MPEG-2 used in standard DTT boxes, allowing more efficient encoding of the broadcast signal. This was essential to the successful delivery and decoding of the HD signals used in the trial, and meant that any households with standard DTT boxes were not able to view the HD services.

Each of the 450 households involved in the trial was given one of these set-top boxes, which they then installed into their home TV system, in place of their existing DTT box. From the perspective of the trialists, the set-top boxes offered functionality that was very similar to a standard DTT receiver; all the Freeview channels could be received as normal, with the four extra HD test streams appearing near the bottom of the electronic programme guide (EPG).

The service

The HD DTT trial service launched on the 9th June 2006, to coincide with the start of the *World Cup*. Its first official programme was the opening game of the competition, between Germany and Croatia, on the BBC's HD test stream. Test signals had been broadcast for several days in advance of this, and trialists installing their new set-top boxes would have been able to identify the four HD test streams being broadcast as part of the trial:

- BBC HD at number 501
- ITV HD at number 503
- C4 HD at number 504
- Five HD at number 505.

Although availability of HD content is currently limited, the trial showcased some of the best HD programming available from each broadcaster, spanning a wide range of genres, to try to learn as much as possible about the appeal and suitability of different types of programming in HD. Below are some of the programme highlights from the trial:

Live Sport

- World Cup football
- Wimbledon tennis

Drama

- Bleak House
- Desperate Housewives
- CSI: Crime Scene Investigation
- Robin Hood
- Amazing Mrs Pritchard
- Torchwood
- Space 1999
- House
- The Chatterley Affair
- Totally Frank
- Lost

Music

- Later With Jools Holland
- Isle of Wight Music Festival
- The Proms

Films

- Trainspotting
- East is East
- Shallow Grave
- The Crying Game
- Fever Pitch
- Purely Belter
- Billy Elliott
- The Life and Death of Colonel Blimp
- Cocktail
- Down and Out in Beverly Hills
- The Cable Guy

Documentaries

- Planet Earth
- Jean-Michel Cousteau: Ocean Adventures
- The Somme
- Galapagos
- Back to the Womb: Mammals
- Lost Cities of the Ancients
- Supervolcano

Comedy

- Everybody Hates Chris
- Lead Balloon
- Hope & Faith
- Jam and Jerusalem

Arts

- Tim Marlow – Museum of Modern Art

The service

As mentioned on page 8, the BBC HD stream was available at all times, while the three commercial PSBs shared their broadcast times over the weeks. During the early stages of the trial, the broadcast schedules were flexible to accommodate the *World Cup* matches, but soon after settled into a regular weekly scheme, shown in the table below.

BBC multiplex

Time	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
All Day	BBC HD	BBC HD	BBC HD	BBC HD	BBC HD	BBC HD	BBC HD

Commercial PSB multiplex

Time	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
12pm - 9pm	C4 HD	ITV HD	ITV HD	C4 HD / ITV HD (alternate weeks)	C4 HD	C4 HD	ITV HD
9pm -11pm	ITV HD	C4 HD	C4 HD	Five HD	ITV HD	ITV HD	C4 HD

Programme schedules were posted for the duration of the trial on a website set up specifically for trialists.

Recruitment and research methodology

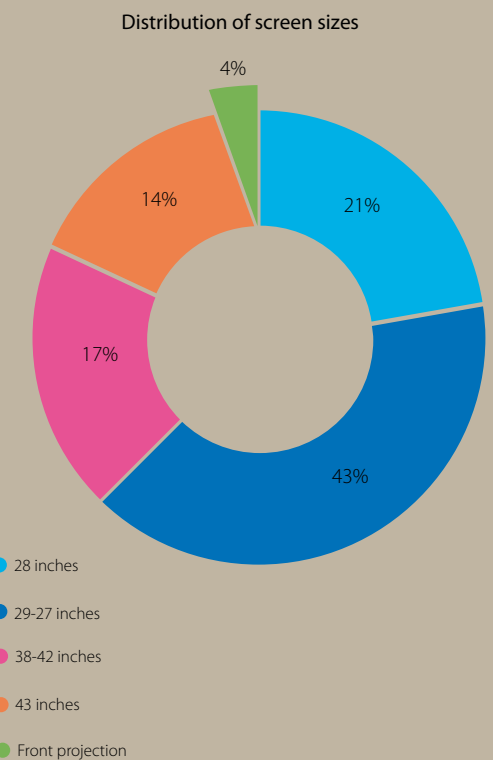
The 450 trialist homes were recruited with the help of research agency TNS, who also managed the trialist sample for the duration of the trial.

The trial was announced publicly in the press and details were posted on each of the broadcasters' websites. Trialists then registered their interest in taking part on a central website managed by TNS.

Trialists were selected on three basic criteria. First, a postcode checker was used to ensure respondents were within the expected London reception area. Second, the trialists needed to already own their own HD Ready TV sets, as these were not provided as part of the trial. Third, all trialists already had to have DTT installed in their homes, which maximised the chance they would be in a good DTT reception area.

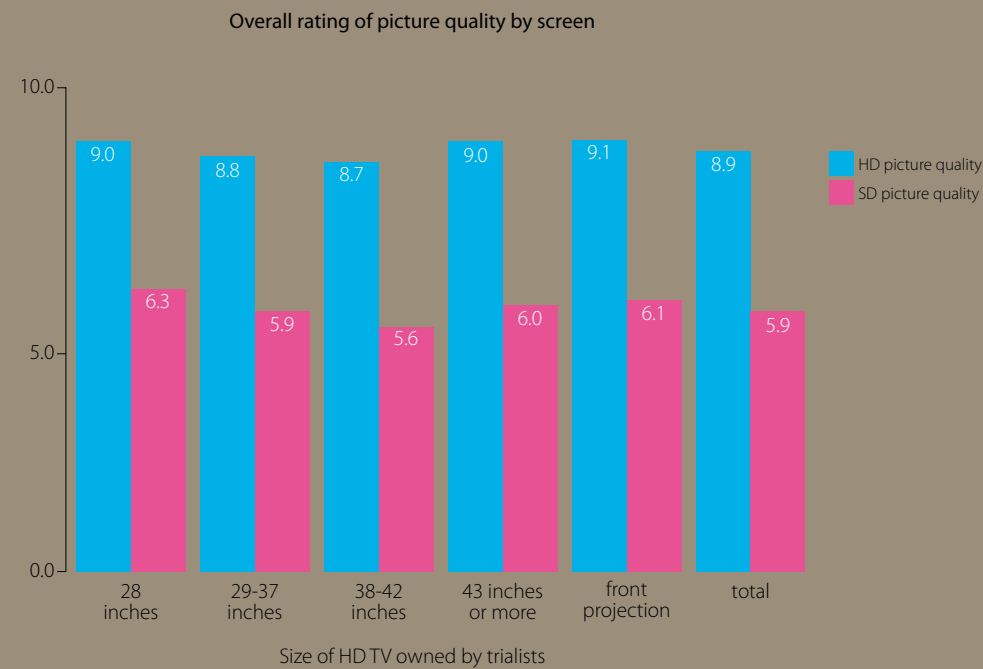
These criteria, particularly the pre-ownership of HD Ready sets, inevitably meant the sample included many early adopters of HD technology. However, overall demand for involvement from the public was high, allowing some flexibility in the selection of participating households to ensure that various demographic segments were represented. Though the main household representatives in our final sample included a sizeable number of young, upmarket men, over 40% of trialists were over the age of 35 and around one in five trialist households had children at home. Many of the male trialists lived with wives or girlfriends, and were asked to take the views of others watching in their household into account when answering questions.

We also captured a spread of homes with different HD screen sizes to investigate the difference that screen size made on appreciation of HD. This distribution is shown here:

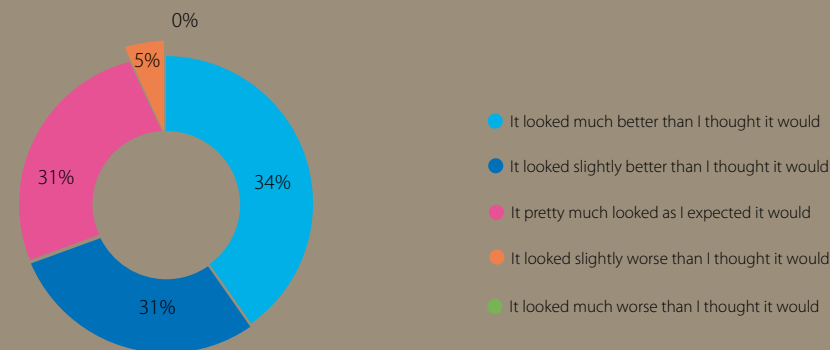


Trialists' reactions and comments on the trial were captured in two ways. Firstly, online questionnaires allowed us to ask detailed questions about trialists' experiences of HD, and their expectations for HD in the future. Three waves of research were conducted between June and October 2006, and these results are summarised in this report. Secondly, trialists were able to post their views online on a forum set up for the trial. This forum enabled trialists to give feedback at any point they liked, and also gave them access to information about the trial including programme schedules from the broadcasters.

What the trialists said



Experience of HD versus expectations



Overall, we believe that the trial has met its objectives and was a success. Trialists have shown high appreciation of HD and its delivery over DTT, and have also provided some interesting issues for consideration through their views and expectations on the future role of the technology in their lives. For many of the trialists, the trial would have been the first time they were able to use the full capability of their often expensive TV purchases, having previously only been able to witness HD through in-store demonstrations. Many trialists described an initial "wow factor" as they first began to live with high definition and although this, inevitably, has diminished slightly over time, their overall impressions of HD have remained high.

High definition versus standard definition

All the trialists had DTT before the start of the trial, so they were already accustomed to the benefits of digital TV. Picture quality was one of these benefits, and 74% reported that they had seen an improvement in their picture quality on switching to digital TV. However, their demand for better picture quality continues, and nearly two-thirds of trialists (64%) said that improving their picture quality was still important to them.

HD appears to satisfy this need. The appeal of HD was strong across demographics, with no significant differences between male and female or older and younger trialists.

"I am totally blown away. The quality of the image is fantastic."

"I must say that I am also getting used to the quality, but now accepting HD as the standard, so find it hard to watch normal TV."

When asked to rate their normal picture quality on a scale of 1 to 10, 15% of trialists gave it a score of 8 or above, doubtless influenced by their exposure to HD content. In contrast, when asked the same question about the quality of the HD pictures they received through the trial, 92% gave a score of 8 or above.

"I just couldn't believe that the picture that we were getting could be any better than that which we were getting on digital broadcasts, however...I am astounded with the difference."

Interestingly, we found that appreciation for the HD picture quality did not vary substantially between trialists who have different sized screens in their homes. Even those with screens smaller than 28 inches still rated the HD picture as substantially better than their equivalent SD picture.

Despite the high expectations of our sample, including many early adopters of HD technology, nearly two-thirds say that the HD content they've seen looks better than they expected, as shown left.

Benefits of HD for different content

As already described, the trial included programming from a diverse range of genres, enabling us to gain some insight into the perceived benefit of these genres in HD.

At the beginning of the trial, we asked trialists which TV genres they would most like to see in HD.

Interestingly, news topped the list, with 84% of trialists saying that they would like to see it broadcast in HD. News programming was not available for use in this trial, though some broadcasters outside the UK have produced HD news. Sport, comedy and drama were the next highest scorers, with documentaries and music also appealing to a majority of trialists.

Examples of most of these genres were available to view during the trial, and trialists subsequently gave their views on the genres that had benefited the most from being shown in HD. The perceived benefit for the main genres tested in the trial is shown right:

This shows that the wildlife genre was perceived to benefit the most from HD, and reflects the high appreciation of programmes such as *Planet Earth*.

“Although I was impressed with the quality of the *World Cup*, I can honestly say that last night’s *Planet Earth* gave me a complete case of jaw-drop for the entire hour!!”

Sport also performed well, and was perceived to benefit greatly from HD. The trial included coverage of World Cup football and Wimbledon tennis.

“...the *World Cup* quality just blows me away, the depth of field that is created and the sharpness and detail of the players really adds to the experience.”

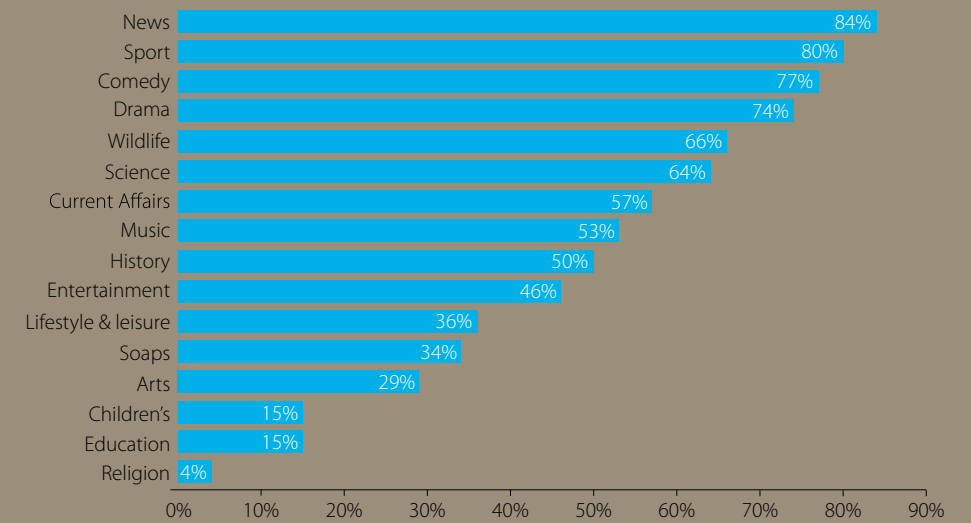
“Extremely impressed with the picture quality, it really adds something to the spectacle of the *World Cup*...hopefully England will make a more convincing job of it on Thursday.”

“Just wanted to say that my wife is now an HD convert! Having no interest in the *World Cup* (unlike myself of course), she really didn’t see what all the fuss was about. Until yesterday when she saw the *Wimbledon* HD broadcast for the first time. Fantastic, vibrant colours and wonderful detail.”

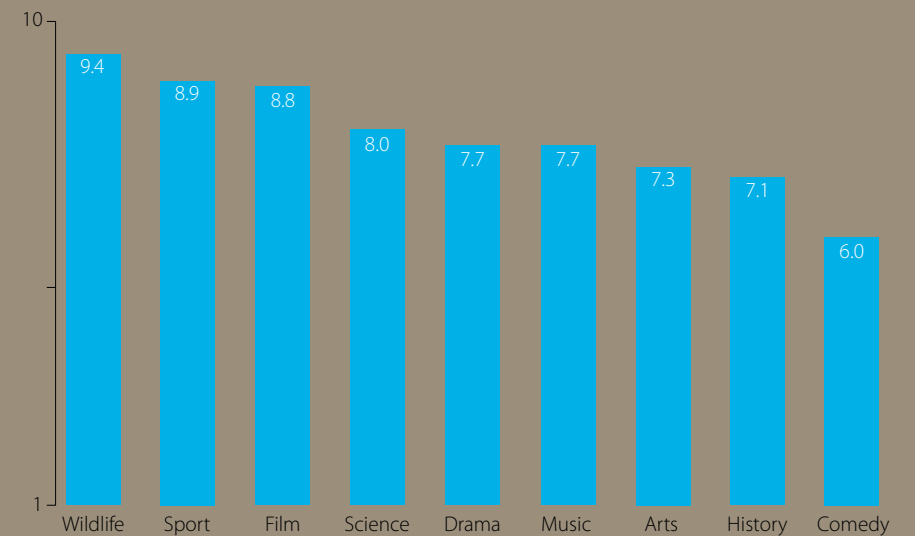
“The clarity and sharpness of the (*Wimbledon*) pictures was amazing. This gave a new view of the competitors’ facial expressions to get an ‘inclusive feel’ for the matches and a clearer view of line calls greatly increased the enjoyment factor. I cannot bear the thought of having to go back to standard definition.”

In addition to TV programming, there were also a number of films shown as part of the trial, ranging from HD transfers of iconic titles of the last fifteen years such as *Trainspotting*, *Billy Elliott*, and *Shallow Grave*, to classic titles such as *The Life and Death of Colonel Blimp*. Film content was highly valued overall, despite some trialists, regarding HD as cutting-edge technology best suited to recent programming, being less appreciative of the older titles that were broadcast.

TV genres that trialists would most like to see broadcast in High Definition



Perceived benefit of HD for different genres (10 = “HD really increases my enjoyment”, 1 = “HD makes no difference”)





Robin Hood, BBC

"Material shot on film and converted to HD looks good for movies. The film grain somehow adds to the atmosphere of the movie or programme."

"Saw the last 20mins (of *Trainspotting*) on C4, and it looked really good. So sharp with vivid colours, much like most of the other older films that have been shown on ITV so far."

"HD is a new standard and I feel it really needs the programming to be a "best of the best" cherry picked selection of programmes that show off the format at its best."

"I have no objection to old films. Last night's showing of the 1943 film '*The Life and Death of Colonel Blimp*' starring Roger Livesey demonstrated how good the picture quality of the HD trial can be. The HD image was very 'film-like'."

Other documentary genres like science and history also performed well, as did the wide range of drama programming on offer – from UK productions like *Bleak House* and *Robin Hood* to high-profile US imports like *House*, *Desperate Housewives* and *CSI: Crime Scene Investigation*.

Bleak House: "The detail in the scenery and household objects as well as the faces of the characters was staggering. I tuned in at about 9pm after returning from a weekend away and only intended to watch for a few minutes as I'd seen all but the last episode before. However, I got hooked by the quality of picture (and production of course) and ended up watching all the remaining episodes. Superb."

Space 1999: "Watched some and was pretty gobsmacked at how such an old programme could look so good."

There was also a selection of live music programming on offer, with HD footage from the *Isle of Wight Festival*, *Later With Jools Holland* and the *Proms*.

"Watched part of the first night of the *Proms* and thought that the close ups of the orchestra and their instruments was fabulous."

"Did anyone see the *Isle of Wight Music Festival* on C4 HD? Absolutely amazing. Broadcasts like this make the HD experience very worthwhile. Apart from sport and documentaries, this was clearly what HD has been designed for."

Other footage from live events, such as *Trooping the Colour*, was also warmly received.

"I can see myself watching quite a lot more TV than I used to. I hadn't watched *Trooping the Colour* for literally decades; but I couldn't tear myself away yesterday. Not only was it spectacular, but the level of detail was unbelievable."

HD and the future

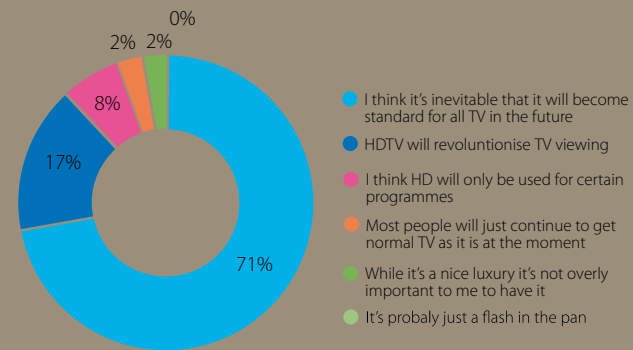
The trialists have high expectations for the future of high definition, and 71% believe that it is inevitable that HD will become standard for all TV in the future. In addition to their high expectations for HD in general, trialists also believe that it is very important that HD is available on DTT in the future. Their expectations on the timescales for HD becoming available on DTT are also high, with the majority of trialists believing that this will happen within the next year or two.

HD and public service broadcasting

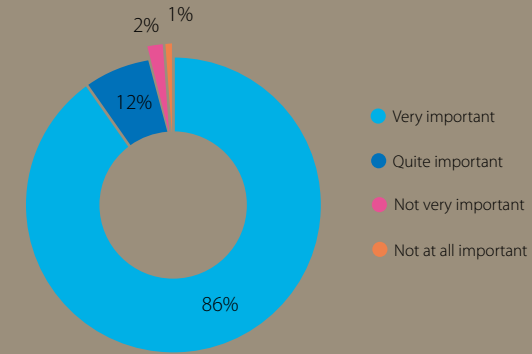
Trialists also strongly believe that it is important for the public service broadcasters to be at the forefront of HD delivery in the UK. When asked how important this is to them, 90% of trialists score it at least 8 out of 10.

Furthermore, a majority of trialists strongly expect that the PSBs will broadcast HD programmes for free on DTT in the future.

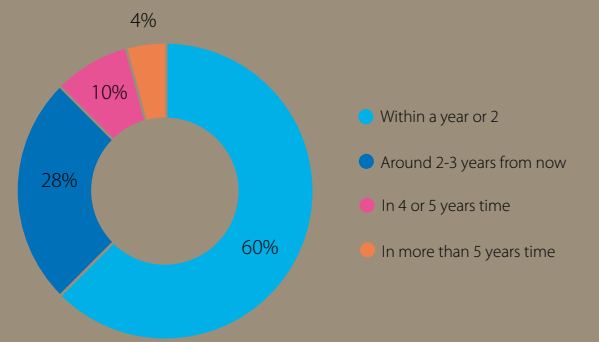
Expected impact of HD TV on the future of television



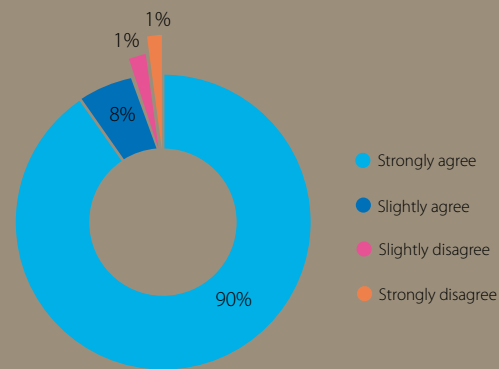
Importance of HD availability on Freeview



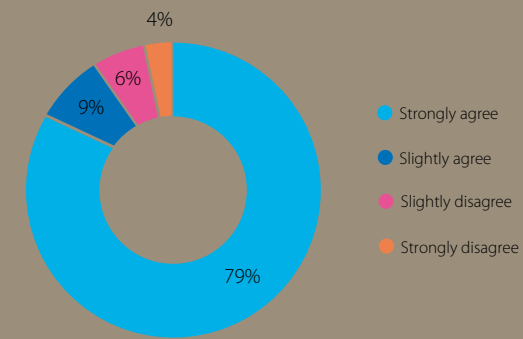
Expectations of timescales for HD availability on Freeview



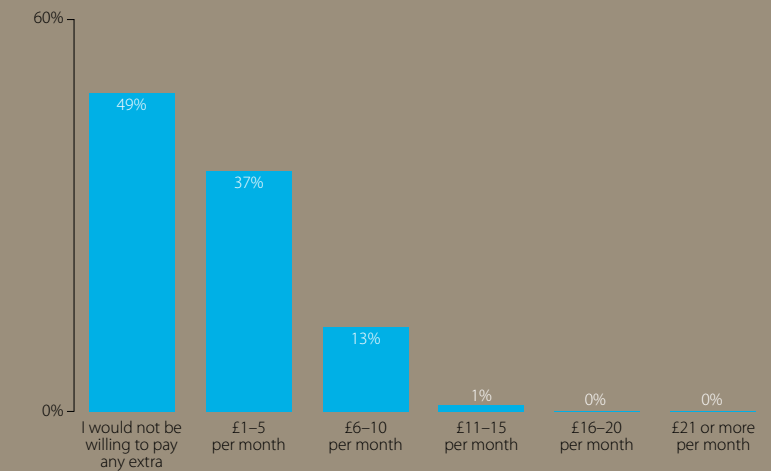
"I think it's more important for companies like the BBC, ITV, Channel 4 and Five to be at the forefront of offering HD services"



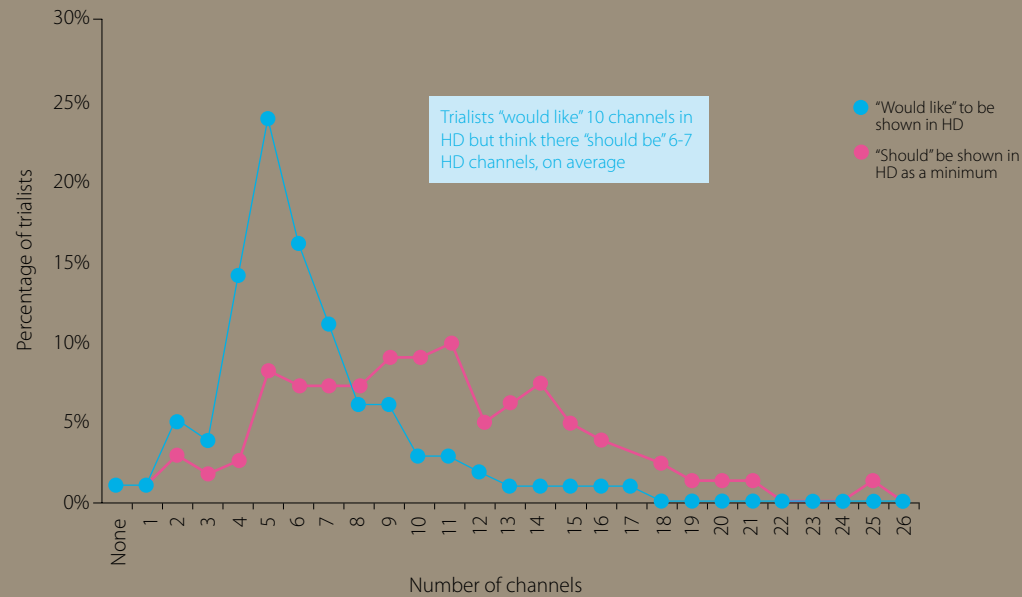
"I expect that programmes from the BBC, ITV, Channel 4 and Five will be shown for free in HD on Freeview in the future"



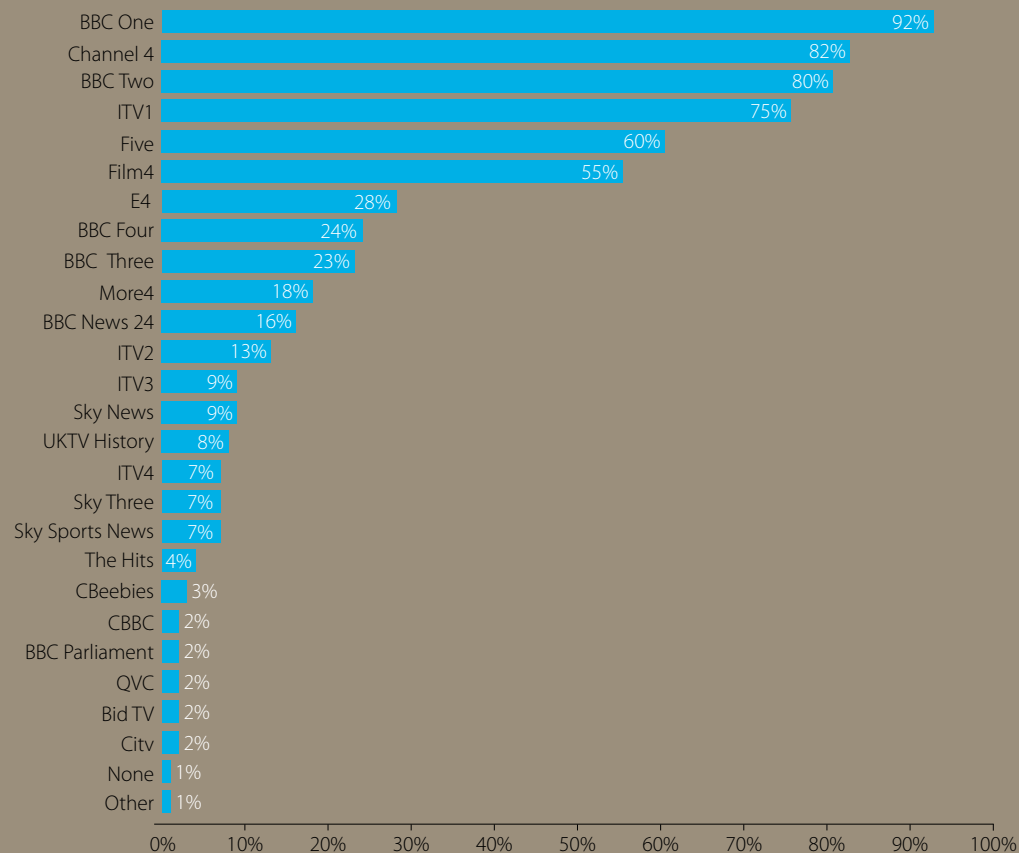
Trialists' willingness to pay to receive their five favourite channels in HD



Number of HD channels to be shown on Freeview



Channels that "should" be broadcast in High Definition on Freeview as a minimum



Do they expect to receive HD for free?

Willingness to pay for new services is a notoriously difficult quantity to measure, particularly with services such as high definition where direct exposure to the technology itself is crucial to consumer understanding of it. However, these trialists have had access to the technology and have been able to experience high definition services for a number of months, albeit through a limited trial. We have therefore attempted to gain some insight into trialists' willingness to pay for HD, and have framed the question in terms of their willingness to pay for their five favourite channels in HD.

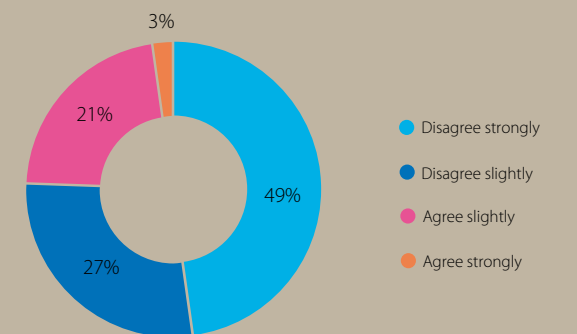
The largest group – about half of trialists – say that they would not be prepared to pay any extra to receive their five favourite channels in HD, perhaps reflecting their historic commitment to free-to-air TV, and their expectations that HD will inevitably become the standard for normal TV. Those that say they would be prepared to pay for these services are willing to pay approximately £4.50 per month, on average. The only other price points in the market at the moment are those which Sky HD and Telewest HD currently operate at. The minimum HD subscription to Sky, for example, would cost £25 per month (£15 per month for a basic channel package and a further £10 per month to receive HD channels), totalling £300 per year.

Expectations for the number of available HD channels

Trialists were also asked which of the DTT channels they thought "should" be broadcast in HD on DTT as a minimum. This produced a range of answers, as might be expected – though on average, trialists responded that although they "would like" around 10 channels in HD, they believe that at least 6-7 channels "should" be broadcast in HD on DTT as a minimum. This reflects an expectation that the analogue terrestrial channels should form a minimum offering, as well as highlighting the potential benefit of HD for some of the digital channels.

In addition, trialists were asked whether a service just comprising BBC1 and ITV1 in HD would be a sufficient HD offering on DTT. Although around a quarter of trialists felt that this might be sufficient, the majority of trialists did not agree, and around half were strongly against the idea.

Would BBC ONE and ITV1 in HD on Freeview be sufficient?



Technical objectives and results

Technical objectives

From a technical standpoint, there was a lot to learn. Among the challenges posed in broadcasting HD television we wanted to:

- Assess the feasibility of distributing HD channels via digital terrestrial television
- Develop an understanding of the physical infrastructure requirements – from links from outside broadcasts to internal connectivity demands in studios
- Establish initial ideal coding and multiplexing settings
- Understand suitable transmission configurations
- Test different video formats and bit-rates, and their impact on the viewer experience
- Develop an initial understanding of the demands from broadcasters on potential HD DTT receiver manufacturers, and assess some early implications for HD Ready screen manufacturers.

Broadcast configuration and transmission tests

Transmitted power and minimising interference

Two digital terrestrial television multiplexes (DTT muxes) were planned on two available frequencies in the London area: UHF channel 27 to be used by ITV, Channel 4 and Five, and managed by Arqiva; and channel 31 to be used by the BBC and managed by NGW. Both were transmitted from Crystal Palace.

In the period between the start of transmission of a test signal in February for coverage and interference checks, and the start of the trial with the *World Cup* in June, Arqiva and the BBC sent monitoring vans to all the potential reception trouble spots to assess any likely impact on existing standard definition services. This led to a recommendation of a 5kW power setting for the BBC signal and between 1 to 1.5kW for the ITV/C4/Five signal. The eventual coverage map for the two muxes is shown on page 25 with the BBC mux coverage in green and ITV/C4/Five in orange.

It was important to be able to receive the signals at the main offices of all participating broadcasters and key monitoring stations such as BBC R&D at Kingswood, and to provide sufficiently wide coverage to allow us to recruit 450 trialists.

These frequencies were only available in the London area and would not support a national network. The power settings for the transmitters were set to be significantly lower than those commonly used in DTT broadcasting to avoid interference with the nearby Bluebell Hill and Sandy Heath transmitters.

The broadcasters' call centres were briefed on possible reception problems and had back-up plans in place for viewers of existing standard definition channels experiencing any interference.





Transmission parameters

Both multiplexes used the more robust 8k modulation to overcome some of the issues with the lower power signal.

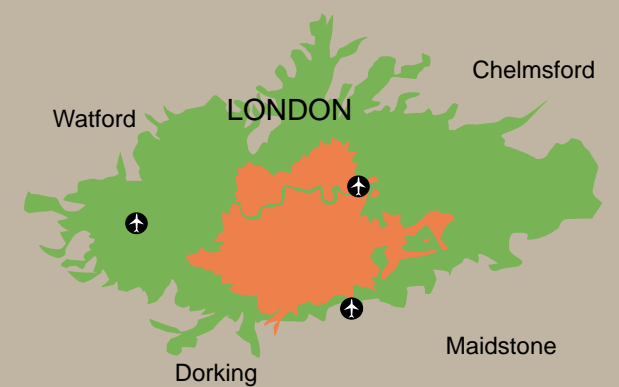
The relatively early stage of development in coding meant that around 20Mbps of bandwidth was required to guarantee excellent picture and audio quality. This meant only one HD stream or channel could be carried on a multiplex, compared to, for example, the 8 standard definition channels broadcast at 64QAM on the Digital 3&4 multiplex². The transmission mode for the trial was set at 64QAM, which maximises the bandwidth in the multiplex.

The signal uses a new and largely untried compression method (MPEG-4 AVC) for which coding equipment is relatively immature. Close collaboration with coder manufacturer Grass Valley Thomson ensured that the broadcasters tracked their product development and offered the best picture quality for the available bit-rate. The broadcasters determined technical parameters along the signal chain, evaluated equipment and were able to carry out troubleshooting in laboratories under representative conditions before deployment on air.

The broadcasters planned experiments with the signal format to get a better understanding of the relative merits of transmitting an interlaced signal (1080i) or a progressive signal (720p), and to start to explore the complex interaction between types of HD content, coded format and practical consumer HD display technology.

Service Information (SI)

BBC R&D and Arqiva collaboratively developed service information parameters for the trial. Service information, or SI, is the name given to the data transmitted alongside the audio and video streams which allows the channels to be identified, decoded and displayed, as well as other supporting information such as schedule data.



²Digital 3&4 operates DTT multiplex 2 and is jointly owned by ITV and Channel 4

Set-top box specification and performance

No commercially available MPEG-4 HD DTT boxes existed at the start of the trial, so it was necessary to have boxes built specially for the trialists. The box requirements (see Appendix 2 for full list) were not intended as a set-top box specification for a possible future market, but simply to serve the needs of the trial.

Two makes of terrestrial HD STB (Humax and ADB) were commissioned and tested within a very tight timescale. Nonetheless the trialists were able to collect their STBs in time for the start of the World Cup on 9th June. There were remarkably few problems reported by the trialists.

Both boxes were based on standard DTT chassis, although each uses a different chip set to decode the H.264 HD pictures. After a couple of revisions, both units reached a standard of RF performance comparable with normal standard DTT STBs. From the trialists' perspective, usability was similar to that of a standard DTT STB, though some advanced features such as interactivity and subtitling were not available.

Humax HDCI-2000T

The box provided by Humax was based on their satellite set-top box but with a DVB-T tuner replacing the DVB-S tuner. There were some issues with overall system interoperability but Conexant created a new version of their chipset drivers which overcame these issues.



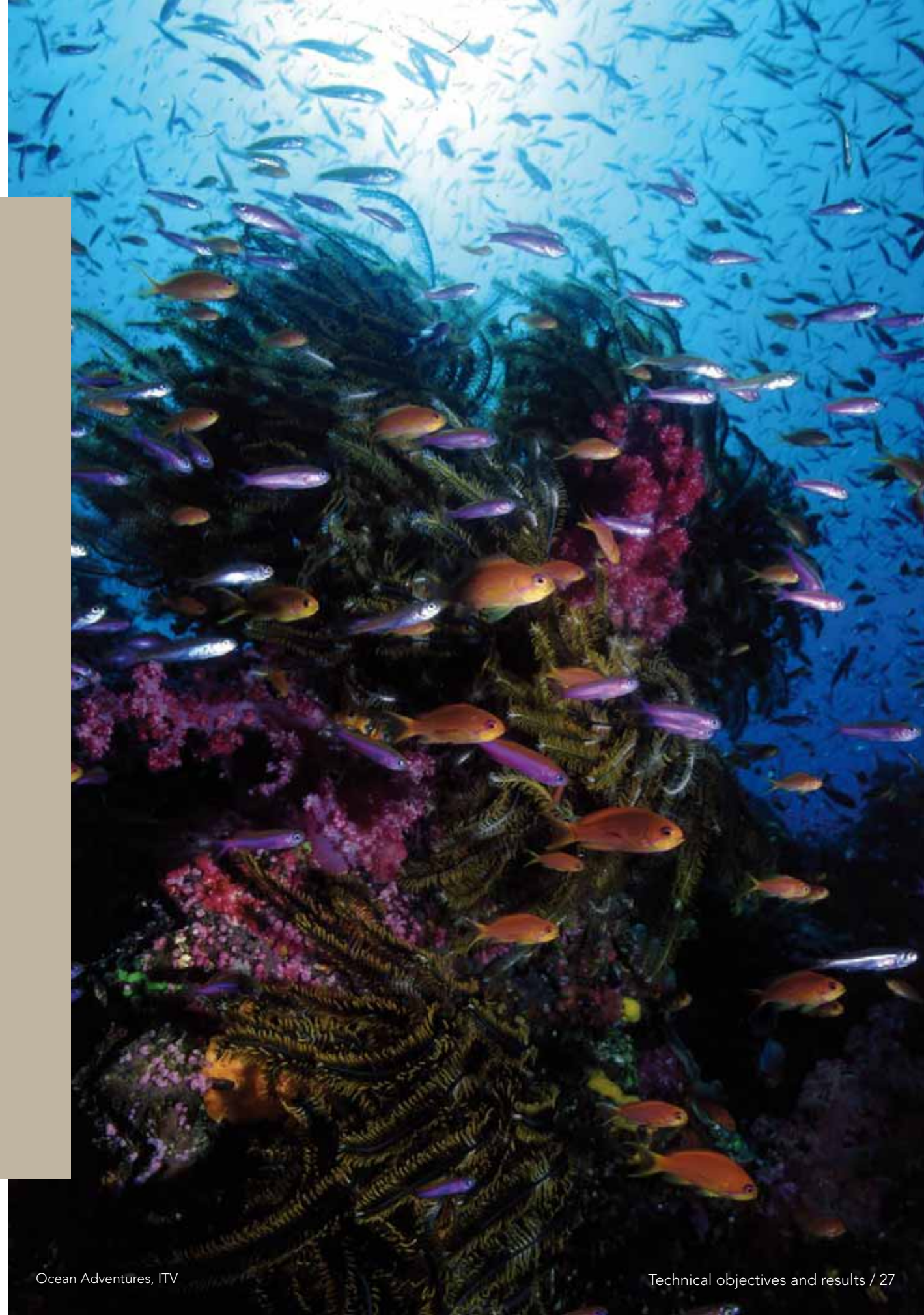
ADB i-CAN 3800T

ADB is a significant player in overseas markets but this was its first STB for the UK market. Problems in early test boxes with both audio and video output were resolved by firmware upgrades after detailed feedback from acceptance testing.



Other boxes

Before and during the course of the trial, boxes from a handful of other manufacturers not selected to supply the trialists were also tested for compliance.





Testing of set-top boxes

In preparation for testing the boxes, test video and audio sequences were played into the encoder and the resulting DVB transport stream was then captured. The transport streams were given valid SI so that they represented the BBC or commercial trial services which would eventually be transmitted.

Both 1080i and 720p sequences were encoded so that the ability of the boxes to handle these different formats could be assessed.

A breakdown of the tests can be seen in Technical Appendix 1.

Display compatibility testing

An important part of the STB testing was their compatibility with the models of HD Ready displays owned by the trialists. The greatest issues were with sound, particularly during the development phase.

Manufacturers of "HD Ready" panels were asked to supply two of their most popular models so that we could run compatibility tests with the set-top boxes. The screens were tested for luminescence as well as looking for possible issues with overscan. The aim was not to test every display, but a representative sample covering variations in input circuitry (see Technical Appendix 2 for the full list).

A number of compatibility issues were found – some a function of the connection with the prototype boxes, others inherent in the displays. In one instance we used the results of these trials to ensure that trialists with a particular model were only given a set-top box from the manufacturer which was compatible with their set.

Overscan

Overscan can cause logos, digital onscreen graphics, subtitles and other graphics to disappear over the edge of the visible screen. Broadcasters need to measure picture overscan so they know how to frame images and ensure viewers do not lose part of the picture. A study was performed to see how much overscan each of the sets applied, in conjunction with each of the boxes, with both 1080i and 720p material.

Key lessons for HD set top boxes and compatibility

A number of important lessons were learnt:

- Further work will clearly be required on the user interface for any consumer product. Specifically, it is likely that consumers will require more information on how best to connect set-top boxes and displays; in particular on the issue of dual SCART and HDMI connections, where the system behaviour may be unpredictable
- It is highly desirable that both displays and set-top boxes implement the optional section of the new HDMI 1.3 specification concerning automatic compensation of Audio/Video timing – that is to recognise the heightened importance of lip-synch in HD
- The audio standards to be used in a broadcast service require further thought. There is an issue of different default audio levels between surround sound and stereo found in the trial. Most home theatre systems are compatible with Dolby Digital, but consideration should be given to alternative formats (e.g. MPEG multichannel) for broadcast with a transcoding option in the STB for such audio systems

End-to-end testing

- HDTV gives the possibility of better graphics for interactivity, EPGs, and so on. It is suggested that an HD graphics plane could be specified for an HD STB, even if the problems of dual authoring for SD and HD services mean that the full potential of HD graphics may not be seen for a few years
- 98% of display-box combinations have less than 5% added overscan, with overscan ranging from 2% to 4% being applied in over 90% of box-display combinations. It should, however, be understood that the trial displays did not include any of the more recent 1920x1080 resolution panels, and there may well be displays that we have not tested which exhibit a larger degree of overscan. It does appear that 5% at each edge might be considered "safe".

Since this trial started, a Digital Television Group (DTG) sub-group with members representing receiver and television manufacturers as well as broadcast industries has been formed to propose an HD technical specification for DTT services and receivers to be incorporated into the current D-Book (see Technical Appendix 1),

HD is particularly suited to broadcasting coverage of big live events such as *World Cup football*, *Wimbledon* and *The Proms*. For these the succession of processes and technologies required to get programme material from the camera to the home is even more complex than for broadcasting a recorded programme.

An important part of the trial was to identify and resolve issues associated with this end-to-end chain. The case study for the *World Cup* (see page 32) examines in detail the work done and highlights issues inherent in the concatenation of distribution chains. Concatenation refers to the issues that arise when all the parts of the distribution chain are put together and tested end-to-end. The equivalent chain for standard definition (SD) television has evolved over the years. HD presents new challenges and a significant number of unknowns.

Concatenation

With live HD content going out direct from studios, the contribution chain is much shorter and concatenation is less of an issue. The BBC's *Strictly Come Dancing* was shown live in HD for the first time on the 28th October, to positive feedback. However, for the *World Cup* coverage, considerably more steps were involved in bringing the content from camera to television and preparatory work was undertaken to ensure that the available and affordable contribution links within and from Germany did justice to the pictures coming from each match. Subsequent live events covered (*Wimbledon* and *Proms*) benefited from successive technological refinements.



The Somme, Channel 4

Case Study: The 2006 World Cup

The *World Cup* comprised 64 matches played in 12 stadia over a period of 31 days between June 9th and July 9th, 2006. In terms of size and ambition, covering the *World Cup* is second only to the *Olympics*.

All matches were captured in HD by the host broadcaster, Host Broadcast Services, using 25 HD cameras in each stadium. This was the first occasion when the host video feeds from a *World Cup* were in HD. ITV and the BBC were joint rights holders of the *World Cup* and agreed plans to share the matches between them. Both showed the final live. Both broadcasters contributed their live coverage in HD to the DTT trial. The video standard was 16:9 1080i 25. Nine HD feeds were made available by the host broadcaster from each match. These were distributed locally at 1485MB/s.

The host broadcaster offered 5.1 surround sound from all matches, which was embedded into the serial digital video. The BBC and ITV both chose to operate in stereo only, for reasons of cost and risk reduction.

All signals, whether from stadia or from OB (outside broadcast) units, were routed to the IBC (International Broadcast Centre) in Munich. For live BBC matches, the action was routed to the BBC studio in Berlin to be mixed with studio presentation, then routed back to the IBC before being passed on to London.

The main feeds between Berlin and Munich, and Munich and London were optical fibre, with a satellite backup. Between Berlin and Munich there were three HD circuits in each direction and six SD, carried on a 620MB/s fibre.

The main links from Munich to London were SD with a single HD feed for the BBC HD stream. Backup for the HD feed was SD, which would be upconverted in London in the event of a failure of the HD circuit. The

Munich to London fibre was 300MB/s and carried two standard SD vision circuits, two low bit-rate SD circuits for BBC Interactive services and one HD circuit, plus some audio, IT and phone lines.

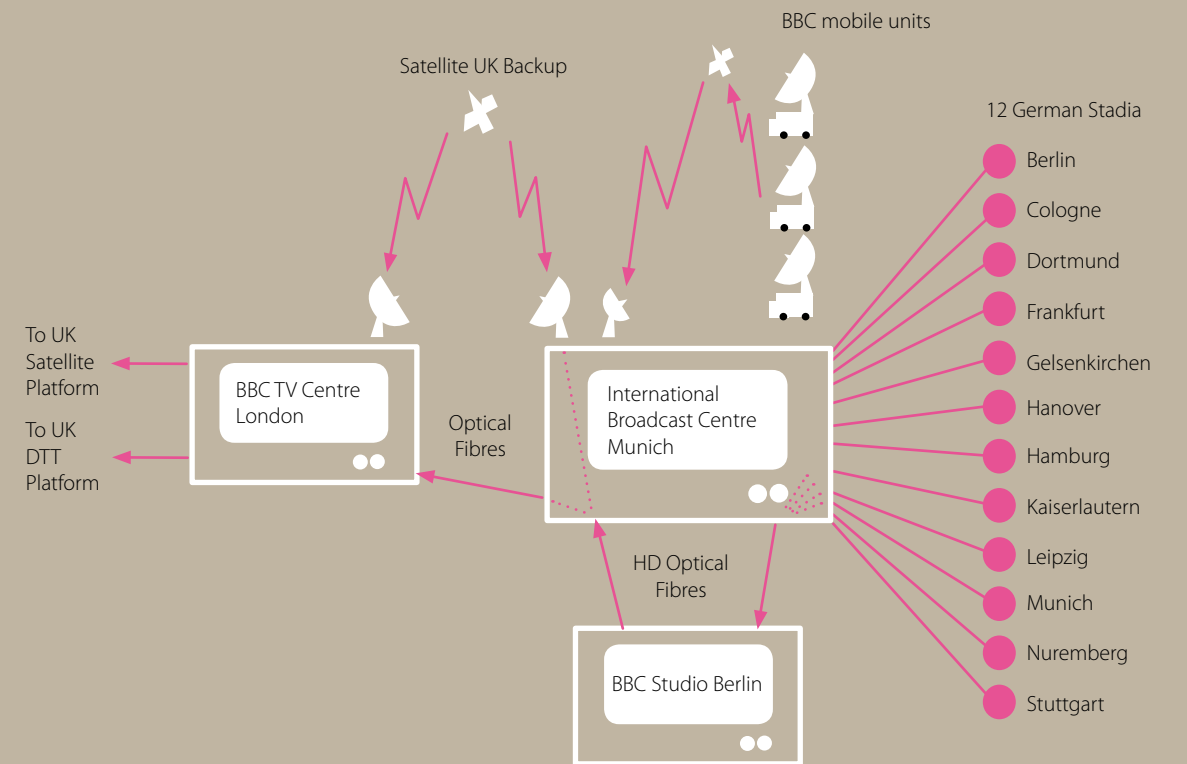
Within Germany, contributions from the England camp and other sites were fed to Munich via 45MHz of leased capacity on Atlantic Bird 2.

Among the lessons learned from broadcasting the *World Cup* in HD were:

- Lip-sync was the biggest challenge. Configurations needed to be checked each morning as they drifted overnight
- World Cup coverage which was captured in HD but broadcast in SD was generally thought to have higher picture quality than coverage which was captured and broadcast in SD
- Concatenation of MPEG processes can cause issues. The highlights show looked worse than the live show due to editing on Avid/SD VTR, which introduced its own compress/decompress processes
- Interlaced pictures are more difficult to encode than progressive pictures. Bi-trates of 80MB/s and above are needed for MPEG contribution links to maintain picture quality to be no more than one grade down from acquisition. For a single link with no other processes, 45MB/s was deemed satisfactory.

To minimise artefacts on pictures it is necessary to:

- Keep the number of hops to a minimum
- Check the bandwidth of each hop (not easy as some links are outside the broadcasters' immediate control).



Technical tests during the trial

Sound

HD television offers the opportunity to incorporate multi-channel audio (MCA) – up to six streams in 5.1 surround sound compared with stereo for SD services. Not all HD programmes are made with surround sound or lend themselves to it, but the trial did offer some opportunities to test delivery of surround sound – for instance for *Wimbledon* and the *Last Night of the Proms*.

- There proved to be a number of issues connected with routing multi-channel audio (MCA) signals around an outside broadcast site and a TV playout infrastructure. Much work was done to ensure, for example, that the *Last Night of the Proms* from the Royal Albert Hall could be broadcast in HD with Dolby 5.1 surround sound rather than just with 2.0 (stereo)
- There is growing evidence that with pictures displayed on a large screen, the viewer is less forgiving of lip-sync errors. (The reasons for this are as yet unclear but may reflect a greater sense of reality and engagement with the content.) There are many points in the broadcast signal at which lip-sync errors may occur and extra care has to be taken to ensure that these errors are minimised
- There is a difference in perceived level between the stereo audio which accompanies SD services and the MCA for HD ones. This is particularly noticeable when changing channel between SD and HD services when the HD service is found to be significantly quieter, which has potential impact on the user experience. This is an issue that has been highlighted during this trial and sustainable approaches to mitigating this are under discussion amongst European broadcasters.

After installation and the successful launch of the HD DTT channels there were still outstanding technical parameters to adjust and questions to investigate, so a set of technical tests was discussed and prioritised. These tests started in October due to a number of factors:

- It was decided that no tests would be started until the high-profile sports events (*World Cup* and *Wimbledon*) were finished
- The audience research needed time to establish a benchmark and assess viewer perceptions before the coding or transmission parameters were altered
- Preparatory lab work was required before moving to live tests.

For the full test schedule, including planned future tests, see Technical Appendix 4. To date, the tests described below have been completed.

Bit-rate & formats

During this trial we were keen to assess the impact on picture quality and the viewer reaction to a range of bit-rates and to the differences between 1080i and 720p formats. A format converter was used at the start of the coding and multiplexing chain to switch between the two formats. The changes in bit-rates were also implemented at the same stage.

The test sequence was:

- Start with 1080i at highest available bit-rate i.e.19.5MB/s
- Change to 720p at lower bit-rate

- Change to 720p at high bit-rate
- Change to 1080i at lower bit-rate.

Finally, we returned to 1080i at the original bit-rate. The results were of limited use for two reasons:

- With so many tests to complete during the trial it was thought that one month for each setting would be excessive, which meant that audience feedback could not come from the monthly research wave. Trialist feedback was restricted to 5 days per setting and did not generate a huge amount of feedback
- The low bit-rate 1080i pictures exposed a compatibility issue between a new software upgrade for the encoders and one of the set top boxes, which made it necessary to revert to the old software before originally planned. This made direct comparisons difficult.

However, some of the trialists' subjective reactions to the format and bit-rate changes were captured:

720p lower bit-rate

"I thought the picture quality of *Robin Hood* on the 14th was excellent...some friends were over at the time, and it was their first experience of HD and they were amazed to say the least. One of them is going to buy a new tv today."

"I've dipped in and out of the BBC rolling promo at 720p, and for the most part, can't see much difference from when it was in 1080i. The studio-based stuff (like *Jools Holland's Later*) *may* be slightly worse...in either case, it still looks stunning."

720 higher bit-rate

"Still looks good but I've really got no idea if it's better or worse [than 1080i]."

"I thought that the picture was good but had lost its glossy effect slightly."

"Looks better than the previous test, though still soft and blurry and lacking detail."

1080 lower bit-rate

"...picture sharpness better, but much more blocking and noise in complex scenes & in dark areas. Picture seems a bit strained and not easy to look at at times."

"I think the preview loop looks really good today. But would still like you to crank it up."

"Big improvement this morning with BBCHD reverting to 1080i. The crystal clarity and naturalness of the picture is back along with that indefinable wow factor that had disappeared with the downgrading to 720p."

Analysis in a lab situation revealed significant differences in picture quality between the settings, but they were not easily noticed in the trialist homes.



CSI: Crime Scene Investigation: Vegas, Five

Future tests

Now that initial tests are complete there are a range of technical tests we would like to implement in the final phase of the trial:

- Standard definition MPEG-4 channel – the HD channels in this trial all take advantage of the newer MPEG-4 video standard, while the older video standard, MPEG-2, is used for all SD DTT transmissions in the UK. Broadcasting an SD channel using MPEG-4 would demonstrate potential bandwidth savings using the new encoding method
- Modulation settings – different combinations of modulation parameters would be tested with the aim of obtaining evidence concerning receivability using different transmission parameters i.e. varying between 2k and 8k modulation, as well as using 16QAM instead of 64QAM
- Statistical multiplexing – this is a method for optimising the bandwidth required by channels in one multiplex. For example, if one channel is showing football while another in the same multiplex is showing something less demanding of the encoders, then more bandwidth can be allocated dynamically to the channel needing it. The current encoder software does not allow for statistical multiplexing
- DVB subtitles – work has been done in developing an HD subtitle standard. Trial boxes did not support this functionality
- Audio Description – work has been done in exploring AD in an HD environment. Current audio standards do not support it
- Interactivity – as above, work is in progress but the necessary MHEG software is not enabled in the trial boxes.

Looking forward: summary and conclusions

This trial has demonstrated the technical feasibility of delivering HD signals on the DTT platform, and has also revealed high appreciation of HD from our trialists.

These trialists come from homes which value TV highly, as indicated by their eagerness to participate in this trial, and their willingness to spend substantial amounts of money on the early generation of high definition TV sets. They are also DTT homes by choice, indicating their appreciation of free-to-air TV. The importance they place on seeing HD on DTT in the future gives an indication of the value they place on both.

Ensuring the ongoing strength of the DTT platform is a key shared goal for the UK's public service broadcasters, and there has been a huge public and private investment commitment made to Freeview and the DTT platform. This research suggests that high definition services could be important in making sure DTT remains a competitive and compelling platform for viewers in the years to come. The migration of viewers away from the DTT platform in search of valued HD services would undermine the investments made and also lead to the platform becoming less spectrally efficient.

However, the national rollout of high definition services on DTT still has some major obstacles to overcome. The biggest obstacle in the path of HD on DTT is the shortage of capacity currently available for the service. Due to the larger amount of information that HD broadcasts need to contain, an HD channel uses a larger

amount of bandwidth. Each HD channel is likely to need bandwidth equivalent to that required by three or four standard definition channels even when using more advanced MPEG-4 technology.

This means that current capacity constraints would not allow a substantial HD service to be broadcast on the DTT platform unless a large number of existing channels were removed from it. While improvements in compression technology and forthcoming mode changes may allow one, or possibly two, HD channels to be squeezed onto the platform at some point in the future, an HD service of five channels, equivalent to that available on analogue terrestrial – the kind of minimum service expected by our trialists – would not be possible.

Several important questions are therefore raised by this trial:

- Is it inevitable that HD will become the standard TV format of the future, and if so, when?
- Would the lack of availability of HD on DTT have implications for the overall prospects for DTT, consumer satisfaction with digital television more generally and the development of the HD market?
- What are the potential routes to ensuring HD is available on the DTT platform?



Partners



Advanced Digital Broadcast provides a range of high-quality products and services to the digital television market world-wide and has deployed more than seven million set-top boxes since 1997. ADB is headquartered in Geneva, Switzerland with main offices in Poland and Taiwan and representation in eight other countries around the world including the UK. ADB is a member of ADB Group (www.adbholdings.com)

www.adbglobal.com



Humax is one of the world's largest manufacturers of digital set-top boxes, exporting its products to over 90 countries across the globe. The company is a leading supplier of high quality, feature-rich digital TV products, including Personal Video Recorders (PVRs) and HD Ready Integrated Digital TVs. The company headquarters and R&D facility are based in Korea, with offices in Dubai, Germany, India, Italy, Japan, the UK and the US.

www.humaxdigital.com/uk



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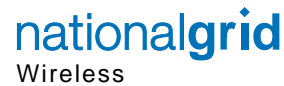
Thomson's Systems and Equipment division develops video and film technologies, products and services sold to all major Hollywood studios, all major television, satellite, and cable broadcasters under the Grass Valley brand-name for the delivery of analogue and digital entertainment. The division also includes Thomson's Access Platforms and Gateways Business, which develops technologies and products for broadband and telecommunication networks to deliver digital entertainment and data to consumers and businesses. The group includes the Technicolor, Grass Valley, RCA and Thomson brands.

www.thomson.net



Arqiva has a 50-year history in transmission and has helped pioneer the technologies of the digital age. The company's Terrestrial Media Solutions division provides national transmission for UK commercial television including ITV, Channel 4, Five and associated digital multiplexes and is playing a leading role in digital switchover. Transmission services also provided to vast majority of UK independent radio stations, both analogue and digital.

www.arqiva.com



National Grid Wireless (NGW) is a wholly owned subsidiary of National Grid and one of two UK providers of terrestrial infrastructure for the transmission of analogue and digital television and radio broadcasts in the UK. National Grid Wireless has a strong position in the growing digital television market, owning two of the six digital terrestrial television licences and providing infrastructure services to all the DTT channels, the BBC and BSkyB. NGW is also the leading independent provider of infrastructure to the mobile telecommunications operators in the UK.

www.nationalgridwireless.com



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www.siemens.co.uk/sbs



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www.tns-global.com

Technical Appendices

Technical Appendix 1: Set-top box specification

Minimum requirements for usable HD STBs in the technical trial:

1. Demodulate 2K and 8K DVB-T signals carrying HDTV in the UHF band:
 - HD STB's for the trial should meet all of the RF performance targets specified in Chapter 9 of the DTG's D-Book ("Digital Terrestrial Television: Requirements for Interoperability", Issue 4.0, January 2005)
2. Decode H.264 / AVC HDTV content:
 - 1080i/25 and 720p/50 modes at up to 20 Mbit/s
3. HDTV display output:
 - Digital HDMI (Required)
 - Analogue Y, Pr, Pb (option)
4. Audio output:
 - Dolby AC-3 multichannel (5.1) via S/PDIF for an external decoder (Required)
 - Stereo down-mixed from delivered Dolby AC-3 signal (option) (Note that it is not expected to transmit both MPEG stereo audio and AC3 multichannel at the same time with the same service.)
5. Provide a user-operable way to select HDTV services (i.e. channel change):
 - It would be useful if the box could also provide an embedded EPG application with support for DVB-EIT P/F and EIT Schedule to provide a now/next and potential a programme guide feature in compliance with the SI and PSI. Reference Chapters 7 and 8 of the DTG's D-Book ("Digital Terrestrial Television: Requirements for Interoperability", Issue4.0, January 2005)

6. Provide unit double-insulated cased and safe to use in users homes
7. Provide adjustable audio delay compensation to maintain lip synchronisation:
 - This is to adjust the delay of the Dolby Digital signal sent to an external surround sound audio system to maintain lip synchronisation with HDTV pictures viewed on displays of various technologies possibly incorporating picture processing circuits that delay the picture by up to several frames.
 - It is expected that audio sent within the HDMI connection to the display (if it has inbuilt speakers) will be appropriately timed according to the display needs.

Additional desirable recommendations to increase STB usability and test more HDTV features

8. Receive DTT SD video and audio services
9. Allow access to SD 'Freeview' MHEG interactivity and subtitles
10. Allow DTT content and interactivity to be routed to the HDTV display interface
11. Provide DVB subtitles on the HDTV display interface
12. PVR/DVR able to timeshift HDTV programmes
13. HDCP option on HDMI/DVI:
 - There is no requirement to switch HDCP during the trial
14. Software upgrade path to add features as the trial progresses:
 - An over-air download channel may not be available on the trial channels

15. Provide switching between 720p and 1080i on HDTV output:
 - Both automatic (i.e. follow source mode) and manual setting desirable
 - One setting may be preferable depending on the effectiveness of the scaling used in the display

Technical Appendix 2: Display compatibility testing

The following models were tested:

Hitachi 42PD7200 42" Plasma	Hitachi 42PD6600 42" Plasma	Panasonic TH-37PV500B 37" Plasma	Panasonic TX-32LXD500 32" LCD	Panasonic TX-32LXD60 32" LCD
Sharp LC-32P50E 32" LCD	Sharp LC-37GD7E 37" LCD	Samsung PS-42E7HD 42" Plasma	Samsung LE32 R74BD 32" LCD	LG 32LP1D 32" LCD
LG 42PX5D 42" Plasma	Philips 32PF 5521D 32" LCD	Philips 37PF 9631D/10 37" LCD	Philips 26PF 5321 26" LCD	Philips 32PF 9830 32" LCD
JVC LT-32DS6BJ 32" LCD	Pioneer PDP-506FDE + PDP-R06E 50" Plasma	Toshiba 32WLT58 32" LCD	Toshiba 32WLT66 32" LCD	Sony KDL-S40A12U 40" LCD
Sagem HD-D45S 45" DLP back-projector				

Technical Appendix 3: Set-up information table

Video parameters :

Playout :	1080i/25	(effective resolution 1440 by 1080)
Emission coding :	H264 (aka MPEG-4 AVC) GOP = 12	High Profile at Level 4
	1080i/25 (1440 by 1080)	@ 19.5 Mb/s May'06 to 12/10/06
	720p/50 (1280 by 720)	@ 14.3 Mb/s 12/10/06 to 17/10/06
	720p/50 (1280 by 720)	@ 19.5 Mb/s 17/10/06 to 23/10/06
	1080i/25 (1440 by 1080)	@ 17.0 Mb/s 23/10/06 to 27/10/06

Audio parameters :

Playout :	PCM stereo & Dolby E MCA
Emission coding :	AC-3 (Dolby Digital) at 384k/s (content ³ dependent on event)

³ eg. 2.0 for stereo, 5.0 for Wimbledon coverage, 5.1 for Last Night of Proms etc.

Technical Appendix 4: Technical test plan, circulated to industry via the DTG

Test	Description	What & How	When	Measurement
1. Format switching	The format of the video will be changed from 1080i to 720p to assess the impact on picture quality.	The DTT coding and multiplexing has been built with an HD cross-converter for this purpose.	October November 2006	Trialist feedback, collected online.
2. Picture format and video component bit-rate changes	Test description: Perform a sequence of format and bit-rate changes to assess viewer reaction. Likely sequence: • Start with 1080i at highest available bit-rate (as now) • Change to 720p with no change to bit-rate • Change to 720p at lower bit-rate (to be determined) • Change to 1080i at the same lower bit-rate • Return to 1080i at the original bit-rate, or other setting if demonstrated to be appropriate by these tests	Depends on: • Relationship between this test and forthcoming firmware upgrades to the HD encoder	November 2006	Trialist feedback collected online
3. Stat-muxing	It is desirable to test the impact on picture quality of encoding more than one channel in a statistically multiplexed bundle.	A new version of software for the HD encoder which supports statistical multiplexing is currently awaiting test by BBC Technology Group.	TBA – this is highly dependent on equipment availability and implementation could be of the order of 12-16 weeks	Trialist feedback, collected online. Lab assessment.
4. SD MPEG4 channel	Encoding of an additional standard definition service using MPEG4	The coder could be installed at Television Centre and added to the existing DTT multiplexer.	As test 3	Concept as yet untested in the lab. Lab test only may be preferable.

Test	Description	What & How	When	Measurement
5. Modulation	The 'modulation' test will transmit the HDTV signal with different combinations of modulation mode parameters, ideally from both multiplexes.	Before any changes to modulation parameters can be made, it is necessary to reduce the multiplex capacity to 18Mbit/s or less, and this should be done for a while and the results observed.	October November 2006	Trialist feedback, collected online, looking particularly for any short term break ups in part of or all of the picture.
6. DVB subtitles	UNSUPPORTED IN TRIAL BOXES		Post March 2007	N/A
7. Audio description	UNSUPPORTED IN TRIAL BOXES		Not yet supported in Dolby - no EAC3 coders exist. To be tested in lab.	N/A
8. Interactivity	PENDING ONGOING RESEARCH			N/A
9. Switching between SD and HD within service	PENDING ONGOING RESEARCH			N/A
10. Dolby issues	PENDING ONGOING RESEARCH			N/A



