Mobile TV

— results from the DVB-H trial in Oxford

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This article explores the results of the mobile TV trials in which Arqiva has been involved – in particular, the Oxford DVB-H trial. It also discusses the technology choices faced by potential service providers in the UK and elsewhere in mainland Europe, given the constraints of spectrum availability.

Mobile TV is now starting to become a reality with the recent launch of 3G services and the significant consumer demand for video-related material. It is generally accepted that these services will initially be delivered by 3G but that, within two years, ***broadcast technologies*** will be needed as demand outstrips 3G's capability to deliver multiple streams.

UK regulator Ofcom is now bringing spectrum to market, which has the capability of delivering a mass-market proposition in a two-year time window. *But what type of content does the consumer want and how should it be presented? What spectrum could be used? And what technology should be used?*

Arqiva has taken part in various trials to answer those three fundamental questions.

- **Oxford** – jointly with service provider O2, using DVB-H technology. This is a large-scale consumer trial, looking at content and usage scenarios, which began in September 2005 and is still on-going.
- **Cambridge** – jointly with Microsoft. This was a technology trial with a small number of participants, which looked at the usage of mobile content taken from different but interconnected sources.
- **London (BT Movio)** – a large-scale consumer trial. As transmission provider for Digital One (the UK national commercial digital radio multiplex operator), Arqiva has been supporting BT with the network to deliver mobile TV to the London metropolitan area using DAB technology. Comprehensive results from this trial are reported in a separate article.

Oxford trial

Around 375 O2 customers have been issued with DVB-H-capable mobile phones to provide valuable feedback on their preferences and experiences of viewing up to 16 "linear" TV channels delivered via broadcast transmitters. The trial is also a useful test-bed for DVB-H technology in a real-world environment.

Arqiva has built a single-frequency network of eight DVB-H transmitters on UHF channel 31, under a special test and development

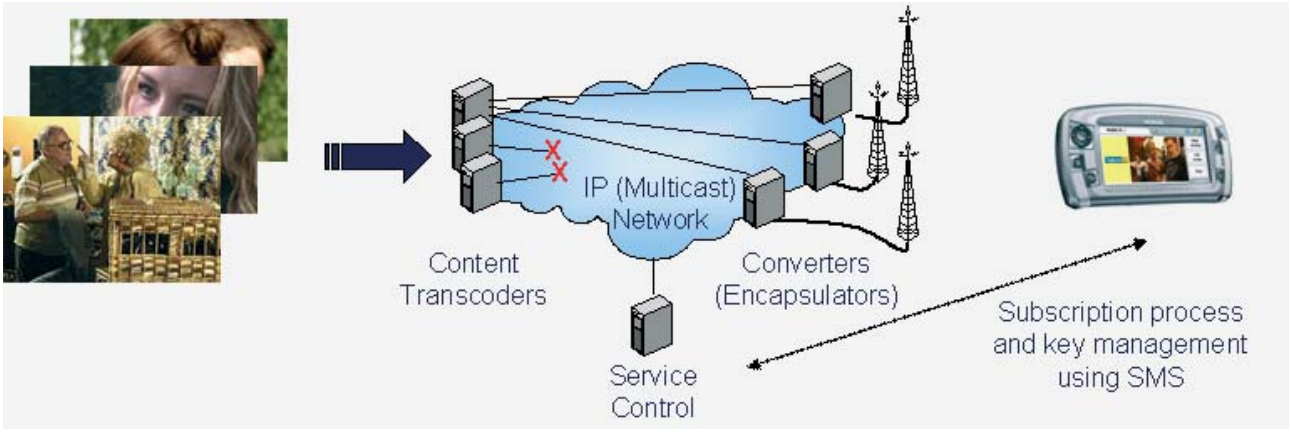
licence obtained from Ofcom. The pictures, at a resolution of 392 x 320 pixels, are displayed on a Nokia 7710 handset using an active screen size of about 5 x 4cm. For this trial, an H.263 encoder is used with the pictures displayed at 12.5 frames per second. Advanced coding at 25 frames per second could be used for any future service, with a consequent improvement in the picture quality. The DVB-H platform itself is already optimized for multichannel TV delivery in a mobile environment, with its robust performance and low battery consumption.

The content partners for the trial were recruited by Arqiva to provide a balance of programme genres. The various feeds are assembled in Arqiva's headquarters at Crawley Court near Winchester, then encoded and multiplexed before being delivered to the Boar's Hill distribution transmitter in Oxford via a 45 Mbit/s landline. The eight transmitters in the SFN each receive an off-air feed for re-transmission on Channel 31. Coverage within the Oxford ring road has been designed to provide reliable reception at street level outdoors, indoors and inside moving vehicles.

The Nokia 7710 handsets, issued by O2 to the triallists, are specially fitted with a slim DVB-H receiver panel on the back of the device. A Nokia "service system", integrated and operated by Arqiva, controls the operation of the end-to-end system. All content is scrambled and the decryption keys are protected by a digital rights management (DRM) system.

The key functions of the Nokia service system are:

- **Subscription Control** – Provides updated decryption keys to the devices monthly via SMS to enable decryption of the TV service. In an operational system it also allows customers to subscribe to TV packages and ensures that the billing system receives information relating to the chosen TV subscriptions. During the trial, participants are given access to all the TV channels free of charge.
- **Electronic Service Guide** – Builds an ESG from the information received from the content providers and sends this via the transmitter network. This provides the information necessary for the handset to find the service and for the user to choose what to watch.
- **Broadcast Control** – Instructs the encapsulators on which information to take from the IP multicast network and what to broadcast. In the future, it could allow regional programming to be carried on the same multicast network as the national programming.



Research is being undertaken by GfK Martin Hamblin who has interviewed all the triallists at monthly intervals and obtained additional qualitative feedback from a small focus group of "super-consumers". Triallists keep a diary, either on paper or online, while automatic logging of data takes place in the case of GPRS-enabled users.

Oxford interim results

First indications from the ongoing trial, published in January 2006, confirm many expectations of the market uptake and technical quality but also reveal some unexpected trends. Usage and viewing duration were exceptionally high and the vast majority of consumers were satisfied with the services.

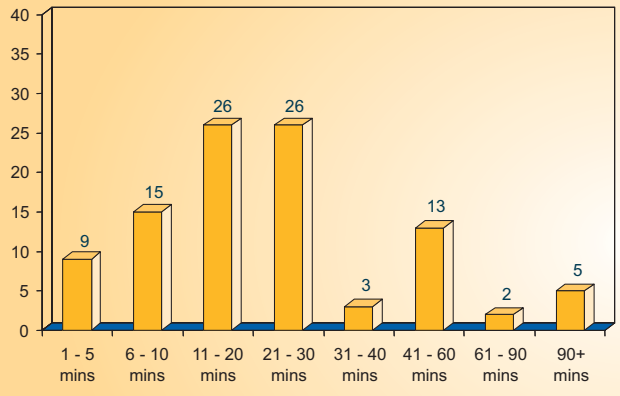
The 375 triallists reported watching TV on their mobiles for an average of 23 minutes per session, with one to two sessions per day and an overall average viewing time of three hours per week. Surprising numbers watched for extended periods, showing that long-form content is not to be ruled out for mobile TV. Not surprisingly, demand is high in the morning and early evening, with viewers using the service on the way to and from work; there was good correlation with a similar trial conducted in Finland. However, most viewing appears to be in the home, which was not expected. It seems that triallists quickly discover the benefits of "personal TV" and find it convenient to keep track of their favourite programmes while moving around the house.

Triallists say they want a broad range of familiar channels and brands. The Oxford trial includes all five main UK terrestrial TV channels plus a good range of more specialised services familiar to digital viewers. For some participants, this was their first experience of multichannel TV. High-quality electronic service guides linked to straightforward service navigation are crucial to the success of these services. A channel-change time of five or six seconds, thought to be on the long side by some industry observers, proved not to be much of an issue although this delay would shorten in a commercial deployment.

Demand for additional multimedia services is high, including digital radio, interactive services and "live" links to channel websites. Seven out of ten triallists would like to have Digital Radio channels included in a commercial service or device.

Usage Levels — How Much (%)

How long on average do you watch the mobile TV service at any one time?

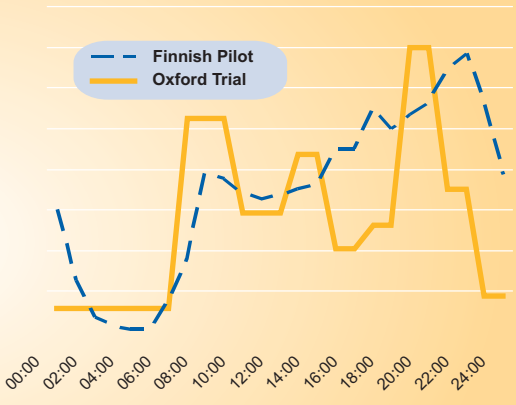


Weekly Viewing
- Over 3 hours per week

Viewing Durations
- Average 23 minutes per session
- Wide range of viewing durations
- Includes short- and long-form programmes

Usage Levels — Time of Day

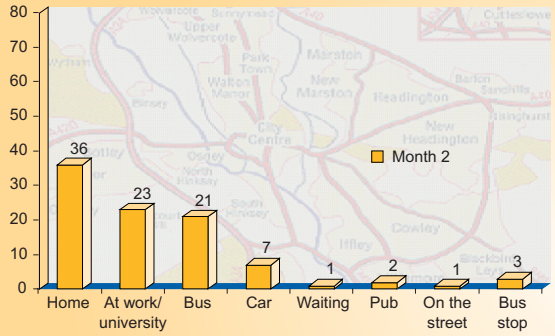
At what time of day do you watch the mobile TV service most often?



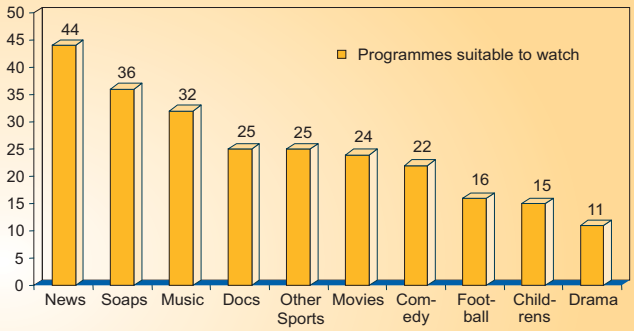
Viewing Peaks
- Breakfast/Morning Commute
- Lunchtime
- Early Evening

Usage Levels — Where (%)

Where do you use the service most often?



Category Champions (%)



16-channel line-up

- Proving very popular
- Evidenced by 83% satisfaction level

Channel branding important

- "Made-for-mobile" content needs more development

Most popular genres

- News, Sport, Music, Docs Sport
- Lunch break – favourite daytime Soaps

Cambridge and London trials

Results from Cambridge and the BT Movio trial in London (see separate article) also show a demand for services additional to linear TV, such as radio and interactive multimedia content. An integrated return channel for downloads and other features will add to the consumer acceptance of these services. Cambridge triallists were able to transfer content seamlessly between a home media centre and vehicle-based or handheld devices using a variety of access technologies such as Wi-Fi, DVB and DAB. But to get mobile TV launched and accepted, it seems sensible initially to "keep it simple" with linear TV services and then add non-linear TV later. The possibilities offered by more complex services using "caching" are not yet appreciated by most consumers.

Overall, the results of all three trials show that there is clearly a commercial opportunity for the creation of a nationwide, mass-market, multichannel mobile broadcasting service.

Handset considerations

Mass-market handsets will be a key element in the delivery of mobile TV. A wide range of devices is required that will appeal to all ages, sexes and tastes within those groups. Your mobile device says as much about you as your car or your clothes. A quick check on the O2 website in mid-February 2006 revealed that they have 165 different devices for sale in the UK. It's reasonable to assume that a minimum of 20 mobile TV-equipped handset types would need to be available with the technology of choice built-in, and that these devices must appeal to a wide proportion of the target market.

Considering the three frequency bands used in the trials (Band III, UHF and L-Band), the integration of antennas into the devices has been easiest at UHF and L-Band because of the shorter wavelengths. Integrating a Band III antenna into a handheld device is very difficult if an antenna gain of around -10 dBi is required, and the only way to achieve this performance is by making the antenna a part of the headset for listening to the audio.

Technology *adoption patterns* and spectrum *availability* in different countries will be crucial to the roll-out of suitable handsets in the mass market.

Spectrum considerations

Band III

In the UK, Ofcom has made the decision that Band III is to be predominantly used for DAB and Private Mobile Radio (PMR). Channels 5 to 9 will be used for PMR and, after the ITU Regional Radio Conference 2006, channels 10 to 12 will be used for Digital Radio (DAB). Channel 10A may be used for programme-making purposes (radio mics etc.)

Channels 5 to 9 to be used for PMR	Convert channels 10 and 11A from PMR to DAB	Channels 11B to 12D are already allocated to DAB

The DAB part of the band is "channelised" into 1.7 MHz blocks and is licensed under the Broadcasting Act (1996) for DAB radio. Ofcom allows 20% of the multiplex capacity to be used for non-radio purposes. This is approximately 200 kbit/s and is the data rate available for BT Movio (who recently announced they will be launching a UK nationwide service later this year, in conjunction with Virgin Mobile).

UHF

With the "digital switchover" planning phase well advanced, the UK spectrum regulator is now consulting on how 14 "freed-up" UHF channels could be used after the switch to digital. These channels could be used for more standard-definition services, for HD services or for mobile TV. If four of the channels were given over to mobile TV, one channel could be used for a national Single Frequency Network (SFN) while the other three blocks could be used to deliver more services in the major metropolitan areas. As digital switchover is not envisaged to end until 2012 in the UK, there is at present no clearly-defined early-access strategy for this spectrum. If a way could be found to make UHF spectrum available earlier, there are two possible technologies that are vying for the use of this band: DVB-H and FLO (the mobile TV technology from Qualcomm).

L-Band

40 MHz of available spectrum is coming to the market in the UK later this year (1452 to 1492 MHz). This spectrum is covered by the Maastricht agreement. There are 25 x 1.7 MHz channels. The top seven blocks are allocated for satellite use and, at the time of writing, it is unclear how these blocks will be used. However, it would be foolish to ignore the possibility of mobile TV services being delivered into Europe by a hybrid of satellite and terrestrial means. The bottom of the band is allocated to T-DAB (16 x 1.7 MHz channels). In the UK it may be possible to re-channelise this to 5 MHz and use the DVB-H standard. Using T-DAB, there is plenty of spectrum with the 16 x 1.7 MHz channels to deliver six multiplexes per metropolitan area. This is possible in the UK as its location offshore means fewer restrictions in the use of frequencies than is the case for countries in mainland Europe. However, questions remain over L-Band propagation inside buildings; more transmission sites and/or higher power may be needed.

Abbreviations

3G	3rd Generation mobile communications	**PMR**	Private Mobile Radio services
DAB	Digital Audio Broadcasting (Eureka-147)	**QVGA**	Quarter Video Graphics Array
DMB	Digital Multimedia Broadcasting	**SFN**	Single-Frequency Network
DVB	Digital Video Broadcasting	**SMS**	Short Message Service
DVB-H	DVB - Handheld	**T-DAB**	Terrestrial - DAB
ESG	Electronic Service Guide	**UHF**	Ultra High Frequency

Technology choices

The technology decision is governed by the number of services, the spectrum and the availability of mass-market handsets and should be the last decision made before deploying a service. This is why Arqiva has supported the development of all standards and has been active in DAB and DVB-H. The trials show that the technologies offered by DAB/DMB and DVB-H are all capable of delivering a rugged mobile TV service.

Some assumptions have to be made about video quality and screen size, and these may be different for different genres of material.

If it is assumed that the screen size on a typical device is QVGA (320 by 240 pixels) and that the video is running at 25 frames per second, the average bitrate for a service is around 250 kbit/s. Based on these assumptions, the choices may be summarized as shown in the following table:

Technology and spectrum option	Assumptions	No. of services per multiplex	No. of multiplexes
DVB-H in 5 MHz L-Band	2K mode with ¼ guard interval QPSK ½ rate convolution code ¾ MPE-FEC	8	3
DVB-H in 8 MHz UHF	8K mode with ⅛ guard interval QPSK ½ rate convolution code ¾ MPE FEC	15	2
DAB in L-Band	Mode 4 ½ rate convolution code RS-FEC	4	5
DAB in Band III	Mode 1 ½ rate convolution code RS-FEC	4	5

From the Oxford trial, it seems that the consumer understands and expects linear TV and that 20 channels would give the majority of people what they want when mobile.

From a UK perspective, Band III does not have enough capacity to deliver 20 mobile TV services due to the 20% limit on data capacity for DAB multiplexes. However there are a significant number of free-to-air radio services in this band so this must not be ignored when a mobile broadcasting strategy for the UK is being developed. As BT Movio has shown, using 20% of a DAB multiplex is a very good way to get first-mover advantage because existing infrastructure allows early launch of a few video services (June 2006 in the UK). This may give BT Movio a two-year lead on any other entrant, depending on other spectrum options.

Global market

Mobile phone handsets are a global market, but will DAB/DMB or DVB-H prevail? L-Band is already channelised for DAB/DMB. There is a risk that L-Band cannot be re-planned for 5 MHz channels across many parts of Europe, making mass-market handsets less likely for DVB-H. But on the other

Simon Mason joined Arqiva (then known as NTL Broadcast) in 1997 to lead its digital radio development team and has since become Head of New Product Development within the company's Mobile Media Solutions group.

Prior to this, Mr Mason read Electronic Engineering at the University of Bradford (UK), then started working for the BBC in 1984 as a network radio engineer. He subsequently joined BBC Transmission (now National Grid Wireless) to roll out BBC Radio One across the UK on FM. In 1991 he worked with BBC Research Department on the Eureka-147 DAB specification and also the first high-power trial of a DAB network in London. He then went on to project-lead the rollout of the BBC's national DAB network, before moving to NTL Broadcast.

hand, the US is using DVB-H in 5 MHz channels in a slightly different part of L-Band so, if that service is successful, this may help with the production of mass-market L-Band DVB-H phones for the European market. The Koreans are manufacturing a range of phones for DMB in the L-Band. This may be a safer strategy so long as the major European handset manufacturers also produce DMB phones. L-Band at present seems to give the best opportunity in the next three years for launching a mobile TV service in the UK, unless Ofcom comes up with an early entry strategy for UHF spectrum for mobile TV.

If the UK industry decides to wait for UHF availability, there is no guarantee that the spectrum will be allocated for mobile TV. At the time of writing, Ofcom is consulting on the use of the UHF spectrum released by digital switchover. From a receiver perspective, DVB-H in UHF seems to offer the widest range of devices for the European market. UHF is the best spectrum choice with respect to receiver antenna integration. It is also the best option for rural, suburban and urban coverage using the ¼ guard interval, if a national SFN were to be constructed.

Trials and tribulations

The choice in the UK therefore boils down to an early deployment of mobile TV in L-Band or to use UHF if spectrum can be found. The former is expected to provide early access to spectrum but there are questions about mass-market devices with any of the potential technologies. The latter approach gives optimum capacity and quality but may put a mobile TV service back to post-2012, and there are other competing applications. So the trials of mobile TV, having shown a latent mass-market demand, are now frustrated by the tribulations of spectrum availability. There is hope yet!