A milestone in the history of the DVB Project

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DTT services began in the UK on 15 November 1998, with six multiplexes offering a mix of free-to-air, primary and premium channels. Four of these multiplexes should reach 90% of the UK population by the end of 1999 while the remaining two will reach around 70% of UK households, because of restrictions.

This article explains the fundamental differences between UK DTT and previous DVB implementations, and argues in favour of open standards and "horizontal" DTT platforms as the model for the future.

Introduction

The launch of DTT services in the UK represents a milestone in the history of the DVB Project [1] and a number of important firsts for digital television. It is the first substantial service using DVB-T and, perhaps more importantly, it is the first implementation of DVB in an open-standards horizontal market, anywhere in the world.

In the UK implementation, four separate and competing multiplex operators originate six multiplexes on a network of 81 transmitter sites, each operator using a different brand of compression equipment. In terms of consumer products, there is an open market in receivers and set-top boxes, with MHEG-5 [2] over-air commands being interpreted by a variety of "content decoder" engines by different suppliers.

A little under one year from the granting of licences, DTT was launched on the 15 November

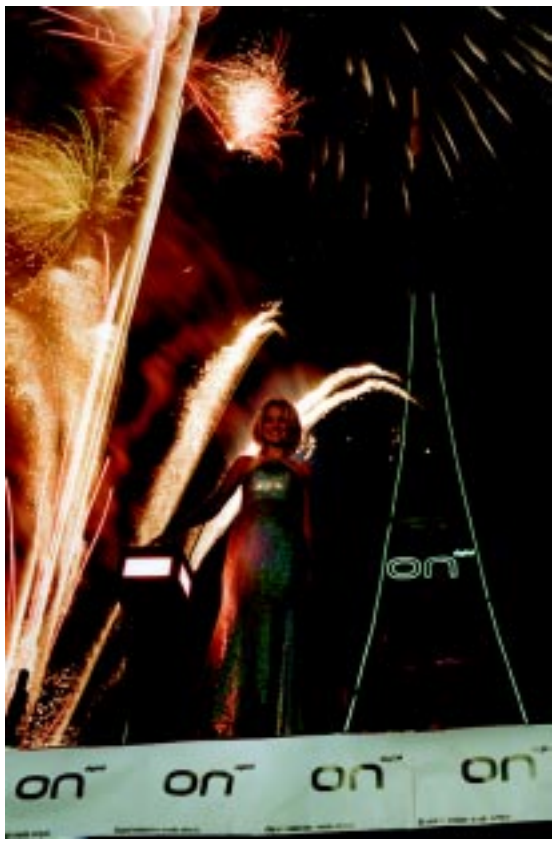

Figure 1
Ulrika Jonsson, the TV personality, inaugurates the launching of DTT services in the UK on 15 November 1998, at the Crystal Palace TV transmitter in London.

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1998 (see *Fig. 1*), with some 30 channels of free-to-air and pay services, and is rapidly becoming a viable alternative to services from the dominant satellite pay-TV operator.

Digital transmission using COFDM

In January 1993, NTL demonstrated their "Spectre" project, where 625-line pictures were transmitted from the Stockland Hill transmitting station in south-west England. The demonstration used a primitive COFDM system, transmitting an MPEG-1 [3] QPSK-modulated bitstream to an assembled audience in an Exeter hotel. Re-reading the report of these tests, the immunity to co-channel analogue interference was already understood at the time, and the desire to move to 16-QAM to increase the data-rate to some 26 Mbit/s was being expressed.

The DVB Project was launched just over five years ago, on 10 September 1993, and produced a stream of fundamental standards for digital broadcasting. But it wasn't until 1995 that the specification of DVB-T was completed. In common with all DVB specifications, industry expertise was pooled to choose the best possible system for the purpose, and the best elements of the contributions from Philips (Netherlands), CCETT (France), JVC and Matsushita (Japan) were invited to form a patents pool. Many other companies, including the BBC and NTL contributed to the specifications.

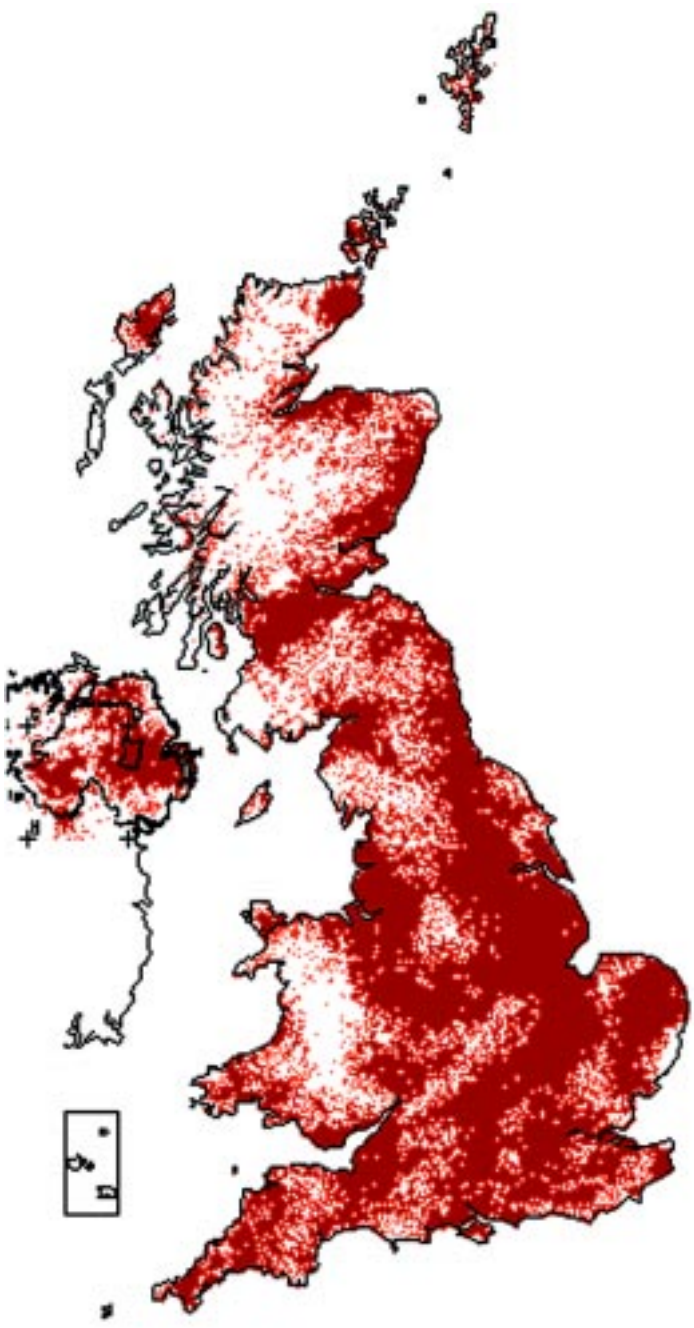

Figure 2
Expected UK coverage of the free-to-air DTT multiplexes by the end of 1999.

COFDM was chosen because of its robustness to reflections, particularly important in inner city and urban situations. It also has excellent properties in terms of its immunity to interference both to and from analogue transmissions, which are important features in the utilization of taboo channels in the crowded UHF spectrum prevalent in Europe. COFDM also allows the possibility of large-area single frequency networks, although these have not been implemented in the UK.

The DVB-T specification allows for the variation of the modulation scheme, code rate and guard interval to achieve the best compromise between data-rate and signal robustness in any specific situation. Thus, at one extreme, QPSK can be used at data-rates of 10 to 12 Mbit/s to achieve mobile reception in high-speed vehicles and trains. More typically, the UK require-

ment of static reception using either roof-top or set-top antennas is satisfied with 64-QAM, operating at a multiplex data-rate of 24 Mbit/s.

The DVB-T standard further offers the choice of two modes of operation known as **2k** (just under 2000 carriers) and **8k** (just under 8000 carriers). The 2k mode can provide optimized performance in mobile situations whereas the 8k mode is generally preferable for large-scale SFNs. For the UK multi-frequency situation, the 2k mode was considered to be very suitable and gave the possibility of an earlier time to market for the products. In the event, many STB implementations already include (or will soon move to) chips which are capable of operating in both the 2k and the 8k modes.

Service-area planning was carried out in the UK during 1995, and it was concluded that it was possible to achieve four multiplexes with some 90% coverage of the UK population from a network of 81 transmitter sites, plus a further two multiplexes with some 70% coverage. (*Fig. 2* shows the expected coverage on the free-to-air multiplexes by the end of 1999.) This planning was used by the UK government to enact the necessary legislation (The Broadcasting Act 1996) and for the Independent Television Commission (ITC) [4] to proceed with the appointment of the multiplex operators.

Allocation of multiplexes

The allocation of the multiplexes was a subtle piece of the legislation. It was designed:

- ⇨ to bring in the existing terrestrial broadcasters (by no means automatically assured);
- ⇨ to provide sufficient financial backing to see the new system through the early loss-making years;
- ⇨ and finally, of course, to bring in new players, new blood and increased competition.

In the legislation, the existing terrestrial broadcasters were to be offered multiplexes with the best coverage to duplicate their existing analogue services, but with sufficient capacity to start new services as well. Thus, the BBC [5] was offered a whole multiplex, allowing for simulcasts of their existing BBC-1 and BBC-2 services, plus capacity for two new television services, BBC News 24 and BBC Choice, together with some additional capacity for audio and data services.

The second multiplex was allocated jointly to ITV [6] and Channel 4 [7], to provide simulcasts of their free-to-air advertising-funded services, plus additional capacity for new services. In the case of ITV, that additional capacity is being used for a new advertising-funded service, ITV-2, designed to complement existing ITV programming and broaden the appeal of the ITV services. Channel 4 has chosen to use its new capacity to launch a subscription movie channel and may also provide a sports channel during daytime hours.

Four new commercial multiplex franchises were awarded by the ITC as follows. One multiplex was awarded to SDN, which is a consortium comprising S4C (the Welsh-language channel), NTL, and United News and Media. The remaining three multiplexes were awarded to British Digital Broadcasting, now trading under the name of ONdigital [8].

Inherent advantages of DTT

Each of the delivery platforms has inherent attributes that are important to recognize in the branding and marketing of service bouquets. In the case of digital terrestrial, the ability to offer a large number of regional variations is an important feature that cannot be economically matched on satellite. Another advantage in the UK is the reception on existing rooftop antennas, which simplifies the consumer proposition. In many cases it is proving possible to receive DTT on portable TV sets as well. Thirdly, although it is not inherently a function of terrestrial TV, the UK DTT service is addressing the replacement television set market, currently running at some 4 million units per year, and for this reason is being strongly supported by manufacturers and retailers alike.

The programme line-up is shown in *Fig. 3*. The consumer proposition has a strong foundation in free-to-air services from known and trusted existing broadcasters. In addition, a package of "primary" subscription services is offered at a modest subscription level, and aimed at a mass audience that has so far resisted pay-TV. Lastly, it includes a small number of the most successful satellite channels – movie and sports services – which are available as "premium" services.

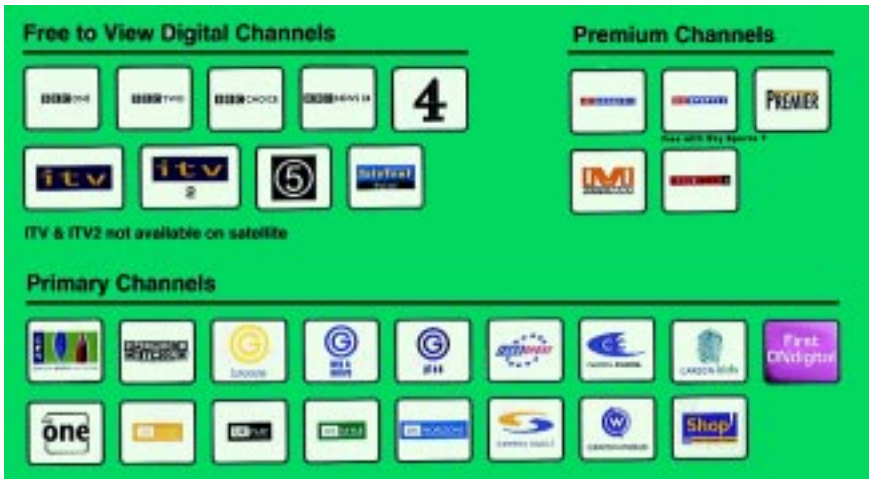

Figure 3
The line-up of programme channels planned for the launch of the UK DTT service.

It is important to recognize the different marketing proposition that the UK terrestrial broadcasters have established to compete with BSkyB digital satellite services [9]. In the UK, satellite pay services in analogue have levelled off at about 30% of the market and there is intense commercial competition to appeal to the 70% of viewers who, currently, are apparently contented with a line-up of four or five free-to-air channels. The digital terrestrial proposition is based on a foundation of free-to-air services and is being offered as a natural progression, offering digital quality, widescreen, some more free-to-air channels and, for those that want it, a very flexible proposition of subscription services.

BSkyB naturally has a different view. Its SkyDigital service has also welcomed free-to-air broadcasters (al-though ITV has refused to offer its services). The SkyDigital bouquet offers a wider choice of services than DTT, and the choice of packages includes a low-cost entry option and a documentary package designed to offer a more up-market brand image. Time will tell what the commercial outcome is likely to be, but there is no doubt that competition is already proving a good thing for the consumer.

The role of the DTG

The Digital Television Group [10] was founded in 1995 with a commitment to the launch of digital television in the UK. From an initial membership of six companies, the DTG now has

over 100 supporting members. A small secretariat, funded by member contributions and a government grant, supports the voluntary committee work of the member companies. The majority of members are concerned with digital terrestrial TV but other platforms are welcomed and are important to the resolution of cross-platform issues.

It is important to recognize that a horizontal market means that no single body is in control of the specification of the operating standards, or the implementation or conformance of the system. An industry body such as the DTG allows scarce technical knowledge to be pooled and provides a neutral platform where all parties can co-operate for the common good.

The DTG has produced a "*Requirements for Interoperability*" for digital terrestrial television. Commonly known as the "*D-Book*", this substantial document contains all the additional detail that is necessary to turn the DVB foundation into a working system. This is, in part, the selection of appropriate parameters from within the DVB family of standards but it is far more than that. The first major implementation of DVB-T has inevitably exposed a number of grey areas in the standards, and the D-Book includes clarification and explanation of the UK system, together with local extensions.

In some cases, UK requirements were seen as having general interest and the DTG has been active on many DVB committees to ensure that, where appropriate, changes have been fed back and incorporated in DVB standards. Such areas include:

- extensions to the Common Interface, which was carried out jointly with DVB;
- the Active Format Descriptor (AFD), which has been accepted as an optional extension of DVB standards for widescreen signalling.

The DTG has also found a role in the dissemination of independent and authoritative information to the industry and to the retail trade, and has been active in publishing advisory brochures to the retail and installer trades, together with "road-shows" and other training activities.

Use of the Common Interface

With the agreement of the multiplex operators concerned, the ITC has mandated the provision of Common Interface slots in receivers and set-top boxes, requiring at least one plug-in slot in a set-top box and two in an integrated TV. The Common Interface is seen as a key feature, not just for the addition of a conditional access module but also for a wide variety of other purposes. For example, development is under way to produce a satellite-input module for a DTT receiver. Also, a module is being developed to permit reception of additional audio channels including audio description services for visually-impaired viewers. As mentioned previously, a DVB task group has produced extensions to the common interface specifications to satisfy these UK requirements and to add additional features for power-saving operation and copy protection.

The common interface provides a way to separate the proprietary parts of a receiver from the open-standards common parts. The ability to add an external CA module as a plug-in option ensures that monopoly gateways do not develop. Also, a television set is a much greater investment for the consumer than a set-top box and methods to upgrade it must be provided. The common interface provides the most reliable way to install new software, to upgrade the hardware, to add new functionality and so on. It has enormous potential, which we have barely started to explore.

The API Story

During 1996, the DTG carried out an exhaustive evaluation of available APIs – which pointed to the technical superiority of the DAVIC [11]/MHEG-5 [2] operating system when used in a horizontal market. This environment is one in which there is multiple sourcing of applications and a variety of API engines in receivers, and there is a risk that "rogue" application software may cause mis-operation in one or all of the population of receivers. In this situation, MHEG-5 "ring fences" the damage, minimizing the effect and making recovery easier. The UK multiplex operators were persuaded by this argument and made a commercial commitment to implement a simplified subset of DAVIC 1.3 for UK DTT.

Existing analogue teletext operators are enthusiastic about the vast improvement in the quality of text and graphics this offers, and are working on developments to their listings and information services to take advantage of the new possibilities. Programme makers and advertisers, too, are busy exploring the possibilities for adding related data services to their programmes and commercials.

As a matter of expediency, the UK "launch" profile of MHEG deliberately omitted access to the modem, in order to minimize the risk of delay in launching the new service, but work is now under way to extend the functionality to include interactivity. A joint activity between the DTG, DigiTAG [12] and EACEM [13] is expected to produce an extended profile in early 1999, under the title of "EuroMHEG". In the event, DVB has opted to develop its future operating system for the Multimedia Home Platform (MHP) based on Java. EuroMHEG will be particularly easy to implement as a plug-in to this engine, when it becomes available.

Abbreviations

16-QAM	16-state quadrature amplitude modulation
64-QAM	64-state quadrature amplitude modulation
AFD	(DVB) active format descriptor
API	Application programming interface
CA	Conditional access
CCETT	(France Telecom's) *Centre Commun d'Etudes de Télédiffusion et de Télécommunications*
COFDM	Coded orthogonal frequency division multiplex
DAVIC	Digital Audio-Visual Council
DigiTAG	Digital Terrestrial Television Action Group
DTG	Digital Television Group
DTT	Digital terrestrial television
DVB	Digital Video Broadcasting
DVB-T	DVB - Terrestrial
EACEM	European Association of Consumer Electronics Manufacturers
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
ITC	Independent Television Commission (UK)
MHEG	(ISO/IEC) Multi- and Hyper-media coding Experts Group
MHP	Multimedia home platform
MPEG	(ISO/IEC) Moving Picture Experts Group
PAL	Phase alternation line
QPSK	Quadrature (quaternary) phase-shift keying
STB	Set-top box
UHF	Ultra high frequency

The DTG argues strongly that the future of digital television is with horizontal markets, employing open standards to avoid monopoly gateways. Where services are launched during the next few years or so – before the DVB-MHP operating system becomes available – we seriously question whether a proprietary API is a sensible choice, particularly if it is integral with the CA system. As the market moves to introduce integrated digital TVs, it is a profound wisdom to proceed with an open-standard API that will provide a migration path to MHP. In the past, services have launched and become successful without an API at all – the programme content still is the primary sales proposition but interactive TV services, although fashionable and offering huge potential, have so far been of limited success. It is more important to get it right and to avoid generating legacy systems sooner than necessary.

How good is DTT?

The UK planners for DTT had to carry out service area planning without any practical experience of COFDM reception, so the planning criteria were deliberately set conservatively. UHF propagation is well understood, of course, but DTT operation in a mixed environment with high-power analogue transmissions requires knowledge from COFDM experts, together with the accumulated wisdom of professional antenna installers. The DTG has brought together experts from both sides to investigate detailed reception requirements and to produce advice on installation practice for the antenna installer trade.

Of particular importance is the ratio of the received signal levels of analogue transmissions and the corresponding level of the digital transmissions. Using the same transmitter sites is essential to maintaining a workable ratio. It is important that analogue carriers do not overload amplifiers in the antenna installation, and installers have to be re-educated into understanding that extra gain is not necessarily a good thing! With that proviso, the experience of just a few weeks of operation (at the time of writing) is that reception is in many cases better than predicted. DTT reception is often possible on old or poor antenna installations where analogue reception is very marginal. Reception on portable TVs with simple set-top antennas ("rabbits ears") is also encouraging.

Interference problems with analogue have been significantly less than expected. Co-channel COFDM interference appears as random noise on analogue signals and the initial practical situation suggests that it may be possible to significantly increase the power of digital transmissions in many cases, once the full facts are known.

Consumer reactions

Although consumers are renowned for their tolerance of poor quality pictures, it becomes apparent that this does not prevent them from seeing improved picture quality as an important benefit of digital services and this fact is being used as an important sales feature. The complete absence of noise and "ghosting" (delayed images on the screen) gives a noticeable improvement on even the best analogue installations, and the increased clarity of component colour signals adds to that benefit.

Widescreen is also being offered as an important additional feature of DTT. When Channel 4 and other broadcasters first experimented with widescreen, it was rapidly discovered that viewers did not like 16x9 letterbox presentations of made-for-television programming when viewed on a 4x3 screen. (This has been presented as a peculiarly British trait but is universal, in the author's opinion. The public can be educated to accept feature films in letterbox format

– indeed some will prefer it since it provides a better representation of the cinema screen – but few will tolerate 16x9 letterbox applied more generally in analogue transmissions.)

Digital transmission in widescreen is different in a number of important ways. Firstly, it is a new service and consumers know that widescreen is part of the new service proposition. Secondly, viewers with 4x3 displays have the choice of letterbox or centre cut-out, which is likely to satisfy a much wider range of tastes. And thirdly, widescreen has become fashionable in the UK. The limited transmissions in PALplus and letterbox, together with modest but growing sales of analogue widescreen television sets, have seeded the market to the point where the UK sold out of widescreen TVs in the run-up to last year's World Cup football (even though the transmitted programmes were all 4x3). By the end of 1998, a total population of some 500,000 widescreen TVs were estimated to be in UK consumers' homes.

***Peter Marshall** has worked in the UK television industry for over 30 years. After an early career in the BBC, he moved to the Independent Broadcasting Authority where he rose to become Principal Engineer in their Technical Quality Control Operation. From there he moved to become Engineering Operations Manager at HTV, the ITV franchisee for Wales and the West of England. After 5 years, he returned to London to become Assistant Chief Engineer at Channel 4 Television, where he was involved with the move to new all-component digital headquarters and with the Channel's experiments with PALplus.*

In 1995, Mr Marshall became involved with the DTG's work in preparation for digital terrestrial broadcasting and, when the possibility arose to become its Technical Director, it was an opportunity he could not refuse. He has been in his present post since Nov 97.

Widescreen has had another vital role to play in the consumer market. In the run-up to the launch of digital services, consumers have shown a natural tendency to hold off replacing old equipment, and the retail trade has had to cope with a potentially serious drop in trade before the new digital equipments become available. Widescreen analogue TVs have fulfilled a vital role in bridging that gap, being offered as a sensible preparation for digital, to which a digital set-top box can be added later.

Future developments

The BBC has been promoting digital television with an awareness campaign using the slogan "*The Adventure Starts Here*". This undoubtedly is as true for the industry as for the consumer, and the launch of DTT in the UK is only the first step. There is much to be done to maintain conformance, to extend coverage to match that achieved in the analogue domain and to develop new services which embrace convergence and interactivity. The DVB project is active in setting the standards needed in their MHP programme and the UK will be keen to implement these important new standards as they become available.

Acknowledgements

The author wishes to thank the membership of the DTG for their far-sighted co-operation which has lead to the successful launch of DTT services in the UK and which is certain to become a model for similar platforms throughout the world.

TV milestones in the UK

31 Mar 30	First transmission of 30-line television with synchronized sound
2 Nov 36	"High-definition" TV officially begins with the launch of the BBC Television Service
12 May 37	Coronation of King George VI – the first BBC TV outside broadcast
7 Jun 46	BBC TV resumes after shutdown during World War II
22 Sep 55	Launch of ITV – a commercial competitor to the BBC
11 Jun 62	First satellite transmission from the USA via *Telstar*
21 Apr 64	BBC-2 launched in London – the first 625-line service
1 Jul 67	First regular colour transmissions (on BBC-2)
15 Nov 69	Colour transmissions begin on BBC-1 and ITV
2 Nov 82	Launch of Channel 4
5 Feb 89	Launch of Sky satellite television via *Astra*
31 Mar 97	Launch of Channel 5
1 Oct 98	Launch of SkyDigital services on satellite
15 Nov 98	Launch of DTT services

Courtesy of ONdigital

Bibliography

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[7] http://www.channel4.com/

[8] http://www.ondigital.co.uk/

[9] http://www.sky.co.uk/digital/

[10] http://www.dtg.org.uk/

[11] http://www.davic.org/

[12] http://www.digitag.org/

[13] http://www.eacem.be/index.htm