DVB-T Digital Video Broadcasting

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DVB-T Digital Video Broadcasting

Digital Video Broadcasting (DVB) is being adopted as the standard for digital television in many countries. The DVB project was an industry led consortium of over 270 television broadcasting associated companies world-wide. The DVB standard offers many advantages over the previous analogue standards and has enabled television to make a major step forwards in terms of its technology.
Digital Video Broadcasting, DVB is now one of the success stories of modern broadcasting. The take up has been enormous and it is currently deployed in over 80 countries worldwide, including most of Europe and also within the USA. It offers advantages in terms of far greater efficiency in terms of spectrum usage and power utilisation as well as being able to affect considerably more facilities, the prospect of more channels and the ability to work alongside existing analogue services.

History of DVB

From the very earliest days of television, right up until the 1990s, all television broadcasts were made using analogue television and it had not been thought feasible to introduce a digital system due to the complexity of the processing required. However with the advance of digital processing techniques and the advances made in integrated circuit technology the possibility of using digital techniques for television broadcasting became a real possibility.
As a result over the course of 1991various organisations discussed how to move forwards with the idea and how to form a pan-European platform that would enable considerable economies of scale to be achieved.
The resulting organisation was named the Electronics Launching Group (ELG), and it developed a memorandum of Understanding that was signed in 1993. At the same time it renamed itself the Digital Video Broadcasting Project (DVB), and the development of the technologies and standards started to move forwards with a swifter pace.
The first of the DVB standards to be agreed was the DVB-S standard for satellite transmission which was agreed in 1994. With the standard agreed, services were commenced in early 1995 and the first operator was the pay TV operator Canalplus in France.
The DVB system used for terrestrial transmissions, DVB-T was agreed later, in 1997. The first countries to deploy the system were Sweden, launching their system in 1998, and the UK launching their system a year later.

Agreement of DVB specifications

The way in which specifications are developed, agreed and released may seem rather complicated, but it has proved to be a successful system, enabling interested parties to have their say in the development and maintenance of the DVB system and its technology. The member organisations of the DVB project develop and agree specifications. Once agreed they are then passed on to the EBU/CENELEC/ETSI Joint Technical Committee, for approval. The specifications are then formally standardised by either CENELEC or, in the majority of cases, ETSI.
The DVB project is managed by the DVB Project Office. This is staffed by personnel who are employees of the European Broadcasting Union in Geneva, Switzerland. While they are technically employees of the EBU, they work exclusively in the interests of the members of the DVB Project.

DVB Variants

Even a quick look at DVB will reveal the fact that there are many flavours of the basic standard. In these days when there are many ways in which television can be carried from the "transmitter" to the "receiver" no one standard can be optimised for all applications. As a result there are many different forms of the Digital Video Broadcasting, DVB, standards, each designed for a given application.
The main forms of DVB are summarised below:

DVB STANDARD	MEANING	DESCRIPTION
DVB-C	Cable	The standard for delivery of video service via cable networks.
DVB-H	Handheld	DVB services to handheld devices, e.g. mobile phones, etc
DVB-RSC	Return satellite channel	Satellite DVB services with a return channel for interactivity.
DVB-S	Satellite services	DVB standard for delivery of television / video from a satellite.
DVB-SH	Satellite handheld	Delivery of DVB services from a satellite to handheld devices
DVB-S2	Satellite second generation	The second generation of DVB satellite broadcasting.
DVB-T	Terrestrial	The standard for Digital Terrestrial Television Broadcasting.

With DVB being widely used in very many countries, it has now become one of the defacto families of standards for broadcasting. Developments have been made beyond the first DVB standards that were introduced, and now new facilities and levels of performance are being achieved.

DVB-T or Digital Video Broadcast - Terrestrial is the most widely used digital television standard in use around the globe for terrestrial television transmissions. It provides many facilities and enables a far more efficient use of the available radio frequency spectrum than the previous analogue transmissions.
The DVB-T standard was first published in 1997 and since then it has become the most widely used format for broadcast digital in the world. By 2008, it was the standard that was adopted in more than 35 countries and over 60 million receivers deployed and in use.

Major milestones in DVB-T development and deployment

- ***December 1994:*** MPEG-2 ISO 13818-1 systems definition available
- ***July 1995:*** demonstrations by BBC of digital terrestrial broadcasting to several UK government officials.
- ***January 1996:*** The 4:2:2 video format standardised
- ***February 1996:*** QAM-COFDM transmission system agreed for DVB-T
- ***9th April 1996:*** Implementation of the first phases of a digital terrestrial television pilot-service from Crystal Palace and Pontop Pike by BBC in the UK

- ***24th December 1996:*** U.S. Government adopts DTV as first step towards a U.S. digital terrestrial network
- ***March 1997:*** First publication of the DVB-T standard
- ***December 1997:*** Over 200 DVB Satellite TV channels live using DVB-T
- ***November 1998:*** Transmission of DVB-T starts in the UK

DVB-T basics

DVB-T makes use of many modern technologies to enable it to deliver high quality video in a broadcast environment.
The DVB-T transmission is capable of carrying a very significant level of data. Normally several television broadcasts may be carried on a single transmission and in addition to this several audio channels may be carried as well. As a result each transmission is called a multiplex.
One of the key elements of the radio or air interface is the choice of the modulation scheme for DVB-T. In line with many other forms of transmission these days, DVB-T uses OFDM, Orthogonal Frequency Division Multiplex.

Note on OFDM:

Orthogonal Frequency Division Multiplex (OFDM) is a form of transmission that uses a large number of close spaced carriers that are modulated with low rate data. Normally these signals would be expected to interfere with each other, but by making the signals orthogonal to each other there is no mutual interference. The data to be transmitted is split across all the carriers to give resilience against selective fading from multi-path effects..

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In order that the DVB-T network is able to meet the requirements of the operator, it is possible to vary a number of the characteristics:

- ***3 modulation options (QPSK, 16QAM, 64QAM):*** There is a balance between the amount rate at which data can be transmitted and the signal to noise ratio that can be tolerated. The lower order modulation formats like QPSK do not transmit data as fast as the higher modulation formats such as 64QAM, but they can be received when signal strengths are lower.
- ***5 different FEC (forward error correction) rates:*** Any radio system transmitting data will suffer errors. In order to correct these errors various forms of error correction are used. The rate at which this is done affects the rate at which the data can be transmitted. The higher the level of error correction that is applied, the greater the level of supporting error correction data that needs to be transmitted. In turn this reduces the data rate of the transmission. Accordingly it is necessary to match the forward error correction level to the requirements of the broadcast network. The error correction uses convolutional coding and Reed Solomon with rates of 1/2, 2/3, 3/4, 5/6, and 7/8 dependent upon the requirements.
- ***4 Guard Interval options:***
- ***2k or 8k carriers:*** According to the transmission requirements the number of carriers within the OFDM signal can be varied. When fewer carriers are used, each carrier must carry a higher bandwidth for the same overall multiplex data rate. This has an impact on the resilience to reflections and the spacing between transmitters in a single frequency network. Although the systems are labelled 2k and 8k the actual numbers of carriers used are 1705 carriers for the 2k service and 6817 carriers for the 8k service.

- ***6, 7 or 8MHz channel bandwidths:*** It is possible to tailor the bandwidth of the transmission to the bandwidth available and the channel separations. Three figures of bandwidth are available.
- ***Video at 50Hz or 60Hz:*** The refresh rate for the a screen can be varied. Traditionally for analogue televisions this was linked to the frequency used for the local mains supplies.

By altering the various parameters of the transmission it is possible for network operators to find the right balance between the robustness of the DVB-T transmission and its capacity.

DVB-T single frequency network

One of the advantages of using OFDM as the form of modulation is that it allows the network to implement what is termed a single frequency network. A single frequency network, or SFN is one where a number of transmitters operate on the same frequency without causing interference.

many forms of transmission, including the old analogue television broadcasts would interfere with one another. Therefore when planning a network, adjacent areas could not use the same channels and this greatly increased the amount of spectrum required to cover a country. By using OFDM an SFN can be implemented and this provides a significant degree of spectrum efficiency improvement.

A further advantage of using a system such as DVB-T that uses OFDM and allows the implementation of an SFN is that very small transmitters can be used to enhance local coverage. Small "gap fillers" may even be used to enhance indoor coverage for DVB-T.

DVB-T hierarchical modulation

Another facility that is allowed by DVB-T is known as Hierarchical Modulation. Using this technique, two completely separate data streams can be modulated onto a single DVB-T signal. A "High Priority" or HP stream is embedded within a "Low Priority" or LP stream. Using this principle DVB-T broadcasters are able to target two different types of receiver with two completely different services.

One example where this could be used is for a DVB-H mobile TV service optimised for more difficult reception conditions could be placed in the HP stream, with HDTV DVB-T services targeted to fixed antennas delivered in the LP stream.

DVB-T specification highlights

PARAMETER	DVB-T
Number of carriers in signal	2k, 8k
Modulation formats	QPSK, 16QAM, 64 QAM
Scattered pilots	8% of total
Continual pilots	2.6% of total
Error correction	Convolutional Coding + Reed Solomon 1/2, 2/3, 3/4, 5/6, 7/8

PARAMETER	DVB-T
Guard interval	1/4, 1/8, 1/16, 1/32

DVB-T is now well established. Many countries, including the UK are moving towards a complete switch-over from analogue to digital, with a resultant digital dividend releasing a significant amount of bandwidth for other services. However as DVB-T has now been in use for ten years a new standard, which is a development of the original DVB-T standard known as DVB-T2 is being developed. This would have backwards compatibility, but allow additional services and flexibility as well as a number of features to future-proof it.

DVB-T2 is the next development of the Digital Video Broadcasting - Terrestrial standards. It builds on the technology and on the success of DVB-T to provide additional facilities and features in line with the developing DTT or Digital Terrestrial television market.
Although some may see DVB-T2 as a competitor to the existing DVB-T standard, this is not the case,. It is planned that the two standards will co-exist for many years, with DVB-T2 allowing additional features and services.

DVB-T2 basics

The DVB-T2 standard uses Orthogonal Frequency Division Multiplex as the basic radio transmission medium. This form of transmission is particularly robust and allows for the reception of data signals (in this case television data) in the presence of some interference or missing channels as a result of effects like multipath.

Note on OFDM:

Orthogonal Frequency Division Multiplex (OFDM) is a form of transmission that uses a large number of close spaced carriers that are modulated with low rate data. Normally these signals would be expected to interfere with each other, but by making the signals orthogonal to each other there is no mutual interference. The data to be transmitted is split across all the carriers to give resilience against selective fading from multi-path effects..

The new DVB-T2 specification provides the facility to select a variety of different options to match the requirements of the network operator.
For error correction technology, that used for DVB-S2 has been incorporated. This comprises LDPC (Low Density Parity Check) coding combined with BCH (Bose-Chaudhuri-Hocquengham) coding. The combination of these two techniques has been proved to provide excellent performance in the presence of high noise levels and interference.
As before, several options are available in areas such as the number of carriers, guard interval sizes and pilot signals, so that the overheads can be minimised for any given transmission channel.

DVB-T2 specification highlights

PARAMETER	DVB-T	DVB-T2
Number of carriers in signal	2k, 8k	1k, 2k, 4k, 8k, 16k, 32k
Modulation formats	QPSK, 16QAM, 64 QAM	QPSK, 16QAM, 64 QAM, 256QAM
Scattered pilots	8% of total	1%, 2%, 4%, 8% of total
Continual pilots	2.6% of total	0.35% of total
Error correction	Convolutional Coding + Reed Solomon 1/2, 2/3, 3/4, 5/6, 7/8	LPDC + BCH 1/2, 3/5, 2/3, 3/4, 4/5, 5/6
Guard interval	1/4, 1/8, 1/16, 1/32	1/4, 19/128, 1/8, 19/256, 1/16, 1/32, 1/128

While DVB-T2 represents the next evolution for digital terrestrial television, it is planned to operate it alongside the current DVB-T standard for many years and evolve the changeover to DVB-T2. This evolution should occur in much the same way that has occurred between DVB-S and DVB-S2.
As DVB-T2 offers additional facilities, it will enable the broadcasters the possibility of offering new and captivating services to ensure that they are able to keep their viewers. Building on the success of the existing digital television services, DVB-T2 is bound to see a significant level of take-up over the coming years.
DVB-H or Digital Video Broadcast - Handheld, is one of the major systems to be used for mobile video and television for cellular phones and handsets. DVB-H has been developed from the DVB-T (Terrestrial) television standard that is used in many countries around the globe including much of Europe including the UK, and also other countries including the USA. The DVB-T standard has been shown to be very robust and in view of its widespread acceptance it forms a good platform for further development for handheld applications.

DVB-H development requirements

The environment for handheld devices is considerably different to that experienced by most televisions. Normally domestic televisions have good directional antenna systems and in addition to this the reception conditions are fairly constant. Additionally most televisions receiving DVB-T will be powered by mains supplies. As a result current consumption is not a major issue.
The conditions for handheld receivers are very different. In the first instance the antennas will be particularly poor because they will need to be small, and integrated into the handset in such a way that they either appear fashionable, or they are not visible. Additionally they will obviously be mobile, and this will entail receiving signals in a variety locations, many of which will not be particularly suitable for video reception. Not only will be signal be subject to considerable signal variations and multi-path effects, but it may also experience high levels of interference. Also some difficulties are presented by the fact that the handset could be in a vehicle and actually on the move. The operation of DVB-H has to be sufficiently robust to accommodate all these requirements.

Note on multi-path effects:
Multi-path effects occur when signals reach the receiver via several different paths from the transmitter. This occurs because the signals leave the transmitter in a variety of directions - typically the transmitter may have an omni-directional radiation pattern so that it radiates signals equally in all directions. Accordingly some of the signal may travel directly to the receiver in what is termed the direct path, but some of the radiated may be reflected off a nearby hill, building or other object. In fact the received signal will consist of components reaching the receiver from the transmitter via a large number of paths. As the path length travelled by each of these components will be slightly different, each component will arrive at a slightly different time. If there are significant differences, this can cause the data being transmitted to be corrupted under some circumstances, although many modern receiver technologies can accommodate this and use the different signals travelling over different paths to reinforce one another.

While DVB-T proved to be remarkably robust under many circumstances, one of the major problems was that of current consumption. Battery life for handsets is a major concern where users anticipated the life between charges will be several days.

Operation of DVB-H

The DVB-H standard has been adopted by ETSI, European Telecom Standards Institute, and in this way the system can be truly international, and this will prevent compatibility problems caused by different countries and operators using different variants of the same system. The documents for the physical layer were ratified in 2004, with the upper layers defined in 2005.
DVB-H (Digital Video Broadcast Handheld) is based on the very successful DVB-T (Digital Video Broadcast Terrestrial) standard that is now used in many countries for domestic digital television broadcasts. DVB-H has taken the basic standard and adapted so that it is suitable for use in a mobile environment, particularly with the electronics incorporated into a mobile phone.
The DVB-H standard like DVB-T uses a form of transmission called Orthogonal Frequency Division Multiplex (OFDM). This has been adopted because of its high data capacity and suitability for applications such as broadcasting. It also offers a high resilience to interference, can tolerate multi-path effects and is able to offer the possibility of a single frequency network, SFN.

Note on OFDM:

Orthogonal Frequency Division Multiplex (OFDM) is a form of transmission that uses a large number of close spaced carriers that are modulated with low rate data. Normally these signals would be expected to interfere with each other, but by making the signals orthogonal to each other there is no mutual interference. The data to be transmitted is split across all the carriers to give resilience against selective fading from multi-path effects..

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There are a variety of modes in which the DVB-H signal can be configured. These are conform to the same concepts as those used by DVB-T. These are 2K, 4K, and 8K modes, each having a different number of carriers as defined in the table below. The 4K mode is a further introduction beyond that which is available for DVB-T.

PARAMETER	2K MODE	4K MODE	8K MODE
Number of active carriers	1705	3409	6817
Number of data carriers	1512	3024	6048
Individual carrier spacing	4464 Hz	2232 Hz	1116 Hz
Channel width	7.61 MHz	7.61 MHz	7.61 MHz

Signal parameters for DVB-H OFDM Signal (8MHz Channel)

The different modes balance the different requirements for network design, trading mobility for single frequency network size, with the 4K mode being that which is expected to be most widely used.
The standard will support a variety of different types of modulation within the OFDM signal. QPSK (Quadrature Phase Shift Keying), 16QAM (16 point Quadrature Amplitude Modulation), and 64QAM (64 point Quadrature Amplitude Modulation) will all be supported, chipsets being able to detect the modulation and receive the incoming signal. The choice of modulation is again a balance, QPSK offering the best reception under low signal and high noise conditions, but offering the lowest data rate. 64QAM offers the highest data rate, but requires the highest signal level to provide sufficiently error free reception.

DVB-H Time slicing

One of the key requirements for any mobile TV system is that it should not give rise to undue battery drain. Mobile handset users are used to battery life times extending over several days, and although battery technology is improving, the basic mobile TV technology should ensure that battery drain is minimised.
There is a module within the standard and hence the software that enables the receiver to decode only the required service and shut off during the other service bits. It operates in such a way that it enables the receiver power consumption to be reduced while also offering an uninterrupted service for the required functions.
The time slicing elements of DVB-H enable the power consumption of the mobile TV receiver to be reduced by 90% when compared to a system not using this technique. Although the receiver will add some additional power drain on the battery, this will not be nearly as much as it would have been had the TV reception scheme not employed the time slicing techniques.

DVB-H Interleaving

Interleaving is a technique where sequential data words or packets are spread across several transmitted data bursts. In this way, if one transmitted burst or group is lost as a result of noise or some other drop-out, then only a small proportion of the data in each original word or packet is lost and it can be reconstructed using the error detection and correction techniques employed.
Further levels of interleaving have been introduced into DVB-H beyond those used for DVB-T. The basic mode of interleaving used on DVB-T and which is also available for DVB-H is a native interleaver that interleaves bits over one OFDM symbol. However DVB-H provides a more in-depth interleaver that interleaves bits over two OFDM symbols (for the 4K mode) and four bits (for the 2K mode).
Using the in-depth interleaver enables the noise resilience performance of the 2K and 4K modes to be brought up to the performance of the 8K mode and it also improves the robustness of the reception of the transmissions in a mobile environment.

MPE-FEC

In view of the particularly difficult reception conditions that may occur in the mobile environment, further error correction schemes are included. A scheme known as MPE-FEC provides additional error correction to that applied in the physical layer by the interleaving. Tjis is a forward error correction scheme that is applied to the transmitted data and after reception and demodulation, allows the errors to be detected and corrected.

DVB-H compatibility with DVB-T

DVB-H is a development of DVB-T and as a result it shares many common components. It has also been designed so that it can be used in 6, 7, and 8 MHz channel schemes although the 8MHz scheme will be the most widely used. There is also a 5MHz option that may be used for non-broadcast applications.
In view of the similarities between DVB-H and DVB-T it is possible for both forms of transmission to exist together on the same multiplex. In this way a broadcaster may choose to run two DVB-T services and one DVB-H service on the same multiplex. This feature may be particularly attractive in the early days of DVB-H when separate spectrum is not available.
DVB-H has been used in a number of trials and appear to perform well. It ahs support from a number of the major industry players and is likely to achieve a considerable degree of acceptance world-wide. Accordingly it is likely to be one of the major standards, if not the major standard used for mobile video.
DVB-SH, Digital Video Broadcast - Satellite services to Handheld devices is a standard or specification that is likely to be widely used for Mobile TV services. The DVB-SH standard has been developed to deliver video, audio and data services to small handheld devices including mobile phones and PDAs and using frequencies typically within S band but in any case below 3 GHz from either satellite or terrestrial networks. DVB-SH has also been designed to complement DVB-H which is focussed on delivering mobile video from terrestrial networks at frequencies within the UHF TV bands.
One of the key features of DVB-SH is that it is aimed for use for both satellite and terrestrial delivery. This is a significant advantage because it allows satellite delivery to achieve coverage of large areas of a country and then terrestrial coverage can be used for gap fillers for example in built up areas in cities where tall buildings may shield the satellite signal.
In view of its specifications, DVB-SH is will be used alongside other forms of cellular technology as it is estimated that most applications will be in small mobile devices such as cell phones, PDAs, etc.

DVB-SH background

The first DVB standard for mobile TV was DVB-H which was published in 2004 and some services using this standard are now being deployed. DVB-H is aimed at terrestrial networks using frequencies at the low end of the UHF spectrum. Seeing the requirement for additional satellite delivery, work was started on the DVB-SH specification in November 2006 and the DVB organisation approving the DVB-SH standard on 14th February 2007.

Basics of DVB-SH standard

In order that the DVB-SH standard is able to deliver the required performance it offers schemes suitable for both satellite and terrestrial delivery. To provide the required performance both OFDM and TDM signal techniques are used. As a result there are two architectures for DVB-SH:

- **SH-A** uses OFDM on both the satellite and terrestrial links
- **SH-B** uses TDM on the satellite link and OFDM on the terrestrial link

While the OFDM (Orthogonal Frequency Division Multiplex) provides excellent characteristics for terrestrial delivery, the TDM (Time Division Multiplex) scheme has advantages for satellite delivery.

Note on OFDM:

Orthogonal Frequency Division Multiplex (OFDM) is a form of transmission that uses a large number of close spaced carriers that are modulated with low rate data. Normally these signals would be expected to interfere with each other, but by making the signals orthogonal to each other there is no mutual interference. The data to be transmitted is split across all the carriers to give resilience against selective fading from multi-path effects..

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The two variants require different architectures in the transmitters and receivers in terms of the demodulators and modulators as well as some of the signal encoding areas. A choice between SH-A and SH-B can then be made according to the satellite characteristics and regulatory considerations.

Signal modulation within the OFDM and TDM signal formats can also be varied. Possible choices can be QPSK, 8PSK and 16APSK are available within the TDM mode using a variety of roll-off factors (0.15, 0.25, or 0.35). For OFDM QPSK, 16 QAM and non-uniform 16QAM are available within the OFDM transmission mode.
Flexibility is also provided within DVB-SH for different bandwidths. This allows service providers to tailor the bandwidth of the transmission according to their constraints. The DVB-SH standard allows a choice of transmission bandwidths between: 8 MHz, 7 MHz, 6 MHZ, 5 MHz, 1.7 MHz. The FFT length choice is between 8k, 4k, 2k, and an additional 1k scaled directly from the 2k mode.
Using DVB-SH it is possible to provide seamless reception of satellite and terrestrial signals using signal diversity either via a Single Frequency Network (SFN) - SH-A only; Maximal Ratio Combining (MRC) - both SH-A and SH-B; or code diversity (complementary puncturing) - SH-B only. The latter scheme is possible via a common frame structure shared between OFDM and TDM modes.

FEC and turbo-coding

The fact that DVB-SH is focussed on frequencies up to 3 GHz, and expected to operate on frequencies around 2.2 GHz means that the performance requirements for the system are more exacting than those for DVB-H where frequencies up to 900MHz are typically used. Typically it is found that the signal to noise ratios are inferior, and this could result in high levels of bit error rate and poor performance unless power levels were raised and dense terrestrial networks employed. As these options are not desirable, enhancements have been included in the signal processing areas of the DVB-SH standard. A state of the art forward error correction system has been included in the form of the 3GPP2 Turbocode. In addition to this, the standard includes a highly effective channel interleaver. This offers time diversity of between 100 ms up to several seconds dependent upon the targeted service levels and also the amount of memory available in the target receivers. By interleaving, the effects of interference can be minimised, and the longer the period of interleaving, the greater the interference duration that can be tolerated.
In addition to this, pilot symbols are used to provide a robust form of signal estimation and fast re-acquisition. This provides considerable performance improvements when there are long shadowing or signal blockages. This scheme is used for both TDM and OFDM modes.

DVB-SH summary

The DVB-SH standard complements the other DVB standards that are in existence and many of which are very well established. With satellite technology relatively commonplace, and satellite distribution an ideal way of broadcasting video media, DVB-SH fills a hole in the marketplace. It also has the advantage that it recognises the limitations of satellite technology for broadcasting to handheld devices by also including a terrestrial method of delivery. In this way the DVB-SH specification provides a complete solution.

With DVB standards being used in many areas of television broadcasting a further standard referred to as DVB-RCS or Digital Video Broadcast - Return Satellite via Satellite is attracting a large amount of interest. Although DVB-RCS was originally intended as a broadcast technology, a number of other users from a broad spectrum of communications users are looking at the technology with a view to its use.
DVB-RCS is one of the DVB family of standards that is in widespread use for a number of television broadcast applications that can be delivered by a variety of methods. The DVB standards now dominate the television area and they have been very successfully implemented in many countries.

What is DVB-RCS?

While most television standards simply involve a one way transmission using a "one to many" concept, DVB-RCS uses a return channel to enable two way transmissions to be made.
Like other DVB standards, DVB-RCS has been designed by the DVB Project. It defines a complete air interface specification for a two way satellite broadband scheme. It uses a VSAT (Very Small Aperture Terminal - an earth station, used for the reliable transmission of data, video, or voice via geo-stationary satellite, with a relatively small dish-antenna often around 1 to 2 metres in diameter). In effect DVB-RCS provides the user with a satellite based ADSL-style link without the need for the land based cables. This makes DVB-RCS ideal for use in many areas where there is no terrestrial infrastructure installed.
Depending on link budgets between the earth station and the satellite as well as other system parameters, DVB-RCS is able to provide up to 20 Mbit/s to each terminal on the outbound link, and up to 5 Mbit/s or more from each terminal on the inbound link.
The DVB-RCS technical specification is now approved as DVB-RCS+M. It provides support for a variety of types of terminal including mobile and nomadic terminals. In addition to this, it provides enhanced support for direct terminal-to-terminal, or mesh connectivity. DVB-RCS+M includes features such as live

handovers between satellite spot-beams, spread-spectrum features to meet regulatory constraints for mobile terminals, and continuous-carrier transmission for terminals with high traffic aggregation. It also includes link-layer forward error correction based on Raptor or Reed-Solomon codes, used as a countermeasure against shadowing and blocking of the satellite link.
The standards for DVB-RCS are maintained by ETSI with the actual standard number: EN 301 790.
In terms of the development of the standard, DVB-RCS was first published in 2000 and since then it has been quite stable. The first major change was the introduction of DVB-RCS+M (for mobile applications), otherwise changes have mainly been for maintenance. These changes included support for the DVB-S2 forward link standard.

DVB-RCS market drivers

The DVB-RCS standard was developed in response to a request from a number of satellite and network operators. These organizations wanted to be able to deploy VSAT systems to enable two way radio communications, i.e. not only from the satellite to the users, but also allowing the user to be able to send data back up to the satellite and hence into a data network.
At the outset of the development of the DVB-RCS standard the partners in the project wanted a standard for a satellite system that would enable two way communications. In addition to this the satellite standard would need to be open to mitigate the risks of being tied to a single vendor.
During the development of the DVB-RCS satellite communications standard a variety of trade-offs needed to be made to ensure that a satisfactory balance was made between cost and performance. Also by including the industry partners and making the standard open, consensus for DVB-RCS was gained across the industry and in this way its future was assured.

DVB-RCS user terminals

One of the major requirements for DVB-RCS is that the user terminals should be relatively small, easy to use, and be manufactured to a cost while remaining reliable. To achieve this the basic form of DVB-RCS provides what may be termed "hub-spoke" connectivity; i.e., all user terminals are connected to a central hub. This hub controls the system and it also acts as a traffic gateway between the users and the wider Internet.
The DVB-RCS user terminal sometimes known as a Satellite Interactive Terminal (SIT) or Return Channel Satellite Terminal (RCST)) comprises a number of items:

- small indoor unit
- outdoor unit which includes a diplexer, low noise amplifier and a transmit RF amplifier
- antenna - size around 1 - 2 metres in diameter

DVB-RCS technical basics

The DVB-RCS satellite system provides the user with an interactive satellite service. Accordingly there are two elements to the system:

- Receive capability
- Transmit capability

The forward link is shared among a population of terminals using either DVB-S (EN 300 421) or the highly efficient DVBS2 standard (EN 302 307). Adaptive transmission to overcome variations in channel characteristics (e.g., rain fade) can be implemented in both the forward and return links.

The DVB-RCS return link or uplink to the satellite utilises a multi-frequency Time Division Multiple Access (MF-TDMA) transmission scheme. This form of scheme enables the system to provide high bandwidth efficiency for multiple users. A key to the high efficiency of the system is the demand-assignment scheme which uses several capacity mechanisms to allow optimisation for different classes of applications, so that voice, video streaming, file transfers and web browsing can all be handled efficiently.

DVB-RCS supports several access schemes making the system much more responsive, and thus more efficient, than traditional demand-assigned satellite systems. These access schemes are combined with a flexible transmission scheme that includes turbo coding, several burst size options and efficient IP encapsulation options. These tools allow systems to be fine-tuned for the best use of the power and bandwidth satellite resources.

The user terminal offers an Ethernet interface that can be used for wired or wireless interactive IP connectivity for a local home or office network ranging from one to several users. In addition to providing interactive DVB services and IPTV, DVB-RCS systems can provide full IP connectivity anywhere there is suitable satellite coverage. As most of the satellites that can provide DVB-RCS are likely to be geostationary, this effectively means anywhere closer to the equator than either 80 degrees north in the Northern hemisphere or 80 degrees south in the Southern Hemisphere.

Beyond the basic hub-and-spoke architecture, the DVB-RCS air interface has also been deployed in systems that provide direct terminal-to-terminal "mesh" connectivity, either through satellite on-board processors that mirror the functions of a ground-based hub, or through transparent satellites, using terminals equipped with an additional demodulator.