Will Broadband TV shape the future of broadcasting?

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Broadband Television (BTV) [1] is a new emerging platform for distributing digital television channels to home consumers using a TV screen.

This article focuses on BTV services which use the conventional telephone infrastructure (i.e. twisted-pair copper lines). These BTV services are often called ADSL TV or DSL TV. Other delivery mechanisms such as coaxial cable, power line communications (PLC), fibre (FTTH) and wireless (UMTS, Wi-Fi and WiMAX) are not covered here.

If commercially successful, Broadband TV may complement traditional DTV services – which use satellite, cable and terrestrial delivery – and may even evolve into a *fourth mass-market* platform for digital television services.

Many telcom and cable operators are in the process of trialling BTV infrastructure and expecting that it could evolve into the next emerging market of 2005 and beyond. Some initial experiences show that the technology is quite mature, the business models potentially sound and the prospective subscribers enthusiastic. Some market analysts even anticipate explosive growth of the broadband television market.

This article attempts to provide some background to BTV developments in Europe and outlines the principal areas of interest such as: (i) the current status of BTV trials, (ii) issues relating to the network and media technologies used, (iii) some content-related issues and, last but not least, (iv) some regulatory matters.

Background

BTV makes use of a television set rather than a PC. There are multiple commercial reasons for this. First of all, TV sets are much more popular domestic appliances than PCs. Today there are about 1.3 billion TV sets worldwide. Secondly, TV is still considered a central home entertainment device for watching films, sports, news, etc. Television is now moving rapidly towards digitization (currently

1. In this article we use the term "Broadband Television", or BTV for short, to denote the linear (“live”) and/or non-linear (“on-demand”) digital television services delivered over IP-based broadband networks in a controlled manner, using dedicated devices such as an STB and a normal TV set (as opposed to a PC). As Internet Protocol (IP) networking is used, BTV is often termed “IPTV”.

with about 18% average annual growth) and some 250 million digital TV households are predicted worldwide by 2008.

While it is true that TV is one of the most important devices in people's lives, it is today an unconnected island of technology in the home. BTV, together with home networking, may bring TV into the networked world, based on Internet Protocol (IP), so that programmes become available on other wired and wireless devices in the home (PCs, mobile phones, PDAs, etc.).

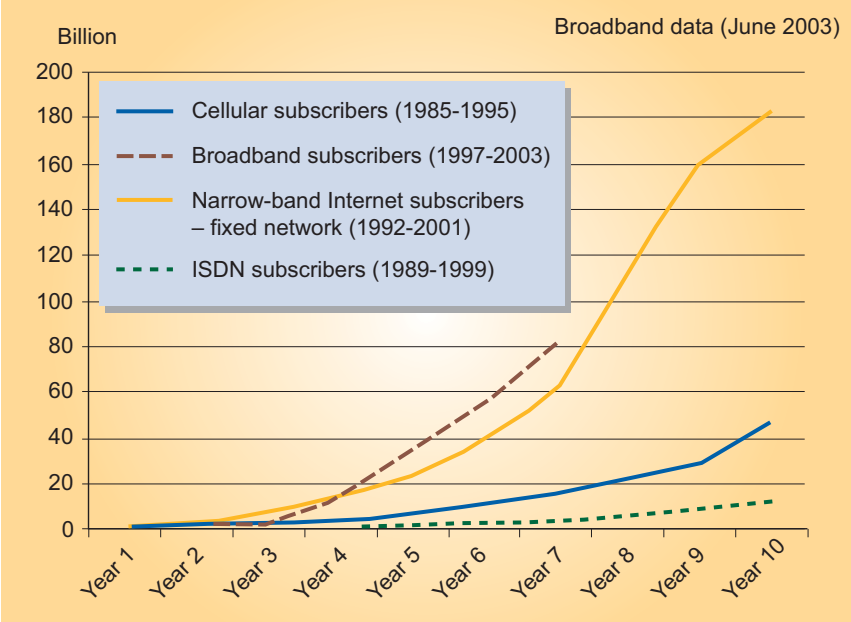

Figure 1
Broadband take-up over 10 years in the OECD compared with other services *(Source: OECD)*

BTV services are now being added to residential broadband offerings but they are probably not sufficient on their own to make consumers pay for broadband. However, adding BTV to the current broadband Internet offerings may attract new customers and so accelerate the take-up of broadband. Broadband is likely to become a vehicle not only for accessing the Internet and to have cheaper VoIP telephony calls but also television services and VoD. Although dedicated terminals are currently used for providing communications and Internet services, experience from trials indicates that there is a wide range of other services that users will wish to access via their TV sets.

Fig. 1 shows that the rate of broadband take-up is relatively fast in the OECD countries, when compared with narrow-band Internet, mobile phones and ISDN services.

Interest in BTV has increased significantly over recent years, as it is seen by many telecom operators as a means of driving revenue growth and compensating for the decreasing revenues in fixed telephone services (voice telephony). Market analyst, Datamonitor, believes that around 15 million households will be accessing BTV services by the end of 2007 – a significant increase over the 1.1 million homes accessing these services at the end of 2004. It is predicted that the revenues will exceed $7.5 billion in 2007 [1].

Some technical details of BTV are given in *Appendix A*. A comprehensive consideration of non-technical matters is given in EBU document BPN 064 [2].

Main BTV features

BTV may be commercially most successful in built-up urban areas that cannot get good satellite reception and where DTT services are hampered by poor coverage or high interference levels. In many apartment blocks there are no cable or integrated reception systems, so the only possible way of getting television is via phone lines.

BTV has been designed to provide normal digital quality ("broadcast quality") television services. However, since these services are delivered over IP networks (which are bi-directional by nature, with an always-on back channel), BTV means not only live television but also interactive television and on-demand television. Audiovisual content and associated metadata can be delivered either in the same stream or in separate streams.

Telecom operators have been traditionally interested in providing communication services (connections) between clients. Now their role is being expanded to provide the so-called ***Triple Play***

offering which consists of three parts:

- communication services (including VoIP in the near future);
- a high-speed Internet connection;
- IP-based television and video-on-demand services (i.e. Broadband TV).

For the first time the telecom companies are faced with a need to provide ***content*** to the user. The word "content" may mean a variety of different media applications that the user can enjoy:

- ***Interactive services:*** User interface, programme guide, interactive gaming, e-government services, targeted advertising, personal video recorder (networked), videoconferencing.
- ***Interactive television (iTV):*** Non-linear TV, time-shifted TV, and PVR services (with a user capability of significantly influencing the flow and rendition of the programme, e.g. selection of camera viewing angle, choosing ancillary information, using trick mode, etc.).
- ***On-demand television (VoD):*** Delivery of films and other programme items, available on-demand individually to each subscriber – either as continuous streams or downloadable files (in the case of local PVRs).
- ***Near-VoD:*** Same film is available on different channels, starting every 10 (say) minutes.
- ***Scheduled VoD:*** A film distributed to a group of users/PVRs, possibly overnight when there is less network traffic.
- ***Video podcasting:*** Audio podcasting is being trialled by some radio broadcasters for programme delivery over the Internet (e.g. the BBC). This type of service allows users to subscribe to an RSS [2] feed to receive regular mp3 audio updates. Similar on-demand services can be made available for popular films and videos that can be pushed from a service provider's server to a user's PVR-enabled STB, played instantly upon request and transferred to a portable device.
- ***"Broadcast" digital television:*** Multi-channel linear (live) television services, broadcast in accordance with a published programme schedule and viewed on a TV set.

As telecos are beginning to enter content-related markets, they may experience many problems which are new to them. For example, they may have difficulties in gaining access to certain content produced by third parties. There are also problems relating to re-purposing, re-packaging and protecting the content. Broadcast rights issues are often a big concern. And finally, there are significant issues relating to coping with the financial aspects of content.

The bandwidth problem

One of the main issues concerning broadband services delivered over the telephone network is their reach (coverage area). Generally, the higher the bitrate of the signal distributed, the lower is the reach of the service. As the bandwidth required for minimum TV quality is relatively high (normally between 2 and 4 Mbit/s in the case of MPEG-2 video) when compared with broadband internet, the TV reach is more limited than the current reach of broadband internet connections. The operators can handle this problem in different ways. They can reduce the TV quality to a minimum level by reducing the bitrate but retaining the coding technology (such as MPEG-2). They can upgrade their networks by introducing more efficient transmission technologies (e.g. ADSL2+ or even VDSL) but these upgrades require significant investment and time. In the near future, operators will also be able to use more advanced encoding schemes such as AVC/H.264 or VC-1 which are estimated to achieve the same subjective video quality at only 50% of the bitrate required by MPEG-2.

The limited capacity of the DSL access network, often limited to 1 Mbit/s or below, is the principal constraint for the introduction of HDTV, as the latter typically requires more bandwidth than standard

2. RSS stands for RDF (Resource Description Framework) Site Summary, Rich Site Summary, or Really Simple Syndication. It is an XML-based format that allows web developers to describe and syndicate web site content.

definition TV (SDTV). The use of advanced coding schemes may help ease this problem. The bandwidth problem becomes even more severe if more than one TV stream to the home is required. Such a need may arise if there are a number of TV sets in a house (e.g. one in the living room and another in a child's bedroom), each requesting a different TV programme at the same time. More than one TV stream is also required if there is a local PVR – one stream can be recorded locally while another is being watched.

BTV vs. Internet streaming

In order to ensure sufficient picture and sound quality, BTV services require a reliable network with a robust Quality-of-Service (QoS) mechanism. The required QoS can only be met by providers that are able to control all elements of the transmission path from the source through to the user's premises – including content resource management, network resource management, system provisioning, system availability, portal management, conditional access systems, etc.

It should be pointed out that ***open Internet*** is not able to offer BTV services, as it cannot guarantee QoS. In addition, streaming over open Internet would require some technical measures that address piracy, spoofing [3] and network congestion.

Table 1 – Differences between closely-controlled BTV and open Internet video services

	Broadband TV	Internet video streaming
Footprint	Local (limited operator coverage)	Potentially supranational or worldwide
Users	Known customers with known IP addresses and known locations	Any users (generally unknown)
Video Quality	Controlled QoS, "broadcast" TV quality	Best effort quality, QoS not guaranteed
Connection bandwidth	Between 1 and 4 Mbit/s	Generally below 1 Mbit/s
Video format	MPEG-2 MPEG-4 Part 2 MPEG-4 Part 10 (AVC) Microsoft VC1	Windows Media RealNetworks QuickTime Flash, and others
Receiver device	Set-top box with a television display	PC
Resolution	Full TV display	QCIF/CIF
Reliability	Stable	Subject to contention
Security	Users are authenticated and protected	Unsafe
Copyright	Media is protected	Often unprotected
Other services	EPG, PVR (local or network)	
Customer relationship	Yes; onsite support	Generally no
Complementarity with cable, terrestrial and satellite broadcasting	Potentially common STB, complementary coverage, common metadata	Pre-view and low-quality on-demand services

Table 1 shows some additional differences between the BTV services provided by telecom operators and the video streaming provided over the Internet.

3. Spoofing is the creation of TCP/IP packets using somebody else's IP address. Routers use the "destination IP" address in order to forward packets through the Internet, but ignore the "source IP" address. That address is only used by the destination machine when it responds back to the source.

Broadband customers expect these services to be available anywhere in the home and on multiple devices. Home gateways and local networks are the enablers of this. As BTV is part of the Triple Play offering, it too must be available anywhere in the home and on multiple devices. In order to provide for this flexibility, comprehensive end-to-end solutions – that help to acquire, protect, manage, promote and distribute these BTV services around the house – are required.

Example: Microsoft IPTV

Microsoft TV IPTV Edition [3] provides the infrastructure and technology partnerships to enable multimedia delivery throughout the home *(see Fig. 2)*. The system contains the following elements:

Content Acquisition
- integrated with encoders
- content packaging tools

Content Protection
- encrypted content
- Windows Media DRM

Service Management
- EPG
- notification
- OSS/BSS (operations and business support services)

Subscriber Management
- billing events
- subscriber validation
- subscriber management

Service Delivery
- VoD
- PVR
- Broadcast TV
- NPVR

Service Consumption
- STB client
- PC client
- consumer devices

The Microsoft TV IPTV system uses a multimedia programme guide, where all the content – broadcast, on-demand, DVR, digital music channels, etc. – is integrated into a single, fast and appealing user experience. The system supports transparent overlays and smooth cinematic fades and transi-

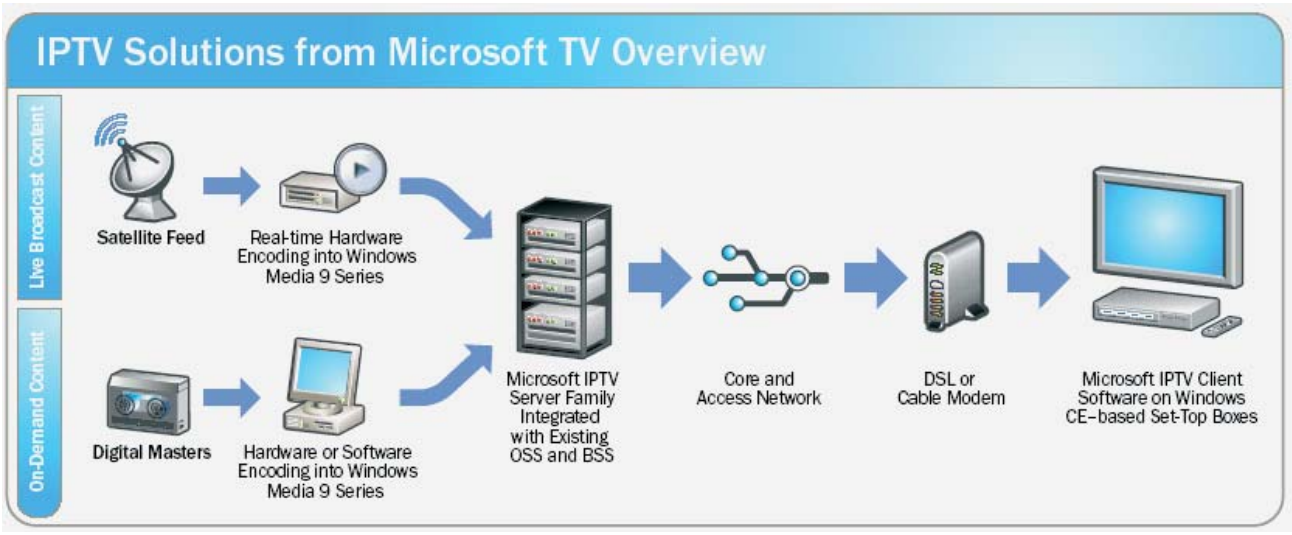

Figure 2
Integrated BTV solution from Microsoft *(Courtesy: Microsoft)*

tions, tunerless picture-in-picture (PiP), as well as a Microsoft technology called *Instant Channel Changing* for tuning to either full-screen TV or picture-in-picture almost instantly. PiP can be delivered in conjunction with the full-screen guide overlay (the full screen video and audio are visible in the background) and within the mini guide.

Current BTV deployments – some examples

Broadband Television is being driven mainly by the telecom operators. They started their business with just telephone services, extended them to data services and are now starting to offer television services [4]. Following several experiments towards the end of the 1990s, a breakthrough was made in 2000 by Fastweb in Italy. Currently, several experimental and operational services exist in France, Germany, Italy, Spain and the UK. The most advanced BTV country is France with six projects being implemented or considered in the forthcoming months. The French operator Neuf Telecom counted 440'000 internet subscribers at the end of 2004, from which only 10'000 subscribed to TV services. The plan is to increase this number to 100'000 by the end of 2005.

There now follows a brief review of the major BTV trials and services operating in Europe.

Fastweb (Italy)

Italy is a country with practically no cable TV, so BTV has found a fertile ground. Fastweb was the first Triple Play operator in Italy and is operated by e.Biscom. VoD trials started from the year 2000 onwards, jointly operated by e.BisMedia and RAI Click *(see the next section)*. In August 2003, multicast TV broadcasting started, providing several football channels to some 60'000 subscribers. Today, BTV services are available in some 160'000 homes and the total number of Fastweb customers is more than half a million in eight major Italian cities: Bari, Bologna, Turin, Genova, Rome, Naples, Milan and Venice. Both fibre-to-the-home (FTTH) and ADSL are used. The former accounts for 20% of customers and the latter, 80%.

Milan, a major Italian city, is 100% FTTH. The commercial service offer is very diverse and includes Triple Play. Phoning between Fastweb clients is free of charge. Fast Internet has a speed of 10 Mbit/s if a fibre connection is available. Live television channels (4 Mbit/s) include all the national channels (RAI, Mediaset, MTV, La7) and a selection of thematic and international channels (e.g. Music Box, Bloomberg, RaiNews 24, RaiSatSport, BBC World, TVE Internacional, TV 5 Europe, Disney, CNN and Cartoon Network). Pay-TV options include Cinema Sky, Sport Sky and Calcio Sky. Due to the high popularity of football in Italy, there are thematic channels dedicated to three famous Italian football clubs: Milan, Inter and Roma (each costing €8 per month).

From 2002, Fastweb has offered VoD services containing more than 5000 titles. The *OnTV* service contains on-demand family-type programmes covering films, sports, children's programmes, music, lifestyle and documentaries, as well as games, T-commerce, interactive areas and interactive advertising. Another on-demand service is Rai Click *(see the next section)*. The EPG service offers a picture-in-picture preview and scheduling information. Some interactive TV services are also included: GiveMe5 Quiz game, Mini BMW and interactive films.

Fastweb uses extensive customer profiling services such as targeted banners and videos. Detailed data reports on service usage are obtained in order to design a better product. Fastweb has also created a Customer Care online service.

Among the Fastweb communications services, we should mention TVcam, Multi-party video conferencing, video messages, video galleries and Chat & Forums.

4. It should be pointed out that cable operators in some countries are also able to offer BTV services. Cable operators however started their business with television services, extended them to data services and are starting now to offer phone (VoIP) services. Triple Play is also of key importance to cable operators.

RAI Click (Italy)

RAI Click was the first VoD television service in Italy [4]. It was born from a partnership between state broadcaster RAI and the broadband operator, Fastweb. RAI Click is responsible for the content, content management, content packaging and also for customer management. The distribution of RAI Click services (over ADSL and fibre networks) to the end user is in the hands of Fastweb. Today RAI Click is the first channel to be present on both broadband television (using a TV set) and broadband internet (using a PC). For TV users, more than 3500 on-demand programmes are available (1500 programmes are available on the web). All programmes are produced by RAI and they cover many areas including sports, news, movies, fiction, cartoons and magazine programmes on food, travel, science, history, etc. All of RAI's programme archives are available on RAI Click. In addition, all of RAI's broadcast programmes are available on RAI Click – but with a delay of half an hour after the broadcast has ended. From April onwards, a new RAI Cinema channel will also be available.

RAI Click is a test bed for interactive programmes and games. In March 2003, the first interactive TV programme – on the occasion of the Sanremo song contest – was performed: 39% of viewers were able to send in their votes. In September 2003, a talk show using a TV camera in every home was tried for the first time and has been continuing ever since. From March 2002, RAI Click has used interactive advertising. Also very effective is a T-shopping service. RAI Click uses a Data-WareHouse (DWH) system which continually records consumer behaviour, including their page impressions and the videos they are playing. This enables an early editorial or commercial response if user demand is sufficiently high.

Free (France)

Free started in December 2003 and is operated by Internet Free. The coverage areas are in Paris and Lyon only, at this stage. The service offers Triple Play (including a 2 Mbit/s internet connection and a BTV service using MPEG-2 coding at 3.5 Mbit/s). But there is no VoD, no picture-in-picture and no network storage. A new Freebox model which includes Wi-Fi was introduced at the end of 2004. Subscribers only pay for telephone and internet charges (€29.99/month) – the basic BTV service (including a Freebox) is offered for free. More than a hundred TV channels, including France 2, 3 and 5, TV5 Monde, Arte and Euronews, are available. 25 of the channels are free of subscription charges while others are paid for individually or come in a package (bouquet). An EPG is provided together with a TV Listings magazine. Up until March 2005, about 200'000 Freeboxes had been distributed.

MaLigne (France)

France Telecom (FT) operates MaLigne which is an IPTV service using ADSL [5]. It is available in several main cities across France. It started in December 2003 by delivering two multiplexes (bouquets) of live television channels: TPSL and CanalSatDSL. In addition a VoD service has been launched on this platform, operated directly by France Telecom. It delivers films and TV content on demand.

At the moment, the system uses MPEG-2 coding and the MPEG-2 Transport Stream. FT plans to introduce H.264 (AVC) coding at the end of this year, initially for the VoD services. The main reason for this is that VoD does not require real-time encoding, so that two-pass encoding can be used, yielding higher picture quality. MPEG-2 and H.264 will be used in parallel for a number of years. However, these two services will be differentiated by their relative picture quality and subscription fees.

During the first half of 2006, HDTV services (using H.264 coding) may be launched. A call for proposals has been issued for consumer manufacturers to produce and manufacture low-cost IPTV

STBs using H.264 decoders. The deployment of HD services is linked to the use of ADSL2 broadband networks.

Today, FT's IPTV services are characterised by two main features:

- enhanced PVR (allowing one programme to be watched while recording another one);
- multiple viewing (concurrent TV viewing on two or more set-top boxes).

It should be pointed out that H.264 is being actively pursued by France Telecom. As H.264 reduces the bandwidth of the signal (by a factor of 2, compared with MPEG-2 for the same quality), the customer reach can be extended considerably.

FT plans to deploy the ***DVB SD&S*** system for service discovery and selection of services.

HomeChoice (UK)

The HomeChoice BTV service is operated by Video Networks in North London, which was set up about a decade ago. Today, its broadband connections are available to 1.25 million London homes and it has 15'000 BTV subscribers. The total investment to date is over £250 million. The HomeChoice offering includes free telephone calls, an "always-on" high-speed internet connection at 1 Mbit/s, digital television channels and on-demand movies. These services are delivered to PCs and TVs, via a small stylish STB, over BT phone lines.

The TV offering includes BBC channels, Paramount Comedy, Discovery and Eurosport. There is a selection of on-demand TV channels such as C-One (which features some of the best recent TV hits from the USA and UK). There are hundreds of new film releases and V:MX music channels covering a range of music genres including hits, pop, urban, easy and dance channels. You can even create your own playlist. There is also "Scamp" – the new kids channel. With a Personal Identification Number (PIN) issued to each member of a household, it is possible to control the viewing. The costs are £35 a month plus £1 for the installation. The STB is free.

Swisscom/Bluewin (Switzerland)

Following extensive trials over several months, Swisscom plans to launch commercial BTV services in the second half of 2005 in several Swiss cities. Currently, the Bluewin trial *(see Fig. 3)* features thirty live TV channels (including four public television channels, 21 FTA channels and five pay-TV channels), teletext, video-on-demand, an EPG service and PVR functionality (with time-shift). One of the objectives of the trial was to assess market acceptance of such a service and to identify the key factors that differentiate it from cable offerings.

The results of the Swisscom/Bluewin TV trial are very interesting and are summarized in the text box on the next page [5].

As a first step in entering the media entertainment domain, Swisscom commercialized a ***Bluewin TV 300*** service in April 2005 [6]. It is essentially an EPG service associated with a local 160 GB PVR box, allowing the user to record up to 200 hours of TV programmes. One of the interesting points which differentiates this service from a dedicated DVD/HDD recorder (such as the LiteOn 5045) is that it is possible to set a recording via a website **www.tv300.bluewin.ch** – but, at the moment, it takes 40 minutes for the command to reach your personal recorder !

5. Please note that these results are very much preliminary and will certainly be improved before regular services are to be launched.

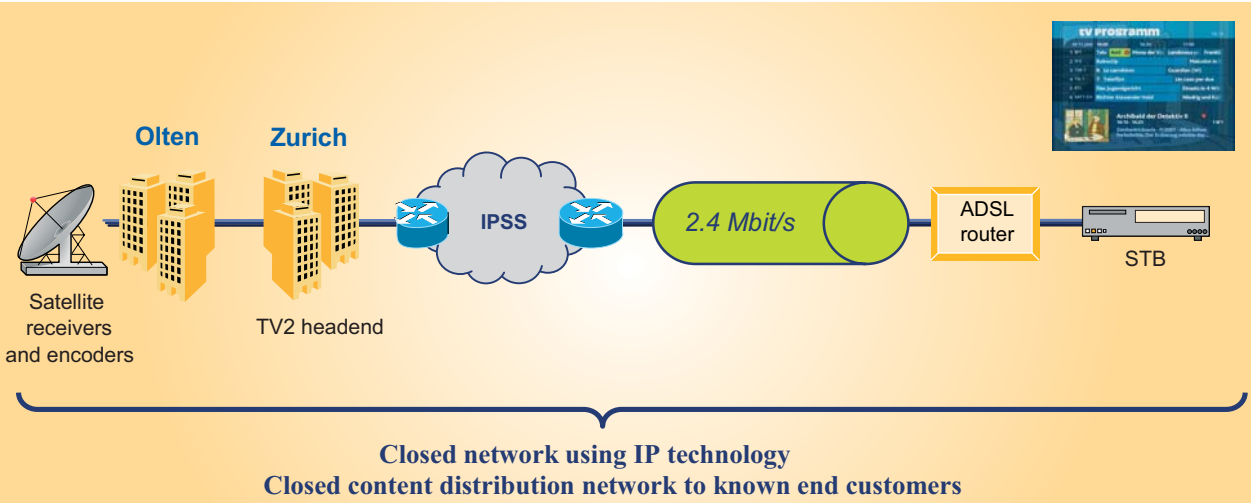

Figure 3
Bluewin TV experimental set-up *(Courtesy: Swisscom)*

Bluewin TV trial – report summary

Set-up

- About 60% of users were not able to perform installation by themselves and needed to call upon the Customer Care service, online support or friends.
- Set-up time: average 90 minutes, more than half needed less than one hour.
- Instruction menus and operational manuals were judged good.

User-friendliness

- All functions considered useful.
- Most interest in Free TV services - 92%.
- Very low interest in Pay TV - 3% and VoD/PVR - 5%.
- Zapping time is satisfactory – below 1s.
- Many complained about the STB crashing very often.
- Some complained that it was not possible to jump back and forth between two channels.

Comparison with cable TV

- Most users preferred cable TV for picture and audio quality, and the choice of programmes.
- Some complained about the poor quality of sport broadcasts on BTV and preferred cable TV.
- Users complained about fan noise produced by the STB's ventilation system.

General users' remarks

Most participants in the trial found the service attractive and the user interface easy to use: they would consider subscribing to the service (and recommending it to family and friends). However, they would expect the main problems to have been addressed and obvious bugs removed. In particular, the system should be able to record one programme while watching another one. Many would give priority to competitive service pricing and were concerned by the lack of key local TV channels, lack of radio channels and the fact that teletext was not present on all TV channels. They also urged the service provider to enable programme recording based on VPS codes.

International standardization efforts

BTV is a relatively recent development and its technologies are not yet fully mature and proven. Today BTV operators are introducing different proprietary industry solutions which prevents full interoperability of the user equipment and software. Specifically, a modem provided by one operator cannot generally be used by someone who subscribes to another operator. In particular, there is no

standardization in the BTV middleware platforms [6]. Most current platforms use a restricted HTML set for the presentation layer. Some other platforms can interpret XML code and display them in a certain styling. However, these solutions are not compatible, as they use different approaches for the procedural and interactive components.

There are areas of BTV that have not yet been standardized internationally. In fact, different BTV aspects are being considered by a number of international bodies, making coordination a major problem. This section identifies the organizations involved in the international standardization work and reviews the principal results of their efforts.

DVB Forum

DVB is probably the most important international body that is developing technical specifications for BTV. The central working group is ***CM-IPTV*** which is in the process of putting together the commercial requirements for BTV and providing some strategic implementation guidelines to DVB Members. One of the most valuable outputs of the group is a document entitled *Commercial Requirements for a Broadband Content Guide (BCG)* [7] [7]. This document provides information on content items and their format. Content may be available over a bi-directional IP network, either "now" or scheduled for some time in the future. It is of particular interest to broadcasters and service providers, as they may use it to define a data and transport model for content information about their broadcasts and on-demand services. BCG may provide information about the content (title, artists, actors, director, copyright owner, programme synopsis, etc) and information relating to the picture format, coding format, availability and access rights. Some organizations may wish to provide only part of the entire data set. Independent third-party organizations that specialise in metadata may offer additional metadata services such as users' ratings and the results from opinion polls.

The BCG is intended to complement the DVB Service Discovery and Selection (SD&S) function; the two functions should be used together in a cohesive way. SD&S has already been defined by DVB in document CM-IPTV 014 [8]. Service discovery is about discovering new services (for example, TV channels) and providing sufficient information about them for the user to make a choice ... and for the home network device to find and access the chosen service or channel. In addition to live broadcasts, BCG supports on-demand services, downloadable media and combined broadcast/broadband services. Service discovery and BCG may or may not be provided by the same organization that provides the media itself.

The ***DVB TM-IPI*** (IP Infrastructure) group has produced a specification for the carriage of digital TV services over broadband IP networks which has been submitted to ETSI [9]. The scope of the current specification (i.e. Phase 1) is restricted to MPEG-2 encoded content carried over an MPEG-2 Transport Stream which, in turn, is carried over IP. The IPI Group plans to extend the Phase 1 specification to allow for carriage of H.264/AVC and other formats according to ETSI TS 101 154 [10]. The future Phase 2 specification will eliminate the MPEG-2 TS entirely and put media content directly onto the IP layer.

The DVB Project is also heavily involved in the home networking area, where wired (e.g. IPTV) and wireless networks will need to be set up and used seamlessly [11]. The interface to a residential home gateway – using remote configuration and management – needs to be specified. By the same token, DVB is concerned with the content security and digital rights management (DRM) issues relating to IPTV access and home networks. The ***DVB-CPCM*** group is studying these matters.

6. Concerning the presentation software used in Broadband Television, the situation resembles the one used in conventional television where several different systems are being used (MHP, OpenTV, MediaHighway, MHEG-5, etc.).

7. Functionally, BCG is the same concept as the more conventional EPG – Electronic Programme Guide.

Digital Living Network Alliance (DLNA)

This is an industry alliance consisting of more than a hundred consumer electronics, PC and mobile device companies who are working together to develop standards for interoperable IP-networked platforms and devices for the all-digital home. The *Home Networked Device Interoperability Guidelines* [12] fulfil that role. This specification does not propose any new standards but achieves interoperability between connected digital media devices in the home by using the existing IEEE, W3C, ISO, UPnP, IETF and ETSI standards.

Networking and connectivity is based on Internet Protocol (IP) and HTTP. Device discovery and control is based on UPnP, which enables a device on a home network to automatically self-configure the networking properties (such as an IP address) in order to discover the presence and capabilities of other devices on the network and to collaborate with these devices in a uniform and consistent manner. UPnP is used also to identify, manage and distribute media content between home network devices such as STBs, DVD players, storage devices, cameras and PCs. The UPnP AV specification defines two types of devices on the home network: *MediaServers* and *MediaRenderers*. All interactions between these devices occur via UPnP control points. The present DLNA specification (version 1.0) only supports interaction scenarios between UPnP MediaServer devices and control points. Future versions may also support interactions involving MediaRenderers.

DVB and the DLNA Forum have recently started discussions aimed at harmonizing their different technical approaches. Emphasis will be given to issues about carrying DVB services in the DLNA home network, and how these services can be discovered and selected by DLNA devices.

DSL Forum

This is an industry consortium of more than 200 telecom, consumer electronics, computer, networking and service provider companies. It was set up about 10 years ago to drive the global mass market for DSL broadband services over existing copper telephone wire infrastructures. This body works on the standardization of broadband technologies such as ADSL, ADSL2plus, SHDSL, VDSL, VDSL2 and others. The outcome of this work is published as Technical Reports that are available from the Forum's website [13]. The Forum's activities are conducted by separate Technical and Marketing working groups. More than seventy technical reports are freely available from the website. The DSL system architecture is IP-centric. Currently, there are more than 100 million DSL users worldwide.

DVB and the DSL Forum recently established a liaison to discuss areas of common interest.

Opportunities and challenges of BTV

Telecom companies are making huge efforts to explore new ways to earn revenues. Broadband TV is seen as one way of doing this. Together with voice (telephone) and broadband Internet, operators can now offer Triple Play, which helps them to retain their existing customers, acquire new ones and thus reduce the "churn rate".

Operators must have in place a functioning operational support system (OSS), a customer care service and a billing system which make sure that all the services work as planned and that access to them is provided subject to appropriate payments. An OSS is fundamental to smooth and effective operation of the whole system; it should execute and perform a variety of management functions relating to service procurement, service assurance, network inventory, network topology, diagnostics and maintenance. It is important that the customer care service should be flexible enough to be able to accommodate new services and applications that may emerge even beyond Triple Play. If an integrated operational support and billing system is used for all services offered, this should reduce the operational costs and revenue leakage while increasing customer satisfaction; for example, by providing a single bill that covers all the services provided.

Abbreviations

ADSL	Asynchronous Digital Subscriber Line
AVC	(MPEG-4) Advanced Video Coding
BAS	Broadband Access Server
BCG	(DVB) Broadband Content Guide
BTV	Broadband Television
CIF	Common Intermediate Format
CPCM	(DVB) Content Protection and Copy Management
DLNA	Digital Living Network Alliance http://www.dlna.org/home
DMT	Discrete Multi-Tone
DRM	Digital Rights Management
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
DTT	Digital Terrestrial Television
DVB	Digital Video Broadcasting http://www.dvb.org/
DVB-CM	DVB - Commercial Module
DVB-H	DVB - Handheld
DVR	Digital Video Recorder
EPG	Electronic Programme Guide
ETSI	European Telecommunication Standard Institute http://pda.etsi.org/pda/queryform.asp
FTA	Free-To-Air
FTTH	Fibre To The Home
HDD	Hard Disk Drive
HDTV	High-Definition Television
HTTP	HyperText Transfer Protocol
IEEE	Institute of Electrical and Electronics Engineers (USA) http://www.ieee.org
IETF	Internet Engineering Task Force http://www.ietf.org/
IP	Internet Protocol
IPTV	Television via Internet Protocol
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization http://www.iso.org
ISP	Internet Service Provider
MPEG	Moving Picture Experts Group
NPVR	Network-based Personal Video Recorder
OECD	Organization for Economic Cooperation and Development http://www.oecd.org/home/
PDA	Personal Digital Assistant
PiP	Picture in Picture
PVR	Personal Video Recorder
QAM	Quadrature Amplitude Modulation
QCIF	Quarter Common Intermediate Format
QoS	Quality of Service
RBE	Routed Bridge Encapsulation
SD&S	(DVB) Service Discovery & Selection
SHDSL	Symmetric High bitrate Digital Subscriber Line
STB	Set-Top Box
STM	Synchronous Transport Module
SWOT	Strengths, Weaknesses, Opportunities, Threats
TCP/IP	Transmission Control Protocol / Internet Protocol
TVWF	(EU) Television Without Frontiers directive
UMTS	Universal Mobile Telecommunication System
UPnP	http://www.upnp.org/default.asp
VDSL	Very high bitrate Digital Subscriber Line
VoD	Video-on-Demand
VoIP	Voice-over-IP
VPS	Video Programme System
W3C	World Wide Web Consortium http://www.w3.org/

But making money is only one challenge. The other, even more far-reaching, challenge is to decouple the network infrastructure from the services and content. The main problems associated with the infrastructure are (i) meeting the increasing bandwidth demands, (ii) ensuring open standardization to facilitate development of horizontal markets and (iii), implementing all-IP technology solutions. The main problems associated with the service aspects are (i) the choice of services, (ii) how to market bundles of them and (iii), how to combat subscriber churn problems.

Depending on the relative commercial success of BTV and DTT services in a local or national market, it could be interesting to explore possible synergies between BTV and DTT in terms of complementary coverage, common sets of services and common set-top boxes. For example, DTT is generally capable of providing several high-quality television channels over a large area. The number of channels will vary from country to country and will depend on the spectrum available and the sharing constraints with other services. Whereas DTT covers the whole territory, reception indoors (within buildings) without external aerials may require excessive transmit power. In such cases, BTV could help and provide the same channels (plus any value-added services), so that both television platforms can be considered complementary.

The rationale for complementarity of BTV and DTT can work in the opposite direction as well; it is probably not viable to implement BTV services over a whole territory, as the number of DSLAMs required would be very large, and thus expensive. DTT could help, so that television services could be integrated into the broadband services offering.

A common set-top box for both DTT and BTV should be developed in order to enable this "synergetic" scenario to materialize. Example: Kreatel: IP-STB 1520. Another condition may be that both DTT and BTV should provide similar television services of comparable service quality, so that the end user does not notice any significant differences between the two platforms.

As a household may have two or three television sets, it is important that different channels can be displayed by these television sets at the same time. This can readily be achieved in broadcasting. However, in broadband, a special provision needs to be made to accommodate two or three simultaneous television streams in the access network.

Business models for BTV

In order to understand the business incentives behind the launch of BTV, it may be instructive to consider the situation in France. The launch of BTV via ADSL was engineered by two important organizations – the French commercial broadcaster, TF1, and the national telecom operator, France Télécom. TF1 launched the BTV services in order to complement (and enhance) their TPS (Télévision par Satellite) services in urban areas where satellite reception is less viable. France Télécom, on the other hand, wanted to boost the use of fixed lines by introducing TV over ADSL (as their business figures for voice communication have been in decline over recent years).

The second factor that contributed to the advent of BTV in France was a successful process of last-mile "unbundling" which potentially opens up competition between ISPs and drives prices down. All major geographical areas of France have been unbundled: Paris, Lyon, Marseille, Nice, Toulouse, Bordeaux, Lille and others.

The third factor was the sharp fall in equipment prices; DSLAMs, modems, coders and decoders are cheaper by a factor of 2 than two years ago.

When this article was being written, digital terrestrial television (DTT) was being launched in France. TF1 is also part of this effort but is convinced that, in the long-term (beyond 2010), ADSL and satellite delivery systems will dominate the French media landscape. TF1 says that DTT is simply too expensive to compete with ADSL in providing local coverage.

Network providers

Network providers gain most from BTV. They all have one main objective: to gain additional profits from BTV. As the telephone cable infrastructure is already in place, the investment costs are relatively low. Nevertheless, network providers have to invest in DSLAM equipment and other special network elements which enable BTV services. In order to provide authentication, authorisation and accounting (billing) services, each user connected through a DSLAM must have a connection to a Broadband Access Server (BAS). To facilitate this connection, the DSLAM can be connected to the BAS directly or via an aggregator to reduce the number of links to the BAS.

Payment models

The broadband environment can provide several ways for users to pay for the services offered. Users can choose the mode of payment that matches their needs and this helps to reduce churn. The most popular payment model today is a prepaid account, where users decide in advance how much they are willing to spend. More conventional models are monthly subscriptions or fixed-price sales. In order to increase revenues, operators offer attractive packages such as the bundling of services and bonus schemes. Bundles allow the segmenting of package pricing, so that users may choose a package that matches their expectations. Bonus schemes aim to increase consumption by offering higher bonuses.

Possible models for broadcasters

There are, or may be, opportunities for broadcasters and possible synergies with other players that should be addressed. For example, a broadcaster may provide TV/video content and package it, and may even act as a BTV service provider. In addition, broadcasters have extensive production facilities and can produce high-quality content (drama, documentaries, news, entertainment, etc.) or they could offer their archives as part of a BTV service.

User costs

Broadband is basically a “one-stop shop” that can deliver a variety of different services over a single transport infrastructure. BTV is just one service, among many others. The user cost model for broadband is similar to that of cable delivery. Generally, the user has to pay for the modem or set-top box, the access and the content packages. Often the user may benefit from paying one bill for a bundle of received services. Different countries have different payment arrangements but, in addition to a subscription for the broadband services received, the end user must also pay a separate licence fee for the public broadcaster's television services that must be carried by the BTV service [8] *(see “Must Carry” in the next section)*. Often a network fee is charged separately (example: T-Online).

Some regulatory matters

As BTV uses broadband connections, it is governed by the regulatory provisions surrounding the rollout of broadband. Countries follow different approaches to regulate broadband, ranging from the "light touch" to "cooperative" and the "government-led" approach. Countries which have adopted the light-touch approach take only small-scale actions to support broadband rollout. This is done by creating transparent regulatory frameworks that facilitate competition and access. There are no direct government subsidies. The cooperative approach involves some economic levers to support and encourage broadband rollout. For example, in the USA this has included direct subsidies and tax reductions. Direct funding of infrastructure expansion has been adopted in Korea, Japan and Sweden. The objective of these countries is to conduct comprehensive government-funded education and training programmes with explicit social and development objectives. Reforms of the regulatory structure, to ensure a competitive industry in broadband delivery, have been carried out.

As BTV is still in its infancy, the regulatory matters associated with it are not always being fully considered by the media / telecom regulatory bodies. For example, many countries are still discussing which authority should be entrusted to regulate broadband ***content***.

The EBU supports the distinction between network infrastructures and the content conveyed over such infrastructures – as a basis for future regulation [14]. Having different regulations addressing the infrastructure and content aspects should not, however, be interpreted as being a complete separation of both. Coordination of the regulatory frameworks is needed to take account of the many links between content and transport, particularly as far as access to content is concerned. The regulation of communications infrastructures must ensure that networks continue to fulfil their vital function in the distribution of audiovisual media and other content services.

In a number of countries, TV channels are subject to regulatory constraints relating to content, child protection and a mandate to support original and sometimes local production. To this end, if we

8. The licence fee is the essential form of funding for public service broadcasters in most European countries; the obligation to pay the licence fee is laid down by law. In certain countries, the requirement to pay this fee is linked to the possession of reception equipment (a radio or television receiver). In the view of the EBU Legal Department, the obligation to pay the licence fee should, in principle, be independent of the transmission means and reception technology used, but attention should be given to the concrete wording of national licence fee conditions.

perceive the telephone network as a "broadcasting" network, it should be addressed just like cable or satellite (a channel is a channel, regardless of its broadcasting mode).

Generally speaking, then, should BTV be regulated by a telecom regulator or by an audiovisual regulator? Making homogenous rules for content, regardless of transmission platform, represents a key issue whose evolution will differ from one country to the next.

The EU *Television Without Frontiers* (TVWF) Directive stipulates that television channels (public and private) are subject to a certain number of rules relating to the content of programmes in terms of, for instance, the protection of minors, advertising, sponsorship and promotion of European works. The development of DTV and new interactive audiovisual services raises the question of whether the current scope of the Directive and the definition of television broadcasting are still adequate. The current EU regulatory framework makes a distinction between television broadcasting services (covered by the Directive) and information society services supplied on demand (covered, in particular, by the EU's e-commerce Directive).

In comparison with the TVWF Directive, the e-commerce Directive is a much lighter framework. At any rate, the present definition of television broadcasting in the *Television without Frontiers* Directive is too narrow to deal with new developments such as BTV. It will be a major challenge to create a regulatory framework for television broadcasting and new interactive television services that is as coherent as possible (it being acknowledged that this may include a graduated approach). Technological developments should not involve any changes to the public-interest objectives that have to be respected by all audiovisual services.

Must-carry

Must-carry rules are a crucial element in ensuring that all viewers continue, in the new technological environment, to receive at least some free-to-air services – no matter which platform they choose. Must-carry rules place an obligation on network operators to distribute certain radio and television channels whose purpose is to fulfil public-interest objectives for society. Under certain conditions – laid down in Article 31 of the EU *Universal Directive on the new regulatory framework for electronic communications networks and services* (adopted in March 2002) – Member States have the possibility of extending the must-carry rules beyond cable networks to cover other distribution platforms. Thus, the must-carry rules should also apply to BTV.

Copyright

Contrary to the open Internet services which are available to anyone with an Internet connection, broadband services (including BTV) are available only to a traceable (e.g. subscription-based) user base, usually located in a closed geographical area within a radius of a few kilometres. To this end, it is possible to limit access to broadband services within a given territory, which would meet the territorial constraints of certain copyright licences. While the streaming of copyrighted material (such as sports events or music) over the Internet may prove to be difficult or even impossible for legal reasons, broadband networks generally have much less difficulties with copyright matters, subject to successful negotiations between rights owners and broadband providers [9]. If there are simultaneous transmissions of broadcast television by broadband operators, this could be regarded – from the regulatory point of view – as analogous to cable transmissions, which implies that broadband operators should be responsible for clearing the necessary rights from all rights holders before they can use any TV channel on their distribution platform.

9. Broadband operators can relatively easily control the reach (coverage) of their services, as every user can be identified by an IP number. The service coverage is usually limited to a specific geographical area and, therefore, the risk of rights infringement is minimal when compared with conventional broadcasting where "technically unavoidable overspill" may imply some uncontrolled access to the content.

Digital Rights Management (DRM)

Copy protection mechanisms may include more or less sophisticated usage control systems. DRM, for example, can allow users to view a movie once, a number of times or indeed without any limitations during a specified period, or for a lifetime. Users can purchase the right to create one or more copies. Allowing for a fine granularity of media consumption, DRM may become a tool for creating new pricing models. The decryption key is delivered upon request to the user through a secure interactive channel from a licence server. However, any DRM system must be acceptable to all stakeholders, including consumers.

Conditional Access (CA)

CA is a mechanism to protect media during its transport from the media server to the user. The use of CA on a BTV network is similar to that in conventional digital television (DVB).

Privacy

In traditional broadcasting, the end users remain anonymous. Broadband operators, on the contrary, can trace the usage of their services and assemble statistics of users' behaviour. This personal data should be suitably protected in accordance with the applicable laws and should not be misused for commercial or similar purposes.

Parental control

In DVB systems, a parental control signal is embedded in the signal, potentially to slow down zapping. In broadband, it is possible to prevent a TV item from being sent to a user who does not fulfil the required criteria. Thus, BTV can provide tighter parental control than conventional TV.

Tentative conclusions

In order to answer the question in the title of this article, we are tempted to claim: Yes, Broadband TV will shape the future of broadcasting. But the real question now is: *When and How?*

There is ample evidence that BTV is successfully moving from an experimental to a commercial stage and is here to stay. Its market share is still modest (compared to conventional broadcasting) but its development is fast indeed and it is likely to become a real mass-market service. The evidence so far shows that, in total, more than one million households have subscribed to BTV services.

It is now clear that BTV may not be successful as a stand-alone service. Rather, it will be viable as part of a bundle of different services which may involve high-speed Internet connections, video-on-demand, dual-mode telephony (mobile/VoIP) and perhaps DVB-H in the future. BTV may be used especially as a complementary service in areas where other delivery platforms such as cable, terrestrial or satellite are not technically possible, available or commercially successful.

Concerning its economic viability, it is evident that BTV implementation and operational costs are more expensive per user than those for conventional digital television services. However, telecom companies have no choice: they need to move further away from their traditional voice communications (telephony) which are losing money, and embark into media business. They must launch broadcast TV services if they wish to revive their Victorian-age telephone infrastructures and make them economically viable.

Franc Kozamernik graduated from the Faculty of Electrotechnical Engineering, University of Ljubljana, Slovenia, in 1972.

He started his professional career as an R&D engineer at Radio-Television Slovenia. Since 1985, he has been with the EBU Technical Department and has been involved in a variety of engineering activities covering satellite broadcasting, frequency spectrum planning, digital audio broadcasting, audio source coding and the RF aspects of various audio and video broadcasting system developments, such as Digital Video Broadcasting (DVB) and Digital Audio Broadcasting (DAB).

During his years at the EBU, Mr Kozamernik has coordinated the Internet-related technical studies carried out by B/BMW (Broadcast of Multimedia on the Web) and contributed technical studies to the I/OLS (On-Line Services) Group. Currently, he is the coordinator of several EBU R&D Project Groups including B/AIM (Audio in Multimedia), B/VIM (Video in Multimedia) and B/SYN (Synergies of Broadcast and Telecom Systems and Services). He also coordinates EBU Focus Groups on Broadband Television (B/BTV) and MultiChannel Audio Transmission (B/MCAT). Franc Kozamernik has represented the EBU in several collaborative projects and international bodies, and has contributed a large number of articles to the technical press and presented several papers at international conferences.

Lieven Vermaele earned an MSc degree in Engineering and Electronics at the University of Gent in 1998. Afterwards he broadened his knowledge in the fields of project management, economics and finance. After one year as a researcher at Intec (University Gent), he started his career at Tractebel (Suez Group) as a project consultant. In 2000 he was attracted by VRT and their digital roadmap. Since 2000, he has been intensively involved in and responsible for different technological, innovative and new media projects.

In 2003 Mr Lieven's focus shifted to the strategic domain, partly through his responsibility in Ratio 2007: the strategic management project that is preparing VRT for its digital future – internally, externally and with the government. Today, he is also charged with advising and realising the agreements between VRT and the network operators and following up the impact of market evolutions.

Differentiation from cable and Internet TV services is very important. In order to be successful, BTV operators should offer "more and better" services. One way is to offer more than one simultaneous stream to every home and to commence HDTV at the appropriate time. Technically there are no major obstacles, now that advanced compression technologies are readily available. This however implies a need for significantly more efficient distribution technologies: e.g. VDSL and ADSL2plus (ADSL2+). These advanced technologies in turn require more investment than conventional ADSL.

So far, most EBU Members have not been actively implementing BTV services – some Members have however been involved in developing particular aspects of the technical design (e.g. metadata, copyright, content repurposing). So far, several EBU Members have shown a keen interest in participating in the BTV trials in their own country ... but it is high time that other EBU Members became actively involved in local BTV developments.

It is probably too early to give a full appreciation of how important these developments will be for broadcasters. There are many open questions about whether or not the BTV business is sustainable in the long term:

- *What may be the role of broadband television within existing digital TV strategies?*
- *What are the main challenges for the BTV service providers and, most importantly, what are broadcasters expected to do about these new challenges?*
- *Which optimal models will allow fruitful collaboration between the telecom operators, television bouquet operators, public and commercial television broadcasters and content producers?*

There are many other open questions which require additional informed consideration by EBU Members.

In order to address these issues, the EBU Broadcast Systems Management Committee (BMC) established a Focus Group B/BTV (Broadband Television) in 2004. This group is chaired by Lieven Vermaele (VRT), a co-author of this article, and currently includes 29 members from 18 organizations including broadcasters, telecom operators and manufacturers. The group started to perform a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis [10], in order to be able to evaluate the merits of broadband television. The group has prepared a draft document entitled *Guidance to broadcasters concerning their strategy on rolling out Broadband Television services* which is now in the process of being discussed by the higher EBU bodies. For the reader's information, it is reproduced in *Appendix B*.

Acknowledgements

The authors would like to thank sincerely the members of the B/BTV Focus Group for all the support and contributions which enabled them to prepare this article. Thanks should also go to the EBU and VRT managements for allocating sufficient resources to running and managing the B/BTV Focus Group.

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Appendix A:
Some technical characteristics of Broadband TV

A BTV system *(see Fig. A1)* consists of a content network, a core network, access network and home network. The core network adapts all the media sources to the access network (also called the last-mile network) which brings the media to the end user. The access network may use several DSL (Digital Subscriber Line) technologies which differ primarily in their spectrum masks and the number of tones used for transmission in each direction. These technologies are steadily improving and new generations continue to be developed:

- ADSL;
- ADSL2;
- Reach Extended ADSL2 (READSL2);
- ADSL2Plus (ADSL2+);
- Very high bitrate DSL (VDSL).

  Two variants of VDSL have been standardized, based on single-carrier Quadrature Amplitude Modulation (QAM) and multi-carrier Discrete Multi Tone (DMT) modulation. DMT offers advan-

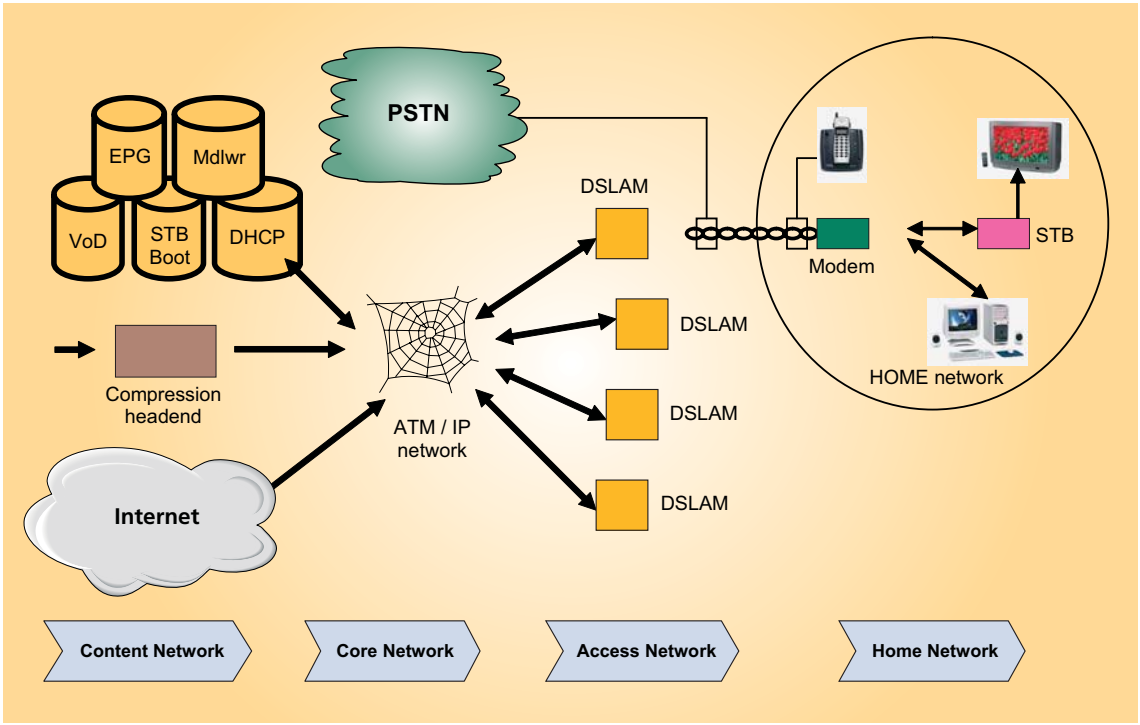

Figure A1
Conceptual diagram of a BTV system

tages over QAM in terms of performance, robustness to noise and spectrum flexibility. It also allows interoperability with ADSL.

An essential element of a BTV network is the Digital Subscriber Line Access Multiplexer (DSLAM). This unit is normally located at the local exchange and is used to concentrate the traffic on the last-mile network onto a higher carrier (e.g. STM-1) of the core IP network. IP-enabled DSLAMs, with built-in aggregation functionality, significantly reduce the required bandwidth in the core network, since IP multicast is used for TV channel distribution from the ISP head-end to the DSLAM. Thus, one TV channel is distributed to each DSLAM only once. For example, consider an ISP who delivers 30 TV channels to its subscribers. Assuming 4 Mbit/s per TV channel, a total capacity of 120 Mbit/s is required for the core network. This will fit into an STM-1 carrier (155 Mbit/s).

The number of TV channels that can be accommodated only depends on the capacity of the core network. The number of subscribers is limited by the unicast traffic allocated to each subscriber. Typically, up to 1000 subscribers can be connected to one DSLAM.

The use of IP multicasting is essential; without this, it would only be possible for about 35 subscribers to be connected at the DSLAM. This is because each user requires a 4 Mbit/s dedicated pipeline, between the DSLAM and the aggregation point, to carry the TV channel. To this end, the STM-1 carrier bandwidth becomes the limiting factor.

In addition to IP multicasting, the Routed Bridge Encapsulation (RBE) model is used with DSL video deployments. The RBE model implies that all packet forwarding is carried out at Layer 3: the IP layer. DHPTV relay forwarding, and auto-instantiation of routing table entries in the aggregation device, help to eliminate any potential issues with IP address allocation and routing.

At the customer premises, the copper pair is terminated in a DSL modem. This modem connects to the telephone and uses 10/100-Base-T Ethernet to the television STB or a PC.

The DSL network architecture can gracefully migrate towards other last-mile technologies without changing the core technology. One last-mile access alternative is Ethernet which is used in FTTH (fibre to the home) networks. In FTTH networks, the copper wire (linking the edge router with the subscriber's DSL modem) is replaced with optical fibre which allows for a symmetrical delivery of several Gbit/s to the end user. Thus, fibre can bring several dozen concurrent TV channels to the home, allowing for seamless switching between them.

Appendix B:
Draft Guidance to broadcasters on a strategy for rolling out Broadband TV services

This document was approved by the EBU Broadcast Systems Management Committee (BMC) in March 2005 and is now being submitted to higher EBU bodies for further discussion and adoption (if approved).

Considering that:

- Broadband television is an alternative possibility for the distribution of TV programmes
- Broadband networks are the fastest growing medium in the home
- Broadband television can deliver a wide range of services from linear, on-demand to interactive TV and totally new creative offers
- Broadband television will cause important changes in the media value chain

Broadcasters should undertake the following activities:

- Produce attractive (interactive) multimedia content – be strong in their content
- Make timely adjustments of their production suites and studios in order to generate interactive multimedia programmes and value-added services
- Establish a positive spirit of cooperation and mutual confidence with telecom operators
- Ensure the presence of their programming on all possible delivery platforms
- Avoid exclusivity deals
- Purchase the rights for all possible distribution channels and make strong long-term deals
- Maximize their relationship with the end user
- Encourage telcos to adopt open and non-discriminatory standards
- Request from the BTV operator all user (audience) data relating to their programmes
- Preserve the "must-carry" rule for public broadcasters

BTV is a great new opportunity for content providers and broadcasters ... but they will need to adapt themselves to produce new attractive content and applications.