

Broadcasters' requirements for

IPTV



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IPTV is not a well-defined term and may be a source of ambiguity and sometimes confusion. This article describes the basic building blocks in order to clarify the difference between “IPTV” and what is increasingly being called “WebTV”. A comparison between IPTV and the DVB transmission schemes for satellite and cable is also made, providing some insight into the similarities between these delivery systems but also revealing subtle differences.

The IPTV requirements for retransmitting live broadcast signals and on-demand services are outlined, and some approaches for meeting these requirements are discussed.

The penetration of households with broadband internet access and downstream data rates of several Megabit per second (Mbit/s) is making steady progress. For example, in Germany, the number of DSL households rose from about 7.6 million in March 2005 to more than 12 million in June 2006 [1], and is growing rapidly. Thus an increasing number of households are getting used to video streaming and download, using the Internet Protocol (IP) to enable interactive retrieval of video content (including TV programmes, either live or on-demand) from the Web. This type of IP video may be termed *WebTV*. WebTV is getting increasingly popular among the audience and many broadcasters have started to offer such services on their websites.

However, unlike conventional television, WebTV does not provide a guaranteed quality of service. Telephone companies are now making an attempt to overcome the deficiencies of WebTV and are launching so-called *IPTV*. The take-up of mobile communications and the resulting decline in telephony on fixed-line networks has stimulated the need for new revenue streams. IPTV is a new buzz word to fill the broadband networks with a compelling high-bandwidth application. Hype and short-lived expectations are not excluded. For example, not all of the above-mentioned DSL households will have access to IPTV, as the first phase of the rollout will concentrate on selected urban areas for upgrading the network.

What chances and what risks does IPTV pose to broadcasters? This article addresses the broadcasters' requirements for IPTV. But in contrast to the pay-services of commercial broadcasters, the focus here is on public service broadcasting in the emerging IPTV arena.

Building blocks for IPTV and broadcasting

Broadband telephone networks

IPTV is gathering momentum. One main driver is the technical developments taking place in telephone networks. That can be illustrated by the sharply increasing downstream data rates becoming

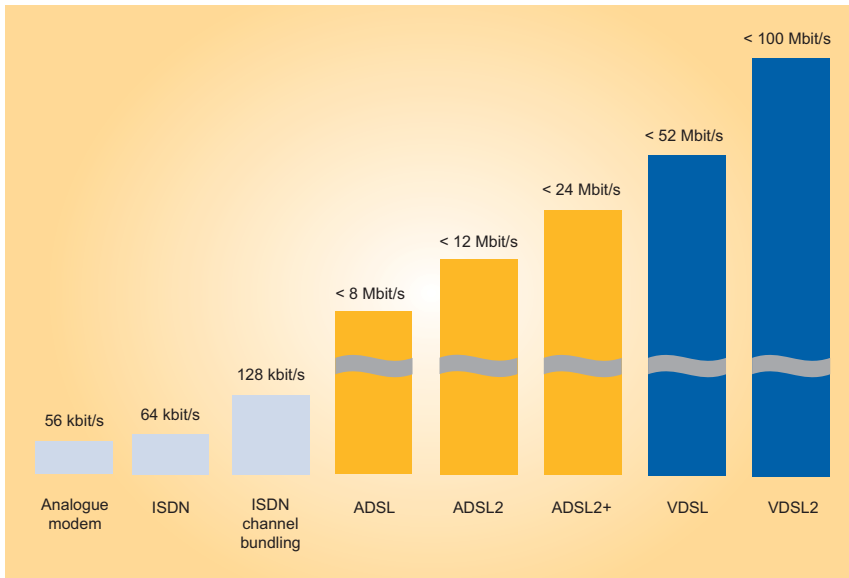


Figure 1
Downstream data rates on twisted-pair copper lines

available on twisted-pair copper lines (see Fig. 1). In the past, with an analogue modem or narrow-band ISDN connection, the last mile to the home was the bottleneck for high bandwidth applications.

DSL (Digital Subscriber Line) technology has provided the breakthrough for broadband telephone networks in recent years. With ADSL, and its variants ADSL2 and ADSL2+, downstream data rates of several Mbit/s are now common in many households. In the future, with VDSL, the data rates will extend well into the two-digit Mbit/s range.

DSL technology is based on sophisticated multi-carrier modulation schemes for physical transmission. The nature of the traffic at the consumer end suggests an asymmetric split with a broadband downstream data rate into the home and a relatively narrow-band upstream data rate from the home to the DSL provider. The multi-carrier approach of discrete multi-tone (DMT) splits the frequency band in a number of subchannels, each addressed by a carrier frequency.

For example, 256 subchannels can be used in **ADSL** [2]. Physically, ADSL uses frequencies up to 1.1 MHz on a twisted-pair copper line. The length and the diameter of the twisted-pair copper line determine the attenuation of the ADSL signal. Line-noise and crosstalk between lines can significantly impair the signal-to-noise ratio. Under ideal conditions, the maximum downstream data rate is in the region of 8 Mbit/s and the upstream data rate is up to 1 Mbit/s. However, if the length of the line approaches the limit of about four to five kilometres, for example in rural areas, the downstream data rate may be just 1-2 Mbit/s or even lower.

ADSL2 [3] extends the maximum downstream data rate to about 12 Mbit/s. **ADSL2+** [4] doubles the upper frequency limit from 1.1 to 2.2 MHz. The maximum downstream data rate is in the region of 24 Mbit/s.

VDSL1 [5] uses frequencies up to 12 MHz on a twisted-pair copper line and **VDSL2** [6] up to 30 MHz. The resulting downstream data rates are in the region of 52 and 100 Mbit/s, respectively.

However, in order to achieve the maximum data rates, the length of the line has to be reduced from several kilometres down to about 150 - 300 metres. Additionally, in order to maintain the very high data rates to and from the provider backbone, typically a **fibre optic network** is needed up to the point where the last mile starts with VDSL transmission. Thus, VDSL requires a major investment. The focus will be on selected urban areas to reach as many households as possible for a given capital investment and operational expenditure. At present it is not clear how fast the telephone companies are going to upgrade their networks to accommodate VDSL and for how long they will stick with ADSL and the variants thereof, for the vast majority of households.

Advanced source coding for data compression

Advanced source coding for data compression enables full-quality television on DSL networks. The transition from the ISO-MPEG-2 standard to MPEG-4 Advanced Video Coding (AVC) [7] reduces the data rates required for the picture signal. Using MPEG-4 AVC, the data rates required for high-quality television in standard definition (SDTV) are in the region of 2 to 4 Mbit/s depending on the

source signal. The data rates of MPEG-4 AVC streams are thus quite commensurate with the data rates available over ADSL. VDSL lends itself even to HDTV.

Source coding is not performed using only the MPEG open standards. On the Web, proprietary codecs that are integrated in downloadable software players are also used. In the case of IPTV, there is notably Microsoft IPTV edition as a platform with integrated data compression, based on Windows Media 9 / VC-1.

IPTV and physical transmission

Technically, IPTV is not a well-defined term. In a layered communication model, the Internet Protocol (IP) resides at the *network layer* and television (TV) at the *application layer*. Nothing is said about the physical transmission. Three simplified examples are shown in *Fig. 2*. After source coding, the compressed video bit-stream is packetized at the network layer with the Internet Protocol. The resulting IPTV packets are then physically transmitted with a transmission scheme that provides a guaranteed quality of service for digital television – in terms of bandwidth, error rate and delay. For example, as shown on the left in *Fig. 2*, DSL is used for physical transmission over twisted-pair copper lines. In the home, the DSL modem contains a so-called Integrated Access Device (IAD) which is connected to an IPTV set-top-box, using a cat-5 (Ethernet) cable. Alternatively, a wireless LAN (WLAN) can be used for connecting the IPTV set-top-box to the IAD.

IPTV is not bound to telephone networks and can be physically transmitted on broadband cable networks as well. One needs a transmission scheme which matches the physical properties of coax cable, e.g. EdgeQAM/ Docsis [8]. A similar reasoning applies to IPTV transmission on fibre-optic networks, e.g. fibre-to-the-curb (FTTC) or fibre-to-the-home (FTTH).

Actually, VDSL networks are typically a combination of FTTC to get to the point where the last mile starts and, from there, VDSL over twisted-pair copper lines to the home. For example, Deutsche Telekom is planning a fibre-optic network in ten German cities (see *Fig. 5*) which, in combination with VDSL2, aims to provide downstream data rates of 25 Mbit/s over the last mile. At a national and European regulatory level, there is much debate about whether competitors of Deutsche Telekom should also have bit-stream access to this new network.

Why is there IP? It is because IP fits in well with the existing infrastructure of the telecom-

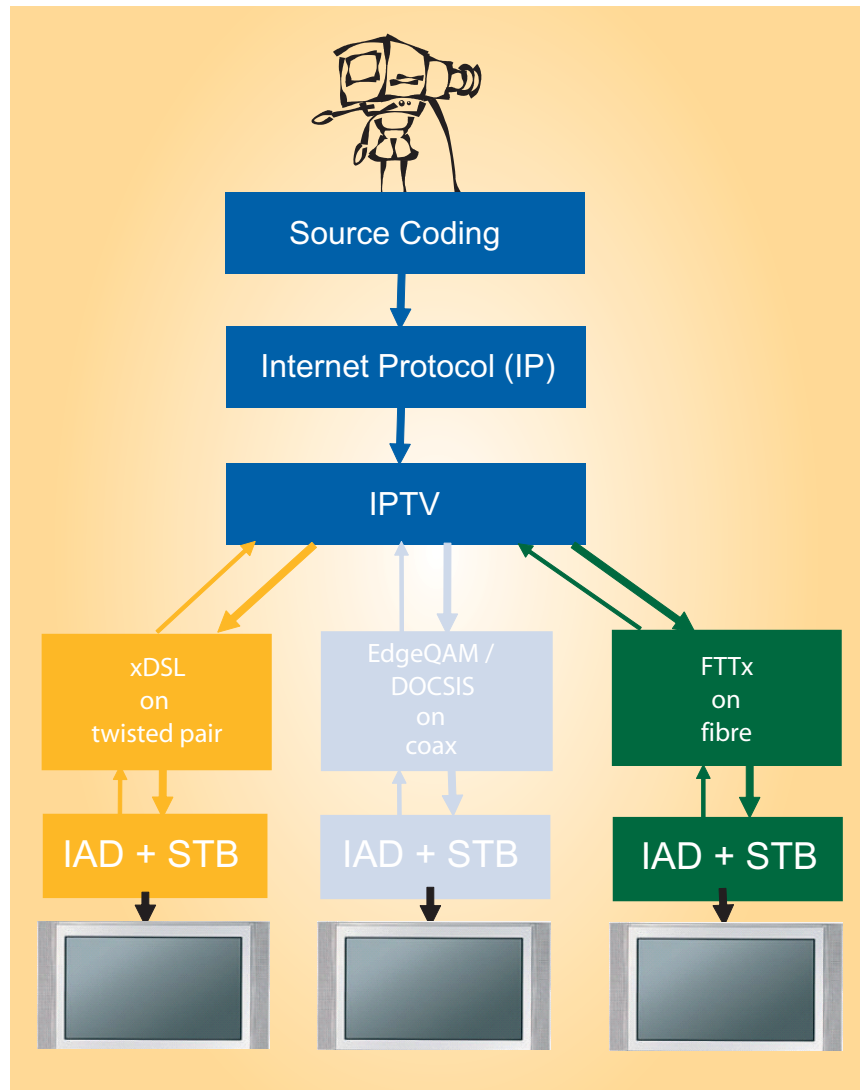


Figure 2
IPTV and physical transmission

munications industry. IP is a bidirectional protocol with source and destination addresses in the IP header. One can address packets using *IP unicast* to a single household for video or television on-demand and, for greater efficiency, use seamless switching to *IP multicast* [9] for addressing packets to a group when live broadcasts attract a large audience. It is not strictly a “must” but typically, as shown in *Fig. 2*, an IPTV system comprises at least a narrow-band return channel to complement the broadband forward channel. Within this asymmetric structure, usually a client server architecture is implemented for IPTV. In that respect, IPTV is interactive from the very start which makes an important difference when compared with one-way digital television such as DTT.

WebTV and IPTV

IPTV, as outlined in this article, should not be confused with WebTV. While WebTV is also based on IP and compressed TV signals, it provides for live video streaming or video-on-demand over the worldwide web. Downloadable software players for a PC or Laptop are common. The quality of service relies on the “best effort” principle. The IP unicast traffic of WebTV can lead to significant distribution costs for the broadcaster, depending on the number of users. In contrast, IPTV is implemented in fully-managed networks similar to broadband cable networks. The quality of service is guaranteed. The IPTV technology is under the control of the provider. Specific provider-defined set-top boxes were common in the early days of IPTV, but open standards should be a requirement and are being developed by DVB.



Figure 3
IPTV for mobiles

For retransmission of live broadcast signals as IPTV, thanks to IP multicast, the distribution costs on the provider’s backbone network do not scale with the number of users.

Moving away from fixed networks for a moment, a similar difference between WebTV and IPTV can be found in the case of terrestrial networks for mobile reception. WebTV over 3G networks is an approach already being followed by the mobile network operators (MNOs). In contrast to mobile WebTV, *mobile IPTV* can be physically transmitted

over a broadband terrestrial forward channel. A suitable broadcast transmission scheme, such as DAB-IP, DMB-DXB or DVB-H, provides a guaranteed quality of service that is independent of the number of users receiving the signal. It is that proposition – in combination with a 3G return channel to deliver IPTV services to battery-powered handheld devices with small displays and integrated antennas (*Fig. 3*) – that is attracting the imagination of MNOs for creating new revenue streams.

IPTV over DSL versus DVB over satellite and cable

Returning to IPTV over DSL again, a simplified comparison with the DVB transmission schemes for satellite (DVB-S) and cable (DVB-C) is shown in *Fig. 4*. The coloured lines are the different television programmes of a digital bouquet that are bundled together in one or more multiplexes, each carrying a multi-programme transport stream (MPTS). Similar to a broadband cable head-end, a DSL head-end picks up the satellite signals and converts them to IPTV signals. The difference here though is the client-server architecture used for IPTV, which sits between the provider backbone and the IPTV

home. In contrast to DVB-S and DVB-C, however, not a single programme goes automatically into the IPTV home. Instead, the press of a button on the remote control is communicated back via the return channel to a server of the provider. The server then routes the requested programme, typically as a single programme transport stream (SPTS), over the backbone to the last mile which, in *Fig. 4*, starts behind the point of presence (PoP) at the DSL access multiplex (DSLAM). In this context, a technical challenge for IPTV is the short time delay during channel hopping (i.e. the zapping time).

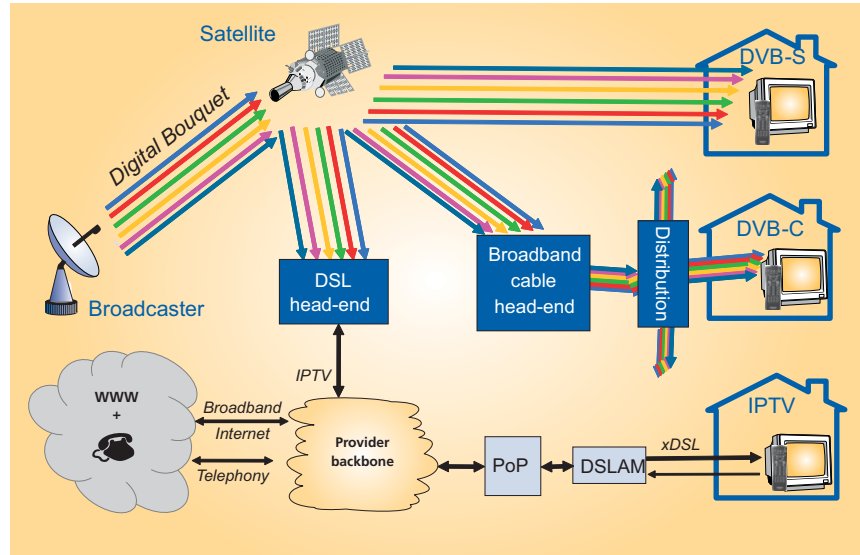


Figure 4
Simplified comparison between IPTV over DSL and DVB-S / DVB-C

Theoretically, every command on the remote control at home can be registered at the back-end system of the provider. This permits the ratings of a television programme for every single home to be measured very accurately and opens up a new dimension for personalised and individualised services on the TV screen. Equally, the client server architecture poses a new challenge to the data protection act and to privacy, quite different from anonymous free-to-air reception in one-way digital television systems.



Figure 5
Examples of xDSL networks for IPTV in Germany

Different IPTV providers may use different DSL head-end structures, different backbones and different client server architectures including the set-top-boxes. Under regulatory terms, market competition among telephone companies in Germany is enabled through bit-stream access at the point of presence (PoP) or at the DSLAM (*Fig. 4*). Thus, a telephone household can choose from several IPTV providers, unlike subscribers to existing coax broadband networks for cable television. The activities of IPTV providers in Germany are, however, still very much in the start-up phase.

To summarize this section, IPTV can be regarded as a new variant of interactive cable television which at present, in Germany, is implemented primarily for DSL transmission over fixed line telephone networks in urban areas (*Fig. 5*).

3. Requirements

For the system outlined in *Fig. 4*, we will now concentrate on the requirements for IPTV over DSL networks. The business model is key. Obviously, Pay-TV and Free-To-Air (FTA) broadcasting are different models. We will focus on the latter for defining the requirements.

Retransmission of live broadcast signals

If one regards IPTV as a new variant of interactive cable television, the general requirements for one-way digital cable television can be carried over. For example, broadcasters wish to provide a guaranteed quality of service with short signal delay, high picture and sound quality and lip sync. If transcoding of compressed source signals is involved at the DSL head-end, for example from MPEG-2 video received from a DVB-S signal to MPEG-4 AVC for IPTV retransmission, special attention has to be paid. The transcoding parameters have to be carefully chosen and adjusted in order to maintain a high picture quality and to make sure that the processed video does not lose the lip sync by delaying the unprocessed audio.

The client-server architecture of a two-way IPTV system leads to additional requirements. Guidelines for programme listings in the navigator and interactive functions have to be revisited. The syntax and semantic for the related metadata server at the provider's back-end system is a new component beyond the traditional broadcasting model. For example, a solution is required for the mapping of DVB service information (DVB SI data) that is carried in the transport stream of a DVB-S signal onto the client-server architecture and to identify what additional data is needed for the metadata server in order to get the electronic programme guide (EPG) or broadband content guide (BCG) fully functional and operational. In order to avoid expensive multi-platform authoring for the IPTV systems of different providers, standard data formats are very helpful, e.g. XML. In particular, if DVB transport streams feed the DSL head-end as shown in *Fig. 4*, one solution is the mechanism of Service Discovery and Selection (SD&S) defined in the DVB-IP (Internet Protocol) recommendation for the transport of DVB services over IP networks [10]. In that case, every DVB-IP receiver, no matter what brand, can access the services and that can be quite relevant for free-to-air broadcasting.

In the IPTV system, the return channel is always on. Therefore, requirements have to address in general what user- and service-related data is or can be collected on the return channel. Broadcasters want access to the interactive network functions, because this adds a new layer of functions for enhancing existing services or creating new ones. For copyright reasons, there should be no redistribution of IPTV content over the worldwide web. On the other hand, if a broadcaster does unicast live streaming over the worldwide web and in parallel the same content is distributed as multicast IPTV, then synergies through clever routing might be possible. An IPTV system can carry IP-Radio as well and therefore the radio requirements have to be negotiated between the broadcaster and the provider where appropriate.

Free-to-air broadcasting, in its strict meaning, relies on unencrypted transmission of all service and bouquet components, not just picture signal and stereo sound but also multi-channel sound, teletext, interactive applications, etc. In terms of signalling, free-to-air means open standards for retransmission and coding such as DVB-IP [10] and MPEG-4 AVC [7]. If a digital rights management (DRM) system is used by the IPTV provider, the functions should be switched off by default for FTA services unless specified otherwise by the broadcaster. The EBU requirements, summarized in the content protection and copy management (CPCM) guidelines, provide a yardstick [11]. The users should have non-discriminatory access to all FTA services through the navigator and EPG/BCG. For the FTA services of public service broadcasters, the IPTV provider should not impose an extra fee on the user, related to content that is already covered through the licence fee.

On-demand IPTV services

For on-demand services, another set of requirements relates to the time-shifted or time-independent use of content. Clearing of copyrights can be difficult. Broadcasters may not have the relevant rights for each programme or item in the archive because, at the time of acquisition, the television on-demand proposition was unknown and therefore not covered in the copyright contract. This brings up the problem of contemplating new and unknown forms of use for repurposed content that will be available in the future through advances in technology. Not an easy task. For rights acquisition today, the aspect of on-demand should be considered from the start alongside live broadcast.

The take-up of hard disk video recording, be it on a server at the provider's back-end system (Network PVR) or at home (PVR) and more recent developments such as podcasting, are merely the tip of the iceberg.

For on-demand it can make a difference whether one deals with (i) streaming and one-off time-independent viewing or (ii) file download yielding a permanent digital copy or, more precisely, a digital clone. Sophisticated DRM systems aim at refining the access rights for maximizing the income of commercial broadcasters and content owners.

In this setting for an IPTV system, very careful thinking is needed when on-demand services are considered for programmes that are originally made for free-to-air public service broadcasting. Non-discriminatory and fair access to the interactive network functions that are relevant for on-demand services is a clear requirement. The IPTV on-demand system has to comply with the national copyright regime. For fully user-controlled personal video recorders (PVRs) that are combined with the IPTV set-top box, similar requirements apply as for PVRs with an integrated DVB-S, DVB-T or DVB-C tuner. For example, a copy for private use must be possible. In the case of a provider-controlled Network PVR or PVR, the terms and conditions have to be negotiated between the broadcaster and the IPTV provider, e.g. unencrypted transmission or the marketing model by which the content is advertised and made available to the user.

The best quality on-demand content is useless if it cannot be searched, located and referenced to others by the user. Metadata is the key to enable podcast-like functions and to facilitate sophisticated navigation tools. The syntax and semantic of relevant metadata should be agreed on between the broadcaster and the IPTV provider. The efficient generation of metadata for search engines and navigation tools is getting increasingly important in the media production process.

In passing, we should note that synergies between on-demand video services for the worldwide web and for IPTV networks could be an interesting follow-up.

Abbreviations

ADSL	Asynchronous Digital Subscriber Line	IP	Internet Protocol
AVC	(MPEG-4) Advanced Video Coding	IPI	(DVB) Internet Protocol Infrastructure
BCG	(DVB) Broadband Content Guide	IPR	Intellectual Property Rights
CPCM	(DVB) Content Protection and Copy Management	IPTV	Internet Protocol Television
DAB	Digital Audio Broadcasting (Eureka-147) http://www.worlddab.org/	ISDN	Integrated Services Digital Network
DMB	Digital Multimedia Broadcasting http://www.t-dmb.org/	ISO	International Organization for Standardization http://www.iso.org
DMT	Discrete Multi-Tone	MHP	(DVB) Multimedia Home Platform
DRM	Digital Rights Management	MPEG	Moving Picture Experts Group http://www.chiariglione.org/mpeg/
DSL	Digital Subscriber Line	MPTS	Multi-Programme Transport Stream
DSLAM	DSL Access Multiplexer	MSO	Mobile Service Operator
DTT	Digital Terrestrial Television	PoP	Point Of Presence
DVB	Digital Video Broadcasting http://www.dvb.org/	PVR	Personal Video Recorder
DVB-H	DVB - Handheld	RSS	Really Simple Syndication
DxB	Combination of DAB and DVB-T/DVB-H	RTSP	Real-Time Streaming Protocol
EPG	Electronic Programme Guide	SD&S	(DVB) Service Discovery & Selection
FTA	Free-To-Air	SDTV	Standard-Definition Television
FTTC	Fibre To The Curb	SPTS	Single Programme Transport Stream
FTTH	Fibre To The Home	STB	Set-Top Box
IAD	Integrated Access Device	VDSL	Very high bit-rate Digital Subscriber Line
IEC	International Electrotechnical Commission http://www.iec.ch/	WLAN	Wireless Local Area Network
IETF	Internet Engineering Task Force http://www.ietf.org/	xDSL	(Different variants of) Digital Subscriber Line

4. Meeting the requirements

In order to meet the requirements for IPTV, a look back at DVB and at the worldwide web is instructive.

The DVB project was created for digital television. It brought together the broadcast industry, i.e. broadcasters, broadcast network operators and manufacturers. Out came mandatory forward transmission schemes for terrestrial, cable and satellite, now commonly used in the European broadcast markets. On the consumer side there is specific hardware, i.e. DVB receivers with mandatory and fixed integrated decoding functions. On top of the mandatory part there are options, e.g. for encryption or the MHP application programming interface.

At the birth of the worldwide web, the Internet Engineering Task Force (IETF) defined the real-time streaming protocol (RTSP) without involving the traditional broadcast industry. Building on RTP/RTSP and other mechanisms defined by the IETF, proprietary audio and video streaming schemes are not uncommon and are even used by broadcasters for WebTV. Proprietary schemes and widespread availability co-habitate through using general-purpose IT consumer hardware (PCs, Laptops) along with proprietary downloadable software players. Recent developments such as podcasting, and related RSS feeds, were originated for user-generated content and again rely on downloadable software. Podcasting is now increasingly used in the broadcast industry, even though it was not co-designed by incumbent broadcasters.

IPTV stands at the crossroads of these two examples, WWW and DVB. There is the **content-provider model** as followed by WebTV and podcasting, and the **broadcaster model** of DVB.

In the content-provider model, one concentrates on the generation of content. For distribution of the content, the necessary functions are specified at a rather abstract level and one does not really care about the specifics of the transmission scheme and the receiver technology. The content-provider model is agnostic to a specific IPTV technology. The IPTV system is a black box. The IPTV technology is left to the IPTV provider who has to make sure that the requirements of the broadcaster are met. For example, abstract requirements include (i) avoiding multi-platform authoring and (ii) ensuring a high quality of service with a free-to-air experience for the user. But how can a broadcaster be sure that such requirements are really met in cases of dispute, when no parameters are defined that could be metered, measured and quantified.

The broadcaster model goes one step further and cares about certain specifics of the transmission scheme and the receiver technology. The business functions are developed into a set of technical requirements. The FTA principle, the avoidance of multi-platform authoring and the benefit of the economies of scale are promoted through technical requirements for open standards such as DVB-IP for transmission and MPEG-4 AVC for source coding. However, the policy of intellectual property rights (IPR) and the conditions for obtaining a licence to apply open standards is getting more difficult as the example of MHP highlights. The IPR policy and the licence conditions for DVB and other standards relevant to IPTV should be clear upfront. Of course, IPR can be an even more important issue in the content-provider model when proprietary systems are involved.

5. Conclusions

IPTV can be regarded as a new variant of interactive cable television. IPTV brings together telephone companies and broadcasters. Partnerships are needed for carrying the concept of free-to-air public service broadcasting forward to IPTV. The implementation of a broadcaster model with broadcast-centric requirements and open technical standards as a base for fair and non-discriminatory access is a worthwhile goal, of benefit of the audience. The high-quality content and the specific know-how of public service broadcasters is a valuable asset for building strategic partnerships with IPTV providers, relevant software and hardware manufacturers and other broadcasters.

The short term effects of IPTV should not be overestimated. In Germany, IPTV is still in its infancy. In the long run, IPTV could have a lasting effect and bring profound changes to the broadcast busi-

ness. IPTV combines the traditional concept of live broadcast with on-demand and interactive viewing. That combination is most likely to prevail because it is an attractive proposition that appeals to a large audience. With ever-increasing bandwidth on the worldwide web, the differences between WebTV and IPTV will eventually vanish. But this will take some time, and the guaranteed quality of service of IPTV is an advantage for the time being.



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Since 2000, Dr Werner has been serving as Chief Engineer at WDR in Cologne, covering the fields of new technologies and innovation management.

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