Receiver Opportunities of World DTTB Standards

a Receiver Manufacturer's view

Cornelis (Koen) M. Huizer and Jan van der Meer
Philips Digital Video Systems

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The introduction of Digital Terrestrial Television Broadcast in the USA and the UK is imminent. This paper analyses the emerging opportunities for DTTB receivers. First we consider why DTTB services are attractive and how to get a successful receiver business. Secondly, a number of different segments in the receiver market will be distinguished. Each of these segments pose different requirements with respect to scope and nature of the standards governing the product specifications. This is followed by two case studies to indicate which products are prime candidates for the DTTB launch in the USA and the UK. It will also be shown which additional products can be realised when currently on-going standardisation activities are finalised. Finally some conclusions will be drawn.

1. Introduction

In the USA as well as in Europe (initially the UK) all necessary preparations are being made to ensure the successful commercial launch of Digital Terrestrial Television Broadcast (DTTB) later this year. It is almost certain that these early examples will be followed by many of the existing television markets.

Two comprehensive body of technical standards for DTTB have been developed, namely ATSC and DVB. ATSC and DVB share important standards - such MPEG-2 video compression - but do also show significant differences.

This paper is not intended to pass judgement on the relative quality and fitness-for-use of ATSC and DVB. Proponents of ATSC and DVB are both right in claiming that they provide the broadcast industry with the basis for a revolution in quality and scope of services.

The purpose of this paper is to present a manufacturer's view on the different opportunities presented by ATSC and DVB. Focus will be on the receiver, however without neglecting insights obtained from our wider (essentially "glass-to-glass") product portfolio.

2. Why are DTTB services attractive - what makes a a successful receiver business

A key factor for the success DTTB receiver business is the attractiveness of the service proposition. Migrating to digital should result in a major improvement over the analogue predecessor. Otherwise there is not sufficient incentive to replace the existing analogue equipment. This should hold true both for the service operator as well as for the consumer. Another key factor, especially for the receiver manufacturer is the relative attractiveness of the DTTB receiver compared to other emerging CE products such as DVD players, Internet-TV "appliances" etc.

Considering the service proposition, we can distinguish four main areas where the digital offering has the potential to excel. First (and perhaps foremost) is a much improved efficiency in spectrum utilisation enabling a major extension of the number of programs assuming constant transmission bandwidth. The limited programming choice of terrestrial broadcast is a major factor fuelling the growth of existing multi-cast technologies such as cable and satellite at the expense of terrestrial. Assuming that attractive content will become available to fill the new channels, this trend could be reversed.

Strongly related to the improved spectrum utilisation is the ability to use Conditional Access (CA) systems allowing new revenue sources such as subscription and pay-per-view services. It is extremely unlikely that the extended program

offering identified above can be funded fully from additional advertising revenue. Many of the extended services will be subscription/pay-per-view based for which effective CA systems are essential.

So far we have not touched the subject of improved picture and sound quality. The minimum picture quality level of all DTTB systems is MPEG-2 MP@ML (at 4:3 and 16:9 aspect ratio) which offers a major improvement over the current analogue NTSC/PAL/SECAM transmission, especially considering the often impaired quality of over-the-air and cable reception. The digital nature of the signals combined with advances in signal processing and display systems provide receiver manufacturers ample opportunity for picture improvement. On top of this the DTTB systems are suitable for the transmission of MPEG-2 MP@HL offering substantially higher picture coding resolutions.

Last but not least the digital DTTB systems offer the ability to devote part of the transmission bandwidth to additional data (text, graphics etc.). This data can be used to create a more interactive viewing experience offering the consumer the ability to access additional information (player statistics in sports), play along etc.

Let 's now turn our attention to the attractiveness of the DTTB receiver as a product of the CE industry. We will consider the model in which the consumer buys a receiver via the customary distribution channels for CE products and ignore the situation in which the service provider takes responsibility for acquisition and distribution of the receivers.

In any CE product - and DTTB offers no exception - opportunities for added value are essential which implies that any standard should offer sufficient freedom of implementation in terms of key components, user interface (ease-of-use) and options for combinations with other products. In addition and especially in case of integrated Digital TV sets, which are seen as a relatively long-term investment by the consumer, the economical life-time of the set is an issue. Rapid obsolescence (e.g. caused by the premature adoption of a short-lived standard) should be avoided. Finally, the standard should be complete enough to provide interoperability to prevent proprietary solutions which fragment the receiver market.

3. Receiver Product Ranges

DTTB services allow considerable variation with respect to product definition. The receiver manufacturer can vary aspects such as screen size, display resolution, sophistication of the EPG, support for enhanced services etc. A successful product range addresses a set of price points, each of these offering the most attractive feature set attainable for that price point.

In the section we will propose some - hypothetical - product ranges. In later sections we will evaluate how well the ATSC and DVB standards support these product ranges and indicate the potential of extensions of the standards. We have organised the receiver options according to two main parameters. The first parameter is display quality and the second one is new services.

Figure 1 below is the starting point for the analysis. This diagram shows the cost to implement a selected set of receiver options. Note that for obvious reasons the drawing is not intended to describe the costs of the various features exactly; the intention is merely to show the trade-off's possible. It can be seen that new services are more affordable than (very) high-end picture quality. Note that receivers supporting Pay-TV are currently often subsidised by the service provider. These subsidies have not been taken into account in Figure 1 and subsequent ones. These subsidies can be significant though and more than compensate for the additional cost incurred in supporting Pay-TV or even interactive services.

The various options are described in more detail in Tables 1 and 2 below. In Table 1, the column "Video Standard" indicates the minimum coding resolution required to realise the potential of the display technology. Note that only the highest quality option requires coding beyond MPEG-2 MP@ML (vertical resolution of 720 and above), although it should be noted that the 16:9 improved category would benefit from progressive coding at 480/576 vertical lines which is an element of MPEG-2 MP@HL.

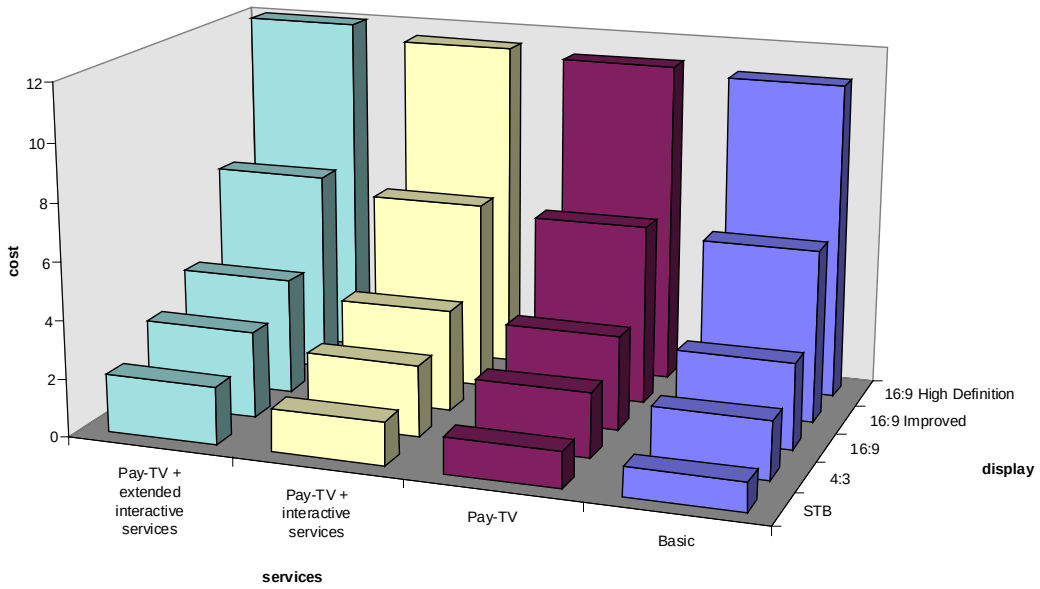

Figure 1 Cost of receiver options associated with display quality and new services

Table 1 Some receiver options related to picture quality

Item	Description	Video Standard
STB (No display capability)	Set Top Box (no display). Picture could be substantially improved over analogue picture but limited by the interface to the analogue TV set used for display.	MPEG-2 MP@ML
4:3	Integrated TV with conventional CRT. Picture substantially improved over analogue picture (horizontal bandwidth, no cross-colour/luminance). Popularity will grow when price difference with analogue set vanishes and end of analogue transmission is in sight.	MPEG-2 MP@ML
16:9	As 4:3. This is the most cost-effective solution to display all material without compromises. Potential to be *the* mainstream DTV receiver.	MPEG-2 MP@ML
16:9 improved	As 16:9 with improved picture processing. Advances in digital signal processing (such as progressive scan conversion) combined with low-cost silicon implementations allow for impressive picture improvement. Interestingly SD display technology can be used.	MPEG-2 MP@ML
16:9 High Definition	High-end sets capable to display 720 lines and above. Considerable additional cost to realise a convincing difference in picture quality compared to "16:9 improved".	MPEG-2 MP@HL

Table 2 Some receiver options related to enabling new services - improved information processing

Item	Description
Basic	Standard receiver with simple EPG
Pay-TV	As previous + support for Conditional Access (incl PSTN return channel), enhanced EPG (Pay Per View)
Pay-TV + basic interactive services	As previous + information browsing, shopping, etc.
Pay-TV + extended interactive services	As previous + games, local storage (e.g. hard disk) to retrieve data over night and store "plug-in's"

A receiver product range offering all 20 possibilities shown in Figure 1 would certainly confuse the consumer and hence not be successful on the market. For a further analysis of some potential product ranges we will use a 2D equivalent form of Figure 1 as the basic tool. See Figure 2. This Figure shows the same information as Figure 1. The position on the horizontal axis represents the cost associated with a specific option related to display quality. Cost related support of services is indicated in the same way on the vertical axis. The dotted lines indicate combinations of product options with equal cost. For a given price point, these lines show the trade-off between picture quality and service options.

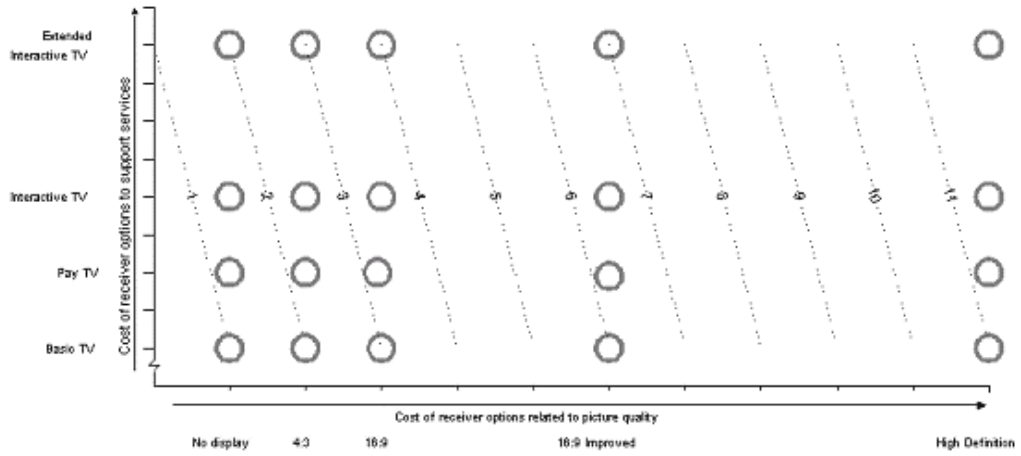

Figure 2 Cost of receiver options associated with display quality and new services (2D view)

In Figure3 we have indicated some - rather obvious - potential receiver product ranges. In the product range "display" the key distinguishing parameter is display quality. Obviously this range is restricted to Integrated Digital TV sets as the installed base of analogue receivers limits the display performance of STB solutions.

In the product range "services (STB)" products differ in the support of new services (pay-TV, interactive enhancements) . The third product range "services and display" combines display quality with new services. Given the relatively low cost of supporting new services, this range is in fact more likely than the "display" range.

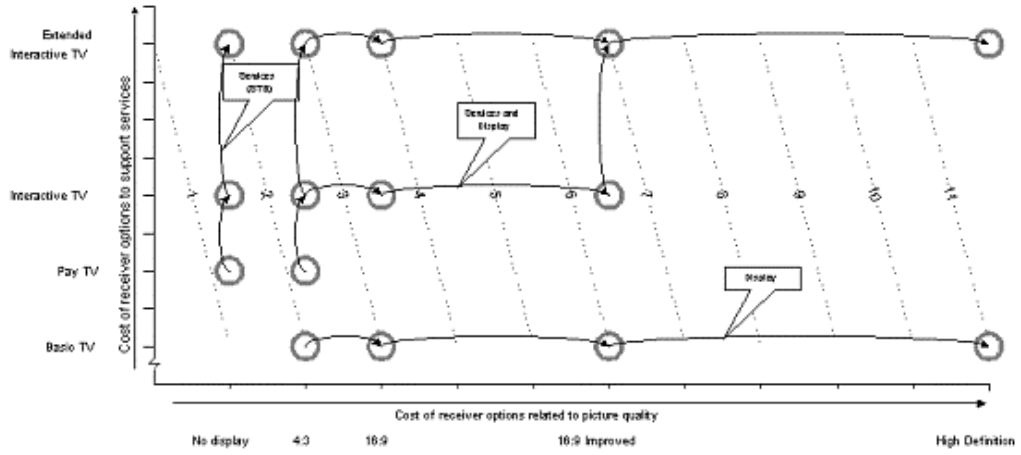

Figure 3 Some potential receiver product ranges

4. Receiver Product Ranges supported by ATSC and DVB

In this section we will evaluate how the ATSC and DVB standards - as planned to be introduced in the USA and the UK - can be used in realising the product ranges identified in the previous section. A short introduction to the UK situation may be helpful. In the UK a significant amount of additional specification work has been done within the "Digital Terrestrial Group" (UK-DTG), a consortium of operators and receiver manufacturers. These additional specifications - bundled in the 'D-book - Requirements for Interoperability" - provide additional precision to maximise interoperability while fully compatible with DVB. The UK-DTG focused not only on enhanced picture quality but rather on a comprehensive set of enhancements provided by digital television, including multi-cast and enhanced services. A major part of the specification effort was concerned with an Application Programming Interface (API) for interactive services. This is an area for which DVB had no activity in the past. The UK-DTG selected ISO/IEC 13522-5 (MHEG-5) to support interactive services. MHEG-5 supports a basic level of interactive services and provides ample extension mechanisms towards more advanced services. See also our paper "Emerging operations for Enhanced TV Experiences", in the session "Consumer Access" in this conference. It should be noted that DVB is currently defining specifications for a "Multimedia Home Platform". Within the scope of this activity, APIs are being addressed. The MHEG-5 solution selected by the UK-DTG is one of the prime candidates.

The following Tables 3 and 4 are the counterparts of Table 1 and 2 of the previous section. They indicate the standards provided by ATSC and DVB/UK-DTG corresponding with the receiver options described in that section.

Table 3 shows the ATSC and DVB standards related to picture quality. ATSC and DVB both provide specifications for standard and high definition. With respect to picture quality the UK-DTG reasoned that the improvement provided by digital 16:9 MPEG-2 MP@ML was sufficiently compelling (and commensurate with affordable display technology) to restrict transmissions to standard definition.

Table 3 ATSC and DVB standards related to picture quality

Item	Description of required standard	ATSC	DVB / UK-DTG
4:3, 16:9 and 16:9 improved	Digital Video compression at Standard Definition	A/53	ETR 154
16:9 High Definition	Digital Video compression at High Definition	A/53	ETR 154 (HD not applicable in the UK)

Table 4 shows the ATSC and DVB standards related to service options. Both ATSC and DVB provide standards for basic TV (channel coding, service information, closed captions/subtitling). The channel coding standards are quite different. The DVB system has several unique features. It has a high tolerance for multi-path reception allowing for mobile and in-house receivers with simple antenna's. Also the system is suitable for use as a Single Frequency Network (not adopted in the UK). These benefits come at the expense of a somewhat higher implementation complexity. Another

difference is that the DVB subtitling standard allows for bitmapped graphics. Finally it should be noted that the DVB standards are modular and cover all prominent transmission technologies: the same set of standards addresses terrestrial, satellite as well as cable systems

With respect to pay-TV and enhanced services, ATSC and DVB have gradually broadened their scope. The corresponding ATSC standards are still under discussion. DVB has comprehensive specifications for conditional access, data broadcast and bi-directional communication. As stated already, the UK-DTG has extended the DVB specification to support basic interactivity. DVB is considering the UK-DTG extensions within its efforts concerning APIs for interactive services.

Table 4 ATSC and DVB standards related to service options

Item	Description of required standard	ATSC	DVB / UK-DTG
Basic	Channel coding & Modulation	A/53	ETS 300 744
	Mega Frame for Single Frequency Network	-	TS 101 191 (not applicable in the UK)
	Service/Program Information to support EPG	A/65	ETS 300 468
	Closed Captions / Subtitling	A/53	ETS 300 743
Pay-TV	Conditional Access - method to scramble the A/V stream	under discussion	ETR 289
	Conditional Access - Interface to add Conditional Access to a generic receiver	under discussion	EN 50221
	Simulcrypt - supporting a receiver population with multiple CA systems	under discussion	TS 101 197
Basic interactive services	Data Broadcasting - protocols for the transmission of generic data over broadcast networks	under discussion	EN 301 192
	Network Independent Protocols for Interactive Services - protocols for the transmission of generic data over bi-directional networks such as PSTN	under discussion	ETS 300 802
	Interaction Channel through PSTN/ISDN	under discussion	ETS 300 801
	Basic Interactive Applications - coding of multimedia and hyper-media objects	under discussion	MHEG-5 (still under discussion in DVB)
Extended interactive services	API	under discussion	under discussion

Figure 4 is derived from Figure 3 above. The regions “ATSC” and “UK-DTG” indicate the receiver options covered by the current status of the respective standards. Early ATSC receivers will most likely target high-end display integrated digital TV sets and be restricted to basic free-to-air services. There is less potential for STBs as the advantages over analogue TV are rather minimal.

In the UK-DTG the initial offering will be broader than ATSC: both integrated digital TV sets (no high definition) and STBs are prime candidates for early deployment. In both cases, the combination of attractive programming (including Pay-TV), improved picture quality, mobile and in-house reception using simple antenna’s and interactive services is an attractive mix which is well positioned to compete with cable and satellite.

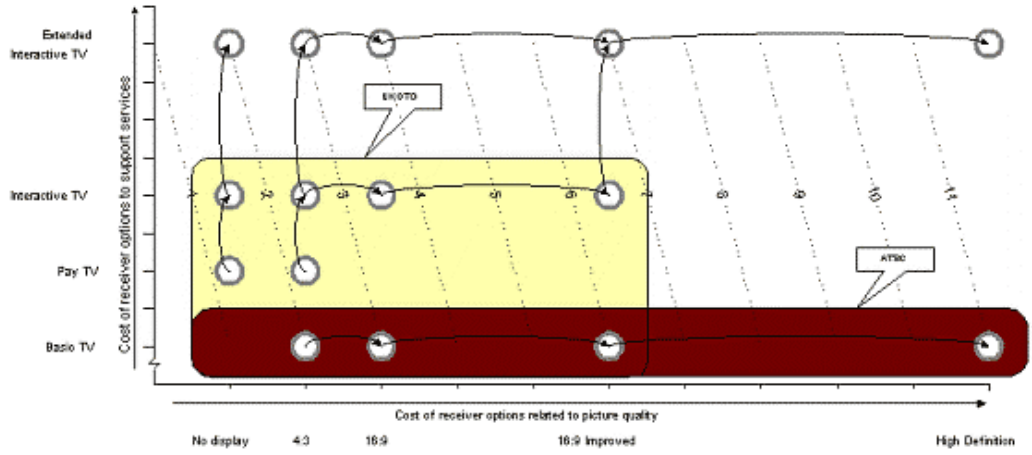

Figure 4 Receiver options supported by ATSC and UK-DTG

It is likely that both ATSC as well as DVB will in future provide standards allowing receivers supporting the full spectrum of options shown in Figure 1 and 2 above.

5. Conclusions and closing remarks

We have seen that both the ATSC as well as DVB standards provide ample opportunity for receiver manufacturers. It is likely though that the initial products ranges will differ substantially. For ATSC receiver manufacturers will focus on High Definition free-to-air integrated television sets whereas the DVB receiver market will be a mixture of (pay-TV) set top boxes and integrated television sets, supporting from day one some enhanced services. In the UK especially the set top box market will be accelerated as the products are likely to be subsidised by the pay-TV operators. The UK terrestrial offering is a powerful combination of improved content, picture quality and services which can be received using simple (mobile and in-house) antenna's. As such it will give terrestrial broadcast a valid opportunity to compete with cable and satellite.

For some consumers a combination receiver which can handle multiple transmission methods may be attractive. An example could be a combined satellite/terrestrial receiver. Here DVB provides inherent advantages due to the modular nature of the specification.