

Exhibit 1025

INTERNET-TV CONVERGENCE IN DVB-MHP¹

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Abstract: *In last decade, we have seen the first steps to the end of passive television. Digital technology is mature enough to enhance traditional TV (limited to content reproduction) with computing capability to run multimedia software integrating richer formats. One step further, Internet access through television is becoming a real possibility. The MHP standard is the first one that tries to define regulations in that sense. Here, we comment some technical aspects of the MHP solution.*

Key words: *Digital Interactive Television, MHP, DVB-HTML, Internet through TV*

1. INTRODUCTION

Digital technology is driving television towards a new world full of amazing possibilities, where spectator is no longer limited to observe contents selected by the operator. More and more, new dynamic and interactive services are being introduced in everyday digital TV: complementary information to audio-visual contents, electronic program guides, selection of properties in configurable contents (language, camera angle or particularised advertisement), pay-per-view, etc.

Broadcasting of a digital transport stream permits operators to mix traditional audio-visual contents with binary data, so making possible to deliver multimedia software applications to be executed in a digital TV or in a SetTop Box. These applications, synchronised with traditional contents, adapt themselves to spectator characteristics, implement interaction with users and provide return channels for communication with content providers. But a lot of decisions must be taken to design the actors of the system: the kind of code of the applications, the running context, the API's supported in the SetTop Box, the life cycle of the applications, the signalling of the operator, etc. Here is where standards play a decisive role to achieve an open market, with compatible equipment, where users are not tied to a brand all along the broadcast chain.

Today, the main regulator body in this field is the DVB (Digital Video Broadcasting) consortium, which dominates the digital TV market with its standards about terrestrial, satellite and cable transmission. Now, the DVB has published a new standard, MHP (*Multimedia Home Platform*) [1], to achieve compatibility in the computing platform that software applications (Xlets or DVB-J applications in MHP jargon) will find when they arrive at the digital TV set. This new standard defines a context for running applications (including a life cycle and signalling mechanisms) and a software interface (the MHP API) for these applications to access hardware resources.

To achieve a compatible environment, Java technology is used. MHP applications are defined to be Java classes which implement some well-defined interfaces. In the SetTop Box,

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a Java Virtual Machine will detach downloaded applications from specific hardware and system software (see figure 1).

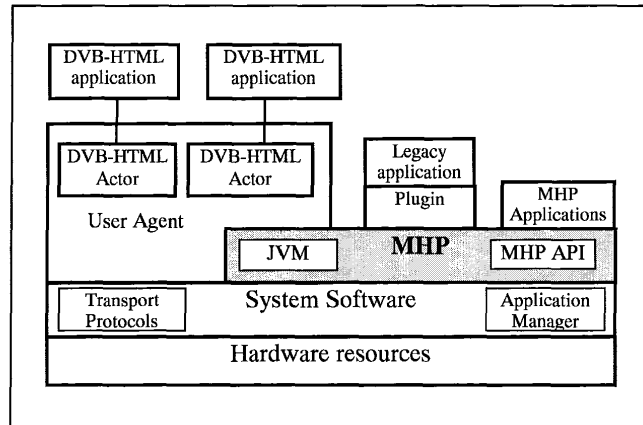


Fig. 1: MHP in the receiver stack.

Standardisation is necessary, but not enough to achieve a successful integration of these new technologies in the TV market. Content providers demand the introduction of new value-added services which users are willing to pay for. Killer applications are needed for users to migrate quickly to this new scenery and for companies to recover their investments. And Internet, of course, fits well in this pattern: enhancing TV with Internet access is useful, feasible and glamorous. Besides, the DVB consortium considers it is necessary to provide digital TV with a "super teletext" system to present structured stylised information to users, and Internet technologies are the natural candidates.

So, MHP pays special attention to the specification of all the necessary details to integrate in its computing model a mechanism to access to Internet or to browser over similar information. Basically, MHP adopts W3C standards as a starting point and defines some reductions and extensions of functionality to cope with the differences between a television and a computer. In the remain of the paper, we present some technical aspects of these adaptations.

2. INTERNET ACCESS THROUGH TV: THE MHP APPROACH

Several Internet technologies complement each other to achieve the amazing web pages we can see every day: several versions of the markup language, styling mechanisms, programmatic access to the internal data structures, applets, cookies, plugins, Flash animations, etc. Here, we only examine a couple of items, where two circumstances concur: the technology is used extensively and the differences with respect to the W3C standards are significant. In the following, some knowledge about W3C technologies is supposed.

2.1 The language: DVB-HTML

The core element of the MHP Internet access is the markup language the browser understands. Following W3C latest standards, DVB has chosen XHTML for this task, using the *XHTML Modularization* [2] standard to build their own language, DVB-HTML. This language is composed of a set of modules, selected from the whole set defined in [2], that bear in mind the critical differences between a computer and a TV set: computing power, screen resolution, observation distance, etc.

The set of modules included is quite ambitious, leaving out very few and, generally, irrelevant or deprecated modules (*complete tables, edit, legacy, server-side image maps, name identification and applet*). Moreover, it substitutes the XHTML *Intrinsic Events* module for the more TV-oriented *DVB Intrinsic Events* module, where the set of events has been refined and adapted to the television environment.

For traditional Java applets, the more general *object* module is adopted. This element also permits the integration of MHP applications in DVB-HTML documents (embedded Xlets). Special considerations for the attributes of the *object* element are defined, so the embedded Xlet can be identified and found in the transport stream. A new MIME type is introduced (*application/dvbj*) to declare these embedded Xlets.

With respect to contents, new information formats are introduced, as can be MPEG-2 I-frames and video drips. DVB-HTML specifies how to reference audio and video information being received in the MHP transport stream. Through a specific *dvb* locator, DVB-HTML documents can play audio and video belonging to a DVB service (a traditional television channel). Even more, MHP applications associated to a DVB service can be referenced and launched from a DVB-HTML document (if authorized by the application manager), enhancing interactive possibilities.

DVB generalises the concept of DVB-HTML document to the DVB-HTML application, which consists in a set of DVB-HTML documents forming a directed graph (with transitions labelled by hyperlinks) and where an entry point and a boundary to specify reachability have been defined. So, in addition to offer an open mechanism to access the whole Internet, the DVB-HTML application model permits the service provider to send formatted and stylised data (several related DVB-HTML documents) in a packed format. Even more important, the downloading, decoding, rendering and interaction processes of DVB-HTML application (performed by a HTML actor – fig. 1) must follow a well-defined life cycle in the user agent, which can be commanded from the content provider through the signalling mechanisms in the digital transport stream as defined in the MPEG-2, DVB and MHP standards.

For this latest task of representing documents specifically designed for DVB-HTML (probably started and commanded by operators and/or MHP applications) the proposed framework seems to be suitable. But browsing web pages in Internet is quite different. Out there, documents can be very complex and, often, not conformant: plugins, Flash animations, complex style sheets, incompatible scripts, wrong tags, etc. Real browsers use to implement a lot of complex code to cope with these problems, to make interpretations about author's intention and to smooth defects to satisfy final observers (who, probably, do not know about author's intentions). This correction task seems to be difficult to achieve in an environment scarce of resources, as TV is. So, there is a risk that final results will disappoint to users.

The idea of commanded web pages (driven by operator signalling) is novel but user's attitude is unpredictable. Will users accept changes in DVB-HTML applications not requested by them? Will not they be confused when this happen with stored applications? We think that the model must be tested and refined to assess what must be and not be permitted.

2.2 Decorating DVB-HTML documents: CSS2

In order to get a proper stylised representation of the contents included in a DVB-HTML document, DVB shares the W3C strategy about separating contents and decoration guidelines. With that goal, the W3C CSS2 standard [3] has been adopted as a language to specify decoration rules needed to render DVB-HTML documents in a stylised way. However, several modifications have been defined to adapt this language to the TV environment:

- It is only mandatory to understand rules directed to two media devices (the *@media* directive): the media *screen* (for a computer screen), and the media *dvb-tv* (for a TV-like device). Last one is defined to differentiate devices with tv-like characteristics: low resolution and computing power, limited scrollability, reduced interfaces, etc.
- A new *at-rule* is introduced (*@viewport*) to integrate the MHP graphics reference model: coordinates of the viewport, size and position respect to the application window, resolution, etc. Some new pseudo-classes are defined to adapt to several parameters tv-related: device aspect (4:3, 16:9...), resolution, etc.
- Lower levels of requirements are demanded to the local fonts resources: observation distance and device resolution make nonsense to demand greater detail in font types and sizes. Only support for Tiresias type, plain, with four large sizes is mandatory.
- A default style sheet for DVB-HTML is provided in the standard.

Basically, the DVB proposal for CSS application to the TV environment is very similar (with respect to the set of mandatory rules that makes a browser conformant) to the later W3C CSS TV Profile [6] (working draft published in December, 2001). As they share a common goal over the same media, a quick convergence is expected.

Content and styling separation through style sheets is a strong bet of W3C that is having difficulties to get wide acceptance. Most of web pages do not use style sheets for formatting, but a lot of elements and attributes marked as deprecated in W3C standards and classified in the *Legacy* module, not included in DVB-HTML. So, a great risk is taken of users not being satisfied with the results of the rendering process. Moreover, experiences with today browsers show that it is difficult to get the same appearance, mostly when user's profiles, rich in configuration options, come into play.

Last, but not least, cascading style sheets application has shown to be an intensive resource demanding process, driving to slow applications when such resources are not available.

2.3 Giving access to the structure of documents: DOM Level 2 and ECMAScript

MHP has adopted the W3C DOM Level 2 [4] and the ECMA ECMAScript [5] standards to offer programmatic access to the internal structure of the document, contents and decoration rules. Of course, as before, several reductions or extensions of functionality have been defined for adaptation to the TV scenery.

The Core and Views modules of DOM Level 2 have been completely integrated. Some HTML DOM features have been omitted, for example, those related to the creation of a document from scratch (the interface only offers document modification). The events module defines mouse events as optional and includes new events related to the life cycle transitions. Moreover, it includes a new kind of event derived from synchronisation signals (triggers) received from the service operator. This mechanism permits user agents to implement an interaction and synchronisation channel with content providers. Last, with respect to DOM CSS2 module, MHP does not require to implement it, but it defines a simpler module to support basic access to CSS rules.

All the interfaces defined in the previous paragraph must be offered as ECMAScript and Java interfaces. So, scripting code and embedded Xlets (applets) have direct access to the internal structure of DVB-HTML documents, their contents and styling information. Besides, an interface must be offered to all MHP API's, including intercommunication ECMAScript-Xlets, which permits the implementation of hybrid applications which divide functionality between scripts and Java code in Xlets. For this communication, and taking into account the differences in the data type systems of these languages, the standard defines extensively a number of casting rules to decide transformations between both data type systems.

Resuming, DVB has adopted a complex model to support dynamic DVB-HTML pages. This is a powerful model but not for free. Computers can pay the price of complexity as resources are not scarce and web pages with ambitious objectives demand powerful technologies. But, what about TV? What do TV user's really need? Or, more important, are they willing to pay for the effects that may be achieved with that complex framework?

3. CONCLUSION

DVB has made a great effort to define a complex framework that integrates W3C technologies for Internet access in the digital TV environment. The result, quite ambitious, seems to be suitable for rendering documents specifically designed for this media. So, a walled garden approach would guarantee a nice and well-structured information repository. But experience has shown that users do not like to be limited to islands in the Web (see WAP reduced deployment) and, when accessing the wider Internet, some doubts arise about the cost of the resources needed to implement it with a minimum efficiency. Is going the user to pay that cost? Is going the user to accept some kind of delay or difference in results? These are questions that should be carefully studied before building the specification.

To start with, the whole process of making the standard has not follow the successful guidelines of Internet technologies: openness and incremental development. The MHP standard has been delivered to public once finished, in their final and complete shape. The result is a lack of feedback along the specification process, and greater difficulties to change the standard now, once different pieces have fit together.

Nobody should forget that history is full of failed projects that proposed a lot of new amazing technical capabilities and were highly supported by industry, organizations or governments. May be market opinion was not carefully listened. Is this the case?

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