Content Delivery Platform for Hybrid Broadcast Broadband Television

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Abstract

Hybrid Broadcast Broadband Television is a technology platform that combines television and Internet services. This work proposes an approach to deliver auxiliary web-based content through broadcast applications bypassing the requirement of Internet connectivity. A complete practical implementation of the solution is provided supporting all technology levels.

1 Introduction

Television broadcasting is a service of delivering television (TV) channels content to a wide dispersed audience [1]. Main content including audio and video, featured with additional data content, is delivered through different mechanisms. Teletext [2] is an efficient mechanism of the delivery of auxiliary content to end-users. However there are new possibilities with digital TV broadcasting.

The SEE TV-WEB project [3] aims to foster accessibility and availability of Internet content to those who do not usually use Internet services and who have no broadband connection. This paper presents a simplified implementation of the SEE TV-WEB project solution. The idea is to use the free digital terrestrial television (DTT) broadcasting frequency spectrum capacities to transmit selected Internet content and ensure a sort of Internet experience via TV devices to certain less advantaged segments of the population or those in rural areas without broadband access.

Digital broadcasting enables the delivery of web-based content through applications mechanism. Hybrid Broadcast Broadband Television (HbbTV) is an open technology platform combining Television and Internet services [4]. This paper focuses on HbbTV applications as a method of content delivery. It presents a complete solution of content delivery processes supporting the scenarios without Internet connectivity. The rest of the paper is structured as follows.

Next section explains the HbbTV concept. HbbTV applications are introduced and explained including the delivery mechanism and HbbTV solution entities. Furthermore HbbTV applications architecture is presented and design requirements and guidelines are listed and explained. Technology limitations related to application design are reported.

Section three presents the implemented solution of dynamic content delivery through HbbTV applications. Complete solution is provided where roles of all solution entities are explained. Content Management System (CMS) design and implementation are explained. Additionally content rendering engine as the core entity of the solution is introduced with design explanation.

Last section closes the paper exposing the platform as one of the possible solutions to dynamically deliver additional content over TV broadcasting networks. Open issues are addressed and future work requirements are reported.

2 Hybrid Broadcast Broadband Television and applications

HbbTV is an industrial standard and European initiative to unify the broadcast, broadband and Internet Protocol Television (IPTV) delivery of TV content to end-users's Smart TVs and set-top-boxes (STB) [5]. Services implementing the HbbTV standard can operate over different broadcasting technologies (terrestrial networks, cable or satellite).

There is the interest to deliver custom content via HbbTV. Data carousel is a mechanism which enables the delivery of interactive applications within the main TV channel stream where each TV channel carries an assigned application which can be modified or replaced at any time, as it is a part of broadcast.

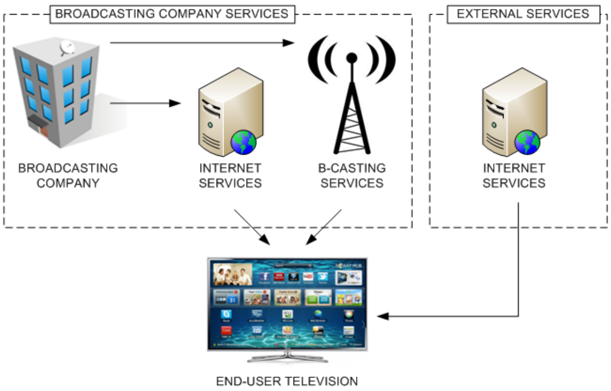


Figure 1. HbbTV content delivery.

Figure 1 shows the HbbTV content delivery schema. There are two options to deliver an application to the end-users:

1. **Data carousel delivery**. It is a broadcasting company method to deliver channel official applications. The application is broadcasted via broadcasting services while the data are accessible through the Internet.
2. **Internet delivery**. It is a scenario where custom content providers deliver their applications to end-users's terminals. These applications are accessible via TV main interface and do not require to be confirmed by broadcasters.

2.1 Applications architecture

HbbTV applications are web-based applications using existing web technologies: HyperText Markup Language (HTML), Cascading Style Sheets (CSS) and JavaScript [6]. However HbbTV applications differ from regular web applications. HbbTV applications need to comply with different accessibility cases and HbbTV limitations.

HbbTV applications do include JavaScript extension supporting different applications scenarios. With JavaScript it is possible to access the prebuilt functionalities of TVs and STBs. It is possible to access features such as video and audio player. In addition, advanced features such as TV navigation interface handling are supported.

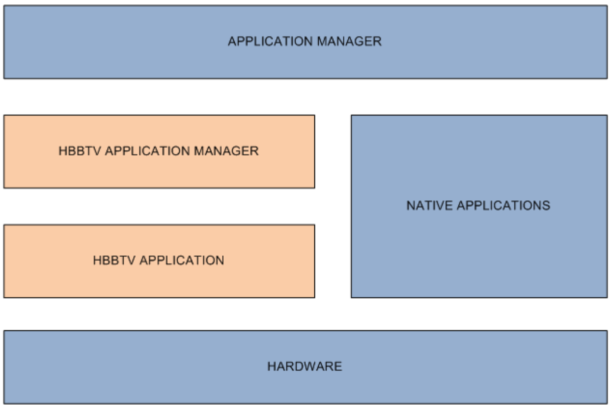


Figure 2. HbbTV applications architecture.

Figure 2 shows the simplified HbbTV applications architecture. TVs and STBs can run various multitasking operating systems. The application manager handles multiple native applications while the HbbTV applications manager handles web-based HbbTV applications, which are the main topic of interests. It is a fact that only one HbbTV application can be displayed at a time. Moreover this impacts on applications to be designed properly not to lock the user interface or the entire system.

2.2 Applications design requirements and guidelines

HbbTV applications have to comply with basic requirements to enable the whole system (HbbTV application manager) to work properly. It is required to:

1. **Enable the application**. In case of data carrousel (channel) applications, application gets started by the application manager automatically. So called "red button applications" were introduced to enable the end-users to decide wherever to use the application or not [7]. When an application is loaded a notification is displayed. With a red button press the application is displayed over the channel video. The application manager triggers the events to the application. The entire procedure has to be handled by the application.
2. **Handle the navigation**. Navigation is in general limited to remote control only. Use of arrows buttons, ok button, numbers and functions buttons is recommended. For registered buttons the application manager triggers appropriate application events. However the application has to handle all events, including system requests such as closing or disabling the application.
3. **Build efficient applications**. In view of the fact that TVs and STBs are low performance devices, applications functionalities have to be optimized for low resources consumption. There is a per application size limit. Depending on the device, only applications between 2MB and 4MB are supported. However this will change in the future with more sophisticated devices.

Nevertheless enabling the application and handling all navigation events user experience depends on additional guidelines [8]:

1. **Internet connection check**. When application is delivered over the data carrousel it is recommended to check the Internet connection before loading remote data. In case of no Internet connectivity the application has to be switched to an alternative mode.
2. **Use of simplified layouts**. TV resolution is limited to 1280 per 780 pixels. Limited content has to be displayed, as larger fonts have to be used. Moreover simple navigation patterns have to be used avoiding the use of unnecessary buttons.

3 Dynamic content delivery application

The goal is to provide a solution to support the live editing of content to be displayed on TV via HbbTV.

Moreover it aims to support the HbbTV scenario where only broadcast without Internet access is available.

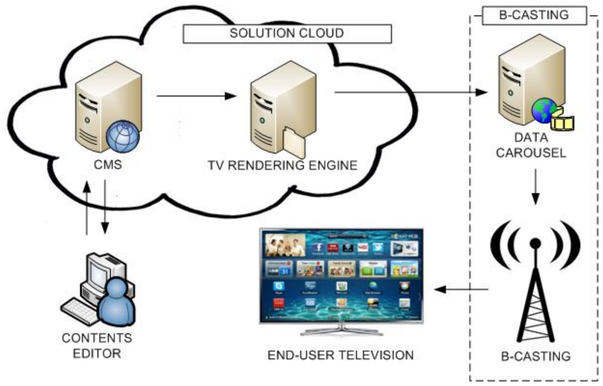


Figure 3. Content delivery solution schema.

Figure 3 shows the main solution schema. It implements a cloud service to edit and define the content to be delivered to end-users. The solution defines five main entities:

1. **Content management system (CMS).** It is a web-based system enabling the editing of content. A general CMS supporting the custom save format data modification can be used. In implemented scenario a learning management system (LMS) Echo was used.
2. **TV content rendering engine.** It is an engine that renders raw data delivered by CMS to a form suitable to be displayed on a TV. Moreover rendering engine implements the required HbbTV application needed to deliver content via data carousel. A custom solution was implemented as the rendering engine.
3. **Broadcasting**. HbbTV broadcasting server supporting the data carousel is a required element of the solution. Brahms server [9] was used.
4. **Content editor**. A web browser with Internet access is required to access the CMS to edit the TV content.
5. **End-user's equipment**. It stands for end-user's TVs or STBs where final application is being used and content are displayed.

Solution provides a large amount of automated processes to properly deliver content to end-users. The solution flow is described as follows:

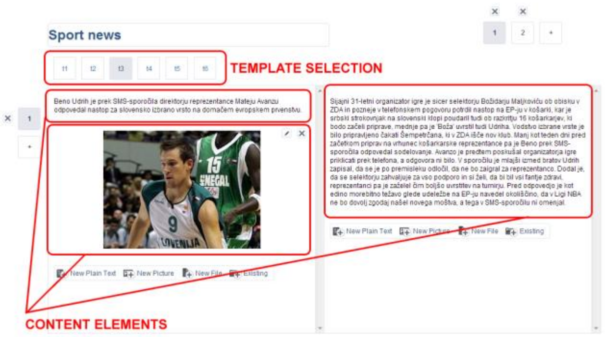
1. An editor edits and saves the content using the CMS.
2. CMS renders raw data in semantic form. Although data separately include content design definitions.
3. Raw data are delivered to the rendering engine via file share or rsync protocol [10].
4. Rendering engine renders data packages and related HbbTV application modifications.
5. Data packages are delivered to broadcasting server and in consequence end-users application is updated.

3.1 Content management system

As a CMS the LMS Echo was used. Echo supports the editing of learning content based on separate basic content elements joint into a single view content using predefined templates as shown in Figure 4.

Echo supports all basic content elements types – text, pictures, video and audio. However, as HbbTV currently does not support offline video, to match the no Internet access criteria, only pictures and texts are supported. Moreover the final application size limit, including offline content, is dependent of the device and is between 2MB and 4MB only.

Content elements are saved in raw format in separate files. Raw data do not include design or interface elements. Joint content is saved in JavaScript object notation (JSON) format in a separate file and it represents a single full screen content to be displayed. In addition it includes predefined meta-data on which depends the final layout of the content. Raw data are regenerated on every content update.



Beno Udrih je prek SMS-sporočila direktorju reprezentance Mateju Avanzu odpovedal nastop za slovensko izbrano vrsto na domačem evropskem prvenstvu.

Sijajni 31-letni organizator igre je sicer selektorju Božidarju Maljkoviću ob obisku v ZDA in pozneje v telefonskem pogovoru potrdil nastop na EP-ju v košarki, kar je srbski strokovnjak na slovenski klopi poudaril tudi ob razkritju 16 košarkarjev, ki bodo začeli priprave, mednje pa je 'Boža' uvrstil tudi Udriha. Vodstvo izbrane vrste je bilo pripravljeno čakati Šempetrčana, ki v ZDA išče nov klub. Manj kot teden dni pred začetkom priprav na vrhunec košarkarske reprezentance pa je Beno prek SMS-sporočila odpovedal sodelovanje. Avanzo je predtem poskušal organizatorja igre priklicati prek telefona, a odgovora ni bilo. V sporočilu je mlajši izmed bratov Udrih zapisal, da se je po premisleku odločil, da ne bo zaigral za reprezentanco. Dodal je, da se selektorju zahvaljuje za vso podporo in si želi, da bi bil vsi fantje zdravi, reprezentanci pa je zaželel čim boljšo uvrstitev na turnirju. Pred odpovedjo je kot edino morebitno težavo glede udeležbe na EP-ju navedel okoliščino, da v Ligi NBA ne bo dovolj zgodaj našel novega moštva, a tega v SMS-sporočilu ni omenjal.

Figure 4. Echo content editor.

A plug-in was built for Echo LMS that supports the simple share of raw data through Samba file share [11] or rsync protocol. Plug-in is in charge of referencing the distributed Echo storage to a single folder.

3.2 TV content rendering engine

Rendering engine is the main entity of the solution. It grabs the CMS raw data files and renders the final content layout to be displayed on TV. As there is a request to support the no Internet access scenario, all content has to be delivered to end-users. Besides content rendering, the rendering engine handles on-the-fly HbbTV application generation as new content depends on new version of the application.

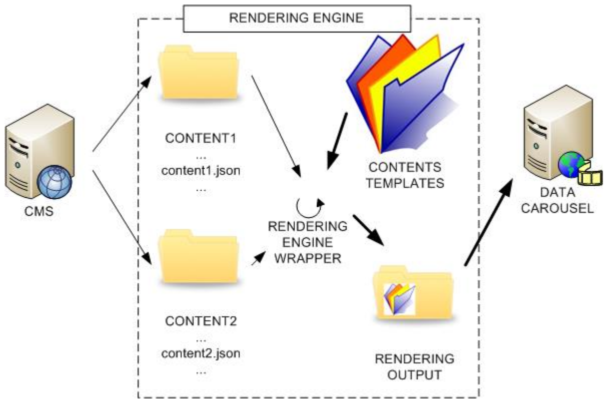


Figure 5. Rendering engine flow.

Figure 5 shows the content rendering engine flow. Input files deployed by the CMS are the entrance point of rendering engine. Input files are stored in a file system in separated folders named with the content identity number. Content elements are stored in separated files under the assigned content folder. Content definition files named with the content identity number followed by files extensions are stored under content folder. Content definition files store raw JSON data defining the content excluding any design information.

Templates are stored separately with the HbbTV application code. Templates are stored in separated files and can easily be updated. Templates are HTML files with related JavaScript code and CSS styles. JavaScript code mainly defines the HbbTV application.

Rendering engine wrapper is the main entity of the rendering engine. It checks the data raw folder for changes. On every change it runs the render procedure on changed content. Rendered files are stored separately in the final output folder. As a rendering engine a Hypertext Preprocessor (PHP) tag template concept was implemented. All rendered files complete the HbbTV application, which is continuously resend over broadcast services.

4 Conclusion

TV applications are an efficient method of content delivery to end-users. With modern TVs and STBs already supporting web-based content it is possible to deliver Internet services to TV. Limited Internet access in certain areas and slow web browsers embedded in TVs and STBs are stopping the evolvement of TV based content. Nonetheless it is realistic to expect the broadband access to expand and TV and STB to be improved with better hardware and better web browsers fully supporting all web client-side technologies.

The solution proposed and implemented solves the issue of automated content delivery through HbbTV applications. Moreover it supports regular content editing the way of editing common web pages. The solution was tested and evaluated using a local broadband server and transmitter. All the same there are no restrictions of porting the solution to a real case scenario as broadcaster's transmitters already support the HbbTV applications the same way. Moreover with few modifications the solution can be deployed to an Internet protocol television (IPTV) or cable provider network.

Currently there are issues of displaying the content on different devices as there are different web browsers being used. Future work will therefore include issues on application and content adaptation for different TVs and STBs receivers. Additional research is needed in field of client side application rendering optimization, as in near future it is not feasible to avoid the low performance TVs and STBs issue. Possibilities of automated porting of regular web pages content to TV content through HbbTV application will be addressed.

Acknowledgments

The work that led to the publication of this paper was partially funded by The South East Europe Transnational Cooperation Programme (TV WEB project) and by the European Social Fund and the Slovenian research Agency, grant No. P2-0246.

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