HYBRIDCAST: A NEW MEDIA EXPERIENCE BY INTEGRATION OF BROADCASTING AND BROADBAND

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ABSTRACT

Broadcasting has a role for the public service. Providing the same information to a large number of people at the same time has benefitted modern society in many ways, including presenting the forefront of lifestyle trends, offering dependable media during disasters and cost-effective transmissions. On the other hand, services over the Internet satisfy the individual's needs as seen in customization for each, interactive communication and user-generated media. NHK is developing "Hybridcast", a service platform integrating broadcasting with the Internet. This platform can enhance broadcasting programs and provide other various services by the best mix of features of both media. This paper describes the system and examples of service on Hybridcast for the general public including minority viewers. The next-generation media for a sustainable society will emerge from Hybridcast which is expected to be launched in 2013.

Keywords— Hybridcast, Interactive Broadcast Broadband System, Multi-screen Service, HTML5

1. INTRODUCTION

The digitization of broadcasting and the rapid spread of broadband environment have led to an information infrastructure that provides high-quality digital broadcasting and a variety of Internet services. A new era will soon dawn when broadcasting and the Internet will work together seamlessly to provide new services. NHK is developing "Hybridcast"[1] for a new era expected to launch in 2013.

Broadcasting guarantees a quality of service (QoS) and an efficient delivery of content to a large number of viewers, whereas Internet systems afford the flexibility to deliver personalized content that meets an individual viewer's preferences. NHK has been contributing to both technical and service developments for combining broadcast and Internet for a long time, taking into account their complementary characteristics, i.e., the efficient delivery of high-quality content on a large scale and the delivery of services tailored to a user's preferences, respectively.

Hybridcast is one of the hybrid broadcasting systems to combine broadcasting and network functionalities seamlessly. A hybrid broadcasting system accepts wide range of services. In general, the services can be categorized into following two types;

a) <u>Broadcast-related services</u>
   These are services strongly tied with broadcasting programs or content. For example, the services are intended to add more information to broadcasting content to enhance it. Though interactive TV services and data broadcasting have provided similar features, hybrid broadcasting systems offer much wider flexibility because network connectivity allows handling much more data than broadcasting channels and offering what individuals need, such as video-on-demand.

b) <u>Independent services</u>
   Like services on a smartphone such as Social Network Services (SNS) or games, independent services are not related to broadcast programs or content.

In hybrid broadcasting systems, the flexibility of the systems allows, for broadcast-related services, to provide additional content elements to make the broadcasting programs or content understandable better for every kind of people including the elderly, people with disabilities and minorities. The flexibility also allows important independent services to take care of every kind of people such as e-health.

Hybridcast is the service platform to enable such services and to bring new TV experience for all viewers. This paper describes the examples of services, its system concept and its architecture.

2. SERVICES ON HYBRIDCAST

Some example services on Hybridcast have been developed to verify system functionalities. Accessibility improvement, provision of better presentation of the event from many aspects, and protection of life and properties of people are taken into account for the examples. In this chapter, such broadcast-related example services are described.

2.1. Multilingual Closed-captioning Service

According to Japanese digital broadcasting standard, closed caption can be provided for up to two languages within a broadcast channel. Two languages may not be enough for some people including minority or foreign travelers. Broadcasting service will target majority in language firstly because broadcasting system is a system to deliver the same information to mass viewers very efficiently. If a viewer would like to watch closed caption in a language not

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delivered over the broadcast channel, the Internet can be used to deliver closed caption data in the preferred language. Hybridcast has a broadcast-broadband synchronization mechanism which enables the synchronization of various types of streams from multiple sources. The closed caption server feeds time-stamped caption data in the requested language and they are presented synchronously with the broadcast program.

Figure 1 shows an example image of this service. In Figure 1, seven languages are available. A viewer selects the preferred language by using a remote controller, and closed caption in selected language is on the screen. Under some conditions, the service provider may offer "user generated closed caption" which can extend the language selection.

By this service, closed caption service even in minor languages can be available without buying a dedicated receiver so that the people can get information through TV set in understandable or preferred language.

Figure 1. Multilingual closed-captioning service

2.2. Sign Language Animation Service

Closed caption is provided with many TV program in Japan. Although this is a useful service for the deaf, there is a need to provide another type of the service to them. For some people, textual representation is something like a foreign language and the so-called mother-tongue is the sign language. In case of an emergency, provision of sign language interpretation to broadcasting program is a critical issue for such people. Reflecting the situation, there is a strong demand from the deaf community for sign language interpretation to broadcasting programs. However, few TV programs are broadcast with a sign language service for the deaf. The reason of being is the insufficient number of sign language interpreters. And probably they will not be available for an emergency broadcasting program at midnight. Considering that the availability of sign language interpreter will not be improve soon, it is important for the deaf community to make sign language interpretation available at all times even in alternative ways.

For this purpose, NHK is developing a technology to generate sign language Computer Graphics (CG) animation by using TVML (TV program Making Language)[2]. The combination of this technology and Hybridcast can provide sign language animation services.

It is important for broadcasting service compatibility of sign language interpretation for people who want and who don't want the service. Sign language interpretation should be switchable at the receiver side, and video image of sign language interpretation should not be overlaid at the broadcast stations. So, video image of sign language should be delivered independently from the broadcasting video image. However, normally broadcast channel is fully occupied by regular broadcasting data and there is no space in broadcast channel to provide switchable animation video images.

When using Hybridcast, sign language animation video images can be delivered over the Internet. The Hybridcast application for CG sign language running on a receiver requests additional video images of sign language interpretation, and by using the broadcast–broadband synchronization mechanism, a sign language animation is presented synchronously with broadcast program (Figure 2). Because TVML technology can generate sign language animation from textual scripts, emergency information can be provided in sign language even at a time when human sign language interpreters are not available. This will help the deaf to evacuate or take an appropriate action in case of an emergency.

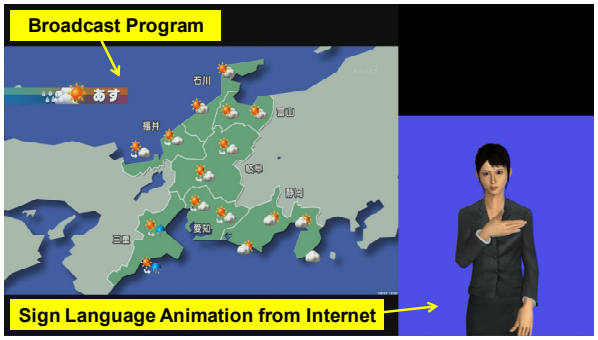

Figure 2. Sign language animation service

2.3. Multiangle Camera Service

Many of the TV programs use multiple cameras during production and each camera shoots different objects or the same object from different angles. It is quite normal for broadcasters to select one of the images as a part of the program production process. On the other hand, viewers may sometimes want to watch the image from another camera. Sports or music program may be typical programs for such needs. For example, during watching a jazz live program, a viewer is interested in each player, on piano, drum, bass, sax and so on. Watching the object on a TV set from multiple angles helps viewers to understand the ongoing event better. Hybridcast with the application for multi-angle satisfies the needs.

This service provides videos of multiple cameras over the Internet. Basic mechanism for synchronization of two video images is the same as for the two services above. The Hybridcast application running on a receiver allocates multiple video images and, in some cases, the selected image can be enlarged by the application. Figure 3 shows an example of a screen image for the service.

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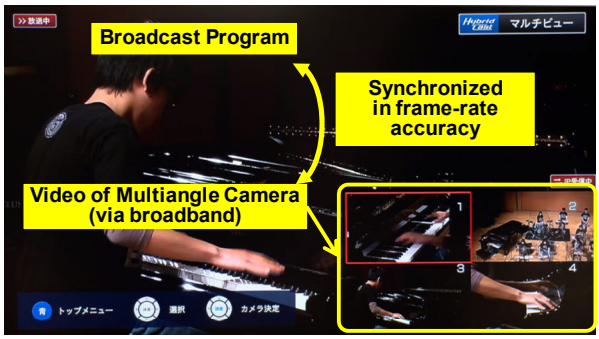

Figure 3. Multiangle camera service

2.4. Language Study Service

Providing an educational broadcasting program is one of the important elements of a public service. A language study program is a typical example of this. Hybridcast can provide a language study service with a secondary screen device (Figure 4), which contributes an efficient and effective education. An application on a tablet is used to ask questions about conversation in the program. Viewers can answer the questions using touch controls.

Synchronization of the application on the tablet is achieved by using a trigger signal within a broadcast channel and multiple-device linkage function in the Hybridcast receiver. A broadcaster sends the trigger signal when asking a question. Once the application on a TV set receives the trigger, it tells the application on the tablet to acquire data of the question over the Internet and to start asking it.

Such a mechanism and user interface of a tablet may introduce viewers to new experience of language learning. Especially, touch interface makes learning fun and viewers may not get tired quickly.

Use of the secondary screen device as an interactive text book can be applied to other subjects of education. It will allow reviewing the matters of wrong answers later very easily, and help effective learning.

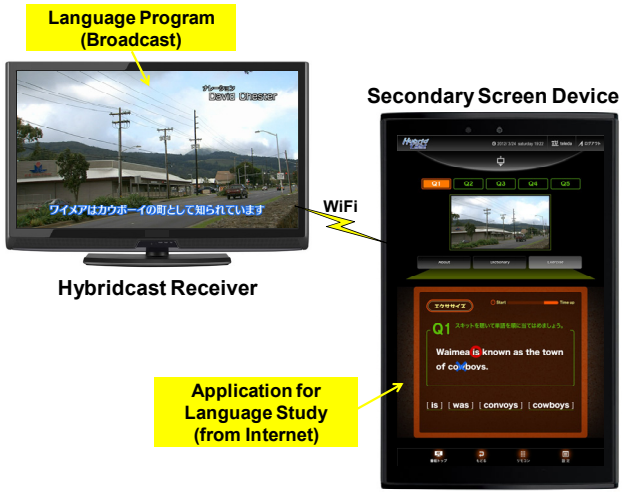

Figure 4. Language study service

2.5. Social TV Service

One of the highlights of TV viewing is to spend time and discuss with family or friends while watching TV programs, especially in live broadcasts. It is quite natural to do so when a family shares the single TV set and watches the same program together. By integrating with an SNS, Hybridcast enables people who are not in the same location to share the feelings as if they were nearby. It is so-called Social TV[4].

Figure 5 shows a chat application example. It lists friends who are watching the same program on top-right of the screen by icon. On the bottom-right, chat messages are displayed.

The Hybridcast application manages the login status of SNS and watching status of the program. The application obtains the ID of program from the receiver. The application then sends the ID of program to the server for the SNS. The friends or family who are logged in and have registered the same ID of program become chat members. Thus, Social TV service can create a virtual space for TV experience and overcomes physical distance among friends or family.

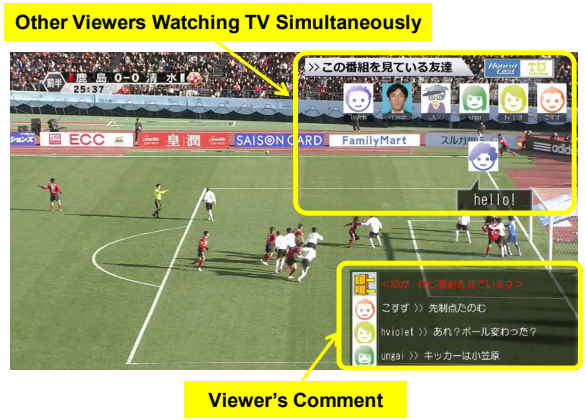

Figure 5. Social TV service

2.6. Prioritized Presentation of Important Information

One of the important roles of broadcasting service is providing emergency information to viewers accurately and quickly as much as possible. This is one of the primary functions of broadcast to communities in case of an emergency. In Japan, the government deployed alert systems against large earthquakes and tsunamis. When broadcasters receive emergency information from the authorities, they have to provide this information to viewers as quickly as possible[5][6]. These systems greatly helped to escape from the disaster when the Great East Japan Earthquake occurred in March, 2011.

This characteristic of broadcast has to be maintained in Hybridcast as well. However, in Hybridcast, two kinds of media share on one TV screen: broadcast video and applications from the Internet, which may be independent each other. If emergency information is broadcast and overlaid information onto the broadcast video hides some pieces of information provided by the broadcasters, there is a risk that viewers may miss the important information.

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Especially, earthquake alert is broadcast a few seconds before the quake hits. There is no time to manipulate something by the viewers. The time remaining may be comparable to watching the screen and understanding what is going to happen.
A presentation control in Hybridcast will be engaged to reduce such risks[7]. Figure 6 shows prioritized presentation of broadcast program which conveys emergency information. A receiver continuously monitors broadcasting signal to detect emergency signal information embedded in it. As soon as such a signal is detected, the receiver controls to enlarge the broadcast video to full-screen and removes the application which is running from view. After the signal is turned off, the former layout is resumed.

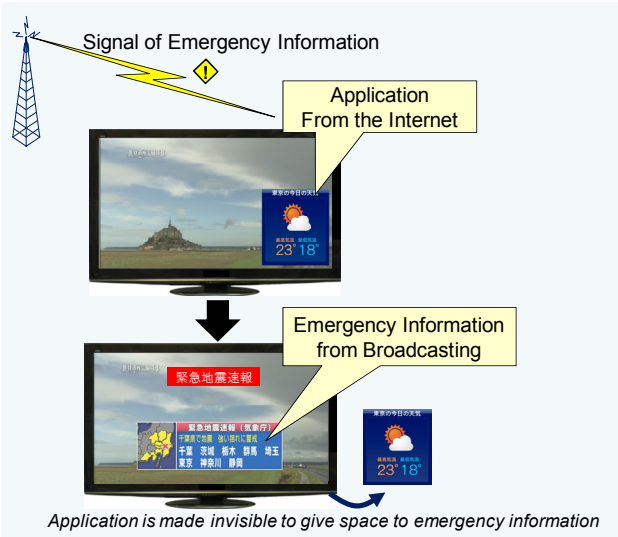

Figure 6. Use case of the presentation control

3. PLATFORM DESIGN

3.1. System Concept

These services are just the tip of the iceberg and so many services that we cannot count will emerge on Hybridcast. Provision of flexibility and service expandability to build a variety of services is the most important characteristics for the Hybridcast platform. Application-oriented approach and introduction of various players, not only broadcasters but also third-party service providers, into the overall system are keys to offering a diversity of services .

3.2. System Requirements

As a first step for system development, the system requirements are determined based on an analysis of the use cases. Most of the requirements derived as a result of the analysis are consistent with those defined in Recommendation ITU-T J.205, "Requirements for an application control framework using integrated broadcast and broadband digital television". Among the requirements of Hybridcast system, five of the most fundamental requirements are described below.

3.2.1. Compatibility with existing broadcasting system

Hybridcast system should be compatible with existing broadcasting systems. In Japan, total shipments for DTV (Digital Television) receiver are over one hundred million. It is impractical to introduce new incompatible broadcasting systems dedicated to Hybridcast. In addition, coexistence with a data broadcasting service is required. Data broadcasting services are widely used and popular. In some cases, it is necessary to start Hybridcast service from a data broadcasting service, and vice versa.

3.2.2. Application management

A viewer can experience various services through the Hybridcast application. This means methods to start and stop the application is essential to the Hybridcast system. For example, when a viewer wants to participate in a quiz show using a Hybridcast application, the application should start at the time of the broadcast program automatically, and stop at the end of the program automatically. On the other hand, there is an application which is independent from a broadcast program such as weather forecast application. This kind of applications should start under the instruction by the viewers at any time, and stop similarly. The application management mechanism in Hybridcast should satisfy these different start and stop scenarios.

3.2.3. Broadcast resource access

The close combination of broadcast and application enables the creation of a new TV experience. Hybridcast applications should be able to access broadcast resources such as video, audio and metadata and to use them TV functions such as tuning to new channel. However, access to those resources should not affect the content integrity of the broadcast.

3.2.4. Receivers

The receiver is one of the key equipment to build the services on the Hybridcast platform. The receiver finally makes presentation, provides interactivity for viewers, handles various control signals, and offer functionalities to the application. If the receiver provides multiple video decoders, it will allow the service to combine multiple video images on the same screen.
Various smart devices such as tablets and smartphones using user-friendly interface have become popular. On Hybridcast, these devices should be available as a remote controller and a screen for displaying information. To use such devices as 'companion devices', it is essential for a receiver to equip link and communication mechanism to them.

3.2.5. Security

Introduction of the third-party service providers will make the range of services wider. Service expandability is a fundamental factor of the system concept of Hybridcast as

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described in chapter 3.1, and Hybridcast welcomes third-party service providers. However, security level of third-party application or services may vary for the each application or service. From this viewpoint, security feature of Hybridcast is more important than for existing broadcasting systems.
The security mechanism in Hybridcast platform should protect interests of stakeholders including broadcasters and viewers. For viewers, unintended access to personal information by the application is one of the risks. For broadcasters, unauthorized overlaying of graphics or text onto broadcast video by the application breaks content integrity. The security mechanism to take control of access to the information or behavior of the application in proper manner will bring safety and comfort to stakeholders, so that more service providers will offer the services, or more viewers enjoy the services.

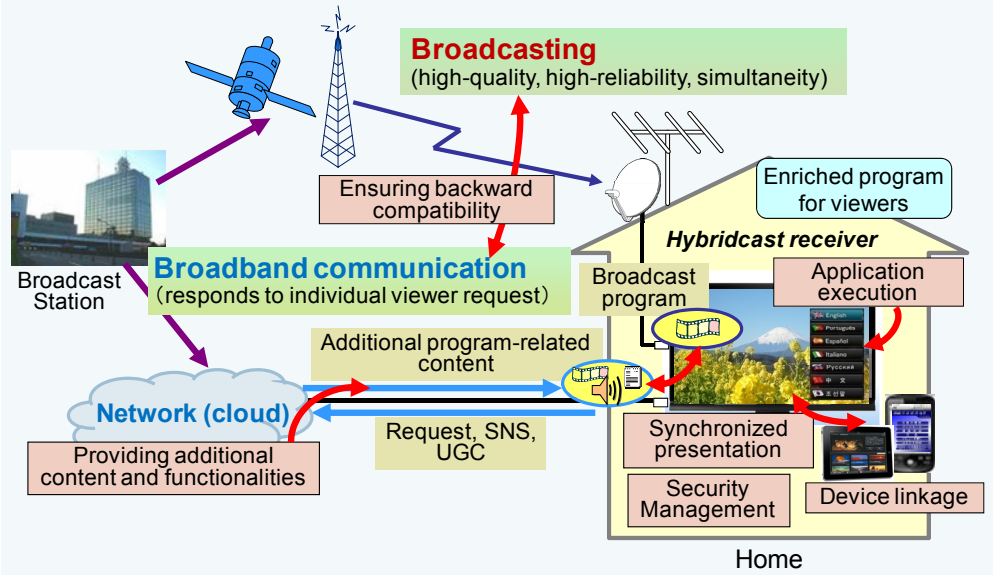

Figure 7. Conceptual diagram of Hybridcast

4. SYSTEM ARCHITECTURE

A conceptual diagram of the Hybridcast is shown in Figure 7. The platform consists of the existing broadcasting system, additional servers in the cloud, and Hybridcast receivers. The receiver functionalities include application execution, the handling of broadcasting resources, multi-device linkage, content synchronization and security management.

4.1. System Overview

To build such a platform, we designed a simple system architecture. The Hybridcast system utilizes the existing broadcast system as much as possible. Figure 8 shows the network part of Hybridcast's basic system architecture. The system consists of three blocks: broadcaster servers, service provider servers, and receivers. The broadcaster servers provide broadcast content and content-related information, which only the broadcasters hold, to the service provider servers. The service provider servers provide applications, content, and relevant information to the services or end users. Hybridcast receivers execute applications to realize various services. Such an application-oriented approach enables a rather simple receiver-side implementation.
Hybridcast applications running on a Hybridcast receiver process the content and relevant information obtained from the service provider servers. The applications on a receiver can access to required information from broadcast and the network, and call functions. Service providers are not only broadcasters but also third-party service providers.

4.2. APIs – Interfaces between Three Entities –

One of the main features of Hybridcast platform design is a structure of the three entities: broadcaster, service provider and receiver (Figure 8). Each entity provides a specific function to other entities via APIs (Application Programming Interfaces). In other words, among these three entities, API is a "grew" to exchange information and request processing information or media content.
APIs in broadcaster side makes it easy to access to them by service providers. Authorized service providers, including third-party, will access broadcast data through the APIs, creating their services, and offer them to the viewers. APIs in broadcaster side can be defined by broadcasters themselves; Common APIs at broadcasters for services providers will reduce complexity and required investment to provide actual services by service providers. The common APIs will be effective when many service providers offer broadcast-related services. Opportunity for the third-party service providers to offer their services on the platform is expected to expand the range of services as well as those by broadcasters. Hybridcast may not only encourage developing new business models for public, but also support to provide various services for minority.
APIs in a receiver have to be standardized to offer built-in functionalities of a receiver to all Hybridcast applications. Standardization of receiver APIs and a format of application signaling is carried out at IPTV FORUM JAPAN for the Hybridcast system.

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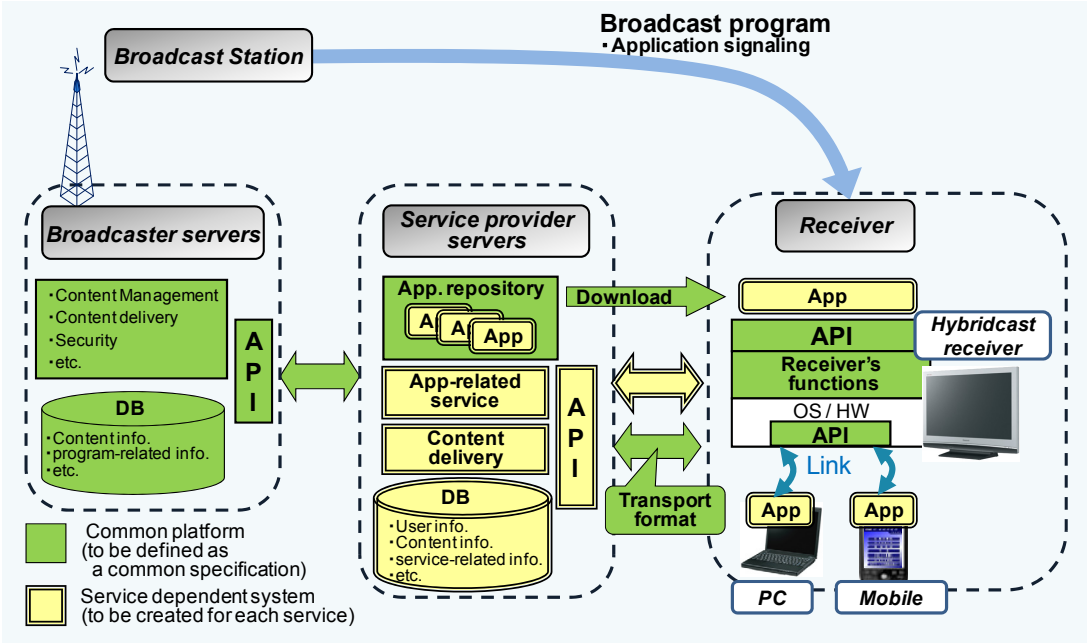

Figure 8. System overview

5. APPLICATION MODEL

Using Hybridcast, viewers can experience various types of services through Hybridcast applications. Considering services offered in Hybridcast, there are several types of applications which execute on the receiver.
Hybridcast applications are categorized as either broadcast-related or independent. For example, the application used for a quiz show should work together with the broadcast program. On the other hand, a weather forecast application is used independently from a broadcast program. As seen in these examples, there are several different application lifecycles, i.e. when to start and when to stop the application, depending on the application type. The lifecycle of a broadcast-related application should be controlled by a broadcast signal to associate with the program, while that of independent applications should be controlled by the viewer. A receiver provides an application launcher that creates an application catalogue for choice of independent applications. If a viewer wants to use such an application, all he or she needs to do is to start the launcher and choose the desired application.

6. HYBRIDCAST RECEIVER

The utilization and management of the application are directly linked to the user experience, because Hybridcast is application-oriented system. In this chapter, the basic architecture of the receiver, application management the mechanism and unique functions of Hybridcast are described.

6.1. Architecture

HTML5[8] is chosen as application environment in Hybridcast. There are three reasons to use HTML5.

(1) Easy implementation. A number of TVs and portable devices provide a Web browser. So, basic functionalities to handle HTML5 are naturally built-in these devices.
(2) High functionality and high efficiency. Using CSS3 (Cascading Style Sheets, level3) and Ajax (Asynchronous JavaScript + XML), applications with a rich interface and functionality can be easily developed.
(3) There are significant support to use HTML5 from many broadcasters and TV manufacturers.

By these reasons, HTML5 is adequate for Hybridcast on consumer electronics devices such as TV sets.

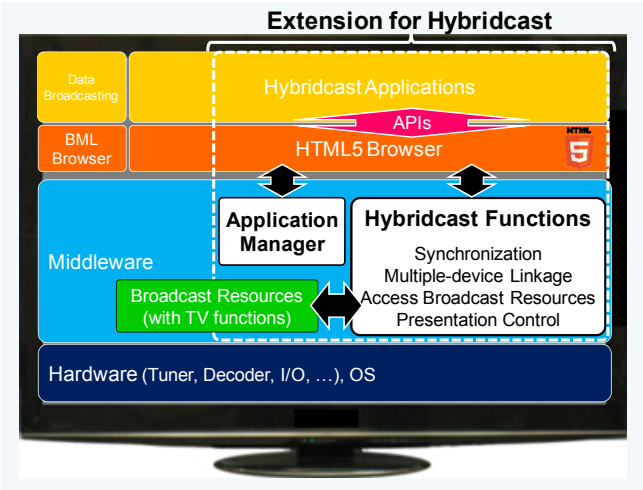

Figure 9. Architecture of a Hybridcast receiver

Figure 9 shows the layer architecture of the Hybridcast receiver. The receiver consists of four layers: the application, browser, middleware, and hardware. A typical Japanese DTV receiver supports data broadcasting services using BML (Broadcast Markup Language). A Hybridcast

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receiver is equipped with a BML browser in parallel to a HTML5 browser. The middleware layer handles broadcast resources. Application manager is introduced for controlling applications on an HTML5 browser. Various functions are also implemented in middleware for broadcast-broadband combination and presentation control for emergency broadcasting. In case of emergency, the HTML5 browser is controlled by presentation control function to stop exhibition of the applications. Standardized APIs are prepared between an HTML5 browser and a Hybridcast application so that Hybridcast applications can use these functions easily.

6.2. Application Manager

The application manager controls the start and stop of applications. To allow program-related applications to work together accurately with a broadcasting program, the manager consistently monitors the control signal in broadcast channel. On the other hand, the manager also starts and stops independent applications at any time by viewer's manipulation. When starting an application, the manager instructs the HTML5 browser to load the application from the location represented in URL in the control signal. When stopping an application, the manager also instructs the HTML5 browser to terminate it.

6.3. Security Control

Hybridcast is an open platform where third-party service providers offer their services. As discussed in 3.2.5, open platforms have potential security risks such as application tampering and leakage of privacy[9]. Improper access to broadcast resource is another potential security risk, which may break copyright. It is important to make the system compliant to fixed rules to protect rights of each entity.
In Hybridcast receiver, many functional blocks provide their own security features. These features work together to satisfy the system requirements for security. According to execution context of the application, each block is designed to consult other relevant blocks for eligibility of access to security sensitive resources such as broadcast signal or non-volatile memory potentially containing user information.

6.4. Unique Functions of Hybridcast

6.4.1. Broadcast-broadband synchronization

A broadcast–broadband synchronization function allows an application to present timed content elements synchronously[10]. Figure 10 shows the typical mechanism of this function. This function synchronously presents timed components delivered from different channels, such as video, audio, and closed captioning. A broadcast signal can be considered as a stable and accurately timed component. In contrast, the packet-arrival time in a broadband network normally fluctuates. One solution to overcome the effect of this fluctuation is to provide a buffer in the receiver and transmit the broadband content earlier than the broadcast program. Content delivered through broadband shall provide time-stamp information so that the receiver can determine a synchronization point of the broadcast stream. By comparing time stamps of both streams, the receiver can adjust the time of presentation properly.
For a live broadcast program, larger buffers in a receiver are required since the additional data to be transmitted through broadband cannot be prepared ahead of time. The size of the buffer should be long enough to compensate for a lag in the broadband-delivered content. Actual buffer size will be determined by investigation of network latency.

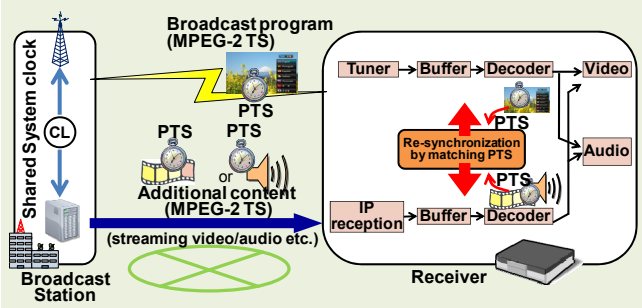

Figure 10. Synchronization mechanism

6.4.2. Multiple-device linkage

As the number of functionalities of broadcasting services and TV sets is increasing, remote controllers become more complicated. Instead of enhancing the functions or buttons on existing remote controller, use of alternative devices with user-friendly interface is one of the practical solutions for advanced services. Touch devices such as tablets or smartphones are typical devices for the usage and have emerged and spread rapidly. These devices have not only user-friendly interface, but also enhanced functionality of presentation of information, which contributes to the improvement of accessibility to all the viewers. Hybridcast provides multiple-device linkage function for this purpose.
Figure 11 shows how the applications on the secondary screen devices interact with the application on TV set through WiFi or a home network. The underlying mechanism of API's on a TV set and the secondary screen devices controls communication across the devices and allows communication between the applications. For example, when a viewer changes the channel using an application on secondary screen device, the application sends the message to the application on TV set. The application on the TV calls the API to tune to the new channel.

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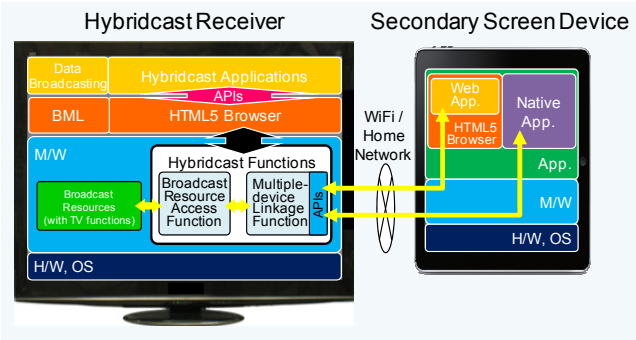

Figure 11. Multiple-device linkage

7. STANDARDIZATION STATUS

Hybridcast, as a service platform, is under standardization at the IPTV FORUM JAPAN. Broadcasters, TV manufactures, telecommunication carriers and service providers are joining a discussion about a specification of the platform toward the launch of Hybridcast in 2013. Among the elements shown in Figure 8, the standardization activity focuses on the receiver and application signaling because these areas are the most important parts for actual deployment of Hybridcast. In fact, the Hybridcast standard defines signaling format, middleware functionalities in a receiver, application format and additional APIs, like standard of HbbTV[11] which is an European hybrid broadcasting system.

Standardization road map of Hybridcast consists of two phases. The specification of the first phase will be finalized in the first half of 2013. The first phase focuses the functionalities for broadcast-related applications and services. Independent application capability and advanced feature such as frame-by-frame synchronization of Hybridcast are subject for standardization in the second phase. However, discussions of the both phases are carried out in parallel, which allows coherent overall system design. The first phase specification allows the service providers to use rich graphics presentation on a TV based on the HTML5 and other related web technology standards, use the secondary screen devices, and synchronize the application behaviors with broadcast program in trigger signal based manner. The standard does not specify actual implementation; the receiver manufacturers are responsible to design and implement the defined functionalities which allow the some of the advanced broadcast centric services, as described in chapter 2 except those in 2.2, 2.3, and 2.6 The second phase specification includes more advanced features such as independent application, an application control mechanism with an application launcher, a security mechanism for independent application, and frame-by-frame synchronization. The second phase specification will allow introduction of the full-fledge Hybridcast services. The finalization of the second phase specification is not yet determined but expected in the near future.

Toward the actual implementation and deployment of the phase one Hybridcast services, some broadcasters including NHK and some manufacturers are working together to establish operational guidelines and test signals of the receiver as well as creating the standard itself.

Knowledge and technologies of Hybridcast have been contributed to create Recommendation ITU-T J.205 and its subsequent series of Recommendations for reference architecture and system specification, Recommendations and Reports on hybrid broadcasting systems at ITU-R Study Group 6, and World Wide Web Consortium (W3C).

8. CONCLUSION

The Hybridcast is a service platform that uses a broadcast-broadband combination to enhance TV programs with variety of services. This paper describes overview of the system and examples of service. In some examples, it is also described that ability of Hybridcast reaches not only for public but also for minority and for family and friends.

NHK is now leading standardization of Hybridcast platform. It is expected that Hybridcast will be launched in 2013 and that it takes a role as a next-generation media for a sustainable society.

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