Method to Reliable Interactive Broadcasting Architecture in Convergence Environment

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Abstract

Owing to the convergence of broadcasting and communication, spread of smart devices, and formation of environments for new media channels, we now face a new paradigm in which wired- and wireless-network-centered content is shared openly. With increasing services that enable the use of real-time broadcasting and content via PCs, smart TVs, and smart phones, users are demanding one-source multi-use (OSMU) services that allow them to use the same content anywhere at any time regardless of device. However, there are difficulties in resolving technical and compatibility issues of smart devices based on different platforms. In addition, there are limitations to developing a reliable certification system for using content freely with heterogeneous devices. This paper suggests a reliable interactive contents delivery system (RICDS) architecture for effectively transmitting and managing OSMU services by using heterogeneous devices in a convergence environment. We also devise a prototype RICDS that is feasible in real system environments.

Keywords: *One Source Multi Use (OSMU), Interactive Content, Heterogeneous Devices, Broadcast/Communication Convergence*

1. Introduction

With the increasing use of smartphones and other mobile devices, the Internet usage has moved from exclusively wire-line to wired and wireless environments [1]. Owing to the explosive growth of wireless data triggered by smart phones, network sophistication is advancing in accord with IT convergence not only in the broadcasting and communication industries but also in all industries. In other words, structures for service and content distribution are being transformed because of devices with excellent individualization and portability regarding broadcasting and communication convergence services such as music, TV programs, and messaging centered on PCs. This requires data conversion into multiple formats appropriate for different devices to offer two-way services and content by ensuring compatibility among devices and linkages [2, 3]. With the paradigm changes have provided opportunities for new entertainment services (e.g., N-screen). We use the term N-screen to refer to multi-device services that provide content across various platforms such as IPTVs, PCs, and mobile devices to share and consume information. The objective of N-screen services is to enable the user to use multiple devices. That is, an N-screen service [4] should consist of integrated platforms for multiple devices. Importantly, users are going beyond the use of real-time broadcasting and content via N-screen services to demand OSMU services that can play the same content on different devices while enabling free conversion. However, current OSMU services can only be realized in devices with the same platform [5]. Moreover, another challenge is the lack of a certification system to develop an environment

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considered reliable by users and devices while using it after converting the content with heterogeneous devices. The remainder of this paper is organized as follows. In Section 2, we examine the status of markets for mobile services platforms. We discuss the problem statement regarding interactive content transmission in Section 3. Subsequently, in Section 4, we suggest a reliable interactive contents delivery system that implements four mechanisms. We then provide an overall algorithm and prototype in Section 5. In Section 6, we analyze our performance and compare it with other platforms for N-screen strategy. Furthermore, we describe the expected benefits of the proposed system in Section 7. Finally, we offer conclusions and suggest directions for the future work in Section 8.

2. Case Study - Status of Smart Mobile Platform in Korea

There have been several studies concerning N-screen service, such as connectivity via different platforms and openness for Internet-enabled devices. In this section, we provide a brief comparison of our system with other proposals.

There are many international companies involved in N-screen services [6, 7]. Telecommunication company A [8, 9] provides high-speed Internet, television, and home telephone services. These services combine computer network connections with fiber optics to provide fast and reliable digital services. In addition, it espouses the 3 screen strategy. Company A[10] also has a store with the potential to offer N-screen services. With company A recently announcing a new TV platform model, people can now view TV programs through the same store they use for smartphone and smartpad applications. This means that users can seamlessly work content across their smartphones, PCs, and TV screens. The same can be said about the smart TV platform model of company G [11]. This platform integrates the android operating system and Chrome browser based on Linux to create an interactive TV overlay on top of existing Internet TV and webTV sites. There are few domestic R&D projects [6, 7] on the N-screen service. Telecommunication Company S recently announced a new service [12] that offers seamless exchange of content on heterogeneous devices such as smartphones, PCs, tablet PCs, and TVs. When the service is connected to a TV, users can play smartphone-stored content on the TV as well as search and buy items online. In Table 1, our work is compared with other R&D projects on N-screen.

Table. 1. Comparisons among the Existing Platforms

Platform / Requirements	A company	G company	S company
Scalability			
· OSMU support	Partially : Only available at own store	Partially : Still under development	Partially : Require a special Platform
Connectivity			
· Mobility in different environments	Yes	Yes	Yes
· Exchange between different devices	Partially : Only worked with own-made	No	Partially : Prefers particular devices
Openness			
· Contents accessibility	Partially : Closed store	Yes : Open market	Yes : Open market
Security			
· Consolidated authentication	No	No	No

3. Problem Statement

The dramatic spread of smart devices is creating demand for technologies that enable the use of content or services among heterogeneous devices—used independently in the past—at the same time and interchangeably in a linked manner. To realize such technologies, attempts are currently being made to manage platforms for mobile, wired Internet, IPTV, and other services in an integrated manner to secure competitiveness [13].

However, there is a limit to establishing a single platform optimized to every service with the technologies that exist today. In other words, the current homogeneous platform enables presentation of content via mobile, web, and TV by ensuring their compatibility. As yet, there is no case in which content is provided via N-screen through independent platforms.

- Given that the current TV platform is developed with Java middleware, there are difficulties such as complexity, development costs. Conversion of web content to that suitable for a TV platform is also difficult.

- Web services are being partially converted through the browser for TV platforms. However, there are many issues such as loading speed, required device functions, and integrated content operation.

- When content is shared among heterogeneous platforms, the N-screen authentication is managed through the PIN authentication of a single set-top box. This makes it difficult to provide a trustworthy environment among users and devices.

- Portable devices cannot support all services because of limited resources such as low bandwidth and power consumption. Multimedia content may not be suitable for limited heterogeneous platforms.

These issues faced by the IT society must be resolved in order to support efficient broadcasting and communication convergence services. In the following section, we suggest a reliable interactive contents delivery system (RICDS) to solve these issues.

4. Reliable Interactive Contents Delivery System

We propose an RICDS (Reliable Interactive Contents Delivery System) that provides transmission of interactive content for heterogeneous devices when content is used through one of the heterogeneous devices of a user. RICDS is composed of 4 mechanisms: 1) a user and device authentication mechanism (UDAM), 2) an interactive content management mechanism (ICMM), 3) a real-time interactive processing mechanism (RIPM), 4) and an interactive content distribution mechanism (ICDM). Figure 1 shows how the RICDS works between a user's heterogeneous devices.

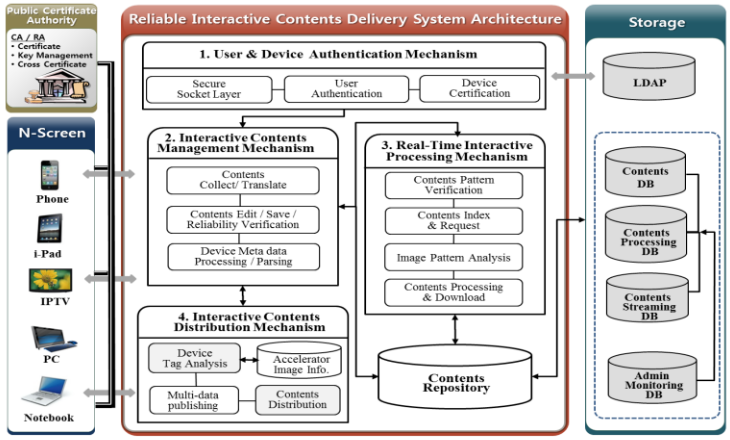

Figure 1. The Architecture of RICDS (Reliable Interactive Contents Delivery System)

The **UDAM (User and Device Authentication Mechanism)** maintains confidentiality of the subjects concerned with RICDS. Through the user and the user's heterogeneous devices, the certification given by the certification authority (CA) provides the verification and execution process of user identity and the final certification of the heterogeneous device [14, 15]. **Interactive Content Management Mechanism** is the integrated contents management store mechanism for contents collecting, managing, editing, producing and storing, inserting metadata, metadata parsing to administers and users. The ICMM can verify the credibility or efficiency of the content by inserting metadata (e.g., resource format, object type, producers) to analyze the content producer information and a credibility authentication code upon completion of the test. Also, Metadata is used to provide diverse content as well as value-added services and to enable rapid search of content related to the user. As for the ICMM, when the user receives a request to convert to a heterogeneous device, an attribute of the to-be-converted device is verified in the ICDM. In other words, heterogeneous devices have different platforms. Thus, the image type that can receive content rapidly is different, and hence this is inspected. The image type of the verified device is delivered to the RIPM, and the content is processed to suit contents type and this is distributed to the user. **Real-time interactive processing mechanism** is providing fast delivery and distribution of the requested contents after authenticate device and users' identity. The RIPM uses an image capture processing method when an authenticated user's heterogeneous devices request content. Image capture processing method is used for seamless contents delivery with consistency and continuity between different smart devices and platform. The content or image selected by the user is extracted from the HTTP streaming servers as an image (e.g., screen capture images). Subsequently, the image on the device and the requested image are analyzed and compared to see how extensive the changes are. If any change is detected, the relevant image is extracted and saved in the predetermined image file format (e.g., jpg, bmp, png). Furthermore, when it is necessary to have content that has already been downloaded once, several image file formats can be sent to various heterogeneous devices. At this point, the content can be processed with speed and expansive compatibilities because these image transmissions are subjected to HTML- and XML-based processing. The **Interactive Content Distribution Mechanism** can quickly help transmit the content requested by the user after analyzing the tag attributes (e.g., device type, device browser type, device mainboard model). The ICDM can recognize events that can be changed to another heterogeneous device during processing because it periodically maintains the verification of a device by using its tag attributes. In addition, accelerator Image Information has image file format (e.g., jpg, bmp, png) information that can transfer rapidly for each heterogeneous device. Therefore, it requests the RIPM to modify the content image if the image type is changed because a digital device is switched. The ICDM verifies the information of the to-be-converted device after the user saves the time at which the content was viewed to convert it into content for the other device. When everything is confirmed, the content is redistributed to the user so that it can be played without stopping. At this point, processing is carried out using XML and HTML to provide a web-based real-time interactive content delivery service in a fast and scalable manner.

5. Prototype and Implementation

5.1. Algorithm

In this section, we provide an algorithm to implement these mechanisms. The RICDS can provide reliable interactive content services swiftly by extracting the images in real time—a necessary condition for each type of heterogeneous device (e.g., IPTV, Smart Phone, Smart TV, and PC)—while maintaining credibility and continuity. We suggest RICDS algorithms that support the four major sub-functions.

Algorithm Reliable Interactive Contents Delivery Management

```
1) User and Device Authentication Mechanism
if Login(user.id, user.pwd, user.cert) = true then
  pki.auth ← CheckAuth(user.id, user.pwd)
  user.cert ← CheckCert(pki.auth)
  return serialNum ← CA(CheckUserInfo(pki.auth))
   if Login (deviceNum, user.cert, serialNum, timestamp) = true the
     device.auth ← CheckAuth (deviceNum, serialNum)
     accessKey ← CheckCert (pki.auth, device.auth)
   else SendDenyMsg(err, 'Access Deny')
 else SendDenyMsg(err, 'Access Deny')
     return false
end if
2) Interactive Content Management Mechanism
if Request(user.id, accessKey, contents) = true then
   if my_contents = contents true then
     contentsView ←SearchContents(my_content, SEND)
    if CheckReliability(ContentsView, accesskey) = true then
     device.info←CheckDevice(accessKey)
     metabasedContent←CollectMetadata(ContentsView, Device.inf
      view_contents ←(metabasedContent, SEND)
   else SendDenyMsg(err, 'Reliability Fail')
  else SendWarningMsg(err, 'Saved Contents Not Exist')
      return DBSave(WebContentSVR)_info
  end if
end if
3) Real-time Interactive Processing Mechanism
 if accessKey ≠ null then
   DBSave(view_contents)
   if UpdateContents(view_contents) = true then
     RequestWebContentsSVR(view_contents, url)
     url ← GetHttpRequest(WebContentSVR)
     content_loc ← new ActiveContent(url)
     contents_loc.open('GET', url)
     blank_file ← CreateFile()
     new_img ← ContentsRepositoryAccess(content_loc)
     if blank_file = null then
        if new_img is valid then
          img ← OverallCapture(new_img)
        end if
     else old_img_size ← SizeofMemory(old_img)
          new_img_size ← SizeofMemory(new_img)
          if old_img_size ≠ new_img_size then
            img ← UpdateCapture(new_img)
          end if
     end if
   end if
 end if
4) Interactive Content Distribution Mechanism
device_character ← CheckDevice(Device_attr)
 /*Device_attr ← Device Type, DeviceTypeofBrowser */
img_kind ← SearchAccleratorInfo(device_character)
switch device_character.type
  case MOBILE:  // SmartPhone Device
      mobile_kind ← device_chracter.model
       /* SKT|LGT|KTF */
     device_kind←device_chracter.device_browser
      /* au|natem|me|telson|....|polaris */
     if mobile_kind is valid and device_kind is valid then
     MPEG4_img ← MobileEncording(img_kind, mobile_kind,
                                          device_kind)
     SendToMobile('HTTP_MOBILE_RESPONSE', MPEG4_img)
     else SendMsg(err, 'Unknown Device')
     end if
  case STB:  // STB Device
      stb_kind ← device_chracter.model
     if stb_kind is valid then
       MPEG4_img ← STBEncoding(img_kind, device_character)
       SendToSTB('HTTP_STB_RESPONS', MPEG4_img)
     else SendMsg(err, 'Unknown Device')
     end if
  case PC:  // Web Device
     pc_kind ← device_chracter.model
     if pc_character is valid then
        MPEG4_img ← PCEncoding(img_kind, device_character)
        SendPC('HTTP_RESPONSE', MPEG4_img)
     else SendMsg(err, 'Unknown Device')
     end if
end switch
```

5.2. Implementation

We implemented the reliable interactive contents delivery system (RICDS) to enable transmission of interactive content for heterogeneous devices in a convergence environment.

The application was developed using the following tools:

- Apache 2.2/JBoss 5.1.0.GA - as the interface in the real-time interactive processing/web system
- MySQL - as the database for data store such interactive contents information (CCTV admin Info, traffic policy, road map, traffic statics info).
- Java1.6., JavaScript, HTML - as the implementation language

The application was developed with a system based on CentOS using the following tools: Apache 2.2/JBoss 5.1.0.GA, JAVA, HTML, and MySQL.

The following is an application of the RICDS to the “N-screen-based CCTV Traffic Information Service System” of the Seoul Metropolitan Facilities Management Corporation. In this case, when real-time traffic image information is provided through heterogeneous devices, a user’s device only handles simple images in response to a request for large-scale content. This makes it possible to use the real-time interactive content service rapidly.

Figure 2. Main Screen of Traffic Information

Figure 3. Output Screen of Traffic Information

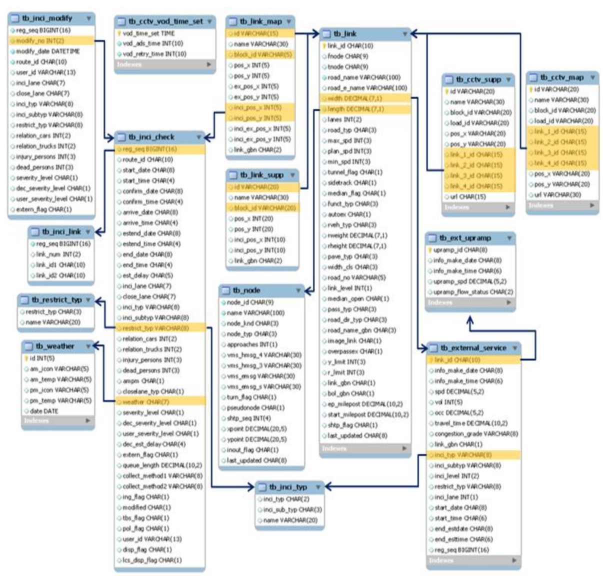

Figure 4. CCTV Database Table of Real-time Road Traffic

Figure 2 depicts the main screen of traffic information and figure 3 shows the CCTV output screen of traffic flow information to TV. Figure 4 shows the composition of the database required to provide CCTV traffic information from the central processing center to heterogeneous devices in real time.

6. Performance Comparison and Analysis

The focus of this paper is on the high performance and security of N-screen services. Performance evaluation criteria such as scalability, connectivity, and concurrency were used for N-screen service requirements, and integrated authorization was used for security. Although there are limits to establishing a platform optimized to every heterogeneous device with currently existing technologies. Our RICDS supports OSMU and provides high performance as well as secure service in convergence environments. This is clear from Table 2, in which our work is compared with other platforms in regard to the N-screen strategy.

Table. 2. Comparative and Analysis of the Various Platforms

Requirements \ Platform	A company	G company	S telecom	RICDS
Scalability				
· OSMU support	△	△	△	○
Connectivity				
· Mobility in different environments	○	○	○	○
· Exchange between different devices	△	X	△	○
Concurrency				
· contents concurrent processing	△	△	△	○
Security				
· Consolidated authentication	X	X	X	○

6.1. Performance and Stress Test

When content was transmitted after being switch to another device, we conducted a performance and stress test in order to provide contents seamlessly to user. The Figure 5 below is a comparative analysis of CPU speed and memory reliability when two hundred users and three hundred users requested OSMU (One Source Multi Use) service.

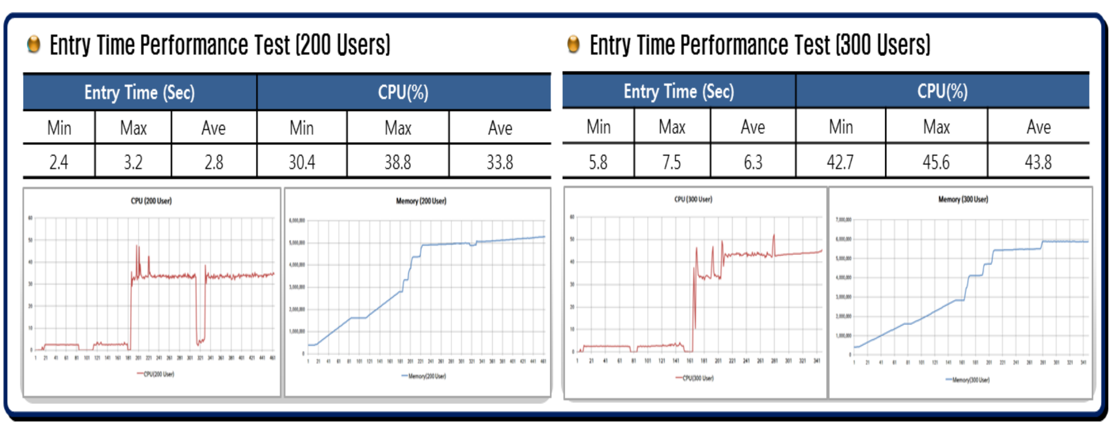

Figure 3. Performance Test of Interactive Entry Time

7. Expected Advantages

The expected advantages of the proposed RICDS are as follows.

- Interoperability of real-time interactive content

  The user's heterogeneous devices only handle simple graphics upon a request for large-scale content. Therefore, real-time interactive content services can be used rapidly. In addition, given that such a structure forms an open platform based on the Internet technology, without changing the communication infrastructure, services compatible with every standard can be received.

- Establishment of content reliability between heterogeneous devices

  By identifying the user and user's device from a reliable certification institution, a trustworthy certification system for sharing and using content in N-screen systems can be established.

8. Conclusion and Future Work

In this paper, we introduce an RICDS that can provide two-way content with heterogeneous devices by establishing an environment in which a user and a device can be trusted via integrated user certification. We proposed the RICDS as a means of interactive content delivery. It based on an image capture processing method to provide a solution for limit problems in which content cannot be played (e.g., because of performance differences between heterogeneous devices, supported data size, and resolution). That is, by suggesting an image processing method to allow image files to be played on a number of devices, our study shows that more effective interactive services can be provided. We show that the RICDS applied in an actual project on traffic information services in Seoul, which may be expanded subsequently to a national scale.

In the future, the proposed RICDS will form the basis for a system that is more reliable and safer when payments are made between heterogeneous devices.

Acknowledgements

This paper was supported by the Sungshin Women's University Research Grant of 2012.

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