

Standardizations and considerations on P2P-based contents distribution for digital signage service

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Abstract— Digital signage service provides advertisement and informational content to audiences by use of electronic displays. Nowadays, the resolution of display goes higher and quality of contents is also increasingly getting higher. On distributing its contents to multiple displays, it takes much time proportional to the number of terminal and size of content. This paper proposes a method for content distribution using P2P with more considerations for digital signage service.

Keywords— P2P, contents delivery, digital signage

I. INTRODUCTION

In order to provide consistent digital signage service, all terminal needs to prepare the contents prior to display on time, except live streaming. In general, a digital signage service provider/operator tends to manage large numbers of terminal. When it distributes contents to massive number of terminals, it takes too much time since there may be a bottleneck problem. For example, when it comes to distribute 100MB movie clip to 100 clients over 100Mbps network by serially, it takes approximately more than 13.3 minutes for completing the distribution. Nowadays, quality of video keeps going higher from HD to 4K/UHD, and display devices are still on extending their resolution for providing more high-quality video. It means that the volume of content would be increased accordingly, and it naturally leads to burden of content distribution for displaying on time. In order to resolve this situation, operators tend to use CDN (Content Delivery Network) services with some expenses. In this paper, we describe standardization status regarding digital signage, and describe several considerations for delivering signage contents using P2P technology.

II. STANDARDIZATION ON P2P-BASED CONTENTS DISTRIBUTION

In the view of standardization, there are two major study groups that are related to this topic; SG11 and SG16. ITU-T Q14/SG16 is focusing on specifying recommendations for digital signage in service level and SG11 is working on constructing managed overlay network. In this clause, we describe their activities regarding P2P-based signage contents distributions.

A. ITU-T SG16 Q.14

ITU-T SG16 Q.14 has developed H.261 that describes functional architecture for digital signage services. ITU-T SG16 has already published H.780 “Digital signage: Service requirements and IPTV-based architecture” [1], and it contains requirements for digital signage services and functional architecture for IPTV-based digital signage service.

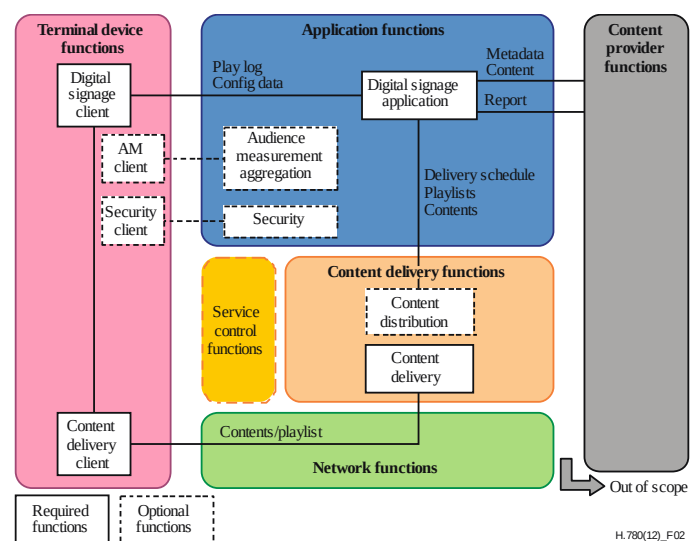


Figure 1. Overview of digital signage architecture [1]

Since architecture of H.780 makes use of IPTV infrastructure for distributing contents, it does not need to define any delivery functions within their architecture. For the case of digital signage service over non-IPTV architecture, SG16 Q.14 has developed H.781 “Digital signage: Functional architecture” [2] that include delivery functionalities within its architecture. H.781 defines several functional entities for accommodating content delivery functionalities, and it also includes P2P-based content delivery. Also, SG11 Q.9 is under development of standards regarding managed P2P that provide more robust and manageable peer-to-peer network. It can provide several management functionalities such as incentive mechanism, service delegation, etc. The method that is proposed by this paper adopt several features of managed P2P for applying to digital signage service.

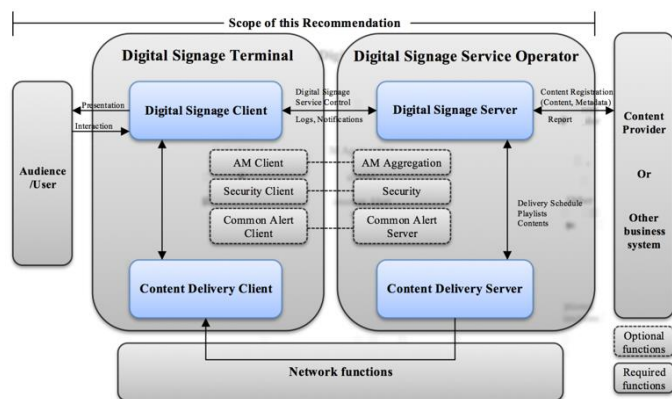


Figure 2. Overview of functional architecture of digital signage [2]

Digital signage service providers need to distribute their contents within pre-constrained time, and also need to be ascertaining whether contents are distributed properly. Since P2P-based contents delivery is basically delay-tolerant method compared to traditional server-client model because most of contents are exchanged among peers those are relatively irresponsible. Hence, it is also required to be capable of delivering contents with traditional push/pull model as well. This clause enumerates several considerations and functional entities for robust contents distribution for digital signage service. H.DS-ARCH has defined functional architecture for content deliver server and client as shown in figure 3.

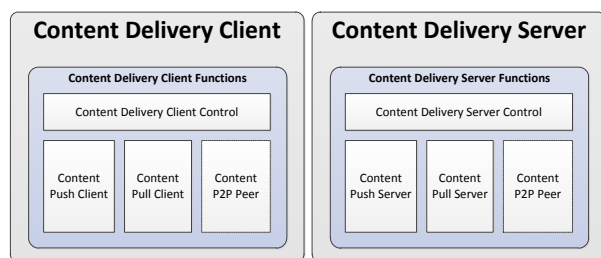


Figure 3. Functional entities for content delivery of digital signage

TABLE 1. FUNCTIONALITIES OF RELATED FES

Content delivery client	
Content delivery client control	This FE receives content delivery plan from server, and controls other functional entities to receive content as written in the plan. It also finds alternative method for delivering contents in case of exceeding time limits for it.
Content push client	This FE is used to get content from server using push method such as notification.
Content pull client	This FE requests particular content to server using pull method such as FTP and HTTP.

Content P2P peer	This FE sends and receives contents among peers simultaneously.
Content delivery server	
Content delivery server control	This FE controls other FEs of server for delivering content, and deliver content distribution plan to client.
Content push server	This FE is in charge of sending contents to remote client. This is useful to send immediate notifications to them compared to pull-based method.
Content pull server	This FE provides contents on the basis of request from remote client.
Content P2P peer	This FE sends logically slice contents to remote peer of client. Since this FE of server already contains full content, it just act as seeder rather than leecher.

B. ITU-T SG11 Q.9

ISO/IEC has published TR 20002 “Managed P2P: Framework” [3] in 2012 that describes problems of existing P2P, requirements and framework for managed P2P networking. ITU-T is working on developing functional architecture [4] and its related necessary protocols since 2013. These manageability features are crucial to distribute digital signage contents to their terminals. Figure 4 shows reference points among several components to provide managed P2P networking.

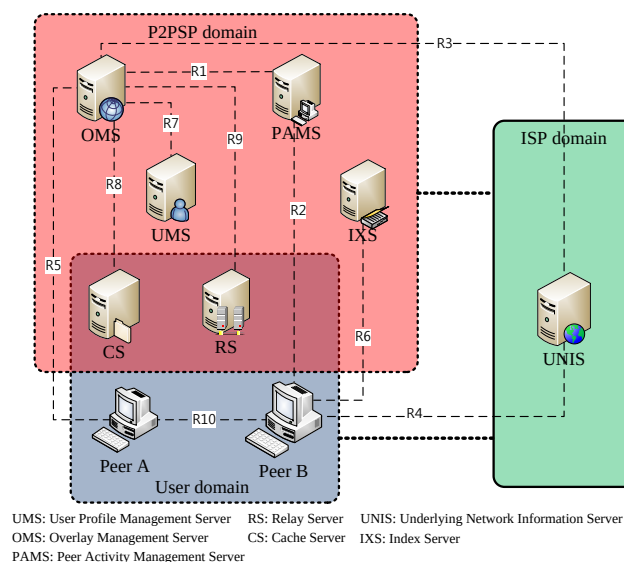


Figure 4. Reference points among entities of MP2P [3]

It should be noted that these series of recommendation does not define P2P protocol itself. There is no need to make another

P2P protocol, and its target is to be used combined with existing P2P solutions. Currently, there are two drafts are under study; peer activity management protocol [5] and overlay resource control protocol [6], and peer activity management protocol can be used to confirm the delivery of digital signage contents. PAMP (Peer activity management protocol) make it possible to keep track of the behaviour of each peer. It is possible to monitor how much resources of peer has been consumed and contributed by aggregating reports from each peer.

III. CONSIDERATIONS ON P2P-BASED SIGNAGE CONTENTS DISTRIBUTIONS

There are several differences from legacy P2P applications as follows;

- **Initiation of delivery:**
Content delivery should be initiated by service operator not by user/peer.
- **Construction of overlay network:**
A service operator already knows the accurate information about the list of peers or terminals to be participated into the overlay network. This means that overlay network is pre-constructed, and does not need join/leave procedures. This may simplify the procedure for tracker protocol
- **Notifications:** When a terminal completely receives content, it should notify to the operator. If it does not make it within time constraints, terminal should try alternatives method, and server also needs to take an action to deal with.
- **Performance vs. fairness:**
Fairness is not concern but distribution time is critical

This clause describes several key considerations to use P2P as a delivery method for digital signage.

A. Robustness of content delivery

In digital signage services, it is not guaranteed that all terminals have same network capacity, since signage terminals are scattered in various locations. Some terminals support Wi-Fi network only, and others may support high speed wired network. Especially, it should be assumed that uplink bandwidth will be different from downlink bandwidth. In general, digital signage service providers already know features of terminal and its location. It is quite useful to make use of this information on planning content distribution.

B. Content distribution schedule

Content delivery server creates schedule or plan for distributing signage contents. Since timing for display of all contents is pre-specified in play schedule that will be managed

by service operators, it is critical to deliver contents prior to actual display. Hence, it should provide alternative delivery methods for the case of delivery failure. This content distribution schedule contains peer lists, contents lists, time constraints per contents, alternative delivery method, etc.

C. Peer and delivery method selection

When selecting a peer for exchanging sliced piece of content, each peer needs to select most appropriate peer based on its current status. If there is enough time, it tries P2P-based method first, and it will try alternative server if it is urgent. The decision can be made based on estimated time of delivery by categorizing three time zones. This time can be measured by use of average download speed and the size of contents.

$$T_{interval} = (L_c * B_{ad}) \times (1 + T_{\alpha})$$

L_c : Size of contents:

B_{ad} : Average downloads bandwidth (MB/s)

T_{α} : Marginal time

If estimated time of delivery is less than $T_{interval}$, it should access to alternative server that delivers contents with traditional pull or push model. If it is less than $T_{interval} \times 2$, it can use P2P-based delivery method but it should select fastest one on selecting peer. Otherwise, it can select any other peers since there is enough time.

IV. PROCEDURES FOR P2P-BASED CONTENT DISTRIBUTION IN DIGITAL SIGNAGE SERVICES

ITU-T Recommendation H.781 described procedures for distributing contents to its terminals by use of P2P method as shown in Figure 5. Since P2P-based method is delay tolerant, it may not meet the requirements that contents need to be delivered within specific time. Hence, it includes alternative methods within a content delivery schedule that will be delivered to each terminal prior to initiation of delivery procedures.

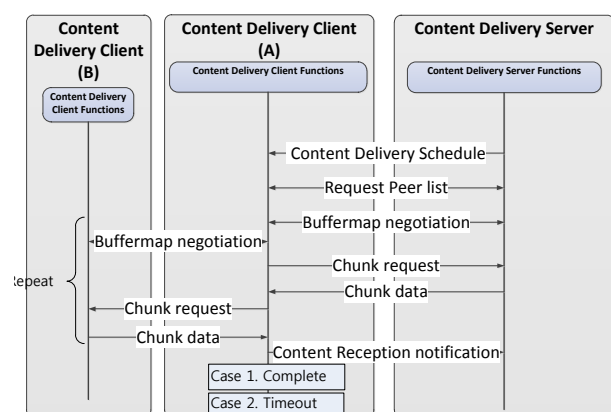


Figure 5. P2P-based content distribution in digital signage services

Figure 5 shows procedures for distributing contents using P2P in digital signage services as following procedures.

1. Digital signage server commences the distribution by sending content delivery plan to content delivery server. The plan already includes the list of terminals to receive the contents.
2. On receiving the plan, it notifies to content delivery client, and delivers the plan as well.
3. Content delivery client requests to server for retrieving peer list for the content. This is similar with existing tracker protocol. The server responds with list for the overlay network.
4. The client simultaneously interacts with multiple peers and content delivery server for negotiating buffermap for the contents.
5. If it finds any missing pieces on comparing buffermap, it requests it to remote peer. This procedure can be done full duplex.
6. If a terminal finds out that it has received content completely, it notifies to remote server. If it does not receive content within time constraints, it initiates alternative delivery

V. CONCLUSIONS

This paper has reviews the recommendations of ITU-T for digital signage services, and describes about several considerations on deploying P2P-based content delivery method to digital signage service. Since P2P-based contents delivery method exchanges contents among all peers, it can decrease the time for content delivery compared to server-client based model. This will retrench the cost of digital signage service providers.

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