System Architecture for IPTV Seamless Service in Mobility

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Abstract—**IPTV is defined as multimedia services, such as TV, video, audio, text, graphics, and data, delivered over IP-based networks managed to support quality of service (QoS), quality of experience (QoE), security, interactivity, and reliability. Those services are now expanded to mobile and wireless networks. This paper illustrates what technical challenges to be considered for IPTV seamless service in wireless environment. Given the critical role of QoS/QoE in the technology's widespread adoption, this paper also proposes efficient system architecture to support QoS/QoE for IPTV seamless service in wireless environment.**

I. INTRODUCTION

IPTV service is rapidly expanded to mobile and wireless areas. In order words, user is able to use IPTV services in everywhere and even in motion. Typically, IPTV services target for the QoS guaranteed wired networks which should provide at least 10 Mbps according to the ITU-T specification [1]. Therefore, IPTV seamless service in wireless environment (a.k.a. Mobile IPTV [2]) must overcome several technical obstacles to a successful launch and wide use. Mobile IPTV implies at least one wireless link between the source, such as a streaming server, and the destination, such as a mobile terminal. Therefore, most of technical challenges are related to the wireless link.

This paper briefly introduces significant obstacles toward IPTV seamless service in wireless environment in accordance with a mobile terminal. All of obstacles must be deeply considered to provide IPTV seamless services in wireless environment. Significant obstacles are as follows; (1) Terminal Capabilities: a mobile terminal content from a standard home display to a mobile terminal with a small screen raises various concerns. Nowadays, almost IPTV contents are HD displayed on the large screen TV (such as 40 inches or larger). Compared to fixed terminals, a mobile terminal has limited capabilities in natural. This trait primarily affects portability, which leads to a small video display (QVGA or VGA), low-power processor (because of a small battery), limited storage, and so on. Being lightweight is also an important feature of a mobile terminal. These capability limitations mean that only a restricted set of technologies is possible through IPTV services in a mobile terminal. For example, the content-providing server should consider the mobile terminal's screen size when sending a video stream. The scalable video coding (SVC)[6] technology lets the system consider the network's terminal types and available bandwidth. Although SVC enables scalable representation of video content with high coding efficiency, it's difficult to perform real-time encoding because of the SVC encoders' complexity. Additionally, further study is needed on how to best control the SVC rate according to network resource availability. (2) Bandwidth: although the wireless link's effective bandwidth is growing rapidly, it won't be sufficient for IPTV services in wireless networks until the 4G wireless network's full deployment. Even when the 4G wireless network is available, the bandwidth might not be sufficient if bandwidth-greedy services such as ultra-definition (UD) video emerge and the number of users increases rapidly. The wireless link will always have less bandwidth than the wired link, and the number of high-bandwidth applications will continue to increase. Therefore, bandwidth-aware solutions are always desirable for IPTV seamless services in the wireless environment. (3) QoS and QoE: for high-quality IPTV services in wireless environment, supporting key QoS factors, such as packet loss, bandwidth, delay and jitter, and packet-error ratio, is important. IPTV delivery systems in wireless environment must be able to handle such factors through careful system design (for example, over-provisioning or use of NGNs), careful traffic control in the network (such as traffic engineering and service differentiation), and optimized buffering and error-correction at the receiver. In particular, reacting quickly to varying conditions in the wireless link is critical. Supporting user-perceived QoE by providing a resource-aware IPTV service is also important in wireless — for instance, increasing or decreasing the transmission rate according to the user's expectation. In this paper, system architecture is newly designed and proposed to resolve the wireless limitation taking three implications listed above into account.

This work was supported by the IT R&D program of MKE/KEIT. [2009-S-014-01,On the development of Sensing based Emotive Service Mobile Handheld Devices] Dr. CS Hong is corresponding author.

II. SYSTEM ARCHITECTURE FOR IPTV SEAMLESS SERVICE IN WIRELESS ENVIRONMENT

IPTV is television. In order words, no user wants to distinguish IPTV experience from the traditional TV experience. It makes IPTV provider very hard to satisfy user's quality of experience (QoE) in wireless environment. In particular, user with a mobile terminal can frequently suffer from an unreliable network connection and insufficient bandwidth. Thus, service continuity requires an awareness of varying wireless-link conditions, such as shadowing and fading. This paper proposes an efficient architecture to support QoS/QoE for seamless IPTV service in wireless environment. The proposed architecture is composed of three functional parts, link characteristics information extraction, high-level protocols for carrying link characteristic information to the IPTV streaming server from a mobile terminal, and streaming

978-1-4244-4316-1/10/$25.00 ©2010 IEEE

adjustment according to link characteristic information. The proposed architecture is thought to be especially suitable for running in a mobile operator's controlled network domain (Figure 1), where a subscribed IPTV mobile terminal can receive reasonably accurate access link information, for example, with the deployment of the IEEE 802.21 Media Independent Handover [3]. For the real implementation, we chose three network interfaces (LAN – high bandwidth connection, WLAN – mid bandwidth connection, and WiBro – low bandwidth connection) and each available bandwidth was piggybacked to the IPTV streaming server by using DCCP (Datagram Congestion Control Protocol)[4] and, SCTP (Stream Control Transmission Protocol)[5]. For carrying link characteristic information to the IPTV streaming server from a mobile terminal, a new option in high-layer protocols is in use in this system architecture.

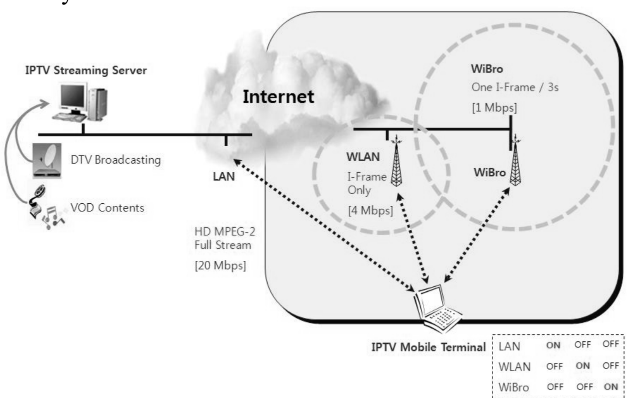

Fig. 1. System architecture for IPTV seamless streaming to mobile terminal according to its ongoing network characteristics. Both a real-time broadcasting content and VOD content are provided to mobile terminal.

The IPTV streaming server has a facility to adjust its streaming volume according to link characteristics information sent by a mobile terminal. Several solutions are now ready for scalable video coding in the market. In our system architecture, we chose very simple and rough approach to scalable video coding. Based on the information sent by a mobile terminal, the IPTV streaming server adjusts its ongoing stream size either intact MPEG-2 original content or minimized MPEG-2 content (pulling out I/B/P frames from the original MPEG-2 content).

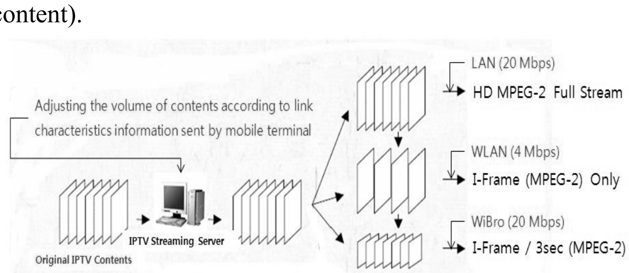

Fig. 2. Scalable video coding approach to adjust stream size according to link characteristic information sent by mobile terminal.

In WLAN case, only I-Frame is delivered to a mobile terminal. In WiBro case, I-Frame is delivered to a mobile terminal in every 3 seconds. Eventually, a bit dim IPTV contents will be shown on a mobile terminal. Consequently, it's trade-off between the continuity streaming service and the content quality in wireless environment.

III. SYSTEM EVALUATION RESULTS AND CONCLUDING REMARKS

In Figure 1, a IPTV mobile terminal has three network interfaces and at least one interface should be switched on. For the evaluation in this paper, we turn on LAN interface and send its link characteristics information to the IPTV streaming server, then MPEG-2 streaming is coming accordingly. After some time, we turn on another interface (either WLAN or WiBro), and switch the enabled interface, and send its link characteristics information to the IPTV streaming server. Then, the ongoing MPEG-2 streaming is adjusted according the selected interface. We presume it occurs handoff between different networks when in motion. Figure 3 shows data throughput from a case in which a mobile terminal moves from a high-bandwidth network to a low-bandwidth network and vice versa. Data throughput equals the amount of data received for stabilization time divided by stabilization time. As the figure shows, the data throughput measured using the system architecture proposed in this paper is efficient to resolve the problems of high packet loss and low data throughput in wireless environment.

DCCP	Log-Bandwidth to High-Bandwidth		High-Bandwidth to Low-Bandwidth	
	Existing Architecture	Proposed Architecture	Existing Architecture	Proposed Architecture
Stabilization Time	399.2ms	133.8ms	3648ms	255.6ms
Data Throughput	246.57Kbps	59.74Mbps	1,876Kbps	6,646Kbps

SCTP	Log-Bandwidth to High-Bandwidth		High-Bandwidth to Low-Bandwidth	
	Existing Architecture	Proposed Architecture	Existing Architecture	Proposed Architecture
Stabilization Time	543.1ms	143.2ms	5,556ms	438ms
Data Throughput	324.32Kbps	49.67Mbps	923kbps	4,563kbps

Fig. 3. Evaluation results in the proposed system architecture in this paper.

This paper has presented the new system architecture that utilizes IPTV seamless services in wireless environment signaling to dynamically adjust IPTV streaming sending rate in the scenarios where user has a IPTV mobile terminal and moves around. This architecture works best when reasonably accurate bottleneck link bandwidth information is available.
In many mobile operators' controlled network domain, this is achievable.

REFERENCE

[1] FG IPTV-DOC-0181, IPTV Architecture, Int'l Telecommunication Union, work in progress, 2007.

[2] S. Park, *Mobile IPTV Approaches, Challenges, Standards, and QoS Support*, IEEE Internet Computing, Vol. 13, Issue 3, pp. 23-31, 2009

[3] IEEE P802.21/D00.05, Draft IEEE Standard for Local and Metropolitan Area Networks: Media Independent Handover Services, Jan. 2006

[4] E. Kohler, *Datagram Congestion Control Protocol Mobility and Multihoming*, IETF Internet draft, work in progress, Jan. 2006.

[5] A. Ezzouhairi, *A New SCTP mobility scheme supporting vertical handover*, IEEE International Conference on WiMob'2006, pp. 205-211, 2006

[6] M. Wien, *Real-Time System for Adaptive Video Streaming Based on SVC*, IEEE Trans. On Circuits and System for Video Technology, Vol. 17, Issue 9, pp. 1227-1237, 2007