MSA-ABR을 이용한 홈 스크린 적응형 차세대 방송 서비스 연구

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Home Screen Adaptive Next Generation Broadcasting Service using MSA-ABR

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요 약

오늘날 매우 복잡한 비디오와 방송 작동들 속에서, 방송사들은 확실히 방송중이나 온라인에서 멀티스크린 시청자들에게 높은 품질과 저지연을 방송하는데 거듭 어려움을 겪는다. 적응 비트율(ABR) 프로토콜들은 인터넷비디오가 다양한 멀티스크린 장치를 가능하게 해준다. 하지만 비디오 품질은 종종 중요하지 않고 오늘날 대형화면에 방송되고 가치 있는 선형 방송 컨텐츠에서는 받아들일 수 없다는 것이 입증될 것이다. ABR에서 미디어 정보 처리 기술은 서비스 제공자들이 제어를하고 집에 모든 스크린에 선형 비디오 서비스가 관리된 품질을 제공한다. 그리고 그것은 단일화된 IP 비디오 사회기반시설을 가진 큰 대형화면을 포함한다. 새로운 멀티스크린 보조 ABR (MSA-ABR)은 기부 컨텐츠, 가상 속에 온라인 출판 서비스, 집중 클라우드 사회기반시설의 절차를 수행하는 방송시설을 대한 멀티스크린 보조 ABR (MSA-ABR)을 기반으로하는 클라우드를 사용하도록 제안된 관리시스템을 가져다 준다.

Key Words : IP Video, IPTV, ABR, Multiscreen-Assisted ABR (MSA-ABR), Next Generation Broadcasting.

ABSTRACT

In this paper, in today's highly complex video and broadcast operations, broadcasters are constantly challenged to reliably deliver low-latency, high-quality video to multiscreen audiences on-air and online. The Adaptive Bit Rate (ABR) protocols enable internet video to a wide range of multiscreen devices. However, video quality is often marginal and would prove unacceptable for valued linear broadcast content delivered to the Big Screen today. The Media information processing technology advances in ABR enables service providers to take control and offer quality managed linear video services to ALL screens in the home, including the Big Screen, with a single unified IP Video infrastructure. The New Multiscreen-Assisted ABR (MSA-ABR) delivery management system proposed using Cloud based multicast-assisted ABR for a broadcast facility that performs routing of contribution content and online publishing services within a virtual, centralized cloud infrastructure.

Ⅰ. Introduction

In recent years, the viewing habits of audiences have evolved significantly. People are spending less time sitting in their living rooms watching live television according to the network's schedule. Instead, media consumption is all about immediate gratification, with consumers in control of what they watch, when they watch it, and what they watch it on - whether it's traditional TV, Internet TV, smartphones, or tablets.

These drivers have led to a significant segmentation of the media market, with online and mobile services,

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overthe- top (OTT) content services, and video on demand (VOD) jostling with broadcast television for market share. For traditional broadcasters, multiscreen and multiplatform delivery is not only difficult to monetize and very costly from a bandwidth perspective, but it has bred a whole new generation of pure-play OTT providers such as Netflix that are turning up the competitive pressure. For broadcasters who can embrace the new paradigms quickly and cost-effectively, the rewards are great: access to lucrative new audiences such as younger viewers, reduced churn in pay TV services, and increased revenue streams through more targeted advertising. The days of "appointment viewing" of over-the-air or cable TV are receding into the distance, since broadcasters now have a means of offering expanded viewing times and other features that enable viewers to watch their content on their own time. However, broadcasters must be able to provide the same quality levels and viewing experience that consumers are accustomed to on their home TVs, including UHD resolutions and low latency. Another important success factor is the ability to leverage legacy systems and workflows for multiscreen delivery. It's not realistic or practical for any broadcaster to abandon its large investment in traditional technologies; instead, stations need solutions that can repurpose output easily and inexpensively for the new viewing paradigms.

Ⅱ. Main Body

1. IP Video Delivery for Broadcasting

IP video delivery started out in the late 90's with the introduction of TV services in Telco / DSL networks. These services typically used multicast/UDP technology to deliver live TV combined with RTSP/UDP for on-demand streams. These technologies require fully managed networks with guaranteed bandwidth, since all streams are pushed from the servers at constant bitrate with no or little adaptation to varying network conditions. These services were therefore limited to operator networks. Some video services were delivered over the Internet, but with limited quality that was not suitable for premium services.

In 2010 a new streaming technology was introduced by Move Networks. Being based on HTTP, this technology could leverage the existing content delivery networks (CDN) to deliver premium video quality over the Internet. The use of HTTP also made it possible to traverse firewalls and gateways, without requiring configuration of these devices.

The HTTP streaming enabled new services like Netflix and Hulu, which were content aggregators without any network infrastructure. Since then a number of streaming formats based on this concept have been introduced, e.g. Microsoft Smooth, Apple HLS, Adobe HDS and MPEG-DASH. Most of the formats in use today are proprietary, controlled by a single company. These technologies turned out to also be a good fit for the smartphones, tablets and connected TVs that were introduced in the same time frame.

Figure 1. Video Service on Different NW and End Device[6]

Today successful video service provider needs to support a large number of different device types and networks so HTTP-based adaptive streaming is increasingly used in traditional IPTV solutions for delivering the prime video services for the living room.

2. HTTP Based Adaptive Streaming

There are two main technology changes that will impact the quality experienced by end user as a result of the network behavior of the HTTP-based adaptive bitrate systems: the use of TCP as the transport protocol and providing content at multiple quality levels. TCP is a bidirectional unicast protocol with built-in congestion control and re-transmission capabilities. Combining this with the multiple quality levels available, a client can adapt to changing network conditions by requesting a quality level that matches the current network state. This allows these technologies to be used to deliver video with high quality over a much broader range of IP networks, including wireless and semi-managed Internet. To allow for clients to change quality levels with decent responsiveness, video is not delivered as a continuous stream. Instead the stream is chopped up into short segments, typically 2-10 seconds long. It is also common to use separate streams for video, audio and sub-titles.

'Lack of bandwidth' is dealt with by lowering the quality. Even though low quality is considered an issue, it's still much more attractive to receive a continuous service at low quality than no service at all.

'Packet losses' will typically not cause any glitches in playback, since lost packets are automatically recovered by the re-transmission capabilities inherent in the TCP protocol. To guarantee a certain bandwidth with packet loss present typically requires twice that bandwidth to be available without packet loss, i.e. the network needs to be over-provisioned.

'Latency' is not a major issue when it comes to user interactivity. On the other hand, TCP relies on low-level handshaking of packets, which is why increased latency will lower the available bandwidth. Doubling the latency will half the maximum bandwidth available. This may prevent high-bitrate streams, e.g. HD or UHD, from being delivered over long-haul networks.

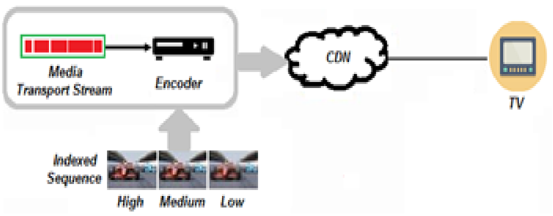

Figure 2. Adaptive Streaming System

With TCP being unicast only, live TV streams have to be delivered using unicast, which is significantly inefficient than the multicast technology that is available in traditional IPTV. Every user will get a unique stream from streaming server to end user, instead of sending one copy between each aggregation point. Control of bandwidth usage is now handed over to the clients, by letting them select the quality level to request based on the bandwidth measured at each client.

3. Adaptive Bit Rate

Streaming video with HTTP over the TCP/IP protocol stack using Apple's HLS, Microsoft's Smooth Streaming or the emerging MPEG DASH schemes, changes the demands imposed on the video delivery network. Video over HTTP uses encoders that process video streams into small files, or chunks, each holding typically two to 10 seconds of displayed video. These chunks are then published to origin servers and sent to caching servers, from which the client application must request each chunk in succession in order to be viewed.

Unlike the UDP/IP protocols used by most providers in the past for streaming video, TCP guarantees the delivery of all packets through packet retransmission, eliminating the need for lossless, low-jitter delivery matching the capabilities of typical internet or wireless network links. If a client-viewing device cannot get chunks fast enough for a high-quality, high-bit-rate stream, it dynamically and seamlessly downshifts and requests a lower-quality, lower-bit-rate stream to display uninterrupted video.

Next, the network must deliver the request, and the server must issue a timely response to this request. The network must then deliver the requested chunk fast enough to the client. Finally, the client must successfully queue the chunk to permit seamless playout to the viewer. This communication between network components and client devices, coupled with the video stream adapting to bandwidth and client device limitations, can be extremely challenging to troubleshoot when something goes wrong if not carefully monitored and managed.

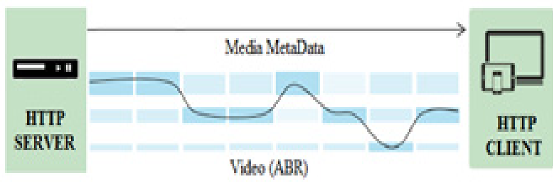

Figure 3. HTTP Adaptive Delivery

The "pull" nature of this process requires the client to initiate the file transfers. This puts new focus on request/response times in which the client, network and server contribute to video playout. Server and link availability, network congestion, and available bandwidth are all critical to avoid quality issues.

Unless a network operations manager understands the dynamics of client type and variant type, as well as bandwidth utilization through insight gained with adequate system management tools, then investing in more available bandwidth can be a shot in the dark. The new investment could simply lead to continued congestion as clients automatically move to higher-bit-rate variants when new bandwidth becomes available. Bandwidth demands would effectively grow in step with available network bandwidth, leaving the service provider one step behind customer demand.

Targeted HTTP streaming-specific metrics, which characterizes per-stream flow QoS performance in terms of the dynamic demands of the client player, provide critical insight into network and system performance. Combined with synchronized player and server metrics, a comprehensive, end-to-end quality assurance solution provides the needed observability to successfully and cost-effectively operate a provider-scale HTTP streaming system.

4. Multiscreen Adaptive ABR

Cloud computing is the outsourcing of storage, data management, or computing tasks to a third party company, known as the cloud provider. Cloud providers sell services rather than products, and in most cases they deliver their services via servers that can be accessed by the Internet. Cloud applications that serve multiple customers are generally referred to as the public cloud, while private cloud applications are supported by servers that are permanently allocated to one customer. In looking toward migrating to IP-based video delivery for primary screens, service providers were faced with two basic choices - multicast delivery of IP video over RTP or unicast delivery of ABR video over HTTP. The first choice would have meant a largely separate and functionally redundant infrastructure for IP video delivery with substantial associated capital and operational costs. The ABR choice would have meant significant capacity upgrades for delivery of unicast video to all subscribers.

Recently, Multicast-assisted ABR (M-ABR) has emerged as a middle road between these two extremes and allows operators to leverage the similar infrastructure used in their TV Everywhere deployments without having the capacity costs of 100% unicast video delivery. A stable multicast delivery can provide clients with an excellent guaranteed QoE, unlike the unstable unmanaged ABR delivery systems.

While the advantages of an Adaptive Bit Rate solution are well known, there is also a need for providing multicast delivery for the most popular content. This has led to a new hybrid system known as MultiScreen Adaptive ABR (MSA-ABR) Architecture which adopts the functional features of Cloud and M-ABR technology to give smooth video service over IP for next generation broadcasting system. This architecture outlined in Figure 4 achieves both the goal of a unified architecture to reach all devices in and outside the home and the goal of minimizing the bandwidth requirements for a Linear IP video service. Three new components are added to the baseline architecture are Multicast Server, Multicast Client, Multicast Controller MSA-ABR system is a standard ABR video system, which uses a transparent caching proxy resident in the Gateway. That transparent cache can be filled either via unicast or multicast. This allows the Player to switch seamlessly between less-popular content only available on unicast and popular content available on multicast as it is completely transparent to the Player whether the content is delivered to the Gateway via unicast or multicast. In fact, the system can switch seamlessly between unicast and multicast delivery of the same stream, as any content not delivered by multicast will be retrieved via unicast.

MSA-ABR is important to note that individual multicast streams do not "adapt" their bit rates. Rather, the term is used to refer to the multicast delivery of video segment files to the Gateway which subsequently delivers these segments via HTTP when they are requested by a streaming video Player. Each multicast stream only contains a single bit rate. The pre-filling of the Gateway's cache is expected to result in the reliable receipt of fragments by the Player, such that the Player does not adapt and instead chooses to remain at that bit rate. However, for robustness, the manifest still generally contains reference to other bit rate encodings of the same content stream. These bit rates can be provided on a separate multicast stream or may be available only via unicast retrieval.

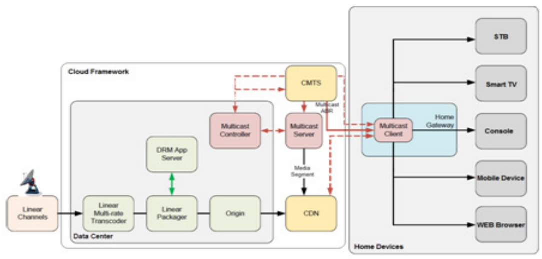

Figure 4. Multiscreen Adaptive ABR

The MSA-ABR sequence is identical to that for unicast, the performance of an MSA-ABR system is never worse than that of unicast and thus the QoE for the end user is also never worse than normal ABR retrieval. This applies to both initial content access and channel changes. But on the flip side, MSA-ABR may provide reliable delivery of multicast streams to clients while unicast stream QoE is suffering from unmanaged ABR instability and fairness issues.

The Technical Report has identified two main approaches to determining what content to provide via multicast:

√ Viewership Driven Multicast
√ Policy Driven Multicast

Viewership-Driven Multicast is an approach whereby the Multicast Controller determines which content to multicast based primarily on the number of simultaneous requests for that content. In this model any content which has more than one viewer is multicast. Thus, this approach takes every opportunity to improve efficiency by multicasting whenever possible. This comes at the expense of complexity as these systems need to be prepared to multicast any content available to viewers. Another negative of this approach is that it can make data traffic engineering more difficult.

Policy-Driven Multicast is an approach to multicasting whereby the operator determines a specific set of channels that are made available for multicast delivery. In this model a maximum number of channels are made available for multicast. This model is not entirely static as the set of channels available on multicast can change, but the changes to this set are driven by operator policy rather than real-time viewership. These systems are generally viewed as simpler but it potentially comes at the expense of efficiency. However, if the operator's ability to predict channel popularity is good, then this approach can be very nearly as efficient as Viewership-Driven Multicast.

There are hybrids possible between these two models. As in Viewership-Driven Multicast, the set of channels multicast at any given time is driven by real-time requests for content. However, like Policy-Driven Multicast, there are a maximum number of channels &/or maximum bit rates that are allowed to be multicast. Thus, choosing a multicast channel selection methodology should be based on other design considerations in addition to efficiency, such as system complexity, ease of traffic engineering, etc.

Ⅲ. Conclusion

Adaptive Bit Rate (ABR) protocols have become the mainstay of multi-screen devices like tablets, smart phones, gaming devices and Smart TVs for accessing video content over IP. But ABR also holds the promise of being the single video delivery mechanism for delivering all video services, including Linear Broadcast to the primary TV screen. However, service providers need to overcome some critical ABR shortcomings with regard to network capacity requirements and QoE.

Technology advances in Cloud and ABR enable service providers to take control and offer quality managed linear video services to ALL screens with a single unified IP Video infrastructure. Research into ABR has led to the evolution of new multiscreen-adaptive ABR (MSA-ABR) delivery that provides QoE guarantees and completely changes the economics of delivering IP Video services. This Multicast-based MSA-ABR solution becomes essential for operators to roll out IP Video on a wide scale.

By adding some cloud based intelligence back into the ABR system, the service providers can regain control to provide a first rate video service with exceptional Quality of Experience while retaining the key underlying benefits of Adaptive protocols. Multiscreen-Adaptive ABR (MSA-ABR) significantly reduces IP Video capacity requirements resulting in lower costs, reduces CDN requirements and enhances Targeted Advertising delivery. The net result shows a significant reduction in cost per IPTV subscriber to roll out a unified, managed IP Video service. Cloud-based Multi-Screen adaptive ABR will become the future of IP Video.

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