Seamless Streaming with Intelligent Rate Determinate Algorithm in Content Centric Networks

JAEHWAN KWON*, JUNGHWAN LEE**, HYUNCHAN PARK**, and CHUCK YOO**
*Mobile R&D Center, Samsung Electronics, South Korea
**Dept. of Computer Science and Engineering, Korea University, South Korea

Abstract— **In this paper, we propose the intelligent Rate Determinate Algorithm (iRDA) for the content centric network (CCN) to provide a seamless video streaming service under fluctuating network bandwidth. iRDA has a method to restart the bit-rate selection of current segment deadline when the threshold value. Compared to the standard, dynamic adaptive streaming over HTTP (DASH), iRDA reduces the amount of freezes time.**

I. INTRODUCTION

Recently, video streaming services such as Netflix and YouTube have become very popular and the amount of video traffic over the Internet has explosively increased. To solve the problems of increasing traffic, the content centric network (CCN) [1], a new paradigm for network structure, has been suggested and is actively being researched. In contrast to existing IP address-based networking, CCN is content-oriented networking, and is able to get the data for a single content name from multiple CCN nodes. In addition, a CCN with an in-network cache saves data in the storage of a node, and consequently is effective in reducing content access time and network traffic.

Moreover, to improve video streaming services, the standard video streaming solution for adapting to changing network conditions is dynamic adaptive streaming over HTTP (DASH) [2], developed by the MPEG forum.

In this paper, we focus on the problem of DASH streaming play in the highly fluctuating network bandwidth environment that occurs in CCNs with an in-network cache. Specifically, if data is or is not present in CCN cache, video may freeze, caused by the difference in network bandwidths.

To solve this problem, we propose the Intelligent Rate Determinate Algorithm (iRDA) for seamless video streaming. We implemented our algorithm in DASH and compared the number of freezes time to that of traditional DASH. With iRDA, users are able to experience a seamless video streaming service, as far as their network conditions allow it.

II. PROBLEM STATEMENTS

To standardize HTTP adaptive streaming, DASH specifies a Media Presentation Description (MPD) file that includes segment information (codec type, play duration, video resolution and bit-rate). Each segment has a variety of different bit-rates, for example 100Kbps, 200Kbps or 1Mbps. A DASH client adaptively selects the bit-rate on the basis of the network bandwidth according to the Rate Determinate Algorithm (RDA) and receives the segment data from the content server.

In order for a DASH client to determine the download bit rate of the i-th segment, RDA selects the bit-rate of the segment by calculating the available bandwidth(ABW) on the basis of segment size and download time, where $ChunkSize_i$ is the size of the i-th segment, t_i is the time needed for download. However, if the i-th segment is present in the CCN cache, the i+1 segment may select a high bit-rate. That is, to respond rapidly the download time as affected by the CCN cache, a DASH client overestimates the available bandwidth.

$$ABW_i = \sum_{i=1}^{i-1}(ChunkSize_i / t_i) \Big/ i-1 \qquad (1)$$

Figure 1 shows an example of DASH streaming play in CCN. When the DASH client requests the selected bit-rate data, it attempts to find the cache of the nearest CCN node. If the selected bit-rate data is present in a CCN node, it is possible to get the data from the CCN cache in the intra network at a high data transmission speed. However, if the selected bit rate data is not present in a CCN node, it gets the data from the content storage through the public Internet as slow data transmission speed.

This results in the problem of video freeze on the DASH client, because it is too difficult for RDA to calculate the network bandwidth and select the optimal bit-rate.

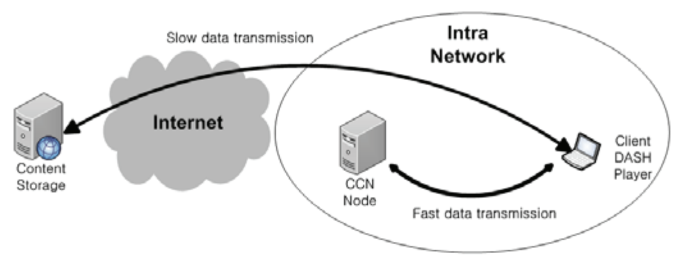

Fig. 1. An example of DASH streaming play in CCN

III. INTELLIGENT RDA FOR SEAMLESS STREAMING

We propose a deadline-based intelligent Rate Determinate Algorithm (iRDA) for seamless DASH streaming in CCN. This algorithm sets a deadline n times as long as the play duration by each segment. When the deadline expires, downloading is stopped and the bit-rate for the i-th segment is reselected according to the following formula where SBW

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indicates the selected bit-rate, and the parameters t_i and pt_i indicate the download and deadline times of the i-th segment, respectively. When the deadline passes, the algorithm reselects the lowest bit rate.

$$IRDA_i = \begin{cases} SBW_i, t_i < pt_i \\ Drop\_SBW_i, t_i \geq pt_i \end{cases} \quad (2)$$

Figure 2 shows the iRDA bit-rate selection scheme. The iRDA restarts the bit-rate selection and resets the timer for the current segment. The first segment of figure 2 receives the data within the proper window because there is enough network bandwidth for both the iRDA and DASH methods. The second segment also receives data within the proper waiting period, again because there is enough bandwidth. However, the DASH method recognizes a high bandwidth network because of the CCN cache of the intra network, so the third segment requests a high bit-rate data. If the segment is not present in a CCN node, the client gets the data through the public Internet, which causes the stream to freeze. In contrast, the iRDA method delays the deadline expiration so the client can reselect and request lowest bit-rate data; the problem of freeze time is then resolved.

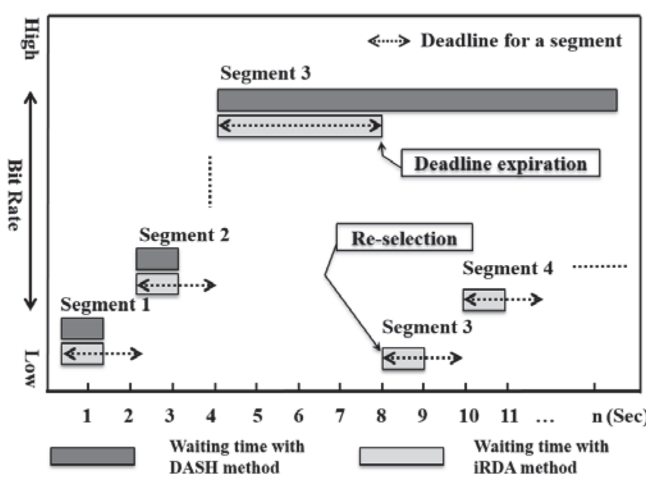

Fig. 2. Bit rate selection of iRDA

IV. Evaluation and Results

We evaluated the proposed method using the CCNx Open Source platform [3] and used the VLC dash plug-in [4] for the DASH client. The intra network topology was constructed using a local virtual router as shown in Figure 1. The cache size on the CCN node is assigned 20MB. The content storage was located in another laboratory 30km away. The video content for the streaming test had the six bit-rates available, from 100Kbps to 1,900Kbps. The total size of the video content was about 30MB(different for segment bit-rate) and the total playing time was 60s. The period of one segment was 2s. A deadline value of iRDA is 4s, double the period of one segment.

The content server connected through the public Internet that had a network bandwidth of about 1MB/s. The DASH client connected to the intra-network using IEEE 802.11n WIFI, which has a network bandwidth of 40MB/s.

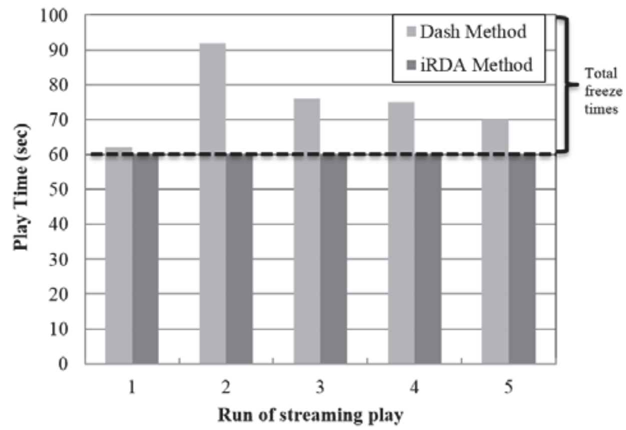

Fig. 3. The result of streaming play time

Freeze time is an important parameter for seamless streaming services. Figure 3 shows the streaming play time of video content on the DASH client. The dotted line is normal play time; any time over the dotted line indicates freeze time during streaming.

Freeze time occurs with the DASH method on, the second run because of improper bit-rate selection by the CCN cache of the intra network. Because of the limit of the cache size in the intra network, all of the data cannot be saved, so despite attempts to increase the length of play time, the problem of freeze time is not resolved. In contrast, the iRDA method is able to play without freeze time and streams seamlessly regardless of the size of the CCN cache.

V. Conclusion

In this paper, iRDA was proposed as a way to play seamless streaming services using DASH of standardizing an adaptive streaming solution in CCN with an in-network cache. We implemented a test-bed using the public Internet, CCNx Open Source, and VLC-DASH Player. Our experimental results demonstrated that the proposed iRDA method provides better seamless streaming services than the original DASH method in CCN with in-network cache.

Future research plans include investigation the effects of various timer threshold values in order to accommodate several of content streams and various network conditions.

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