2011 International Conference on Software and Computer Applications
IPCSIT vol.9 (2011) © (2011) IACSIT Press, Singapore

A Hybrid Broadcasting Method for Video-on-Demand Services

Po-Tsun Liu+ and Yu-Wei Chen

National Taipei University of Technology, Graduate Institute of Information and Logistics Management, Taipei, Taiwan

Abstract - In this work, we propose a hybrid broadcasting method combining the Crescent and Staggered Broadcasting schemes. Consider N (= Nc + Ns) channels to deliver a video with length D, where Nc is the number of Crescent channels and Ns is the number of Staggered channels. The performance of our proposed scheme is superior to the previous methods.

Keywords: broadcasting, patching, video-on-demand, waiting time, buffer requirement

1 Introduction

The broadcasting approach works by dividing file into several segments then allocate those segments into the specific channel for delivering periodically. Many broadcasting schemes have some similar skill on transmission allocated processing. While checking the broadcasting process, there are some factors might cause the significant influence inside, such as the waiting time, buffer requirement size and playback control. To reduce the impact of the tough situation in streaming flow, many broadcast scheme had been created through these years and we will introduce some later. Assume the whole data size is equally spread at any point of the video, we use different aspect to improve the method of streaming transmission, here we call those distinguish method as "scheme". For example, there are Fast Patching scheme [2], Harmonic scheme [3], Staircase scheme [4], Bespoke scheme [5], Crescent broadcasting [6], and some other method, and we will check some of above later in the section 2. Here we combine Crescent and Staggered scheme protocol into the whole structure of broadcasting work frame.

In this work, we propose a hybrid broadcasting method combining the Crescent and Staggered Broadcasting schemes. Consider *N* (= *Nc* + *Ns*) channels to deliver a video with length *D*, where *Nc* is the number of Crescent channels and *Ns* is the number of Staggered channels. The performance of our proposed scheme is superior to the previous methods.

The rest of this paper is organized as follows. In Section 2, we present the related work. In Section 3, we present the proposed Crescent-Staggered Broadcasting scheme. In Section 4, we evaluate the performance of the proposed scheme. Some conclusions are addressed in Section 5.

2 Related Works

In this section, we review some related works [2][3][6]. All these methods are designed for broadcasting a constant-bit-rate (CBR)-encoded video. For convenience, we assume that the consumption rate of a CBR-encoded video is *b* Mbps.

2.1 Fast patching scheme (FP)

There are two types of channels in FP: Fast and Staggered. First of all, we observe that Fast patching (FP) will divide the forward segment into double for the next channel. According to the bandwidth capability, we assume the number of the channel: c; hence, in the part of Fast section, the total segment will be: $c*2^c$, and the max segment will be 2^c-1. Then, in the entire FP, we need to add Staggered into consideration.

2.2 Harmonic Staggered

+ Corresponding author: Po-Tsun Liu. Tel.: + (886-2)27712171#2364; fax: +(886-2).
E-mail address: ywchen@ntut.edu.tw (Yu-Wei Chen).bjlp16@gmail.com (Po-Tsun Liu)

In the Harmonic scheme, a video is partitioned into equal-sized segments. Each segment is transmitted by one channel. Bandwidths of all channels form a harmonic series, i.e., 1, 1/2, 1/3, …. For example, segment 3 is divided into 3 sub-segments and transmitted over channel 3 with bandwidth b/3. Also, in the entire Harmonic Staggered(HS), we need to add Staggered for accomplishment.

2.3 Crescent scheme

First of all, we divide the bandwidth for separating the channels, and each one has the same bandwidth size. For those channels, channel 1 need no to be separated till the end; but each channel has to be divided into 2 same size bandwidth channel, here we call it “sub-channel”. Secondly, in sub-channel, the bandwidth is keep divided into 2 sub-sub-channel for the first sub-channel, and divide into 3 part of sub-sub-channel for another (second sub-channel), and go on to do so on the next channel; on the other hand, each segment will be divided into different quantity of the slice as sub-segment according to where the segment was allocated. For example, the segment 4 is divided into 4 slices (also segment 5); the segment 6 is divided into 6 slices (also segment 7 and segment 8). At Fig.1, you can take a look at the way the bandwidth in each sub-sub-channel of the sub-channel to be allocated.

ch	s-s-ch	segment																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	b
C1	C1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	b
C2	C2	2,1	2,2	2,1	2,2	2,1	2,2	2,1	2,2	2,1	2,2	2,1	2,2	2,1	2,2	2,1	2,2	2,1	2,2	b/2
	C3	3,1	3,2	3,1	3,2	3,1	3,2	3,1	3,2	3,1	3,2	3,1	3,2	3,1	3,2	3,1	3,2	3,1	3,2	b/2
C3	C4	4,1	4,2	4,3	4,4	4,1	4,2	4,3	4,4	4,1	4,2	4,3	4,4	4,1	4,2	4,3	4,4	4,1	4,2	b/4
	C5	5,1	5,2	5,3	5,4	5,1	5,2	5,3	5,4	5,1	5,2	5,3	5,4	5,1	5,2	5,3	5,4	5,1	5,2	b/4
	C6	6,1	6,2	6,3	6,4	6,5	6,6	6,1	6,2	6,3	6,4	6,5	6,6	6,1	6,2	6,3	6,4	6,5	6,6	b/6
	C7	7,1	7,2	7,3	7,4	7,5	7,6	7,1	7,2	7,3	7,4	7,5	7,6	7,1	7,2	7,3	7,4	7,5	7,6	b/6
	C8	8,1	8,2	8,3	8,4	8,5	8,6	8,1	8,2	8,3	8,4	8,5	8,6	8,1	8,2	8,3	8,4	8,5	8,6	b/6
C4	C9	9,1	9,2	9,3	9,4	9,5	9,6	9,7	9,8	9,1	9,2	9,3	9,4	9,5	9,6	9,7	9,8	9,1	9,2	b/8
	C10	10,1	10,2	10,3	10,4	10,5	10,6	10,7	10,8	10,1	10,2	10,3	10,4	10,5	10,6	10,7	10,8	10,1	10,2	b/8
	C11	11,1	11,2	11,3	11,4	11,5	11,6	11,7	11,8	11,1	11,2	11,3	11,4	11,5	11,6	11,7	11,8	11,1	11,2	b/8
	C12	12,1	12,2	12,3	12,4	12,5	12,6	12,7	12,8	12,1	12,2	12,3	12,4	12,5	12,6	12,7	12,8	12,1	12,2	b/8
	C13	13,1	13,2	13,3	13,4	13,5	13,6	137	13,8	13,9	13,10	13,11	1312	13,1	13,2	13,3	13,4	13,5	13,6	b/12
	C14	14,1	14,2	14,3	14,4	14,5	14,6	14,7	14,8	14,9	14,10	14,11	14,12	14,1	14,2	14,3	14,4	14,5	14,6	b/12
	C15	15,1	15,2	15,3	15,4	15,5	15,6	15,7	15,8	15,9	15,10	15,11	15,12	15,1	15,2	15,3	15,4	15,5	15,6	b/12
	C16	16,1	16,2	16,3	16,4	16,5	16,6	16,7	16,8	16,9	16,10	16,11	16,12	16,1	16,2	16,3	16,4	16,5	16,6	b/12
	C17	17,1	17,2	17,3	17,4	17,5	17,6	17,7	17,8	17,9	17,10	17,11	17,12	17,1	17,2	17,3	17,4	17,5	17,6	b/12
	C18	18,1	18,2	18,3	18,4	18,5	18,6	18,7	18,8	18,9	18,10	18,11	18,12	18,1	18,2	18,3	18,4	18,5	18,6	b/12

Fig. 1. Segment placement of the Crescent scheme with four channels.

3 Crescent-Staggered Broadcasting

In this section, we will propose our main intention, using the Crescent broadcasting and the pre-proposed Staggered channel allocated method to build up a compound broadcasting structure, the Crescent Staggered Broadcasting combine with the short front part (*Dc*), and the long forward part (*Ds*). As the pre-understand concept, if we lost some part of the video, we use Crescent as the patching method, then the Staggered channel is ready to match up right after the patching processing(Crescent) finishes. Staggered channel will re-broadcast again while passing through every duration *Dc*.

3.1 The operation of server side

In Fig. 2, we define the factors for the whole processing of Crescent Staggered Broadcasting structure. The total length of the video is *D*; the length of the patching zone which is using Crescent scheme is *Dc*; the length of Staggered channel is *Ds*; and each length of duration of the segment is *d*. Here we assign the sequence of the number for each segment in Crescent are segment 1 to segment n, and the forward one-long segment in Staggered channel is segment number n+1. Then we check these the operation of two side, server and client. Here we set the bandwidth of Staggered channel is b, and each channels of the Crescent scheme are also *b*. According to the segment allocation, we have the equation.

$$Ds = t(Dc + d)\ ,\ t \geqq 1 \tag{1}$$

Ns represent as the number of the Staggered channels.

$$Ns = \frac{D}{Dc} \tag{2}$$

The entire number of the segment of patching zone is $5*2^{Nc-2}-2$ as i, while c represent as the number of the Crescent channels; therefore, we can forward get the maximum waiting time *w*.

$$w = \frac{Dc}{i} \tag{3}$$

The total number of the channels *N* is composed by Crescent channels (*Nc*) and Staggered channels (*Ns*); therefore, we have the equation.

$$N = Nc + Ns = \log 2\left(\frac{4Dc+8d}{5d}\right) + \frac{D}{Dc} \tag{4}$$

3.2 The structure of Crescent Staggered Broadcasting

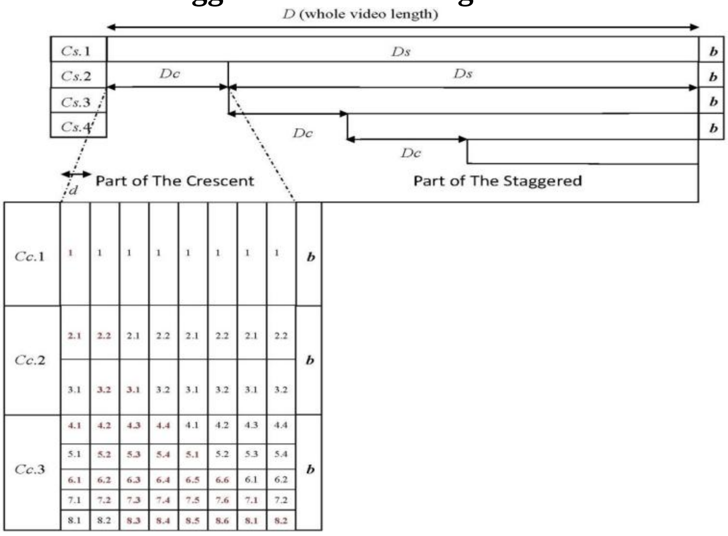

Fig. 2 Crescent Staggered Broadcasting

At the very first of the beginning, the Staggered is the only channel exists, then the Staggered channel will be recreated though every period of *Dc*, however, if the request join timing is due to this period *Dc*, the Crescent service will be triggered and the request will be served by following the way Crescent operates.

4 Performance Analysis

After we view the operation of each two side, and check the way each of them engage, we go forward to understand how the performance will be while going through this process.

4.1 The waiting time

As we know, the maximum waiting time is a length of a segment, d; however, since here we combine two method together, the maximum waiting time ω is as :

$$\omega = \frac{D}{(5*2^{Nc-2}-2)*Ns} \text{, where } Nc \text{ is the channels of Crescent} \tag{5}$$

4.2 The buffer requirement

Since we know the max buffer requirement of Crescent scheme is 26.5%, we can get the consequence of the buffer requirement β while using Crescent Staggered Broadcasting.

$$\beta = \frac{D}{Ns}*26.5\% \tag{6}$$

4.3 The client bandwidth

The Crescent scheme uses 4 channels for most, therefore, the whole channels which is combined with Crescent and Staggered is four plus one equals five. From the result, the total bandwidth θ that client may need to carry is:

$$\theta \leq 5b \tag{7}$$

4.4 The comparison between proposed scheme and others

In Table. 1, we show the comparison of those three schemes. Our proposed scheme: Crescent Staggered Broadcasting make a better performance than Fast patching and Harmonic Staggered does. After then, we set up the value for the parameters: number of Crescent channels, Fast channels, Harmonic channels and Staggered channels for observing the performance of the waiting time as the Fig. 3.

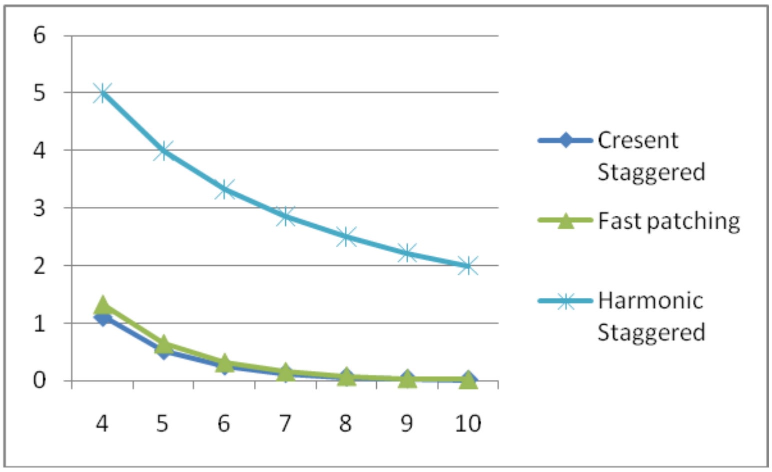

Fig. 3 the comparison of the maximum waiting time in CS, FP and HS with 6 Staggered channels and different Crescent, Harmonic and Fast channels as X axis

Ratio of CS/FP:

$$\frac{2^{cf}-1}{5*2^{Nc-2}-2} >\approx 0.8$$

Ratio of CS/HS:

$$\frac{Ns(N-1)}{5*2^{Nc-2}-2} >\approx 0.1$$

Table. 1 The performance comparison

Aspect of each scheme approaching	maximum waiting	buffer requirement	Maximum client handle bandwidth
Crescent Staggered Broadcasting	$\frac{D}{(5*2^{Nc-2}-2)*Ns}$	$\frac{D}{Ns}*b*26.5\%$	$5b$
Fast patching	$\frac{D}{(2^{cf}-1)*Ns}$ cf: fast channels	$\frac{D}{Ns}*b*50\%$	$(cf+1)b$
Harmonic Staggered Broadcasting	$\frac{D}{Ns(N-1)}$ N: number of segments	$\frac{D}{Ns}*b$	$\sum_{i=1}^{N-1}\frac{b}{i}+b$

5 Conclusion

Sometimes, we just caught between the buffer requirement and the clients' waiting time while trying to make a better method to broadcast (transmit), but now in this paper (In Table.6), here we prove it is more efficient to approach the receiving though our proposed scheme, Crescent Staggered Broadcasting. Although the maximum bandwidth requirement of the Harmonic Staggered is less than ours, client need only wait for a short time in using ours but long time in Harmonic Staggered. To use our proposed scheme, clients may be served more smoothly. Within the path of the broadcasting transmit environment, the network architecture may always be constructed by several heterogeneous node zone, hence, the quality of transmit is probably unstable, therefore, we figure this better way out to overcome the obstruction of the path, maintaining the service quality.

6 References

[1] E. Song, H. Kim and S. Park. Fast patching scheme for Video-on-Demand service. Communications, 2007. APCC 2007. Asia-Pacific Conference on. 2007, 523-526.

[2] L. S. Juhn and L. M. Tseng. Harmonic broadcasting for video-on-demand service broadcasting, IEEE

Transactions on. 1997, 43, issue 3: 268 – 271.

[3] T. Kim, H. Kim and S. Park. A hybrid multicast patching method using staircase scheme for VoD broadcasting. TENCON 2007 - 2007 IEEE Region 10 Conference, pp. 1-4.

[4] S. Chand and H. Om. Modified bespoke data broadcasting scheme for popular videos. Consumer Electronics IEEE Transactions on. 2003, 49, issue 4: 1378-1382.

[5] Y. W. Chen and J. Uemura. An interleaving crescent broadcasting protocol for near video-on-demand services. Multimedia Tools and Applications. 2010, 49(2): 299-321.