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Multimedia Service using Equi-loaded Distributed web-cache in Wire/Wireless LAN

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Abstract

This paper[2] proposes multimedia service system using equi-loaded distributed web-caching mechanism in the wire/wireless network environment. This proposed multimedia service system is composed of integrated switching agent (ISA), several proxies and access points(APs) with buffer in wire/wireless LAN. The ISA is the core of this system and performs switching the streams transmitted from server to proxies. The proxies stores the streams serviced to the users and the loads of them are evenly distributed by the ISA. The APs with buffer take charge of connection to the proxies and the multimedia server on Internet, and reduce service delay for mobile devices. We confirm that this system provides equi-loaded proxies, and reduces the amount of use of network resources and the load of multimedia server in wire and wireless network by the aid of ISA.

Keywords: *Web-cache, Multimedia, wireless LAN*

1. Introduction

Multimedia service including video, audio, MP3 and web-games has been increased on Internet according to the development of the speed of wire/wireless network and the capacity of mobile devices. Multimedia services in wire/wireless network are experiencing the deficiency of network resources and the massive load of server. Thus, many researches have studied for the reduction of server load and effective use of network resources. The more users for multimedia service increase, the more loads of the server. Traditional services are obviously inefficient to provide high-quality, high-capacity contents to users [1, 2]. Thus, the technique for web-cache multimedia service was studied.

Although, many researches use several proxies to solve these problems, they have another problem that the proxies have different load due to the contents of multimedia according to the popularity of them [3, 4].

The distributed web-cache policy including CDN(contents delivery network) that several proxies have advantages of reducing the load of multimedia server on Internet [5-7]. But continuous communication is needed in order to maintain file synchronization of current cache state among multiple proxies, and the problem for the duplication of cache data and the waste of cache space is arisen [8, 9].

This paper proposes equi-loaded distributed web-cache policy that several proxies and APs with cache are controlled by ISA (Integrated Switching Agent). And this paper use effectively deficient network bandwidth under the control of ISA. Proxy server and

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AP in this paper are controlled by the ISA to avoid duplication of multimedia contents in the cache. The proposed mechanism in this paper may use effectively for the various multimedia service request in wire/wireless network. This paper uses LFU(least frequent used) cache replacement according to the shortage of cache.

The rest of this paper is as follows: Section 2 describes the structure and operations of multimedia service system using distributed web-cache policy and explains the operation. Section 3 proposes algorithms to support equi-loaded cache mechanism. Section 4 deals with the results of simulation for the proposed system. And finally, we discuss our conclusion.

2. The Structure and Operation of Multimedia Service System using Distributed Web-cache Policy

The structure of the proposed multimedia system using equi-loaded distributed web-cache policy as shown in Figure 1 is composed of a multimedia server on Internet, a ISA(Integrated Switching Agent), several proxies, access points(AP) with cache and a number of user computers including mobile devices.

The multimedia server stores the multimedia contents and receives service request from the client through ISA, proxy and AP when the multimedia streams requested are do not save in proxy and AP cache. And the server transmits multimedia contents requested to ISA.

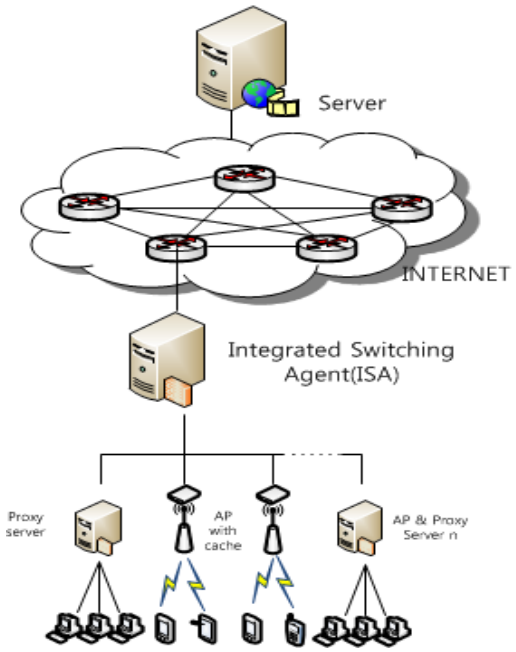

Figure 1. The Structure of proposed distributed web-cached multimedia system

ISA is the core component of this system, takes charge of control the proxies and AP and manages video cache table(VCT). The ISA splits the multimedia contents transmitted from server into the form of the segment, switches them to corresponding proxies according to the request. These streams are stored distributively on the multiple proxy server to use efficiently the cache-space in the case of popular multimedia [6]. The ISA is located between proxies

and APs. The VCT in ISA is the table that indicates the proxy where the streams requested are stored. The ISA notifies to the client that the proxy to connect.

The VCT is divided into two parts: video content number(*Video #*) and segment number(*Segment #*). When ISA splits video contents, the segment # is numbered from the starting point of the video contents. If a specific user requests multimedia contents #2, the ISA checks a VCT table whether the requested contents store on proxy. If there is no contents on the proxy, the ISA requests contents to the server. Then the ISA updates VCT table and notifies to the corresponding proxy to store contents transmitted from server, and we call this stream segment #1. And other users request the same video contents, the ISA switches the successive streams to be stored on distributed proxies according to the order of request. Then the successive streams(segment #2 and #3) are stored on proxy #2 and #3. The popular multimedia requested are stored nearly evenly on almost all proxies in this network. This proposed mechanism contributes equitable load balancing according to the requests. The detailed explanation is given in below.

2.1. The Operation for Multimedia Service Transmission

To process a service request, ISA determines the method of providing services as the position of contents. Method of providing services can be divided into two methods significantly. A server transfer mode when the content does not exist in the proxy server, another one is the multiplex transmission mode when some of the content resides. AP or proxy server receives the service request of the client and transmits to the ISA. ISA which has received the service request, checks for the existence of the video content of the proxy server by referring to VCT of the ISA. In the case of the proxy server is in the initial state or no video content for cache replacement policy, Proxy server receives the service request of the client, which forwards the request to the ISA. Because the video content does not exist in the cache, ISA perform the operation of the server transfer mode that requires the video content to the multimedia server. Multimedia server that received the request transmits the video content corresponding to the ISA.

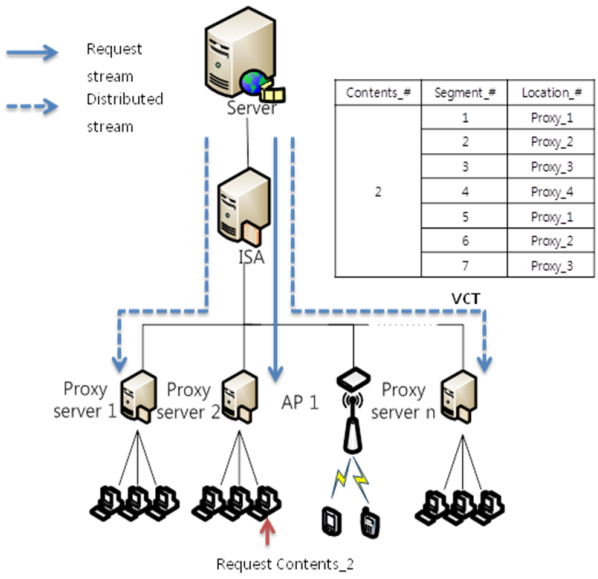

Figure 2. The Structure of Server Operation

ISA is numbered sequentially in units of segments the video content that has been transferred and executing the distributed saving to a proxy server segments as shown in Figure 2. When the client requests video content #2 in the proxy server #2, ISA sequentially stores the stream to the proxies about content #2. VCT shows that four proxies distributively stores the 7 segment about video content #2. Later, if the user requests by other segments of the content #2, ISA provides switching mechanism by referring to the VCT table.

Distributed stream is the core part of this paper, contributes to reducing the delay and load on the media server to client requests in accordance with the store segments to other proxy servers. When the ISA is referenced the VCT, ISA have all segments of the video content of the requested client or several segments are present, The multiplex transmission mode operates. As above the ISA performs forwarding to the client by grouping the client requests the same video content, if there is no request for the same video content, ISA performs unicast forwarding only to the requesting client of the existing. However, if the segments there are several, to supplement the rest, ISA requests the video content corresponding to the multimedia server. In such cases, after removing the segments overlap ISA, video content that is transmitted from the multimedia server is distributed saving to the proxy server the rest.

As described above, ISA controls the proxy and AP through the transmission mode of the two way. The ISA store information about the storage and movement of a segment of the entire network by the integrated control system.

2.2. The Operation of AP in Wireless LAN

As described above, AP performs the operation on the WLAN only. The AP, a mechanism for providing multimedia services to mobile nodes that are connected to a wireless network is limited unlike proxy on the wired network, it has a cache of relatively small capacity. Therefore, in this paper, we provide a way to save only the first segment of the media content to the AP cache space for providing fast start stream to the mobile node. Those who use the service, usually, there is a tendency to decide whether to view video content watching only before the media content.

When a user requests a video content in AP, ISA confirms by referring to the VCT that whether video content in corresponding AP cache. When video content segment exist in AP cache, AP provides a quick start stream by sending immediately the segment #1 to the corresponding mobile node. ISA checks rest of segment location by referring to the VCT and switch the streams for continuous service. But when video content segment not exist in AP chche, AP has to access to the multimedia server. However, The LFU policy is based on popularity, the segment is stored in the cache Which content with the high popularity. For this reason, The user's request of many segments are popular relationship with The probability and frequency of occurrence ranking is based on the law of zipf. It is appropriate conditions to provide a valid start stream.

For the rest, mechanisms of AP operates the same as service mechanisms the proxy server provides. In comparison with proxy, hit rate of a segment of the required data is low. The reason of that AP saves the first segment of the media content in order to provide a quick start stream.

3. The Algorithm for Distributed Web-cached Multimedia Services in Wire/Wireless LAN

As follows, the cache replacement policy of the paper, as well as the popularity of video content, the segment number is also reflected in the priority of the cache deletion. Therefore, the proxy server is preferentially removed the video content popularity is low in the cache. This is because the relatively large demand for popular video content. In addition, the proxy server, perform the removal in the order of high number of segments of video content. This is because there is a tendency to decide whether to video content viewing most clients looking at the front of the video content.

Service algorithm

i) ISA receives the request of client i for video content k and checks whether it through the proxy or AP

ii) The ISA checks VCT table whether the video content k is stored on the proxies

iii) If the video content k is stored on the proxies then notifies to the corresponding proxies to send them to the client requested and goto the procedure of Wired Network or Wireless Network
else the ISA requests for the video content k to the multimedia server

iv) The multimedia sever sends video content k to the ISA

v) The ISA receives video content k

vi) The ISA sends video content k streams to the corresponding proxy or AP and goto the procedure of wired Network or Wireless network

Wired Network

i) If there is a storage space in the corresponding proxy
then store the streams requested on the proxy
else performs the cache replacement strategy for LFU

ii) Store distributive the streams requested on the proxies according to the order of service request when the other clients request the same contents

iii) The proxy transmits stored streams to the client requested and does not store the streams when they are transmitted from other proxies

iv) The client requested receives the streams the corresponding proxy

Wireless Network

i) AP receives video content k from the proxy or the ISA

ii) If the AP receives it from the ISA

then the AP stores only the first stream on its buffer

else the AP requests streams to the corresponding proxies under the control of the ISA

iii) The AP sends the streams to the client requested

iv) The client receives the streams

4. Simulation

To analyze the performance of the network model proposed in this paper, based on Java, was constructed the simulation environment as shown in Table 1.

Table 1. Simulation Parameter

Parameter	Default value	Range
Number of video contents	100	50~300
Video running time(minutes)	10	N/A
Request rate(request/min)	30	10~50
Size of proxy cache(minutes)	100	N/A
Size of proxy cache(minutes)	10	N/A
Number of proxy server	3	1~5
Number of AP	3	1~5

The number of video content stored in the multimedia server 100, the length of the video content was set at 10 minutes. Video content is divided into 10 segments. Video content request rate of the client (λ) was set to 30. Based on the Poisson distribution, the client requests the video content. To represent the pattern of video content client request, Using the Zipf's distribution proportional certain laws exists between the frequency of requests and popular, determine the order of from 1 to 100 the distribution of video content [10].

$$P_N(i) = \frac{\Omega}{i^{\alpha}} \text{ where } \Omega = \left(\sum_{i=1}^{N} \frac{1}{i^{\alpha}}\right)^{-1} \quad \textbf{(1)}$$

N is the total number of video content by the formula (1). To rank the popularity of video content. (i = 1,2, ..., N). The conditional probability $P_N(i)$ is a service request probability of video content i is a value indicating how the distribution of the requests has been concentrated in the upper popularity as a skew factor.

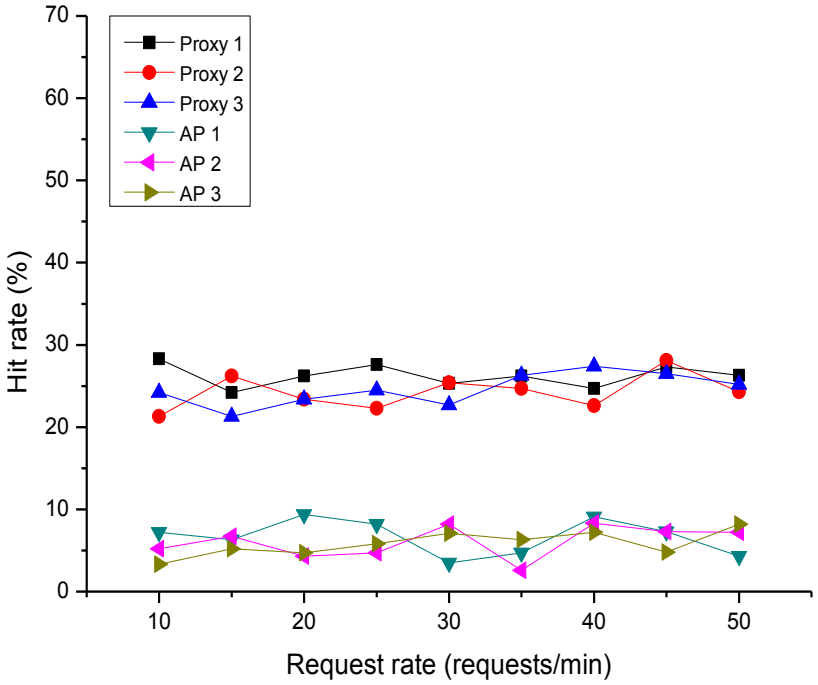

Figure 3. The Hit rate according to the request rate

Figure 3 is that which is kept constant at 100 minutes total cache size, in the case of 10 to 50, request rate for the case where there are three AP and proxy server to measure total hit rate.

Service request rate of the client even if the increase, load of proxy server can be seen that between 21.3% and 29.4%, load of the AP are distributed almost evenly 4-9%. As described above, the reason that hit rate of AP is low compared to the proxy, capacity is smaller than the proxy, it is to store only the first segment.

The Figure 4 compares the total hit rate for proxy server and AP corresponding to the number of video content. Shows the total hit rate for the case of increasing to 50 to 300 the number of video content when there are three AP and proxy. Total hit rate of proxy decreased 41%, in the case of AP, the decline is relatively small and is about 7% decline. When The Number of video content increases, It needs to be stored in the limited storage space.

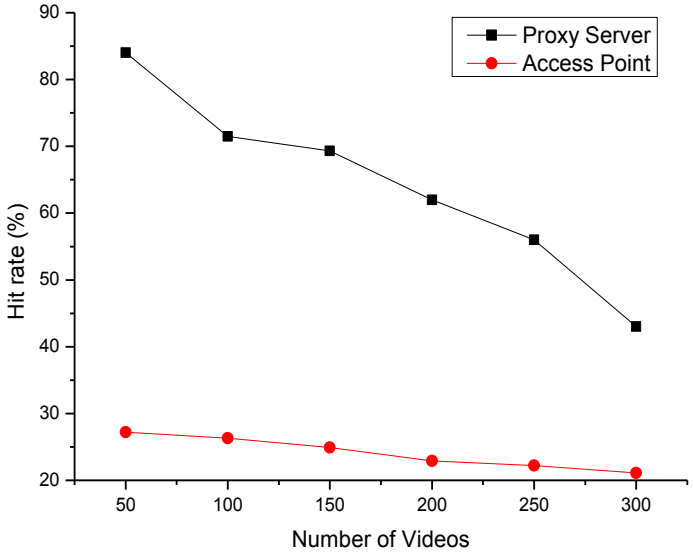

Figure 4. The cache-hit rate according to the number of video contents

4. Conclusion

In this paper, we have proposed multimedia system using distributed equi-loaded web-cache policy in a wire/wireless network environment. The proposed service providing method distributively stores the contents to several proxies and APs. So the ISA controls multimedia service with reference video cache table. Also we can confirm that effective use of network resource by using cache replace strategy which based on popularity. Thus the proposed mechanism can provide service having fast start-up time in wired and wireless network. Finally, the proposed distributed web-cached multimedia system contributes to solving the problem of media server load that occurs when the number of service request increases. Research results of the present paper is expected to contribute to improvement of the wired/wireless internet integration services to configure a new next-generation networks.

Acknowledgements

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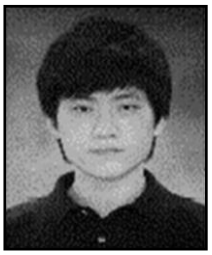

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