Reducing Outgoing Traffic of Proxy Cache by using Client-Cluster

Kyungbaek Kim and Daeyeon Park

Department of Electrical Engineering & Computer Science,

Division of Electrical Engineering,

Korea Advanced Institute of Science and Technology (KAIST),

373-1 Guseong-dong, Yuseong-gu, Daejeon 305-701, Republic of Korea

E-mail: kbkim@sslab.kaist.ac.kr and daeyeon@ee.kaist.ac.kr

Abstract

Many web cache systems and policies have been proposed. These studies, however, consider large sized objects less useful than small sized objects for the performance and evict them as soon as possible. Even if this approach increases the hit rate, the byte hit rate decreases and the connections occurring over the congested links to outside networks waste more bandwidth to obtain large sized objects.

This paper suggests the web cache system which uses the client-cluster which is composed of the residual resources of clients as an exclusive storage for large sized objects. This proposed system achieves not only the high hit rate but also the high byte hit rate, and reduces the outgoing traffics. We use DHT based peer-to-peer lookup protocol to manage the client-cluster. With the natural characteristics of this *protocol, our system with the client-cluster is self-organizing, fault-tolerant, well-balanced and scalable. Additionally, we manage the large sized object by the index based allocation method and balance the loads of all clients well.*

We examine the performance of the cache system via a trace driven simulation and demonstrate effective enhancement of the proxy cache performance.

keywords : peer-to-peer, clustering, web cacing, replacement algorithm

1 Introduction

The recent increases in popularity of the Web has led to a considerable increase in the amount of Internet traffic. Especially, requests for large sized objects such as music and video files increase exponentially. As a result, web caching has become an increasingly important issue. Web caching aims to reduce network traffic, server load, and user-perceived retrieval delay by replication popular content on caches that are strategically placed within the network. Web caches are often deployed by institutions(corporations, universities, and ISPs) to reduce traffic on access links between the institution and its upstream ISP.

By caching requests for a group of users, a web proxy cache can quickly return objects previously accessed by other clients and reduce bandwidth consumption and network traffic. To maximize the cache performance, a proxy cache tries to handle as many requests as possible. However, the storage of a proxy cache is limited and it can not store all requested object in its storage. If a cache is full and needs space for new objects, it evicts the other objects which is not useful for cache performance; this is the replacement policy of a web proxy cache [14], [2], [1], [7], [13]. Generally, if a cache needs space, it evicts large sized objects first in compliance with the replacement policy. According to this behavior, a cache has more small sized objects and achieves higher hit rate and reduces more access links between the institution and its upstream ISP.

Using these replacement policies, large sized objects are not cached for long time, there is few chance for large sized objects to hit in a cache. According to this, though these replacement policies increase the hit rate, they reduce the byte hit rate which is the number of bytes that hit in the proxy cache as a percentage of the total number of bytes requested. This degradation of byte hit rate makes a proxy cache use more outgoing traffic even if few access links exist. As is the case for the web proxy cache, we assume that the intra-community file transfers occur at relatively fast rates, whereas file transfers into the community occur at relatively slow rates. As an example, the community may be a university or corporate campus, with tens of thousands of peers in the campus community interconnected by high speed LANs, but with connections to the outside world occurring over congested campus access links. Consequently, if we leave the proxy cache to waste more outgoing traffic, the performance not only of a proxy cache but also of the connections to the outside network decreases more.

To prevent this degradation, we should store large sized objects and maximize the chance to hit these objects. As a naive approach, a proxy cache increases its local storage. However this approach is only a temporary solution and is still affected by the general replacement policies. Therefore we need an exclusive storage for large sized objects. We can use CDN services to do this, but these services need expensive cost for hardwares and managements. Moreover, these approaches need too much administrative cost for the frequent variation of clients. For example, a growth in client population necessitates increasing the storages and updating the system information.

In this paper, we suggest a new web cache system which uses the residual resources of clients. Basically, a web proxy cache stores small sized objects and resources of clients are used to store large sized objects. This separation of storages make a proxy cache storing more small sized objects, because it does not need to store any large sized objects, and large sized objects are stored in an exclusive storage which is supplied by clients. According to this behavior, a proxy cache keeps or improves its performance such as the hit rate ,the byte hit rate and the usage of outgoing bandwidth. Furthermore, the size of an exclusive storage increases as more clients use a proxy, and this reduces the administrative cost and makes the proxy cache more scalable.

The client-cluster is composed of the client's residual resources. Since clients join and leave dynamically, in order to use its storage efficiently, the client-cluster must be self-organizing and fault tolerant and the load of each client should be balanced. To cope with these requirements, we manage the client-cluster by using Distributed Hash Table (DHT) based peer-to-peer protocol. By using this protocol, all clients receive roughly the same load because the hash function balances load with high probability. Moreover, the proxy cache does not need to manage information about these clients and we save administrative cost.

This protocol matches an object with a client. However, we try to store large sized objects in client-cluster and it is hard and unfair for a client to store a large sized object. Therefore, we break up a large sized object into many small sized blocks and store these blocks to many clients by using the index based allocation method. All of blocks are distributed in the client-cluster and the storage overhead for each client reduces balances. When a proxy cache sends requests to a client-cluster and the requested objects are not stored in it, the proxy cache takes on additional latency. To prevent this latency, we use a cache summary with a Bloom filter, which determines whether the requested objects are in the client-cluster.

This paper is organized as follow. In section 2, we describe web caching and peer-to-peer lookup algorithm briefly. Section 3 introduces the detail of the client-cluster storing for large sized objects. The simulation environment and the performance evaluation are given in section 4. We mention other related works in section 5. Finally, we conclude in section 6.

2 Background

2.1 Web caching and replacement policy

The basic operation of the web caching is simple. Web browsers generate HTTP GET requests for Internet objects such as HTML pages, images, mp3 files, etc. These are serviced from a local web browser cache, web proxy caches, or an original content server - depending on which cache contains a copy of the object. If a cache closer to the client has a copy of the requested object, we reduce more bandwidth consumption and decrease more network traffic. Hence, the cache hit rate and byte hit rate should be maximized and the miss penalty, which is the cost when a miss occurs, should be minimized when designing a web cache system.

If a web cache has the infinite storage, there is no problem for caching objects and a web cache achieves maximum of hit rate and byte hit rate. A web cache, however, has the size-limited storage and if a cache needs space for new objects, it evicts the other cached objects which is not useful for cache performance. In this case, the policy of selecting object is the replacement policy.

Many replacement policies are proposed and generally evict large sized object first for new objects and some policies even give up storing large objects [14], [2], [1], [7], [13]. Because of these policies, the web cache stores more objects ,increases the hit rate and decreases the number of access links between the institution and its upstream ISP. However, because these policies evict large sized objects first, the large sized objects are not cached for long time and there is few chance for the large sized objects to hit in the cache. Although the web cache can achieve high hit rate with these policies, it can not achieve high byte hit rate and wastes more upstream bandwidth for retrieving large sized objects. If the requests of large sized objects increase, this degradation appears remarkably.

Even if a storage of a web cache increases for caching large sized files, it is only a temporary solution and needs expensive costs for the cache management, such as new hardwares and re-configuration. That is, this approach is not scalable and resourceful.

2.2 Peer-to-Peer Lookup

Peer-to-peer systems are distributed systems without any centralized control or hierarchical organization, where the software running at each node is equivalent in functionality; this includes redundant storage, selection of nearby servers, anonymity, search, and hierarchical naming. Among these features, lookup for a data is an essential functionality for peer-to-peer systems.

A number of peer-to-peer lookup protocols have been recently proposed, including Pastry, Chord, CAN and Tapestry [12], [11], [15], [10]. In a self-organizing and decentralized manner, these protocols provide a DHT (distributed hash-table) that reliably maps a given object key to a unique live node in the network. Because DHT is made by a hash function that balances load with high probability, each live node has the same responsibility for data storage and query load. If a node wants to find an object, a node simply sends a query with the object key corresponding to the object to the selected node determined by the DHT. Typically, the length of routing is about O(log n), where n is the number of nodes. According to these properties, peer-to-peer systems balance storage and query load, transparently tolerate node failures and provide efficient routing of queries.

3 Proposed Idea

3.1 Overview

As we described in the previous section, a web proxy cache evicts large sized objects first to get free space which is used to store a new cached object and this feature reduces the cache performance, especially the byte hit rate. According to this, the large sized object is the main obstacle of the cache performance. To solve this problem, we exploit the residual resources of clients for a proxy cache. That is, any client that wants to use the cache provides small resources to the cache and the proxy cache uses these additional resources to maintain the proxy cache system. This feature makes the proxy cache resourceful and scalable.

We use these resources as an exclusive storage for large sized objects. Generally a web proxy cache stores all of requested objects in the local storage, but in our system, a cache only stores small sized objects and large sized objects are stored in the exclusive storage which is distributed among the client cluster. When a proxy cache receives a request, it checks its local storage. If a hit occurs, it returns the requested object; otherwise, it sends a lookup message to the exclusive storage and this message is forwarded to the client that has responsibility for storing the object. The behavior of the cache depends on the size of the requested object. If the size is small, the cache deals with the object in the local cache, otherwise, it turns over the object to the exclusive storage. According to this behavior, we can achieve the high byte hit rate and save more outgoing bandwidth. Additionally, the proxy cache stores more small sized objects and the hit rate increases more.

3.2 Management of Client-Cluster

In our scheme, a proxy cache uses the resources of clients that are in the same network. Generally, if a peer wants to use other peers, it should have information about those. This approach is available when the other peers are reliable and available. However, the client membership is very large and changes dynamically. If the proxy cache manages the states of all clients, too much overhead is created to manage the client information and complex problems such as fault-tolerance, consistency and scalability arise. In consideration of these issues, we establish the proxy cache such that it has no information for the clients and the client-cluster manages itself.

We design the client-cluster by using DHT(distributed hash table) based peer-to-peer protocol [11], [12]. To use this protocol, each client needs an application whose name is *Station*. A Station is not a browser or a browser cache, but a management program to provide clients' resources for a proxy cache. A client can not use resources of a Station directly, while a proxy cache sends requests issued from clients to Stations in order to use resources of a client-cluster. When a Station receives requests from a proxy cache, it forwards requests to another Station or checks whether it has the requested objects. Each Station has a unique node key and a DHT. The unique node key is generated by computing the SHA-1 hash of the client identifier, such as an ip address or an ethernet address, and the object key is obtained by computing the SHA-1 of the corresponding URL. The DHT describes the mapping of the object keys to responsible live node keys for efficient routing of request queries. It is similar to a routing table in a network router. A Station uses this table with the key of the requested object to forward the request to the next Station. Additionally, the DHT of a Station has the keys of *neighbor Stations* which are numerically close to the Station, like the leaf nodes in PASTY or the successor list in CHORD.

The basic operation of the lookup in a client-cluster is shown in figure 1. When a proxy cache sends

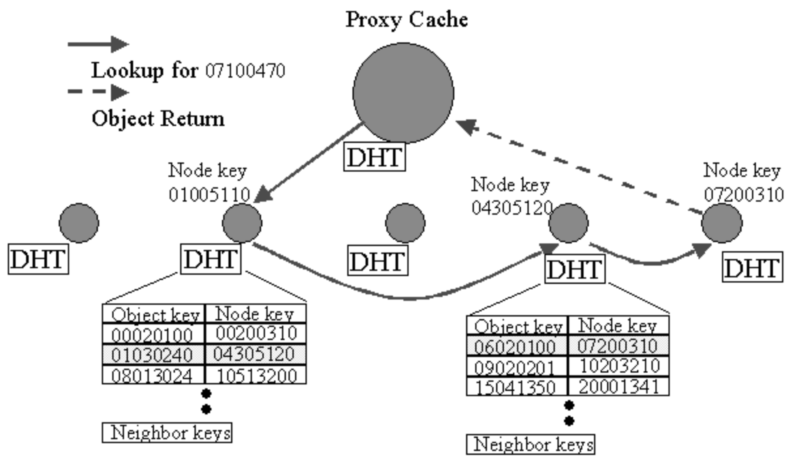


Figure 1. Basic lookup operation in the client-cluster. In this figure, total hop count is 3 for an object.

a request query to one Station of a client-cluster, the Station gets the object key of the requested object and selects the next Station according to the DHT and the object key. Finally, the *home Station*, which is a Station having the numerically closest node key to the requested object key among all currently live nodes, receives the request and checks whether it has the object in local cache. If a hit occurs, the home Station returns the object to the proxy cache; otherwise, it only returns a null object. In figure 1, the node whose key is 07200310 is the home Station for the object whose key is 07100470. The cost of this operation is typically O(log n), where n is the total number of Stations. If 1000 Stations exist, the cost of lookup is about 3, and if 100000 Stations, the cost is about 5. Since the RTT for any server in the Internet from one client is 10 or 100 times bigger than that for another client in the same network, we reduce the latency for an object by 2 or 20 times when we obtain the object in the client-cluster.

The client-cluster can cope with frequent variations in client membership by using this protocol. Though the clients dynamically join and leave, the lazy update for managing the small information of the membership changes does not spoil the lookup operation of this protocol. When a Station joins the client-cluster, it sends a join message to any one Station in the client-cluster and gets new DHT and other Stations to update their DHT for the new Station lazily. On the other hand, when a Station leaves or fails, other Stations which have a DHT mapping with the departing Station detect the failure of it lazily and repair their DHT. According to this feature, the client-cluster is self-organizing and fault-tolerant.

All Stations have roughly the same amount of objects, because the DHT used for the lookup operation provides a degree of natural load balance. Moreover, the object range, which is managed by one Station, is determined by the number of live nodes. That is, if there are few live nodes, the object range is large; otherwise, it is small. According to this, when the client membership changes, the object range is resized automatically and the home Stations for every object are changed implicitly.

3.3 Storage for Large Sized Objects

In our system, large sized objects are stored in the client-cluster. Basically, the client-cluster stores the object in the corresponding node which has numerically closest node key to the object key. However, each node in the client-cluster supports the residual resource which are not used by a node and it is too small to store the whole of the large sized object. To solve this problem, we break up the large sized object into many small sized blocks and store these blocks to many nodes. Each block has the block key which is obtained by hashing the block itself and the home node that has numerically closest node key to the block key stores the block. According to this, all of blocks for a large sized object are distributed in the client-cluster and the storage overhead for each client reduces and balances.

We use the index based allocation method to store large sized objects, because this method is simple ,cost-effective and easy to access randomly. Figure 2 shows the simple structure of our index based allocation method. First of all, we need the object header block which has the basic information about

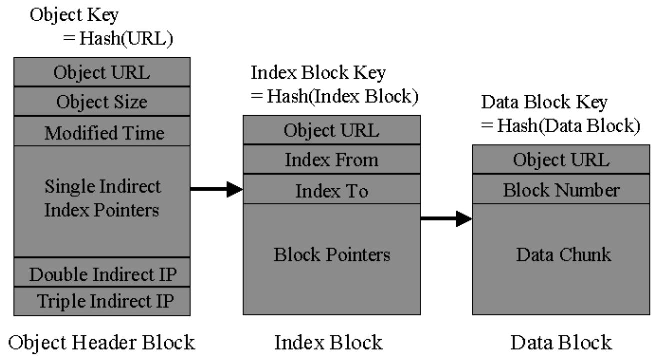


Figure 2. The structure of our index based allocation method

the large sized object, such as URL, size and modified time, and indirect pointers, such as the single indirect IPs, the double indirect IP and the triple indirect IP. We do not use direct pointers in the object header block. In the general indexed method, the direct pointer is used to store small sized files to avoid making unnecessary index blocks. In our client-cluster, however, the size of the stored objects is enough large to neglect the overhead of index blocks. The home node for an large sized object store this object header block instead of the object itself and manage these header blocks as a LRU list separately from data blocks.

An index pointer indicates an index block by using index block key which is the hashed value of the index block itself. The index block is composed of URL, the block pointers which address data blocks by using data block key and the range of the block pointers. The data block is the leaf block of this method and stores the real data chunk. Each data block has URL and block number which is assigned continuously from the start of the object to the end.

The basic operation for requesting the object is shown in figure 3. Client A wants to get an object and sends a request to the proxy cache. The proxy first checks its local storage, because it has no idea about the size of the requested object. If a hit occurs, the proxy cache return the object to Client A and this

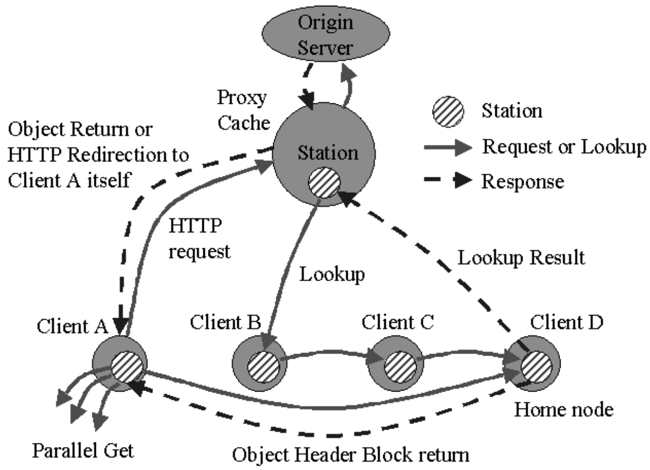


Figure 3. Operation of the client-cluster, when Client A wants to get an object.

object is the small sized object. Otherwise, the proxy cache sends a lookup message to the client-cluster. In this figure, Client B gets this lookup message first and forwards it to Client C, and finally this message arrives at Client D, the home node for the large sized object. This home node returns a lookup result which indicates whether the node has the object header block or not. If the object header block exists, the proxy returns the redirection class response, especially 302 Moved Temporarily response whose destination is the Station of Client A, and the Station obtains the object header block from Client D and gets data blocks by using parallel connections. Otherwise, the proxy sends a request to the origin server for the object and obtains the object. If the size of the object is small, the proxy cache stores this object in its local storage and returns the object to Client A, otherwise, it just relaies the object and Client A takes a charge of storing this object such as creating data blocks, index blocks and the object header block and distributing these blocks into the client-cluster.

3.4 Client-Cluster Summary

When the proxy misses the object in its storage, it always checks the client-cluster without regard to the size of the object. If the object is the large sized object, this overhead is negligible, because the transfer overhead for the large sized object is much more than this. However, if the object is the small sized object, this lookup behavior is unnecessary and we get additional latency by this behavior and waste the internal bandwidth. To prevent this leakage, the proxy can have a summary of the objects in the client-cluster.

We use Bloom filter [5] as the summary of the client-cluster. A Bloom filter is a method for representing a set $A = a_1, a_2, ..., a_n$ of *n* elements to support membership queries. The idea is to allocate a vector *v* of *m* bits, initially all set to 0, and then choose *k* independent hash functions, $h_1, h_2, .., h_k$, each with range $1, ..., m$. For each element $a \in A$, the bits at positions $h_1(a), h_2(a), ..., h_k(a)$ in *v* are set to 1. Given a query for *b* we check the bits at position $h_1(b), h_2(b), ..., h_k(b)$. If any of them is 0, then certainly b is not in the set A. For a Bloom filter to represent the large sized objects in the client-cluster, when the proxy cache obtains an large sized object from the outside network, we insert a key for the object to the summary; when the objects in the client-cluster are removed we delete the key from the summary. Using to this summary, we can know whether the requested object is in the client-cluster or not and reduce the unnecessary lookups.

3.5 *n*-chance Replacement on Client-Cluster

Each client whose key range does not overlap stores index blocks and data blocks as an LRU list. This behavior distributes an large sized object over the client-cluster very well, but missing just one block spoils the whole of the large sized object. This block missing occurs, when a client leaves/fails or, a client evicts blocks to store new blocks; the replacement. We can overcome the failure or leaving of clients by appling the simple replication strategy to the p2p protocol for client-cluster. To solve the problem of the replacement, we move the evicted blocks to other clients before evicting blocks. When a client evicts a block, it first regenerates the different block key by hashing the block and an optional suffix which is the random value. To move the block correctly, the client finds the object header block and the index block by URL and the block number of the evicted block and update the block pointer with the new block key. We permit this chance of moving blocks for one large sized object until the number of the chance is bigger than the threadhold value, *n*. If an large sized object uses all of *n* chance, whole of blocks of the object is removed from the client-cluster. That is the *n*-chance replacement policy.

4 Evaluation

In this section, we present the results of extensive trace driven simulations that we have conducted to evaluate the performance of our system. We design our proxy cache simulator to conduct the performance evaluation. This simulator illustrates the behavior of a proxy cache and client-cluster. We have assumed that we simulate the behavior of a proxy cache effectively. The proxy cache is error-free and does not store non-cachable objects: dynamic data, control data and etc. We also assume that there are not any problems in the network, such as congestions and overflow buffers. The size of a proxy cache is in the range from 0.5MByte to 500MBytes. Each client uses one Stations which has the storage, about 40MBytes. The client-cluster stores large sized objects whose size is bigger than 1MBytes and the size of each block for the large sized objects is 32KBytes.

Traces	Measureing Day	Request Size	Object Size	Request Number	Object Number	Hit Rate	Byte Hit Rate
Trace 1	2001.10.08	9.02GB	3.48GB	699280	215427	69.19%	63.60%
Trace 2	2001.10.09	11.66GB	1.38GB	698871	224104	67.93%	57.79%

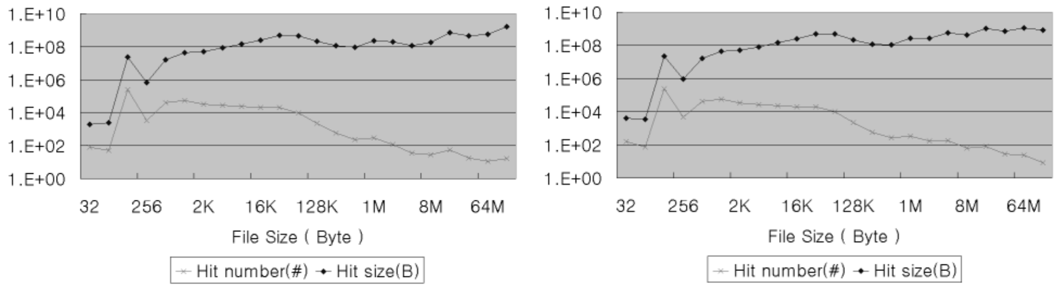
Table 1. Traces used in our simulation

4.1 Traces used

In our trace-driven simulations we use traces from KAIST, which uses a class B ip address for the network. The trace from the proxy cache in KAIST contains over 3.4 million requests in a single day. We have run our simulations with traces from this proxy cache since October, 2001. We show some of the characteristics of these traces in table 1. Note that these characteristics are the results when the cache size is infinite. However, our simulations assume limited cache storage and ratios including hit rate and byte hit rate can not be higher than *infinite-hit rate* and *infinite-byte hit rate*, which are the hit rate and the byte hit rate when the infinite storage is used.

4.2 Preliminary inspection

When we use a proxy cache, we first observe the proxy cache handling how many objects to estimate the performace of it. That is, if more hits occur in a proxy cache, the proxy cache achieves better performance. However, every hit does not have same weight in other aspect, the byte hit. Since the size of a requested object is variable, both of a large number of hits for a small sized object and a few of hits for a large sized object achieve similar byte hits. In figure 4, we show the distribution of the hits which occurs in a proxy cache, when we use traces which is mentioned above and simulate a proxy cache whose storage is infinite. We distribute the hits by the size of a file. we get the maximum hit number takes place on files whose size is about 256 Byte and the minimum value on about 64MB files. However,



(a) Trace 1 (b) Trace 2

Figure 4. Hit distribution in the proxy cache which has the infinite storage

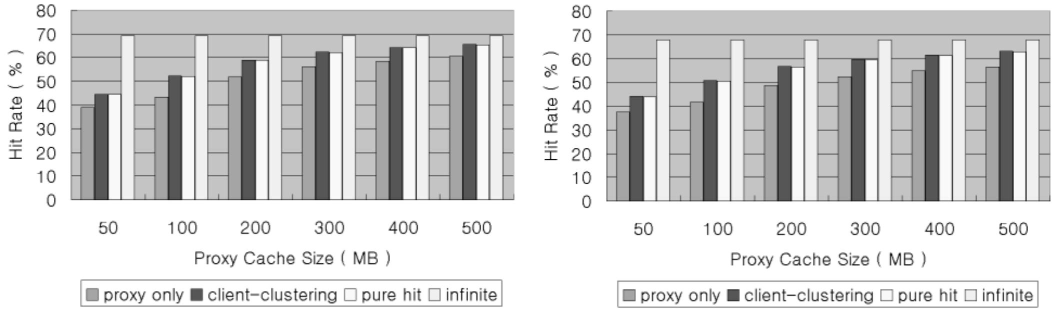
in the aspect of the byte hit, the byte hits on about 64MB files are bigger than it on about 256MB files.

According to this result, if the general replacement algorithms evict large sized objects to achieve the high hit rate, they should give up the high byte hit rate. To prevent this degradation of the byte hit rate, we must store large sized objects in the exclusive storage which has no relation to a proxy cache. We store large sized objects in the client-cluster, which is composed of clients and needs no cost to manage a proxy cache or other storages.

Additionally, in figure 4, hits decrease rapidly on about 1MByte files. We exploit this value, 1MByte, as the threshold value to select large sized object.

4.3 Hit Rate and Byte Hit Rate

Figure 5 and 6 show comparisons of the hit rate and the byte hit rate. By the hit rate, we mean the number of requests that hit in the proxy cache as a percentage of total requests. A higher the hit rate means the proxy cache can handle more requests and the original server must deal with proportionally lighter load of requests. The byte hit rate is the number of bytes that hit in the proxy cache as a percentage



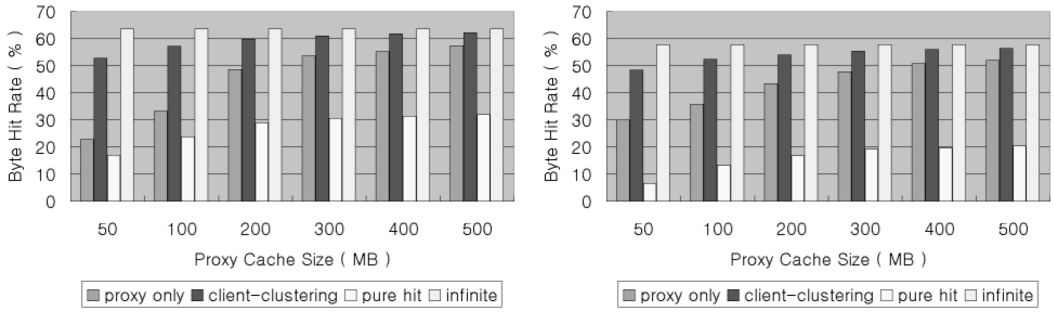
(a) Trace 1 (b) Trace 2

Figure 5. Hit rate comparison between only proxy cache and client-clustering

of total number of bytes requested. A higher byte hit rate results in a greater decrease in network traffic on the server side.

In the figures, *proxy only* means using only a proxy cache and *client-clustering* means using the client-cluster to store large sized objects. When we use the client-cluster, a hit do not only occurs at the local storage of a proxy cache but also at the client-cluster. To separate the two types of hits, we use *pure hit* that indicates the hit or byte hit rate which is obtained at the local storage of a proxy cache. *infinite* is the rate when a proxy cache has infinite storage.

The figure 5 shows the effect of using a client-cluster to the hit rate. When we use a client-cluster to store large sized objects, the hit rate increases by about 10% without any relation to the proxy cache size. Moreover, in every case, the hit rate of *pure hit* is very similar to the hit rate of *client-clustering*. Numerically the difference of these two value is only about 0.2%. Most of hits occur in a local storage of a proxy cache and few hits (about 0.2%) occur in a client-cluster. When using a client-cluster, the increasing effect of the hit rate is due to the increase of the hit rate in the local storage of a proxy cache. That is, a proxy cache does not handle large sized objects any more and it can store more small sized



(a) Trace 1

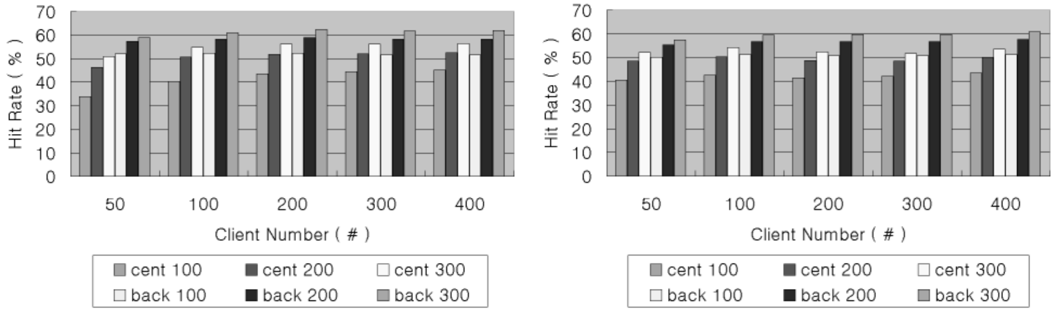
(b) Trace 2

Figure 6. Byte Hit rate comparison between only proxy cache and client-clustering

objects, and the hit rate of the whole system increases.

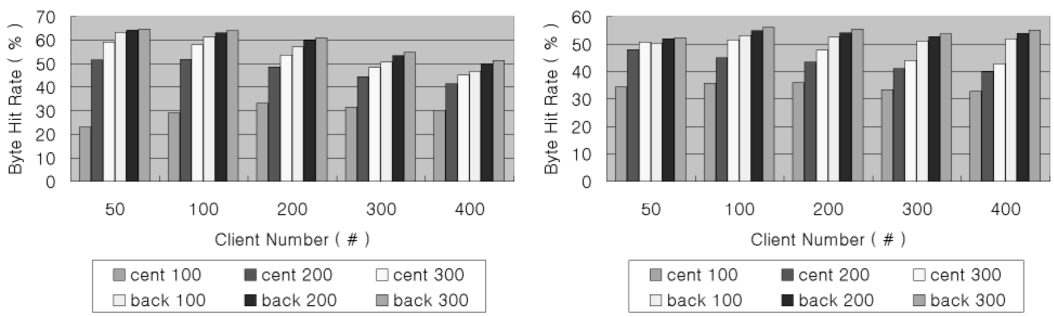
From the result of the hit rate, when we use a client-cluster only few hits occur in the client-cluster for large sized objects. However, these hits bring very big byte hits because of the large size of requested objects. In figure 6, when using a client-cluster, the byte hit rate increases remarkably and it achieves similar value to the infinite-byte hit rate without any relation to a proxy cache size. Differently form the hit rate, the byte hit rate of *pure hit* is smaller than the rate of *client-clustering* or the rate of *proxy only*. Especially, in the result of trace 2, the byte hit rate which is obtained from the local storage of a proxy cache is smaller than a third of the byte hit rate from a client-cluster. According to these, though a proxy cache achieves high hit rate, small sized objects in the proxy cause the low byte hit rate. We can cope with this weak point to store large sized objects in a client-cluster. Consequently, to use a client-cluster which is a exclusive storage for large sized objects, we achieve not only the high hit rate, but also the high byte hit rate. We can preserve and improve the performance of a proxy cache without the expensive management cost.

Additionally, to show scalability of the proxy cache which use the client-cluster, we assume every



(a) Trace 1 (b) Trace 2

Figure 7. Hit rate comparison with various client number



(a) Trace 1 (b) Trace 2

Figure 8. Byte Hit rate comparison with various client number

100 clients make 0.35 million requests and simulate with variable client number. The results are shown in figure 7 and figure 8 where the cent *n* indicates use of only a proxy cache whose size is *n* hundreads MB and the back *n* means a proxy cache and a client-cluster are used. In every case, when we use the client-cluster, the hit rate increases by about 10% and the byte hit rate icreases by about 10% – 15%. Note that in figure 8 (b) the byte hit rate achieves the high hit rate without any relation to the number of clients. This means that a proxy cache which use a client-cluster cope with a growth of the client

population without any management cost, that is, the proposed system is scalable.

In figure 8 (a), the whole of the byte hit rate decreases severely, however, the hit rate is high in figure 7 (a). The characteristics of the trace 1 cause this appearance. In the table 1, the request size of the trace 2 is about 11 times the object size, however, the request size of the trace 1 is only about 3 times the object size. That is, the trace 1 has much more requests for small sized objects than large sized objects and the effect of storing large sized objects is insufficient to compensate the degradation of the byte hit rate. In order to prevent this happening, the proxy cache should have a backup storage such as an proposed system in [8] and maximize the hit rate for the small sized objects.

4.4 Client Load

We examine the client loads, which include the request number, storage size, stored object, etc, to verify that the client-cluster balances the storage and requested queries. Table 2 shows a summary of the supported storage size, the requested number and the requested byte of clients. According to this table, in order to store the whole of large sized objects in the client-cluster, each client should supply about 10MB – 20MB storages to the proxy cache and handle about 1000 – 4000 requests for a day. These loads are enough for any client to handle in these days and if a number of client is 300 or more, these loads are negligible. The deviation value of each metric is less than 4% and each client receives roughly same load. Furthermore, when the client number increases the load of each client decreases. We are sure of the scalability of our system according to these results.

Client Number	Mean Size	Max Size	dev.	Mean Req.	Max Req.	dev.	Mean Byte Req.	Max Byte Req.	dev.
100	20967KB	21659KB	1.65	3662	3899	2.12	120025KB	127762KB	2.1
200	10586KB	11141KB	2.48	1842	2001	2.99	60374KB	65568KB	2.98
300	7081KB	7372KB	1.98	1230	1375	4.1	40327KB	45056KB	4.09

Table 2. Summary of client loads for Trace 1 with the 200MB proxy

5 Related work

Many peer-to-peer applications such as Napster, Kazza and Morpheus become popular. Additionally, large area file systems using peer-to-peer have been proposed, including PAST [4], CFS [3] and Oceanstore [9]. The target of these systems, however, is a wide area network, and they address issues of the characteristics of web objects such as size, popularity and update frequency.

A similar proposal for our approach appeared in [8] and [6]. In [6], they use web browser caches of clients itself. This approach do not concern about large sized objects and the load of each client can not balance well. Moreover, when the availability of clients is asymmetric, some clients decrease the total performance of the cache system. In [8], they use residual resources of clients as a backup storage of a proxy cache and maximize the hit rate which is similar to the infinite-hit rate. However, this proposed system is affected by large sized objects. Therefor, they cannot achieve high byte hit rate and cannot balance the load about the byte requests.

6 Conclusion

In this paper, we propose and evaluate the peer-to-peer client-cluster which is used as an exclusive storage for a web proxy cache. The proxy cache with this client-cluster achieves not only high hit rate but also high byte hit rate. This behavior reduces the outgoing traffic which occurs over the congested links and improves the performance of the connections to the outside world. Moreover, the client-cluster supported by the clients which use the proxy cache is highly scalable and the proxy just needs low administrative cost. Even if the clients take the load, this load has been verified on a range of real workloads to be low and well balanced. Additionally, if we use this client-cluster not only as an exclusive storage of a proxy cache but also as a backup storage of a proxy cache, we achieve the high value for both of the hit rate and the byte hit rate, which is similar to the value when we use the infinite cache. This is our ongoing work.

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