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BANDWIDTH OPTIMISATION USING CACHING TECHNIQUES FOR PERFORMANCE ENHANCEMENT IN A SYSTEM

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ABSTRACT

A Web cache is a mechanism for the temporary storage (caching) of web documents, such as HTML pages and images, to reduce bandwidth usage, server load, and perceived lag. A web cache stores copies of documents passing through it; subsequent requests may be satisfied from the cache if certain conditions are met. The World Wide Web suffers from scaling and reliability problems due to overloaded and congested proxy servers. Caching at local proxy serves help, but cannot satisfy more than a third to half of requests; more requests are still sent to original remote servers. This paper as case study discusses and analysed several web caching schemes and to optimised the network of organisation for bandwidth enhancement. Clustering improves the retrieval latency and also helps to provide load balancing in distributed environment. But this cannot ensure the scalability issues, easy handling of frequent disconnections of proxy servers and metadata management issues in the network.

Index Terms: *Web caching, Metadata Server (WCMS), Distributed Web Caching, Clustering, Latency (DWCCL), Robustness, Scalability, Disconnection Handling, Proxy server, clients.*

1. INTRODUCTION

The organisational networking system is one of the most essential assets for any organisation to support and deliver numerous key services. This is also an integral part of computing environment that supports organizational business activity and official works. It is not viable for any big organization to operate if it is not connected to the entire offices spread across the country side. This means, the survival is dependent on good working access of Intranet. [1] In the current paper, one of the core issues of network management system, i.e. to make available adequate bandwidth is discussed in detail by considering case study of Chanakya Organisation, This organisation has various categories of users with varying network requirements and service utilisation trends. This paper has also tried to identify the major bottleneck applications which generally eat one of the most valuable and limited resources of the organisation's network, i.e. bandwidth followed by designing of policy framework by considering both technical and managerial possible solutions.[11]

The surge in popularity of the World Wide Web (WWW) has introduced new issues such as Internet traffic and bandwidth consumption. Recently much research has focused on improving Web performance by reducing the bandwidth consumption and WWW traffic. It means that fewer requests and responses need to go over the network and fewer requests for a server to handle. A *Web cache* sits between one or more Web servers (also known as *origin servers*) and a client or many clients, and watches requests come by, saving copies of the responses like HTML pages, images and files (collectively known as *representations*) for itself. Then, if there is another request for the same URL, it can use the response that it has, instead of asking the origin server for it again. There are two main reasons that Web caches are used:

A. To **reduce latency** — Because the request is satisfied from the cache (which is closer to the client) instead of the origin server, it takes less time for it to get the representation and display it. This makes the Web seem more responsive.

B. To **reduce network traffic** — Because representations are reused, it reduces the amount of bandwidth used by a client. This saves money if the client is paying for traffic, and keeps their bandwidth requirements lower and more manageable. [**9**]

Kinds of Web Caches

A. ***Browser Caches***: If you examine the preferences dialog of any modern Web browser (like Internet Explorer, Safari or Mozilla), you'll probably notice a ―cache‖ setting. This lets you set aside a section of your computer's hard disk to store representations that you've seen, just for you. The browser cache works according to fairly simple rules. It will check to make sure that the representations are fresh, usually once a session (that is, the once in the current invocation of the browser).This cache is especially useful when users hit the ―back button or click a link to see a page they've just looked at. Also, if you use the same navigation images throughout your site, they'll be served from browsers' caches almost instantaneously.

B. ***Proxy Caches***: Web proxy caches work on the same principle, but a much larger scale. Proxies serve hundreds or thousands of users in the same way; large corporations and ISPs often set them up on their firewalls, or as standalone devices (also known as *intermediaries*).Because proxy caches aren't part of the client or the origin server, but instead are out on the network, requests have to be routed to them somehow. One way to do this is to use your browser's proxy setting to manually tell it what proxy to use; another is using interception. *Interception proxies* have Web requests redirected to them by the underlying network itself, so that clients don't need to be configured for them, or even know about them. Proxy caches are a type of *shared cache*; rather than just having one person using them, they usually have a large number of users, and because of this they are very good at reducing latency and network traffic. That's because popular representations are reused a number of times.

C. ***Gateway Caches*****: Also** known as —reverse proxy caches or —surrogate caches, gateway caches are also intermediaries, but instead of being deployed by network administrators to save bandwidth, they're typically deployed by Webmasters themselves, to make their sites more scalable, reliable and better performing. Requests can be routed to gateway caches by a number of methods, but typically some form of load balancer is used to make one or more of them look like the origin server to clients. *Content delivery networks* (CDNs) distribute gateway caches throughout the Internet (or a part of it) and sell caching to interested Web sites. Speedera and Akamai are examples of CDNs. **[8][13][14]**

2. NECESSITY OF BANDWIDTH MANAGEMENT

The bandwidth simply represents the capacity of the communication media to transfer data from source to destination. Wider the route/path for data transmission, more packets of information will be transmitted to the user's Intranet enabled devices. Bandwidth is both absolutely and relatively much more expensive for any organisation. Many organisations are finding that they still do not have reliable, usable Intranet Access for their offices and staff despite considerable investment. Improving the performance of the information delivery chain is urgent if organisation and staffs are to be benefited from the Intranet and take part in the organisational activity [**9**].

3. BACKGROUND TO THE PROBLEM

Chanakya is a virtual org having large network infrastructure which is spread across the country. [11]. the initial networks was functioning on 2 Mbps for voice and file transfer purpose. Automation of org started on 2000. By 2012 the various networks user increased manifold. The users were using networks for voice, data transfer, video, photo, emails, file transfer, website and online database accesses activity. The BW has been increase up to 8 mbps by different via media like line, wireless, microwave and VSAT. Now the network is facing congestion during day time from morning 9 am to 6 pm and mission critical web applications are not accessible across the users of Chanakya. Chanakya is under pressure to provide their staff and offices with reliable Intranet access. As Intranet connectivity is increasingly becoming a strategic resource for firm management. The use of the Intranet can enhance the efficiency and capacity of Chanakya. Intranet connectivity provides a gateway to vast amounts of information from the headquarters to area offices and thus provides support and enhances recourses and activity management by both staff and officials. Chanakya have set aside a significant fraction of their budgets towards increasing their bandwidth and upgrading their networks. Despite considerable investment in bandwidth, many of these Area offices are still finding themselves not having reliable, usable Intranet access for their staffs and offices.

As the popularity and usage of heavy bandwidth consuming applications grows and the number of network users multiplies, the need for a concerted and co-ordinate effort to monitor bandwidth utilization and implementation of effective bandwidth management strategies becomes increasingly important to ensure excellent service provision. Policy based bandwidth management was adopted and BW was optimized up to some extent. However in spite of all, the data base web services are still not able to get access in far flung of field unit/offices. Since bandwidth is a strategic resource, the efficient usage and management of such a resource should always be a priority. Without bandwidth management, mission critical applications would be starved of bandwidth, disrupting services that impact the operational activities of a Chanakya [11].

As such, this study sought to illuminate the bandwidth management strategies that were being employed by Chanakya in his large network. The case study concentrated on technology based I.e. Cashing techniques to optimize the bandwidth at server end and browser end.

4. THE PROBLEM

The demand for bandwidth [12] within Chanakya is on a constant rise. The available bandwidth is generally not enough to meet demands and to support optimal usage. The major challenges experienced by Chanakya are:

(a) Database web application not accessible at field/mobile units/offices.

(b) Violations of network due to peer–to-peer (P2P) file sharing.

(c) Poor application performance and Quality of Experience (QoE) during congestion.

(d) Mission critical and time application not able to access in last end office/units.

(e) Experience of sluggish network speed during peak office hours.

(f) Sudden very less bandwidth availability at user end and non response of web enabled hosted applications.[11]

5. OBJECTIVES OF STUDY

1. Deploying a caching mechanism that will save precious bandwidth and increase user response time
2. Clustering cache servers with load balancing and fail-over mechanisms
3. GUI based reporting tool to monitor web usage and bandwidth management
4. To implement and study the cashing techniques to enhance and optimise bandwidth for performance enhancement on an organisation network.

6. METHODOLOGY

Caching Techniques. Caching is the approach of temporary storage of web objects, such as HTML files, for later retrieval. Few approaches have been suggested for effective web caching schemes. [7][14][18]

A. *Proxy caching* A proxy cache server receives HTTP requests from clients for a web object and if it finds the requested object in its cache, it returns the object to the user without disturbing the upstream network connection or destination server. If it is not available in the cache, the proxy attempts to fetch the object directly from the object's home server. Finally the originating server, which has the object, gets it, possibly deposits it and returns the object to the user. The benefits of proxy caching are supposed to reduce network traffic and reduce average latency. Proxy caches are often located near network gateways to reduce the bandwidth required over expensive dedicated Internet connections.[24]

B. *Reverse Proxy Caching* An interesting variation to the proxy cache approach is the notation of reverse proxy caching, in which caches deployed near the servers, instead of near the clients. This is an attractive solution for servers that expect a high number of requests and want to assure a high level of quality of service (QoS). Reverse proxy caching is a useful mechanism when supporting virtual domains mapped to a single physical site, which is an popular service for many different service providers.[25]

C. *Transparent Caching* One of the main drawbacks of the proxy server approach is the requirement to configure web browsers. The architecture of transparent caching eliminates this handicap. Transparent caches work by intercepting HTTP requests and redirecting them to web cache servers or clusters.

D. *Adaptive web caching* The adaptive web caching system provides an effective evolutionary step towards the above goal. Adaptive caching consists of multiple, distributed caches which dynamically join and leave cache groups based on content demand. Adaptive caching uses the Cache Group Management Protocol (CGMP) and the Content Routing Protocol (CRP), CGMP specifies how meshes are formed and how individual caches join and leave that meshes.CRP is used to locate cached content from within the existing meshes.

E. *Push Cashing* The idea of having a server decides when and where to cache its documents, was introduced as push cashing. The key idea behind this architecture is to keep cached data close to those clients requesting that information. Data is dynamically mirrored as the originating server identifies where requests originate**.**

F. *Active caching* An active cache scheme is proposed in to support caching of dynamic contents at Web proxies. The growth of the Internet and the World Wide Web has significantly increased the amount of online information and services available to the general population of the society. The Active Cache is a scheme which migrates parts of server processing on each user request to the caching proxy in a flexible on demand fashion via —cache applets.

7. CACHING TECHNIQUES SETUP

The cashing techniques trail implementation is planned at main headquarters server farm. Cashing server was placed at main server. HTTP proxy cashing [**2**][23] is setup through cyberoam UTM which is implemented at area offices server room at four locations. Proxy can be

a. Apache proxy
b. MS proxy server
c. Squid – Squid is popular because it is powerful, configurable and free

We have deployed our system on a web application server. The application provides a variety of data information to end users by retrieving data from a number of data sources such as database systems, content management systems, and remote web servers. Pages in the site are generated using ASP scripts. We performed a set of experiments using this application to compare the performance of our proxy-based caching system with that of a system without any caching. Each page selected for the experiments consists of 9 fragments.[11][23][24]

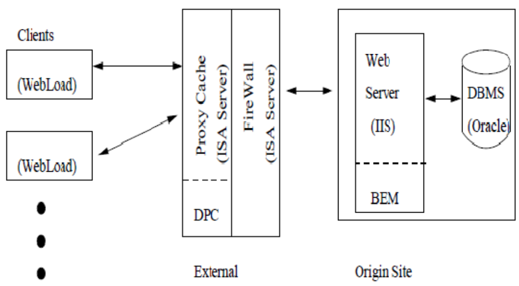

Figure 1. Cashing Techniques Set Up at Chanakya Server farm [11]

8. IMPLEMENTATION

Caches was implemented within a Web browser, within the network itself (typically in proxy servers, which might be located between a department and an enterprise network, between an enterprise network and the Internet, or on a link out of a country), and at servers. Whenever a Web [**3**] document is requested from a browser, proxy, or server cache, the cache directory is checked to see if a copy of the document is contained in the cache. If it is (called a cache hit), the cached copy is returned; otherwise (a cache miss) the document is requested from some other entity (e.g., another cache or the origin server). Proxy caches reduce bandwidth and alleviate delays associated with the World-Wide Web.

The software systems use Squid, a high performance proxy server for web clients. Squid [**5**] handles all requests in a single, non-blocking, I/O driven process. Squid keeps meta data and especially hot objects cached in RAM, caches DNS lookups and implements negative caching of failed requests. Squid keeps frequently used objects in cache and discards less used objects [**3**] (or less priority objects identified by a replacement policy).

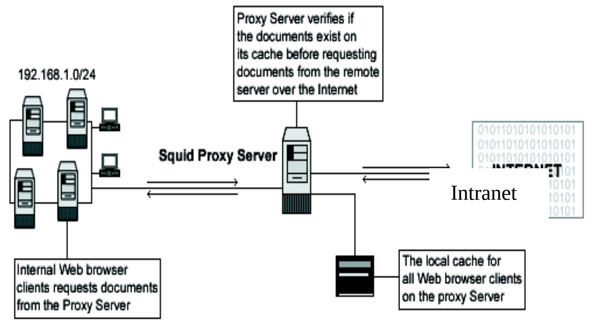

Figure 2.Cashing Techniques Set Up at Chanakya Area Offices [24][11]

A. **Distributed Web Caching Configuration**

As the Chanakya is a big networks and spread across the country side. We have used the technique based upon the Distributed Web Caching for clustering based environment in geographical region i.e DWCC (Distributed Web Caching with Clustering). The entire geographically together proxy servers are placed in the same cluster i.e area offices. This dynamic scheme provides easy management of metadata. Low latency by a factor of s/m can be achieved by this scheme. Unlike previous techniques there was no need of metadata exchange before serving any request. [11][16][17][22]

The proposed strategy includes origin server farm, clusters of proxy servers and clients as shown in Figure 3. MDS's task is to maintain metadata of all proxy servers within own cluster and metadata of neighbouring cluster. In previous strategy [3] every proxy server itself maintains metadata of its own cluster as well as of their neighbouring clusters. So this strategy will reduce efforts and time of proxy servers [6][20][21]

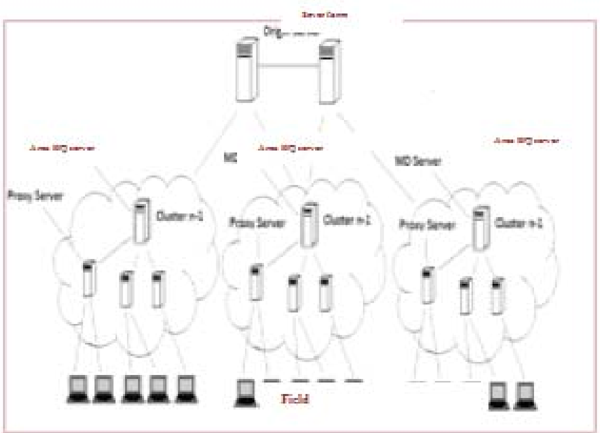

Figure 3. Distributed Web Caching with Clustering at Chanakya[11][6]

9. RESULT AND PERFORMANCE ANALYSIS

Caching has three significant advantages [**4**] to web caching: reduced bandwidth consumption (fewer requests and responses that need to go over the network), reduced server load (fewer requests for a server to handle), and reduced latency (since cached responses are available immediately, and closer to the client being served). One more advantage is sometimes added: more reliability, as some objects may be retrievable via cache even when the original servers are not reachable. [21]

A. Cache Hit ratio

The hit ratio gives you an idea of the effectiveness of cache. A higher the ratio means that more requests are served from the cache rather than the network. The hit received is as shown in figure.

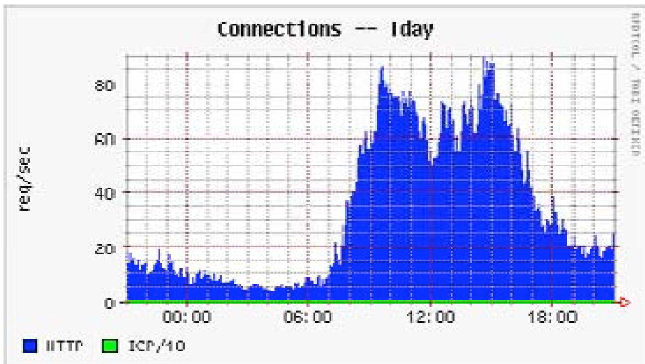

Figure 4: The graph on the left shows the number of connections per second to your Squid cache.*[11]*

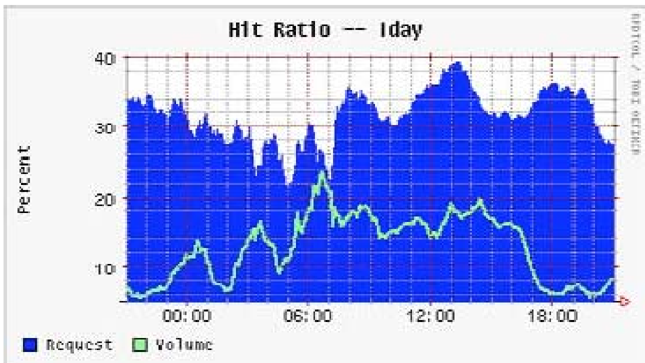

Figure 5. The graph on the right shows the cache hit ratio as expressed by the number of requests (the dark area) and volume (the light line)[11]

B. *CPU Utilization*

Periods of constant 100% utilization may indicate a problem that needs investigation. The CPU can also become a hardware bottleneck, and constant high utilization may mean that you need to optimize your Squid, upgrade your server, or lighten the load by bringing up another cache box .[8]

C. Performance metrics

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Performance metrics used are bandwidth, in bytes per second and average response time, the end-to-end delay in delivering an HTML page. In our experiments, we vary load, measured in transactions per second (TPS). Bandwidth is measured between the web server and the DPC using Sniffer. Figure .6 shows the performance results in terms of bandwidth as load is varied. Note that the y-axis is shown on a log scale. In both the no cache and cache cases, bandwidth increases as load increases. However, the no cache curve is much higher than the cache curve. As load increases beyond about 10 TPS, the dynamic proxy cache results in an order-of-magnitude reduction in bandwidth. Given that the proxy-based cache requires additional scanning of the page templates.

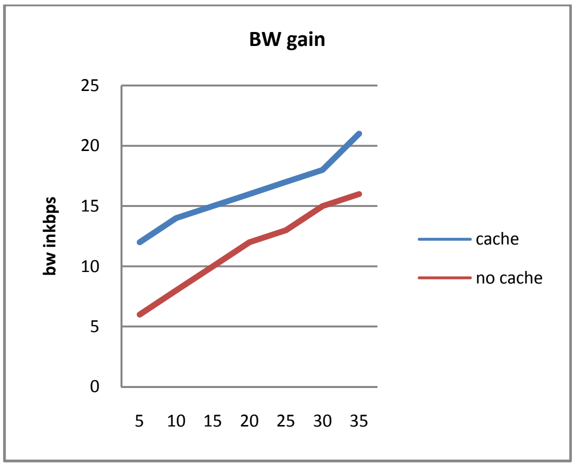

Figure 6: Experimental Results: Comparison of Bandwidth [11]

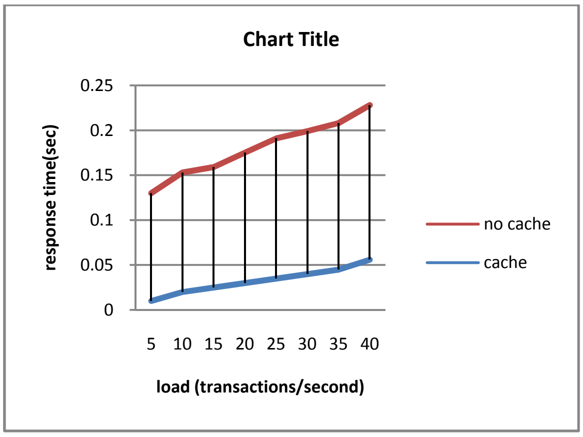

Figure 7: Experimental Results: Comparison of Response Times[11]

It is of interest to examine the impact on response times. Figure 7. shows the performance results in terms of average response time as load is varied. As this figure shows, the cache case significantly outperforms the no cache case under the conditions used in our experiments. In fact, the cache case provides an order-of-magnitude reduction in average response times over the entire range shown.

Bandwidth availability for mission critical and time bound application has been increased by 21 % which is as shown in figure 8.

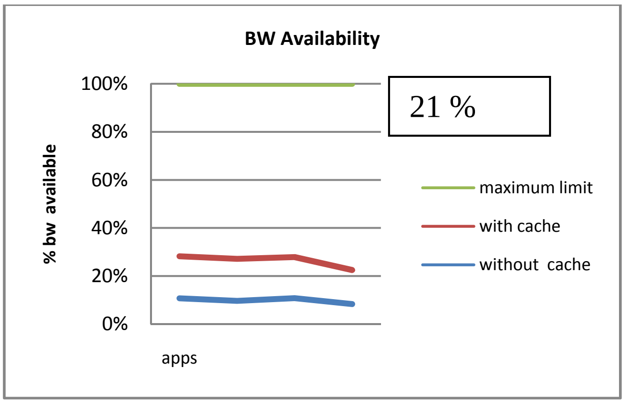

Figure 8: Bandwidth Availability for Mission Critical Application

10. CONCLUSIONS AND FUTURE WORKS

Web caching is the best solution to reduce the internet traffic and bandwidth consumption. It is also a low cost technique for improving the Web latency. Now days, proxy caches are increasingly used around the world to reduce bandwidth and make less severe delays associated with delays. Web proxy servers sharing their cache directories through a common mapping service that can be queried with at most one message exchange. A number of caching schemes already exits. In this case study, we have not tested a strategy called ―*Improved Metadata Management & Scalability in Dynamic Distributed Web Caching*‖ that can be easily deployed in the future. This is based on the DWCRLD to improve the scalability and to alleviate extra overhead of metadata management of the proxy servers and also reduces the network traffic as well. This scheme also makes it easy to handle frequent disconnections in the network. By this even if the number of proxy servers grows in the network, metadata management will never be an issue.

REFERENCES

[1] Curz Peter, (2000). "Adopting a Business-Oriented Approach to Bandwidth Management — Technology Information". *Computer Technology Review*, 10 Nov.

[2] "Cyberoam UTM announced On-appliance SSL VPN". (2014). Elite core Technologies Limited. 10 Dec. 2014.

[3] Rajeev Tiwari, Neeraj Kumar, Static *and Dynamic Web Caching: for Robustness, Low Latency & Disconnection Handling,* 2nd IEEE international conference on Parallel, Distributed and Grid Computing, 2012 .

[4] Chankhunthod et. al., *A hierarchical internet object cache*, in Proc. 1996 annual conference on USENIX Annual Technical Conference, San Diego, CA, Jan. 1996.

[5] Squid Web Proxy Server documentation ,squid-cache.org.

[6] "Decentralized Network Management at UW". (2004). *Report from the Adhoc Committee on Network Management*, Organisation of Waterloo. 12 Dec. 2014.

[7] Rosenberg Diana, (2005). "Digital Libraries". *International Network for the Availability of Scientific Publications (INASP)*. 13 Dec. 2014. < www.inasp.info>

[8] "How to Accelerate Your Intranet", (2006). 10 Oct. 2014./chapter2.pdf>.

[9] McGuigan, Brendan. (2010). "What is bandwidth". 10 Dec. 2014 **[10]** "Bandwidth Management Position Paper". (2007). Aptivate. 12 Dec. 2010. .BMOPositionPaper/AptivateBMOPositionPaper.pdf>.

[11] Chanakya virtual organization Annual Technical Journal and IT Policy.

[12] Chanakya Technical Networks, Components and Infrastructure guide.

[**13**] K. Claffy, H.W. Braun, *Web traffic characterization: An assessment of the impact of caching documents from NCSAs web server*, in Electronic Proc. 2nd World Wide Web Conf.94: Mosaic and the Web, 1994

[**14**] Pablo Rodriguez, Christian Spanner, and Ernst W. Biersack, *Analysis of Web Caching Architectures: Hierarchical and Distributed Caching*, IEEE/ACM Transactions On Networking, Vol. 9, NO. 4, AUG 2001

[**15**] Chankhunthod et. al., *A hierarchical internet object cache*, in Proc. 1996 annual conference on USENIX Annual Technical Conference, San Diego, CA, Jan. 1996.

[**16**] Povey and J. Harrison, *A distributed Internet cache*, in Proc. 20th Australian Computer Science Conf., Sydney, Australia, Feb. 1997.

[**17**] V. Cardellini, M. Colajanni, P.S. Yu, *Geographic Load balancing for scalable distributed Web systems*, Proc. of MASCOTS'2000, IEEE Computer Society, San Francisco, CA, pp 20-27 Aug. 2000.

[**18**] D.Wessels and K. Claffy, *Application of Internet cache protocol (ICP)*, version 2, Internet Engineering Task Force, Internet Draft: draft-wessels-icp-v2-appl-00. Work in Progress., May 1997.

[**19**] V. Valloppillil and K. W. Ross., *Cache Array Routing Protocol*, v1.1. Internet draft. [Online]. Available: http://ds1.internic.net/internetdrafts/draft-vinod-carp-v1-03.txt, 1998

[**20**] Rajeev Tiwari, Lalit Garg, *Robust Distributed Web Caching Scheme: A Dynamic Clustering Approach*, in International Journal of Engineering Science and Technology in ISSN : 0975-5462 Vol. 3 No. 2 Feb 2011,pp 1069-1076.

[**21**] R. Tewari, M. Dahlin, H. M. Vin, and J. S. Kay, *Beyond hierarchies: Design considerations for disturbed caching on the Internet*, in *Proc. ICDCS '99 Conf.*, Austin, TX, May 1999.

[**22**] A. Rousskov and D. Wessels, *Cache digest*, in *Proc. 3rd Int. WWW Caching Workshop*, June 1998, pp. 272–273.

[**23**] M. Arlitt, R. Friedrich, and T. Jin, "Performance Evaluation of Web Proxy Cache Replacement Policies" Technical Report HPL, Hewlett-Packard Laboratories, June 1998.

[**24**] Ajay Prabhu and Sachin Bhatkar, Computer Science Department, University Of Maryland, Baltimore County, "A Web Server Caching Proxy Mechanism", Dec 2001

[**25**] Roland P. Wooster and Marc Abrams, Network Research Group, Computer Science Department, Virginia Tech., "Proxy Caching That Estimates Load delays", April 1997.

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