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Impact of Local Domain Name System (DNS) on Corporate Network Bandwidth

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Abstract: The Domain Name System (DNS) is the most crucial component of today's Internet. DNS is a service which translates human readable domain names into IP addresses and acts like the telephone directory of internet. Just as a phone number such as 0181-2226715 is mapped into a name in telephone directory, similarly every device on internet is identified by unique id known as IP address and are mapped to human readable names known as host names such as www.example.com. For an end user, performance of internet depends heavily on the performance of DNS because generally it is the first service used for accessing a web page. Performance enhancement of internet and effective use of bandwidth has been a major concern for researchers in the field of computer networks. In this study concept of having a local DNS in the network is used so that impact of Local DNS on the bandwidth can be studied. In this study, Network Simulator (NS2) is used to analyze the behavior of network when local DNS is used. Two different scenarios are created in the simulation one without local DNS and the other having local DNS. NS2 traces the flow of packets and generates graphs, from which impact of local DNS will be studied.

Keywords: Local DNS, NS, NS2

I. INTRODUCTION

The Internet is a global system of interconnected computer networks and using the standard protocol suite TCP/IP (Transmission Control Protocol/Internet Protocol) to serve the billions of users worldwide. TCP/IP was developed in the early 1980s and quickly became the standard network protocol. Internet has infinite number of applications which are used for searching useful information and getting knowledge without boundary restrictions. While browsing, user required to enter the name of website, and subsequently which is converted to the IP address of the concerned web server. IP address is a numeric label and it is the fundamental identifier on the Internet for its services and various Internet devices, but practically it is not possible to remember all of them manually. Therefore, IP addresses on the Internet are identified with textual word called host name.

A. Domain Name System

The role of Domain Name System (DNS) is to convert the user friendly domain names to unique IP addresses The domain name system (DNS) is a distributed database and provides name resolution service to the internet users. Distributed database Of DNS allows local control of the segments of the overall database, yet data in each segment are available across the entire network through a client−server scheme. By providing a worldwide distributed database for name resolution, DNS is an essential component of the functionality of Internet. For human beings it is not easy to remember IP addresses therefore, DNS provides the mechanism of translating the easily memorable host names into IP addresses. There are different methods to resolve this problem; 1) **Host file**: In this method a file named as HOSTS.TXT is created to resolve the IP addresses. A single file, HOSTS.TXT,

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contained all the information which user needed to know about those hosts or computers and it is maintained manually and is also known as manual conversion tables. 2) **DNS**: It becomes very difficult to add IP addresses manually when internet is having billion computers. DNS provides a management system for names which is hierarchical and easier to administrate.

B. DNS HIERARCHICAL TREE STRUCTURE

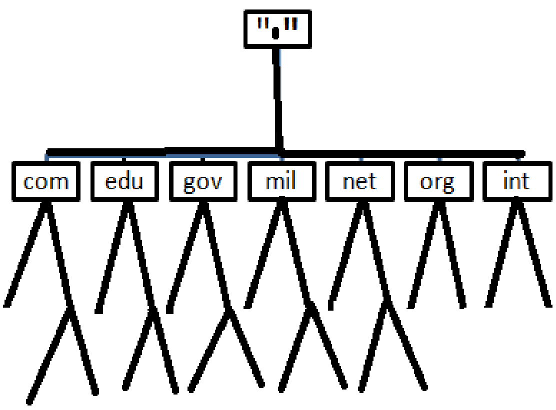

Fig. 1. DNS Architecture

The whole database is pictured as the inverted tree with root node at the top and null label is reserved for root node. The root node is top level node denoted by "**.**".The depth of the tree is limited to 127 levels (a limit which is not likely to reach). Each node in the tree has a label associated with it. Label is a string of characters with maximum value of 63. It necessary that children of a node have different labels so that, uniqueness can be ensured. However, label for children of different nodes may be same.If a domain name is terminated with a null string then, it is called as Fully Qualified Domain Name (FQDN).

DNS has three main components; Name space, Name server and resolver. DNS's distributed database is indexed by domain names. Each domain name is essentially just a path in a large inverted tree, called the domain name space.The programs that store information about the domain name space are called name servers. These name servers are responsible for storing all the information about some part of domain name space which is known as zone. Complete information about a zone is loaded from a file or it is loaded from other name servers. DNS resolvers are the clients that access name servers. DNS queries for name resolution are sent by resolver itself. Main responsibilities of resolver are: Querying name server, Interpreting responses given by name server.

C. Bandwidth

For any network, bandwidth is the basic requirement for smooth running of internet applications. Saving bandwidth is main concern of researchers by avoiding repetitive queries and unnecessary data so that it can be used for other internet applications. Bandwidth in computer networks represents the overall capacity of a connection as the amount of data that can pass via that connection over a time period - it is measured in bits-per-second (bps). Throughput or maximum throughput is sometimes used as a synonym for bandwidth. Latency or delay is an important design and performance characteristic of a computer network or telecommunications network. The delay of a network specifies how long it takes for a bit of data to travel across the network from one node or endpoint to another. It is typically measured in multiples or fractions of seconds. Various factors which contribute to network delay are: Processing Delay, Queuing Delay, Transmission delay and Propagation Delay.

II. RELATED WORK

Mockapetris and Dunlap (1988) described Domain Name System (DNS) as one of the largest name services in operation, which serves a highly diverse community of hosts, users, and networks, and uses a unique combination of hierarchies, caching, and datagram access. Initially DNS was installed for DARPA Internet. Ideas behind the initial design of the DNS in 1983 are examined and also the evolution of these ideas into the current implementations and usages is discussed. An attempt is made to predict the future evolution of DNS. Also, success and shortcomings of DNS is studied.

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Liston *et. al* (2002) discussed about the diversity in the DNS performance in the different physical locations in the world. DNS employs caching to increase the performance. A cached domain name record circumvents wide area DNS operation, so lookups for this name are not subject to variations in the wide area resolution mechanism. Some studies demonstrate that even when caching is enabled the lookup times for domain names can be quote long. Liston measured diversity in performance for the non-cached DNS servers.

Klensin (2003) reviewed the original function and purpose of the domain name system (DNS). It contrasts that history with some of the purposes for which the DNS has recently been applied and some of the newer demands being placed upon it or suggested for it. A framework for an alternative to placing these additional stresses on the DNS is then outlined. This document and that framework are not a proposed solution, only a strong suggestion that the time has come to begin thinking more broadly about the problems that are encountered and possible approaches to solving them.

Park *et. al* (2004) introduce CoDNS, a lightweight, cooperative DNS lookup service that can be independently and incrementally deployed to augment existing name servers. It uses a locality and proximity-aware design to distribute DNS requests, and achieves low-latency, low-overhead name resolution, even in the presence of local DNS name server delay/failure. Using live traffic, the study show that CoDNS reduces average lookup latency by 27-82%, greatly reduces slow lookups, and improves DNS availability by an additional '9'. This article also show that a widely-deployed service using CoDNS gains increased capacity, higher reliability, and faster start times.

Lim *et. al* (2007) mentioned Domain Name System (DNS) as the core system for managing Internet address resources, providing the most fundamental naming service. Currently, the DNS is classified into a tree structure. In this structure, normal access to the lower DNS is difficult when there is an error in the upper DNS. Such risk still remains even when a supplementary DNS is operated. However, due to the merit of the DNS enabling fast searches, it is impracticable to abandon the current tree structure. To efficiently correspond to DNS errors, this study suggests a method where the merit of the current tree structure is kept, while a temporary operation of the local DNS is available when errors occur by adding a horizontal and independent DNS structure.

Tamrakar (2008) discussed the methods of handling large number of DNS (domain name system) for online social networking sites. The number and use of the social networking sites in the recent years has grown rapidly, social networking sites have redefined the way, users interact online. Most of the social networking sties provide customizable personal pages to its members. During customization user may embed contents from different web sites that provide contents in a form of HTML embed codes. Thus a page may contain different contents from several different web sites. As a result a page download may generate hundreds of DNS queries and even if few people visit these social networking sites at the same time and if they are using same Internet service provider, the number of DNS queries sent to local DNS server is quite huge. In many cases the local DNS server are unable to handle such DNS traffic thereby it slows down all its services. Such overloaded DNS server is susceptible to Denial of Service attacks as well. In this paper, Tamrakar tried to mention some of available methods that social networking sites could implement to reduce such DNS references and also tried to mention some methods to improve the carrier network so that it can handle such huge DNS traffics.

Ager *et. al* (2010) defined Domain Name System (DNS) as a fundamental building block of the Internet. The performance of more and more applications depend not only on the responsiveness of DNS, but also the exact answer returned by the queried DNS resolver, e. g., for

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Content Distribution Networks (CDN). In this paper, local DNS resolvers compared against Google DNS and Open DNS for a large set of vantage points. Our end-host measurements inside 50 commercial Internet Service Providers (ISPs) re- veal that two aspects have a significant impact on responsiveness: (1) the latency to the DNS resolver, (2) the content of the DNS cache when the query is issued. Also significant diversity is observed, even at the AS-level, among the answers provided by the studied DNS resolvers. This diversity is attributed to the location-awareness of CDNs as well as to the location of DNS resolvers that breaks the assumption made by CDNs about the vicinity of the end-user and its DNS resolver. Findings in this paper pinpoint limitations within the DNS deployment of some ISPs, as well as the way third-party DNS resolver bias DNS replies.

III. METHODOLOGY

In present study impact of localization of DNS is shown on the network bandwidth with the help of parameters such as delay and throughput. Materials and methods to demonstrate the impact of localization of local DNS are given in this chapter.To show the impact of local DNS two different scenarios are created and results of both the scenarios are compared with each other These two scenarios are created with the help of NS2. NS2 is discrete event packet level simulation software which animates the behaviour of network in user defined conditions.

- In first scenario queries are answered by DNS which is not local to the network.
- In second scenario queries are answered by a DNS local to the network.

A. *Non local DNS*

In the existing technique i.e. first scenario, non local DNS server is configured to resolve the DNS queries. The whole scenario consisting of nodes and routers is divided into number of four locations. A node itself cannot forward query outside the network therefore, in each location a router is deployed which is responsible for forwarding the DNS query request to global DNS. If the location in which query is generated is not local to the DNS then router is unable to directly communicate with DNS server. To overcome this problem, intermediate routers or sometimes also known as Hops are responsible for forwarding the query to Global DNS server.

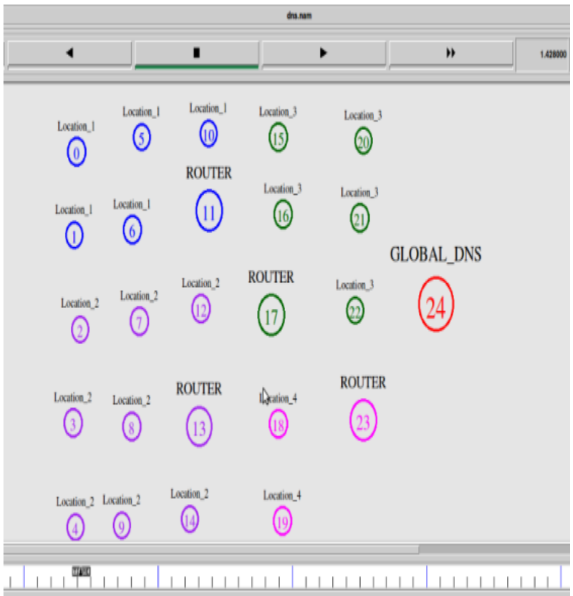

Fig. 2. Network with non local DNS

Figure shown above demonstrates the network having four locations each having a different colour. In this case DNS queries are answered by single DNS server. Packets have to travel a longer path and use more network resources. Sometimes queries may get timed out and remain unanswered because of the increased load/burden on the single DNS server.

B. *Local DNS*

In the new approach, the local DNS servers are deployed at each location so that the queries generated by nodes from different locations can be answered locally. For each different location a different router is responsible for forwarding the queries to the local DNS. Routers at

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different locations forward the network traffic to local DNS and thus keep the network traffic in local. The local DNS servers are synchronized with each other time to time, to maintain data consistency. The proposed approach will reduce delay and enhance network throughput as a result of which it will consume less bandwidth because the data packets containing DNS data need to travel shorter path as compared to previous scenario.

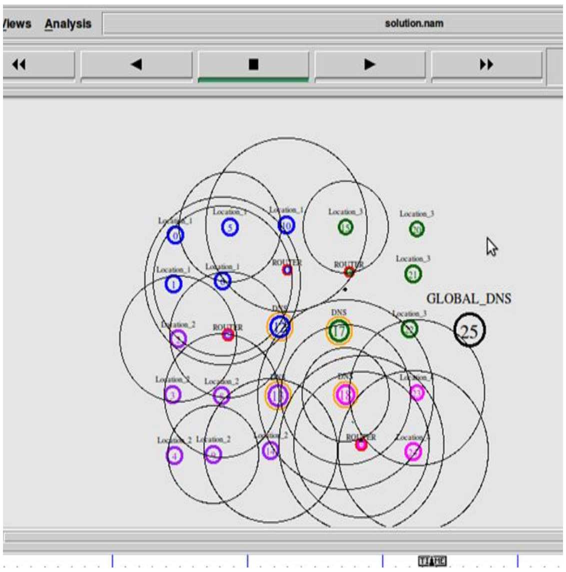

Fig. 3. Network with Local DNS

Figure shown above demonstrates the network having local DNS server at each location. Nodes numbered at 12, 13, 17 and 18 are local DNS servers. Now the queries from each location will be answered by the local DNS. Local DNS will resolve the queries of that data which are added in its database.

C. Performance degradation in Non-Local DNS:

It has been found by many researchers that number of DNS queries remain unanswered. This may be because of the increased burden on the single DNS server for a large area. Increased delay in case of non-local DNS is also the main concern. High speed internet is of no use when DNS server takes long time intervals to resolve the DNS queries generated by computers/hosts. Performance of the network is degraded in case of non-local DNS because of higher delay.

IV. Results and discussion

A. Simulation Parameters

Value of parameters in first scenario where local DNS is not present are in table 1 and value of simulation parameters where local DNS is present are in table 2.

Table I simulation parameters for Non-Local DNS

Parameter	**Value**
Area of Network	1000m*1000m
Number of Nodes	24
Position of non local NS	(456,530)
Number of locations/network segments	4
Number of NS_s	1
packet size	1000 bit

Table II simulation parameters for Local DNS

Parameter	**Value**
Area of Network	1000m*1000m
Number of Nodes	25
Position of local DNS at node 12	(-91.90, 524.67)
Position of local DNS at node 13	(-97,346.72)
Position of local DNS at node 17	(72.18,514.4)
Position of local DNS at node 18	(88.85,349.87)
Position of local DNS at node 25	(434.57,518.68)
Number of locations/network segments	4
Number of NS_s	5
packet size	1000 bit

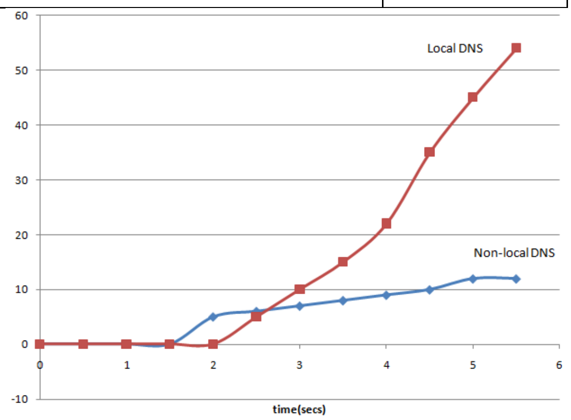

Fig. 4. Graph for comparison of Throughput

Figure 4 shows the comparison between throughputs of two networks with local DNS and other without local DNS respectively. From the graph shown in figure 4 it is clear that the throughput of network having local DNS is higher than the throughput of network with non-local DNS server. This is because the traffic load of the DNS is

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managed in the local network. As a result of which more data can be sent and processed in a network having Local DNS. High through in case of Local DNS shows that Bandwidth in case of Local DNS is being used more effectively when compared with non-local DNS. At first throughput of the network with local DNS may remain low because Local DNS may not have cached the domain names and might need to consult other non local DNS servers. But, after caching the domain names local DNS can directly answer the query generated for cached names as result of which DNS queries will not have to go outside local network which will reduce the network traffic.

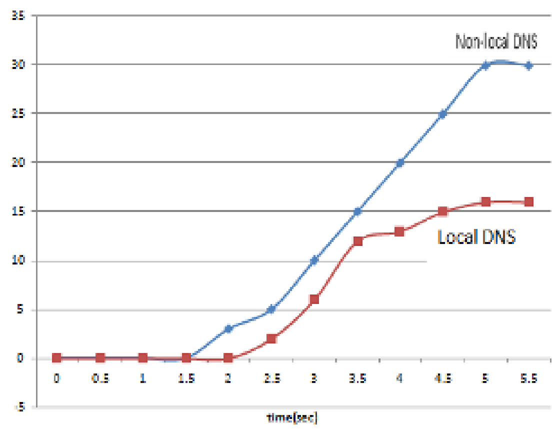

Fig. 5. Graph for comparison of Network Delay

Figure 5 shows the comparison of the delay/latency of the network with and without local DNS servers. Blue line in the graph (fig 4) shows the old delay of first scenario and red line shows the new delay of second scenario. Graph shows that the delay in network having local DNS is less than the network with non-local DNS. It can be seen from the graph that new delay of the second scenario is less than the old delay (first scenario) because the network traffic remains local to each location. DNS queries travel shorter distance w.r.t number of hops which reduces transmission delay and less number of network resources are used.

CONCLUSION

Having a DNS local to the network is an effective method to use the network Bandwidth. Figure 4 and figure 5 given above show that delay is reduced and throughput of Network increases when Local DNS is used. Increased throughput means that bandwidth is being used in more efficient way. Main advantages of local DNS are: 1) it act as a facilitator to the network. This means that it can facilitate the DNS data going outside the network. Many of the queries can be completed by the local DNS and the one's which it can't are routed by it to get the relevant response. 2) It can reduce the delay of DNS queries travelling through the network and thus resulting in improvement of response time of web servers.3) It provides fault tolerance by having the same DNS data at different local DNS servers i.e. if one of the DNS server fails other can still bear the load of DNS queries. 4) Reduces the dependency of local network on the entire network because for resolving DNS queries instead of going to non local DNS it can be done by the Local DNS server.

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BIOGRAPHIES

Dr. OP Gupta, alumni of PAU, Ludhiana, Thapar University, Patiala and GNDU, Amritsar has demonstrated his intellectual, interpersonal and managerial skills in various domains. He is the winner of PAU Meritorious Teacher Award for 2009-10. Currently he is Associate Professor of Computer Science. His areas of interests include Parallel and Distributed Computing, Grid Computing for Bioinformatics, Network Testing and Network Management.

Mohit Dhawan is pursuing his M.Tech (CSE) degree from Punjab Agricultural University, Ludhiana, Punjab (India) respectively. Done B.Tech degree from Punjab Technical University, Jalandhar, Punjab. His research interests are in Biometrics, Computer Networks, and WSN. Along with being a committed student he is actively involved in sports and social activities.