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STUDIES ON WEB BASED MANAGEMENT SYSTEM USING LOAD BALANCING SYSTEM

S. ARUNKUMAR
ASST. PROFESSOR
DEPARTMENT OF COMPUTER APPLICATIONS
ADHIPARASAKTHI ENGINEERING COLLEGE
MELMARUVATHUR

ABSTRACT

The internet has experienced a near exponential growth in user base, infrastructure, content size and resources like low-latency, high throughput network links. According to the internet world stats initiative, Internet users now total over one billion – approximately 16 percent of the world's population. This explosive increase means that high traffic sites offering e-commerce, community and other resource intensive services, face an enormous challenge when it comes to ensuring high availability and fault tolerance for their services. This paper examines how load balancing is used as a central concept to achieve these goals and interoperability with existing technology. A structured approach to high availability and fault tolerance is essential in a production-grade service delivery network, where delays and faults can occur for a multitude of reasons. In this paper, we consider the high level scheduling and load balancing properties offered by the Domain System, as implemented in popular DNS software packages. At this level, the scheduling mechanism can account for server availability, geographical proximity, time zones, etc. We explore the performance and capabilities of high-level DNS-based load balancing, where we draw special attention to the choice of caching policy (time-to-live) for DNS data. Our findings confirm the high performance of modern DNS server implementations, but question the use of DNS as a suitable load balancing mechanism in itself. Further, we analyze the use of a database-supported DNS service for allowing highly dynamic query responses, and show that this approach has both potentially negative (single point of failure) and positive (improved balancing flexibility) properties.

KEYWORDS

Quality of Service, DNS, Load balancing, Load buffer, Caching.

1. INTRODUCTION

In recent years, the number of people using internet services has grown dramatically due to rapid development of the Internet. To cope with the increasing user demand, it becomes a common practice nowadays to use multiple web servers to process user requests in parallel. However, if the user requests cannot be spread among web servers evenly such that some servers become overloaded while the others remain idle, the overall web server's utilization will be dropped, resulting in poor and unstable quality of service for the whole system.

This uneven server load problem has been addressed by many researchers over the years. [1] Classifies existing load balancing architecture into four classes, namely client-based, dispatcher-based [5], DNS-based [7] and server-based [3] [4] [8] load balancing architecture. In this paper we focus on the DNS-based load balancing architecture. In such architecture, web servers are usually placed in geographically decentralized areas, and a Domain Name Server (DNS) acts as a request dispatcher that dispatches requests to web servers. The advantage of this approach is that by considering the geographical relation between a client and each web server, the DNS can assign a web server with lower propagation delay to that client to provide better quality of service. In order to achieve load balancing, the DNS typically uses Round Robin scheduling to map different clients to different web servers in a logical cluster. [10] Showed that the classic algorithms, such as Round Robin, are not adequate for the DNS scheduler. To improve the load imbalance issue, [7] proposed an adaptive time-to-live (TTL) policy in DNS-based architecture which assigns a different TTL value to each address based on client request rates. To resolve the issue of uneven domain load distribution, requests coming from popular domain load distribution, requests coming from popular domains will receive a lower TTL. In a dynamic environment, the algorithms using the detailed load information from the servers can achieve better load balancing, but at the cost of extra computation and communication. Unlike a traditional parallel/distributed system, web servers are geographically distributed, and the DNS cannot obtain their states too often to avoid network congestion and bandwidth waste. Therefore, a method that uses asynchronous feedback alarms and required only limited state information from the overloaded servers had been proved more effective than those that use periodic feedback information from every server to make scheduling decision [10].

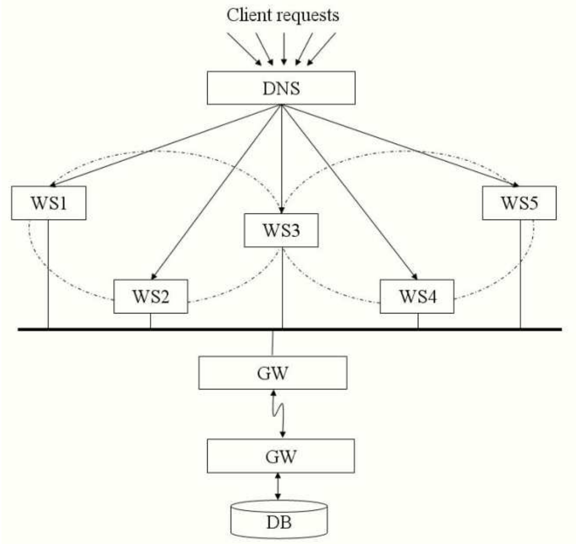
A conventional asynchronous feedback method for DNS-based load balancing architecture often sets a so-called *load buffer range* with low and high thresholds to decrease the state change frequency of a web server. If the load of a web server exceeds the high threshold, an overload alarm signal will be sent back to the DNS. DNS will then exclude this web server from further assignments of new requests. This web server will remain in an overloaded state until its utilization drops under the low threshold, then another asynchronous message will be sent to the DNS. The DNS will resume assigning the requests to the web server. Without care, however, setting the load buffer range improperly may result in load oscillation among web servers. To address this problem, we propose a random early detection (RED) method with the intuition that the probability for a web server to become overloaded in the near future is directly proportional to its current load.

In this paper we are concerned with Distributed web-server system, DNS based load balancing architecture, load buffer range method and random early detection method.

2. DISTRIBUTED WEB-SERVER SYSTEM

The web server system architecture consists of three entities: the client, the domain name server (DNS) and the web server. The distributed web-server system can be organized into several web servers and a cluster DNS that resolves all initial address resolution requests from local gateways. Each client session can be characterized by one address resolution and several web page requests. At first, the client receives the address of one web-server of the cluster through the DNS address resolution. Subsequently, the client submits several HTTP requests to the web-server. In addition to resolving the URL-name to the IP address of a web server, the DNS of a distributed web-server system can collect information from web-servers for various statistics [11]. The DNS can select the address of a web-server based on the collected information. In order to select the address of a suitable web-server, the DNS could use some scheduling policy to balance the load among several web-servers to avoid becoming overloaded.

FIG. 1: STRUCTURE OF DISTRIBUTED WEB-SERVER SYSTEM

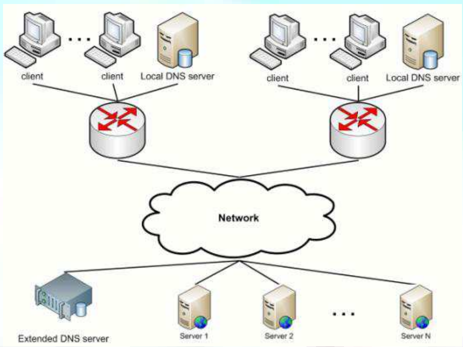


Many existing distributed web-server systems assign the client requests arriving at the DNS in a round-robin manner among the web-servers. The round-robin DNS policy is efficient in the system where the clients requests from local gateways are uniformly distributed due to IP address caching mechanism at the client. Another approach to the DNS scheduling policy is to allow the DNS to select a web-server from the cluster based on some load information from the web-servers. The DNS can collect various kinds of data from the web-servers such as history of server state, the number of active server connections or detailed processor loads. Most conventional load balancing schemes have used this kind of approach using the load information from servers [1].

3. DNS BASED LOAD BALANCING ARCHITECTURE

The DNS-based load balancing architecture is illustrated in Fig. 2, in which clients are partitioned into several groups according to the local DNS (LDNS) servers they use, respectively. When a client wants to obtain a service from a web server with a particular domain name, he/she first sends the domain name resolution query to the LDNS server. After receiving a domain name resolution query, the LDNS server first checks to see whether there is a valid and unexpired IP address of that domain name. If so, the LDNS server sends the IP address to the client directly. Otherwise, the LDNS server would ask the root DNS server for the IP address of a DNS server (the Extended DNS server in Fig. 2 also called EDNS server) that is responsible for resolving that domain name; the LDNS server then forwards the domain name resolution query to the EDNS server to obtain a new mapping IP address and its associated TTL time. Finally, the LDNS server sends the new IP address to the client, and records the TTL time of this IP address. Before the TTL time expires, each domain name resolution query for the same domain name can be directly sent by the LDNS server without asking the EDNS server again.

FIG. 2: DNS-BASED LOAD BALANCING ARCHITECTURE



The characteristics of DNS-based load balancing architecture are as follows:

- All service servers can be placed in a geographically distributed area.
- There is no direct geographical relationship between DNS server and service web servers.

In such architecture, one can exploit the geographical relationship between web servers and clients to minimize the query propagation delay for clients. Moreover, because of the existing mature master/slave architecture of DNS, slave DNS servers may periodically backup the data of the master server, and assist in apportioning the domain name resolution queries of the master DNS server. If the master DNS server fails, one of the slave DNS servers can take over the subsequent work for the master DNS server, therefore achieving high reliability.

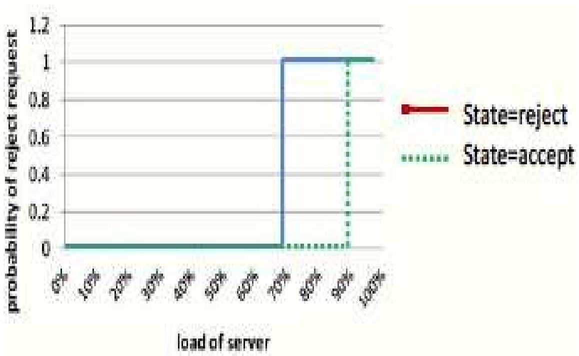
On the other hand, in typical DNS architecture there is usually little or no information exchanged between the DNS server and web servers. Accordingly, conventional DNS-based load balancing methods usually use a random or round robin approach to perform simple load balancing; they are more likely to cause unbalanced load distribution among web servers. Therefore, we are motivated to consider how to use infrequent server state information to achieve a higher degree of load balancing among web servers.

4. LOAD BUFFER RANGE METHOD

In the use of DNS-based load balancing method, the DNS server divides the load among servers in a round-robin manner, and the service server periodically sends its load status to the DNS server. Based on the load data collected from the web servers, the DNS server can skip the overloaded ones when dispatching requests [2].

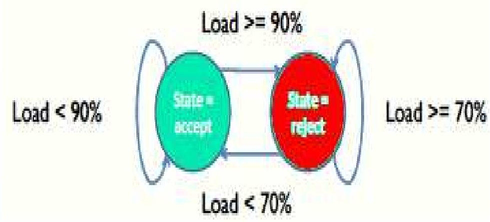
There is basically no direct geographical relationship between the DNS server and web servers, the web server should not send its state information to the DNS server too often so as to avoid congesting in the network or wasting network bandwidth [7]. For this reason, a conventional method defines a load buffer range (LBR) with low and high thresholds for each web server.

FIG. 3: SHOWS THE STATE TRANSITION DIAGRAM OF THE LBR EXAMPLE



In fig.3, before the load of a web server exceeds 90% (high threshold), the server is not overloaded. That is, the DNS server can assign new client requests to that web server. Once the load of that web server is greater than 90%, it enters into the overloaded state. A web server in overloaded state notifies the DNS server not to assign new client requests to that web server until its utilization return under 70% (low threshold).

FIG.4 STATE CHANGE OF CONVENTIONAL LBR METHOD

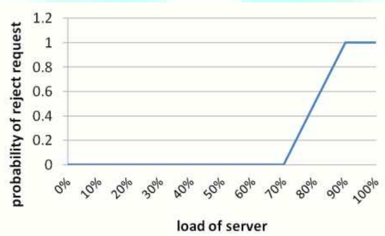


This probability of the overloaded state against to the server load is shown in Fig4. In this method, when there are not many service servers and the amount of requests is high, once one of the service servers is overloaded, it must keep its overloaded state until its load is under 70% and then notify DNS server to assign new client requests to that web server. During this period, the other web servers may need to share the additional 20% (90%-70%) load from that overloaded server. This may in turn cause other web servers to become overloaded, and so on, resulting in unstable service quality.

5. RANDOM EARLY DETECTION METHOD:

For solving the load oscillation phenomenon of web servers mentioned previously, we consider that the state of overload or under-load of a web server in the load buffer range should be a probability rather than definite, in order to avoid burdening the other web servers with too much load. Hence, we use the concept of random early detection (RED) method to determine the overload status of web servers probabilistically. The RED idea is first presented in [9] for congestion avoidance in packet-switched networks. When the average queue size exceeds a preset threshold, the gateway drops or marks each arriving packet with a certain probability, where the probability is a function of the average queue length. It puts emphasis on avoiding the TCP global synchronization that results from each connection reduces the window to one and goes through Slow-Start in response to a dropped packet at the same time. In [6], the RED gateway calculates the average queue size, which is compared to a minimum and maximum threshold. When the average queue size is between the minimum and maximum thresholds, each arriving packet is dropped with probability pa, where pa is a function of the average queue length. Applying the RED idea here in the context of DNS-based load balancing, the probability of a web server becoming overloaded is directly proportional to its current load. A line chart example of the probability of a web server becoming overloaded is shown in Fig. 5.

FIG. 5: CHANGE OF STATE OF RED METHOD



In the above example, the minimum threshold is 70% and the maximum threshold is 90%. When the load of a service server is less than 70%, its state should be under-load. When the load of a service server is greater than 90%, its state would be overloaded. Finally, when the load of a service server is between 70% and 90%, the probability of its state becoming overloaded is proportional to its current load.

6. CONCLUSION

In this paper we examined various techniques for a DNS-based distributed web-server system and summarized their load balancing performance. This paper concludes that various studies on web based management system using load balancing techniques: i) in distributed web server systems like round robin method, ii) in DNS based load balancing single point of failure can be overcome by if the master DNS server fails, one of the slave DNS servers can take over the subsequent work for the master DNS server, therefore achieving high reliability, iii) in load buffer range method, a conventional method defines a load buffer range (LBR) with low and high thresholds for each web server, iv) in Random Early Detection method, when the load of a service server is between 70% and 90%, the probability of its state becoming overloaded is proportional to its current load.

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