UNIVERSITY OF GOTHENBURG

Performance Monitoring of Web-Based IT Systems

Master of Science Thesis in Software Engineering and Management

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Abstract

Web-based IT systems have become very popular among corporations being a strategic part of their business approach. However, the success of web-based IT systems is very dependent on the performance at the customer end. Today, IT departments are responsible for the performance and the availability of their web-based business applications. They often receive complaints about the performance degradation of these applications at customer sites, thus IT departments need to provide answers with evidence to their customer why they are experiencing bad performance. In order to answer their customers, they need a very quick and easy way to determine the possible causes of the performance degradation at customer sites. To do this, they must first identify in which part of the end-to-end client-server communication the problem lies.

The main focus of this thesis is to address the problem of performance degradation that is experienced by web-based IT systems at customer sites, by identifying the part of the end-to-end client-server communication in which the problem might exist. In this study, we propose a model that aims to measure response time for different web servers by generating simple web requests and then to provide statistical analysis to identify whether the problem lies in Local Area Network (LAN) at the customer site, Wide Area Network (WAN) or LAN at the server site. The proposed model is based on findings from the literature review and interviews in the IT industry. We have performed a case study at Volvo IT in order to validate the usability and practicality of the proposed model. The results of the case study provide a way to quickly identify the part of the end-to-end client-server communication where the problem lies. The results of the case study also reveal the possibility of determining the LAN status at customer sites of the web-based IT systems.

Acknowledgment

I wish to thank, first and foremost, my supervisor Claes Runnquist at Volvo IT. His interest in this topic motivated and inspired me to complete this study with high quality. I appreciate his valuable contribution in this research work and this study would not have been possible without his support.

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Key Terms

This section provides the definitions of the key terms used throughout in this document.

Term	Description
Web-based IT systems	This term refers to the IT systems that are implemented using web technologies and accessible through web browsers.
IT systems	In IT industry, this term is used for almost every kind of system for example real time systems or embedded systems. However in this study IT systems only represent web-based IT systems.
Web applications	In industry this term is used for the applications that use Internet or Intranet to provide services to the end user.
End-to-End (E2E)	This term refers to End-to-End hosts in the client-server communication.
Performance degradation	This term is used for the problem of performance degradation experienced by web-based IT systems at their customer sites. For instance, if the user complains that the web-based system is responding too slowly.
Customer Sites	Customer sites in this study represent the sites in which end users are using web-based IT system.
End users	In this study, end users represent the actual users of the web-based IT systems at the customer site.
Akamai	Akamai, with capital A, represents the company Akamai Technologies.
akamai	akamai, with small a, represents the web server that is accessed when the official home page of company Akamai Technologies is accessed.
google	google, with small g, represents the web server that is accessed when the google search engine page of the company Google is accessed.
volvo1	This term represents the web server for the official web site of the company Volvo that does not use any kind of performance improving services from Akamai.
volvo2	This term represents the web server for the official web site of company Volvo which uses cloud platform and dynamic site accelerator services provided by Akamai.
Volvo IT	Volvo IT, part of Volvo Group, provides reliable and state-of-art IT solutions to the automotive industry. A case study performed in this study with Volvo IT.
Problem Area	Part of the end-to-end client-server communication where the problem lies, causing performance degradation.

Chapter 1: Introduction

This chapter discusses the background of the study at hand. It provides the description and the aims of this research. It also presents the research questions, followed by the description of the case study.

1.1 Background

The Internet has become a vital requirement for the accessibility of most of the IT systems around the globe since Information Technology (IT) has become a strategic part of business approach of many successful companies [9]. These IT systems, also known as web applications, can be of varying complexity and from various domains including automotive, healthcare, e-government and business. Since, some of the main key success factors of these applications are performance and reliability, it becomes very annoying for the customers if there is problem with system availability and performance while navigating and using the system [18]. The problem of performance degradation and availability affect the popularity of the system as well as the business. Companies and organizations, which are using these applications as part of their business, need to provide the Quality of Service (QoS) to their customers in order to stay competitive in business.

Today the Internet is also used for several other purposes, for instance multimedia sharing, social networking and its uses as communication media [1][2][3][18]. Figure 1 illustrates the growth of the internet users in the span of 15 years from 1995 to 2010.

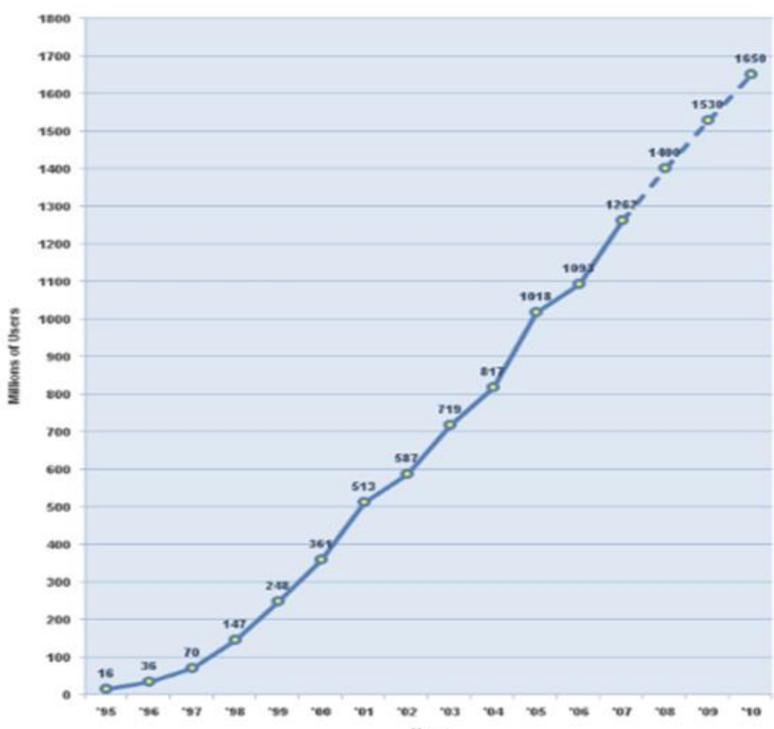

Figure 1: Internet users' growth [18]

The popularity of the Internet and its growing usage has led to immense traffic and network congestion [18]. As a result, end users experience the problem of performance degradation [3]. The performance degradation directly affects the response time of the IT systems at customer sites, which might lead to customer dissatisfaction [8][9]. In some cases, customer dissatisfaction may also lead to a breach of the Service Level Agreement (SLA) [4][5]. The web-based IT system might experience the problem of performance degradation due to the following reasons [2][9]:

- The quality of customers' networks (LAN), IT infrastructure or equipment may not be adequate to run web applications with the desired performance
- Problem with the end-to-end path, packet loss, latency issues over the internet (WAN),
- Servers fail to respond to web requests or the problem in the server side networks (LAN) for web applications

Figure 2 illustrates end-to-end client server communication between two customer sites and a server site. This figure depicts three potential problem areas that might cause the problem of performance degradation at these customer sites. We categorize these three problem areas based on the above discussed reasons for performance degradation.

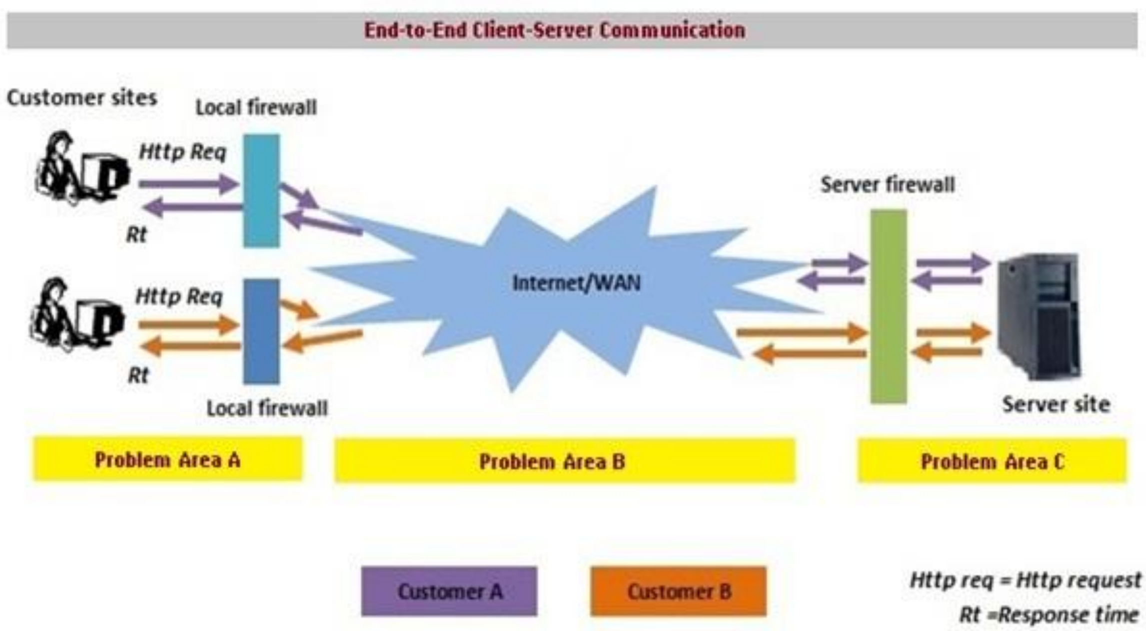

Figure 2: Problem Domain

A lot of work has been done on performance improvements at server end through developing proxy servers, introducing multiple servers, having load balancing methodologies and increasing the bandwidth of the backbone link [2][9]. Companies are also opting for other expensive solutions to improve the server end. However, there is still no guaranteed Quality of Service (QoS) on the Internet because of the quality of the path between the E2E hosts [2].

To overcome the problem of performance degradation, it is very important to identify the factors that lead to the problem. Performance monitoring is used to analyze the response time between E2E hosts, network bandwidth, packet delays and packet loss [6]. Understanding the response time measurement of web requests is a key prerequisite for performance monitoring of web applications [10]. The response time is the complete round trip time of the HTTP web request from client to server and vice versa [6]. The response times which are obtained during the performance monitoring indicate the quality of service between E2E hosts. For example, high response times indicate that any part of the E2E client-server communication could be the problem area as illustrated in Figure 2.

Trammell [4] compared three approaches for E2E performance monitoring (Synthetic, Active and Distributed), and introduced a new approach called Centralized Passive Monitoring. The first three approaches have their own benefits and trade-offs but none of them monitors real-time transactions. In other words, these approaches provide response time measurements from simulated environments. Centralized Passive Monitoring technique becomes relatively more technical in nature and expensive due to the introduction of collector devices to the ports at the server end of the application to be monitored [4]. The main advantage of this new technique was to measure response time of real transactions from actual end users [4]. Trammell also proved that the response times measured in simulated environments cannot be a substitute for observing and measuring response time through real transaction in real-time environment [4].

Performance monitoring of web applications encounters a lot of challenges when using these applications in the real-time environment at customer sites in normal operating conditions. A lot of performances monitoring techniques and frameworks have been discussed in previous studies [1][4][6][9][10][15][18][16][17][19] but most of them measure response times in virtual and simulated environments. The main challenge is to get the client-perceived response times in the actual environment in which the application is being used without disturbing the operations of other running IT systems at the customer sites [16]. Another challenge is to reach out to end users to run performance monitoring and compliance tests from their sites, although it may become challenging depending upon the corporate policies, security concerns and SLAs to run these tests from customer sites. Many performance monitoring tools are available in the industry, but not all are suitable for the corporations and their IT infrastructure and environment.

1.2 About Our Research

Customer satisfaction is one of the most important things in any kind of business. In the IT industry, key factors which influence customer satisfaction are the functionality and quality of the systems they are using. Another important thing is that any performance issues found at the customer site requires technical support. As a result, extra resources are needed to resolve these problems and this leads to increased maintenance costs.

Today, many corporations understand and pay attention to the importance of IT departments and its responsibilities in addressing systems' issues related to the performance and availability. Though great attention is paid to the product development process and testing, there are still performance issues pointed out by some customers when these systems are used at the customer sites in a real environment. This problem shifts the focus of performance monitoring to the customer end and to identify the problem area in E2E client-server communication [10]. IT departments must answer these questions on why some users, using the application around the globe, have experienced bad performance at their sites. To be able to do this, they need to have a fast and easy way of determining the problem area as well root causes for the problem without disturbing the operations of currently running IT systems.

1.2.1 Purpose and Aims

The purpose of this research is to address the problem of performance degradation experienced by IT systems at customer sites and to quickly determine the problem area as well as to predict the factors that lead to the problem. This thesis focuses on the passive E2E performance monitoring for web-based IT systems to measure the client-perceived response times from actual customer sites. Also, the project studies corporate IT infrastructure and attempts to identify why existing off-the-shelf performance monitoring tools are not usable or useful.

The aim of this study is to present a quick way of identifying the problem area where IT departments can dig in further to address the problem of performance degradation.

The objective of this thesis is to propose a model to address the problem of performance degradation at the customer sites by measuring the client-perceived response times, in such way that will help to identify the problem area as illustrated in Figure 2:

- whether the problem resides at the customer site or in its local area (Problem Area A)
- whether the problem is in WAN/Internet (Problem Area B)
- whether the problem resides at the server site (Problem Area C)

Considering the objective, we perform an experiment through a case study at Volvo IT and the statistical analysis of the results is used to reflect on the hypothesis presented in the case study.

1.2.2 Research Questions

This research is intended to answer the following research questions in the context of web-based IT Systems. The 'customer sites' mentioned below and in the rest of the document mean the customers of these IT systems. Table 1 presents our research questions.

#	Research Question
RQ1	Are there existing software solutions or methods that can be used to address the problem of performance degradation at the customer sites for web-based IT systems?
RQ2	What kind of models need to be created in order to identify the problem area for the performance degradation in web-based IT systems?
RQ3	Is the proposed model (RQ2) usable and useful for the industry?

Table 1: Research questions

1.2.3 Case Study

A case study at Volvo IT is performed to validate the proposed model in this research. Volvo IT, part of Volvo Group, provides reliable and state-of-art IT solutions for the automotive industry. They provide cost effective and high quality IT solutions to Volvo Group, Volvo Cars and other customers for the whole industrial process, product development, sales, aftermarket and administration [7]. They also provide technical support to their customers.

The reason to choose Volvo IT as a case study is that they have complex web-based IT systems that are used by their customers all around the globe. Some of their systems experience the problem of performance degradation when these systems are used at the customer sites in real environment. Volvo IT already pays attention to product development process and quality assurance. They use dedicated, high speed, secure and highly expensive servers (Volvo Corporation Network) to host IT systems for their customers. Yet, there are performance issues as pointed out by some customers. The company has huge interest in this study and they want to find out the solution to address the issues discussed above and factors which lead to performance decrease at the customer sites.

Chapter 2: Methodology

This chapter explains in detail the research approach that is used to conduct this study. It discusses the background of the selected research approach and several of its activities. It also outlines and explains the research methodology followed in this study.

2.1 Research Approach

The approach used to conduct this research is an empirical study and includes both qualitative and quantitative research methods. Seaman has discussed the set of categories in which empirical studies can be categorized based on the type and the design employed to carry out the empirical study [11]. The study carried out in this project falls into the category of *Single Project Study* because it provides the in-depth study of single project case study to investigate, examine and analyze the problem of performance degradation at the customer sites with in real-life context [11]. The case study is discussed in detail in chapter 4, explaining the methods and guidelines model used while performing the case study.

Both qualitative and quantitative studies have limitations due to the circumstances in which the data is collected and share a common problem in interpreting the results of research [12]. The combination of these two methods is usually more beneficial than using just one of them in isolation [11]. Table 2 provides the reasons for using both qualitative and quantitative methods collectively to achieve the goals of this study [11][12][13][14].

Approach	Description	Why used in this research?	Used How?
Qualitative	• Situation specific • Used to conduct case study • Studies complexities of human behavior (Why, When, How, Who, Where and What) • Force the focus of researcher into the complexity of the problem • Used for analysis	• To understand academia and the industry perspective at the topic of ongoing research • To get input for the proposed model • To carry out the case study • To identify key variables for the prototype • To validate the case study	• Literature review • Interviews • Observation • Case Study • Analysis

Quantitative	• Experimental • Hypothesis driven	• To perform an experiment in the case study • To perform statistical analysis of the results • To validate the results of the experiment • To validate hypothesis in the case study	• Experiment to collect data • Statistical analysis of the results

Table 2: Research methods

A literature review is used to understand the background of the ongoing research and to explore the following topics related to this study:

- Existing software solutions and methods for performance monitoring
- The problem of performance degradation in IT systems at customer sites
- E2E performance monitoring of web-based IT systems

Findings from the literature review are discussed in Chapter 3 along with the method used to conduct it. The interviews and observation techniques are used to collect the preliminary information that can be used to dig deeper into the study for obtaining the information about the corporate culture and IT infrastructure. Both techniques are used to collect the data from the industry perspective and to perform the case study. Table 3 elaborates on the use of these three qualitative techniques in this study and explains why and how these techniques are used [11].

Technique	Description	Why used in this research?	Used Where and How?
Literature Review	• Provides a thorough summary and critical analysis of existing relevant research • Explores and classifies existing research	• To explore, understand and provide a background based on the current literature on the topic • To provide a justification of this study as future topic of research • To provide analysis of the existing methods and software solutions	• Traditional literature review is performed in this research • Used in early phases of this study

		• To explore the related work to address the problem of performance degradation • To propose a new model	
Interviews	• Get opinions and information • Clarify things that happened during case study and observation	• To get information about the ongoing research • To propose and validate new model • To get information about to carry out the case study • To identify key parameters for the prototype and experiment • To validate the results of the case study	• Semi structured and unstructured interviews • Used in meetings and discussions • Face to face interviews
Observation	• Captures behavior and interactions that are not possible to ask directly	• To understand the company environment and IT infrastructure • To understand the company and customers relationship	• Used during meetings, discussions and interviews • Used during the case study

Table 3: Qualitative techniques

2.2 Research Methodology

The research methodology followed in this case study consists of the following steps covering both qualitative and quantitative techniques discussed above.

- Literature study on the topic of existing methods and software solutions for performance measurement
- Literature study on the topic of the problem of performance degradation and E2E performance monitoring for web-based IT systems
- Interviews and observation techniques are used throughout the research
- A model is proposed based on findings of the literature studies and the interviews
- A case study is performed to validate the new proposed model
- An experiment is conducted in the case study
- Statistical analysis is performed at the result of experiment

- Analysis of the results of the research

Figure 3 illustrates the research methodology. Each box in this picture represents a step of research methodology and the arrows represent transitions from one phase of this study to another. Based on the findings of the literature review, the interviews and the observation, the conceptual model is proposed. The proposed conceptual model along with feedback from the industry is then used in a case study to obtain results.

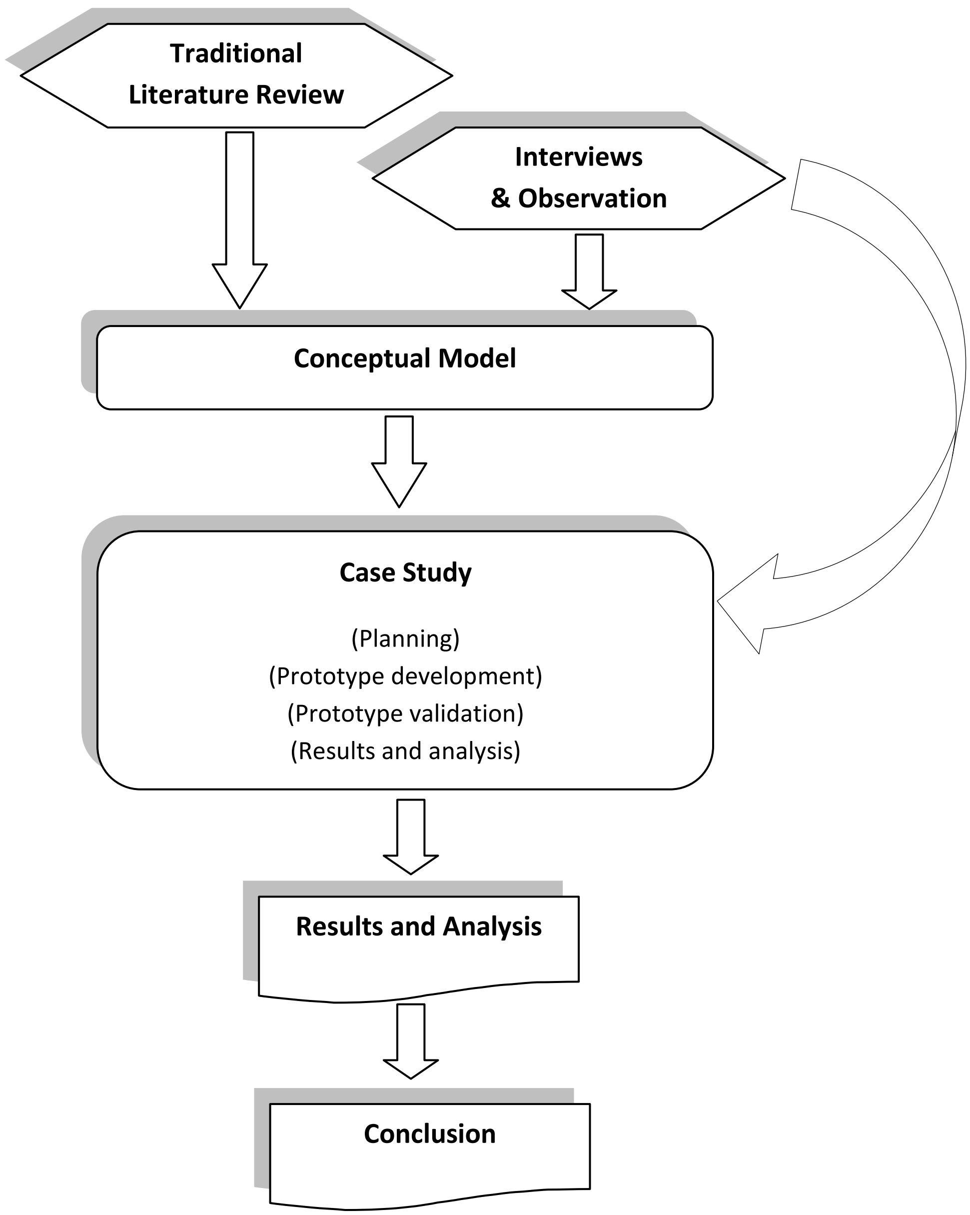

Figure 3: Research methodology

Table 4 provides the details of planned the activities to carry out this research based on the above discussion and their relationship with the research questions.

#	Activities	Technique	Research Question
1	• Understanding the background of the ongoing research • Identifying existing methods for performance measurement and software solutions in the industry • Analyzing the existing methods and software solutions • Understanding the industry's perspective about the problem of performance degradation • Exploring different approaches for end-to-end performance monitoring to address the problem of performance degradation	• Literature Review • Interviews • Observation	**RQ1 & RQ1.1**
2	• Proposing new model to address the problem of performance degradation based on the results of above activities	• Literature Review • Interviews • Observation	**RQ2**
3	• Performing an case study • Developing prototype • Conducting an experiment • Analyzing the results of the experiment and the case study • Validating the proposed model	• Case Study • Interviews • Statistical Analysis	**RQ3**
4	• Drawing conclusions based on our experimental results		

Table 4: Planned activities

Chapter 3: Literature Review and Conceptual Model

This chapter presents the findings of the literature review in this study. It also explains the method used to conduct the literature review. Finally, it proposes the new conceptual model at the end.

3.1 Literature Review Method

A customized method is used to conduct the literature review which followed the guidelines presented by Kitchenham and Charters [14] for conducting literature review. Figure 4 presents this method and illustrates its activities.

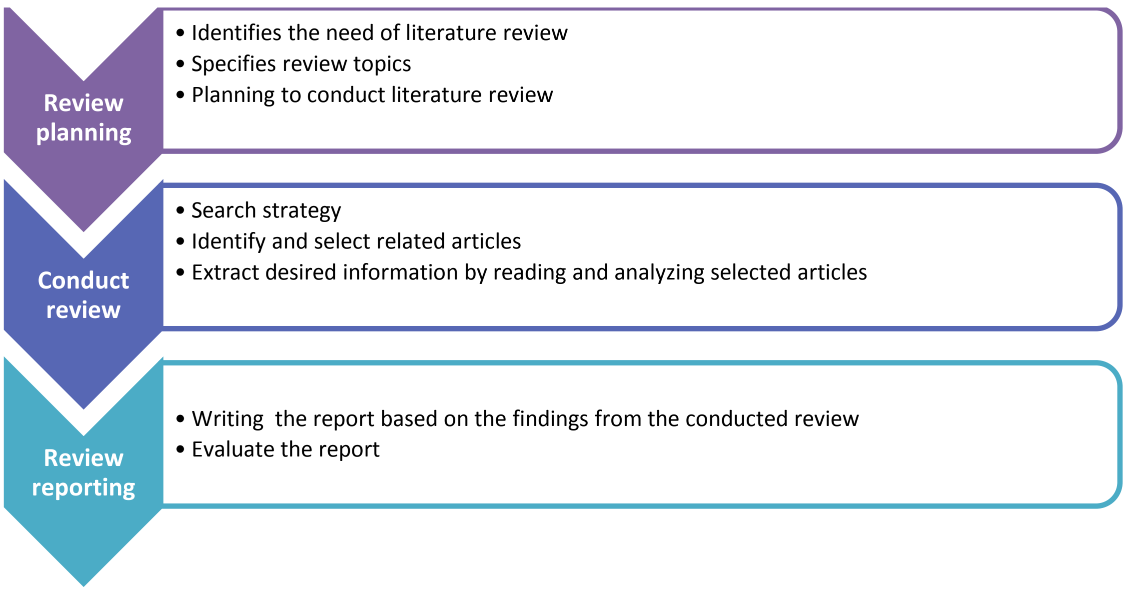

Figure 4: Literature review method

3.1.1 Planning and Search Strategy

This section discusses the planning and searching strategies used to conduct the literature review in this study. The first step that is taken into account is to identify possible keywords within the scope of this study. Initially keywords are identified from the research questions. Later on, more keywords are identified after the preliminary review to enrich search queries to have all possible relevant studies.

The following main keywords are identified and used to search online databases to explore existing literature.

- Performance Degradation: In IT this term refers to the problem of performance degradation experienced by the end users of the system.
- Performance Measurement: Performance measurements are used to determine the cause of performance degradation.
- Performance Testing: In IT, this term refers to the testing of the system from the perspective of its performance.
- E2E Performance Monitoring: This is a process of monitoring IT systems in order to keep check on the performance and the availability.

- Web Response Times: This is a general term refers to the response time of web requests or web pages. Web Response Times are usually defined as how quickly a web application responds to end user's requests.
- Client-perceived response time: This term specifies response time measurements as perceived at the client side.
- Web retrieval latency: Web retrieval latency is the time taken to retrieve the requested web contents.

The online resources used to search and explore the related studies are given in Table 5.

Resource	Description and reason to use
IEEE Explore (Primary resource)	• A rich source of technology related literatures • A very commonly used database • A reliable resource
ACM Digital Library (Primary resource)	• Premier digital library related to the area of Computing • Reliable and commonly used source for leading-edge publications

Table 5: Selected databases

3.2 Literature Review

During the literature review, we have identified several solutions that address the problem of performance degradation and also the factors that lead to the problem. However, the problem is that all the existing methods do not address the important factors like response times in real-time environment at client site and do not support quick identification of the problem area in different parts of E2E Client-server communication. Therefore, in our study we came up with an idea that has not been mentioned in the literature so far. Our idea uses a different approach to quickly address the performance degradation problem and could be easily adaptable in complex IT infrastructures. Two literature studies are conducted in this research on the topics mentioned in chapter 2. These studies are presented below.

3.2.1 Existing Methods and Software Solutions

This section presents the literature study on the topic of existing methods for performance measurements that are used to address the problem of the performance degradation in web-based IT systems. The aim of this literature study is to provide an analysis of the existing methods in the literature as well as of the commercial software solutions available in the market.

According to [2], a lot of work has been done on performance improvements at the server end through developing proxy servers, introducing multiple servers, having load balancing methodologies and increasing the bandwidth of the backbone link. Wei and Xu [15] also discussed that the focus of the existing work is on web servers without considerations of network delays or request processing time at the server end. According to them, response time of a web page including all its embedded objects is used to measure the QoS at the client site [15]. The response time is a complete round trip time of the HTTP web request in E2E client-server communication including server side latencies, queuing delays and request processing time [15][9]. Figure 5 illustrates the actual flow of the web request and how client-perceived response time is measured. It demonstrates the complete web request cycle and shows all the steps for measuring the client perceived response time. The arrow lines show the transitions of web request between client and server.

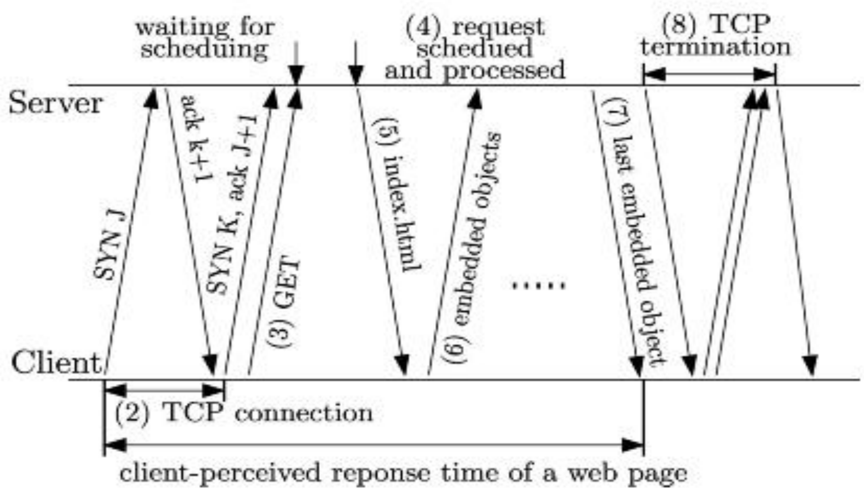

Figure 5: Complete cycle of a response time [15]

Several methods have been proposed for determining and measuring the client-perceived response times in previous studies [15]. Table 6 provides the analysis and summary of the these methods [4][9][10][16].

Method	Description
M1	Method M1: • Measures response times periodically • Uses geographically placed monitors to obtain response time • Provides approximation of response times • Generally do not share measured response times with the web server In this method, the web server cannot respond to changes in response times to meet end-to-end QoS. In some cases, the Internet Service Provider (ISP) also tries to improve client-perceived response times by placing web servers close to the location of monitors.
M2	Method M2: • Uses existing web pages to measure response time by modifying web pages with the performance monitoring code using client side scripting • Uses a post-connection approach and does not account for the time lost because of connection failure and queue delays. • Does not work for files other than HTML In this method, modifying client web browsers to obtain response times could avoid some of these limitations, but these measurements also do not help to find out the cause of the problem and the problem area.

M3	Method M3: • Uses web server applications to track client request • Uses only information available at web servers • Does not include network level latencies and problems • Does not take into account the time because of connection failure and queue delays
M4	Method M4: • Analyzes network packets to measure the response time experienced at client sites by using both online/offline approaches. In online approach, it is difficult to keep pace with the high traffic rate at the server end • Passively captures packets from the network • Requires monitoring machines which makes it costly and difficult to manage
M5	Method M5: • Uses an online approach to measure client-perceived response times using the information available at server side • Does not require modification of existing web pages and any change at client side • Decomposes response times to find out the cause of the problem
M6	Method M6: • Uses collector devices that are attached to mirror ports of the network switches at the server end to capture and examine the Transmission Control Protocol (TCP) packets • Uses passive monitoring approach • Measures response time of the real transactions The Collector devices measure the latency of the TCP packets in different parts of the E2E client-server communication. These measurements are used to identify the source of the problem; whether it is because of the application, the server or the network.

Table 6: Existing methods

Ksniffer [10], Certes [15] and a framework for measuring client-perceived response times presented by [9] are examples based of the methods discussed in Table 6.

This literature study also shows that many performance monitoring tools are available in the industry as well to address the problem of performance degradation of web applications. These tools are also known as third party sampling tools and some of them are also explored in [15]. Table 7 provides the summary of some of currently available third party performance monitoring tools.

Tool	Description
Keynote [20]	• Is performance monitoring tool for web applications • Is used to provides solutions to companies to know about how their application performs on actual browsers and networks
Compuware APM [21]	• Is used for optimizing the performance of web, non-web, mobile, streaming and cloud applications based on the real user experience with such applications

CitraTest APM [22]	• Is used for E2E performance and application monitoring • Is driven by end-user experience
CA Application Delivery Analysis [23]	• Is used for monitoring E2E response time and there is no need of desktop or server monitors.
CA Application Performance Management Cloud Monitor [24]	• Is used to provide up-to-the-minute performance monitoring to ensure end-to-end performance monitoring and availability of the application • Is easy to use

Table 7: Third party software solutions

3.2.2 Performance Degradation &E2EPerformance Monitoring

This section presents the literature study on the topic of performance degradation and E2E performance monitoring. The aim of this literature study is to understand the problem of performance degradation at the customer sites and to explore the different approaches of performance monitoring to overcome this problem. This section provides the related work and existing theories of E2E performance monitoring.

Web applications have become very popular because of their cross-platform compatibility, maintainability and accessibility around the globe. However, the role of the Internet is very important in the popularity of web applications [17]. End users often complain about the performance of these applications. Most of these complaints are related to performance degradation or availability and arise during interaction of customers with these applications [17]. According to [17], E2E performance monitoring of web applications, especially in the context of end users, turns very valuable for companies and organizations.

E2E Performance monitoring is used to keep check on the delays and availability of the system to ensure end-to-end QoS and to provide desired level of performance. It is used to analyze the response times between E2E hosts, network bandwidth, packet delays and packet loss in order to address the problem of performance degradation. There have been two E2E performance monitoring approaches discussed in the literature to diagnose the problem of performance degradation by measuring the response times [4]. The first one is *active performance monitoring*, which can lead to overloading the path between E2E hosts by generating test packets continuously to measure the elapsed time. It provides reliable results because it checks the state of the network path regularly. Therefore, sometimes it affects the performance of the application that is being monitored [4]. The other method is *passive performance monitoring*, in which packets are generated after specific time interval to overcome the problem of the path overloading [4].

This literature study also shows that different approaches for end-to-end performance monitoring have been discussed in previous studies [1][4][6][9][10][15][18][16][17][19]. These techniques are based on either one of the following:

- Simulation of web application contexts
- Monitoring real transactions in real-time contexts

A typical architecture of simulated and automated performance testing tool is shown in Figure 6. It has two sections client and server. The client section consists of analyst, controller, virtual user generator and virtual users. The task of virtual user generator is to generate virtual users and notify the controller about that. The controller is responsible for communication of virtual users with the server side via both Internet and dedicated link. It also communicates with the analyst at the client's side. The task of the analyst is to analyze the results and generate reports. The server section consists of typical web server settings (Web server, Application server and Database repository) and a conductor that communicates with the server, database and client section.

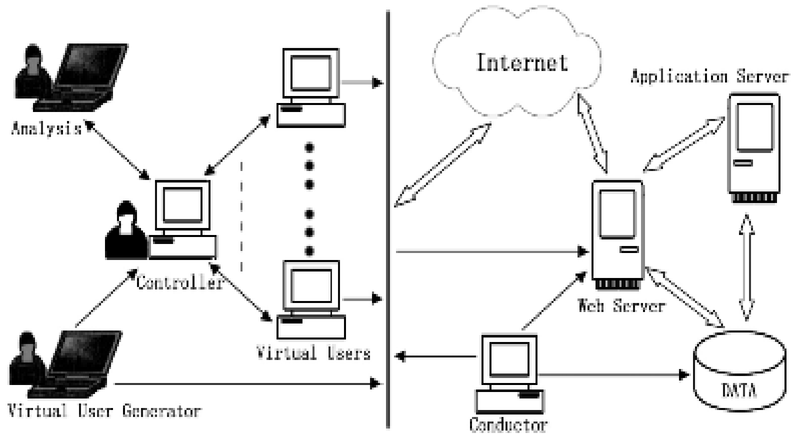

Figure 6: Example of simulated environment [19]

According to [4] [3] [15], end-to-end performance monitoring in a simulated-environment cannot reach the actual workload and behavior as in real-time environment. Also, analyzing simulated traffic cannot provide actual measurements for end-to-end performance. Response time measurement of real transactions in normal operating conditions is very important because simulated measurements are not an alternative for observing real-time transactions [4].

Kushida and Shibata [3] explained that end-to-end path between source and destination hosts over the Internet is not fixed. It can vary for each web request from end users, depending on the bandwidth, packet delay and loss. According to them, the performance measurements between end hosts is used to improve the contents deliver system, selection of different web servers and alternate paths over the Internet. They developed a framework to measure and analyze end-to-end performance. They used active performance monitoring approach to measure and estimate end to end performance. Figure 7 illustrates the measurement and analysis model for the framework developed by Kushida and Shibata [3]. Measurement instruments 1 in Figure 7 consists of five different components. The 'Packet Generator' is responsible for generating and sending probing packets to the Measurement Instrument 2. The 'Packet Receiver' of Measure Instruments 2 is responsible for carrying out several tasks. It receives all the probing packets generated by 'Packet Generator' of Measurement Instruments 1, examines them and also notifies the 'Packet Generator' of Measurement Instruments 2 about the information regarding received packet. The ‘Packet Generator’ of Measurement Instrument 2 sends that information back to the host from where it is originated. The packets that are received at the ‘Packet Receiver’ of Measurement Instruments 2 are then sent to ‘Parameterizer’ of Measurement Instruments 2. ‘Parameterizer’ of Measurement Instruments is not only responsible for parameterizing that packet information but also sending the parameters to ‘Parameterizer’ of Measurement Instruments 1. This component (‘Parameterizer’ of Measurement Instruments 1) receives the parameters and sends them to ‘Packet Receiver’ of Measurement Instruments 1. All this information is transferred to the ‘Analyzer’ of Measurement Instruments 1 where it is analyzed as a historical data. ’Reporter’ is responsible for reporting the analyzed results to end user and also for storing that historical data for the future use.

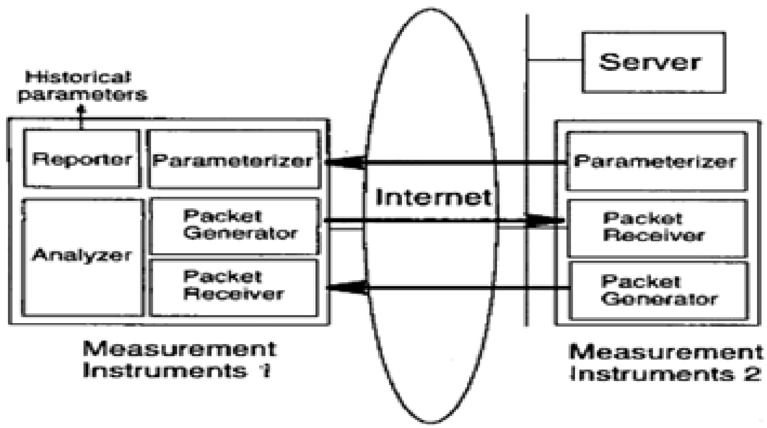

Figure 7: Measurement and analysis system [3]

3.3 Conceptual Model

Literature studies show that server sides for IT system already have been well improved by applying firewalls, load balancing methods and by improving bandwidth at server side. However, the problem of performance degradation still exists for most of web-based IT systems so the focus of the research has been shifting towards the customer site. It also insists on the importance of measuring of client-perceived response time in real-time environment. A lot of methods and software solutions are available in the literature as well as on the Internet but not all of them are suitable for the corporations and their IT infrastructure and environments.

Our literature review demonstrates that there are solutions available in both the academia and industry to address the problem performance degradation and to identify the factors that lead to the problem. However, the existing methods do not measure response times in real-time environment at client site and are not useful to quickly identify the problem area in different parts of the E2E client-server communication. Only one method, M2 in Table 6, is able to obtain performance measurements from customer sites by modifying web pages of the IT systems. However, the measurements obtained through this method do not help in identifying the problem area and the cause of the problem. We have conducted interviews in the industry to validate the results of the literature review. Based on the literature studies, interviews and observations we propose the conceptual model to measure response time from customer sites. Figure 8 illustrates the new proposed model.

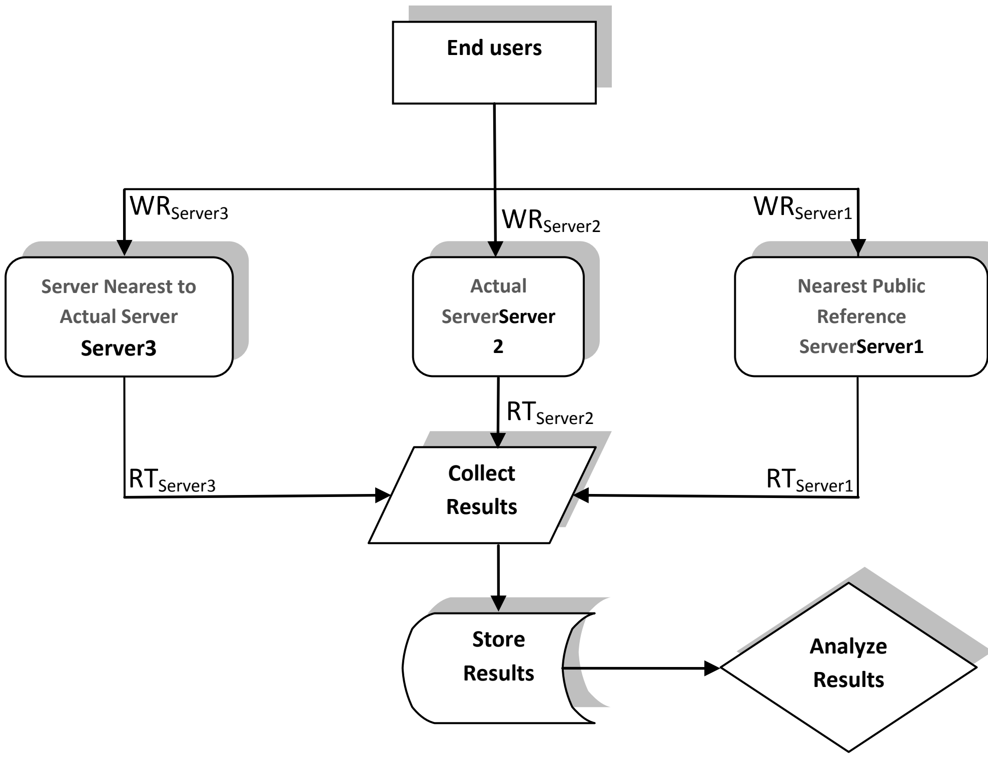

Figure 8: Proposed conceptual model

The purpose of the new model is to measure response time for different web servers from the customer sites and to analyze response times through graphical representation and statistical analysis that will help to identify the problem area and causes of the problem. The idea is to send a traditional web request to web servers and to measure response time for that request. The characteristics of these web servers discussed in Table 8.

Server	Characteristics
SERVER1	SERVER1 is: • Publically accessible web server • Accessed from the nearest point regardless of the geographical location of the end user • Aimed to provide low and consistent response times
SERVER2	• SERVER2 is a web server for the actual IT system that experienced the problem of performance degradation at customer sites
SERVER3	• SERVER3 is a web server in the same LAN environment as for the SERVER2 Preferably, both SERVER2 and SERVER3 should share services of the same ISP.

Table 8: Characteristics of the proposed model's web severs

Based on the above conceptual model, one can discompose the response time of the actual system into different times to identify the problem area. Table 9 presents the decomposition of the response time of the actual system with its details.

Time	Details
$LocalTime_{ActualSystem}$	• The time spent by a web request in the LAN or local region of the customer site • The response time for nearest public reference server that is $RT_{Server1}$as illustrated in Figure 8.
$WANTime_{ActualSystem}$	• The time spent by a web request in WAN/Internet or the time from the nearest public reference server to reach the SERVER2 • The difference of the response times for SERVER1and SERVER3
$ServerLANTime_{ActualSystem}$	• The time spent by a web request in the server side LAN to reach the actual system • The difference of the response times for SERVER2and SERVER3

Table 9: Decomposition of the response time of the actual system

The following equations are used in this study to calculate $LocalTime_{ActualSystem,}$ $WANTime_{ActualSystem}$ and $ServerLANTime_{ActualSystem}$ for the web request of the actual system.

$$LocalTime_{ActualSystem} = RT_{Server1}$$

$$WANTime_{ActualSystem} = RT_{Server3} - RT_{Server1}$$

$$ServerLANTime_{ActualSystem} = RT_{Server2} - RT_{Server3}$$

Chapter 4: Case Study: E2E Performance Monitoring of Web-Based IT Systems

Case Studies provide a systematic approach for observing things, data collection, analysis of collected data and presenting results in the form of a report [25]. The case study that is performed in this research has followed the guidelines presented in [25]. Figure 9 illustrates the general organization of the case study phases that are followed in this research.

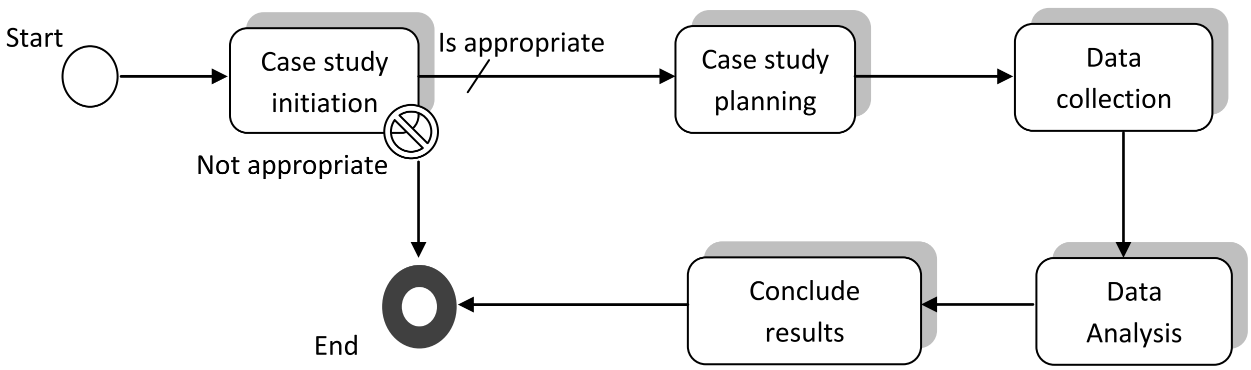

Figure 9: Organization of case study phases

Table 10 describes the phases that are used to perform the case study in this project.

Phases	Description
Case Study Initiation	This phase ensures that sufficient studies have been undertaken before going further with the case study and that the case study objectives are clear. Following steps are taken into consideration in this phase: • Defining case study objectives • Conducting comprehensive literature review • Deciding if the case study is feasible
Case Study Planning	The purpose of this phase is to determine the focus of the case study and it follows the following steps: • Identify the focus of the case study • Enhance conceptual framework and hypothesis • Identify the geographical sites that are the focus
Data Collection	This phase follows the following three main principles for the data collection • Define method for collecting results • Creation of a database • Data validation
Data Analysis	In this phase, analysis of collected data is performed and method of the analysis is selected based on the type of the data.

Table 10: Phases of the case study

The rest of chapter explains these phases of the case study in detail and discusses the activities performed in each phase.

4.1 Case Study Initiation

This section provides the objectives of the case study and the justification of its feasibility.

The objective of this case study is to investigate the problem of performance degradation experienced by IT systems at customer sites in the real time environment and to validate the usability and usefulness of the proposed model. Considering this objective, the company Volvo IT is selected to perform the case study. The case study is classified as an empirical case study. It aims to understand the corporate environment as well as their IT infrastructure and perform an experiment to collect data from various customer sites. In order to determine the feasibility of the case study, we have conducted a literature review and an interview with Volvo IT. The outcomes of both investigations support the fact that it is appropriate to continue with the case study.

4.2 Case Study Planning

This section discusses the focus of the case study. It discusses the proposed model with the perspective of this case study and presents a hypothesis. It also provides details of the focused geographical sites in this case study.

4.2.1 Focus of the Case Study

The focus of the case study is to identify the problem area in the E2E client-server communication when web-based IT systems experience the problem of performance degradation at customer sites. After interviews with the company a web-based IT system, named LDS, is selected to proceed with this case study. The LDS system provides services to the dealers of the company around the globe. It provides services for purchasing the trucks and different kind of the spare parts from Volvo.

Figure 10 demonstrates the network environment for the LDS system.

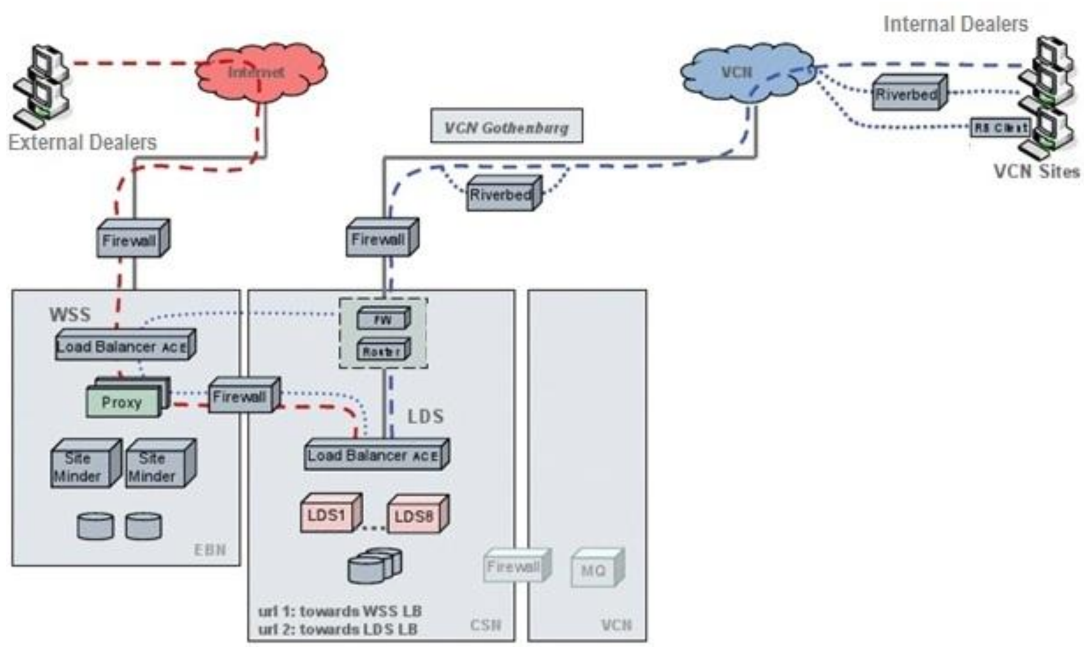

Figure 10: LDS system overview

There are two types of the dealers who used LDS system. The dealers are:

- **Dependent Dealers:** These dealers are owned by Volvo and use the services of the VCN, provided by Volvo IT, to access the LDS system. Dependent dealers are also known as internal dealers and the site that use VCN services are also known as VCN Sites in the company. These dealers access the LDS system thorough secure and dedicated path as shown in Figure 10.
- **Independent Dealers:** These dealers are independent of Volvo and the company does not provide VPN services to these dealers. They are also known external dealers. They access the LDS system via the Internet as shown in Figure 10.

The reason for the selection of the LDS system in this case study is the following.

- Complex web-based IT system
- Important system for Volvo IT because of its high business value
- Some of the independent dealers face the problem of performance degradation

4.2.2 Enhanced Conceptual Model and Hypothesis

This section discusses the proposed model, in this research, with the perspective of this case study. It also presents the hypothesis to validate the proposed model.

To carry out the case study further, there is a need to find out a web server that fulfills the basic characteristics of SERVER1 of the proposed model. The aim is to find out a server that is accessible from the nearest point from the customer site regardless of its geographical location. Based on the interviews, it is learned that the company is using Akamai's Dynamic Site Accelerator services for their official web site to provide better performance to its customers around the globe.

Figure 11 illustrates the cloud platform mechanism provided by Akamai.

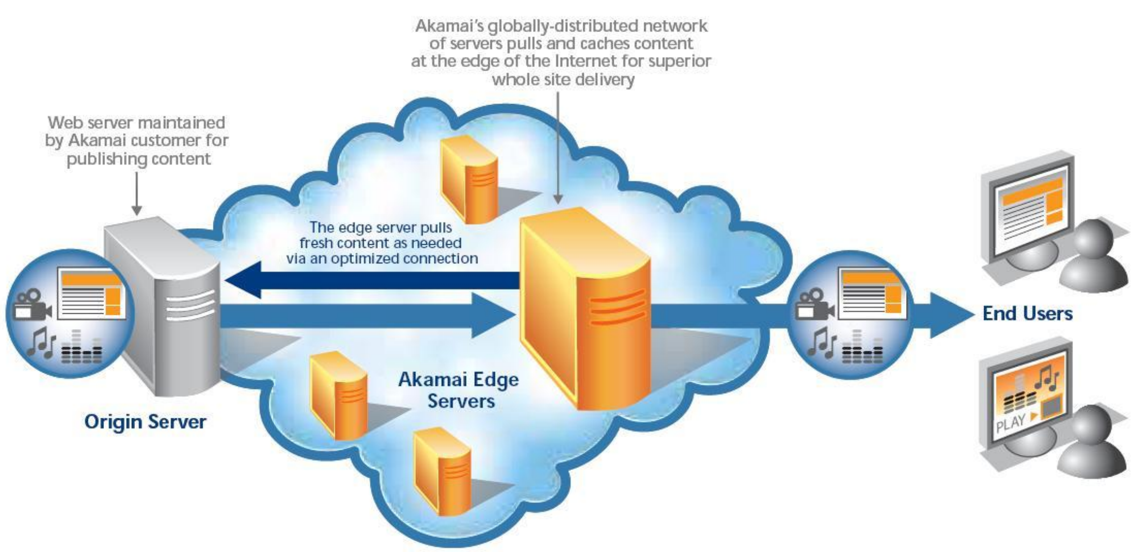

Figure 11: Akamai's cloud platform [28]

Akamai [26] is the leading cloud platform for helping enterprises to provide following benefits to the end users of their web-based IT systems:

- High performance for the end users regardless of their geographical location by providing accessibility from the same region or nearest server
- 24x7 availability of the system

The Akamai cloud platform provides the web server close to the end user location that caches the web contents of the web-based IT system maintained by Akamai. The aim of this cloud platform is to provide instant access to the web content from the nearest point on the Internet to the end users regardless of their geographical location. Based on the characteristics of the Akamai maintained web server, it is decided to use best available cached web server as SERVER1 for the proposed model.

The web server of the LDS system is SERVER2 of the proposed model because it is the system that experiences the problem of performance degradation at some of the dealer sites. After conducting interviews at the company it is decided to use the web server for the official Volvo web site as SERVER3 of the proposed model. This server does not use the Akamai's Dynamic Site Accelerator services. Figure 12 provides an overview of the enhanced conceptual model to get performance measurement in real-time environment for the LDS system from its dealer sites.

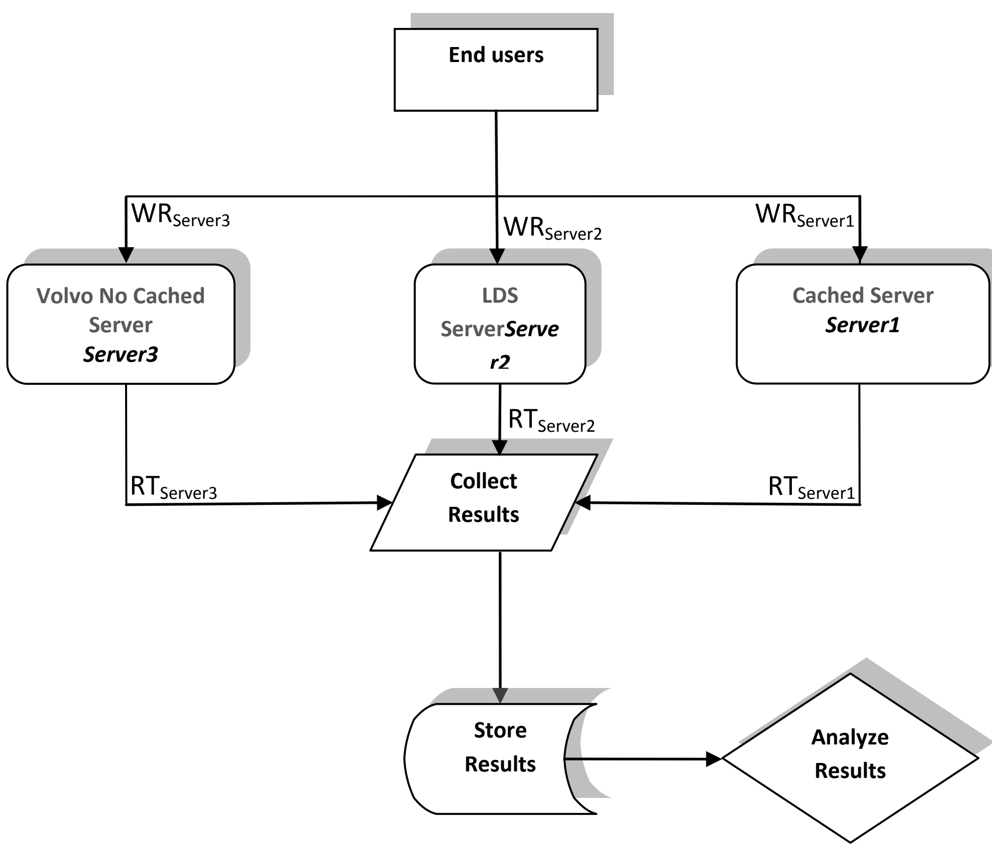

Figure 12: Enhanced conceptual model

The following hypothesis is generated in this case study to validate the proposed model.

Hypothesis: Identifying a web server close to the customer site and the system that experiences the problem of performance degradation, will help to quickly determine the problem area in the E2E client-server communication.

4.2.3 Focused Geographical Sites

This case study focuses on two kinds of physical sites named as primary and secondary sites for conducting the experiment. Primary sites consist of specific dealer sites for the LDS system within the company context where as secondary sites consist of the sites varying in geographical location and independent of the company. These sites are used to collect the data from the end users. Table 11 provides a list of the selected sites for this case study.

Type	Country	Reason for selection
Primay sites	Primary sites are located in: • China • Thailand	• Dealer sites of the LDS system • Experience the problem of performance degradation
Secondary sites	Secondary sites are located in: • Pakistan • Gothenburg • France • Brazil • England	Secondary sites are selected to: • Find out SERVER1 for the proposed model • Validate the results • Test the prototype

Table 11: Focused sites

4.3 Data Collection

This section provides the details of the method that is used to collect data from the selected sites in this case study.

A prototype is developed based on the conceptual model to collect data in this case study. It is used to measure the response times simply by generating web requests for the LDS system and other selected web servers. The developed prototype uses the passive monitoring approach for E2E performance monitoring. Figure 13 illustrates the prototype model. The end user at the selected dealers' sites executes the prototype. The prototype takes the server list from configuration file; it communicates with these servers and stores measured response time in CSV (Comma-Separated Values) files.

Furthermore, an experiment is performed to collect data from multiple sites. The purpose of this experiment is to run the prototype at both the primary and the secondary sites. The details of these sites are already discussed in Table 11. The data is collected in the form of CSV files from each site as illustrated in the prototype model in Figure 13. Based on these CSV files, a central excel data sheet is created after validating data from each site. The experiment is conducted in two phases.

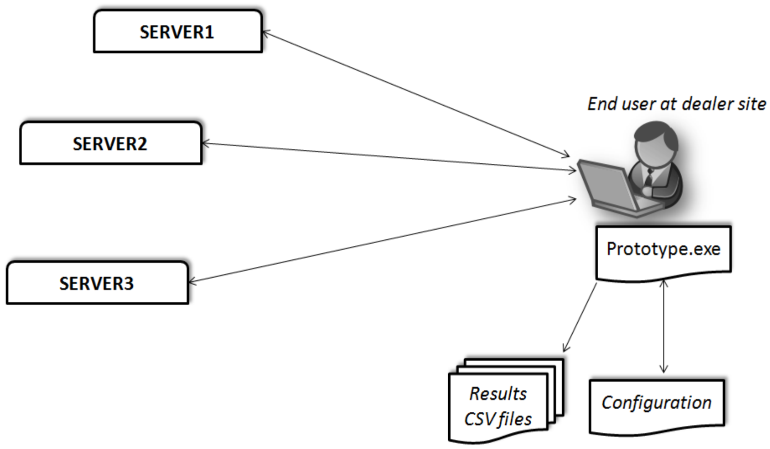

Figure 13: Prototype model

In PHASE1 of the experiment the data is collected from the both primary and secondary sites. The purpose of PHASE1 is to run the prototype at each site to measure response time for the selected web servers in normal operating conditions. The aim of this phase is to find out the web server that performs better and consistently as compared to the other servers based on the data collected from all sites. The selected web server will be used as the SERVER1 of the proposed model.

In PHASE2 of the experiment the data is collected only from the primary sites. The purpose of this phase is to run the prototype at the selected sites to measure response times for the web servers based on the enhanced proposed model. The aim of this phase is to collect data from the dealer sites of the LDS system for the analysis and to validate the hypothesis.

4.4 Data Analysis

The results obtained from the experiment are presented below along with their analysis from each phase respectively.

4.4.1 PHASE1: Finding SERVER1 of the Proposed Model

Based on the interviews with Volvo IT, the following three web servers are selected to measure response times from Brazil, China, England, France, Pakistan and Sweden. These web servers are presented in Table 12 along with the rationale for the selection.

Web Server	Rationale	URL
volvo1	• This web server, hosting main page of the official web site of the company, is maintained by Akamai to provide better performance to the end users. • This web server uses Akamai's Dynamic Site Accelerator services and cloud platform.	http://www.volvo.com/group/volvosplash-global/en-gb/Pages/volvo_splash.aspx

akamai	• This web server, hosting main page of the official web site of the Akamai company, is maintained by Akamai. • This web server uses Akamai's Dynamic Site Accelerator services and cloud platform.	http://www.akamai.com/
google	• This web server hosts the main page for the google search engine. • This web server does not use Akamai's Dynamic Site Accelerator services. It is learned in the testing phase of the prototype development that the web page for google provides very low response times and good consistency. It is decided in the interview with company to include this server in PHASE1 of the experiment.	http://www.google.com/

Table 12: Selected web servers for PHASE1

Table 13 presents the details of the sites that are used to collect the data in this phase of the experiment.

Country	Site	Location	Internal IP	External IP
Brazil	**SITE1**	Curitiba, Parana	169.254.87.72	189.32.56.60
China	**SITE 2**	Beijing	10.101.135.86	114.242.106.194
	SITE3	Kunming, Yunnan	10.101.131.201	202.98.70.140
UK	**SITE4**	Oldham, Oldham	192.168.0.5	2.223.245.232
France	**SITE5**	Villeurbanne, Rhone-Alpes	192.168.1.26	82.226.209.221
	SITE6	Valbonne, Provence-Alpes-Cote d'Azur	192.168.1.22	84.101.189.178
Pakistan	**SITE7**	Lahore, Punjab	10.28.80.96	110.93.205.130
Sweden	**SITE8**	Göteborg, Vastra Gotaland	192.168.0.104	109.228.162.186
	SITE9	Göteborg, Vastra Gotaland	192.168.1.78	217.208.132.217

Table 13: Details of sites for PHASE1 of the experiment

The results are presented in the form of graphs from the sites listed in Table 13. Each graph presents the measured response time for all three web servers google, volvo1 and akamai respectively. The x-axis represents the date and time of the web request that is generated to measure response time after every hour and the y-axis of each graph represents the measured response time per second for that web request. The average and standard deviation of the response times for each web server is calculated to provide statistical analysis for all of the graphs. The purpose of the statistical analysis is to verify and to provide rationale for the graphical interpretation of the graphs. In order to provide statistical significance for our results, we calculated the 95% confidence interval by using the Bootstrap method. 95% confidence interval means that there is 95% chance that the mean of the sample data will lie between the obtained lower and upper bound. This method is used to increase sample data from each site by re-sampling [28]. We used the statistical tool IBM SPSS [27] to calculate confidence intervals by increasing sample size to 1000. We show the results obtained from SPSS in Appendix A. Results of phase 1 are given below.

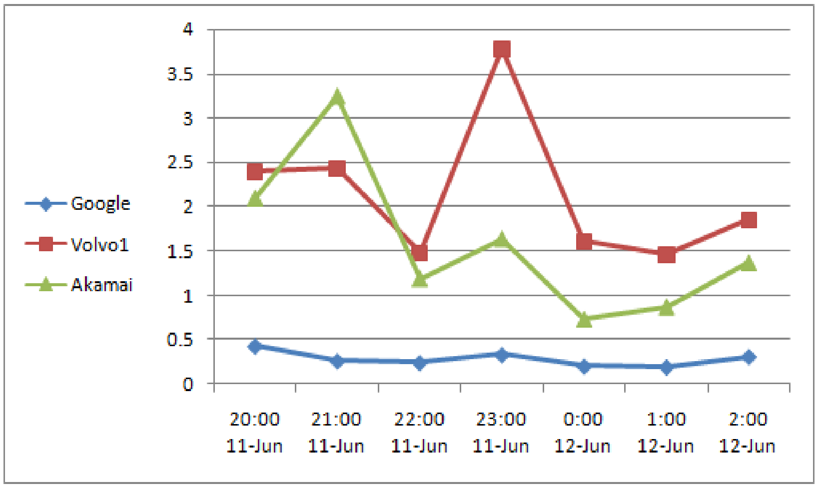

Figure 14: Response times measured from SITE1

The graph in Figure 14 presents the response times measured for the selected web servers from SITE1 that is located in Brazil. This graph shows the consistent behavior and low response time of google for every web request as compared to the other servers. The low response times for google also suggest that it is being accessed from a nearby location closed to SITE1. The average and standard deviation of the response times are given in Table 14 for each web server based on the results presented in the above graph.

Web Server	Average RT (Sec)	Standard Deviation (Sec)	95% Confidence Interval Lower	Upper	Nearest & Consistent Server
google	**0.28**	**0.08**	**0.227**	**0.341**	**google**
volvo1	2.14	0.83	1.657	2.755	
akamai	1.59	0.86	1.057	2.254	

Table 14: Statistical analysis of the response time measured from SITE1

The statistical numbers in Table 14 show that the average and standard deviation of response times for google is very low as compared to the other servers. The lower and upper bounds of the confidence interval provides us the 95% confidence that the average response time of each web server lays between that interval. These statistical numbers in table 14 validate that google is the best performing and consistent server at this site.

The graphs in Figure 15 and Figure 16 present the results from SITE2 and SITE3 respectively located in China.

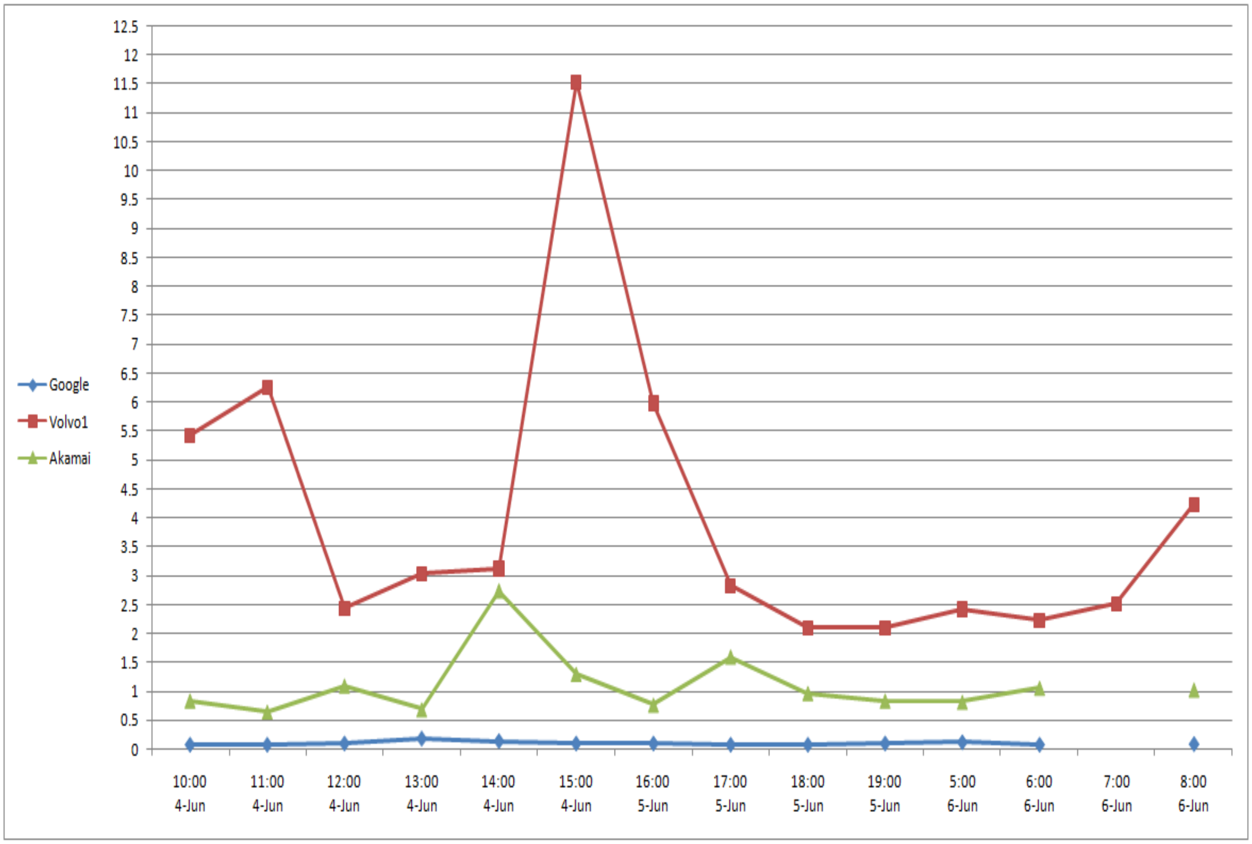

Figure 15: Response times measured from SITE2

The graph in Figure 15 presents the results from SITE2 in Beijing, China. It also shows similar kind of consistent behavior for google as at SITE1. Two blank data points for both google and akamai in this graph show the web request failure at that time. In the case of web request failure, both average and standard deviation are calculated by excluding such data points. The average and standard deviation of the response times for each web server based on the results from SITE2 are given in Table 15.

Web Server	Average RT (Sec)	Standard Deviation (Sec)	95% Confidence Interval Lower	Upper	Nearest & Consistent Server
google	**0.10**	**0.03**	**0.075**	**0.114**	**google**
volvo1	4.01	2.61	2.860	5.492	
akamai	1.1	0.55	0.748	1.356	

Table 15: Statistical analysis of the response time measured from SITE2

Similar to SITE1, the statistical numbers from Table 15 shows that google is the best performing and consistent web server at SITE2.

The graph in Figure 16 presents the results from SITE3 in the Yunnan region of China. It shows variations in the response times of the both web servers. However, the behavior of google is still consistent and the response times are low in different time intervals as compared to volvo1. Such variations can occur because of the performance issues at the site itself. For example, the local network experienced performance bottle necks at the time when request was generated. Figure 16 also shows the constant web request failure for akamai web server at this site.

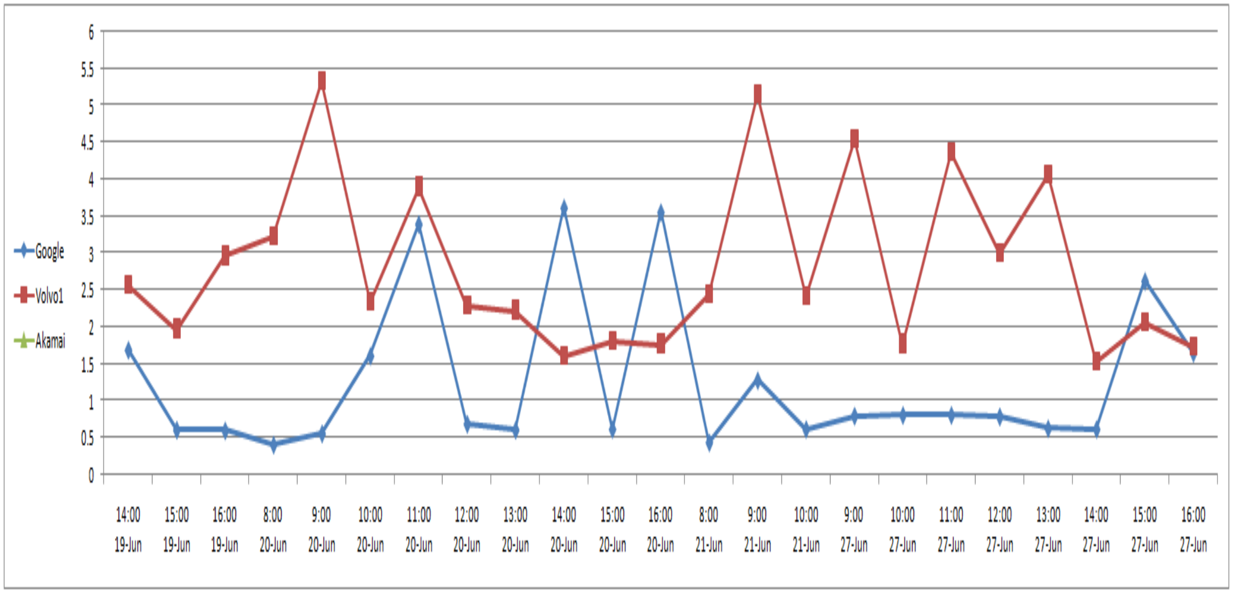

Figure 16: Response times measured from SITE3

The average and standard deviation of the response times for each web server based on the results from SITE3 are given in Table 16.

Web Server	Average RT (Sec)	Standard Deviation (Sec)	95% Confidence Interval Lower	Upper	Nearest & Consistent Server
google	**1.27**	**1.03**	**0.892**	**1.717**	**google**
volvo1	2.84	1.17	2.374	3.296	
akamai	NA	NA	NA	NA	

Table 16: Statistical analysis of the response time measured from SITE3

The statistical numbers in Table 16 show that google is the best performing and consistent web server as compared to volvo1 at SITE3.

The graph in Figure 17 presents response times measured for the selected web servers from SITE4 that is located in UK. This graph shows the consistent behavior of google for every web requests as compared to the other servers. The response times for google are also better at this site. Similar to SITE3, this site experiences the constant web request failure for akamai web server as well.

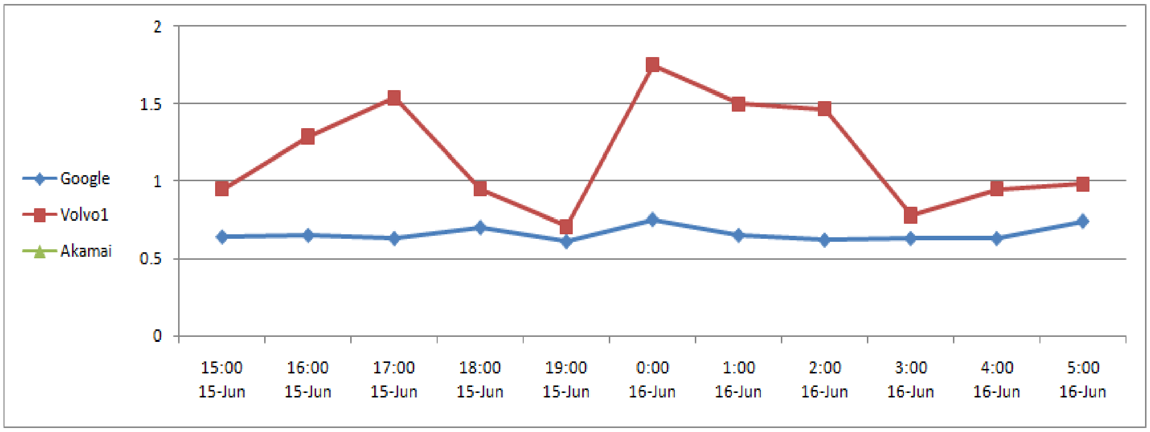

Figure 17: Response times measured from SITE4

The average and standard deviation of the response times for each web server based on the response time measured at this site are given in Table 17.

Web Server	Average RT (Sec)	Standard Deviation (Sec)	95% Confidence Interval Lower	Upper	Nearest & Consistent Server
google	**0.49**	**0.01**	**0.488**	**0.496**	google
volvo1	1.17	0.35	.974	1.369	
akamai	NA	NA	NA	NA	

Table 17: Statistical analysis of the response time measured from SITE4

Similar to SITE1 and SITE2, the statistical numbers in Table 17 show that google is the best performing and consistent web server at SITE4.

The graph in Figure 18 and Figure 19 present response times measured for the selected web servers from SITE5 and SITE6 respectively located in France.

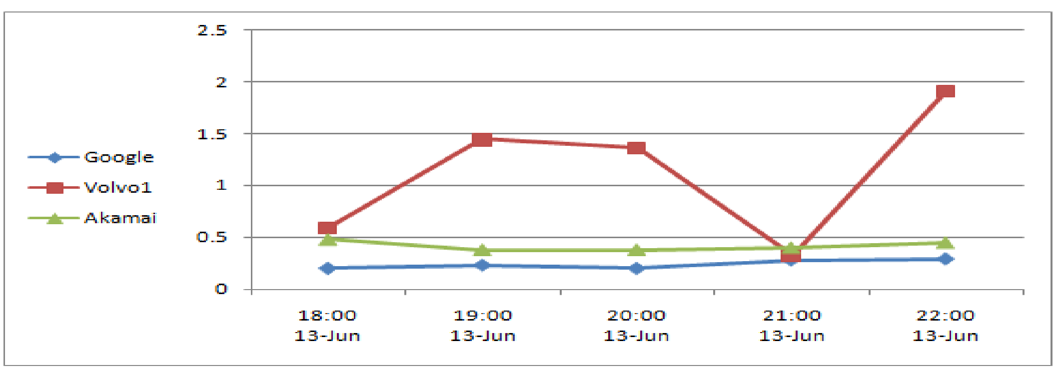

Figure 18: Response times measured from SITE5

The graph in Figure 18 presents the results from SITE5. It shows the same consistent behavior for both google and akamai web servers. Statistical analysis is needed to understand the difference in the behavior of the both web servers. The average and standard deviation of the response times for each web server based on the response time measured at SITE5 are given in Table 18.

Web Server	Average RT (Sec)	Standard Deviation (Sec)	95% Confidence Interval Lower	Upper	Nearest & Consistent Server
google	**0.24**	**0.04**	**0.206**	**0.274**	**google**
volvo1	1.12	0.65	0.638	1.690	
akamai	0.42	0.04	0.384	0.454	

Table 18: Statistical analysis of the response time measured from SITE5

The graph in Figure 19 presents the results from SITE6. It shows the consistent behavior of google for each web requests as compared to the other servers. It also shows that the response times are also better for google.

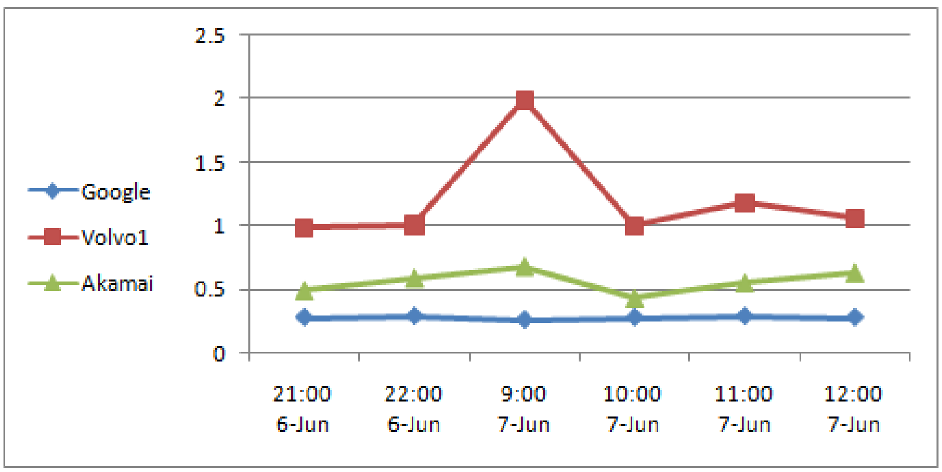

Figure 19: Response times measured from SITE6

The average and standard deviation of the response times for each web server based on the results from SITE6 are given below in Table 19.

Web Server	Average RT (Sec)	Standard Deviation (Sec)	95% Confidence Interval Lower	Upper	Nearest & Consistent Server
google	**0.28**	**0.01**	**0.272**	**0.287**	**google**
volvo1	1.21	0.39	1.008	1.525	
akamai	0.56	0.09	0.493	0.627	

Table 19: Statistical analysis of the response time measured from SITE6

The statistical analysis in Table 19 shows that google is the consistent and best performing server at this site.

Figure 20 presents response times measured for the selected web servers from SITE7 that is located in Pakistan. This graph shows that there are variations in the response times of google but still there is consistency in its behavior in different time intervals. The response times for google are also better as compared to the other servers.

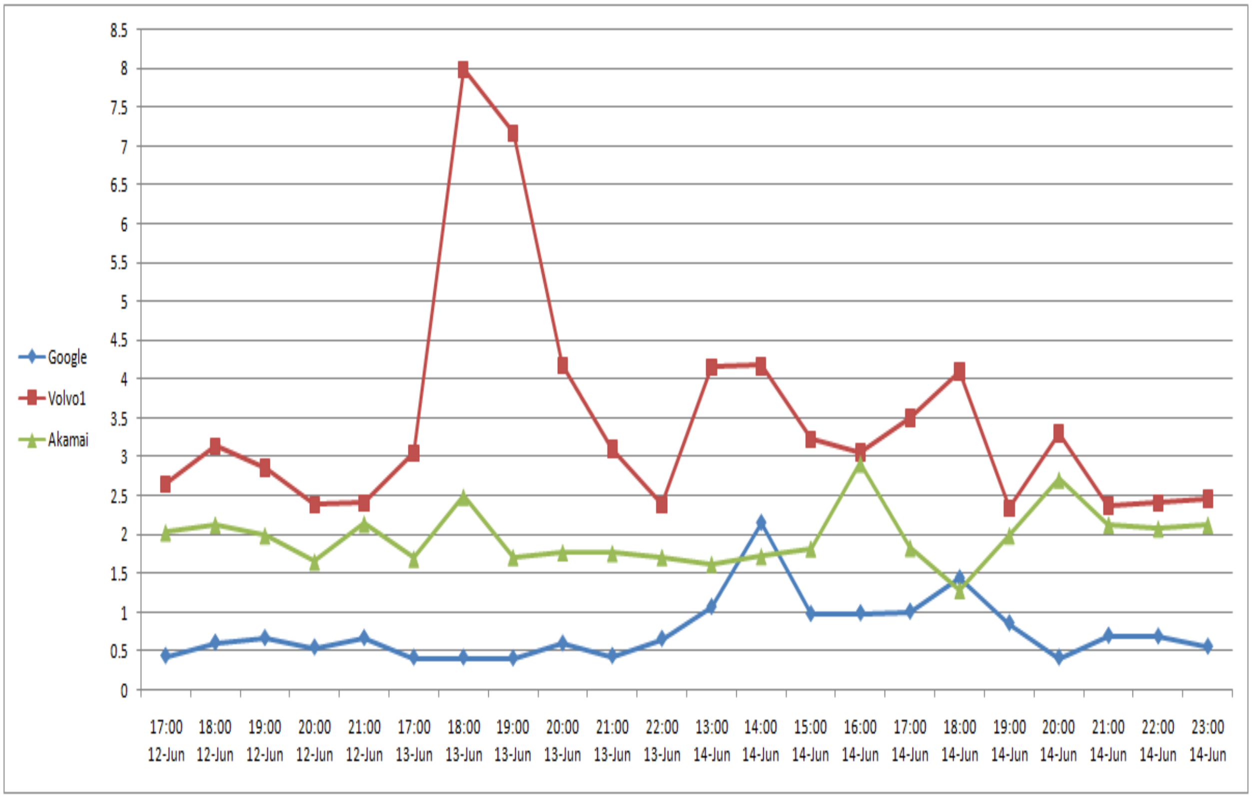

Figure 20: Response times measured from SITE7

The average and standard deviation of the response times for each web server based on the response time measured at SITE7 are given in Table 20.

Web Server	Average RT (Sec)	Standard Deviation (Sec)	95% Confidence Interval Lower	Upper	Nearest & Consistent Server
google	**0.76**	0.41	**0.612**	**0.934**	**google**
volvo1	3.47	1.48	2.913	4.166	
akamai	1.97	**0.37**	1.817	2.118	

Table 20: Statistical analysis of the response time measured from SITE7

The statistical analysis in Table 20 shows that the average of the response times for google server is much better as compared to the other web servers. On other hand, the standard deviation of the response times for akamai is slightly better as compared to the other web servers. However, the graph for this site shows the consistent behavior of google for most of the web request as compared to akamai except the few request made on 14-June. The difference between standard deviation is also negligible as compared to the average response time for both google and akamai. By neglecting this minor difference of the standard deviation, google is the consistent and best performing web server at this site.

Figure 21 and Figure 22 present results from SITE8 and SITE9 respectively located in Sweden.

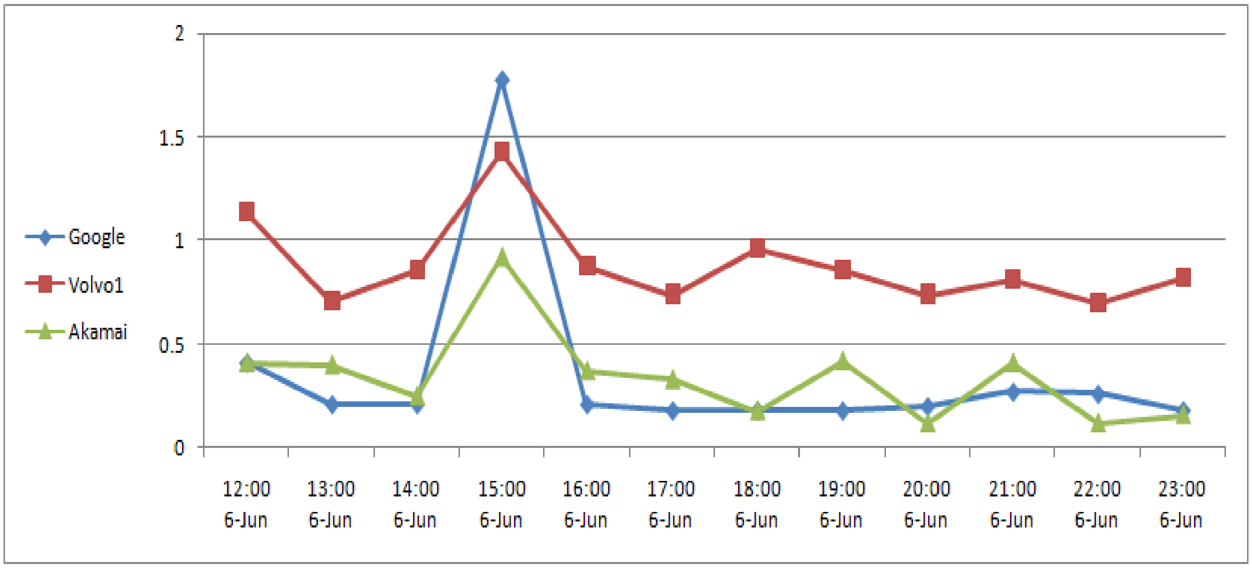

Figure 21: Response times measured from SITE8

The graph in Figure 21 presents the results from SITE8. Graph above shows that the results for google are consistent for most of the web requests except one request at 15:00, 6 June. The response times for google are also better as compare to the other servers. The average and standard deviation of the response times for each web server based on the response time measured at SITE8 are given in Table 21.

Web Server	Average RT (Sec)	Standard Deviation (Sec)	95% Confidence Interval Lower	Upper	Nearest & Consistent Server
google	0.36	0.45	**0.201**	**0.628**	??
volvo1	0.89	0.21	0.785	1.015	
akamai	0.34	0.22	0.232	0.466	

Table 21: Statistical analysis of the response time measured from SITE8

Based on the statistical analysis provided in Table 21, akamai is the best performing server at this site but by ignoring web request at 15:00, 6 June the even more consistent behavior can also be seen for google as well. The new average and standard deviation of the response times for each web server by ignoring the web request made at 15:00, 6 June are given in Table 22.

Web Server	Average RT (Sec)	Standard Deviation (Sec)	95% Confidence Interval Lower	Upper	Nearest & Consistent Server
google	**0.23**	**0.07**	**0.194**	**0.271**	**google**
volvo1	0.84	0.13	0.774	0.921	
akamai	0.29	0.12	0.221	0.356	

Table 22: New statistical analysis of the response time measured from SITE8

The statistical numbers in Table 22 show that google is consistent and the best performing server at SITE8. There is not much difference in the average response time of the all web servers in this new Table but there is significant difference in the standard deviation for google.

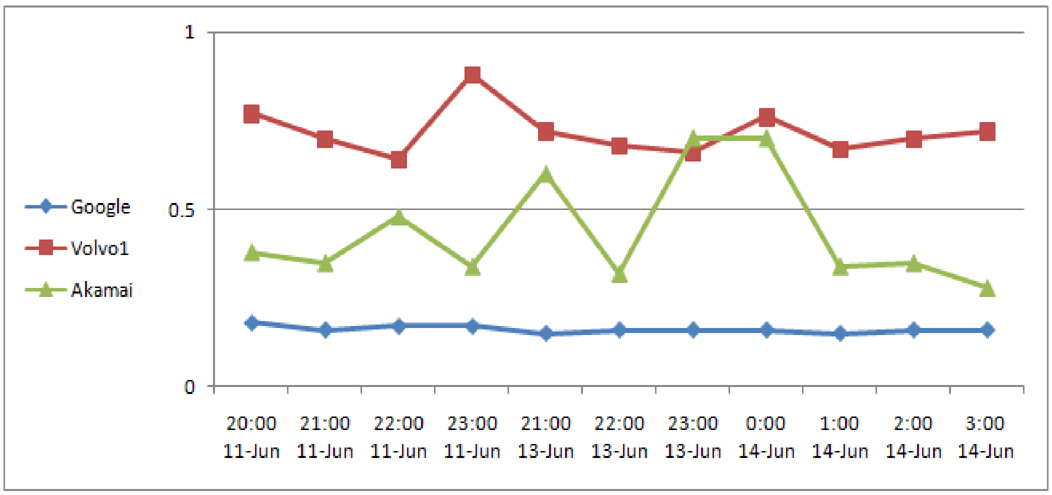

Figure 22: Response times measured from SITE9

The graph in Figure 22 presents the results from SITE9. This graph shows the more consistent behavior of google as compared to SITE8. The average and standard deviation of the response times for each web server based on the results from SITE9 are given in Table 23.

Web Server	Average RT (Sec)	Standard Deviation (Sec)	95% Confidence Interval Lower	Upper	Nearest & Consistent Server
google	**0.16**	**0.01**	**0.157**	**0.167**	**google**
volvo1	0.72	0.07	0.686	0.759	
akamai	0.44	0.16	0.357	0.534	

Table 23: Statistical analysis of the response time measured from SITE9

The statistical numbers in Table 23 show that google is the consistent and best performing server at SITE9.

Table 24 provides the average response time of the all three web servers for each site. It provides the overall average of the standard deviation and average of the measured response times at all sites.

Server	Site	Average RT (sec)	SD RT	Average RT of All Sites (sec)	Average SD of All Sites
google	SITE1	0.28	0.08	**0.42**	**0.19**
	SITE 2	0.10	0.03		
	SITE3	1.27	1.03		
	SITE4	0.49	0.01		
	SITE5	0.24	0.04		
	SITE6	0.28	0.01		
	SITE7	0.76	0.41		
	SITE8	0.23	0.07		
	SITE9	0.16	0.01		
volvo1	SITE1	2.14	0.83	1.95	0.85
	SITE 2	4.01	2.61		
	SITE3	2.84	1.17		
	SITE4	1.17	0.35		
	SITE5	1.12	0.65		
	SITE6	1.21	0.39		
	SITE7	3.47	1.48		
	SITE8	0.84	0.13		
	SITE9	0.72	0.07		
akamai	SITE1	1.59	0.86	0.91	0.31
	SITE 2	1.10	0.55		
	SITE3				
	SITE4				
	SITE5	0.42	0.04		
	SITE6	0.56	0.09		
	SITE7	1.97	0.37		
	SITE8	0.29	0.12		
	SITE9	0.44	0.16		

Table 24: Statistical analysis for all sites of PHASE1

The average response time of all sites shows that the response times for google are better as compared to the other web servers. Similar is the case with the average standard deviation of all sites for google. The statistical numbers in Table 24 show that google is the nearest and the most consistent web server regardless of the actual location of the end users. Based on such characteristics of google this study uses it as SERVER1 of the proposed model to continue the experiment for PHASE2.

4.4.2 Discussion PHASE 1

The main aim of PHASE1 of the experiment is to study to the behavior of the selected web servers to find out the best performing and consistent web server. Therefore, a statistical analysis of the results of each selected site is used to motivate the selection of the best server.

According to the statistical analysis of the results, if the average and standard deviation of the response times of one web server is less than the other servers then it can be selected as best server. Theoretically, this difference should be very small for the volvo1 and akamai web servers because they both are using same kind of methods to provide best performance to end users. However, based on the results presented above, it is not the case with these servers. According to the analysis provided in Table 24 the volvo1 web server experienced a big difference in both the average and standard deviation of the response times as compared to akamai web server. One possible reason behind this difference can be the number of requests to access the web contents from volvo1. The mechanism used by Akamai provides cached version of the web contents at the nearest location from where the web server is accessed frequently. Therefore, it is possible that volvo1 server is not accessed from the nearest location. However, the experiment performed in PHASE1 does not dig into this matter further because the aim is to find only one best server that can be used further in this study as the nearest and consistent public reference server.

During this phase of the experiment, it is learned that there is a need to get response time measurement more frequently rather than generating web request after an hour. It will increase the reliability of the results.

4.4.3 PHASE2: Verification of the Proposed Model

In PHASE2, the experiment is performed to investigate the LDS system to indentify the problem area for its performance degradation at some of the dealer sites in the China. In this phase the prototype is used to measure the response times for the following three web servers from the primary sites of this case study. Table 25 presents the selected web servers in PHASE2 of the experiment.

Web Server	Rationale	URL
Google	• This web server selected based on the experiment performed in PHASE1.	https://www.google.com/
LDS	• It is the web server for the LDS system.	https://www.secure4.volvo.com/lds_cn
Volvo2	• It is the web server that is hosting official page of the company but it does not use Akamai's Dynamic Site	http://origin-www.volvo.com/group/volvosplash-global/en-gb/Pages/volvo_splash.aspx

	Accelerator services. • This web server is in the same LAN environment as the web server for LDS system. Both LDS and Volvo2 servers share the services of the same ISP.	

Table 25: Selected web servers for PHASE2

Table 26 presents the details of the sites that are selected in this phase of the experiment. These sites are located in the different regions of China. The criterion for the selection of these sites is already discussed in section 4.2.3.

Country	Site	Location	Internal IP	External IP
China	**SITE1**	Kunming, Yunnan	10.101.131.201	182.245.68.4 182.245.68.193
	SITE2	Guangzhou, Guangdong	10.101.129.230	113.119.130.49 113.119.129.234 113.119.130.150 113.119.131.14
	SITE 3	Shanghai	192.168.0.92	58.32.219.222
	SITE4	Wuhan, Hubei	10.101.133.220	58.49.53.118

Table 26: Details of sites for PHASE2 of the experiment

In this phase of the experiment the results are presented also in the form of graphs. Each graph presents the measured response times for all three web servers of the proposed model. The x-axis presents the date and time of the web request that is generated to measure response time after every 15 minutes. The y-axis of each graph presents the measured response times in seconds for each web request. The average and standard deviation of the response times for each web server is calculated to provide statistical analysis for each site. Similar to Phase1, we also calculated a 95% confidence interval for the average response time of each web server to establish the significance of our results. The following equations are used to calculate the average time spent by the web requests of the LDS system in the local area of the customer site, in the WAN and in the server side LAN.

$$\text{LocalTime}_{\text{LDS}} = \text{RT}_{\text{google}}$$

$$\text{WANTime}_{\text{LDS}} = \text{RT}_{\text{volvo2}} - \text{RT}_{\text{google}}$$

$$\text{ServerLANTime}_{\text{LDS}} = \text{RT}_{\text{LDS}} - \text{RT}_{\text{volvo2}}$$

The dash lines in the each graph present the average of the response times for all web servers for that particular site. These graphs are given below.

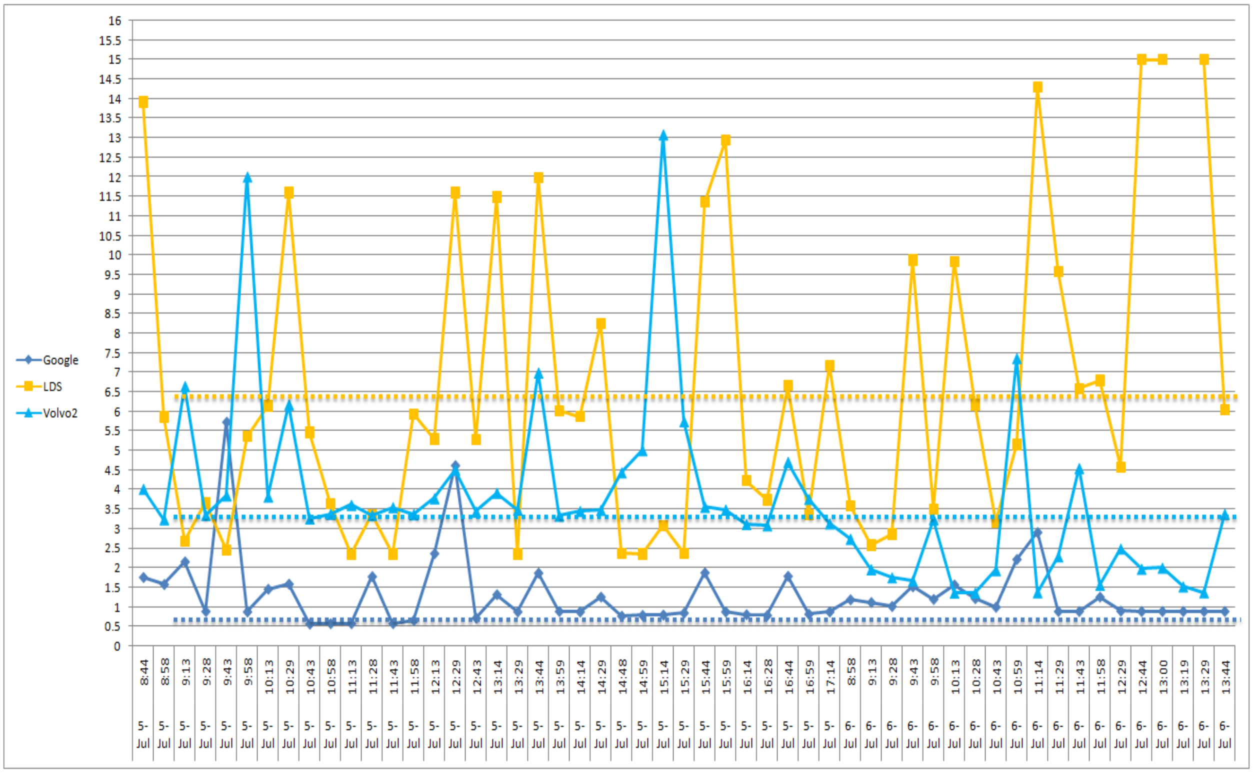

Figure 23: Response times measured from SITE1 of PHASE2

The graph in Figure 23 presents the response times measured of the selected web servers from SITE1 that is located in the Yunnan region of China. This graph presents the results of only two days from SITE1. Complete graph for a total of 159 web requests is provided in Appendix A. It shows the consistent behavior and better response times for google in different time intervals as compared to the other two web servers at this site. However, it can be observed in the graph that the response times for the LDS system are very high as compared to the volvo2 web server. According to the proposed model, both of these systems exist in the same LAN environment. Therefore, this difference shows that there are performance issues at the sever end of the LDS system. The analysis of the average and standard deviation of the response times for each web server, based on the response time measured from SITE1, is given in Table 27.

Web Server	Average RT (sec)	Standard Deviation (sec)	95% Confidence Interval		Analysis
			Lower	Upper	
google	1.24	0.79	1.111	1.362	• Better and consistent response times for google as compared to the other web servers • Even though both average and standard deviation of the response times are high at this site but still they verify that google is accessible from the nearby location closed to SITE1

					• Similar results are also obtained in PHASE1 of the experiment from this same site but with better consistency as illustrated in Figure 16 • The same results also validate PHASE1 of the experiment and show similar behavior of google at this site • The difference in standard deviation at both phases might be because of the difference in number of requests generated in each phase
LDS	**6.73**	**3.83**	**6.132**	**7.411**	• Higher response times and standard deviation shows that the performance of the LDS system is not satisfactory at this site
volvo2	3.82	1.91	3.513	4.091	• Higher response times and standard deviation for this web server shows that its performance is also inadequate at this site but it is much better than the LDS system • The average time spent in the WAN by the web requests of LDS is 2.58 (sec). Because of the different routes over the WAN and based on the geographical location of the sites this time can vary among these sites

Table 27: Statistical analysis of the response time measured from SITE1 of PHASE2

Table 28 provides LocalTime, WANTime and ServerLANTime of the LDS system at this site based on the analysis provided in Table 27.

Site	Web Request Time	Average time (sec)
SITE1	$\mathrm{LocalTime}_{\mathrm{LDS}}$	1.24
	$\mathrm{WANTime}_{\mathrm{LDS}}$	2.58
	$\mathrm{ServerLANTime}_{\mathrm{LDS}}$	**2.91**

Table 28: Decomposition of the average response time of the LDS System based on Table 27

Table 28 shows that the average time spent by the web requests of the LDS system, in the server side LAN, is very high as compared to the time spent in the local area of the site and WAN. This time is higher than the time spent in the WAN. Therefore, it shows that the LDS system experiences the problem of the performance degradation because of the performance issues at the sever end.

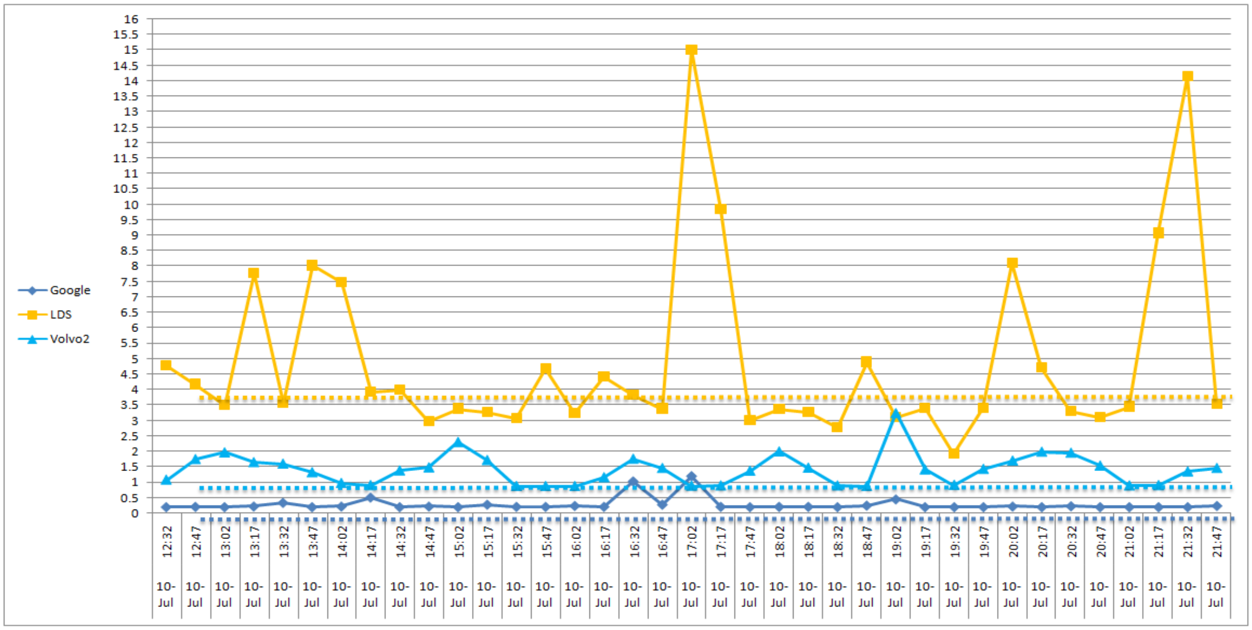

Figure 24: Response times measured from SITE2 of PHASE2

The graph in Figure 24 presents the results from SITE2 that is located in the Guangdong region of China. This graph presents the results of only one day. The complete graph for a total of 217 web requests is provided in Appendix A. It shows consistent behavior and better response times for google at this site as compared to the other two web servers. Similar to SITE1, it can be observed in above graph that the response times for the LDS system are very high as compared to the volvo2 web server. As said earlier, both of these systems exist in the same LAN environment. Therefore, this difference shows that there are performance issues at the sever end of the LDS system. The analysis of the average and standard deviation of the response times for each web server based on the results of this site is given in Table 29.

Web Server	Average RT (Sec)	Standard Deviation (Sec)	95% Confidence Interval Lower	Upper	Analysis
google	0.42	0.81	0.313	0.547	• The average of the response times for google at this site is much better as compared to SITE1 of this phase, hence showing that google is accessible from the nearest location • The standard deviation of the response times at this site is same as for SITE1, hence showing similar consistency for the google web server at both sites
LDS	**4.22**	**2.32**	**3.917**	**4.589**	• Higher response times and standard deviation shows that the performance of the LDS system inadequate at this site

volvo2	1.43	1.02	.297	1.447	• The average and standard deviation of the response times for the volvo2 web server is better at this site as compare to the results of SITE1 • The average time spent in the WAN by the web requests of the LDS system is 1.01(sec).

Table 29: Statistical analysis of the response time measured from SITE2 of PHASE2

Table 30 provides LocalTime, WANTime and ServerLANTime of the LDS system at this site based on the analysis provided in Table 29.

Site	Web Request Time	Average time (sec)
SITE2	$LocalTime_{LDS}$	0.42
	$WANTime_{LDS}$	1.01
	$ServerLANTime_{LDS}$	**2.79**

Table 30: Decomposition of the average response time of the LDS System based on Table 29

Table 30 shows that the average time spent by the web requests of the LDS system, in the server side LAN, is very high as compared to the time spent in the local area of the site and WAN. Therefore, it shows that the LDS system experiences the problem of the performance degradation at this dealer site because of the performance issues at the sever end. A Similar behavior of the LDS system is observed at SITE1.

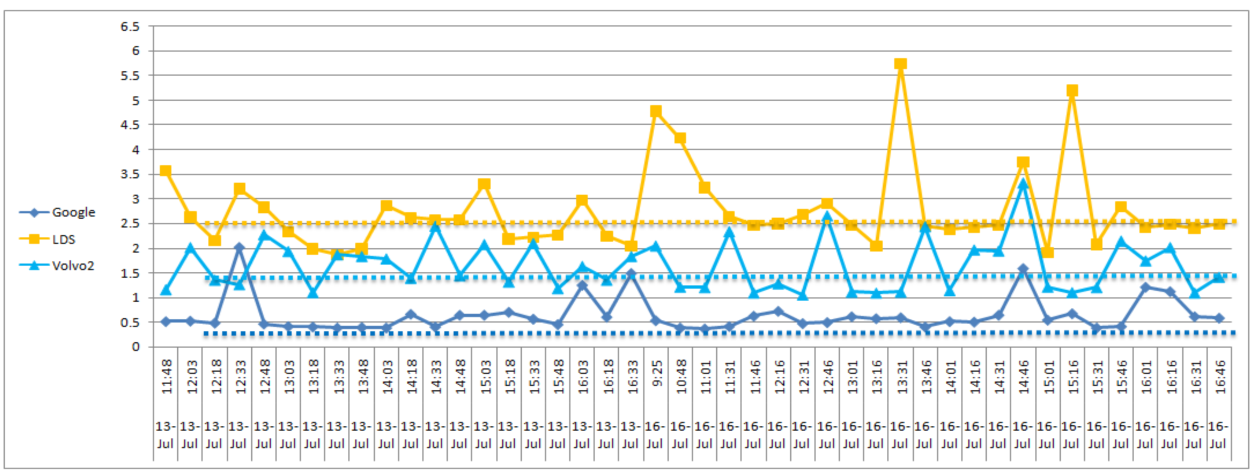

Figure 25: Response times measured from SITE3 of PHASE2

The graph in Figure 25 presents the response times measured for the selected web servers from SITE3 that is located in the Shanghai region of China. This graph shows variations in the response times of all the web servers. The behavior of google is still consistent and the response times are better at this site in different time intervals as compared to other two web servers. However, it can be observed in the graph that the response times for the LDS system are very high as compared to the volvo2 web server. The analysis of the average and standard deviation of the response times for each web server, based on the response time measured from SITE3, is given in Table 31.

Web Server	Average RT (Sec)	Standard Deviation (Sec)	95% Confidence Interval		Analysis
			Lower	Upper	
google	0.64	0.36	0.548	0.759	• Similar to SITE2, the average of the response times for google at this site is better as compare to SITE1 of this phase, hence showing that google is accessible from the nearest location • The standard deviation of the response times is better at this site as compare to SITE1 and SITE2
LDS	**2.76**	**0.84**	**2.523**	**3.030**	• Higher response times and standard deviation shows that the performance of the LDS system is inadequate at this site as compared to the volvo2 server
volvo2	1.65	0.53	1.499	1.811	• The standard deviation of the response times for volvo2 web server is better at this site as compare to SITE1 and SITE2 • Similar to SITE2, the average time spent in the WAN by the web requests of the LDS system is 1.01(sec)

Table 31: Statistical analysis of the response time measured from SITE3 of PHASE2

Table 32 provides LocalTime, WANTime and ServerLANTime of the LDS system at this site based on the analysis provided in Table 31.

Site	Web Request Time	Average time (sec)
SITE3	$LocalTime_{LDS}$	0.64
	$WANTime_{LDS}$	1.01
	$ServerLANTime_{LDS}$	**1.11**

Table 32: Decomposition of the average response time of the LDS System based on Table 31

Table 32 shows that the average time spent by the web requests of the LDS system, in the server side LAN, is very high as compared to the time spent in the local area of the site and the WAN. Therefore, it shows that the LDS system experiences the problem of the performance degradation at this dealer site because of the performance issues at the sever end.

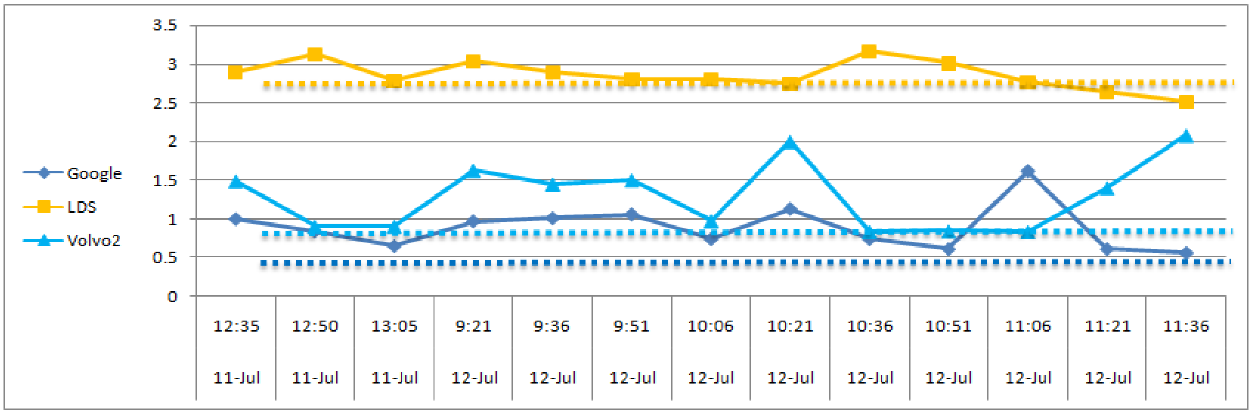

Figure 26: Response times measured from SITE4 of PHASE2

The graph in Figure 26 presents the results from SITE4 that is located in the Hubei region of China. It shows the variations in the response times of google and volvo2 web servers. It shows the more consistent behavior of the LDS system at this site. However, regardless of the better consistency, a difference in the response times can be observed for the LDS system and volvo2. Both of these systems exist in the same LAN environment. Therefore, this difference shows that there are performance issues at the sever end of the LDS system. The analysis of the average and standard deviation of the response times for each web server, based on the response time measured at SITE4, is given in Table 33.

Web Server	Average RT (Sec)	Standard Deviation (Sec)	95% Confidence Interval Lower	Upper	Analysis
google	0.89	0.29	0.745	1.060	• Similar to SITE2 and SITE3, the average of the response times for google at this site is better as compared to SITE1 of this phase • It shows the similar consistency as at SITE3
LDS	**2.86**	**1.03**	**2.757**	**2.961**	• Higher response times and standard deviation shows that the performance of the LDS system is inadequate at this site as compared to the volvo2 web sever
volvo2	1.29	0.92	1.0754	1.526	• The standard deviation of the response times for volvo2 shows similar consistency as at SITE2 • The average time spent in WAN by the web requests of the LDS system is .41 (sec). At this site, time spent in WAN by the web requests of the LDS

					system is very low as compared to the other sites in PHASE2 of the experiment

Table 33: Statistical analysis of the response time measured from SITE3 of PHASE2

Table 34 provides LocalTime, WANTime and ServerLANTime of the LDS system at this site based on the analysis provided in Table 33.

Site	Web Request Time	Average time (sec)
SITE4	$LocalTime_{LDS}$	0.89
	$WANTime_{LDS}$	0.41
	$ServerLANTime_{LDS}$	**1.56**

Table 34: Decomposition of the average response time of the LDS System based on Table 33

Table 34 shows that the average time spent by the web requests of the LDS system, in the server side LAN, is very high as compared to the time spent in the local area of the site and the WAN as well. Therefore, it shows that the LDS system experiences the problem of the performance degradation at this dealer site because of the performance issues at the sever end.

Based on the results presented above, from the primary sites of this case study, it is observed that the performance of the LDS system is inadequate at the dealer sites. The results from the sites in PHASE2 of the experiment also show that there are performance issues at the server end of the LDS system. Figure 27 highlights the probable problem area of the LDS system at the server end.

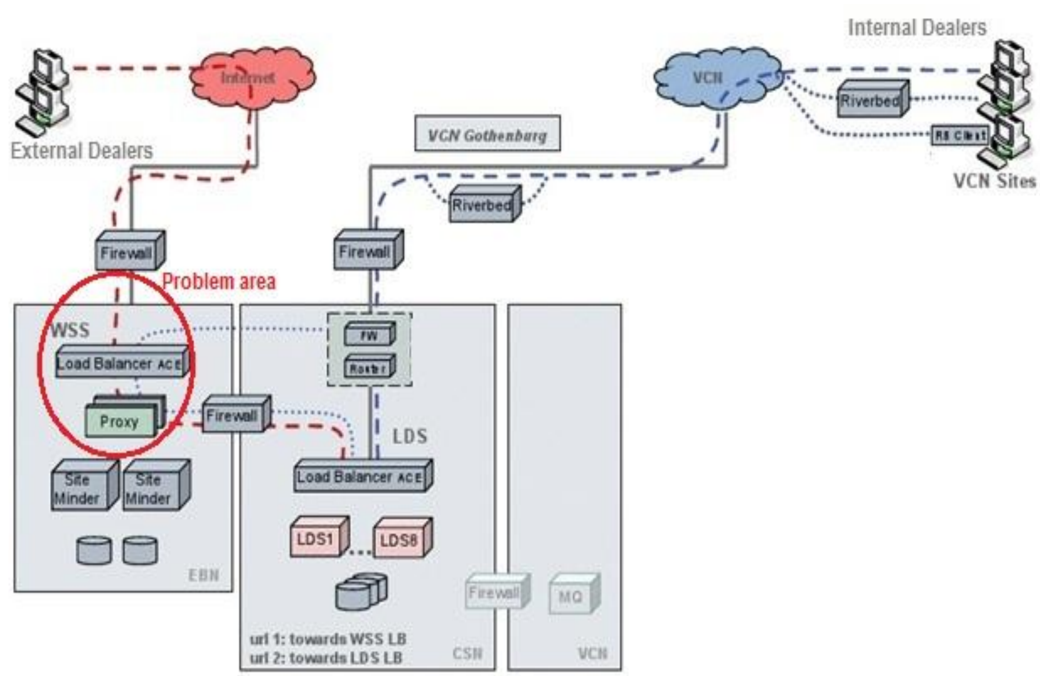

Figure 27: Problem area for the LDS system

Based on the results of PHASE2, it is observed that the standard deviation of the google web server at SITE1 and SITE2 is very high as compared to SITE3 and SITE4. The result from SITE1 and SITE2 also show similar inconsistent behavior of the other two web servers. This shows that there are some network issues at the local end of the dealer site. It verifies that the proposed model can be used to predict the network status at the local end of the dealer site. Table 35 provides the analysis of the standard deviation for all the web servers from each site.

Site	Google	LDS	Volvo2	Analysis
SITE1	**0.79**	3.83	1.91	• The results from SITE1 show that if the standard deviation for google is high then similarly it is also high for the LDS system and volvo2 • The high standard deviation for all web servers predicts that there are some network issues at the local end of SITE1.
SITE2	**0.81**	2.32	1.02	• Similar to SITE1, the results from SITE2 show that if the standard deviation for google is high then similarly it is also high for the LDS system and volvo2 • The high standard deviation for all web servers predicts that there are some network issues at the local end of SITE2.
SITE3	**0.36**	0.84	0.53	• The results from SITE1 show that if the standard deviation for google is low then similarly it is also low for the LDS system and volvo2 • The low standard deviation for all web servers predicts that the network at the local side of SITE3 is better as compared to SITE1 and SITE2.
SITE4	**0.29**	1.03	0.92	• Similar to SITE3, the results from SITE4 show that if the standard deviation for google is low then similarly it is also low for the LDS system and volvo2

				• The low standard deviation for all web servers predicts that the network at the local side of SITE4 is better as compared to SITE1 and SITE2.

Table 35: Analysis of the standard deviations for all web servers of PHASE2

The analysis provided in Table 35 show that if the standard deviation for google varies from one site to another site then the standard deviation for the other servers also varies. This implies that it is possible to predict the network status of the customer site based on the standard deviation of the response times at different sites.

4.4.4 Discussion PHASE2

The main aim of PHASE2 of the experiment is to investigate the problem of the performance degradation at the different sites in the China for LDS system and to validate the proposed model. Therefore, a statistical analysis of the results from each selected site is used to validate the usability and usefulness of the proposed model.

According to the results of PHASE2, it is possible to calculate the time spent by the web request of the actual system in the local area of the customer end, the WAN and the LAN at the server end. Therefore, based on these times and the proposed model, it is also possible to identify the problem in the end-to-end communication path for the actual system that experiences the problem of the performance degradation. The results of PHASE2 show that LDS system experiences this problem because of the performances issues at the server end. The analysis of the results in PHASE2 can also be used to predict the network status at the local end of the customer site. However, it is not possible to determine the exact area in the local environment that might be creating the problem. It is also not possible to determine the factors that are decreasing performance at the local end.

4.4.5 Validity Threats

The possible validity threats to the results of the performed experiment are discussed in this section.

One possible threat to the validity of the results is that the experiment is not performed in a strict manner. For example, the prototype is not run for the same period of the time at all sites. Moreover, the prototype is not run at the same time in all the selected sites to measure response times. Due to this, the results of one site cannot be compared to results of another site. The main reasons behind this validity threat are:

- Limited access to the site
- Privacy concerns of the end user
- Lack of interest of the end users in the results of the experiment

Another threat to the validity of the results is that the numbers of sites selected for the case study are not sufficient. For example, if the data is collected from more sites then it could strengthen the results of PHASE1 in choosing one of a best server. The analysis of the larger set of the results from more sites can also help to identify the key performance indicator for the selected web server. The main reason behind this validity threat is that the prototype developed in this case study has compatibility issues with different operating systems, thus limiting the number of sites.

The time difference between the generations of the web request through the prototype is also a validity threat to the results. For example, the prototype generates request for selected web servers one by one. Mostly, this time difference between two consecutive requests is small but in the case of a web request failure or web delays this time can vary. If this time difference between web requests is high then it can provide different results since it is quite possible for the network status to vary in that particular time period.

4.5 Case Study Conclusion

The aim of the case study is to validate the usability and usefulness of the proposed model. The proposed model is used to investigate the problem of the performance degradation, experiences by the web-based IT systems, at the customer sites. Therefore, an experiment and statistical analysis is performed in the case study. The analysis of the results validates the hypothesis presented in this case study. Overall, this case study shows that the proposed model can be used to identify the problem in the E2E client-server communication for the selected IT system that experiences the problem of performance degradation at the customer sites. The interviews are conducted at the end of the case study to validate the proposed model that it can identify the problem area and can also be use to predict the network status at the customer site.

Chapter 5: Results and Discussion

This chapter analyses the results of the research which is conducted in this thesis project. It also elaborates the research question and provides the answers. We categorize the discussion based on our research questions into three categories which are existing methods and software solutions, conceptual model and usability and usefulness of the proposed model.

5.1 Existing Methods and Software Solutions

This section provides the answer to the first research question of this study. The first research question of this study was:

RQ1:"*Are there existing software solutions or methods that can be used to address the problem of performance degradation at the customer sites for web-based IT systems?*"

The objective of this question is to explore the existing work that addresses the problem of performance degradation for web-based IT systems. We have conducted a literature study and interview in the industry in order to answer this research question. The literature study aims to identify existing methods and software solutions from both the academia and industry. The purpose of the interview is to understand how the industry is currently addressing the problem of performance degradation for web-based IT systems.

According to our literature study, E2E performance monitoring is used to ensure the end-to-end QoS and to provide the desired level of performance. It shows that different approaches for the E2E performance monitoring have been discussed in previous studies. However, they focus on the understanding of the client-perceived response times and the runtime performance monitoring of web-based IT systems. Methods to measure response times are discussed in Table 6. There are also many other performance monitoring tools available in the industry. They aim to improve the performance of web-based IT systems and to identify the factors that lead to the problem of performance degradation. The details of some of the performance monitoring tools are given in Table 7.

The results of the interview with Volvo IT also shows that the company is using different performance monitoring tools to address the problem of performance degradation for their web-based IT system. Currently, they are trying the combination of different performance monitoring tools to identify the problem area in the E2E client-server communication.

The literature study and the interview show several approaches, frameworks and third party software solutions that can be used to address the problem of performance degradation and to identify the factors that cause the problem. However, it raises another research question that is given below.

RQ1.1. *"If yes, then are existing methods or software solutions useful to identify the problem area in the E2E client-server communication?"*

The objective of this question is to find out whether the existing methods and software solutions are useful to quickly identify the part of the E2E client-server communication where the problem might lies.

In order to answer this question, we have performed the analysis of the existing methods based on the findings of our literature review and conducted another interview with Volvo IT. The aim of the interview is to find out how useful the performance monitoring tools are for the industry to identify the problem area.

The analysis of the existing methods in Table 6 demonstrates that only one method M2 measure response time from customer sites but it does not help to identify the problem area and also the cause of the problem. Method M5 uses the approach of response time decomposition to identify the cause of the performance degradation. Method M6 uses collector devices to measure response time in different parts of the E2E client-server communication to identify the source of the problem; whether it is because of the application, the server or the network. However, both M5 and M6 do not take performance measurement from customer sites. The results of the analysis show that the existing methods do not help to identify the part of the E2E client-server communication in which the problem might exist by taking performance measurements from customer sites.

The interview shows that the company needs to use a combination of different performance monitoring tools and approaches at both customer and server end to identify the problem area. As said earlier, Volvo IT is currently trying the combination of performance monitoring tools available in the industry to identify the problem area. However, it is very time consuming and expensive for the company to use these kinds of solutions. The different geographical locations of the customers also make such solutions more difficult to implement. It is difficult for the company to gain the customer trust to run the third party performance monitoring tools at customer sites. It is possible for Volvo IT to use this kind solution at the customer sites that are owned by them. However, the case is different with the dealers that independent of them because of the corporate and privacy policies of these customers.

It is also observed in the company that they pay a lot of attention to their customer values. Volvo IT is keen to provide their customers with best services concerning their IT systems. It is also important to quickly indentify the problem area so they can put more focus on solving the problem in that particular area.

The results of our literature study show that the existing methods and approaches are not usable to identify the problem area. The results of the interview show that it is possible for Volvo IT to identify the problem area, however, it is difficult and expensive to use different performance monitoring tools and approaches.

5.2 Conceptual Model

We proposed the following research question based on the findings in the RQ1.

RQ2:*"What kind of models need to be created in order to identify the problem area for the performance degradation in web-based IT systems?"*

The objective of this research question is to address the need of a new model to identify the problem area in the E2E client-server communication for the problem of performance degradation in web-based IT systems. The need of a new model is identified in the answer to RQ1. In order to answer this research question, we have conducted another literature study and interview with Volvo IT. The interview is used to validate the need of a new model. The literature study is used to provide directions for proposing a conceptual model based on the existing methods for performance measurement and approaches for E2E performance monitoring.

The results of the interview show that Volvo IT is interested in a solution that can quickly identify the problem area in the E2E client-server communication so that they can focus on that specific area to address the problem.

Based on the results of the interview and literature study a conceptual model is proposed. The purpose of the model is to measure response times for different web servers based on the geographical location of the customer site and server site. The aim of the model is to analyze measured response time in a way that will help to identify the problem area and to predict the cause of the problem. The details of proposed model have been discussed in section 3.3.

5.3 Usability and Usefulness of the Proposed Model

This section provides the answer to the final research question of this study. The final research question of this study was:

RQ3:*"Is the proposed model (RQ2) usable and useful for the industry?"*

The objective of this research question is to validate the usability and usefulness of the proposed model in this research. In order to answer this research question, we have performed a case study with Volvo IT and validated the hypothesis that is generated based on the proposed model in the case study. The details of the case study have been already discussed in the chapter 4. We have also conducted an interview with Volvo IT to validate the results of the case study.

The results of the case study show that the proposed model can identify the problem area that causes the problem of performance degradation at customer site. It also shows that the proposed model can also be used to predict the network status at the customer site. The results of the interview with the company also validate the usability and usefulness of the proposed model. Based on the results of the case study, Volvo IT can look further into the problem area of the IT system that is investigated in the case study. The results provide them evidence about the problem area.

Chapter 6: Conclusion

The aim of this research is to the address the problem of performance degradation at the customer sites for web-based IT systems. For this purpose we have conducted a literature study in order to identify the existing methods and software solutions. The results of the literature study show that there are solutions available in both the academia and the industry. However, the results of this review raised another question if the existing methods and software solutions for performance monitoring are useful to identify the problem area in E2E client server communication. The analysis of the existing methods identified the need of a new model that can be used to determine the problem area in a quick way. We have conducted another literature study and several interviews to understand the existing approaches and theories for E2E performance monitoring. The results of this literature study and the interviews have provided directions to propose a new model. The aim of the proposed model is to quickly identify the problem area by measuring and analyzing response times for different web servers from customer's perspective.

We have performed a case study with Volvo IT to investigate the problem of performance degradation experienced by one of the web-based IT system at the company. A prototype based on the proposed model is developed to measure response times for the selected web servers. Further, the experiment is conducted in two phases. In PHASE1 the prototype is used to collect data from both the primary and the secondary sites of the case study. The statistical analysis of the results from each site is performed to provide rationale to select the SERVER1 of the proposed model. In PHASE2 of the experiment, the response times are measured for the selected web servers from the primary sites.

It is evident thorough case study that the proposed model can be used to identify the problem area. The analysis of the measured response times can also be used to predict the network status at customer site. The proposed model also provides evidence to the IT departments so they can focus to solve the performance degradation problem for their web-based IT systems. The analysis of the results in PHASE2 also shows that it is possible to predict the network status at the customer end. However, if the mentioned validity threats to the results of the case study are removed, then experiment can be repeated to investigate the network status at the customer end. For this purpose the prototype should be run at the same time so that results from one site can be compared with other sites in order to study the difference in the behavior of web servers. Further, the prototype can be improved by adding ability of tracing out the web requests over the Internet path. In this way, the analysis can be performed based on the Internet routes to examine response times in accordance with network routes followed by web requests.

The results of PHASE1 of the experiment prove that google provides consistent and better response time regardless of the geographical location of the customer site. However, a further study can be conducted to create key performance indicators for determining the network status at particular customer site. To achieve this goal, experiments should be performed at a large number of sites and prototype should be run at the same time at all of these sites.

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Appendices

Appendix A- Results of the Case Study

The snapshots of the results obtained through both phases of the experiment along with the SPSS report of comparing means with 95% confidence interval is given below.

PHASE1 Results

Full results of PHASE1 are available **online**.

Below is the snapshot of the results from SITE1.

Host	Host IP	External IP	Country Code	Country Name	Region Name	City	Req	Bytes Read	Time of Req	Date of Req	Local Hour	Local Time of Req	Req RT	Req Note
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	secure4.v	9886	11:39:00 PM	11-Jun	20:00	8:39:00 PM	4.81	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	secure4.v	9886	12:39:00 AM	11-Jun	21:00	9:39:00 PM	3.49	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	secure4.v	9886	1:39:00 AM	11-Jun	22:00	10:39:00 PM	2.46	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	secure4.v	9886	2:39:00 AM	11-Jun	23:00	11:39:00 PM	4.11	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	secure4.v	9886	3:39:00 AM	12-Jun	0:00	12:39:00 AM	2.88	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	secure4.v	9886	4:39:00 AM	12-Jun	1:00	1:39:00 AM	2.8	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	secure4.v	9886	5:39:00 AM	12-Jun	2:00	2:39:00 AM	2.41	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.akai	32427	11:39:00 PM	11-Jun	20:00	8:39:00 PM	2.1	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.akai	32427	12:39:00 AM	11-Jun	21:00	9:39:00 PM	3.25	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.akai	32427	1:39:00 AM	11-Jun	22:00	10:39:00 PM	1.19	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.akai	32427	2:39:00 AM	11-Jun	23:00	11:39:00 PM	1.64	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.akai	32427	3:39:00 AM	12-Jun	0:00	12:39:00 AM	0.73	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.akai	32427	4:39:00 AM	12-Jun	1:00	1:39:00 AM	0.87	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.akai	32427	5:39:00 AM	12-Jun	2:00	2:39:00 AM	1.37	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.chal	109745	11:39:00 PM	11-Jun	20:00	8:39:00 PM	2.4	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.chal	109745	12:39:00 AM	11-Jun	21:00	9:39:00 PM	1.15	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.chal	109745	1:39:00 AM	11-Jun	22:00	10:39:00 PM	1.96	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.chal	109745	2:39:00 AM	11-Jun	23:00	11:39:00 PM	1.88	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.chal	109745	3:39:00 AM	12-Jun	0:00	12:39:00 AM	1.9	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.chal	109745	4:39:00 AM	12-Jun	1:00	1:39:00 AM	1.36	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.chal	109745	5:39:00 AM	12-Jun	2:00	2:39:00 AM	1.4	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.goo	41143	11:39:00 PM	11-Jun	20:00	8:39:00 PM	0.43	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.goo	42138	12:39:00 AM	11-Jun	21:00	9:39:00 PM	0.26	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.goo	41143	1:39:00 AM	11-Jun	22:00	10:39:00 PM	0.24	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.goo	41158	2:39:00 AM	11-Jun	23:00	11:39:00 PM	0.33	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.goo	42117	3:39:00 AM	12-Jun	0:00	12:39:00 AM	0.2	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.goo	41110	4:39:00 AM	12-Jun	1:00	1:39:00 AM	0.19	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.goo	41098	5:39:00 AM	12-Jun	2:00	2:39:00 AM	0.31	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.volv	112021	11:39:00 PM	11-Jun	20:00	8:39:00 PM	2.4	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.volv	112021	12:39:00 AM	11-Jun	21:00	9:39:00 PM	2.43	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.volv	112021	1:39:00 AM	11-Jun	22:00	10:39:00 PM	1.48	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.volv	112021	2:39:00 AM	11-Jun	23:00	11:39:00 PM	3.78	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.volv	112021	3:39:00 AM	12-Jun	0:00	12:39:00 AM	1.61	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.volv	112021	4:39:00 AM	12-Jun	1:00	1:39:00 AM	1.46	
Gandalfo	169.254.8	189.32.56.6	BR	Brazil	Parana	Curitiba	www.volv	112021	5:39:00 AM	12-Jun	2:00	2:39:00 AM	1.85	

SITE1: SPSS Report for Compare Means with 95% Confidence Interval and bootstrap

Mean

	Statistic	Bootstrap[a]			
		Bias	Std. Error	95% Confidence Interval	
				Lower	Upper
google	.2800	.0007	.0297	.2271	.3428
volvo1	2.1443	.0071	.2924	1.6571	2.7555
akamai	1.5929	-.0031	.3012	1.0573	2.2541

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Below is the snapshot of the results from SITE2.

Host	Host IP	External IP	Country Code	Country Name	Region Name	City	Req	Bytes Read	Time of Req	Date of Req	Local Hour	Local Time of Req	Req RT	Req Note
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		10:02:00 AM	4-Jun	10:00	10:02:00 AM	1.44	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		11:02:00 AM	4-Jun	11:00	11:02:00 AM	4.79	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		12:02:00 PM	4-Jun	12:00	12:02:00 PM	1.84	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		1:02:00 PM	4-Jun	13:00	1:02:00 PM	4.44	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		2:02:00 PM	4-Jun	14:00	2:02:00 PM	2.01	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		3:02:00 PM	4-Jun	15:00	3:02:00 PM	1.45	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		4:02:00 PM	5-Jun	16:00	4:02:00 PM	1.96	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		5:03:00 PM	5-Jun	17:00	5:03:00 PM	10.17	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		6:02:00 PM	5-Jun	18:00	6:02:00 PM	1.23	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		7:02:00 PM	5-Jun	19:00	7:02:00 PM	3.7	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		5:00:00 AM	6-Jun	5:00	5:00:00 AM	1.95	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		6:03:00 AM	6-Jun	6:00	6:03:00 AM	1.82	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		7:00:00 AM	6-Jun	7:00	7:00:00 AM	4.32	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	secure4.v		8:00:00 AM	6-Jun	8:00	8:00:00 AM	1.63	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		10:03:00 AM	4-Jun	10:00	10:03:00 AM	0.83	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		11:03:00 AM	4-Jun	11:00	11:03:00 AM	0.64	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		12:03:00 PM	4-Jun	12:00	12:03:00 PM	1.09	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		1:03:00 PM	4-Jun	13:00	1:03:00 PM	0.68	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		2:03:00 PM	4-Jun	14:00	2:03:00 PM	2.73	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		3:03:00 PM	4-Jun	15:00	3:03:00 PM	1.29	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		4:03:00 PM	5-Jun	16:00	4:03:00 PM	0.76	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		5:03:00 PM	5-Jun	17:00	5:03:00 PM	1.59	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		6:03:00 PM	5-Jun	18:00	6:03:00 PM	0.96	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		7:03:00 PM	5-Jun	19:00	7:03:00 PM	0.83	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		5:00:00 AM	6-Jun	5:00	5:00:00 AM	0.81	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		6:04:00 AM	6-Jun	6:00	6:04:00 AM	1.05	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		7:05:00 AM	6-Jun	7:00	7:05:00 AM		WebExcept
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.aka		8:00:00 AM	6-Jun	8:00	8:00:00 AM	1.02	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.chal		10:03:00 AM	4-Jun	10:00	10:03:00 AM	3.44	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.chal		11:03:00 AM	4-Jun	11:00	11:03:00 AM	3.92	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.chal		12:03:00 PM	4-Jun	12:00	12:03:00 PM	4.34	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.chal		1:03:00 PM	4-Jun	13:00	1:03:00 PM	6.75	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.chal		2:03:00 PM	4-Jun	14:00	2:03:00 PM	6.22	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.chal		3:03:00 PM	4-Jun	15:00	3:03:00 PM	4.39	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.chal		4:03:00 PM	5-Jun	16:00	4:03:00 PM	6.38	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.chal		5:03:00 PM	5-Jun	17:00	5:03:00 PM	3.82	
vit-ldstest	10.101.135.86	114.242.106.194	CN	China	Beijing	Beijing	www.chal		6:03:00 PM	5-Jun	18:00	6:03:00 PM	3.2	

SITE2: SPSS Report for Compare Means with 95% Confidence Interval and bootstrap

Mean

	Statistic	Bootstrap[a]			
		Bias	Std. Error	95% Confidence Interval	
				Lower	Upper
google	.0950	.0001	.0100	.0750	.1143
volvo1	4.0129	-.0121	.6754	2.8601	5.4923
akamai	1.0200	.0046	.1576	.7480	1.3557

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Below is the snapshot of the results from SITE3.

Host	Host IP	External IP	Country Code	Country Name	Region Name	City	Req	Bytes Read	Time of Req	Date of Req	Local Hour	Local Time of Req	Req RT	Req Note
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	6:20:00 AM	19-Jun	14:00	2:20:00 PM	4.33	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	7:46:00 AM	19-Jun	15:00	3:46:00 PM	5.21	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	7:20:00 AM	19-Jun	15:00	3:20:00 PM	3.16	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	8:46:00 AM	19-Jun	16:00	4:46:00 PM	5.74	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	12:51:00 AM	20-Jun	8:00	8:51:00 AM	7.98	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	1:51:00 AM	20-Jun	9:00	9:51:00 AM	7.33	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	2:51:00 AM	20-Jun	10:00	10:51:00 AM	3.78	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	3:51:00 AM	20-Jun	11:00	11:51:00 AM	10.33	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	4:51:00 AM	20-Jun	12:00	12:51:00 PM	3.19	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	5:52:00 AM	20-Jun	13:00	1:52:00 PM	7.96	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	6:51:00 AM	20-Jun	14:00	2:51:00 PM	3.59	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	7:51:00 AM	20-Jun	15:00	3:51:00 PM	3.53	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	8:51:00 AM	20-Jun	16:00	4:51:00 PM	3.12	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	12:54:00 AM	21-Jun	8:00	8:54:00 AM	5.5	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	1:54:00 AM	21-Jun	9:00	9:54:00 AM	5.08	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	2:55:00 AM	21-Jun	10:00	10:55:00 AM	4.88	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	1:11:00 AM	27-Jun	9:00	9:11:00 AM	3.62	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	2:11:00 AM	27-Jun	10:00	10:11:00 AM	3.24	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	3:11:00 AM	27-Jun	11:00	11:11:00 AM	4.13	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	4:11:00 AM	27-Jun	12:00	12:11:00 PM	7.52	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	5:11:00 AM	27-Jun	13:00	1:11:00 PM	5.98	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	6:11:00 AM	27-Jun	14:00	2:11:00 PM	4.15	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	7:11:00 AM	27-Jun	15:00	3:11:00 PM	3.74	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	secure4.v	9886	8:11:00 AM	27-Jun	16:00	4:11:00 PM	3.68	
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	www.akai		6:21:00 AM	19-Jun	14:00	2:21:00 PM		WebExcept
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	www.akai		7:46:00 AM	19-Jun	15:00	3:46:00 PM		WebExcept
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	www.akai		8:46:00 AM	19-Jun	16:00	4:46:00 PM		WebExcept
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	www.akai		12:52:00 AM	20-Jun	8:00	8:52:00 AM		WebExcept
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	www.akai		1:52:00 AM	20-Jun	9:00	9:52:00 AM		WebExcept
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	www.akai		2:52:00 AM	20-Jun	10:00	10:52:00 AM		WebExcept
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	www.akai		3:52:00 AM	20-Jun	11:00	11:52:00 AM		WebExcept
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	www.akai		4:52:00 AM	20-Jun	12:00	12:52:00 PM		WebExcept
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	www.akai		5:53:00 AM	20-Jun	13:00	1:53:00 PM		WebExcept
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	www.akai		6:52:00 AM	20-Jun	14:00	2:52:00 PM		WebExcept
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	www.akai		7:52:00 AM	20-Jun	15:00	3:52:00 PM		WebExcept
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	www.akai		8:52:00 AM	20-Jun	16:00	4:52:00 PM		WebExcept
dell-e668	10.101.131.201	202.98.70.1	CN	China	Yunnan	Kunming	www.akai		12:55:00 AM	21-Jun	8:00	8:55:00 AM		WebExcept

SITE3: SPSS Report for Compare Means with 95% Confidence Interval and bootstrap

Mean

	Statistic	Bootstrap[a]			
		Bias	Std. Error	95% Confidence Interval	
				Lower	Upper
google	1.2717	-.0038	.2163	.8927	1.6999
volvo1	2.8370	.0011	.2401	2.3880	3.3034

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Below is the snapshot of the results from SITE4.

Host	Host IP	External IP	Country Code	Country Name	Region Name	City	Req	Bytes Read	Time of Req	Date of Req	Local Hour	Local Time of Req	Req RT	Req Note
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	google.co	43467	2:52:00 PM	15-Jun	15:00	3:52:00 PM	0.49	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	google.co	43411	3:52:00 PM	15-Jun	16:00	4:52:00 PM	0.49	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	google.co	43518	4:52:00 PM	15-Jun	17:00	5:52:00 PM	0.49	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	google.co	43478	5:52:00 PM	15-Jun	18:00	6:52:00 PM	0.49	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	google.co	43478	6:07:00 PM	15-Jun	19:00	7:07:00 PM	0.51	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	google.co	43656	11:43:00 PM	16-Jun	0:00	12:43:00 AM	0.49	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	google.co	43568	12:46:00 AM	16-Jun	1:00	1:46:00 AM	0.49	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	google.co	43548	1:51:00 AM	16-Jun	2:00	2:51:00 AM	0.49	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	google.co	43516	2:51:00 AM	16-Jun	3:00	3:51:00 AM	0.48	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	google.co	43516	3:51:00 AM	16-Jun	4:00	4:51:00 AM	0.49	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	google.co	43532	4:36:00 AM	16-Jun	5:00	5:36:00 AM	0.5	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	secure4.v	9886	2:52:00 PM	15-Jun	15:00	3:52:00 PM	0.64	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	secure4.v	9886	3:52:00 PM	15-Jun	16:00	4:52:00 PM	0.65	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	secure4.v	9886	4:52:00 PM	15-Jun	17:00	5:52:00 PM	0.63	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	secure4.v	9886	5:52:00 PM	15-Jun	18:00	6:52:00 PM	0.7	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	secure4.v	9886	6:07:00 PM	15-Jun	19:00	7:07:00 PM	0.61	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	secure4.v	9886	11:43:00 PM	16-Jun	0:00	12:43:00 AM	0.75	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	secure4.v	9886	12:46:00 AM	16-Jun	1:00	1:46:00 AM	0.65	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	secure4.v	9886	1:51:00 AM	16-Jun	2:00	2:51:00 AM	0.62	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	secure4.v	9886	2:51:00 AM	16-Jun	3:00	3:51:00 AM	0.63	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	secure4.v	9886	3:51:00 AM	16-Jun	4:00	4:51:00 AM	0.63	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	secure4.v	9886	4:36:00 AM	16-Jun	5:00	5:36:00 AM	0.74	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	volvo.com	110830	2:52:00 PM	15-Jun	15:00	3:52:00 PM	0.95	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	volvo.com	111899	3:52:00 PM	15-Jun	16:00	4:52:00 PM	1.29	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	volvo.com	111899	4:52:00 PM	15-Jun	17:00	5:52:00 PM	1.54	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	volvo.com	111899	5:52:00 PM	15-Jun	18:00	6:52:00 PM	0.95	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	volvo.com	110830	6:07:00 PM	15-Jun	19:00	7:07:00 PM	0.71	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	volvo.com	111899	11:43:00 PM	16-Jun	0:00	12:43:00 AM	1.75	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	volvo.com	111899	12:46:00 AM	16-Jun	1:00	1:46:00 AM	1.5	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	volvo.com	111899	1:51:00 AM	16-Jun	2:00	2:51:00 AM	1.47	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	volvo.com	111899	2:51:00 AM	16-Jun	3:00	3:51:00 AM	0.78	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	volvo.com	111899	3:51:00 AM	16-Jun	4:00	4:51:00 AM	0.95	
SalBuU-PC	192.168.C	2.219.26.1	GB	United Kingdom	Oldham	Oldham	volvo.com	111899	4:36:00 AM	16-Jun	5:00	5:36:00 AM	0.98	

SITE4: SPSS Report for Compare Means with 95% Confidence Interval and bootstrap

Mean

	Statistic	Bootstrap[a]			
		Bias	Std. Error	95% Confidence Interval	
				Lower	Upper
google	.4918	.0000	.0021	.4882	.4964
volvo1	1.1700	-.0017	.1008	.9745	1.3689

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Below is the snapshot of the results from SITE5.

Host	Host IP	External IP	Country Code	Country Name	Region Name	City	Req	Bytes Read	Time of Req	Date of Req	Local Hour	Local Time of Req	Req RT	Req Note
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	secure4.v	9886	4:45:00 PM	13-Jun	18:00	6:45:00 PM	0.55	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	secure4.v	9886	5:45:00 PM	13-Jun	19:00	7:45:00 PM	0.81	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	secure4.v	9886	6:45:00 PM	13-Jun	20:00	8:45:00 PM	0.74	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	secure4.v	9886	7:45:00 PM	13-Jun	21:00	9:45:00 PM	0.83	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	secure4.v	9886	8:45:00 PM	13-Jun	22:00	10:45:00 PM	0.72	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.akai	32261	4:45:00 PM	13-Jun	18:00	6:45:00 PM	0.48	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.akai	32261	5:45:00 PM	13-Jun	19:00	7:45:00 PM	0.38	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.akai	32261	6:45:00 PM	13-Jun	20:00	8:45:00 PM	0.38	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.akai	32261	7:45:00 PM	13-Jun	21:00	9:45:00 PM	0.4	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.akai	32261	8:45:00 PM	13-Jun	22:00	10:45:00 PM	0.45	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.chal	109817	4:45:00 PM	13-Jun	18:00	6:45:00 PM	0.68	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.chal	109817	5:45:00 PM	13-Jun	19:00	7:45:00 PM	0.74	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.chal	109817	6:45:00 PM	13-Jun	20:00	8:45:00 PM	0.74	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.chal	109817	7:45:00 PM	13-Jun	21:00	9:45:00 PM	0.68	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.chal	109817	8:45:00 PM	13-Jun	22:00	10:45:00 PM	1.13	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.goo	44295	4:45:00 PM	13-Jun	18:00	6:45:00 PM	0.2	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.goo	44295	5:45:00 PM	13-Jun	19:00	7:45:00 PM	0.23	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.goo	45242	6:45:00 PM	13-Jun	20:00	8:45:00 PM	0.2	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.goo	44283	7:45:00 PM	13-Jun	21:00	9:45:00 PM	0.28	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.goo	44565	8:45:00 PM	13-Jun	22:00	10:45:00 PM	0.29	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.volv	112021	4:45:00 PM	13-Jun	18:00	6:45:00 PM	0.59	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.volv	112021	5:45:00 PM	13-Jun	19:00	7:45:00 PM	1.44	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.volv	112021	6:45:00 PM	13-Jun	20:00	8:45:00 PM	1.36	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.volv	112021	7:45:00 PM	13-Jun	21:00	9:45:00 PM	0.32	
Fred-PC	192.168.1	82.226.209.	FR	France	Rhone-Alpes	Villeurbar	www.volv	112021	8:45:00 PM	13-Jun	22:00	10:45:00 PM	1.91	

SITE5: SPSS Report for Compare Means with 95% Confidence Interval and bootstrap

Mean

	Statistic	Bootstrap[a]			
		Bias	Std. Error	95% Confidence Interval	
				Lower	Upper
google	.2400	-.0001	.0171	.2060	.2740
volvo1	1.1240	.0077	.2572	.6384	1.6900
akamai	.4180	.0002	.0180	.3840	.4540

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Below is the snapshot of the results from SITE6.

Host	Host IP	External IP	Country Code	Country Name	Region Name	City	Req	Bytes Read	Time of Req	Date of Req	Local Hour	Local Time of Req	Req RT	Req Note
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	secure4.v	9886	7:54:00 PM	6-Jun	21:00	9:54:00 PM	0.65	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	secure4.v	9886	8:54:00 PM	6-Jun	22:00	10:54:00 PM	0.69	
UFN-PC	127.0.0.1	84.101.189.	FR	France	Provence-Alpe:	Biot	secure4.v	9886	7:21:00 AM	7-Jun	9:00	9:21:00 AM	0.71	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	secure4.v	9886	8:21:00 AM	7-Jun	10:00	10:21:00 AM	0.59	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	secure4.v	9886	9:21:00 AM	7-Jun	11:00	11:21:00 AM	0.72	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	secure4.v	9886	10:21:00 AM	7-Jun	12:00	12:21:00 PM	0.67	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.akai	32427	7:54:00 PM	6-Jun	21:00	9:54:00 PM	0.49	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.akai	32427	8:54:00 PM	6-Jun	22:00	10:54:00 PM	0.59	
UFN-PC	127.0.0.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.akai	32427	7:21:00 AM	7-Jun	9:00	9:21:00 AM	0.68	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.akai	32427	8:21:00 AM	7-Jun	10:00	10:21:00 AM	0.43	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.akai	32427	9:21:00 AM	7-Jun	11:00	11:21:00 AM	0.55	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.akai	32427	10:21:00 AM	7-Jun	12:00	12:21:00 PM	0.63	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.chal	109748	7:54:00 PM	6-Jun	21:00	9:54:00 PM	0.43	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.chal	109748	8:54:00 PM	6-Jun	22:00	10:54:00 PM	0.45	
UFN-PC	127.0.0.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.chal	109748	7:21:00 AM	7-Jun	9:00	9:21:00 AM	0.57	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.chal	109748	8:21:00 AM	7-Jun	10:00	10:21:00 AM	0.41	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.chal	109748	9:21:00 AM	7-Jun	11:00	11:21:00 AM	0.4	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.chal	109748	10:21:00 AM	7-Jun	12:00	12:21:00 PM	0.41	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.goo	43940	7:54:00 PM	6-Jun	21:00	9:54:00 PM	0.28	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.goo	43916	8:54:00 PM	6-Jun	22:00	10:54:00 PM	0.29	
UFN-PC	127.0.0.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.goo	41937	7:21:00 AM	7-Jun	9:00	9:21:00 AM	0.26	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.goo	41949	8:21:00 AM	7-Jun	10:00	10:21:00 AM	0.28	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.goo	41925	9:21:00 AM	7-Jun	11:00	11:21:00 AM	0.29	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.goo	41949	10:21:00 AM	7-Jun	12:00	12:21:00 PM	0.28	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.volv	112021	7:54:00 PM	6-Jun	21:00	9:54:00 PM	0.99	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.volv	112021	8:54:00 PM	6-Jun	22:00	10:54:00 PM	1.01	
UFN-PC	127.0.0.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.volv	112021	7:21:00 AM	7-Jun	9:00	9:21:00 AM	1.99	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.volv	112021	8:21:00 AM	7-Jun	10:00	10:21:00 AM	1	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.volv	112021	9:21:00 AM	7-Jun	11:00	11:21:00 AM	1.18	
UFN-PC	192.168.1	84.101.189.	FR	France	Provence-Alpe:	Biot	www.volv	112021	10:21:00 AM	7-Jun	12:00	12:21:00 PM	1.06	

SITE6: SPSS Report for Compare Means with 95% Confidence Interval and bootstrap

Mean

	Statistic	Bootstrap[a]			
		Bias	Std. Error	95% Confidence Interval	
				Lower	Upper
google	.2800	.0000	.0041	.2717	.2867
volvo1	1.2050	.0006	.1427	1.0083	1.5250
akamai	.5617	-.0006	.0342	.4933	.6267

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Below is the snapshot of the results from SITE7.

Host	Host IP	External IP	Country Code	Country Name	Region Name	City	Req	Bytes Read	Time of Req	Date of Req	Local Hour	Local Time of Req	Req RT	Req Note
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3373	12:24:00 PM	12-Jun	17:00	5:24:00 PM	1.27	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3373	1:24:00 PM	12-Jun	18:00	6:24:00 PM	1.12	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3373	2:25:00 PM	12-Jun	19:00	7:25:00 PM	1.38	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3373	3:25:00 PM	12-Jun	20:00	8:25:00 PM	1.66	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3373	4:25:00 PM	12-Jun	21:00	9:25:00 PM	1.26	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3375	12:11:00 PM	13-Jun	17:00	5:11:00 PM	1.88	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3375	1:11:00 PM	13-Jun	18:00	6:11:00 PM	1.78	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3375	2:11:00 PM	13-Jun	19:00	7:11:00 PM	1.28	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3375	3:11:00 PM	13-Jun	20:00	8:11:00 PM	1.78	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3375	4:11:00 PM	13-Jun	21:00	9:11:00 PM	1.93	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3375	5:11:00 PM	13-Jun	22:00	10:11:00 PM	1.84	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3374	8:00:00 AM	14-Jun	13:00	1:00:00 PM	2.2	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3374	9:02:00 AM	14-Jun	14:00	2:02:00 PM	119.17	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3374	10:00:00 AM	14-Jun	15:00	3:00:00 PM	2.06	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3374	11:00:00 AM	14-Jun	16:00	4:00:00 PM	1.94	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3374	12:00:00 PM	14-Jun	17:00	5:00:00 PM	1.98	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3374	1:00:00 PM	14-Jun	18:00	6:00:00 PM	1.1	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3374	2:00:00 PM	14-Jun	19:00	7:00:00 PM	1.49	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3374	3:00:00 PM	14-Jun	20:00	8:00:00 PM	1.1	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3374	4:00:00 PM	14-Jun	21:00	9:00:00 PM	1.16	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3374	5:00:00 PM	14-Jun	22:00	10:00:00 PM	1.23	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	secure4.v	3374	6:00:00 PM	14-Jun	23:00	11:00:00 PM	1.23	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	32261	12:25:00 PM	12-Jun	17:00	5:25:00 PM	2.03	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	32261	1:25:00 PM	12-Jun	18:00	6:25:00 PM	2.13	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	32261	2:25:00 PM	12-Jun	19:00	7:25:00 PM	1.99	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	32261	3:25:00 PM	12-Jun	20:00	8:25:00 PM	1.65	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	32261	4:25:00 PM	12-Jun	21:00	9:25:00 PM	2.14	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	32261	12:12:00 PM	13-Jun	17:00	5:12:00 PM	1.69	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	32261	1:12:00 PM	13-Jun	18:00	6:12:00 PM	2.49	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	32261	2:12:00 PM	13-Jun	19:00	7:12:00 PM	1.71	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	32261	3:12:00 PM	13-Jun	20:00	8:12:00 PM	1.77	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	32261	4:12:00 PM	13-Jun	21:00	9:12:00 PM	1.76	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	32261	5:12:00 PM	13-Jun	22:00	10:12:00 PM	1.71	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	31907	8:01:00 AM	14-Jun	13:00	1:01:00 PM	1.62	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	30183	9:02:00 AM	14-Jun	14:00	2:02:00 PM	1.72	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	30183	10:00:00 AM	14-Jun	15:00	3:00:00 PM	1.82	
nx00311	10.28.80.	110.93.205.	PK	Pakistan	Punjab	Lahore	www.akai	30183	11:01:00 AM	14-Jun	16:00	4:01:00 PM	2.92	

SITE7: SPSS Report for Compare Means with 95% Confidence Interval and bootstrap

Mean

	Statistic	Bootstrap[a]			
		Bias	Std. Error	95% Confidence Interval	
				Lower	Upper
google	.7618	-.0013	.0854	.6128	.9345
volvo1	3.4714	-.0022	.3189	2.9129	4.1662
akamai	1.9682	-.0036	.0766	1.8168	2.1177

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Below is the snapshot of the results from SITE8.

Host	Host IP	External IP	Country Code	Country Name	Region Name	City	Req	Bytes Read	Time of Req	Date of Req	Local Hour	Local Time of Req	Req RT	Req Note
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	secure4.v	9886	10:22:00 AM	6-Jun	12:00	12:22:00 PM	0.63	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	secure4.v	9886	11:22:00 AM	6-Jun	13:00	1:22:00 PM	0.31	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	secure4.v	9886	12:22:00 PM	6-Jun	14:00	2:22:00 PM	0.33	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	secure4.v	9886	1:22:00 PM	6-Jun	15:00	3:22:00 PM	0.85	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	secure4.v	9886	2:22:00 PM	6-Jun	16:00	4:22:00 PM	1.41	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	secure4.v	9886	3:22:00 PM	6-Jun	17:00	5:22:00 PM	0.26	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	secure4.v	9886	4:22:00 PM	6-Jun	18:00	6:22:00 PM	0.33	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	secure4.v	9886	5:22:00 PM	6-Jun	19:00	7:22:00 PM	0.66	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	secure4.v	9886	6:22:00 PM	6-Jun	20:00	8:22:00 PM	0.29	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	secure4.v	9886	7:22:00 PM	6-Jun	21:00	9:22:00 PM	0.34	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	secure4.v	9886	8:22:00 PM	6-Jun	22:00	10:22:00 PM	0.44	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	secure4.v	9886	9:22:00 PM	6-Jun	23:00	11:22:00 PM	0.26	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.akai	32059	10:22:00 AM	6-Jun	12:00	12:22:00 PM	0.41	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.akai	32427	11:22:00 AM	6-Jun	13:00	1:22:00 PM	0.4	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.akai	32427	12:22:00 PM	6-Jun	14:00	2:22:00 PM	0.25	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.akai	32427	1:22:00 PM	6-Jun	15:00	3:22:00 PM	0.92	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.akai	32427	2:22:00 PM	6-Jun	16:00	4:22:00 PM	0.37	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.akai	32427	3:22:00 PM	6-Jun	17:00	5:22:00 PM	0.33	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.akai	32427	4:22:00 PM	6-Jun	18:00	6:22:00 PM	0.18	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.akai	32427	5:22:00 PM	6-Jun	19:00	7:22:00 PM	0.42	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.akai	32427	6:22:00 PM	6-Jun	20:00	8:22:00 PM	0.12	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.akai	32427	7:22:00 PM	6-Jun	21:00	9:22:00 PM	0.41	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.akai	32427	8:22:00 PM	6-Jun	22:00	10:22:00 PM	0.12	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.akai	32427	9:22:00 PM	6-Jun	23:00	11:22:00 PM	0.16	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.chal	109748	10:22:00 AM	6-Jun	12:00	12:22:00 PM	0.34	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.chal	109748	11:22:00 AM	6-Jun	13:00	1:22:00 PM	0.23	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.chal	109748	12:22:00 PM	6-Jun	14:00	2:22:00 PM	0.22	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.chal	109748	1:22:00 PM	6-Jun	15:00	3:22:00 PM	1.78	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.chal	109748	2:22:00 PM	6-Jun	16:00	4:22:00 PM	1.76	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.chal	109748	3:22:00 PM	6-Jun	17:00	5:22:00 PM	0.34	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.chal	109748	4:22:00 PM	6-Jun	18:00	6:22:00 PM	0.22	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.chal	109748	5:22:00 PM	6-Jun	19:00	7:22:00 PM	0.24	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.chal	109748	6:22:00 PM	6-Jun	20:00	8:22:00 PM	0.21	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.chal	109748	7:22:00 PM	6-Jun	21:00	9:22:00 PM	0.24	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.chal	109748	8:22:00 PM	6-Jun	22:00	10:22:00 PM	0.43	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.chal	109748	9:22:00 PM	6-Jun	23:00	11:22:00 PM	0.3	
mozart	192.168.(	109.228.162	SE	Sweden	Vastra Gotaland	Göteborg	www.goo	41521	10:22:00 AM	6-Jun	12:00	12:22:00 PM	0.41	

SITE8: SPSS Report for Compare Means with 95% Confidence Interval and bootstrap

Mean

	Statistic	Bootstrap[a]			
		Bias	Std. Error	95% Confidence Interval	
				Lower	Upper
google	.3558	-.0055	.1237	.2009	.6282
volvo1	.8875	-.0022	.0592	.7850	1.0150
akamai	.3408	-.0034	.0605	.2325	.4658

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Below is the snapshot of the results from SITE9.

Host	Host IP	External IP	Country Code	Country Name	Region Name	City	Req	Bytes Read	Time of Req	Date of Req	Local Hour	Local Time of Req	Req RT	Req Note
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	secure4.v	9886	6:11:00 PM	11-Jun	20:00	8:11:00 PM	1.45	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	secure4.v	9886	7:11:00 PM	11-Jun	21:00	9:11:00 PM	0.22	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	secure4.v	9886	8:11:00 PM	11-Jun	22:00	10:11:00 PM	0.2	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	secure4.v	9886	9:11:00 PM	11-Jun	23:00	11:11:00 PM	0.2	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	secure4.v	9886	7:05:00 PM	13-Jun	21:00	9:05:00 PM	0.35	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	secure4.v	9886	8:05:00 PM	13-Jun	22:00	10:05:00 PM	0.2	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	secure4.v	9886	9:05:00 PM	13-Jun	23:00	Akamai	0.18	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	secure4.v	9886	10:05:00 PM	14-Jun	0:00	12:05:00 AM	0.19	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	secure4.v	9886	11:05:00 PM	14-Jun	1:00	1:05:00 AM	0.2	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	secure4.v	9886	12:05:00 AM	14-Jun	2:00	2:05:00 AM	0.19	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	secure4.v	9886	1:05:00 AM	14-Jun	3:00	3:05:00 AM	0.17	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.aka	32427	6:11:00 PM	11-Jun	20:00	8:11:00 PM	0.38	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.aka	32427	7:11:00 PM	11-Jun	21:00	9:11:00 PM	0.35	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.aka	32427	8:11:00 PM	11-Jun	22:00	10:11:00 PM	0.48	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.aka	32427	9:11:00 PM	11-Jun	23:00	11:11:00 PM	0.34	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.aka	32261	7:05:00 PM	13-Jun	21:00	9:05:00 PM	0.6	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.aka	32261	8:05:00 PM	13-Jun	22:00	10:05:00 PM	0.32	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.aka	32261	9:05:00 PM	13-Jun	23:00	11:05:00 PM	0.7	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.aka	32261	10:05:00 PM	14-Jun	0:00	12:05:00 AM	0.7	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.aka	32261	11:05:00 PM	14-Jun	1:00	1:05:00 AM	0.34	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.aka	32261	12:05:00 AM	14-Jun	2:00	2:05:00 AM	0.35	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.aka	32261	1:05:00 AM	14-Jun	3:00	3:05:00 AM	0.28	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.chal	109772	6:11:00 PM	11-Jun	20:00	8:11:00 PM	0.24	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.chal	109772	7:11:00 PM	11-Jun	21:00	9:11:00 PM	0.23	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.chal	109772	8:11:00 PM	11-Jun	22:00	10:11:00 PM	0.22	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.chal	109772	9:11:00 PM	11-Jun	23:00	11:11:00 PM	0.34	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.chal	109817	7:05:00 PM	13-Jun	21:00	9:05:00 PM	1.83	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.chal	109817	8:05:00 PM	13-Jun	22:00	10:05:00 PM	2.15	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.chal	109817	9:05:00 PM	13-Jun	23:00	11:05:00 PM	1.82	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.chal	109901	10:05:00 PM	14-Jun	0:00	12:05:00 AM	5.37	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.chal	109901	11:05:00 PM	14-Jun	1:00	1:05:00 AM	1.83	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.chal	109901	12:05:00 AM	14-Jun	2:00	2:05:00 AM	2.13	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.chal	109901	1:05:00 AM	14-Jun	3:00	3:05:00 AM	1.76	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.goo	41953	6:11:00 PM	11-Jun	20:00	8:11:00 PM	0.18	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.goo	41953	7:11:00 PM	11-Jun	21:00	9:11:00 PM	0.16	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.goo	41953	8:11:00 PM	11-Jun	22:00	10:11:00 PM	0.17	
Ida-Dator	192.168.1	217.208.132	SE	Sweden	Vastra Gotalan	Göteborg	www.goo	41953	9:11:00 PM	11-Jun	23:00	11:11:00 PM	0.17	

SITE9: SPSS Report for Compare Means with 95% Confidence Interval and bootstrap

Mean

	Statistic	Bootstrap[a]			
		Bias	Std. Error	95% Confidence Interval	
				Lower	Upper
google	.1618	.0001	.0026	.1573	.1673
volvo1	.7182	.0009	.0186	.6864	.7591
akamai	.4400	-.0021	.0444	.3573	.5336

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

PHASE2 Results

Full results of PHASE2 are available **online**.

Below is the snapshot of the results from SITE1.

Host	Host IP	External IP	Country Code	Country Name	Region Name	City	Req	Bytes Read	Time of Req	Date of Req	Local Time of Req	Req RT	Req Note
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294358	12:57:00 AM	2-Jul	8:57	0.57	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294310	1:11:00 AM	2-Jul	9:11	0.83	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294298	1:22:00 AM	2-Jul	9:22	0.66	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294262	1:26:00 AM	2-Jul	9:26	0.61	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294346	1:37:00 AM	2-Jul	9:37	0.79	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294298	1:42:00 AM	2-Jul	9:42	0.58	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294322	1:52:00 AM	2-Jul	9:52	0.81	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294274	1:56:00 AM	2-Jul	9:56	0.54	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294310	2:09:00 AM	2-Jul	10:09	0.65	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294262	2:11:00 AM	2-Jul	10:11	0.37	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294274	2:22:00 AM	2-Jul	10:22	0.58	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294298	2:26:00 AM	2-Jul	10:26	0.65	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294358	2:37:00 AM	2-Jul	10:37	0.59	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294286	2:41:00 AM	2-Jul	10:41	0.44	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294322	2:52:00 AM	2-Jul	10:52	2.91	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294346	2:56:00 AM	2-Jul	10:56	0.67	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294310	3:07:00 AM	2-Jul	11:07	0.63	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294310	3:12:00 AM	2-Jul	11:12	0.89	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294298	3:22:00 AM	2-Jul	11:22	1.74	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294298	3:26:00 AM	2-Jul	11:26	0.72	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294286	3:37:00 AM	2-Jul	11:37	2.88	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294298	3:41:00 AM	2-Jul	11:41	1.89	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294286	3:52:00 AM	2-Jul	11:52	0.89	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294298	3:56:00 AM	2-Jul	11:56	0.71	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294298	4:07:00 AM	2-Jul	12:07	0.91	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294322	4:11:00 AM	2-Jul	12:11	0.71	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294298	4:22:00 AM	2-Jul	12:22	0.9	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294274	4:27:00 AM	2-Jul	12:27	0.85	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294322	4:37:00 AM	2-Jul	12:37	0.93	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294286	4:43:00 AM	2-Jul	12:43	1	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294298	4:52:00 AM	2-Jul	12:52	0.9	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294334	4:56:00 AM	2-Jul	12:56	1.9	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294262	5:07:00 AM	2-Jul	13:07	0.88	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294274	5:11:00 AM	2-Jul	13:11	1.56	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294334	5:22:00 AM	2-Jul	13:22	0.89	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294286	5:26:00 AM	2-Jul	13:26	0.72	
dell-e668e2e	10.101.131.201	182.245.68.4	CN	China	Yunnan	Kunming	google.com	294358	5:38:00 AM	2-Jul	13:38	0.88	

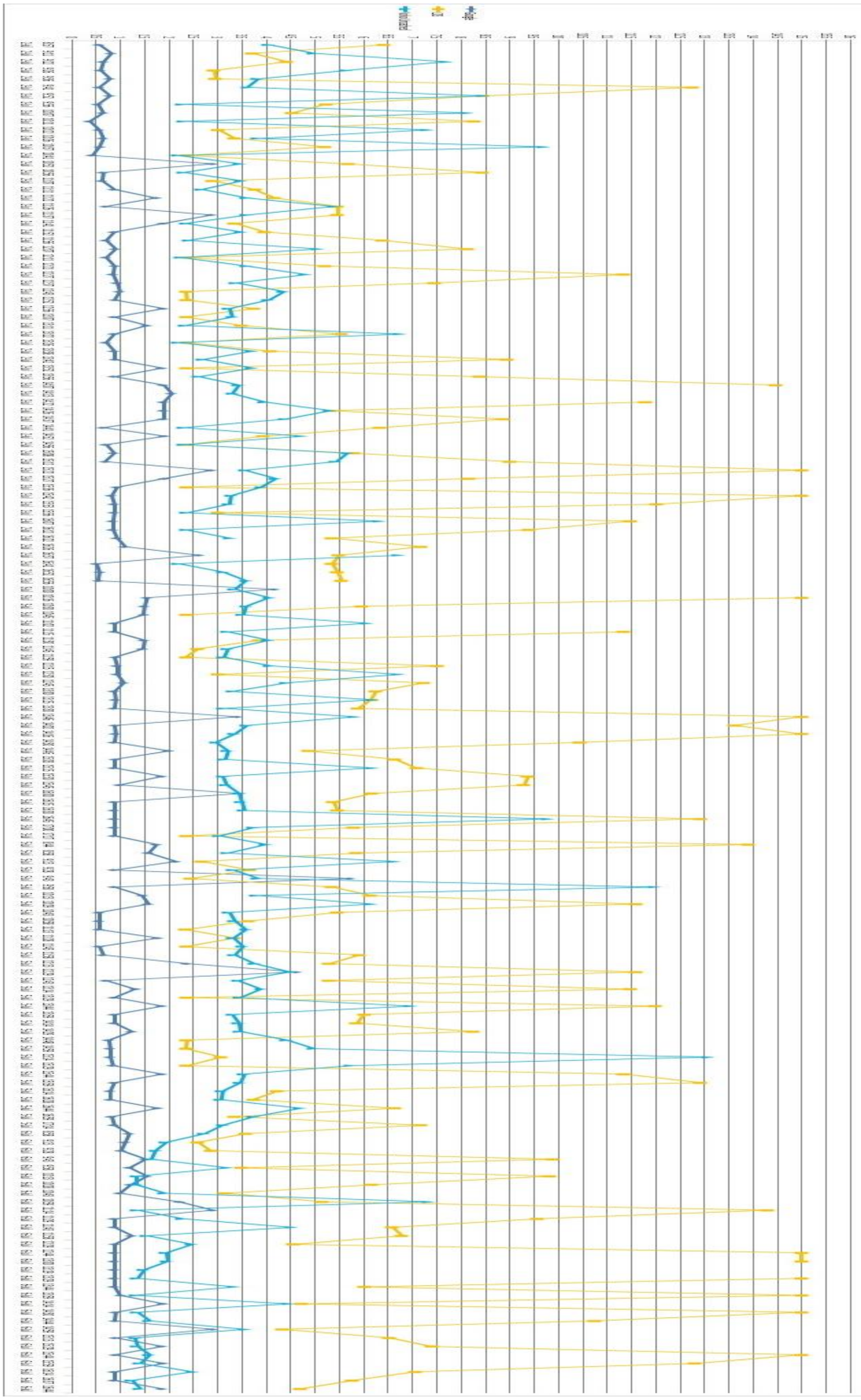
SITE1: SPSS Report for Compare Means with 95% Confidence Interval and bootstrap

Mean

	Statistic	Bootstrap[a]			
		Bias	Std. Error	95% Confidence Interval	
				Lower	Upper
google	1.2252	.0016	.0619	1.1112	1.3621
volvo2	3.8064	-.0028	.1481	3.5131	4.0912
LDS	6.7294	.0165	.3137	6.1322	7.4112

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Complete graph based on the total results from SITE1 is given below and can be found **online**.



Below is the snapshot of the results from SITE2.

Host	Host IP	External IP	Country Code	Country Name	Region Name	City	Req	Bytes Read	Time of Req	Date of Req	Local Time of Req	Req RT	Req Note
dell-pc1	10.101.12	183.2.145.105	CN	China	Guangdong	Guangzho	google.co	294286	3:26:00 AM	5-Jul	11:26	0.25	
dell-pc1	10.101.12	183.2.145.105	CN	China	Guangdong	Guangzho	google.co	294274	3:41:00 AM	5-Jul	11:41	0.2	
dell-pc1	10.101.12	183.2.145.105	CN	China	Guangdong	Guangzho	google.co	294262	3:56:00 AM	5-Jul	11:56	0.22	
dell-pc1	10.101.12	183.2.145.105	CN	China	Guangdong	Guangzho	google.co	294286	4:11:00 AM	5-Jul	12:11	0.2	
dell-pc1	10.101.12	183.2.145.105	CN	China	Guangdong	Guangzho	google.co	294274	4:26:00 AM	5-Jul	12:26	0.2	
dell-pc1	10.101.12	183.2.145.105	CN	China	Guangdong	Guangzho	google.co	294274	4:42:00 AM	5-Jul	12:42	0.23	
dell-pc1	10.101.12	183.2.145.105	CN	China	Guangdong	Guangzho	google.co	294286	4:57:00 AM	5-Jul	12:57	0.38	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294274	4:33:00 AM	9-Jul	12:33	0.18	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294262	4:47:00 AM	9-Jul	12:47	0.98	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294286	5:02:00 AM	9-Jul	13:02	0.21	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294274	5:17:00 AM	9-Jul	13:17	9.85	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294286	5:32:00 AM	9-Jul	13:32	0.77	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294274	5:47:00 AM	9-Jul	13:47	0.2	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294286	6:02:00 AM	9-Jul	14:02	0.26	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294334	6:17:00 AM	9-Jul	14:17	1.58	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294274	6:33:00 AM	9-Jul	14:33	0.52	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294298	6:47:00 AM	9-Jul	14:47	2.42	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294274	7:02:00 AM	9-Jul	15:02	1.27	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294274	7:17:00 AM	9-Jul	15:17	0.21	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294262	7:32:00 AM	9-Jul	15:32	0.23	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294274	7:48:00 AM	9-Jul	15:48	0.29	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294286	8:02:00 AM	9-Jul	16:02	0.56	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294286	8:17:00 AM	9-Jul	16:17	0.26	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294286	8:32:00 AM	9-Jul	16:32	0.21	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294286	8:47:00 AM	9-Jul	16:47	0.26	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294250	9:02:00 AM	9-Jul	17:02	0.2	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294322	9:17:00 AM	9-Jul	17:17	0.55	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294298	9:33:00 AM	9-Jul	17:33	0.23	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294310	9:47:00 AM	9-Jul	17:47	0.29	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294298	10:02:00 AM	9-Jul	18:02	3.16	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294256	10:17:00 AM	9-Jul	18:17	0.42	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294298	10:32:00 AM	9-Jul	18:32	0.36	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294250	10:47:00 AM	9-Jul	18:47	0.2	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294274	11:02:00 AM	9-Jul	19:02	0.28	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294262	11:17:00 AM	9-Jul	19:17	0.2	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294334	11:32:00 AM	9-Jul	19:32	0.2	
dell-pc1	10.101.12	113.119.130.150	CN	China	Guangdong	Guangzho	google.co	294292	11:47:00 AM	9-Jul	19:47	0.27	

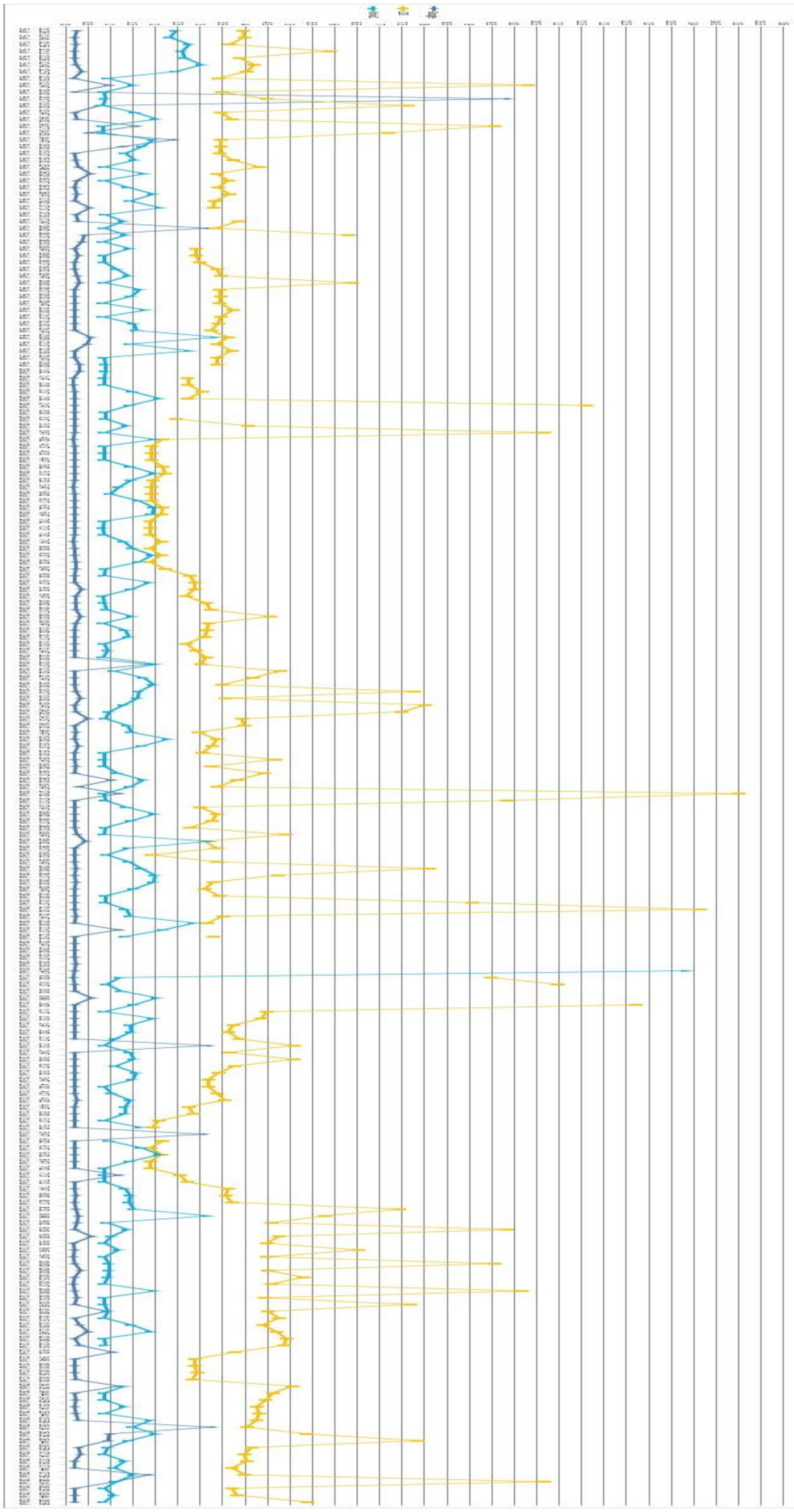
SITE2: SPSS Report for Compare Means with 95% Confidence Interval and bootstrap

Mean

	Statistic	Bootstrap[a]			
		Bias	Std. Error	95% Confidence Interval	
				Lower	Upper
google	.4088	.0009	.0580	.3128	.5468
volvo2	1.3724	-.0013	.0375	1.2970	1.4474
LDS	4.2475	-.0012	.1674	3.9172	4.5896

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Complete graph based on the total results from SITE2 is given below and can be found **online**.



Below is the snapshot of the results from SITE3.

Host	Host IP	External IP	Country Code	Country Name	Region Name	City	Req	Bytes Read	Time of Req	Date of Req	Local Time of Req	Req RT	Req Note
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294276	7:31:00 AM	11-Jul	15:31	0.47	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294312	7:33:00 AM	11-Jul	15:33	0.87	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294372	12:42:00 AM	12-Jul	8:42	0.38	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294300	12:57:00 AM	12-Jul	8:57	1.07	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	296301	1:12:00 AM	12-Jul	9:12	0.37	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	296361	1:27:00 AM	12-Jul	9:27	0.37	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	296373	1:42:00 AM	12-Jul	9:42	0.4	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	296301	1:58:00 AM	12-Jul	9:58	1.27	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	296289	2:12:00 AM	12-Jul	10:12	0.37	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	296337	2:27:00 AM	12-Jul	10:27	1.92	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	296313	2:42:00 AM	12-Jul	10:42	0.92	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	296325	2:57:00 AM	12-Jul	10:57	0.42	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294147	3:48:00 AM	13-Jul	11:48	0.51	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294099	4:03:00 AM	13-Jul	12:03	0.52	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294141	4:18:00 AM	13-Jul	12:18	0.48	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294159	4:33:00 AM	13-Jul	12:33	2.02	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294123	4:48:00 AM	13-Jul	12:48	0.46	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294135	5:03:00 AM	13-Jul	13:03	0.41	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294147	5:18:00 AM	13-Jul	13:18	0.4	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294111	5:33:00 AM	13-Jul	13:33	0.38	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294135	5:48:00 AM	13-Jul	13:48	0.39	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294183	6:03:00 AM	13-Jul	14:03	0.38	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294135	6:18:00 AM	13-Jul	14:18	0.66	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294129	6:33:00 AM	13-Jul	14:33	0.4	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294135	6:48:00 AM	13-Jul	14:48	0.64	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294135	7:03:00 AM	13-Jul	15:03	0.64	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294135	7:18:00 AM	13-Jul	15:18	0.7	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294147	7:33:00 AM	13-Jul	15:33	0.56	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294123	7:48:00 AM	13-Jul	15:48	0.45	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294111	8:03:00 AM	13-Jul	16:03	1.25	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294099	8:18:00 AM	13-Jul	16:18	0.6	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294111	8:33:00 AM	13-Jul	16:33	1.49	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294123	1:25:00 AM	16-Jul	9:25	0.53	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294123	2:48:00 AM	16-Jul	10:48	0.38	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294135	3:01:00 AM	16-Jul	11:01	0.36	
liying	192.168.(	58.32.219.222	CN	China	Shanghai	Shanghai	google.co	294147	3:31:00 AM	16-Jul	11:31	0.41	

SITE3: SPSS Report for Compare Means with 95% Confidence Interval and bootstrap

Mean

	Statistic	Bootstrap[a]			
		Bias	Std. Error	95% Confidence Interval	
				Lower	Upper
google	.6420	.0007	.0520	.5484	.7586
volvo2	1.6491	-.0028	.0796	1.4989	1.8111
LDS	2.7605	-.0039	.1250	2.5230	3.0300

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Below is the snapshot of the results from SITE4.

Host	Host IP	External IP	Country Code	Country Name	Region Name	City	Req	Bytes Read	Time of Req	Date of Req	Local Time of Req	Req RT	Req Note
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294286	9:15:00 AM	9-Jul	17:15	0.88	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294274	9:30:00 AM	9-Jul	17:30	1.02	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294324	4:35:00 AM	11-Jul	12:35	1	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294348	4:50:00 AM	11-Jul	12:50	0.84	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294336	5:05:00 AM	11-Jul	13:05	0.65	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	296385	1:21:00 AM	12-Jul	9:21	0.97	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	296313	1:36:00 AM	12-Jul	9:36	1.01	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	296301	1:51:00 AM	12-Jul	9:51	1.06	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	296301	2:06:00 AM	12-Jul	10:06	0.74	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	296397	2:21:00 AM	12-Jul	10:21	1.13	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	296325	2:36:00 AM	12-Jul	10:36	0.74	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	296301	2:51:00 AM	12-Jul	10:51	0.61	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	296289	3:06:00 AM	12-Jul	11:06	1.62	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	297275	3:21:00 AM	12-Jul	11:21	0.61	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	296325	3:36:00 AM	12-Jul	11:36	0.56	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	296502	12:42:00 AM	13-Jul	8:42	0.57	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	296514	12:57:00 AM	13-Jul	8:57	0.88	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294501	1:12:00 AM	13-Jul	9:12	0.66	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294501	1:27:00 AM	13-Jul	9:27	0.71	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294465	1:42:00 AM	13-Jul	9:42	0.65	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294501	1:57:00 AM	13-Jul	9:57	0.95	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294159	2:12:00 AM	13-Jul	10:12	0.95	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294195	2:27:00 AM	13-Jul	10:27	0.57	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294099	2:42:00 AM	13-Jul	10:42	0.57	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294135	2:57:00 AM	13-Jul	10:57	1.1	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	google.co	294111	3:12:00 AM	13-Jul	11:12	0.61	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	origin-ww		9:15:00 AM	9-Jul	17:15		WebExcept
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	origin-ww		9:30:00 AM	9-Jul	17:30		WebExcept
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	origin-ww	111899	4:35:00 AM	11-Jul	12:35	1.49	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	origin-ww	111899	4:50:00 AM	11-Jul	12:50	0.9	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	origin-ww	111899	5:05:00 AM	11-Jul	13:05	0.9	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	origin-ww	111899	1:21:00 AM	12-Jul	9:21	1.63	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	origin-ww	110830	1:36:00 AM	12-Jul	9:36	1.45	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	origin-ww	110830	1:51:00 AM	12-Jul	9:51	1.5	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	origin-ww	110830	2:06:00 AM	12-Jul	10:06	0.97	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	origin-ww	110830	2:21:00 AM	12-Jul	10:21	2	
zyp	10.101.13	58.49.53.11	CN	China	Hubei	Wuhan	origin-ww	110830	2:36:00 AM	12-Jul	10:36	0.83	

SITE4: SPSS Report for Compare Means with 95% Confidence Interval and bootstrap

Mean

	Statistic	Bootstrap[a]			
		Bias	Std. Error	95% Confidence Interval	
				Lower	Upper
google	.8877	.0028	.0787	.7454	1.0600
volvo2	1.2938	-.0010	.1167	1.0754	1.5262
LDS	2.8585	-.0009	.0501	2.7569	2.9615

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples