

CHAPTER IV

THE EXPERIMENTS FOR THREE NETWORK MODELS

4.1 Introduction

This chapter explains the factors and the experiments of three network models, in order to test and compare the performance in response time of the World Wide Web usage.

The commonly used factors to evaluate Web caching policies [6] are listed as the follow;

1. Hit rate

The hit rate is generally a percentage ratio of documents obtained through using the cache size versus the total document requested. In addition, if measurement focuses on byte transfer efficiency, weighted hit rate is a better performance measurement.

2. Cache size

The Cache size is the ability to cache frequently accessed documents on Internet based on user requests in order to conserve network bandwidth and reduce network response times for users. This is designed of caching for Proxy Server. Proxy server can cache queries for HTTP documents that is relative to Hit rate in the percentage of utilization.

3. Response time /access time

The response time is the time it takes for a user to get a document. There are various patterns as users access. The pattern or model can significantly affect to the performance.

The mentioned factors are tested with three network models in this chapter. The experiment is tested on campus network in Chulalongkorn University with Node A [10]. To understand the experimental network models as shown in the Figure 4.1, 4.2, and 4.3 respectively [7].

4.2 Experimental Information

Three network models use the same configuration of Personal Computer (PC), Server computer and router, except for the network model. The reasons to use the Direct Access model, Single Level model, and Hierarchy Level model that are described later, are explained as following

Technically, Direct Access model is a simple network model, not complicated network, less users and mostly used to be a basic network model in order to compare the performance with another models. It is usually implemented in small or department area within organization. In this experiment, it is used to be a basic network model.

Single Level Model is enhance network model from a basic network model, due to it is implemented to handle a large traffic. It adds a Proxy server designed in the network, in order to store and forward a huge data that are response to users rapidly. Mostly Single Level is designed with a medium or enterprise organization and campus.

Hierarchy Level Model is high performance network model from a basic network model, due to it is implemented with more than one Proxy server depending on the number of users. The Proxy servers within network are work correspond each other likely load balance to handle a huge data. Mostly it implemented in a campus network or enterprise network. It is used to be one model for this experiment. The description of Direct Access, Single Level and Hierarchy Level, are explained more details with a figure.

4.2.1 Direct Access Model

This model supports direct access for Internet using that consists of Personal computer and run a World Wide Web browser application to navigate and test the listed Web sites as shown in the Figure 4.1

4.2.2 Single Level Model

This model supports a one Proxy server that is implement to store and forward the data request from Internet, before direct to Internet. It consists of Personal Computer and run a World Wide Web browser application to navigate and test the listed Web sites as shown in the Figure 4.2

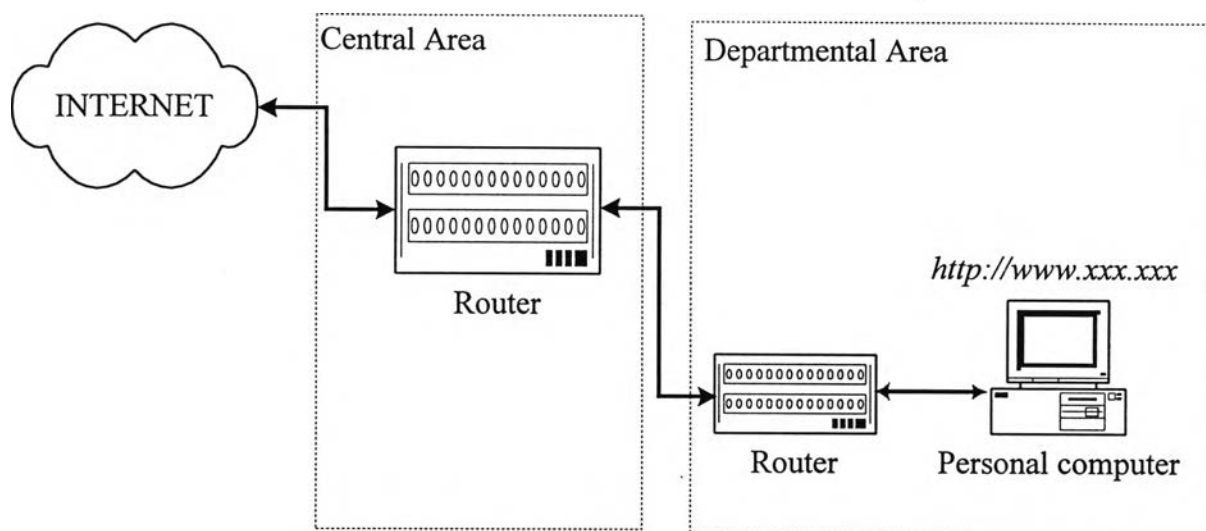


Figure 4.1 Network design of Direct Access Model

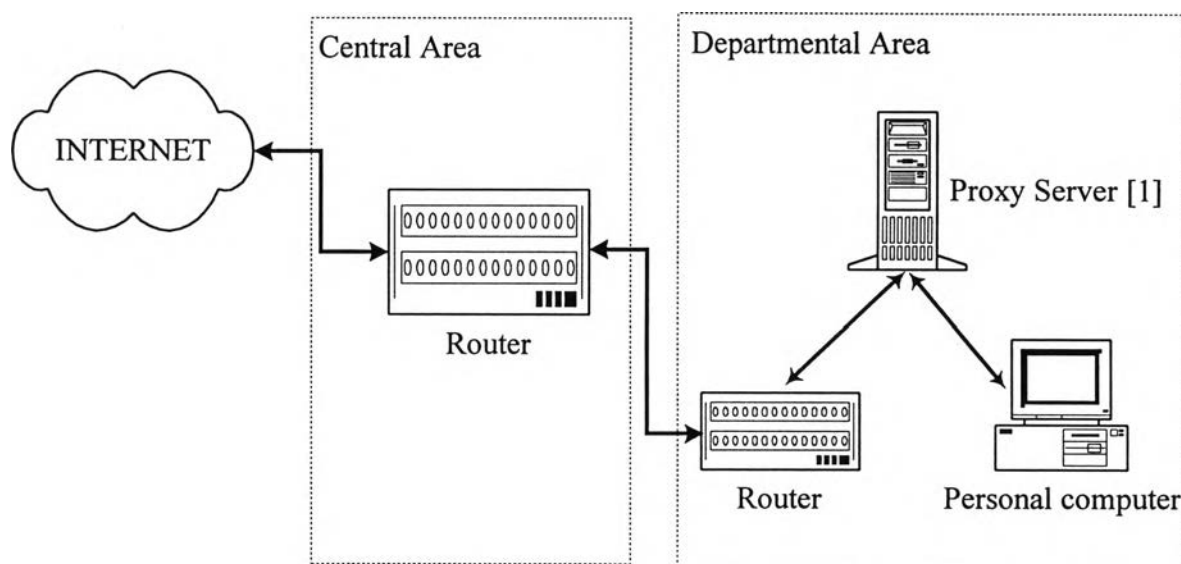


Figure 4.2 Network design of Single Level Model

4.2.3 Hierarchy Level Model

This model supports a one Proxy server implement in network department and the other one a proxy server or cache engine implement in a center office, before direct to Internet. Hierarchy consists of Personal Computer and run a World Wide Web browser application to navigate and test the listed Web sites as shown in the Figure 4.3

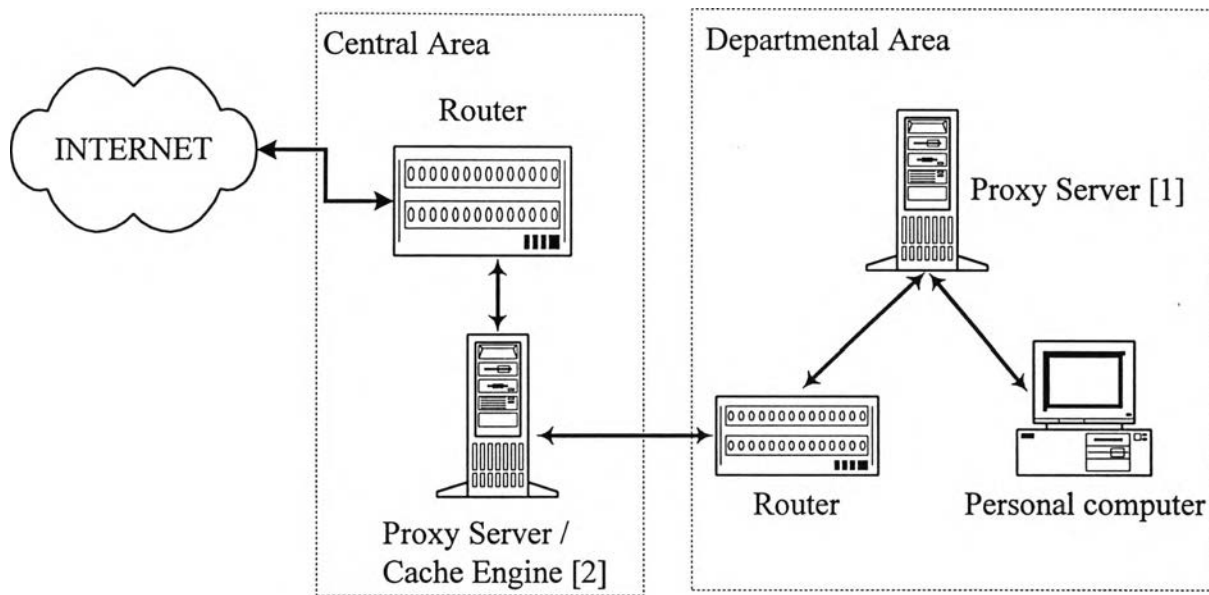


Figure 4.3 Network design for Hierarchy Level Model

4.3 The Objective of this experiment

The objectives of three experimental network models are as follows;

1. Investigate the HTTP packet with the frequent accessed sixteen Web sites at congestion average hourly of Internet utilization in campus network.
2. Investigate the increasing performance in response time of each models
3. Test the hypothesis for a comparison of each models

To investigate and consider the best network model among—Direct access, Single level, and Hierarchy level---. Under the same condition, test through the same Web sites which shown in the Table 4.1

The indicator for consideration of the increasing performance, is *response time*. The response time is a one factor that is mainly described for the service performance of HTTP as the World Wide Web. As a result, which model can perform the traffic of HTTP with the less response time, it is the best model to increase the performance of this experimentation.

Table 4.1 List of sixteen Web sites for this experiment

No.	Web Site
1	.geocities.com
2	.inet.co.th
3	<u>siampage.com</u>
4	*.sanook.com
5	.beseen.com
6	*.phonelink.net
7	*.thaiicq.com
8	.yahoo.com
9	.imgis.com
10	*.bluemountain.com
11	.hunsa.com
12	*.fsn.net
13	microsoft.com
14	*. <u>go.com</u>
15	*.click2net.com
16	*.yumyai.com

4.4 Experimental Variables

There are two variable factors that are present as below;

- 1) Response time: The response time is the time it takes for a user to get a document. There are various patterns as users access. The pattern or model can significantly affect to the performance.

- 2) Network models: Direct Access Model, Single Level model, and Hierarchy Level model that are described previously.

4.5 Data Collection

In order to collect data from the real situation in a campus network, it could not control other factors like the behavior of each user who uses World Wide Web in various times. Practically the data collection process is independent between group of Samples among Direct Access, Single Level and Hierarchy Level models. They are not depending on a user, time to navigate Web sites. There are data collection of three models described as below;

4.5.1 Experiment for Direct Access Model

In the Figure 4.1, it presents how direct access test and experiment in the period of the congestion average at 12:00 a.m. to 4:00 p.m in June 1999. As a result, the testing data is shown in the Table 4.2.

Table 4.2 Testing data of the response time for Direct Access Model

No	Web sites	Frequency														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Response Time (second)														
1	<i>.geocities.com</i>	19	23	22	28	19	16	26	38	18	16	1.04	52	1.06	37	27
2	<i>.inet.co.th</i>	30	17	31	18	18	22	33	20	17	30	22	56	1.08	1.04	28
3	<i>siampage.com</i>	22	39	44	40	40	52	40	35	43	34	47	38	32	33	39
4	<i>*.sanook.com</i>	18	18	27	17	17	27	16	18	30	28	19	28	24	26	22
5	<i>.beseen.com</i>	10	11	9	9	10	14	9	11	15	16	18	11	13	15	12
6	<i>*.phonelink.net</i>	13	12	13	13	13	12	13	14	13	15	16	19	20	22	14
7	<i>*.thaiicq.com</i>	52	1.18	53	1.23	1.1	49	48	51	54	1.08	59	52	47	38	55
8	<i>.yahoo.com</i>	13	22	15	19	20	20	18	21	18	23	22	24	29	35	19
9	<i>.imgis.com</i>	28	15	16	21	57	31	22	34	26	32	38	40	32	35	31
10	<i>*.bluemountain.com</i>	1.16	1.14	50	35	45	1.09	49	1.32	41	1.02	49	58	1.03	56	52
11	<i>.hunsa.com</i>	52	40	41	1.02	59	54	1.02	1.02	27	35	1.14	57	52	59	38
12	<i>*.fsn.net</i>	7	13	12	14	15	13	12	13	14	17	18	19	20	28	21
13	<i>microsoft.com</i>	15	21	24	22	18	19	18	21	19	14	22	17	18	25	20
14	<i>*.go.com</i>	14	34	20	27	47	37	42	27	27	33	52	49	47	35	38
15	<i>*.click2net.com</i>	12	17	20	19	19	17	16	16	18	17	22	19	18	26	24
16	<i>*.yumyai.com</i>	14	13	13	14	16	13	14	13	14	14	17	22	18	19	13

4.5.2 Experiment for Single Level Model

In the Figure 4.2, it presents how Single Level test with one Proxy server in order to contain all retrieving data from Internet before response to users and experiment in the period of the congestion average at 12:00 a.m. to 4:00 p.m in June 1999. As a result, the testing data show in the Table 4.3.

Table 4.2 Testing data of the response time for Direct Access Model (cont.)

No	Web sites	Frequency														
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		Response Time (second)														
1	<i>.geocities.com</i>	27	32	1.13	34	25	44	31	23	23	30	28	27	32	31	28
2	<i>.inet.co.th</i>	18	1.38	16	17	13	47	13	1.29	44	1.1	31	32	34	37	40
3	<i>siampage.com</i>	42	50	49	48	41	44	37	33	35	46	42	46	41	39	48
4	<i>*.sanook.com</i>	21	19	27	23	14	15	26	27	28	29	26	27	27	27	24
5	<i>.beseen.com</i>	17	14	16	10	9	12	11	10	13	12	16	14	14	15	16
6	<i>*.phonelink.net</i>	18	17	15	13	14	12	19	22	18	15	15	19	17	15	13
7	<i>*.thaiicq.com</i>	1.13	1.2	48	57	46	35	39	29	55	57	52	47	47	48	51
8	<i>.yahoo.com</i>	27	17	16	18	23	27	33	20	19	25	20	19	22	21	22
9	<i>.imgis.com</i>	29	26	25	18	45	46	37	29	22	27	32	31	32	33	30
10	<i>*.bluemountain.com</i>	42	48	47	55	1.1	54	57	45	39	55	1.1	59	1.2	48	59
11	<i>.hunsa.com</i>	39	55	52	47	49	48	338	51	59	1.02	35	37	41	41	42
12	<i>*.fsn.net</i>	16	14	17	19	24	13	15	14	16	13	13	14	15	13	14
13	<i>microsoft.com</i>	21	17	28	16	27	19	24	22	21	27	21	20	19	23	22
14	<i>*.go.com</i>	30	46	27	29	28	22	30	27	37	32	28	27	29	31	26
15	<i>*.click2net.com</i>	30	17	19	22	20	24	21	20	17	18	18	19	17	19	21
16	<i>*.yumyai.com</i>	16	14	14	15	16	27	32	27	14	13	13	14	13	14	13

Table 4.2 Testing data of the response time for Direct Access Model (cont.)

No	Web Sites	Frequency										
		31	32	33	34	35	36	37	38	39	40	41
		Response Time (second)										
1	<i>.geocities.com</i>	27	27	26	24	28	29	32	30	27	27	27
2	<i>.inet.co.th</i>	45	40	31	37	39	35	42	39	56	1.2	1.1
3	<i>Siampage.com</i>	45	39	41	50	49	43	47	41	43	42	43
4	<i>*.sanook.com</i>	21	20	27	23	32	27	28	27	26	23	24
5	<i>.beseen.com</i>	14	12	29	14	13	14	13	11	14	16	14
6	<i>*.phonelink.net</i>	12	16	15	15	15	17	16	18	15	15	17
7	<i>*.thaiicq.com</i>	57	53	56	49	55	58	58	58	55	56	52
8	<i>.yahoo.com</i>	21	20	23	19	22	18	19	22	21	22	22
9	<i>.imgis.com</i>	31	32	34	29	27	32	30	29	27	19	32
10	<i>*.bluemountain.com</i>	58	1.1	1.02	59	1.1	57	1.1	1.15	1.28	59	57
11	<i>.hunsa.com</i>	47	40	52	41	43	44	45	42	40	58	59
12	<i>*.fsn.net</i>	11	13	13	13	14	15	16	13	11	13	13
13	<i>Microsoft.com</i>	21	25	22	24	22	22	21	21	21	22	20
14	<i>*.go.com</i>	27	32	28	27	29	38	28	26	31	29	27
15	<i>*.click2net.com</i>	21	17	18	17	17	17	17	18	17	16	15
16	<i>*.yumyai.com</i>	13	12	13	14	13	11	17	13	13	15	13

Table 4.3 Testing data of the response time for Single Level Model

No	Web sites	Frequency														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Response Time (second)														
1	<i>.geocities.com</i>	15	15	15	9	8	12	11	11	10	15	16	12	11	10	9
2	<i>.inet.co.th</i>	4	6	4	9	15	6	7	3	10	4	3	4	5	8	10
3	<i>siampage.com</i>	14	15	20	21	20	23	20	17	21	24	22	20	19	21	22
4	<i>*.sanook.com</i>	16	14	12	10	12	15	11	12	21	19	14	13	12	15	12
5	<i>.beseen.com</i>	47	3	4	5	3	2	3	5	4	3	4	3	2	3	4
6	<i>*.phonelink.net</i>	3	3	2	3	3	3	3	2	3	2	2	2	2	3	4
7	<i>*.thaiicq.com</i>	9	3	3	6	4	11	6	2	2	11	10	8	6	4	11
8	<i>.yahoo.com</i>	43	24	15	13	23	11	13	12	21	12	14	12	10	13	11
9	<i>.imgis.com</i>	7	4	4	4	4	5	4	4	3	4	5	5	5	6	5
10	<i>*.bluemountain.com</i>	43	21	8	47	41	24	42	42	40	39	28	25	24	30	29
11	<i>.hunsa.com</i>	58	55	39	31	32	36	39	48	12	30	28	30	34	32	35
12	<i>*.fsn.net</i>	11	4	7	7	6	3	7	4	6	8	8	8	7	6	5
13	<i>microsoft.com</i>	11	12	14	12	13	15	16	13	12	10	14	15	15	15	15
14	<i>*.go.com</i>	42	23	20	22	24	23	22	25	22	21	22	24	22	22	23
15	<i>*.click2net.com</i>	28	9	12	11	12	11	12	16	13	12	13	11	11	13	15
16	<i>*.yumyai.com</i>	6	9	11	11	8	9	7	8	11	9	9	8	10	7	8

Table 4.3 Testing data of the response time for Single Level Model (cont.)

No	Web sites	Frequency														
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		Response Time (second)														
1	<i>.geocities.com</i>	14	13	15	14	12	11	17	15	13	10	11	15	13	12	11
2	<i>.inet.co.th</i>	9	4	3	6	7	5	3	4	6	4	7	6	4	3	4
3	<i>siampage.com</i>	23	20	21	22	27	21	19	18	17	18	21	21	21	22	20
4	<i>*.sanook.com</i>	14	11	12	10	15	13	12	11	14	10	13	12	14	14	14
5	<i>.beseen.com</i>	5	7	3	4	3	4	3	6	3	8	4	5	7	4	5
6	<i>*.phonelink.net</i>	2	3	4	2	3	3	3	2	2	3	3	5	3	3	3
7	<i>*.thaiicq.com</i>	6	5	4	4	3	2	10	8	3	3	8	7	9	7	7
8	<i>.yahoo.com</i>	11	12	13	13	13	11	10	12	14	12	17	23	21	12	12
9	<i>.imgis.com</i>	4	4	4	4	3	6	5	5	4	5	8	7	4	4	5
10	<i>*.bluemountain.com</i>	40	32	33	25	26	23	31	27	26	35	28	29	28	27	29
11	<i>.hunsa.com</i>	34	36	37	40	38	36	34	35	33	37	34	34	32	36	37
12	<i>*.fsn.net</i>	6	4	6	7	4	6	6	6	4	5	7	8	7	6	9
13	<i>microsoft.com</i>	16	10	11	9	12	13	15	16	12	13	12	14	12	14	12
14	<i>*.go.com</i>	21	22	23	22	22	23	23	25	22	25	22	24	22	23	20
15	<i>*.click2net.com</i>	14	15	13	12	8	10	12	13	15	16	11	12	11	14	11
16	<i>*.yumyai.com</i>	6	4	7	8	5	9	6	7	6	7	8	7	9	9	9

Table 4.3 Testing data of the response time for Single Level Model (cont.)

No	Web Sites	Frequency										
		31	32	33	34	35	36	37	38	39	40	41
		Response Time (second)										
1	<i>.geocities.com</i>	12	14	12	13	11	10	11	15	17	13	14
2	<i>.inet.co.th</i>	3	5	4	4	4	3	6	3	3	4	3
3	<i>Siampage.com</i>	27	21	18	22	21	22	20	21	22	24	20
4	<i>*.sanook.com</i>	15	12	13	16	17	14	13	14	13	14	13
5	<i>.beseen.com</i>	6	4	6	3	2	4	3	4	4	4	4
6	<i>*.phonelink.net</i>	3	2	2	4	3	3	3	3	2	4	2
7	<i>*.thaiicq.com</i>	9	8	8	11	9	9	9	10	8	7	9
8	<i>.yahoo.com</i>	12	21	12	12	11	12	14	13	12	16	12
9	<i>.imgis.com</i>	4	3	4	4	4	6	4	6	4	3	4
10	<i>*.bluemountain.com</i>	28	26	32	29	28	31	29	29	28	27	26
11	<i>.hunsa.com</i>	38	34	32	35	35	35	36	34	33	36	37
12	<i>*.fsn.net</i>	7	7	4	7	7	8	9	7	8	7	8
13	<i>.microsoft.com</i>	13	12	12	13	17	12	12	14	11	13	12
14	<i>*.go.com</i>	20	22	22	22	20	22	23	24	22	22	23
15	<i>*.click2net.com</i>	12	13	11	10	12	11	14	11	15	16	11
16	<i>*.yumyai.com</i>	6	8	8	9	9	8	9	8	8	7	8

4.5.3 Experiment for Hierarchy Level Model

In the Figure 4.3, it presents how Hierarchy Level test with two Proxy servers or cache engine in order to contain all retrieving data from Internet before response to users and experiment in the period of the congestion average at 12:00 a.m. to 4:00 p.m in June 1999.. As a result, the testing data is shown in the Table 4.4.

Table 4.4 Testing data of the response time for Single Level Model

No	Web sites	Frequency														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Response Time (second)														
1	<i>.geocities.com</i>	10	13	28	18	7	2	5	7	18	4	3	2	3	6	10
2	<i>.inet.co.th</i>	2	5	4	9	8	5	6	4	4	8	5	6	4	3	5
3	<i>siampage.com</i>	9	11	15	17	18	20	21	20	23	20	19	21	18	20	14
4	<i>*.sanook.com</i>	12	14	13	13	24	20	10	9	15	17	18	12	15	14	16
5	<i>.beseen.com</i>	29	4	4	3	4	2	3	2	3	3	5	3	6	8	4
6	<i>*.phonelink.net</i>	2	4	3	5	5	3	3	4	3	3	2	3	3	3	4
7	<i>*.thaiicq.com</i>	6	5	3	5	3	8	11	5	6	9	8	7	6	4	11
8	<i>.yahoo.com</i>	32	21	17	15	16	21	20	12	11	12	14	11	11	11	11
9	<i>.imgis.com</i>	4	5	6	4	4	3	3	4	3	4	6	8	5	4	3
10	<i>*.bluemountain.com</i>	32	25	22	23	22	21	30	35	26	40	27	26	25	25	25
11	<i>.hunsa.com</i>	41	30	37	32	28	27	26	38	22	26	28	32	32	32	35
12	<i>*.fsn.net</i>	9	6	5	7	4	3	4	5	6	8	6	8	6	4	3
13	<i>Microsoft.com</i>	8	8	10	9	19	12	14	13	12	11	12	15	12	13	17
14	<i>*.go.com</i>	30	21	20	21	20	22	23	24	22	21	21	25	22	19	22
15	<i>*.click2net.com</i>	21	12	10	13	14	15	12	11	13	12	13	10	11	13	12
16	<i>*.yumyai.com</i>	4	7	10	8	8	9	7	8	9	8	7	8	10	7	8

Table 4.4 Testing data of the response time for Single Level Model (cont.)

No	Web sites	Frequency														
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		Response Time (second)														
1	<i>.geocities.com</i>	2	6	11	11	3	8	11	2	7	8	9	11	12	11	12
2	<i>.inet.co.th</i>	6	7	9	4	12	6	5	4	8	7	4	3	2	4	3
3	<i>siampage.com</i>	22	21	23	22	26	29	19	24	15	21	20	21	21	20	23
4	<i>*.sanook.com</i>	15	10	13	14	16	16	15	13	15	12	14	13	13	13	11
5	<i>.beseen.com</i>	4	4	6	6	5	6	3	5	3	8	4	3	4	4	4
6	<i>*.phonelink.net</i>	2	3	5	6	3	4	3	5	3	4	3	2	2	3	2
7	<i>*.thaiicq.com</i>	5	7	3	2	4	2	10	4	7	4	6	7	6	5	6
8	<i>.yahoo.com</i>	12	13	13	14	15	11	10	12	14	15	11	11	12	11	10
9	<i>.imgis.com</i>	4	3	3	4	3	5	5	5	4	3	3	3	3	3	4
10	<i>*.bluemountain.com</i>	26	25	24	22	20	21	32	28	27	25	24	25	26	25	25
11	<i>.hunsa.com</i>	34	36	37	28	27	24	34	35	33	32	32	32	32	31	32
12	<i>*.fsn.net</i>	4	5	3	4	4	4	6	6	4	4	6	4	6	6	6
13	<i>microsoft.com</i>	16	12	10	13	11	13	15	16	12	11	12	12	12	11	12
14	<i>*.go.com</i>	20	19	22	21	21	23	32	23	24	25	21	24	22	21	20
15	<i>*.click2net.com</i>	14	11	12	13	9	11	9	12	11	11	10	11	11	12	11
16	<i>*.yumyai.com</i>	6	4	6	6	6	8	6	7	8	9	8	7	8	7	8

Table 4.4 Testing data of the response time for Single Level Model (cont.)

No	Web Sites	Frequency										
		31	32	33	34	35	36	37	38	39	40	41
		Response Time (second)										
1	<i>.geocities.com</i>	12	13	12	12	11	10	13	12	11	13	13
2	<i>.inet.co.th</i>	4	4	3	5	3	4	3	4	4	4	4
3	<i>siampage.com</i>	25	20	22	20	21	19	21	21	21	24	21
4	<i>*.sanook.com</i>	15	15	14	15	14	14	16	13	15	14	13
5	<i>.beseen.com</i>	4	4	4	4	4	4	3	2	3	3	4
6	<i>*.phonelink.net</i>	3	2	2	2	2	2	2	3	2	6	3
7	<i>*.thaiicq.com</i>	5	6	6	5	5	6	7	8	6	8	6
8	<i>.yahoo.com</i>	12	11	13	11	11	9	11	12	11	11	13
9	<i>.imgis.com</i>	3	3	3	4	3	3	3	2	3	3	3
10	<i>*.bluemountain.com</i>	24	25	26	25	25	23	27	28	25	26	25
11	<i>.hunsa.com</i>	32	33	30	29	35	38	32	32	32	32	31
12	<i>*.fsn.net</i>	7	5	6	5	5	6	4	6	6	6	4
13	<i>microsoft.com</i>	12	12	13	14	12	12	12	12	14	10	11
14	<i>*.go.com</i>	20	20	20	21	20	20	19	18	20	19	20
15	<i>*.click2net.com</i>	13	11	10	11	11	12	11	11	10	9	10
16	<i>*.yumyai.com</i>	7	8	8	6	7	8	8	8	8	6	8

4.6 Normality Testing

To test hypothesis of testing data between a mean of population, in this case the two groups of population are independent, so it use hypothesis test a form of independent group. If one of two population groups is not normal distribution, it could not to use the T test in normal distribution for these testing data.

Therefore, before decision making of this hypothesis testing it has to test between two populations whether it is normal distribution or not.

4.6.1 The distribution population Testing

Hypothesis setting;

H_0 : Population ditribution is normal

H_1 : Population ditribution is not normal

By using Bowman-Shelton Test, it considers a value of Skewness and Kurtosis in the distribution form, in order to compare a value of B in the following formular;

$$B = \frac{n (\text{Skewness})^2}{6} + \frac{(\text{Kurtosis} - 3)^2}{24}$$

n is a Sample size

Skewness is a bent value of sample distribution as follow

$$\text{Skewness} = \frac{n}{(n-1)(n-2)} \frac{\sum (X - \bar{X})^3}{S}$$

S is standard derivation of sample

$$S = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$

Kurtosis is a height value of sample distribution

$$\text{Kurtosis} = \frac{n(n+1)}{(n-1)(n-2)(n-3)} \frac{\sum (X - \bar{X})^4}{S^2} - \frac{3(n-1)^2}{(n-2)(n-3)}$$

After calculate the B value of each pair models, there are three pairs as Direct Access model / Single Level model, Single Level model / Hierarchy Level model, and Direct Access model / Hierarchy Level model. There are the results of sample data as in 4.6.2



4.6.2 The result of Normality Test

Table 4.5 The result between Direct Access model and Single Level model

Web sites	Direct Access Model			Single Level Model			Distribution
	B	$B\alpha = 0.05$	Result	B	$B\alpha = 0.05$	Result	
<i>.geocities.com</i>	2.987	3.990	Accept H_0	23.597	3.990	Reject H_0	not normal
<i>.inet.co.th</i>	22.719	3.990	Reject H_0	24.291	3.990	Reject H_0	not normal
<i>Siampage.com</i>	7.821	3.990	Reject H_0	3.739	3.990	Accept H_0	not normal
<i>*.sanook.com</i>	26.489	3.990	Reject H_0	9.466	3.990	Reject H_0	not normal
<i>.beseen.com</i>	110.947	3.990	Reject H_0	2118.950	3.990	Reject H_0	not normal
<i>*.phonelink.net</i>	18.308	3.990	Reject H_0	10.449	3.990	Reject H_0	not normal
<i>*.thaiicq.com</i>	22.646	3.990	Reject H_0	29.513	3.990	Reject H_0	not normal
<i>.yahoo.com</i>	10.747	3.990	Reject H_0	221.618	3.990	Reject H_0	not normal
<i>.imgis.com</i>	5.257	3.990	Reject H_0	13.375	3.990	Reject H_0	not normal
<i>*.bluemountain</i>	38.940	3.990	Reject H_0	3.127	3.990	Accept H_0	not normal
<i>.hunsa.com</i>	1480.753	3.990	Reject H_0	20.062	3.990	Reject H_0	not normal
<i>*.fsn.net</i>	15.013	3.990	Reject H_0	10.764	3.990	Reject H_0	not normal
<i>microsoft.com</i>	12.984	3.990	Reject H_0	18.869	3.990	Reject H_0	not normal
<i>*.go.com</i>	12.841	3.990	Reject H_0	1248.104	3.990	Reject H_0	not normal
<i>*.click2net.com</i>	13.042	3.990	Reject H_0	279.055	3.990	Reject H_0	not normal
<i>*.yumyai.com</i>	57.379	3.990	Reject H_0	12.320	3.990	Reject H_0	not normal

Table 4.6 The result between Direct Access model and Hierarchy Level model

Web sites	Direct Access Model			Hierarchy Level Model			Distribution
	B	$B\alpha = 0.05$	Result	B	$B\alpha = 0.05$	Result	
<i>.geocities.com</i>	2.987	3.990	Accept H_0	6.451	3.990	Reject H_0	not normal
<i>.inet.co.th</i>	22.719	3.990	Reject H_0	13.224	3.990	Reject H_0	not normal
<i>Siampage.com</i>	7.821	3.990	Reject H_0	5.425	3.990	Reject H_0	not normal
<i>*.sanook.com</i>	26.489	3.990	Reject H_0	13.032	3.990	Reject H_0	not normal
<i>.beseen.com</i>	110.947	3.990	Reject H_0	1510.889	3.990	Reject H_0	not normal
<i>*.phonelink.net</i>	18.308	3.990	Reject H_0	18.548	3.990	Reject H_0	not normal
<i>*.thaiicq.com</i>	22.646	3.990	Reject H_0	13.127	3.990	Reject H_0	not normal
<i>.yahoo.com</i>	10.747	3.990	Reject H_0	135.442	3.990	Reject H_0	not normal
<i>.imgis.com</i>	5.257	3.990	Reject H_0	19.146	3.990	Reject H_0	not normal
<i>*.bluemountain</i>	38.940	3.990	Reject H_0	26.685	3.990	Reject H_0	not normal
<i>.hunsa.com</i>	1480.753	3.990	Reject H_0	11.748	3.990	Reject H_0	not normal
<i>*.fsn.net</i>	15.013	3.990	Reject H_0	15.263	3.990	Reject H_0	not normal
<i>microsoft.com</i>	12.984	3.990	Reject H_0	6.834	3.990	Reject H_0	not normal
<i>*.go.com</i>	12.841	3.990	Reject H_0	39.935	3.990	Reject H_0	not normal
<i>*.click2net.com</i>	13.042	3.990	Reject H_0	129.223	3.990	Reject H_0	not normal
<i>*.yumyai.com</i>	57.379	3.990	Reject H_0	8.529	3.990	Reject H_0	not normal

Table 4.7 The result between Hierarchy Level model and Single Level model

Web sites	Single Level Model			Hierarchy Level Model			Distribution
	B	$B_{\alpha} = 0.05$	Result	B	$B_{\alpha} = 0.05$	Result	
<i>.geocities.com</i>	23.597	3.990	Reject H_0	6.451	3.990	Reject H_0	not normal
<i>.inet.co.th</i>	24.291	3.990	Reject H_0	13.224	3.990	Reject H_0	not normal
<i>Siampage.com</i>	3.739	3.990	Accept H_0	5.425	3.990	Reject H_0	not normal
<i>*.sanook.com</i>	9.466	3.990	Reject H_0	13.032	3.990	Reject H_0	not normal
<i>.beseen.com</i>	2118.950	3.990	Reject H_0	1510.889	3.990	Reject H_0	not normal
<i>*.phonelink.net</i>	10.449	3.990	Reject H_0	18.548	3.990	Reject H_0	not normal
<i>*.thaicq.com</i>	29.513	3.990	Reject H_0	13.127	3.990	Reject H_0	not normal
<i>.yahoo.com</i>	221.618	3.990	Reject H_0	135.442	3.990	Reject H_0	not normal
<i>.imgis.com</i>	13.375	3.990	Reject H_0	19.146	3.990	Reject H_0	not normal
<i>*.bluemountain</i>	3.127	3.990	Accept H_0	26.685	3.990	Reject H_0	not normal
<i>.hunsa.com</i>	20.062	3.990	Reject H_0	11.748	3.990	Reject H_0	not normal
<i>*.fsn.net</i>	10.764	3.990	Reject H_0	15.263	3.990	Reject H_0	not normal
<i>microsoft.com</i>	18.869	3.990	Reject H_0	6.834	3.990	Reject H_0	not normal
<i>*.go.com</i>	1248.104	3.990	Reject H_0	39.935	3.990	Reject H_0	not normal
<i>*.click2net.com</i>	279.055	3.990	Reject H_0	129.223	3.990	Reject H_0	not normal
<i>*.yumyai.com</i>	12.320	3.990	Reject H_0	8.529	3.990	Reject H_0	not normal

From the Table 1, 2, and 3 all cases of testing is not normal distribution at the significant 5 %. The details of normality test of three network models are available [10]. The reason is to use Nonparametric testing that is suitable analysis to fit these data testing.

4.7 Analysis

The distribution of two population is not normal distribution, it is suitable to use Nonparametric Methods and concern the data testing that is independent each other. The Mann-Whitney U Test is the testing to consider two populations that is independent.

4.7.1 Hypothesis Testing

- 1) Hypothesis testing between Direct Access Model and Single Level Model.
For our expectation, Single Level is take response time less than Direct Access.

Hypothesis set;

H_0 : Population distribution between Direct Access Model and Single Level Model is not different

H_1 : Population distribution of Direct Access Model is ship to right hand side of Population distribution of Single Level Model

If the result is accept H_0 . It means that the performance in response time of Direct Access model is same Single Level model. But if the result is reject H_0 , Direct Access model is take response time more than Single Level model or Single Level model is better performance than Direct Access model.

- 2) Hypothesis testing between Hierarchy Level Model and Single Level Model.
For our expectation, Hierarchy Level is take response time less than Single Level

Hypothesis set;

H_0 : Population distribution between Hierarchy Level Model and Single Level Model is not different

H_1 : Population distribution of Single Level Model is ship to right hand side of Population distribution of Hierarchy Level Model

If the result is accept H_0 . It means that the performance in response time of Single Level model is same Hierarchy Level model. But if the result is reject H_0 , Single Level model is take response time more than Hierarchy Level model or Hierarchy Level model is better performance than Single Level model.

- 3) Hypothesis testing between Direct Access Model and Hierarchy Level Model.
For our expectation, Hierarchy Level is take response time less than Direct Access

Hypothesis set;

H_0 : Population distribution between Direct Access Model and Hierarchy Level Model is not different

H_1 : Population distribution of Direct Access Model is ship to right hand side of Population distribution of Hierarchy Level Model

If the result is accept H_0 . It means that the performance in response time of Direct Access model is same Hierarchy Level model. But if the result is reject H_0 , Direct Access model is take response time more than Hierarchy Level model or Hierarchy Level model is better performance than Direct Access model.

Finally, Hierarchy should be the best network model of this experiment while Direct Access takes response time more than both Single Level and Hierarchy Level. Then Single Level takes response time more than Hierarchy Level model.

4.7.2 Testing

For *Mann-Whitney U Test*. It could calculate a U value as following;

$$U = n_1 n_2 + \frac{n_1 (n_1 + 1)}{2} - R_1$$

n_1 is size of sample group 1

n_2 is size of sample group 2

R_1 is Rank Summation of size of sample group 1

The sample size of group 1 assume the population distribution is ship to the right hand side of the population distribution of sample size of group 2

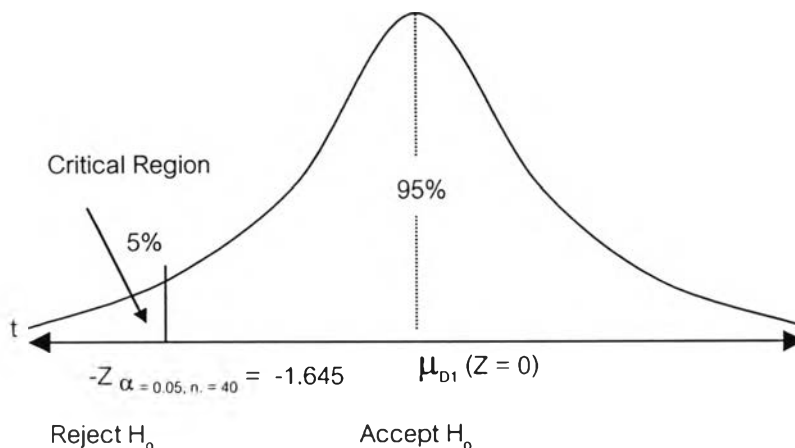
In this experiment, the sample size is about 40 that it could use Z test for U as the follow;

$$Z = \frac{U - \mu_u}{\delta_u}$$

$$\mu_u = \frac{n_1 n_2}{2}$$

$$\delta_u = \sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}}$$

When Z calculated is compared to Z in table at significant level 0.05 that in critical region is over -1.645



4.8 The result of Testing

4.8.1 Direct Access Model / Single Level Model

Testing the difference of population of Direct Access Model and Single Level Model.

(a) To test for each Web sites

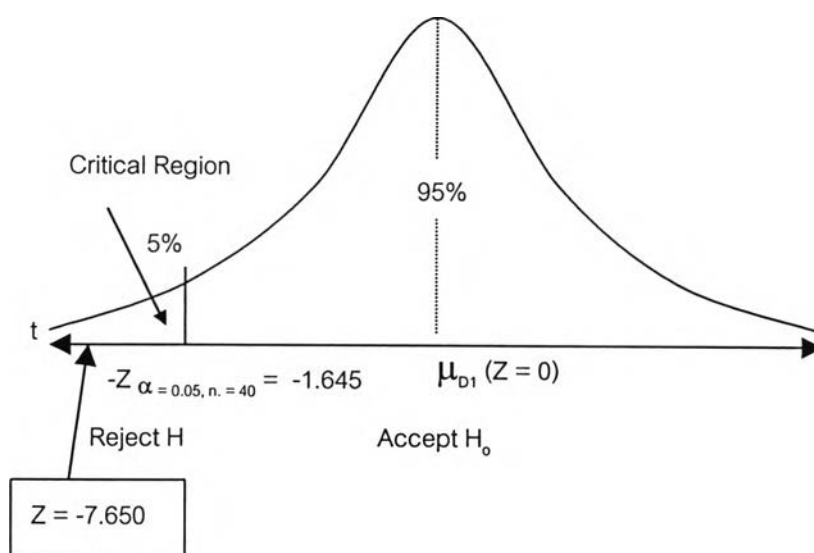
Table 4.8 The different population of Direct Access model and Single Level model

Web Site	Z	$-Z_{\alpha = 0.05}$	Result
<i>.geocities.com</i>	-6.495	-1.645	Reject H_0
<i>.inet.co.th</i>	-5.369	-1.645	Reject H_0
<i>Siampage.com</i>	-7.607	-1.645	Reject H_0
<i>*.sanook.com</i>	-7.303	-1.645	Reject H_0
<i>.beseen.com</i>	-7.313	-1.645	Reject H_0
<i>*.phonelink.net</i>	-7.698	-1.645	Reject H_0
<i>*.thaiicq.com</i>	-5.389	-1.645	Reject H_0
<i>.yahoo.com</i>	-5.644	-1.645	Reject H_0
<i>.imgis.com</i>	-7.698	-1.645	Reject H_0
<i>*.bluemountain</i>	-1.674	-1.645	Reject H_0
<i>.hunsa.com</i>	-4.205	-1.645	Reject H_0
<i>*.fsn.net</i>	-7.539	-1.645	Reject H_0
<i>microsoft.com</i>	-7.477	-1.645	Reject H_0
<i>*.go.com</i>	-6.404	-1.645	Reject H_0
<i>*.click2net.com</i>	-7.082	-1.645	Reject H_0
<i>*.yumyai.com</i>	-7.684	-1.645	Reject H_0

From the Table all Web site reject H_0 that is correspond to our expectation. Single Level Model takes response time less than Direct Access Model. Single Level Model is better performance than Direct Access Model. However there is the overall test for this experiment to confirm the result.

(b) To test for overall Web sites

The overall Web sites test is to calculate Z value that is about -7.650 . Z calculated is less than Z in table at significant 5% shown in the Figure. The result reject H_0 , it means that Single Level Model take less response time than Direct Access Model under our expectation.



4.8.2 Single Level Model / Hierarchy Level Model

Testing the difference of population of Hierarchy Level Model and Single Level Model.

(a) To test for each Web sites

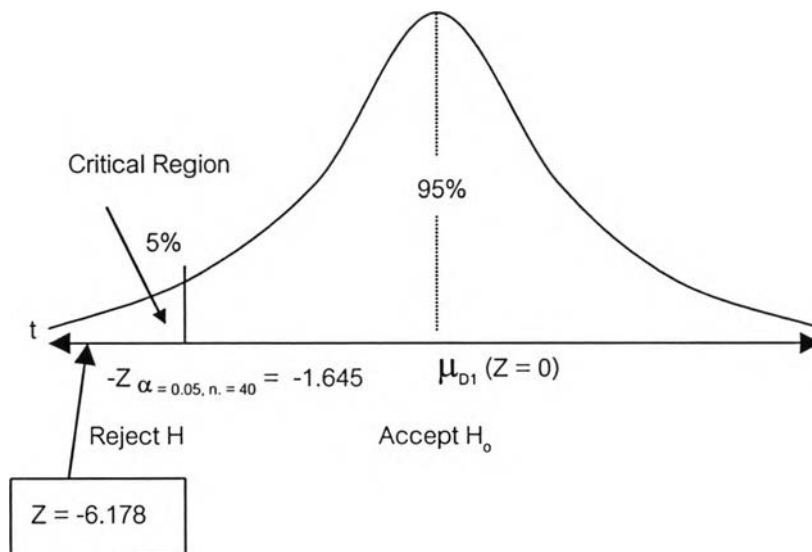
Table 4.9 The different population of Single Level model and Hierarchy Level model

Web Site	Z	$-Z_{\alpha=0.05}$	Result
<i>.geocities.com</i>	-3.685	-1.645	Reject H_0
<i>.inet.co.th</i>	-0.226	-1.645	Accept H_0
<i>Siampage.com</i>	-0.548	-1.645	Accept H_0
<i>*.sanook.com</i>	1.795	-1.645	Accept H_0
<i>.beseen.com</i>	-0.067	-1.645	Accept H_0
<i>*.phonelink.net</i>	0.880	-1.645	Accept H_0
<i>*.thaiicq.com</i>	-1.590	-1.645	Accept H_0
<i>.yahoo.com</i>	-1.766	-1.645	Reject H_0
<i>.imgis.com</i>	-3.406	-1.645	Reject H_0
<i>*.bluemountain</i>	-4.123	-1.645	Reject H_0
<i>.hunsa.com</i>	-3.642	-1.645	Reject H_0
<i>*.fsn.net</i>	-3.358	-1.645	Reject H_0
<i>microsoft.com</i>	-1.665	-1.645	Reject H_0
<i>*.go.com</i>	-2.944	-1.645	Reject H_0
<i>*.click2net.com</i>	-2.083	-1.645	Reject H_0
<i>*.yumyai.com</i>	-1.703	-1.645	Reject H_0

From the Table there are ten Web sites that reject H_0 and six Web sites that accept H_0 . For accepting H_0 , it means that the performance of Single Level model is equal to Hierarchy Level model. For rejecting H_0 , it means that the performance of Single Level model is less than Hierarchy Level model. In order to confirm our expectation, it must test for the overall Web sites.

(b) To test for overall Web sites

The overall Web sites test is to calculate Z value that is about -6.178 . Z calculated is less than Z in table at significant 5% shown in the Figure. The result reject H_0 , it means that Single Level Model take more response time than Hierarchy Level Model under our expectation or Hierarchy Level model takes less response time than Single Level model.



4.8.3 Direct Access Model / Hierarchy Level Model

Testing the difference of population of Hierarchy Level Model and Direct Access Model.

(a) To test for each Web sites

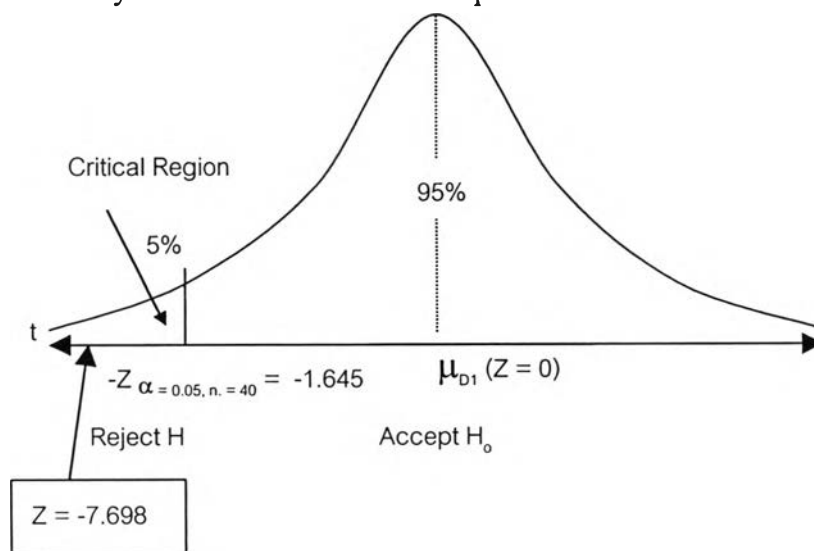
Table 4.10 The different population of Direct Access model and Hierarchy Level model

Web Site	Z	$-Z_{\alpha=0.05}$	Result
<i>.geocities.com</i>	-6.283	-1.645	Reject H_0
<i>.inet.co.th</i>	-5.389	-1.645	Reject H_0
<i>Siampage.com</i>	-7.607	-1.645	Reject H_0
<i>*.sanook.com</i>	-7.053	-1.645	Reject H_0
<i>.beseen.com</i>	-7.318	-1.645	Reject H_0
<i>*.phonelink.net</i>	-7.698	-1.645	Reject H_0
<i>*.thaiicq.com</i>	-5.389	-1.645	Reject H_0
<i>.yahoo.com</i>	-6.625	-1.645	Reject H_0
<i>.imgis.com</i>	-7.698	-1.645	Reject H_0
<i>*.bluemountain</i>	-1.900	-1.645	Reject H_0
<i>.hunsa.com</i>	-5.177	-1.645	Reject H_0
<i>*.fsn.net</i>	-7.660	-1.645	Reject H_0
<i>Microsoft.com</i>	-7.472	-1.645	Reject H_0
<i>*.go.com</i>	-6.495	-1.645	Reject H_0
<i>*.click2net.com</i>	-7.260	-1.645	Reject H_0
<i>*.yumyai.com</i>	-7.698	-1.645	Reject H_0

From the Table all Web sites reject H_0 under our expectation. It means that Direct Access model takes response time more than Hierarchy Level model or Hierarchy Level is better performance than Direct Access model. In order to confirm our expectation, it must test for the overall Web sites.

(b) To test for overall Web sites

The overall Web sites test is to calculate Z value that is about -7.698 . Z calculated is less than Z in table at significant 5% shown in the Figure. The result reject H_0 , it means that Direct Access Model takes more response time than Hierarchy Level Model under our expectation



4.9 Conclusion

Considering the three experimental network models, it summaries as the following:

- 1. Single Level Model takes response time, less than Direct Access model*
- 2. Hierarchy Level Model takes response time, less than Single Level model*
- 3. Hierarchy Level Model take response time, less than Direct Access Model*

Finally, it can conclude in statistic model that Hierarchy Level Model is to be the best increasing performance of HTTP. Because it takes response time less than Single Level model and Direct Access model, under the condition.

Technically, the Hierarchy Level Model implement with two level of Proxy servers and can support the traffic with load balance between two servers.