

Non-Functional Testing – Project
Web application Load and Capacity Test

LOAD AND CAPACITY TEST PLAN AND REPORT

TABLE OF CONTENTS

1. Introduction.....	3
1.1 Purpose of load test	3
1.2 Purpose of capacity test	3
1.3 Test Environment	3
1.4 Test design	3
1.5 Test data	8
1.6 Metrics	10
1.7 Test Cases	10
2. Test Results	12
3. Demonstration of resource utilization	17
4. Analysis and Findings	21
5. Conclusion	21

1 INTRODUCTION

1.1 PURPOSE OF LOAD TEST OF THE WEB APPLICATION

Load testing is a type of performance testing in which the system is tested for real-time load that the system will encounter after going into production. In other words, it is to see how the system will behave when multiple users use it at same time. It will be helpful since the development team will know in advance if the application will be able to work normally under normal and peak load. There are multiple tools available to perform load testing. In this project, we will be using **JMeter** to do load testing by simulating behavior of different number of users trying to use the address-book application at same time and see how changing the number of users impact the resources.

1.2 PURPOSE OF CAPACITY OR VOLUME TESTING

Capacity testing/volume testing is a type of performance testing which determine how many users the application can handle without degrading the performance of the application. This is also called flood testing, since application is subjected to huge volume of data. In other words, the performance of the application will be examined after increasing the volume of data in the database. In our project we will be performing various CRUD commands on the database. CRUD means create, read, update, and delete commands will be used to add any record, read record from database, update any existing record, or delete the existing record. So, objective is to examine the performance of the application when the volume of data is increased in the database.

1.3 TEST ENVIRONMENT

Test environment gives feedback about the quality and behavior of SUT by allowing us to run the test cases. In general, a test environment includes desktop, server, network, OS, hardware, software, browser. For performing the load and volume testing of the application, we are using personal laptop, personal internet, windows 10 OS, Opera web browser, JMeter, Apache tomcat web server, MYSQL community server, My sql connectors, Command prompt to execute SQL queries.

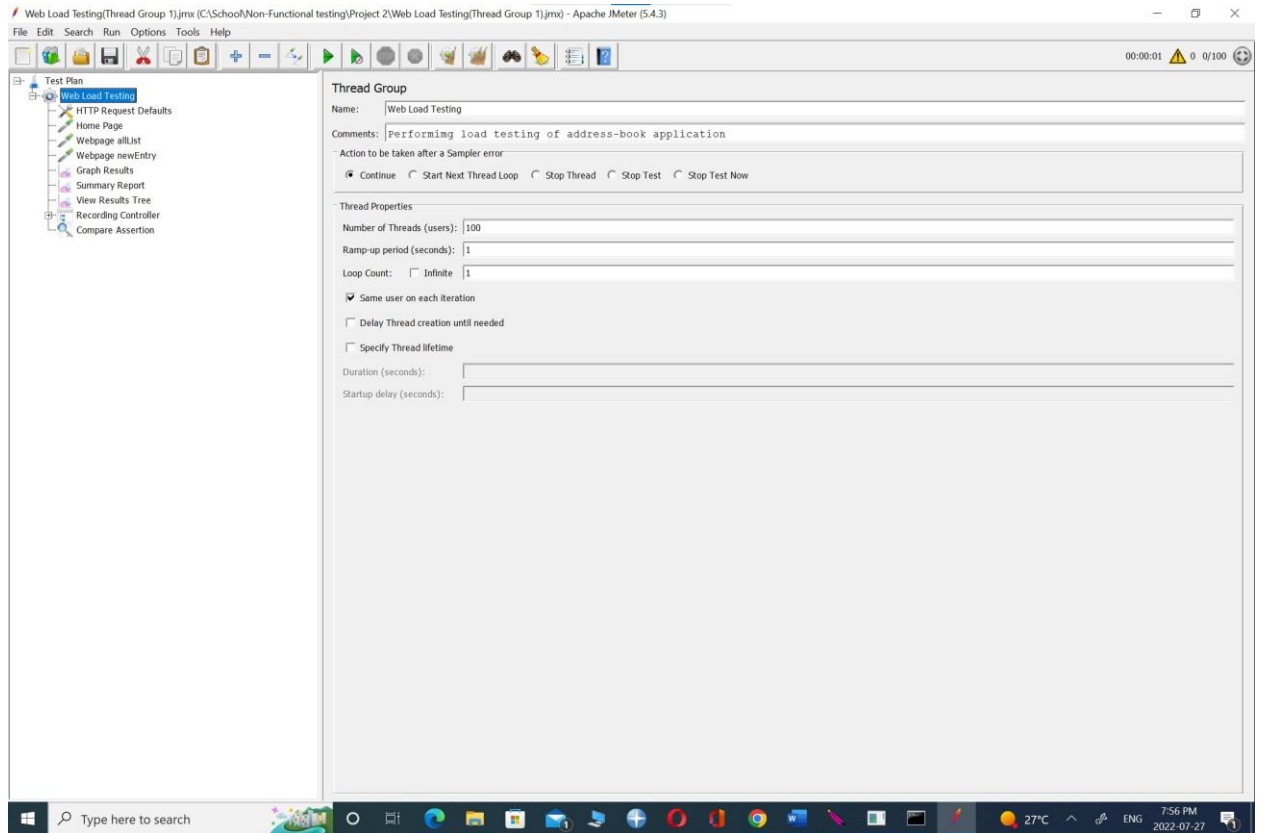
JMeter is a testing tool that will help to make http calls to the application by changing the number of users making calls at a time. Also, it will enable to create JDBC connection to the database and execute various CRUD SQL commands. It allows to view the result in various forms like summary report, Graph results, view result tree and many more.

1.4 TEST DESIGN

To perform the load and volume testing, we used JMeter to create a test plan with two thread group:

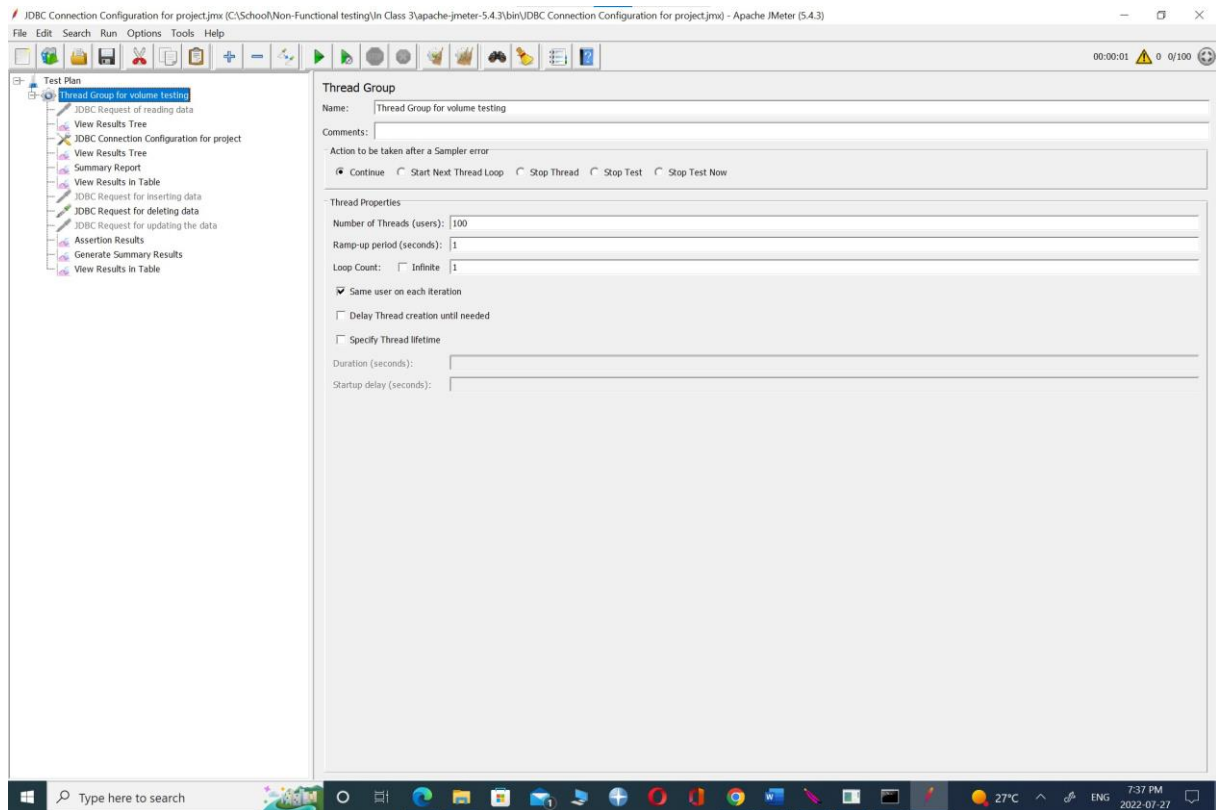
1. **Thread group for web load testing**
2. **Thread group for Volume testing**

1. Thread group for web load testing:



To the Thread group we added, http request, recording controller and assertions. Http request is used to send http requests to webpages of the application: *Home page*, *Webpage allList*, *Webpage newEntry*. We changed the number of users from the Thread properties. Assertions are used to validate the response of the request sent to the server. Added listeners to view the result of the test plan. Recording controller act as a storage for recording steps.

2. Thread group for Volume testing:

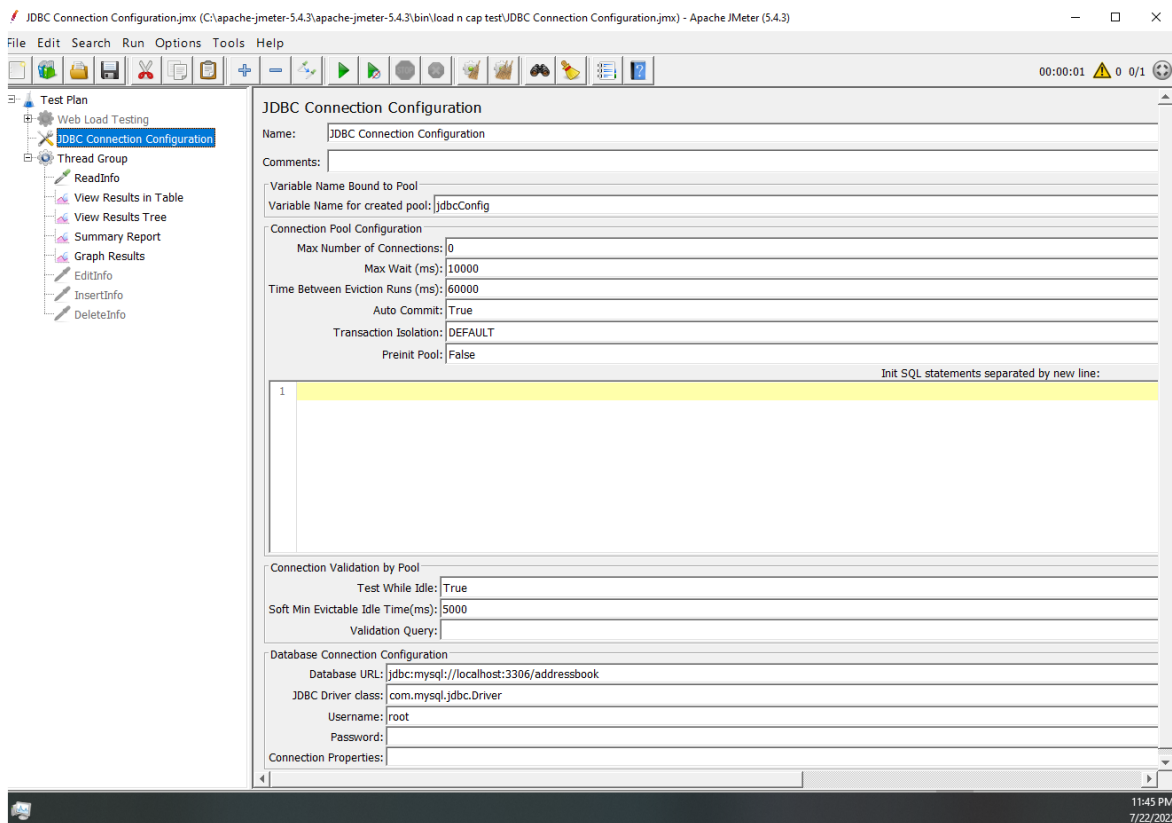


For volume testing, we created JDBC connection to the database using JMeter. The screenshot is provided on the next page.

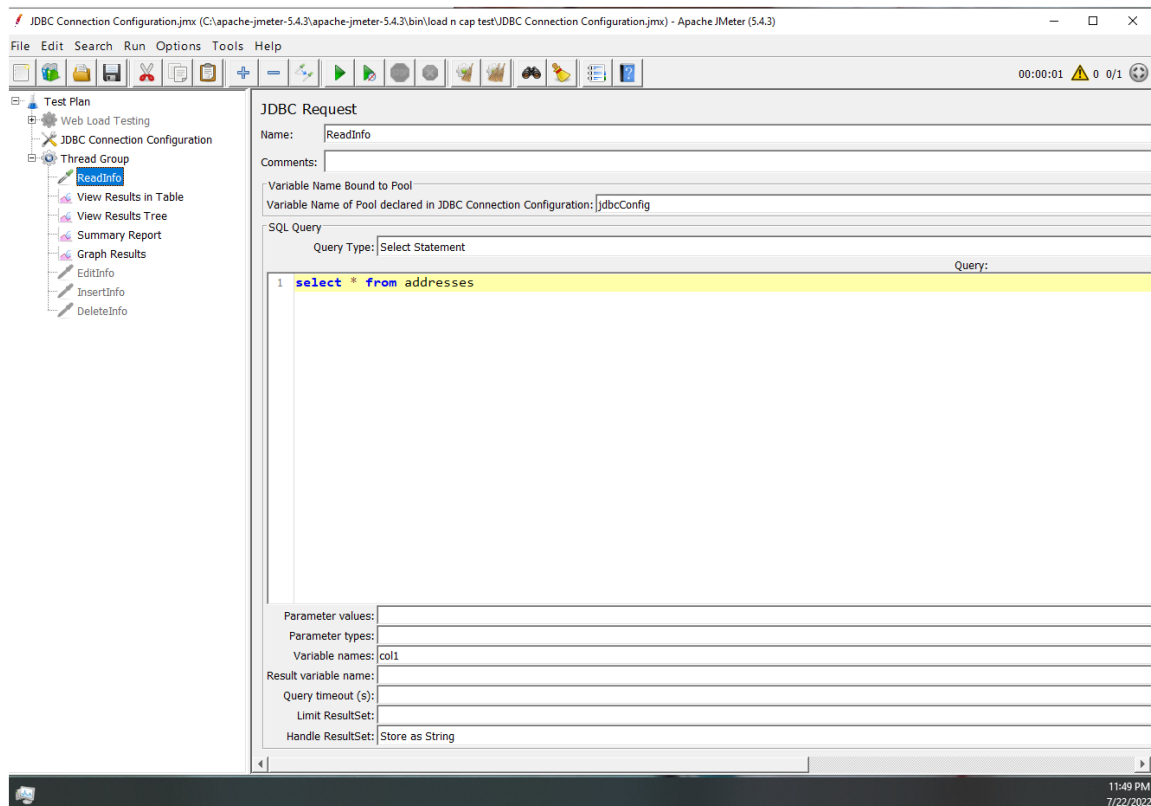
After configuring the JDBC connection, we created JDBC request for different CRUD operations. So, four JDBC requests were created:

- JDBC request for Read.
- JDBC request for Insert.
- JDBC request for Delete.
- JDBC request for Update.

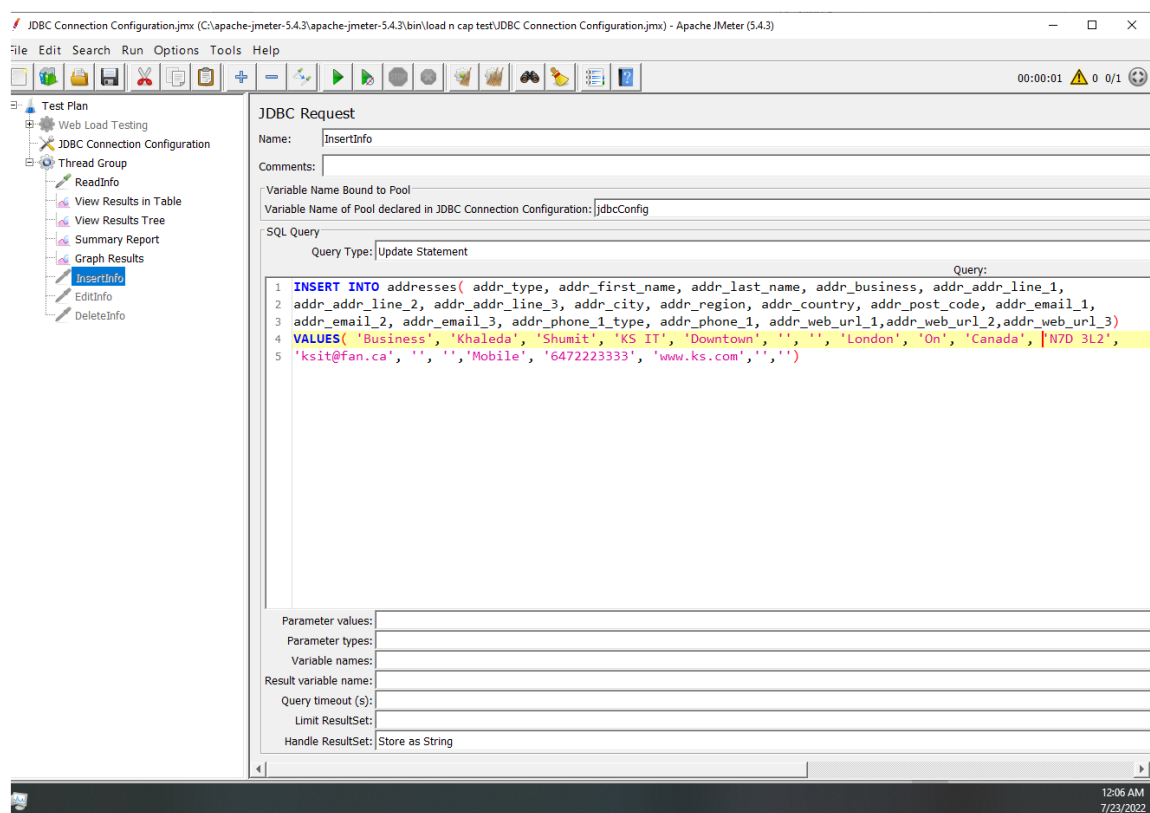
The screenshots of the four JDBC requests mentioned above are provided below:



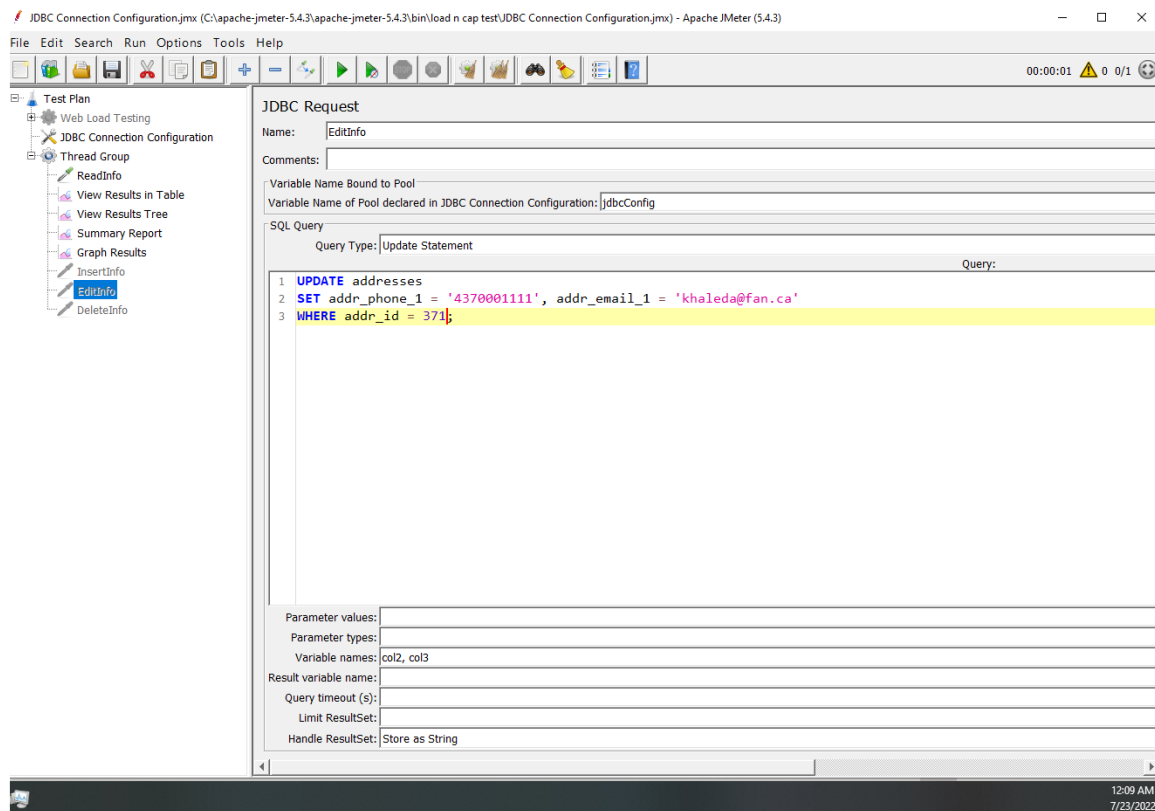
JDBC connection Configuration



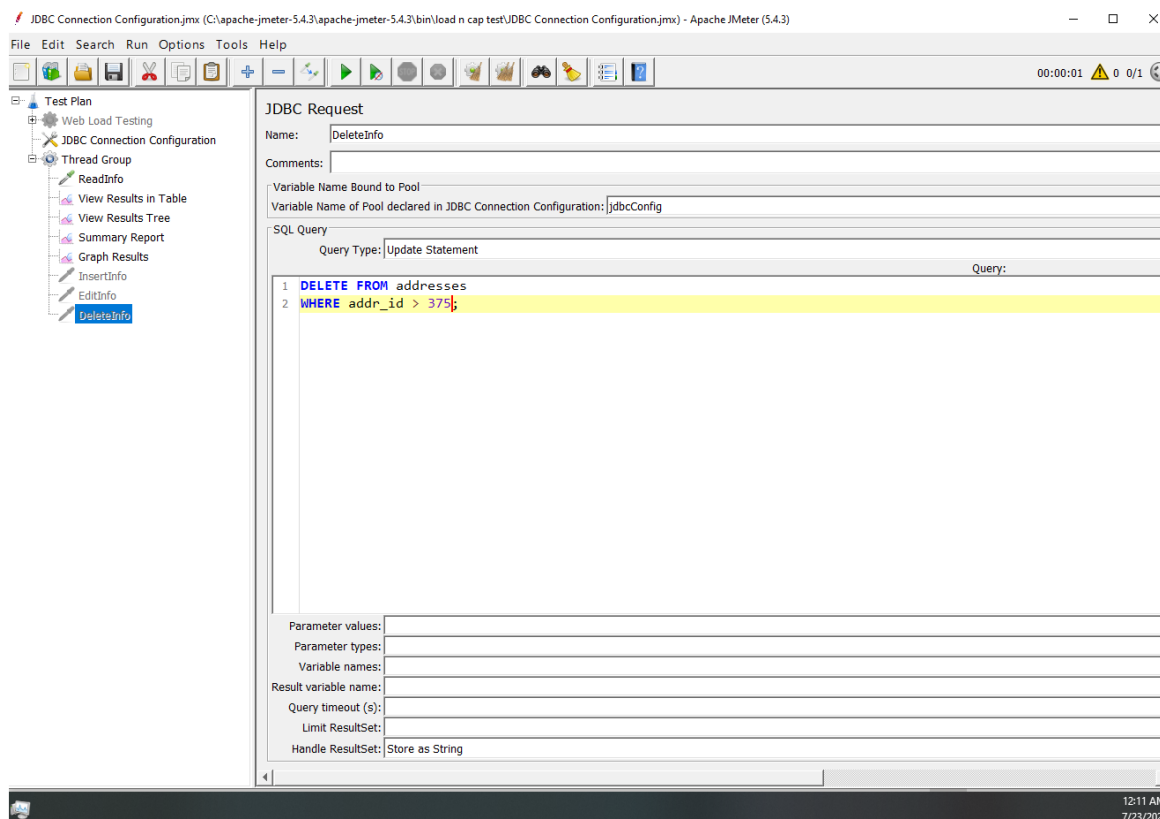
JDBC request for Read



JDBC request for Insert`



JDBC request for Update



JDBC request for Delete

After this, we ran the test plan by changing the number of users and enabling one JDBC request at a time. Also, we captured the results adding various listeners like Summary report, Result view table, Result view tree etc. Results are provided in the test report.

1.5 TEST DATA

Data can be generated in two ways:

1. By going to web application home page and clicking on the Add new Entry.
2. By using Insert command in the JMeter' JDBC request. Also, other commands like read, update, or delete can be used to retrieve or alter any data.

Special consideration should be made about the data type of the data being entered into the database. Data type of the data to be entered in the database is given below:

Input Fields	Type
addr_id	INT
addr_type	VARCHAR
addr_first_name	VARCHAR
addr_last_name	VARCHAR
addr_business	VARCHAR
addr_addr_line_1	VARCHAR
addr_addr_line_2	VARCHAR
addr_addr_line_3	VARCHAR
addr_city	VARCHAR
addr_region	VARCHAR
addr_country	VARCHAR
addr_post_code	VARCHAR
addr_email_1	VARCHAR
addr_email_2	VARCHAR
addr_email_3	VARCHAR
addr_phone_1_type	VARCHAR
addr_phone_1	VARCHAR
addr_phone_2_type	VARCHAR
addr_phone_2	VARCHAR
addr_phone_3_type	VARCHAR
addr_phone_3	VARCHAR
addr_web_url_1	VARCHAR
addr_web_url_2	VARCHAR
addr_web_url_3	VARCHAR

1.6 METRICS

Following response and volume metrics are used to determine the performance of address-book application:

- Average response time: It is the average of the time taken to respond to requests. Time is measured from the moment request is made (request cycle) till the response of the request is sent back.
- Error rate: It is calculated as percentage of number of requests that encountered error to the total number of requests made.
- Concurrent users/Sample: It is the measure of the number of virtual users active at any point in time.
- Requests per Second: It is the count of the request that are sent to the server in a second.
- Throughput: It tells how many requests an application can handle in a minute or an hour.

1.7 TEST CASE(S)

Test Case ID	Description	Inputs	Actual Result	Avg. Response time(MS)	Pass/Fail
TC_101	Read data from database, when users = 1	Select * from addresses	Display all records of the table	340	Pass
TC_102	Read data from database, when users = 10	Select * from addresses	Display all records of the table	23	Pass
TC_103	Read data from database, when users = 100	Select * from addresses	Display all records of the table	111	Pass
TC_104	Read data from database, when users = 250	Select * from addresses	Display all records of the table	64	151 Sample Pass 99 sample failed
TC_105	Read data from database, when users = 500	Select * from addresses	Display all records of the table	124	151 Sample Pass 349 Sample failed
TC_106	Insert data into the database, Where users = 1	Execute insert command	Record gets updated in the database.	13	Pass

TC_107	Insert data into the database, Where users = 100	Execute insert command	Record gets updated in the database	13	Pass
TC_108	Insert data into the database, Where users = 500	Execute insert command	Record gets updated in the database	16	151 sample Pass 349 sample failed
TC_109	Update data from the database, Where users = 1	Execute Update command	Record gets updated in the database	15	Pass
TC_110	Update data from the database, Where users = 100	Execute Update command	Record gets updated in the database	12	Pass
TC_111	Update data from the database, Where users = 500	Execute Update command	Record gets updated in the database	97	151 sample Pass 349 sample failed
TC_112	Delete data from the database, where users = 1	Execute Delete command	Record gets deleted from the database.	22	Pass
TC_113	Delete data from the database, where users = 100	Execute Delete command	Record gets deleted from the database.	13	Pass
TC_114	Delete data from the database, where users = 250	Execute Delete command	Record gets deleted from the database.	16	Pass
TC_115	Delete data from the database, where users = 500	Execute Delete command	Record gets deleted from the database.	99	151 sample Pass 349 sample failed s

TC_116	Make http request to 3 pages of the address book app, user = 1	NA	Request to all 3 pages is sent	24	Pass
TC_117	Make http request to 3 pages of the address book app, user = 100	NA	Request to all 3 pages is sent	300	Pass
TC_118	Make http request to 3 pages of the address book app, user = 500	NA	Request to all 3 pages is sent	423	Pass

2 TEST RESULTS - REPORT

We executed insert, read, delete, and update commands by changing the number of users and received following values for deviation, error rate and throughput:

Command Type	Number of users	Error rate (%)	Deviation	Throughput/sec
Read	1	0	0	2.9
	10	0	5.13	10.7
	100	0	85.73	96.7
	250	39.60	77.54	242.7
	500	69.80	184.83	254.8
	1500	90.00	545.17	460.8
	3000	95.03	947	611
Insert	1	0	0	76.9
	10	0	4.37	81.6
	100	0	4.64	97.9
	250	39.60	51.03	213.5
	500	69.80	21.83	349.2
	1500	90	1049	337

	3000	95	825	585
Delete	1	0	5	183
	10	0	3.83	10.8
	100	0	3.17	97.1
	250	39.60	26.16	246.3
	500	70	210.55	399
	1500	89.9	34.98	775
	3000	94.97	361	1207
Update	1	0	0	66.7
	10	0	3.83	10.8
	100	0	3.17	97.1
	250	39.60	26.16	246.3
	500	70	210	399.4
	1500	89.93	44.89	710.9
	3000	95.7	117	1041

Following are provided the random screenshots from JMeter showing the results captured after running the test cases:

- **Result of Read commands when user = 1**

The screenshot displays the Apache JMeter 5.4.3 interface. The 'Test Plan' tree on the left shows a sequence of steps: Thread Group for volume testing, JDBC Request for reading data, View Results Tree, JDBC Connection Configuration for project, Summary Report for user = 1/ read, View Results in Table, JDBC Request for inserting data, JDBC Request for deleting data, and JDBC Request for updating the data. The 'View Results Tree' panel is active, showing the results for the 'JDBC Request for reading data' sampler. The response body contains a table with columns for address and contact information.

addr_id	addr_type	addr_first_name	addr_last_name	addr_business	addr_line_1	addr_line_2	addr_line_3	addr_phone_1	addr_phone_2	addr_phone_3	addr_email_1	addr_email_2	addr_email_3	addr_web_url_1	addr_web_url_2	addr_web_url_3
1	Family	a	a	a	Home Fax	6	b	b	6	Home	b	6	q	q	q	q
2	Business	v	v	v	Mobile	3	v	v	3	Work	q	q	q	q	q	q
101	Family	Sumeet	Dhillon	Opa	Rundview RD	NE	Calgary	Calgary	AB	CA	82761261267	Mobile	6727272			
102	Others	Hazel	Dhillon	Opa	Rundview RD	NE	Calgary	Calgary	AB	CA	82761261267	Mobile	6727272			
103	Others	Hazel	Dhillon	Opa	Rundview RD	NE	Calgary	Calgary	AB	CA	82761261267	Mobile	6727272			
107	Others	Hazel107	Dhillon	Opa	Rundview RD	NE	Calgary	Calgary	AB	CA	82761261267	Mobile	6727272			
108	Others	Hazel108	Dhillon	Opa	Rundview RD	NE	Calgary	Calgary	AB	CA	82761261267	Mobile	6727272			
109	Others	Hazel108	Dhillon	Opa	Rundview RD	NE	Calgary	Calgary	AB	CA	82761261267	Mobile	6727272			
110	Others	Hazel108	Dhillon	Opa	Rundview RD	NE	Calgary	Calgary	AB	CA	82761261267	Mobile	6727272			

View Result Tree listener

- Result of Insert command when user = 10

The screenshot shows the Apache JMeter Summary Report for a test named 'Summary Report_users = 10-insert'. The report displays a table with the following data:

Label	# Samples	Average	Min	Max	Std. Dev.	Error %	Throughput	Received KB/sec	Sent KB/sec	Avg. Bytes
JDBC Request for ...	10	14	11	27	4.37	90.00%	10.9/sec	0.38	0.00	36.0
TOTAL	10	14	11	27	4.37	90.00%	10.9/sec	0.38	0.00	36.0

Summary report listener

- Result of Delete command when users = 100

The screenshot shows the Apache JMeter 'View Results in Table' listener. It displays a detailed table of test results for 100 samples. The table includes columns for Sample #, Start Time, Thread Name, Label, Sample Time(ms), Status, Bytes, Sent Bytes, Latency, and Connect Time(ms). The data shows a consistent pattern of successful JDBC requests with varying sample times and latencies.

Sample #	Start Time	Thread Name	Label	Sample Time(ms)	Status	Bytes	Sent Bytes	Latency	Connect Time(ms)
1	13:44:06.507	Thread Group for vo...	JDBC Request for d...	11	✓	9	0	10	9
2	13:44:06.494	Thread Group for vo...	JDBC Request for d...	25	✓	9	0	25	19
3	13:44:06.517	Thread Group for vo...	JDBC Request for d...	7	✓	9	0	7	6
4	13:44:06.527	Thread Group for vo...	JDBC Request for d...	5	✓	9	0	5	4
5	13:44:06.536	Thread Group for vo...	JDBC Request for d...	5	✓	9	0	5	4
6	13:44:06.545	Thread Group for vo...	JDBC Request for d...	5	✓	9	0	5	5
7	13:44:06.557	Thread Group for vo...	JDBC Request for d...	6	✓	9	0	6	6
8	13:44:06.567	Thread Group for vo...	JDBC Request for d...	6	✓	9	0	6	5
9	13:44:06.576	Thread Group for vo...	JDBC Request for d...	19	✓	9	0	19	18
10	13:44:06.588	Thread Group for vo...	JDBC Request for d...	27	✓	9	0	27	24
11	13:44:06.596	Thread Group for vo...	JDBC Request for d...	32	✓	9	0	32	30
12	13:44:06.607	Thread Group for vo...	JDBC Request for d...	32	✓	9	0	32	30
13	13:44:06.618	Thread Group for vo...	JDBC Request for d...	31	✓	9	0	31	30
14	13:44:06.627	Thread Group for vo...	JDBC Request for d...	44	✓	9	0	44	39
15	13:44:06.667	Thread Group for vo...	JDBC Request for d...	36	✓	9	0	35	28
16	13:44:06.686	Thread Group for vo...	JDBC Request for d...	28	✓	9	0	28	27
17	13:44:06.696	Thread Group for vo...	JDBC Request for d...	60	✓	9	0	60	58
18	13:44:06.646	Thread Group for vo...	JDBC Request for d...	76	✓	9	0	76	75
19	13:44:06.635	Thread Group for vo...	JDBC Request for d...	88	✓	9	0	88	87
20	13:44:06.696	Thread Group for vo...	JDBC Request for d...	38	✓	9	0	38	37
21	13:44:06.707	Thread Group for vo...	JDBC Request for d...	31	✓	9	0	31	30
22	13:44:06.727	Thread Group for vo...	JDBC Request for d...	11	✓	9	0	11	10
23	13:44:06.677	Thread Group for vo...	JDBC Request for d...	65	✓	9	0	64	64
24	13:44:06.718	Thread Group for vo...	JDBC Request for d...	27	✓	9	0	27	26
25	13:44:06.737	Thread Group for vo...	JDBC Request for d...	8	✓	9	0	7	7
26	13:44:06.747	Thread Group for vo...	JDBC Request for d...	7	✓	9	0	7	6
27	13:44:06.757	Thread Group for vo...	JDBC Request for d...	5	✓	9	0	5	5
28	13:44:06.767	Thread Group for vo...	JDBC Request for d...	6	✓	9	0	6	6
29	13:44:06.776	Thread Group for vo...	JDBC Request for d...	5	✓	9	0	5	5
30	13:44:06.786	Thread Group for vo...	JDBC Request for d...	5	✓	9	0	5	5
31	13:44:06.797	Thread Group for vo...	JDBC Request for d...	6	✓	9	0	6	6
32	13:44:06.809	Thread Group for vo...	JDBC Request for d...	5	✓	9	0	5	5
33	13:44:06.818	Thread Group for vo...	JDBC Request for d...	6	✓	9	0	6	6
34	13:44:06.826	Thread Group for vo...	JDBC Request for d...	7	✓	9	0	7	6
35	13:44:06.836	Thread Group for vo...	JDBC Request for d...	9	✓	9	0	9	8
36	13:44:06.846	Thread Group for vo...	JDBC Request for d...	14	✓	9	0	14	13
37	13:44:06.856	Thread Group for vo...	JDBC Request for d...	15	✓	9	0	15	15
38	13:44:06.867	Thread Group for vo...	JDBC Request for d...	12	✓	9	0	12	12
39	13:44:06.877	Thread Group for vo...	JDBC Request for d...	14	✓	9	0	14	13
40	13:44:06.887	Thread Group for vo...	JDBC Request for d...	12	✓	9	0	12	11
41	13:44:06.897	Thread Group for vo...	JDBC Request for d...	13	✓	9	0	13	12
42	13:44:06.906	Thread Group for vo...	JDBC Request for d...	11	✓	9	0	11	11

View Result in Table listener

- **Result of Update command when users = 500**

JDBC Connection Configuration for project:jmx (C:\School\Non-Functional testing\In Class 3\apache-jmeter-5.4.3\bin\JDBC Connection Configuration for project:jmx) - Apache JMeter (5.4.3)

File Edit Search Run Options Tools Help

00:00:01 0 0/500

Test Plan

- Thread Group for volume testing
 - JDBC Request of reading data
 - View Results Tree
 - JDBC Connection Configuration for project
 - View Results Tree_user = 500- update
 - Summary Report_user = 500- update
 - View Results in Table_users = 500- update**
 - JDBC Request for inserting data
 - JDBC Request for deleting data
 - JDBC Request for updating the data

View Results in Table

Name: View Results in Table- users = 500_update

Comments:

Write results to file / Read from file

Filename: Browse... Log/Display Only: ☐ Errors ☐ Successes ☐ Configure

Sample #	Start Time	Thread Name	Label	Sample Time(ms)	Status	Bytes	Sent Bytes	Latency	Connect Time(ms)
1	17-44-50.064	Thread Group for vo...	JDBC Request for u...	166	✓	9	0	166	147
2	17-44-50.069	Thread Group for vo...	JDBC Request for u...	189	✓	9	0	189	157
3	17-44-50.100	Thread Group for vo...	JDBC Request for u...	166	✓	9	0	165	137
4	17-44-50.253	Thread Group for vo...	JDBC Request for u...	15	✓	9	0	15	8
5	17-44-50.115	Thread Group for vo...	JDBC Request for u...	155	✓	9	0	155	153
6	17-44-50.122	Thread Group for vo...	JDBC Request for u...	150	✓	9	0	150	147
7	17-44-50.127	Thread Group for vo...	JDBC Request for u...	149	✓	9	0	149	147
8	17-44-50.124	Thread Group for vo...	JDBC Request for u...	155	✓	9	0	155	150
9	17-44-50.131	Thread Group for vo...	JDBC Request for u...	150	✓	9	0	150	148
10	17-44-50.129	Thread Group for vo...	JDBC Request for u...	152	✓	9	0	152	149
11	17-44-50.133	Thread Group for vo...	JDBC Request for u...	154	✓	9	0	154	152
12	17-44-50.137	Thread Group for vo...	JDBC Request for u...	152	✓	9	0	152	149
13	17-44-50.133	Thread Group for vo...	JDBC Request for u...	158	✓	9	0	158	152
14	17-44-50.144	Thread Group for vo...	JDBC Request for u...	150	✓	9	0	150	147
15	17-44-50.136	Thread Group for vo...	JDBC Request for u...	160	✓	9	0	160	122
16	17-44-50.149	Thread Group for vo...	JDBC Request for u...	148	✓	9	0	148	145
17	17-44-50.234	Thread Group for vo...	JDBC Request for u...	66	✓	9	0	66	22
18	17-44-50.145	Thread Group for vo...	JDBC Request for u...	155	✓	9	0	155	150
19	17-44-50.113	Thread Group for vo...	JDBC Request for u...	188	✓	9	0	188	138
20	17-44-50.106	Thread Group for vo...	JDBC Request for u...	196	✓	9	0	196	137
21	17-44-50.152	Thread Group for vo...	JDBC Request for u...	150	✓	9	0	150	147
22	17-44-50.102	Thread Group for vo...	JDBC Request for u...	201	✓	9	0	201	141
23	17-44-50.148	Thread Group for vo...	JDBC Request for u...	156	✓	9	0	156	153
24	17-44-50.158	Thread Group for vo...	JDBC Request for u...	154	✓	9	0	154	152
25	17-44-50.158	Thread Group for vo...	JDBC Request for u...	156	✓	9	0	156	154
26	17-44-50.161	Thread Group for vo...	JDBC Request for u...	158	✓	9	0	158	156
27	17-44-50.163	Thread Group for vo...	JDBC Request for u...	162	✓	9	0	162	160
28	17-44-50.158	Thread Group for vo...	JDBC Request for u...	170	✓	9	0	170	165
29	17-44-50.164	Thread Group for vo...	JDBC Request for u...	166	✓	9	0	166	164
30	17-44-50.163	Thread Group for vo...	JDBC Request for u...	169	✓	9	0	169	166
31	17-44-50.164	Thread Group for vo...	JDBC Request for u...	172	✓	9	0	172	170
32	17-44-50.163	Thread Group for vo...	JDBC Request for u...	175	✓	9	0	175	172
33	17-44-50.098	Thread Group for vo...	JDBC Request for u...	264	✓	9	0	264	262
34	17-44-50.098	Thread Group for vo...	JDBC Request for u...	265	✓	9	0	265	262
35	17-44-50.165	Thread Group for vo...	JDBC Request for u...	207	✓	9	0	207	204
36	17-44-50.174	Thread Group for vo...	JDBC Request for u...	200	✓	9	0	200	196
37	17-44-50.168	Thread Group for vo...	JDBC Request for u...	207	✓	9	0	207	201
38	17-44-50.174	Thread Group for vo...	JDBC Request for u...	202	✓	9	0	202	198
39	17-44-50.180	Thread Group for vo...	JDBC Request for u...	198	✓	9	0	198	195
40	17-44-50.177	Thread Group for vo...	JDBC Request for u...	203	✓	9	0	203	198
41	17-44-50.179	Thread Group for vo...	JDBC Request for u...	201	✓	9	0	201	198
42	17-44-50.182	Thread Group for vo...	JDBC Request for u...	200	✓	9	0	200	197

Scroll automatically? ☐ Child samples? No of Samples 500 Latest Sample 1 Average 97 Deviation 151

- **Result of Insert command when users = 1500**

JDBC Connection Configuration for project:jmx (C:\School\Non-Functional testing\In Class 3\apache-jmeter-5.4.3\bin\JDBC Connection Configuration for project:jmx) - Apache JMeter (5.4.3)

File Edit Search Run Options Tools Help

00:00:04 0 0/1500

Test Plan

- Thread Group for volume testing
 - JDBC Request of reading data
 - View Results Tree
 - JDBC Connection Configuration for project
 - View Results Tree
 - Summary Report**
 - View Results in Table
 - JDBC Request for inserting data
 - JDBC Request for deleting data
 - JDBC Request for updating the data

Summary Report

Name: Summary Report

Comments:

Write results to file / Read from file

Filename: Browse... Log/Display Only: ☐ Errors ☐ Successes ☐ Configure

Label	# Samples	Average	Min	Max	Std. Dev.	Error %	Throughput	Received KB/sec	Sent KB/sec	Avg. Bytes
JDBC Request for ...	1500	659	1	4317	1049.02	90.00%	337.3/sec	52.07	0.00	158.1
TOTAL	1500	659	1	4317	1049.02	90.00%	337.3/sec	52.07	0.00	158.1

Include group name in label? ☐ Save Table Data ☒ Save Table Header

- **Result of Read command when users = 3000**

Summary Report
 Name: Summary Report
 Comments:
 Write results to file / Read from file
 Filename: Log/Display Only: ☐ Errors ☐ Successes

Label	# Samples	Average	Min	Max	Std. Dev.	Error %	Throughput	Received KB/sec	Sent KB/sec	Avg. Bytes
JDBC Request of r...	3000	817	0	3870	947.63	95.03%	611.9/sec	3924.89	0.00	6568.5
TOTAL	3000	817	0	3870	947.63	95.03%	611.9/sec	3924.89	0.00	6568.5

☐ Include group name in label? ☒ Save Table Header

- **http request sent to web pages when users = 100**

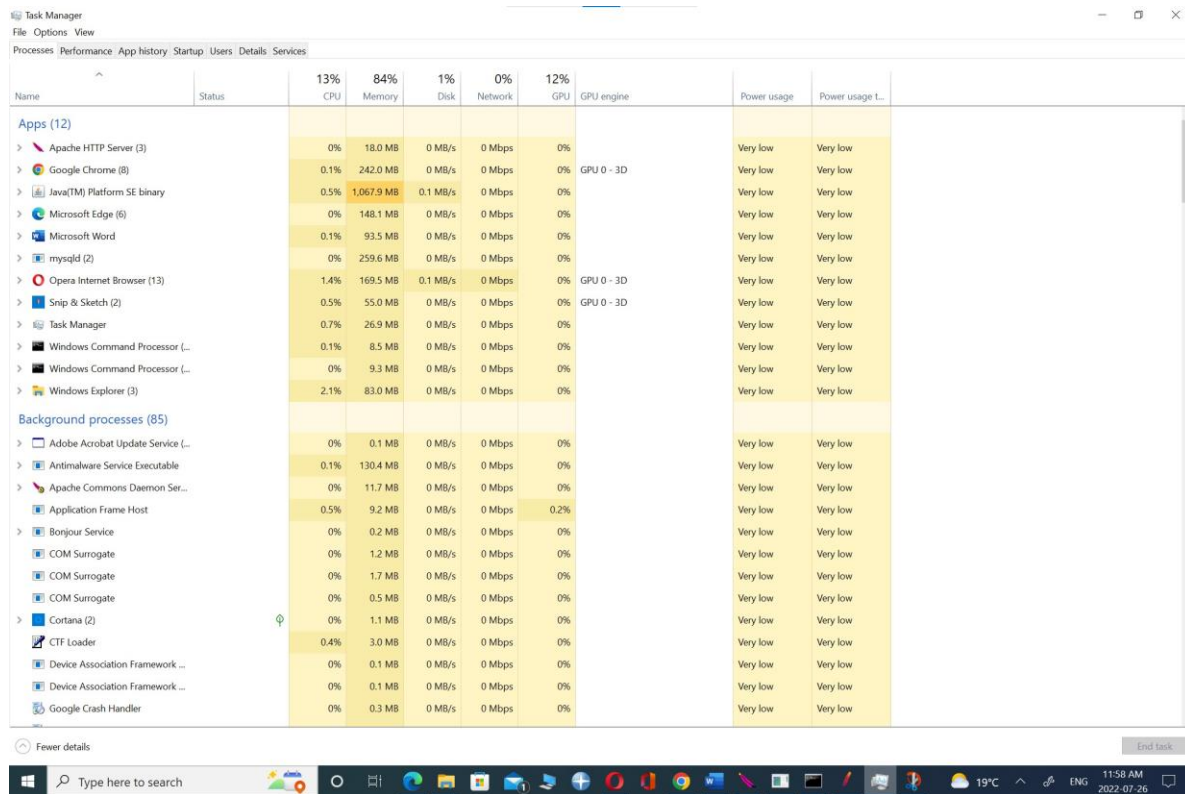
Summary Report
 Name: Summary Report
 Comments:
 Write results to file / Read from file
 Filename: Log/Display Only: ☐ Errors ☐ Successes

Label	# Samples	Average	Min	Max	Std. Dev.	Error %	Throughput	Received KB/sec	Sent KB/sec	Avg. Bytes
Home Page	100	441	121	802	196.52	0.00%	97.1/sec	2735.89	10.52	28856.0
Webpage allList	100	251	14	777	144.97	100.00%	114.2/sec	74.80	13.60	671.0
Webpage newEntry	100	180	6	593	153.43	100.00%	168.6/sec	110.50	20.26	671.0
TOTAL	300	291	6	802	199.83	66.67%	271.2/sec	2666.39	31.43	10066.0

☐ Include group name in label? ☒ Save Table Header

3 DEMONSTRATION OF RESOURCE UTILIZATION

Below are the screenshots of task manager collected while running the test cases on JMeter:



The screenshot displays the Windows Task Manager interface with the 'Performance' tab selected. The 'Processes' section is expanded, showing a list of applications and background processes. The columns displayed are Name, Status, CPU, Memory, Disk, Network, GPU, GPU engine, Power usage, and Power usage L... (likely Log). The 'Apps (12)' section lists applications like Apache HTTP Server, Google Chrome, Java(TM) Platform SE binary, Microsoft Edge, Microsoft Word, mysqld, Opera Internet Browser, Snip & Sketch, Task Manager, Windows Command Processor, and Windows Explorer. The 'Background processes (85)' section lists services like Adobe Acrobat Update Service, Antimalware Service Executable, Apache Commons Daemon Ser..., Application Frame Host, Bonjour Service, COM Surrogate, Cortana, CTF Loader, Device Association Framework, and Google Crash Handler. The CPU usage is 13%, Memory is 84%, Disk is 1%, Network is 0%, GPU is 12%, and Power usage is Very low.

Name	Status	13% CPU	84% Memory	1% Disk	0% Network	12% GPU	GPU engine	Power usage	Power usage L...
Apps (12)									
Apache HTTP Server (3)		0%	18.0 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Google Chrome (8)		0.1%	242.0 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
Java(TM) Platform SE binary		0.5%	1,067.9 MB	0.1 MB/s	0 Mbps	0%		Very low	Very low
Microsoft Edge (6)		0%	148.1 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Microsoft Word		0.1%	93.5 MB	0 MB/s	0 Mbps	0%		Very low	Very low
mysqld (2)		0%	259.6 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Opera Internet Browser (13)		1.4%	169.5 MB	0.1 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
Snip & Sketch (2)		0.5%	55.0 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
Task Manager		0.7%	26.9 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Windows Command Processor (...)		0.1%	8.5 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Windows Command Processor (...)		0%	9.3 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Windows Explorer (3)		2.1%	83.0 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Background processes (85)									
Adobe Acrobat Update Service (...)		0%	0.1 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Antimalware Service Executable		0.1%	130.4 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Apache Commons Daemon Ser...		0%	11.7 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Application Frame Host		0.5%	9.2 MB	0 MB/s	0 Mbps	0.2%		Very low	Very low
Bonjour Service		0%	0.2 MB	0 MB/s	0 Mbps	0%		Very low	Very low
COM Surrogate		0%	1.2 MB	0 MB/s	0 Mbps	0%		Very low	Very low
COM Surrogate		0%	1.7 MB	0 MB/s	0 Mbps	0%		Very low	Very low
COM Surrogate		0%	0.5 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Cortana (2)		0%	1.1 MB	0 MB/s	0 Mbps	0%		Very low	Very low
CTF Loader		0.4%	3.0 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Device Association Framework ...		0%	0.1 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Device Association Framework ...		0%	0.1 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Google Crash Handler		0%	0.3 MB	0 MB/s	0 Mbps	0%		Very low	Very low

users = 1

When No. of

Task Manager									
File Options View									
Processes Performance App history Startup Users Details Services									
Name	Status	29% CPU	83% Memory	1% Disk	0% Network	0% GPU	GPU engine	Power usage	Power usage L...
Apps (11)									
> Apache HTTP Server (3)		0%	17.9 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Google Chrome (8)		0.1%	241.5 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Java(TM) Platform SE binary		17.2%	1,081.6 MB	0.1 MB/s	0 Mbps	0%	GPU 0 - 3D	High	Low
> Microsoft Edge (6)		0%	148.0 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Microsoft Word		0%	81.7 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> mysqld (2)		4.2%	263.6 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Low	Very low
> Opera Internet Browser (13)		2.5%	169.2 MB	0.1 MB/s	0 Mbps	0%	GPU 0 - 3D	Low	Very low
> Task Manager		0.5%	26.9 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Windows Command Processor (...)		0%	8.5 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Windows Command Processor (...)		0%	9.3 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Windows Explorer (3)		1.0%	74.3 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
Background processes (87)									
> Adobe Acrobat Update Service (...)		0%	0.1 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Antimalware Service Executable		0.2%	129.1 MB	0.1 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Apache Commons Daemon Ser...		0.1%	10.8 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Application Frame Host		0%	7.4 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Bonjour Service		0%	0.2 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> COM Surrogate		0%	1.2 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> COM Surrogate		0%	1.6 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> COM Surrogate		0%	0.5 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Cortana (2)		0%	1.0 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> CTF Loader		0.1%	3.0 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Device Association Framework ...		0%	0.1 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Device Association Framework ...		0%	0.1 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Google Crash Handler		0%	0.3 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Google Crash Handler (32 bit)		0%	0.3 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low

When No. of users = 100

Task Manager									
File Options View									
Processes Performance App history Startup Users Details Services									
Name	Status	35% CPU	84% Memory	0% Disk	0% Network	3% GPU	GPU engine	Power usage	Power usage L...
Apps (11)									
> Apache HTTP Server (3)		0%	17.9 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Google Chrome (8)		0.1%	241.5 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Java(TM) Platform SE binary		10.4%	1,125.6 MB	0.1 MB/s	0 Mbps	0%	GPU 0 - 3D	Moderate	Low
> Microsoft Edge (6)		0%	148.0 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Microsoft Word		0%	81.7 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> mysqld (2)		4.9%	260.1 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Low	Very low
> Opera Internet Browser (13)		2.5%	169.2 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Task Manager		5.2%	26.9 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Low	Very low
> Windows Command Processor (...)		0%	8.4 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Windows Command Processor (...)		0%	9.3 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Windows Explorer (3)		1.8%	78.4 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
Background processes (88)									
> Adobe Acrobat Update Service (...)		0%	0.1 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Antimalware Service Executable		0.3%	135.2 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Apache Commons Daemon Ser...		0%	10.9 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Application Frame Host		0%	8.7 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Bonjour Service		0%	0.2 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> COM Surrogate		0%	1.2 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> COM Surrogate		0%	1.6 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> COM Surrogate		0%	0.5 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Cortana (2)		0%	1.0 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> CTF Loader		2.3%	3.0 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Device Association Framework ...		0%	0.1 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Device Association Framework ...		0%	0.1 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Google Crash Handler		0%	0.3 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
> Google Crash Handler (32 bit)		0%	0.3 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low

When No. of users = 250

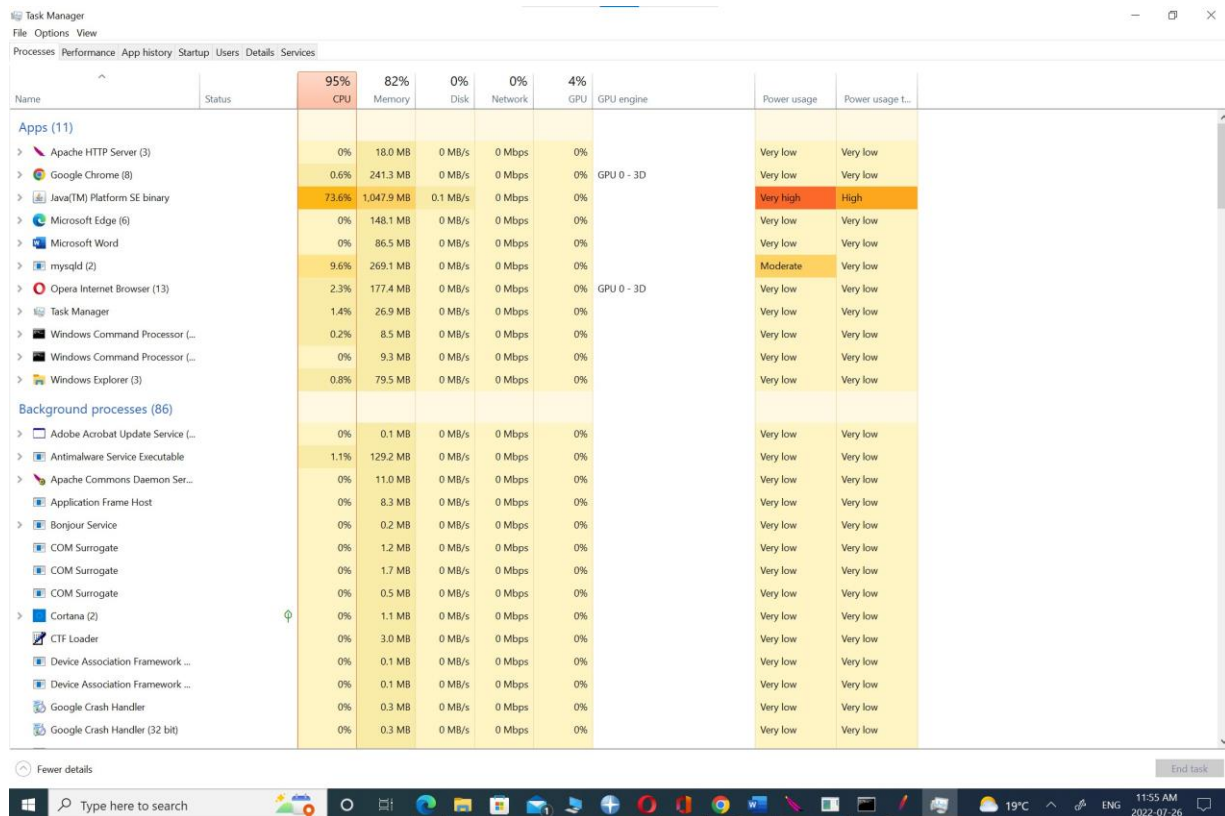
Task Manager									
File Options View									
Processes Performance App history Startup Users Details Services									
Name	Status	53% CPU	85% Memory	3% Disk	0% Network	3% GPU	GPU engine	Power usage	Power usage L...
Apps (11)									
Apache HTTP Server (3)		0%	17.9 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Google Chrome (8)		0.4%	241.6 MB	0.1 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
Java(TM) Platform SE binary		30.3%	1,239.8 MB	0.1 MB/s	0 Mbps	0%		Very high	Moderate
Microsoft Edge (6)		0.1%	148.0 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Microsoft Word		0.1%	81.7 MB	0 MB/s	0 Mbps	0%		Very low	Very low
mysqld (2)		11.0%	260.0 MB	0 MB/s	0 Mbps	0%		Moderate	Low
Opera Internet Browser (13)		1.9%	163.1 MB	0.1 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
Task Manager		1.4%	26.9 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Windows Command Processor (...)		0.1%	8.4 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Windows Command Processor (...)		0%	9.3 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Windows Explorer (3)		1.8%	75.5 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Background processes (88)									
Adobe Acrobat Update Service (...)		0%	0.1 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Antimalware Service Executable		0.7%	131.6 MB	0.1 MB/s	0 Mbps	0%		Very low	Very low
Apache Commons Daemon Ser...		0%	11.1 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Application Frame Host		0%	8.8 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Bonjour Service		0%	0.2 MB	0 MB/s	0 Mbps	0%		Very low	Very low
COM Surrogate		0%	1.2 MB	0 MB/s	0 Mbps	0%		Very low	Very low
COM Surrogate		0%	1.6 MB	0 MB/s	0 Mbps	0%		Very low	Very low
COM Surrogate		0%	0.5 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Cortana (2)		0%	1.0 MB	0 MB/s	0 Mbps	0%		Very low	Very low
CTF Loader		0.1%	3.0 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Device Association Framework ...		0%	0.1 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Device Association Framework ...		0%	0.1 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Google Crash Handler		0%	0.3 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Google Crash Handler (32 bit)		0%	0.3 MB	0 MB/s	0 Mbps	0%		Very low	Very low



users = 500

Task Manager									
File Options View									
Processes Performance App history Startup Users Details Services									
Name	Status	64% CPU	85% Memory	2% Disk	0% Network	1% GPU	GPU engine	Power usage	Power usage L...
Apps (11)									
Apache HTTP Server (3)		0%	17.9 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Google Chrome (8)		0%	213.2 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
Java(TM) Platform SE binary		41.9%	1,250.2 MB	0.1 MB/s	0 Mbps	0%		Very high	Moderate
Microsoft Edge (6)		0%	121.1 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Microsoft Word		0.1%	81.7 MB	0 MB/s	0 Mbps	0%		Very low	Very low
mysqld (2)		12.7%	260.4 MB	0 MB/s	0 Mbps	0%		Moderate	Low
Opera Internet Browser (13)		2.2%	153.2 MB	0 MB/s	0 Mbps	0%	GPU 0 - 3D	Very low	Very low
Task Manager		1.0%	26.9 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Windows Command Processor (...)		0.1%	8.4 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Windows Command Processor (...)		0%	9.3 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Windows Explorer (3)		0.8%	74.9 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Background processes (85)									
Adobe Acrobat Update Service (...)		0%	0.1 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Antimalware Service Executable		0.9%	129.3 MB	0.1 MB/s	0 Mbps	0%		Very low	Very low
Apache Commons Daemon Ser...		0%	11.3 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Application Frame Host		0%	8.8 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Bonjour Service		0%	0.2 MB	0 MB/s	0 Mbps	0%		Very low	Very low
COM Surrogate		0%	1.2 MB	0 MB/s	0 Mbps	0%		Very low	Very low
COM Surrogate		0%	1.6 MB	0 MB/s	0 Mbps	0%		Very low	Very low
COM Surrogate		0%	0.5 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Cortana (2)		0%	1.0 MB	0 MB/s	0 Mbps	0%		Very low	Very low
CTF Loader		0%	3.0 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Device Association Framework ...		0%	0.1 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Device Association Framework ...		0%	0.1 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Google Crash Handler		0%	0.3 MB	0 MB/s	0 Mbps	0%		Very low	Very low
Google Crash Handler (32 bit)		0%	0.3 MB	0 MB/s	0 Mbps	0%		Very low	Very low

When No. of users = 1000



When No. of users = 1500

From the screenshots above, it can be said that the resources (CPU, memory, power) usage went higher with increase in the number of the users. 95% of CPU was used when users = 1500. Power usage went from low to moderate to very high with increasing load.

4 ANALYSIS AND FINDINGS

1. In terms of the application performance, how did the address-book application perform?

When considering the load testing, we ran the test cases of http requests made to web pages of the application by varying the number of the users, the avg. response time was good. For the volume testing as well the response time for performing various CRUD commands was good. However, it kept changing every other time the test case was run. Also, the response time kept increasing with the increase in number of users. Another interesting thing that we noticed was read operation was successful for all users when test case run for 250 users, but many transactions failed when same was run after some. So, the error rate varied for same test case when run at different times.

2. Which metrics did you collect for verifying the performance of the application?

We collected average response time for each test case. Also, error rate and throughput.

3. In terms of the capacity of the database what was your observation?

Capacity wise the database was good. We ran 1000s of insert commands and read commands. The throughput was satisfactory.

4. Which metrics did you collect for analyzing your result?

We used response time and error rate as the major metrics to analyze our reports and reach to a conclusion.

5. What would be your overall recommendation to the business if they want to promote this application to production?

The error rate kept increasing with the increase in the user, so that factor needs to be considered before taking the application to production. Otherwise, it will be great problem for the users when accessing the application concurrently.

5 CONCLUSION

To conclude, the performance of the app was good only when the number of users performing CRUD were less. The error rate was 0 for users till 150, however for 200 its 25% and 250 it went to approx.40% and it kept increasing with the increase in number of users. So, it did not pass the volume testing. For any test case, if users > 150, then only 151 samples were success all other were failed. So, it can handle 151 concurrent users at a time. On the other hand, considering the http request sent to the app had good response time without any failure.