



Linnéuniversitetet

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Report

Performance Engineering Assignment



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Table of Contents

1 Using operational law to calculate service time	1
2 Model the system using queueing networks	2
2.1 Model	2
2.2 Service time	2
2.3 Routing	3
2.4 System simulation	4
2.4.1 <i>System response time</i>	4
2.4.2 <i>Utilization</i>	5
2.4.3 <i>Throughput</i>	6
3 System upgrade	7
3.1 Analysis	7
3.1.1 <i>Workload</i>	7
3.1.2 <i>Web server</i>	7
3.1.3 <i>Software search engine</i>	7
3.1.4 <i>Software upload manager</i>	7
3.1.5 <i>Database</i>	7
3.1.6 <i>Contribution reward service</i>	8
3.2 Simulation result	8
3.2.1 <i>System response time after upgrading the system</i>	8
3.2.2 <i>Utilization after upgrading the system</i>	9
3.2.3 <i>Throughput after upgrading the system</i>	10

1 Using operational law to calculate service time

Use the operational laws to calculate the service time S_k of the *SoftwareSearchEngine*, the *SoftwareUploadManager*, and *Database*; and to calculate the average number of iterations that the *SoftwareUploadManager* needs to execute to serve a request of a contributor.

Calculations:

Table 1. The service centres and related service time S_k

	<i>SoftwareSearchEngine</i>	<i>SoftwareUploadManage</i>	<i>Database</i>
S_k	0.2	0.4	0.25

Software Search Engine:

$$C_k = 129600 \times 0.85 = 110160$$

$$U_k = 8.5\% = 0.085$$

$$\frac{B_k}{259200} = 0.085$$

$$B_k = 22032$$

$$S_k = \frac{22032}{110160} \approx 0.2$$

Software Upload Manager:

$$X_k = \frac{C_k}{T} = \frac{0.1754}{0.4677} \approx 0.38$$

$$U_k = \frac{B_k}{T} = \frac{38900}{259200} \approx 0.15$$

$$S_k = \frac{U_k}{X_k} = \frac{0.15}{0.37} \approx 0.4$$

Database:

$$D_k = V_k \cdot S_k$$

$$S_k = \frac{D_k}{V_k} = \frac{2}{8} = 0.25$$

Software Upload Manager (Average Iterations):

$$C_k = \frac{B_k}{S_k} = \frac{38900}{0.4} = 97250$$

$$C_k = C \times \text{Iterations} \times 15\% \Rightarrow \text{Iterations} = \frac{97250}{129600 \times 15\%} \approx 5$$

2 Model the system using queueing networks

Model the system using queueing networks (in JMT or in your preferred Queueing Network simulation engine). Add screenshots of: the structure of the network and about all the information you add to each component (service times, routing probabilities, etc.). Simulate the model to calculate the System Response time, the Utilization and Throughput of each of the five components in the system and show screenshots of the results.

2.1 Model

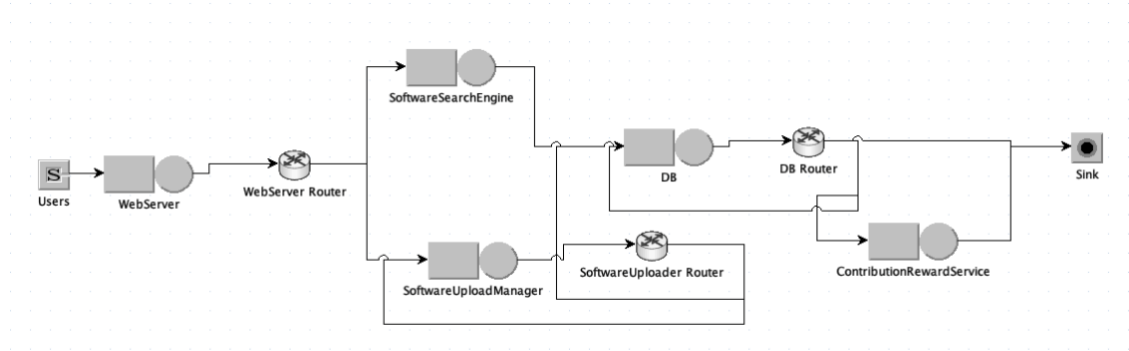
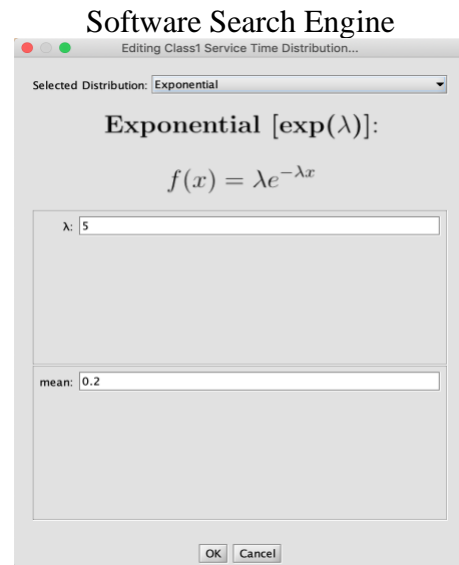
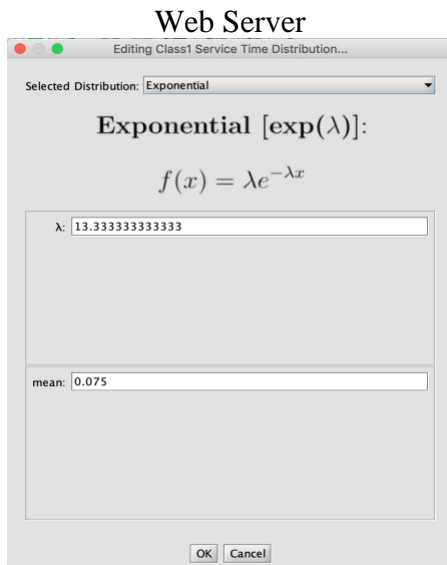


Figure 1. System Queueing Network Model

2.2 Service time

In this section, the screenshots for different service components regarding service will be presented.



Software Upload Manager

Editing Class1 Service Time Distribution...

Selected Distribution: Exponential

Exponential [exp(λ)]:

$$f(x) = \lambda e^{-\lambda x}$$

λ : 2.5

mean: 0.4

OK Cancel

Database

Editing Class1 Service Time Distribution...

Selected Distribution: Exponential

Exponential [exp(λ)]:

$$f(x) = \lambda e^{-\lambda x}$$

λ : 4

mean: 0.25

OK Cancel

Contribution Reward Service

Editing Class1 Service Time Distribution...

Selected Distribution: Exponential

Exponential [exp(λ)]:

$$f(x) = \lambda e^{-\lambda x}$$

λ : 2

mean: 0.5

OK Cancel

2.3 Routing

In this section, the screenshots of routers and the corresponding probabilities will be presented.

Web Server Router

Station Name: WebServer Router

WebServer Router Parameters Definition

Routing Section

Class	Routing Strategy
Class1	Probabilities

Description: Jobs are routed to stations connected to the current one according to the specified probabilities. If the sum of the probabilities is different from 1, all the values will be scaled to sum 1.

Routing Options

Destination	Probability
SoftwareSearch...	0.85
SoftwareUpload...	0.15

Done

Software Uploader Router

Station Name: SoftwareUploader Router

SoftwareUploader Router Parameters Definition

Routing Section

Class	Routing Strategy
Class1	Probabilities

Description: Jobs are routed to stations connected to the current one according to the specified probabilities. If the sum of the probabilities is different from 1, all the values will be scaled to sum 1.

Routing Options

Destination	Probability
DB	0.2
SoftwareUpload...	0.8

Done

Database Router

Station Name: DB Router

DB Router Parameters Definition

Routing Section

Class	Routing Strategy
Class1	Probabilities

Description
Jobs are routed to stations connected to the current one according to the specified probabilities. If the sum of the probabilities is different from 1, all the values will be scaled to sum 1.

Routing Options

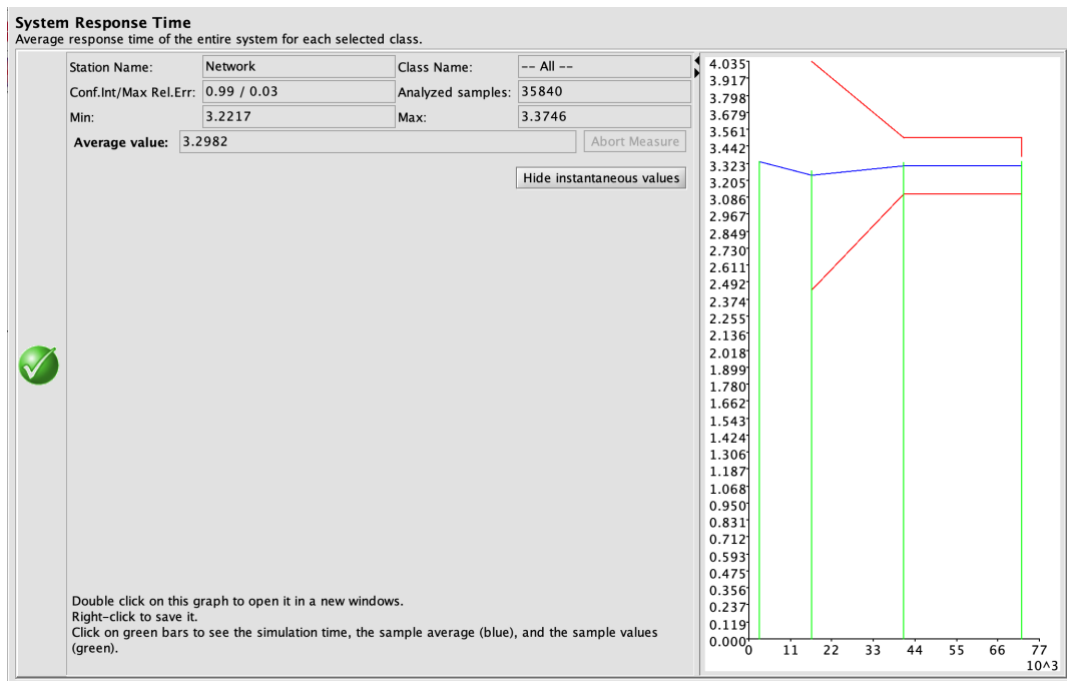
Destination	Probability
DB	0.875
ContributionRe...	0.01875
Sink	0.10625

Done

2.4 System simulation

In this part, the simulation regarding the system response time, the utilization and throughput of each of the five components will be presented.

2.4.1 System response time



2.4.2 Utilization

Utilization

Average utilization for each selected class at each selected station. For multi-server queueing stations this is the average utilization of each server. The utilization of a delay station is the average number of customers in the station (may be greater than 1).



2.4.3 Throughput



3 System upgrade

Suppose that some of our software has become popular by university students in one of their courses. It means that, by the date of the utilization of the software in the course, there will be a huge increment in the requests from users to download that software, and an increment in the new versions of that software that are uploaded to the system. Concretely, we expect that: 1) the workload increases $\times 18$, that is, it passes from an average of 30 requests per minute to $30 \times 18 = 540$ requests per minute; 2) the proportion of contributor uses increases from 15% to 25%.

3.1 Analysis

Under the new scenario, the service components need to be re-calculated in order to fulfill the service demands, the analysis process can be found as following.

3.1.1 Workload

The total amount of workload increases 18 times which means now the total user sessions are $18 \times 129600 = 2332800$.

3.1.2 Web server

$$\begin{aligned}C_k &= 2332800 \\S_k &= 0.075 \\X_k &= \frac{2332800}{259200} = 9 \\U_k &= X_k \times S_k = 9 \times 0.075 = 0.675\end{aligned}$$

The U_k is lower than 1, therefore, 1 server for web server is sufficient.

3.1.3 Software search engine

$$\begin{aligned}C_k &= 2332800 \times 0.75 = 1749600 \\S_k &= 0.2 \\X_k &= \frac{1749600}{259200} = 6.75 \\U_k &= X_k \times S_k = 6.75 \times 0.2 = 1.35\end{aligned}$$

Since the U_k has to be lower than 1, therefore, the number of the servers for search engine needs to be 2.

3.1.4 Software upload manager

$$\begin{aligned}C_k &= 2332800 \times 0.25 = 583200 \\S_k &= 0.4 \\X_k &= \frac{583200}{259200} = 2.25 \\U_k &= X_k \times S_k = 2.25 \times 0.4 \times 5 = 4.5\end{aligned}$$

Since the U_k has to be lower than 1, therefore, the number of the servers for search engine needs to be 5.

3.1.5 Database

$$\begin{aligned}C_k &= 2332800 \\S_k &= 0.25\end{aligned}$$

$$X_k = \frac{2332800}{259200} = 9$$

$$U_k = X_k \times S_k = 9 \times 0.25 \times 8 = 18$$

Since the U_k has to be lower than 1, therefore, the number of the servers for database needs to be 19 to keep it lower than 1.

3.1.6 Contribution reward service

$$C_k = 583200$$

$$S_k = 0.5$$

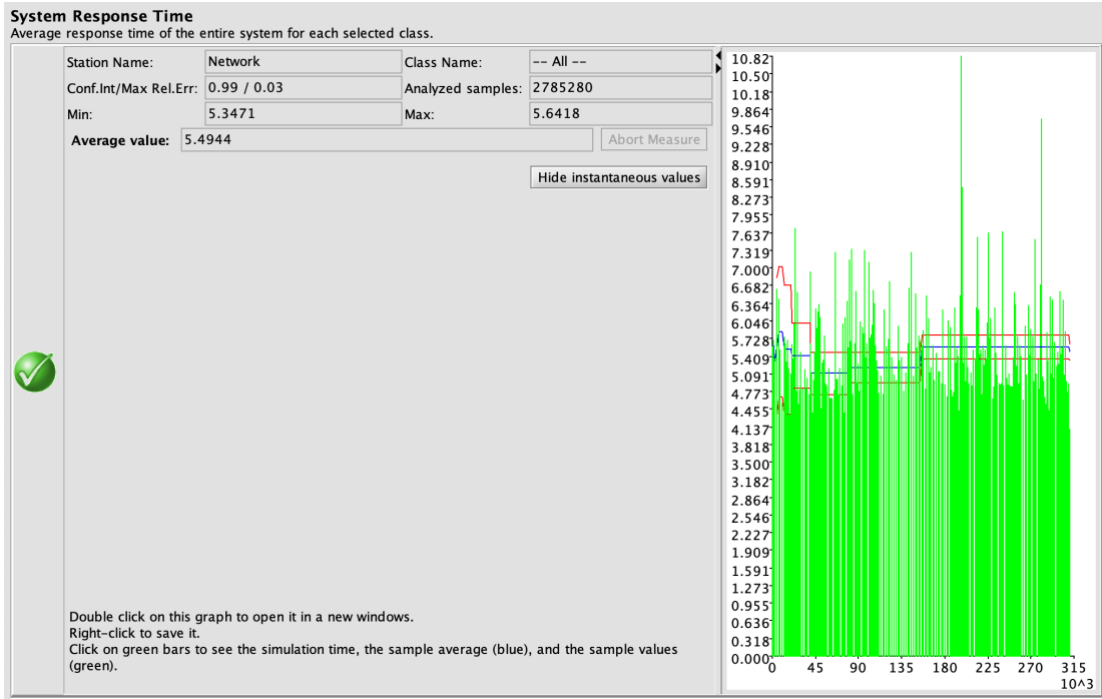
$$X_k = 2.25$$

$$U_k = X_k \times S_k = 2.25 \times 0.5 = 1.125$$

Since the U_k has to be lower than 1, therefore, the number of the servers for contribution reward needs to be 2.

3.2 Simulation result

3.2.1 System response time after upgrading the system



As we can see, after the system upgrade the system response time is around 5.49 seconds.

3.2.2 Utilization after upgrading the system



3.2.3 Throughput after upgrading the system

