



**Linnæus University**  
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[Document type]

# Performance Engineering

*[Subtitle]*



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## Table of contents

<b>1</b>	<b>Introduction.....</b>	<b>3</b>
<b>2</b>	<b>Calculations .....</b>	<b>3</b>
2.1	<i>Web Server .....</i>	<i>4</i>
2.2	<i>Winner Payment Server.....</i>	<i>4</i>
2.3	<i>Player Engagement Server.....</i>	<i>4</i>
2.4	<i>Database.....</i>	<i>5</i>
2.5	<i>Betting Server.....</i>	<i>5</i>
<b>3</b>	<b>Model .....</b>	<b>6</b>
3.1	<i>Service Time .....</i>	<i>6</i>
3.1.1	<i>Web Server.....</i>	<i>6</i>
3.1.2	<i>Winner Payment Server .....</i>	<i>7</i>
3.1.3	<i>Player Engagement Server .....</i>	<i>7</i>
3.1.4	<i>Database .....</i>	<i>8</i>
3.1.5	<i>Betting Server .....</i>	<i>8</i>
3.2	<i>Routing Probabilities .....</i>	<i>9</i>
3.2.1	<i>Router Web Server.....</i>	<i>9</i>
3.3	<i>Resources.....</i>	<i>9</i>
3.4	<i>Number of Customers.....</i>	<i>11</i>
3.5	<i>Response Time.....</i>	<i>11</i>
3.6	<i>Residence Time.....</i>	<i>12</i>
3.7	<i>Utilization.....</i>	<i>12</i>
3.8	<i>Throughput.....</i>	<i>13</i>



## 1 Introduction

This report shows the results of the mathematical representation of the behaviour from the system proposed, a model created with JMT and the results got by it.

## 2 Calculations

$T$  = length of time we observe the system

$A_k$  = number of session arrives we observe for source  $k$

$C_k$  = number of session completions we observe at source  $k$

$B_k$  = total amount of time during which the source  $k$  is busy ( $B < T$ )

$N_k = X_k \times R_k$  = average number of jobs in the system

$R_k$  = average source  $k$  residence time per job

$$\lambda_k = \frac{A_k}{T} = \text{arrival rate}$$

$$X_k = \frac{C_k}{T} = \text{throughput rate}$$

$$U_k = \frac{B_k}{T} = \text{utilization}$$

$$S_k = \frac{B_k}{C_k} = \text{mean service time per completed job in the system}$$

$$V_k = \frac{C_k}{C} = \text{mean number of visits per completed job}$$

$$D_k = V_k \times S_k = \text{mean demand time per completed job in the system}$$



Server	S	X	U
Web Server	0.03 s	1.5	0.045
Winner Payment Server	1	0.375	0.375
Database	0.08		
Betting Server	0.199	1.050	0.2091

### 2.1 Web Server

$$T = 5 \text{ days} = 5 \times 24 \times 60 \times 60 = 432000 \text{ s}$$

$$C_1 = 648000$$

$$S_1 = 30 \text{ ms} = 0.03 \text{ s}$$

$$B_1 = C_1 \times S_1 = 648000 \times 0.03 = 19440$$

$$X_1 = \frac{C_1}{T} = \frac{648000}{432000} = 1.5$$

$$U_1 = \frac{B_1}{T} = \frac{19440}{432000} = 0.045$$

Right

### 2.2 Winner Payment Server

$$C_2 = C_1 \times 0.25 = 648000 \times 0.25 = 162000$$

$$U_2 = 0.375$$

$$X_2 = \frac{C_2}{T} = \frac{162000}{432000} = 0.375$$

$$B_2 = U_2 \times T = 0.375 \times 432000 = 162000$$

$$S_2 = \frac{B_2}{C_2} = \frac{162000}{162000} = 1$$

Right

### 2.3 Player Engagement Server

$$C = 2 \text{ iterations}$$

$$C_3 = C_1 \times 0.75 \times C = 648000 \times 0.75 \times 2 = 972000$$

$$S_3 = 400 \text{ ms} = 0.4 \text{ s}$$



The average number of visits is 2. All requests execute in the PlayerEngagement and the Database, and they iterate 2 times in average. From the problem description:  
-“After transferring the credit, the session continues in the PlayerEngagementServer,”  
- If the user is not a winner of a previous bet, [...] the user session moves directly to the PlayerEngagementServer.

## 2.4 Database

$$C_4 = C_3 = 972000$$
$$V_4 = \frac{C_4}{C_1} = \frac{972000}{648000} = 1.5$$

$$D_4 = 120 \text{ ms} = 0.12 \text{ s}$$
$$S_4 = \frac{D_4}{V_4} = \frac{0.12}{1.5} = 0.08$$

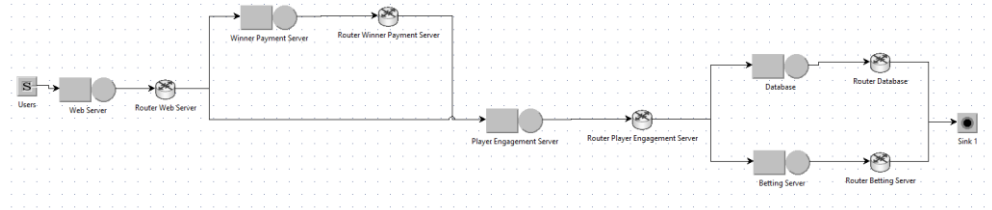
## 2.5 Betting Server

$$N_5 = 0.265$$
$$R_5 = 0.2525 \text{ s}$$
$$U_5 = 0.2091$$
$$X_5 = \frac{N_5}{R_5} = \frac{0.265}{0.2525} \approx 1.050$$
$$S_5 = \frac{U_5}{X_5} = \frac{0.2091}{1.050} \approx 0.199$$

Right



### 3 Model



#### 3.1 Service Time

##### 3.1.1 Web Server

Editing Class1 Service Time Distribution...

Selected Distribution: Exponential

Exponential  $[\exp(\lambda)]$ :

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

$\lambda$ : 33.333333333333

mean: 0.03

OK Cancel



### 3.1.2 Winner Payment Server

Editing Class1 Service Time Distribution...

Selected Distribution: **Exponential**

Exponential  $[\exp(\lambda)]$ :

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

$\lambda$ : 1

mean: 1

OK Cancel

### 3.1.3 Player Engagement Server

Editing Class1 Service Time Distribution...

Selected Distribution: **Exponential**

Exponential  $[\exp(\lambda)]$ :

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

$\lambda$ : 2.5

mean: 0.4

OK Cancel



## 3.1.4 Database

Editing Class1 Service Time Distribution...

Selected Distribution: Exponential

Exponential  $[\exp(\lambda)]$ :

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

$\lambda$ : 12.5

mean: 0.00

That is not correct, but it was already penalized in previous exercise

OK Cancel

## 3.1.5 Betting Server

Editing Class1 Service Time Distribution...

Selected Distribution: Exponential

Exponential  $[\exp(\lambda)]$ :

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

$\lambda$ : 5.025125628141

mean: 0.199

OK Cancel





## 3.2 Routing Probabilities

### 3.2.1 Router Web Server

Editing Router Web Server Properties...

Station Name: Router Web Server

Router Web Server Parameters Definiton

Routing Section

Routing Strategies

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
Winner Payment ...	0.25
Player Engage...	0.75

Done

## 3.3 Resources

Only PlayerEngagementServer has 2 servers working in parallel.

Editing Player Engagement Server Properties...

Station Name: Player Engagement Server

Player Engagement Server Parameters Definiton

Queue Section Service Section Routing Section

Number of Servers

Number: 2

Service Time Distributions

Class	Strategy	Service Time Distribution	
Class1	Load Independent	exp(1)	Here it should be exp(2.5) Edit

Done



There is no System Response Time to choose in Performance Indices in this version.

**Define performance indices**

**Performance Indices**  
Define performance indices to be collected and plotted by the simulation engine.

---Select an index---

Performance Index	Class/Mode	Station/Region/System	Stat.Res.	Conf.Int.	Max Rel.Err.
Number of Customers	Class1	Web Server	<input type="checkbox"/>	0.99	0.03
Response Time	Class1	Web Server	<input type="checkbox"/>	0.99	0.03
Residence Time	Class1	Web Server	<input type="checkbox"/>	0.99	0.03
Utilization	Class1	Web Server	<input type="checkbox"/>	0.99	0.03
Throughput	Class1	Web Server	<input type="checkbox"/>	0.99	0.03

**Statistical Results CSV file**  
Check the 'Stat.Res.' button to collect samples in a CSV file for additional statistical analysis. This option may produce a file with a large size.  
CSV files path: C:\Computer Science\UML\UMT

Browse

Delimiter: .  
Decimal separator: ,

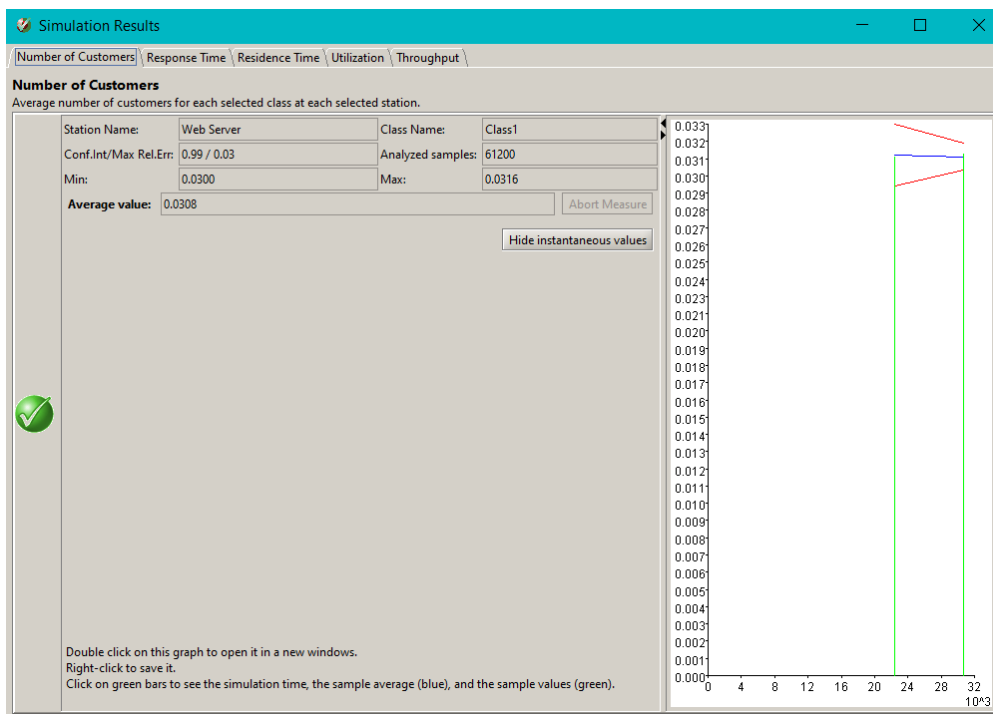
Done

---Select an index---

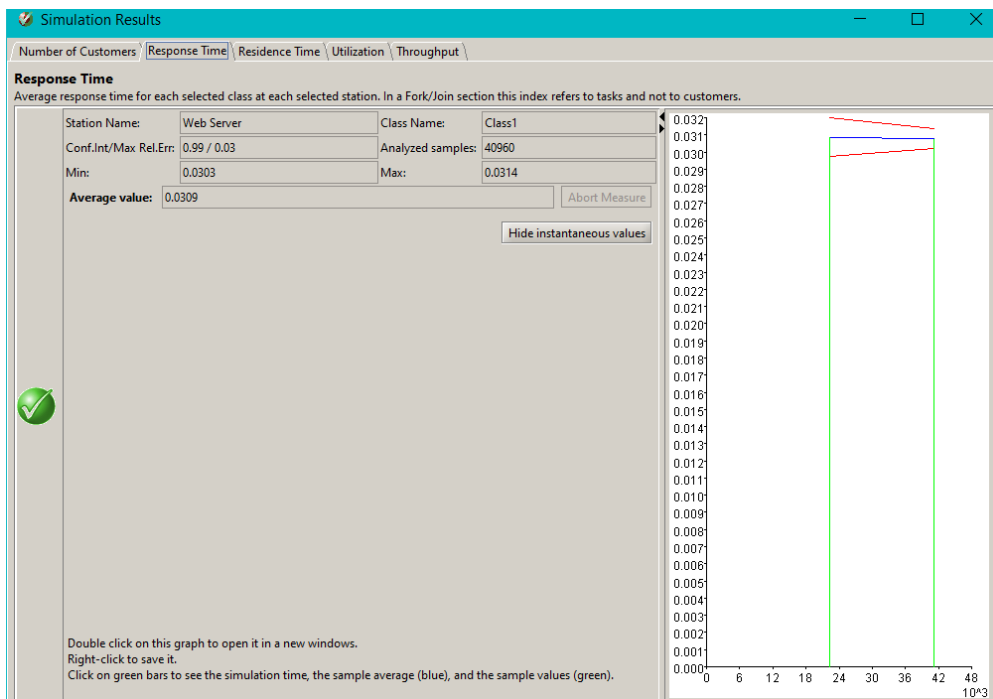
- Number of Customers
- Queue Time
- Response Time
- Residence Time
- Utilization
- Throughput
- Drop Rate
- Power
- Response Time per Sink
- Throughput per Sink
- FCR Total Weight
- FCR Memory Occupation
- Fork Join Number of Customers
- Fork Join Response Time
- Firing Throughput



## 3.4 Number of Customers

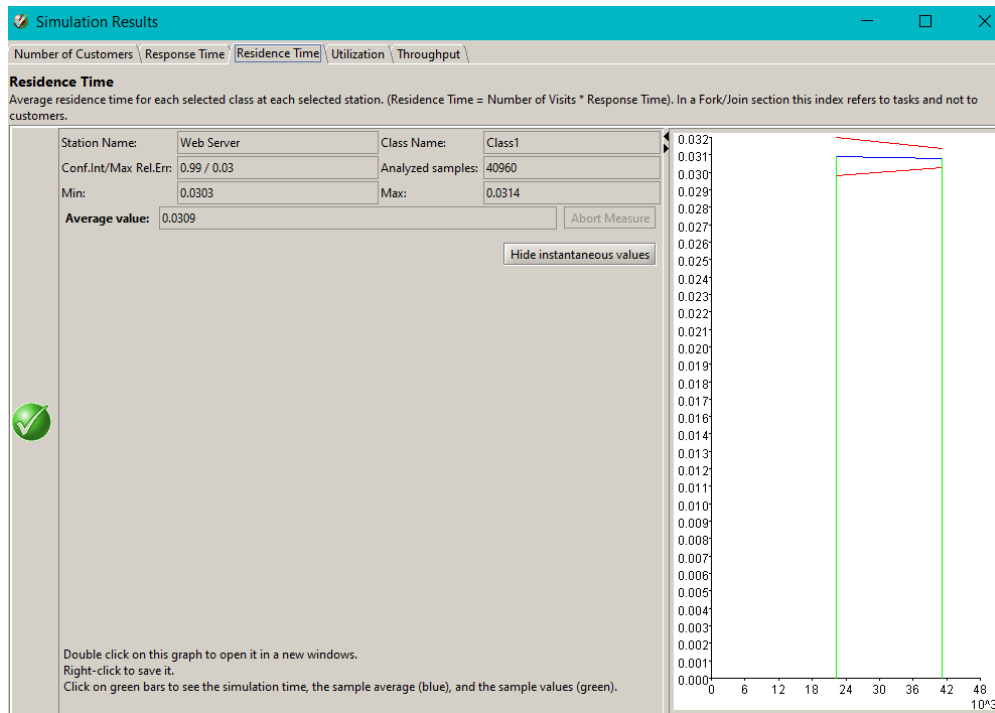


## 3.5 Response Time

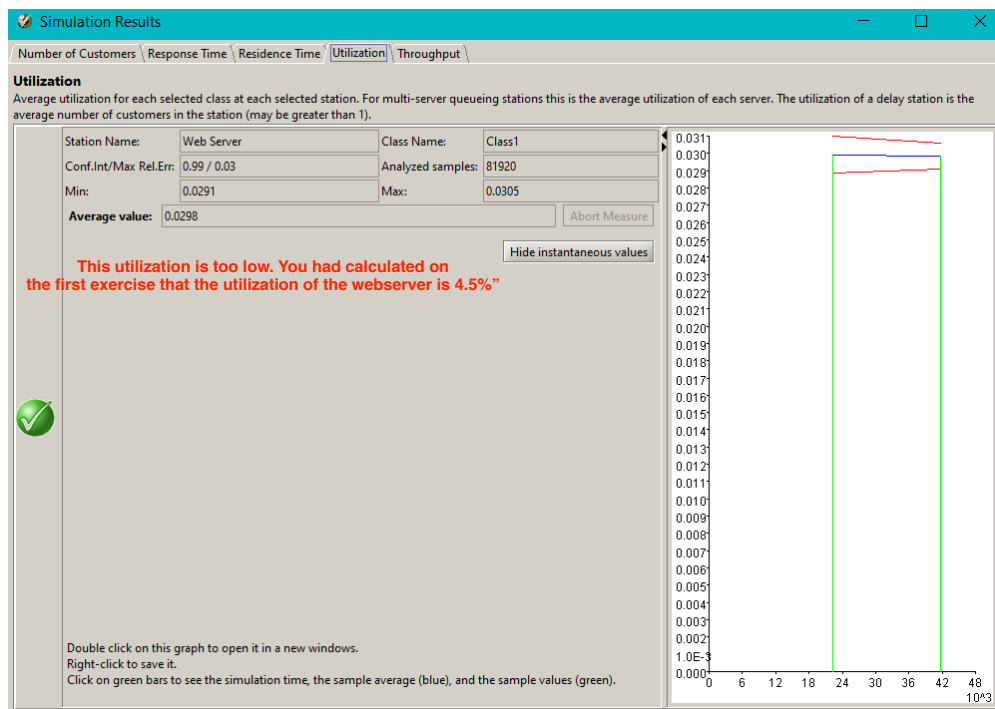




## 3.6 Residence Time

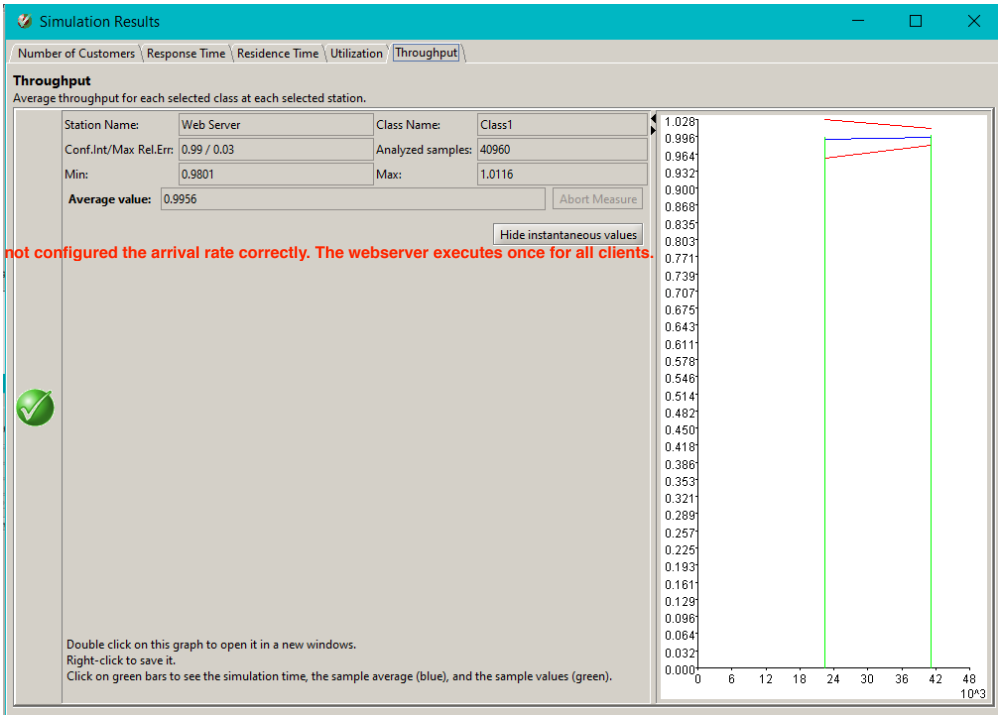


## 3.7 Utilization





3.8 Throughput



Part C not answered