

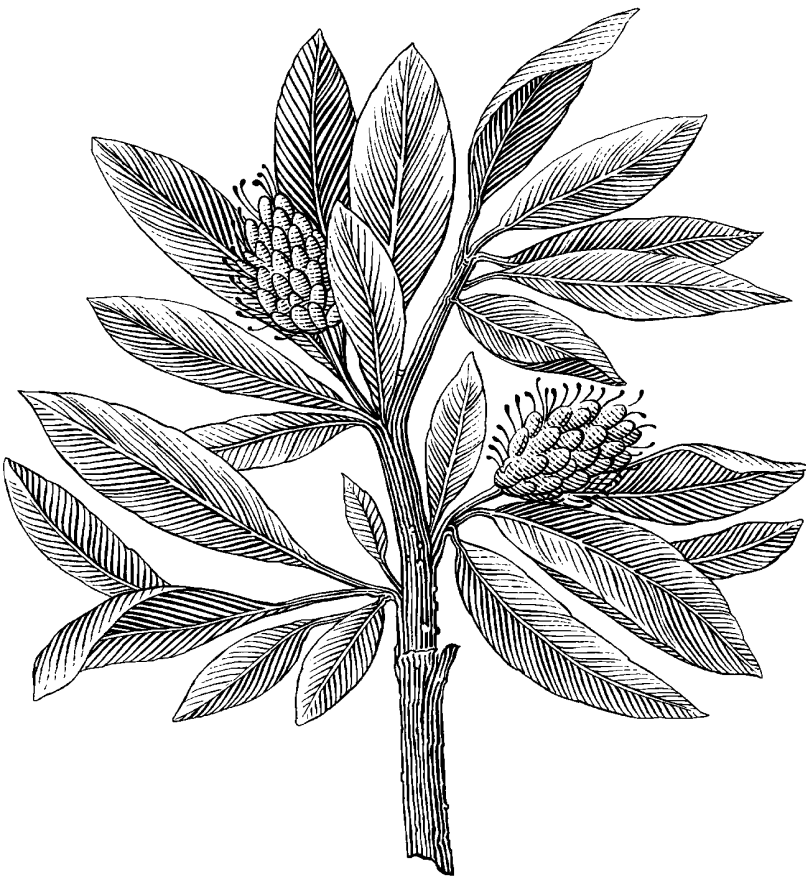


**Linneuniversitetet**  
Kalmar Väst

Exam

# Performance Engineering

2DV608



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*Semester:* Spring 2021  
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# 1 Problem A

This section shows the calculations for each server. It also shows the calculations for the service time of the of the *WinnerPaymentServer*, *Database*, *BettingServer*, and the utilization for the *WebServer*.

## 1.1 Calculations

Cells that with ‘-’ signify that the value was not needed for further calculations. Values in red are the ones that were required.

Server	S	X	U
WebServer	0.03	1.5	0.045
WinnerPaymentServer	1	0.375	0.375
PlayerEngagementServer	0.4	-	-
Database	0.06	-	-
BettingServer	0.199	1.049	0.2091

## 1.2 WebServer

$$S_{ws} = 0.03, C_{ws} = 648,000, T = 432,000$$

$$X_{ws} = C_{ws}/T = 648,000 / 432,000 = 1.5$$

$$U_{ws} = X_{ws} * S_{ws} = 1.5 * 0.03 = 0.045$$

## 1.3 WinnerPaymentServer

$$U_{wps} = 0.375$$

$$C_{wps} = 648,000 * 0.25 = 162,000 \text{ (25\% of C)}$$

$$X_{wps} = C_{wps} / T = 162,000 / 432,000 = 0.375$$

$$S_{wps} = U_{wps} / X_{wps} = 0.375 / 0.375 = 1 \text{ (Using Utilization Law)}$$

## 1.4 Database

$$D_{db} = 0.12, V_{db} = 2$$

$$S_{db} = D_{db} / V_{db} = 0.12 / 2 = 0.06$$

## 1.5 BettingServer

$$N_{bs} = 0.265, R_{bs} = 0.2525, U_{bs} = 0.2091$$

$$X_{bs} = N_{bs} / R_{bs} = 0.265 / 0.2525 = 1.049 \text{ (Using Little's Law)}$$

$$S_{bs} = U_{bs} / X_{bs} = 0.2091 / 1.049 = 0.199 \text{ (Using Utilization Law)}$$

Frequency at which users proceed to betting server or finish session:

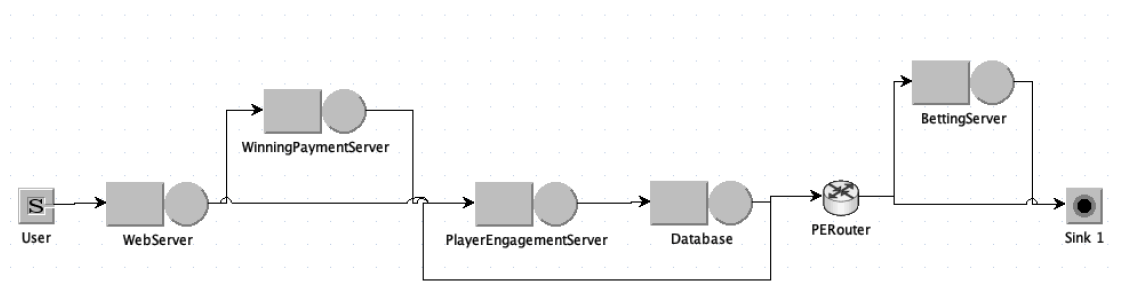
$$C_{bs} = X_{bs} * T = 1.049 * 432,000 = 453,168$$

$$\text{Frequency} = (C_{bs} / C) * 100 = (453,168 / 648,000) * 100 = 69.99\%$$

## 2 Problem B

This section contains screenshots from the JMT Model including the *System Response Time*, *Utilization* and *Throughput* for each server.

### 2.1 Model



### 2.2 Service Time

Selected Distribution: Exponential

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

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

$\lambda$ : 33.33333333333333

mean: 0.03

WebServer

Selected Distribution: Exponential

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

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

$\lambda$ : 1

mean: 1

WinningPaymentServer

Selected Distribution: Exponential

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

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

$\lambda$ : 2.5

mean: 0.4

PlayerEngagementServer

Selected Distribution: Exponential

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

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

$\lambda$ : 16.666666666667

mean: 0.06

Database

Selected Distribution: Exponential

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

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

$\lambda$ : 5.025125628141

mean: 0.199

BettingServer

Selected Distribution: Exponential

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

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

$\lambda$ : 1.5

mean: 0.666666666667

Class arrival rate

## 2.3 Routing

WebServer Parameters Definition

Queue Section | Service Section | Routing Section

Class	Routing Strategy
Class3	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.

Destination	Probability
WinningPayment...	0.25
PlayerEngagem...	0.75

WebServer

Database Parameters Definition

Queue Section | Service Section | Routing Section

Class	Routing Strategy
Class3	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.

Destination	Probability
PlayerEngagem...	0.5
PERouter	0.5

PlayerEngagementServer)

Database (Iterating Twice to

PERouter Parameters Definition

Routing Section

Routing Strategies

Class	Routing Strategy
Class3	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
BettingServer	0.69
Sink 1	0.31

PERouter (From PlayerEngagingServer to BettingServer or finishing)

Station Name  
Station Name: PlayerEngagementServer

PlayerEngagementServer Parameters Definition

Queue Section Service Section Routing Section

Number of Servers

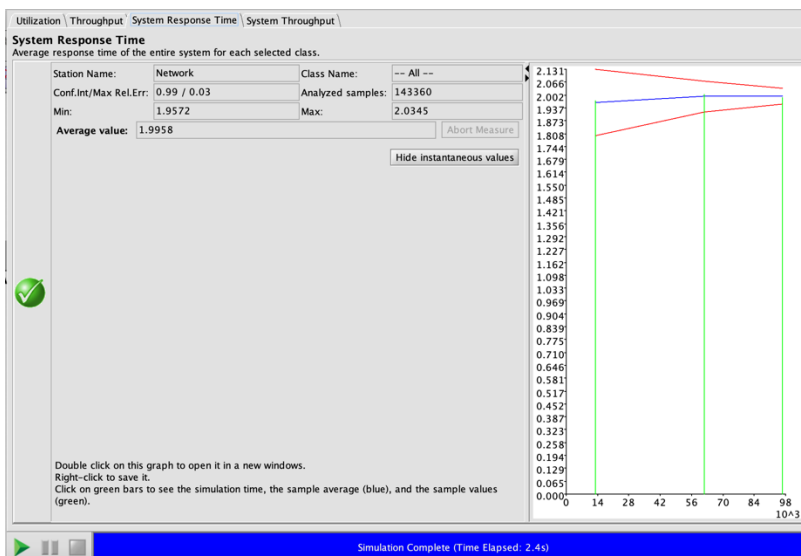
Number: 2

Service Time Distributions

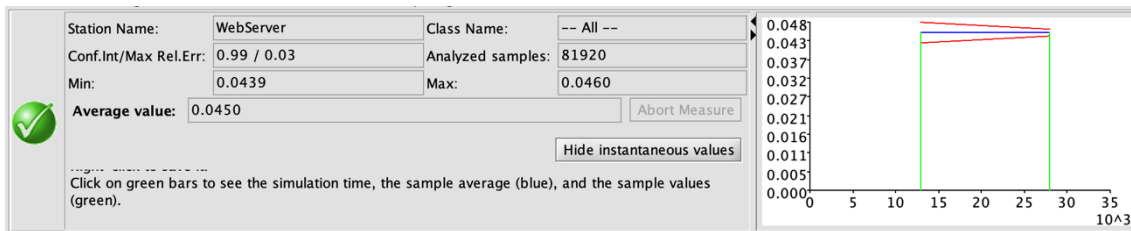
Class	Strategy	Service Time Distribution	Edit
Class3	Load Independent	exp(2.5)	Edit

Two servers for PlayerEngagementServer

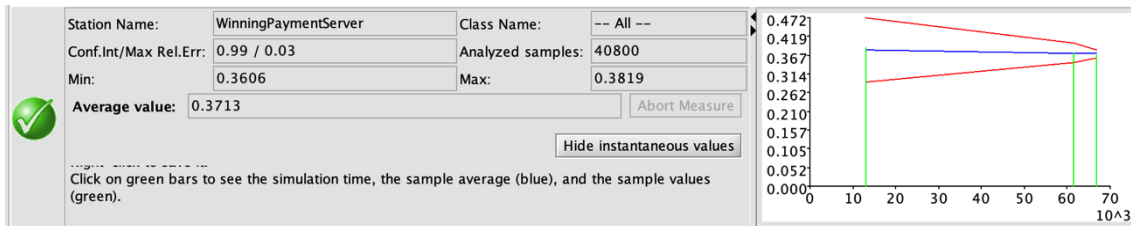
## 2.4 System Response Time



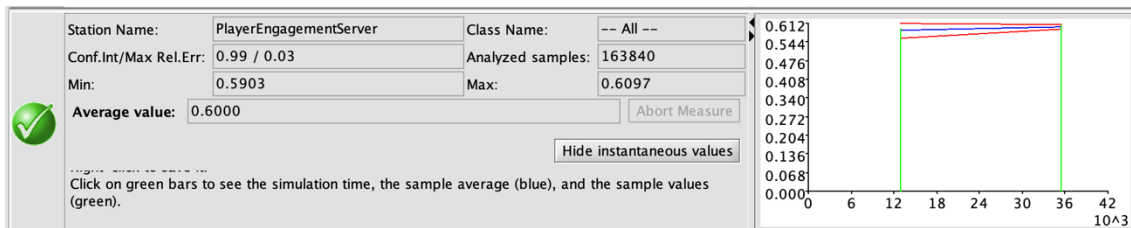
## 2.5 Utilization



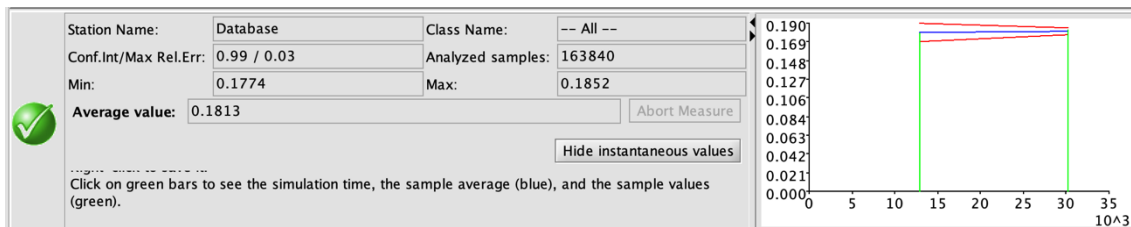
WebServer



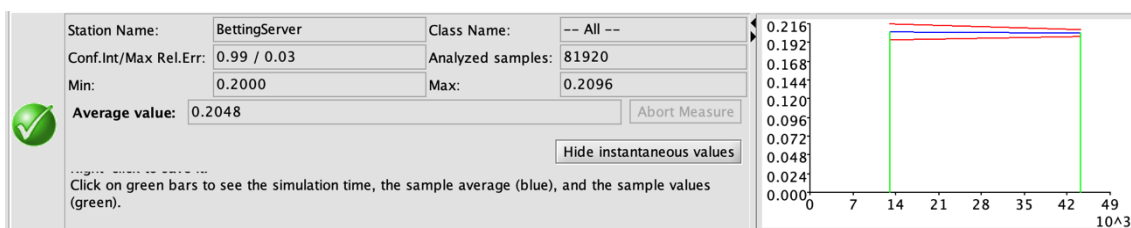
WinningPaymentServer



PlayerEngagementServer

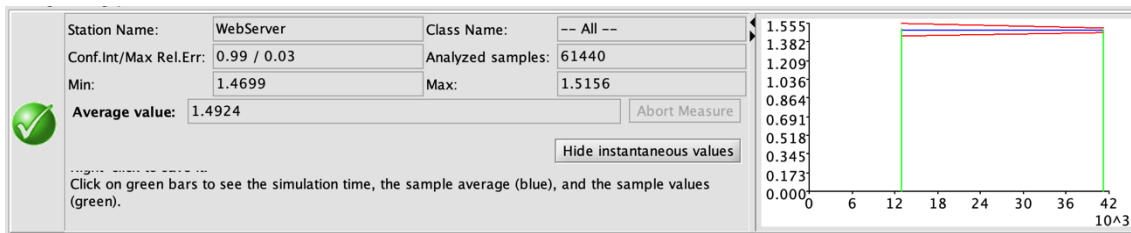


Database

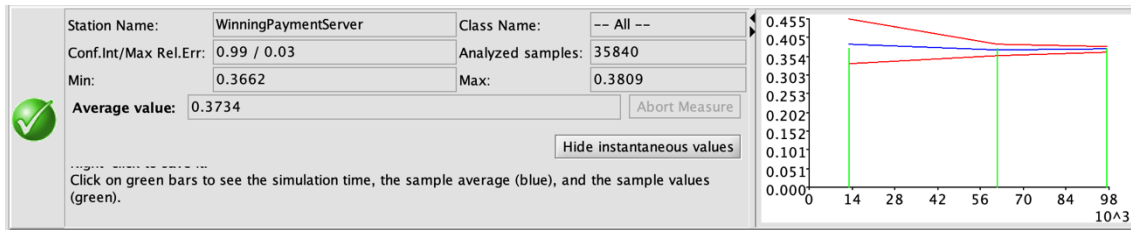


BettingServer

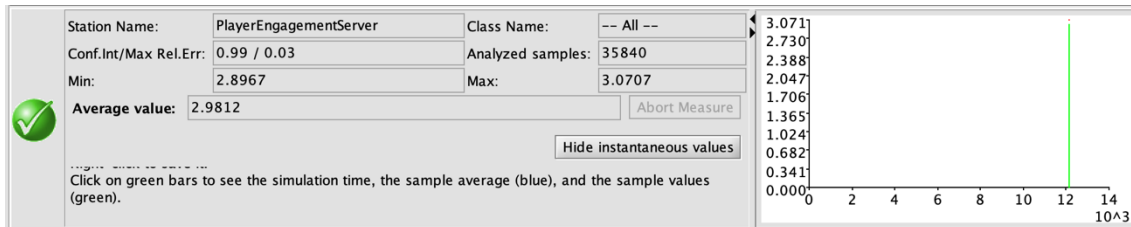
## 2.6 Throughput



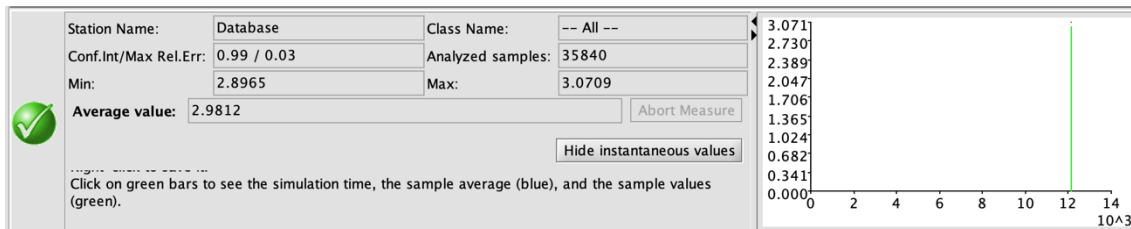
WebServer



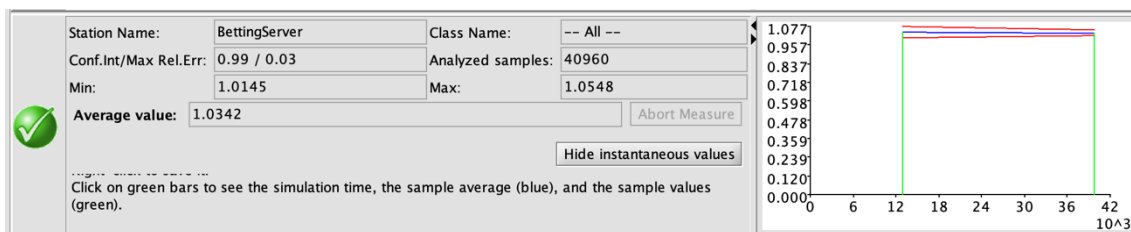
WinningPaymentServer



PlayerEngagementServer



Database



BettingServer

## 3 Problem C

This section includes the calculations and screenshots of the updated JMT model.



### 3.1 PlayerEngagementServer Calculations

$X = 3$  (180 users per minute) ,  $S_{pes} = 0.4$  ,  $V_{pes} = 4$  ,  $c_{pes} = 2$

$$X_{pes} = V_{pes} * X = 4 * 3 = 12$$

$$U_{pes} = (X_{pes} * S_{pes}) / c_{pes} = (12 * 0.4) / 2 = 2.4 = 240\%$$

With 2 parallel servers the system saturates. However, using 5 parallel servers ( $c = 5$ ) prevents saturation as seen below:

$$U_{pes} = (X_{pes} * S_{pes}) / c_{pes} = (12 * 0.4) / 5 = 0.96 = 96\%$$

### 3.2 Database Calculations

$X = 3$  ,  $S_{pes} = 0.06$  ,  $V_{pes} = 4$

$$X_{pes} = V_{pes} * X = 4 * 3 = 12$$

$$U_{pes} = X_{pes} * S_{pes} = 12 * 0.06 = 0.72 = 72\%$$

Out of the PlayerEngagementServer and the Database, the PlayerEngagementServer will saturate first. For the database no extra parallel servers are needed.

### 3.3 Updated Iterations and Users per minute and No. of Servers

Class	Routing Strategy
Class3	Probabilities

Destination	Probability
PlayerEngagem...	0.75
PERouter	0.25

Iterating four times to PlayerEngagementServer

Selected Distribution: Exponential

Exponential  $[exp(\lambda)]$ :

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

$\lambda$ : 3

mean: 0.333333333333

180 users per minute

Station Name:

**PlayerEngagementServer Parameters Definition**

Queue Section | Service Section | Routing Section

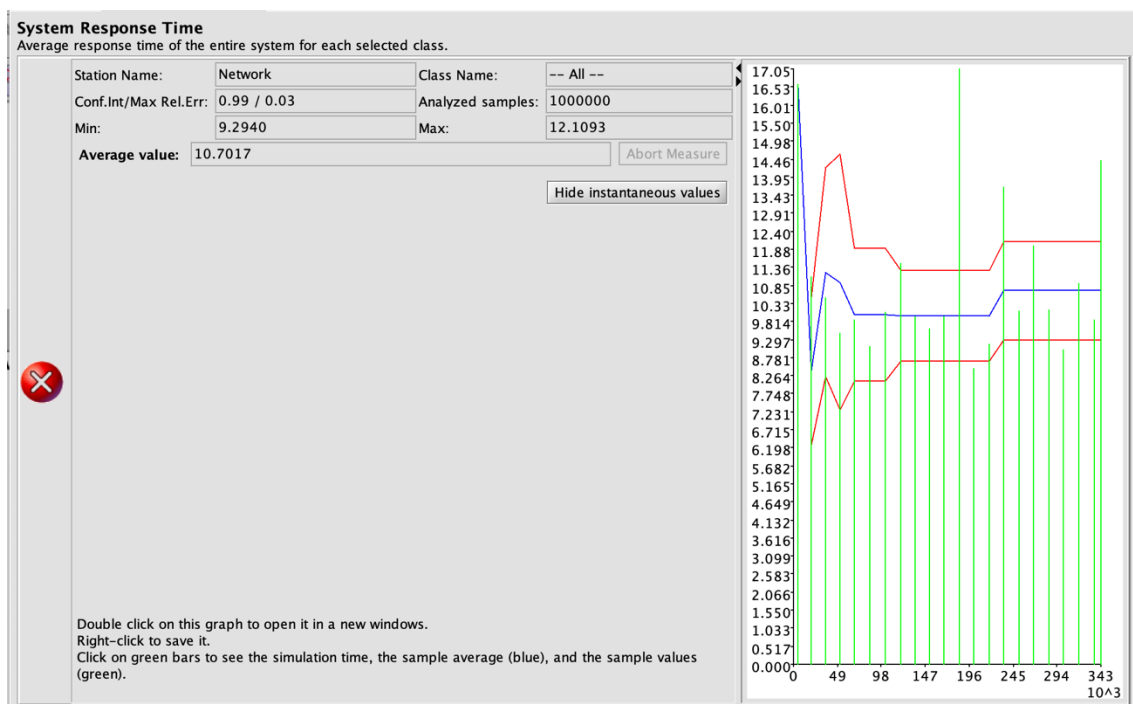
Number of Servers: Number:

**Service Time Distributions**

Class	Strategy	Service Time Distribution	Edit
Class3	Load Independent	exp(2.5)	Edit

Three parallel servers for PlayerEngagementServer

### 3.4 System Response Time



As shown the System Response Time is 10.7. It is also red; this is due to the high variance and the fact that the PlayerEngagementServer and Database are so close to being saturated.