

Performance evaluation of software systems - Tools

Software Engineering - Design

2DV608

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Linnæus University



Java Modelling Tools

- 1. Obtain and install JMT tool**
- 2. Getting familiar with JMT**
 - 1. Model open queue. Define performance indexes.
Evaluation**
 - 2. Model closed queue. Evaluation**
- 3. Evaluating computing infrastructures with JMT**
 - 1. Performance evaluation through QN simulation**



Obtain and install JMT

- Download from:
<http://jmt.sourceforge.net>

- Install FULL version
- Execute JMT.jar

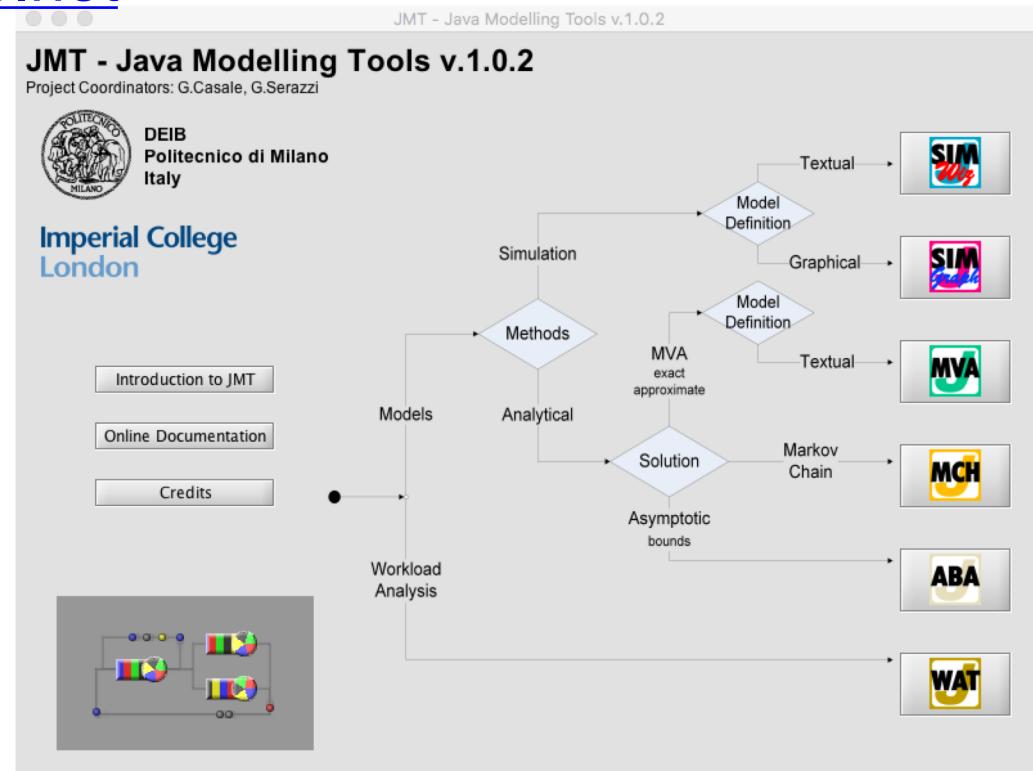


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1. Obtain and install JMT tool

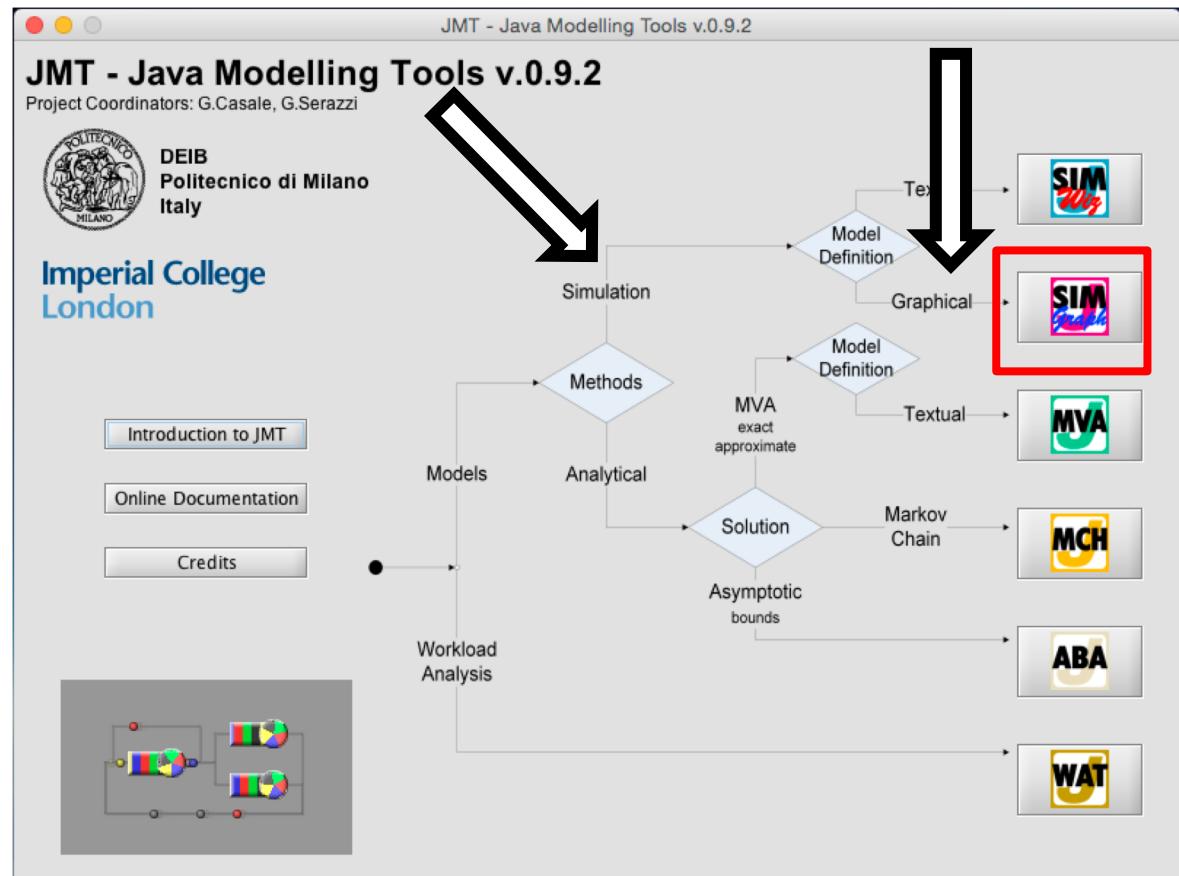
2. **Getting familiar with JMT**
 1. Model open queue. Define performance indexes.
Evaluation
 2. Model closed queue. Evaluation

3. Evaluating computing infrastructures with JMT
 1. Performance evaluation through QN simulation



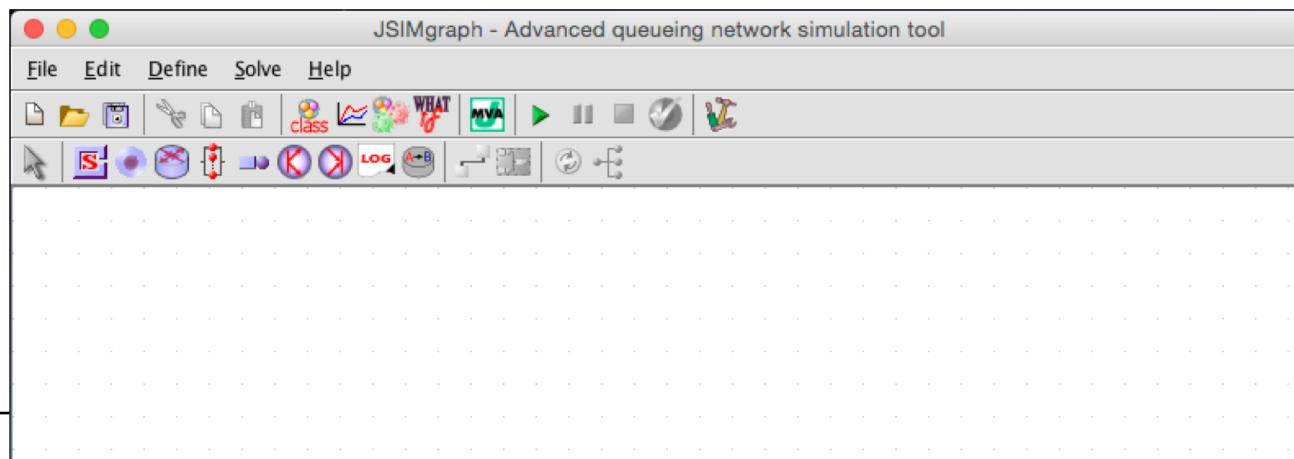
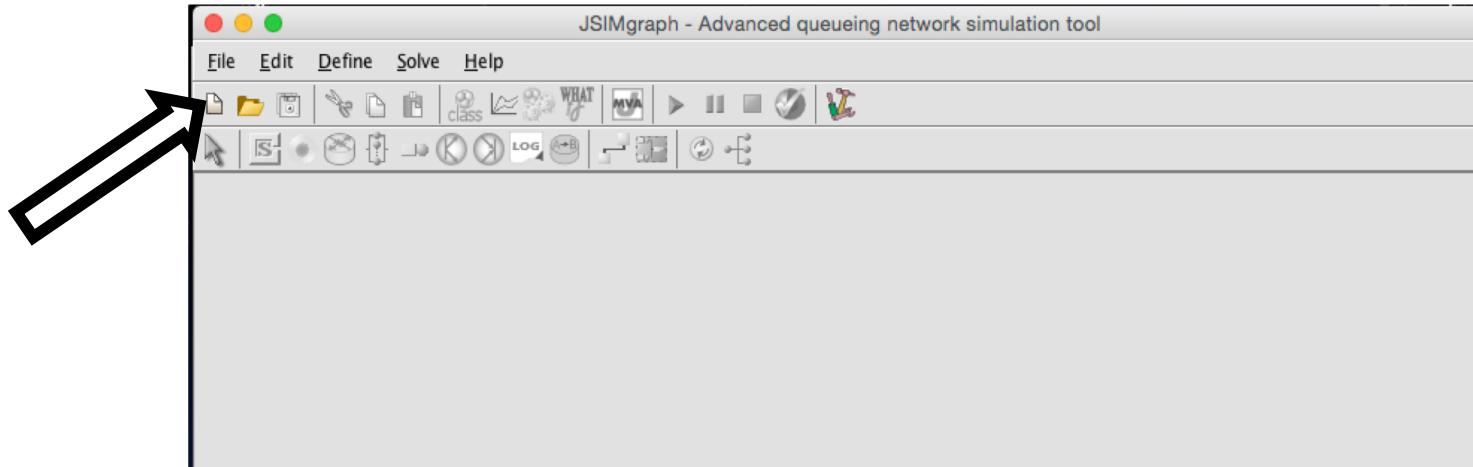
Getting Familiar with JMT

- Start with SIMgraph



Getting Familiar with JMT

- Create new model





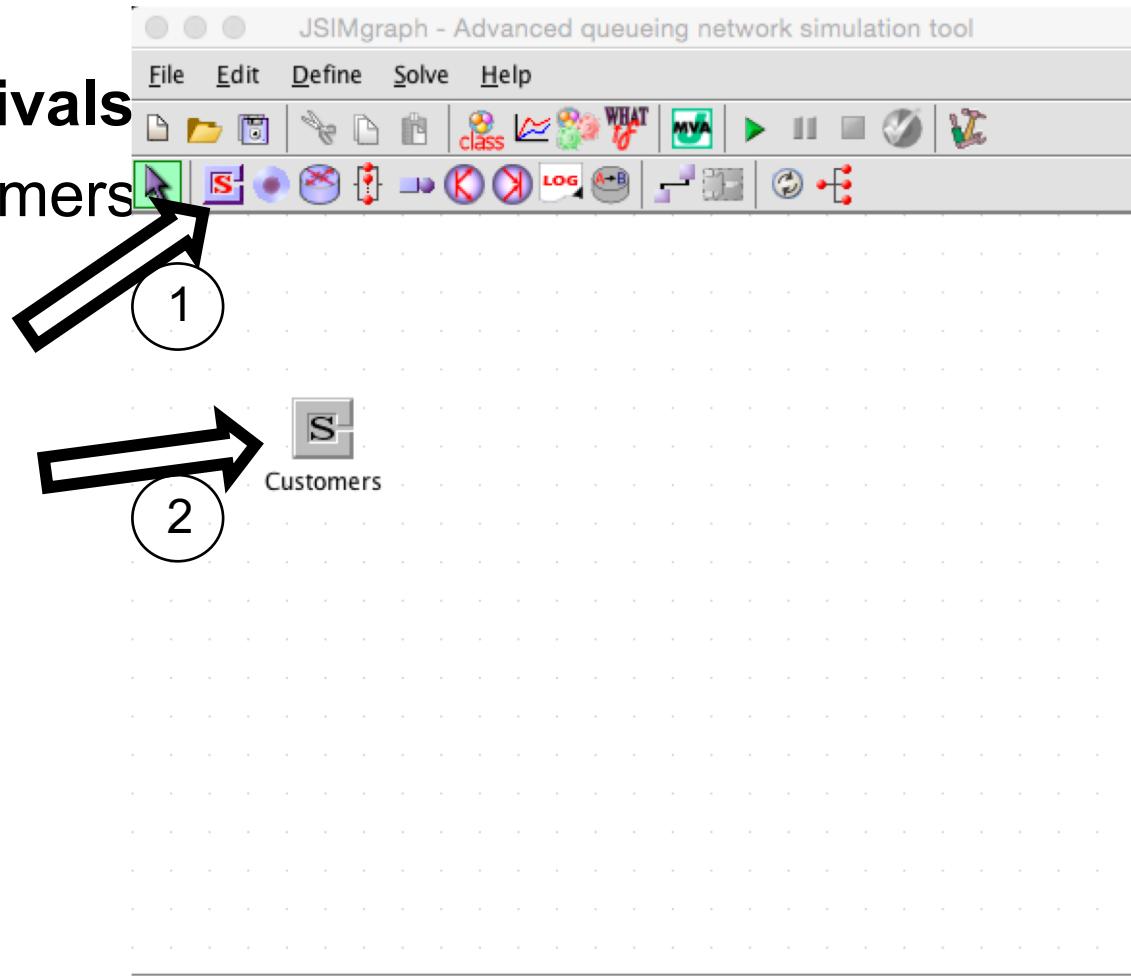
Getting familiar with JMT

Model open queue. Define performance indexes.
Evaluation

Getting Familiar with JMT: Model open queue

- We need:

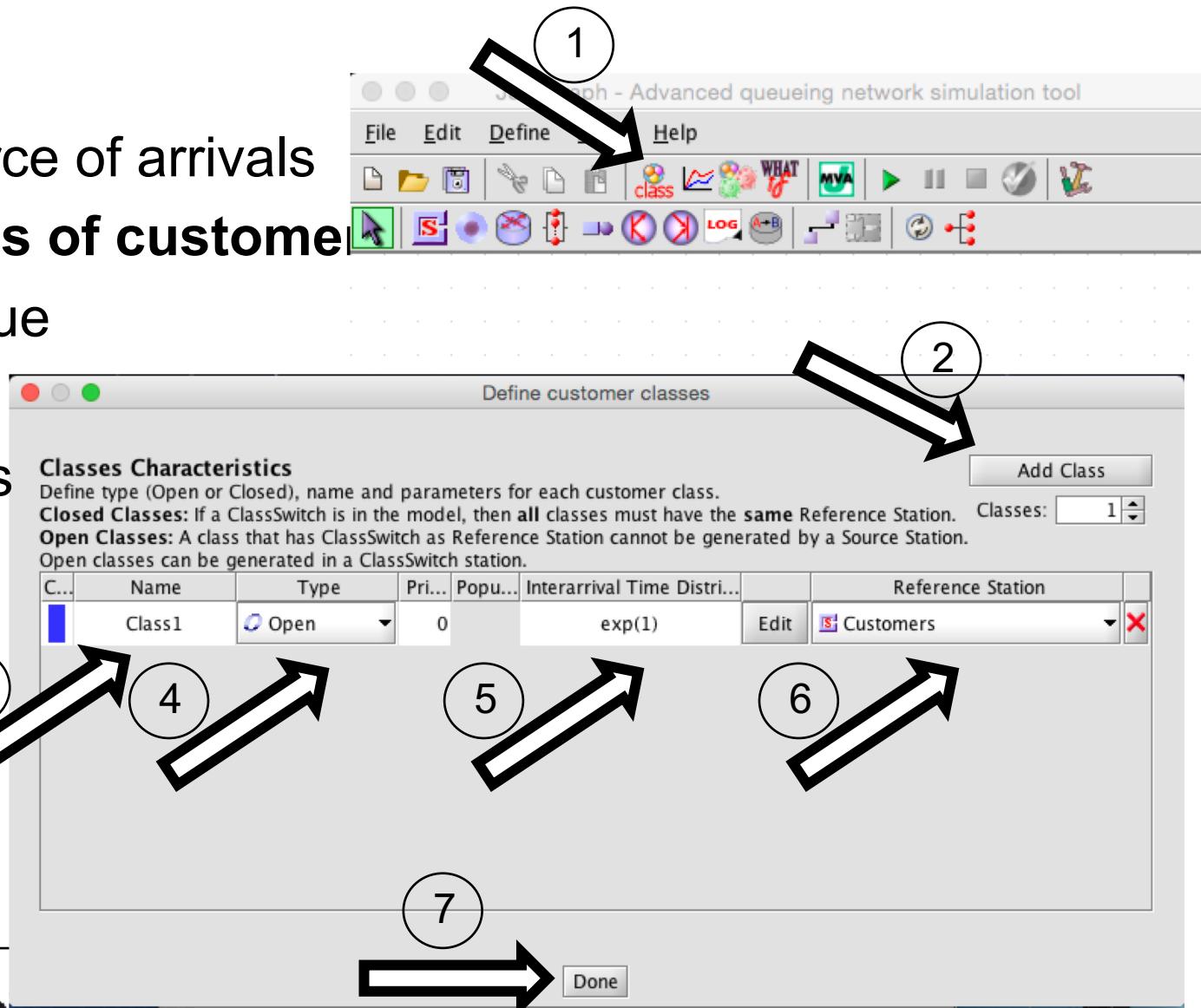
- **Source of arrivals**
- Class of customers
- Queue
- Sink
- Links



Getting Familiar with JMT: Model open queue

- We need:

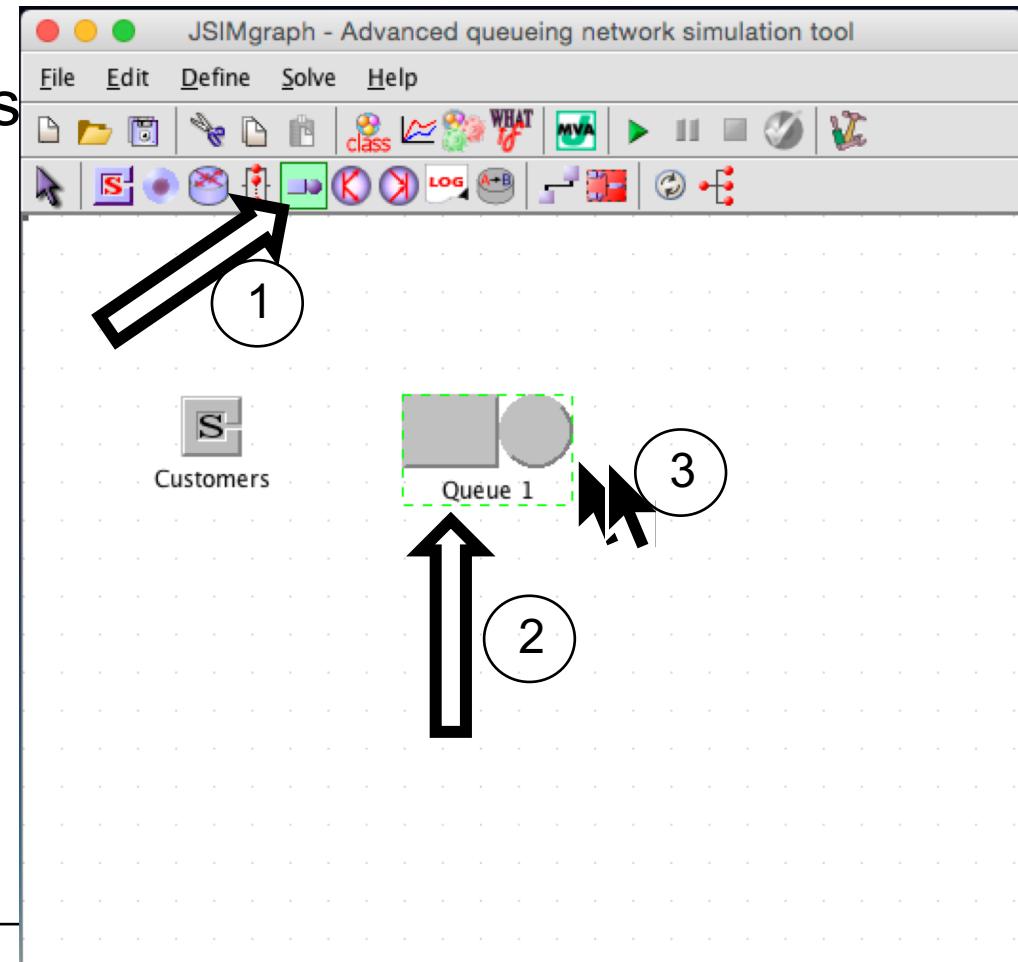
- Source of arrivals
- **Class of customer**
- Queue
- Sink
- Links



Getting Familiar with JMT: Model open queue

- We need:

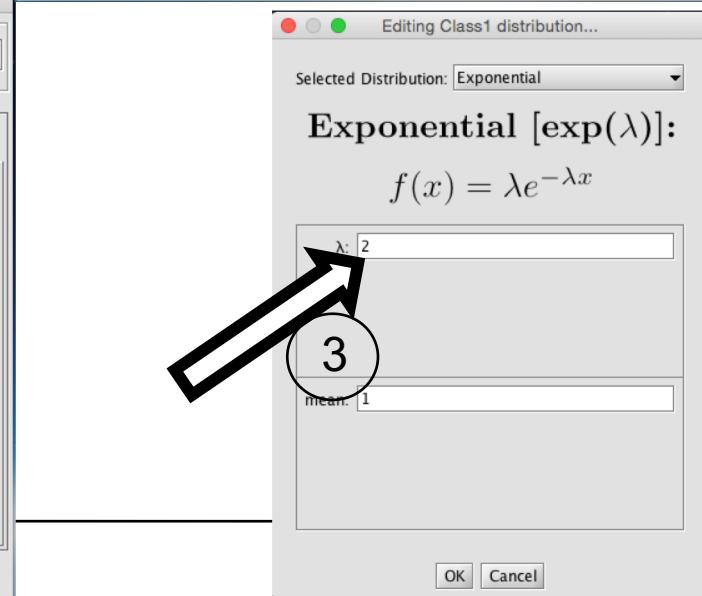
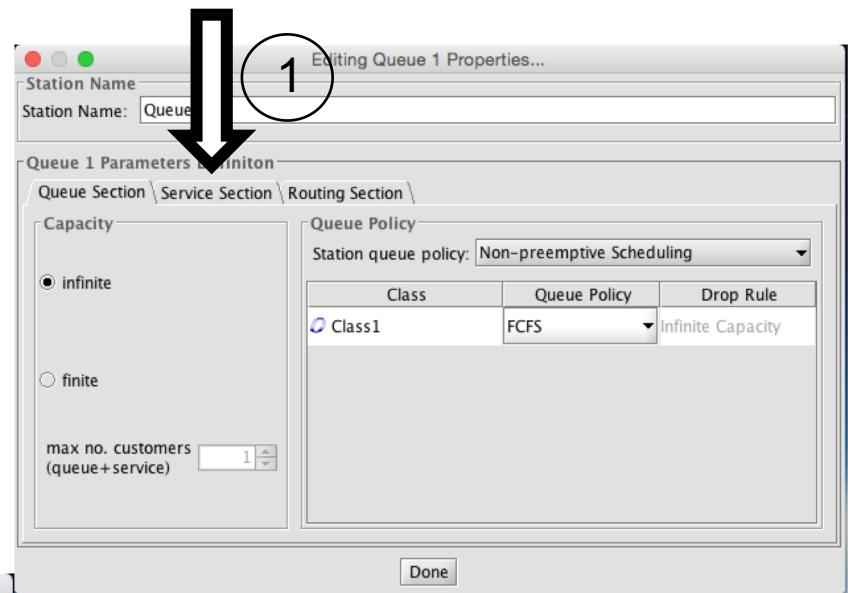
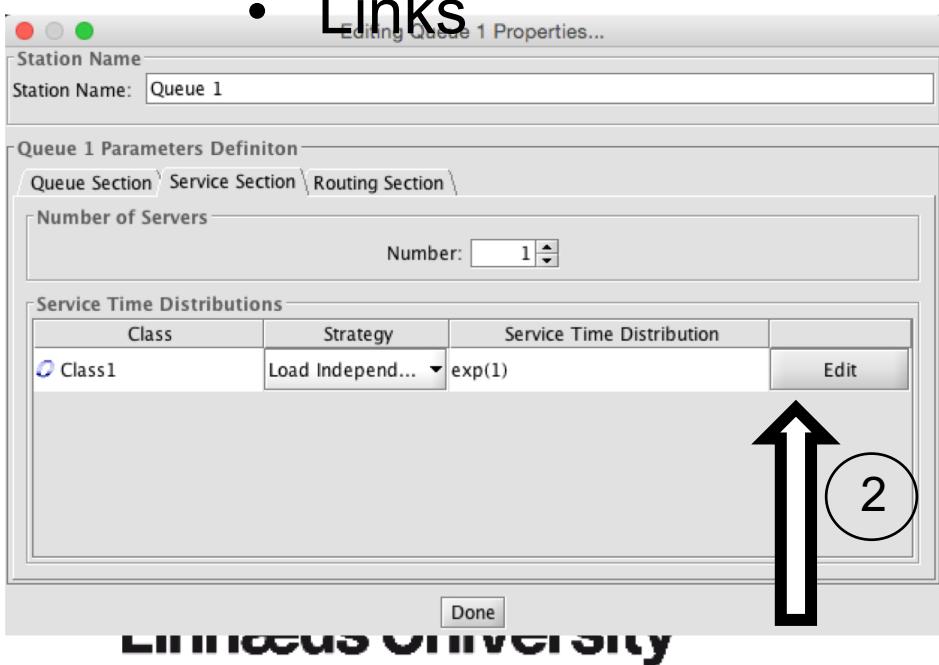
- Source of arrivals
- Class of customers
- Queue
- Sink
- Links



Getting Familiar with JMT: Model open queue

- We need:

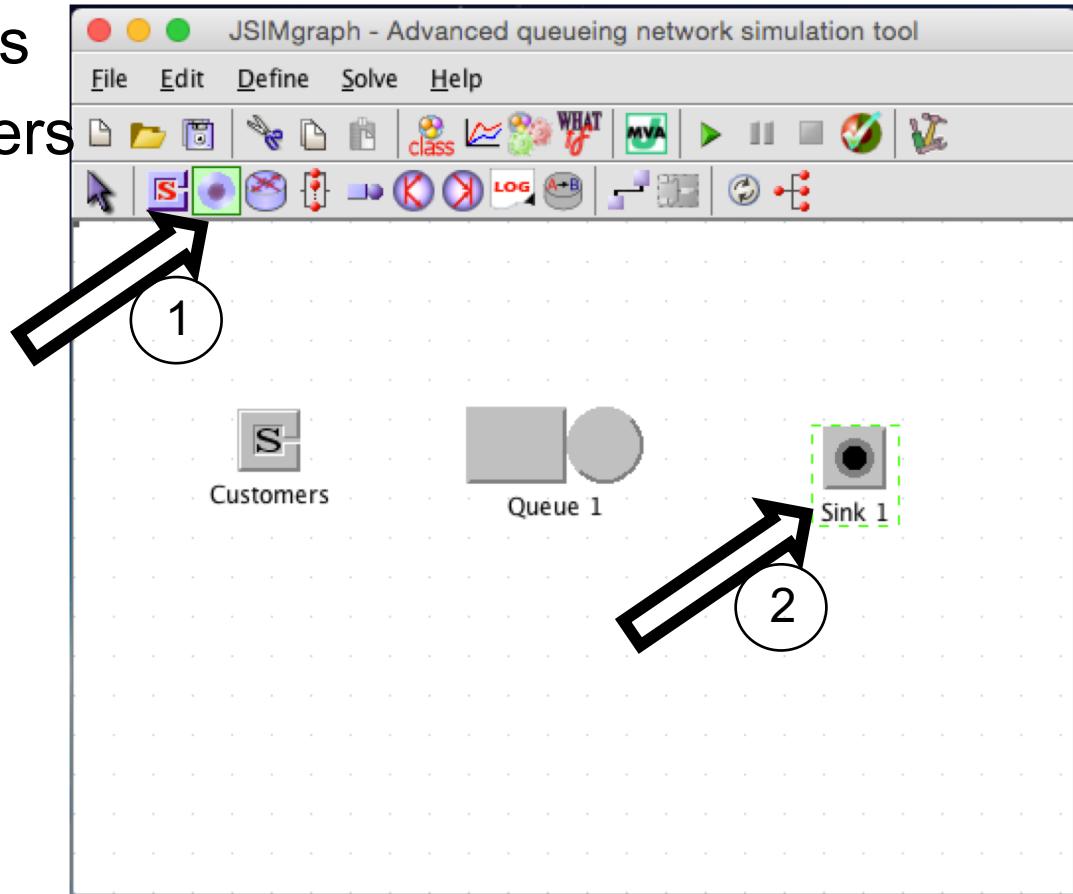
- Source of arrivals
- Class of customers
- Queue
- Sink
- Links



Getting Familiar with JMT: Model open queue

- We need:

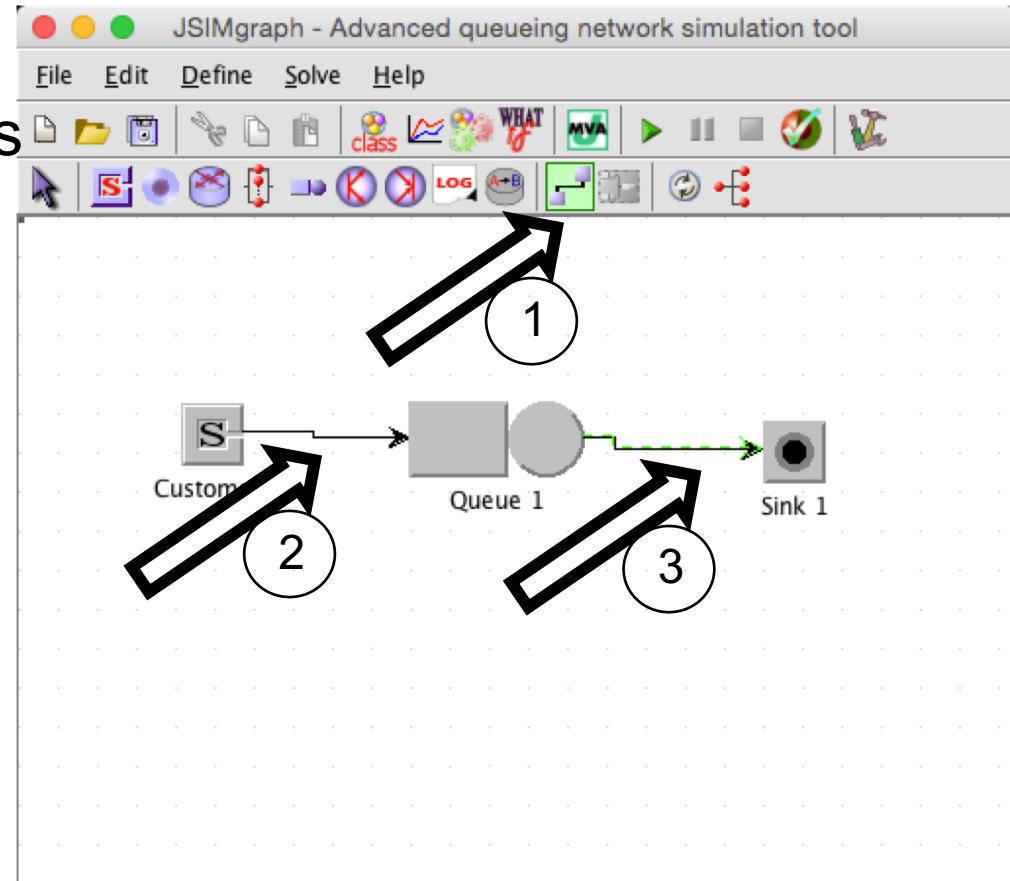
- Source of arrivals
- Class of customers
- Queue
- **Sink**
- Links



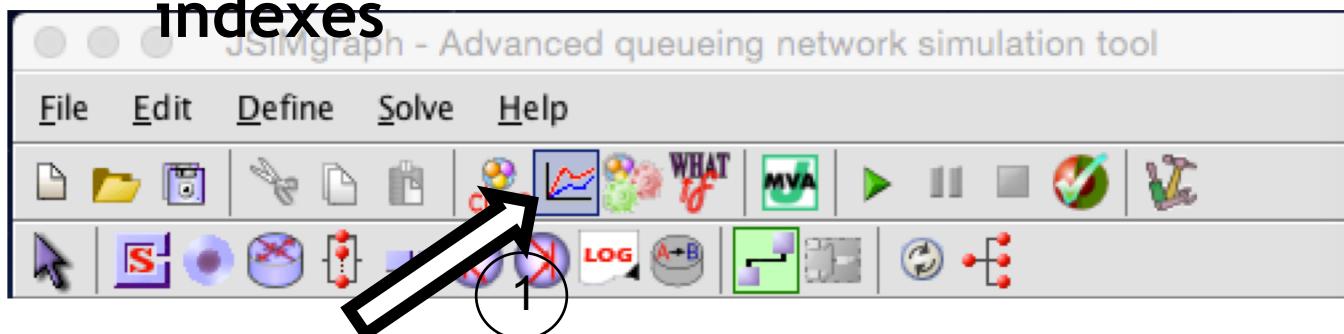
Getting Familiar with JMT: Model open queue

- We need:

- Source of arrivals
- Class of customers
- Queue
- Sink
- Links



Getting Familiar with JMT: Define performance indexes



Define performance indices

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

Performance Index	Class	Station/Region	Stat.R...

---Select an index---

- Select an index---
- Number of Customers
- Queue Time
- Residence Time
- Response Time
- Utilization
- Throughput
- Drop Rate
- System Throughput
- System Response Time
- System Drop Rate
- System Number of Customers
- System Power
- Throughput per Sink
- Response Time per Sink

Decimal separator: .

Statistical Results CSV file
Check the 'Stat.Res.' button to collect samples in a CSV file for additional analysis. This may produce a file with a large size.

CSV files path: /Users/perez/JMT

A large black arrow labeled '2' points to the dropdown menu titled '---Select an index---'. Red arrows point from each item in the dropdown menu to its corresponding entry in the list below it.



Getting Familiar with JMT: Define performance indexes

Define performance indices

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

Performance Index	Class	Station/Region	Stat.Res.	Conf.Int.	Max Rel.Err.	
Number of Customers	Class1	Queue 1	<input type="checkbox"/>	0.99	0.03	X
Residence Time	Class1	Queue 1	<input type="checkbox"/>	0.99	0.03	X
Response Time	Class1	Queue 1	<input type="checkbox"/>	0.99	0.03	X
Utilization	Class1	Queue 1	<input type="checkbox"/>	0.99	0.03	X
Throughput	Class1	Queue 1	<input type="checkbox"/>	0.99	0.03	X
System Response Time	Class1		<input type="checkbox"/>	0.99	0.03	X
System Throughput	Class1		<input type="checkbox"/>	0.99	0.03	X

---Select an index---

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.

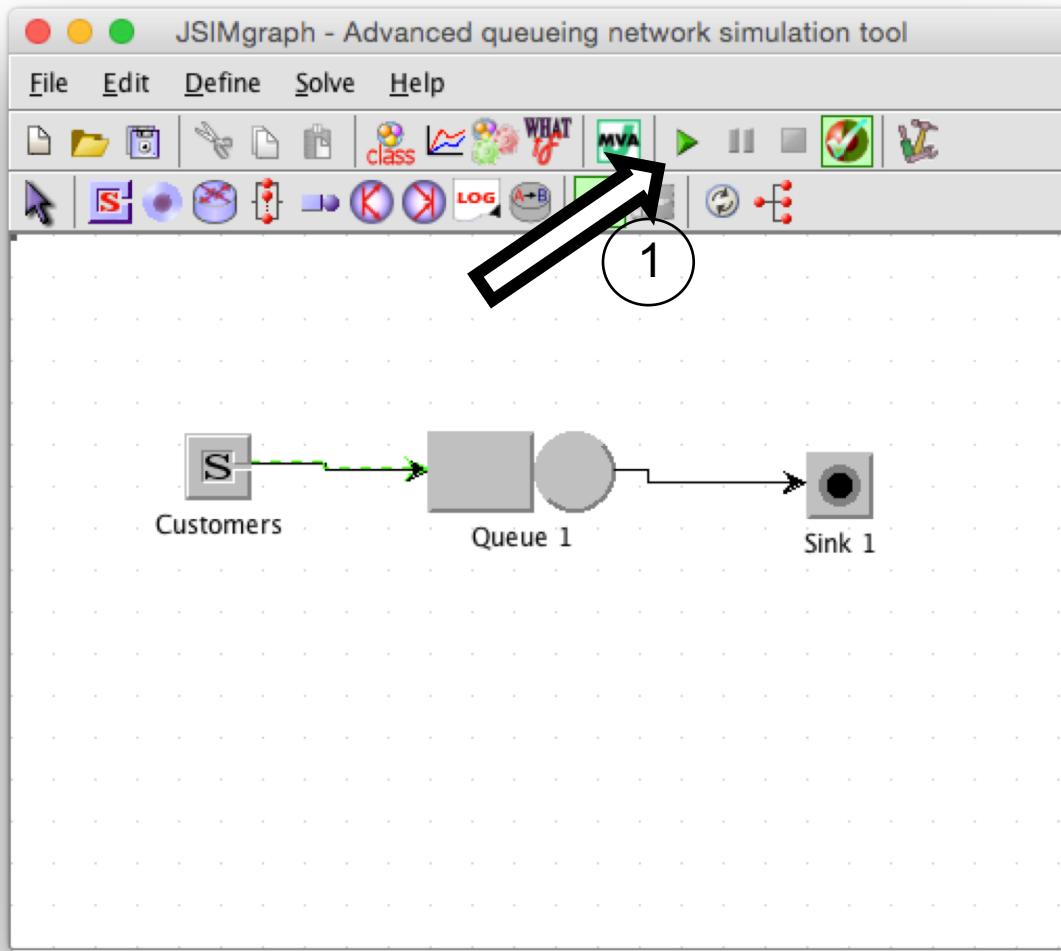
CSV files path: /Users/perez/JMT

Delimiter: ;

Decimal separator: .

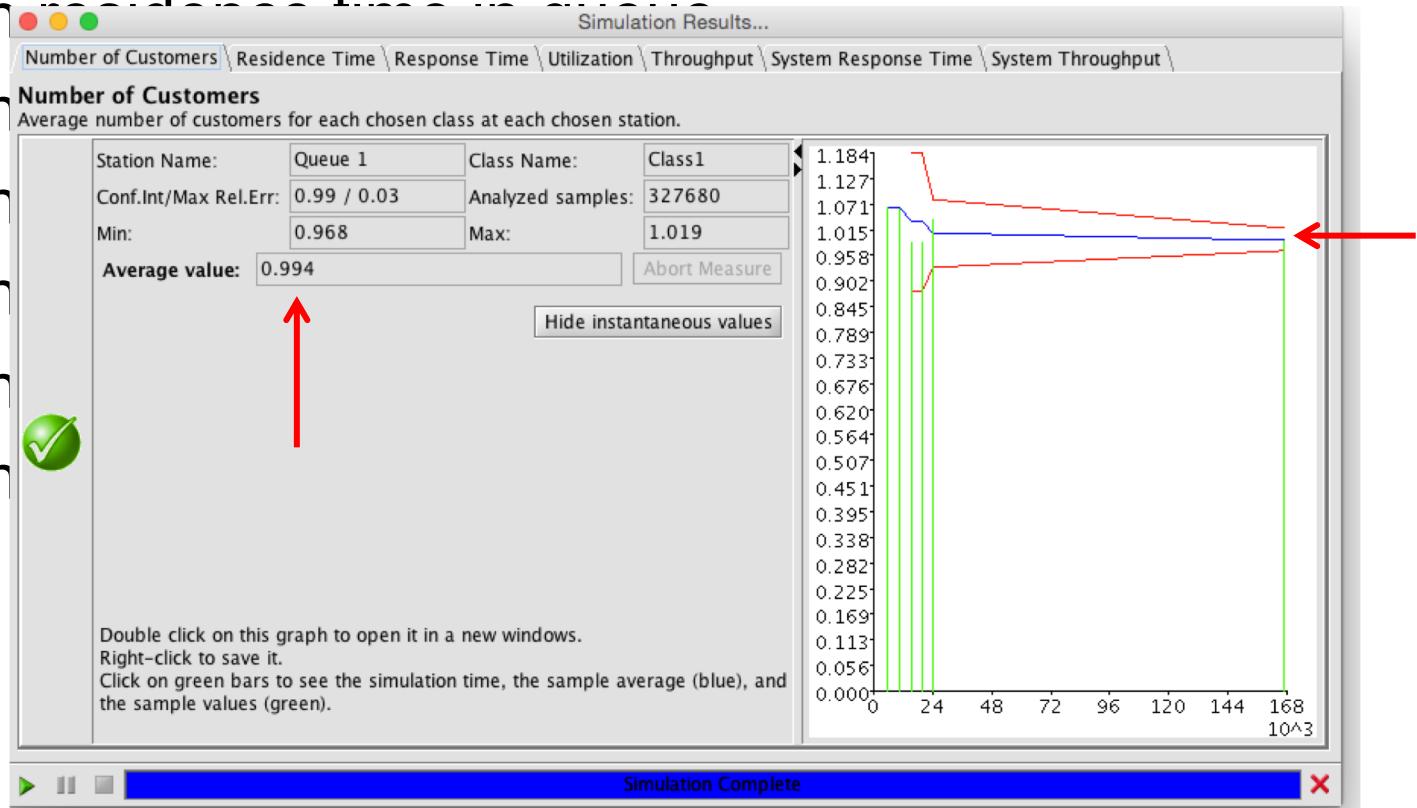


Getting Familiar with JMT: Evaluation



Getting Familiar with JMT: Evaluation

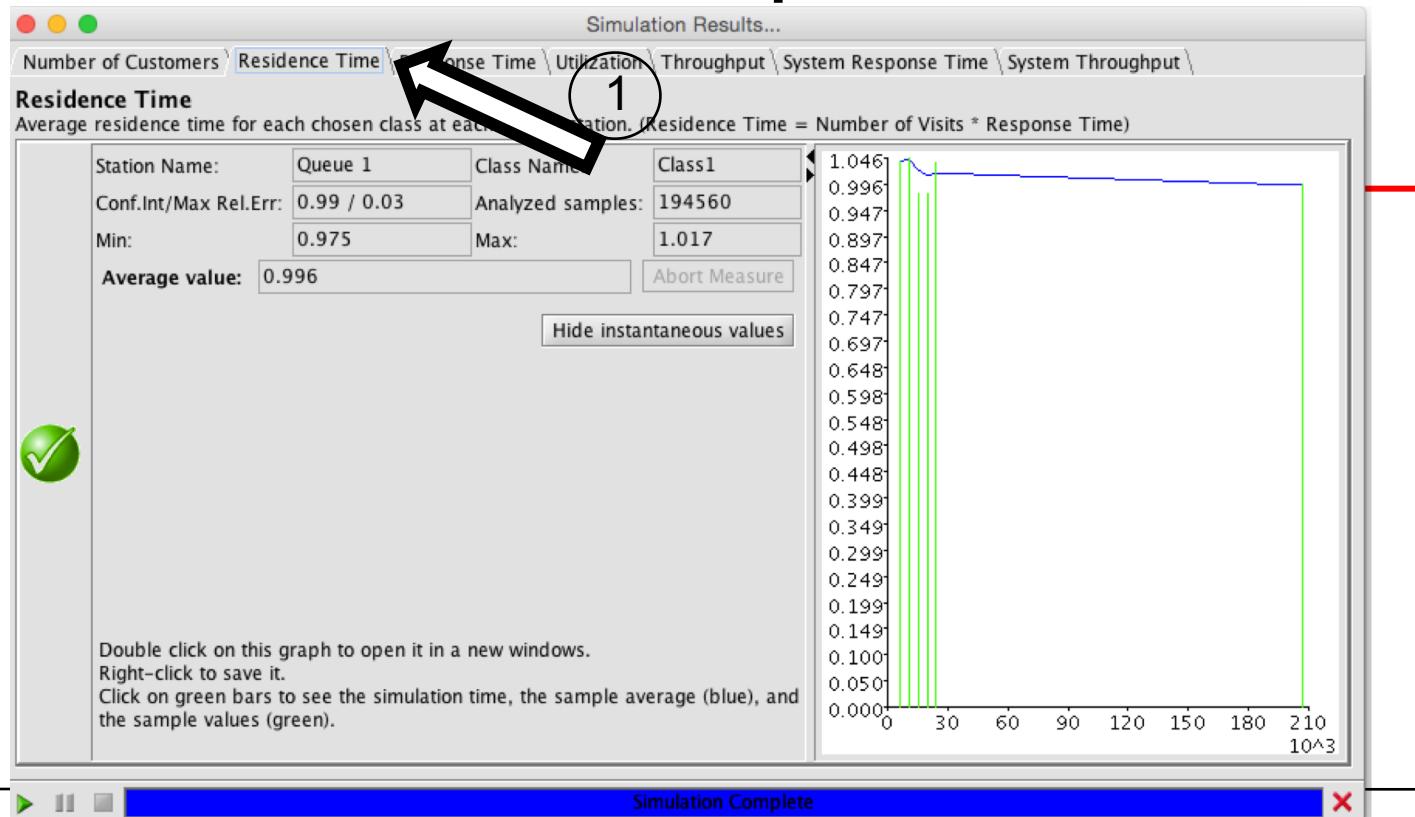
- We evaluated:
 - Mean number of costumers
 - Mean residence time
 - Mean response time
 - Mean utilization
 - Mean throughput
 - System response time
 - System throughput



Getting Familiar with JMT: Evaluation

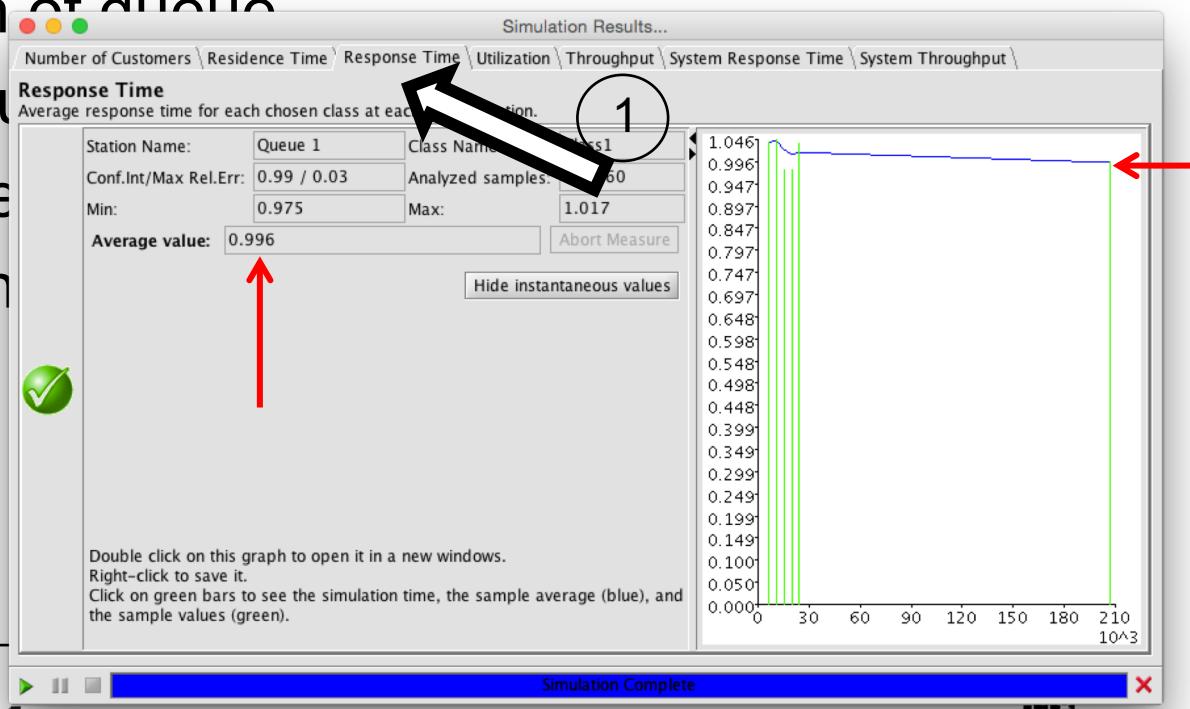
- We evaluated:

- Mean number of costumers
- **Mean residence time in queue**



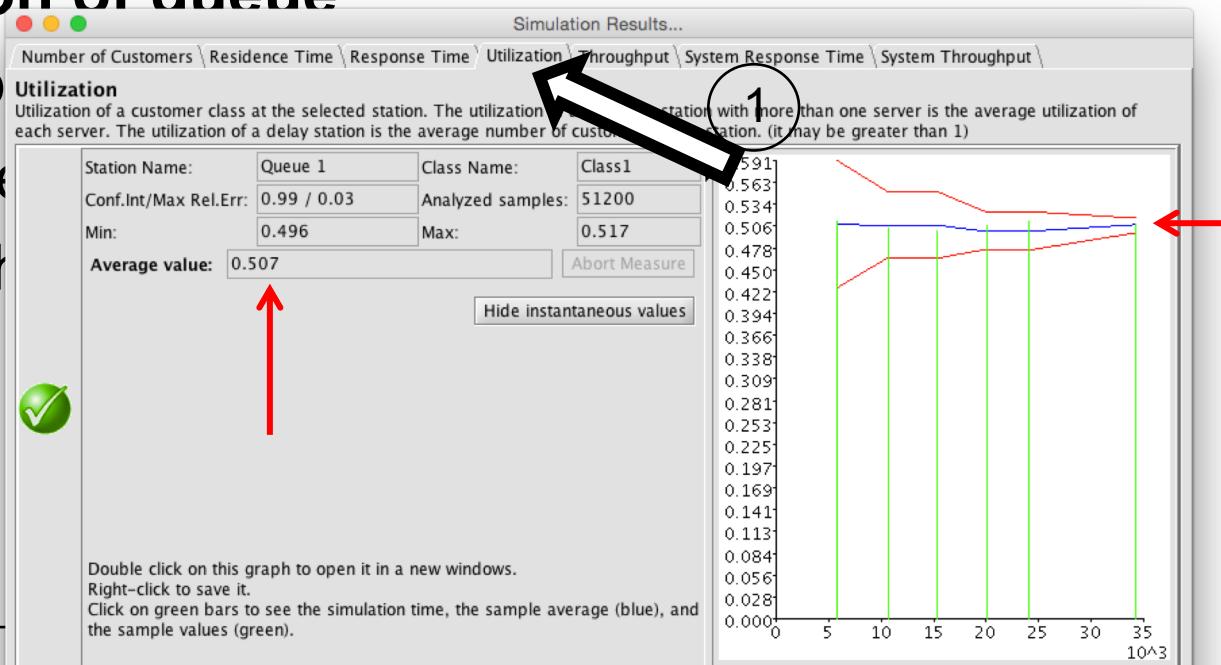
Getting Familiar with JMT: Evaluation

- We evaluated:
 - Mean number of costumers
 - Mean residence time in queue
 - **Mean response time queue**
 - Mean utilization of queue
 - Mean throughput
 - Mean system response time
 - Mean system throughput

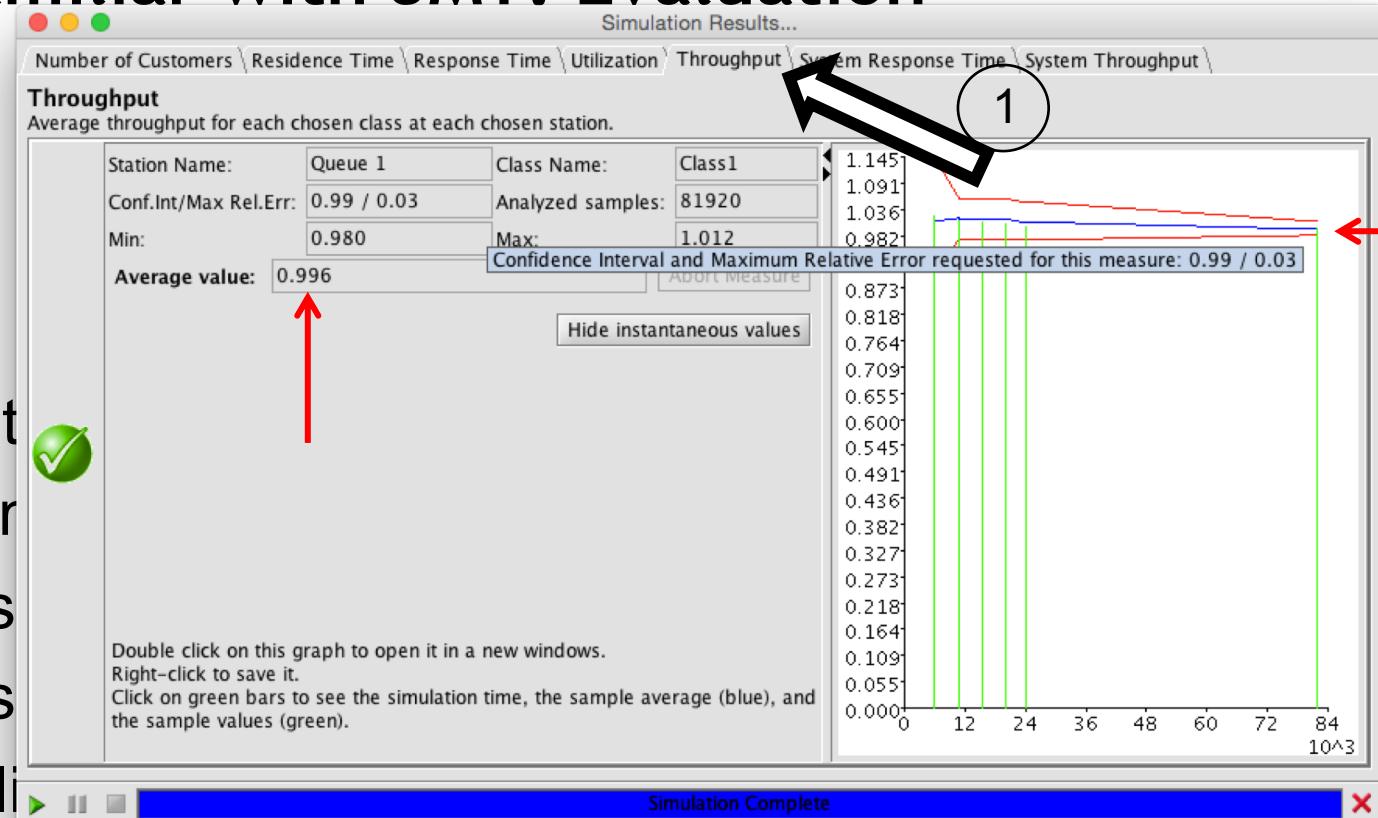


Getting Familiar with JMT: Evaluation

- We evaluated:
 - Mean number of costumers
 - Mean residence time in queue
 - Mean response time queue
 - **Mean utilization of queue**
 - Mean throughput
 - Mean system response time
 - Mean system throughput



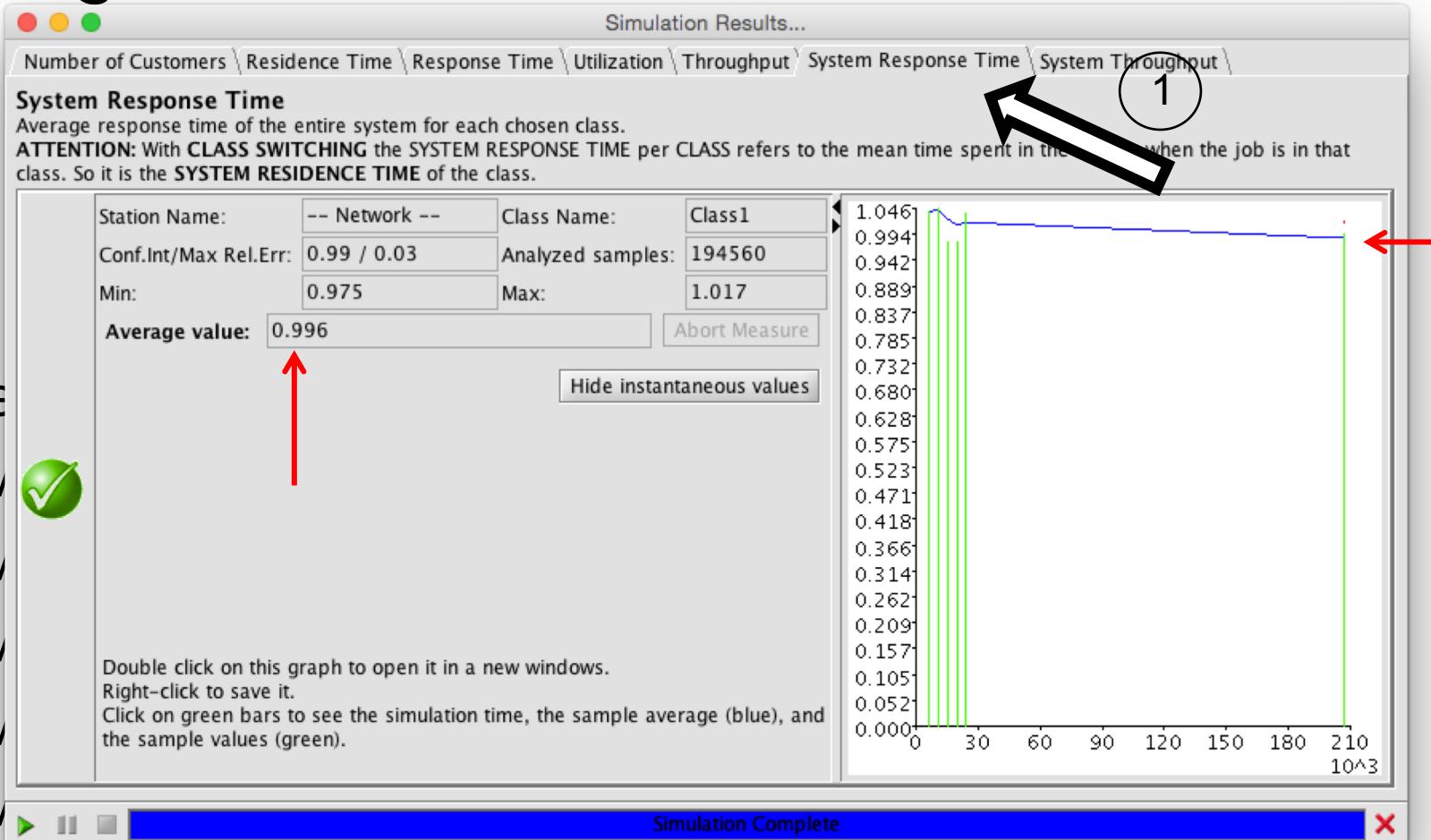
Getting Familiar with JMT: Evaluation



- We evaluate:
 - Mean number of customers
 - Mean response time
 - Mean resource utilization
 - Mean throughput of queue
 - Mean system response time
 - Mean system throughput



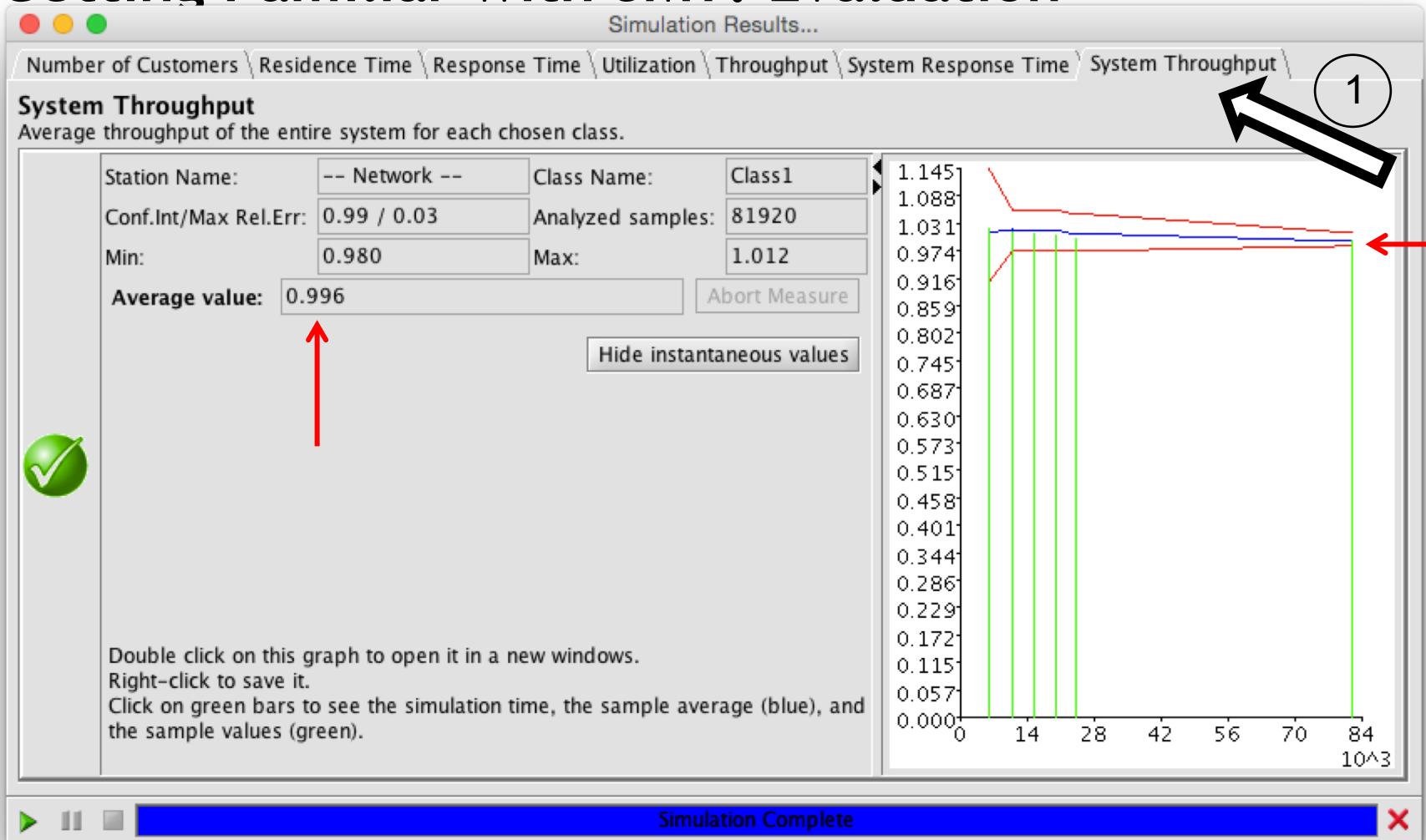
Getting Familiar with JMT: Evaluation



- We can evaluate:
 - Mean system response time
 - Mean system throughput
 - Mean system utilization
 - Mean system throughput
 - Mean system utilization
 - Mean system response time
- Mean system throughput
- Mean system utilization



Getting Familiar with JMT: Evaluation

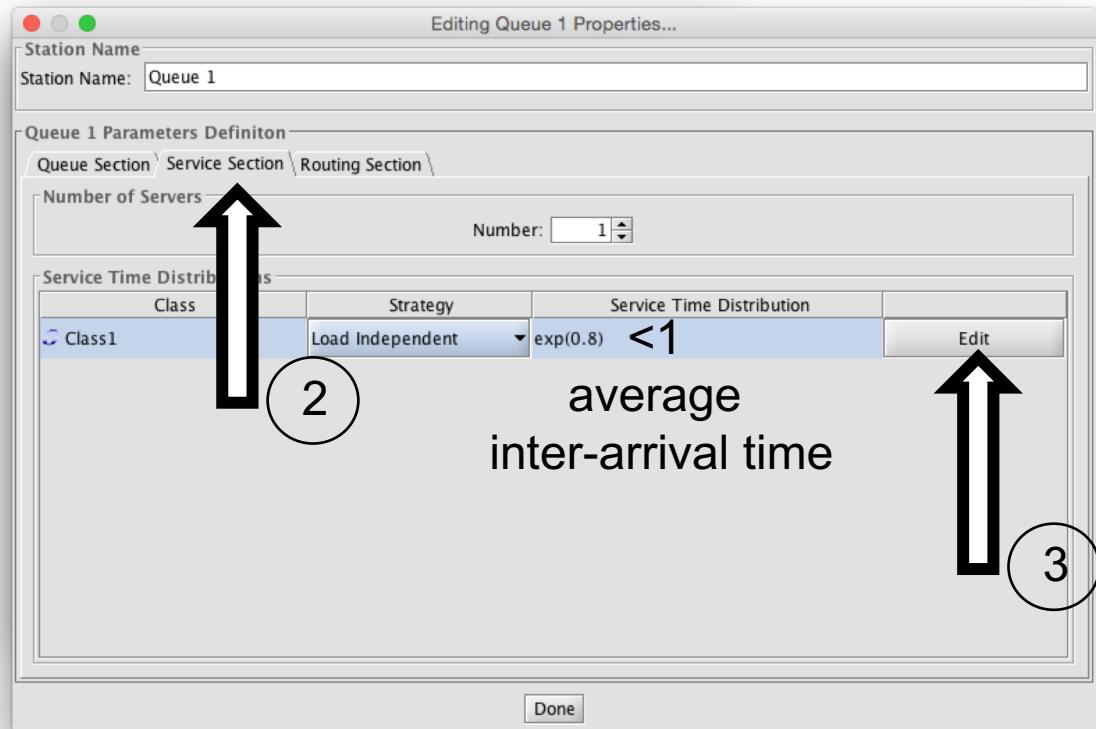
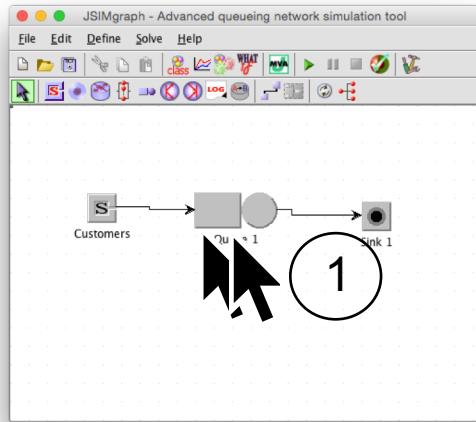


- **Mean system throughput**



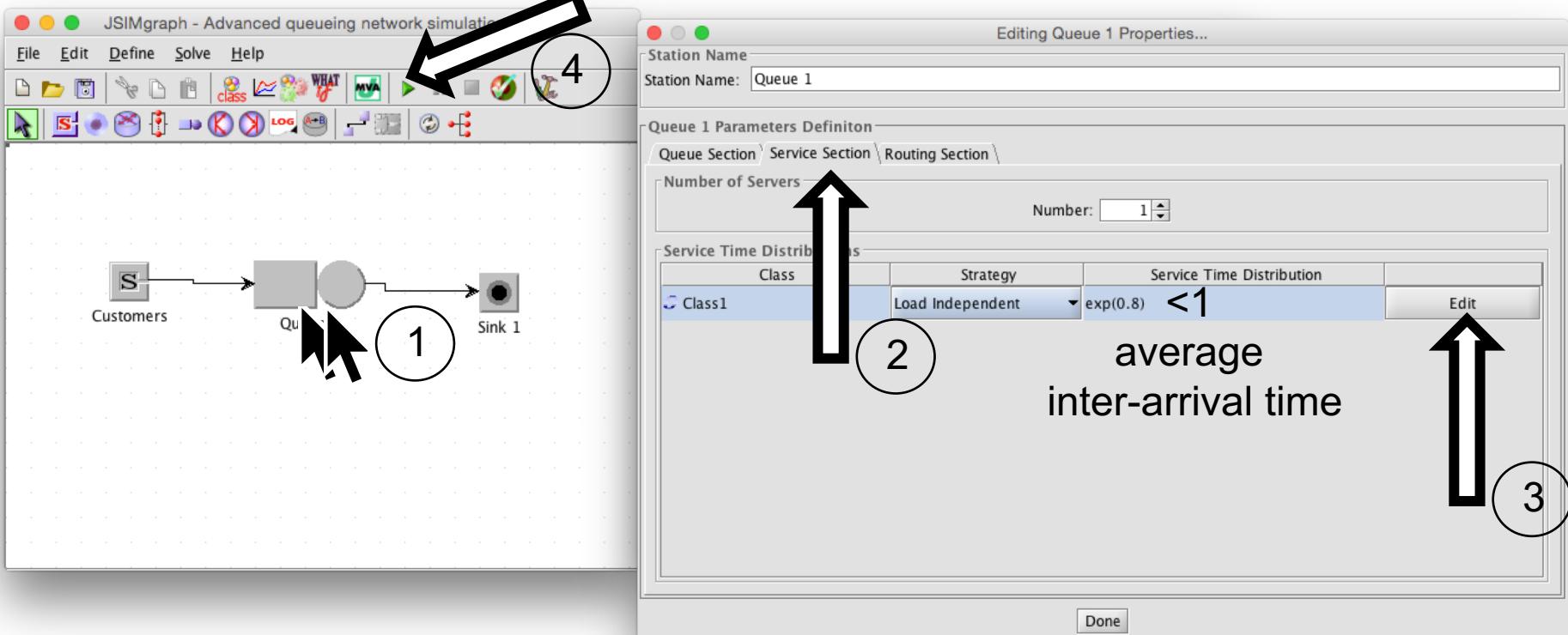
Getting Familiar with JMT: Evaluation

- We know that if utilization of servers is >1 the system is not stable. Let's try it with JMT



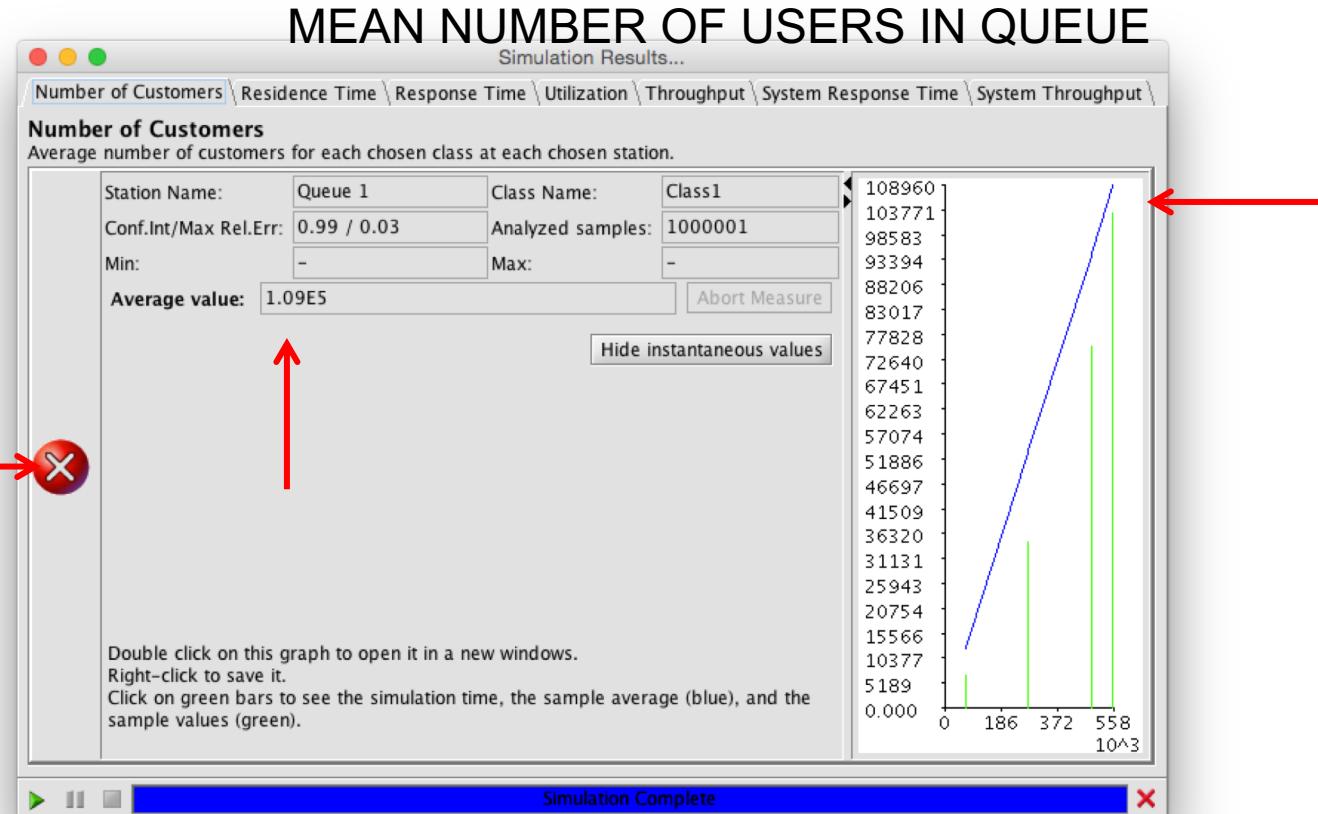
Getting Familiar with JMT: Evaluation

- We know that **if utilization** of servers is >1 the system is not stable. Let's try it with JMT



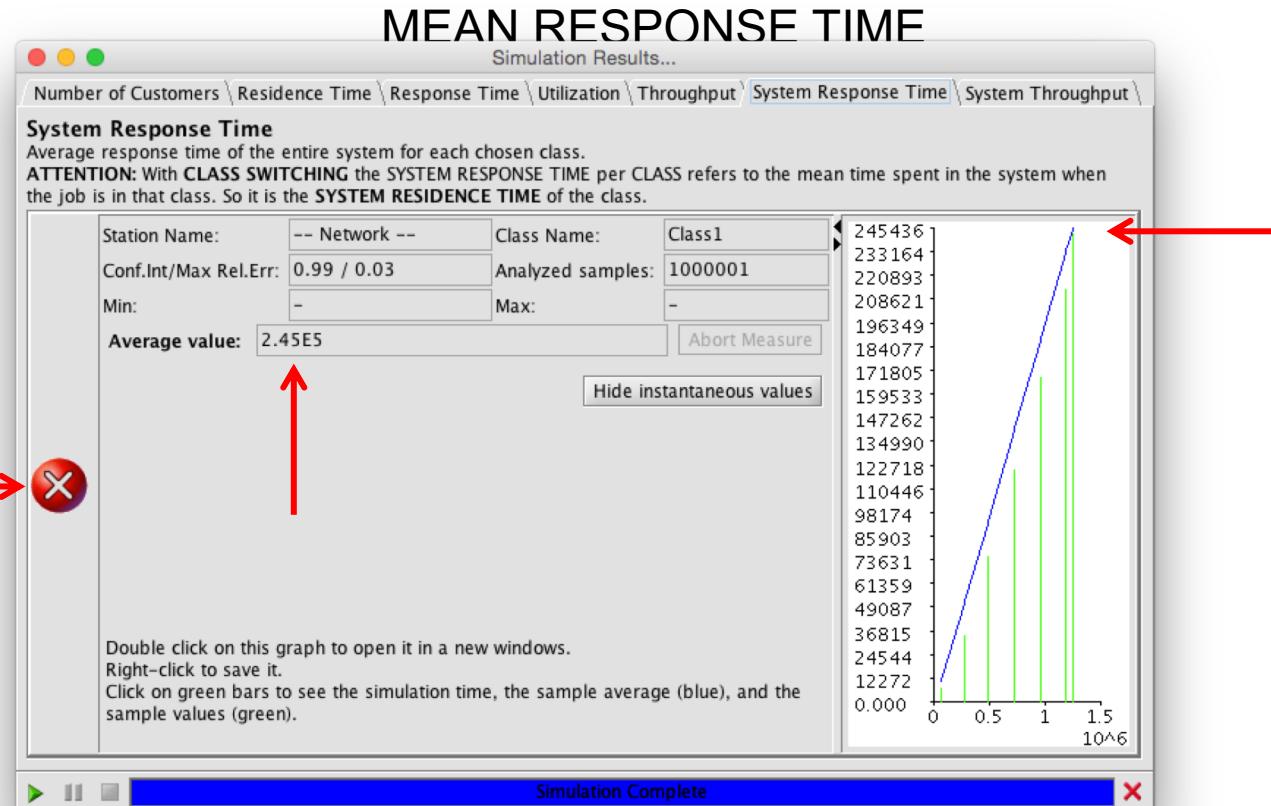
Getting Familiar with JMT: Evaluation

- We know that **if utilization** of servers is >1 the system is not stable. Let's try it with JMT



Getting Familiar with JMT: Evaluation

- We know that **if utilization** of servers is >1 the system is not stable. Let's try it with JMT





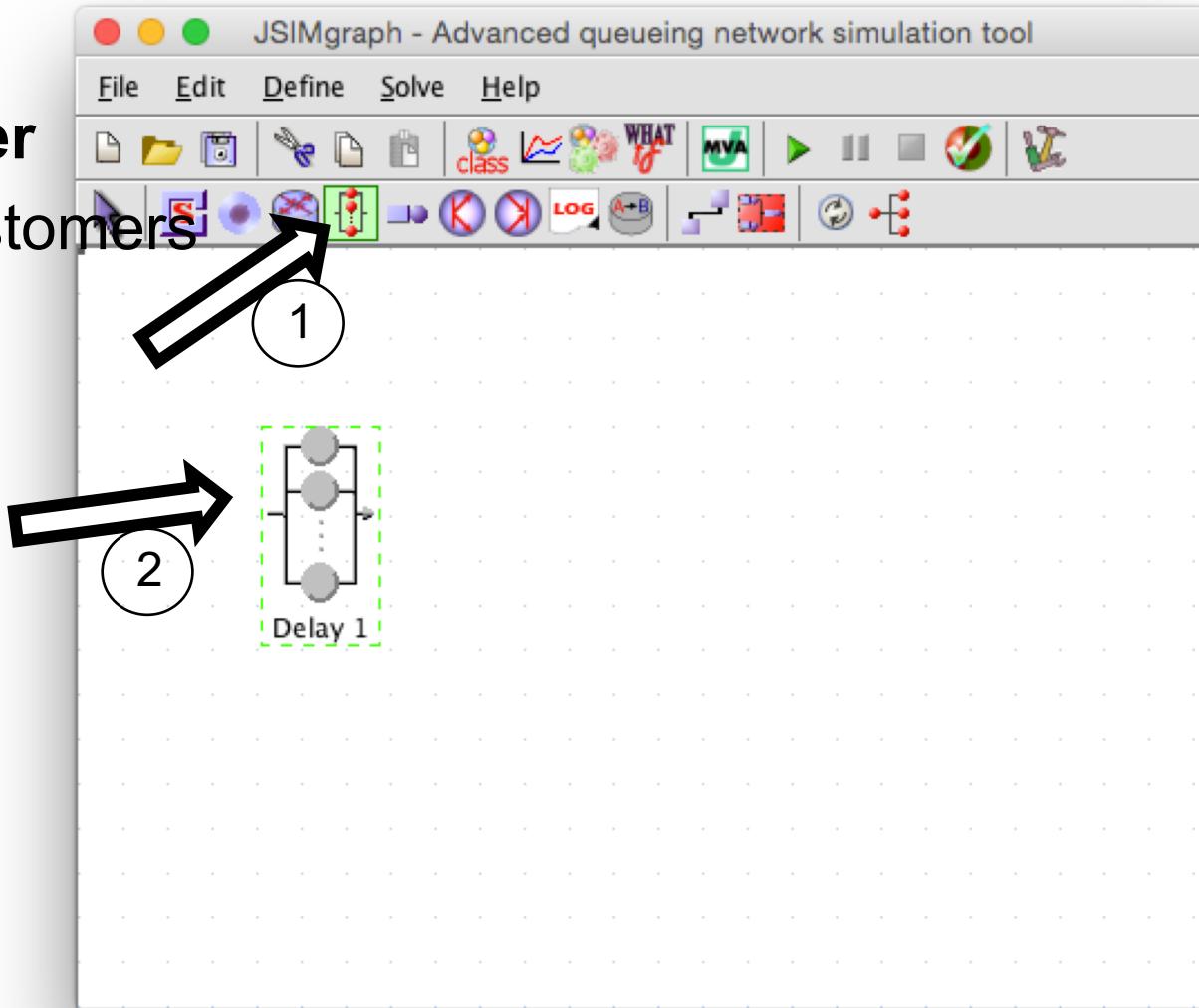
Getting familiar with JMT

Model closed queue. Evaluation

Getting Familiar with JMT: Model closed queue

- We need:

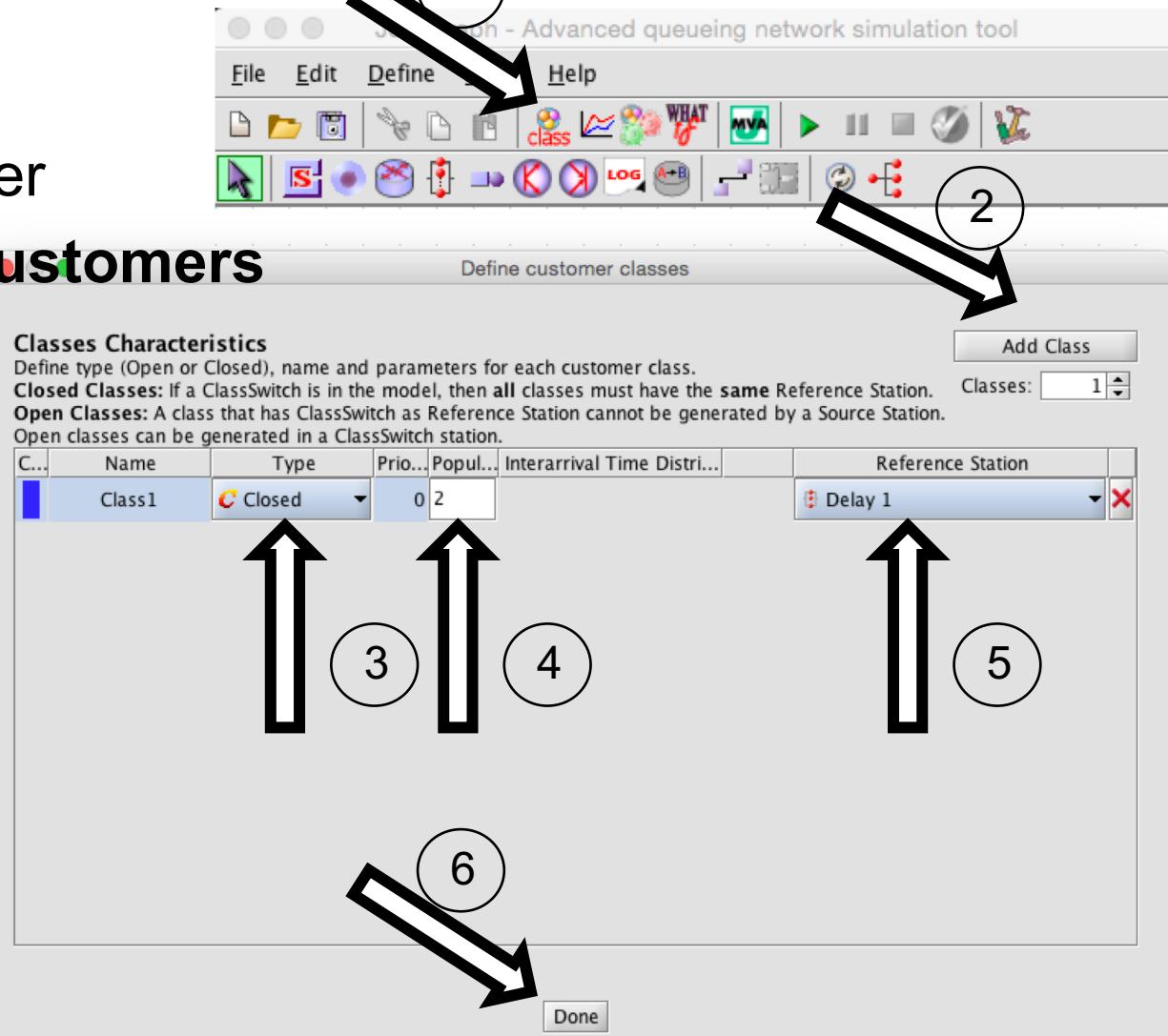
- **Delay center**
- Class of customers
- Queue
- Links



Getting Familiar with JMT: Model closed queue

- We need:

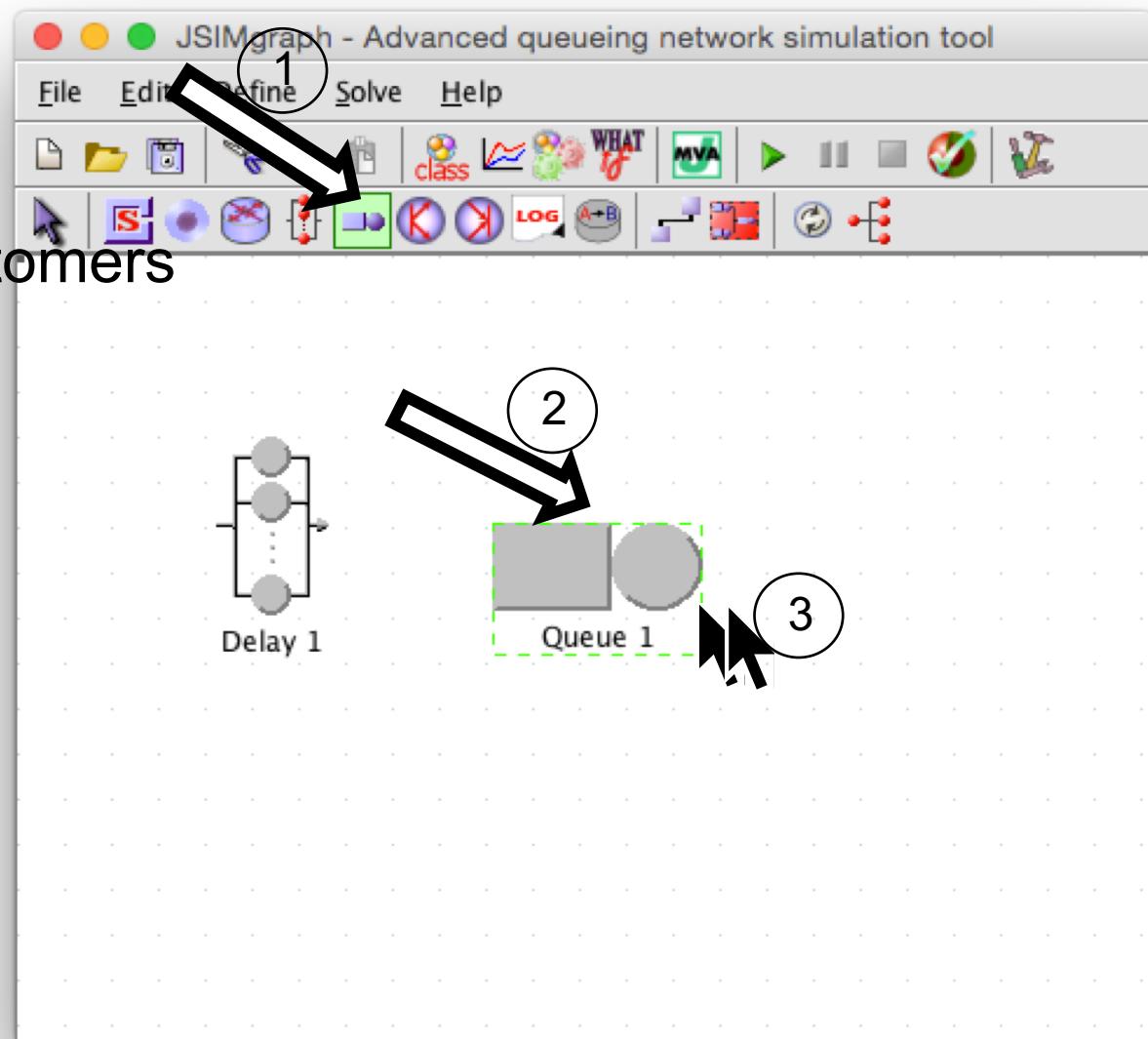
- Delay center
- **Class of customers**
- Queue
- Links



Getting Familiar with JMT: Model closed queue

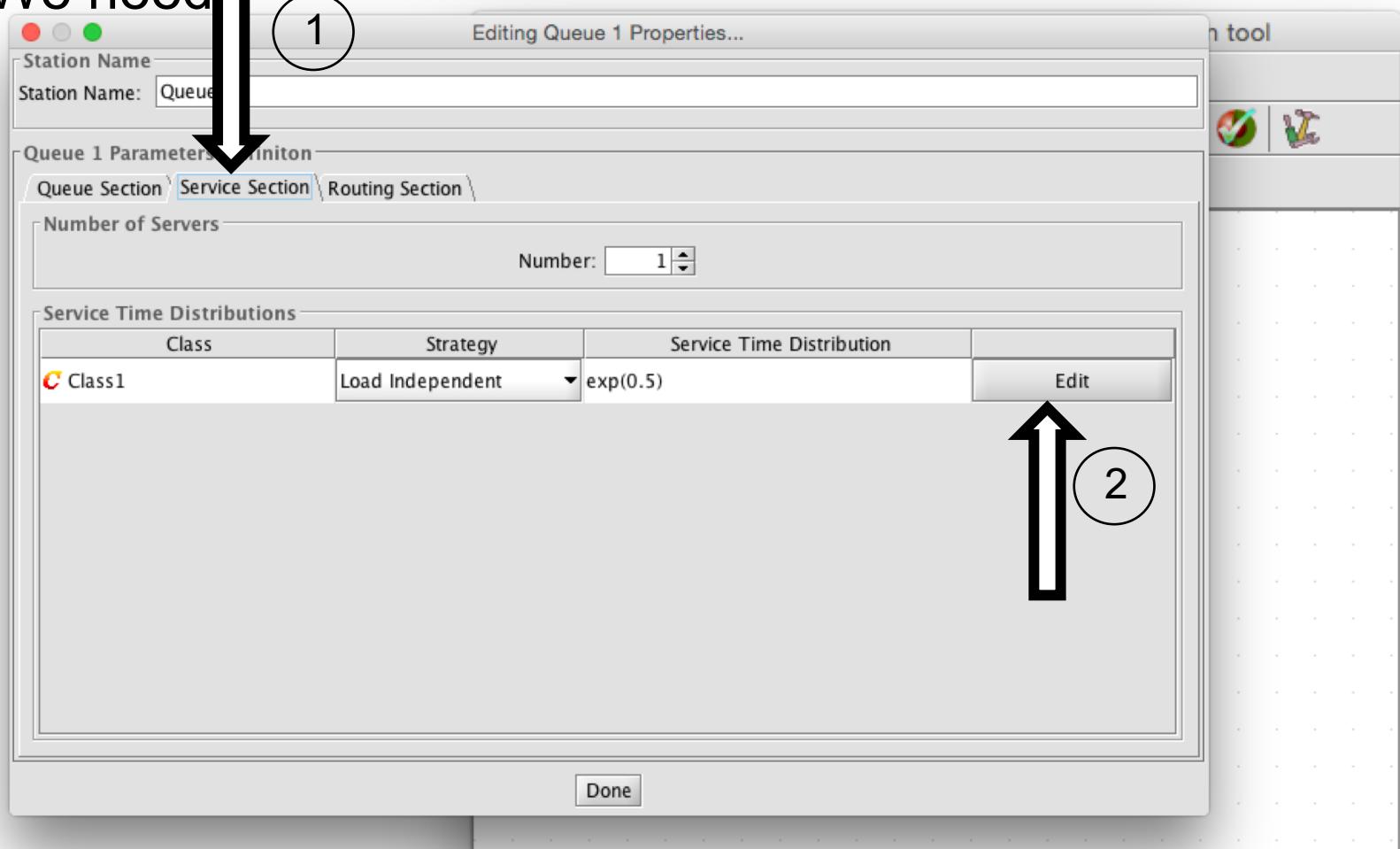
- We need:

- Delay center
- Class of customers
- Queue
- Links



Getting Familiar with JMT: Model closed queue

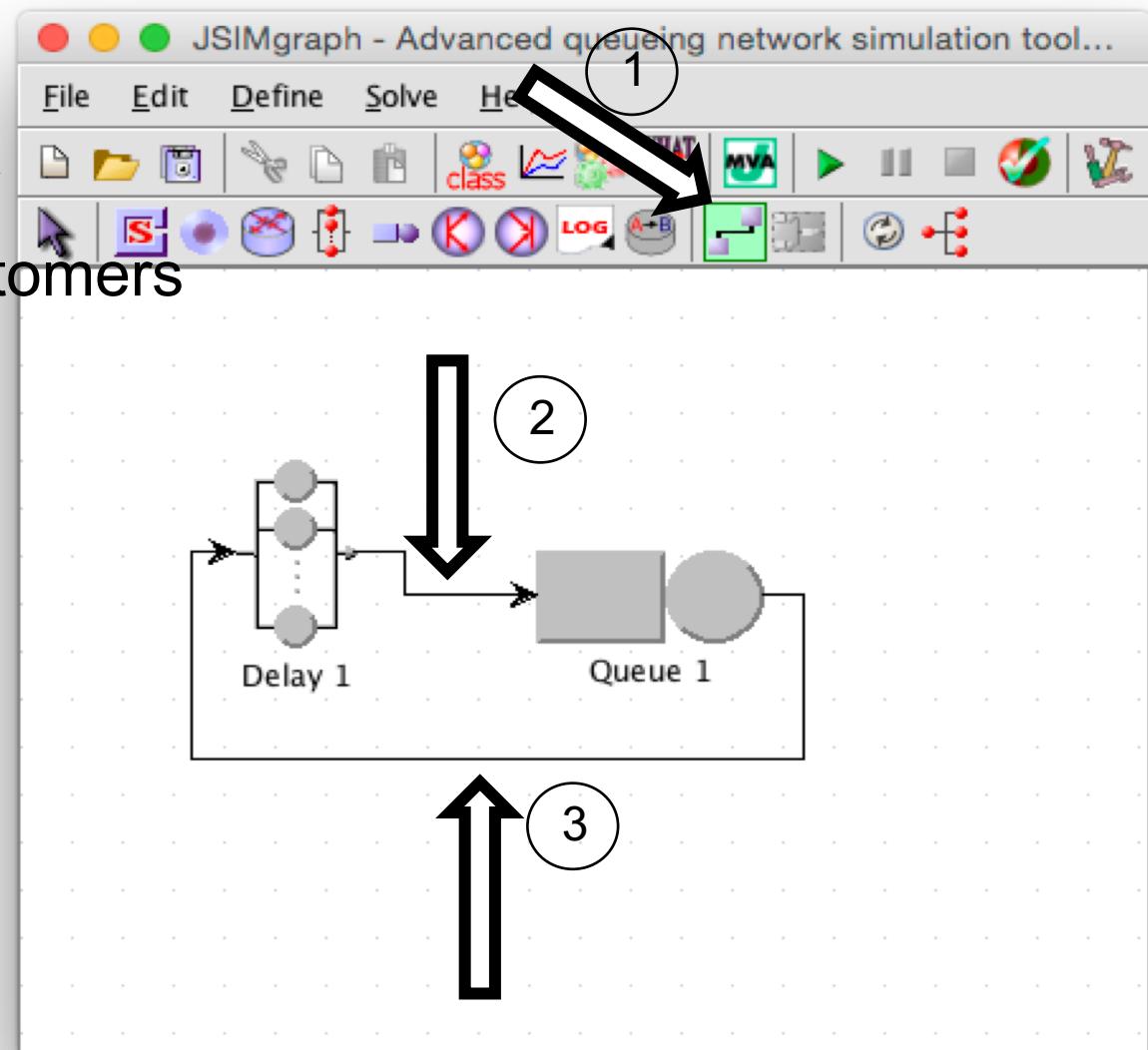
- We need



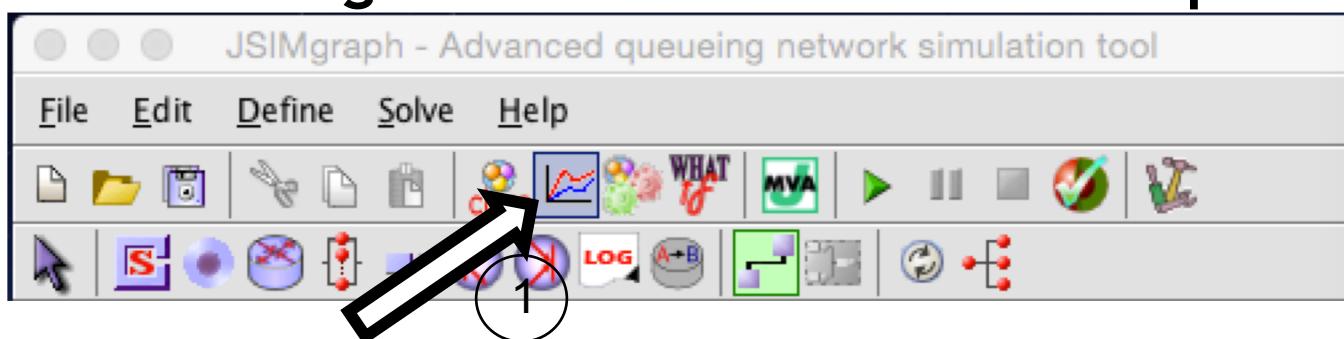
Getting Familiar with JMT: Model closed queue

- We need:

- Delay center
- Class of customers
- Queue
- Links



Getting Familiar with JMT: Define performance indexes



JSIMgraph - Advanced queueing network simulation tool

File Edit Define Solve Help

Define performance indices

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

Performance Index	Class	Station/Region	Stat.R...
-------------------	-------	----------------	-----------

---Select an index---

- Select an index---
- Number of Customers
- Queue Time
- Residence Time
- Response Time
- Utilization
- Throughput
- Drop Rate
- System Throughput
- System Response Time
- System Drop Rate
- System Number of Customers
- System Power
- Throughput per Sink
- Response Time per Sink

Decimal separator: .

Statistical Results CSV file
Check the 'Stat.Res.' button to collect samples in a CSV file for additional analysis. This may produce a file with a large size.

CSV files path: /Users/perez/JMT

Done

Same ones as in the previous open load case, but we will see their values in the queue and the delay center



Getting Familiar with JMT: Define performance indexes

The screenshot shows the JSIMgraph software interface with the title bar "JSIMgraph - Advanced queueing network simulation tool...". Below the title bar is a menu bar with "File", "Edit", "Define", "Solve", and "Help". The main window contains a toolbar with various icons for file operations, simulation control, and analysis. A sub-dialog box titled "Define performance indices" is open in the foreground.

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

Performance Index	Class	Station/Region	Stat.Res.	Conf.Int.	Max Rel.Err.	
System Number of Customers	Class1		<input type="checkbox"/>	0.99	0.03	X
Residence Time	Class1	Queue 1	<input type="checkbox"/>	0.99	0.03	X
Response Time	Class1	Queue 1	<input type="checkbox"/>	0.99	0.03	X
Utilization	Class1	Queue 1	<input type="checkbox"/>	0.99	0.03	X
Throughput	Class1	Queue 1	<input type="checkbox"/>	0.99	0.03	X
System Response Time	Class1		<input type="checkbox"/>	0.99	0.03	X
System Throughput	Class1		<input type="checkbox"/>	0.99	0.03	X
Utilization	Class1	Delay 1	<input type="checkbox"/>	0.99	0.03	X
Response Time	Class1	Delay 1	<input type="checkbox"/>	0.99	0.03	X
Number of Customers	Class1	Delay 1	<input type="checkbox"/>	0.99	0.03	X
Number of Customers	Class1	Queue 1	<input type="checkbox"/>	0.99	0.03	X

---Select an index---

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: /Users/perez/JMT

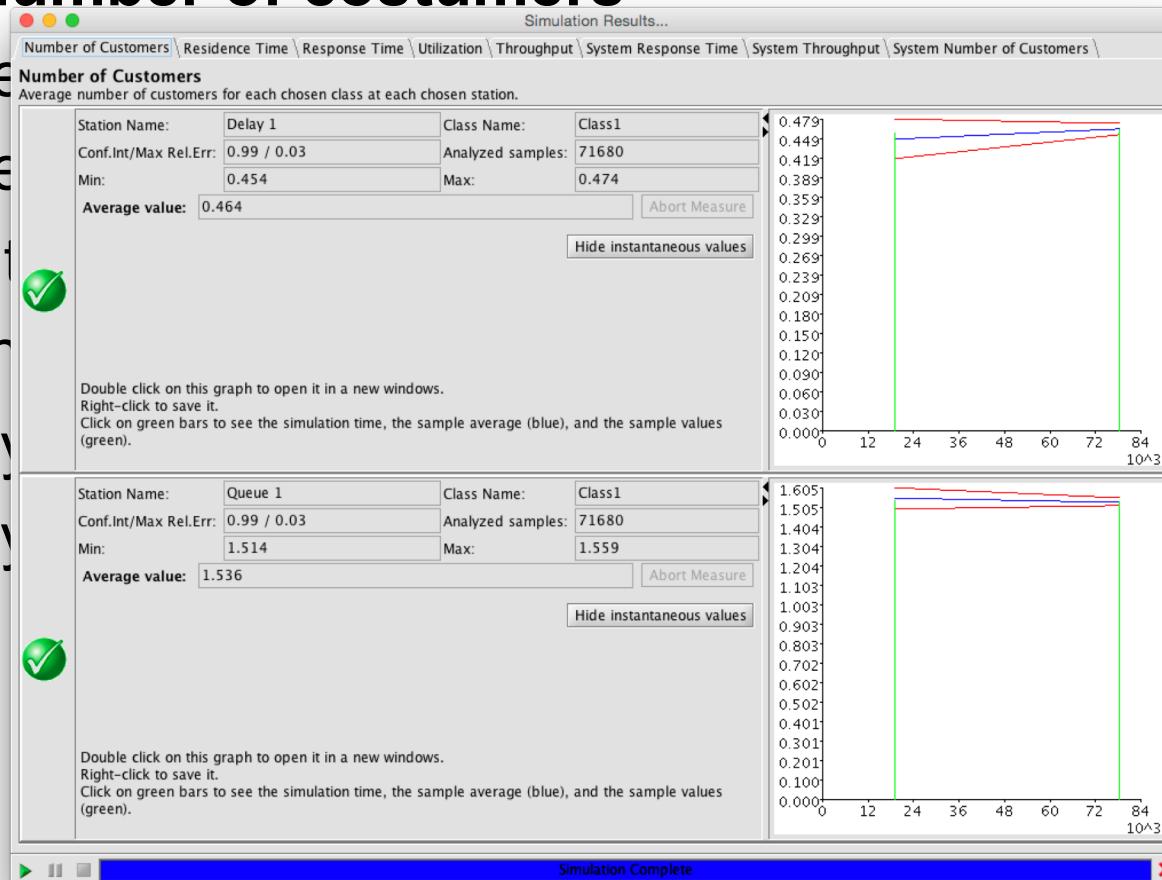
Delimiter: ;

Decimal separator: .



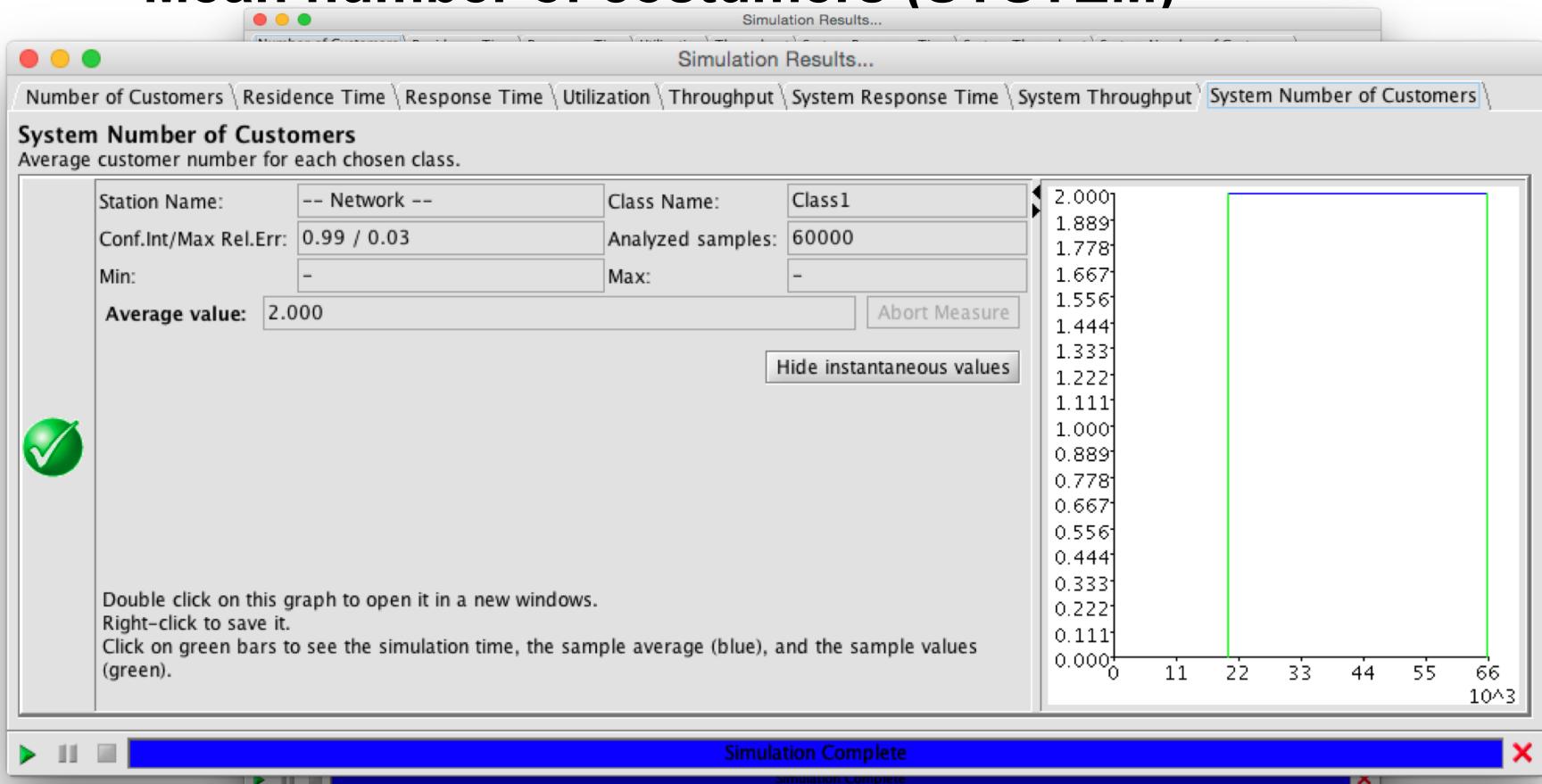
Getting Familiar with JMT: Define performance indexes

- We evaluated:
 - Mean number of costumers



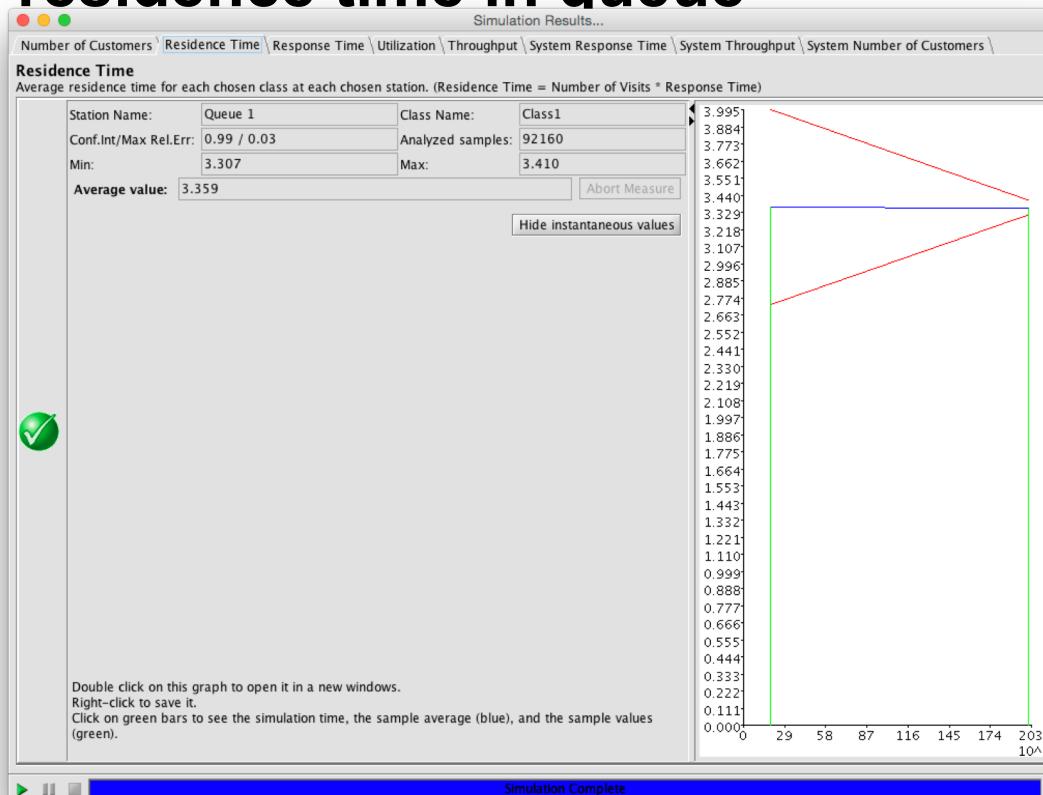
Getting Familiar with JMT: Define performance indexes

- We evaluated:
 - **Mean number of costumers (SYSTEM)**



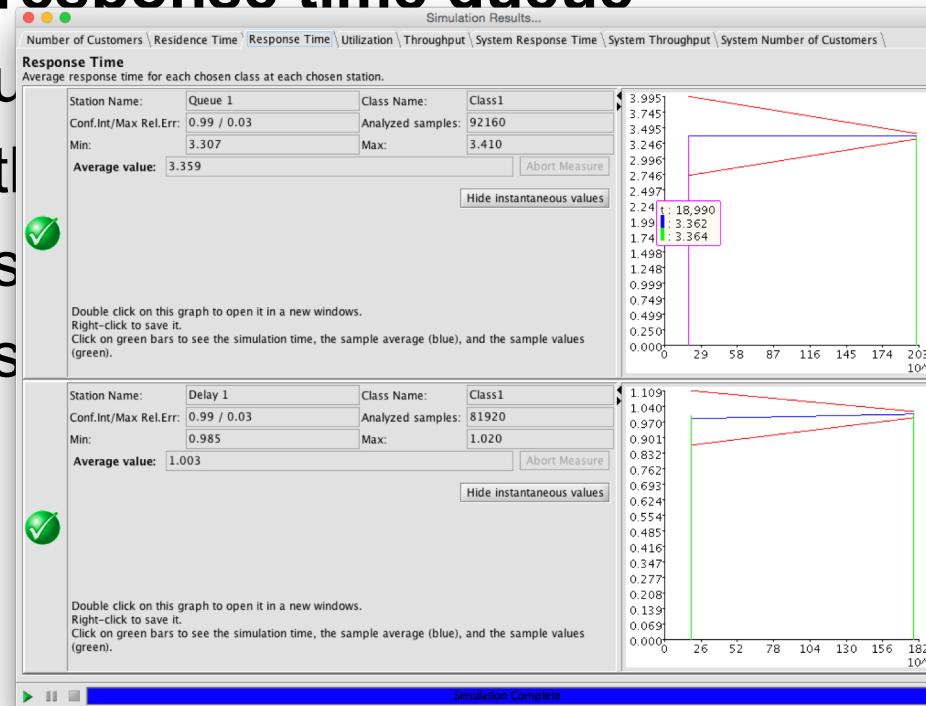
Getting Familiar with JMT: Define performance indexes

- We evaluated:
 - Mean number of costumers
 - **Mean residence time in queue**
 - Mean
 - Mean
 - Mean
 - Mean
 - Mean



Getting Familiar with JMT: Define performance indexes

- We evaluated:
 - Mean number of costumers
 - Mean residence time in queue
 - **Mean response time queue**
 - Mean utilization
 - Mean throughput
 - Mean system response time
 - Mean system throughput



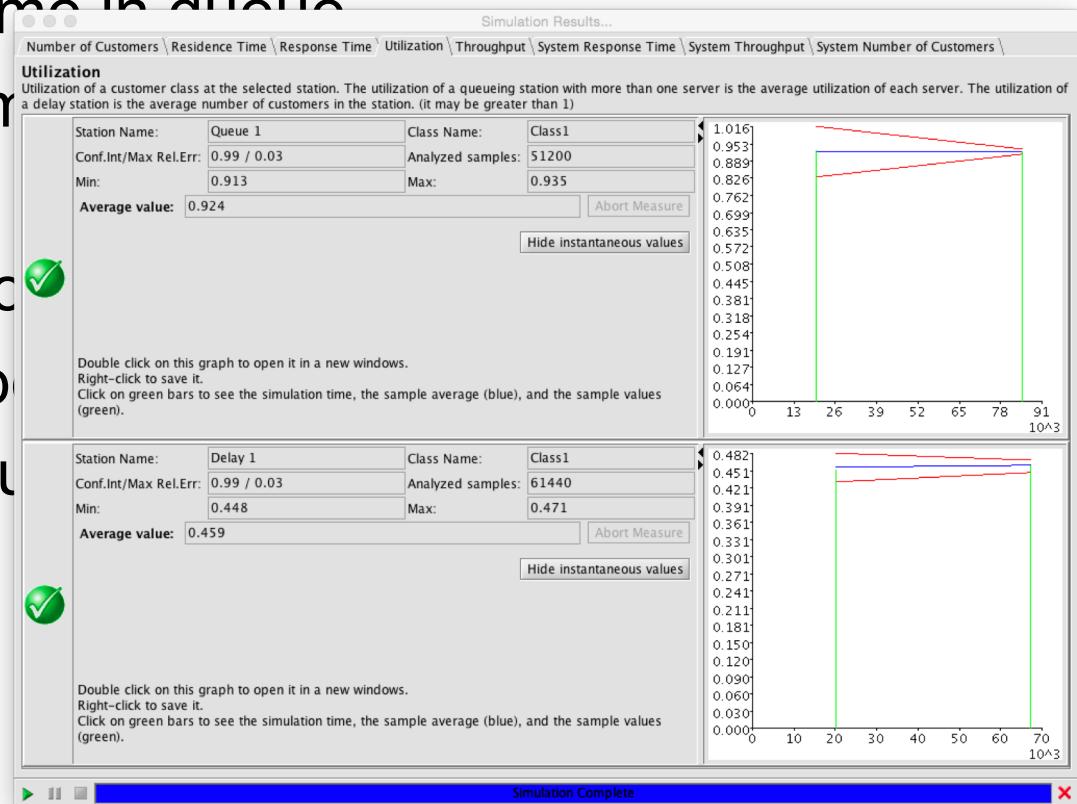
Queue Residence Time
Vs
Queue Response Time

Constant

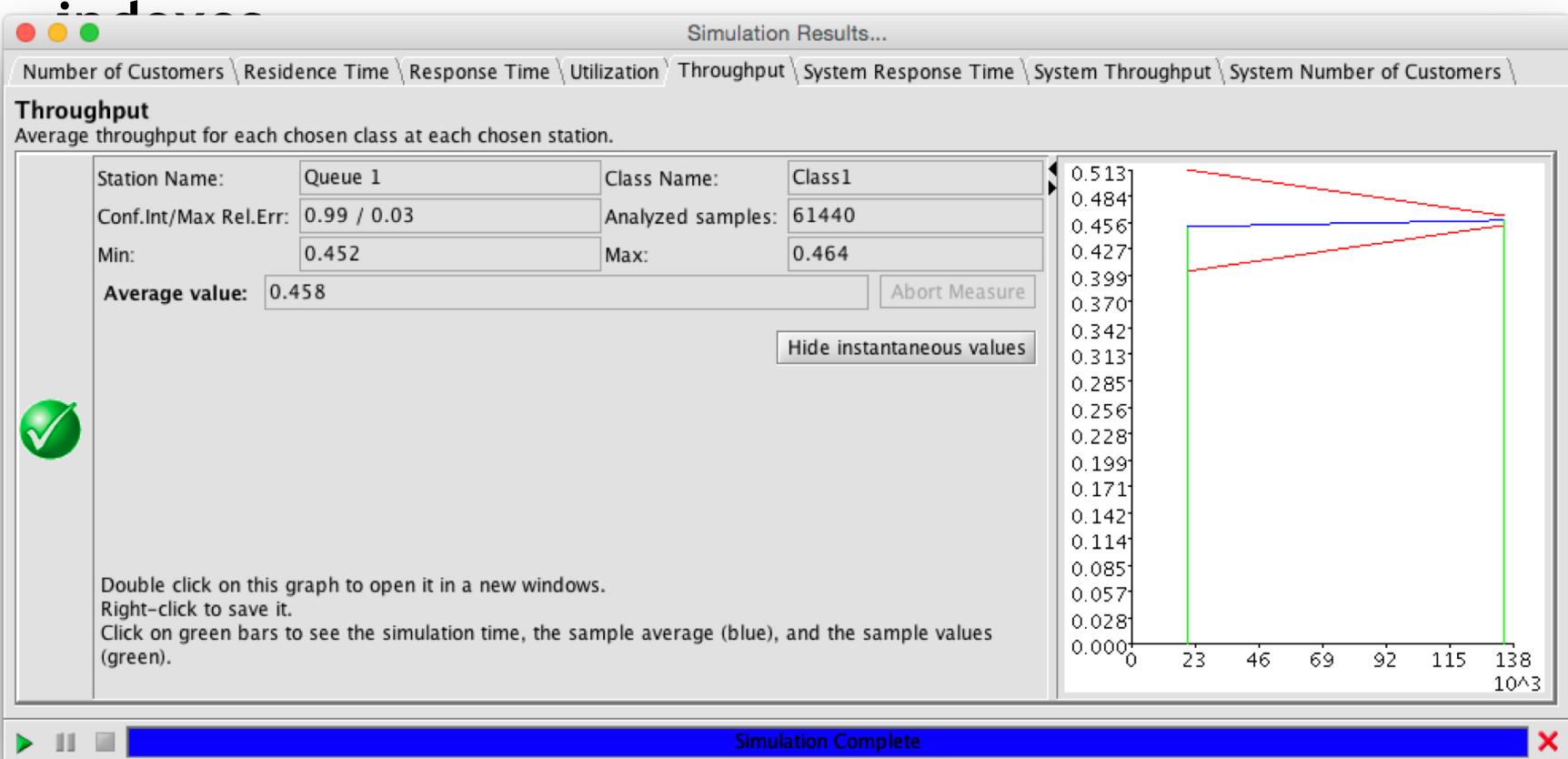


Getting Familiar with JMT: Define performance indexes

- We evaluated:
 - Mean number of costumers
 - Mean residence time in queue
 - Mean response time
 - **Mean utilization**
 - Mean throughput
 - Mean system response time
 - Mean system throughput



Getting Familiar with JMT: Define performance

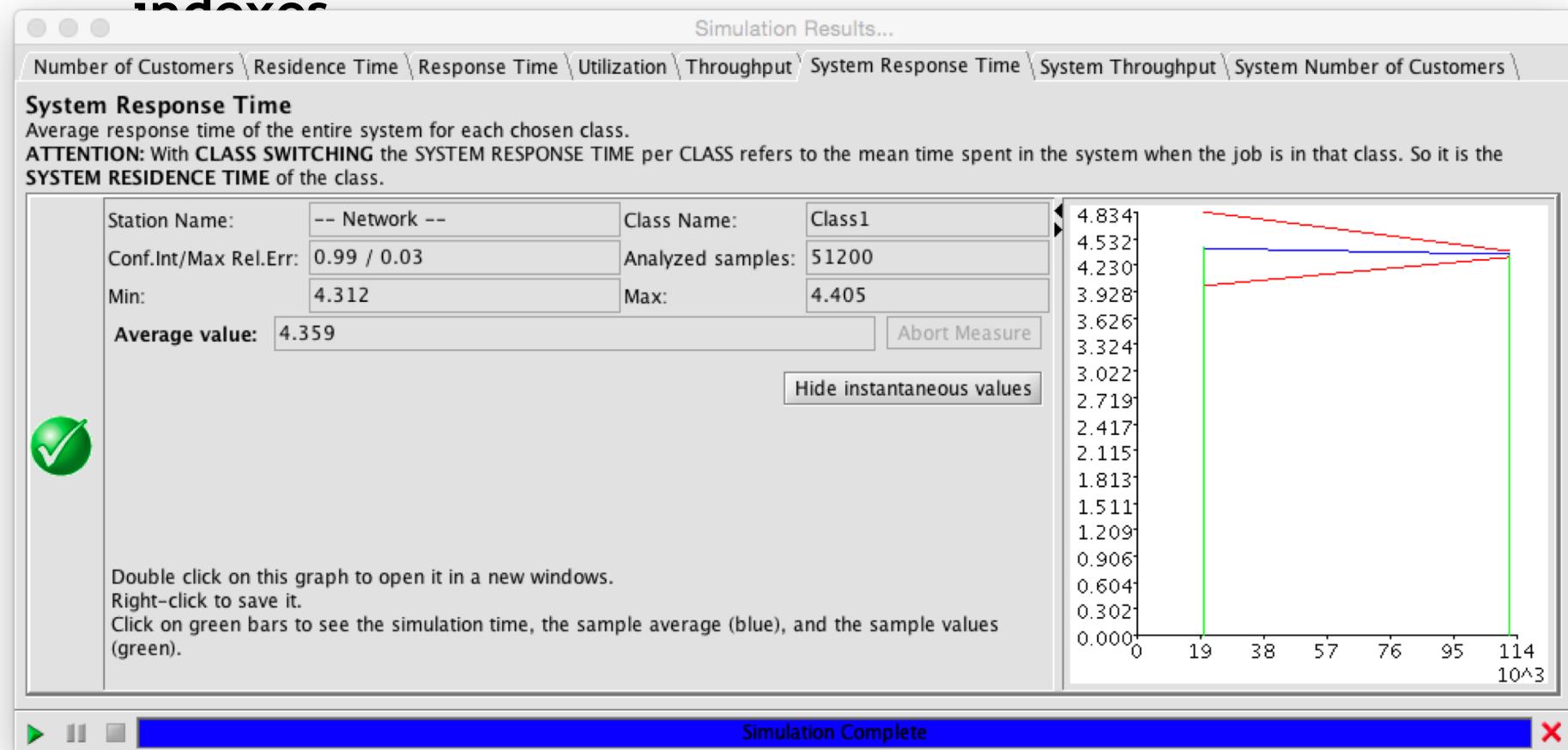


- Mean throughput of queue
- Mean system response time
- Mean system throughput

Utilization Law?



Getting Familiar with JMT: Define performance indexes

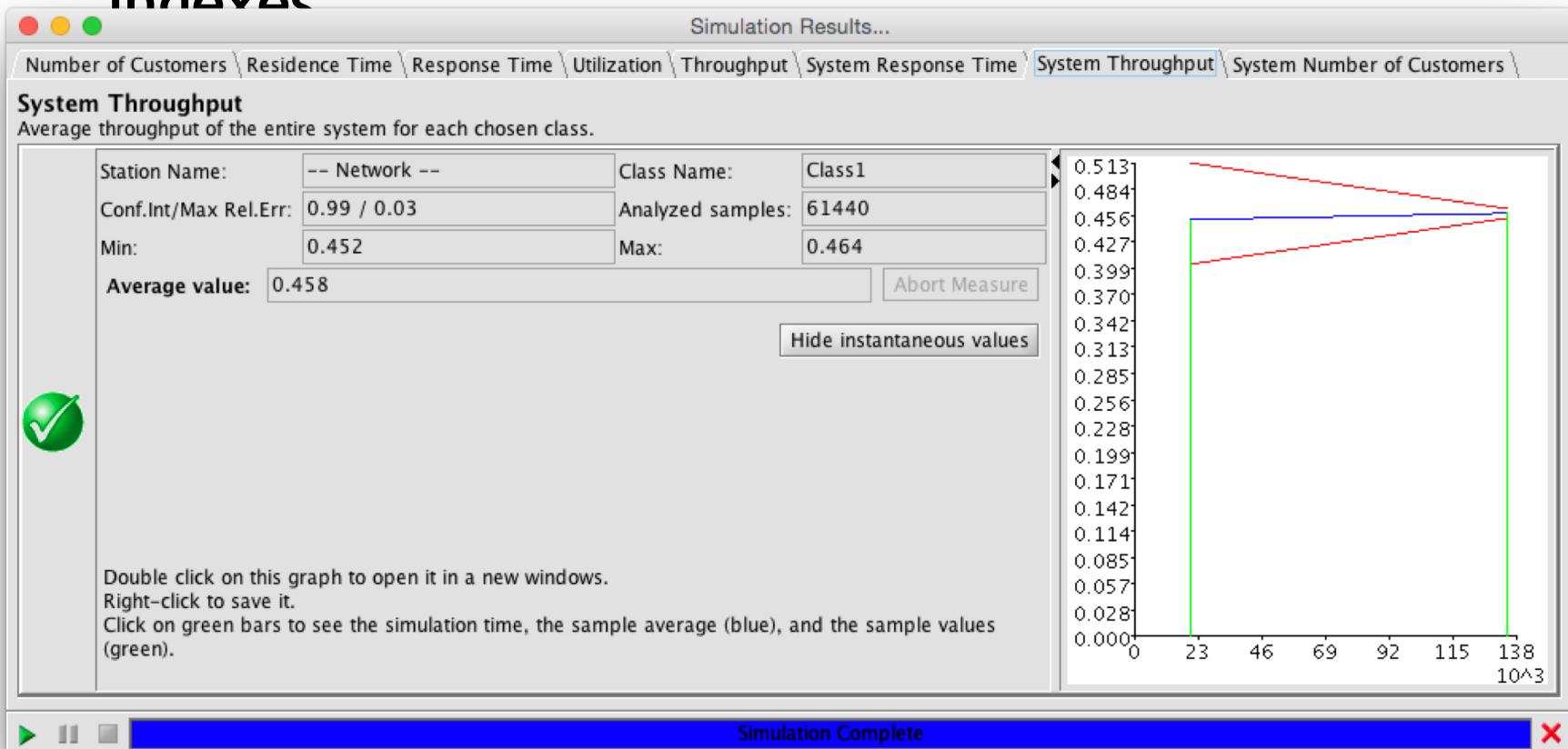


- **Mean system response time**
- Mean system throughput

Sum of response times?
Vs
Little Law?
Sum of residence times?



Getting Familiar with JMT: Define performance indexes



- Mean throughput of queue
 - Mean system response time
 - **Mean system throughput**
- Linnæus University

Sum of response times?
Vs
Sum of residence times?



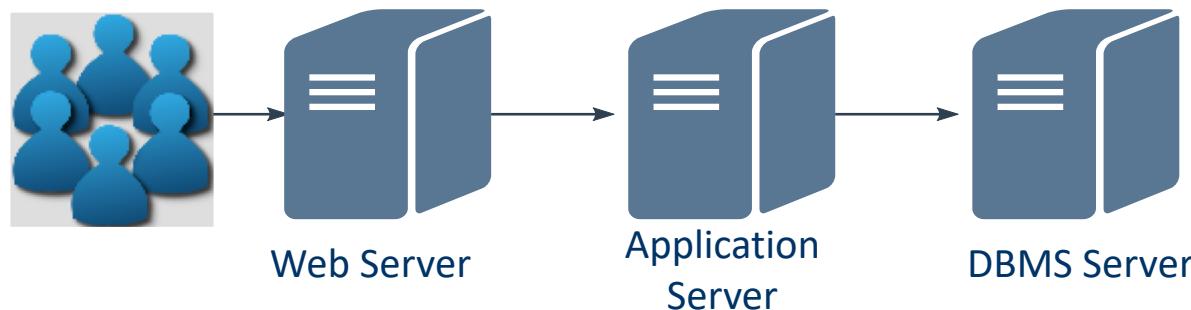


Evaluating computing infrastructures with JMT

A more elaborated example

Example

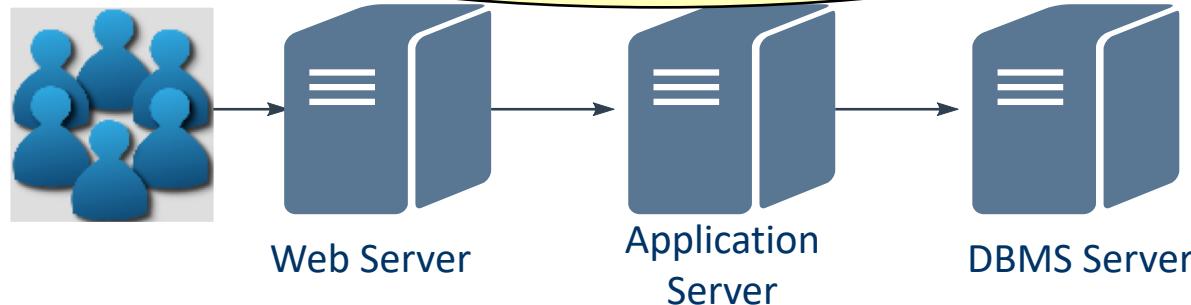
- The document repository system at our company has the following characteristics:
 - Users connect via web to a web server. There are **400** users.
 - The web server receives users requests and communicates to the application server of the system.
 - The application server processes the document to extract data of structured fields and connects to the Data Base server to store the document



Example

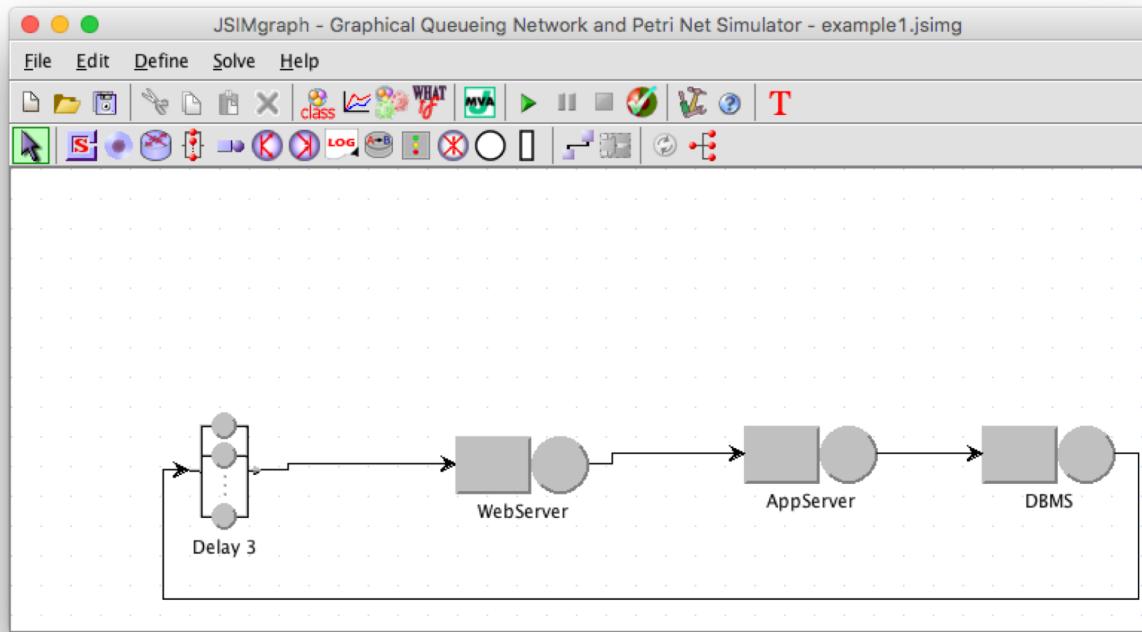
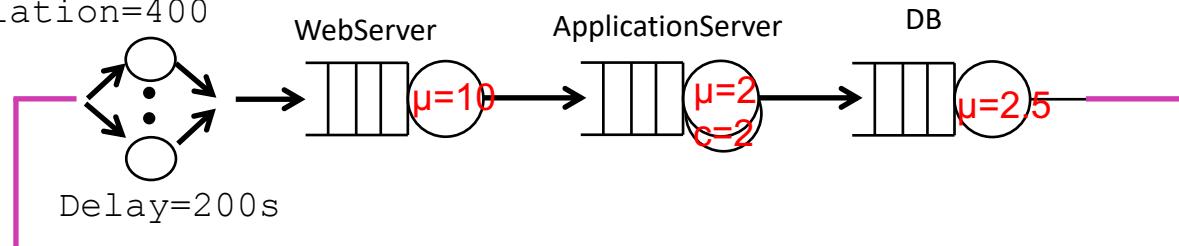
- The document has the following characteristics:
 - Users need 100ms to process the request
 - Application server requires 500ms to process a request and has 2 computing resources
 - The DB requires 400ms to store the information

When an interaction has finished, users need in average **200 seconds** of work in a document before requesting a new storage



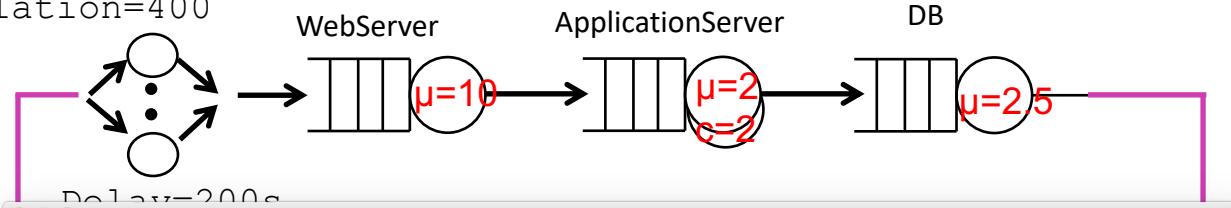
Examples

Population=400



Examples

Population=400



Define performance indices

---Select an index---

Performance Index	Class/Mode	Station/Region	Stat.Res.	Conf.Int.	Max Rel.Err.
System Response Time	--- All Classes ---		<input type="checkbox"/>	0.99	0.03
System Throughput	--- All Classes ---		<input type="checkbox"/>	0.99	0.03
Utilization	--- All Classes ---	AppServer	<input type="checkbox"/>	0.99	0.03
Utilization	--- All Classes ---	DBMS	<input type="checkbox"/>	0.99	0.03
Utilization	--- All Classes ---	WebServer	<input type="checkbox"/>	0.99	0.03
Utilization	--- All Classes ---	Delay 3	<input type="checkbox"/>	0.99	0.03
Number of Customers	--- All Classes ---	AppServer	<input type="checkbox"/>	0.99	0.03
Number of Customers	--- All Classes ---	DBMS	<input type="checkbox"/>	0.99	0.03
Number of Customers	--- All Classes ---	WebServer	<input type="checkbox"/>	0.99	0.03
Number of Customers	--- All Classes ---	Delay 3	<input type="checkbox"/>	0.99	0.03
Response Time	--- All Classes ---	AppServer	<input type="checkbox"/>	0.99	0.03
Response Time	--- All Classes ---	DBMS	<input type="checkbox"/>	0.99	0.03
Response Time	--- All Classes ---	WebServer	<input type="checkbox"/>	0.99	0.03
Response Time	--- All Classes ---	Delay 3	<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.

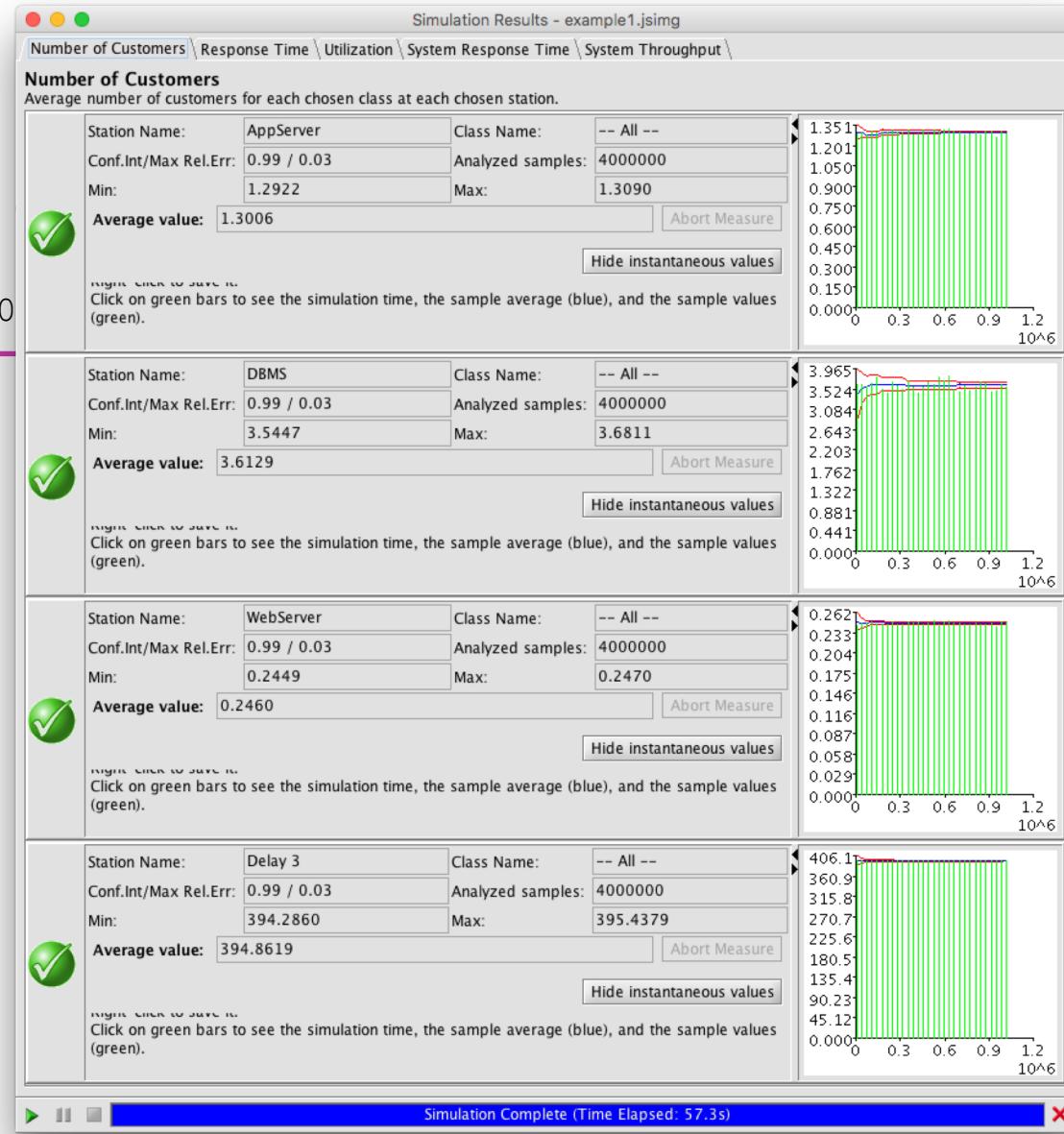
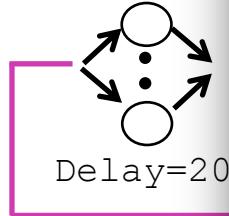
CSV files path: /Users/dipeab/JMT Delimiter:
Decimal separator:

Done



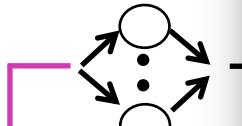
Examples

Population=400

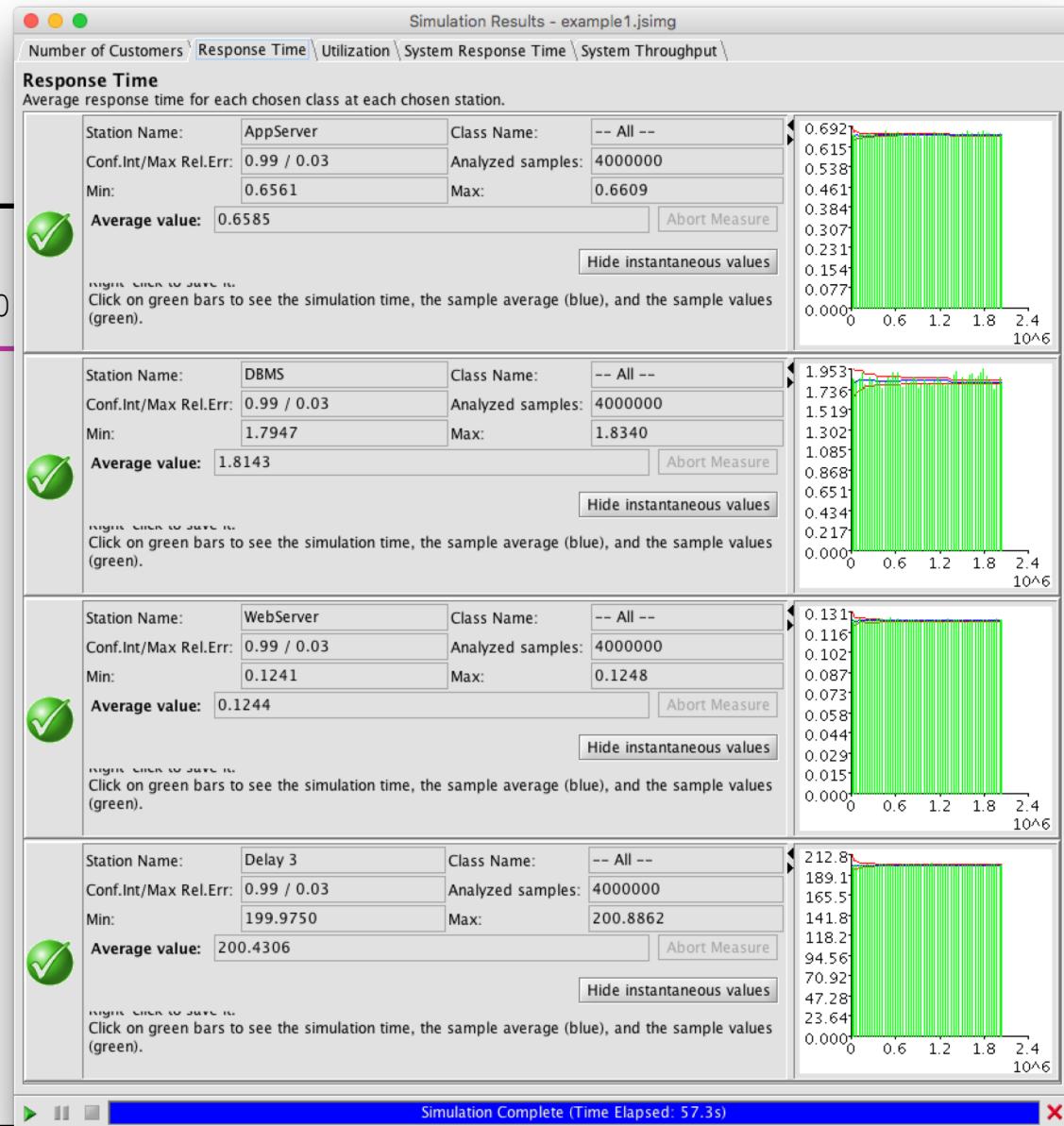


Examples

Population=400

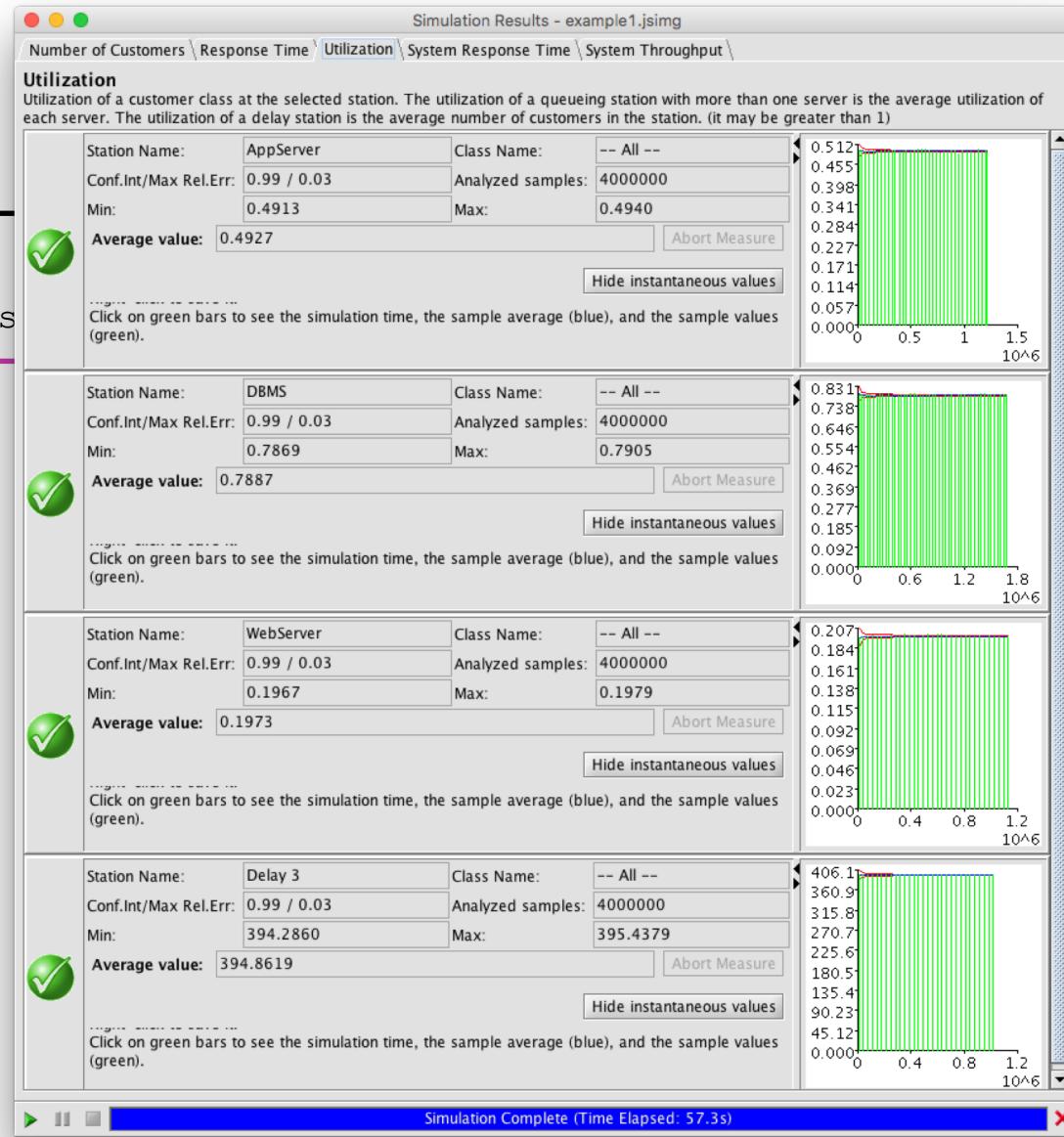
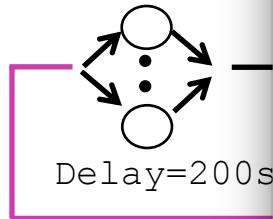


Delay=200



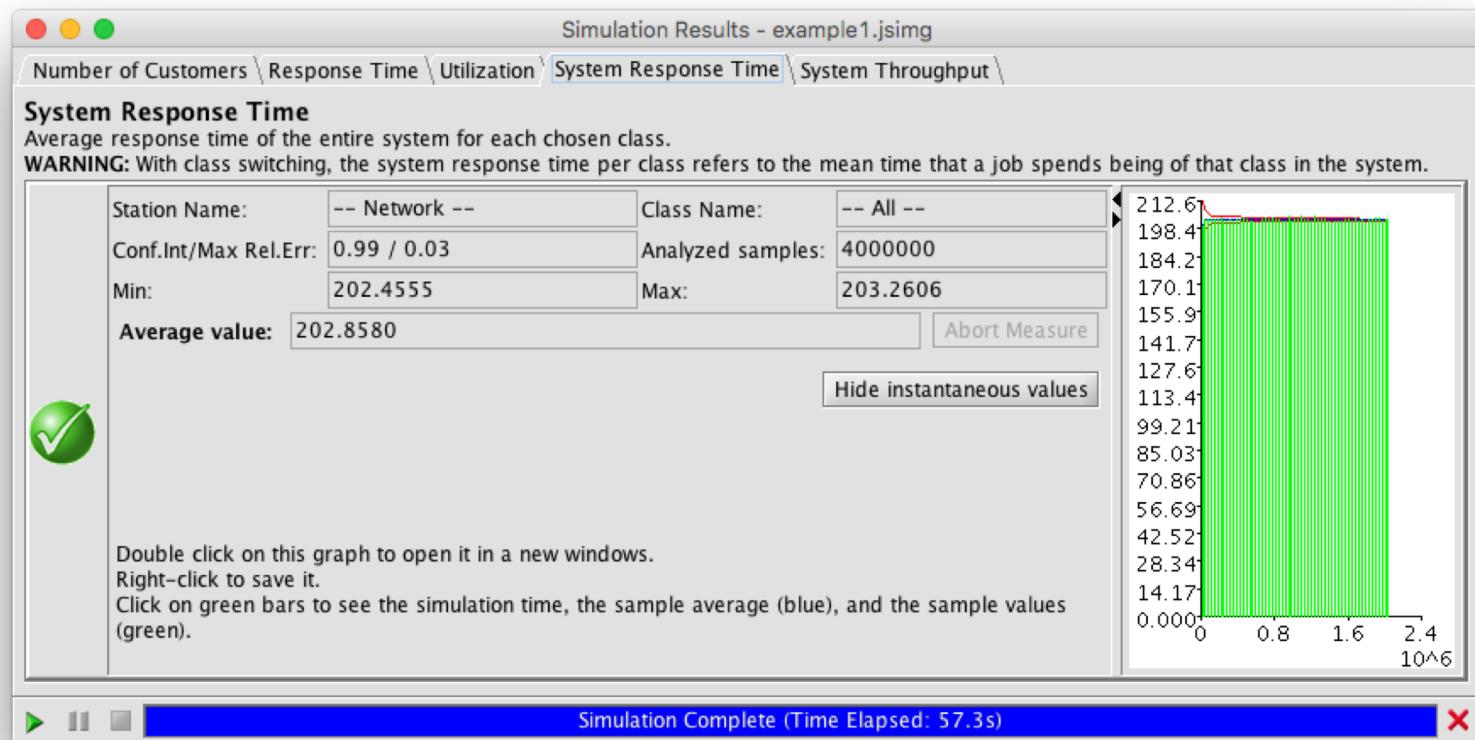
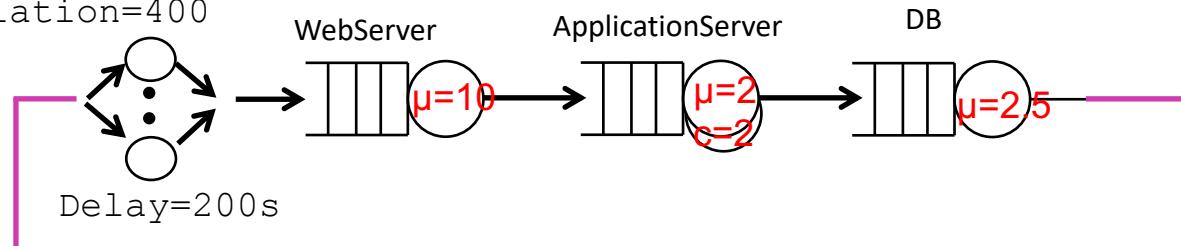
Examples

Population=400



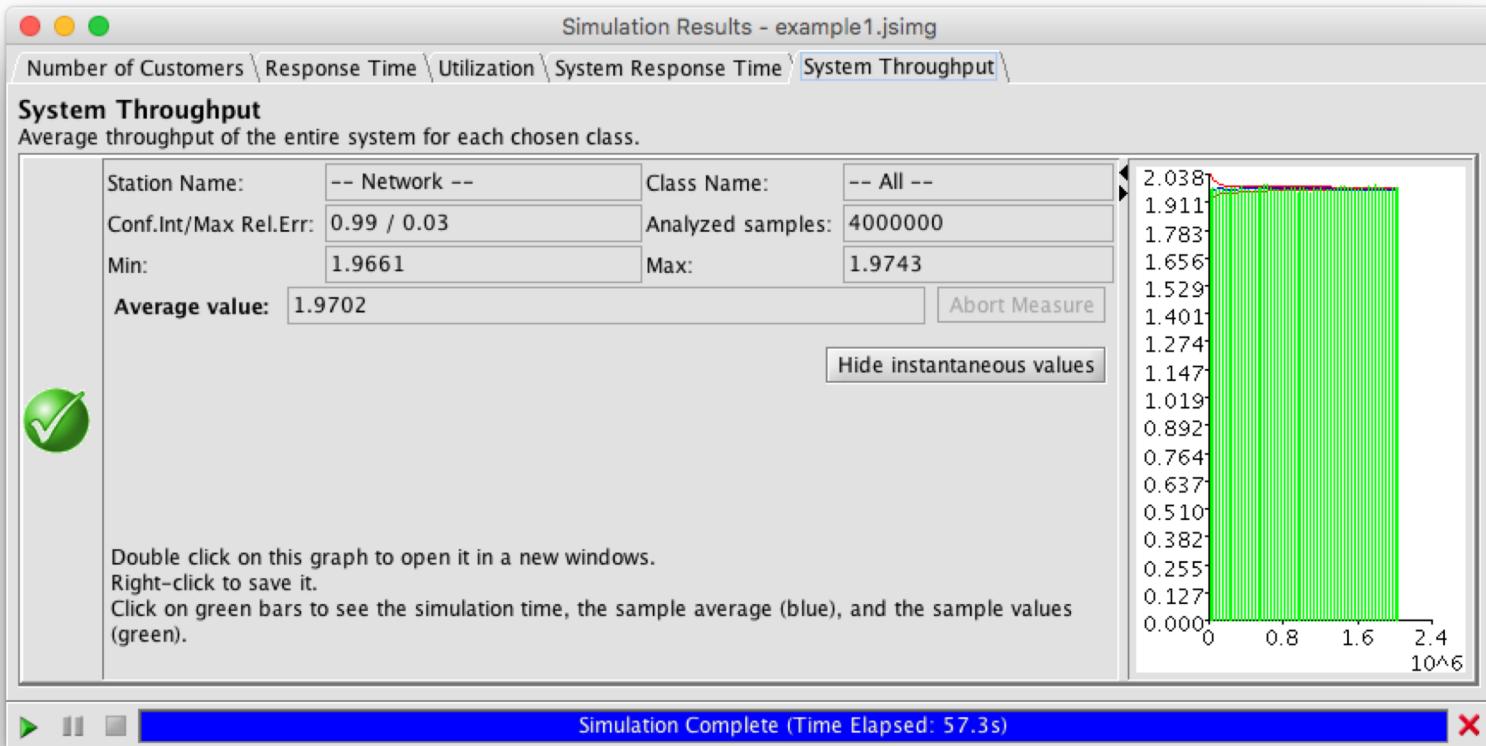
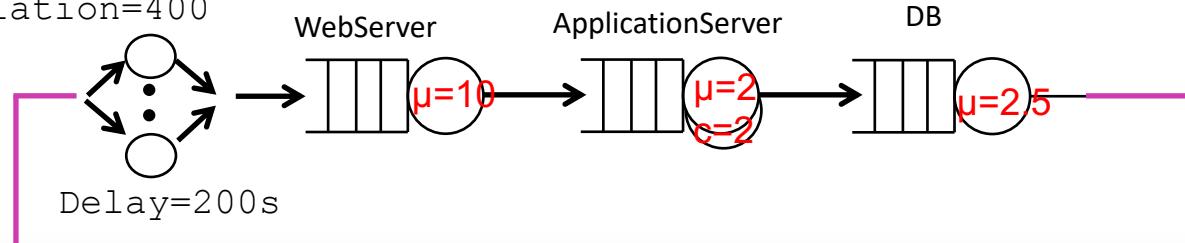
Examples

Population=400

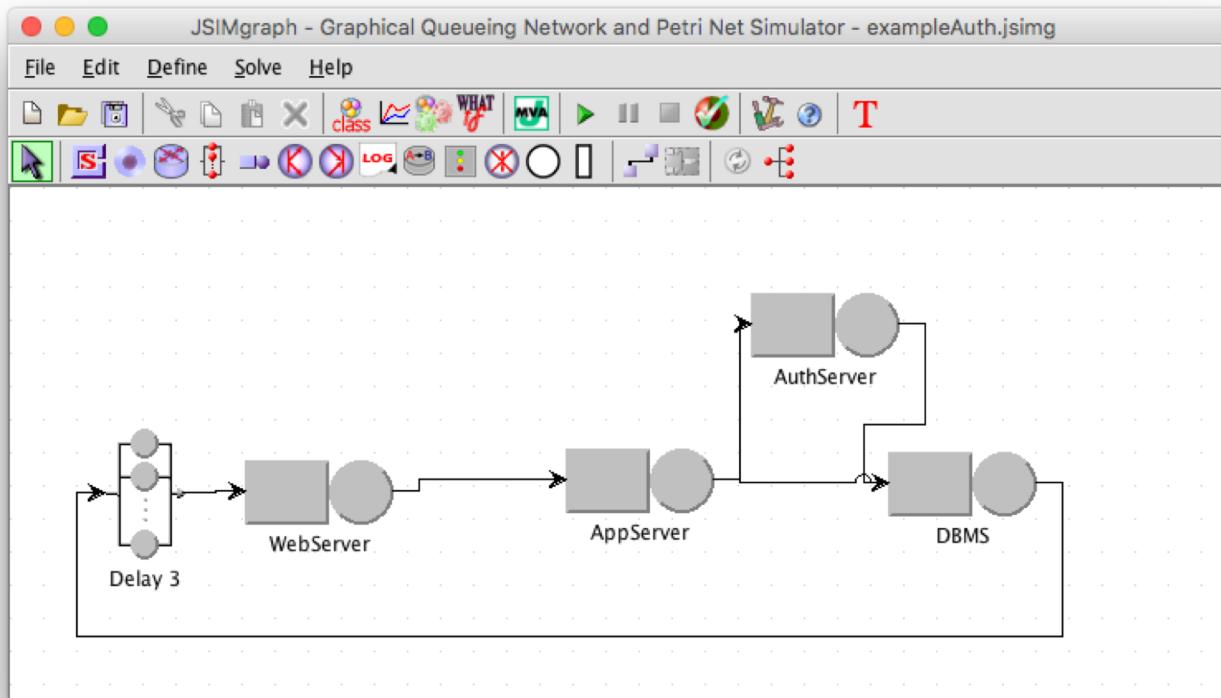
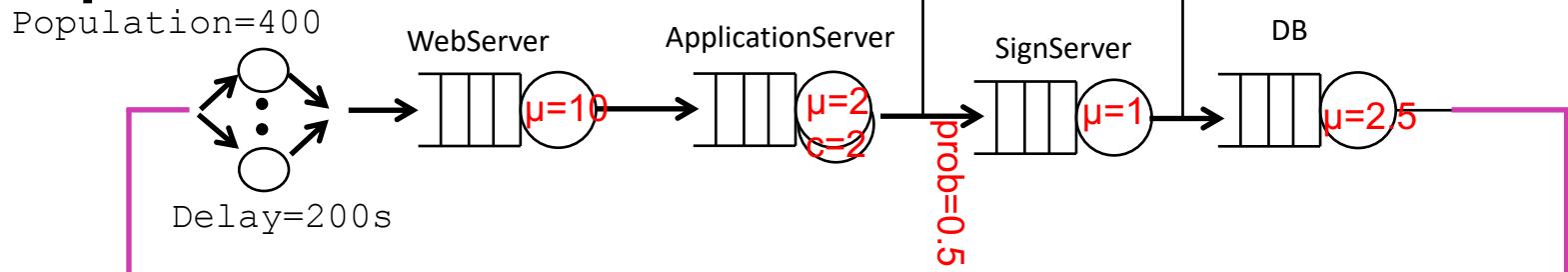


Examples

Population=400

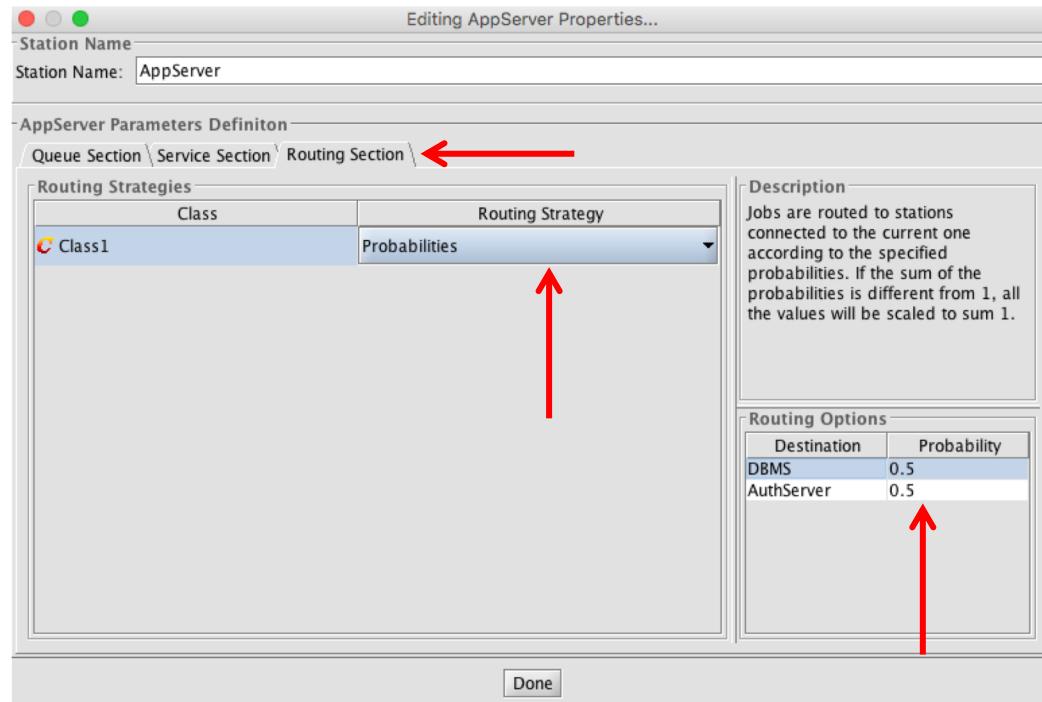
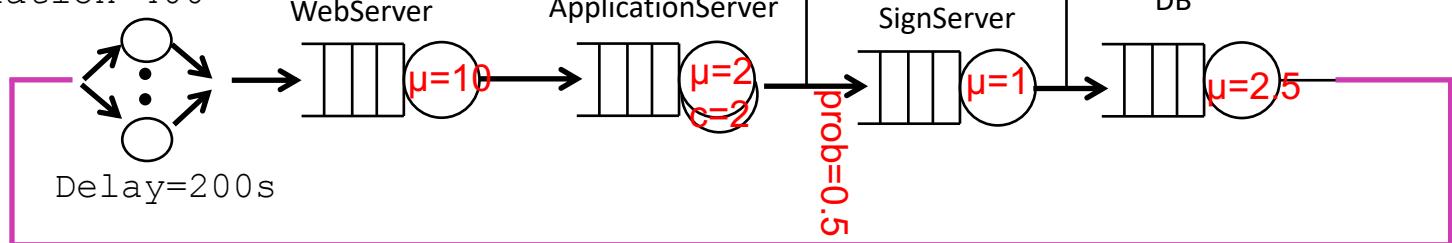


Examples



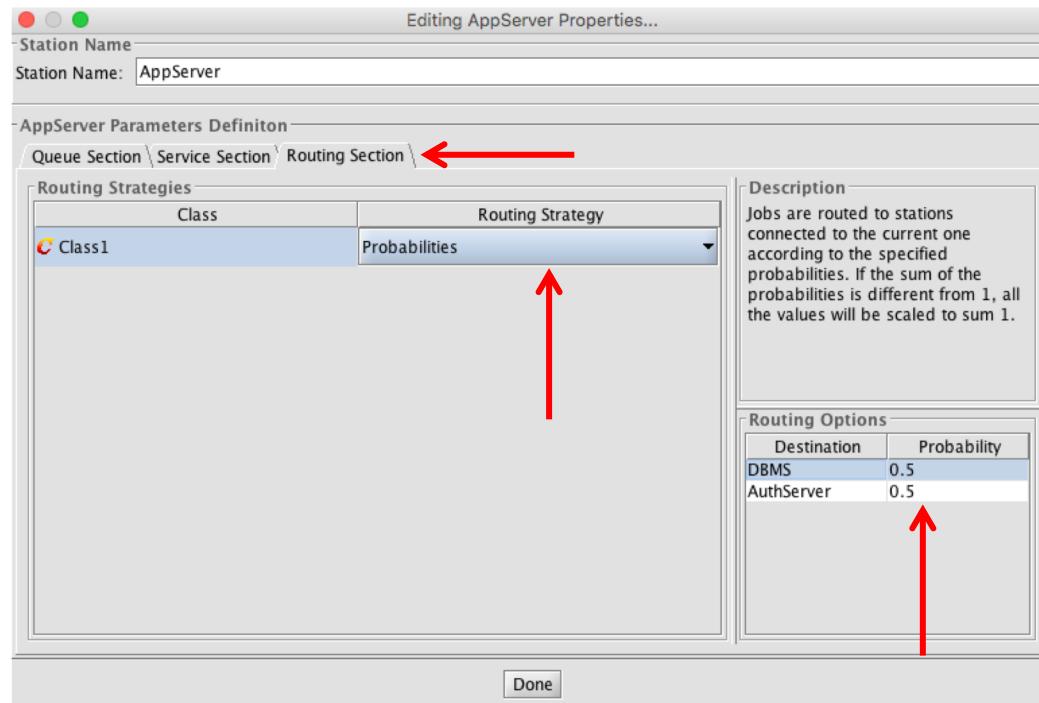
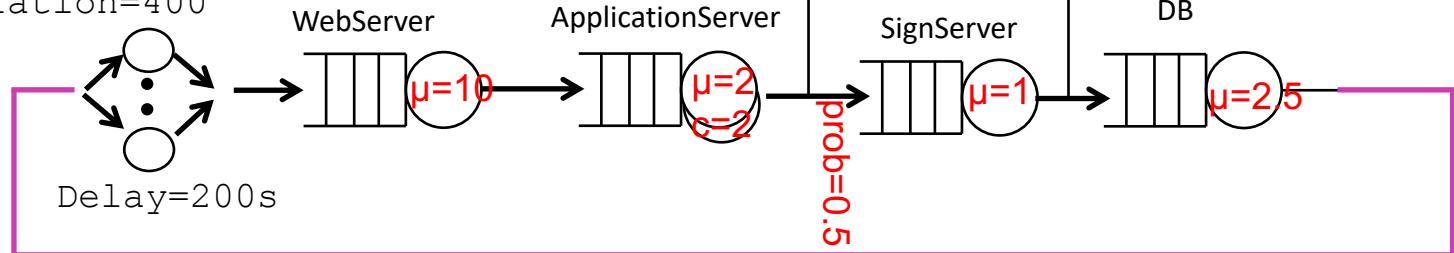
Examples

Population=400



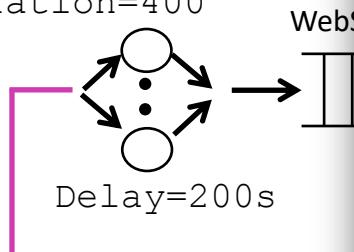
Examples

Population=400



Examples

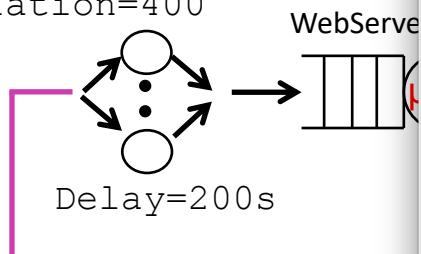
Population=400





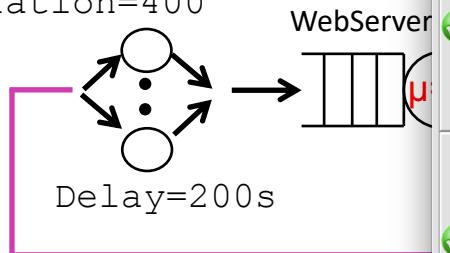
Examples

Population=400



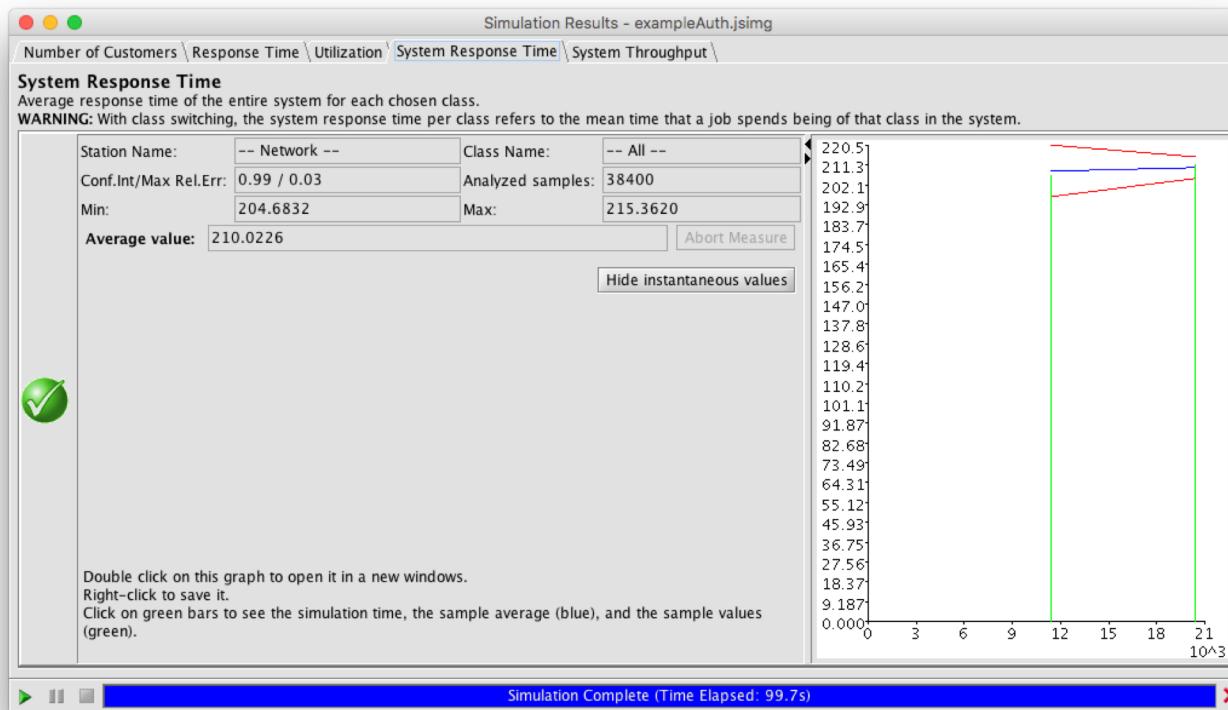
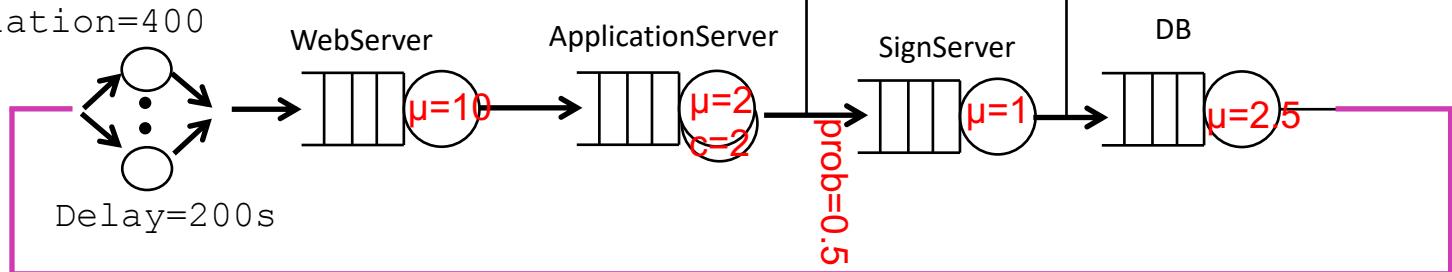
Examples

Population=400



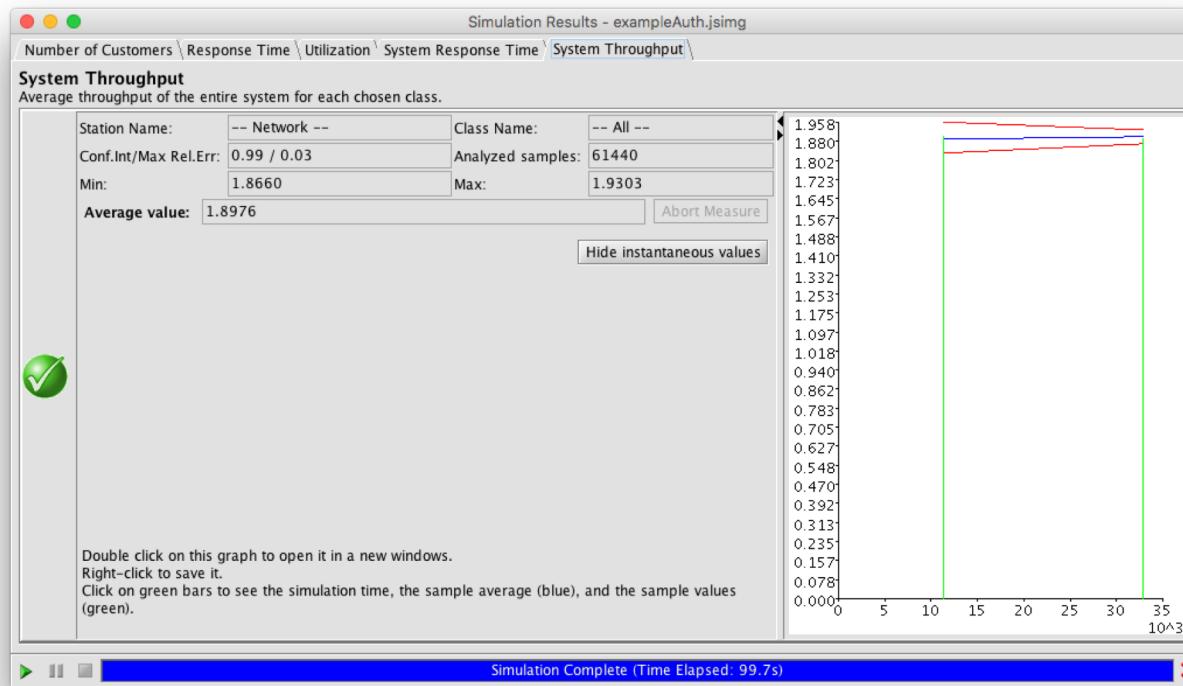
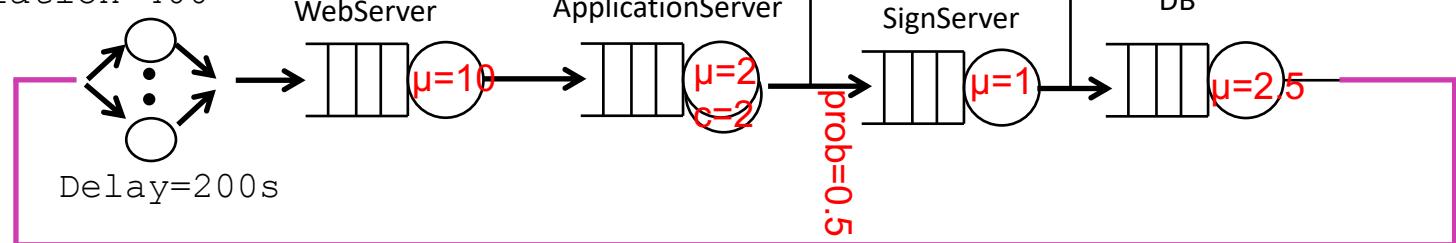
Examples

Population=400



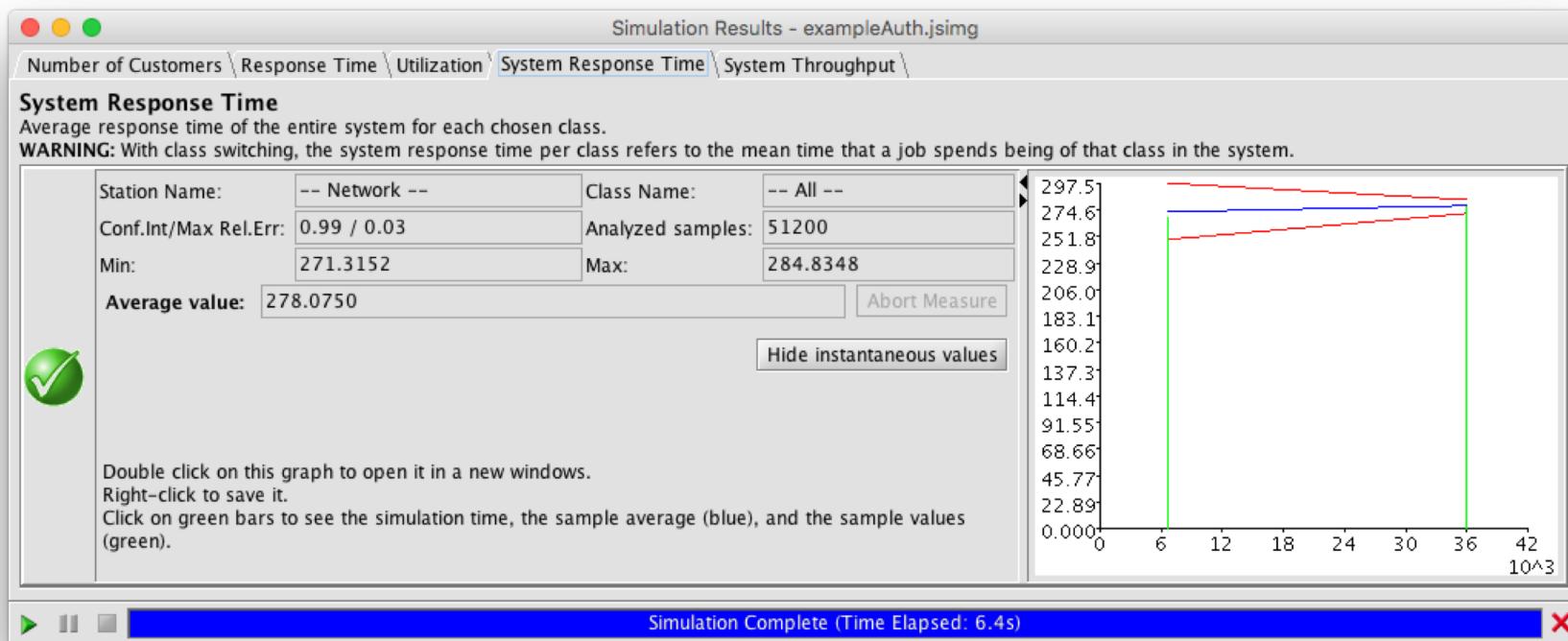
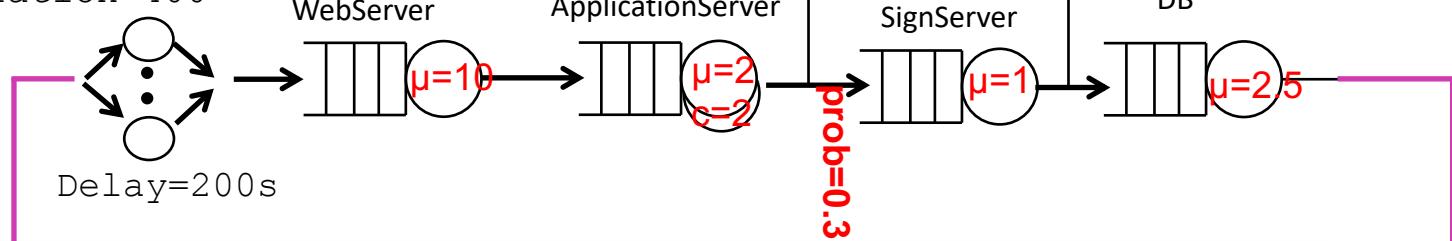
Examples

Population=400



Examples

Population=400



Examples

prob=0.7

