



University of L'Aquila

Department of Engineering and
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Report Homework #2

Water Distribution, Leakage and Quality Control System

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Github Project Repository:

<https://github.com/GaetanoFichera/Water-Quality-Control-System>

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Chapter 1

Our Homework

The task in this second homework is to create a Performance Model based on the system that we have modeled in the first homework. Using the Sequence Diagrams, we built the Execution Graph, and, through the Deployment Diagram we have built a Queueing Network. From the analysis of the Execution Graph we obtained the Demand Vectors that we used to parameterize the Queueing network. After that, the network has been resolved through a tool in order to obtain the output parameters that would allow to evaluate the system performance. In the final phase through the Architectural Description Language Aemilia we had the possibility to have a further evaluation of the system's performance.

Work Planning

the workflow was:

- Light rework on our UML Model;
- Study of theoretical concepts of Queuing Networks and how to create the Execution Graph from Sequence Diagram;
- Connection between Deployment and Component Diagram;
- Drafting of the Execution Graph;
- To simplify the amount of calculations to be done to obtain consumption of physical resources we used an Excel file;
- Drafting of the Queueing Network;
- Performance Analysis and evaluation, and Refactoring of the Queueing Network Model;
- Study of Aemilia;
- Drafting of the State Diagrams for the implementation in Aemilia;
- Drafting of the Flow Graph;
- Performance analysis in Aemilia;

Light Rework On Our UML Model

After serious consideration of our last homework, we noticed that there were failures. Below is a list of rework:

- We have applied the stereotypes to the Communication Paths within the Deployment Diagram;
- in order to improve system performance and to better stratify the deployment, we decided to add 3 new nodes:
 - "SeaweedPickingInlandControlUnit";
 - "Seaweed Picking Outgoing Control Unit";
 - "MagikarpControlUnit".

and , for this purpose we have also inserted a new profile called "Control Unit" from the server stereotype, these 3 new nodes are connected to the server with a wired connection and to sensors with a wireless connection;

- For the connections between the Control Center Server and the two Inland and Outgoing Seaweed Picking Control Units we have inserted a new communication path stereotype that does not consume resources because when we started the modeling work for the Queueing Network we considered the two Control Units located in the same physical space as the Control Center Server, then we use a "Internal Connection" stereotype with zero consumption of resources;
- We have added the operations to the components subsequently reused in the Sequence Diagram;
- we realized the lack of an internal server to the Control Center Pomezia that managed the requests coming from the App inside it;
- we realized that in the sequence diagram "check quality" the call from the component "check quality parameters inland / outgoing" was missing to the component "parameters Quality archieve" to retrieve the desired water parameters;
- we have established the types of connections between one node and the other of the deployment diagram, obtaining:
 - between the Control Center Server and the two Apps a Wired Connection;
 - between Control Center Server and Seaweed Picking a Wireless Connection;
 - between the Control Center Server and the Water Company Server and the Purification System Center an Internet Connection.
- we have agreed that there is a single database that is connected to the water company server or water archives;

- we realized that in the water sampling phase, the sensors will send the data of the water samples to the Control Center Server which, in turn, using the sample archive component will send the data to the water company server, the problem is that in the SD after the component sample archive is not invoked any component that refers to the water company server. Solution:
 - We have decided to add a component called "Sample Archive" to the water company server which is responsible for saving data on the DB. In going to add this correction we realized that in fact we have failed to use sample sender. Then we have made a small change:
 - * sample sender is inside the control center server;
 - * sample archive is located inside the water company server and manages the data on the db.
- We modified the sequence diagram of "SturtUpSamplingWater" as we realized that the component sample data on the SeadweedPickingInland / Outgoing node communicated with the "SampleSender" component on the ControlCenterServer node but from our component + deployment diagram it was not.

Below you can find the description of the new profiles popping out.

3.1 Wired Connection Profile

| | |
|-------------------------|--|
| Wired Connection | |
| Metamodel Class | Communication Path |
| Description | It is a representation of the physical meaning of Wired Connection |
| Tagged Values | |
| Constraints | |

3.2 Internet Connection Profile

| | |
|----------------------------|---|
| Internet Connection | |
| Metamodel Class | Communication Path |
| Description | It is a representation of the physical meaning of Internet Connection |
| Tagged Values | |
| Constraints | |

3.3 Wireless Connection Profile

| | |
|----------------------------|---|
| Wireless Connection | |
| Metamodel Class | Communication Path |
| Description | It is a representation of the physical meaning of Wireless Connection |
| Tagged Values | |
| Constraints | |

3.4 Internal Connection Profile

| | |
|----------------------------|---|
| Internal Connection | |
| Metamodel Class | Communication Path |
| Description | It is a representation of the physical meaning of Internal Connection |
| Tagged Values | |
| Constraints | |

3.5 Control Unit Profile

| | |
|----------------------------|--|
| Internal Connection | |
| Metamodel Class | Node |
| Description | It is a representation of the physical meaning of Control Unit |
| Tagged Values | |
| Constraints | |

Use Cases Decision

In building the Performance Model we considered only two use cases. To satisfy the Homework request the Use cases choosen are:

- StartUp Sampling Water activated by Sample Supervisor;
- Check Water Quality activated by Quality Control Supervisor.

Identification Of Performance Requirements

The following consideration has been made:

one kilometer of the route with respect to the connection point with the system is taken into account for an Entry Water Channel or Exit of 5 meters radius, and every 10 meters must be 10 Seaweed Picking, with a total of 1000 Seaweed Picking.

Non-functional requirements are:

- Each sensor must take 100 ms to carry out a sampling;
- The time between a sampling and an other is 500 ms;
- The time that each node must use to send the data to the archive is 200 ms;
- The time of use of each node must be less than 90
- The response time of an Actor Task must not exceed 300 ms.

Development Of Component Diagram Into Deployment Diagram

In reference to the Use Cases taken into consideration, to better understand our architecture, we have combined the Deployment Diagram with Component Diagram. In the figure below this is represented.

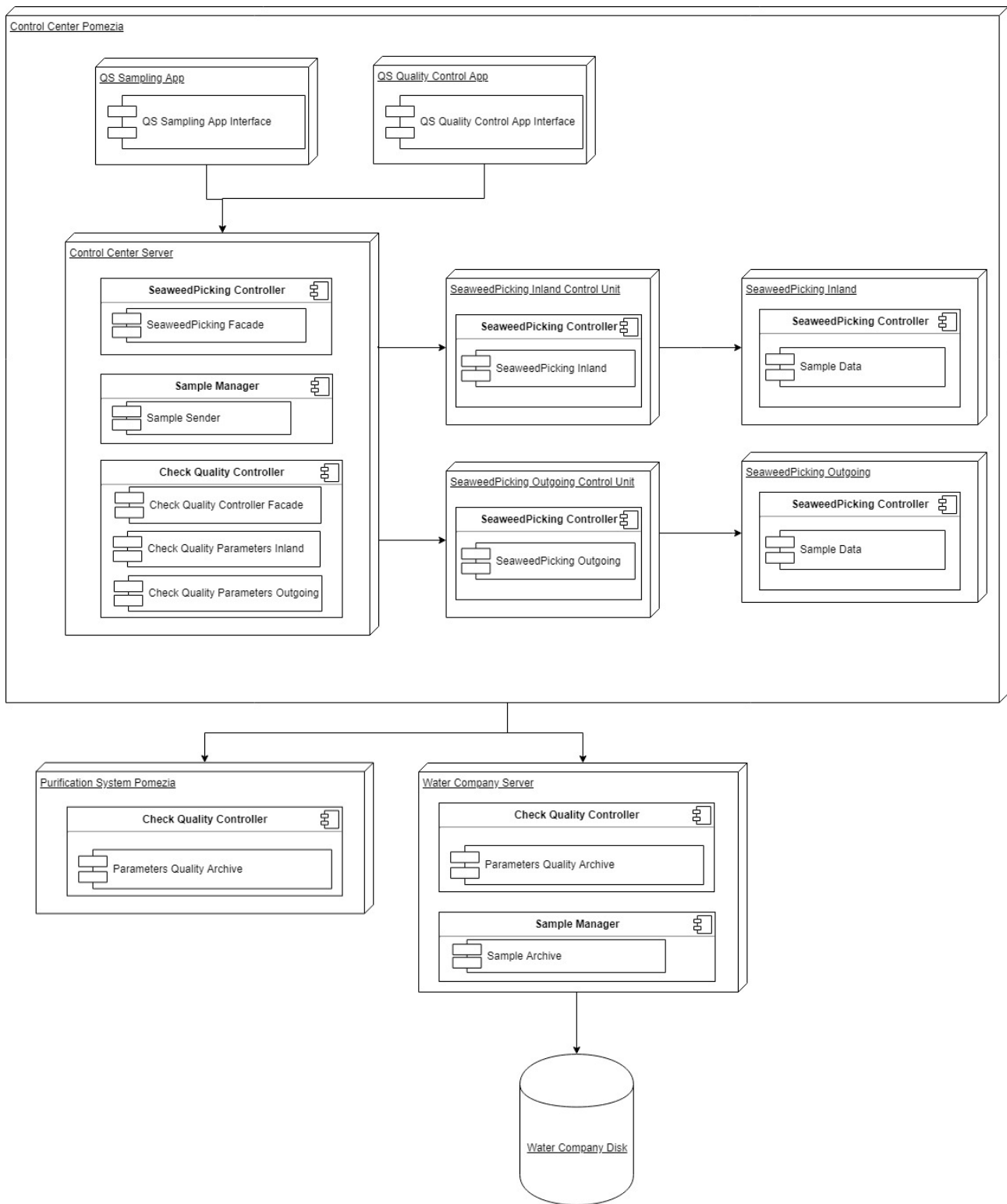


Figure 6.1: Deployment Diagram + Component Diagram

Model WCS With Execution Graphs

7.1 Demand Vector

Analyzing the sequence diagram, component and deployment diagram we have obtained this demand vector which represents virtual resources related to our architecture:

| | |
|--|---|
| Wired Connection Request | Estimated consumption of the request to the Wired Connection |
| Wireless Connection Request | Estimated consumption of the request to the Wireless Connection |
| Internet Connection Request | Estimated consumption of the request to the Internet Connection |
| Database Request | Estimated consumption of the request to the Database |
| Control Center Server CPU | Estimated consumption of the request to the Control Center Server CPU |
| Water Company Server CPU | Estimated consumption of the request to the Water Company Server CPU |
| Purification System Pomezia CPU | Estimated consumption of the request to the Purification System Pomezia CPU |
| Seaweed Picking Inland Control Unit CPU | Estimated consumption of the request to the Seaweed Picking Inland Control Unit CPU |
| Seaweed Picking Outgoing Control Unit CPU | Estimated consumption of the request to the Seaweed Picking Outgoing Control Unit CPU |
| Seaweed Picking Outgoings Sample Request | Estimated consumption of the request to the Seaweed Picking Outgoing Sample |
| Seaweed Picking Inlands Sample Request | Estimated consumption of the request to the Seaweed Picking Inlands Sample |

The Execution Graphs obtained are:

- Sampling Water activated by Sample Supervisor:

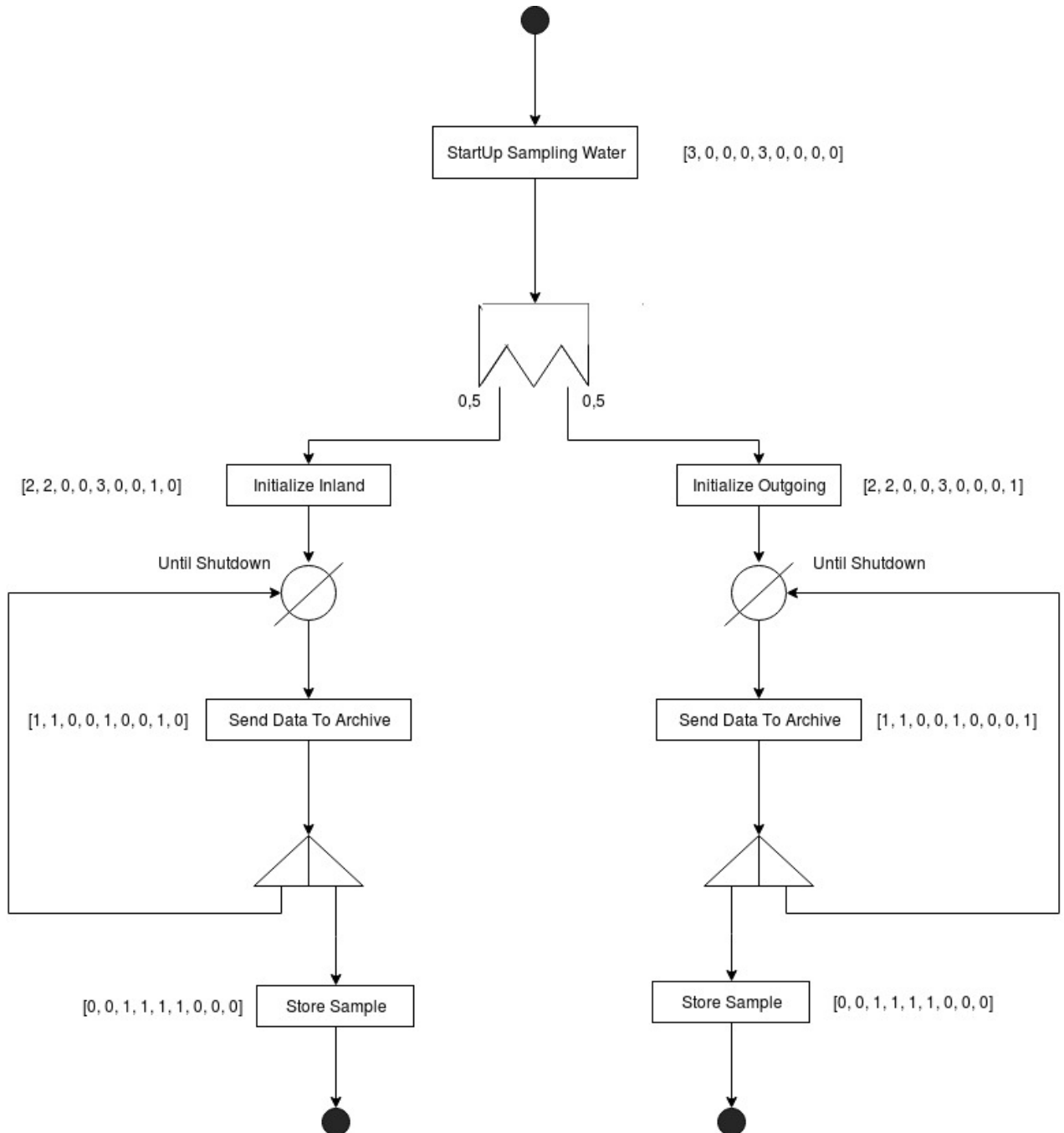


Figure 7.1: EG UC1 StartUp Sampling Water

- Check Water Quality activated by Quality Control Supervisor:

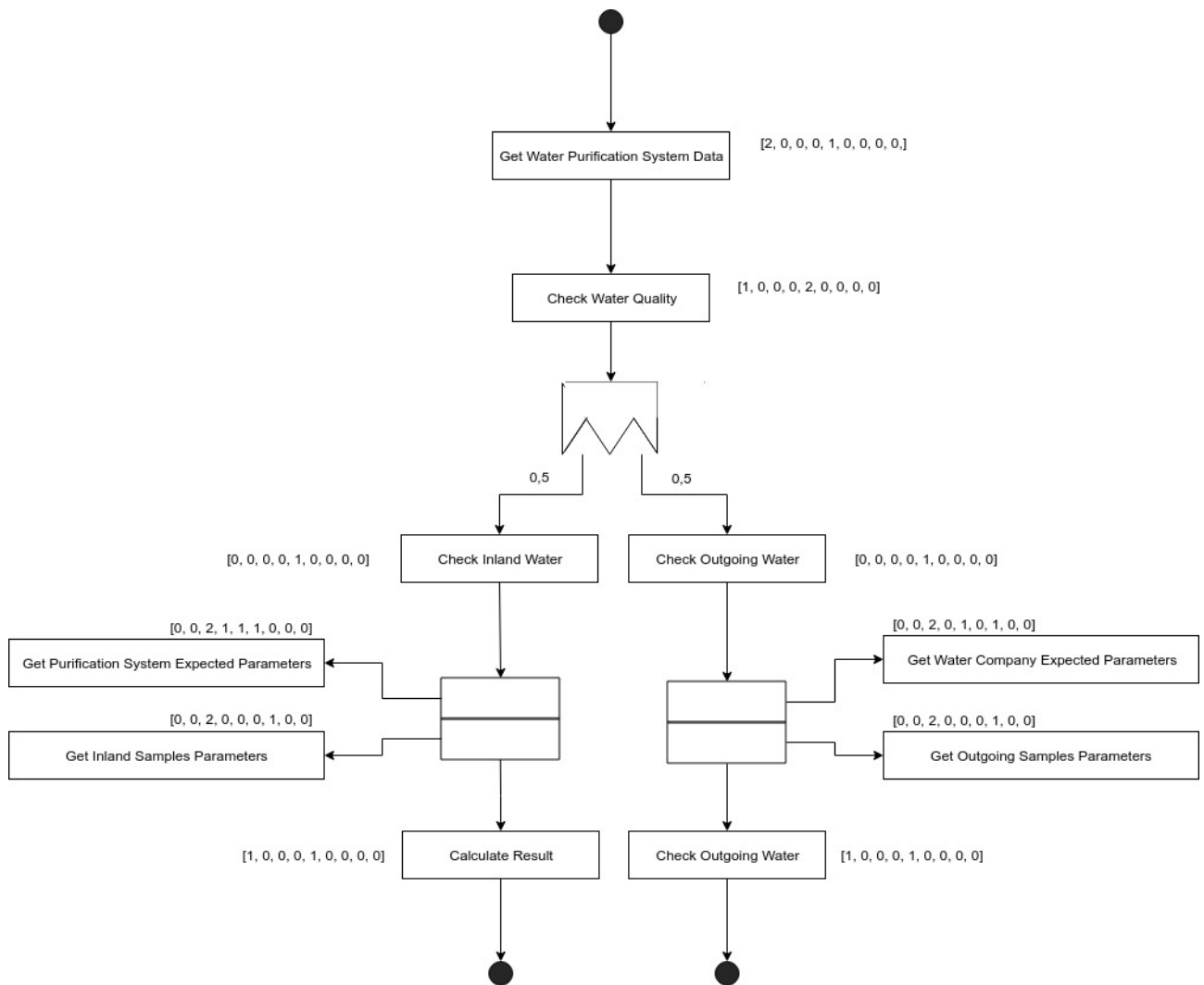


Figure 7.2: EG UC3 Check Water Quality

Queueing Network Model

Then we have identified the physical nodes of our system going to introduce how the Execution Graphs are connected to them:

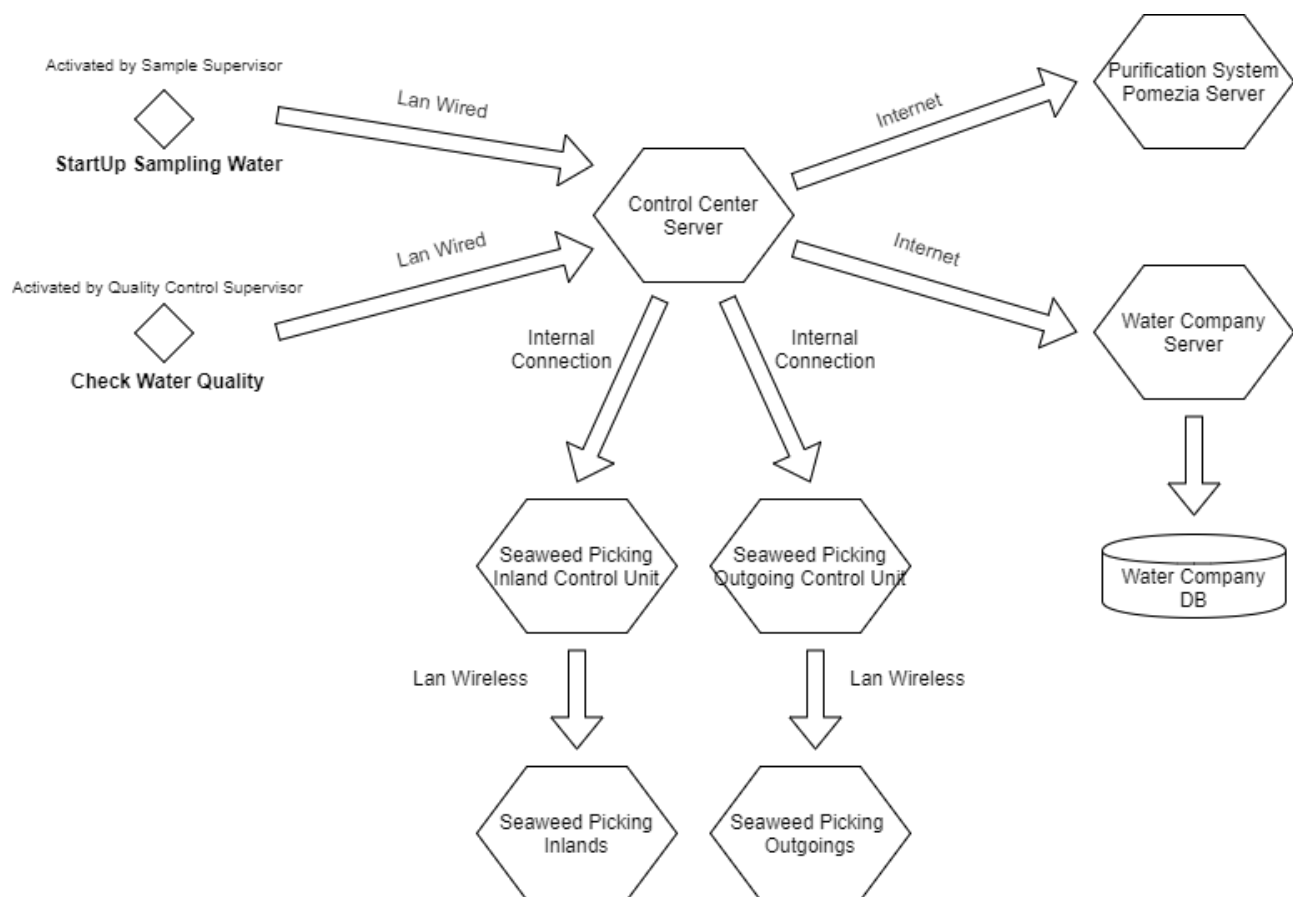


Figure 8.1: Physical Nodes

This is the Queueing Network so obtained:

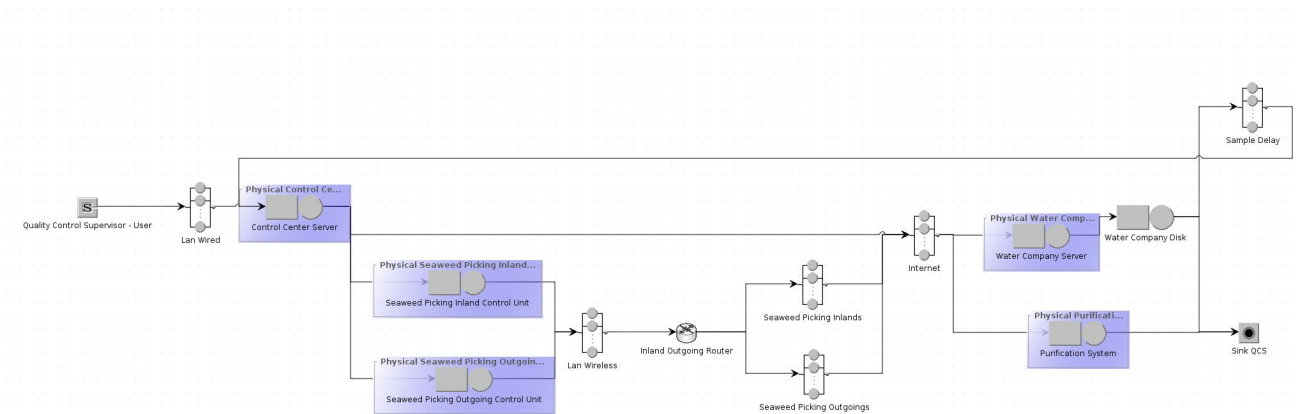


Figure 8.2: Queueing Network

After several tests, we agreed to reduce the sampling time to 500 seconds to refine the performance analysis. On JMT for the same reason we have only one SeaweedPicking Control Unit and no two for In / Out. We have also decided to eliminate the finite capacity regions as useless for the purposes of our project. So our final Queueing Network has become this:

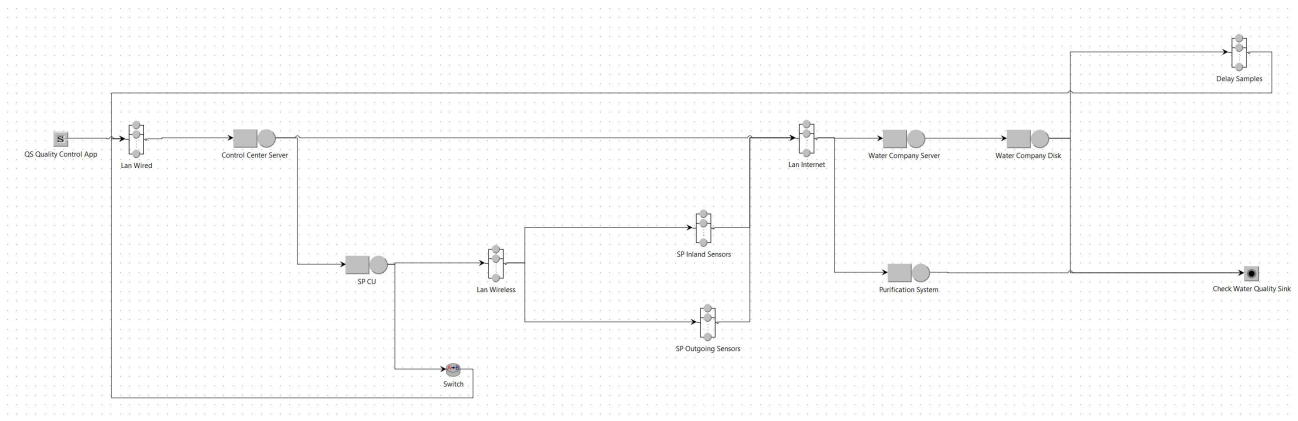


Figure 8.3: Final Queueing Network

Chapter 9

AEmilia Model