



Industrial Cyber-
Physical Systems

Assignment 1



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OPC UA Server

The company “IoT is here” is worried because its platform doesn’t have an OPC UA interface. They would like to modernize their solution by building an OPC UA server that can provide the common OPC UA interface to their customers.

Your group was hired to implement the OPC UA interface solution. The system architecture and components are illustrated in Figure 1. Your group is responsible only for the development of the red square denominated “OPC UA Server”. Therefore, all devices (sensors and actuators) can expose their data and actuation points by using high-level commands through OPC UA. In this way, any client application will be able to communicate with the end devices, independent of low-level protocols.

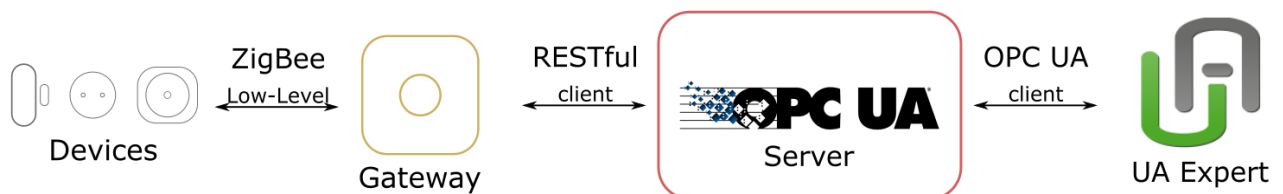


Figure 1 System architecture

a) Devices

In your OPC UA server, you should consider the following devices for connection. There are two devices, not previously known by your group. But they come with a manual, describing their functionalities and measurement/actuation points.

Sensor	Characteristics
Motion sensor	Shows activity in the room, illuminance in lux, temperature, etc.
Power plug	Turn on/off the power connection. Energy measurement.
Window sensor	Installed on windows and doors. Status shows if they are open or closed.
Secret device #1	Please read manual
Secret device #2	Please read manual

You need to pair your device to the gateway (please see how this is done on the manual of each device). You also need to learn which information is provided by each device.

You also need to analyze two devices that were not previously seen in the classroom. The manual for each device will be provided, so please read carefully about what the equipment is made for (sensor/actuator), how to pair this element to the gateway, and later what kind of information can be extracted.

b) Gateway

The paring function can be established by the gateway web interface. It is also possible to list all functionalities and logical devices of each sensor and actuator. You can access the gateway interface by accessing the following address:

`[gateway_address]/#/dashboard.`

The gateway provides the RESTful interface by accessing the Swager interactive API Documentation. You can access the API, by using the following link. The address is the IP address of the gateway in the network.

`[gateway_address]/api-docs/interactive.`

You should be able to see a similar interface illustrated in Figure 2. All the operations necessary for the implementation are described in the “zb” section.

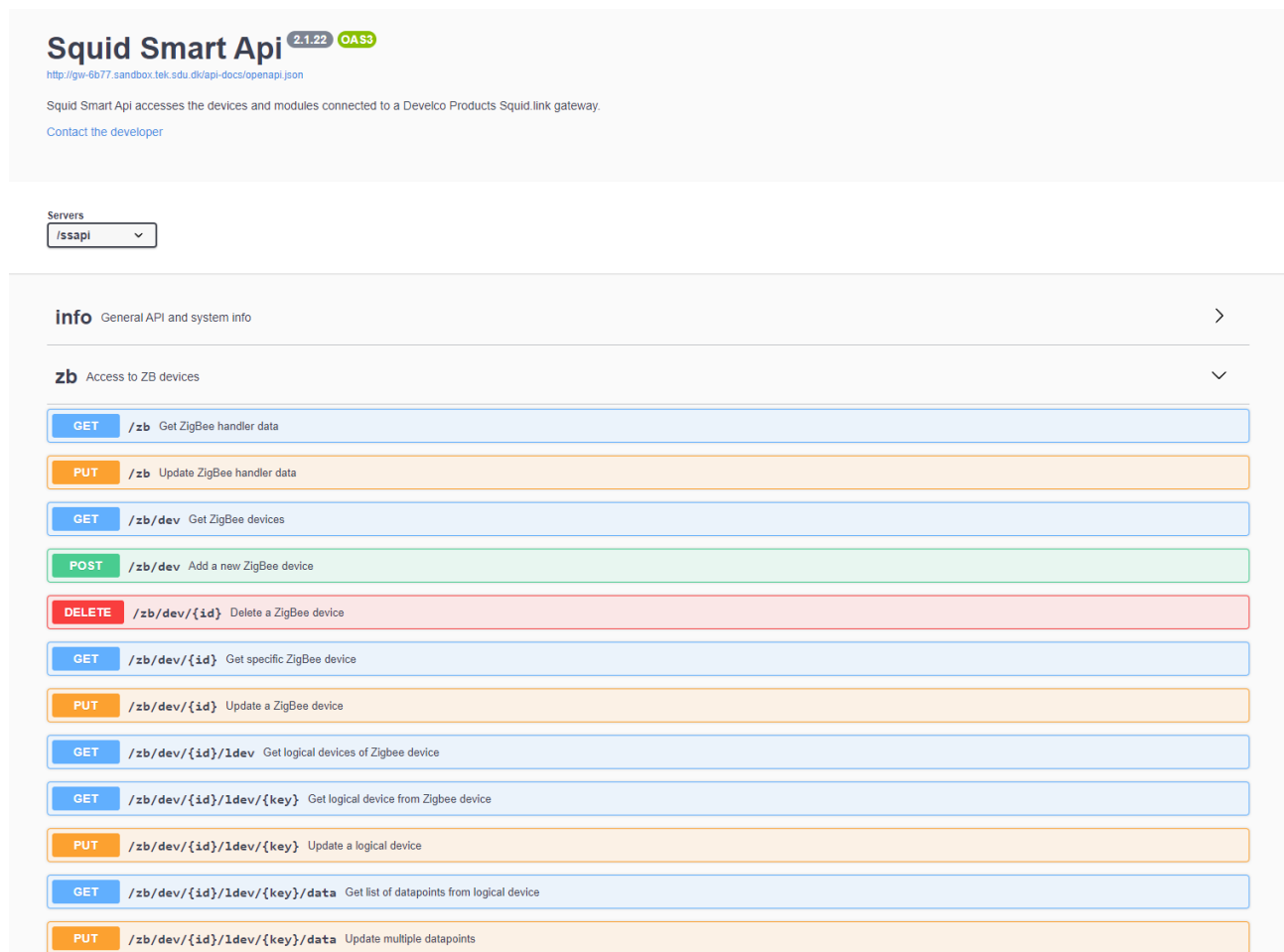


Figure 2 Interactive Swager interface

You need to select the necessary request methods for reading information from a sensor or writing information from a sensor. Please see in the interactive Swager API interface what is the appropriate request for each function.

c) OPC UA server

This is the focus of your group work. You need to implement an OPC UA server able to expose all data from sensor devices. It also should provide an interface for receiving write commands to change states from actuator devices.

The implementation should be done using the JAVA library Apache Milo OPC UA. The OPC UA server doesn't need to implement any certification criteria. But in order to provide a simple security level, it will be necessary to provide authentication information by providing the 'user' and 'password' registered on the server side.

Your OPC UA server needs to consider:

- a) Address Space: how to map different devices and logic devices in a tree structure. Remember to organize the endpoints in different endpoint types: folders, variables, parameters, etc.
- b) Each node with a value needs to specify a specific type that needs to be mapped in one of the different types provided by the OPC UA specification.
- c) Endpoints have different access types: Read/Write/Historical. You need to select the one more appropriate to the datapoint associate in the Swagger interface.

Remember that the system can change state in two ways:

- 1. When the environment changes. In this case, the sensor or actuator will update their respective logical devices with the new state values.
- 2. When there is a write request from a client application. In this case, only actuators needs to be taken into consideration. The new state values flow from the client to the OPC UA server, and then from the OPC UA server to the gateway system. The gateway is responsible for the final update to the system.

Remember also that clients should be able to subscribe to endpoints from the OPC UA server. However, the gateway API is based on HTTP requests and, therefore, is not able to provide subscription methods directly. It is your work to make sure that subscriptions work properly.

d) Client application

Any client application that has the right authentication data (user and password) should be able to connect to the OPC UA server. To test the right implementation of your server, we will use a commercial software visualization: UA Expert. The client application should be able to:

- 1. Connect to the OPC UA server using the right credentials
- 2. Show the address space and its tree structure
- 3. Show the node properties, such as nodeId, namespace index, IdentifierType, Value, Timestamp, Access Level, etc.
- 4. Sensor data should have Access Level as "CurrentRead".
- 5. Actuator variables should have Access levels as "CurrentRead", and "CurrentWrite".

6. You need to map variable types from the Java system to their respective type in OPC UA.
7. Changes in the environment should be seen on the UA Expert "Data Access View"
8. Write requests from UA Expert should be sent to the selected actuator.

Evaluation criteria

No report is necessary. Each group will have 20 for presentation in the Ø40-606a-0 lab. There will be two phases of the presentation:

1. The students explain how they designed their OPC UA server. Some code can be shown to highlight design decisions.
2. Execution of the system. The solution should be demonstrated by using UA Expert to test the 8 points listed in section d) Client application.

The grade has only a pass/fail criteria and will be included in the assignments portfolio of each group.