

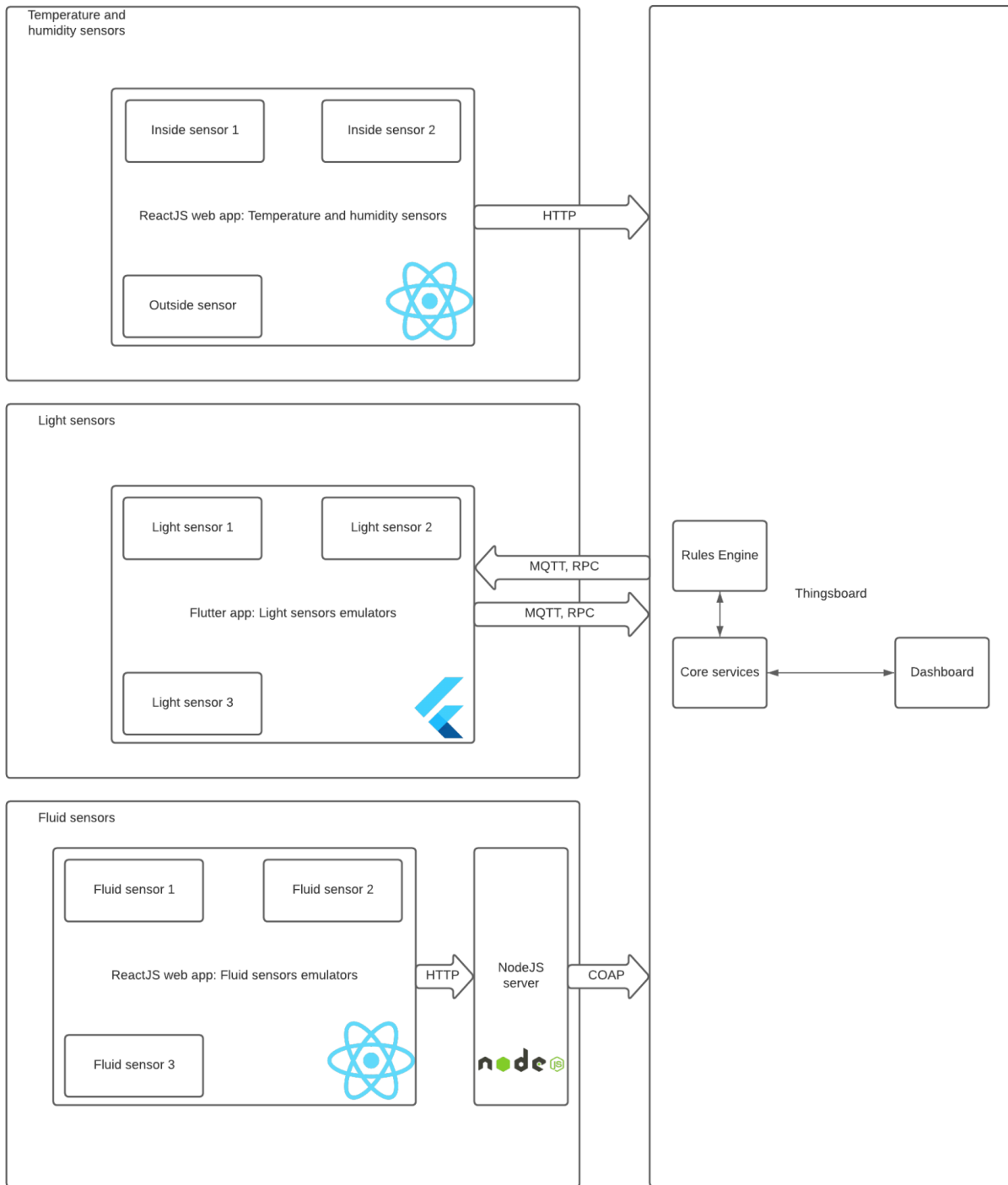
IoT architecture

Our project is a smart greenhouse. We are emulating a structure in which we can grow plants and vegetables, while monitoring key variables like temperature or humidity. Through thingsboard dashboards, we can watch the temperature inside and outside our greenhouse. We can also watch the current water, fertilizer and weed killer levels. It is even possible to watch and change the current light intensity and status from the dashboard. Our thingsboard architecture allows us to define many rules and compute relevant data, so that the people in charge of the greenhouse can have all the data they need.

The architecture

Our architecture is composed of 3 light sensors, 3 temperature and humidity sensors and 3 fluid sensors. We use flutter, ReactJS and NodeJS to emulate our sensors.

- Our light sensors are emulated by using a flutter app that communicates with the thingsboard server through MQTT.
- Our temperature sensors are emulated by using a ReactJS web app that sends HTTP requests to the thingsboard server.
- Our fluid sensors are emulated by using a ReactJS web app and a NodeJS server. Our ReactJS app emulates the fluid sensors and sends HTTP calls to the NodeJS server, which sends COAP requests to the thingsboard.



2. Devices

2.1 Light sensors

In the thingsboard server, we defined 3 light sensors. They all use the same “Light sensor” device profile and use MQTT as a transportation setting.

2.2 Temperature and humidity sensors

In the thingsboard server, we defined 3 temperature and humidity sensors. We have 1 indoor sensor which uses a “Indoor temperature sensor” device profile, and 2 outdoor sensors that use the same “Outdoor temperature sensor”.

2.3 Fluid sensors

In the thingsboard server, we defined 3 fluid sensors sensors. They use 3 different device profiles “Fluid sensor 1”, “Fluid sensor 2” and “Fluid sensor 3”. We use different device profiles to better filter the telemetry data by sensor inside the rules engine.

3. Assets

3.1 Greenhouse

This asset is used to store alarms and telemetry data computed by our rule engine and that combines data of different devices.

4. Telemetry data

4.1 Light sensors

Example: {"status": true, "intensity": 50, "longitude": 50, "latitude": 50}

Name	Type	Unit	Possible values	Definition
status	boolean	-	True - False	Represents whether a light is on or off.
intensity	double	lux	0 to 100	Represents the intensity of the light.
longitude	double	degrees	-180 to 180	Position of the sensor.
latitude	double	degrees	-90 to 90	Position of the sensor.

4.2 Temperature and humidity sensors

Example: {"temperature": 20, "humidity": 50, "longitude": 50, "latitude": 50}

Name	Type	Unit	Possible values	Definition
temperature	double	Celsius degrees	-273.15 to infinite	Represents the current temperature
humidity	double	-	0 to 100	Represents current humidity.
longitude	double	degrees	-180 to 180	Position of the sensor.
latitude	double	degrees	-90 to 90	Position of the sensor.

4.3 Fluid sensors

Example: {"status": true, "intensity": 50, "longitude": 50, "latitude": 50}

Name	Type	Unit	Possible values	Definition
type	string	-	"water", "fertilizer" or "weedKiller"	Type of fluid.
consumedVolume	double	litters	-	Amount of fluid that was just consumed.
capacity	double	litters	-	Capacity of the fluid recipient.
totalVolume	double	litters	-	Total volume of the fluid left.

totalConsumption	double	litters	-	Total volume of fluid that was consumed.
longitude	double	degrees	-180 to 180	Position of the sensor.
latitude	double	degrees	-90 to 90	Position of the sensor.

5. Rules

We have many rules in our rules engine. Some are specific to a sensor while some gather data from several types of devices.

5.1 Light sensors rules

Name	Effect
Light Sensor Root Chain	Intercepts the inputs, filters the messages and redirects to the next rules.
Process Light sensor input	Processes the telemetry data that was received, checks its validity, saves it and sends it to the next rules. If input is a response to a rpc call, convert this data to telemetry data, check validity, save it and send it to the next rules.
Process Light sensor rpc request	Processes the rpc requests from the dashboard to the devices. Converts the data to telemetry, saves it, and sends the rpc request to the device.
Average light intensity of the day	Calculates the average light intensity of a sensor, over a day.

5.2 Temperatures and humidity sensors rules

Name	Effect
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Temperature Sensor Root Chain	Intercepts the inputs, filters the messages and redirects to the next rules.
Delta between temperature the last 15 minutes	Computes the delta of temperatures between now and the last 15 minutes, and creates an alarm if it's greater than 15.
Average temperature of the day	Calculates the average temperature of the day.
Temperature / Humidity ratio	Calculates the ratio between temperature and humidity

5.3 Fluid sensors rules

Name	Effect
Fluid Sensor Root Chain	Intercepts the inputs, filters the messages and redirects to the next rules.
Transform fluid telemetry fluids	Converts the telemetry data to separate by type. For example: { type: "water" consumedVolume: 10 } becomes { type: "water", consumedWaterVolume: 10 } Saves telemetry data and redirects to the next rules.
Calculate fluids total consumption	Calculates total consumption across different types of fluids and saves it.
Calculate fluids total capacity	Calculates total capacity across different types of fluids and saves it.
Calculate daily fluids consumption per type	Calculates daily consumption of fluid per fluid type, and saves it.
Calculates total daily fluid consumption	Calculates the daily fluid consumption across all fluid types, and saves it
Fluid delta	Computes total consumption of a fluid sensor, at the same time the day before, and saves it.

5.4 Combination of devices

Name	Effect	Devices
Calculate difference between inside and outside temperature	Calculates the difference between indoor and outdoor temperature sensors, and saves it.	Indoor temperature sensors. Outdoor temperature sensors.
Determine if too much light because of heat	Calculates the ratio between the indoor temperature and the light intensity. If it's too high, meaning there is too much light and it's affecting temperature, create an alarm to inform the user.	Indoor temperature sensors. Light sensors.
Heat to water ratio	Calculates the ratio between temperature from temperature sensors and consumed water from fluid sensors. Saves the result and creates an alarm if it's too high, meaning the high temperature might be accelerating water consumption.	Indoor temperature sensors. Fluid sensors (water)
Calculate total consumption across all fluid sensors	Calculates the total fluid consumption across all fluid sensors.	Fluid sensors

6. Dashboards

6.1 Light x3

A dashboard that displays a light sensor's data.

Widget	Function
Intensity controller	Controls device light intensity by sensing rpc calls.
Intensity indicator	Displays the latest intensity telemetry data.
Status controller	Controls device light status.

Alarms	Shows all alarms related to the light sensor.
Average intensity of the day	Displays average intensity of the day.

6.2 Temperature x3

Widget	Function
Temperature indicator	Displays current temperature.
Humidity indicator	Displays current humidity.
Data table	Displays data about the sensor.
Alarms	Shows all alarms related to the sensor.
Average temperature	Displays average temperature of the day.
Map	Shows the location of sensors.

6.3 Fluid x3

Widget	Function
Total consumption	Displays total fluids consumption
Total consumption per fluid type	Displays total consumption per fluid type
Consumed fertilizer	Displays consumed fertilizer (litters)
Consumed water	Displays consumed water (litters)
Consumed weed killer	Displays consumed weed killer (litters)
Available water	Displays available water (litters)
Available fertilizer	Displays available fertilizer (litters)
Available weed killer	Displays available weed killer (litters)
Alarms	Shows all alarms related to the sensor
Quantity of consumed fluids over time	Displays consumed fluids in a graph
Data table	Displays sensor data

Map	Displays location of the sensor
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6.4 Greenhouse

A dashboard that displays data related to all devices, computed by the rule engine.

Widget	Function
Heat water ratio	Displays heat / water ratio between temperature sensors and fluid sensors.
Intensity All fluid sensors consumption	Displays the fluid consumption across all fluid sensors.
Temperature difference Outside / Inside	Graph that displays the difference in temperature between indoor and outdoor temperature sensors.
Alarms	Shows alarms related to the greenhouse.
Temperature difference Outside / Inside (thermometer)	Thermometer that displays the difference in temperature between indoor and outdoor temperature sensors.
Map	Displays location of all devices