LOTUS

LOW-COST INNOVATIVE TECHNOLOGY FOR WATER QUALITY MONITORING
AND WATER RESOURCES MANAGEMENT FOR URBAN AND RURAL WATER SYSTEMS IN INDIA

Deliverable D5.6
Integrated platform demonstration, first version

Lead: UNEXE

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Project Deliverable

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Title
D5.1 Conceptual design and architecture of the platform, first version

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Abstract
This document captures the first version of the global system architecture, outlining all the components, their inputs and outputs and how they integrate with each other. It also identifies areas where existing technology will make up part of the solution and provides the foundations for designing a highly flexible, modular and expandable platform that will be suitable for the conditions in India and take advantage of the specific capabilities of the LOTUS sensor.

Keywords
Platform, system architecture

Disclaimer

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The LOTUS Project

LOTUS is a project funded by DG Environment under the European Union Horizon 2020 Research and Innovation Programme and by the Indian Government. It brings together EU and prominent Indian organisations with the aim to co-create, co-design and co-develop innovative, robust, affordable low-cost sensing solutions for enhancing India's water and sanitation challenges in both rural and urban area.

The LOTUS solution is based on an innovative sensor and includes tailor-made decision support to exploit the capabilities of the sensor as well as a specific approach to co-creation. LOTUS aims to be co-designed and co-produced in India, and have a wide, diverse and lasting impact for the water sector in India due to intense collaborations with commercial and academic partners in India.

Based on the low-cost sensor platform, solutions for the early detection of water quality problems, decision support for countermeasures and optimal management of drinking and irrigation water systems, tailored on the functionalities of the new sensor, will be developed and integrated with the existing monitoring and control systems.

This sensor will be deployed in five different use cases: in a water-network, on ground-water, in irrigation, in an algae-based wastewater treatment plant and water tankers. The packaging of the sensor, as well as the online and offline software tools, will be tailored for each of the use cases. These last will enable us to test the sensors and improve them iteratively.

The project is based on co-creation, co-design and co-production between the different partners. Therefore, an important stakeholder engagement process will be implemented during the project lifetime and involve relevant stakeholders, including local authorities, water users and social communities, and will consider possible gender differences in the use and need of water. Broad outreach activities will take place both in India and in Europe, therefore contributing to LOTUS impact maximization.

The further development and exploitation (beyond the project) of the novel sensor platform will be done in cooperation with the Indian partners. This will create a level playing field for European and Indian industries and SMEs working in the water quality area.

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Acronyms and Definitions

Acronyms	Defined as
API	Application programming interface
CRUD	Create, read, update and delete
DSS	Decision support system
EC	Electrical conductivity
GPS	Global positioning system
IoT	Internet of things
JSON	JavaScript Object Notation
JSON-LD	JavaScript Object Notation for Linked Data
LoRaWAN	Long range wide area network
LWM2M	Lightweight Machine-to-Machine
MVC	Model, view and controller
NGSIv2	Next Generation Service Interface v2
ONA	Open network architecture
OPC	Open platform communication
OPC-UA	Open Platform Communications United Architecture
OWASP	Open Web Application Security Project
PDPA	Personal Data Protection Act
SCADA	Supervisory control and data acquisition
SQL	Structured query language
TDS	Total dissolved solids
WDN	Water distribution network
WP	Work package
XSS	Cross-site scripting
XXE	XML External Entity
XML	Extensible Mark-up Language

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1 Introduction

This document is the progress report for the integrated LOTUS platform, first version. The deliverable consists of the following sections:

Requirements
This section details what the integrated platform will achieve for this iteration. Given the low rate of uptake from the use cases and the limited availability of data, it was decided to develop functionality based on the Guwahati use case and covers the key use case collaborations for the demonstrator to implement.

Demonstration
This section contains a walk-through of the integrated platform, with respect to the key use case collaboration from the requirements section.

Demo
The platform demonstrator is hosted at http://167.172.49.166:5100/.

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2 Requirements

This section of the report covers the requirements of the current demonstrator iteration, given the COVID-related challenges of senor development and data availability.

2.1 Goals

The over-arching goal for this iteration of the platform demonstrator is to take a step back from the LOTUS use-case centric logical architecture reached in the D5.1 deliverable and develop a platform that meets the broader goals of the for the platform, 'to design a platform that will enable the consortium to demonstrate the advanced capabilities of the LOTUS sensor with the management solutions', (Annex 1).

With that in mind, the platform demonstrator has four broad areas of functionality to consider: collection of data from LOTUS sensors and other sources, storage / management of data, processing of data and dashboard application(s) enabling users to interact with data.

2.2 LOTUS Sensor data

Given that the LOTUS sensor is not yet in a position to be able to generate on-site data, sensor data will be synthesized to give typical LOTUS sensor properties and readings.

2.3 Demonstrator functionality

For this iteration of demonstrator, the Guwahati case study has been taken as a starting point to provide the following functional goals:

2.3.1 Data collection

Appropriate sensor data will be generated and collected from multiple virtual sensors within the Guwahati area. Given that the sensors are virtual, their properties will be drawn from suitable LOTUS senor properties and any other relevant properties and measures that support the demonstrator.

Sensor data will be generated periodically to simulate typical sensor operation, though this can be made more or less frequent as required.

Sensor data is assumed to be valid.

2.3.2 Data management

Once collected, sensor data will be stored in a time-series context broker, together with the locations and other properties associated with sensors. The temporal variations of data will

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be presented on the map, linking with the positions of sensors.. Stored sensor data will be persistent and will survive context broker restarts.

2.3.3 Data processing

Stored data will be processed on demand for user applications. It is assumed that data processing will not update data stored in the context broker.

2.3.4 Application dashboard

The demonstrator will provide two sets of application dashboard functionality: admin role & customer role.

The 'admin role' will provide a web-based application (browser) that will enable administrators to view and manage aspects of the demonstrator. Users will be able to set alarm limits for sensor properties, view the status of sensors geographically, as graphs and textually.

The 'customer role' will provide a mobile application that reports the status of the system to 'increase trust in piped water supply' (use case). The mobile app will be presented as a proof of concept that data can be shared between the platform and a mobile app rather than a 'final quality' mobile application.

2.3.5 Control dashboard

In order to inject and test 'edge cases' the demonstrator will include a control dashboard that will allow users to set the state of sensors and the value of their properties in order to show how the demonstrator responds to situations.

2.4 User-centric Use Cases

Much of the platform demonstrator is server-based, therefore, to give a clearer view of functionality, the following user-centric use cases have been considered.

2.4.1 Administrator webapp

- User sets alarm limits for sensor property
  System updates sensor property alarm limits

- User views alarm state for sensor properties (textually)
  System generates a list of sensors that are currently generating alarms and presents them to user through webapp.

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- User views current status of sensors in geographic context
  System builds sensor information and presents to user in a map context through webapp

- User views historical status of a sensor property in graphical context
  System builds sensor information and presents to user in a graph context through webapp

2.4.2 Customer mobile app

- Customer receives up-to-date information about state of water network / quality
  Mobile app requests network state information, system responds with information for mobile app user.

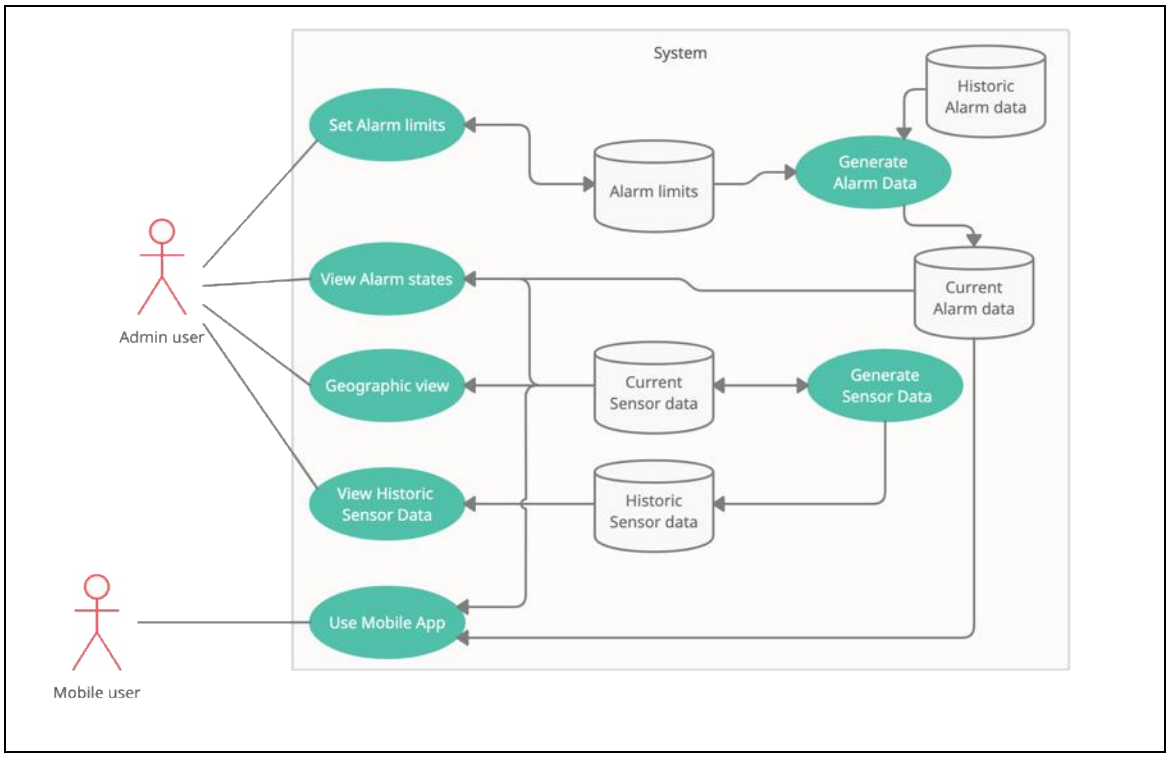

Figure 1 - System use case collaborations

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3 Demonstration

The platform demonstrator is a Flask server hosted at http://167.172.49.166:5100/. The platform synthesizes sensor data and serves web content for the administrator webapp and handles http requests for the customer mobile app.

3.1 Administrator webapp

3.1.1 Set alerts

The set alerts screen allows users to set the minimum and maximum values for each property that each sensor consists of, Figure 2.

Figure 2 – Set Alert Screen

On entering each value or setting the active flag, the client sends the current property state to the server. On receipt, the server updates the current alert settings, generating new alerts (where necessary).

3.1.2 View alerts

The view alerts screen allows users to view the current active alerts. Alerts are generated under two conditions: 1. a sensor property is outside of the minimum / maximum ranges defined for it or 2. a sensor is offline (in FIWARE terms, its device state is 'Red').

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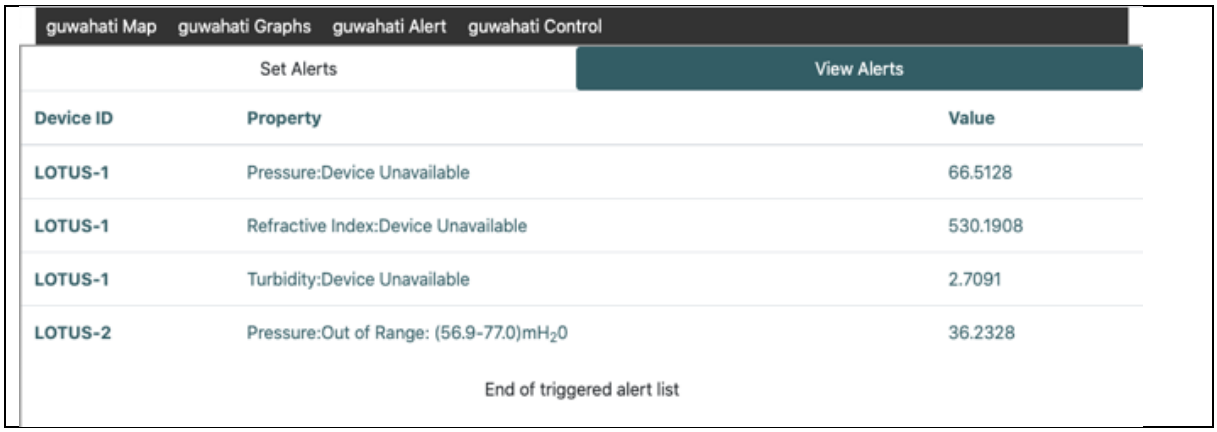

Figure 3 - View Alert Screen

3.1.3 Geographic Context

The geographic context screen provides an environment for users where sensor data is displayed in a map environment, Figure 4. The underlying background can be viewed in stylised street maps or as a traditional satellite image.

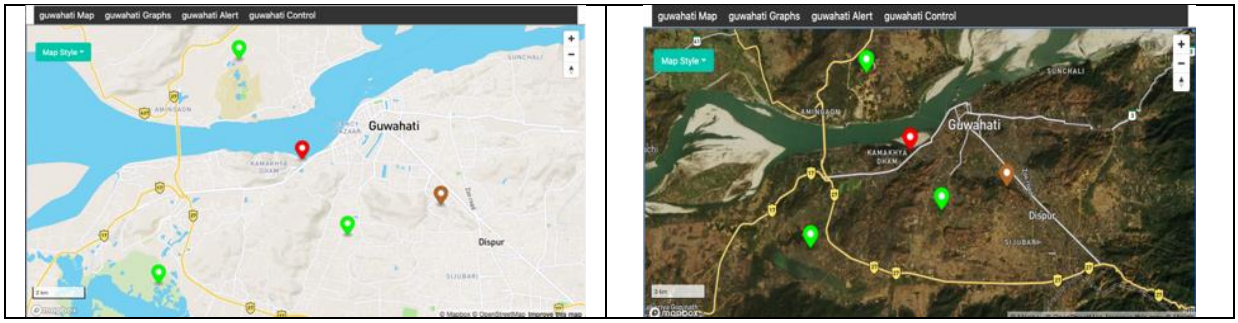

Figure 4 - Geographic context, street map (left) and satellite (right)

To aid evaluating sensor state, the sensors are colour-coded (Figure 5). Clicking on a sensor marker will reveal sensor details, Figure 6

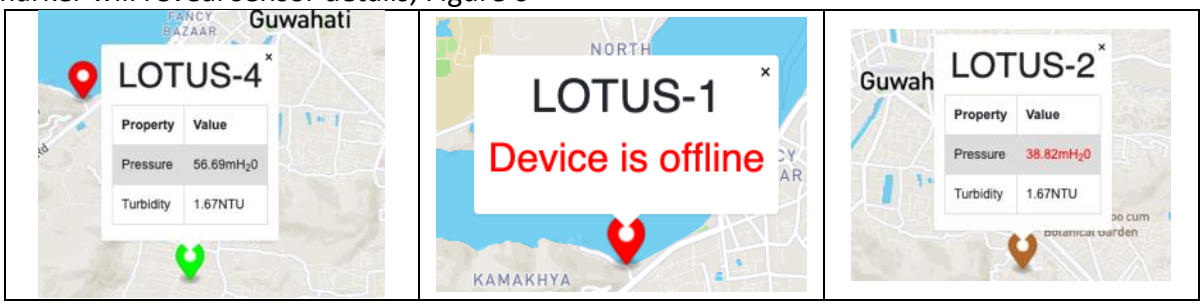

Figure 5 - Sensor status: working and properties in range (left), offline (centre) and working but at least one property out of range

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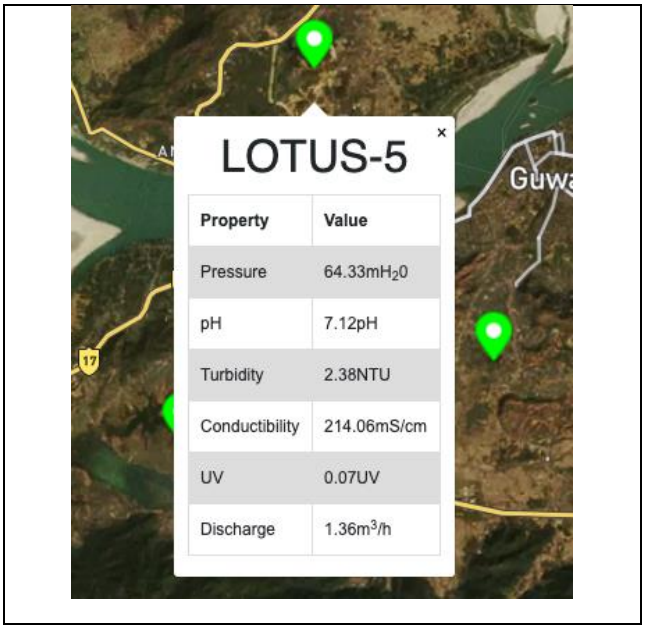

Figure 6 - Sensor showing property details

3.1.4 Graphing context

The graphing screen allows users to view sensor property data over an historic timeline, Figure 7. Sensors may be chosen from the left dropdown whilst their individual properties can be selected with the right dropdown.

The graph shows property readings over time, with the red horizontal lines showing the minimum and maximum alert values for the selected property. This instance, the property has been generating 'out of range' warnings, given that most of its values are under its minimum alert threshold.

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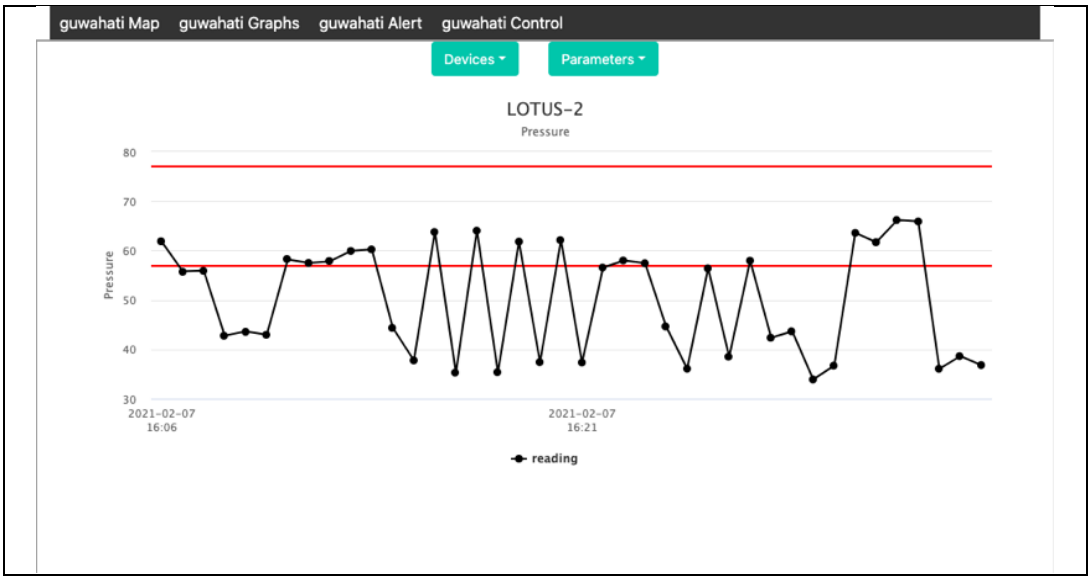

Figure 7 - Graph view of sensor property

3.2 Customer Mobile App

The customer mobile app is a proof-of-concept app that demonstrates that data can be polled (via http requests) from the platform to a remote device.

Currently, the mobile app receives sensor data on-demand from a user, Figure 8. For a more refined mobile application, user data would be processed either on the platform or another service and passed to the mobile app using an appropriate transport (http requests, sockets etc).

Figure 8 - Mobile app

3.3 Control webapp

The control webapp, Figure 9 is currently part of the admin webapp but exists as an html link on the webapp and could easily be relocated to a separate webapp.

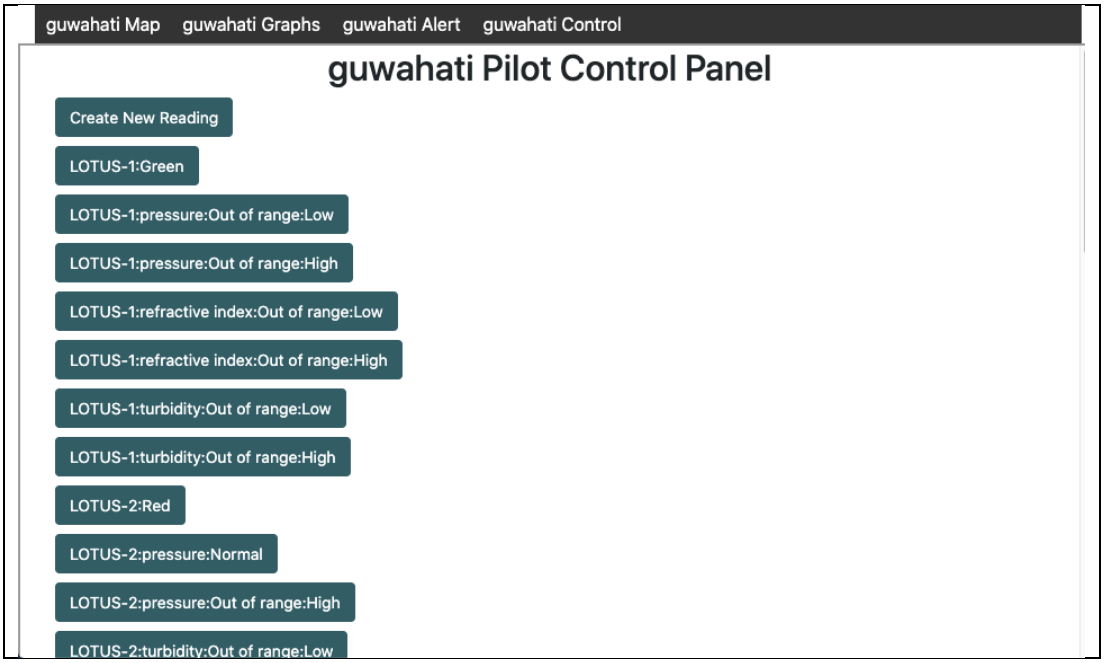

Figure 9 - Control Panel

The role of the control webapp is to inject the context broker with new states for sensors and their properties allowing situations to be created without the need to write explicit code.

The buttons are split into three different types:

- Create new reading
  This button will force the platform to create a new set of sensor readings

- Sensor Green | Red
  These buttons will toggle the operational state of a sensor: red implies off-line, green implies on-line

- Sensor Property Normal | Out of Range: Low | Out of Range: High
  These buttons will toggle modes of data generation. Normal implies that the property will remain 'in range' of the values that are set for it (in code rather than the alert limits). Out of Range: Low will return a value that is beneath the minimum alert value, whilst Out of Range: High will return a value that is above the maximum alert value.

For the sensor and sensor property buttons, the current state of the button is not displayed, for example if a sensor is currently on-line, only the Red (off-line) state will be shown.

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