

# CEng 491 - Group 4 - Project KickOff Document

## LPWAN KickOff Document

### Description

#### The end-product

The project LPWAN (IoT Platform for Asset Tracking with Low-Power Wide-Area Network) aims to develop a system that will continuously receive data from Lora sensors, transfer it to cloud/remote server via gateways and store data in it. Then, the system will detect the probable location of the objects (traffic lights, signs etc.) by comparing the sensors' signal strength taken by gateways. In addition, to check that the object is at the expected place or not, there will be a dashboard to list and see the location and specifications of all the objects.

#### Which need it will serve?

Displacements of traffic lights or signs may cause serious problems in traffic. And these traffic objects may not be followed easily by the local authorities. There must be a way to follow these objects easily. Using Bluetooth and Wi-Fi is not so effective because of their low-range connectivity. On the other hand, using connections like GPS or 4G is too costly in terms of power and money. At this point, we develop an IoT project LPWAN, since it has four main advantages:

- Long-range connectivity
- Low-powered
- Low cost.
- Secure

Also, we will use cloud system since it is reliable and cost-effective. Data can be reachable from everywhere.

#### The expected users

Local authorities can take the advantage of our project to manage their inventories well.

## Master feature list

MF-1: Sensors send data regularly

MF-2: Gateways receive data from sensors and transfer to cloud/server

MF-3: Managing data on the cloud/server

MF-4: Providing a service that can detect location of the objects with accuracy narrower than 500m in a wide network area

MF-5: Asset management dashboard

MF-6: Authentication on dashboard

MF-7: Positioning on the map

MF-8: Notification by getting e-mail in case of a displacement

MF-9: Giving report about the items in the inventories periodically

## Workpackages

W P #	Term	WP title (this should be as short and as descriptive as possible)	Estimated number of person-months
1	491	Project planning and architecture design	3
2	491	Literature research	3
3	491	Installation of LoRa sensors and gateways	4
4	491 & 492	Preparing the cloud / remote server for the project	2
5	491 & 492	Transferring the data from gateways to cloud / remote server	3
6	491 & 492	System Analysis and Design	3
7	492	Calculating and verifying positions of the assets	3
8	492	Creating Asset Management backend services	3
9	492	Creating Asset Management dashboard UI	3
10	492	Integration and Testing	3
11	492	Mobile Application (Bonus)	5
		Total:	30+5

## **Detailed Descriptions of High-Level Workpackages**

### **WP1 - Project planning and architecture design**

In this workpackage, the following functionalities / features / work items will be implemented

1. Develop the list of master features of the project.
2. Produce project development plan in accordance with Master Feature List.
3. Design the overall architecture of the project.
4. Analyze risks and make a management plan.

### **WP2 - Literature research**

1. Reading papers related to the project
2. Each group member will summarize the papers that he reads
3. Inspecting documentation and code of similar projects
4. This process will be spread through the year. Literature research will be done before each sprint

### **WP3 - Installation of LoRa sensors and gateways**

1. Evaluating the sensor and gateway alternatives and choosing the most suitable one.
2. Placing the sensors on the assets
3. Placing the gateways with certain intervals across the target area
4. Checking if sensors send data to gateways properly by communicating over LoRaWAN
5. Making gateways manage the signals coming from multiple sensors

### **WP4 - Preparing the cloud / remote server for the project**

1. Deciding whether using cloud platform or local server; if it is cloud platform, choosing the best service available
2. Configuring database system on the cloud/remote server
3. Preparing cloud/remote server to receive and insert data

### **WP5 - System Analysis and Design**

1. Deciding best technologies to implement IoT dashboard UI (e.g. JavaScript (ReactJs, AngularJs), Html, CSS)
2. Deciding best technologies for the back-end (e.g. ExpressJs, Django)
3. Deciding database (e.g. NoSQL, MySQL)
4. Design documentation

### **WP6 - Transferring the data from gateways to cloud/remote server**

1. Connecting gateways that we placed to cloud/remote server
2. Convert radio signals to internet signals in the gateway before sending to cloud/remote server
3. Applying and testing TCP connection for data transfer
4. Store the data about and received from gateway into the remote database

### **WP7 - Calculating and verifying positions of the assets**

1. Calculating the position of the assets by applying one of the 3 algorithms below:
  - Triangulation
  - Trilateration
  - Multilateration
2. Relocating gateways for effective position asset calculations

### **WP8 - Creating Asset Management backend services**

1. Creating tables in database
2. Interface for CRUD (Create, Read, Update, Delete) operations
3. API in case we decided to use remote server instead of cloud platform
4. User authentication
5. Using a notification application to alarm users in case of displacement of an asset
6. Periodic report about assets for troubleshooting

### **WP9 - Creating Asset Management dashboard UI**

1. Map for tracking the positions of the assets in the range of the system
2. Login and Sign up screen
3. GUI for the CRUD operations for the assets
4. Notification screen

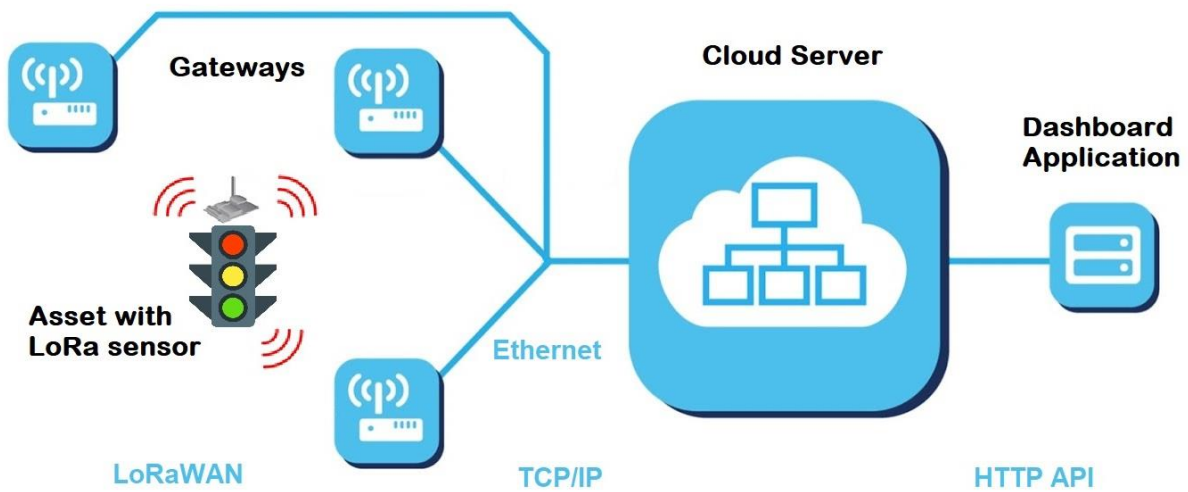
### **WP10 - Integration and Testing**

1. Testing compatibility between components
2. Automated unit and integration tests
3. UI testing with real-users
4. Live testing of the project for the notifications

### **WP11 - Mobile Application (Bonus)**

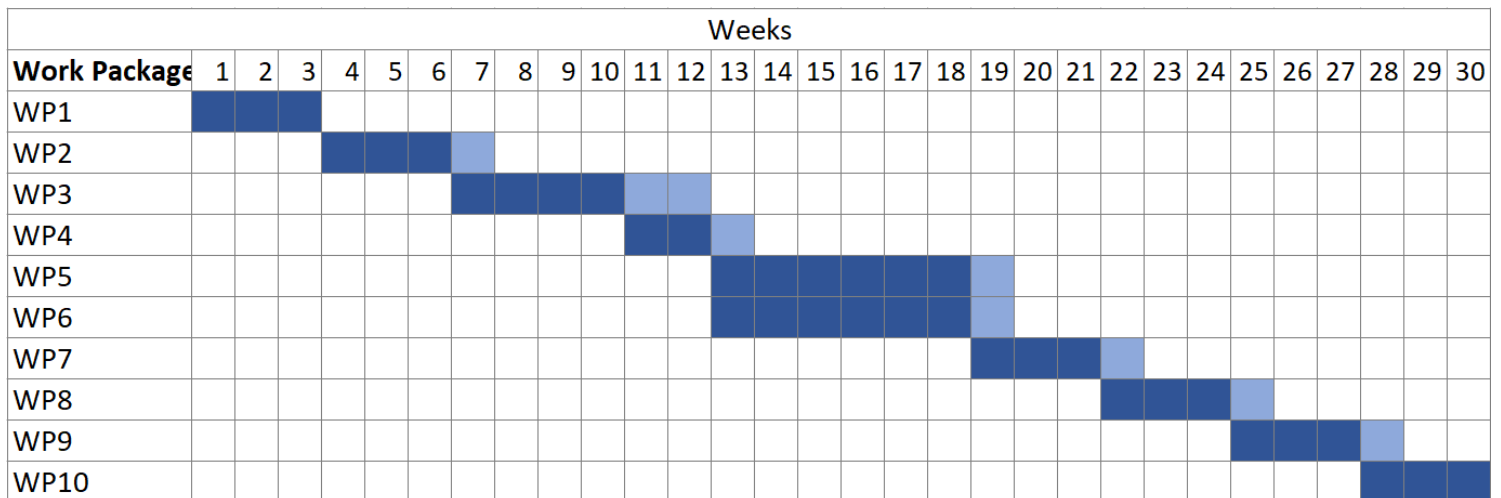
1. Map for tracking the positions of the assets in the range of the system using Google's API
2. Login and Sign up screen
3. GUI for the CRUD operations for the assets
4. Notification operation
5. Cross-platform will be supplied by React Native (both Android & IOS)

## Overall Systems Architecture



LoRa sensors transmit data to gateways via wireless communication LoRa protocol. Gateways transmit data to the cloud/remote server. By comparing the signal strength received by each Gateway, location of the assets are detected. A dashboard application shows the locations of all inventories in the system. By using a web service, notification will be sent in case of displacement of any item.

## TimeLine



## Risk Assessment

<b>Risk #</b>	<b>Description</b>	<b>Possible Solution(s)</b>
1	Technologies used in this project (LPWA, LoRa, LoRaWAN) are relatively new in the field. Therefore, lack of the research material or resources is major risk/problem.	The proposer company Parabol can provide extra resource materials for the students.
2	Hardware problems might occur due to weather conditions or reckless human behaviors.	Regular checking of hardware
3	Gateway to cloud/remote server connection problems	Contacting with internet provider