Scope Statement

Smart Parking

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1 Concept

1.1 Problem

Urban car parking is a major issue in big cities. Following the rapid increase in car ownership, many cities are experiencing a shortage of parking spaces due to an imbalance between supply and demand, which can be regarded as the root cause of city parking issues. There are many common parking issues, including a lack of parking spaces, high parking fees, and traffic backups caused by people looking for parking.

1.2 Context of the project

Smart Parking, powered by IoT technology, is making it easier for drivers to find free parking spots. Cities can better manage their parking assets and maximize the revenue available to them as a result. Drivers searching for parking create congestion and pollution by circling and hunting for available parking. Smart Parking services are able to significantly ease these problems by guiding a driver directly to a parking space.

Most cities propose increasing parking spaces to combat the problem. Parks and vacant plots are used as potential parking spaces and multi-level facilities are being built, irrespective of the limited land space and resources. But there exists a silly problem. People enter the parking and then came to know that it's full. Is automation necessary? Don't you think, we should already know if the parking has space for us or not ? Yeah, isn't it a good thought ?

This project will help us show the availability of car slots to park the vehicle. This is implemented by using Raspberry Pi and multiple sensors.

Figure 1: Smart Parking with IoT

1.3 Ambitions

The goal of this project is to prototype as many appliances as is practical. Giving owners complete control over parking is also required. By carrying out this project, we hope to :

- **Develop a smart parking system**: Conception and realize a full prototype of a smart parking with the ability to book and pay remotely which reduces the travel time, carbon emission, search time, traffic congestions in the city. In addition, it improves traffic flow within the parking lot with efficient design and creating a safer ecosystem for the guests

- **Use different Inner and Outer network technologies:** The use of different communication techniques between the objects, main server, and the owner's control application.
- **Use devices that are easy to install:** An ideal combination of components must be chosen in order to minimize costs, allow for simple installation in existing infrastructure, and make the components simple to use and interact with.
- **Make it suitable for inexperienced users:** One of the main goals is to make the user experience as simple as possible because various social classes can use this system. The application should therefore primarily be simple to use and comprehend.
- **Scalability:** The network must be scalable, which means that it must be possible to add new smart devices and appliances to the IoT network and that these devices must be simple to integrate into the control application.

2 Functionalities

In this section, a detail of the functionalities of the project. We can split the functionalities into two parts: The first one details the sensors and the IoT network, and the second is the details of the mobile application used to control the appliances.

2.1 Sensors and IoT netwok:

Different sensors will be used to monitor different measures:

- **Online Reservation of Parking spots:** The user should be able to reserve parking spots through a Mobile application. The pre-booking would be retained for a specific period of time and reassigned in case of no show.
- **Pass Based Parking:** There should be an option for users to buy Monthly, Quarterly or yearly passes for hassle free experience. The motorists opting for this category would be identified using RFID based, NFC based smart card or any other advanced technology as deemed fit by the System Integrator.
- **Premium Paid Parking:** There should be an option for users to choose premium parking spaces for e.g.: near the entrance or exit. The corporate offices can also choose this option to reserve premium parking space for their employees. The motorists opting for this category would be identified using RFID based, NFC based smart card or any other advanced technology as deemed fir by the System Integrator.

2.2 Mobile application:

- The mobile application can be used from different platforms like Android, iOS, Web, etc.
- The application offers an automatic Parking System with Zero Human Intervention
- The driver is able to RFID Scan for Access Verification
- The mobile application enables the driver from an automatic Gate Barriers for Entry Exit
- Parking Slot Sensors for Empty Slot Detection
- Online Parking Slot availability on Phone An Easy to Use application

3 Components

- Raspberry Pi: The Raspberry Pi is a small, inexpensive computer the size of a credit card that connects to a computer monitor or TV and uses a regular keyboard and mouse to operate. It is a small, versatile device that can connect via Wi-Fi and Bluetooth and interact with various sensors. The project's brain will be the Raspberry Pi. It will be in charge of informing the mobile application of/with the state of the sensors.
- Sensors
  - Camera(s): capture the situation to extract the information
  - IR sensor: calculate the available slots
  - NFC/RFID reader: contactless one-way sensor
- 12V power supply for powering the Raspberry Pi

A Raspberry Pi 4 board should be used for processing because it has more computing power, so it can run powerful AI models, and it can interact with many sensors at once.

4 Technologies

In order to implement the different home automation functionalities into the mobile application different technologies will be used to develop this app.

4.1 Back-end :

- **MongoDB :** A NoSQL document-oriented database. MongoDB is used to store users data. MongoDB is practical and easy to use with Node.js.
- **MQTT :** A lightweight publish-subscribe network protocol used to communicate sensor-collected data to a cloud MQTT broker (Mosquitto).
- **Node RED :** Handles and manages sensor collected data based on specific events.

4.2 Middleware:

- **Jakarta EE:** Jakarta EEis a set of software components, APIs, for developing specifically enterpriseJava applications. These components are often referred to as specifications.
- **WildFly :** Formerly known as JBoss Application Server or JBoss, is a Free Java EE application server written in Java, released under the GNU LGPL license. Being written in Java, WildFly can be used on any operating system providing a Java virtual machine.

4.3 Front-end:

- **PWA:** Progressive Web Applications are web applications that leverage service workers, manifests, and other web-platform characteristics along with progressive enhancement to provide users with a native app-like experience.

5 Architecture

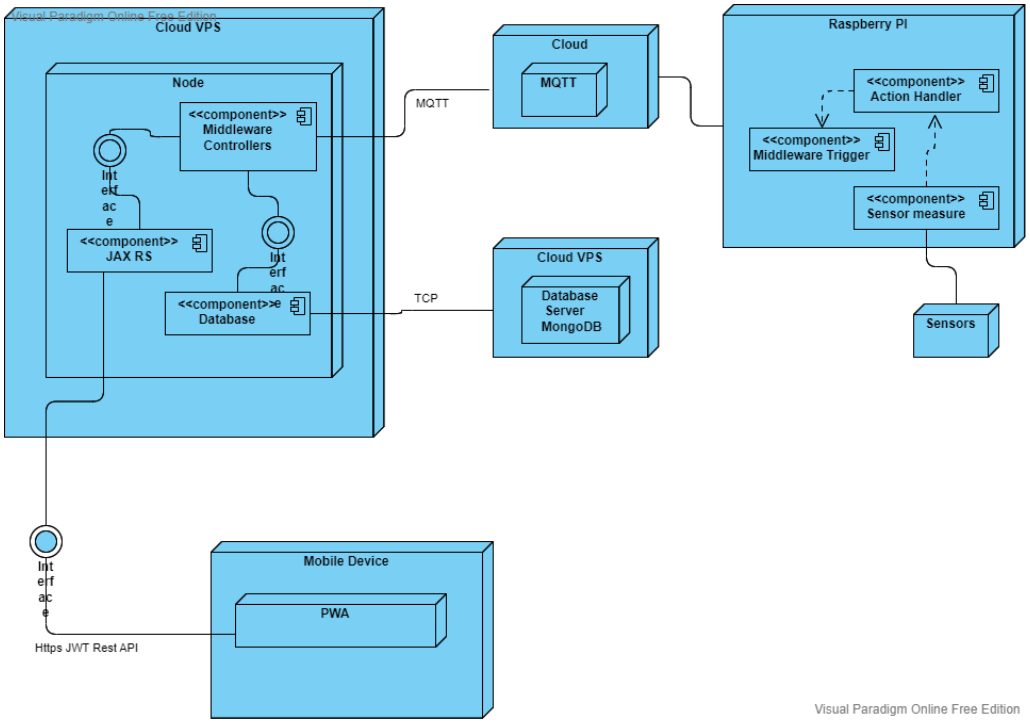

Figure 2: Smart Parking Application deployment diagram

The diagram above describes the main architecture of the smart parking application which is mainly composed by **Backend**, **Middleware** and **Frontend**

6 Timeline & Tasks

The project development will undergo different steps:

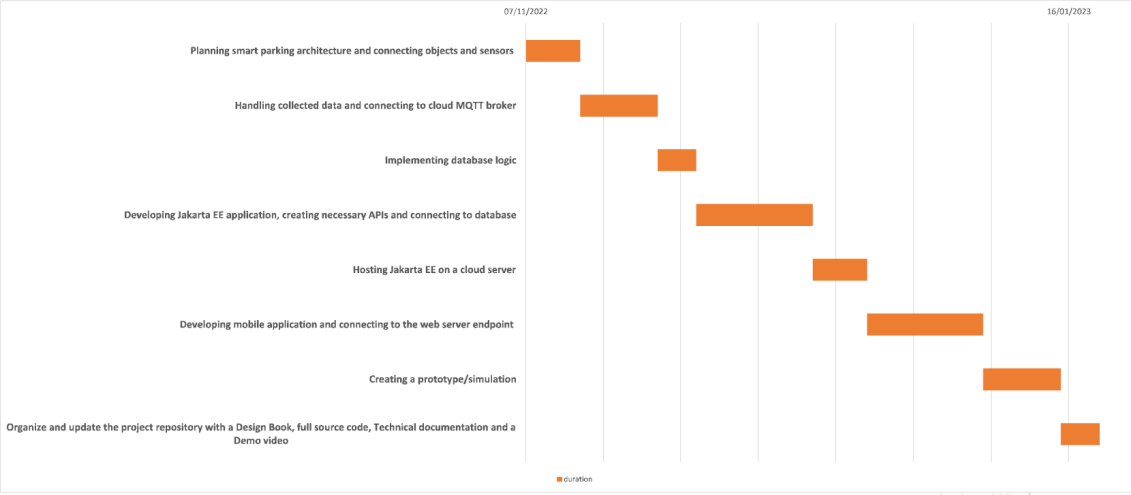

Figure 3: Project's Gantt diagram

The Gantt diagram, which enables the project's progress to be graphically represented, is shown in the explanation above. It makes it possible to visually illustrate the project's progress and the length of each process.

7 Delivrables

At the end of the project, the following items will be delivered:

- Smart parking mobile application.
- Source code for different project components on GitHub.
- Smart parking prototype/simulation.
- Detailed report about the solution.

8 Business Study

Overall summary of the business model that shows the main aspects such as value proposition, customer segmentation, channels, cost structure, revenue stream etc. can be found on the Figure.4.

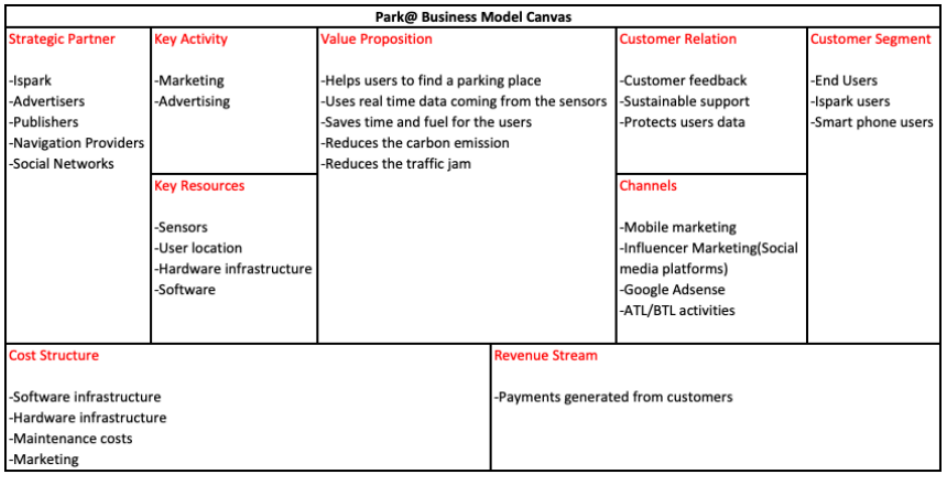

Figure 4: Smart Parking Business Model Canvas

9 Marketing Study

9.1 4P Marketing Mix

Our project of Smart Parking makes use of the marketing mix strategically to achieve not only the marketing objectives but also the broader organizational objectives.

Marketing Mix for Smart Parking is presented below:

Figure 5: 4P Marketing Mix

- **Product:**

  - A good architecture of IoT components
  - The good management of a car park with a mobile application
  -Payment with NFC technology
  -Warranty or after-sales service

- **Price:**

  - Sale price with customization rates added
  - Maintenance costs
  -A discount in case of payment in cash
  -Payment by facility over 12 months at most

- **Promotion:**

  - Social networks
  - Publicité à travers nos partenaires

- **Place:**
  - Direct word-of-mouth contact

9.2 SWOT Analysis

SWOT analysis is a vital strategic planning tool that can be used by Smart Parking Limited managers to do a situational analysis of the firm . It is an important technique to evalauate the present Strengths (S), Weakness (W), Opportunities (O) Threats (T) Smart Parking Limited is facing in its current business environment.

Figure 6: SWOT Analysis

10 Assumptions

The biggest constraint in our project are :

- **Multitudes of unpredictable scenarios**: A robust solution must contain unit tests to ensure the perfect functioning of the application, one can then obtain hidden defects in the developed solution if one does not manage to cover all the possible scenarios with unit tests.

- **methodology of work:** We will opt for the Extreme Programming (XP) strategy which is an agile software development framework aimed at producing better quality software, XP is the most specific of the agile frameworks concerning the appropriate engineering practices for software development. In the case of pair programming, systematically two people work simultaneously on the code, and are therefore ideally seated directly next to each other. One writes the code while the other verifies it in real time.