**5. PUBLIC TRANSPORT OPTIMIZATION**

**MICROCONTROLLER:**

We had chosen ESP32 micro controller as well as Arduino UNO micro controller.

1. **ESP32 -** The ESP32 is a very versatile System On a Chip (SoC) that can be used as a general purpose microcontroller with quite an extensive set of peripherals including WiFi and Bluetooth wireless capabilities. The high-level option is MicroPython for ESP32. Where the user doesn't even really need to install anything on their computer: anything that can open a serial terminal will do. The Python language itself is much more beginner friendly than the C language used by Arduino and ESP-IDF.
2. **Arduino UNO -** The Arduino IoT Cloud is a platform that allows anyone to create IoT projects, with a user friendly interface, and an all in one solution for configuration, writing code, uploading and visualization. Arduino uses a variant of the C++ programming language. The code is written in C++ with an addition of special methods and functions.

**SENSORS:**

**1. “GPS and GNSS Sensors: “** Global Positioning System (GPS) and Global Navigation Satellite System (GNSS) sensors are used to track the real-time location of vehicles. This data is essential for tracking bus or train movements, optimizing routes, and providing accurate arrival time predictions to passengers.  
  
**2. “Vehicle Health Monitoring Sensors: “** IoT sensors can monitor the health of transportation vehicles by collecting data on engine performance, fuel consumption, tire pressure, and other crucial metrics. This data helps in preventive maintenance, reducing breakdowns, and improving overall fleet efficiency.  
  
**3. “Passenger Counting Sensors: “** These sensors use infrared, ultrasonic, or camera technology to count the number of passengers boarding and disembarking vehicles. Passenger data helps transit agencies adjust service frequency and allocate resources based on demand.  
 **4. “Smart Fare Collection Sensors: “** IoT sensors integrated into fare collection systems, such as contactless payment readers or ticket validators, enable seamless, fast, and secure payment processes. They also collect data on fare transactions for analysis.  
 **5. “Environmental Sensors: “** Sensors for measuring environmental factors like air quality, temperature, humidity, and noise levels can be installed in transportation hubs and vehicles. This information can be used to monitor and improve passenger comfort and safety.  
 **6. “Traffic and Intersection Sensors: “** IoT sensors placed at intersections and traffic lights help optimize traffic flow and reduce congestion. This is especially important for buses and other forms of public transportation that operate on city streets.  
 **7. “Security and Surveillance Sensors: “** Cameras and sensors can be used for both passenger safety and security. They can monitor for accidents, suspicious activities, or unauthorized access to restricted areas within transportation facilities.  
 **8. “Energy Consumption Sensors: “** Public transportation agencies can use energy consumption sensors to monitor and optimize the energy usage of their vehicles and facilities, helping to reduce operational costs and environmental impact.  
 **9. “Weather and Road Condition Sensors: “** These sensors provide data on weather conditions and road surfaces, allowing transportation operators to make informed decisions about route changes and adjustments during adverse weather conditions.  
  
**10. “Wi-Fi and Cellular Connectivity Sensors: “** IoT sensors for connectivity enable passengers to access Wi-Fi and cellular networks while on public transportation, improving the passenger experience and enabling real-time communication.  
  
**11. “Seat Occupancy Sensors: “** In the era of COVID-19 and social distancing measures, seat occupancy sensors can help manage capacity and maintain safe distances between passengers.  
  
**12. “Wheelchair and Accessibility Sensors:”** Sensors can be used to monitor and improve accessibility features, such as wheelchair ramps and priority seating for individuals with disabilities.

**CONNECTIVITY:**

1. **BLE -** Bluetooth Low Energy is a wireless, low-power personal area network that operates in the 2.4 GHz ISM band. Its goal is to connect devices over a relatively short range. BLE was created with IoT applications in mind, which has particular implications for its design.
2. **WIFI -** WIFI stands for Wireless Fidelity which is a wireless technology standard for wireless Internet access. It is used as a replacement for cable connections and other types of wires.
3. **ZIGBEE -** Zigbee is a wireless protocol that is used to allow Smart Devices such as light bulbs, sockets, plugs, smart locks, motion sensors and door sensors to communicate with each other over a "PAN" (Personal Area Network).

**CLOUD:**

**Beeceptor -** Beeceptor is a no code solution for building and hosting a mock server. Beeceptor gives you a dashboard to intercept and inspect all HTTP requests in real time. Simulate higher latencies by introducing delays and timeouts. This helps you validate rarely reachable code paths. Use reverse proxy to quickly switch APIs endpoints. E.g. A/B testing by switching API endpoints or versions without any redeployment. Send hyper-customized responses using the Handlebar template.

**PROTOCOL:**

1. **MQTT -** MQTT is a standards-based messaging protocol, or set of rules, used for machine-to-machine communication. Smart sensors, wearables, and other Internet of Things (IoT) devices typically have to transmit and receive data over a resource-constrained network with limited bandwidth.
2. **HTTP -** The Hypertext Transfer Protocol (HTTP) is an application-level protocol for distributed, collaborative, hypermedia information systems. This is the foundation for data communication for the World Wide Web (i.e. internet)
3. **AMQP -** Advanced Message Queuing Protocol (AMQP) is an open source published standard for asynchronous messaging by wire. AMQP enables encrypted and interoperable messaging between organizations and applications. The protocol is used in client/server messaging and in IoT device management.

**PUBLIC PLATFORM:**

We have planned to display the data in the open source web server or in a suitable application with a highly convenient protocol and safety measures.