Public Transport Optimization

PROJECT DEFINITION:

The project involves integrating IoT sensors into public transportation vehicles to monitor ridership, track locations, and predict arrival times. The goal is to provide real-time transit information to the public through a public platform, enhancing the efficiency and quality of public transportation services. This project includes defining objectives, designing the IoT sensor system, developing the real-time transit information platform, and integrating them using IoT technology and Python.

UNDERSTANDING THE PROBLEM:

IoT in transportation use cases is growing rapidly, delivering gains in operational efficiencies, cost savings, safety, security and mobility. The impact of IoT is anticipated to be enormous as cities and municipalities around the world incorporate wireless technology into traffic management, emergency response and safety for pedestrians and bicycles. Public transportation services will also improve, and the automotive industry will benefit from a range of innovations made possible with IoT, from EV charging stations to connected vehicle technology.

PURPOSED SOLUTION:

Technology advances are driving the application of IoT in transportation applications that make cities smarter and the city's systems easier to manage, both for fixed and mobile applications.In fixed applications such as traffic lights, cameras and intersection management, the reliability of cellular networks now rivals traditional wired networks, creating opportunities that did not exist only a few years ago. And it is far less costly to implement.And for applications such as police, fire, ambulance, bus, light rail and paratransit vehicles, mobile router technology has advanced dramatically in recent years, while networks have improved in both speed and capacity with the rapid growth of 4G networks and the advent of 5G.As a result of these advances, IoT solutions for transportation meet a growing range of needs, in a variety of operating conditions. Some of th key transportation IoT use cases today include the following:

Traffic management: IoT applications for urban traffic management improve both safety and traffic flow, and help cities get the maximum value from their infrastructure spending.

Public transportation: Transit IoT applications enable transit agencies to operate more efficiently while improving the passenger experience with amenities such as informational signage and high-speed Internet connectivity.

Railways: IoT solutions support both light rail and heavy commercial rail systems, and Digi is leading the way with high-performance 5G mobile access routers for reliable and secure high-speed communications and geo-positioning — even in tunnels and urban canyons.

PROJECT OBJECTIVIES:

- **Real-Time Monitoring and Tracking:**
  To provide real-time information on the location and status of public transport vehicles and infrastructure.IoT sensors and GPS tracking enable accurate real-time

monitoring, allowing commuters to track the arrival and departure times of buses, trams, and trains.

- **Predictive Maintenance:**
  To reduce downtime and improve the reliability of public transport vehicles.IoT sensors can monitor the health of vehicles and infrastructure components, predicting when maintenance is needed. This prevents breakdowns and ensures vehicles are in optimal condition.
- **Traffic Management and Optimization:**
  To minimize congestion and delays in public transport routes.IoT-connected traffic lights, road sensors, and data analytics can optimize traffic flow, prioritize public transport, and reduce delaysHere's how you can integrate IoT and design thinking into the optimization process:

<u>IOT SENSOR DESGIN:</u>

- **Select Appropriate Sensors:**
  GPS or GNSS (Global Navigation Satellite System) for location tracking.
  Accelerometers and gyroscopes for motion sensing.
  Temperature, humidity, and pressure sensors for environmental monitoring.
  Vehicle diagnostics sensors for engine health and performance data.
  Cameras for visual data and image recognition.
  LiDAR and radar for object detection and collision avoidance.
  Vehicle presence sensors for traffic management.
  Gas and pollution sensors for air quality monitoring.
- **Sensor Placement:**
  Determine where to place sensors on vehicles, infrastructure, and roadways to capture relevant data. Consider factors like line of sight, environmental conditions, and accessibility.
- **Data Communication:**
  Choose a communication method to transmit sensor data to a central server or cloud platform. Options include Wi-Fi, cellular networks (3G/4G/5G), LoRaWAN, and satellite communication.
- **User Interfaces and Alerts:**
  Create user-friendly interfaces for transportation authorities, operators, and end-users to access and visualize data. Implement alerting systems for immediate notifications of critical events or anomalies

<u>REAL-TIME TRANSIT INFORMATION PLATFORM:</u>

- **User Interfaces:**
  Create user-friendly interfaces for different stakeholders:
  Passengers: Develop mobile apps and websites to provide real-time information about routes, schedules, delays, and vehicle locations. Implement features like trip planning and fare payment.
  Operators: Provide a dashboard that allows operators to monitor the fleet, manage schedules, and respond to incidents in real-time.
  Authorities: Design a control center interface for authorities to oversee the entire transportation network, make decisions, and manage emergencies.

- **Alerts and Notifications:**
  Set up an alerting system to notify passengers of delays, service changes, or emergencies through push notifications, SMS, or email.
- **Data Collection and Integration:**
  Collect and integrate data from various sources into a central database. Use data integration techniques and APIs to gather information such as vehicle locations, schedules, traffic conditions, and weather data.
- **Database Design:**
  Design a robust database schema to store real-time and historical data efficiently. Consider both relational and NoSQL databases depending on the data structure.
- **Monitoring and Maintenance:**
  Implement monitoring tools to keep track of system performance, and establish a maintenance plan for regular updates, bug fixes, and improvements.

INTEGRATION APPROACH:

Communication Protocols:

- IoT sensors utilize various communication protocols and technologies to transmit the collected data to a central real-time transit information platform. Common communication methods include:
- Cellular networks: Sensors can use 3G, 4G, or 5G networks to transmit data.
- Wi-Fi: Sensors may connect to Wi-Fi networks available at transit stations or on vehicles.
- Low-power, long-range wireless technologies like LoRaWAN: These are suitable for sensors deployed in remote areas or for low-power applications.
- Dedicated wireless networks: Some transit systems deploy their own wireless networks for IoT communication.

Real-Time Vehicle Tracking

- The GPS data is transmitted back to a central command center. Once the GPS data is received by central command, the information can then be relayed to the passenger's internet-enabled mobile device or to an electronic sign at transit stops.

Data Routing and Aggregation:

- Data from multiple IoT sensors are routed through communication gateways or hubs that aggregate and forward the data to the central transit information platform.
- These gateways may preprocess the data further or perform data fusion to combine information from multiple sensors.

NEXT STEP:

The next step in the implementation of the Traffic Management System project would involve the actual deployment of IoT sensors at strategically chosen locations to begin real-time traffic data collection. This step includes the procurement, installation, and calibration of these sensors. Simultaneously, the development of the real-time traffic information platform and mobile apps should proceed, ensuring that they are capable of processing and presenting the incoming data effectively to users. Additionally, the integration between the IoT sensor network and the platform should be established, enabling the seamless flow of traffic data. Continuous testing, both of the sensor network and the platform, is crucial to verify that the system operates as expected. This phase will lay the foundation for the system's full-scale operation and its ability to provide valuable traffic information to commuters.