Vivekanand Education Society's

Institute of Technology

(Af... ...rsity of Mumbai, Approved by AICTE & Recognized by Govt. of Maharashtra)

Department of Information Technology

IOE Lab

CONTINUOUS ASSESSMENT - 2

Aim: Design of IOT application.

Name	Anjali Punsi
Roll No.	57
Class	D20B
Subject	Internet of Everything
Grade:	

Aim: Design of IOT application.

To do:

- Identify the layer specific actions/responses/activities (for each layer - edge - fog - cloud)
- Identify the sensors/actuators required
- Identify the best suited protocols
- Select the architecture
- Identify the information needed to be sent at the higher level

Theory :-

"Connected Roadways" application - Connected roadways involve using IoT (Internet of Things) and smart technologies to improve the efficiency and safety of road networks. Here's a breakdown of the layers, sensors/actuators, protocols, architecture, and information flow for connected roadways:

Layers specific activities:

1. Edge Layer :-This is the lowest layer, situated at or near the road infrastructure.The edge layer of your IoT workload consists of the physical hardware of your devices, the embedded operating system that manages the processes on your device, and the device firmware, which is the software and instructions programmed onto your IoT devices. The edge is responsible for sensing and acting on other peripheral devices. Common use cases are reading sensors connected to an edge device, or changing the state of a peripheral based on a user action, such as turning on a light when a motion sensor is activated.the AWS IoT Lens is applicable to all IoT systems, industrial IoT deployments often have additional safety, resiliency, and compliance requirements.Industrial IoT deployments consist of a combination of plant-local Operational Technology (OT), plant-local Information Technology (IT) resources, and remote IT resources, which might be in the public cloud or an enterprise datacenter. The benefit of splitting workloads between local and remote processing is to balance the timeliness and high bandwidth of local resources with the scale and elasticity of remote resources.

2. Fog Layer :- An intermediate layer that can aggregate data from multiple edge devices and process it locally.Fog architecture involves using services of end devices (switches, routers, multiplexers, etc) for computational, storage and processing purposes. Fog computing architecture consists of physical as well as logical elements of the network, software, and hardware to form a complete network of a large number of interconnecting devices. Fog node distribution (physical as well as geographical, along with the topology and protocols used form key architectural features of a fog architecture. Fog architecture involves the distribution of functions at different layers, the types and the number of protocols used, and the constraints imposed at various layers.

3. Cloud Layer :- The highest layer where centralized data processing, storage, and analytics take place.Fog architecture involves using services of end devices (switches, routers, multiplexers, etc) for computational, storage and processing purposes. Fog computing architecture consists of physical as well as logical elements of the network, software, and hardware to form a complete network of a large number of interconnecting devices. Fog node distribution (physical as well as geographical, along with the topology and protocols used form key architectural features of a fog architecture. Fog architecture involves the distribution of functions at different layers, the types and the number of protocols used, and the constraints imposed at various layers.

Edge Layer Actions/Responses/Activities:

- Collect data from various sensors.
- Monitor traffic conditions (vehicle presence, speed, congestion, etc.).
- Communicate with nearby vehicles (V2X communication).
- Control traffic signals and signs.
- Detect and respond to road hazards in real-time.

Fog Layer Actions/Responses/Activities:

- Aggregate data from multiple edge devices.
- Perform local analytics for real-time decision-making.
- Manage and optimize traffic flow.
- Serve as a bridge between the edge and cloud layers.

Cloud Layer Actions/Responses/Activities:

- Centralized data storage and management.
- Long-term analytics for traffic pattern analysis.
- Traffic prediction and optimization algorithms.
- Integration with other smart city systems (public transportation, emergency services).

Sensors/Actuators Required:

1. Traffic Cameras: For vehicle and pedestrian monitoring.
2. Vehicle Detection Sensors (e.g., inductive loops or radar): To detect the presence of vehicles at intersections and along roadways.
3. Traffic Lights: Actuators for controlling traffic flow.
4. Variable Message Signs (VMS): Actuators for providing real-time information to drivers.

5. Vehicle-to-Everything (V2X) Communication Devices: To enable communication between vehicles and infrastructure.

Actuators:

1. Signal Actuators: Signal actuators control roadways signals, ensuring proper signaling for train traffic management and safety.
2. Barrier Actuators: Barrier actuators control roadway crossing barriers, preventing unauthorized access to tracks during train crossings.
3. Emergency Brake Actuators: These actuators trigger emergency braking systems on trains in response to detected critical anomalies or safety threats.
4. Intercom Systems: Intercom systems enable communication between personnel on the tracks and control centers, facilitating coordination during maintenance and emergencies.

Suited Protocols :-

1. Wireless Communication for Remote Sensors: LoRaWAN

- Description: LoRaWAN (Long Range Wide Area Network) is ideal for covering large expanses of roadway tracks. It provides long-range communication with low power consumption, making it

suitable for remote sensors. It's particularly useful in areas where traditional cellular networks may not have coverage.

2. Local Communication within Train Compartment or Station: Zigbee

- Description: Zigbee is a low-power, short-range wireless protocol well-suited for connecting sensors and devices within train compartments or station areas. It provides reliable and

energy-efficient communication for localized monitoring and control.

3. Data Transmission to Central Servers or Cloud: MQTT (Message Queuing Telemetry Transport)

- Description: MQTT is a lightweight, publish-subscribe messaging protocol that's efficient for transmitting data from sensors to central servers or cloud platforms. It's suitable for IoT applications and can handle intermittent or unreliable network connections, which can be beneficial in remote roadway locations.

4. Data Exchange between Devices and Servers: RESTful APIs

- Description: Representational State Transfer (REST) APIs are widely used for data exchange between devices and servers. They use standard HTTP methods, making integration with other

5. **Real -Time Communication for Signaling: DNP3 (Distributed Network Protocol)**

- Description: DNP3 is a protocol commonly used in the utility and industrial sectors for real-time data exchange. It's suitable for communication between roadway signaling devices, allowing for precise control and monitoring of the roadway network.

6. **Security and Authentication: OAuth 2.0**

- Description: OAuth 2.0 is an industry-standard protocol for securing API endpoints and ensuring authorized access. It can be used to protect sensitive data and control access to roadway track monitoring systems.

Architecture

- **Edge devices**: Raspberry Pi or specialized edge computing devices.
- **Fog layer**: Local servers or gateways for data aggregation and processing.
- **Cloud layer**: Cloud-based servers and databases for centralized data storage and analytics.

Information Flow at Higher Level:-

- **Edge Layer to Fog Layer**: Real-time traffic data, sensor statuses, and immediate hazard alerts.
- **Fog Layer to Cloud Layer**: Aggregated traffic data, localized traffic patterns, and event logs.
- **Cloud Layer to Edge Laye**r: Optimized traffic signals, traffic pattern predictions, and long-term analytics reports.

Hybrid Architecture for roadway Track Monitoring System- In a roadway track system hybrid architecture that combines centralized and decentralized elements ensures efficient and reliable track monitoring and maintenance. The system is designed to cover vast roadway networks and provide real-time insights while optimizing resources.

Components of the Architecture:

1. **Sensors:p**

- Deployed along roadway tracks to collect real-time data on track conditions, temperature, vibrations, and other parameters.
- Include a variety of sensors such as vibration sensors, temperature sensors, infrared motion sensors, and cameras for comprehensive monitoring.

2. **Local Gateways:**

- Local gateways are strategically placed along the roadway tracks to collect data from sensors.
- They perform initial data preprocessing, filtering, and basic analytics at the edge.
- Forward the processed data to the central cloud server for further analysis.

3. **Cloud Server:**

- The central cloud server serves as the heart of the system.
- It stores all collected data and performs complex analytics, including video analytics, predictive maintenance, and anomaly detection.
- Supports real-time and historical data analysis.

- **Command and Control Center:**
- The command and control center monitors data from the cloud server.
- It issues alerts, notifications, and commands to ground personnel based on critical events or anomalies detected.

Benefits of the Hybrid Architecture:

- Security: Data is stored in the secure cloud environment, reducing the risk of data loss or tampering at the local level.
- Scalability: Easily scalable by adding more local gateways to cover additional track sections.
- Cost-effectiveness: Local gateways perform basic analytics, reducing the load on the cloud server and lowering operational costs.
- Performance: The system processes data in real-time at the local gateway, ensuring timely response to critical events.

Information Needed at the Higher Level:

For effective roadway track monitoring, the following information is essential at the higher level:

1. **Track and Train Information:**
- Real-time location and speed of trains.
- Status of switches and signals.
- Track condition, including temperature, wear, and damage.

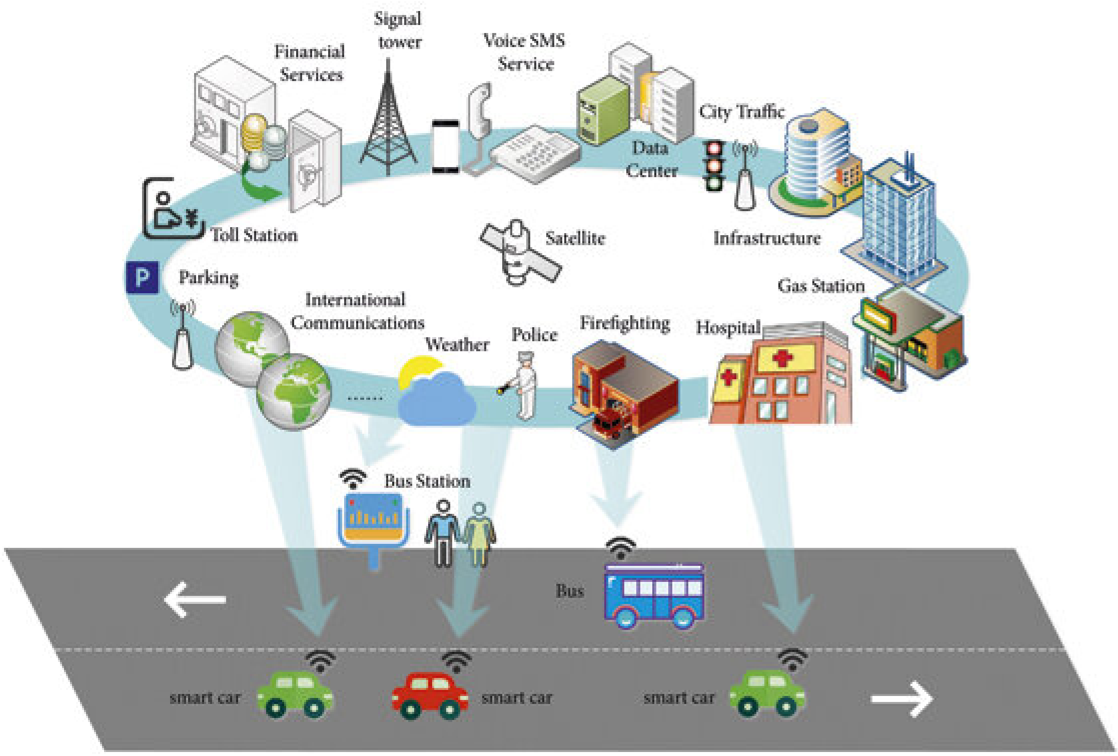
2. **Environmental Conditions:**
- Weather data (temperature, humidity, wind speed, precipitation).
- Monitoring for extreme weather conditions (e.g., storms, heavy snow).
- Detection of obstacles or debris on tracks.

3. **Safety and Security Data:**
- Video feeds from cameras positioned along the tracks.
- Access control and intrusion detection information for restricted areas.
- Activation of emergency buttons or alarms from trains or stations.

4. **Maintenance and Performance Metrics:**
- Data on wear and tear of track components (rails, switches, etc.).
- Sensor data indicating potential maintenance needs (e.g., abnormal vibration).
- Predictive maintenance analytics and recommendations.

5. **Passenger Information:**
- Passenger counts on trains and at stations.
- Occupancy levels in different compartments or sections of trains.

- Information on passengers with special needs or assistance requirements.



Conclusion:

In conclusion, designing an IoT application for a roadway Track Monitoring selecting suitable protocols, considering efficient data exchange, and implementing an appropriate architecture. The chosen protocols like LoRaWAN and Zigbee enable wireless communication and local interactions. The hybrid architecture, combining edge, fog, and cloud layers, ensures optimal data processing and analysis. By integrating these components, the system can achieve effective monitoring, safety, and performance enhancement across the roadway network.