

# ***Project Description : Full Platform Architecture: Cooperative, Resilient IoT Infrastructure***

## **1. DEVICE LAYER (Edge Devices)**

❖ **Hardware:** *ESP32, STM32, or custom embedded systems.*

❖ **Functions:**

- *Sensor data collection*
- *Local pre-processing*
- *Secure TLS communication (MQTT or CoAP)*

❖ **Software:**

- *Lightweight firmware with OTA update support*
- *mbedTLS or WolfSSL for encryption*
- *MQTT/CoAP client*
- *Device attestation (signed identity)*

## **2. EDGE LAYER (Gateways / Local Brokers)**

❖ **Hardware:** *Raspberry Pi, Jetson Nano, Intel NUC*

❖ **Functions:**

- *Act as MQTT broker for nearby devices (e.g., [Mosquitto], [EMQX])*
- *Buffer data in case of uplink failure*
- *Run lightweight AI/ML models (TinyML, TensorFlow Lite)*
- *Connect to federated cloud or local clusters*

❖ **Key Tech:**

- *Dockerized services*
- *SQLite or InfluxDB (local data buffer)*
- *WireGuard or ZeroTier for secure mesh VPN to cloud*
- *Edge authentication (public key exchange)*

### 3. FEDERATED CLOUD INFRASTRUCTURE

Designed for *portability, scalability, and no lock-in*.

<b>Component</b>	<b>Technology</b>
<b>Message Broker</b>	<i>EMQX Cluster, VerneMQ (open source MQTT)</i>
<b>Time Series DB</b>	<i>TimescaleDB, InfluxDB, or QuestDB</i>
<b>Object Storage</b>	<i>MinIO (S3-compatible, self-hosted)</i>
<b>Function-as-a-Service</b>	<i>OpenFaaS or Knative (event-driven processing)</i>
<b>Data Bus</b>	<i>Apache Kafka or NATS</i>
<b>Analytics</b>	<i>Apache Flink, ClickHouse</i>
<b>APIs</b>	<i>FastAPI or NestJS</i>
<b>Container Orchestration</b>	<i>Kubernetes (K3s for light deployments)</i>

### 4. IDENTITY & GOVERNANCE (Blockchain-backed)

❖ **Purpose:**

- *Ownership, audit, governance voting, secure device identity*

❖ **Core Tools:**

- *Hyperledger Fabric (modular permissioned DLT)*
- *Smart Contracts: Track device registration, update rights, voting*
- *DID (Decentralized ID) system for device + stakeholder identity*

❖ **Governance:**

- *Devices and organizations register as DAO members*
- *Each member has a voice on protocol changes, pricing, updates*

## 5. DASHBOARD & ADMIN PANEL

### ❖ **Frontend:**

- *React.js or Next.js*
- *Real-time graphs (Recharts, D3.js, ECharts)*
- *Role-based dashboards for:*
  - *Device status and logs*
  - *Analytics and alerts*
  - *Governance actions (vote, audit logs)*

### ❖ **Backend:**

- *Node.js (NestJS) or Python (FastAPI)*
- *Auth via OAuth2 / Web3 Wallets / DID*

### ❖ **DevOps:**

- *GitHub Actions + Docker + Kubernetes deployment pipelines*
- *CI/CD to bare metal, cloud, or hybrid servers*