IoT System Design (Industrial Predictive Maintenance)

Our IoT application is an industrial predictive maintenance system designed to monitor a machine during operation and predict failure risk before a breakdown happens. The machine is equipped with multiple sensors that continuously capture key operating signals. In our dataset, the main sensor measurements include air temperature, process temperature, rotational speed, torque, and tool wear. These signals represent the machine's condition and workload over time and are commonly used in real manufacturing environments to detect early signs of abnormal behavior.

Data Collection and Sampling

In a real IoT deployment, the sensors would collect readings at a fixed time interval (for example, every 1 minute). The dataset does not contain real timestamps, so we treat tool wear "minutes" as a practical proxy for time progression. This supports time-aware modeling and allows us to structure the data as sequential observations, which is important for time-series analysis.

Edge and Cloud Processing

After data collection, the sensor readings would be sent to an edge device (such as an embedded controller or gateway located near the machine). The edge device performs lightweight processing, such as basic filtering, validation checks, and simple anomaly flagging (for example, detecting sudden spikes in torque or temperature). This reduces noise and ensures only useful data is transmitted forward.

The processed data is then transmitted to the cloud layer through the network (e.g., Wi-Fi, Ethernet, or industrial gateways). In the cloud, the data is stored in a database and used for machine learning. The system runs predictive models that estimate failure risk and support maintenance planning. The cloud layer also supports long-term storage for trend analysis and model updates over time.

End-User Dashboard and Decision Support

The final outputs are presented to the maintenance team in a dashboard view. The dashboard is designed to show key sensor trends, highlight abnormal patterns, and display model predictions (such as predicted failure risk or failure classification). This helps maintenance staff make faster decisions, schedule inspections, and prevent unplanned downtime. The overall goal is to turn raw sensor streams into clear operational insights that support proactive maintenance instead of reactive repair.