The Industrialization of IoT and its Implementation

Overview

The internet of things (IoT), and its ability to transform business, has become pervasive in the context of product development in the manufacturing industry as digitization is now a business priority for many organizations. IoT connects physical machines and manufacturing equipment with the digital world of cloud, analytics, artificial intelligence, and more. This results in systems that can monitor, collect, exchange, analyze, and deliver valuable new insights that help to drive smarter, faster business decisions for industrial companies.

Forward-thinking manufacturers are harnessing the emerging technologies that blur the boundaries between the physical and the digital worlds. The primary objective of the Industrial Internet of Things (IIoT) is to compute and analyze the generated data to drive insightful actions that optimize operations and boost productivity at an industrial plant or similar ecosystem.

Whether it's enabling predictive analytics to detect corrosion inside a refinery pipe, providing real-time production data to uncover additional capacity in a plant, or accelerating new product development by improving the product design cycle, IIoT – and the software solutions powered by it – are driving powerful business outcomes.

Adoption of IIoT in digital manufacturing is increasing because early adopters have realized the benefits, including increased process efficiency, lower operational costs, and increased product quality, safety, and sustainability. Although there are multiple benefits of IIoT, the journey to achieve it is not easy. This point of view provides a brief analysis of the digitization of manufacturing and the challenges faced during IIoT implementation.

Implementation of IIoT

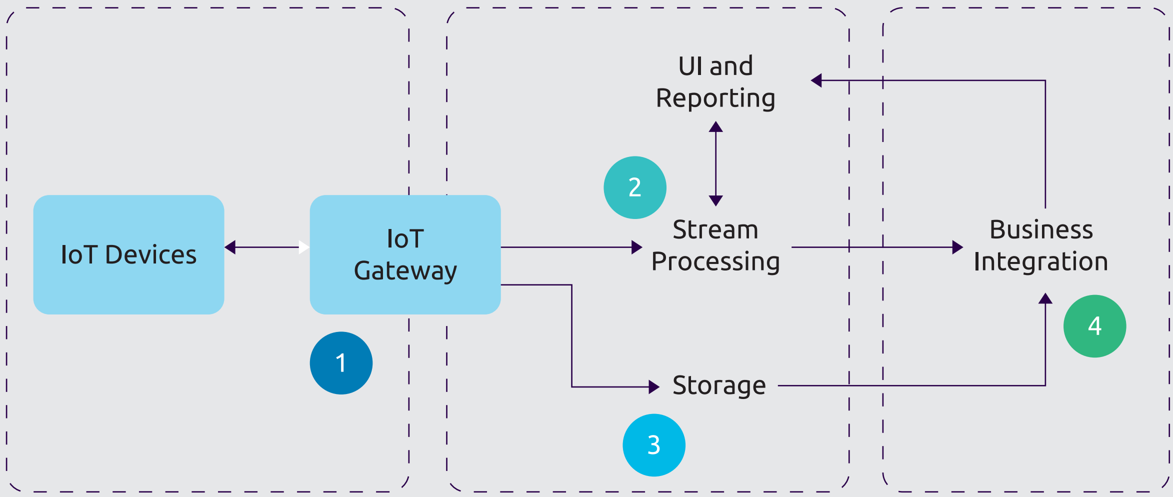
IIoT is transforming industry – changing the way industrial companies operate from day to day. As a part of the next industrial revolution, the adoption of IIoT in manufacturing operations is also known as digital factory/smart factory. Various stakeholders with diverse expertise need to align to ensure the successful implementation of the digital factory. These include:

- Key business users
- Domain consultants
- Sensor connectivity experts
- Control systems experts, industrial protocol and devices experts
- Enterprise solution software architects responsible for overall solution includes understanding of site, connectivity, and application
- Cloud architects
- Big data experts
- Scrum Master for project management
- Development team with experience in technologies such as serverless apps, web apps, document database, timeseries database, big data.

The challenge for management is to deliver the project in an agile way with the help of multiple stakeholders.

The stages of telemetry data flow

The diagram shows the end-to-end flow of telemetry (sensor data) and event data from machines/equipment at factory level to the end-user application.



Below is a brief description of data flow stages:

Connectivity – IoT devices collect the various telemetry data parameters (temperature, location, and production data, etc.). An IoT edge gateway is used to connect devices to the cloud, which is responsible for managing the devices and ingesting data to the cloud for further processing.

Stream processing – Analyzes large streams of data records and evaluates rules for the incoming streams. This is real-time analytics and complex event processing, which is major step in IoT application implementation.

Data storage – Store the raw sensor data and the processed data based on the business requirement. Different types of storage options are available from cloud providers, such as time series data base, NoSQL database, or big data for large volume of telemetry data.

Business process integration – Performs actions based on insights from the device data. This could include storing informational messages, raising alarms, sending emails or messages, or integrating with CRM. The cloud provider has a list of services for business process integration.

The challenges during implementation

Technical challenges come up at different stages of the data flow, from sensor to the end-user application. Below are some of the challenges confronted during implementation of microservices, serverless apps, micro-front architecture, public cloud PaaS services, and Edge Gateway.

Connectivity

The issues listed below may occur in getting data from the Edge devices and data ingestion to the cloud. This impacts the quality of data coming from Edge:

- Delayed data
- Out of order data
- Duplicate data
- Missing data

The root cause of the above-listed points may be data collection from sensors using industrial protocols, data handling at Edge, or internet connectivity. The identification and rectification of some of these issues is discussed in next section on stream processing.

Data processing

Delayed data: Incoming sensor data can be treated as an event during processing. Data can be processed based on either event time or arrival time. Event time is the timestamp present in event payload when the event was generated at source. Arrival time is the timestamp when the event is received at the input for processing.

Out-of-order data: The event may arrive out of order. After the event time is adjusted based on late arrival settings, you can also choose to automatically drop or adjust events that are out of-order. Ideally, out-of-order should be 0 seconds.

Duplicate data: Sometimes, an application can get duplicate events or a duplicate batch of data. This can lead to incorrect processing, use of more storage space, and unwanted data. Detection of duplicate events or batches is easy to recognize and solve. Duplicate events or batches can be dropped during processing or fixed at the sender's Edge device.

Missing data: This can be overcome at the Edge device by fixing the settings or code. The challenges in connectivity and data processing can be overcome by executing end-to-end testing, which covers:

- Timing of incoming data at different hopes
- Creating scenarios using an emulator to generate delayed data, out-of-order data, duplicate data, missing data
- Testing with real-time factory data.

Data storage: The Edge devices require enough storage to store unstructured data generated by sensors collected at different frequencies. The challenge is to design a device that can handle storage in case of unavailability of internet connectivity and ingest data once connectivity is restored. This requires sufficient bandwidth to handle speed of data being ingested into the IoT storage systems. A time series database service makes the data storage simple and easy. This service is used to efficiently store, process, and analyze incoming data from edge devices.

Business process integration: IoT application development requires data from existing enterprise applications as an input to process real-time or historical edge device data for writing business logic. For example – get production schedule from SAP, get product category, and get geographical hierarchy of the plants. Another way of integration with Enterprise Application is to send the processed data or insights for further appropriate action. The choice for this type of integration is REST services. The challenges during this integration are timing and frequency of getting updated data from enterprise applications, availability of APIs, and difference in web service contacts.

Conclusion

The design of IoT solution implementation in manufacturing operations needs to handle real-time data generated by sensors at machine/equipment level. This comprises connectivity, data processing, large data storage, business processes. The anticipating challenges in early phases of the project and solution will help organization management and business to complete digitization faster.

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