Internet of things (IOT) applications covering industrial domain

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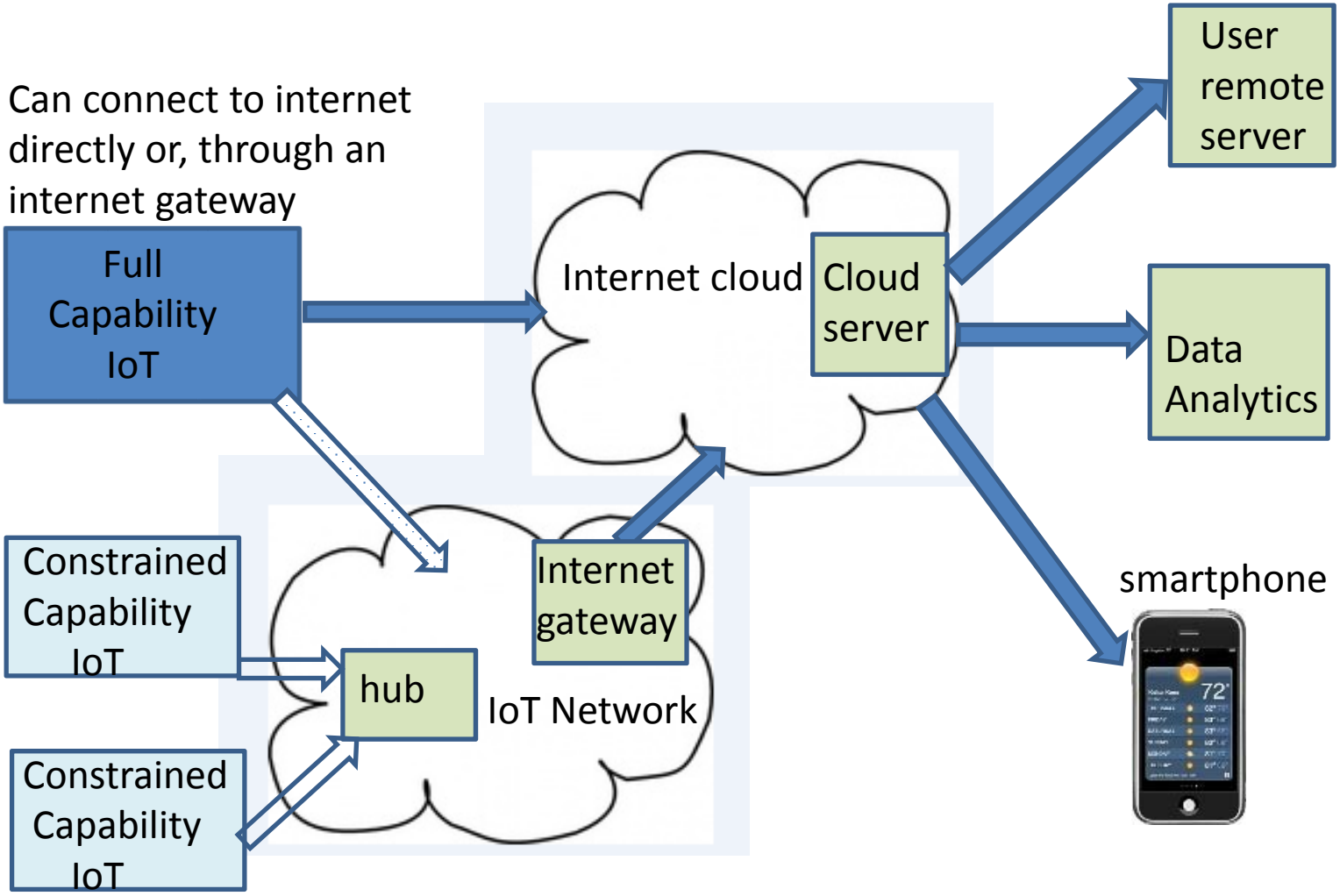
Outline

- Internet of things
  - What is Internet of things (IOT)
  - Simplified IOT System Architecture
- IOT Protocols
  - Multiple protocols of IOT
  - MQTT application layer protocol
  - MQTT architecture diagram
  - COAP Application layer protocol
  - DDS application layer protocol
  - DDS Architecture diagram
  - Lower layer protocols
- Industrial Internet of things
  - What is Industrial Internet of Things (IIoT)
  - Industrial IOT Requirements
  - Industrial IoT system architecture
  - IIOT Architectural components
  - Edge Processing Device Technology
- Conclusion

What is Internet of Things(IoT)?

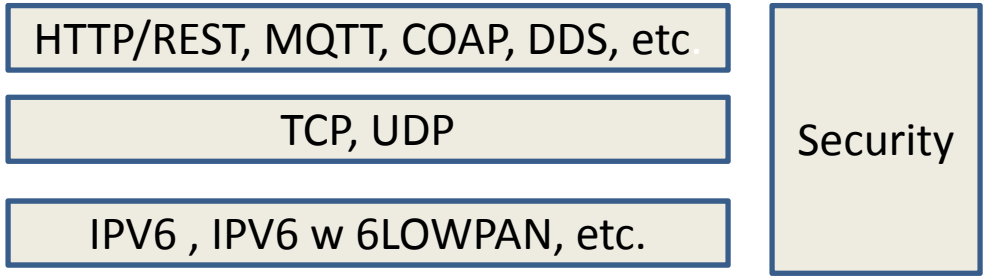
- New services by integrating with everyday objects
  - Objects are globally accessible from the Internet
- Embedded system device
  - Processing subsystem with full network connectivity
  - Run the application on the device
- In contrast, “Things” are resource constrained
  - Energy, data throughput, computing and connectivity
  - The IOT application runs as a web application on the cloud or, in the cloud connected dedicated server

Simplified IoT System Architecture



Multiple Protocols of IoT

- Higher layer protocols
  - Application
  - Transport
  - Network



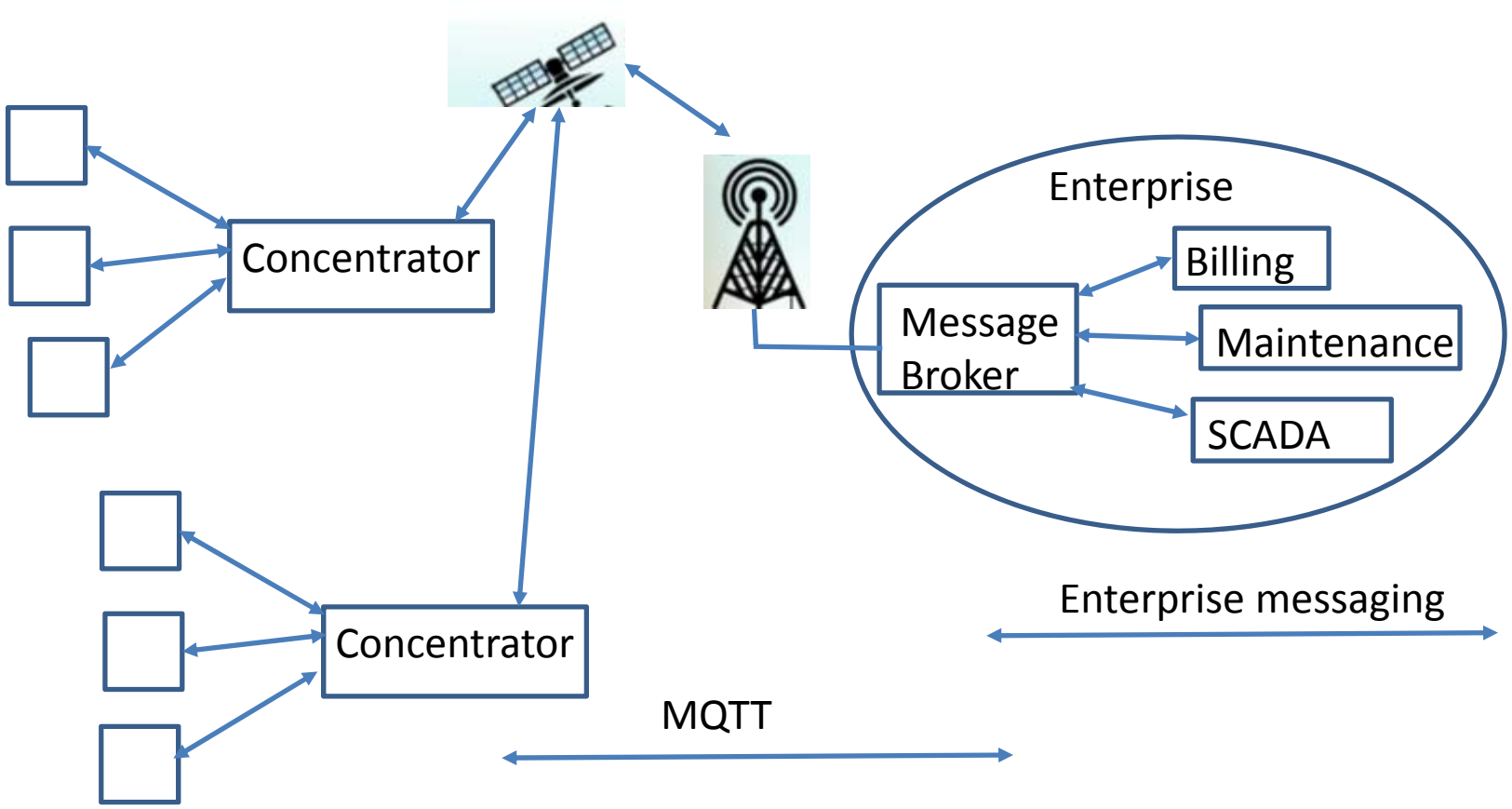
- Lower layer protocols
  - Link layer



MQTT Application layer Protocol

- MQTT (Message Queue Telemetry Transport)
  - Extremely lightweight publish/subscribe messaging transport.
    - Small device, low bandwidth, intermittent connectivity.
    - MQTT is message oriented with message size as small as 2 byte. Good for small footprint device with intermittent internet connection such as through a satellite link, primarily for collecting data and response delay of ~10ms
  - A hub-and-spoke architecture is natural for MQTT.
    - Client Server architecture for data collection. Protocol works on top of TCP to avoid data loss and provides a simple, reliable stream.
  - The publisher subscriber model allows MQTT clients to communicate one-to-one, one-to-many and many-to-one.

MQTT architecture diagram



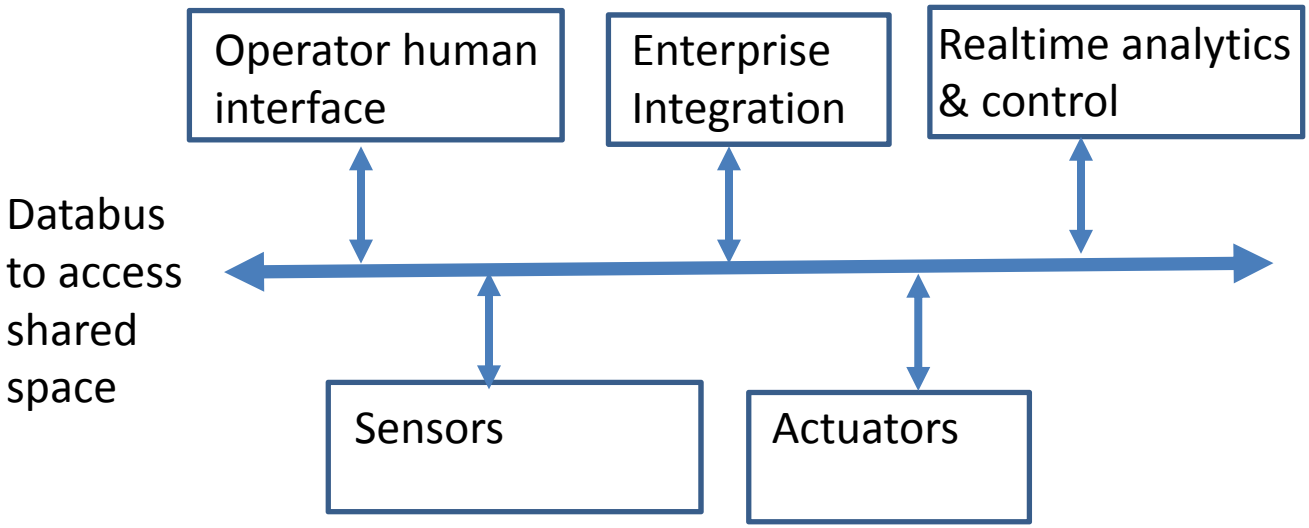
COAP Application layer Protocol

- Constrained application protocol(COAP) over UDP
  - Resource constrained with small device memory
  - Short message for low-power devices.
- COAP with Datagram Transport Layer Security (DTLS)
  - (DTLS) security on top of UDP to provide transmission protection(by retransmission and sequence number within handshake).
  - DTLS secures CoAP with features like integrity, authentication and confidentiality.
  - can work between device to server and has a response time of ~10ms.

DDS Application layer Protocol

- Data Distribution Service (DDS)
  - Direct device-to-device “bus” communication with a relational data model. This is exactly what many high-performance devices need to work together as a single system.
  - DDS is a data centric publish and subscribe technology to address the data distribution requirements of real time systems
  - Real time response of ~0.1ms and good for control and data distribution between smart devices with good network connectivity.

DDS architecture diagram



Lower layer Protocols

- WiFi
  - Integrates Security (WPA2 uses an encryption device which encrypts the network with a 256 bit key)
  - Higher cost & power (~100mW) than 802.15.4 or, BT
  - Data transfer rate 54 Mb/s, Range 100 m
- 802.15.4
  - 802.15.4 good for sensor related low-data-rate applications
  - extended-life low-power-consumption uses (~1mW)
  - Security 128 bit AES
  - Data transfer rate 250 Kb/s, Range 10 to 100m
- Bluetooth LE
  - BTLE has very long battery life with sleep mode and used for medical sensors (0.1 to 0.5mW)
  - Security 128 bit AES
  - Data transfer rate lower than 100 kb/s, Range 50m

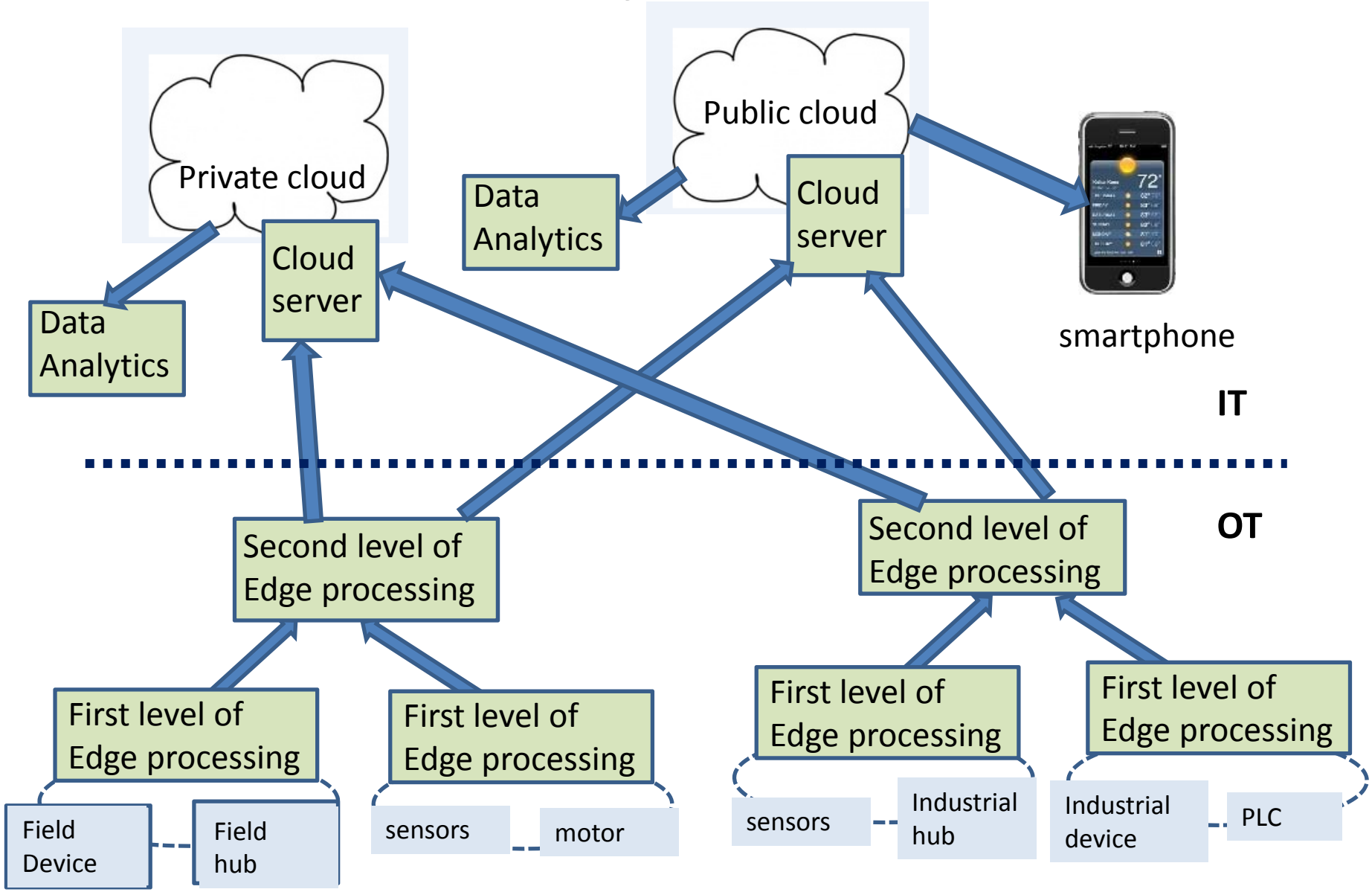
What is Industrial Internet of things?

- What it is
  - Existing plant field is connected with sensors, data management, advanced analytics, decision making, people and automation
  - Allows enterprise to control and communicate to field assets
- Difference with general class of IOT
  - Large number of nodes
  - Controlled latency at various levels of hierarchical data processing
  - Keep existing plant field running
- What is the benefit
  - Asset optimization
  - Process optimization
  - Business Optimization

Industrial IoT Requirements

- Existing manufacturing field industrial I/O devices including sensors, actuators, analyzers, drives, vision, video, and robotics
- Accommodate large number of nodes
- Controlled latency at various levels of hierarchical processing
- High reliability, high availability, safe & resilience to failure
- Provides smarter services (monitoring, alarm management)
- Non-invasive IT integration with Operational technology
  - IT is top down designed from business point of view, well defined
  - Operational technology is defined bottom up with different vendor proprietary equipment
  - Communication network system that works in presence of internet, intermittent internet or, independent and connects to edge nodes for real time processing
- High access security and provision
- Human interaction

Industrial IoT System Architecture



IIoT Architectural components

- Operational Technology (OT)
  - Characteristics (Triggered by event, Changing data, low latency real time)
  - Use of MQTT, COAP (D2S,~10ms, collect) or, DDS (D2D,~0.1ms, distribute)
  - First level of edge processing (low latency)
    - Real time connectivity with data aggregation, device management, device security, communication gateway and processing
    - Support low latency industrial real time process management and event generation
    - Connects actuators, analyzers, drives, vision, video, controllers and robotics
  - Second level of edge processing (medium latency)
    - Supports medium latency industrial process management, alarm generation, storage

IIoT Architectural components (Contd.)

- Informational Technology (IT)
  - Characteristics (Triggered by query, stored data, high latency non real time)
  - Enterprise Data processing
    - Integration of data and virtualization of data for further processing by applications and analytics
    - Application level protocols processing
    - Historical data analysis, business decisions and processes

Edge Processing Device Technology

- Hardware
  - Interface for collecting sensor data from in the industrial field directly or, through a hub
    - Wired: RS 422/RS485/RS232, Digital Input/output (5 to 48V) powered
    - Wireless: Zigbee, Bluetooth, 3G
  - Interface to next level of edge processing/cloud
    - Wireless: 3G, WiFI
    - Wired: Ethernet
  - Processing module
    - Microcontroller with MMU, memory, Flash, storage
    - ADC, DAC
    - USB, SPI

Edge Processing Device Technology(Contd.)

- Software
  - Operating system: Embedded OS with low latency TCP/IP
  - Security
    - Open SSL Library, SRM Signing Tool, Certificate Management, SecureBoot,

      Application Integrity Monitor, Application Resource Control, Secure Package

      management, encrypted storage, application whitelisting, NSA Suite B algorithms

      for public and private key cryptography
  - Management: OMA DM, TR-069, Web-based configuration interfaces

Conclusion

- Progression from IOT to IIOT are covered
  - Applications, system, architecture and protocols
- Following Key questions related to IOT and IIOT are answered
  - What constitutes an IOT, its architecture and protocols
  - What way Industrial IOT is different from general class of IOT
  - How OT and IT are combined to create Industrial IOT
  - What kind of hardware and software technologies are used in Edge processing device