Internet of Things (IoT) Networking

Course Description

Internet of Things (IoT) technologies brings tens of billions new devices to be connected to the network, while these connections have new requirements that are not common to standard communications networks that we have in the last decades. New architectures and communications protocols have been developed for the purpose including 802.15.4, special WiFi implementations, cellular protocols, LoRaWAN and others. In this course we talk about the network architectures including the access networks, the improvements and adaptions of the TCP/IP protocol stack, the application and management protocols, IoT network security and applications. We focus on the requirements, the network architectures and the protocols that comes to fulfil these requirements and the how they work.

Course Objectives

By the end of the course, the participant will be able to:

- Describe the requirements from an IoT network
- Describe the architecture on IoT networks
- Describe the network protocols of IoT, and the differences between them
- Perform network design for IoT networks

Target Audience

R&D, engineering and technical Support, IT and communications managers

Prerequisites

High-level understanding of the TCP/IP protocol stack

Duration

3 days

Outline

1. Introduction to IoT
   - What is IoT
   - IoT technology brief
   - Sensors and actuators, gateways and servers
     - Sensors and actuators – types and requirements
     - gateways and servers
     - Requirements and constrains

- IoT network challenges
    - Requirement's – sensors quantities, coverage ranges, bandwidth and more
    - Requirements trade-offs – what we gain and what we lose
    - Which protocols fits
- Architecture models
    - ETSI Machine to Machine (M2M) and OneM2M
    - The IoT World Forum (IoTWF)
    - The IIC Industrial Internet Reference Architecture (IIRA)
- Getting practical
    - Access – gateways and backhaul – applications
    - Application – network – sensor networks
    - Sensors networks and their challenges
- Protocols structure
    - The protocol tree and what works with what

2. Founding technologies
   - New computing structures
       - IT and OT networks (not so new but much relevant...)
       - Cloud networks and services
       - Distributed computing and its appliance to IoT
       - Cloud – Fog – Edge networks
   - IP version 6 (IPv6)
       - Protocol basics
       - IPv6 addressing
       - IPv6 packet structure and headers

3. IP optimization for IoT networks
   - Network constrains in IoT networks
   - 6LoWPAN and 6Lo
   - Header compression
   - Fragmentation
   - Mesh addressing and address design
   - Routing in Mesh networks and RPL routing in low power lossy networks
   - Time-Slotted Channel Hopping (6TiSCH)

4. IoT network protocols choices
   - IoT network protocols structure – how does it works

- Layered architecture, protocols and what works with what
- Layers 1/2 - 802.15.4, Bluetooth Low Energy (BLE), WiFi, 3GPP and RFID
- Layers 3/4 – IPv4/v6, 6LoWPAN, TCP/UDP
- Layers 5-6-7 - XMPP, MQTT, CoAP and others
- Multi-layer architectures – ZigBee, LoRa/LoRaWAN and others

5. 802.15.4 protocols
   - Introduction, protocol structure
   - 802.15.4 advantages for IoT
   - 802.15.4 development, 4g and 4e standards
   - 802.15.4 device types – FFD and RFD and device addressing
   - 802.15.4g and the physical layer
     o Frequencies, channels and modulation
     o Radio transceiver activation and deactivation
     o Link quality indication and operation
   - 802.15.4e and MAC enhancements
     o Frame types – Beacon and EB, data, Ack/eAck, command frames and Information Elements (IEs)
     o Super frames
     o MAC enhancements – security, channel hopping and Coordinated Sample Listening (CSL)
   - 802.15.4 network architecture

6. Cellular Networks and IoT
   - Cellular networks structure (brief)
     o Cellular network development
     o 4th/5th Generation network architecture and structure
     o Cellular networks characteristics
     o Operations and data structure
     o Security mechanisms
     o Standards and standardization
   - Cellular networks and IoT
     o NB-IoT protocols
     o LTE-M protocols
     o IoT and 5th generation

7. IoT and Wireless (WiFi) Protocols
   - Wireless (WiFi) networks
     o Wireless network structure

- WiFi standards and what fits IoT
- Security mechanisms
- Standards and standardization
- WiFi for IoT
- 802.11ah protocol
- IoT networks with 802.11ah

8. Low Power WAN and LoRaWAN
- LPWAN technologies
- ISA100.11a
- WirelessHART
- Introduction to LoRa and LoRaWAN network architecture
- LoRa and the physical layer
- Frequencies and modulation
- Frame structure
- LoRaWAN, MAC and network architecture
- Full Function Device (FFD) and Reduced Function Device (RFD)
- Device classes (A/B/C)

9. ZigBee
- Network architecture – coordinators, routers and end devices
- Packets and messages
- Address assignments

10. Management Protocols for IoT
- Constrained Application Protocol (CoAP)
- Message Queue Telemetry Transport (MQTT)
- Supervisory Control and Data Acquisition (SCADA)

11. IoT Security
- Information Technology (IT) and Operational Technology (OT) networks, the differences between them, and should they be connected
- Security protocols and measures (brief)
- Traditional threats and vulnerabilities and their relevance to IoT networks
- Methods applicable to IoT security

12. IoT Applications and Networks
- IoT for transportation
- IoT for public safety
- IoT for heath organizations

- IoT for manufacturing
- IoT for smart cities
- IoT for energy