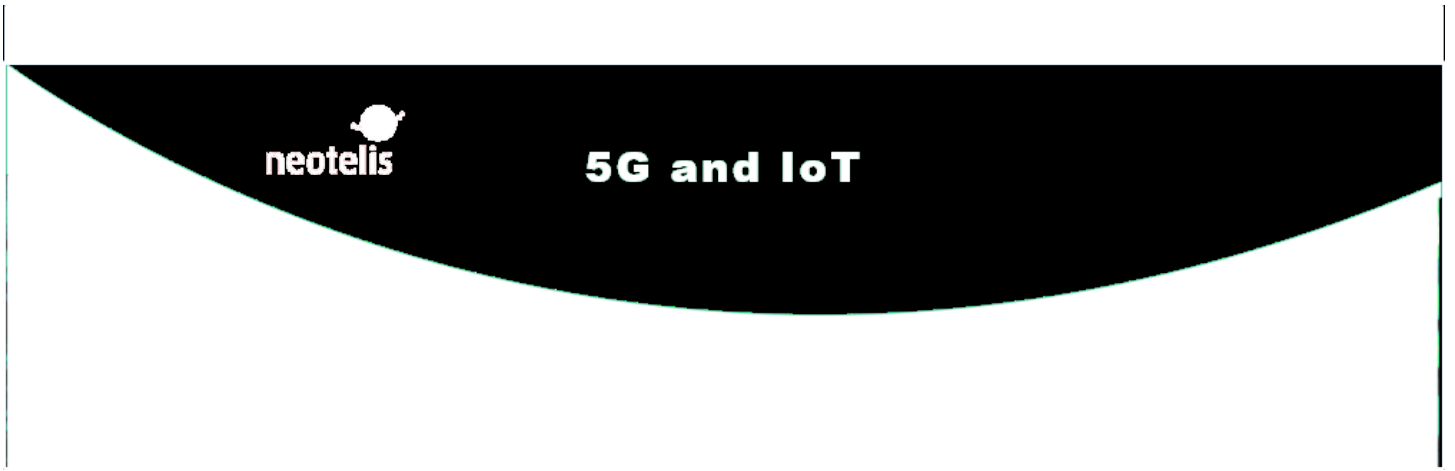
# ENG-515 - 5G and IoT





## Description

Current Telco architecture is transforming from being composed of vertically integrated discrete network elements to being cognitive, cloud-optimized and seamless in operation. Such next-generation networks will not be server-centric, but instead will focus on data and content requirements. Data and the applications that use it will be decoupled. The new network architecture will support easy scalability, have built-in security and privacy, enable energy efficient operation, offer lower Operational Expenses (OPEX), and flexibly support an extremely wide range of uses.

This 4-day course is designed to provide an overview of 5G and the Internet of Things (IoT), from a technical point of view.

## Learning Outcomes

At the end of the course, participants will be able to:

- Identify 5G and IoT technology enablers and the features of both technologies
- Understand the detailed technical architecture and components of a 5G network
- Discuss the challenges of migration to 5G and some use cases of this new type of network
- Describe the applications and advancement of 5G, assess security considerations and the role of analytics and applications
- Understand what is IoT and describe the relationship between IoT and 5G
- Explain the architecture, layers and stack for IoT and assess its features and requirements

## Topics

The training course covers the following topics:**DAY 1**

- **5G and IoT Technology Enablers**
    - Dynamic Spectrum Access (DSA)
    - Interference management
    - Small cells
    - Coordinated multipoint
    - Mass-scale MIMO, massive MIMO
    - Personal mobile internet
    - Software-Defined Radio (SDR)
    - Cognitive radio
    - Smart-radio
    - Multi-hop networks
    - Direct device-to-device (D2D) communications
    - Dynamic Adhoc Wireless Networks (DAWN)
    - IPv6 and 6LowPAN
    - Centralized RAN vs. cloud RAN
    - NFV, SDN, and cloud networking
    - Massive Machine Communication (MMC)
    - Massive Internet of Things (IoT)
    - Moving Networks (MN)
    - Ultra-Dense Networks (UDN)
    - Ultra-Reliable Communication (URC)
    - Mobile ad hoc network (MANET)
    - Wireless mesh network (WMN)
    - Vandermonde-subspace frequency division multiplexing (VFDM)
    - Millimeter-Wave
    - 5G Cloud radio access network (C-RAN)
    - Ultra small cells based heterogeneous network (HetNet)

    - Heterogeneous cloud radio access network (H-CRAN)
    - Ultra Reliable and Low Latency Communication (URLLC)
    - Full dimension MIMO
    - Adaptive Coding and Modulation (AMC)
    - Filter-Bank Multi-Carrier (FBMC)
    - Frequency and Quadrature Amplitude Modulation (FQAM)
- **5G Introduction**

    - Road map to 5G
    - 5G technology detail
    - Features of 5G
    - 5G spectrum needs
    - Evolution
    - Introducing the key concepts of 5G framework
    - Introducing the key components 5G architecture
    - Overview of cloud computing & SDN
    - Economic principles driving 5G & IoT

**DAY 2**

- **5G Architecture**

  The service-driven 5G network architecture aims to flexibly and efficiently meet diversified mobile service requirements. With software-defined networking (SDN) and Network Functions Virtualization (NFV) supporting the underlying physical infrastructure, 5G comprehensively cloudifies access, transport, and core networks.

    - Objective of the architecture
    - Architecture of 5G
    - Differences from LTE
    - Master core technology
    - Flexible frame structure & design
    - 5G design principles
    - Flexibility
    - Reliability
    - Various components and functions
    - Network softwarization and programmability
    - Impact on mobile technologies
    - Impact on service & infrastructure management and orchestration
    - Key differences between 5G & previous cellular technologies
    - Security- 5G planning using heuristic algorithm
    - Dimensioning use of millimeter wave (mmw) carrier frequencies
- **5G Advancement**

- 5G radio
  - 5G performance requirements
  - 5G spectrum; multi spectrum scenario
- Air interface
  - Software defined air interface
  - New multiple accesses (“no cell” concept)
  - Physical layer procedures, and coding
  - New modulations schemes
  - Channel models for 2.3 GHz, 2.6 GHz, 5.25 GHz, 26.4 GHz, and 58.68 GHz.
  - Advanced MIMO technology with wider bandwidths
  - Propagation modeling of densely populated urban areas
  - Beam forming, network discovery, and relaying
  - Coding and modulation algorithms
  - Interference management
  - Non-orthogonal, asynchronous waveforms
  - Millimeter-wave beam forming
  - Cooperative diversity and flexible modulation
- Radio Network Virtualization (Cloud RAN)

**DAY 3**

- **Migration to 5G**
  - Challenges for migration
  - Options
  - Advanced features details
  - How operators can move smoothly to 5G
  - 5G use cases
    - Mobile broadband
    - Automotive
    - Smart society
    - Smart grids
    - Health
    - Industrial
    - Logistic/ freight tracking

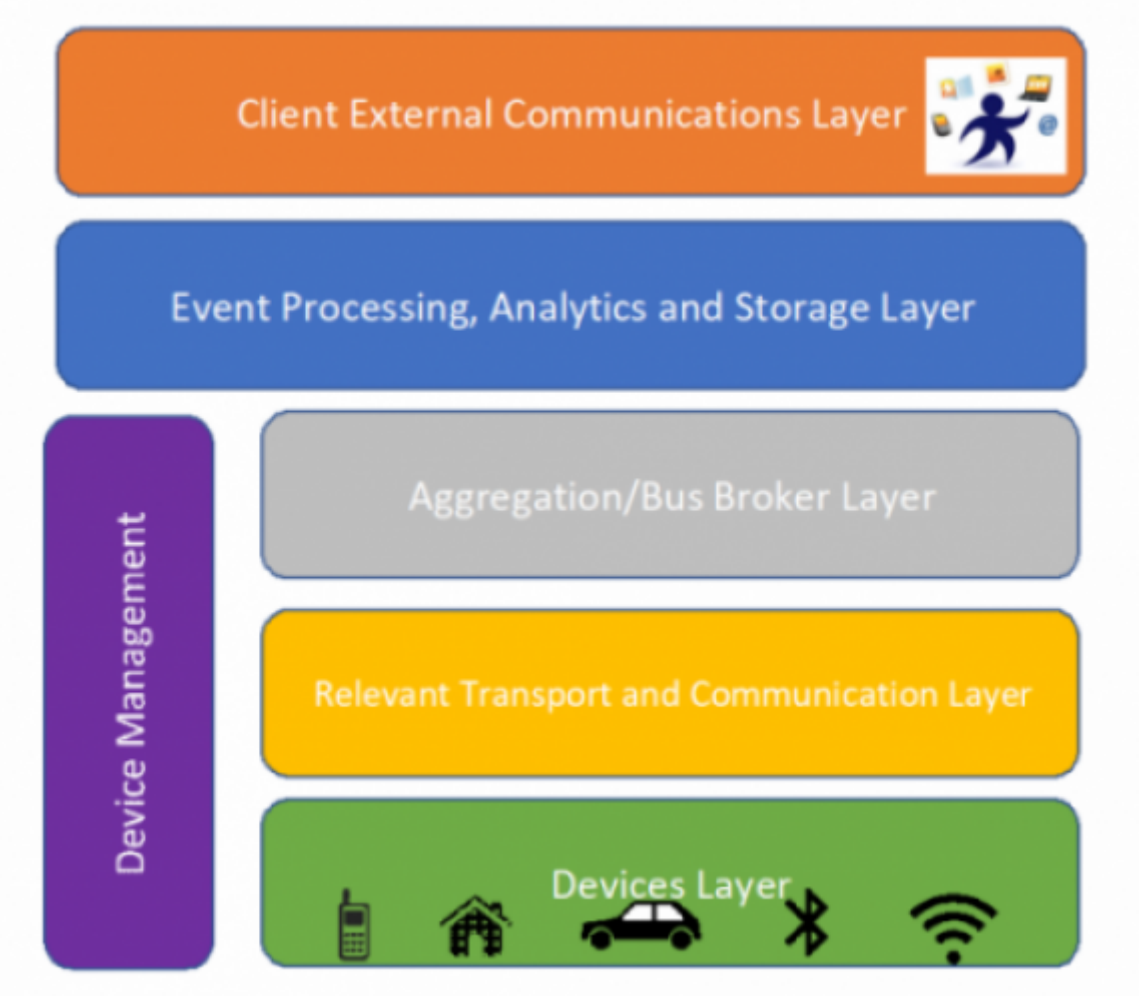
- **Applications of 5G**
  - Security considerations in 5G
    - Cloud security
    - Application security
  - Role of analytics & applications in 5G
    - 5G use cases; smart cities, critical assets, smart homes, manufacturing etc.
    - Introduction to analytics (basic & advanced)
    - Role of analytics in 5G
  - IOT & 5G

- 5G fundamental role in IoT
- Relationship between 5G and IoT
- Understanding the IoT & 5G frameworks
- 5G & IoT framework compatibility

**DAY 4**

- **IoT Architecture and Layers**

  The reference architecture consists of different layers. Layers can be realized by means of specific technologies. There are also some cross-cutting/vertical layers such as access/identity management.




- **IoT stack**

  - Device hardware (sensors, hardware/firmware)
  - Device software
  - Communication (device hub/gateway, device management…)
  - Cloud platform (data management & intelligence, API design/build, API runtime

management, application PaaS (aPaaS), iPaaS middleware…)
- Cloud applications (website, mobile apps, mobile aPaaS…)

- **Overview of IoT connectivity Methods and technologies**

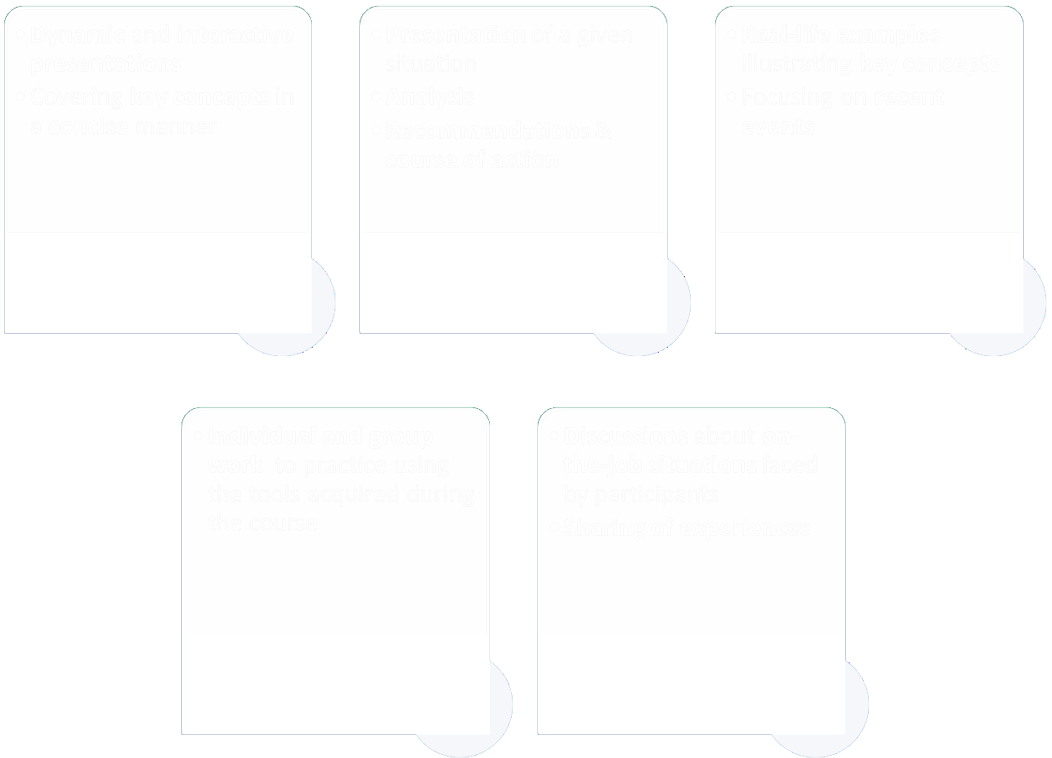
  - ZigBee PRO, ZigBee 3.0 and ZigBee IP
  - 6LowPAN
  - RFID
  - Bluetooth LE or bluetooth smart technology
  - Z-Wave
  - IEEE 802.15.4, IEEE 802.15.4e, 802.11ah
  - 802.11ah, Wi-Fi HaLow
  - GSM, CDMA, GPRS,3G, LTE, small cells, SATCOM
  - Sensors and sensor networks
  - MIPI, M-PHY, UniPro, SPMI, BIF, SuperSpeed USB Inter-Chip (SSIC), Mobile PCIe (M-PCIe) and SPI
  - Wired connectivity
  - IPv4/IPv6

## Target Audience

- Strategic or technical managers, consultants, communications professionals, network professionals and others who plan on using, evaluating or working with 5G wireless networks, applications and services, including IoT

## Methodology

A combination of engaging activities and dynamic presentations to stimulate and maximize participants' learning.




## Location

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