5G NR Air Interface

The cellular industry is gearing up for 5G. The industry is planning to support a variety of new and exciting services such as Augmented Reality (AR)/Virtual Reality (VR), hologram videos, and self-driving cars. Such services require a wide range of network capabilities to support a variety of consumer devices and Internet-of-Things (IoT) devices. This course takes an in-depth look at the 5G NG-RAN architecture and major operations that enable a 5G network to support the target 5G services. Various aspects of the NG-RAN are described. Registration and session setup are discussed along with a look at network slicing. The data transfer in both downlink and uplink is described. Mobility in connected, inactive, and idle modes is discussed. Finally, the status of 5G in in the industry is summarized.

Intended Audience

This detailed technical course is intended for engineering and related job functions who need to get an in-depth understanding of 5G NG-RAN architecture and operations.

Objectives

After completing this course, the student will be able to:

- Illustrate the architecture of the NG-RAN
- Describe the frame structure with numerology of the air interface
- Summarize architecture enhancements such as Cloud-RAN and Dual Connectivity
- Identify key steps of network acquisition, random access, and connection setup
- List main steps of registration, network slice selection, and session setup
- Give examples of QoS parameters in 5G
- Explain how data is transferred in the downlink and the uplink
- Differentiate between the connected mode mobility and the idle/inactive mode mobility

Prerequisites

- Introduction to 5G: (Blended Learning)
- Technology Primers: 5G Services and Network Architecture, 5G Radio Technologies and Deployments

Required Equipment

- None

Course Outline

1. 5G in a Nutshell
1.1 Evolution to 5G
1.2 Services and performance goals
1.3 Key 5G components
1.4 SA and NSA deployments

2. NG-RAN Architecture
2.1 5G network architecture
2.2 Multi-RAT dual Connectivity (e.g., EN-DC)
2.3 gNB-CU and gNB-DU
2.4 Protocols for NG-RAN interfaces
2.5 Cloud RAN
2.6 NG-RAN and UE identifiers

3. New Radio (NR) Air Interface
3.1 mmW and sub-6 GHz spectrum
3.2 Massive MIMO
3.3 Multiplexing and multiple access
3.4 Numerology and frame structure
3.5 Physical signals and channels
3.6 Dual RRC, RRC states, and state transitions
3.7 Air interface protocol stack

4. Network Acquisition, Random Access, and Connection Setup
4.1 DL synchronization
4.2 Minimum SI and Other SI
4.3 Random access procedure
4.4 Connection establishment with gNB-CU

5. Registration and Session Setup
5.1 Overview of registration
5.2 Network slicing
5.3 PDU session establishment
5.4 QoS in 5G

6. DL and UL Data Transfer
6.1 Overview of data transfer
6.2 Measurements
6.3 Scheduling
6.4 Data transmission
6.5 H-ARQ
6.6 RLF: detection and resolution

7. Operations in Connected, Inactive, and Idle Modes
7.1 Cell- and Beam-level mobility
7.2 Handover stages
7.3 Inter-DU/Intra-CU mobility
7.4 LTE mobility with dual connectivity
7.5 Cell reselection
7.6 Paging and RNA

Award Solutions