

5G NR: Deep Dive into Rel 17 & Outlook to Rel 18

Course Duration:

- 2 days

Course Description:

- This course focuses on the evolution of 5G from 3GPP Rel 15/16 towards Release 17 with a quite detailed outlook towards Release 18. We also depict the envisaged timeline of 3GPP towards 6G.
- After a review of 5G NR with Release 15 and a focus on Release 16 features, the course initially provides an overview of all relevant Release 17 features like NTN, RedCap, CE, 1024-QAM, MIMO-enhancements and many others.
- The following three chapters provide deep dives into the most important new features of Release 17, namely NTN, RedCap and CE. Please refer to the detailed description in the table of content.
- The final chapter is dedicated to Release 18, which is the first 5G Advanced Release according to 3GPP. Focus here is on network energy savings, eRedCap, MIMO evolution and SBF (TDD-evolution).

Prerequisites:

- The student must possess detailed knowledge about the PHY and protocol stack in NR.
- Detailed knowledge of general RF-issues like link budget, receiver sensitivity is strongly recommended.

Some of your questions that will be answered:

- How does NR over NTN (non-terrestrial networks) operate?
- What is the difference between transparent and regenerative payload?
- Why NTN may make sense after all failed attempts to add satellite services to cellular in the past three decades?
- What are the impacts of NTN on latency, mobility and services?
- How does cell selection work in NTN?

- What are characteristics of RedCap-devices?
- What are the implications of operating RedCap-devices?
- Why do we need special BWP for RedCap-devices?
- Which special operation do RedCap-devices need to obey?
- How does coverage enhancement (CE) work in Release 17?
- What is TBoMS and how is it parametrized?
- Which performance improvements can be expected from CE?
- Which implications do network energy savings (NES) have on the UE?
- How and where can SBFDD be deployed and how does it work?

Course Target:

- The student is enabled to state the Release 17 and Release 18 specific enhancements of NR.
- The student understands in detail the implications of NTN, RedCap, NES and CE.

Table of Content:

Chapter 1: Review & Warming Up

(2.0 - 3.0 h)

- **The timeline from 5G to 6G** / Rel 15, Rel 16, Rel 17, Rel 18, Rel 19, Rel 20 and Rel 21 (6G)
- **Reviewing 5G and NR with Rel 15 and 16** / differences and enhancements compared to LTE, most important updates with Rel 16
- **Overview Rel 17 RAN Features** / NTN, RedCap, Coverage Enhancements (PUSCH and PUCCH), UE power savings, Multi-SIM, 1024-QAM in DL, FR2-range extension, FR2-extension with new SCS 480+960 kHz, fast SCell activation, UL carrier switching, Small Data Transmission (SDT)

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Chapter 2: Deep Dive into NTN

(2.0 - 3.0 h)

- **Architecture & Implementation Options** / Transparent vs. Regenerative Payload, Satellite Types, NR-NTN, IoT-NTN, NTN Protocol Stacks, NTN-specific frequency bands
- **NTN: Technical Challenges & Terminology** / Nadir Position, Path Loss, Doppler Shift and Doppler Rate, Latency
- **Operation 1** / Cell Selection with NTN
- **Operation 2** / RRC-Connection Setup, SIB1 and SIB19/SIB31, UE-Capabilities for NTN
- **Operation 3** / Mobility and Handover

Chapter 3: Deep Dive into RedCap

(2.0. - 3 h)

- **Overview** / Use Cases and RedCap-Capabilities, Differences to IoT, eMBB and URLLC, Risk of Abuse
- **Detailed Look at technical Reliefs for RedCap Devices** / BW, Half-duplex operation option, MIMO, modulation, N1, N2, CA&DC
- **Operation 1** / RedCap specific BWP-allocation through SIB1
- **Operation 2** / RRC-Connection Setup, early indication in RA-procedure, UE-Capabilities (RedCap-specific)

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Chapter 4: Deep Dive into Coverage Enhancements (2.0. - 2.5 h)

- **Why, when and where?** / Uplink, PUSCH and PUCCH, typical applications
- **PUSCH 1:** HARQ vs blind repetitions, operation with Rel 16, changes with Rel 17, joined operation of HARQ and blind repetitions
- **PUSCH 2: Joined Channel Estimation (JCE)**, operation and parametrization, time domain window, measurement through UE
- **PUSCH 3: TBoMS (TB processing over Multi-Slot)** / operation and parametrization
- **PUSCH 4: Msg3 repetition** / operation and parametrization
- **PUCCH** / Coverage enhancements for the PUCCH
- **Performance improvements to be expected**

Chapter 5: Contents of Rel 18 (1.0. - 2.0 h)

- **NES (Network Energy Savings)** / CellDTX/DRX, CSI-based Spatial Domain Adaptation, SSB-less Scell Operation
- **MIMO Evolution** / coherent (Rel 18) & non-coherent (Rel 17) transmission
- **eRedCap** / Differences to RedCap, performance
- **SBFD** / operation, challenges, time-frequency grid
- **more important Rel18 Contents**