

# MCNS Training Program

5G RAN NR over Satellite

## 5G RAN NR over Satellite

This course contains 5G NR RAN architectures over LEO and GEO satellite, cubeSates, mini satellites, 5G over satellite link budgets planning and optimizing, MAC, RLC, PDCP, RRC protocol layers parameters, timers and configuration.

### COURSE REVIEW

This training course is designed for engineers with knowledge of **Satellite Communications** and **5G**, who desire to acquire greater knowledge in the areas of **Network Planning**, satellite use cases, and technical and regulatory challenges for **5G over Satellite**. It offers an understanding of the network deployment opportunities, challenges, and risks that's needed to exploit and deploy the **5G RAN NR SA over satellite** in mmW band, from the throughput perspective up to number of users supported.

It combines case studies from both planning and optimization, reviewing the MAC, RLC, PDCP and RRC parameters, timers and procedures. A thorough analysis follows the corresponding timers from delay perspective trying to emphasize on parameter configurations and performance optimization. Participants will be also exposed to link power budget, propagation delays, free space loss, multiple access techniques and LEO small satellites. The course is supported by proper **excel dimensioning (calculator)** files for practical exercises and case studies.

### AIMED AT

This course is mainly aimed at a technical audience. It is suitable for technical professionals, **RAN operators, Radio planning engineers, RAN optimization engineers**, Research Institutes, defense sector, who currently are or will be involved in **5G NR SA** over satellite deployments. Moreover it is useful for Broadcasting companies utilizing satellites as well as satellite operators wishing to move towards **5G NR deployments**.

Prerequisites: Those wishing to take this course should have a good and solid understanding of **5G technology** with emphasis on **5G NR air interface and signaling**, as well as **Satellite communication basic principles**.



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### Course Benefits for individuals (Professionals)

- Understanding **5G SA RAN over satellite** requirements
- Explore 5G RAN over satellite coverage and capacity principles
- Learn how to plan for **5G NR Non Terrestrial Networks (NTN)** coverage and capacity
- Introduce engineers into the fundamentals of satellite communications with reference to **5G** and satellite use cases for 5G
- Understand the principles behind the control channels and reference signals capacity and coverage requirements for **5G NR NTN networks**
- Learn how to configure basic parameters and timers for NTN deployment
- Practice on **5G NR over satellite** capacity and coverage planning tools (i.e. excel calculators examples) through practical exercises

### Course Benefits for your Organization

- Equip organization engineers with the necessary knowledge to accomplish difficult and complex tasks related to 5G NR SA RAN planning over satellite.
- Keep ahead of competitors in offering new user cases and perspectives for 5G over satellite scenarios
- Identify new revenue streams that can be enabled through **5G over satellite**
- Prepare for future network expansions and quality performance optimization

### Training Format

Instructor-Led Training  
On-Site Classroom: 3 days  
Web delivered (Virtual): 3 days  
**Excellent and descriptive course material (pdf file) will be provided**

## Customer Tailored!

We can tailor the included topics, tech level, and duration of this course right to your team's technical requirements and needs

Section 1: 5G NR Technology Review

# Course Program Outline

## Module 1: 5G New Radio (NR) Physical Layer Preview

- 5G Air interface overview
- 5G NR FR1 and FR2 bands
- Scalable numerology
- NR frame structure
- FDD – TDD modes
- NR signals and channels review
- 5G NR Radio Link supervision and unsynchronization
- Stand-Alone (SA) architecture

## Module 2: 5G New Radio (NR) Layer 2 Preview

- 5G NR RACH channel
- 5G NR RACH Preambles properties
- 5G NR MAC layer procedures and timers
- 5G NR RLC procedures
- 5G NR RLC Radio Link Failure analysis
- 5G NR RRC signaling messages and timers
- 5G SA Service: eMBB
- Excel file calculator including protocol layer parameters and timers

## Module 3: MIMO & mMIMO Technology overview

- LTE to 5G MIMO review
- 3GPP Massive MIMO standardization
- Active Antenna Systems; Active Antenna Units
- Beam-forming principles
- Massive MIMO panels and EIRP
- Massive MIMO beamforming gain: Practical approach



Section 2: Introduction to Satellite Communications

## Course Program Outline

### Module 4: Satellite Communication Principles

- Satellite Frequency Spectrum and Propagation
- Satellite Orbits: LEO, MEO, GEO
- Satellite Limitations: Propagation Delay
- Large Earth Stations and VSATs
- Satellite Orbit and distance to Earth Station

### Module 5: 5G over Satellite Architectures

- 3GPP standards: 3GPP RAN1, “3GPP TR 38.811
- H2020 5GPPP project “SaT5G”: Satellite and Terrestrial Network for 5G
- 5G NR support for Non Terrestrial Networks
- 5GC virtualization review
- Transparent satellite-based NG-RAN architecture
- Regenerative satellite-based NG-RAN architectures
- 5G fixed backhaul
- Satellite backhaul to individual cell towers
- 5G moving platform backhaul

### Module 6: 5G LEO sat-cubes

- The cube satellites: perspective for LEO approach
- LEO satellite for 5G
- Doppler shift and Inter-Carrier Interference (ICI)
- Angle of arrival and active period
- LEO satellite handover



Section 3: 5G RAN NR Design over Satellite

# Course Program Outline

## Module 7: 5G over Satellite Channel Modeling

- What is a Satellite Channel model ?– general principles
- Non-Line of Sight and Rayleigh modeling
- LoS and Rice modeling
- 5G NR mMIMO over satellite
- Satellite modeling : Macro sector with multiple footprints
- Doppler effects and channel models
- Case Study: 5G over Satellite channel model BLER vs. SINR
- Exercise: Channel model calculations using Excel calculator

## Module 8: 5G over Satellite Link Budget analysis

- Satellite Signal Propagation
- Atmosphere effects in signal propagation
- Mathematical approach for atmosphere scattering margin
- GEO Link Power Budget: Path Loss and EIRP
- GEO DL Cascaded Power amplifiers
- GEO UL UE power requirements
- GEO Footprints: Global, Regional and Narrow Spot Beams

*See next box*

## Module 8: 5G over Satellite Link Budget analysis

*Cont'd from previous box*

- LEO Link Power Budget: Path Loss and EIRP
- LEO DL Cascaded Power amplifiers
- LEO UL UE power requirements
- LEO Footprints: Global, Regional and Narrow Spot Beams
- FR2 Pathloss models for mmW (24-30 GHz, 30-40 GHz, 50-60 GHz)
- Case Study: 5G over Satellite Link budget analysis
- Exercise: Link Budget calculations using Excel calculator



Section 3: 5G RAN NR Design over Satellite

# Course Program Outline

## Module 9: 5G over Satellite Coverage analysis

- Physical layer signals and received requirements
- Physical layer channels and received level requirements
- MIB and SIB1 receiving requirements
- SSB beam sweeping and delay approach
- Beam management in 5G over satellite
- LEO footprint coverage and delay analysis
- Case Study: 5G over Satellite Coverage analysis
- Exercise: Coverage calculations using Excel calculator

## Module 10: 5G over Satellite Capacity planning

- GEO MAC layer RACH procedure and preamble requirements
- GEO RAR response and link requirements
- LEO MAC layer RACH procedure and preamble requirements
- LEO RAR response and link requirements
- MAC layer parameters consideration
- MAC timers consideration and configuration
- RLC protocol buffers and parameter consideration
- RLC timers and procedures
- PDCP protocol buffers and parameter consideration

*See next box*

## Module 10: 5G over Satellite Capacity planning

*Cont'd from previous box*

- PDCP timers and procedures
- RRC protocol parameter consideration
- RRC timers and procedures for 5G over Satellites
- GEO satellite capacity (#users) estimation
- GEO satellite throughput estimation
- LEO satellite capacity (#users) estimation
- LEO satellite throughput estimation
- Case Study: 5G over Satellite capacity analysis
- Exercise: Throughput estimation using Excel calculator

