MCNS
Mobile | Cloud | Network Services

MCNS Training Program

MW design for mobile networks

MW design for mobile networks

MW design for mobile networks deals with the Microwave (MW) Links planning for both mobile network backhaul and fronthaul, including the long-haul as well as the short-haul design

COURSE REVIEW

This 4G(LTE)/5G MW training course is designed for engineers with knowledge of MW technology and MW Link Communications who desire to acquire greater knowledge in **MW link applications** in the areas of **Mobile fronthaul and backhaul network**. It offers basic understanding of **MW link design**, fully analyzing the atmospheric and terrain propagation conditions and effects up to the basic MW link budget design.

Emphasis is given to the MW design for mobile network deployment opportunities, challenges, and risks that's needed to exploit and deploy the **4G(LTE)/ 5G fronthaul over MW** from the throughput, Quality of Service and capacity perspective. **The course is supported by proper excel dimensioning (calculator) files for practical exercises and case studies**.

AIMED AT

MW design for mobile networks is mainly aimed at a technical audience. It is suitable for **technical professionals**, **RAN operators**, **RF and MW engineers**, **Radio planning engineers**, **RAN optimization engineers**, **defense sector** who currently are or will be involved in 4G(LTE)/5G fronthaul and backhaul over MW link deployments. Moreover it is useful **for Broadcasting and Transmission network companies** wishing to move towards more flexible 4G(LTE)/5G deployments over MW transmission links.

Prerequisites: Those wishing to take this course should have a good understanding of **Mobile and 4G(LTE)/5G technology** as well as **Microwave (MW) link communication** basic principles.

MW design for mobile networks

MW design for mobile networks deals with the Microwave (MW) Links planning for both mobile network backhaul and fronthaul, including the long-haul as well as the short-haul design

Course Benefits for individuals (Professionals)

- Understanding 4G(LTE)/5G deployment over MW requirements
- Explore **4G(LTE)/5G fronthaul and backhaul over MW coverage and capacity** principles
- Learn about MW transmission networks and its link performance.
- Introduce engineers into the fundamentals **of MW link communications** with reference to MW link budget and throughput.
- Explore the **MW transmission** characteristics and atmospheric propagation effects.
- Practice on 4G(LTE)/5G network over MW link capacity and coverage planning tools (**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 **Mobile network backhaul and fronthaul planning over MW**.
- **Keep ahead of competitors** in offering new user cases and perspectives for 4G(LTE)/5G over MW link scenarios.
- Learn how to design **MW transmission networks for Mobile technology.**
- Identify new revenue streams that can be enabled with MW transmission networks for 4G(LTE)/5G.
- 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: Microwave (MW) Link basics

Course Program Outline

Module 1: Microwave Transmission Basics

- Radio Frequency (RF) propagation
- MW (E) and (H) fields
- Sky wave, ground wave and sea level propagation
- Line-of-Sight (LOS) and non-Line-of-Sight (non-LOS) propagation
- Free space path loss models

Module 2: L Microwave (MW) propagation

- Ground Reflection
- Sky Reflection
- Radio Refraction
- Ground Diffraction
- Atmospheric Scattering
- Earth's curvature and shadow
- Fresnel zones
- Absorption in terrestrial and sea environments

Section 1: Microwave (MW) Link basics

Course Program Outline

Module 3: ITU-R MW Propagation models

- Propagation over smooth earth
- Propagation over irregular terrain
- Propagation over rough and smooth sea level
- Diffraction over irregular terrain
- Reflection over smooth terrain and building walls
- Reflection over smooth sea surface
- Scattering over rough sea level
- Case study I: MW short-haul and long-haul ground propagation characteristics
- Case study II: MW short-haul and long-haul land-to-sea propagation characteristics

Module 4: MW atmospheric effects

- Refraction and variations in radio refractivity (N factor)
- Snell's law and the effective earth radius (K factor)
- Rain attenuation
- Specific rain rate and effective path length
- ITU rain attenuation model
- Cloud and fog attenuation
- Other atmospheric attenuation

Section 2: Microwave (MW) Link Planning

Course Program Outline

Module 5: Microwave (MW) Antenna Basics

- Isotropic and dipole radiators
- Antenna gain and gain references
- Estimating antenna gain
- Effective Isotropic Radiated Power (EiRP)
- Antenna Reflector techniques, array techniques
- Families of antennas used in wireless: Architecture and characteristics
- Implications of propagation driving antenna selection
- Multipath scattering in fixed and mobile clutter environment
- Beamwidths and tilt considerations for MW antennas
- Radiation patterns
- Antenna gains, patterns, and selection principles
- Exercise with excel calculators for antenna Gain estimation

Module 6: Microwave (MW) Link Budget

- Link budget overview
- Line-of-sight (LOS) path loss models
- Fresnel zone
- Path loss and free space path loss
- Antenna gain and frequency considerations
- Atmospheric, weather, and rain attenuation
- Terrain factors
- Multipath loss
- Rician and Raleigh fading considerations
- Transmission line loss
- Exercise: Typical MW link budget calculation

Section 3: Microwave (MW) Link Performance

Course Program Outline

Module 7: Microwave (MW) Link Channel Performance

- Multipath fading
- Rician, Raleigh and Nakagami fading
- Threshold crossing rate and average fade duration
- Delay spread
- Scatter function, WSSUS model and SCRM model
- Doppler shift effects
- Channel coherence time and coherence bandwidth
- Multipath fading margin
- Channel impairments

See next box

Module 7: Microwave (MW) Link Channel Performance

forw'd from previous box

- Forward Error Correction (FEC)
- Definition of coding types and coding gain
- Types of block codes with examples: CRC and Hamming codes
- Space-time and space-frequency block coding
- Convolutional coding and Viterbi decoding, with example
- Interleaving and turbo codes
- FEC coding gains and margins
- Interleaving gain margin
- Channel estimation and equalization

See next box

Module 7: Microwave (MW) Link Channel Performance

forw'd from previous box

- Linear versus non-linear equalization
- Transversal filter
- Zero-forcing equalization versus minimum mean-square error
- Decision feedback equalization and training equalizer
- Equalization gain margin
- Antennas Diversity
- Diversity types: Space, frequency, angle, polarization, hybrid
- Diversity combining and improvements over non-diversity systems
- Power Control
- Practical exercises using excel calculator

Section 3: Microwave (MW) Link Performance

Course Program Outline

Module 8: Microwave (MW) Link Quality of Service

- ITU standards and recommendations
- Real MW equipment parameters and characteristics
- Channel Capacity
- IP transmission
- Throughput estimation
- Availability and error rate objectives
- Measurements of bit error rate, eye patterns, and jitter
- Practical exercise using Excel

Module 9: Microwave (MW) Link Interference

- Interference analysis for co-channel and adjacent-channel
- Carrier-to-Interference (C/I) ratio
- Threshold-to-interference (T/I) ratio
- Manual and computer-aided design for intra-system interference
- Manual and computer-aided design for inter-system interference
- Frequency planning
- Case study: Detailed analysis of a terrestrial RFI case

Section 4 : Mobile Network Microwave (MW) Link Design

Course Program Outline

Module 10: Mobile Network Overview

- LTE architecture
- 5G NR NSA and SA architectures
- 5G EPC architecture
- CUPS split
- 5GC architecture and slicing
- 5GS implementations
- S1 & X2 interface
- NG & Xn interface

Module 11: 5G RAN Network overview

- 5G gNodeB interfaces
- 5G NR Air interface
- Active Antenna Units (AAU)
- CU_DU split architectures
- F1 & E1 interfaces
- F1 & E1 protocols & messages
- 5G NR Lower Layer split
- 5G NR Higher Layer split
- 5G Virtualized RAN (vRAN)
- CPRI & eCPRI

Module 12: 5G RAN Network Design over MW

- 5G Service: eMBB
- 5G over MW BLER vs. SINR
- E1 & F1 over MW link
- eCPRI & CPRI over MW link
- S1 & X2 interface over MW
- NG & Xn interface over MW
- Case Study: Mobile Network fronthaul over MW capacity analysis
- Throughput estimation using Excel calculator