Microwave Design for Mobile Networks – 3 days

CONTENTS

This training course is designed for engineers with knowledge of Microwave (MW) technology and Microwave (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 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.

TARGET AUDIENCE

This course 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 5G fronthaul and backhaul over MW link deployments. Moreover, it is useful for Broadcasting and Transmission network companies wishing to move towards more flexible 5G deployments over MW transmission links.

PREREQUISITES

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

COURSE OBJECTIVES

- Understanding 5G deployment over MW requirements.
- Explore 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 5G network over MW link capacity and coverage planning tools (i.e. excel calculator 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 5G over MW link scenarios.
- Learn how to design MW transmission networks for Mobile (5G) technology.
- Identify new revenue streams that can be enabled with MW transmission networks for 5G.
- Prepare for future network expansions and quality performance optimization.

Customization: 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

Microwave (MW) 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
- Ground Reflection

- Sky Reflection
- Radio Refraction
- Ground Diffraction
- Atmospheric Scattering
- Earth's curvature and shadow
- Fresnel zones
- Absorption in terrestrial environments
- X-Pol conditions and dependency
- ITU-R MW Propagation models

Microwave (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

Microwave (MW) Antenna Basics

- Isotropic and dipole radiators
- Dish antennas and its characteristics
- Estimating antenna gain and Effective Isotropic Radiated Power (EiRP)
- Beam-widths and tilt considerations for MW antennas
- Radiation patterns and sidelobes
- Antenna selection principles
- **Exercise with excel calculators for antenna Gain estimation**

Microwave (MW) Link Budget Analysis

- MW Indoor Unit (IDU) characteristics – HW example
- MW Outdoor Unit (ODU) characteristics – HW example
- ODU Transmitting Power – HW example
- IDU receiving sensitivity – HW example
- Feeder and jumper losses
- Link budget overview
- Line-of-sight (LOS) path loss models
- Fresnel zone
- Path loss and free space path loss
- Terrain factors - Multipath loss
- Transmission line loss
- **Exercise: Typical MW link budget calculation**

Microwave (MW) Link Design

- MW bands and sub-bands selection
- IDU feature characteristics – HW example
- MW IDU Capacity expansion – HW example
- Channel Capacity and IP transmission
- Throughput estimation vs. frequency and bands
- Adaptive Modulation and Coding (AMC)
- Link Aggregation
- Adaptive Transmit Power Control (ATPC)
- Antennas Diversity
- Diversity types: Space, frequency, angle, polarization, hybrid

- Diversity combining and improvements over non-diversity systems
- **Exercise: Typical MW Capacity calculation**

Section 3: Microwave (MW) Link Performance

Microwave (MW) Link QoS & Performance

- ITU standards and recommendations
- Multipath (Rician, Raleigh and Nakagami) fading
- Threshold crossing rate and average fade duration
- Delay spread and Scatter function
- Channel coherence time and coherence bandwidth
- Multipath fading margin
- Forward Error Correction (FEC)
- Channel estimation and equalization in IDU
- Equalization gain margin
- Availability and error rate objectives
- Measurements of bit error rate, eye patterns, and jitter

Microwave (MW) Link Interference

- Interference analysis for co-channel and adjacent-channel
- Carrier-to-Interference (C/I) ratio
- Threshold-to-interference (T/I) ratio
- Design for intra-system interference
- Design for inter-system interference
- Frequency planning
- **Case study: Detailed analysis of a terrestrial MW Network**

Section 4: Mobile Network MW Transport Network Design

Mobile Network Overview

- LTE architecture
- 5G NR NSA and SA architectures
- 5G EPC architecture
- 5GC architecture and slicing
- S1 & X2 interface
- NG & Xn interface
- 4G/5G Transport MW Network Design principles.
- **Case study using Practical exercise on Excel**