BLACKBIRD FOR TRAINING

Microwave Backhaul Link Design & Network Performance Engineering

14 – 18 November 2027
Istanbul (Turkey)

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Ref: 3255614_205904 **Date:** 14 – 18 November 2027 **Location:** Istanbul (Turkey) **Fees:** 4900 GBP

Introduction

Microwave backhaul is a critical component of modern mobile networks, delivering high-capacity and low-latency transport for LTE and 5G NR deployments. As operators move toward network densification and higher spectrum utilization, precise microwave link engineering becomes essential to maintain reliability, availability, and performance.

This intensive one-week program provides comprehensive coverage of microwave point-to-point P2P link design, complete link budget methodologies, rain fade analysis, frequency planning, and advanced network performance engineering. The course also integrates 5G NR coverage planning principles, 3D beamforming concepts, Massive MIMO techniques, and capacity dimensioning strategies to ensure full alignment between the radio access network and the backhaul transport layer. Participants will gain practical engineering knowledge to design resilient, high-performance microwave networks in dense and high-demand environments.

Course Objectives

By the end of this program, participants will be able to.

- Design microwave P2P links using complete link budget calculations, including EIRP, receiver sensitivity, and fade margin.
- Analyze propagation mechanisms such as free space path loss, rain attenuation, and multipath fading.
- Evaluate link availability objectives from 99.99% to 99.999% using ITU-R models, including ITU-R P.530 and ITU-R P.838.
- Apply Fresnel zone clearance and path profiling principles.
- Perform frequency planning and mitigate co-channel, adjacent-channel, and cross-polarization interference.
- Plan 5G NR coverage across Sub-6 GHz and mmWave environments.
- Implement 3D beamforming and massive MIMO concepts to enhance spectral efficiency.
- Execute capacity planning and backhaul dimensioning for dense 5G NR networks.
- Interpret and optimize latency, jitter, QoS parameters, and end-to-end network performance KPIs.



Course Outlines

Day 1: Microwave Fundamentals and Propagation Engineering

- Microwave spectrum bands and regulatory considerations.
- Point-to-point microwave system architecture.
- Free space path loss and propagation mechanisms.
- Fresnel zone clearance and path profiling principles.
- Overview of ITU-R propagation recommendations.

Day 2: P2P Link Budget and Rain Fade Analysis

- Complete link budget structure including EIRP, receiver sensitivity, and fade margin.
- Adaptive modulation and throughput trade-offs.
- Rain attenuation modeling using ITU-R P.530 and ITU-R P.838.
- Availability objectives from 99.99% to 99.999%.
- Fade margin dimensioning and reliability planning.

Day 3: Frequency Planning and Interference Management

- Frequency band selection criteria.
- Co-channel and adjacent-channel interference mechanisms.
- Cross-polarization interference mitigation strategies.
- Frequency reuse and coordination planning.
- Multi-hop backhaul network design.

Day 4: 5G NR Coverage Planning and 3D Beamforming

- 5G NR architecture and transport requirements.
- Propagation environments for sub-6 GHz and mmWave.
- Coverage planning methodology.
- 3D beamforming principles.
- Massive MIMO and spectral efficiency enhancement.

Day 5: Capacity Dimensioning and Network Performance Engineering

- Traffic modeling and throughput estimation.
- Capacity planning for dense urban deployments.
- Backhaul dimensioning for 5G NR networks.
- Latency, jitter, and QoS considerations.
- End-to-end performance KPIs and optimization strategies.



Why Attend This Course? Wins & Losses!

- Master advanced microwave backhaul link design techniques.
- Improve link availability and reliability through precise rain fade analysis and fade margin planning.
- Enhance 5G NR network performance through accurate coverage planning and capacity dimensioning.
- Reduce interference through structured frequency planning and coordination strategies.
- Optimize network performance KPIs, including latency, jitter, and throughput.
- Strengthen alignment between backhaul engineering and 5G NR deployment objectives.

Conclusion

In today's high-capacity 5G NR era, microwave backhaul link design and network performance engineering are no longer optional technical skills but strategic capabilities that define network success. This program equips you with the expertise to engineer highly available, interference-resilient, and performance-optimized microwave networks aligned with modern 5G architecture requirements.

By mastering link budget design, rain fade analysis, frequency planning, 3D beamforming, Massive MIMO, and capacity dimensioning, you position yourself at the forefront of next-generation telecom engineering. This is your opportunity to transform complex microwave and 5G challenges into measurable network excellence and competitive advantage.

