Training Course on Satellite Communication Technologies

Professional Development Training Course Outline

Category	Engineering	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

Introduction

This comprehensive training course provides a deep dive into Satellite Communication Technologies, exploring the fundamental principles, system architectures, and advanced techniques that underpin global connectivity. Participants will gain a robust understanding of orbital mechanics, satellite link design, modulation and coding schemes, and the various satellite system segments (space, ground, and user). Training Course on Satellite Communication Technologies emphasizes the intricate challenges of signal propagation in space, earth station design, and multiple access techniques, equipping engineers and technicians with the essential knowledge to design, analyze, and operate satellite-based communication systems across diverse applications, from broadcasting and broadband internet to remote sensing and navigation.

In an era of increasing demand for ubiquitous connectivity, IoT backhaul, 5G/6G integration, and disaster resilience, the role of satellite communication is more critical than ever. This course delves into trending topics such as Non-Terrestrial Networks (NTN), LEO/MEO satellite constellations, High Throughput Satellites (HTS), satellite-IoT (SatIoT), cybersecurity for space assets, and the future of inter-satellite links. Through a blend of theoretical foundations, practical link budget calculations, simulations, and real-world case studies, attendees will develop invaluable expertise in planning, deploying, and managing cutting-edge satellite communication solutions that bridge geographical divides and enhance global communication infrastructure.

Programme Curriculum

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Course Objectives

1. Understand the fundamental principles of satellite communication and its evolution.
2. Analyze various satellite orbits (GEO, MEO, LEO) and their impact on system design.
3. Perform comprehensive satellite link budget calculations for forward and return links.
4. Comprehend different modulation and coding schemes optimized for satellite channels.
5. Design and select appropriate multiple access techniques (FDMA, TDMA, CDMA, SDMA) for satellite networks.
6. Understand the architecture and components of Earth Stations for various applications.
7. Analyze signal propagation characteristics in the space environment, including atmospheric effects.
8. Explore the design and challenges of High Throughput Satellites (HTS) and their applications.
9. Investigate Non-Terrestrial Networks (NTN) and their integration with terrestrial 5G/6G.
10. Understand the principles of satellite-IoT (SatIoT) for global M2M connectivity.
11. Evaluate cybersecurity threats and mitigation strategies for satellite communication systems.
12. Discuss emerging technologies such as inter-satellite links and optical satellite communications.
13. Contribute to the planning, deployment, and optimization of modern satellite communication systems and services.

Organizational Benefits

1. Enhanced Global Connectivity: Extending reach to remote and underserved areas.
2. Improved Network Resilience: Providing backup and redundancy for terrestrial networks.

3. Support for Critical Applications: Enabling secure and reliable communications for defense, disaster relief.
4. Optimized Bandwidth Utilization: Efficient use of satellite resources for cost savings.
5. Faster Deployment of Services: Rapid setup of communication links in challenging environments.
6. Development of New Satellite-Enabled Products: Innovating solutions for IoT, autonomous systems.
7. Competitive Advantage: Leading in the adoption of cutting-edge satellite technologies.
8. Reduced Operational Costs: Efficient management and troubleshooting of satellite systems.
9. Skilled Workforce: Empowered employees proficient in satellite communication design and operation.
10. Strategic Infrastructure Planning: Informed decisions on integrating satellite solutions into overall network architecture.

Target Participants

- Satellite Communication Engineers
- Telecommunication Engineers
- Network Architects and Planners
- Ground Segment Engineers
- Space Systems Engineers
- R&D Engineers in Satellite Technology
- IoT Solution Architects
- Defense and Aerospace Professionals
- Broadcast Engineers
- Government and Regulatory Professionals involved in space communication

Course Outline

Module 1: Introduction to Satellite Communication Systems

- **History and Evolution of Satellites:** From Sputnik to modern constellations.
- **Advantages and Disadvantages of Satellite Communication:** Global coverage, cost, latency.
- **Satellite System Segments:** Space Segment, Ground Segment, User Segment.
- **Types of Satellite Services:** Broadcasting, broadband, mobile, navigation, remote sensing.
- **Case Study:** Analyzing the role of satellite communication in providing internet access to remote communities.

Module 2: Satellite Orbits and Constellations

- **Geostationary Earth Orbit (GEO):** Characteristics, advantages, and limitations.
- **Medium Earth Orbit (MEO):** Properties, latency, and constellation design.
- **Low Earth Orbit (LEO):** Key features, global coverage, large constellations (Starlink, OneWeb).
- **Orbital Mechanics Basics:** Kepler's Laws, orbital parameters.

- **Case Study:** Comparing the design considerations and service capabilities of a GEO satellite vs. a LEO constellation for broadband internet.

Module 3: Satellite Link Design Fundamentals

- **The Satellite Link Budget:** Calculating signal strength at receiver.
- **Key Parameters:** Equivalent Isotropically Radiated Power (EIRP), Gain-to-Noise Temperature Ratio (G/T).
- **Free Space Path Loss (FSPL):** Calculation and impact.
- **Noise and Interference:** Thermal noise, inter-satellite interference.
- **Case Study:** Performing a basic forward link budget calculation for a C-band VSAT system.

Module 4: Signal Propagation in Satellite Links

- **Atmospheric Effects:** Rain attenuation, atmospheric absorption (gases), tropospheric scintillation.
- **Fading and Multipath in Satellite Channels:** Causes and mitigation.
- **Polarization and Cross-Polarization Interference:** Dual polarization techniques.
- **Ionospheric Effects:** Faraday rotation, scintillation.
- **Case Study:** Quantifying rain fade for a Ku-band satellite link in a tropical region.

Module 5: Modulation and Coding for Satellite Communications

- **Digital Modulation Schemes:** BPSK, QPSK, 8PSK, QAM (16-QAM, 32-APSK for DVB-S2/S2X).
- **Error Control Coding:** Block codes, Convolutional codes, Turbo codes, LDPC codes.
- **Concatenated Codes:** Combining inner and outer codes.
- **Adaptive Coding and Modulation (ACM):** Optimizing for channel conditions.
- **Case Study:** Comparing the spectral efficiency and power efficiency of QPSK vs. 16-APSK for a satellite video broadcast.

Module 6: Multiple Access Techniques

- **Frequency Division Multiple Access (FDMA):** Single Channel Per Carrier (SCPC), Multiple Channel Per Carrier (MCPC).
- **Time Division Multiple Access (TDMA):** Burst synchronization, guard times.
- **Code Division Multiple Access (CDMA):** Spread spectrum, PN sequences.
- **Space Division Multiple Access (SDMA):** Spot beams, multibeam antennas.
- **Case Study:** Designing a multiple access scheme for a fleet of IoT devices communicating via satellite.

Module 7: Earth Station Technology

- **Antenna Types:** Parabolic reflectors, phased arrays, flat panel antennas.
- **High Power Amplifiers (HPAs):** Klystrons, TWTAs, SSPAs.
- **Low Noise Amplifiers (LNAs):** Maximizing receiver sensitivity.
- **Frequency Converters:** Up-converters, Down-converters.
- **Case Study:** Designing an Earth station antenna system for a satellite broadband gateway.

Module 8: Satellite Transponders and Payloads

- **Transponder Architecture:** Input/Output filters, converters, amplifiers.
- **Bandwidth and Power Allocation:** Efficient use of transponder resources.
- **Multi-Beam Antennas and Flexible Payloads:** Dynamic resource allocation.

- **Digital On-Board Processing (OBP):** Regenerative vs. bent-pipe transponders.
- **Case Study:** Analyzing the resource allocation for a multi-beam satellite serving different geographic regions.

Module 9: High Throughput Satellites (HTS) and VHTS

- **HTS Concept and Architecture:** High-capacity spot beams, frequency reuse.
- **HTS Advantages:** Increased throughput, lower cost per bit.
- **Gateway Design for HTS:** Complex ground segment.
- **VHTS (Very High Throughput Satellites):** Next generation HTS with even higher capacity.
- **Case Study:** Exploring the design and operational challenges of an HTS system for global broadband access.

Module 10: Satellite-IoT (SatIoT) and M2M Communications

- **Motivation for SatIoT:** Global coverage for remote assets.
- **LPWAN Technologies for SatIoT:** LoRaWAN, NB-IoT over satellite.
- **SatIoT System Architectures:** Direct-to-satellite, hybrid terrestrial-satellite.
- **Use Cases for SatIoT:** Asset tracking, environmental monitoring, smart agriculture.
- **Case Study:** Designing a SatIoT solution for tracking shipping containers across oceans.

Module 11: Non-Terrestrial Networks (NTN) and 5G/6G Integration

- **NTN Concept:** Extending 5G/6G services via satellite, HAPS, drones.
- **3GPP Standardization for NTN:** Release 17 and beyond.
- **Challenges of NTN Integration:** Handover, mobility, QoS, latency.
- **Use Cases for NTN:** Rural connectivity, disaster recovery, global mobility.
- **Case Study:** Analyzing the technical challenges of integrating a LEO satellite constellation into a 5G core network.

Module 12: Cybersecurity in Satellite Communications

- **Threat Vectors in Satcom:** Jamming, spoofing, cyber-attacks on ground and space segments.
- **Satellite Network Security Principles:** Encryption, authentication, access control.
- **Resilience and Redundancy:** Protecting against single points of failure.
- **Regulatory Aspects of Satcom Security:** International guidelines.
- **Case Study:** Proposing mitigation strategies for a jamming attack on a satellite ground station.

Module 13: Satellite Navigation Systems (GNSS) and Augmentation

- **Global Navigation Satellite Systems (GNSS):** GPS, GLONASS, Galileo, BeiDou.
- **Principles of Satellite Positioning:** Trilateration, time measurements.
- **GNSS Augmentation Systems:** SBAS (WAAS, EGNOS), GBAS.
- **Applications of GNSS:** Navigation, timing, surveying.
- **Case Study:** Analyzing the factors affecting the accuracy of a GPS receiver in different environments.

Module 14: Emerging Satellite Technologies and Trends

- **Inter-Satellite Links (ISL):** Communication between satellites (RF, Optical).
- **Optical Satellite Communications (Lasercom):** High-speed inter-satellite and space-to-ground links.

- **Flexible Payloads and Software-Defined Satellites:** Reconfigurable in orbit.
- **On-Board Processing (OBP) Advancements:**

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

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