5GWORLD PRO RECORDED TRAINING CATALOGUE

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COURSE 1: 5G TRAINING FOR EVERYONE

The most comprehensive introductory 5G training, covering end-to-end technical concepts including 5G New Radio, core architecture, IoT technologies, deployment status, and use cases. Designed to build a strong foundational understanding of 5G for both technical and non-technical professionals.

Duration	6 hours (Recorded)
Audience	CTOs, Network Managers, Consultants, Graduates

COURSE CONTENT

5G Concepts and Use Cases

- What is 5G?
- 5G promises and value proposition
- 5G use case families: eMBB, URLLC, mMTC
- 3GPP standardization landscape
- Services and requirements for vertical sectors

5G New Radio

- Spectrum fundamentals
- 5G frequency bands
- 5G New Radio overview
- New radio technologies
- Massive MIMO
- 5G Beamforming

5G End-to-End Architecture

- 5G radio architecture
- Standalone vs Non-Standalone architectures
- 5G deployment options
- 4G to 5G migration strategies
- 5G Core architecture
- Network Slicing

Internet of Things

- Definition of IoT LPWA networks

- IoT technologies: NB-IoT, LTE-M, and LoRa
- Types of IoT devices
- IoT use cases
- Evolution of IoT technologies to 5G

5G Deployment Updates

- 5G market updates
- Operator spectrum strategies (C-band and mmWave)
- 5G device ecosystem update
- 5G spectrum auction trends

5G EMF International Limits and Thresholds

- 5G EMF update (Electromagnetic Fields)
- EMF features proposed by vendors for impact control
- EMF simulation

COURSE 2: 5G NR ADVANCED TRAINING

An in-depth technical course on 5G New Radio (NR) as defined by 3GPP standards. Covers end-to-end 5G system architecture, air interface protocol structure, physical layer design, numerologies, beam management, and 3GPP Release 16/17/18 features. Includes systematic comparisons with LTE.

Duration	8 hours (Recorded)
Audience	Telecom Engineers, Technical Managers, Consultants

COURSE CONTENT

5G Concepts and Use Cases

- What is 5G?
- 5G promises and value proposition
- 5G use case families: eMBB, URLLC, mMTC
- 3GPP standardization landscape
- Services and requirements for vertical sectors

5G New Radio

- Spectrum fundamentals
- 5G frequency bands
- 5G New Radio overview
- New radio technologies
- Massive MIMO
- 5G Beamforming

5G End-to-End Architecture

- 5G radio architecture
- Standalone vs Non-Standalone architectures
- 5G deployment options
- 4G to 5G migration strategies
- 5G Core architecture
- Network Slicing

5G Design and Key Radio Functionalities

- 5G NR Physical Layer

- Numerology and frame structure
- Physical channel design and structures
- Bandwidth Part introduction
- QoS architecture in 5G NR

5G Physical Layer and Design

- 4G vs 5G channel comparison
- 5G DL channel design and comparison with 4G
- PDCCH CORESET concept
- 5G UL channels and comparison with 4G
- 5G Physical Layer Reference Signals

Beamforming and Initial Access

- 5G NR Initial Access
- SS Burst principle
- Beam Management in NR (sweeping, measurement)
- Initial beam establishment
- Beam Management in SA and NSA

3GPP Features: Release 16, 17, and 18

- 3GPP release planning and timeline
- Key subjects in Release 16 and 17
- Focus on Release 18 features
- Industrial IoT features
- Verticals features
- Network deployment and automation features
- Device enhancements

Internet of Things

- Definition of IoT LPWA networks
- IoT technologies: NB-IoT, LTE-M, and LoRa
- Types of IoT devices
- IoT use cases
- Evolution of IoT technologies to 5G

COURSE 3: 5G NR RF PLANNING

Technical deep dive into radio network planning principles for 5G deployments in mid-band and mmWave spectrum. Covers RF design, link budget calculations, propagation models, capacity dimensioning, and planning tool features with practical examples.

Duration	6 hours (Recorded)
Audience	RF Engineers, Technical Consultants, Technical Managers
Prerequisites	5G NR Advanced Training (Course 2) recommended

COURSE CONTENT

5G Link Budget and Propagation Models

- 5G bands and edge throughput benchmarks
- 5G link budget and comparison with 4G
- 5G propagation models

5G Planning Parameters and Process

- Propagation model parameters: 5G vs 4G comparison
- 5G network planning process
- 5G ray tracing model and 3D digital maps
- 4G/5G planning differences: 8T8R vs 64T64R coverage

5G RF Planning (Beamforming, PRACH, PCI, Neighbor)

- 5G Massive MIMO beam planning
- 5G downtilt planning
- 5G PRACH planning
- 5G neighbor cell planning
- 5G PCI planning

5G Capacity Planning and Dimensioning

- 5G capacity and Shannon Law
- 5G NR throughput calculation
- 5G capacity limiting factors
- 5G dimensioning

- 3D Monte Carlo simulation

5G Planning Tools and Practical Features

- 5G NR network parameters in planning tools
- EN-DC use case with planning tools
- 3D beamforming in planning tools
- Dynamic Spectrum Sharing in planning tools

COURSE 4: 5G FOR BUSINESS

A non-technical training covering 5G business models, monetization strategies, co-innovation between operators and verticals, industry use cases, and deployment trends. Designed for decision-makers who need to understand the strategic and commercial dimensions of 5G.

Duration	8 hours (Recorded)
Audience	CTOs, CEOs, Directors, Senior Managers (Operators, Enterprises, Verticals, Regulators)

COURSE CONTENT

5G Concepts and Use Cases

- What is 5G?
- 5G promises and value proposition
- 5G use case families: eMBB, URLLC, mMTC
- 3GPP position with 5G
- Services and requirements for vertical sectors

5G Business Models and Monetization

- 5G segments and categories
- 5G value proposition
- New 5G business models
- How to monetize 5G
- Monetization options for operators

5G Enabling Real-Time Enterprises

- 5G requirements and specifications
- Multi-service connectivity
- 5G applications market potential
- Connected and real-time enterprise with 5G
- 5G use case details
- 5G frequencies for vertical use cases

Co-Innovation Between Verticals

- 5G opportunities
- How co-innovation can be effective
- 5G Automotive Association (5GAA)

- 5G Alliance for Connected Industries and Automation (5G-ACIA)

5G Use Cases by Industry

- Industry 4.0
- Healthcare
- Automotive industry
- Enterprise applications

5G Deployments, Devices, and Health Impact

- 5G market updates
- Operator spectrum strategies (C-band and mmWave)
- 5G device update
- 5G spectrum auction procedures
- 5G EMF update

Mobile Edge Computing (MEC)

- Edge computing as a game changer
- Key drivers for MEC demand
- Business opportunities with MEC
- MEC market dynamics

5G and Satellite Networks

- Types of satellites and NTN
- What is new between satellite and 5G
- Using satellite with smartphones via 5G
- 3GPP progress with 5G, satellite, and NTN

COURSE 5: 5G KPI, OPTIMIZATION & TROUBLESHOOTING

Covers 5G key network performance indicators, counters, practical call flows, real-world optimization issues and solutions, and 5G low-throughput troubleshooting in both NSA and SA modes.

Duration	9 hours (Recorded)
Audience	RF Engineers, Optimization Engineers, Technicians, Technical Managers
Prerequisites	5G NR Advanced Training (Course 2) and 5G NR RF Planning (Course 3) recommended

COURSE CONTENT

Key 5G NR Technologies: FDD vs TDD Comparison

- 5G 3GPP update and 5G bands
- 4G OFDM vs 5G F-OFDM
- Massive MIMO with SU/MU-MIMO
- 5G Beamforming procedures (correlation, weighting, implementation)
- 5G FDD vs 5G TDD comparison

5G KPIs/Counters and Mobility Management

- 5G KPI definition in SA and NSA
- 5G counters with call flow procedures
- 5G NSA mobility management

5G NSA KPI Acceptance

- 5G Attach procedure call flow with traces
- 4G/5G Attach failure use cases and call flows
- 5G mobility call flow in different use cases

5G Practical Feature Applications

- Split Bearer in NSA mode
- 5G DSS with practical deployments and constraints
- 5G logo icon / upper layer indication
- Feature optimization for high-speed mobility (DMRS, RACH, Hyper Cell)
- SRB3 activation in 5G

Real-World 5G Optimization Issues and Solutions

- 5G coverage comparison and optimization in NSA
- Anchor and mobility optimization cases
- SCG failure and NR radio timer optimization
- 5G access common issues
- 5G summary analysis process

5G Low Throughput Troubleshooting (SA/NSA)

- 5G NR throughput calculation
- Factors and prerequisites to reach max 5G throughput
- Number of grants and RB troubleshooting

COURSE 6: 5G OPEN RAN

Technical overview of Open RAN and O-RAN Alliance architecture. Covers RAN types (D-RAN, C-RAN, V-RAN), O-RAN ecosystem, architecture deep dive (SMO, RIC, O-CU, O-DU, O-RU, O-Cloud), split options, challenges, and operator deployment case studies.

Duration	8 hours (Recorded)
Audience	Technical and Non-Technical Engineers with basic 5G knowledge
Prerequisites	5G NR Advanced Training (Course 2) recommended

COURSE CONTENT

Introduction to Open RAN

- What is Open RAN
- Understanding Classical and Distributed RAN (D-RAN)
- Equipment from traditional vendors (BBU and boards)
- Centralized RAN (C-RAN)
- Virtualized RAN (V-RAN)
- Evolution towards Open RAN

Open RAN Groups and Ecosystem

- Open RAN groups and initiatives
- Telecom Infra Project (TIP)
- O-RAN Alliance
- Open RAN players and ecosystem
- Open RAN trials and deployments

Deep Dive into O-RAN Architecture

- RU/CU/DU split
- O-RAN architecture
- Service Management and Orchestration Framework (SMO)
- RAN Intelligent Controller (RIC)
- O-Cloud, O-CU, O-DU, O-RU

O-RAN Split Options

- Different RAN split options (8 options)

- Which split option to consider
- Relevant interfaces in O-RAN architecture

Open RAN Drivers, Challenges, and Use Cases

- Open RAN drivers
- Open RAN challenges
- The 7 benefits of Open RAN
- Use cases: traffic steering, QoS optimization, Massive MIMO optimization

Open RAN Deployment Case Studies

- New telco models
- Cloud service models for telecom
- Operator Open RAN deployment case studies

COURSE 7: 5G CORE AND 5G SLICING

Focused on 5G Core (5GC) network functionalities for 5G Standalone, with a deep dive into 5G Network Slicing. Covers Service-Based Architecture, network functions, slice types, NRF, 5G signaling, and EPC-to-5GC migration scenarios.

Duration	8 hours (Recorded)
Audience	CTOs, Network Managers, Core Engineers, Consultants, Graduates

COURSE CONTENT

Benefits and Design of 5G Core Network

- 3GPP update
- 5G architectures and deployment options
- Core network definition
- Benefits of 5G Core network
- Main principles of 5GC transformation (CUPS, SBA)

5G Service-Based Architecture and Protocols

- 4G Core vs 5G Core
- 5G SBA network function details (SMF, UPF, NRF, AUSF)
- Mapping of 5GC to EPC functions
- Service-based interface protocols (HTTP/2, REST, TLS, X.509)

Network Slicing and Technical Components

- What is Network Slicing (3GPP, NGMN, 5G PPP)
- Benefits of Network Slicing
- Technical components (NSSAI, SST, SD, NSI)
- Types of NSSAI
- Slice selection procedure and call flow

Types of Slicing and End-to-End Features

- 5G slice attributes and evolution
- Pre-slicing, static slice, and dynamic slice
- NFV, SDN, and orchestration
- Slice management lifecycle

- Slicing features in RAN, transport, and core
- QoS comparison: 5G NSA vs 5G SA

5G Slicing Use Cases

- Automotive industry
- Healthcare industry
- Public sector
- Government and emergency services
- Manufacturing industry
- Gaming industry

Focus on 5G NRF

- NRF role and service framework engine
- NF service mechanisms
- AMF journey using NRF (registration, discovery)

5G Signaling in 5G Core

- Introduction to mobile signaling
- Evolution of mobile signaling: 2G/3G/4G/5G
- Main items of 5G signaling

Migration Scenarios: EPC to 5GC

- Moving from 5G NSA to 5G SA
- Interworking between EPC and 5GC
- 4G to 5G migration strategy
- Migration scenarios from 4G Core to 5G Core

COURSE 8: 5G PRIVATE NETWORKS

Deep dive into 5G Private Networks, covering drivers, challenges, deployment models (SNPN, PNI-NPN), MEC integration, and industry use cases including Industry 4.0, smart mines, smart ports, and indoor building solutions.

Duration	8 hours (Recorded)
Audience	CTOs, Network Managers, Enterprise Architects, Consultants, Graduates

COURSE CONTENT

5G Private Network Fundamentals

- Drivers and challenges for 5G Private Networks
- Deployment models and guidelines
- SNPN: Standalone Non-Public Network
- PNI-NPN: Public Network Integrated Non-Public Network

Mobile Edge Computing in 5G Private Networks

- MEC architecture for private networks
- MEC requirements for 5G private network services

Industry Use Cases

- Industry 4.0 and smart manufacturing
- Automated Guided Vehicle (AGV) use cases
- 5G smart mine use cases

Indoor Building Solutions

- Technical indoor building solutions
- Types of DAS and evolution to 5G
- 5G small cells, Wi-Fi, and digital indoor solutions
- 5G DAS planning
- 5G IBS planning for stadiums and mines

COURSE 9: 5G INDOOR RADIO PLANNING

Focused on indoor scenarios for 5G deployment. Covers indoor use cases (stadiums, metro), DAS network design and troubleshooting, 5G indoor distributed site planning, and deployment modes for various indoor scenarios.

Duration	6 hours (Recorded)
Audience	Radio Engineers, Planning Engineers with 5G NG-RAN knowledge
Prerequisites	5G NR RF Planning Training (Course 3) recommended

COURSE CONTENT

5G Indoor Use Cases

- 5G indoor use case: Stadium
- 5G indoor use case: Metro

Troubleshooting of DAS Networks

- Passive Intermodulation (PIM) issues in DAS
- Interference from 5G outdoor to 5G indoor (SSB and SIB1)
- Monitoring your DAS network

COURSE 10: CLOUD, NFV, AND KUBERNETES

Covers virtualization approaches, cloud computing environments, NFV, OpenStack, Docker, Kubernetes, cloud-native concepts, and Software-Defined Networking. Includes practical demos of OpenStack and Kubernetes comparisons.

Duration	6 hours (Recorded)
Audience	Telecom Engineers, IT Architects, Network Managers

COURSE CONTENT

What is Cloud?

- Cloud fundamentals
- Essential cloud characteristics
- Service models (IaaS, PaaS, SaaS)
- Deployment models

Virtualization and Hypervisors

- Virtualization concept and rationale
- Single/multi-tenancy
- Benefits of virtualization
- Virtualization vs cloud
- Hypervisor solutions: Type 1 and Type 2

Containers, Docker, and Kubernetes

- History of virtualization towards containers
- What is a container
- Virtualization vs containers
- Docker and Kubernetes

Cloud Native

- Key cloud-native trends
- Purpose of cloud native
- Customer journey to the cloud
- Microservices vs monolithic applications
- Cloud-native concepts (DevOps, API, multi-cloud)

OpenStack Architecture

- What is OpenStack?
- OpenStack components
- Main OpenStack architecture
- Practical demo of OpenStack

Keystone and Authentication

- Keystone component
- Identity management in OpenStack
- Token generation
- Command line and demo

Launching Instances in OpenStack

- OpenStack server concepts
- Launching instances
- Nova architecture

Evolution and Types of Kubernetes

- Evolution of Kubernetes
- From AWS to Google Kubernetes
- Types of Kubernetes distributions
- VMware Tanzu vs Red Hat OpenShift vs AWS EKS vs GKE

Kubernetes Architecture

- Global architecture and components
- Master node in Kubernetes
- Worker node in Kubernetes
- Pods in Kubernetes

OpenStack vs Kubernetes / NFV

- NFV and ETSI MANO
- ETSI NFV standards
- Official NFV use cases
- VMware and OpenStack in NFV

Software-Defined Networking (SDN)

- What is SDN?
- Why SDN?

COURSE 11: ARTIFICIAL INTELLIGENCE IN TELECOM

Comprehensive AI training for telecom professionals. Covers AI fundamentals, machine learning, deep learning, generative AI (ChatGPT), big data, Python basics, AI frameworks, and practical 4G/5G AI use cases for network management, optimization, and operations.

Duration	8 hours (Recorded)
Audience	All Engineers and Managers (Technical and Non-Technical)

COURSE CONTENT

What is Artificial Intelligence?

- Introduction to AI
- AI classification
- Introduction to machine learning
- AI background and definitions
- AI in telecom

Application Fields of AI

- AI in self-driving cars
- AI in industry

Machine Learning

- What is machine learning
- Supervised learning
- Unsupervised learning
- Semi-supervised learning
- Reinforcement learning

Deep Learning Concepts and Techniques

- What is a neural network?
- Supervised learning with neural networks
- Why deep learning is taking off
- Origins of neural networks
- Self-organizing networks
- Multi-layer perceptron

- Binary classification

Deep Learning Architectures

- CNNs, LSTMs, RNNs, GANs
- RBFNs, DBNs, RBMs
- MLPs, SOMs, Autoencoders

Introduction to Python

- Types and expressions
- Variables and strings
- Tuples
- Lists and dictionaries

Big Data and AI

- Introduction to big data
- Types and characteristics of big data
- Roles of big data

AI Frameworks

- Microsoft CNTK, TensorFlow, PyTorch
- DeepLearning4J, Keras, ONNX
- MXNet, Caffe

Deep Dive into ChatGPT and Applications

- Overview of ChatGPT and its evolution
- Technology behind ChatGPT
- ChatGPT and chatbots
- Language generation, sentiment analysis, text summarization
- ChatGPT in medical diagnosis

AI Adoption in Telecoms

- Telecom complexity requires AI
- AI technology adoption with service providers
- Challenges for successful AI adoption
- Benchmark of AI offerings within telcos

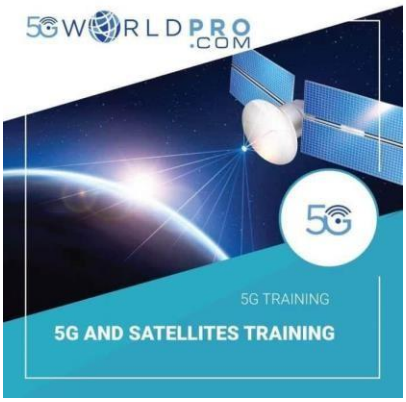
AI for Data-Driven Networks

- Added value of AI in operators
- Why AI in 4G/5G networks?
- What can AI do for networks?
- How to introduce AI in networks
- ETSI-ENI architecture

4G/5G AI Use Cases

- AI for RAN network management
- Fault detection in 4G and 5G RAN
- Customer QoS determination
- AI for network optimization (practical)
- AI for network operations

COURSE 12: 5G AND SATELLITE (NTN)



Covers 5G and satellite communications (NTN): architecture options, 3GPP standardization (Release 15–18), spectrum allocation, commercial constellations, RF propagation models, protocol adaptations, and IoT over NTN.

Duration	8 hours (Recorded)
Audience	Telecom Engineers, Satellite Engineers, Consultants, Managers

COURSE CONTENT

The Need for 5G and Satellite

- Definition of Non-Terrestrial Network (NTN)
- NTN categories
- NTN backhaul and connectivity
- Evolution from NTN to 5G NTN
- 5G satellite use cases and challenges

NTN in 3GPP Standards

- 5G NTN at 3GPP
- 3GPP NTN work: RAN, SA, and Core
- Focus on NTN Release 15 through 18
- NR NTN enhancements for Release 18/19

5G NTN Frequencies and Commercial Market

- Satellite spectrum allocation (L/S/C/Ku/Ka/Q/V bands)
- Co-existence of 5G and NTN bands
- Commercial constellations: Starlink, OneWeb, Kuiper, Telesat
- Benefits and risks of satellite constellations

5G NTN Architecture and Terminology

- 5G NTN system architecture
- Transparent NTN NG-RAN architecture
- Regenerative NTN NG-RAN architecture
- Inter-satellite links (ISL)
- 5G NTN quality of service

- Ephemeris parameters
- Beam footprints and phased arrays

NTN RF Propagation Models

- NTN channel modeling
- Propagation delay and Doppler shift
- Rain attenuation, atmospheric absorption, and scintillation
- Large-scale fading effect
- NTN link budget
- Beamforming and NTN advantages

NTN Protocols and Procedure Updates

- 5G protocol stacks and channels
- NTN NR PHY/MAC-layer challenges
- Protocol stack modifications for 5G NTN
- HARQ solutions for NTN
- UL synchronization in NTN
- Satellite mobility in NTN

5G Internet of Things and NTN

- IoT in 5G
- Use cases of IoT over NTN
- 3GPP work on NTN IoT
- IoT architecture supported by NTN
- NTN IoT challenges

COURSE 13: 5G V2X (VEHICLE-TO-EVERYTHING)

Covers 5G V2X and Intelligent Transport Systems (ITS): use cases (safety, autonomous driving, platooning), NR-V2X architecture, PC5 interface, QoS, network slicing, synchronization, mobility, roaming, and MEC integration for V2X.

Duration	7 hours (Recorded)
Audience	Telecom and Automotive Engineers with 5G knowledge
Prerequisites	Basic 5G knowledge required

COURSE CONTENT

V2X Fundamentals

- V2X high-level goals
- Intelligent Transport Systems
- V2X terminology
- V2X communication standards: DSRC vs C-V2X

ITS Architecture

- Sensors
- LiDAR and RADAR
- ITS stations and layers

3GPP NR-V2X Architecture

- V2X application layer
- Key 5G nodes for V2X
- 5G V2X RSU (Road Side Units)
- Multicast Broadcast Service architecture

V2X Services and Use Cases

- V2X telematics
- Autonomous vehicles
- 3GPP use case groups
- 5GAA use cases

Safety, Convenience, and Autonomous Driving Use Cases

- Cooperative traffic gap
- Interactive VRU crossing
- Automated valet parking
- Obstructed view assist
- Tele-operated driving
- Cooperative maneuvers for emergency situations

Platooning, Traffic Efficiency, and Society

- Vehicle platooning
- Green lights coordination
- Accident report
- Patient transport monitoring

NR-V2X Registration, QoS, and PC5

- 5G registration procedure
- PCF authorization
- 5G PDU session for V2X
- QoS flows
- PC5 configuration and direct communication modes
- NR-PC5 protocols

V2X Network Slicing, Synchronization, and Mobility

- Uu and PC5 QoS
- V2X network slicing
- NR-V2X synchronization
- Xn and N2 handover
- Interworking and roaming
- MEC for V2X

COURSE 14: 5G PRACTICAL OPTIMIZATION (NSA & SA)

Hands-on 5G optimization training covering coverage enhancement, Massive MIMO optimization, DSS impact, practical access issues, anchor optimization, mobility management, and NSA-to-SA migration with real-world case studies.

Duration	9 Hours (Recorded)
Audience	RF Engineers, Optimization Engineers, Technical Managers
Prerequisites	Solid foundation in 5G RAN required

COURSE CONTENT

5G Architecture and SA Deployments

- 3GPP timeline
- Non-Standalone and Standalone
- Which 5G option to choose and when?

5G Coverage Enhancement (NSA and SA)

- 5G coverage checklists
- Enhancing NR DL and UL coverage for C-band
- Practical and theoretical 5G EN-DC coverage vs 4G
- EN-DC combinations depending on UE capability
- Supplementary Uplink and Super Uplink
- 5G Carrier Aggregation and SA impact
- Case study

5G Site Selection Criteria

- Typical 5G network construction modes
- FDD NR: selecting first frequency
- C-band high-value site ranking criteria
- Factors impacting Massive MIMO capacity
- Massive MIMO product comparison
- MetaAAU with 384 antenna elements

5G Massive MIMO Optimization

- Key indicators for NR coverage

- Coverage problem analysis process
- Max transmit power calculation
- DL interference with SSB optimization
- 5G broadcast beam and coverage scenarios
- Massive MIMO downtilt optimization

Common Coverage Problem Analysis

- 5G BF optimization
- Weak coverage optimization
- Overshoot coverage optimization

DSS Practical Impact and Optimization

- Evolution paths towards 5G FDD in B1/B3
- DSS device ecosystem
- 5G DSS impacts and features
- MBSFN option for DSS
- LTE-CRS rate matching impact
- DSS architecture impact

5G NSA Practical Access Issues

- EN-DC strategy and combinations
- Event B1 optimization
- Blind PSCell configuration
- 5G measurement gap

5G Anchor Optimization

- Anchoring optimization
- LTE EN-DC anchoring strategy
- 5G NSA anchoring proposal
- Smart anchor and adaptive anchor solutions

5G Practical Access Issues in SA

- 5G SA call flow
- SA access problem overview
- RRC connection setup issues
- Random access failure
- NG signaling and NAS issues
- PDU session setup failure

5G Mobility Management (NSA and SA)

- Mobility management architecture in 5G
- Mobility in 5G vs 4G comparison
- Practical examples: mobility improvement, DAPS
- Inter-gNodeB handover failure in SA

Moving from 5G NSA to SA

- Migration: NR bands
- Migration: coverage and peak rates
- 5G Core readiness requirements
- N26 interface

COURSE 15: 5G INDUSTRY APPLICATIONS

Overview of 5G industry applications including smart power grids, healthcare, smart cities, live broadcast, security, and business models.

Duration	1.5 hours (Recorded)
Audience	Everyone

COURSE CONTENT

5G Industry Applications

- 5G service transformation
- 5G live broadcast applications
- 5G Smart Power Grid
- 5G Smart Healthcare
- 5G security applications
- 5G Smart City
- 5G business models

COURSE 16: CYBERSECURITY TECHNOLOGIES

Provides a solid understanding of cybersecurity fundamentals, common threats, protection strategies, network security architecture, cryptography, identity and access management (IAM), and security detection and response technologies.

Duration	2 hours (Recorded)
Audience	ICT Engineers, Network Security Professionals

COURSE CONTENT

Cybersecurity Evolution and Basic Concepts

- Cybersecurity history
- What is cybersecurity?
- Software vulnerability
- Security intelligence

Most Common Network Threats

- Brute-force attacks
- DoS and DDoS
- Botnets
- Phishing and social engineering
- Ransomware
- Data breach

Main Means of Protection

- Best practices for individuals and businesses
- IPDRR cybersecurity framework
- Security tools

Network Architecture and Security

- Network protocol model basics
- Firewall isolation and filtering
- VPN and tunneling
- Network traffic identification

Cryptography and PKI

- What is cryptography?
- Cryptographic algorithms and keys
- Symmetric key algorithms
- Digital certificates and PKI
- Cryptographic protocols

Identity and Access Management (IAM)

- Definition of IAM
- Account management
- Authentication factors and selection methods
- Authorization principles and access control

Security Detection and Response

- Basic principles of detection and response
- DoS attack detection
- Security vulnerability and intrusion detection
- Application of detection and response technologies

COURSE 17: 5G FIXED WIRELESS ACCESS (FWA)

Deep dive into 5G FWA covering architecture, CPE management, spectrum challenges, capacity dimensioning, mmWave FWA, monetization strategies, and practical deployment considerations.

Duration	7 hours (Recorded)
Audience	Telecom Engineers and Managers with 5G knowledge
Prerequisites	Basic 5G knowledge required

COURSE CONTENT

Module 1: 5G FWA Introduction

- Indoor and outdoor CPE
- Advantages and disadvantages of FWA
- 5G FWA drivers
- Migration from mobile to FWA
- 5G FWA dimensioning
- Fair usage policy in FWA

Module 2: 5G FWA Market and Spectrum

- 5G FWA market overview
- Monetization strategies
- 5G FWA offers by country
- 5G FWA spectrum
- 4G and 5G coexistence in TDD

Module 3: 5G FWA End-to-End Architecture

- Benefits of 3GPP for FWA
- Key components of FWA
- Indoor and outdoor architecture
- PDU session establishment
- 5G FWA QoS and slicing

Module 4: 5G FWA Capacity and Performance

- Improving CPE performance
- Massive MIMO, beamforming, modulation

- FWA deprioritization feature
- Capacity dimensioning

Module 5: 5G CPE and Device Management

- CPE technical requirements
- Device management
- 5G FWA voice
- Indoor/outdoor DNN configuration
- CPE cell lock

Module 6: 5G FWA mmWave

- mmWave FWA market positioning
- mmWave coverage
- mmWave CPEs
- mmWave FWA trial results

COURSE 18: 5G VoNR TECHNICAL TRAINING

Comprehensive VoNR (Voice over New Radio) training covering voice solution options in NSA/SA, IMS architecture, SIP protocols, voice codecs, registration and signaling procedures, and 5G New Calling services.

Duration	8 hours (Recorded)
Audience	Telecom Engineers, Core Network Professionals
Prerequisites	5G knowledge required

COURSE CONTENT

Module 1: VoNR Deployment Challenges and Architecture

- Evolution to Vo5G
- VoNR drivers and deployment challenges
- VoNR standardization
- VoNR high-level architecture

Module 2: 5G Voice Solutions in NSA and SA

- 5G voice solution options
- CSFB, VoLTE, RAT Fallback, EPS Fallback, VoNR
- Key considerations and recommendations
- VoLTE as prerequisite for SA launch
- VoNR vs EPS Fallback technical comparison

Module 3: IMS Architecture and Protocols

- IMS architecture
- Key IMS requirements for VoNR
- IMS control and user plane protocols
- P-CSCF, I-CSCF, S-CSCF
- VoNR application servers

Module 4: 5G Voice Identifiers, SIP, and Codecs

- IMS identifiers
- SIP protocol

- Diameter base protocol
- 5G voice codecs

Module 5: IMS Registration Procedure

- SA VoNR/EPS Fallback registration
- IMS registration process and messages
- IMS registration call flow
- SIP messages with traces

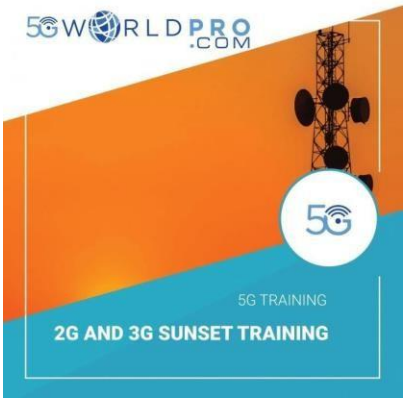
Module 6: VoNR Signaling Procedure

- Basic VoNR procedure
- EPS Fallback signaling procedure and call flows
- VoNR to VoLTE handover procedure
- VoNR signaling procedure and call flows

Module 7: 5G New Calling Service

- 5G New Calling overview
- Evolution of 3GPP standards
- New calling services and features
- New calling technology and nodes
- GSMA evolution

COURSE 19: 2G/3G SUNSET



Comprehensive training on 2G/3G network sunset: prerequisites, methodologies, business cases, regulatory considerations, successful case studies, and spectrum refarming strategies.

Duration	6 hours (Recorded)
Audience	Telecom Professionals with mobile technology knowledge
Prerequisites	Basic mobile network knowledge required

COURSE CONTENT

Module 1: 2G/3G Sunset Global Situation and Drivers

- Global view of 2G/3G shutdown
- Sunset drivers and challenges
- Country strategies: Germany, UK, Taiwan

Module 2: Best Practices, Opportunities, and Challenges

- 2G/3G sunset best practices
- Regulatory issues
- Opportunities from sunset
- IoT and M2M challenges

Module 3: Key Steps, Methodology, and Solutions

- Dimension evaluation for 2G/3G sunset
- Key steps for smooth sunset
- Sunset solution and methodology
- Risks and mitigation
- Successful case studies

Module 4: Capacity and Optimization Improvement

- Coverage evaluation
- Capacity evaluation
- GSM-UMTS-LTE interoperability
- GSM and UMTS capacity improvement

Module 5: Trends and Dynamics

- Transitioning from 2G/3G to 4G/5G
- Three phases of sunsetting legacy networks
- Service continuity and efficiency
- Managing devices and sunset strategies

COURSE 20: 6G TRAINING FOR EVERYONE

Comprehensive overview of 6G covering standardization, spectrum management, device evolution, air interface innovations, AI-native networks, joint communication and sensing (JCAS), terahertz communication, and sustainable network design.

Duration	6 hours (Recorded)
Audience	Telecom Professionals, Researchers, Strategists

COURSE CONTENT

Module 1: 6G Standardization and Ecosystem

- From 5G Advanced to 6G
- 6G ecosystem and research framework
- 6G 3GPP and ITU timelines
- Challenges for mobile service providers

Module 2: 6G Use Cases and Requirements

- 6G: evolution or revolution?
- 6G driven by value and sustainability
- 6G use cases
- Performance and societal requirements
- Key value indicators

Module 3: 6G Spectrum

- 6G spectrum strategy
- Refarming and new spectrum
- Sub-THz frequency challenges
- Frequencies in WRC-27

Module 4: 6G Devices

- 6G smartphones
- 6G wearables
- Extended Reality (XR)
- mMTC communications

Module 5: 6G Key Design Principles

- 6G main objectives and services
- 6G architecture principles
- 6G air interface
- 6G lean signaling
- AI-native air interface

Module 6: 6G Technology Enablers

- New 6G spectrum
- Radio sensing and imaging
- Satellite and High-Altitude Platforms (HAPs)
- Reconfigurable Intelligent Surfaces (RIS)
- Zero Energy Devices (ZED)
- JCAS: Joint Communication and Sensing

Module 7: 6G Deployment Challenges

- 6G cost considerations
- 6G security considerations
- 6G sustainability
- AI and machine learning integration

COURSE 21: AI IN PRACTICE AND 5G DATA ANALYTICS

Explores the convergence of AI and 5G technologies, from generative AI fundamentals and LLM deployment to NWDAF, AI-driven network operations, Open RAN ML use cases, and the AI-RAN Alliance. Includes hands-on exercises and real-world case studies.

Duration	7 hours (Recorded)
Audience	IT and Telecom Professionals, Data Analysts, Engineers, CXOs

COURSE CONTENT

Generative AI and Large Language Models

- Overview of Generative AI and LLMs
- Understanding and mitigating hallucinations
- Technology behind ChatGPT

Hands-On with Hugging Face and LLM Deployment

- Exploring Hugging Face and model parameters
- LLM investment options: build, enhance, or fine-tune
- Running LLMs on-device
- Practical exercise: creating a simple generative AI model

AI in 5G: Key Application Areas

- AI-driven network operations
- AI-enabled real-time optimization
- AI-based fault detection and management
- AI-powered subscriber experience

Introduction to 5G Data Analytics (NWDAF)

- NWDAF overview
- Available NWDAF solutions
- NWDAF use case examples

5G + AI for Network Operations

- Intelligent network operations
- Automated fault detection and resolution

- Dynamic configuration management
- Smart resource allocation

AI/ML in 5G and Open RAN

- Machine learning in the RIC
- Traffic steering, QoE, and QoS use cases
- Massive MIMO beamforming use cases
- RAN slicing and dynamic handover use cases

AI-RAN Alliance and Industry Activities

- AI and RAN initiatives
- AI on RAN developments
- AI for RAN applications

COURSE 22: 5G FRMCS (FUTURE RAILWAY MOBILE COMMUNICATION SYSTEM)

Comprehensive technical training on the transition from GSM-R to FRMCS over 5G. Covers end-to-end FRMCS architecture, QoS mechanisms, radio layer design, spectrum strategy, MCX services, and migration planning for mission-critical railway communications.

Duration	6 hours (Recorded)
Audience	Telecom Professionals, Railway Engineers, System Integrators

COURSE CONTENT

Module 1: From GSM-R to FRMCS

- What is FRMCS
- Limitations of GSM-R
- Drivers for change
- FRMCS standardization timeline
- Key 5G FRMCS use cases
- Global FRMCS deployment status

Module 2: 5G FRMCS End-to-End Architecture

- 3GPP update and 5G capabilities
- 5G FRMCS end-to-end architecture
- 5G Core network transformation
- FRMCS architecture based on IMS and MCS

Module 3: UE Registration, Session Management, and QoS

- Registration signaling flow for train-mounted UEs
- PDU session setup for FRMCS
- 5QI values, ARP levels, and GBR/non-GBR mapping
- FRMCS multi-layered security architecture
- Network slicing for rail: operational, safety, and passenger slices

Module 4: Radio Layer Design and Spectrum Strategy

- FRMCS spectrum evolution and standardized railway bands
- Bandwidth options, FDD/TDD, and duplex planning
- Coverage vs capacity strategy (n100 and n101)
- 5G numerology, PRBs, and radio resource structure
- GSM-R coexistence and migration planning

Module 5: Service Architecture, Interworking, and Migration

- FRMCS multi-layer service architecture
- Roaming models: cross-operator continuity
- FRMCS reference points
- Migration architecture Phase 1 and Phase 2

Module 6: MCX Services and Common Architecture

- MCX services architecture for railway safety
- Group communication for emergency and operational calls
- Proximity-based communication using ProSe
- Multicast and broadcast (MBS)

Module 7: MCX Operational Considerations and Call Control

- MCX identities and user profiles
- Network access and MC authentication
- IMS registration and third-party MC registration
- MCPTT call types and group variations
- MCPTT group call signaling and floor control

COURSE 23: 5G Device to cell (D2C) Training

This 5G D2C training provides a complete and practical overview of Direct-to-Cell (D2C) and 5G Non-Terrestrial Networks (NTN), covering WRC-23/27 regulatory decisions, satellite constellations, 3GPP D2X standardisation, and the latest Direct-to-Device architectures.

Duration	6 hours (Recorded)
Audience	Telecom Professionals, Railway Engineers, System Integrators

COURSE CONTENT

Module 1: WRC-23 & WRC-27: Regulatory Foundations for D2C

- WRC-23 recap: key agenda items and decisions impacting 5G NTN and Direct-to-Device (D2C).
- WRC-27 in China: main topics related to mobile–satellite convergence and NTN/D2C.
- How WRC-27 outcomes could unlock or limit large-scale D2C deployments.
- Regional dynamics (US, Europe, Asia, Africa) related to D2C.

Module 2: G NTN & D2C Use Cases and Constellations

- Overview of satellite constellations relevant for NTN & D2C.
- Starlink, OneWeb, Kuiper, and other major players.
- NTN and D2C use cases in Mobile and Broadband.
- LEO’s impact on mobile backhauling.

Module 3: D2C & NTN Standardisation in 3GPP

- 3GPP NTN / D2C standardisation roadmap: from Rel-17 to Rel-19.
- NR-NTN and IoT-NTN evolution.
- Frequencies for D2C: MSS, FSS, and IMT spectrum.
- D2C in MSS vs IMT spectrum.
- Standardisation of D2C services.
- 3GPP target bands for MSS-based D2C.

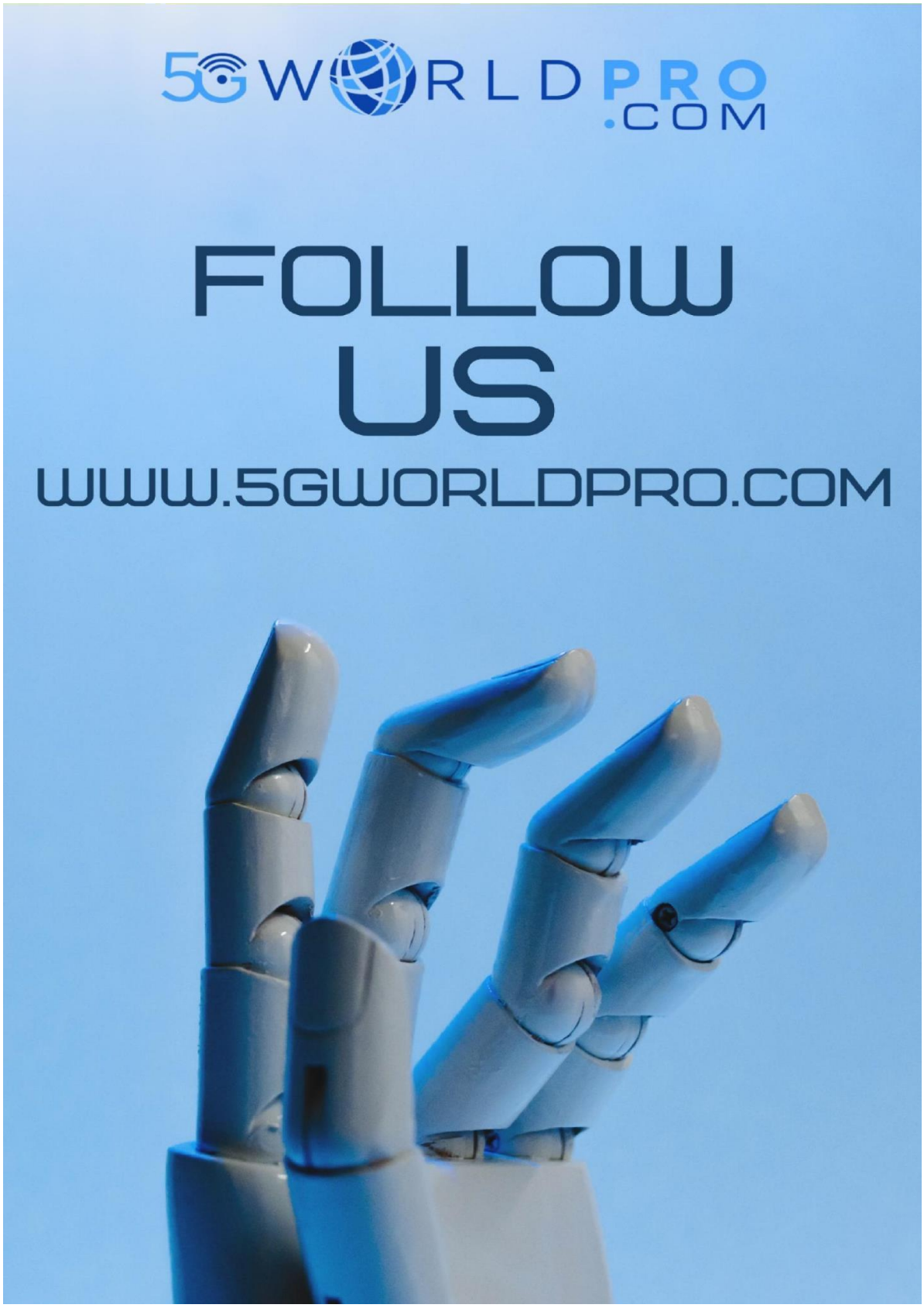
Module 4: Direct-to-Cell Solutions & Architectures

- ntegrated smartphone with satellite capability.
- Unmodified smartphones for D2C.

- NR-NTN-enabled smartphones.
- IoT-NTN-enabled devices.
- Transparent and regenerative architectures.
- Introduction to semi-transparent / semi-regenerative architectures.

Module 5: D2C Ecosystem & Starlink Direct-to-Cell Capacity Analysis

- Mapping the D2C ecosystem (operators, satellite players, chipset vendors, regulators).
- Starlink's Device-to-Cell (D2C) solution description.
- Capacity analysis and performance assessments.
- Downlink and uplink throughput expectations.
- Limitations and strategic implications for MNOs.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