ETS
Engineering & Technology Solutions
To Empower Through Excellence

5G, ORAN, PRIVATE NETWORKS

Training Programs

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ABOUT

TRAINING
5G , ORAN, PRIVATE NETWORKS

This is a comprehensive Training Program designed to meet the requirements of professionals working with Telecom Operators, Equipment Vendors and Managed Services Providers in Planning, Optimization, Deployment and Managed Services Departments. The main modules of the program includes:

- 5G Radio Planning, Dimensioning and Optimization
- 5G Core Featuring Planning, Operations, Architecture and Security.
- ORAN Principles, Architecture, Drivers & Challenges and Protocol Testing.
- 5G Private Networks Architecture, Designing, Deployment & Integration, Network Management & Optimization

CUSTOMIZATION
AVAILABLE

Duration : 72 Hours
Mode : Onsite or ONLINE

OUR SERVICES

TELECOM SERVICES
2G, 3G, 4G, 5G, ORAN

Planning & Optimization, Deployment, Managed Services NOC Management, Remote Support, Tools Consultancy

RECRUITMENT & OUTSOURCING
TELECOMMUNICATIONS

Recruitment & Outsourcing of highly qualified tech staff for Telecommunication Sector

TRAINING SERVICES
TELECOMMUNICATIONS

Planning & Optimization, Testing & Log Analysis, Configurations , RAN, CORE, TxN, Transport Network

5G RADIO PLANNING , DIMENSIONING & OPTIMIZATION

Setting the Stage
- 5G NR Technical Review
- LTE Air interface overview
- Scalable numerology
- NR frame structure
- FDD – TDD modes
- NR signals and channels review
- Air interface channel mapping
- Power control overview
- Non-Stand Alone (NSA) vs. Stand Alone (SA) architecture
- 5G Services – eMBB, massive IoT, URLLC

NG RAN Architecture
- 5G Network Architecture
- Deployment and Architecture Scenarios
- NG-RAN and 5GC Architecture
- Multi-RAT Dual Connectivity with 4G EPC
- Functionality Split
- NR Air Interface Protocol Stack
- Evolving Functionality Split of RAN in 5G
- NG-RAN Interfaces and Protocols
- gNB-to-5GC Interfaces (N2 and N3)
- gNB-to-gNB Interfaces (Xn-C and Xn-U)
- gNB-CU-to-gNB-DU interfaces (F1-C and F1-U)
- Cloud-RAN
- Transport Connectivity for NG-RAN
- NG-RAN and UE Identifiers

Massive MIMO Technology
- LTE to 5G MIMO review
- 3GPP Massive MIMO standardization
- Beamforming and Beamwidth principles
- Massive MIMO Beamwidth gain – practical approach
- Active Antenna Systems – Active Antenna Units

New Radio Air Interface
- NR Air Interface Overview
- 5G Frequency Bands
- Using Massive MIMO
- What is Digital Beamforming
- What is Analog Beamforming
- Hybrid Beamforming using Massive MIMO
- Hybrid Beamforming in Action
- Air Interface Features for Beamforming
- Bandwidth Adaptations
- 5G-Orthogonal Frequency Division Multiplexing
- OFDMA in 5G
- Frame Structure Enhancements
- Orthogonal Subcarriers and Symbol Duration
- Numerology and Associated Parameters
- Numerology
- Slots, Mini-slots and Symbols
- 5G Downlink Signals and Physical Channels
- Downlink Channels and SS/PBCH Block
- SS/PBCH Block
- SS/PBCH Block Transmit Time/Repititions
- PDSCH Plus DM-RS
- CSI-RS
- 5G UL Signals and Physical Channels
- Uplink Channels and Signals
- PUCCH Formats
- PRACH Formats
- Subcarrier Mapping in PRACH
- NR RRC States
- Dual RRC in MR-DC
- Air Interface Protocol Stack- User Plane
- Air Interface Protocol Stack- Control Plane

UpLink Planning
- Customer Quality requirements
- Vendor (Equipment) requirements
- RACH and RACH success probability
- Power control factor
- Uplink Interference factor
- Coverage planning for PUSCH channel
- Coverage planning for control channels (PUCCH, RACH)
- Coverage planning for signals (SRS, DMRS)
- Capacity calculations – single service
- Capacity calculation – combined services
- UL Throughput calculation

5G RADIO PLANNING , DIMENSIONING & OPTIMIZATION

Downlink Planning
- Customer Quality requirements
- Equipment requirements
- Power gain calculation
- Downlink Interference factor
- Coverage planning for PDSCH channel
- Coverage planning for control channel PDCCH
- Coverage planning for signals (PSS, SSS, PBCH, DMRS)
- Capacity calculations – single service
- Capacity calculation – combined services
- DL Throughput calculation (Average, cell edge) vs SINR

RAN Parameters Insight
- Idle mode measurements overview
  - SS-RSRP, SS-RSRQ, SS-SINR
  - CSI-RSRP, CSI-RSRQ, CSI-SINR
- Pathloss Model Analysis
- Channel model analysis
- Low/Mid/High bands configured & licensed parameters
- Numerology & Channel Bandwidth
- TDD frame structure
- UL/DL spatial multiplexing layers vs beamforming
- Analog/Digital Beamforming & number of supported beams
- Capacity - RRC connected users
- Cell peak throughput
- NSA EN-DC PDCP aggregation
- SA aggregation
- Low Band FDD MIMO antennas
  - FDD 400 MHz-2.6 GHz bands
  - 2T2R, 4T4R, 8T8R
  - TM3, TM4, TM7, TM8, TM9
- Mid Band TDD MIMO antennas
  - 2T2R, 4T4R, 8T8R MIMO antennas
  - TM3, TM4, TM7, TM8, TM9
- Mid/High Band TDD mMIMO antennas
  - 32T32R, 64T64R mMIMO AAS units
    - Elevation beamwidths vs. Azimuthial beamwidths
  - CSI-RS based Beam Management
    - CSI-RS vendor equipment port configuration (8, 16, 32)
    - Number of available beams
    - Beamwidth granularity
  - PCI planning 3GPP TS 28.541 spec
  - RACH planning
  - Review Exercises and Examples

5G New Radio (NR) SA Optimization
- Idle mode behavior review
- Cell search Optimization
- SSB synchronization
  - SSB Detection Probability vs. SINR
  - MIB & CORESET0 detection probabilty vs. SINR
  - SSB Coverage optimization (coverage improvements & detection probability enhancements)
- Initial Cell Selection optimization
  - Parameter check
  - Optional features review
- Initial Cell Reselection optimization
  - Parameter check (Priority, Inter RAT, etc)
  - SA Optional Features review
- Random Access successful performance analysis
- Random Access coverage improvements
  - RACH preample pattern vs. Cell range
  - LTE NSA accessibility success rate
  - 5G NSA accessibility success rate
  - 5G SA accessibility success rate
- TDD frame structure optimization
  - TDD special slot vs. Cell range
- NR Throughput optimization
  - Vendor specific RB capacity vs. SINR
  - Cross-Link Interference detection and solution
  - TDD frames optimization
  - DL/UL unbalance
  - UE power saturated
- SA Mobility Optimization
  - 5G SA mobility analysis based on KPIs and log files
- Exercises & examples

5G NSA Optimization
- 5G NSA EN-DC connectivity optimization overview
  - EN-DC abnormal NR leg drop analysis
  - 5G NSA EN_DC establishment success rate
  - 5G NSA EN_DC DRB retainability
  - 5G NSA EN_DC mobility analysis (eNodeB & gNB)
- 5G NSA re-establishment
  - EN-DC split bearer to LTE MCG bearer Analysis & Optimization
- NSA mobility optimization
- 5G NSA aggregation optimization
- Exercises & examples

5G CORE FEATURING PLANNING, OPERATIONS, ARCHITECTURE AND SECURITY

5G Overview
- The Way to 5G
- New Services Proposed
- ITU 5G Use Cases
- 5G Assumptions and Technical Expectations
- Critical MTC: Communications Distance vs. Latency
- Summary of 5G Technology Capabilities
- The Evolution of 5G
- What are Small Cells in 5G Technology?
- IMT 2020
- 5G Performance Requirements
- Capacity Increase
- 5G New Spectrum and Considerations
- Five Key Technology Components of 5G

Understanding 5G Core
- Introduction to Service Based Architecture model for 5GC
- Introduction to the NG-RAN:
- gNB, N3IWF for WiFi, AMF, eNB, ng-eNB, ng-gNB
- Interfaces: Xn, N2, N3
- NR and E-UTRAN Dual Connectivity Options
- Architecture Options: gNB CU and DU, CU/DU Separation
- Introduction to 5G Core Network Functions
- AMF, SMF, UPF, UDR, UDM, AUSF, NEF, PCF, NSSF, NRF, SEPP, NWDAF
- Interfaces: N1, N4, N5, N6, N7, N8, N9, N10, N11, N12, N13, N14, N15, N35, N36, N37
- Non-Stand Alone (NSA) and Stand-Alone (SA) Options
- 5G Reference Interfaces (Roaming and Non-Roaming)
- Distributed and Flexible Architecture
- Mobile Edge Computing Architecture
- Distributed Cloud Edge Computing
- Connectivity to Non-3GPP
- User Plane Resources:
- Definition of PDU Sessions
- Signaling Flow for AF Selection, QoS Session and UE Context Creation
- Service Data Flows
- QoS Flows, Rules, Profiles
- SDF Templates
- Data Radio Bearers and N3 Tunnels
- SMF Control of UPF over N4 Interface
- Policy and Charging Control (PCC)
- Access and Mobility Handling
- QoS/QoE Handling for PDU Sessions

Architecture (Service Based)
- Technical Overview of SDN and SDN Architectures
- Technical Overview of ETSI NFV
- NFV Use Cases
- Service Chaining
- Management and Orchestration
- Telecom Software Architectures and Evolution
- Monolithic, Virtualized, Containerized, Function-based
- Definitions of
- Service Based Interfaces
- Network Function (NF)
- NF Service
- Service Producer
- Service Consumer
- NF Registration, Discovery and Selection Procedures
- SBI Protocols
- RESTful APIs
- HTTP, HTTP/2, JSON
- Zero Touch Service and Network Management
- Cognitive Autonomy

5G Services
- Mechanisms for External AFs to Control Access and QoS
- Role of Packet Flow Description Function (PFDF)
- User Plane Splitting: Multiple N6 Interfaces for Service-Aware Traffic Steering
- Network Exposure Function (NEF)
- Functionality
- Interactions between 5GC and 3P-NFs

5G NR – Flexible Frame Structure
- Physical Resource Block (PRB)
- Frequency Domain
- Time Domain
- PHY Layer – Frame Structure (Time Domain)
- DL:UL Frame Arrangements
- Subframe Types
- 5G Air Interface

5G Air Interface Physical Channels
- DL Sweeping Subframes
- xPBCH – Physical Broadcast Channel
- SS/PBCH Block
- The Reference Signals

5G CORE FEATURING PLANNING, OPERATIONS, ARCHITECTURE AND SECURITY

5G Air Interface Call Flow

- Initial Attach Procedure and Re-attach Procedure
- Connection Establishment Flow
- Uplink PDU Transfer Flow
- Set-up of a PDU Session
- Mobility Flows

5G Network Slicing

- Requirements Grouped by Category
- 5G Radio/Core Network Deployment Scenarios
- Standalone
- Non-Standalone
- Comparison of EPC and 5GCN
- NFV as a Tool to Implement Network slicing
- PFCP vs. OF (OpenFlow)
- Service Function Chaining (SFC)
- Identifiers of Network Slices: NSI ID, NSSAI, S-NSAAI
- GTP Tunnel and PDU Session Types
- Transport Network Slicing – System View
- 3GPP Network Slicing – E2E Service View
- Data-Driven Orchestration

For In-House Options

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5G Security Features

- Non-Standardized Network Security Measures
- Elements of a 5G Security Architecture
- 5G Security Algorithms
- SDN Security
- NFV Security
- Major 5G Security Issues
- Network Slicing and Network Slice Isolation
- Status in 5G Security Standardization
- WBPLSec Model and Application in 5G
- SEAF / ARPF / SEPP
- Authentication Protocols and Key Agreement
- AV Generation: Kausf, XRES, AUTN, RAND
- 5G AKA
- Key Derivation at the AMF
- Device Authentication
- 5G HE AV, 5G SE AV, HXRES*, HRES*, Kseaf
- Security Procedures
- Key Distribution in 5G & Key Hierarchy
- NAS Signalling Security
- RRC Signalling Security
- SUPI and SUCI
- Multiple Registrations
- Securing AN to CN Communications
- IPSec Basic Operation and IPSec ESP
- Establishment of gNB Security Associations
- X.501 Certificate Exchange
- Inter Operator Network Security
- SBA: Risks, Threats and Recommendations
- Cloud and Virtualization Security
- C-RAN Security
- 5G IoT Security
- MEC/Distributed Cloud Security
- Safety of 5G Network Physical Infrastructures
- 5G Customer Edge Switching Security
- 5G Positioning and Privacy
- Securing 5G Automation
- Software Defined Security Monitoring in 5G
- 5G Monitoring and Security Operations
- Implementing and Auditing 5G Security Controls
- 5G Forensics and Analysis
- 5G Cybersecurity Risk Management and Recommendations

ORAN PRINCIPLES , ARCHITECTURE, DRIVERS & CHALLENGES , PROTOCOL TESTING

ORAN Basics
- What is Open RAN
- Understanding Classical and Distributed RAN (DRAN) Equipment from traditional vendors (BBU & Boards) C-RAN or Centralised RAN)
- V-RAN or Virtualizes RAN
- Evolution towards Open RAN

ORAN Architecture
- RU/CU/DU Split Oran Architecture
- Service Management and Orchestration Framework (SMO)
- RAN Intelligent Controller (RIC)
- O-Cloud, O-CU, O-DU, O-RU
- Relevant interfaces in O-RAN architecture

ORAN Groups
- Open RAN Groups & Initiatives
- Telecom Infra Project
- ORAN Alliance
- Open Ran players & Ecosystem
- Open Ran Trials & deployments

ORAN Split Options
- Different RAN split options
- Which Option split to consider
- Relevant interfaces in O-RAN architecture

ORAN Drivers & Challenges
- Open RAN drivers Open RAN challenges
- The 7 benefits of Open ran Open RAN
- Use cases (Traffic steering,
- Qos Optimization,
- Massive Mimo Optimization)

ORAN Advance
- ORAN Fronthaul Planes: Introduction to CUS & M Planes
- SMO (Service Management and Orchestration) in 5G/ORAN
- O-RAN : SMO(Service Management and Orchestration) Interfaces
- O-RAN RIC: xApps
- CPRI & eCPRI
- O-RAN Working Group 4 (WG4): Open Fronthaul Interfaces
- ORAN: Introduction of C-Plane (Control Plane)
- ORAN: Introduction of U-Plane (User Plane)
- ORAN: Introduction of S-Plane (Synchronization Plane)
- ORAN: Introduction of M-plane (Management Plane)
- Clock model and synchronization topology in ORAN
- M-Plane architecture model in ORAN: Hierarchical and Hybrid Models

Protocol Testing
- Technologies : ORAN,5G
- Log exposure : LTE,5G and ORAN with concept/analytical skill
- Mentorship (support provided for any discussion)
- Tools : QXDM,Wireshark,SDN

5G PRIVATE NETWORKS DESIGN, DEPLOYMENT AND MANAGEMENT

Introduction to 5G Technology
- Overview of 5G architecture and components
- Key features and capabilities of 5G
- Differences between public and private 5G networks

5G Standards and Specifications
- 3GPP standards and releases
- Spectrum allocation and regulations
- Subcarrier spacing (SCS) and numerology

Private 5G Network Architecture
- Core network components (5G Core, MEC, etc.)
- Radio Access Network (RAN) components
- Network slicing and its relevance to private networks

Designing Private 5G Networks
- Network planning and design principles
- Site survey and radio frequency (RF) planning
- Capacity planning and scalability considerations

Deployment and Integration
- Installation and commissioning of network components
- Integration with existing enterprise IT and OT systems
- Interoperability with legacy systems (LTE, Wi-Fi)

Network Management and Optimization
- Network monitoring and performance management
- Fault management and troubleshooting
- Optimization techniques for coverage, capacity, and quality of service (QoS)

Security in Private 5G Networks
- Security threats and vulnerabilities in 5G networks
- Security measures and best practices
- Regulatory compliance and data privacy

Use Cases and Applications
- Industry-specific use cases (manufacturing, healthcare, logistics, etc.)
- IoT and machine-to-machine (M2M) communication
- Enhanced mobile broadband (eMBB), ultra-reliable low latency communication (URLLC), and massive machine-type communication (mMTC)

Edge Computing and Private 5G
- Introduction to Multi-Access Edge Computing (MEC)
- Benefits of edge computing in private 5G networks
- Deployment scenarios and use cases for MEC

Future Trends and Developments
- Evolution of 5G technology
- Upcoming features and enhancements in 5G
- Transition to 6G and its potential impact on private networks

Hands-on Labs and Practical Sessions
- Setting up a private 5G network in a lab environment
- Practical exercises on network configuration and management
- Troubleshooting and resolving common issues

About Organizer:

ETS is Pakistan's leading Training provider. With 60+ Consultants from all over the world make it possible to deliver trainings, workshops and conferences around the world covering up to date technologies. Through our dedication to customer-centric innovation and strong partnerships, we have established end-to end advantages in Telecom Services, Solutions and Trainings. ETS is committed to create maximum value for companies, enterprises and consumers by providing competitive solutions and services.