V1.000

TETRA System from A - Z

Course Duration:

2 Days

Course Description:

- This course addresses the needs of engineers and technicians who are involved in the design, development and operation of TETRA networks and solutions and need to understand the architecture and implementation options.
- The course starts with an overview of Terrestrial Trunked Radio solutions and secure authority signaling environments such as Police, Fire Departments, Rescue and Emergency Services and other Public Safety Forces.
- We will clarify the different terms and definitions and the distinction, such as TETRAPOL, BOS, FMT and identify the scope of TETRA and the migration from analogue emergency radio technology to digital trunked radio, including a short system comparison.
- The second part of the course will focus on the architecture details with base stations, network control functions, gateways to public communication systems and the different types of terminals, analogue and digital pagers and phone / pager combinations.
- The basic operational modes, trunked mode and DMO will be discussed in detail, also the network and mobility management functions. This includes the details of the TETRA protocol stack with a PHY and MAC layer overview, higher layer control plane entity details and the user plane functionality.
- TETRA interworking with IP networks, IPI and ToIP, TETRA data service, voice coding with ACELP and a comparison with GSM / GPRS and future outlook on possible convergence will conclude this section.
- We then have a in depth review of the TETRA air interface with TDMA frame structuring, channel mappings, modulation and FEC schemes. The MAC and LLC structure and the PDU types including the mapping from application to the physical transport will be evaluated in detail.
- Identification of TETRA identities and the addressing scheme together with a comparison to public mobile communication systems will finalize the system understanding.
- The TETRA security architecture is then evaluated with the air interface authentication and encryption and the key management mechanisms, such as OTAR protocol and the use of cipher keys.
- The course will then sum up the technology with the discussion of selected call scenarios for individual circuit mode and group voice calls with the focus on call setup and call clearing. .

Some of your questions that will be answered:

- What is TETRA, TETRAPOL, BOS, FMT and how do these systems interwork?
- Who is involved in the standardization of TETRA and what is the role of TETRA MoU?
- Which are the voice and data features supported by TETRA??
- What does the protocol stack for TETRA service look like and how does it compare to public Mobile Systems such as GSM and GPRS?
- What is the possible TETRA evolution towards 3G / UMTS?
- Which logical and physical channels are defined for TETRA and how do they map to the physical transport?
- Why is TDMA being used for TETRA rather than FDMA?
- What are the modulation and FEC schemes and what is their benefit?
- How does mutual authentication and air interface encryption work in TETRA, what are the protocols, security classes and keys used?
- How does the call setup and call clearing work and compare to e.g. GSM?

Who should attend this class?

- The course is particular useful to design engineers and technicians who are involved in the design, implementation and operation of TETRA networks and solutions.
- Network operators, security and technical staff who need understand the TECTRA communication environment, the technical basis and signaling options.
- Everybody who requires detailed knowledge about the TETRA signaling mechanisms.

Pre-Requisites:

- The student should possess basic technical understanding of Mobile Communication technologies, such as GSM and GPRS.
- A general understanding of physical layer coding, modulation schemes and multiplexing technologies would be helpful.

Course Target:

After the course, the student will be able to …

- Deeply understand the TETRA architecture and the benefits for emergency communication and secure alarm signaling between different public authorities.
- Provide a detailed comparison between the TETRA system and public mobile network systems such as GSM.
- Explain the TETRA radio interface specifics in detail, identify the channel structure and their mapping to physical resources and describe the flow of signaling and data PDUs through the protocol layers.
- Understand and apply the TETRA addressing schemes and use of identifiers.
- Understand the TETRA authentication and encryption methods, the key handling and provision and can provide detailed comparison to public mobile network authentication and encryption.
- Identify and list the different type of TETRA services and their application.

Table of Contents:

⇒ TETRA DMO Back to Back Operation Example

- **Address System Overview**
  ITSI, GTSI, ATSI

  ⇒ Short Subscriber Identity Details
  ISSI, GSSI, ASSI, USSI, Use of the Identities

  ⇒ Other Important TETRA Identities
  NSAP Address, Static Binding, Dynamic Binding, Event Label, TETRA Management Identity, TETRA Equipment Identity, Fleet Specific Short Number

TETRA Air Interface Details

- **TETRA Channel Overview**
- **Logical Channels**

  ⇒ Traffic and Control Channels
  Phase Modulation Control Channel, QAM Control Channels
- **Physical Channels**
- **Multiple Access and Timeslot Structure**

  ⇒ Frame Alignment
- **The different Burst Types**

  ⇒ Bursts for Phase Modulation
  Normal Continuous DL Burst, π/4-DQPSK Modulation Bit Allocation, π/8-D8PSK Modulation Bit Allocation, Synchronization Continuous DL Burst, π/4-DQPSK Modulation Bit Allocation, Normal Discontinuous DL Burst, π/4-DQPSK Modulation Bit Allocation, π/8-D8PSK Modulation Bit Allocation, Synchronization Discontinuous DL Burst, π/4-DQPSK Modulation Bit Allocation, Normal UL Burst, π/4-DQPSK Modulation Bit Allocation, π/8-D8PSK Modulation Bit Allocation, Control UL Burst, π/4-DQPSK Modulation Bit Allocation, π/8-D8PSK Modulation Bit Allocation, Linearisation UL Burst, Linearisation downlink burst , Training Sequences and Slot Stealing Recognition

  ⇒ Bursts for QAM Modulation
  QAM Modulation Bit Allocation
- **DMO Burst Types**
  DM Normal Burst (DNB), DM Linearisation Burst (DLB), DM Synchronization Burst (DSB)

  ⇒ Throughput Rate Examples
- **The TETRA Signal Processing Chain**

  ⇒ Phase Modulation

  ⇒ Physical Layer Functions
  The In-Phase – Quadrature (I/Q) Introduction, Éxample: 8-PSK in the I/Q-Plane

  ⇒ π/4-DQPSKConstellation

  ⇒ π/8-D8PSKConstellation

  ⇒ QAM Modulation
  QAM Constallations

- **Coding, Interleaving and Scrambling**

  ⇒ Overview of Channel Coding / Error Correction Principles

  ⇒ Convolutional Decoder Example

- **RF Power Control and Radio Link Measurements**

  ⇒ Power Control
  Open Loop Power Control, Closed Loop Power Control, Outer Loop Power Control , Inner Loop Power Control

- **MAC Layer Details**

  ⇒ Tasks and Functions of the MAC Layer

  ⇒ Architecture of the MAC Layer
  Lower MAC - TMV-SAP, Upper MAC, TMA-SAP, TMB-SAP, TMC-SAP, TMD-SAP, TLE-SAP

  ⇒ Mapping of Logical Channels to Physical π/4-DQPSK Channels
  Frame Mapping to TP and CP Channels, Shared Control Channel Allocation, MCCH, Common SCCH, Associated SCCH, ACCH

  ⇒ MAC PDU TYPES
  TMA-SAP Uplink, TMA-SAP Downlink, TMB-SAP Downlink, TMD-SAP Bi-Directional, MAC Internal PDU's, BSCH Burst and Channel Mappings, Practical Exercise: Calculation of TN for the CP Channel, BNCH Burst and Channel Mappings, AACH Burst and Channel Mappings, Random Access Procedure, Obtaining Random Access Parameters, Random Access Request, Random Access Response, LCH Burst and Channel Mappings, SCH/F Burst and Channel Mappings, SCH/HD Burst and Channel Mappings, SCH/HU Burst and Channel Mappings, TCH / STCH Burst and Channel Mappings

  ⇒ MAC PDU Mapping Example

  ⇒ Selection of the Operation Mode

  ⇒ Mapping of Logical Channels to Physical 8DPSK Channels

  ⇒ Mapping of Logical Channels to Physical QAM Channels

- **Link Layer Details**

  ⇒ LLC Function Overview
  PDU Structures

  ⇒ LLC PDU Types for the Basic Link

  ⇒ LLC PDU Types Advanced Link

  ⇒ Layer Communication Model

  ⇒ Acknowledged Data Transmission on Basic Links

  ⇒ Link Setup and Close on Advanced Links

- **Direct Mode Protocol Architecture**

Higher Layer Protocol Functions

- **MLE Functions**
  Attachment Management, Data Transfer, Network Broadcast, Management

  ⇒ MLE SDU Types
  Cell Selection Scenario, Un-Announced Cell Reselection
- **CMCE Functions**
  Protocoll Control, CMCE Message Overview

  ⇒ Protocol Timers

  ⇒ Call Setup Procedure

  ⇒ Call Rejection by Application

  ⇒ Transmission Control Procedure
  Request-to-Transmit

  ⇒ Call Disconnect Procedure
  Network initiated disconnection

  ⇒ Call Disconnect Procedure (continued)

  ⇒ Acknowledged Group Call Setup

  ⇒ Group Call Disconnection Procedure
- **Air Interface PDU Transfer – Direct Setup**

  ⇒ Setup Overview

  ⇒ Direct Setup – Detailed Scenario

  ⇒ Mobility Management Overview

  ⇒ Mobility Management Message PDU's

  ⇒ Activation Procedure
  Scenario Description:, Deactivation procedure

  ⇒ Registration Procedure – MLE initiated

Overview of TETRA Security

- **Air Interface Authentication and Key Management**

  ⇒ Authentication in TETRA

  ⇒ TETRA Encryption Overview

  ⇒ The Encryption Process

  ⇒ Air Interface Traffic Keys