

## ***GSM from A-Z***

### **Course Duration:**

- 2 days

### **Course Description:**

- This course addresses the needs of engineers and technicians who require detailed technical knowledge on GSM, GPRS and EGPRS
- This first part of the course is a condensed and detailed introduction to GSM with focus on the GSM air interface, the GSM network architecture and an introduction to the upcoming changes with the integration of the IMS.

As in all our courses we integrated several interactive exercises for a perfect learning experience.

### **Prerequisites:**

- A basic understanding of telecommunication systems in general and mobile network operation in particular is required.
- Previous knowledge of GSM is favorable but not required.

### **Course Target:**

- The student will be enabled to understand all important aspects of GSM networking and GSM procedures.

### **Some of your Questions that will be answered:**

- How can different operators have their networks in the same geographic area and how do they prevent their subscribers from registering in a different network?
- What is the GSM network architecture? What is the function and specifics of the various network elements including the SIM and the mobile station? What is a hierarchical network architecture? What are umbrella cells?
- What is a location area? What is the meaning and differences of the various GSM identifiers like IMSI, IMEI, LAC, BSIC, CGI and so on?
- How is the GSM radio interface organized? What are TDMA and FDMA?
- Why does GSM require different burst types? What is their function? On which channels are they used? What is the meaning of the stealing flags?

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- What is the difference between logical and physical channels in GSM? What is the function of the different channel types?
  - What is the goal of channel coding and interleaving and how does it work in GSM for the different channel types?
  - How do Authentication and Ciphering work in GSM?
  - What are the functions and differences of DTX and DRX in GSM?
  - What is the content of measurement reports?
  - How does call establishment work in GSM? How is a certain channel type selected in case of speech or data transmission?

**Who should attend this Course:**

- Design Engineers of GSM network equipment and GSM mobile stations.
- Network Planners who need to build joined GSM networks.
- Field and test engineers who have to learn GSM operation and procedures.
- Consultants who require a thorough understanding of GSM

## Table of Content:

### 1 The GSM System and Channels

- **The GSM Network**

- ⇒ Network Evolution

- ⇒ Architecture of BSS and NSS

- Tasks and Functions of the BSC, Tasks and Functions of the BTS, Tasks and Functions of the TRAU

- **The Mobile Station (MS)**

- Mobile Equipment and SIM Card, Dual SIM Mobiles

- **Network Evolution**

- ⇒ Turning the BSS into GERAN

- The Release 4 Core Network, The Iu Mode, Other Modifications, Migration towards IP Transport

- ⇒ MSC Pooling

- The Pool-Area, The Network Resource Identifier, The Node Selection Function (NSF)

- **The GSM Air Interface**

- ⇒ Gaussian Minimum Shift Keying (GMSK)

- Minimum Shift Keying (MSK), Gaussian MSK (GMSK)

- ⇒ TDMA Frames

- Frequency Division Multiple Access (FDMA), FDMA in GSM

- ⇒ GSM is a Cellular Network

- Frequency Reuse (FR), The Cell, BCCH Carrier, Base Transceiver Station (BTS), Sectorization

- ⇒ TDMA/FDMA in GSM

- Timeslot and Carrier, FDD and TDD, GSM Bands, The Dual Band Cell

- ⇒ Frame Hierarchy

- Why Multiframe?, Multiframe in GSM

- ⇒ Logical Channels

- Basic Logical channels, Broadcast Channels (BCH), Common Control Channels (CCH), Standalone Dedicated Control Channels (SDCCH), Associated Control Channels (ACCH), Traffic Channel (TCH), Additional Logical Channels, Notification Channel (NCH), Packet Data Channel (PDCH), Enhanced Circuit Switched Data (ECSD) Channels

- ⇒ Multiframe

- Example for the DL 51-TDMA Multiframe, The 51 TDMA Multiframe, Common Channel Capacity, SDCCH Capacity, Example for the UL 51-TDMA Multiframe, The Random Access Channel, Random Access Procedure, Example for the 26-TCH Multiframe (UL + DL), 26 TDMA Multiframe, Slow Associated Control Channel (SACCH), Half Rate (HR) Channel, Other Combinations, Control Channel Configuration, PCH and AGCH, PCH/AGCH Control Parameters

- ⇒ Transmission over the Air-Interface

- Burst Types in GSM, Why different Bursts?, Normal Burst, Frequency Correction Burst, Access Burst, Dummy Burst, The Synchronisation Channel (SCH), Content of the Synchronisation Channel, The BSIC, Cell Search in GSM, GSM RSSI Measurements, Initial BSIC Identification, BSIC Reconfirmation, Measurement in GSM\_Connected Mode, The Role of the Stealing Bits in the Normal Burst, The Stealing Bits, Training Sequences, The Training Sequence and the BSIC, The Base Station Identity Code (BSIC), The Training Sequence and the BCC, Timing of Bursts, UL and DL Timing, Timing Advance (TA), Extended Cell

## ⇒ Physical Layer Processing

Physical Layer Processing Chain in UL and DL, The TX Path , The RX Path, Interleaving, Interleaving for FR Speech, Interleaving and HR Speech , GSM Security, GSM Security Features, The Cipher Algorithm A5, Ciphering, Versions of the Ciphering Algorithm

## ⇒ Coding

Coding and Forward Error Correction (FEC), Forward Error Correction (FEC), Channel Coding of the Access Burst, Access Burst , Power of the Burst , Content of the Access Burst, Coding of the SACCH, The SACCH, SACCH Messages, Channel Coding for FR speech, The Speech Encoder, System Information (SI), SI Messages, BCCH extended

## ⇒ Slow Frequency Hopping

Why Hopping?, Frequency Hopping, Synthesizer Hopping or Radio Frequency (RF) Hopping, Base Band (BB) Hopping, The Hopping Sequence, Hopping Sequence Number (HSN), Cyclic Hopping , Pseudo Random Hopping , Mobile Allocation Index Offset (MAIO)

## ⇒ Receivers in GSM

The Equalizer, The Radio Interface, Receiver Performance, Downlink Advanced Receiver Performance (DARP), DARP Phase I, DARP Phase II , Characteristics of SAIC, Link Budget, Planning, Pathloss Balance, Receiver Sensitivity of MS, Sensitivity, Reference Sensitivity.

## ⇒ VAMOS

Introduction to VAMOS, Capacity increase, VAMOS Mobile Stations, Legacy Devices. , VAMOS Support Indication:, Training Sequence Codes, VAMOS and legacy Devices, VAMOS in Downlink, VAMOS in Uplink , The shifted SACCH Concept, Shifted SACCH for VAMOS II Devices

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## 2 GSM basic Procedures

### ● Main GSM Protocols

#### ⇒ GSM Protocol Overview

Radio Interface Protocols, Core Network Protocols

#### ⇒ Protocols of the MS

The LAPD Protocol

#### ⇒ The SACCH Downlink Format

### ● Procedures

#### ⇒ The Location Area

The Location Area Identity (LAI), The Location Area Concept, Location Area Planning, Location Area and BSC Area

#### ⇒ The Location Update Procedure – Part 1

### ● Call Setup

#### ⇒ The Mobile Originating Call Setup – Part 1

#### ⇒ The Mobile Terminated Call Setup – Part 1

### ● Measurement Reporting

Measurement Reports, Calculating the BER Value

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## 3 Measurements and Mobility

- **Measurement Quantities**

- ⇒ RXLEV and RXQUAL

- Radio Link Measurements , Range of RXLEV:, Range of RXQUAL

- **Power Saving**

- ⇒ Power Control

- General , Power Control in Uplink, Power Control in Downlink

- ⇒ Discontinuous Transmission (DTX)

- DTX on the Radio Interface, Discontinuous Transmission (DTX), DTX and Half Rate, DTX and Voice Activity Detection, The Voice Activity Detection (VAD) Flag, SID Updates

- **Cell Selection and Reselection**

- ⇒ PLMN Selection

- Automatic Network Selection Mode

- ⇒ Idle Mode Procedures

- Cell Selection, Idle Mode , Measurements for Normal Cell Selection , Criteria for Cell Selection , Cell Reselection, Cell Reselection Criteria, C1 as Criteria for Cell Reselection , Cell Reselection based on Priorities, C2 Cell Reselection Criteria, How to use the C2 Criteria

- **Handover for the Connected Mode**

- ⇒ Why Handover?

- Purpose of Handover, Handover Types, Handover Failures

- ⇒ Handover Procedure

- Finely synchronized Intercell Handover, Presynchronized Intercell Handover, The Handover Command, The Failed Handover

- ⇒ Handover Types

- Intra Cell Handover, Description, Triggers for Intra Cell Handover , Intra Cell Handover Execution, Cells with different Bands, Intra-BSC-Handover, Handover Decision, Handover Execution, Inter-BSC / Intra-MSC Handover, Handover Decision, MSC controlled Traffic Reason Handover , Inter-MSC Handover, Inter MSC Handover and Anchor Functionality, Handover Number

- **The SACCH**

- ⇒ Radio Link Timeout and Call Reestablishment

- Radio Link Timeout, Example Description, Call Re-establishment, Motivation, Impacts on User Quality, Call Reestablishment Procedure

- ⇒ Repeated ACCH

- Why Repeated ACCH?, Repeated FACCH, Repeated SACCH

- ⇒ Gain of Repeated ACCH

- Gain of Repeated ACCH, Repeated FACCH for old MSs.

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## 4 GSM Services

- **GSM Services**

- Teleservices (TS), SMS-Cell Broadcast (SMS-CB), Unstructured Supplementary Service Data (USSD), Bearer Services

## ⇒ TTY / CTM

Teletypewriter (TTY), Global Text Telephony (GTT) , Cellular Text Telephone Modem (CTM) , CTM Transmitter/Receiver

## ● **GSM Voice Codec Family**

Codec selection, FR, HR and the EFR Codec, Adaptive Multi-Rate Wideband (AMR-WB) , Notations

## ● **Speech in GSM**

Motivation for Codec Selection, Channel-Rates, ISDN Codec, Transcoder, Coding and FEC, Transcoder Free Operation (TrFO) and Tandem Free operation (TFO)

## ● **Adaptive Multi-Rate Speech (AMR)**

### ⇒ AMR Codecs

The AMR Family, Speech Coding

### ⇒ AMR Bit Classes

Coding for AMR Voice

### ⇒ AMR Frame Types

TCH/AFS (Traffic Channel, Adaptive Full rate Speech), TCH/AHS (Traffic Channel, Adaptive Half rate Speech), RATSCCH(Robust AMR Traffic Synchronized Control Channel)

### ⇒ Coding of DTX Frames

Channel Coding SID\_UPDATE Frame (AFS), Channel Coding of SID\_FIRST Frame, Channel Coding of ONSET Frame (AFS)

### ⇒ Link Adaptation

EFR and AMR FR versus C/I, Codec Performance , Active Code Set (ACS), Codec Selection, Mode Adaptation , Initial Codec, Link Adaptation (LA), Link Adaptation Parameters, Thresholds and Hysteresis Values, Codec Mode Commands and Requests, Alternating Transmission of Codec Modes Parameters, Signaling for Codec Mode Adaptation

## ● **AMR-WB Codec**

### ⇒ Codec Mode

Higher Sampling Rate, Wide Band Adaptive Multi-Rate (WB-AMR)

### ⇒ AMR-WB in the Network

Functional Overview, Functions of Network Elements, Transcoding and AMR-WB

### ⇒ Extended AMR Codec (AMR-WB+)

Why AMR-WB+