

SIGTRAN

Protocol Testing & System Integration

Course Duration:

- ▶ 2 days

Course Description:

- ▶ This course addresses the needs of everybody who needs a detailed understanding of SIGTRAN.
- ▶ The course starts with an introduction to SIGTRAN and the related protocols and continues with the description of the QoS-requirements on SIGTRAN.
- ▶ This part ends with a comparison of SIGTRAN and its alternatives (e.g. SIP, DIAMETER, ...) on different interfaces.
- ▶ The following part reviews important characteristics of the CCS7-protocol suite that SIGTRAN shall more or less replace. Focus is on SPC- and Global Title based routing procedures, SLS-based load sharing and MT-2 and MTP-3 management procedures.
- ▶ The course continues with a detailed consideration of the SCTP. Among others we evaluate in detail the SCTP association establishment and security threats for SCTP.
- ▶ Special focus is on SCTP association management procedures like HEARTBEAT, RTO-calculation, data transfer and acknowledgement (SACK) and congestion control.
- ▶ This part concludes with the discussion of the optimum setting of SCTP-parameters like RTO.Initial, SACK-Delay, Path.Max.Retrans or RTO.Alpha.
- ▶ The next chapter evaluates in detail various important adaptation layer protocols like M2PA, M2UA, M3UA and SUA.
- ▶ This part includes the discussion of the N+K-redundancy concept and the related ASP-management procedures.
- ▶ The final chapter deals with SIGTRAN problems and testing. Major focus is on the discussion of SIGTRAN-operation across so called "battlefield"-networks using IPsec and through NAT's.
- ▶ The course concludes with the discussion of suitable SIGTRAN-testing procedures for vendors and operators.

Pre-Requisites:

- ▶ Good IP-knowledge. Previous exposure to design, operation and/or level 2 maintenance of IP-networks is necessary.
- ▶ Good CCS7-knowledge. Previous exposure to design, operation and/or level 2 maintenance of CCS7-networks is necessary.

Course Target:

- ▶ After the course the student is enabled to perform sophisticated network analysis in SIGTRAN-enabled networks and to nail down typical network failures.
- ▶ The student can be assigned to any SIGTRAN-related engineering task in design, test, implementation or validation projects.

Some of your questions that will be answered:

- ▶ How can an IP-network be reliable and secure enough in the first place to convey critical and confidential CCS7-information?
- ▶ Which address information is used within and among CCS7-networks to route information between adjacent nodes and end-to-end?
- ▶ Are there any means for load sharing among CCS7-links?
- ▶ What is the best adaptation layer protocol for our implementation? Shall we use M2PA, M2UA, M3UA or SUA?
- ▶ Which security mechanisms does SCTP support?
- ▶ Which packet format and chunk types does SCTP define and what are they used for?
- ▶ How does SIGTRAN mimic classical CCS7-parameters like OPC, DPC, SLS, SLR or DLR?
- ▶ How does the network layout differ between classical CCS7 and SIGTRAN?
- ▶ In which way does SIGTRAN provide for link supervision as CCS7-does?
- ▶ Does SIGTRAN support load sharing? If yes, is it more flexible than load sharing in legacy CCS7?
- ▶ In which way does SIGTRAN provide for CCS7-management procedures likes Change Over / Change Back (COO / CBD)?
- ▶ Is there a link establishment procedure in SIGTRAN comparable to the CCS-link establishment procedure through SLTM / SLTA?
- ▶ Which test procedures can be recommended upon SIGTRAN-commissioning?
- ▶ How well does SIGTRAN operate through NAT's and NAPT's?
- ▶ Can SIGTRAN operate with IPsec?
- ▶ What are the optimum settings for the different SCTP-parameters like for example RTO.initial, RTO.Min and Max or HB.interval under which conditions?
- ▶ What are typical error situations that SIGTRAN-enabled networks will encounter?

Who should attend this class?

- ▶ Design and test engineers of SIGTRAN equipment vendors.
- ▶ Engineering staff of network operators who require inside knowledge of SIGTRAN network operation (e.g. TAC II and III)
- ▶ Everybody who requires detailed knowledge of SIGTRAN technology and network operation.

Table of Contents:

Introduction

- **The Legacy CCS7-Protocol Stack**
 - ⇒ Overview of the Presented CCS7-Protocols
- **Introducing SIGTRAN**
 - ⇒ The CCS7-Protocol Stack in Case of SIGTRAN
- **Introduction to SCTP**
 - ⇒ Important SCTP-Functions
 - ⇒ Important SCTP-Terminology
 - Association, ASP's and AS's, Multihoming, Path, Well known SCTP-Port Numbers, Stream, Chunk, Chunk Bundling, SCTP-Packet, Primary, Idle and Inactive Paths, Heartbeating
 - ⇒ Practical Exercise: Stream Oriented Data Transfer
 - ⇒ Example of an SCTP-Packet
- **Overview of the Adaptation Layers**
 - ⇒ SUA
 - ⇒ M3UA
 - ⇒ M2UA
 - ⇒ M2PA
 - ⇒ IUA / DUA
 - ⇒ ISUA
 - ⇒ TUA
- **Advantages of SIGTRAN vs. CCS7-based Transport**
 - ⇒ Best of both Worlds
 - ⇒ Use of lower Cost Equipment
 - ⇒ Easy Deployment
 - ⇒ Overcomes inherent CCS7-Resource Limitations
- **QoS-Considerations**
 - ⇒ Reliability related QoS-Requirements

⇒ Delay related QoS-Requirements

- **Future and Alternatives of SIGTRAN**

⇒ Use Case 1: Call Establishment (Q.931-related / UNI)

⇒ Use Case 2: Call Establishment (ISUP-related / NNI)

⇒ Use Case 3: AAA-Services

⇒ Use Case 4: IN- and CAMEL-Services

⇒ Use Case 5: Access Network / Core Network Interconnection

Reviewing Important Assets of the CCS7 Protocol Suite

- **Network Topology**

⇒ Overview

⇒ Another View – Introducing SP/SEP/SSP, STP and SCP

- **Routing Issues**

⇒ Data Transfer & Routing within and among CCS7-Networks

Routing through MTP-3, Signaling Point Code (SPC), Network Indicator (NI), The Routing Label

⇒ End-to-End Routing through the SCCP

⇒ Loadsharing of CCS7-Signaling Traffic between SP's

Principles, Loadsharing when STP's are involved

- **CCS7-Frame Formats**

⇒ MSU-Format

⇒ FISU-Format

⇒ LSSU-Format

SIO, SIN, SIE, SIOS, SIPO, SIB

- **Operational Issues**

⇒ CCS7-Link Setup

Before Link Establishment, Link Alignment Initiated, Test Phase, Layer 3 Message Exchange

⇒ CCS7-Link Change Over (COO / COA)

⇒ SCCP-Connection Operation and Identification

Details of SCTP

- **Association Establishment**

- ⇒ Overview

- ⇒ Detailed View

- Triggering the Transmission of an INIT-chunk, Reception of an INIT-chunk / Generate State Cookie, Content of an INIT-ACK-chunk, Generate COOKIE-ECHO, Receive COOKIE-ECHO / State Cookie Authentication, Transmit COOKIE-ACK / Confirm Association Establishment

- **Association Management and Operation**

- ⇒ Overview

- Heartbeating, Path MTU-Discovery (PMTU), RTO-Determination, User Data Transfer Process, Association Release

- **Detailed Consideration of Heartbeating**

- ⇒ Consequences of unsuccessful Heartbeating

- RTO-Expiry, Error-Counter = Path.Max.Retrans

- ⇒ Example of a HEARTBEAT-Chunk

- **Details of RTO- and RTT-Measurements**

- ⇒ Interpretation of these Formulas

- **User Data Transfer Process**

- ⇒ Process Overview

- ⇒ Congestion Control in SCTP

- Slow Start and Congestion Avoidance Operation (Important Rules upon Initialization, Behavior in Slow Start [RFC 2960 (7.2.1)], Behavior in Congestion Avoidance [RFC 2960 (7.2.2)], Important Rules upon Packet Loss [RFC 2960 (7.2.3)], Important Rules upon RTO-Expiry [RFC 2960 (7.2.3)], Important Rules when Paths are idle for some (configurable) Time)

- ⇒ Acknowledging DATA-Chunks

- Good Case (all Chunks are acknowledged) (TSN-Numbering, Delayed Acknowledgements, No of Duplicate TSN), Bad Case (Chunk needs to be retransmitted) (Error Description, Immediate Acknowledgement, Fast Retransmit Algorithm in SCTP, Interpretation of the Gap Block Information Element)

- **Association Release**

- **Security Threats for SCTP**

- ⇒ DoS-Attack

- ⇒ Flooding with SCTP-Chunks

- ⇒ MitM-Attack: Eavesdropping

⇒ MitM-Attack: Unrecognized Data Alteration

- **SCTP Packet and Chunk Format**

- **Selected Chunk Types**

⇒ The DATA-Chunk

The U-Flag (Unordered), The B-Flag (Beginning Fragment), The E-Flag (Ending Fragment)

⇒ The SACK-Chunk

⇒ The INIT-Chunk

Chunk Flags, Initiate Tag, Number of Streams (Inbound and Outbound), Initial TSN, Cookie Preservative, Supported Address Types

⇒ The INIT-ACK-Chunk

⇒ The AUTH-Chunk

Shared Key Identifier, Message Digest Algorithm Identifier

- **Important SCTP Parameters**

⇒ Timers

Valid.Cookie.Life, RTO.Initial, RTO.Min, RTO.Max, HB.Interval, SACK-Delay, Chunk Bundling Timer

⇒ Counter

Association.Max.Retrans, Path.Max.Retrans, Max.Init.Retransmits

⇒ Other Parameters

RTO.Alpha, RTO.Beta, a_rwnd

Details of some interesting User Adaptation Layers

- **Protocol Stack View and Implementation Issues**

⇒ M2PA – with SGW-Involvement

Typical Implementation

⇒ M2PA – all IP-Architecture

⇒ M2UA – with SGW-Involvement

Typical Implementation

⇒ M2UA – all IP-Architecture

⇒ M3UA – with SGW-Involvement

SCCP-Based Routing in case of M3UA, ISUP-Based Routing in case of M3UA (Call from the PSTN hits the GMSC-S, Relay to SGW and Routing Decision within SGW, Relay to HLR of called Subscriber and Request for MSRN, Relay of IAM to Target MSC-S)

⇒ M3UA – all IP-Architecture

Example of an M3UA-Data Message (lu-cs Interface)

⇒ SUA – with SGW-Involvement

⇒ SUA – all IP-Architecture

⇒ Summary: When to use M2PA, M2UA, M3UA or SUA ...

- **Redundancy Modes & Options**

- ⇒ The N+K Redundancy Model

- ⇒ ASP-Management

- ASP-Up-Procedure ($N + K = 2 + 1$), ASP-Activation-Procedure ($2 + 1$ / Loadshare Mode), ASP-Traffic Failover-Procedure ($2 + 1$ / ASP-Outage)

- **SCTP-Associations and Streams in Context with important XUA-Protocols**

- ⇒ M2PA

- ⇒ M2UA

- ⇒ M3UA

- ⇒ SUA

Practical Operation and Test of SIGTRAN

- **Showstoppers and Stumbling Stones**

- ⇒ Overview

- Network-Internally, Interworking with CCS7-Network, Interworking through NAT/NAPT, VPN-Operation

- ⇒ Coping with NAT/NAPT

- Problem Description, Resolution Approaches

- ⇒ Coping with IPsec- and IKE-related Problems

- Overview, Approach: Use Application Server Clustering instead of Multihoming, Protocol Stack Details (SGSN to HLR with two SEG's and NAT)

- **SIGTRAN Testing**

- ⇒ Important Test Areas

- Performance Tests, Interoperability Tests, CCS7-Conformance & Interworking Tests

- ⇒ Possible Setup for Interoperability Tests CCS7 / SIGTRAN

- ⇒ Possible Setup for SIGTRAN Node Testing