v1.400

GPRS
Network Optimization & Trouble Shooting

Course Duration:

- 3 days

Course Description:

- This course is targeted at engineers and technicians who are involved in the operation, optimization and troubleshooting of GPRS-networks.
- The course starts with a comprehensive and detailed examination of the capabilities of GPRS and the maximum performance that can be achieved, considering the various restrictions and interdependencies of the different components involved, like application protocols, the network architecture, the mobile station and the host software.
- The course lines out the different means and options of how to determine the performance and quality of a GPRS network and how to make these results reproducible.
- Most interesting is the detailed presentation of how to fine-tune the different components of a GPRS-network to achieve the optimum performance.
- The course concludes with the detailed analysis of typical errors and failures in GPRS networks, discriminating mobile station issues from network problems.

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

Pre-Requesites:

- Very good understanding of GPRS networks, protocols, operation and parameters. Previous knowledge of all GPRS-details from our training course “GPRS from A-Z” is required.
- Good understanding of the IP-world is necessary as this course lines out in detail the interdependency of achieving the best achievable performance of TCP/IP applications over the GPRS-bearer.

To cope with these requirements, we strongly recommend to take our course “GPRS – Signaling & Protocol Analysis” (RAN & Mobile Station) + (Core Network) beforehand.

Course Target:

- The student is enabled to troubleshoot and optimize GPRS networks and mobile stations.

Some of your questions that will be answered:

- How can engineers in the core network and in the radio network determine the actual network performance?
- What are the performance requirements of the different TCP-applications?
- How can I distinguish application and mobile station failures which are outside of our scope from real network problems?
- How to nail down performance bottlenecks in the different parts of your network?
- How to optimize the performance for the different applications?

Who should attend this class?

- Network operators who need to optimize the performance of their networks
- System supplier staff who is involved in the troubleshooting and optimization of GPRS-networks
- Design engineers of mobile stations and PDA's for GPRS

Table of Contents:

Quality of Service in GPRS-Networks

⇒ TCP
⇒ Relative Performance Leakage
Example Calculations

The Definition of Key Performance Indicators
⇒ Measurement Applications
⇒ Environmental Constraints
⇒ Timing KPI's
⇒ Throughput KPI's
⇒ The Definition of Timing KPI's
End-to End Time Measurements
Example: RTT-Measurements during an FTP-Upload
Intermediate Time Measurements
Example: Access Time on Gb- and Abis-Interface

The TCP/IP World in the Mobile Environment

Introducing the IP-Protocol Stack

IP-Addresses
⇒ IP-Address Classes
⇒ Special IP-Address Notations
⇒ Determination of the Owner of an IP-Address

The Process of IP-Address Allocation
⇒ The Dynamic Host Configuration Protocol (DHCP)
Automatic Allocation
Dynamic Allocation
Manual Allocation
Operation of the DHCP in GPRS
⇒ Private IP-Addresses
Mobile Subscribers entering the Internet
Private IP-Address Ranges
⇒ Using Network Address Translation (NAT) for Interconnection
Principles of Network Address Translation
⇒ Liabilities of NAT
IPsec in Transport Mode
Streaming Applications
Push Services
⇒ Optimized Use of NAT in GPRS
Business and Power Users
Standard Users

The IP-Header
⇒ Overview

⇒ Example of an IP-Header
⇒ The IP-Header / Octet 1 – 4
⇒ The TOS- Field (Type of Service)
⇒ The TOS- Field / Differentiated Services
⇒ Using Differentiated Services for the Intra-PLMN Backbone
  Principles
  Implementation
  Differentiation of Control Information and User Data with Different QoS
⇒ The IP-Header / Octet 5 – 8
⇒ Fragmentation Control in IP
⇒ The IP-Header / Octet 9 – 20
⇒ The IP-Header / Octet 21 – N (IP-Options)

Details of the Internet Control Message Protocol (ICMP)
⇒ ICMP-Message Format
⇒ I
  Echo Reply
  CMP-Messa
  Destination Unreachable
  Source Quench
  Redirect
  Echo Request
  Router Advertisement
  Router Solicitation
  Time Exceeded for a Datagram
  Parameter Problem on a Datagram
  Timestamp Request
  Timestamp Reply
  Information Request
  Information Reply
  Address Mask Request
  Address Mask Reply

Using ICMP for Roundtrip Time (RTT) Measurements in GPRS
⇒ Use Trace Route to Determine the IP-Address of the 1st Router
  Ping with 32 Octets of Data (no Segmentation)
  Ping with 544 Octets of Data (still no Segmentation)
  Ping with 1000 Octets of Data (Segmentation)

Details of the Transmission Control Protocol (TCP)
⇒ Services of TCP
⇒ TCP Connection Establishment
  (1) Example for TCP Connection Establishment
⇒ TCP Connection Release
  (1) Example for TCP Connection Release
⇒ The TCP-Header
  The TCP-Header / Octet 1 – 12

The TCP-Header / Octet 13 – 20
The TCP-Header / Octet 21 – n (Options)
⇒ The Roundtrip Time (RTT) in TCP-Connections
Roundtrip Time (RTT) and Retransmission Timeout (RTO)
Long Term Behavior of SRTT and RTO
⇒ Advanced TCP-Features
⇒ The Nagle Algorithm and Delayed Acknowledgements
⇒ The Slow Start and Congestion Avoidance Algorithms
Introduction
Slow Start and Congestion Avoidance in Operation
Long Term Characteristics
⇒ The Ultimate Importance of RTT and CWND for GPRS
The formula for calculating SRTT and RTO is tailored for wireline connections
In GPRS, the RTT is highly variable and may therefore cause unnecessary retransmissions
Slow start memorizes instances when RTT ≥ 2 x SRTT
RTT variance in GPRS can have many reasons
⇒ Consequences of the RTT-Variance for the GPRS Performance
Example: FTP-Upload at 150 km/h
⇒ The Fast Retransmit Algorithm
⇒ The Fast Recovery Algorithm

And what about TCP/IP in GPRS ?

⇒ Some Basic Questions
How do the various TCP/IP algorithms impact GPRS operation ?
Can GPRS be considered as a typical Dial-Up Service ? (which implicitly requires similar settings)
How critical is the high variance of RTT during a GPRS data transfer when it comes to unnecessary retransmissions ?
⇒ The Bandwidth Delay Product
Some Example Calculations for GPRS and Dial-Up
Consequences for GPRS
Performance Improvement through MSS-Adjustment
Setting of the Parameter IPMTU in WINDOWS 98
Setting of the Parameter DefaultRcvWindow in WINDOWS 98

Important Application Protocols

⇒ Access to Applications ⇒ The Domain Name System (DNS)
⇒ The Hypertext Transfer Protocol (HTTP)
The HTTP-Message Format
Operation of the Hypertext Transfer Protocol
Download of a given Web Page
⇒ GPRS Performance Measurements with HTTP
Definition of Trigger Points
Impact of GPRS Specific Delays on HTTP-Performance
Example of an HTTP-Transaction ⇔ The Request

Example of an HTTP-Transaction ⇔ The Response
⇒ The File Transfer Protocol (FTP)
GPRS Performance Measurements with FTP
Example: FTP-Upload
Example: FTP-Download
⇒ Latency Requirements

GPRS Dial Up Network Access
⇒ The Point-to-Point Protocol (PPP) Frame Format
⇒ Operation of Dial Up Network Access
Link Establishment Phase
Authentication and Network Layer Setup
Link Termination
(1) Example for Dial-Up Network Access using the PPP

End-to-End GPRS Operation

The GPRS Life Cycle
⇒ Cell Selection
⇒ GPRS Attachment
⇒ PDP-Context Activation
⇒ PDP-Context Active
⇒ PDP-Context Deactivation
⇒ GPRS Detachment

GPRS Operation: Mobile Station ⇔ PCU
⇒ Resource Allocation in Uplink and Downlink Direction
⇒ Signaling during Initial Resource Allocation
For Uplink Data Transfer
For Downlink Data Transfer
⇒ Concurrent Resource Allocation
⇒ Uplink and Downlink Resource Release
Uplink Resource Release
Downlink Resource Release

GPRS Operation: PCU ⇔ SGSN

GPRS Operation: SGSN ⇔ GGSN

GPRS Operation: GPRS Mobility Management (GMM)
⇒ The Ready Timer
⇒ GMM Procedures
⇒ Network Operation Modes (NOM)

Optimization of the GPRS Network Performance

Scope of GPRS Network Optimization

⇒ Optimization of Network Parameters
⇒ Optimization of Client Settings

Optimization of the RLC/MAC-Layer

⇒ Functions of RLC/MAC
⇒ Important Procedures and Parameters for Optimization
ACCESS_BURST_TYPE
Type of Access (One-Phase / Two-Phase)
BS_CV_MAX
Format of PACK_CTRL_ACK-Messages
Network Control Order
NON-DRX-Timer
PAN_INC, PAN_DEC, PAN_MAX
Resource Allocation Methods
Timer T3168
Timer T3192

Optimization of the BSSGP- and NS-Layers

⇒ Functions of BSSGP and NS
⇒ Important Procedures and Parameters for Optimization
Bc and Tc (⇔ Frame Relay)
Automatic Resumption
Flow Control

Optimization of the LLC-Layer

⇒ Functions of LLC
⇒ Important Procedures and Parameters for Optimization
N201 (max. Number of Octets in the Information Field)
Encryption
N200 (Number of Retransmissions) and T200

Optimization of the GMM-Layer

⇒ Functions of GMM
⇒ Important Procedures and Parameters for Optimization
READY Timer
Network Operation Mode (NOM) and T3312
Routing Area Size

Enclosures for the Practical Exercises

Solutions for the Practical Exercises