v 1.801

HSUPA
Design Details & System Engineering

Course Duration:

- 2 days

Course Description:

- This course appeals to all engineers and technicians who want to gain expert knowledge about the key functions of HSUPA like E-TFC selection (E-DCH Transport Format Combination) or scheduling grants.

- The course focuses on the necessary extensions of the UTRAN architecture in NodeB and the UE, in order to explain in detail the requirements for HSUPA. Further emphasis is on the protocol enhancements like MAC-es/MAC-e and the new physical channels.

- Special focus is put on UE's physical layer aspects, which allow a higher user data throughput in the uplink far beyond the conventional 64kbit/s. In that respect, the uplink scheduling mechanism located in the NodeB is of central importance for HSUPA granting maximum allowed power ratios to each E-DCH capable UE.

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

Prerequisites:

- Very good understanding of WCDMA networks, protocols, operation and parameters. Previous knowledge of UMTS-details from our training course "UMTS Design Details & System Engineering" is advantageous. In addition, we advise our course "UMTS – Signaling & Protocol Analysis (UTRAN & UE)" to be taken in advance.

- Previous design and/or testing experience with WCDMA-networks and / or User Equipment are favorable.

- As every E-DCH capable UE has to mandatory support HSDPA, a profound knowledge of HSDPA is highly beneficial for the understanding of HSUPA..

Course Target:

- The student will be enabled to understand all relevant details of HSUPA within the UTRAN and the User Equipment.

- The participant is enabled to develop, test and operate HSUPA hard- and software.

Some of your Questions that will be answered:

- What are the motivation and drivers for HSUPA?
- Supported data rates with HSUPA?
- What are the key concepts of HSUPA?
- What impact does HSUPA have on the system architecture?
- What is the purpose of E-DCH (Enhanced DCH) and E-TFC?
- Is there a new modulation scheme coming with HSUPA?
- What are the advantages for the subscriber using HSUPA capable UE's?
- How are HARQ and Fast Packet Scheduling done?
- What are the differences and pros/cons between HARQ II and HARQ III?
- What are the impacts of HSUPA in Iub & Iur User and Control Plane?
- What adaptations are required on the UE and network side to provide for HSUPA?
- How does the F-DPCH benefit UTRAN?
- What is the purpose of Primary and Secondary E-RNTI?
- Why are Absolute and Relative Grants used to control UE's uplink E-DPDCH Power?
- What are the differences between E-DCH Serving RLS and E-DCH Non-Serving RLS?
- When are scheduled and when are non-scheduled Grants issued?

Who should attend this Course:

- Everybody who needs to design HSUPA capable UEs and network equipment
- Operators who need a detailed understanding of HSUPA
- Test engineers who need to integrate HSUPA equipment and UEs

Table of Content:

Details on Operation, Scheduling, E-TFC Selection and HARQ

⇒ Summary on High Uplink Data Rate – Top Contributors

- **UMTS Roadmap for HSUPA and HSDPA**

  ⇒ Improvement of HSDPA in Rel. 6

  ⇒ UMTS Release 7/8 - HSPA+

The Physical Layer of HSUPA

- **HSUPA Uplink Frame Structures**

  ⇒ DPCCH Frame Structure

  ⇒ Details on E-DPCCH
  E-DPCCH Frame Structure, Relation between RSN and E-DCH RV Index, HARQ Comparison between HSDPA and HSUPA, Outband Happy Bit on the E-DPCCH, Practical Exercise: Happy / Unhappy Determination?

  ⇒ Details on E-DPDCH
  E-DPDCH Frame Structure, Physical Channel Bit Rates for DPDCH and E-DPDCH

- **Uplink Spreading and I / Q Mapping**

  ⇒ Uplink Modulation

  ⇒ Code Multiplex versus Time Multiplex

  ⇒ Multicode Operation in HSUPA (Cat 6 with 4 x E-DPDCH)
  DPCCH + 6 x DPDCH's, HS-DPCCH + 0 x DPDCH + DPCCH, HS-DPCCH + 1 x DPDCH + DPCCH, DPCCH + 1 x DPDCH + 1 x E-DPDCH, DPCCH + 1 x DPDCH + HS-DPCCH + 1 x E-DPDCH, DPCCH + 0 x DPDCH + HS-DPCCH + 2 x E-DPDCH, DPCCH + HS-DPCCH + 4 x E-DPDCH

- **HSUPA Uplink Scheduling**

  ⇒ E-DCH RNTI

  ⇒ WCDMA Review:
  SIR Considerations in a CDMA-system, Uplink Load Curve – Rise over Thermal, Measurement of Air Interface Load, Uplink Load, Load Estimation based on Receive Total Wideband Power (RTWP), Noise Rise or Rise over Thermal – RoT

  ⇒ HSUPA Scheduling Grant
  Scheduling Overview, Meaning of Absolute Grant Value, UE Monitoring of two E-RNTI's in parallel, Relative Grant Usage, Three Index Step and Two Index Step Thresholds, Example of Serving Grant Update – Receiving UP, Relative Grant Timing – ETPR versus LUPR, Practical Exercise: Message and BPSK Bit-Mapping on E-RGCH, Reception of Grants from Non-Serving RL and Serving RLS, Practical Exercise: Rules for Updating Serving Grant

  ⇒ UE's Scheduling Requests
  Inband Scheduling Info on the E-DCH, Details on UE Power Headroom (UPH)

- **HSUPA Downlink Frame Structures**

  ⇒ Details on E-AGCH
  E-AGCH Frame Structure, E-AGCH Processing Chain

  ⇒ Details on E-RGCH

E-HICH and E-RGCH Signature Sequence, Orthogonal Signature Hopping of E-HICH and E-RGCH, E-RGCH Frame Structure

⇒ Details on E-HICH
E-HICH Frame Structure, Practical Exercise: Serving RLS and Non-Serving RL's HARQ and RG Bit Mapping, Practical Exercise: ACK / NACK Mapping on E-HICH, Multiplexing of E-HICH and E-RGCH

- **Details on E-DCH**

⇒ Review of Rel. '99 till Rel. 5 Uplink TFC Selection

⇒ Transport Format Combination Selection in the UE
E-DPDCH Power Control, Example for deriving ß(ed,j,harq), Power, Beta-Values and Transport Block Size Relationship, E-TFC Selection Method – Principle , E-TFC Selection in UE governed by NodeB, E-DCH Transport Block Size Calculation , Extract from a Ratio Bearer Setup Message, E-TFCI Tables – Slow and fast Throughput Growth, E-TFC Selection Flow

⇒ Transport Channel Comparison
DCH versus E-DCH

⇒ Practical Exercise: Compare HS-DSCH with E-DCH

- **HSUPA Timing Relations – Examples for TTI = 10 ms**

⇒ E-AGCH Timing 10 ms

⇒ E-RGCH Timing 10 ms
E-RGCH Timing of Serving RLS, E-RGCH Timing of Non-Serving RL's

- **Compressed Mode and Uplink Transmission Gap**

⇒ Details for 10 ms E-DCH TTI

⇒ Downlink Power Control & Compressed Mode

- **Purpose of F-DPCH (associated with HSDPA)**
- **Preamble and Postamble in HSDPA Release 6**

HSUPA Protocol Enhancements and Extensions

- **HSUPA and DPCH Operation – HSUPA Setup**

⇒ RRC and NAS Signaling for E-DCH Setup
RRC Connection Establishment Procedure, GMM Service Request & Activate PDP Context Request, RAB Assignment and Radio Bearer Setup, Activate PDP Context Accept

⇒ NBAP Messages for E-DCH Setup
Radio Link Setup Request and Response

- **Radio Resource Management**
- **E-DCH UTRAN Architecture**
MAC-d Flow Concept

⇒ MAC-e/es in UE

⇒ MAC-e in NodeB

⇒ MAC-es in SRNC

- **Data Flow through Layer 2**

  ⇒ MAC-d PDU Encapsulation into MAC-e PDU – UE Side
  MAC Multiplexing on E-DCH

  ⇒ Data Descriptor Indicator Mapping Table - Example
  E-DCH MAC PDU: Parameters of the involved MAC headers

  ⇒ MAC-d / Flow Interworking in UTRAN
  Data Flow from TCP/IP Layer to MAC-e, TCP/IP and RTP/UDP/IP Overhead Ratio, Practical Exercise: Calculate the throughput offered to applications on top of TCP/IP, MAC-e PDU – Inband Control Signaling in Uplink

- **Scheduling Info PDU**
  UL Scheduling information
- **E-DCH Frame Protocol – Data Frame Structure**

  ⇒ E-DCH FP Header
  Indication of HARQ Failure

  ⇒ E-DCH Payload
- **E-DCH / HS-DSCH Serving Cell Change – E1D**

Rel. 7 Amendments

- **HSUPA Feature Summary Rel. 7**
  Enhanced F-DPCH, Support of UL Slot Format #4

  ⇒ Example of HSUPA Category 7 UE with Multi-Code Operation
- **HSUPA Categories Rel.6 and Rel. 7**
- **Serving Grant Table 2 (Rel. 7)**
- **E-AGCH and E-DPCCH Amendments**
  Changes in the E-TFCI tables, Changes in the Absolute Grant table, Changes in the SG tables

Appendix-A: E-TFCI Tables for FDD

Appendix-B: Quantization Tables

Appendix-C: Quantization for delta_E-DPDCH

Appendix-D: Information Field Mapping

Appendix-E: HS-DSCH Categories

Solutions for Practical Exercises

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