HSPA
Network Optimization & Trouble Shooting

Course Duration:

- 4 days.

Course Description:

- This course is targeted at engineers and technicians who are involved in the operation, optimization and troubleshooting of UMTS Rel. 5 and 6 high speed networks.
- This fascinating blend of practical experience and theoretical knowledge is a must for everybody who shall tune a HSDPA and HSUPA network.
- Part 1 of the course starts with practical issues of nowadays HSDPA networks followed by hands-on exercises of important throughput calculations, then continues with the analysis of parameter settings found in drive-test logfiles and Iub protocol traces and finally shows you how to debug HARQ logfiles.
- The second part of the course starts with an in-depth refresher on HSUPA topics like new physical channels, HARQ and E-TFCI Selection, continues with the update of SG in UE and lets the student determine possible max throughput rates, followed by parameter analysis found in drive-test and Iub protocol traces.
- Both high speed parts focus on mobility issues like cell change procedure and SRNS relocation issues affecting the throughput.
- The course explains the KPI's and what problems can particularly throttle down the throughput in uplink and downlink and how to overcome these problems.

WCDMA EUL E-TFCI Usage

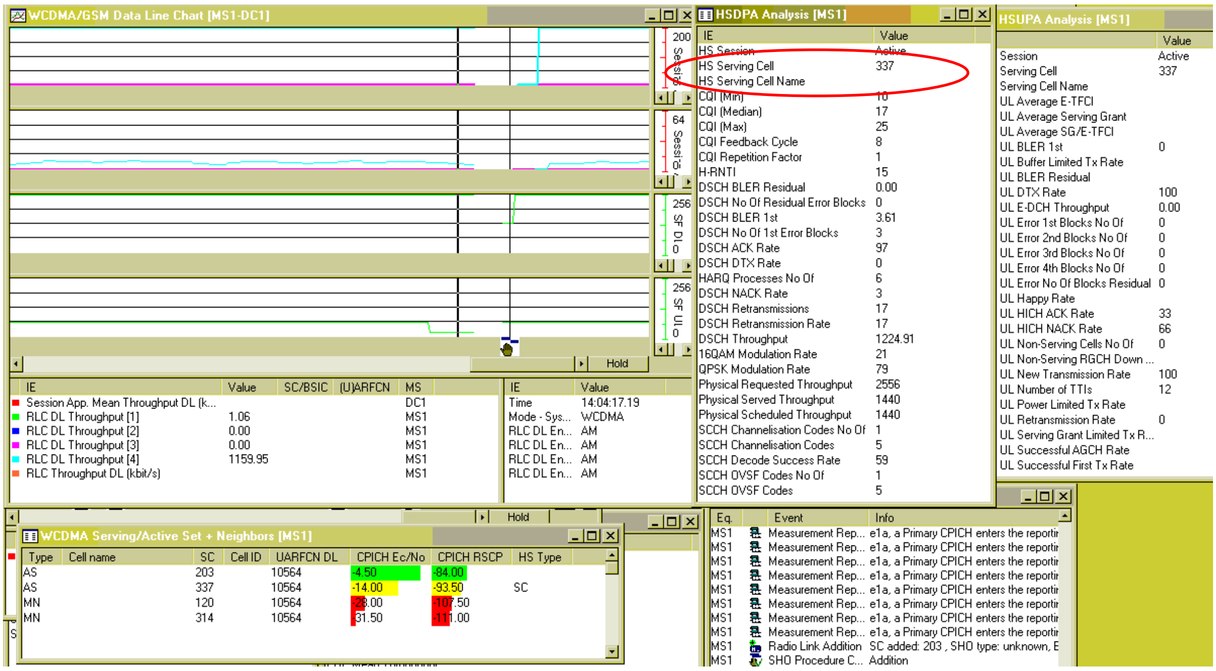
					Block Error Rate								
E-TFCI	Bits	Count	Usage	Avg SG	Total	TX 1	TX 2	TX 3	TX 4	TX 5	TX 6	TX 7	TX 8
0	18	3	0.05 %	0.00	0.00 %	0.00 %	0.00 %	-	-	-	-	-	-
1	186	4	0.07 %	6.00	0.00 %	0.00 %	-	-	-	-	-	-	-
3	354	80	1.30 %	11.25	1.19 %	1.25 %	0.00 %	-	-	-	-	-	-
7	690	12	0.20 %	23.08	0.00 %	0.00 %	-	-	-	-	-	-	-
15	1362	23	0.37 %	13.48	0.00 %	0.00 %	-	-	-	-	-	-	-
39	4740	37	0.60 %	18.00	1.88 %	2.03 %	0.00 %	-	-	-	-	-	-
47	6084	1	0.02 %	24.00	0.00 %	0.00 %	-	-	-	-	-	-	-
49	6420	7	0.11 %	19.00	12.50 %	14.29 %	12.50 %	12.50 %	0.00 %	-	-	-	-
65	9108	1	0.02 %	24.00	0.00 %	0.00 %	-	-	-	-	-	-	-
69	9780	21	0.34 %	21.00	0.00 %	0.00 %	-	-	-	-	-	-	-
75	10788	1	0.02 %	24.00	0.00 %	0.00 %	-	-	-	-	-	-	-
77	11124	1	0.02 %	24.00	0.00 %	0.00 %	-	-	-	-	-	-	-
83	12132	7	0.11 %	23.00	0.00 %	0.00 %	-	-	-	-	-	-	-
95	14148	1	0.02 %	24.00	0.00 %	0.00 %	-	-	-	-	-	-	-
97	14484	5941	96.76 %	24.00	0.50 %	0.42 %	4.29 %	7.35 %	5.00 %	-	-	-	-

Pre-Requisites:

- Participants need to be already familiar with UMTS and HSPA in particular. Experience in UMTS Rel. 99 optimization is advantageous.
- Customer should have collected Drive-test logs (e.g. TEMS, ROMES, XCA/XCAP, Agilent etc.) as well Iub- & Iu-ps Protocol Traces containing User Plane. The logs from the network are analyzed and used for immediate troubleshooting of flow control problems, HARQ retransmissions during cell change, throttled throughput, etc.

Course Target:

- The student understands the critical parameters of uplink and downlink high speed and learns how to optimize them in order to reach best throughput performance.
- The participant is able to counteract the negative impact of HSDPA and HSUPA on Rel. 99 bearers coexisting on the same carrier.
- Moreover the student is enabled to evaluate drive-test logs and Iub protocol traces so he/she can identify UE or NodeB or RNC related faults. The participant can then improve the KPI's based on parameter tunings and verify the improved performance.



Some of your questions that will be answered:

- Why there is still a Rel. 99 DCH, so called A-DCH needed for HS-DSCH operation?
- What HS-DSCH and E-DCH related parameters can be configured and reconfigured through e.g. Radio Bearer Setup, Radio Bearer Release, Radio Bearer Reconfiguration, Transport Channel Reconfiguration, Physical Channel Reconfiguration etc.?
- How can E-DCH and HS-DSCH coexist with Rel. 99 traffic on the same carrier without deteriorating RAB Success Rate / worsen Drop Rate?

- How can the F-DPCH enable the NodeB to serve more than 3 users simultaneously out of a pool of 15 HS-PDSCH's?
- Why does the HS-DSCH downlink throughput decrease in SHO and what are the possible countermeasures?
- What influences the CQI reporting in UE and how can the UTRAN deal with inaccurate CQI's in the long run?
- How can I identify faults in HS-DSCH Frame Protocol and RLC-AM throttling down the throughput?
- Why are frequent cell changes harmful for HS-DSCH performance and less for E-DCH?
- How to optimize the RLC-AM parameters (e.g. MaxDAT, timerPoll, transmissionWindowSize, pollPDU, inSequenceDelivery, timerStatusProbhibit etc.) of bearers mapped on HS-DSCH and E-DCH?
- Why is suddenly a RLC PDU size of 656 bits necessary for HSDPA Cat 8?
- What is the purpose of MAC-hs, Window Size and Reorder Release Timer T1 and how can they be optimized for different QoS requirements?
- What are the effective throughput rates at application layer for HS-DSCH and E-DCH considering UTRAN and TCP/IP (or RTP/UDP/IP) protocol overhead?
- How to tune power control parameters to reduce missed TTI's and ACK/NACK misdetections in UE and NodeB for HS-DSCH and E-DCH operation?
- How can I interpret the parameters of HS-SCCH (e.g. code group indicator, code offset indicator, NDI X(RV) etc.) and debug HARQ logfiles?

scch demod	scch_valid	HS-DSCH status	new transmission	code_group indicator	code_offset indicator	modulation scheme	harq process_id	Redundancy version_xrv	HS TB_size	uncoded quantized CQI	The UE has transmitted
Attempted	TRUE	CRC NOK	new Tx	4	1	(1) 16QAM	2	0	6101	31	NACK
Attempted	TRUE	CRC NOK	new Tx	4	1	(1) 16QAM	3	0	6101	18	NACK
Attempted	TRUE	CRC OK	new Tx	4	1	(1) 16QAM	4	0	4420	31	ACK
Attempted	TRUE	CRC NOK	new Tx	4	1	(1) 16QAM	5	0	4420	18	NACK
Attempted	TRUE	CRC NOK	new Tx	4	1	(1) 16QAM	1	0	4748	31	NACK
Attempted	TRUE	CRC NOK	new Tx	4	1	(1) 16QAM	0	0	4748	17	NACK
Attempted	TRUE	CRC OK	Re-Tx	4	1	(1) 16QAM	2	3	6101	31	ACK
Attempted	TRUE	CRC NOK	Re-Tx	4	1	(1) 16QAM	3	3	6101	15	NACK
Attempted	TRUE	CRC NOK	new Tx	4	1	(1) 16QAM	4	0	4420	31	NACK
Attempted	TRUE	CRC OK	Re-Tx	4	1	(1) 16QAM	5	2	4420	13	ACK
Attempted	TRUE	CRC OK	Re-Tx	4	1	(1) 16QAM	1	2	4748	31	ACK
Attempted	TRUE	CRC OK	Re-Tx	4	1	(1) 16QAM	0	2	4748	14	ACK
Attempted	TRUE	CRC OK	new Tx	3	1	(0) QPSK	2	0	2404	31	ACK
Attempted	TRUE	CRC OK	Re-Tx	4	1	(1) 16QAM	3	2	6101	18	ACK
Attempted	TRUE	CRC OK	Re-Tx	4	1	(1) 16QAM	4	2	4420	31	ACK

- How does compressed mode work with both high speed technologies and how is the impact on throughput?
- Can I mitigate the negative impact of HS-DSCH transmission on Rel. 99 traffic operating on the same carrier? And what is the impact of E-DCH transmission on Rel. 99 uplink bearers?
- How can I convert a certain SG into throughput taking the list of reference E-TFCI's and power offset into account?
- Is HS-DSCH transmission superior than Rel. 99 in pilot polluted areas with Ec/No < -14 dB?
- Under what conditions is a non serving E-DCH cell allowed to send a relative grant Down?

Who should attend this class?

- Network operator staff who are involved in the optimization of HSDPA and EUL and who need to continuously improve the network performance.
- System vendors who are involved in second and third level troubleshooting activities of HSPA.

Table of Content:

Part I: HSDPA Optimization & Trouble Shooting

Chapter 1: HSDPA in Practice

- **Logical Channel, Transport Channel and Physical Channel Details**
  - ⇒ Practical Exercise: Name all the physical channels involved in HSDPA Rel. 5 operation
- **Channel Type Switching (possible RRC State changes with and w/o HSDPA)**
  - ⇒ Practical Exercise: Determine the RRC State(s) where HS-DSCH transmission is allowed!
- **Gross Throughput Calculations**
  - ⇒ HSDPA category table and IR performance
  - ⇒ Stop & Wait scheme with minimum HARQ RTT of 12 ms
  - ⇒ Possible throughput rates considering various practical code rates R
  - ⇒ Practical Exercise: Determine the physical throughput rate of Cat 8 UE with 10 HS-PDSCH's; 16-QAM and R = 2/3
- **CQI Reporting**
  - ⇒ Purpose of CQI: Equal distribution of 30 CQI values over SNR range
    CQI change by 1 corresponds to app. 1 dB power variation on HS-DSCH
  - ⇒ Practical Exercise: Work out the min. time between the radio conditions leading to an extreme good CQI report and the time instance the UE receives the actual related HS-DSCH block?
    What is the min. CQI necessary to tempt the NodeB to go for a code rate 2/3 & 16-QAM?
- **Compressed Mode & HSDPA**
  - ⇒ Reasons for CM: AMR 12.2 kbit/s and HSDPA, Inter Frequency HO, Cell Change Order 3G ➔ 2G
  - ⇒ Option 1: A-DCH in CM and HS-XXXCH applying higher layer scheduling

⇒ Option 2: Reconfiguration to Rel. 99 DCH/DCH only
384kbit/s DL & 64 kbit/s UL, Start and stop of Radio Bearer during Inter Frequency HO

⇒ Practical Exercise: Determine the CM method, parameter and pattern(s) for Inter Frequency HO and Inter RAT HO from a live trace

- **HSDPA Downlink Channel Power**

⇒ Method 1: Assign HS-PDSCH's and HS-SCCH's a fix max. power value

⇒ Method 2: Allow HS-PDSCH's and HS-SCCH's to use always the left over on available power in the cell

⇒ Impact of HSDPA transmit power on UE's camping in idle mode
Ec/No deterioration at cell edge, ping pong 3G ⇔ 2G cell reselections, study case: MPO reduction of 2 dB and CPICH power increase of 2 dB ➔ reduced IRAT cell reselections

⇒ Impact of HSDPA transmit power on Rel. 99 in CELL_DCH and CELL_FACH on the same carrier
Bearers over A-DCH (SRB) and Rel. DCH drop more often in case of high load / weak Ec/No

⇒ Practical Exercise: Determine the HS-PDSCH reference power for CQI reporting based on P-CPICH TX Power (e.g. 1 W), Measurement Power Offset Γ (value: 18 to be converted in dB) and path-loss of 110 dB!

- **HS-SCCH Power Control**

⇒ Possibility 1: Fix power offset for HS-SCCH TTI relative to A-DCH

⇒ Possibility 2: Closed loop power control with CQI and ACK/NACK/DTX decoding performance

⇒ Practical Exercise: What is the impact on HS-SCCH Power Control when the A-DPCH power benefits from SHO gain (typically 3 dB)?

- **HS-DPCCH Decoding Success**

⇒ Improve Gain settings of ß(hs) for ACK, NACK and CQI

⇒ Problem: SHO enforces lower power on uplink DPCCH
Problem mitigation in case of HS-DPCCH softer handover in NodeB

⇒ Practical Exercise: Determine the power offset for HS-DPCCH relative to DPCCH using a quantized amplitude ratio of 24/15!

- **HS-PDSCH's and Rel. 99 Code Shortage**

⇒ Alternative 1: Introduce 2nd Frequency F2 beside F1
F1 is for Idle mode & Rel. 99 traffic, F2 is the HSDPA preferred layer

⇒ Alternative 2: Allow Secondary Scrambling Code on F1
HS-PDSCH's and HS-SCCH's on Secondary Scrambling Code, Impact on Admission and Congestion Control, Transmitted Carrier Power Utilization

⇒ Alternative 3: Flexible code tree management

Dynamic code tree handling instead of static HS-PDSCH's and HS-SCCH's

⇒ Practical Exercise: Try to assign 15 HS-PDSCH's to an OVSF-tree under the primary scrambling code on F1 and another time on F2.
Please consider:
- 3 x SF256 should be used for A-DCH's as 3 users should be in CELL_DCH,
- allocate the common channels P-CPICH and P-CCPCH to their mandatory fix channelization codes,
- allocate AICH and PICH on the next possible channelization codes,
- use separate S-CCPCH for PCH and FACH (assign FACH1 for SRB0 and FACH 2 for 32 kbit/s PS)
- how is the code shortage improved / fixed with F-DPCH in Rel. 7?

- **RLC Single Sided Re-establishment**

⇒ Reasons behind 336 bits and 656 bits RLC-AM PDU size

⇒ Practical Exercise: Determine the RLC-PDU sizes in a live trace!
Work out the potential data loss when RLC-AM PDU size gets reconfigured from size "656" to "336" one time with single sided RLC reestablishment and another time without that feature (⇔ Rel. 99)!

- **SIB-5 Enhancement: Indication of HS capable Cell**

⇒ Flag: HS-DSCH capable cell, Flag: E-DCH capable Cell

Chapter 2: Hands-on Exercises

- **HSDPA Protocol Stack**

⇒ Rel. 5: DTCH's only mapped on HS-DSCH

⇒ Rel. 6: DCCH's can be alternatively mapped on HS-DSCH

⇒ Practical Exercise: How long would it take to transmit a Radio Bearer Reconfiguration via HS-DSCH?
Considerations: RB Reconfiguration consists of 4 segments each one with a RLC-AM PDU size of 144 bits and on HS-DCH a SRB speed of 28.8 kbit/s is employed?

⇒ MAC-d Flow replacing Rate Matching Attribute and TrCH Multiplexing

⇒ Practical Exercise: Determine the MAC-d flow parameters one time for the UE and another time for the NodeB based on live traces! What parameters are needed to support Streaming QoS?

- **MAC-hs Protocol PDU**

⇒ MAC-hs header parameter details
Questions to be answered:
Can several MAC-d flows (e.g. DCCH and DTCH be multiplexed into the same TTI?
Can there be MAC-d flows with more than one RLC-AM PDU size configured?
How is RRC Signaling transmitted in a separate MAC-d flow and how is the treatment of the control plane in HS-Scheduler?

- **Practical Exercises: Exhaustive Throughput Calculations**

  ⇒ Application Layer throughput of Cat 8 UE
  Max possible rates on Physical Layer Throughput, MAC-hs Throughput, RLC-AM throughput, TCP/IP Throughput with and w/o PDCP, RTP/UDP/IP Throughput with and without PDCP

  ⇒ Required minimum uplink RLC bearer capacity for a Cat 8 UE
  Consideration of max TCP/IP throughput, Delayed TCP ACK (e.g. every 2nd TCP/IP frame gets acknowledged), TCP/IP SDU size = 40 bytes (no special options), RLC-AM PDU size in uplink is 336 bits

- **Scheduler Performance**

  ⇒ Scheduling Types
  Max-C/I, Proportional Fair Resource/Throughput; Opportunistic Scheduling with the help of CQI (~ 6ms between CQI reporting and earliest possible HS-DSCH reception)

  ⇒ Inaccurate CQI Reporting
  Correction of wrong CQI taking the ACK/NACK ratio into account, Weighting the deviation of actual ACK/NACK ratio relative to desired BLER of 10%

Chapter 3: Drivetest Analysis

- **RRC messages and parameter**

  ⇒ Radio Bearer Details
  Setting of parameter values for MaxDAT, TimerPoll, TimerPollProhibit, TX/RX Window Size, Missing PDU Indicator, In-Sequence Delivery, TimerStatus, TimerStatusProhibit, etc.

  ⇒ Uplink Bearer Transport Format Combination
  Purpose of CTFC (TFCI), flexible uplink bearer throughput rates from 0k, 16k, 32k, …384k

  ⇒ MAC-hs Configuration in UE and NodeB
  Number of HARQ processes and memory partioning, MAC-hs Window Size and Reorder Release Timer, Size Index, Priority Queue

  ⇒ Meaning of Minimum E-TFCI (HSUPA)
  NodeB lets the UE starve without SG, what is the SG needed for 3 Mbit/s HS-DSCH download and what is recommended for uplink TCP-ACK transmission?

```
|2.1.1.2.1.1.1.8.3.1 dl-TransportChannelType                                              |
|          |2.1.1.2.1.1.1.8.3.1.1 hsdsch                |0 ⇔ specifies that HS-DSCH has to be used |
|2.1.1.2.1.1.1.8.3.2 tfs-SignallingMode                                                   |
|2.1.1.2.1.1.1.8.3.2.1 hsdsch                                                             |
|2.1.1.2.1.1.1.8.3.2.1.1 harqInfo ⇔ Hybrid Automatic Repeat Request Information           |
|----101- |2.1.1.2.1.1.1.8.3.2.1.1.1 numberOfProcesses  |6 ⇔ 6 Stop and Wait Processes / HARQ |
|2.1.1.2.1.1.1.8.3.2.1.1.2 memoryPartitioning ⇔ soft memory distribution among the HARQ Processes |
|          |2.1.1.2.1.1.1.8.3.2.1.1.2.1 implicit       |0 ⇔ equal softmemory for all 6 HARQ Processes |
|2.1.1.2.1.1.1.8.3.2.1.2 addOrReconfMAC-dFlow ⇔ MAC-d Flow addition or Reconfiugration    |
|2.1.1.2.1.1.1.8.3.2.1.2.1 mac-hs-AddReconfQueue-List              MAC-hs configuration   |
|2.1.1.2.1.1.1.8.3.2.1.2.1.1 mAC-hs-AddReconfQueue                                        |
|***b3*** |2.1.1.2.1.1.1.8.3.2.1.2.1.1.1 mac-hsQueueId   |0 ⇔ MAC-hs Queue ID = 0            |
|-000---- |2.1.1.2.1.1.1.8.3.2.1.2.1.1.2 mac-dFlowId     |0 ⇔ MAC-d flow ID = 0 associated with Queue 0 |
|----0100 |2.1.1.2.1.1.1.8.3.2.1.2.1.1.3 reorderingRel..|rt50 ⇔ Reordering Release Timer = 50 ms |
|100----- |2.1.1.2.1.1.1.8.3.2.1.2.1.1.4 mac-hsWindowS..|mws16 ⇔ MAC-hs Window Size = 16    |
|2.1.1.2.1.1.1.8.3.2.1.2.1.1.5 mac-d-PDU-SizeInfo-List                                    |
|2.1.1.2.1.1.1.8.3.2.1.2.1.1.5.1 mAC-d-PDUsizeInfo                                        |
|**b13*** |2.1.1.2.1.1.1.8.3.2.1.2.1.1.5.1.1 mac-d-PDU..|336 ⇔ MAC-d PDU Size                |
|---000-- |2.1.1.2.1.1.1.8.3.2.1.2.1.1.5.1.2 mac-d-PDU..|0 ⇔ MAC-d PDU Size Index 0          |
|2.1.1.2.1.1.1.9 ul-ChannelRequirement                                                    |
|2.1.1.2.1.1.1.9.1 ul-DPCH-Info                                                           |
|2.1.1.2.1.1.1.9.1.1 ul-DPCH-PowerControlInfo                                             |
|2.1.1.2.1.1.1.9.1.1.1 fdd                                                                |
|***b7*** |2.1.1.2.1.1.1.9.1.1.1.1 dpcch-PowerOffset    |-43 ⇔ -86 dB DPCCH Power Offset
To be used when Synchronization Procedure B has to be used
DPCCH_Initial_power = DPCCH_Power_offset - CPICH_RSCP
```

⇒ Uplink HS-DPCCH Power
ß(hs) for ACK and NACK, Pro and Con of ACK/NACK repetitions

⇒ CQI Configuration
ß(hs) for CQI, Pro and Con of CQI repetitions, feedback cycle and measurement power offset Γ

- **HARQ Process Analysis**

⇒ HS-SCCH Decoding
Code Group Indicator and Code Offset Indicator (number of HS-PDSCH's), TBS, modulation type, HARQ process ID, new/retransmission, redundancy & constellation version
Practical Exercise: Determine why certain processes hang in retransmissions

⇒ ACK/NACK mis-detection by NodeB

⇒ Practical Exercise: How to distinguish retransmission types Full IR, Partial IR and Chase Combining?

- **MAC-hs Decoding and Stall Avoidance**

⇒ MAC-hs window size and reorder release timer verification
Practical Exercise: Find out the various conditions for T1 to expire or terminate

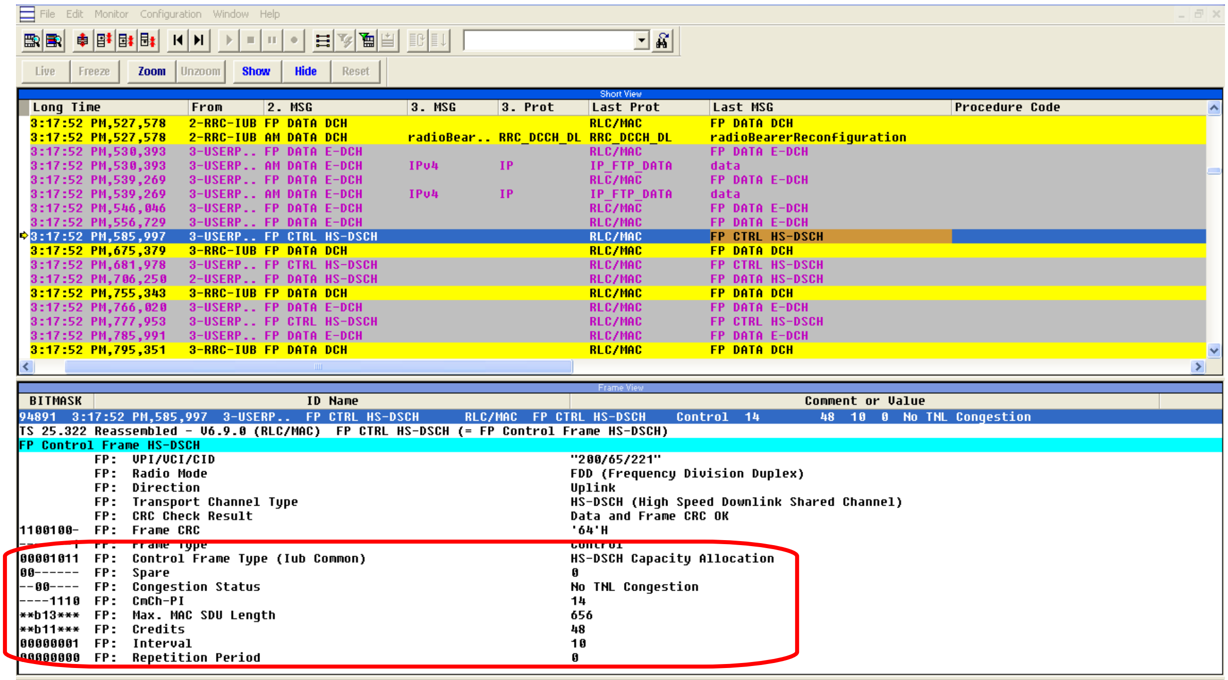
- **Determine optimum RLC parameter settings**

⇒ Considering HARQ retransmissions, MAC-hs window size & T1, uplink DCH bearer

- **Release 6 HSDPA Improvements**
  - ⇒ Preamble and Postamble for better ACK/NACK from DTX distinction in NodeB
    Lower gain settings for ACK/NACK
  - ⇒ Active Set Update message capable of HS-DSCH cell change
  - ⇒ DCCH on HS-DSCH
  - ⇒ F-DPCH
    Fully supported or not fully supported
- **Etheral/Wireshark Trace**
  - ⇒ Practical Exercise: Determine TCP parameters
    MSS, SACK, RX/TX Window Size, RTT

Chapter 4: Iub Protocol and KPI Analysis

- **NBAP Physical Shared Channel Reconfiguration message**
  - ⇒ Max TX Power to be allowed for HS-PDSCH & HS-SCCH in dBm
  - ⇒ Scrambling code on which HS-PDSCH and HS-SCCH is transmitted
  - ⇒ HS-PDSCH & HS-SCCH channelization code Information



- **Purpose of NBAP Radio Link Parameter Update message**
  ⇒ Possibility for NodeB to change CQI feedback cycle; ACK, NACK, CQI PO and Repetition Factor
- **Iub Flow Control Management for HS-DSCH**
  ⇒ NodeB's Capacity Allocation
  CmCh-PI, Number of Credits, MAC-d SDU Length of 336 bits (656 bits), Interval, Repetition Period
  ⇒ SRNC's Capacity Request
  User Buffer Size
  ⇒ HS-DSCH Data Frame
  CmCh-PI, MAC-d PDU Length, Flush, Number of MAC PDU, User Buffer Size
  ⇒ Practical Exercise: Judge good from bad HS-DSCH flow control based on 'Credits allocated' versus 'Credits utilized' versus 'User Buffer Size' graph
- **Performance Measurements**
  ⇒ HARQ NACK ratio, number of concurrent users per cell
  ⇒ HS-PDSCH's utilization, Transmitted Carrier Power (non HSDPA)
  ⇒ Cell throughput over HS-DSCH (i.e. per scheduling priority)

Chapter 5: HSDPA Mobility Performance

- **MAC-hs Reset Impact on Throughput**
  ⇒ MAC-hs preservation feature for Intra NodeB cell change
  HARQ and MAC-hs details can be forwarded within NodeB channel cards
  ⇒ Data loss or RLC-AM retransmissions
  RLC-UM has to live with data loss, RLC-AM retransmissions are invoked from SRNC
- **HSDPA Performance in Pilot polluted Areas**
  ⇒ A-DCH in SHO with e.g. 3 Cells and Ec/NO < - 14 dB
  Enhanced performance requirements type 1 (receiver diversity), Enhanced performance requirements type 2 (chip equalizer)
  ⇒ Possible Fallback to Rel. 99 DCH/DCH?
- **HSDPA Cell Changes**
  ⇒ Inter Iub cell change
  Possible Trigger: Event 1D, Event 1A, Event 1C
  ⇒ Inter RNC with and w/o Iur
  Reconfiguration to DCH/DCH (no HS-DSCH support on Iur), Outward and Inward Mobility
- **SRNS Relocation**
  ⇒ Iur not supported or not in use for HS

RRC Connection Release with Cause directed signalling connection re-establishment

⇒ UE involved or not involved SRNS Relocation
Routing Area Update, UTRAN Mobility Information Confirm

Part II: HSUPA Optimziation & Troubleshooting

Chapter 6: HSUPA Refresher

- **Logical Channel, Transport Channel and Physical Channel Details**

  ⇒ Practical Exercise: Name all the physical channels involved in HSUPA Rel. 6 operation

- **Channel Type Switching and Bit Rate Adaptation**

  ⇒ Practical Exercise: Determine the possible TrCH combinations in CELL_DCH for uplink and downlink with HS-DSCH, E-DCH and A-DCH.

- **HARQ with 2 ms or 10 ms TTI**

  ⇒ HARQ_RTT values

  ⇒ Configuration of Full IR, Partial or Chase considering the code rate R
  Deterministic retransmissions depending on code rate R and RV-table

  ⇒ Practical Exercise: Determine the retransmission scheme applied by UE for the 4th retransmission of process X considering a TTI of 2 ms and an initial code rate R of 2/3! (refer to the parameters from the live trace)

- **Throughput and E-TFCI Calculations**

  ⇒ HSUPA category table
  Purpose of Puncturing Limit PL on SF-Selection, PLnon-max and Plmax

  ⇒ E-TFCI comparison of various vendors
  Analysis of the best E-TFCI Scaling taking the downlink pathloss, UE TXPower and ul DPCCH SIR into account

  ⇒ Expected Noise Rise due to E-DCH
  RTWP rise due to E-DCH transmission in conjunction with mixed traffic (R99 CS and PS)

  ⇒ Non-Scheduled transmission – Guaranteed Throughput
  Delay critical CS services and control plane obtain NodeB scheduler independent guaranteed throughput rates

Serving Grant			SGP unquantized Calculations			
Value	index	Power Offset	Ke,ref	Aed,ref	Le,ref	Ke,j
6.33	24	16.0	12468	4	2	15628.29
5.60	23	15.0	11124	3.53	2	12467.00
5.00	22	14.0	11124	3.53	2	11137.86
4.47	21	13.0	9780	3.13	2	9937.17
4.00	20	12.0	186	0.6	1	8266.67
3.53	19	11.0	186	0.6	1	6450.30
3.13	18	9.9	186	0.6	1	5072.52
2.80	17	8.9	186	0.6	1	4050.67
2.53	16	8.1	186	0.6	1	3315.85
2.27	15	7.1	186	0.6	1	2654.52
2.00	14	6.0	186	0.6	1	2066.67
1.80	13	5.1	186	0.6	1	1674.00
1.60	12	4.1	186	0.6	1	1322.67
1.40	11	2.9	186	0.6	1	1012.67
1.27	10	2.1	186	0.6	1	828.96
1.13	9	1.1	186	0.6	1	663.63
1.00	8	0.0	186	0.6	1	516.67
0.87	7	-1.2	186	0.6	1	388.07
0.80	6	-1.9	186	0.6	1	330.67
0.73	5	-2.7	186	0.6	1	277.85

Theoretical max TBS / Ke,j according to formula, but Ke,j ist not allowed to exceed the next Ref-ETFCI value of 12468 thus 13971.33 is reduced to 12467 Bits

Note: The TBS freezes for Ke,ref(1) = 186 at 9779 bits
Similar: For Ke,ref(2) = 9780 the Ke,j freezes at 11123 bits

⇒ ß(ed,j,harq)/ßc Amplitude Ratio
Reference E-TFCI list and reference power offset

⇒ Possible throughput rates as a function of the Serving Grant and Reference E-TFCI(s)
HARQ Power Offset purpose to decrease the initial BLER

⇒ Practical Exercise: Determine the critical TBS where the HSUPA switches to lower SF or to multi-code operation!
At what TBS does the SF change from SF8 to SF4, SF4 to 2xSF4, 2xSF4 to 2xSF2 and 2xSF2 to 2xSF2 + 2xSF4 considering a PLnon-max = 0.84 and another time PLnon-max = PLmax = 0.44?

⇒ Practical Exercise: 10ms TTI E-DCH E-TFC Restriction
The purpose is to verify that the UE stops using a currently employed E-TFC when its remaining power margin is not sufficient to support that E-TFC, and resumes using that E-TFC when its remaining power margin is sufficient to support it.

- **Compressed Mode of HSUPA**

⇒ Scaling down of SG in case of 10 ms TTI
Sort of "Higher Layer Signaling" in case of 2 ms TTI

- **Message Flow for a PDP Context Activation and HSPA Serving Cell Change**

⇒ Practical Exercise: Complete the prepared message flows of PDP Context Activation and HSPA Serving Cell Change.
Fill in the correct RRC message names, RRC states and vital IE's based on the description provided.

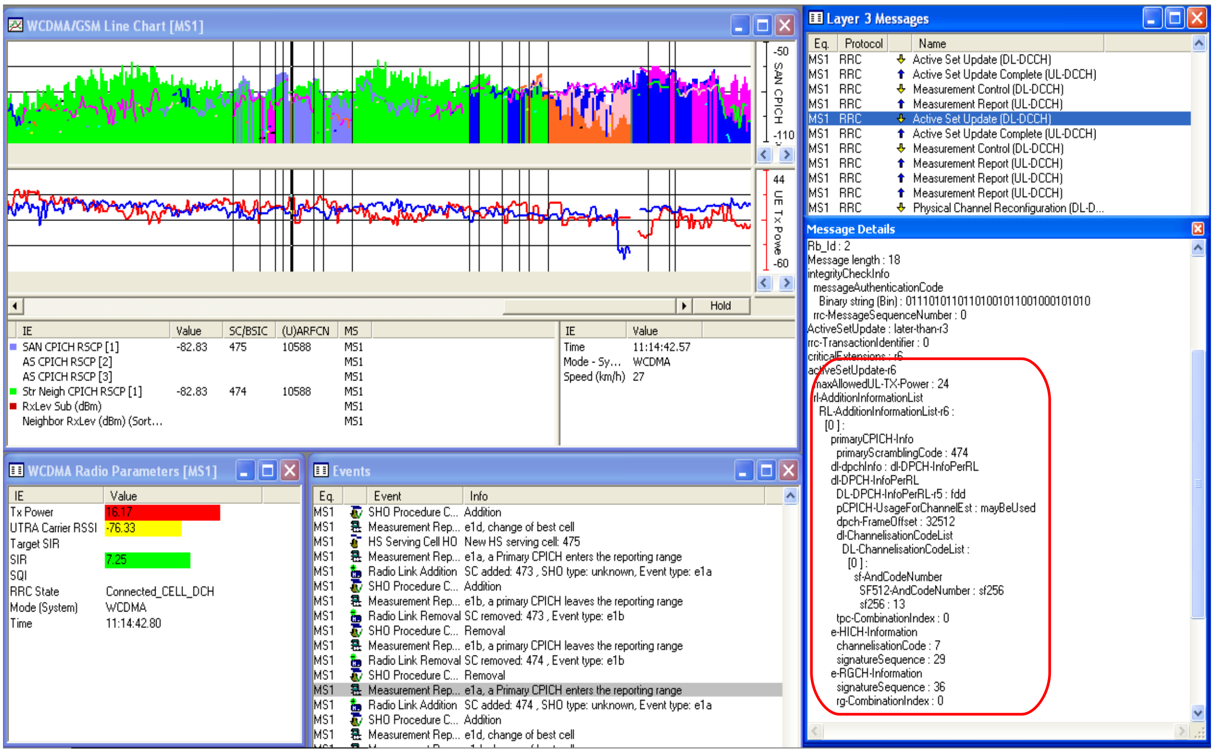
Chapter 7: HSUPA in Practice

- **Relative versus Absolute Grant**
  - ⇒ Serving Grant Update
    Relative Grant DOWN from non-serving cell, Relative Grant UP from serving cell, Secondary or Primary Absolute Grants, 3-index and 2-index threshold
  - ⇒ Practical Exercise: Determine the new SG for new and retransmissions after a Relative Grant DOWN!
    What happens to retransmissions if continues DOWN's are received?
- **Primary versus Secondary E-RNTI**
  - ⇒ Monitoring of one or two E-RNTI's
    Group Scheduling, Individual Scheduling, Time Rate Scheduling
- **HSUPA Protocol Stack**
  - ⇒ Difference between scheduled and non-scheduled MAC-d flows
    Minimum Set E-TFCI, MAC-d Flow Multiplexing, SRB on E-DCH
  - ⇒ MAC-e/es PDU header
    Data Descriptor Indicator
  - ⇒ Practical Exercise: Calculate the application layer throughput for a Cat 6 UE taking TCP/IP overhead into account!
    RLC-AM PDU size = 336 bits, no MAC-d flow multiplexing ⇔ only a single DDI is used, no PDCP header compression, MTU size = 1460 Bytes, no special options for TCP and IP frames

Chapter 8: Drivetest Analysis

- **Parameter Analysis of a HSPA Radio Bearer Setup**
  - ⇒ E-DCH and E-DCH MAC-d flow parameter
    Max Number of Retransmissions, Power Offset, E-DCH TTI, RLC PDU Size List, Scheduling Info etc.
  - ⇒ E-DPDCH and E-DPCCH parameter
    E-DPCCH PO, Happy Bit Delay Condition, E-TFCI Table Index, Reference E-TFCI and E-TFCI PO, PLnon-max, Periodicity for SI
  - ⇒ Radio Link related Parameter
    Serving E-DCH Radio Link Indicator, E-AGCH Info, E-HICH Info (channelization code and signature sequence), E-RGCH Info (RG Combination Index, signature sequence), TPC Combination Index
  - ⇒ Practical Exercise: Which RRC messages can start, stop and/or reconfigure HSUPA?
    Selection: {RRC Connection Setup, Radio Bearer Setup, Radio Bearer Release, Radio Bearer Reconfiguration, Transport Channel Reconfiguration, Physical Channel Reconfiguration, Cell Update Confirm, Active Set Update, RRC Connection Release}

- **Throughput Analysis**
  - ⇒ SG versus E-TFCI
    Happy Bit rate, Scheduling Info with UPH and buffer load
- **Active Set Update**
  - ⇒ E-DCH soft and softer Handover – Serving E-DCH RLS
    TPC Combination Index and RG Combination Index
  - ⇒ Practical Exercise: How many channelization codes must a UE receive in downlink considering a max Active Set Size of 6 for Rel. 99 and a max Active Set Size of 4 for E-DCH related RL's.



- **HARQ Process Analysis**
  - ⇒ Verification of SG, TBS, ACK/NACK, RSN
- **Etheral/Wireshark Trace Analysis**
  - ⇒ FTP Upload

Chapter 9: Iub Protocol and KPI Analysis

- **NBAP Physical Shared Channel Reconfiguration**
  - ⇒ E-AGCH, E-RGCH and E-HICH code reservation

⇒ Maximum transmission power to be allowed for HS-PDSCH, HS-SCCH; E-AGCH, E-RGCH and E-HICH codes over cell portion

⇒ Uplink RTWP and E-DCH total power
Maximum target RTWP, Reference RTWP, Target non-serving E-DCH to total E-DCH power ratio

⇒ Practical Exercise: What are the criteria's which have to be fulfilled so that an E-DCH non serving cell is allowed to send RG DOWN? (two items)

- **E-DCH Frame Protocol Analysis**

⇒ HARQ failure indication
Setting of CFN and Subframe Number, Number of MAC-es PDUs, Number of HARQ Retransmissions

⇒ SIR target update for uplink DPCCH ⇔ Outer Loop Power Control
Influence of HARQ retransmissions, HARQ failure indications

- **RLC-AM Performance**

⇒ Optimum parameter settings for user RAB and SRB's
TimerPoll, TimerPollProhibit, MaxDAT, MaxRST, In-SequenceDelivery, TimerStatusProhibit, PollWindow, PollPDU, PollSDU etc.

- **Performance Measurements**

⇒ Total RTWP

⇒ Provided bit rate per LCH priority per cell

Chapter 10: HSUPA Mobility Performance

- **MAC-e/es Reset Impact on Throughput**

⇒ E-DCH TTI Change (2 ms ⇔ 10 ms)

⇒ E-DCH Cell Change
Event 1D, Soft and Softer Handover, Inward and Outward Mobility

- **E-DCH Synchronized Cell Change Procedures**

⇒ Intra-Node B synchronized serving E-DCH cell change

⇒ Inter-Node B (intra RNC) synchronized serving E-DCH cell change

⇒ RNSAP support for E-DCH
Fallback to Rel. 99 DCH