

# High Speed Downlink Packet Access

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# Agenda

- HSDPA Overview
- HSDPA Basic Principles
- HSDPA Channels & Bearers
- HSDPA Connection Handling
- HSDPA Mobility

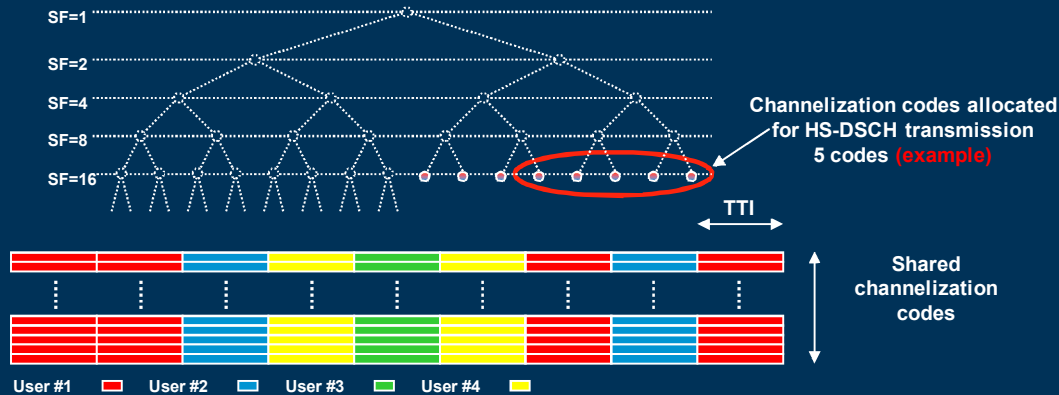
# What's NEW ?

- **Fixed set of codes shared between users**
- **Adaptive Modulation**
- **A new measure of Radio quality - CQI : Channel Quality Indicator, Fast Adaptation/Scheduling based on CQI.**
- **New MAC-hs for faster scheduling in Node B !**
- **2 ms TTI (Transmission Time Interval) for lesser delay.**
- **Best effort service.**



# Shared Channel Transmission

- A set of radio resources dynamically shared among multiple users, primarily in the time domain



- In P5, up to 15 codes (SF16) can be allocated and shared between the users. It also depends on what the UE can support.

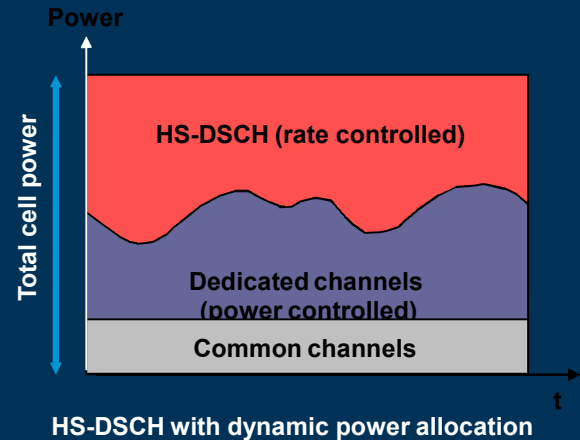
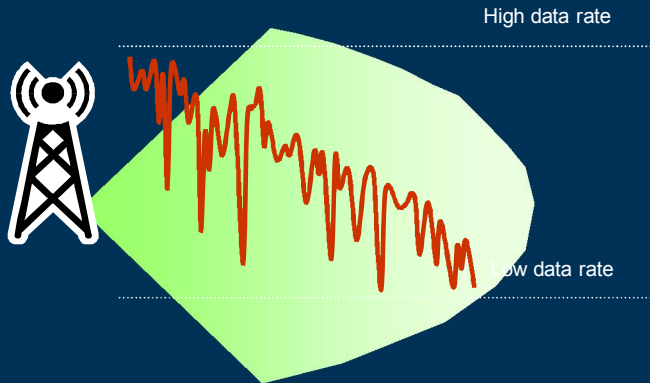
# CQI – Channel Quality Indicator

- UE sends CQI info in the UL to aid rate adaptation and scheduling
- CQI (1-30) provides the Node B with a measure of the UE's perceived channel quality and the UE receiver performance
- The CQI report estimates the number of bits that can be transmitted to the UE using a certain assumed power with a block error rate of 10%
- UE assumes a HS- PDSCH power to calculate CQI

$$P_{\text{HS\_assumed}} = \text{RSCP}_{\text{CPICH}} + \text{hsMeasurementPowerOffset} + \Delta$$

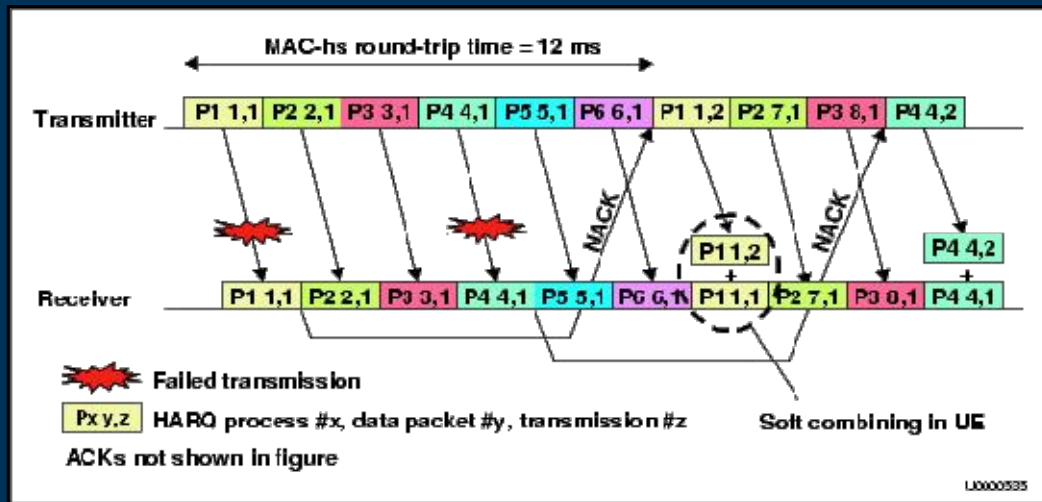
# Fast Link Adaptation

- Rate control
  - Adjusts data rate based on the Radio conditions (CQI)
  - Fast Adaptation : 2 ms TTI basis
  - Adaptive Modulation (QPSK and 16 QAM) and Coding
  - Use “available power”



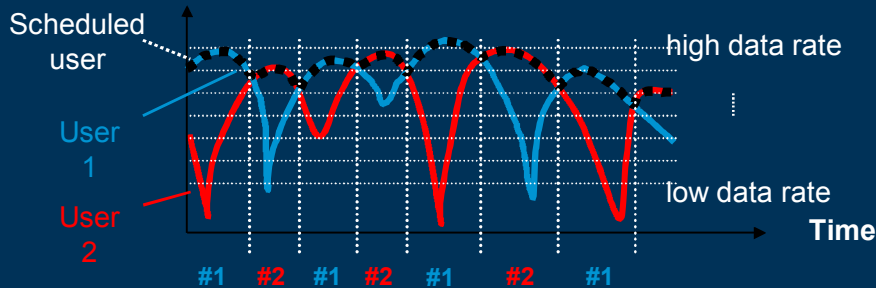
# Fast Hybrid ARQ with Soft Combining

- Rapid retransmissions of erroneous data
  - Hybrid ARQ protocol terminated in Node B  
⇒ short RTT (typical example: 12 ms)
  - Soft combining in UE of multiple transmission attempts  
⇒ reduced error rates for retransmissions



# Fast Channel-dependent Scheduling (MAC-hs)

- Scheduling => which UE to transmit to at a given time instant and at what rate
  - MAC-hs (a new MAC sub-layer in RBS)
- Basic idea: transmit at fading peaks
  - May lead to large variations in data rate between users





# MAC-hs Functions

## Resource Estimation

- Estimation for available HS-PDSCH power and codes
  - $P_{HS} = P_{max} - \text{hsPowerMargin} - P_{non-HS}$
  - $P_{HSPDSCH} = P_{HS} - P_{HSSCCH}$
- HS-SCCH power is set with reference to CPICH
- Code information available from RNC

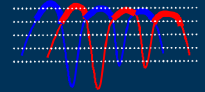
## Queue Validation

- Data to transmit is available
- ADCH in uplink in synch for the UE
- UE's minimum TTI capability is ok
- Adjusted CQI exists for the UE
- Suitable HARQ process exists
- MAC-hs transmission window is not full

## Queue Selection

- $f(\text{CQI})$
- $f(\text{delay})$
- $f(\text{average rate})$

# Queue Selection Algorithms



- Ericsson supports the following Scheduling Algorithms and is configurable per Node B (*queueSelectAlgorithm*)
  - Round Robin (RR) – Ericsson Recommended
    - Cyclically assign the channel to users without taking channel conditions into account
    - Simple but poor performance
  - Proportional Fair (PF) – Cingular Requested
    - Assign the channel to the user with the best relative channel quality
    - High throughput, fair
  - Max C/I Ratio
    - Assign the channel to the user with the best channel quality
    - High system throughput but not fair

# Agenda

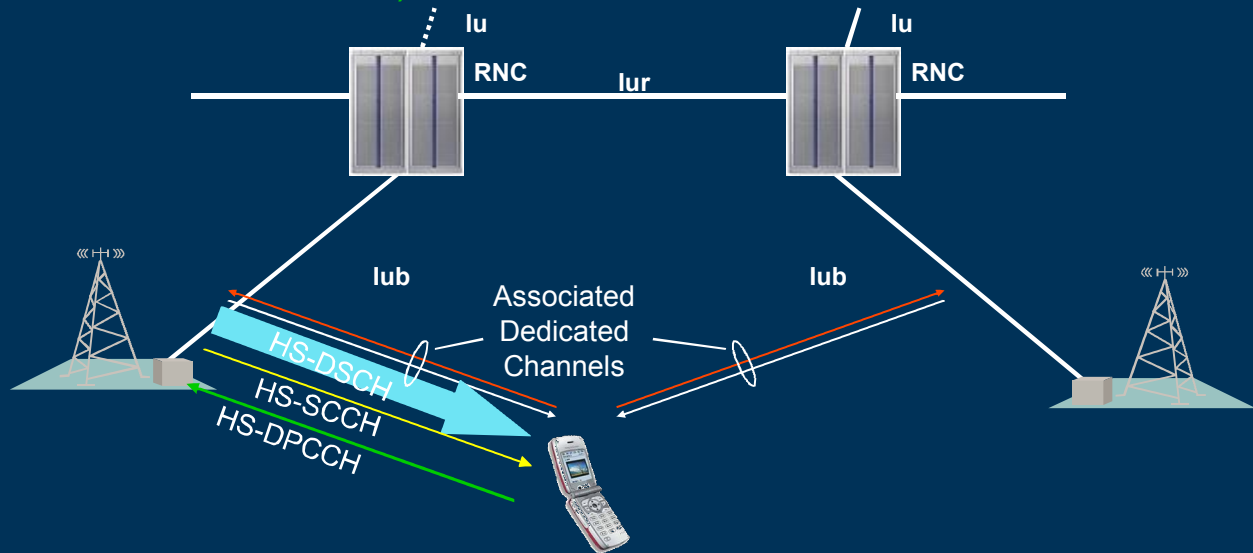
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- **HSDPA Channels & Bearers**
- HSDPA Connection Handling
- HSDPA Mobility

- R5 of 3GPP standard introduces 3 new channels that support HSDPA.
  - One HS-DSCH (High Speed Downlink Shared Channel)
    - Mapped to up to 15 (5 in P4, 15 in P5) HS-PDSCH
    - Dynamic allocation every 2 msec
    - Time sharing only in P4. Code sharing in P5.
  - One HS-SCCH (High Speed Shared Control Channel)
    - Control information (UE ID, HARQ, TFRC)
    - SF 128, 2msec, downlink
  - One HS-DPCCH (High Speed Dedicated Physical Control Channel) per UE in the uplink
    - HARQ UL (ACK, NACK), CQI

# HSDPA channel structure

2/2

- DL: High-Speed Downlink Shared Channel – HS-DSCH
- DL: High-Speed Shared Control Channel(s) – HS-SCCH (SCHEDULING)
- Associated Dedicated Channel – A-DCH
- UL :HS Dedicated Physical Common Control Channel - HS-DPCCH (CQI, HARQ ACK/NACK)



# HSDPA RABs

- Interactive PS 64/HS and PS 384/HS (optional)
- Interactive 64/HS kbps PS RAB
  - UL: Interactive 64 kbps PS RB + 3.4 kbps SRBs on DPCH
  - DL: Interactive PS RB on HS-DSCH + 3.4 kbps SRBs on DPCH
- Interactive 384/HS kbps PS RAB
  - UL: Interactive 384 kbps PS RB + 3.4 kbps SRBs on DPCH
  - DL: Interactive PS RB on HS-DSCH + 3.4 kbps SRBs on DPCH

# HS-DSCH Iub Flow Control

- To control the data frames between the RNC and the RBS (IUB interface). The RBS sets the pace at which data comes from the RNC
- Takes into account (as input)
  - Iub link overload condition
  - Length of the Priority Qs
  - Throughput rate to the UE
- Output is a capacity allocation message asking the RNC to either “slow down” or send more data

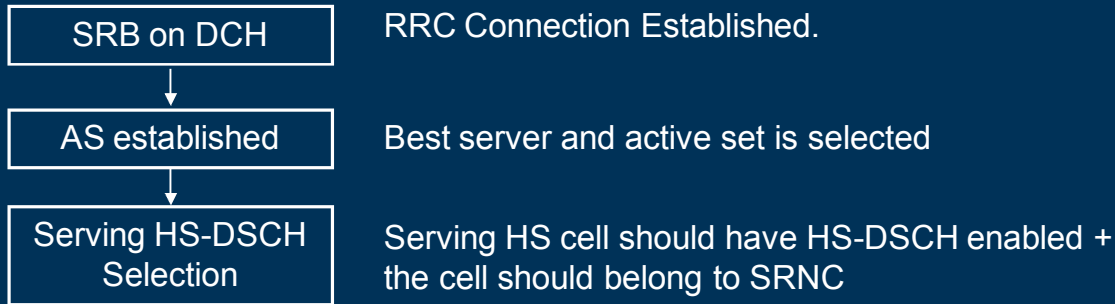
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# HSDPA Connection Establishment

- When the interactive RAB is requested, the system tries to establish the following RABs
  - 384/HS-DSCH
  - 64/HS-DSCH
- UE indicates HSDPA capability in “RRC Connection Setup Complete” message

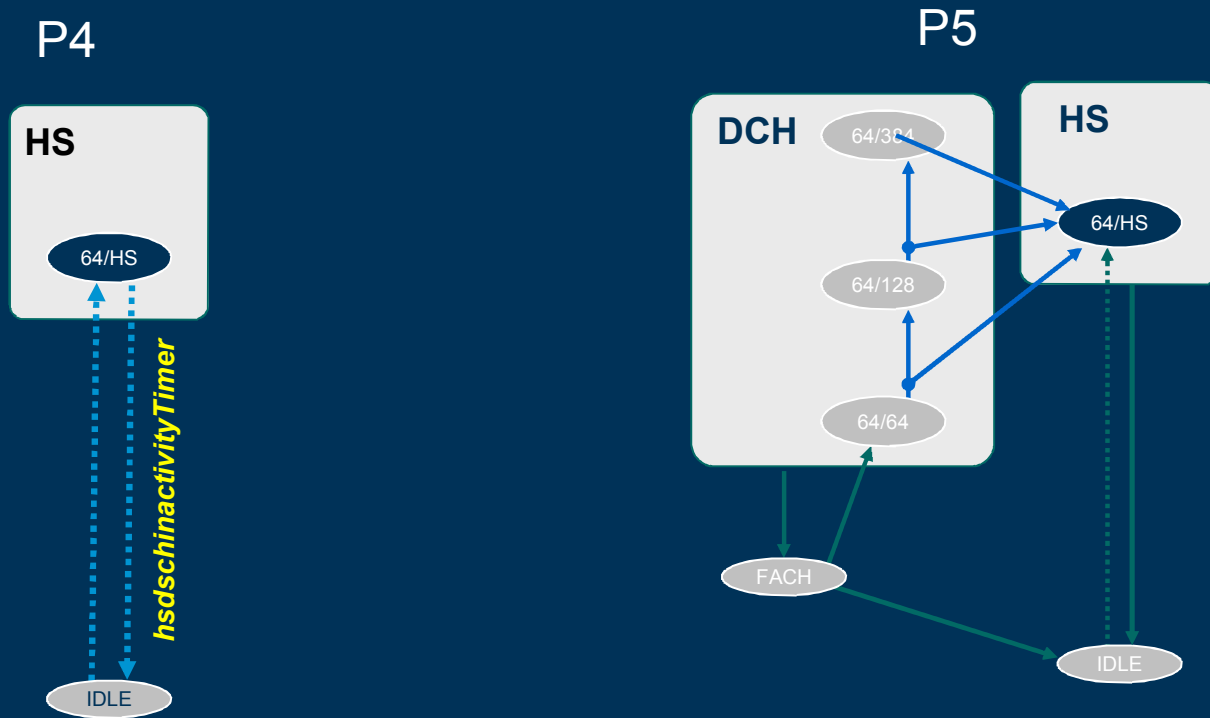


# Serving HS-DSCH Selection

The HS-DSCH serving cell selection is made at RAB Establishment

1. The best cell of the active set selected as a suitable serving HS-DSCH cell
2. Another cell than the best cell of the active set is selected as a suitable serving HS-DSCH cell
  - **hsOnlyBestCell** is set to False
  - The selected cell has a coverage relation that covers or overlaps the best cell.
  - The pathloss criteria of the best cell is fulfilled
3. A suitable serving HS-DSCH cell selected in new active set (hard handover inter-frequency)
4. No suitable serving HS-DSCH cell selected. PS 64/64 or FACH is established

# Channel Switching (New in P5)



Switching between HS-DSCH and DCH happens to support Iur, IRAT and IFHO Mobility.

# Agenda

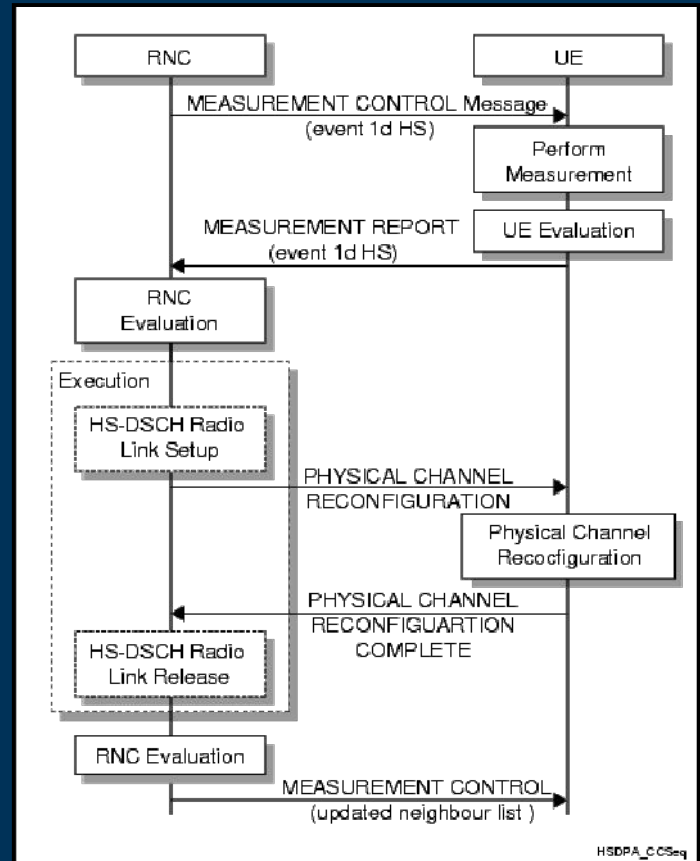
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# HS-DSCH Mobility - Overview

- HS-DSCH and HS-SCCH do not support soft/softer handover
- ADCH support soft/softer handover (SRB and uplink DCH)
- HS-DPCCH support only softer handover
- HS connections perform a HS cell change through Physical Channel Reconfiguration Message.
- HS cell change performed only with cells in the Active Set.

# Event 1d HS

- Event 1d HS is similar to event 1d
- Event 1d HS occurs when the signal level of a cell already included in the Active Set becomes stronger than the current best cell in the Active Set
- Different Hysteresis, Time to trigger and quality criteria for 1d HS



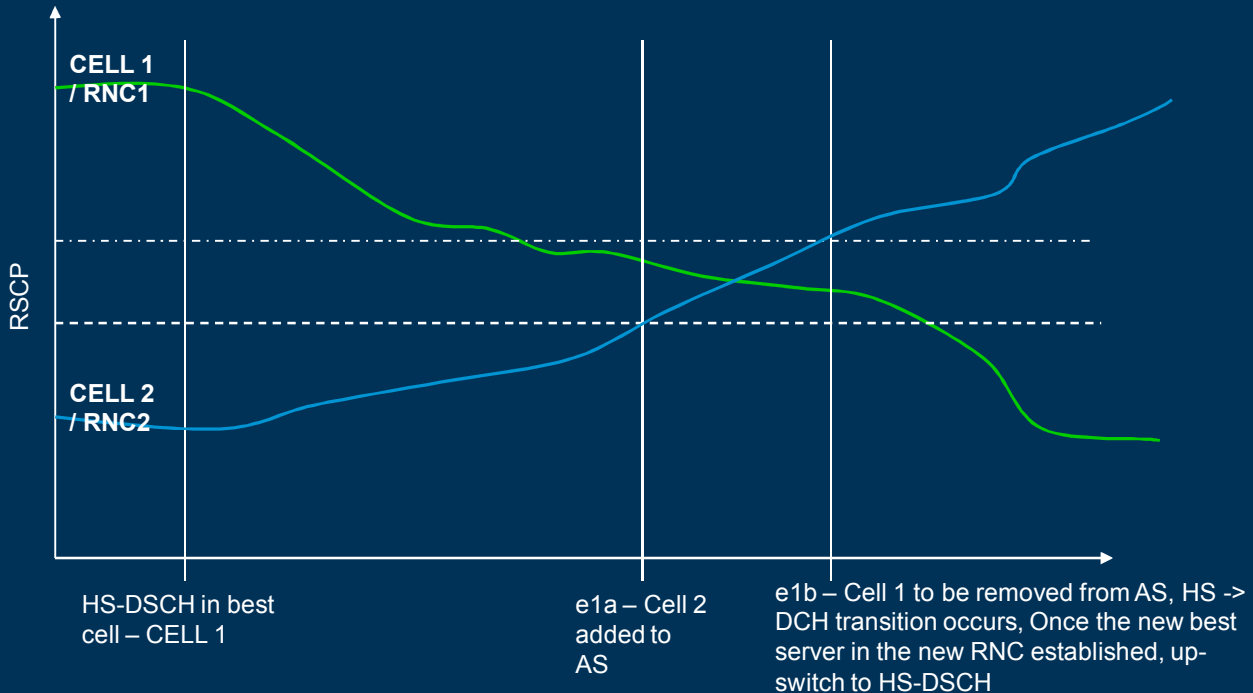
# HSDPA Mobility Phase 2 (P5)

Supports the following HSDPA Mobility cases

- Inter-RNC mobility (Iur)
- Inter-Frequency mobility (IFHO)
- IRAT mobility (3G → 2G)
- All cases handle Multi-RAB (SP+HS)

# Inter-RNC (Iur) HSDPA Mobility

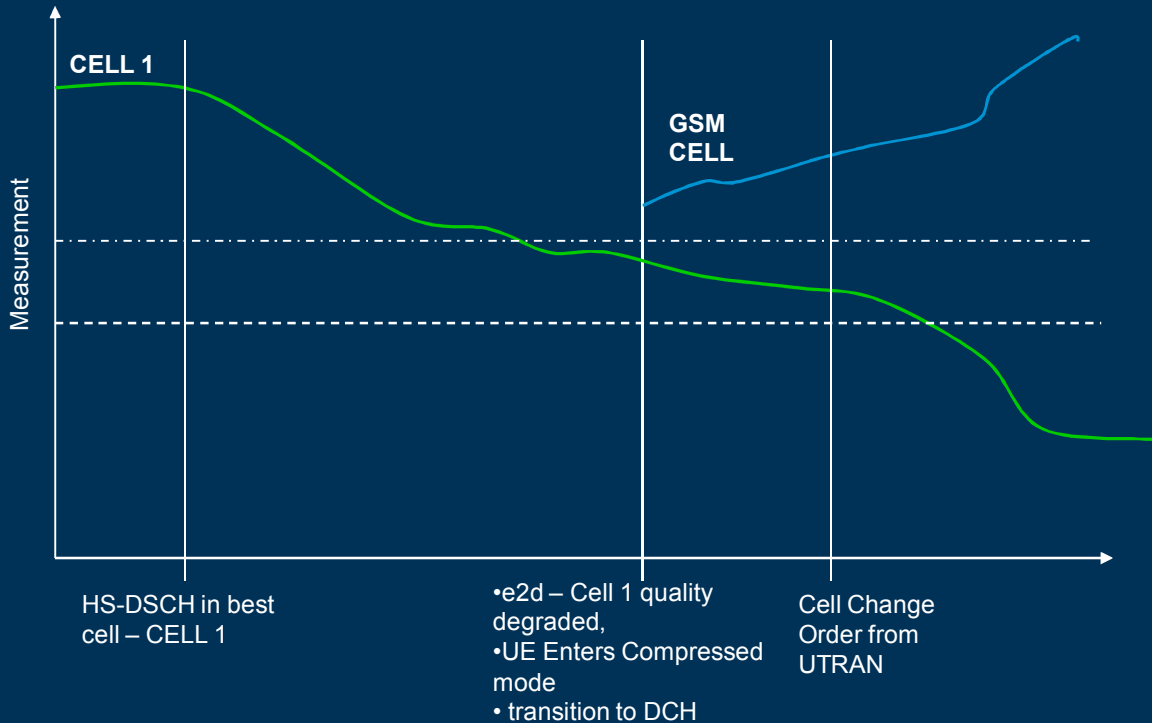
- Parameter *hsCellChangeAllowed* & *hsToDchTrigger* are set to TRUE.





# IRAT HSDPA Mobility

- Parameter *hsCellChangeAllowed* & *hsToDchTrigger* are set to TRUE.



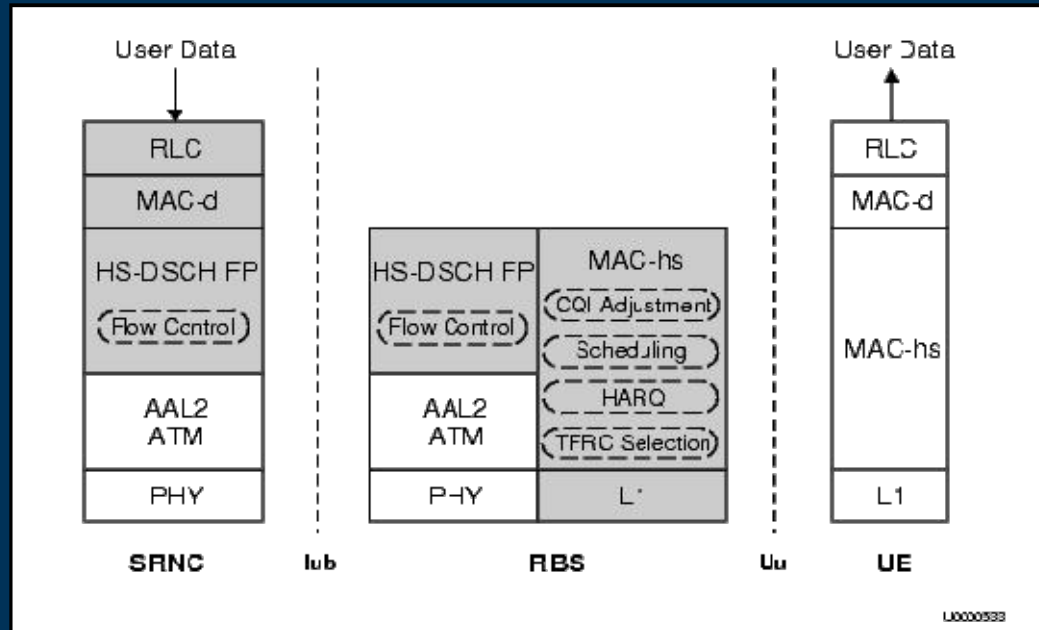
# Q & A

# APPENDIX A - HSDPA UE

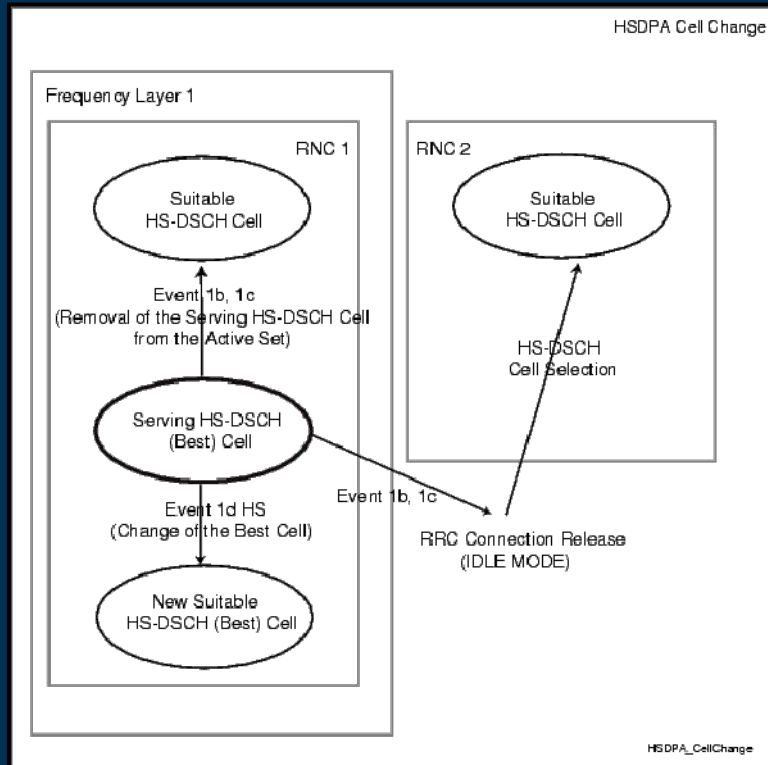
Category	Maximum number of supported HS-DSCH codes	Minimum inter-TTI interval	Number of soft values in terminal's hybrid ARQ buffer	L1 peak rate [Mbit/s]	Modulation schemes
Category 1	5	3	19,200	1.2	16QAM, QPSK
Category 2	5	3	28,800	1.2	16QAM, QPSK
Category 3	5	2	28,800	1.8	16QAM, QPSK
Category 4	5	2	38,400	1.8	16QAM, QPSK
Category 5	5	1	57,600	3.6	16QAM, QPSK
Category 6	5	1	67,200	3.6	16QAM, QPSK
Category 7	10	1	115,200	7.3	16QAM, QPSK
Category 8	10	1	134,400	7.3	16QAM, QPSK
Category 9	15	1	172,800	10.0	16QAM, QPSK
Category 10	15	1	172,800	14.0	16QAM, QPSK
Category 11	5	2	14,400	0.9	QPSK
Category 12	5	1	28,800	1.8	QPSK

# APPENDIX B - MAC-hs

- MAC-hs is a new MAC protocol defined for HSDPA



# APPENDIX C - HS-DSCH Cell Change Summary (P4)



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