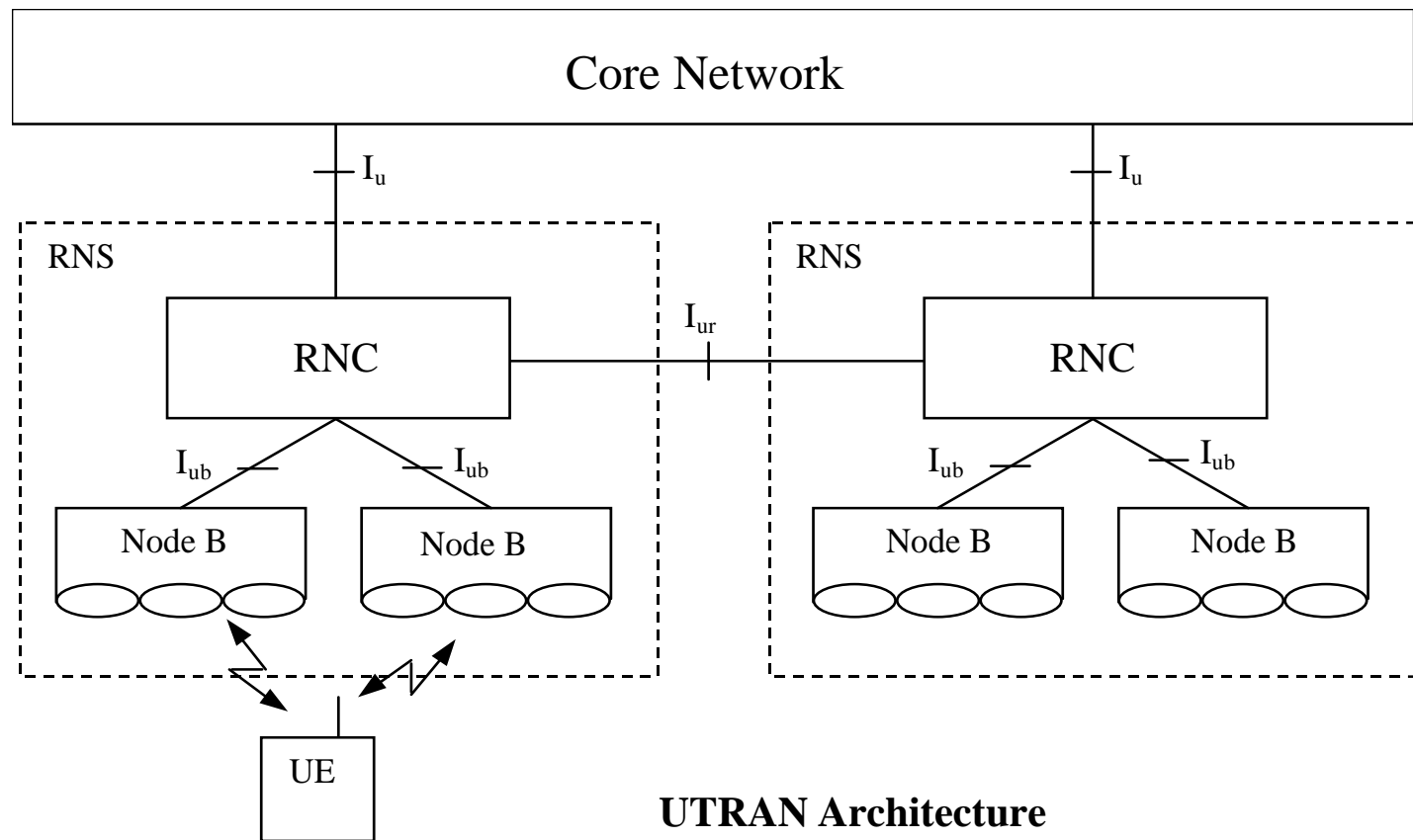


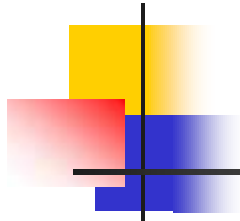


Overview of HSDPA channel structure and Data rate control in HSDPA

By: Dr. Kourosh Parsa
September 30th, 2007

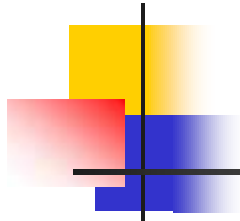
UTRAN Architecture





HSDPA features

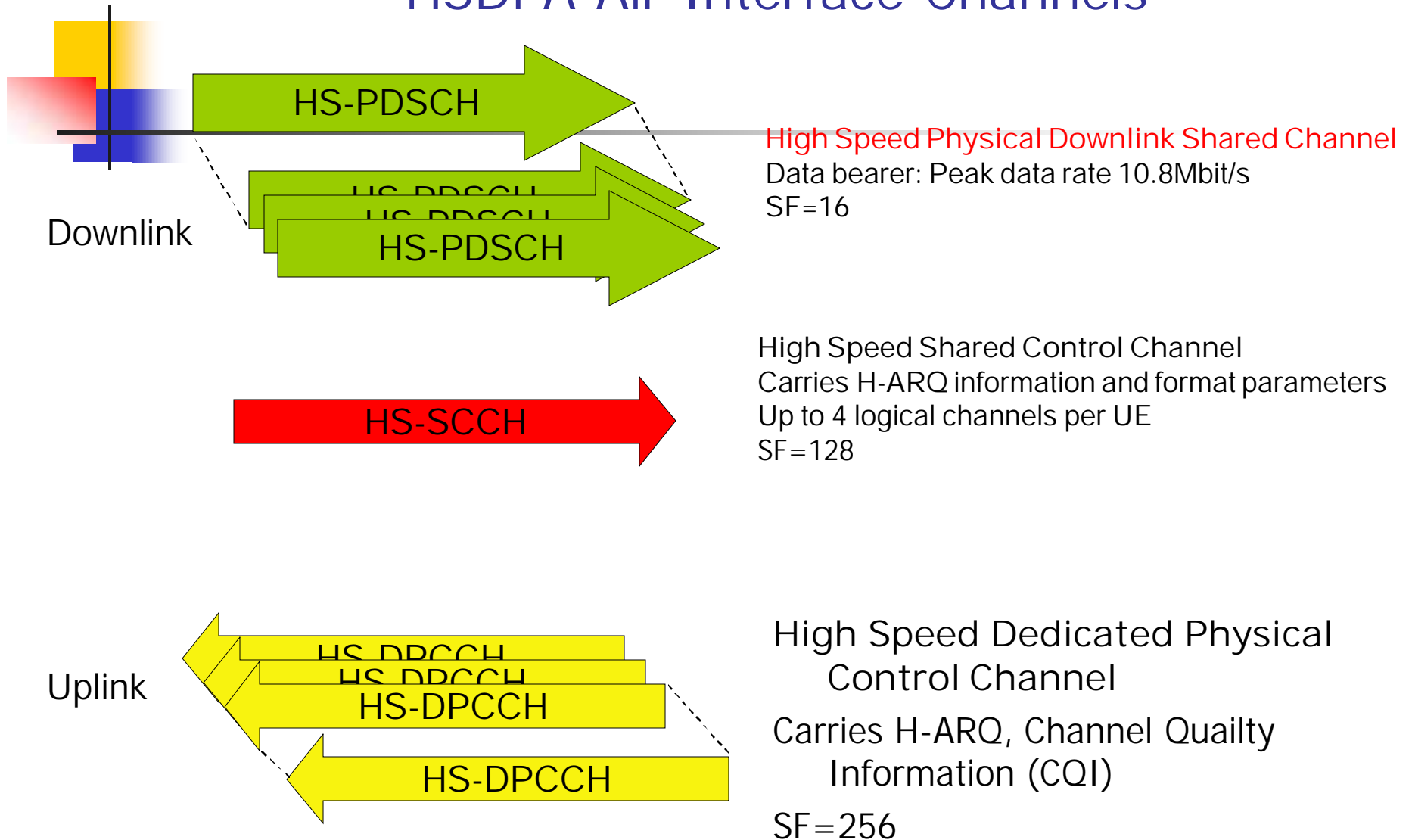
- High Speed Downlink Packet Access (HSDPA) is a packet-based data service in W-CDMA downlink with data transmission up to 8-10 Mbps over a 5MHz bandwidth in WCDMA downlink. HSDPA implementations includes Adaptive Modulation and Coding (AMC), Hybrid Automatic Request (HARQ), and advanced receiver design.



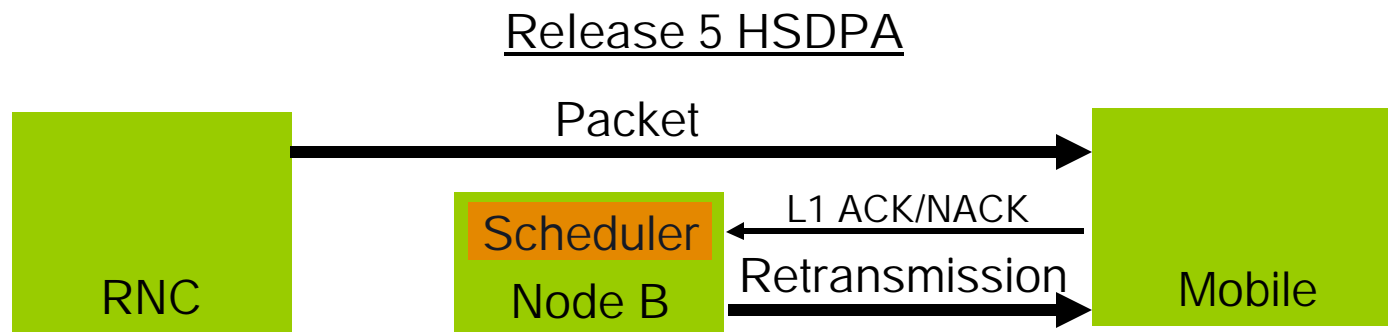
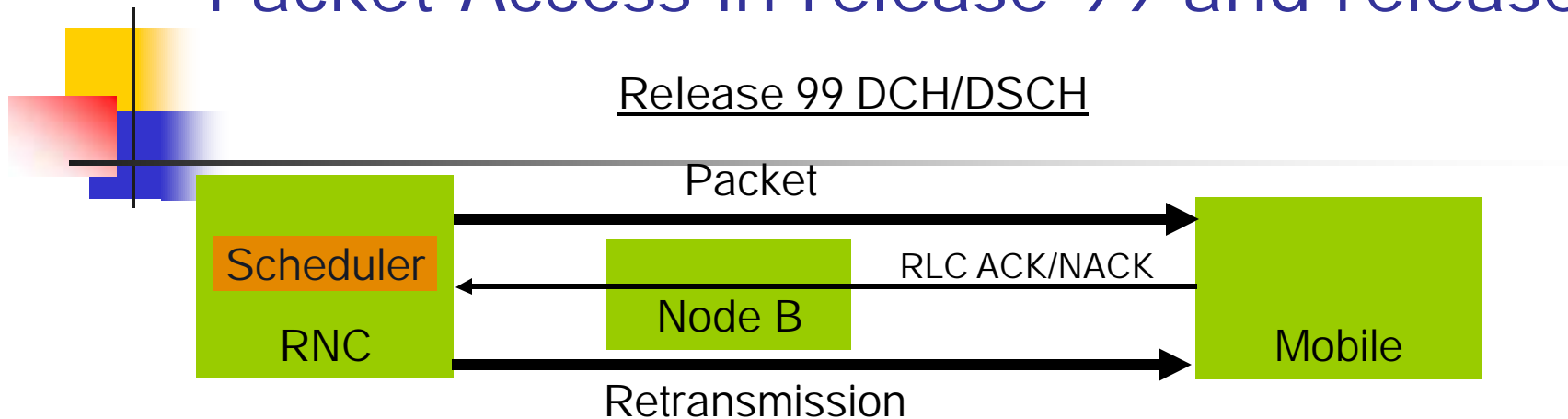
HS-PDSCH

- A HS-PDSCH corresponds to one channelization code of fixed spreading factor $SF=16$ from the set of channelization codes reserved for HS-DSCH transmission. Multi-code transmission is allowed, which translates to UE being assigned multiple channelisation codes in the same HS-PDSCH subframe, depending on its UE capability.
- An HS-PDSCH may use QPSK or 16QAM modulation symbol

HSDPA Air Interface Channels



Packet Access in release 99 and release 5



Low Latency



HSDPA overhead Requirements



HSDPA – Data Pipe



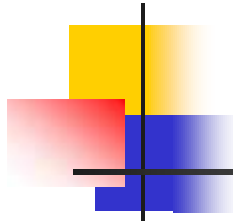
HS-SCCH – downlink signaling related to HS-DSCH – 60 kbps broadcast

DPCCH – physical layer control channel

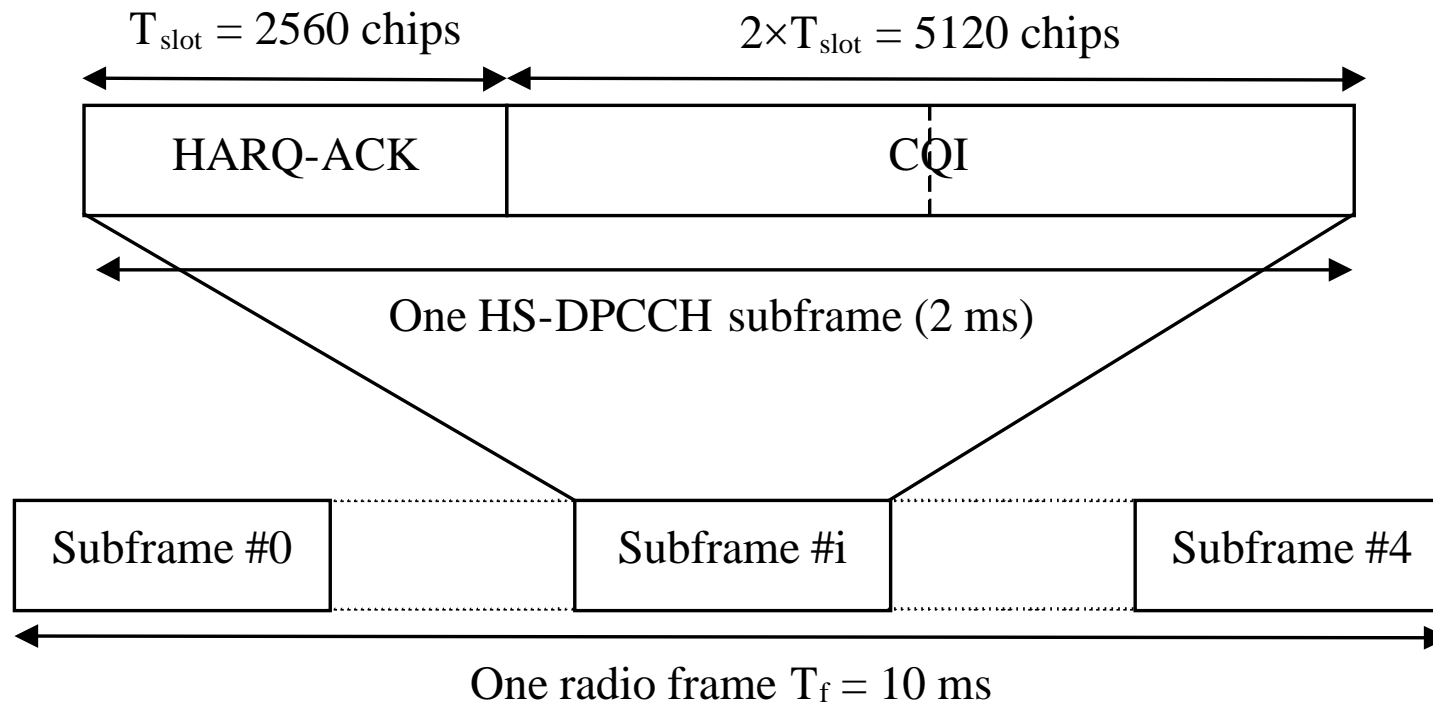
HS-DPCCH – CQI, HARQ ACK/NAK

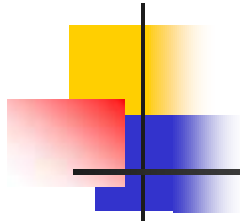
DPCCH – physical layer control channel

DPDCH – L3 signaling information



Frame structure for HS-DPCCH

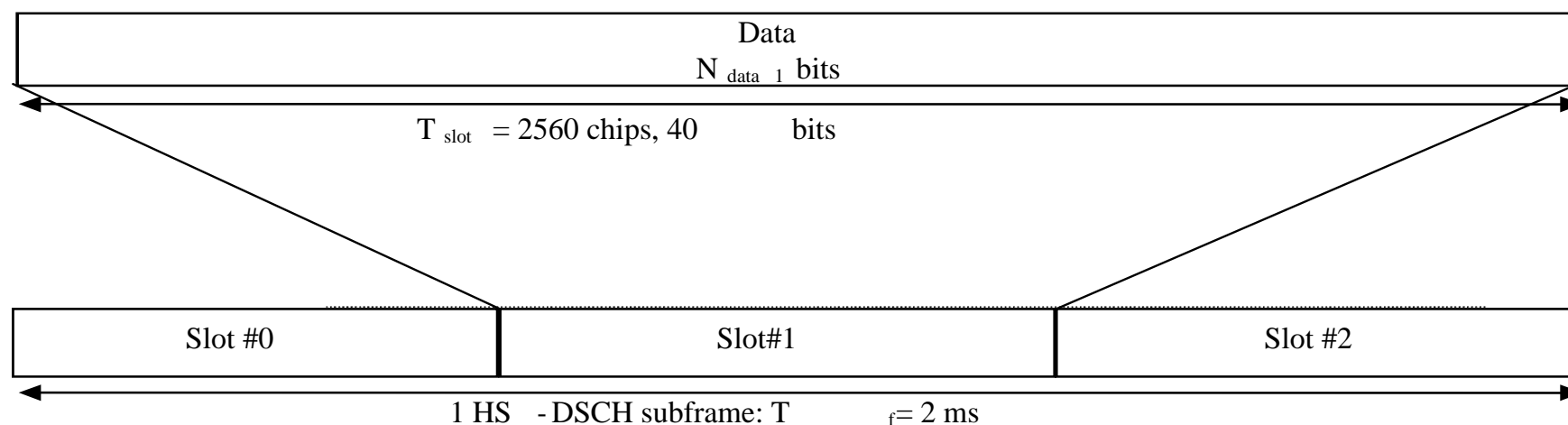




HS-DPCCH

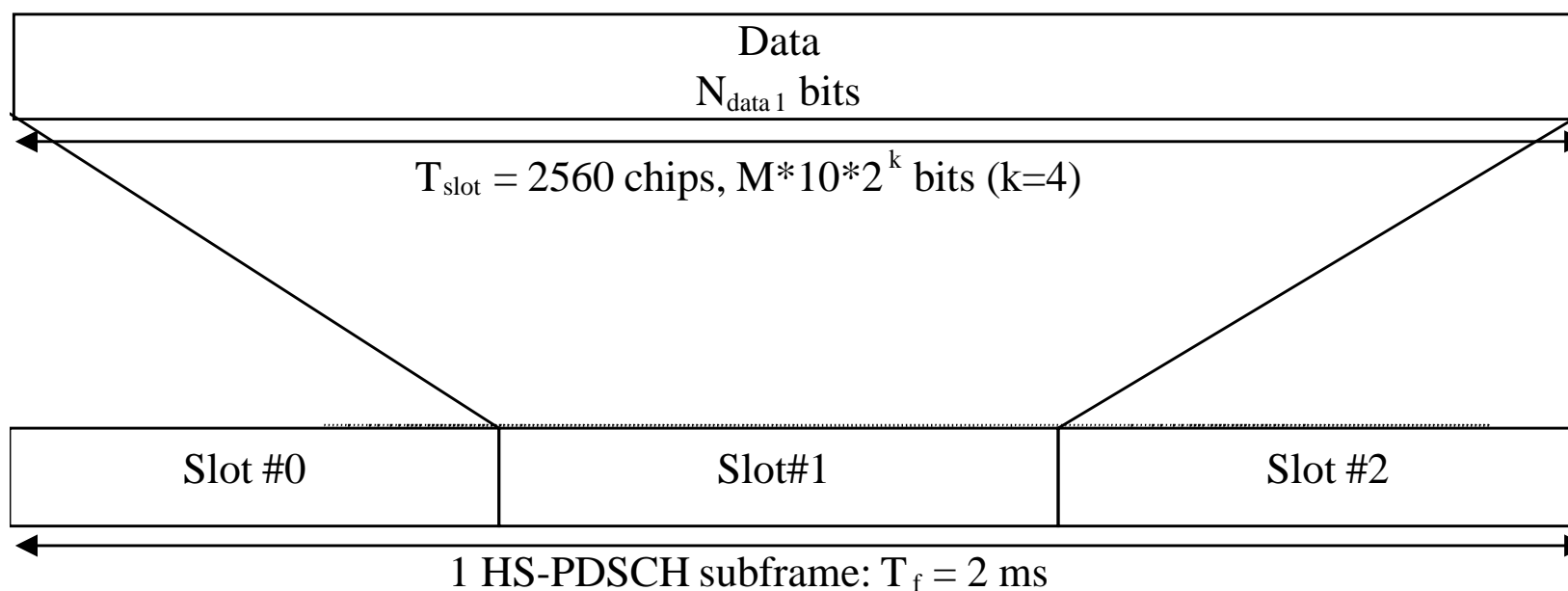
- The HS-DPCCH carries uplink feedback signalling related to downlink HS-DSCH transmission.
- The HS-DSCH-related feedback signalling consists of Hybrid-ARQ Acknowledgement (HARQ-ACK) and Channel-Quality Indication (CQI).
- Each sub frame of length 2 ms (3×2560 chips) consists of 3 slots, each of length 2560 chips. The HARQ-ACK is carried in the first slot of the HS-DPCCH sub-frame. The CQI is carried in the second and third slot of a HS-DPCCH sub-frame.

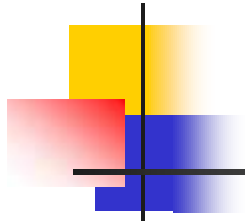
Sub-frame structure for the HS-SCCH



The HS-SCCH is a fixed rate (60 kbps, $SF = 128$) downlink physical channel used to carry downlink signalling related to HS-DSCH transmission.

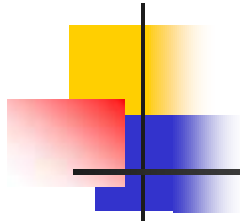
Sub-frame structure for the HS-PDSCH





HS-DSCH fields

Slot format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ HS-DSCH subframe	Bits/ Slot	Ndata
0(QPSK)	480	240	16	960	320	320
1(16QAM)	960	240	16	1920	640	640

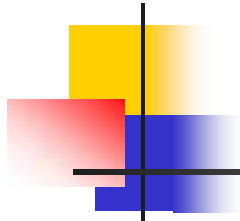


Transport Format

- This is defined as a format offered by L1 to MAC (and vice versa) for the delivery of a Transport Block Set during a Transmission Time Interval on a Transport Channel. The Transport Format constitutes of two parts – one dynamic part and one semi-static part.
 - Attributes of the dynamic part are:
 - - Transport Block Size;
 - - Transport Block Set Size;
 - - Transmission Time Interval
 - Attributes of the semi-static part are:
 - - Transmission Time Interval (mandatory for FDD)
 - - error protection scheme to apply;
 - - type of error protection, turbo code, convolutional code or no channel coding (TDD only);
 - - coding rate;
 - - static rate matching parameter;
 - - size of CRC.

Dynamic part: {320 bits, 640 bits}, Semi-static part: {10ms, convolutional coding only, static rate matching parameter = 1}.

An empty Transport Format is defined as a Transport Format that has Block Set Size equal to zero.



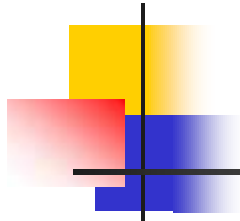
Transport Format Set

- This is defined as the set of Transport Formats associated to a Transport Channel.
- The semi-static parts of all Transport Formats are the same within a Transport Format Set.
- Effectively the Transport Block Size and Transport Block Set Size form the instantaneous bit rate on the Transport Channel. Variable bit rate on a Transport Channel may, depending on the type of service, which is mapped onto the transport channel, be achieved by changing between each Transmission Time Interval one of the following:
 - The Transport Block Set Size only (not applicable for HS-DSCH);
 - both the Transport Block Size and the Transport Block Set Size
- Example 1 for DCHs:
 - - dynamic part: {20 bits, 20 bits}; {40 bits, 40 bits}; {80 bits, 80 bits}; {160 bits, 160 bits}.
 - - Semi-static part: {10ms, Convolutional coding only, static rate matching parameter = 1}
- Example 2 for DCHs:
 - - dynamic part: {320 bits, 320 bits}; {320 bits, 640 bits}; {320 bits, 1 280 bits}.
 - - Semi-static part: {10ms, Convolutional coding only, static rate matching parameter = 2}.
- Example 3 for HS-DSCH:
 - - dynamic part: {320 bits, 320 bits, Redundancy version 1, QPSK}; {640, 640, Redundancy version 1, QPSK}; {1280, 1280, Redundancy version 2, 16QAM}.
Static = ?



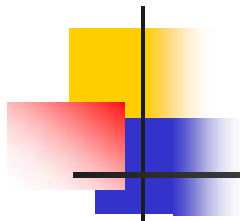
Transport Format Indicator (TFI)

- The TFI is a label for a specific transport format within a transport format set. It is used in the inter-layer communication between MAC and L1 each time a transport block set is exchanged between the two layers on a transport channel.
- Transport Format Combination Indicator (TFCI): This is a representation of the current Transport Format Combination.
- There is a one-to-one correspondence between a certain value of the TFCI and a certain Transport Format Combination. The TFCI is used in order to inform the receiving side of the currently valid Transport Format Combination, and hence how to decode, de-multiplex and deliver the received data on the appropriate Transport Channels. The TFCI is not used for the HS-DSCH.



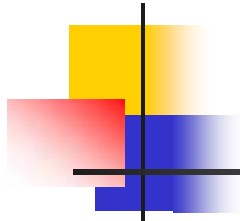
HARQ information-HSDPA

- Hybrid ARQ is defined for HS-DSCH. With the help of the HARQ information the UE is enabled to identify the process being used for the transport block that is received on the HS-DSCH. The HARQ information also includes information that indicates whether a new data block is transmitted for the first time or a retransmission. Furthermore it is used to decode the received data correctly.



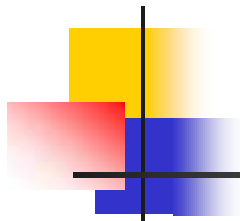
Transport Format and Resource Indication (TFRI)

- The TFRI includes information about the dynamic part of the HS-DSCH transport format, including transport block set size and modulation scheme. The TFRI also includes information about the set of physical channels (channelisation codes) onto which HS-DSCH is mapped in the corresponding HS-DSCH TTI.



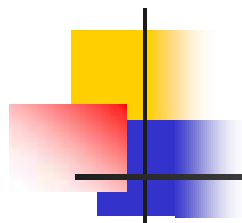
Characterisation of Transport Format

		HS-DSCH
Dynamic part	Transport Block Size	1 to 200 000 8 bit granularity
	Transport Block Set Size	1 to 200 000 8 bit granularity
	Modulation scheme	QPSK, 16 QAM
	Redundancy version/Constellation	1 to 8
Static part	Transmission Time Interval	2ms for FDD 5 ms for 1.28 Mcps TDD 10 ms for 3.84 Mcps TDD
	Type of channel coding	Turbo coding
	Code rates	1/3
	CRC size	24



Transport Format for HS-DSCH

- This is defined as a format offered by L1 to MAC (and vice versa) for the delivery of a transport block during a Transmission Time Interval on a Transport Channel. The Transport Format consists of three parts – one dynamic part, one semi-static part and one static part.
- The Transport Format for HS-DSCH is always explicitly signalled. There is no support of blind transport format detection.
- Attributes of the dynamic part are:
 - - Transport block size (same as Transport block set size);
 - - Redundancy version/Constellation;
 - - Modulation scheme.
- Attributes of the semi-static part are:
 - - no semi-static attributes are defined.
- Attributes of the static part are:
 - - Transmission time interval. The Transmission time interval is fixed to 2ms in FDD.
 - - error protection scheme to apply;
 - - type of error protection is turbo coding;
 - - coding rate is 1/3;
 - - size of CRC is 24 bits.



New Features in HSDPA

- HARQ
- CQI (Channel Quality information)
- Fast Scheduling
- Base Node scheduler
- TFCI signals the downlink data rate
- Scheduling algorithm in Base Node can be implemented differently by various vendors.



Performance of HSDPA

- The combination of HARQ and adaptive modulation coding in the downlink and scheduling algorithm enables the higher throughput.