HSPA+
Technology Enhancements

In order to benefit from the full potential of WCDMA operation, the performance of HSPA-based radio networks is further enhanced in terms of spectrum efficiency, peak data rate, and latency. These improvements have been included in 3GPP Releases 7 and 8, which are outlined below.

HSPA+ Release 7 includes downlink MIMO operation, higher-order modulation, and protocol improvements specifically allowing a high number of "always on" users to be supported in the network. Peak data rates reach 21 Mbit/s and 28 Mbit/s in the downlink by applying 64QAM modulation or MIMO, respectively. In the uplink, 16QAM modulation increases the available data rate to up to 11.5 Mbit/s. Additionally, the continuous packet connectivity (CPC) feature reduces round-trip times to less than 50 ms and significantly increases VoIP system capacity.

HSPA+ Release 8 provides further improvements such as downlink dual carrier operation and the combination of MIMO and 64QAM modulation. Both features enable a maximum data rate of 42 Mbit/s in the downlink. Furthermore, circuit switched voice over HSPA provides an optimized support of voice services in an HSPA packet switched radio access network. In addition, latency is further improved by allocating common E-DCH resources in CELL_FACH state and applying Layer 2 enhancements in the uplink.

Rohde&Schwarz offers a complete product portfolio for highly accurate WCDMA/HSPA tests from R&D and production right through to conformance. HSPA+ test functions are also available, and future implementations will reflect the latest 3GPP enhancements.

HSPA+ Downlink Release 7

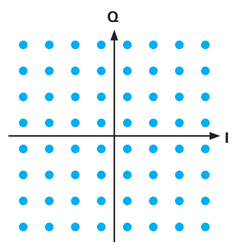
HSDPA: UE Categories

HS-DSCH category	Maximum number of HS-DSCH codes received	Minimum inter-TTI interval	Maximum data rate (Mbit/s)	Modulation	MIMO
1	5	3	1.22	QPSK, 16QAM	–
2	5	3	1.22	QPSK, 16QAM	–
3	5	2	1.82	QPSK, 16QAM	–
4	5	2	1.82	QPSK, 16QAM	–
5	5	1	3.65	QPSK, 16QAM	–
6	5	1	3.65	QPSK, 16QAM	–
7	10	1	7.21	QPSK, 16QAM	–
8	10	1	7.21	QPSK, 16QAM	–
9	15	1	10.13	QPSK, 16QAM	–
10	15	1	13.98	QPSK, 16QAM	–
11	5	2	0.91	QPSK	–
12	5	1	1.82	QPSK	–
13	15	1	17.64	QPSK, 16QAM, 64QAM	–
14	15	1	21.10	QPSK, 16QAM, 64QAM	–
15	15	1	23.37	QPSK, 16QAM	✓
16	15	1	27.95	QPSK, 16QAM	✓
17	15	1	17.64	QPSK, 16QAM, 64QAM	–
	15	1	23.37	QPSK, 16QAM	✓
18	15	1	21.10	QPSK, 16QAM, 64QAM	–
	15	1	27.95	QPSK, 16QAM	✓
19	15	1	35.28	QPSK, 16QAM, 64QAM	✓
20	15	1	42.20	QPSK, 16QAM, 64QAM	✓
21	15	1	23.37	QPSK, 16QAM	–
22	15	1	27.95	QPSK, 16QAM	–
23	15	1	35.28	QPSK, 16QAM, 64QAM	–
24	15	1	42.20	QPSK, 16QAM, 64QAM	–

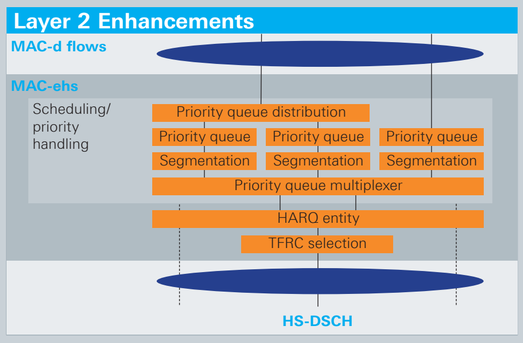
Release 5 Release 7 Release 8

64QAM Modulation

- New additional fixed reference channel H-Set 8 for terminal testing
- New relative code domain error (RCDE) test for verification of NodeB modulation accuracy

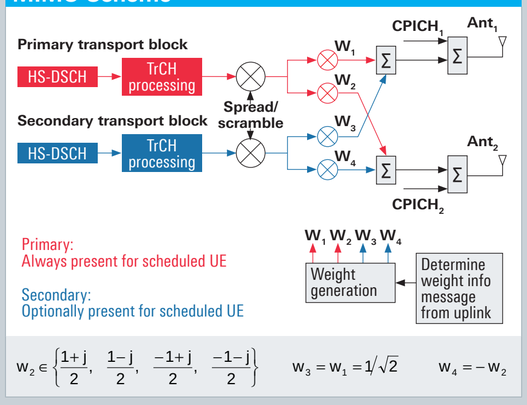


Layer 2 Enhancements



- MAC-ehs supports flexible RLC PDU sizes
- Single/dual stream transmission (MIMO) per TTI
- Reordering enabled due to transmission sequence numbers

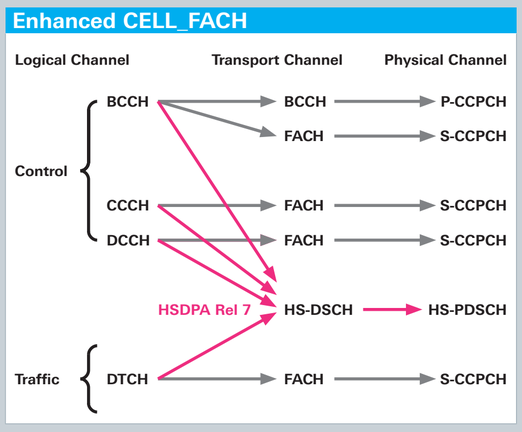
MIMO Scheme



$$w_2 \in \left\{\frac{1+j}{2}, \frac{1-j}{2}, \frac{-1+j}{2}, \frac{-1-j}{2}\right\} \qquad w_3 = w_1 = 1/\sqrt{2} \qquad w_4 = -w_2$$

- Simultaneous transmission of two independent data streams in a 2x2 MIMO scheme using the same channelization code
- New precoding feedback from the terminal taken into account by NodeB scheduler

Enhanced CELL_FACH



- HS-SCCH is continuously monitored in CELL_FACH, URA_PCH and CELL_PCH state with data transfer via the associated HS-DSCH
- Increased data rate, reduced signaling delay, and accelerated state changes

HSPA+ Uplink Release 7

HSUPA: UE Categories

E-DCH category	Maximum number of E-DCH codes	Minimum spreading factor	TTI (in ms)	Modulation	Maximum data rate (in Mbit/s)
1	1	SF4	10	QPSK	0.71
2	2	SF4	10 / 2	QPSK	1.45 / 1.40
3	2	SF4	10	QPSK	1.45
4	2	SF2	10 / 2	QPSK	2.00 / 2.89
5	2	SF2	10	QPSK	2.00
6	4	SF2	10 / 2	QPSK	2.00 / 5.74
7	4	SF2	10 / 2	QPSK, 16QAM	2.00 / 11.50

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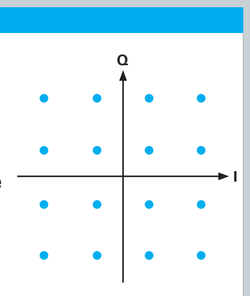
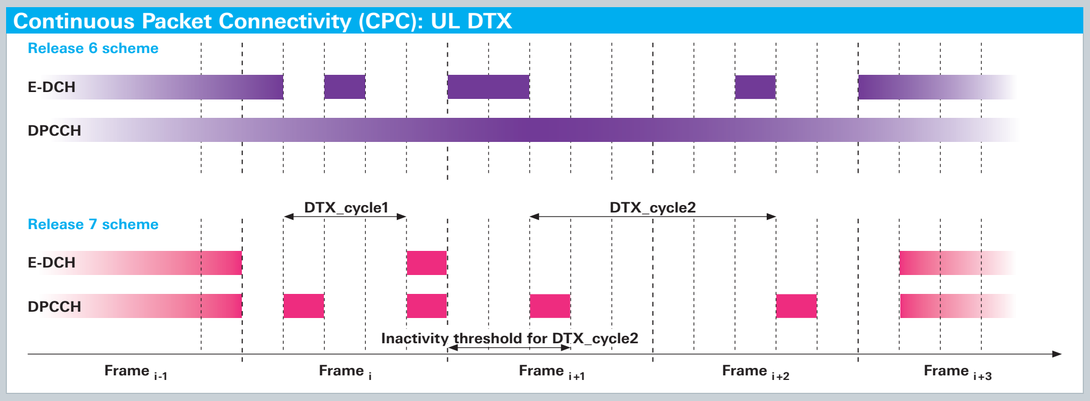
16QAM Modulation

- Increased maximum data rate using two E-DPDCH with SF2 plus two E-DPDCH with SF4
- 4PAM per E-DPDCH code
- New EVM requirement (≤14%) and RCDE test for verification of UE modulation accuracy



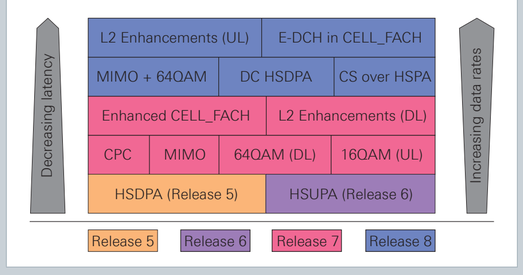
Continuous Packet Connectivity (CPC): UL DTX



- UL DPCCH is discontinued if there is no transmission on E-DCH or HS-DPCCH
- UL transmission reduced to a known pattern, needed to maintain synchronization and power control loop

HSPA+ Release 8

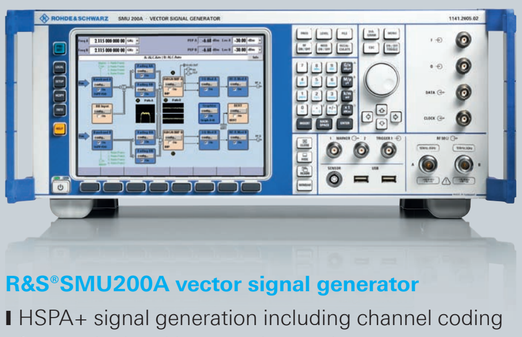
HSPA+ Feature Set



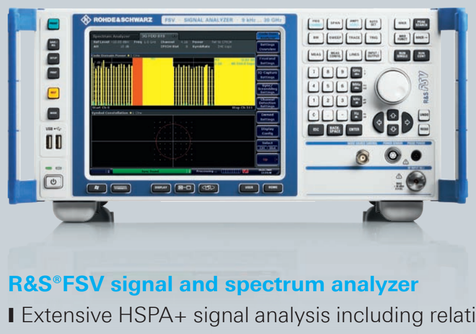
- Further increase of data rates by the combination of MIMO and 64QAM
- Allocation of two adjacent 5 MHz carrier frequencies to the UE (dual-cell HSDPA)
- Additional protocol improvements to further reduce latency in the network such as UL Layer 2 enhancements and E-DCH transmission in CELL_FACH state, i.e. fast E-DCH resource allocation during RACH procedure
- CS over HSPA optimizes support of voice services in the PS domain

Glossary:
3GPP = Third Generation Partnership Project; **4PAM** = Four-Level Pulse Amplitude Modulation; **BCCH** = Broadcast Common Control Channel; **CCCH** = Common Control Channel; **CPICH** = Common Pilot Channel; **CS** = Circuit Switched; **DC HSDPA** = Dual-Cell HSDPA; **DL** = Downlink; **D(P)CCH** = Dedicated (Physical) Control Channel; **DTCH** = Dedicated Traffic Channel; **DTX** = Discontinuous Transmission; **E-DCH** = Enhanced Dedicated Channel; **E-DPDCH** = E-DCH Dedicated Physical Data Channel; **EVM** = Error Vector Magnitude; **FACH** = Forward Access Channel; **HARQ** = Hybrid Automatic Repeat Request; **HS-DPCCH** = High Speed DPCCH; **HS-(P)DSCH** = High Speed (Physical) Downlink Shared Channel; **HS-SCCH** = High Speed Shared Control Channel; **HS(D/U)PA** = High Speed (Downlink/Uplink) Packet Access; **MAC-d** = Medium Access Control entity handling dedicated transport channels; **MAC-ehs** = Evolved Medium Access Control entity handling HS-DSCH; **MIMO** = Multiple Input, Multiple Output; **P-CCPCH** = Primary Common Control Physical Channel; **PDU** = Packet Data Unit; **PS** = Packet Switched; **QAM** = Quadrature Amplitude Modulation; **QPSK** = Quadrature Phase Shift Keying; **RACH** = Random Access Channel; **RLC** = Radio Link Control; **RNC** = Radio Network Controller; **S-CCPCH** = Secondary Common Control Physical Channel; **SF** = Spreading Factor; **TFRC** = Transport Format and Resource Combination; **TrCH** = Transport Channel; **TTI** = Transmission Time Interval; **UE** = User Equipment (terminal); **UL** = Uplink; **VoIP** = Voice over IP; **WCDMA** = Wideband Code Division Multiple Access

Selection of Rohde&Schwarz Test Solutions for HSPA+



R&S®SMU200A vector signal generator
- HSPA+ signal generation including channel coding for terminal and base station testing
- Unique 2x2 MIMO receiver tests including realtime fading in one box



R&S®FSV signal and spectrum analyzer
- Extensive HSPA+ signal analysis including relative code domain error (RCDE) measurement
- Fastest analyzer on the market
- Touch screen for easy operation

R&S®CMW500 wideband radio communication tester
- Scalable one-box solution for all stages of wireless device testing
- Ready for MIMO and multi-RAT testing
- Included in R&S®TS8950/80 RF test systems, which fulfill all requirements for conformance tests

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