HSUPA Overview

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Agenda

What is HSUPA?

Layer 1 Overview

UE and Network HSUPA Additions: Layer 2 and 3 Overview

HSUPA Throughput

HSUPA Test Environment

Agilent Solutions for HSUPA
What is HSUPA? Who Benefits?
What’s New with HSUPA?
What is HSUPA?

3GPP’s high level objectives for HSUPA:

• “The technical objective of the FDD Enhanced Uplink work item is to improve the performance of uplink dedicated transport channels, i.e. to increase capacity and throughput and reduce delay.”

HSUPA is often considered solely as a means of increasing mobile uplink data rates. However, higher data rates will not always be possible or necessary.

HSUPA has other benefits to packet data operation on the network. Significant gains in overall network capacity can be realised by the ability to quickly change data rate. The reduction of delays will also improve the performance of applications.
HSUPA – Who Benefits?

Customer Benefits:
Faster data rates (uplink, but also downlink)
Ability to run applications requiring lower latency (mobile gaming, two way VOIP)
Larger area of coverage for reasonable data rates

Operator Benefits:
More flexible allocation of bandwidth
Ability to sell new services (e.g. YouTube uploads, two way VOIP)

Marketing Message Benefits: “HSPA is as fast as 1xEVDO”

1xEVDO Release A: 3.1 Mbps / 1.8 Mbps
1xEVDO Release B: 15 Mbps / 6 Mbps
HSPA likely first combination: 7.2 Mbps / 2 Mbps
HSPA maximum data rate: 14 Mbps / 5.74 Mbps
HSUPA Timing Predictions

- 2006
  - DO Rel A Initial Mfg.
  - HSUPA Initial Mfg. (2-3 PC cards)

- 2007
  - HSUPA Initial Mfg. (first UEs)
  - HSUPA First Networks
  - DO Rel B Initial Mfg.
  - HSUPA Volume Mfg. (2-3 PC cards)

- 2008
  - HSUPA Initial Mfg. (many UEs)
  - HSUPA Many Networks
  - HSUPA Volume Mfg. (first UEs)
Increasing Capacity

“The technical objective of the FDD Enhanced Uplink work item is to improve the performance of uplink dedicated transport channels, i.e. to increase capacity and throughput and reduce delay.”

The uplink capacity of a cell is limited by interference. Each UE that is transmitting on a cell will add to the uplink interference – the overall effect is known as the ‘noise rise’ at the Node B. The more power that is used by a UE, the more interference generated by it. This will reduce the number of UEs that can use the cell.

Standard WCDMA data connections assign a fixed maximum data rate to be used by a UE throughout a connection. Depending on connection type, the UE is not transmitting at this data rate all of the time – but a noise rise budget is assigned to it anyway.

HSUPA aims to increase capacity by frequently modifying the power used by the UEs in a cell – only assigning as much resource as necessary. This will allow more efficient management of the cell resource.
Increasing Throughput

“The technical objective of the FDD Enhanced Uplink work item is to improve the performance of uplink dedicated transport channels, i.e. to increase capacity and **throughput** and reduce delay.”

The throughput of a data channel in a WCDMA based system depends on the spreading factor used, the amount of channel coding protection used and the number of channels that are transmitted on.

Smaller spreading factors provide less processing gain when they are decoded by the receiver. To allow them to be successfully decoded, they must be transmitted with a higher power level.

Transmitting on more channels will also increase the power needed.

Therefore, for HSUPA to increase the throughput, the maximum power that can be used by an UE to transmit data must be increased.

HSUPA allows a UE to transmit on up to 4 physical channels, use spreading factors as low as 2 and lower the level of coding protection.
Reducing Delay

“The technical objective of the FDD Enhanced Uplink work item is to improve the performance of uplink dedicated transport channels, i.e. to increase capacity and throughput and reduce delay.”

Three causes of delay in WCDMA are:

• The period of time over which a block of data is interleaved (known as the Transmission Time Interval or TTI). This dictates how frequently an application can be fed a block of data – this is important for the likes of mobile gaming.

• The time taken to retransmit a erroneous block of data. A small turnaround time means that data transmission does not stall due to the protocol stack waiting for packets to be retransmitted.

• The time taken between requesting data transfer and actually being allowed to do so.

HSUPA introduces a smaller TTI. It also introduces new entities into the MAC layer to perform Hybrid ARQ. The scheduling mechanism is also modified to allow quick responses to requested changes in data rate.
HSUPA Downlink and Uplink Channels: Layer 1 Overview

Channel Mapping
Downlink Channels
Uplink Channels

Diagram:
- L3 RRC
- L2 MAC
- L1
Available Today … In Theory

Uplink Code Domain view

HS-DPCCH @SF256(64)

DPDCH1 @SF4(1)

DPDCH2 @SF4(1)

DPDCH3 @SF4(1)

DPDCH4 @SF4(3)

DPDCH5 @SF4(2)

DPDCH6 @SF4(2)

DPDCH1 @SF4(1)

DPDCH2 @SF4(1)

DPDCH3 @SF4(3)

DPDCH4 @SF4(3)

DPDCH5 @SF4(2)

DPDCH6 @SF4(2)

DPDCH1 @SF4(1)

DPDCH2 @SF4(1)

DPDCH3 @SF4(3)

DPDCH4 @SF4(3)

DPDCH5 @SF4(2)

DPDCH6 @SF4(2)

DPDCH1 @SF4(1)

DPDCH2 @SF4(1)

DPDCH3 @SF4(3)

DPDCH4 @SF4(3)

DPDCH5 @SF4(2)

DPDCH6 @SF4(2)

DPDCH1 @SF4(1)

DPDCH2 @SF4(1)

DPDCH3 @SF4(3)

DPDCH4 @SF4(3)

DPDCH5 @SF4(2)

DPDCH6 @SF4(2)
Available Today … In Practice

Uplink Code Domain view

DPDCH1
@SFn(n/4), n = 256,128,64,32,16,4

DPCCH

HS-DPCCH
@SF256(64)
The absolute grant channel is only sent by the serving cell. Relative Grants and ACK/NACKs from the same Radio Link Set (RLS) are the same – will be soft combined by the UE. E-DCHs (carried on E-DPDCH) will be soft-combined at Node B. Non-Serving RLS Cells cannot increase data rate – only hold or decrease it.
New Uplink Transport Channel

The E-DCH (Enhanced Dedicated Channel) is a transport channel that can carry one block of data per TTI from the UE to the Node B.

For a 2ms TTI, these blocks of data can be as small as 18 bits or as large as 11478 bits every TTI. The 11478 bits block size would give the theoretical maximum HSUPA data rate of 5.74 Mbps.

The UE will determine the maximum block size it can use based on how much power it is allowed to transmit. This will dictate the spreading factor and number of physical channels that it is possible to use.

This successful or unsuccessful reception of this block of data by a Node B will be indicated by an ACK or a NACK being sent on the downlink.

The E-DCH is the name used to refer to HSUPA in the 3GPP specifications. Elsewhere, the term HSUPA has become the standard.
New Uplink Physical Channels

The **E-DPDCH** (Enhanced Dedicated Physical Data Channel) (or channels – there can be up to 4) carry the data sent on the E-DCH.

The **E-DPCCH** (Enhanced Dedicated Physical Control Channel) carries control information associated with the E-DPDCH data.

The UE will always be transmitting the standard DPCCH control channel at the same time as the above channels.

It may also be transmitting the DPDCH (carrying, for example, speech data) and the HS-DPCCH (sending ACK/NACKs in response to downlink HSDPA data).
DPDCH + E-DPDCHs at the Same Time

Uplink Code Domain view

Notes:
- DPDCH constrained to SF16 when E-DPDCH is present.
- Max E-DPDCH configuration is 2 x SF2 when DPDCH is present.
Removing the DPDCH allows 4 E-DPDCHs

Uplink Code Domain view

E-DPDCH1 @SF_n(n/4),
n = 256, 128, 64, 32, 16, 8, 4

Notes:
F-DPCH must be present in downlink in these configurations – to provide TPC bits
New Downlink Physical Channels

The **E-RGCH** and the **E-AGCH** (Enhanced Relative/Absolute Grant Channel) control the maximum power that the UE can use to transmit. This directly affects the choice of data rate that the UE can make on each TTI.

The **E-HICH** (Enhanced Hybrid Indicator Channel) carries the ACK/NACKs from the Node B to the UE. It is very similar to the HS-DPCCH in HSDPA, but it does not carry a CQI.

The **F-DPCH** (Fractional Dedicated Physical Channel) was not added specifically for HSUPA, but using it is necessary to achieve the highest data rates. If no DPCH is present, this carries the TPC bits to the UE to control the power of the uplink DPCCH.
Power Control

HSUPA does not change the fundamental way in which UE power control is managed in WCDMA.

The Node B is still trying to balance the received power of the DPCCH from each UE in the cell to be roughly the same.

What is being varied to allow one UE to transmit at a higher data rate than another one is the relative difference in power level between the power allowed on for transmitting E-DPDCHs and the power of the DPCCH.

Other HSPA power level assignments (E-DPCCH & HS-DPCCH) are also relative to the DPCCH.
Absolute Grants (sent on the E-AGCH)

Absolute Grants provide an absolute limitation of the maximum amount of UL resources the UE may use. They are sent to the UE on a common channel, usually at the start of an HSUPA connection.

Absolute Grant Value

- Indicates the maximum E-DCH traffic to pilot ratio (E-DPDCH/DPCCH) that the UE is allowed to use in the next transmission

Absolute Grant Scope

- Indicates the applicability of the Absolute Grant, either Per HARQ process or All HARQ processes
Relative Grants (sent on the E-RGCH)

Relative Grants increase or decrease the resource limitation compared to the previously used value. Can be sent every TTI, on a dedicated channel.

Changes E-DPDCH power in small amounts relative to the previous value.

Different relative grants can be received from each Node B in the radio link set.

Only serving RLS can increase resource limitation – but other cells may need to reduce the resource limitation and must be obeyed.
What the UE does with Power Control Information

The UE uses the information in the absolute and relative grants to calculate its **Serving Grant**. This is updated at every TTI boundary.

The Serving Grant allows it to calculate the maximum power it can use to transmit data on the E-DPDCH(s).

The UE has been informed at connection setup how much power is needed to use each physical channel combination so knows what is the maximum block size is can transmit for each TTI.

The UE may choose to use less resource (e.g. to transmit an RRC control message)
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### Serving Grant

1. **Absolute Grant**
2. **2-step threshold**
3. **3-step threshold**

### 2-step threshold

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What is Sent on the E-DPCCH

Happy Bit (1 bit)

- Indicates whether the UE is satisfied with the current Serving Grant
- If set to ‘Not Happy’, then the UE is telling the network that it could use more resources: i.e. UE cannot empty buffer in ‘n’ ms AND UE is utilizing all of its current Serving Grant AND UE could transmit at a higher power level

E-TFCI (7 bits)

- Indicates the Transport Format Combination Information. This is used by the Node B to decode the E-DPDCH

RSN: Retransmission Sequence Number (2 bits)

- Indicates the redundancy version (RV) of each HARQ transmission
- This allows the Node B to use chase combining/incremental redundancy to help decoding of retransmissions
ACK/NACKs

The E-HICH channel carries a separate ACK or a NACK from each cell inside the active set to the UE.

Since the UE is sending the same data to all cells at the same time, if any cell sends an ACK for the data, it does not need to be retransmitted.

The timing of the ACK or NACK will be a fixed period after the transmission of the E-DPDCH(s) that are being acknowledged – this means there is no ambiguity over what the ACK/NACK refers to.
The absolute grant channel is only sent by the serving cell. Relative Grants and ACK/NACKs from the same Radio Link Set (RLS) are the same – will be soft combined by the UE. E-DCHs (carried on E-DPDCH) will be soft-combined at Node B. Non-Serving RLS Cells cannot increase data rate – only hold or decrease it.
HSUPA Additions:
Layer 2 and 3 Overview

Layer 2/3 Additions
UE Additions
Network Additions
MAC-es/e (network)

MAC-es (RNC)
- Reordering queue
- Macro diversity selection

MAC-e (Node-B)
- Scheduler
- De-multiplexer
- HARQ processes
**MAC-es/e (UE)**

- Single sub-layer
- E-TFC selection
- Multiplexing
- HARQ Processes
HARQ Operation

Concept is similar to HSDPA operation. Like HSDPA, retransmissions in the UL are synchronous (i.e. a fixed time after the original transmission), with a maximum limit on the number of times a block can be retransmitted.

TSN (Transmission Sequence Number) used to track which block of data is being sent.

RSN (Retransmission Sequence Number) to track redundancy. Incremental redundancy or Chase Combining is then used by Node B to combine blocks.

4 Processes for TTI = 10ms (gives 40ms turnaround time)
8 Processes for TTI = 2ms (gives 16ms turnaround time)
Node B Scheduler

Balances the amount of UL resources each UE in the cell may use by controlling the E-DPDCH/DPCCH power ratio of the active processes.

Monitors interference from UEs in other cells and changes UE’s allocated resources to optimize capacity.

The location of scheduling in Node B (rather than the RNC) makes it more difficult to avoid a UE interfering with other Node Bs.

Phones will need to be kept ‘unhappy’ – otherwise more resource than necessary will need to be reserved for them.
E-TFC Selection

At connection setup, a set of up to 8 reference E-TFCs (Enhanced Transport Format Combinations), their transport block size and quantization amplitude ratios are signaled to UE. Then, during an HSUPA connection, for a given scheduling grant, this tells the UE which TFC can be used.

RRC also signals the maximum amount of puncturing that can be applied and the maximum channelization code(s) which are used to determine the SF and number of E-DPDCHs needed.

At each TTI boundary, UE determines the state of each E-TFC (supported or blocked) based on the E-TFC’s required transmit power versus the maximum allowed UE transmit power.

Once the E-TFC is selected along with all of the signaled parameters, the UL is completely configured and the data rate for the next transmission is known.
Scheduling Information

MAC in the UE can send (as frequently as every HARQ process) detailed information to allow the Node B scheduler can make appropriate scheduling decisions. This is sent along with the data blocks that are being sent.

• Information sent:
  – Identity of the highest priority logical channel with available data (HLID, 4 bits)
  – Total E-DCH buffer status (TEBS, 5 bits)
  – Buffer occupancy of highest priority logical channel (HLBS, 4 bits)
  – UE power headroom as ratio between available UE Tx power and DPCCH power - stops Node B asking UE to transmit more power than it is capable of. (UPH, 5 bits)
HSUPA Throughput

E-DCH UE Categories
Theoretical Data Rates
Realistic Data Rates
# E-DCH UE Categories

<table>
<thead>
<tr>
<th>E-DCH Category</th>
<th>E-DCH TTI (ms)</th>
<th>Max number of E-DCH codes transmitted</th>
<th>Min spreading factor</th>
<th>Max number of E-DCH transport block bits transmitted</th>
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## For Comparison - HSDPA UE Categories

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<th>HS-DSCH category (FDD)</th>
<th>Maximum number of HS-DSCH codes received</th>
<th>Minimum inter-TTI interval</th>
<th>Maximum number of bits of an HS-DSCH transport block received within an HS-DSCH TTI</th>
<th>Maximum Theoretical Throughput (Mbps)</th>
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<td>Category 12</td>
<td>5</td>
<td>1</td>
<td>3630</td>
<td>1.815</td>
</tr>
</tbody>
</table>
HSPA Throughput

It is very unlikely that devices will be released that support HSUPA but do not support HSDPA. Therefore the **combination** of the HSDPA and HSUPA category will be what is quoted when a device is sold. This will lead to devices being described as (for example) Category 2 in the uplink and Category 6 in the downlink.

Use of HSDPA will affect the maximum data rate achievable by an HSUPA configuration (and vice-versa) but not by much. An FTP session at 3.6 Mbps in the downlink generates about 100 kbps of TCP acknowledgements in the uplink.
Theoretical HSUPA Data Rates

The theoretical maximum throughput on the uplink is 5.74 Mbps.

Initial plans for all announced HSUPA devices and chipsets target 2 Mbps theoretical maximum throughput.

<table>
<thead>
<tr>
<th>Effective Coding Rate</th>
<th>Number of E-DPDCH Channels x Spreading Factor (SF)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 x SF4</td>
</tr>
<tr>
<td>1/2</td>
<td>480 kbps</td>
</tr>
<tr>
<td>3/4</td>
<td>720 kbps</td>
</tr>
<tr>
<td>4/4</td>
<td>960 kbps</td>
</tr>
</tbody>
</table>
Realistic HSUPA Data Rates

Maximum throughput can be demonstrated in a lab with a one phone on the network, one Node B and interference free conditions.

In the real world, maximum throughput could only be achieved with near perfect conditions and by giving the vast majority, if not all, of the capacity to one user – a very unlikely scenario! This would also assume that a UE could not interfere with other cells.

Field trials on HSDPA networks indicated throughput rates of 65 to 80% of the possible maximum are obtainable in ‘real world’ conditions for a Category 12 HSDPA device.

Cannot assume the same analysis for HSUPA:

• Uplink speeds will be dependant on where a phone is located in a cell and the number of other Node Bs nearby.
• Will be surprising if a UE can get much above 1 Mbps in a macro cell.
### HSUPA UL Reference Channels

<table>
<thead>
<tr>
<th>UE E-DCH Category</th>
<th>Number of Processes</th>
<th>TTI</th>
<th>Maximum Data Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>10 ms</td>
<td>0.7296 Mbps</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>10 ms</td>
<td>1.4592 Mbps</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>2 ms</td>
<td>1.4595 Mbps</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>10 ms</td>
<td>1.4592 Mbps</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>10 ms</td>
<td>2.0 Mbps</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>2 ms</td>
<td>2.9185 Mbps</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>10 ms</td>
<td>2.0 Mbps</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>10 ms</td>
<td>2.0 Mbps</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>2 ms</td>
<td>5.76 Mbps</td>
</tr>
</tbody>
</table>

Different HSUPA UL reference channels are used for each category of UE. They are a combination of HSUPA channels, HS-DPCCH, DPCCH and DPDCH (where appropriate).

The E-DPDCHs used will depend on the category of the UE tested. This will range from one channel using SF4 to test category 1, to a configuration with two SF2 channels and two SF4 channels – to test category 6.

On uplink DPCH use 12.2k RMC with the DPCCH/DPDCH power ratio given by the beta values in the table on the next slide. Use H-Set 1 to stimulate the HS-DPCCH.
# HSUPA UL Reference Channels

## Beta Values

<table>
<thead>
<tr>
<th>Sub-test</th>
<th>$\beta_c$</th>
<th>$\beta_d$</th>
<th>$\beta_d$ (SF)</th>
<th>$\beta_c/\beta_d$</th>
<th>$\beta_{HS}$ (Note 1)</th>
<th>$\beta_{ec}$</th>
<th>$\beta_{ed}$ (SF)</th>
<th>$\beta_{ed}$ (Codes)</th>
<th>CM (dB) (Note 2)</th>
<th>MPR (dB) (Note 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11/15</td>
<td>15/15</td>
<td>64</td>
<td>11/15</td>
<td>22/15</td>
<td>209/225</td>
<td>1309/225</td>
<td>4</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>6/15</td>
<td>15/15</td>
<td>64</td>
<td>6/15</td>
<td>12/15</td>
<td>12/15</td>
<td>94/75</td>
<td>4</td>
<td>1</td>
<td>3.0</td>
</tr>
<tr>
<td>3</td>
<td>15/15</td>
<td>9/15</td>
<td>64</td>
<td>15/9</td>
<td>30/15</td>
<td>30/15</td>
<td>$\beta_{ed1}$: 47/15</td>
<td>4</td>
<td>2</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$\beta_{ed2}$: 47/15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2/15</td>
<td>15/15</td>
<td>64</td>
<td>2/15</td>
<td>4/15</td>
<td>2/15</td>
<td>56/75</td>
<td>4</td>
<td>1</td>
<td>3.0</td>
</tr>
<tr>
<td>5</td>
<td>15/15</td>
<td>15/15</td>
<td>64</td>
<td>15/15</td>
<td>30/15</td>
<td>30/15</td>
<td>24/15</td>
<td>134/15</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Note 1: $\Delta$ACK, $\Delta$NACK, $\Delta$CQI = 30/15 with $\beta_{HS} = 30/15 * \beta_c$

Note 2: CM = 1 for $\beta_c/\beta_d = 12/15$, $\beta_{hs}/\beta_c = 24/15$. For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.

Note 3: For subtest 1 the $\beta_c/\beta_d$ ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 10/15$ and $\beta_d = 15/15$.

Note 4: For subtest 5 the $\beta_c/\beta_d$ ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 14/15$ and $\beta_d = 15/15$. 

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**Agilent Technologies**

**HSUPA Overview**

**17/03/2009**
HSUPA Tx Conformance Tests

Included in the standards documents today:

- Spectrum emission mask with E-DCH
- ACLR with E-DCH
- Maximum output power with E-DCH and HS-DPCCH

Coming later:

- EVM with E-DCH
  - Probably not a composite measurement of waveform quality as the WCDMA/HSDPA equivalent is today.
  - Instead a code-based measurement where EVM per code channel is returned.
HSUPA Performance Tests

Included in Section 10 of 34.121 today:

- Detection of E-DCH HARQ ACK Indicator Channel (E-HICH)
- Detection of E-DCH Relative Grant Channel (E-RGCH)
- Demodulation of E-DCH Absolute Grant Channel (E-AGCH)

All these tests check the ability of the UE to decode the new downlink physical channels. Nothing yet checks if the UE can actually sustain high data throughput in the uplink.
Loopback Testing

34.109 will soon be modified to clearly define a loopback from downlink HS-PDSCHs to uplink E-DPDCCHs.

This will provide the UE with enough data to continuously run at defined data rates. Without this, the transmitted power level would change if the UE ran out of data to transmit – 34.121 test cases demand known conditions.

In theory, this loopback would also allow an HSDPA BER test to be introduced.
Agilent Solutions for HSUPA

HSUPA to ESG
Download Signal to ESG

HSUPA_VSA_Throughput
Throughput Curve
HSUPA Connected Solutions – ADS2005A with HSPA Wireless Library (E8887) Add-On

http://www.agilent.com/find/eesof
3GPP WCDMA HSPA Signal Generation: E4438-419

Test W-CDMA, HSDPA receivers for BTS with HSUPA channels

- E-DPDCH physical channel coding
- E-DCH transport layer coding
- Quick setup FRC1 to 7
- Configurable E-DPCCH
- Scenario base and External input for HARQ functionality and E-TFC switching
- Assess receiver performance under noisy conditions. (Requires E4438C-403)
- Fade the signal using N5115B Baseband Studio for Fading
- Output the test signal as RF, analog I/Q, digital IQ or IF with the N5102A Baseband Studio Digital Signal Interface Module

http://www.agilent.com/find/esg
Signal Studio N7600B : HSPA ARB Based Solution

- W-CDMA, HSDPA, HSUPA DL/UL multi carrier configuration
- Generate physical layer signals for W-CDMA, HSDPA, HSUPA DL/UL
- Open loop diversity
- Full API support
- Add calibrated AWGN

http://www.agilent.com/find/signalstudio
Agilent Solutions for HSUPA Signal Analysis

- MXA Signal Analyzer with HSDPA/HSUPA Measurement Applications
  - Code Domain Analysis
  - Modulation Accuracy for Composite EVM, Peak CDE, and Frequency Error
  - RF Power Measurements

http://www.agilent.com/find/mxa/
Agilent Solutions for HSUPA Signal Analysis

- PSA Series Spectrum Analyzer with HSDPA/HSUPA Measurement Personality
  - Code Domain Analysis
  - Modulation Accuracy for Composite EVM, Peak CDE, and Frequency Error
  - RF Power Measurements

http://www.agilent.com/find/psa/
Agilent 8960 Solutions for HSUPA

Coming Soon for the 8960 in 2007:

- HSUPA End-End Data Throughput Testing
- Parametric Testing – 34.121 HSUPA Measurements

http://www.agilent.com/find/8960/