Keysight Technologies
Testing HSUPA devices

Article Reprint

This article first appeared in EE Times Asia, November 16-30, 2007.

Author: Jeanne Fightmaster
Learning Products Engineer
Mobile Broadband Division
Electronic Measurements Group
Keysight Technologies Inc.

KEYSIGHT TECHNOLOGIES
Unlocking Measurement Insights

Testing HSUPA devices

By Jeanne Fightmaster
Learning Products Engineer
Mobile Broadband Division
Electronic Measurements Group
Agilent Technologies Inc.

Release 6 of the 3GPP standard adds high-speed uplink packet access (HSUPA). A complement to HSDPA, HSUPA allows uplink rates of up to 5.74Mbps. However, with this increase in data rate comes a much more complex and dynamic uplink signal that requires more robust transmitter design and verification. These high data rates also stress the device's processing power and internal transfer speeds, especially when used in conjunction with HSDPA, requiring careful analysis of the device's application performance and actual throughput while sending and receiving high-speed data.

There are several changes in the uplink signal for HSUPA:

- The addition of two new physical channels in the uplink results in a higher crest factor in the uplink signal than in HSDPA.
- Uplink code channel relative power differences can be up to 45Db.
- Large power changes in the uplink (up to 27dB) can occur at the Transmission Time Interval (TTI) boundaries, e.g. when HSUPA transmission turns off or on.
- The uplink configuration is very dynamic. The number of E-DCH Dedicated Physical Data Channels (E-DPDCHs), their spreading factors and power levels can change each TTI.

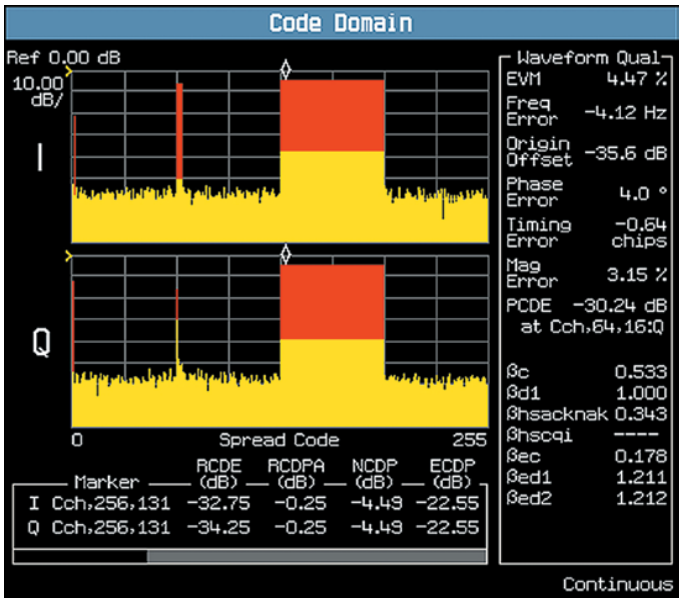

Figure 1: Agilent 8960 Wireless Test Set's Code Domain measurement is for testing 34.121 5.2D and 5.13.2B.

These changes can result in a worsening of transmitter distortion and modulation quality. It is not sufficient to simply test the HSDPA capability of a high-speed packet access (HSPA) device. It must also operate properly while transmitting HSUPA channels.

HSUPA overview

Although HSDPA and HSUPA are independent services, they will typically be used together for applications such as VoIP and mobile gaming. HSPA is an industry term for HSDPA + HSUPA.

HSUPA uses Hybrid Automatic Repeat-reQuest (ARQ) as in HSDPA—but in HSUPA, the Node B acknowledges the user equipment's (UE) data transmission. Node B dynamically allocates power among the UEs on a TTI basis. The UE's serving grant (power allocation) effectively determines the data rate at which it may transmit. To achieve 5.74Mbps in the uplink, UEs must support the (optional) 2ms TTI defined for HSUPA. Early (category 5) devices support only the 10ms TTI, limiting the uplink data rate to 2Mbps.

HSUPA introduces several new uplink and downlink channels. The Enhanced Dedicated Channel (E-DCH) uplink transport channel carries one block of data per TTI. The E-DPDCH carries the uplink user data. The UE can transmit up to four E-DPDCHs, at a spreading factor of SF256 to SF2. 2*SF2 E-DPDCHs are required to achieve 2Mbps, the maximum data rate supported by early devices. The E-DCH Dedicated Physical Control Channel (E-DPCCH) uplink channel carries the control information needed by Node B to decode the uplink E-DPDCH, such as the E-DCH Transport Format Combination Indicator (E-TFCI), which indicates block size, Retransmission Sequence Number and the Happy Bit, which indicates whether the UE is happy with its current serving grant. The three new downlink physical channels are as follows: the E-DCH HARQ Acknowledgement Indicator Channel is used to acknowledge the UE's data; the E-DCH Absolute Grant Channel provides the absolute limit of the power resources (serving grant) the UE may use; and the E-DCH Relative Grant Channel moves the UE's serving grant up or down (or signals a hold).

A new HSUPA loopback using Radio Bearer Test Mode is defined in 3GPP TS 34.109. It requires an HSDPA downlink with a carefully chosen data rate such that the UE is provided a steady stream of data to loop back up on its HSUPA channels, but without excessively overflowing its buffers.

Testing performance

There are several new tests defined in 3GPP TS 34.121 for testing HSUPA performance. However, many of the existing Release 99 and HSDPA tests in 34.121 can be replaced by the new HSUPA tests.

- 5.2B Maximum Output Power with HS-DPCCH and E-DCH—This verifies that the UE reaches its maximum rated output power, which is scaled back to account for the higher crest factor of HSUPA. This

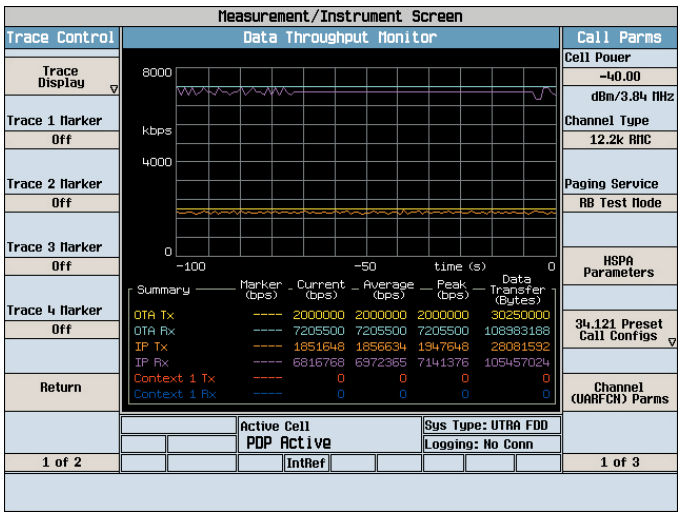

Figure 2: Agilent 8960 Wireless Test Set's Data Throughput Monitor measurement shows the UE's HSPA over-the-air and IP connection rates during a bidirectional FTP Note: This UE is not yet capable of reaching the maximum rates of 2Mbps UL/7.2Mbps DL).

Test	Rel99	HSDPA		HSUPA
Max power	5.2	5.2A	5.2AA	5.2B
RCDPA		5.2C		5.2D
HS-DPCCH		5.7A		
Spectrum emission mask	5.9	5.9A		5.9B
ACLR	5.10	5.10A		5.10B
EVM/Phase disk	5.13.1, 5.13.3	5.13.1A	5.13.1AA	Coming soon
Code domain	5.13.2	5.13.2A		5.13.2B
Max input level	6.3	6.3A		N/A

Shown are the tests required for HSPA devices.

test ensures that the UE allows adequate cell coverage without interfering with other channels or systems.

- 5.2D UE Relative Code Domain Power Accuracy for HS-DPCCH and E-DCH and 5.13.2B Relative Code Domain Error with HS-DPCCH and E-DCH—These tests examine the UE's modulation accuracy of individual code channels (vs. the composite signal) to ensure that the code channels are properly modulated and are transmitting the proper relative code power levels.
- 5.9B Spectrum Emission Mask with E-DCH and 5.10B Adjacent Channel Leakage Power Ratio with E-DCH—These tests check for out-of-channel interference due to the increased spectral splatter of an HSUPA uplink signal.

As many of the high-speed applications targeted for use on HSUPA devices require transmission of Internet protocol (IP) data, it is useful to also ensure that the HSUPA device is capable of transferring data at its specified rate, and that the device's applications perform as expected under various channel conditions. The use of a network emulator can establish an end-to-end IP connection between a server and the HSUPA device/client and then vary the serving grant, additive white gaussian noise, code channel levels, induce fading and perform handovers, as well as change properties of the IP connection and examine the effects on data rate (both uplink and downlink) and application performance.

HSUPA is an exciting new technology that will enable much higher data rates in the uplink than current systems. Used in conjunction with HSDPA, this will allow a wider array of high-speed wireless services such as VoIP and mobile gaming. However, HSUPA places high demands on the wireless device's transmitter, processor, internal buses and memory allocation. The device's performance must be tested while HSUPA channels are active—it is not sufficient to merely test its Release 99 or HSDPA characteristics. Fortunately many of the existing 3GPP TS 34.121 tests can be replaced by their new HSUPA equivalents, thus minimizing the effects of HSUPA on total device test time.

Keysight Technologies, 2007 - 2015
Printed in USA, May 13, 2015
5989-7843EN