



**Delivering the
Full Potential of HSPA+
using
qBoost™ Envelope Tracking
technology**

Summary



High-speed wireless data applications are exploding in popularity. For wireless carriers, these data offerings are a lucrative new revenue source and also provide a way to differentiate their service plans. To ensure their data services live up to expectations, carriers are introducing evolved High-Speed Packet Access technology, HSPA+, to increase capacity and data speeds. But in many cases today's smart phones and data cards cannot output enough maximum signal power to deliver the promised speeds. Without enough signal power, either data transmission must be slowed down or data coverage is significantly reduced, seriously reducing the benefit of these HSPA+ enhancements. Quantance helps eliminate these problems at the source with a unique and patented technology that enables more uplink power, opening the door to the full potential of HSPA+ for wireless data.

Wireless Data Use Expanding Dramatically

Facebook, Twitter, Bebo, YouTube, Flickr – these are just a few of the popular social networking and multimedia applications expanding virally worldwide and moving into the wireless space. Personal use via phones, smart phones, ultra mobile PCs and laptops with internal modems or USB data cards has skyrocketed and this same popularity is infiltrating the enterprise markets, as entire organizations use mobile applications to manage resources and exchange critical information while on the go.

In all major markets, wireless carriers are reporting dramatic increases in data usage. According to *Fierce Wireless Europe*, in the case of Orange in France, data card subscriptions surged by 2000% during 2008¹. While Orange's growth rate may seem staggeringly large, it is comparable to what other wireless carriers around the world are experiencing.

This growth has resulted from the confluence of popular applications that lend themselves to the mobile lifestyle; new and creative wireless service plans; and mobile devices that are finally approaching the ability to deliver services with the speed and reliability that consumers expect. In fact, the *Wireless Federation* noted in late 2008, "mobile network operators in developed regions should prepare for a tenfold increase in wireless network traffic by 2015, as data traffic rapidly overtakes voice²...."

USB data card subscriptions surged 2,000% in 2008 for mobile carrier Orange.

- *Fierce Wireless Europe*
January 2009

¹ *Mobile Data Usage Doubles Quarter Over Quarter*, Fierce Wireless Europe, January 2, 2009

² *Wireless Network Traffic To Increase Tenfold*, Wireless Federation, November 28, 2008

Carriers Deploy HSPA+ to Meet the Need

With the increasing demand for high-speed data, wireless carriers are seeing a great opportunity to grow their revenue and differentiate their offerings. Beyond new creativity and publicity in wireless data plans, the most apparent evidence of this new priority is their rush to enhance their underlying network technology with the latest wireless data standards, enabling their networks to handle more data, and pass data at faster data rates.

In recent years, the high speed packet access (HSPA) standard has been introduced as the first step toward higher performance. According to recent estimates, HSPA has already been launched commercially worldwide by over 200 operators.

But with the accelerating growth of data services, networks must deliver service capacity and speed beyond what the initial HSPA standard can provide.

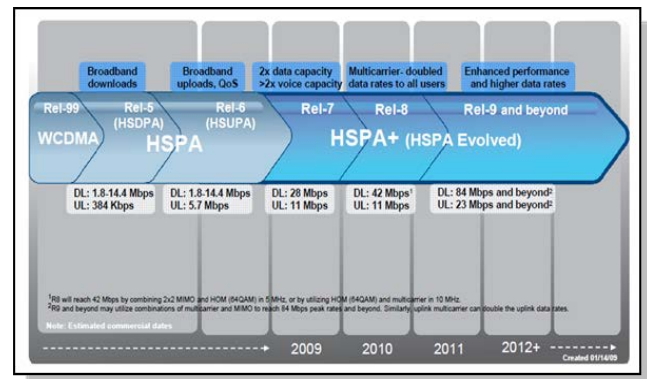


Figure 1: HSPA evolution (Source: Qualcomm³)

To address these immediate needs without significant changes to the network infrastructure, most wireless carriers are upgrading their networks to HSPA+. HSPA+ is a set of HSPA enhancements that improve mobile broadband, initially offering increased data capacity and uplink data speeds two times faster than the HSPA standard, with further speed increases planned. The expected timing HSPA and HSPA+ is shown in Figure 1.

But Wait, It's Not that Easy

HSPA+ enhancements are designed specifically to improve data speed and capacity by using higher order modulation (HOM) to pack more data into the same radio bandwidth, resulting in much faster data speeds. The relative density of information between HSPA+ and HSPA can be seen in Figure 2, showing HSPA+ signals are 4 times more complex than today's HSPA signal. This increased signal complexity requires more signal power to maintain performance, yet today's mobile devices are often unable to produce maximum power signals consistently or reliably.

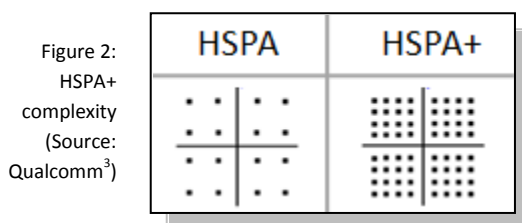


Figure 2:
HSPA+
complexity
(Source:
Qualcomm³)

As a result, HSPA+ is faced with a very serious limitation: Without enough signal power, either data transmission must be slowed down, or data coverage is significantly reduced, effectively eliminating much of the benefit of the HSPA+ enhancements.

The effect of this need for more signal power is shown in Figure 3, a schematic representation of a group of typical cell towers and their collective service coverage. Today's voice and basic data service coverage for a single cell reaches to the outer dotted line. However, when mobile devices are used for more advanced data services on HSPA+ networks, they require a lot more uplink transmit power. If mobile devices cannot produce the power needed, they don't experience the speed benefit, and may not even be able to make the high speed data connection, degrading back to slower 2.5G

³ HSPA+ for Enhanced Mobile Broadband, Qualcomm White Paper, February 2009

technology. Unfortunately, this is already fairly common on today's HSPA networks. So the benefit offered from HSPA+ occurs in a much smaller area, effectively shrinking the cell to a much smaller size (shown in white).

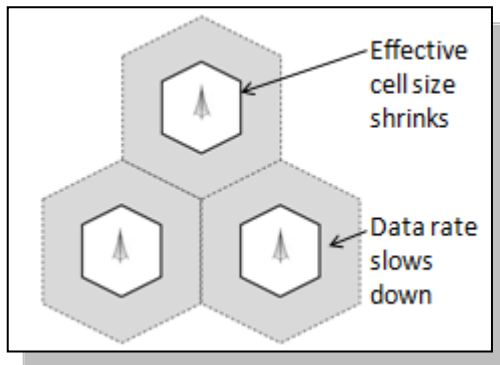


Figure 3: Network shrinks without adequate power

And even if the signal from a mobile device located in the grey area is able to reach the cell tower, the data rate will likely be much slower than promised by the HSPA+ standard due to the reduced power.

So networks are literally shrinking under the strain of more users and complex HOM schemes. Recent studies show that for a HSPA network in a typical urban area (e.g., the SF Bay Area), up to 54% of users will be impacted by reduced coverage or data speed resulting from the lack of sufficient signal power from the mobile device. The problem is even worse for HSPA+ because it is four times more complex than HSPA. The same study shows the projected subscriber impact for HSPA+ to be up to 75%.

How to Get the Most Out of HSPA

Clearly, the industry must do something about this signal power problem to deliver the full potential of HSPA+. A few options exist:

1. Do nothing. The industry can ignore these problems, but this will severely shortchange the promise of HSPA+ and thus is not a viable course.

2. Increase cell density. Wireless carriers could add more cell towers to provide better coverage. But this is extremely expensive and time consuming. Doing so would necessitate an overhaul of the carrier networks and the approval of local governments for locating new towers and other new equipment in new areas. There are so many cost and political barriers that this solution is generally unrealistic as an overall solution.

3. Increase signal power. The more effective and universally acceptable alternative is to somehow increase the signal power being transmitted in the network as needed.

So to reach its full potential, HSPA+ needs more uplink signal power transmitted from the mobile device to the cell site. However, mobile device transmit circuits use power amplifiers (PAs) that either simply cannot produce the maximum signal strength needed, or struggle to produce it and end up over-heating, distorting the signal, or using battery power unacceptably fast.

For data transmissions, the HSPA+ signals have high peak to average ratios (PAR), which cause very large swings in voltage levels at the PA and distort much more easily as they are amplified by the PA, particularly at high PA output power. Today, in order to maintain signal quality and appropriately manage the high PAR signals, the PA must actually *reduce* its maximum transmit power levels. So in a case where more power is needed, ironically, less power is produced. The typical PAR level is high for HSPA signals and higher yet for HSPA+ signals, which leads to significant power reduction.

Figure 4 shows actual WCDMA Release 99 (R99) and HSPA laboratory measurements of maximum uplink power outputs averaged across several different commercial data cards. Notice that as the standards advance and more complex standards are used, the maximum output power becomes correspondingly smaller. On average, HSPA uplink power from data cards reaches only about 20dBm output levels (measured at the antenna), which is 4.0 dB below the baseline 3GPP specification. For HSPA+, the maximum output power is expected to be even less at 19.5 dBm, reduced 4.5dB from the baseline specification. On an absolute scale, for HSPA+ this is a factor of three times less power compared to the baseline specification.

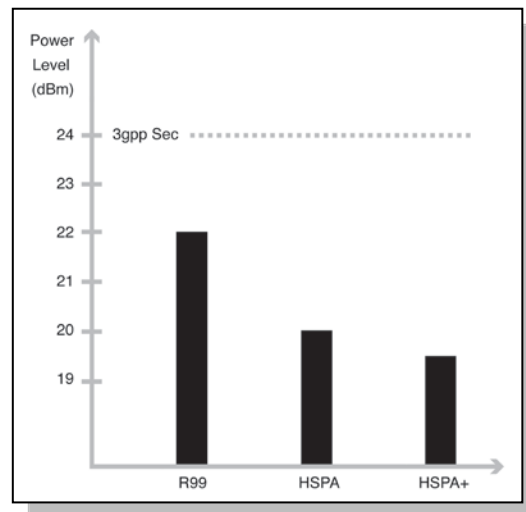


Figure 4: Data card uplink power measurements

The Quantance Solution for More Power

Quantance is attacking these power challenges at the source of the problem by making the RF front end of mobile devices operate more efficiently, thus enabling more transmit power.

This unique approach consists of patented technology that eliminates the PA inability to efficiently amplify high PAR HSPA+ signals at maximum and midrange output powers. As shown in Figure 5, the Quantance solution intelligently manages the voltage to the PA using unprecedented closed loop feedback and high-speed power conversion.

This enables the PA to operate efficiently enough that peak power is increased while maintaining signal linearity. To achieve this PA performance improvement, mobile device manufacturers can add a small chip from Quantance, called the Q1000, to the RF front end, as described later in this document.

The net result? The Quantance chip eliminates the problems associated with limited PA output power, by enabling a device to regain most of the power the PA cannot otherwise produce for high PAR signals.

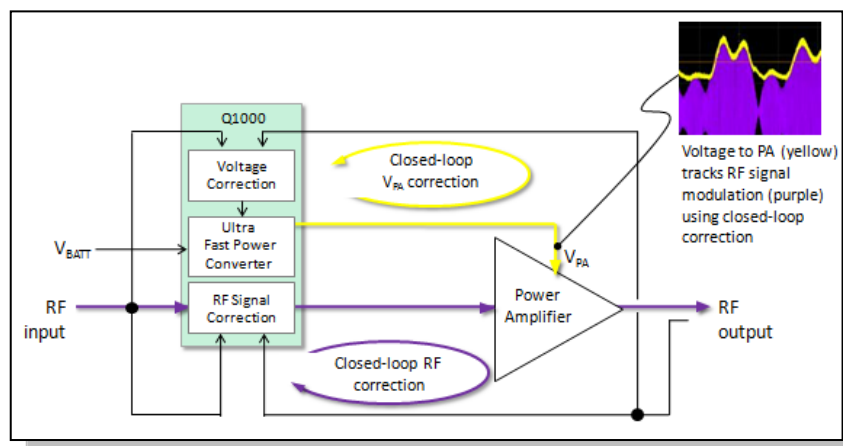


Figure 5: Quantance closed loop and fast power converter technology for PA efficiency

Delivering the Full Potential of HSPA+

Figure 6 shows confirmation of the Quantance benefit for several commercial data cards measured in Quantance labs. The green bars indicate the improved performance when the Quantance chip is used in the same data cards reference earlier.

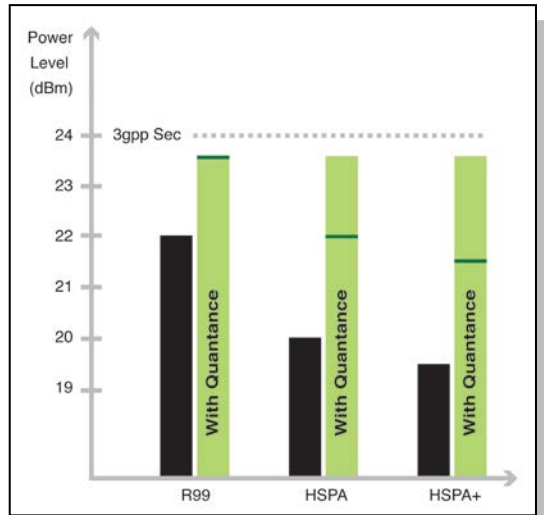


Figure 6: Data card measurements with Quantance technology

As shown, Quantance technology can return anywhere from 2 to 4dB to the user in many environments, dramatically improving performance and regaining the full benefits of HSPA+.

The horizontal mark on each green bar indicates today's Q1000 performance, whereas the top of each green bar indicates the capability planned on the Quantance roadmap.

What does this mean to a real user? Loading your latest photos to Facebook using your smart phone or a data card with Quantance technology enables that upload to happen 3 times faster where power is limited in a typical cell. So in certain conditions an upload of a simple video or photo can be reduced from one minute to 20 seconds using Quantance technology.

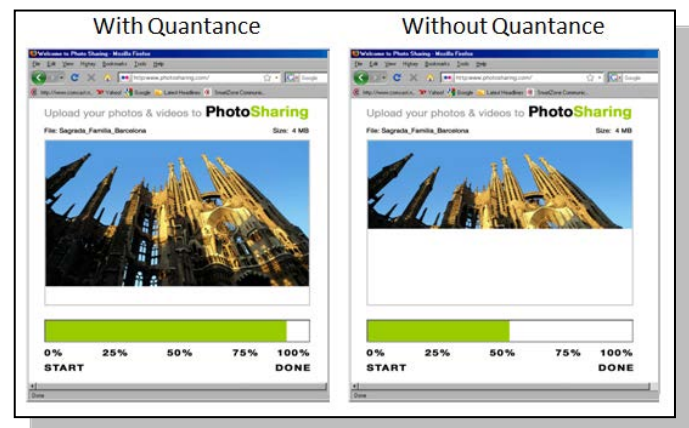


Figure 7: User impact of Quantance technology (photo upload example)

Improves
HSPA+
Performance

Quantance technology further enhances the benefits of the 3GPP standards to deliver the full potential of HSPA+. For as little as 2dB signal strength improvement, the data rate with Quantance technology increases threefold across the majority of a typical cell area.

Solves
Problem
Universally

Quantance technology provides a universal solution. Any device that uses the Quantance chip is capable of the improved performance, not matter where that device is used. It is not restricted by network upgrades or tied to costly network changes or government policy.

Benefits
Grow As
Standards
Progress

Quantance benefits increase as signal modulation schemes become more complex, with higher PAR signals. As a result, the benefits are compelling for HSPA and HSPA+, and offer further improvements for 4G systems.

While Quantance technology offers compelling benefits at the user level, Quantance benefits are impressive at the OEM level as well. Figure 8 shows the relationship of a PA with and without Quantance intelligently managing its voltage, plotting uplink signal power versus battery current. Actual measurements are available from Quantance, but it can be seen from the representative curves that benefits include those listed at right.

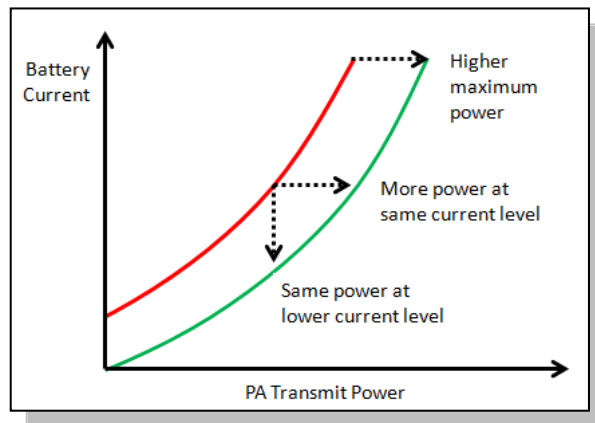


Figure 8: Quantance benefits for the OEM

- **Higher Maximum Power:** Quantance technology enables a higher peak power than can be achieved otherwise.
- **Better Mid-Range Power Capability:** For mid-range power applications, Quantance technology enables the PA to provide more power for the same current, or the same power output for significantly less current.
- **Improved PA Efficiency:** Quantance improves the operational efficiency of the PA, enabling significant current savings that improve battery life and significantly reduced PA junction temperature.
- **Improved Signal Linearity:** Quantance technology maintains ACPR and EVM while enabling improved efficiency and maximum power.

Integrating Quantance Technology in Wireless Devices

As shown in the two simplified block diagrams (Figures 9 and 10) of a typical wireless device, the Quantance technology can be simply and seamlessly integrated into the RF front end by adding the Q1000 (Figure 11). There are no modem or platform changes required, no software changes necessary, and the Quantance technology is cellular baseband and PA agnostic.

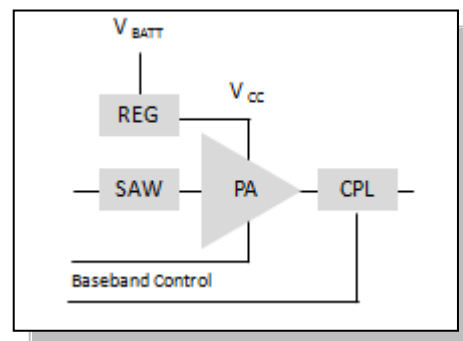


Figure 9: Typical data card or smart phone circuit



Figure 11: Quantance Q1000

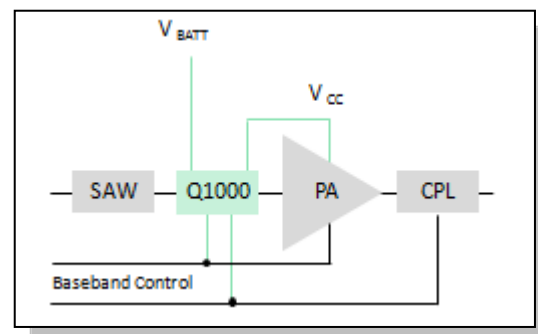


Figure 10: Same as Figure 9, but with Quantance Q1000

Conclusion

The exploding demand for high-speed wireless data is driving the deployment of HSPA+ to provide faster, higher capacity data services. However, with that performance comes the need for more uplink signal power from the mobile device that cannot be easily met by today's PA technology. Quantance technology helps solve this problem by addressing the fundamental problem, PA efficiency.

By intelligently managing the PA in high PAR conditions common to HSPA+, Quantance technology can be used in any 3G wireless device to maximize uplink signal, delivering the full potential of HSPA+.

About Quantance

Quantance is a venture-backed analog/RF semiconductor startup based in Silicon Valley. Through proven innovations in RF transmit chain efficiency that result in more signal power using less battery power, Quantance technology enables wireless phones, data cards, and other mobile consumer devices to support 3G, 3.5G, and 4G services with greater power output, longer battery life, and without excessive heat buildup.

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