Next-Gen Now

3G wireless might by synonymous with data, but there's more to the new standards than than.

By Tim Kridel

From a distance, 3G wireless looks like a revolution. But dig into the standards and the networks that rely on them, and 3G starts to look more like an evolution.

Case in point: In 2007, two major standards bodies — the 3G Partnership Project (3GPP) for the Global System for Mobile communications/Universal Mobile Telecommunications System (GSM/UMTS) family of technologies and its Code Division Multiple Access (CDMA) counterpart, the 3GPP2 — say they plan to finalize new technologies that promise to push data rates as high as 200 Mbps. But the new standards all have a healthy respect for the past, including keeping forklift upgrades to a minimum and protecting the wireless killer app: voice. Here's an overview of what lies ahead.

GSM's Evolution

GSM includes older, well-known technologies such as General Packet Radio Service (GPRS) and Enhanced Data rates for GSM Evolution (EDGE), and new technologies including EDGE Evolution, High Speed Uplink Packet Access (HSUPA), HSPA+ and Long Term Evolution (LTE):

EDGE EVOLUTION: EDGE Evolution increases peak download speeds to about 1.3 Mbps, with 500 Kbps under the initial Type 1 version expected to make its commercial debut around 2008–2009. EDGE Evolution also increases spectral efficiency nearly 50% by borrowing techniques from High Speed Downlink Packet Access (HSDPA). However, it still uses the same 200 KHz channels as GSM, as well as the world's two most widely used bands: 900 MHz and 1800 MHz. That design could make it attractive to carriers that want to launch 3G services in the 2G spectrum they already own, avoiding the need to purchase new spectrum licenses and thereby reducing their overhead costs.

The cost of EDGE Evolution depends partly on the age and upgradeability of each carrier's infrastructure. Although the 3GPP is still finalizing some of its features, EDGE Evolution probably will be more of a software upgrade than a hardware upgrade. "People don't look at this as a forklift upgrade," said Chris Pearson, president of 3G Americas, a regional trade association for GSM. "It won't be too expensive."

In fact, EDGE Evolution's cost structure could be one of its biggest selling points for carriers, especially those in price-sensitive markets such as Latin America.

The technology also could be an attractive option in rural areas, where some carriers currently use GPRS or EDGE because there's not enough demand to justify upgrading their network to HSDPA.

"Carriers will be looking at it for their outlying areas, whether that's in Europe or South America or North America," Pearson said. "They'll be thinking, 'When we get HSPA out, is the step-down to regular EDGE acceptable to customers, or do we need to upgrade those outlying areas to make that step-down less noticeable?'"

HSUPA: HSUPA is an upgrade to UMTS that increases upload speeds to a maximum of 1 Mbps, with averages of 250–450 Kbps. HSUPA is a potential fit for mobile business users who often send and receive large files and for Echo Boomers who produce user-generated content such as mobile video blogs. "Everyone realizes now that even though the downlink has the majority of the traffic, the uplink is becoming more and more important," said Pearson, who expects commercial HSUPA services to debut in late 2007 or early 2008.

HSPA+: HSPA+ — also known as High Speed Packet Access Evolution (HSPA Evolution) — is an interim step toward LTE. HSPA+ utilizes techniques that will be used in LTE and applies those that don't require forklift upgrades. Later versions of HSPA+ will include antenna technologies such as Multiple Input Multiple Output (MIMO).

"Theoretically, for the initial implementations of HSPA+ without MIMO, you're looking at 14.4 Mbps peak network speeds on the downlink and peaks of 5.76 Mbps on the uplink," Pearson said. "That would double if you use 2+2 MIMO: 28 Mbps and 11.5 Mbps."

HSPA+ is still a work in progress at 3GPP but could be ratified by late this year. "Commercial deployments are anticipated in 2008–2009," Pearson said.

LTE: LTE could support peak downlink network speeds of 100 Mbps and uplink speeds of 50 Mbps. User speeds haven't been determined yet but would be lower. LTE can be used in 20 MHz spectrum blocks, as well as other bandwidths. "We expect [commercial availability] in the 2009 timeframe," Pearson said.

LTE's backers say the technology will be two to four times more spectrally efficient than HSPA Release 6. It also will have latency of about 10 ms for the trip between the user's device and the Node B, so it could be a good fit for delay-sensitive applications such as Voice over Internet Protocol (VoIP), Virtual Private Networks (VPN) and real-time gaming.

CDMA2000 Through 2010

The first commercial CDMA2000 service launched in October 2000, with 1xRTT. The latest version is CDMA2000 Evolution–Data Optimized (EV-DO), whose Release 0 is commercially available from more than 57 networks, according to the CDMA Development Group (CDG). New and forthcoming EV-DO revisions include:

Will the Real 4G, Please Stand Up?

The term "4G" is quickly becoming what "3G" was a decade ago – a catch-all term that's rendered almost meaningless as backers of every technology adopt it in an effort to brand their innovations as the next big thing in wireless. Over the past year, even mobile WiMAX (IEEE 802.16e) has been touted as 4G.

The closest that the industry has to a standard definition for 4G is "International Mobile Telecommunications (IMT) - Advanced," the nascent International Telecommunication Union (ITU) successor to the IMT-2000 initiatives that produced 3G. IMT-Advanced's minimum requirements include 100 Mbps peak rates at high vehicle speed and 1 Gbps peaks for stationary mobile devices. Forthcoming technologies such as CDMA2000 1xEV-DO Rev. C, LTE and mobile WiMAX fall far short of those minimums, at least for fixed applications.

For more information about IMT-Advanced, visit the ITU's Web site at www.itu.int. For more information about mobile WiMAX, see "WiMAX Reality Check".

Revision A: Revision A has been commercially available since October 2006 in a few countries, including South Korea and the United States. Rev. A supports peak download speeds of 3.1 Mbps, which is about 700 Kbps faster than the 450–800 Kbps average of Release 0. The biggest difference is on the uplink side, where Rev. A delivers peak speeds of 1.8 Mbps and averages of 300–400 Kbps. In addition, Rev. A supports per-user and per-application QoS. Like HSUPA, Rev. A is a potential fit for applications that require transmission of large amounts of data.

The Rev. A latency of 50 ms is also lower than Rel. 0, which could make it attractive for enterprises that use mobile VPNs. Low latency sets the stage for CDMA2000 operators to offer mobile VoIP. The low latency coupled with QoS support also is one of the reasons why Sprint Nextel plans to migrate its iDEN Push-To-Talk (PTT) customers to QChat using Rev. A infrastructure over the next few years.

Revision B: Revision B combines multiple 1.25 MHz Rev. A carriers to increase throughput. For example, the CDG said that when 15 channels are combined, Rev. B will support peak download speeds of 46.5 Mbps, with 27 Mbps peak uploads. The carriers' spectrum bands don't have to be contiguous, giving operators more flexibility. The 3GPP2 published the Rev. B standard in March 2006, and the CDG expects it to be commercially available by 2008.

Revision C: Revision C could support peak download speeds of 200 Mbps in 20 MHz bandwidth, according to the CDG, although that could change by the time the 3GPP2 ratifies the standard sometime in 2Q 2007. Rev. C is expected to have latency of about 16.8 ms and peak upload speeds of 68 Mbps. Also known as Ultra Mobile Broadband (UMB), Rev. C follows the industry-wide trend toward 3G technologies that support dynamic channel bandwidths, with UMB likely to range from 1.25 MHz to 20 MHz. UMB could make its commercial debut by late 2008, the CDG said.

Growing Pains, Financial Pains

All 3G technologies have at least one thing in common: As they deliver faster upload and download speeds, their backhaul requirements increase exponentially. According to a March 2006 report by Heavy Reading, an independent analyst firm, "Carriers are typically basing their initial HSDPA/EV-DO deployment plans around two T-1/E-1 backhaul circuits per cell site; but as capacity expands, they are talking about having to support as many as 10 such circuits."

Backhaul isn't a minor expense. For most carriers, it represents up to 25% of OpEx, Heavy Reading estimates. If a carrier has to add two or more T-1 lines to each cell site to accommodate demand for 3G services, their backhaul costs could double or quadruple. For an operator upgrading 10,000 base stations to 3G, annual backhaul costs can easily grow by $30 million to $60 million. Even if the operator's 3G services are enormously popular, it's doubtful that they would drive enough additional revenue to offset $60 million or more in annual additional backhaul costs, if they still use T-1 for backhaul transport.

To avoid getting into that financial bind, many operators worldwide are considering or already migrating to Ethernet-based backhaul, which has a per-megabit cost that can be 25% or more lower than that of T-1 lines, based on Tellabs' research. Infrastructure vendors are already responding to this trend by adding IP/Ethernet interfaces to their base stations.

"With more and more bandwidth required, Ethernet — not E-1s or T-1s — will be the only way to cost effectively manage backhaul," said Kevin Lee, a wireless technology specialist at Tellabs.

Quality First

Migrating to Ethernet backhaul in order to accommodate 3G's bandwidth demands comes with a few caveats. One is that backhaul can't become the network's weak link in terms of Quality of Service (QoS) and reliability, especially when enterprises and other early adopters often pay a premium for 3G.

But Ethernet doesn't provide any effective mechanism to manage QoS for 3G applications or the reliability requirement. To meet those requirements, Ethernet transport services must support a deterministic QoS. In fact, to be a viable alternative to backhaul mainstays such as Asynchronous Transfer Mode (ATM), Ethernet must be able to deliver the availability, latency and jitter that operators and their radio infrastructure are accustomed to getting from legacy technologies.

Vendors addressing those needs with products such as the Tellabs® 8600 Managed Edge System using Pseudowire Edge-to-Edge Emulation (PWE3) and Multiprotocol Label Switching (MPLS) technologies, which provides resiliency across an Ethernet network by, for example, ensuring fast switchovers. "In a traditional Ethernet network, re-converging the stream can take seconds, maybe even tens of seconds," said Dan Lewallen, a wireless technology specialist at Tellabs. "With the Tellabs® 8600 system, we're able to re-converge in hundreds of milliseconds."

QoS is key for supporting delay-sensitive, real-time applications such as VoIP and streaming multimedia. But it also could be used to enable service tiers, where users pay a premium for certain QoS guarantees. "You could leverage it to offer platinum-, gold- and bronze-type services." Lewallen said.

Layering It On

Another issue that operators face during their 3G migration is the fact that 3GPP and 3GPP2 don't provide clear guidelines for Layer 2 transport. "They define the Radio Access Network (RAN) interfaces and logical network connection interfaces in the IP layer," Lee said. "But they've left how to establish and implement the transport up to carriers."

That omission is surprising, considering that Layer 2 is a more economical and effective backhaul transport technology than Layer 3, where the equipment tends to be more expensive and the management issues are more complex. One option is to employ Tellabs 8600 system and the Tellabs® 8800 Multiservice Router (MSR) Series. For example, operators can use the Tellabs 8600 system to manage backhaul transport in the RAN and the Tellabs® 8800 MSR series to manage core transport and routing. The Tellabs 8600 system provides high resiliency across an Ethernet network using MPLS Label Switched Path (LSP) by, for example, ensuring fast switchovers.

The Tellabs 8800 MSR series can function as Provider Edge (PE) router over a larger IP MPLS-enabled network or a Synchronous Optical Network (SONET) ring. The Tellabs 8800 MSR series provides efficient IP routing, Ethernet demarcation, testing access and enormous savings in the optical ports that can be very expensive (up to 8x) in a typical IP router.

Catering to the Killer App

Although next-gen technologies such as HSPA+ and UMB get attention for their data rates, voice will remain the killer app. "Voice applications will be there forever, regardless of whether they're circuit-switched or VoIP," Lee said.

Landline quality voice is key for mobile operators because the easier it is to hold a conversation, the more likely customers will talk more — and spend more in the process. Another reason is that although wireline displacement is growing in most world regions, mobile operators that don't address voice QoS can't maximize that trend.

As wireless penetration grows and wireless minutes of use grow, the odds increase that more of each mobile user's calls will be to another cell phone. In some countries, that trend has a bigger effect on voice QoS. In North America, CDMA and GSM/UMTS are both widely used, whereas in Europe GSM/UMTS is the de facto standard. As a result, North American mobile operators must address multi-technology transcoding, such as from CDMA's Enhanced Variable Rate CODEC (EVRC) to GSM's Adaptive Multi-Rate (AMR).

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