# LTE: Huge Technology, Huge Challenges

Long Term Evolution *is* global 4G. It's available on **57** networks in **34** countries, according to wireless industry advocate 4G Americas, with **100** networks in total expected by the end of this year. It's fast, and it could help IT fulfill mobility challenges. Too bad it faces significant obstacles.

**By Peter Rysavy**

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## Dark Side of Mobility

**The mobile broadband industry** is becoming a victim of its own success. Mobility initiatives are huge for companies, and that translates to an unprecedented number of bytes flowing through wireless networks. Yet efforts to free up additional spectrum are going nowhere fast, putting carriers between a dysfunctional government and enterprise and consumer customers who want their entertainment, apps and data, now.

Long Term Evolution, with its more efficient use of spectrum and an impressive road map of features to increase capacity, is a crucial element in how operators will address demand. By itself, though, it's not enough. For enterprise IT teams, that means work in two areas.

First, think carefully about your mobility partner. Among respondents to our latest Mobile Device Management and Security Survey who have IT-driven device and carrier selection, Verizon (68%) and AT&T (58%) are the top choices, but neither offers an unlimited data plan for new customers. Be sure that
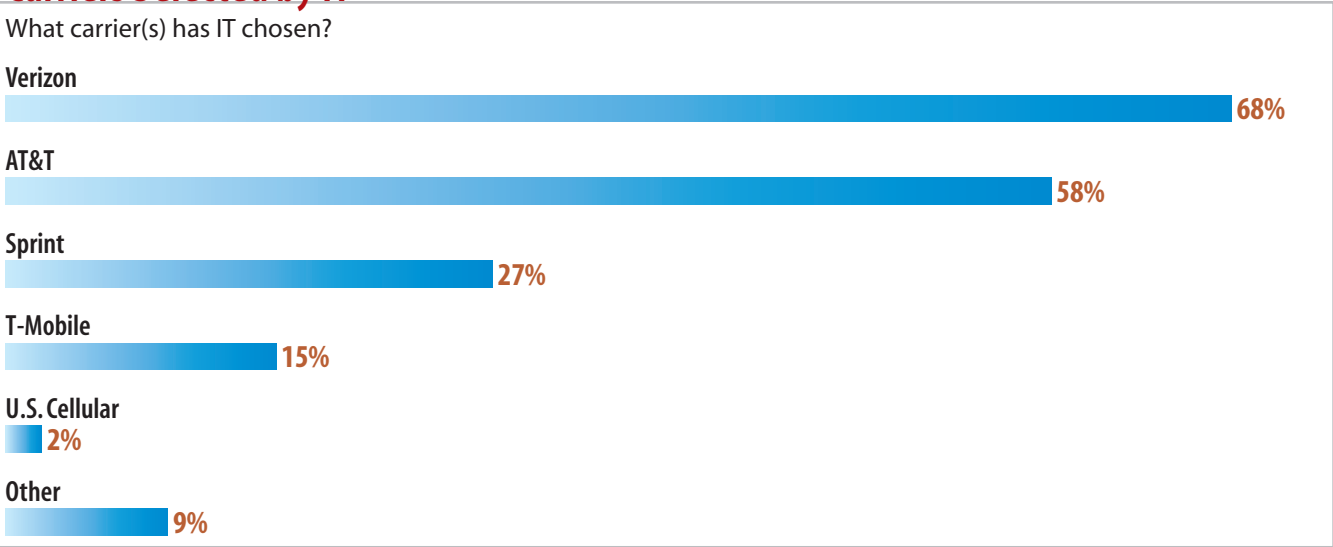
whichever carrier you partner with has a road map to blend technology, such as LTE and eventually LTE-Advanced, with efforts to obtain more spectrum; pricing policies you can live with; increases in the number of cell sites, including small cells such as femtocells and

picocells; and data off-load onto Wi-Fi, which we discuss in more depth here.

Also keep bandwidth limitations in mind when considering new mobility initiatives. For example, 68% of respondents to our MDM survey say they use or plan to use virtual desk-

**Figure 1**

### Carriers Selected by IT

What carrier(s) has IT chosen?

| | |
|---|---|
| Verizon | 68% |
| AT&T | 58% |
| Sprint | 27% |
| T-Mobile | 15% |
| U.S. Cellular | 2% |
| Other | 9% |

Note: Multiple responses allowed
Base: 188 respondents at organizations with standardized mobile platforms and IT-driven device and carrier selection
Data: *InformationWeek* 2011 Mobile Device Management and Security Survey of 323 business technology professionals, August 2011

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top technologies (terminal services, VDI, Citrix) via tablets. Fifty-nine percent say the same about enabling access to cloud services or SaaS via mobile devices.

Fortunately, LTE can help address not only capacity concerns, but quality-of-service control, voice over IP and operation in fragmented radio bands that are anything but harmonized globally.
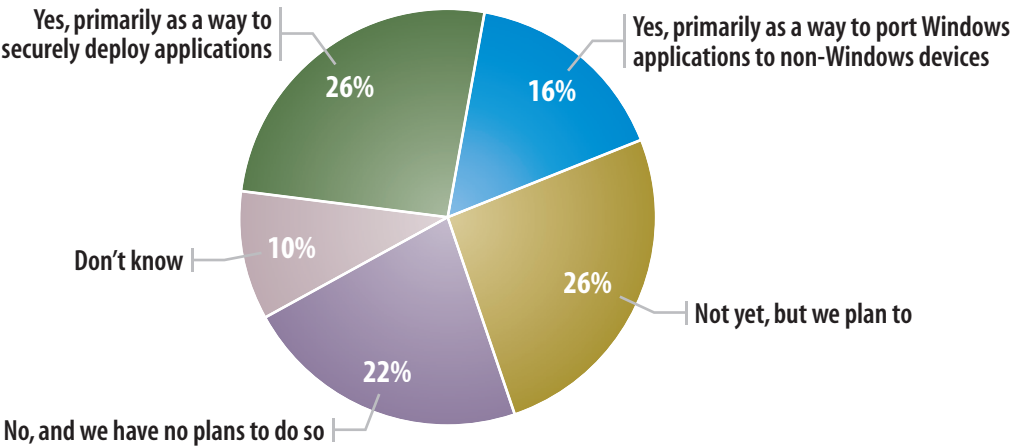
### Why LTE Is Amazing

Before we confront some harsh mobility realities, let's take a moment to appreciate LTE. First, it's blazing fast, with speeds far exceeding any previous wide area wireless technology. Following the "underpromise and overdeliver" business plan—and anticipating slowdowns as their networks become saturated—operators quote modest rates. Verizon states an average of 5 to 12 Mbps on the downlink and 2 to 5 Mbps on the uplink. But the reality is better, often much better. Signals Research Group, for example, measured an average 23.6 Mbps on the downlink and an average 15.2 Mbps uplink speeds on AT&T's network in Houston.

**Figure 2**

## Use of Virtual Desktop Technologies Via Tablets

Do you use or plan to use virtual desktop technologies (terminal services, VDI, Citrix) via tablets?



- Yes, primarily as a way to securely deploy applications — 26%
- Yes, primarily as a way to port Windows applications to non-Windows devices — 16%
- Not yet, but we plan to — 26%
- No, and we have no plans to do so — 22%
- Don't know — 10%

Data: *InformationWeek* 2011 Mobile Device Management and Security Survey of 323 business technology professionals, August 2011

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Metrico Wireless, another company that does performance testing, reported a mean downlink speed of 13 Mbps on AT&T's LTE network and 10 Mbps on Verizon's LTE network.

In the future, speeds will go even higher.

Current networks use either 5- or 10-MHz radio channels. LTE, however, actually supports 20-MHz radio channels, which by itself would double throughputs. Operators would love to deploy in wide radio channels like this because not only does it boost performance, it doubles capacity for the same amount of network infrastructure. The problem is, they just don't have enough available spectrum.

Speed-boosting innovations are also in the

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works, such as higher-order Multiple In-put/Multiple Output radio systems, which rely on multiple simultaneous transmissions through the environment on the same frequency. Current networks use 2X2 MIMO on the downlink (two transmit antennas at the base station, two receive antennas at the mobile device); 4X2 MIMO, with four transmitters at the base station, will further increase throughput.

Probably the biggest gain, however, will come through the next major release of LTE, called LTE-Advanced, which will start to see deployment next year.

LTE-A permits aggregation of radio channels, making it possible for operators to piece together 10 MHz here, 10 MHz there; eventually, it adds up, effectively overcoming fragmentation of the airwaves. AT&T will use aggregation to boost LTE performance via spectrum it acquired from Qualcomm. LTE-A, in fact, allows aggregation of up to 100 MHz of spectrum. Even with only 20 MHz, however, LTE-A, in combination with 8X8 MIMO, can deliver a blistering 1.2 Gbps of theoretical

**Figure 3**

## Access to Cloud Services Via Mobile Devices

Is your organization enabling access to cloud services or SaaS via mobile devices?
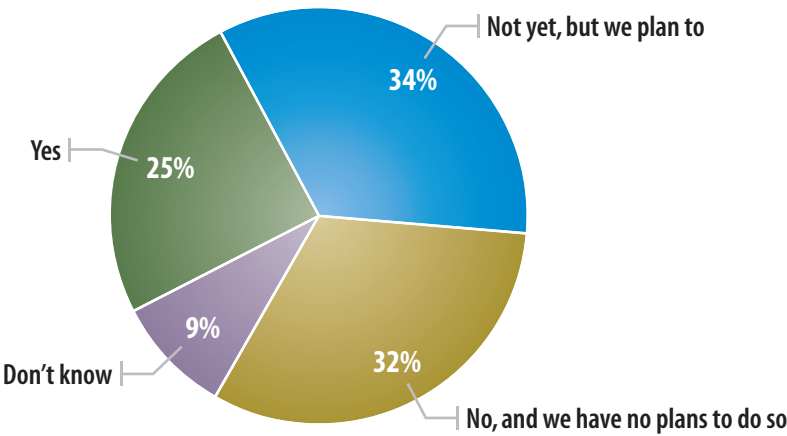


- Not yet, but we plan to — 34%
- Yes — 25%
- Don't know — 9%
- No, and we have no plans to do so — 32%

Data: *InformationWeek* 2011 Mobile Device Management and Security Survey of 323 business technology professionals, August 2011

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throughput. We do have to emphasize the word "theoretical," since it will be a long time before you see rates like that in the real world. Still, speeds will keep increasing.

Latency (delay) is also lessened, with packet round-trip times measured in tens of milliseconds instead of hundreds, as with previous wireless technologies.

Additional features that excite operators, although they're probably of less interest to IT, include being able to deploy LTE so that it operates on a time-division duplex basis and being able to use LTE itself for backhaul (base station to core network) connections to simplify deployment. Both of these increase deployment options for operators

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and help ensure that LTE will remain the wireless technology of this decade.

**Market Developments**

To gain insight into mobility challenges, we have to look at mobile broadband market reality. First, smartphones are becoming the "typical" phone—there are now more than 1 million mobile applications, and networks are getting faster; they, along with tablets, are redefining the nature of computing. Eighty-two percent of respondents to our MDM survey say smartphones will increase in importance over the coming 24 months; 79% say the same about tablets versus just 34% putting their money on laptops.

But consumer market developments are having a progressively bigger impact on mobile broadband networks—and thus, enterprises. With a finite amount of spectrum, your employees and customers are up against two killer trends.

The first is consumption of Internet-based shows and movies from a wide array of sources, including YouTube, Netflix, Hulu, Ama-

**Figure 4**

## LTE Features (Including LTE-Advanced)

| Feature | Details |
|---|---|
| Throughput | Highest of any wide area wireless technology with users measuring tens of Mbps today and hundreds of Mbps in the pipeline. |
| Latency | Tens of milliseconds |
| Instant-on | The delay from radio dormant to active is a fraction of a second. |
| Quality of service | Sophisticated QoS architecture can control throughput/delay/reliability on application-flow basis. |
| Smart off-load | With LTE-A, different application flows will be able to go through specific networks; say, general browsing through Wi-Fi but operator VoIP through LTE. |
| All-IP architecture | LTE handles all traffic in the IP domain, which will eventually lead to much better integration among voice, multimedia and data applications. |
| HetNets | Support for heterogeneous networks in LTE with improved support in LTE-A sets the stage for large eventual capacity gains by integrating macrocells (traditional cells) with picocells (city-block size) and femtocells (house/building size). |
| Coordinated multipoint processing | Combining signals from multiple base stations in LTE-Advanced will improve cell-edge performance. |

Data: *InformationWeek Reports*

zon, iTunes and traditional television channels. The NFL even provided a video stream for the 2012 Super Bowl via its website. A recent Nielsen report, "The Cross-Platform Report," shows a 37% increase in the number of mo-

bile video users between 2011 and 2010. We're hearing about more people cutting the cord to their cable providers and consuming entertainment and news only over broadband connections. Some of this is occurring

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over Wi-Fi, but an increasing amount of video is consumed over mobile broadband connections. That's the leading reason usage amounts are growing from tens of megabytes per month to many hundreds of megabytes, if not gigabytes.

Couple this with another trend, namely cutting the phone cord. Close to 30% of U.S. households have wireless phones only, according to government estimates. How long before U.S. consumers question the proposition of paying for a fixed broadband connection as well as a mobile broadband connection?
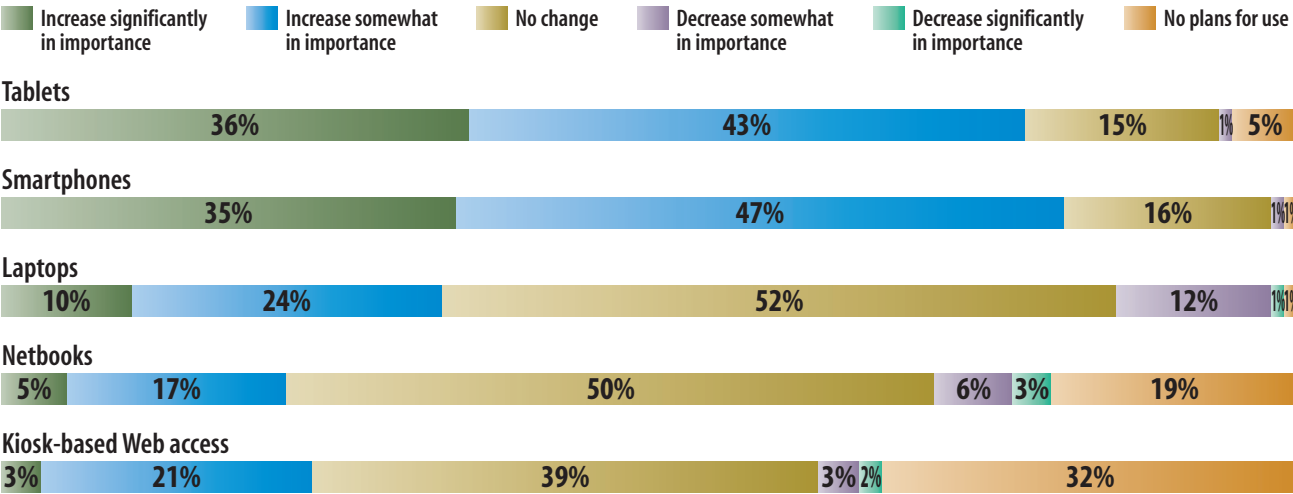
A lack of unlimited data plans may slow this trend, but when you run the numbers, paying for extra data on your mobility plan is often less than the monthly cost of a fixed connection.

The net result is more and more content streaming over wireless networks—the same networks your employees depend on for the increasing number of business applications that incorporate video, including collaboration, telemedicine, field service and training.

**Figure 5**

## Mobile Technology Impact on Productivity

Thinking about the next 24 months, how critical a role will the following mobile technologies play in business productivity at your company?

Legend: Increase significantly in importance | Increase somewhat in importance | No change | Decrease somewhat in importance | Decrease significantly in importance | No plans for use

| Technology | Increase significantly | Increase somewhat | No change | Decrease somewhat | Decrease significantly | No plans for use |
|---|---|---|---|---|---|---|
| Tablets | 36% | 43% | 15% | 1% | | 5% |
| Smartphones | 35% | 47% | 16% | 1% | 1% | |
| Laptops | 10% | 24% | 52% | 12% | 1% | 1% |
| Netbooks | 5% | 17% | 50% | 6% | 3% | 19% |
| Kiosk-based Web access | 3% | 21% | 39% | 3% | 2% | 32% |

Data: *InformationWeek* 2011 Mobile Device Management and Security Survey of 323 business technology professionals, August 2011

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In fact, video consumption on wireless networks is growing tremendously, and it's unclear how long operators will be able to keep up. In the absence of new spectrum, which unfortunately does not seem to be materializing nearly fast enough (see "Wireless Spectrum Doomsday Looms"), the result will be networks running at capacity.

This unfortunately means two things for IT: congestion and prices that aren't going down.

### Challenges

LTE's most visible benefit is its high data throughput, on both the downlink and the uplink. IT teams need to have realistic expectations, however, because the capacity of the

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network is highly constrained and thus prone to congestion. It takes only a handful of users in a coverage area streaming video to consume the entire sector capacity.

What does that mean? Let's look at some numbers. According to work done by this author for 4G Americas in a joint analysis of operators and infrastructure vendors, LTE as currently deployed has a downlink spectral efficiency of 1.4 bps/Hz. Typical deployments by AT&T and Verizon use 10-MHz radio channels for downlink, meaning the aggregate capacity in a coverage area is just 14 Mbps—bandwidth that has to be shared by multiple users in coverage areas that might span three city blocks in urban deployments. With music streaming at 100 to 200 Kbps and video streaming at rates between 200 Kbps and 5 Mbps, depending on resolution and quality, it takes only a small number of users to grind things to a standstill. That's one reason Veri-

**Verizon just announced that, without new spectrum, it will hit LTE capacity limits in 2013 in some markets.**

zon just announced that, without new spectrum, it will hit LTE capacity limits in 2013 in some markets.

And network loading isn't the only factor. Modern wireless technologies, especially LTE, are designed to exploit the highest instantaneous spectral efficiency based on the quality of the radio signal. What that means is that users close to the base station, and especially with a line of sight, will get much higher throughput than those at the edge of the cell or deep inside a building. Thus average speeds may be good, but there is uneven distribution of speeds over the coverage area. As a result, while LTE on average will deliver excellent performance, IT should anticipate as much as a 10-to-1 difference between lowest and highest values.

We'll discuss in more depth what that means for teams designing mobile applications or working on initiatives to stream desktops or software-as-a-service on tablets or smartphones. On the infrastructure side, it may be time to revisit adding femtocells and upgrading the wireless LAN to handle de-

mand on-site. Mesh networks are also an option for large campuses or when you need to support a temporary influx of mobile users, as at a conference or special event.

## No Moore's Law Here

Because users will consume every drop of network capacity, operators have responded with tiered pricing plans that average about $10 per gigabyte. AT&T, for example, has a smartphone plan that provides for 3 GB for $30 and then $10 per gigabyte over that. Streaming 720p quality video at 1.5 Mbps (suitable for watching a movie on a laptop for example) consumes 0.675 GB per hour. Few people will want to watch video at $6.75 per hour. A video-based training session or video-conferencing at 480p resolution using 0.5 Mbps, on the other hand, would cost $2.25 per hour. IT and business managers need to decide if that's reasonable.

As for whether prices will go down, historically they have. But with carriers using cost as a tool to depress demand, we don't recommend betting your budget on less-ex-
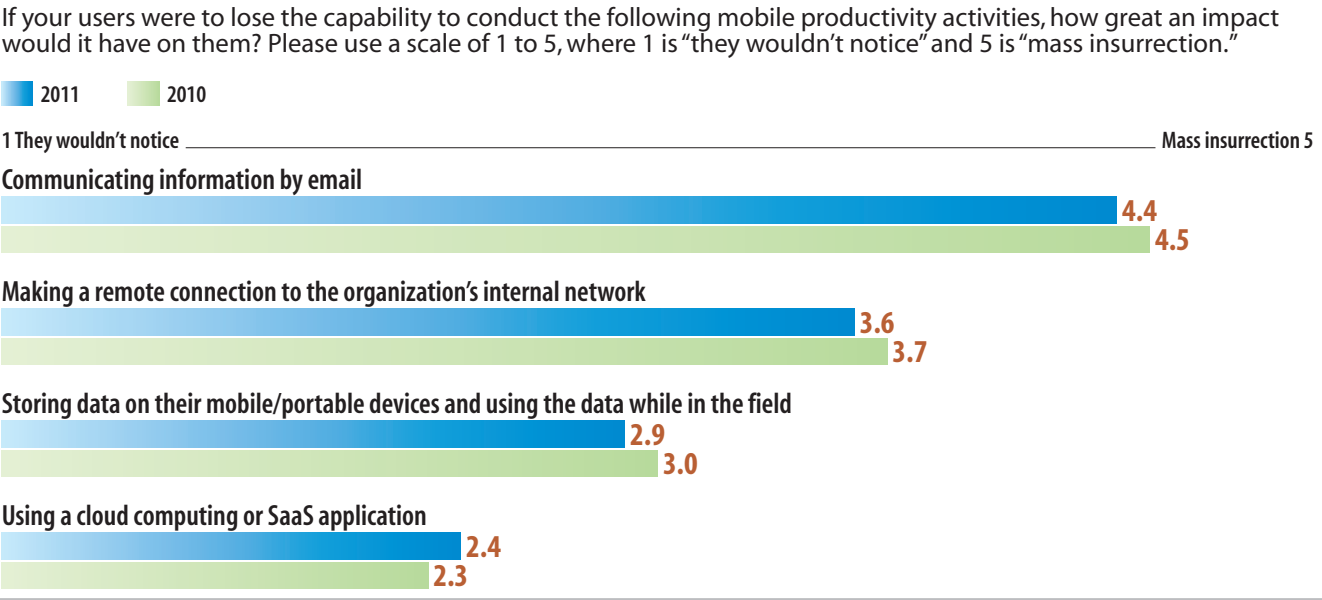
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pensive plans. AT&T stated in its Jan. 26 earnings call that in the absence of new spectrum, the company would have to increase prices and impose data-use restrictions. We recommend that IT do business planning based on current pricing, develop insights into how much data their various applications actually consume and selectively offload onto Wi-Fi as per our report, "Convergence of 3G/4G and Wi-Fi."

Battery life is another challenge that LTE faces. Nokia Siemens Networks documents this in a preliminary study that shows LTE devices consuming 5% to 20% more power than previous-generation phones, depending on application used. Multiple factors contribute to high power demand: displays, data consumption, immature chipset designs that aren't as fully integrated as they will be in the future and multiradio operation. Displays and LTE are actually independent of each other; it's just that the largest, most powerful smartphones sporting LTE also are the ones with larger displays—and large displays tend to consume more power than any other component.

**Figure 6**

## Lack of Access to Mobile Productivity Activities: Impact on Employees

If your users were to lose the capability to conduct the following mobile productivity activities, how great an impact would it have on them? Please use a scale of 1 to 5, where 1 is "they wouldn't notice" and 5 is "mass insurrection."

■ 2011    ■ 2010

1 They wouldn't notice _____ Mass insurrection 5

**Communicating information by email**
4.4
4.5

**Making a remote connection to the organization's internal network**
3.6
3.7

**Storing data on their mobile/portable devices and using the data while in the field**
2.9
3.0

**Using a cloud computing or SaaS application**
2.4
2.3

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Note: Mean average ratings
Base: 323 respondents in August 2011 and 307 in March 2010
Data: *InformationWeek* Mobile Device Management and Security Survey of business technology professionals

What is specific to LTE, however, is a more complex radio, as well as higher rates of data consumption. LTE uses two receive radios to enable 2X2 MIMO operation on the downlink. As for data consumption, an LTE smartphone can chow down data at a typical rate of 10 Mbps, some five to 10 times faster than 3G. It simply takes a certain amount of power to operate a radio at high data bandwidth. So the more data received, or especially transmitted, the shorter the battery life. Metrico Wireless in one test measured only about one-third the battery life when streaming video compared with push-based

email in an idle state.

For IT, that means ensuring that smart-phones and tablets have enough battery life to support business-usage scenarios.

**State of Global Confusion**

If you support employees who travel extensively, take that into consideration when selecting a device to issue or when setting up bring-your-own-device guidelines.

The good news is that 2G/3G service is now largely available globally across six frequency bands, which are supported by many phones. In other words, you can use a multi-band phone (so long as it's based on Global System for Mobile Communications/High Speed Packet Access technology) for 2G and 3G service all over the world. When it comes to LTE, however, roaming is a particularly sad state of affairs, with operators using widely different bands. For example, U.S. carriers are rolling out

> **For the foreseeable future, it's unlikely that any LTE phone or modem will work on other than its home network.**

LTE in 700 MHz, Europe is likely to use 2.6 GHz, while China is using an entirely different form of LTE, time division duplex, at 2.3 and 2.5 GHz. Japan will use 1.5 GHz and 2.1 GHz. The Third Generation Partnership Project that develops LTE specifications has in fact specified LTE operation in more than 30 bands.

Consequently, for the foreseeable future, it's unlikely that any LTE phone or modem will work on other than its home network. Instead, for roaming, it will fall back to 3G (or even 2G) operation. This will be fine for email or Web browsing, but if your users need those high LTE speeds in China, they'll be out of luck.

Even in the United States, the situation is complicated with incompatibility among operator networks. An AT&T LTE device won't work on Verizon's network, for example. That's for two reasons. One is that AT&T and Verizon use different 700-MHz frequency bands. And even if a device were able to support both sets of LTE bands, AT&T and Verizon also use different 3G technologies, so falling back to 3G when outside of an LTE coverage area would fail.

There's also voice to consider. In LTE specifi-

cations, voice can be handled either by falling back to 2G/3G to place a circuit-switched call or by doing a VoIP call over LTE. The VoIP option requires that the LTE network implement Voice over LTE functionality, which requires additional infrastructure on the operator side. Given the complexities involved in this approach, VoLTE isn't expected to become available until 2013. Until then, voice calls will be handled over the underlying 3G network. New LTE smartphones are designed to simultaneously handle an LTE data session and 3G voice call. Running two radios like this at the same time does, however, increase power consumption. Once VoLTE is the norm for voice calls, this power issue will go away.

Still, how and when operators implement VoLTE will vary, so consider testing LTE smartphones—especially before making a volume purchase—to make sure voice operates as expected, especially when moving on a live call between LTE and non-LTE coverage areas.

The final area to monitor is quality of service. LTE employs a sophisticated QoS architecture with which the network can control items such

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as bit-transfer reliability, throughput rates, priority and latency. This architecture will be primarily employed, at least initially, by operators themselves for making their own services, such as native VoIP, work reliably. Otherwise, large data downloads could mess up voice calls. The first customer-accessible QoS application will be Verizon's "Turbo" function, with which an application can make a call to a network-optimization API to request higher bandwidth on a fee basis. Details are still sketchy, but according to *PC Magazine*, the API will be available in the third quarter of this year.

We view this as Verizon putting its toe in the water to see how it might monetize QoS. Ultimately, the QoS architecture could let operators offer premium services that make certain applications function better (say, video in congested networks), or even to offer discounted plans in which users opt in for lower priority traffic. (See my report to the FCC on this topic.)

**Target Applications**

Should IT teams ramping up mobility be encouraged or discouraged by the complex-

**Figure 7**

## Summary of LTE Challenges

| Item | Explanation |
|------|-------------|
| **Throughput** | Blazing fast but vulnerable to network congestion because of growing popularity of mobile broadband. Also, all modern wireless technologies have performance that varies based on signal quality. |
| Pricing | At about $10 per gigabyte, video can get expensive in a hurry. Prices may not come down very quickly given network capacity constraints. |
| **Battery life** | Shorter battery life in early smartphones due to new technology, consumption of more data, and needing both 3G and 4G radio connections. |
| Roaming | With different countries using different radio bands for LTE, don't expect to be able to use LTE around the world. More likely devices will fall back to 3G. |
| **Voice** | Implemented as VoIP, an all-new approach for cellular networks. Hiccups may occur. |
| Quality-of-service control | LTE has it but it will take some time for operators to figure out appropriate business models. |

Data: *InformationWeek Reports*

ities we've discussed? Our net recommendation is to be cautiously optimistic. LTE really does work as advertised, providing jaw-dropping throughputs. The biggest threat to this is congestion. But operators realize that poor performance will discourage use, so expect them to manage capacity carefully and to do

everything they can to provide reasonable performance levels.

For IT teams designing mobile applications, make sure they work reasonably well at throughput rates lower than those advertised. That's especially true for apps that require constant connectivity. As exciting as it may be

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to have a Windows 7 desktop appear on an iPad, that kind of application is vulnerable to congestion and latency. Traditional client-server applications—say, an Outlook email client communicating with an Exchange server—are less affected by fluctuating throughput. Similarly, background cloud synchronization is also relatively immune.

What can IT do to compensate for mobile apps that absolutely have to have fast connectivity? Using known (enterprise) Wi-Fi connections when available is one answer. Public Wi-Fi, however, can suffer from congestion just as much as cellular. Beyond that, IT should look for usage options that users can select to minimize bandwidth requirements. A video-conferencing application might have an easy fallback to voice-only operation; for example, Skype provides a simple button to turn off its video. It also dynamically adjusts video quality for available bandwidth.

As for pricing, since new spectrum is years away, pricing may remain at current levels for some time. Most IP networking applications will work extremely well over LTE. Be careful,

however, about mission-critical applications where consequences of slow connectivity could spell trouble.

Of course, that's always been true. Radio has been and always will be a finicky beast; treat it with respect, and it will be kind in return.

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