Enterprise users are demanding mobile broadband, but the complexity has many IT managers confused. Here’s how to evaluate rapidly improving 3G technologies.

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BY PETER RYSAVY
CELLULAR PROVIDERS ARE IN A HIGH-STAKES RACE WITH WiMAX and Wi-Fi proponents, each seeking to dominate the transition from today’s 3G services to next decade’s 4G technologies. This jockeying is nothing new—over the past decade, a heady cycle of reinvention and evolution has propelled about one new wide-area wireless technology down the pike every year. Ardis, Mobitex, CDPD, Ricochet, GPRS, 1xRTT, EDGE, 1xEV-DO, UMTS, HSDPA … all tried to capture the fancy of mobile users—and the dollars of enterprise IT groups tasked with keeping those mobile users productive.

This time, IT should be in the driver’s seat. Rather than taking what your service providers are offering, consider your requirements. We’ve got the information you need to plan for the next wave of wide-area wireless.

To start with, architecting a comprehensive wireless access strategy goes beyond choosing an operator. You must consider what types of devices to use, whether to employ mobile/wireless middleware, how to manage mobile computers and their configurations in the field, and how to implement security. We help with the device decision in our comparative review of 3G-enabled notebooks (see nwcreports.com). Justification involves a careful examination of the job function being performed and how it might change with mobile access to enterprise data. In addition, supporting mobile systems in the field requires expertise that many organizations are only beginning to acquire.

The good news: Wide-area wireless networks are really starting to hum, delivering excellent speeds with good resulting application performance and, by the end of this year, high-speed 3G networks will be available in most U.S. metro areas.

The bad news: The number of wireless technologies you need to assess keeps increasing, with new 3G offerings and alternate technologies, such as WiMAX and metropolitan Wi-Fi, being evaluated or tested by operators for large-scale deployments. If that’s not confusing enough, entirely new standards, including IEEE 802.20 mobile broadband, are on the fast track for completion.

A carefully developed and implemented mobile and wireless computing plan will benefit most companies, but creating such a plan is a complex undertaking, which explains the slow adoption rates we’ve seen so far. We discuss adoption and more in our original in-depth research and analysis report on the mobile broadband market at nwc.com/nwcanalytics, but, for example, only 11 percent of readers polled for this article cited widespread adoption of wide-area wireless data in their organizations.

Still, billions of dollars will be spent this decade on

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**IMPACT ASSESSMENT: MOBILE BROADBAND DATA**

**IT Organization**

- **BENEFIT**: The ability to have real-time access to enterprise systems from anywhere greatly extends the reach of IT managers to efficiently perform their job functions.

- **RISK**: Monthly service plans cost $50 to $60, although cheaper plans are available for smartphones. Specialized support may be required.

**Business Organization**

- **BENEFIT**: Businesses can improve many of their internal communications through the use of wireless technologies.

- **RISK**: Real-time communications can just as often be a distraction as a productivity enhancer. Businesses must decide which workers to target with mobile data systems.

**Business Competitiveness**

- **BENEFIT**: Businesses can improve overall efficiency in many job functions if mobile workers have real-time access to enterprise data, which can result in reduced downtime and improved customer responsiveness.

- **RISK**: To be effective, businesses must verify that applications work well over wireless connections, and may need to implement mobile middleware and adjust their remote-access security architectures.

**BOTTOM LINE**: Mobile broadband data offers many benefits, such as performing job functions more efficiently and helping employees deliver superior customer service. However, a successful deployment is not trivial—it requires careful research and planning, and rigorous trials to test applications.
these new networks as operators vie for supremacy. We'll look ahead three years to sort out promise from reality by examining various networks, their capabilities, their availability and their costs. Choosing a network based on coverage or speed is straightforward. It’s the other items, such as figuring out return on investment and how to manage devices in the field, that can flatten you if you’re not paying attention.

HOW WE GOT HERE

A decade ago, wide-area wireless networks had throughput rates of only about 10 Kbps and were dedicated to data. CDPD, Mobitex, Ardis and Metricom’s Ricochet were the big fish, but they ruled a small pond: None netted subscriber numbers greater than the hundreds of thousands.

In the late 1990s, wireless data systems became integrated into cellular networks, which had been deployed first for analog, then digital, voice service. Initial data speeds were relatively slow, still around 10 Kbps, and were based on a circuit-switched (dial-up) model where data essentially consumed a voice channel.

However, speeds quickly increased, and the model switched to packet-based IP. GPRS (General Packet Radio Service) for GSM networks, operated by Cingular Wireless and T-Mobile, had average throughput rates of 30 Kbps to 40 Kbps; throughput improved to around 100 Kbps with EDGE (Enhanced Data Rates for GSM Evolution), and CDMA networks, operated by Sprint Nextel and Verizon, had average rates of around 70 Kbps. Network latency was quite high in early networks, but started to decrease for round-trip times to below 500 milliseconds (msec).

Today, most cellular operators are deploying what are called 3G technologies (1G is analog; 2G, digital). Average downlink throughput rates for 3G networks are quoted by operators as 400 Kbps to 700 Kbps—50 times faster than earlier networks. Moreover, network latency has improved significantly, approaching 100-msec round-trip times in the latest systems. Pricing has also improved: A year ago, unlimited data plans cost $80 per month; these plans are now trending toward $50 per month.

But though the industry has made tremendous progress, relatively high service costs, connections that aren’t as stable as wireline links and complicated security mean wireless data remains challenging for many organizations. Evidence of this: Wireless operators have worked hard to get data revenues to reach 10 percent of their total revenues. However, adoption is growing rapidly, and is likely to double within three years, according to Yankee Group. Voice continues to dominate as the killer app.

CELLULAR WIRELESS DOMINATION

You can’t argue with more than 2 billion subscribers worldwide—clearly, cellular operators are providing extremely broad coverage of wireless services. The United States alone has more than 160,000 cell sites, providing service in virtually all areas where people work and live, as well as all major and many minor highways. And now that cellular networks provide both voice and data services,

<table>
<thead>
<tr>
<th>Technology</th>
<th>Peak rate downlink</th>
<th>Peak rate uplink</th>
<th>Average downlink</th>
<th>Average uplink</th>
<th>Typical latency to Internet site</th>
<th>Major U.S. operators</th>
<th>Deployment</th>
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<tr>
<td>CDMA2000 1xRTT</td>
<td>153 Kbps</td>
<td>153 Kbps</td>
<td>50–70 Kbps</td>
<td>50–70 Kbps</td>
<td>500 msec</td>
<td>Alltel, Sprint/Nextel, Verizon</td>
<td>Available nationwide</td>
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<tr>
<td>CDMA2000 EV-DO Rev 0</td>
<td>2.4 Mbps downlink</td>
<td>153 Kbps</td>
<td>400–700 Kbps</td>
<td>50–70 Kbps</td>
<td>250 msec</td>
<td>Alltel, Sprint Nextel, Verizon</td>
<td>Top 100 metro areas by year end; currently available in more areas than HSDPA</td>
</tr>
<tr>
<td>CDMA2000 EV-DO Rev A</td>
<td>3.1 Mbps downlink</td>
<td>1.8 Mbps</td>
<td>450–800 Kbps</td>
<td>300–400 Kbps</td>
<td>Improved over EV-DO Rev 0</td>
<td>Sprint and Verizon have announced intentions to deploy</td>
<td>Expected 2007</td>
</tr>
<tr>
<td>EDGE</td>
<td>200 Kbps</td>
<td>200 Kbps</td>
<td>70–135 Kbps</td>
<td>70–135 Kbps</td>
<td>450 msec</td>
<td>Cingular, T-Mobile</td>
<td>Available nationwide</td>
</tr>
<tr>
<td>HSDPA (UMTS Release 5)</td>
<td>1.8, 3.6, 7.2 Mbps(^1)</td>
<td>128 Kbps or 384 Kbps(^1)</td>
<td>400–700 Kbps</td>
<td>110 Kbps or 300 Kbps</td>
<td>150 msec</td>
<td>Cingular; T-Mobile also plans deployment</td>
<td>Top 100 metro areas by year end</td>
</tr>
<tr>
<td>HSDPA with HSUPA (UMTS Release 6)</td>
<td>1.8, 3.6, 7.2 Mbps(^1)</td>
<td>1.46, 2.0, 5.76 Mbps(^2)</td>
<td>400–700 Kbps</td>
<td>Likely 300 to 400 Kbps</td>
<td>Improved over UMTS Release 5</td>
<td>Cingular; T-Mobile likely</td>
<td>Expected 2007</td>
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\(^{1}\) Depends on market; most markets are being upgraded to 384 Kbps. \(^{2}\) Depends on device capabilities.
data is available in more locales than ever before. Although hotspots and metro Wi-Fi are available in an increasing number of areas, their total coverage constitutes a fraction compared with cellular coverage. For any truly mobile application, it’s hard to beat cellular-based services.

But just how useful are these services for data apps? We summarize the capabilities of today’s networks, using speeds derived from operator-stated performance and prior NWC tests in “Cellular Carriers Rule the Market,” below left. As you can see, speeds are quite good, and these services are suitable for a wide range of applications. Two important technical issues to consider: the hybrid nature of today’s 2G-3G networks and variabilities in network performance.

Operators are deploying EV-DO (Evolution-Data Optimized) and HSDPA (High-Speed Downlink Packet Access) as high-speed overlays to substrate 1xRTT (one carrier, radio transmission technology) and EDGE networks. By year’s end, Cingular, Sprint and Verizon plan to have coverage in the Top 100 metropolitan areas, but elsewhere, devices will fall back to slower service. Fortunately, connectivity is relatively seamless, and the networks support handover from one service to the other, even in midsession, albeit with delays that may approach tens of seconds. This means if your users are going to work across large geographic areas, you must ensure that your applications work well with both the current faster and the older, slower data services.

The other consideration is variables in network performance. Wireless networks use extremely sophisticated methods to reliably deliver bits in widely varying RF conditions, to widely varying loads of voice and data users across an extremely finite spectrum resource. However, because radio technologies dynamically adjust to radio conditions, throughput and latency can vary, especially in poor signal situations, and you’ll need to manage end user expectations. It’s not unusual to see the 1-Mbps downlink throughput that 3G services deliver in good situations, and you’ll need to manage end user expectations. It’s not unusual to see the 1-Mbps downlink throughput that 3G services deliver in good

SMARTER THAN YOUR AVERAGE PHONE

Although Symbian devices represent the majority of smartphones sold globally and continue to do well in Europe, the OS still has little recognition in the United States. Palm OS has sold well through the Treo line, but the current version is reaching the end of its life. Palm-Source (now owned by the Japanese company Access) says it intends to evolve the platform to a Linux base.

RIM’s powerful BlackBerry 8700 keeps BlackBerry solidly atop the smartphone game. So far, we see no indication that any of these four primary smartphone platforms is going to go away, which complicates the lives of IT managers who must support multiple platforms. Linux will also be a contender in the near future.

Managers must decide whether to have separate remote-access architectures for smartphones and laptops. Conventional IPsec VPNs do not support smartphone platforms, but mobile VPNs, from NetMotion and others, and SSL VPNs, from companies like Aventail, have increasing support for mobile platforms, which makes a unified remote-access architecture feasible. Your circumstances will dictate which approach makes the most sense.

Finally, IT managers may encounter workers who want to use their personal phones for business. Given that phones are highly personal items, accommodating user preferences is an additional complexity. Despite all these challenges, according to ABI Research, smartphone sales will exceed 120 million units this year, and will constitute a 15 percent share of the mobile phone market.
conditions fall to several 100 Kbps in poor conditions. Loading from other data or voice users can also affect network performance. For any large-scale deployment, make sure your app can tolerate the full range of speeds users will experience. Today’s 3G networks have uplink speeds that are generally slower than downlink speeds, but that will change in next versions of the systems, expected in 2007, where links will be closer to symmetric.

If users are on the move, they may lose the signal entirely. Moreover, when the link picks up again, the new connection could come with a new IP address. This may adversely affect some software, such as VPNs. The bottom line, though, is that you can use off-the-shelf IP-based networking applications over today’s wireless networks. There is a “but,” however: If apps are going to be used on a continual basis by workers for productivity applications, you must perform rigorous pilots to make sure they work as dependably as you need. Fortunately, nearly all large application vendors, including IBM, Microsoft, Oracle and Sybase, are rewriting their applications so they work well over wireless links. There are also mobile/wireless middleware providers whose mobile VPNs mitigate against connection loss, provide seamless connectivity over different types of networks (such as cellular and Wi-Fi), and offer end-to-end security.

**FAST AND CHEAP**

While speeds have gone up, prices for services have dropped significantly. As we mentioned, a year ago major operators were charging $80 per month for unlimited data usage. Now, plans are generally $50 to $60 per month when combined with voice service. T-Mobile has the most aggressive pricing, with data plans at $30 per month. Unlimited-use plans will readily support business applications, but if you’re thinking of hosting a Web server or want to start downloading movies, you may get a cease-and-desist letter from your operator.

Smartphone plans are less expensive, typically $40 per month for unlimited use. Still, in our reader poll for this article, slightly more than half of respondents said pricing...
for cellular-data services is still too high, and 85 percent said they prefer flat-rate plans over usage-based offerings. Looking into the future, networks will just keep getting faster. The next major upgrade to cellular networks for both EV-DO and UMTS (Universal Mobile Telecommunications Systems)—due in 2007—will provide faster uplink speeds, with expected averages of around 400 Kbps. We expect that, by the end of the decade, average throughput rates will be nearly 10 times higher than what we see on today’s networks.

THE WI-FI DISRUPTION FACTOR
A completely different approach for mobile broadband is metro or municipal Wi-Fi. Here, a new breed of operator is deploying APs throughout city areas, using a mesh architecture, where APs can act as repeaters and only a subset of APs need wireline connections to a core network.

The attraction is obvious, especially for laptop users who have Wi-Fi cards in their computers. Wi-Fi offers better network application performance, thanks to its higher throughput rates and lower latency. Wi-Fi also can deliver higher data throughput densities than 3G networks because the spectrum serves a small number of users in cells much smaller than those of cellular networks. Typical deployment densities are 20 to 40 APs per square mile, with theoretical aggregate throughputs of 20 Mbps to 100 Mbps in that area—more than 10 times higher than what can be achieved with a 3G base station.

Another benefit is the availability of 4.9-GHz licensed spectrum for public safety applications. Motorola and other vendors have multimode APs that can simultaneously support the 4.9-GHz band for government applications, and 2.4 GHz for residential and business users. Operators can provide tiered service, charging for one level of throughput while offering free or discounted service at throttled-down speeds. There’s even an IEEE standard in development, IEEE 802.11s, that will standardize mesh architectures and protocols.

That’s the good news about metro Wi-Fi. Unfortunately, there are some serious concerns. One is that at affordable deployment densities, the signal can be quite weak by the time it reaches some buildings. In many cases, this will mandate repeaters to relay the outside signal indoors. This problem is being reported in many places.

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<th>DECISION POINTS: CHOOSING A WIRELESS NETWORK</th>
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<tr>
<td>Throughput, coverage and cost are the Big 3 considerations, but here are some other factors to consider:</td>
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<tr>
<td>Consideration</td>
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| Platform type | • Smartphones/PDAs  
• Laptops | Smartphones are well-suited for e-mail and to access select data. Platforms include Linux, Palm OS, RIM, Symbian and Windows Mobile. For more information, see “Smarter Than Your Average Phone,” page 47. |
| Laptop computer approaches | • Tethered (such as Bluetooth)  
• PC Card modem  
• Embedded (built-in) | The tethered approach works well for occasional connections and allows the same data plan for both smartphone and laptop use. PC Card modems provide the greatest flexibility in laptops for heavier data usage. Embedded solutions lock you into a specific technology and operator, but offer simpler setup and more dependable operation. |
| Application type | • Applications optimized for wireless networks  
• Standard IP-based networking applications | With Wi-Fi, most applications work acceptably. With 3G, you can make light use of most applications, but serious productivity apps may need optimization, or to be combined with wireless middleware. Large application vendors are now “mobilizing” their applications or working with middleware vendors to extend capabilities to mobile devices. |
| Security | Many e-mail solutions provide their own security architectures | In our e-poll, security was rated as a major obstacle to deployment. Your security architecture must have to support both handhelds and laptops. |
| VPN | • Standard  
• Mobile VPNs | Standard VPNs will work over wireless connections but do not offer some mobility enhancements and performance optimizations available with mobile VPNs. |
| Device management | Multiple entities are vying for this market: device vendors like Nokia; mobile security software vendors such as Symantec; remote-access system vendors, including Cisco; conventional device–management companies like Novell; mobileMiddleware vendors such as Sybase; mobile operators; and conventional enterprise–management system vendors, including IBM and Microsoft | You must do your homework on this one. The larger the wireless deployment, the more critical your management system. |
WHAT'S THE ROI FOR WIRELESS DATA?

That's a complicated question, and one we struggled with. Our reader poll showed wireless data providing a significant benefit for personal productivity, increased operational efficiency, satisfying general information needs of mobile employees, providing senior executives access to critical information, more positive customer interaction, as well as faster and better decision making.

Finally, the IEEE 802.11s standard is not expected to be completed until 2008, meaning that deployments today are based on vendor solution.

And let's not forget yesterday's mobile-connectivity poster child: hotspots. Although media attention has waned, providers keep adding locations. According to JiWire, a company that compiles hotspot locations and statistics, as of May 2006, there were 114,150 hotspots in 126 countries, with 38,588 in the United States. Last time we took a large-scale look at hotspots, in May 2003, there were only 20,000, with Gartner estimating 120,000 worldwide by 2007; looks like that may be on target (see "Wireless Hotspots Heat Up," at nwc.com/1409/1409f1.html).

So will Wi-Fi compete with 3G? It certainly will take some customers away, especially laptop users who need only occasional connectivity in places where they know they can obtain Wi-Fi coverage. However, we see the technologies as generally complementary. Wi-Fi, while offer-

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ing good performance, is available in only a tiny fraction—less than 1 percent—of the area covered by cellular networks. Many of your users will want Wi-Fi for better performance when available, but will desire the broader coverage of cellular networks the rest of the time.

Users will have no problem taking advantage of an ever-increasing number of networks, depending on their circumstances and location. Long term, the addition of Wi-Fi capabilities to mobile phones will blend Wi-Fi and 3G network technologies, allowing their use over corporate and home Wi-Fi networks. This is very much a work in progress, however, requiring additional infrastructure in operator networks as well as new types of service plans.

**Wimax and Other Long-Term Disruptions**

One potential threat to 3G’s hegemony is WiMAX, a broadband wireless technology standardized in IEEE 802.16. Not that carriers are too nervous yet: Any over throw will take years to happen. The version of WiMAX available now in shipping equipment is Fixed WiMAX (meaning with stationary endpoints), which provides an alternative to DSL, cable modem or T1 services. The most likely deployments are in rural areas or developing countries. The greatest vendor interest, however, is centered on Mobile WiMAX, an enhanced version of WiMAX that allows high-speed movement and hand-offs across base stations. Standards work is complete, but we’re still about a year away from certified equipment. Mobile WiMAX could be a high-speed data overlay for future cellular systems, or could exist as a standalone network.

Although Mobile WiMAX promises higher levels of performance than current 3G systems, there are big questions about available spectrum, and which operators are in a position to actually deploy it. In the United States, only Sprint Nextel has spectrum for wide scale deployment, using its sizeable holdings in the 2.5-GHz band. On Aug. 8, Sprint Nextel announced its decision to proceed with a Mobile WiMAX deployment, with a network that will reach 100 million people in the U.S. by 2008. The company promises typical throughput rates of 2 Mbps to 4 Mbps, which is a bit optimistic, especially once people start using the network. Nevertheless, this constitutes a strong endorsement for the technology. Meanwhile, Clearwire, another operator with 2.5-GHz spectrum and broadband wireless coverage that emphasizes secondary markets, recently received $600 million from Intel and $300 million from Motorola to help fund WiMAX deployment.

Beyond Mobile WiMAX and UMTS-TDD, there’s also the IEEE 802.20 mobile broadband standard, which has been revitalized with Qualcomm’s active participation following its acquisition of Flarion and Flarion’s Flash OFDM technology. Work on 802.20 has been suspended due to allegations of improprieties in the standards process, though this is likely a short-term upset. IEEE 802.20 products and infrastructure could be available by 2008, and 802.20 might be a serious contender. There’s a proposal within CDMA2000 standards work to harmonize it with a future version of CDMA2000, EV-DO Rev C.

What we’re now witnessing is nothing short of a global wireless battle to achieve a dominant position as we move from 3G services to 4G. Never mind that 4G is still completely undefined ... this is the opportunity WiMAX proponents are reaching for, but they’ll be competing with IEEE 802.20, evolved 3G systems, and the cellular community’s own aggressive evolution path to next-generation systems such as 3GPP LTE (Third Generation Partnership Project Long Term Evolution).

In reality, it will be the end of the decade before any entirely new wireless technologies could be widely available, and which one will prevail is hard to predict. For now, what IT managers need to know is that CDMA2000 and GSM/UMTS/HSDPA networks dominate in the wide area. For an evolution timeline of the major technologies, see “Mobile Data Evolution,” at nwcreports.com.

**Beyond Speed**

Throughput, coverage and costs aren’t the only considerations when choosing a wireless network to serve mobile employees; there are quite a few other items that you need to consider; we summarize some of them in “Decision Points: Choosing a Wireless Network,” page 52.

Given the complexity of developing a strategy, it’s no wonder wireless-data adoption has been slow. It’s one thing for an individual mobile professional to run an enterprise VPN over a 3G data service to connect from the road. It’s another matter to architect a comprehensive mobile computing program that supports both laptops and smartphones, while addressing all the security, reliability, performance and management aspects. Users in the field also need different types of support, such as centrally managed tools that monitor remote device configurations and can update systems accordingly.

This may explain why a limited number of poll respondents indicated widespread cellular-data usage, and a bit higher Wi-Fi usage. Nevertheless, the hardware, software and network options for mobile/wireless are better than ever, so we expect these numbers to grow steadily.

Bottom line, networks are faster and more capable, usage prices are dropping, smartphones are becoming more powerful, more applications run better over wireless, and built-in mobile broadband is now a practical option. We don’t quite have ubiquitous, low-cost mobile broadband, but we’re closer than ever before. If you work through the issues outlined above, it’s highly likely that a sizeable portion of your workers can benefit.