3G Wireless Networks, Wi-Fi Wireless LANs, and Secure VPNs:

Perspectives for Mobile Operators



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Bell Labs Innovations

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At the time of publication, this White Paper reflects the latest information on:

3G Wireless Networks, Wi-Fi Wireless LANs, and Secure VPNs: Perspectives for Mobile Operators

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Lucent Technologies, headquartered in Murray Hill, N.J., USA, designs and delivers networks for the world's largest communications service providers. Backed by Bell Labs research and development, Lucent relies on its strengths in mobility, optical, data and voice networking technologies as well as software and services to develop next-generation networks. The company's systems, services and software are designed to help customers quickly deploy and better manage their networks and create new, revenue-generating services that help businesses and consumers. For more information on Lucent Technologies, visit its Web site at http://www.lucent.com

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1 INTRODUCTION

Businesses are becoming increasingly mobile. Mobile phones have become less of a luxury and more of a critical part of conducting day-to-day business. And the increased need for employee flexibility, cost cutting, and customer responsiveness in the work place has led to more and more employees looking for the ability to remain connected to their data networks outside of the office.

Mobile data solutions that address the speed, coverage, security, and ease of use requirements for enterprises have just started to penetrate the market – prior solutions have fallen short and been disappointing. But with powerful laptop and PDA devices, VPN technology, 3rd Generation mobile data technologies like CDMA2000 and UMTS, supplemented by Wi-Fi wireless LANS for in-building enterprise speed demands, business data users now have all the tools they need to take their office wherever they go.

The following pages explore reasons for why mobile data has taken so long to find its place in business, business user needs for mobile data solutions, and how 3G mobile data and Wi-Fi complement each other for a complete mobile data solution.

2 BACKGROUND ON THE WIRELESS DATA MARKET

The Way it Was

An explosion of mobile data applications has been projected since the dawn of CDPD (Cellular Digital Packet Data) service, back in 1994. Even then, early focus groups of target enterprise users strongly indicated that they see clear value in mobile data solutions that would allow them to access their corporate networks while out of the office. The communications industry has witnessed projections for strong growth in wireless data take-up continually pushed out in time, but always promised.

Mobile data growth was limited for reasons such as speed, security, coverage, ease of use and cost. Proprietary and/or customized network security solutions built upon technologies like CDPD and other low-speed data technologies were unable to meet the needs for general intranet access, and were limited to short emails without attachments, or short-length transactional type of data exchanges. A critical factor, coverage has been relatively spotty, typically confined to major metropolitan areas

That was Then, This is Now

The advent of secure, higher speed 3G wireless packet data networks like CDMA2000 and UMTS and VPN technology (IPSec), now let mobile service providers deliver a solution that can provide the corporate user, mobile information worker and anyone on-the-move with the mobile data solution they've been waiting for. Together, they offer security that is strong enough to meet the needs of an IT department, speed high enough that can both address corporate application needs and support security overhead, and coverage that can match user's needs.

Pricing plans for mobile data have also come down to levels that are easily justifiable by the productivity gains that they enable. With "all you can eat" mobile data service at $100 or less

per month, the expected increase in sales or field service effectiveness easily justifies the expenditure.

Some ease of use challenges remain, but the net productivity benefits that can be had by corporate users in certain applications can easily justify the learning curve investment. In addition, major software providers like Microsoft are making significant advances in optimizing operating systems and application software to adapt to the unique challenges of always-on, mobile data services.

Lucent's primary market research has clearly shown that the early adopters for high-speed mobile data service will be, as expected, the enterprise users. With a higher willingness to pay than consumers because of productivity gain justification, they will be the first users to jump-start this new market. Enterprise users that can most immediately benefit from mobile data solutions include the field sales, field service, and traveling executive users. While field sales and service workers have very unpredictable geographic patterns – they go where the customers or the work are – they also have a strong need for coverage in their hotels when traveling. Traveling executives are more likely to have a concentration of their remote communications needs in hotels or airports, where they experience their downtime for the day.

Hold this Thought

Even the vast coverage of mobile networks has some very well known issues with in-building coverage, critical for a comprehensive coverage solution to provide an always-on user experience. And it's no secret that Wi-Fi wireless LANs have made significant penetration into businesses and homes.

Wi-Fi wireless LANS provide a cost-effective method to address the in-building coverage problem and are a natural complement a wide area 3G mobile data network solution that effectively leverages both technologies.

3G mobile and Wi-Fi technologies can and do complement each other to cost-effectively meet the always-on ubiquitous coverage needs that are at the top of the priority list of mobile enterprise workers, as well as other key needs.

3 WHAT ENTERPRISE USERS SAY THEY NEED

Access to corporate applications and services

The primary driving need for enterprise users to adopt a mobile data service is access. Key horizontal applications that apply to virtually all users are email (with attachments), corporate intranet access, and general Internet access. Depending on job functions, users will rely on corporate specific applications - some off-the-shelf like Siebel, Dendrite, or SAP, and others that are custom-developed to suit the needs of the specific company's methods and procedures. Sales Force Automation is a very key application type used by field sales people. By having the ability to use these tools when they are with the customer, sales people can typically increase their ability to close sales on the spot, for example by performing instant credit checks, providing real-time pricing quotes and getting acceptance of terms by the customer. By closing sales in real time, the period of time the buyer has to reconsider their purchase decision is eliminated, resulting in higher sales closing rates. And field service personnel, in addition to having access to information that they may need in real time to address the situation at hand, can also use the data network to offer the customer alternative solutions to repair, such as purchase of a replacement product.

Always-on High Performance Mobile Data

For field sales and service workers to be most productive, they require an always-on, high performance mobile data solution that can be relied upon wherever they need it. Coverage is critical, and adequate speed for their key applications is very important. The benefit of real-time sales closing or "on the spot" offering of alternative product is lost if the user has to leave the premises to look for data coverage. And while data speed must support reasonable performance for an application that does not try user or customer patience, no user will ever complain that their data service is too fast.

High Security

But applications, speed, and coverage are not enough. Solutions must address corporate security standards for the enterprise. The corporate IT department must be assured that the user's information will be secure and that corporate assets like PCs, servers, and data networks cannot be compromised through the mobile data network by unauthorized intruders. By using a widely accepted remote access security solution like IPSec VPN along with mobile data technology, most corporate security concerns may easily be put to rest.

Ease of Use and Cost Control

Ease of use and cost control are also corporate concerns that are tightly linked and, to a certain extent, addressed by using standardized technologies. By improving ease of use, user support costs are reduced by fewer calls to the customer care center. By standardizing on a single remote access security method (e.g. IPSec VPN) for all access techniques (dialup, wireless, cable, DSL), users only have to learn one way to gain remote access, and support center operations are also streamlined. Also, to enhance ease of use, operating systems should hide the complexity of the technology from the user as much as possible. In addition to the costs of customer care, enterprises are also concerned that they have clear business cases to justify technology investments, especially in the current economic times of cost cutting. Investments should have clear payback, and ideally, technology investments in user devices must have a life of two years or better.

4 3G & WI-FI: PROVIDING ALWAYS ON, HIGH PERFORMANCE MOBILE DATA

Location, Location, Location….

In order to define a solution that can provide coverage to users wherever they go, it is necessary to understand where mobile workers travel throughout the course of their work day, and what they need to do in different locations. The following charts indicate the amount of time that is spent away from the office by the three most mobile job functions identified in the previous section – field sales forces, field service workers, and mobile executives.

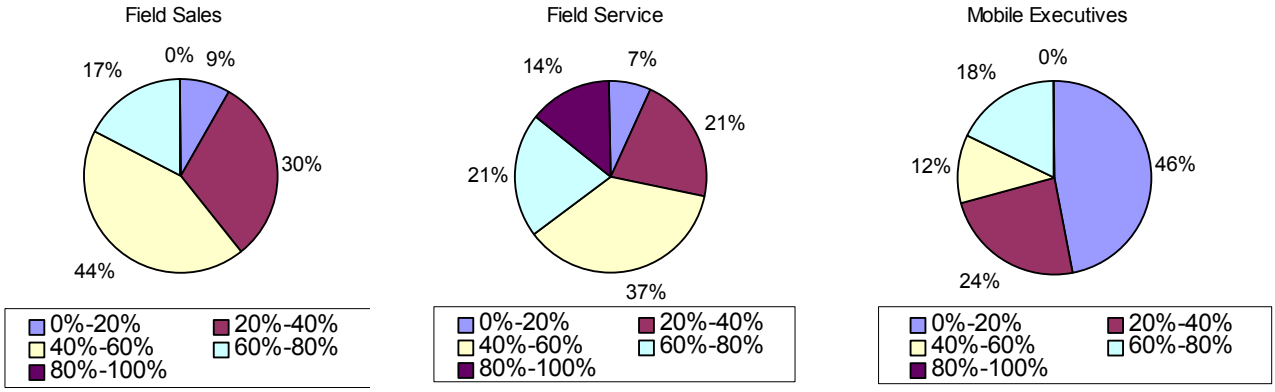


Figure 1 - TIME SPENT AWAY FROM THE OFFICE[1]

The vast majority of field sales and service people and almost 30% of mobile executives spend half or more of their time away from the office. Where do they spend the rest of their time, and what kind of data needs would they have in each of the places they go? The following explores some of the typical activities that could occur in various places.

In the office – whether in a traditional office or in a home office, this is typically a place where a user would require communications with local resources like network printers, other computers on the network, and local servers. This is typically the place where the highest amount of data exchange takes place across the network. And with the trend of replacing desktop computers with laptops, more and more users want to remain connected wherever they go within their office complex.

On the road – typically not much data is actively exchanged while a user is actively on the road, mostly consisting of short messages sent to a pager, cell phone, or PDA. However, if the user is a passenger rather than the driver, (as in a commuting situation or with field service teams), this is time that can be spent more productively if the user had the ability to be connected with their corporate network. Business commuters could jump-start their day by getting access to backed up email or researching a key project over the Internet; field service workers can use down time in the car for downloading up-to-date information or instructions relevant to the next job site that they have to visit.

In client homes or business locations – field sales and service people spend a great deal of time in these locations where they are typically left without connectivity to their own corporate network. As a result, most sales and service operations today are set up to work "off-line" and suffer a great deal of inefficiency that could be improved if the user could remain connected. For example, with an always-available connection, a sales agent could perform an instant credit check on the client, get an exact quote for products or services based on the client's specific profile, complete a contract and close a sale on the spot, eliminating the time away from the client to complete the appropriate paperwork. This instant information can in many instances make the difference between making the sale or not, eliminating the opportunity for the buyer to reconsider their decision or look to a competitor for a lower price. And field service workers can have more flexibility in reacting to situations, even to the point of selling a replacement product and arranging delivery if the product they've come to repair is not worth the repair cost.

[1] Lucent Technologies survey of enterprises considering 3G data, December, 2002

At field sites – field sales and service people like insurance and real-estate professionals need to perform assessments of situations in the field, such as a damage assessment at the scene of an accident or a property appraisal. Data entry – including image capture and accident reporting - on the spot tends to reduce the number of errors that occur when compared with transcription of written information into the computer when the employee gets back to the office.

Hotels and airports – for many mobile workers, the hotel is currently their lifeline back to the office, and they use their evening down time to check email, synchronize files, and enter the day's log of collected data. Typically this involves a struggle to find a cable and jack and determine the appropriate number to dial, just to get a mediocre connection typically less than 50 kbps. Airports also represent a long period of down time for mobile professionals, especially with the more stringent security procedures since 911. Some mobile professionals pay high fees to join the airport executive lounges just to be able to get data connectivity.

Key Points

- Users' productivity can be dramatically increased if they can remain connected with their corporate resources in all the places that they go during the day.
- Wireless technology, combining 3G mobile networks and Wi-Fi wireless LANs, has the ability to significantly affect user productivity for the better. One of Lucent's studies with a potential 3G customer (a large insurance company) showed that equipping their field sales and service employees with a complete mobile data solution would result in productivity gains on the order of $15,000 per year per mobile employee due to increased sales and reduced costs and claims payouts.
- Wireless LAN is an excellent technology to satisfy the demands of mobile employees within their enterprise location, or in homes where there are multiple computers. Because of the very high-speed expectations and intra-premises dominated communication, the wireless LAN provides cost-effective mobility functioning as an extension to the wired LAN, optimizing private networking costs and minimizing facilities bottlenecks to speed.
- Outside the enterprise, 3G wireless technology provides a means for users to do what could not be done before – remain connected to their business critical applications wherever they need to go. The wide area coverage of 3G networks will make it possible for users to do business in entirely new ways, and significantly improve ease of use by using the same connection procedures wherever they may be outside of the office.

Wi-Fi – what's so hot about it?

Wi-Fi, or 802.11 wireless LANs, are getting a great deal of attention. No wonder. Market projections for Wi-Fi user devices offer one of the glimmers of light in an otherwise dim economy. At the end of 2002, there were nearly 19 million wireless LAN user devices installed worldwide, with this number projected to grow to 88 million by the end of 2006[2]. The enterprise is the driving force in these growth projections, accounting for nearly 80% of wireless LAN equipment revenue in 2002 and continuing to remain the bulk of the market through 2006 with 60% of the overall revenue. The remaining wireless LAN market is split relatively evenly between residential applications and public wireless LAN "hot-spots".

In the enterprise, wireless LANs have demonstrated significant savings in terms of cabling costs and labor (versus traditional LAN wiring runs to each desk), and also have significant impacts on

[2] IDC: Worldwide Wireless LAN Equipment Market Forecast and Analysis, 2002–2006

employee productivity. For example, a study by the Wireless LAN association[3] has shown clear payback for wireless LAN in different industries as follows:

Per Company	Retail	Manufacturing	Healthcare	Office Automation	Education
Benefits ($M)	5.6	2.2	0.94	2.5	0.5
Costs ($M)	4.2	1.3	0.9	1.3	0.3
Payback (mo.)	9.7	7.2	11	6.3	7.1

Much of the need for wireless LAN in the enterprise is spurred by a trend to replace desktop computers with laptop PCs for general corporate applications, as newer laptops offer the power of a desktop computer in a portable format that is suitable for most employees. This trend is especially the case in the US and other developed countries.

The high acceptance within enterprises has led to steep reduction in prices, making wireless LAN an affordable method for home networking, as more and more homes now have multiple PCs that need to share peripherals like printers and files across PCs. Many laptop computers can be ordered with built-in wireless LAN devices, further improving the cost of the technology. In fact, with Intel's soon to be released Centrino™ mobile technology, wireless LAN will become an integral part of their new portable PC architecture, further reducing cost and improving performance.

The Hot Spot

Acceptance in the office and in homes has spurred a new market for public Wi-Fi hot-spots. Public Wi-Fi service will allow users with Wi-Fi compliant laptops or PDAs to get high-speed data service at hotels, airports, cafes, and other popular sites by either signing up for service on the spot or subscribing to the service through the public Wi-Fi operator or through their mobile service provider.

Building on the opportune base of Wi-Fi user devices that exist and will continue to grow dramatically (if industry projections hold true), many service providers around the world (existing wireless and wireline operators, as well as several startup ventures) are considering how to add public Wi-Fi service to their portfolio of services that they offer enterprise users to enable high speed connections when they are away from the office.

But what about security?

In addition to the press that Wi-Fi is getting for the positive, there is at least as much publicity related to the security vulnerabilities surrounding Wi-Fi compliant wireless LANs. Existing WEP (wireline equivalent privacy) methods that are part of the Wi-Fi specifications are well known for their easy-to-break security holes. But enterprises that are conscious of security issues have looked to work-arounds that fill these security gaps. One of the most popular methods for accomplishing this is by separating the wireless LAN from the corporate intranet using a virtual LAN (VLAN) and firewall, and encrypting the stream using IPSec VPN technology, authenticating the user before granting them access through the firewall. Some enterprises continue to use WEP as a first line of attack prevention to keep casual intruders from accessing the wireless LAN.

Using IPSec VPN technology has advantages when considering a complete mobility solution relative to ease of use – this is the same method that can assure secure access that meets most

[3] WIRELESS LAN ASSOCIATION – WIRELESS LAN ROI RESEARCH STUDY, 2001
http://www.wlana.org/learn/roi.htm

corporate requirements on the 3G mobile network, or via any other access technique like cable modem, DSL, or dialup.

In addition, new Wi-Fi standards are emerging that will significantly improve native security. Known as WPA (Wi-Fi protected access), the first step is an early subset of the emerging 802.11i security specifications for 802.11 LANs. It leverages 802.1X framework for authenticating devices seeking access to the network, and an Extensible Authentication Protocol (EAP) server such as a centralized RADIUS server that will authenticate user credentials before granting access to the wireless LAN, and support frequent key updates.

Is there a business case for operators in public Wi-Fi?

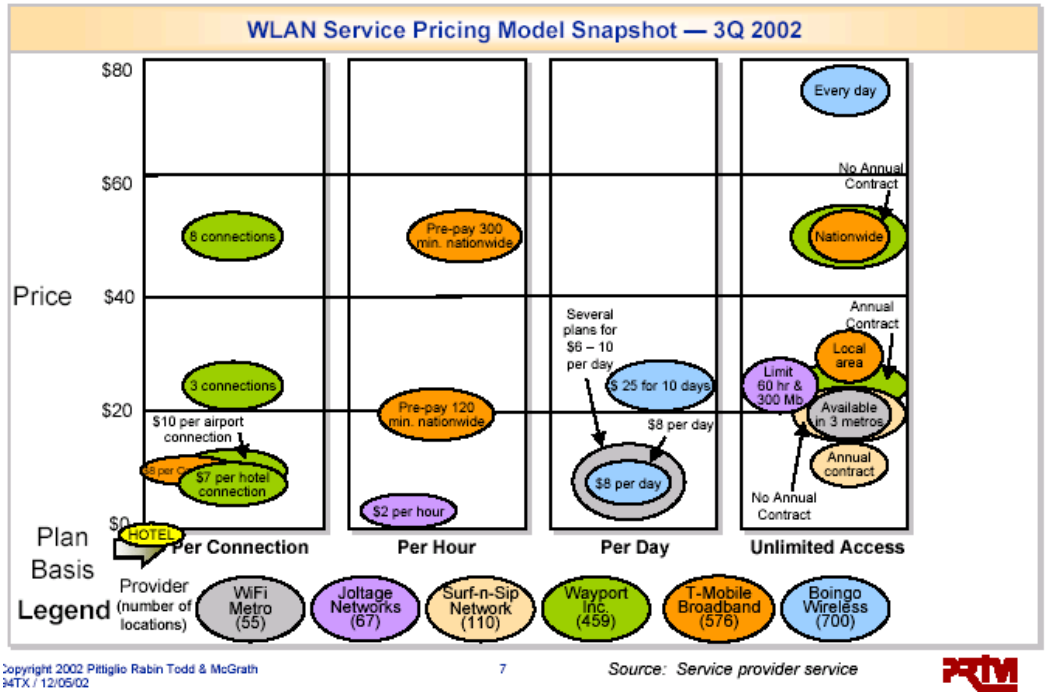
The business case for public Wi-Fi is very complex, and needs to consider factors such as retention of valuable business subscribers, complicated revenue/cost sharing arrangements, uncertain user price points, and technology and market risks. The following paragraphs will attempt to characterize some of the benefits, costs, and risks associated with the public Wi-Fi business.

Benefits to the operator:

- More and more business customers are looking to support for public wireless LAN as part of a complete remote access service offering. This support is likely to become “table stakes” for a mobile operator to capture enterprise business as Wi-Fi public hot-spots become more widely available. However, with this requirement will likely come incremental willingness to pay for Wi-Fi access in addition to 3G service for the benefit of augmented coverage (in-building) and speed. For public Wi-Fi operators that are not currently mobility operators, there is a growing base of users that are ready to take advantage of service due to the number of Wi-Fi equipped laptops and PDAs that exist.

Pricing

- Monthly subscription subscribers are clearly more desirable than pay-per-use subscribers. However, willingness to pay will vary based on number, location, and type of hot-spots. Users that spend more “down-time” as part of their normal business travel day are more likely to accept higher price points – e.g. hotels. In addition, mobile operators are best positioned to gain subscription type of users if they can offer them seamless roaming among multiple Wi-Fi hot-spot operators on a single unified bill with predictable rates. Consistent with this willingness to pay, there is currently a very wide variation in price points for public Wi-Fi service, and as you can see from the chart below, the fees can vary greatly depending on the type of plan and the number of hot-spots accessible to the user via their service provider. And it is yet to be proven that a significant number of users will be willing to pay upwards of $80 per month for unlimited service (see Boingo pricing in the following figure).



Capital expenses (CAPEX)

- It is widely believed that because Wi-Fi equipment is so inexpensive, that CAPEX for such a venture will be minimal. However, while they are indeed inexpensive, Wi-Fi access points are a small fraction of the initial cost of covering a public hot-spot (5-15%, depending on the type of venue). Building wiring, router and gateway equipment, installation services, network management, and back-office billing integration systems are much greater components of CAPEX. To the extent that an operator already has access to these types of capabilities that they can leverage in a given venue, their CAPEX will be either positively or negatively impacted.

Operational Expenses (OPEX)

- One of the key variables will be revenue sharing and roaming agreements. Hot-spot operators will need to develop value-sharing relationships with venue owners (for access to rights of way and building infrastructure), mobile operators (for bringing customers onto the network), and aggregators (to facilitate broader and global Wi-Fi roaming networks). Costs associated with customer acquisition and churn will be major OPEX contributors. To the extent that an operator can leverage their existing subscriber base into the Wi-Fi business, these costs will be either greater or less. Customer service and technical support will also present major cost components in operating a public Wi-Fi network. Leveraging these capabilities for existing data services will provide an operator with an economies of scale advantage over an operator that does not offer data services in addition to their Wi-Fi service. Also, initially these costs will be higher until user familiarity with the service and technical issues associated with gaining access to service stabilize. Customer acquisition, churn, customer service and technical support costs will be reduced as a percentage of overall OPEX as the industry moves from predominantly pay-per-use to a more subscription-based model.

- Wide area network connection fees (T1's, DSL, etc.) will be a significant contributor to the overall monthly operating expenses. Depending on whether it is a wireless or wireline operator operating the hot-spot, this will have a greater or lower impact on the business. If the operator uses facilities that they also offer as part of their normal business, this will give them higher value in the overall Wi-Fi business value-chain. Wireless operators have some options in this area as well as wireline operators. For example, instead of using wireline T1 or DSL lines to connect Wi-Fi hot-spots to the Internet, they could leverage 3G technology such as CDMA2000 1xEV-DO, or interconnect Wi-Fi hot-spots with their cell-site backhaul network using point-to-point wireless facilities, essentially achieving "free" Internet connections since it would be integrated with the rest of their business. For hot-spots that have infrequent visitor traffic[4], this could make or break the profitability of the site. Other possibilities to reduce this cost are to collaborate with local businesses that would need Internet connectivity, and share the cost of the public service Internet connectivity with the local private businesses.

Risks

The following are some risks that must be considered and managed as part of an overall business analysis for public Wi-Fi:

- Low barriers to entry – because Wi-Fi operates in unlicensed spectrum, it is very easy for a competitor or local business to set up a Wi-Fi network in a nearby location. This could either divert traffic away from the operator's site, or have a negative effect on both performance and acceptable price points.

- Uncertain user adoption rates – as mentioned previously, current usage levels for public Wi-Fi networks are relatively unpredictable across the breadth of venue types. Hotels and airports would tend to have a more predictable user base, and as such are more desirable properties for public Wi-Fi.

- Security/Fraud management – For private Wi-Fi networks, security has been a significant barrier to adoption, but has some effective solutions that will become even more so with emerging Wi-Fi standards. For public Wi-Fi, operators will have to balance the need for protecting themselves against fraudulent usage and network break-in with at present more complicated procedures for security protection. Balancing ease of use with secure access will be a challenge to be managed by the operators and standards going forward.

- Difficulty of managing service quality – Given the complex nature of roaming arrangements in the public Wi-Fi market, operators will have to depend on partners to deliver service quality to their users. Without direct control, this can make it difficult to offer and enforce service level agreements with end-users.

- Technology migration – 802.11 LAN standards, the basis for Wi-Fi public LANs, are rapidly evolving to include higher rate services (802.11a and g), quality of service mechanisms (802.11e), and enhanced security procedures (802.11i). In choosing infrastructure to build-out a public Wi-Fi network, the ease with which this infrastructure can be enhanced to support emerging standards must be considered carefully.

Mitigating risks and maximizing profits

Mobile operators should focus on what they do well and have done for years – manage mobility for the subscribers. They have a great deal of experience in providing unified billing to subscribers across multiple network operators, hiding the complexity of roaming from the end-users. This puts them in an excellent position to continue to be the mobility manager for the subscriber when adding

[4] At time of writing, public information indicates that T-Mobile averages 1-2 users per hot-spot per day, making economic justification of a T1 facility difficult.

Wi-Fi service to their mobility portfolio. In order to negotiate favorable roaming agreements with Wi-Fi operators, mobile operators may need to own and operate a few key properties themselves. However, by keeping these to a minimum and taking a roaming strategy, wireless operators can minimize their exposure to the high-risk of public Wi-Fi deployments while leveraging the promise of the technology. By bringing their subscribers to public Wi-Fi venues, they offer Wi-Fi operators a source of revenue and value, and wireless operators can also find value in offloading their licensed spectrum in key high-density areas. Strong consideration should be given to supporting dedicated client software that shields users from decisions on what network to use when, while assuring the mobile operator that appropriate policy decisions are applied to maximize revenue, profit, and user experience.

Yes, you do need 3G even if public Wi-Fi takes off… Here's why

In Lucent's surveys of corporate mobile users, they routinely cite always-on, continuous coverage as a top need for data service to provide satisfactory performance. As shown earlier (see Figure 1), most mobile users are away from the office more than half of the time. And they go places that will not have predictable access to a wireless LAN. As home users and enterprises become more conscious of security on wireless LANs, sharing access to open networks in client homes becomes less likely over time. While Wi-Fi public hot-spots may offer a higher speed convenience versus 3G in certain instances (like hotels or airports) for business travelers, most field sales and service workers will fail to be satisfied by the coverage offered by public Wi-Fi service.

Speed is also critical. 2-2.5G technologies do not have adequate performance to meet the needs of general corporate applications that are required by field sales and service forces. E-mail with attachments, large file downloads, and custom applications typically stall at data rates that are slower than a good dialup connection. Users have told us that while speed is secondary to coverage, they still need a mobile data solution to offer speeds that are "better than dialup" in order for them to perceive adequate performance.

Finally, Wi-Fi is not an appropriate technology for wide area deployments. Due to the use of unlicensed spectrum, it will be difficult for a network operator to control quality, especially in dense urban environments. The technology is designed for low power transmission, with distances less than 1000 feet from the access point. While the cost of access points themselves may be low, the associated deployment, operation, and maintenance costs of a wide area deployment for public access would be prohibitive.

CDMA2000 1xEV-DO wireless technology, a 3G standard, currently can offer speeds up to 2.4 Mbps peak rates, with average carrier throughput of 600 – 800 kbps and is designed for wide area deployments in licensed spectrum bands. UMTS, also for wide area deployments in licensed spectrum bands, will offer 384 kbps data rates, and in the next few years High Speed Downlink Packet Access technology will improve this speed significantly. These technologies offer a cost-effective method of providing always-on service to the mobile user when and where they need it.

5 OPERATORS WIN WITH ENTERPRISE MOBILE DATA

Wi-Fi and 3G are naturally complementary technologies – Wi-Fi for local network – in-building and campus – coverage, and 3G for the wide area, always-on coverage that is demanded by heavy mobile enterprise users, such as field sales, field service, and mobile executive employees.

For the enterprise user, Wi-Fi will provide the most cost effective solution with the best performance WITHIN the enterprise itself, since much of the user's traffic will be destined for printers and servers locally. As the user leaves the premises, 3G will service the broadest range of needs for highly mobile users, providing wide area, always-on coverage. Dedicating 3G bandwidth to data and using a highly efficient data technology such as CDMA2000 1xEV-DO will assure operators that

they can deliver the best price/performance to enterprise users on the 3G network. The 3G network service would be of particular use for enterprise users that are involved with field sales and service, or are mobile executives.

By supplementing 3G in key areas like hotels and airports where frequent travelers visit, mobile operators may supplement their 3G networks with a public Wi-Fi offering to gain additional revenue, offer potentially higher data rates to business end-users, and off-load their licensed spectrum for better service of voice traffic if needed.

The mobile operator should focus on ease of use and unified billing for the user, regardless of what network they are using to access mobile data service. The operator can also play a critical role in supporting seamless mobility, or handoff, between the wireless LAN and the 3G network. This will be most important initially for vertical industries like public safety and fleet applications like package delivery. Over time, this seamless handoff will become more important for a broader set of user segments as connected PDA penetration increases and device/battery life improvements make "always-on" service truly feasible for PDA type devices.

Operators should also consider the benefits of using their 3G wireless infrastructure as an asset to reduce their cost in deploying their own set of Wi-Fi hot-spots. For example, CDMA2000 1xEV-DO can provide an effective Internet connection for certain Wi-Fi hot-spots such as those that have limited user traffic as well as those that are mobile by nature (such as commuter buses and trains).

Lucent is the leader in spread spectrum technology development, the leading technology for 3G and Wi-Fi wireless LANs. As a pioneer and the industry leader in data networking, Lucent has been at the forefront of integrating 3G and Wi-Fi wireless LAN technology towards seamless mobility and handoff. Our extensive professional services organization is available to work with operators to help them build the right strategy and a corresponding network integration plan to assure success as they look to a future which will involve merged 3G/ Wi-Fi data networks to satisfy the demands of the mobile enterprise user. By partnering with Lucent for 3G and Wi-Fi, operators can leverage Lucent's experience, as well as that of numerous leading industry participants that Lucent partners with to bring Wi-Fi and 3G solutions to the market.

To learn more about Lucent's High Speed Mobile Data Solutions for Enterprises, please contact us at 888-552-2544, or visit our web site at http://www.lucent.com.

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