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Impact & Opportunity: Public Wireless LANs and 3G Business Revenues

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This report has been produced by the UMTS Forum, an association of telecommunications operators, manufacturers and regulators. The UMTS Forum comprises IT and media industries interested in broadband mobile multimedia that are active both in Europe and other parts of the world and who share the vision of UMTS (Universal Mobile Telecommunications System). These are key industry members of the Forum and have contributed significantly to this report. In terms of a technology platform UMTS will move mobile communications forward from today's environment to the Information Society incorporating third generation mobile services that will deliver speech, data, pictures, graphics, video communication and other wideband information direct to people on the move. UMTS UTRA (Universal Terrestrial Radio Access) is a member of the IMT-2000 family of standards.

This report is one of the series of UMTS Forum reports. It deals with views on WLANs and their impact on 3G.

The views and conclusions in this Report are purely those found and expressed during the work of creating this document and exempts National Administrations who are UMTS Forum members from being bound to them.

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INTRODUCTION

The 3G / WLAN Debate: What is the impact of WLAN on 3G business ?

Global public and industry interest in Wireless LANs (WLANs) has exploded in the past year. Companies are deploying WLANs in offices and factories as replacements for wired LANs or to provide employees with untethered access to the corporate network. Universities and hospitals are also deploying WLANs. In some countries, public WLAN service

providers have launched fee-based WLAN services in public venues such as coffee shops, hotels, and airports. In the private sector, WLANs are being installed by consumers to create in-home networks, and in public spaces by community groups to provide free Internet access to citizens. The list of major (and start-up) telecommunications hardware and software manufacturers, as well as service providers, supporting WLAN grows almost daily.

All this has occurred despite the existence of competing standards, security and privacy concerns, and the cries of various WLAN critics. WLAN is a reality that needs to be considered in juxtaposition with 3G services.

Considerable debate in the wireless industry has recently been focused on the impact of public WLAN services on the forecast service provider revenues for 3G. One result of this debate is that a number of industry analysts have reduced their forecasts for 3G revenues due to their belief that public WLAN deployment will “cannibalise” potential 3G revenues.

It is UMTS Forum’s belief that WLAN and 3G are generally complementary within a total mobile data services portfolio. Thus, the UMTS Forum has started a number of objective studies in this area. This is the first report targeting the business value of WLANs for public 3G operators.

WLAN provides nomadic (quasi-stationary) wireless access to the Internet / IP network. The UMTS Forum 3G service vision incorporates six service categories that provide connectivity to content and people through personalised, location-based services, integrating voice with multimedia. While mobile access to the Internet is an important element of that vision, it is only one portion of the much richer portfolio of capabilities that 3G can offer. The intent of this report is to clarify the underlying assumptions relating to one of the six service categories, namely Mobile Intranet/Extranet

Access and to examines the relationship between 3G and public WLAN operator in the context of revenue forecasts.

The Mobile Intranet/Extranet Access service category is specifically defined for workers on the move with a need to remotely access the corporate intranet or extranet as well as the public Internet, and is therefore related to business use of public WLAN services. For brevity this service category is referred to as the 'Mobile Intranet' service in this report.

Based on the analysis presented in this report, we conclude:

- Public WLAN could be a significant industry development.
- Public WLAN gives an opportunity to expand both overall market size and competitive position for data services
- Public WLAN service may be an additional source of competitive differentiation for 3G operators.

DEFINITION OF WIRELESS LAN

A wireless local area network (WLAN) is a data communication system implemented as an extension to, or as an alternative for, a wired Ethernet LAN within a building or campus. Private WLANs are being deployed for in-home, institutional (e.g. universities and hospitals), and single-company use, typically as a replacement for a wired LAN. Public WLANs are also being deployed by WLAN service providers and public operators in high-traffic "hot spots" (i.e. hotels, airports, convention centres, and cafés) to allow high-speed Internet access while "on-the-go" meaning that while WLAN could be used in different "hot spots", it requires the user to be stationary while accessing services. A comparison of private and public wireless LAN characteristics is presented in Table 1. Unlike private WLANs, public WLAN services must also address billing, ease-of-use, and more stringent security, privacy, and traffic management issues.

Table 1. A comparison of private and public wireless LAN characteristics.

Characteristics	Private WLAN	Public WLAN
Location	Homes, businesses and factories	"Hot spots": hotels, airports, cafés, public spaces
Operated by	Individual businesses and individuals	WLAN Service Providers and public operators
User base	Desktop and non-desktop employees, individuals	Individuals
Purpose	Replacement for wired LAN and/or access to company network; also provides an "instant" LAN	Medium to high bit rate access to Internet and/or company VPN
Security & Privacy	Medium but adequate	Medium but being improved

Source: UMTS Forum, May 2002

WLAN is simply a wireless access mechanism for reaching an Ethernet LAN and the wired Internet or corporate/institutional intranet/extranet. As such, the WLAN user has nomadic access to all the information and IP-based rich media services currently available on the wired Internet.

Due to the currently limited availability of 3G networks this nomadic access can provide an early opportunity for the higher data rate market. However, even when 3G has become fully established, WLAN services could remain a useful complement.

WLAN TECHNOLOGY AND KEY ATTRIBUTES

The emerging *de facto* standards for WLANs are 802.11b and 802.11a, but there are other contenders that could be used in the same market sector. The following describes possible wireless access technologies, including: 802.11b, 802.11a, 802.11g, 802.11h, DECT, UTRA TDD, Hiperlan 2, and Bluetooth.

The key attributes of WiFi, the de facto WLAN standard, are: licence-exempt spectrum, high-speed, and wide availability.

IEEE 802.11b (Wireless Fidelity – WiFi): Operating in the licence-exempt 2.4 GHz band, the IEEE 802.11b standard currently dominates the WLAN space. Using Direct Sequence Spread Spectrum (DSSS) techniques it delivers more throughput (up to a theoretical 11 Mbit/s) and greater range than the alternative of Frequency Hopping Spread Spectrum (FHSS) used in

both Bluetooth and HomeRF.¹

Interference concerns regarding the use of 802.11b and Bluetooth in the same physical space exist. Studies and technology trials indicate that the two standards can coexist but with some performance deterioration in some circumstances.² Efforts are currently underway to minimise the interference potential.

IEEE 802.11a (WiFi5): Using Orthogonal Frequency Division Multiplexing (OFDM) instead of spread spectrum techniques, the 11a standard is intended to operate in the 5 GHz spectrum band. With the potential to deliver up to a theoretical 54 Mbit/s, the use of OFDM also improves the ability of radio devices to operate in a complex environment where multipath fading will be commonplace.

Several vendors are shipping 802.11a-compatible devices.

IEEE 802.11g: The draft IEEE 802.11g specification is generating interest (and confusion) in the WLAN community. 802.11g, an extension of the 802.11b standard and also operating in the 2.4 GHz band, uses the same OFDM modulation scheme as

¹ Essentially a further development of DECT, HomeRF uses a control point to communicate with a range of devices from laptops to audio headsets as well as providing support for peer-to-peer interactions. Designed from the start to handle voice communications as well as streaming media and Ethernet data it offers a peak data rate of 10 Mbit/s and fallback modes of 5 Mbit/s, 1.6 Mbit/s and 0.8 Mbit/s and operates in the 2.4 GHz band.

² "Companies to Show Bluetooth, WLAN Coexistence," 802.11Planet News, Matthew Peretz, November 29, 2001

802.11a to provide a theoretical maximum data rate of 54 Mbit/s. Though the higher-speed advantages of 802.11g over 802.11b are obvious, numerous engineering and standards-ratification issues remain to be resolved before 802.11g is formally adopted as a standard and compatible products become commercially available (most likely late 2003 or 2004).³

IEEE 802.11h: An extension to 802.11a, 802.11h will provide support for Dynamic Frequency Selection and Transmit Power Control to bring it into line with European radio regulations. The 802.11h extension has not yet been ratified, but this is expected to happen soon.

DECT: DECT⁴ is one of the IMT-2000 radio standards and operates in 1900 MHz licence-exempt spectrum. It is designed to handle both voice and data traffic. The technology has been undergoing an upgrade over the last year to support the packet environment and to deliver data rates up to 2 Mbit/s.

Hiperlan 2: Using OFDM techniques and operating in the 5 GHz band, the Hiperlan 2 concept promises to match 802.11a data rate of up to 54 Mbit/s. But unlike the 802.11 standards, Hiperlan 2 is being designed to support the high data rates with QoS for voice and multimedia services and to complement 3G. Hiperlan 2 standards development is being handled by ETSI.⁵ At the present time, the future market prognosis of the Hiperlan is uncertain.⁶

UTRA TDD: UTRA TDD is one of the IMT-2000 radio standards and is designed to handle both voice and data. TDD is seen as a technology that can support high data rate services (up to 2 Mbit/s), subject to range etc. Although it is not a WLAN technology it has some potential to serve the market that WLAN is addressing. TDD will provide full mobility and could operate in both licensed and license-exempt IMT-2000 spectrum,

Bluetooth: Bluetooth is a global computing specification for short-range communications between computers, handsets, PDAs, printers, and other devices. It uses the licensed-exempt 2.4 GHz band and currently has a maximum range of approximately 10 metres. Efforts are underway to increase the range to 100 metres.

³ "Clarity & Understanding: The High-speed WLAN standards debate," 802.11Planet.com, Tyler Burns, March 12, 2002

⁴ Digital Enhanced Cordless Technology.

⁵ European Telecommunications Standards Institute.

⁶ "HiperLAN collapse opens European door to 802.11a," ZDNet UK News, Peter Judge, December 18, 2001

Key Attributes of 802.11b

Numerous attributes have contributed to the market interest and deployment of public 802.11b (WiFi) WLANs:

- Technology of choice for private WLANs (office and home)
- The appearance of community grassroots initiatives to provide free access to the Internet via WLAN in public spaces
- High data rate access to the Internet, in areas where high data rate access has not been economical previously
- Economies of scale and declining component costs
- Growing need for un-tethered access to the Internet or corporate systems and information
- Use of license-exempt spectrum
- Wide availability of WiFi-compatible products (e.g. wireless modems, routers, access points).

WiFi, though the dominant WLAN technology, faces several key constraints to widespread deployment as a public network access technology:⁷

- Shared spectrum: WiFi shares the license-exempt 2.4 GHz spectrums with other devices, including household appliances (e.g. microwave ovens and garage door openers), Bluetooth and HomeRF devices. As WiFi deployment and usage increases, the spectrum will become increasingly crowded. This may result in a degradation of WiFi performance in some situations but this may be avoided via the additional WLAN opportunities at 5GHz.
- Operational regulations for WiFi and other WLAN technologies vary by country. For example, some countries do not allow public access applications and other restrict the amount of the bandwidth that can be utilized.
- Deployment and scaling difficulties: The coverage area of a WiFi access point depends on a number of environmental factors, including: the distance and configuration of nearby walls, the material content of the walls, and the proximity of reflective surfaces. In a situation where the users are expected to be stationary, WiFi network planning is relatively simple (single cell approach). However, if users are expected to re-locate/move

⁷ "WLAN: 3G Friend or Foe?," ABN-AMRO, August 14, 2001

from the coverage area of one access point to that of another, WiFi network planning becomes more difficult (cellular approach).

- Security and privacy constraints: There is considerable debate regarding the security and privacy capabilities of WiFi. Researchers have shown that holes in Wired Equivalent Privacy (WEP), the encryption technique used by WiFi, can be exploited by hackers to uncover the encryption key used to encrypt WiFi traffic.⁸ WiFi opponents and proponents both agree that the 802.11b protocol does not provide true end-to-end security. However, proponents feel the level of privacy is comparable to that experienced on wired Ethernet LANs. Currently, WLAN access providers and third-party developers are working on methods to enhance WiFi security and privacy capabilities.
- Optimal user data rates are generally not attainable: The characteristics of the physical surroundings, Ethernet collision-avoidance schemes, quality of WiFi network design, and the number of simultaneous users (among other things), all contribute to actual shared user data rates to below the nominal 11 Mbit/s. A similar situation exists for wired Ethernet LAN. The actual total data throughput is about 6 Mbit/s over a short range and degrades over distance, number of users and location of users within the coverage area. A similar situation exists for the other WLAN technologies. In short, unlike 3G, 802.11 technologies do not allow guaranteed data throughput and in general, provide neither quality of service management nor guarantee quality of service.

8 "Your 802.11 Wireless Network has No Clothes", William A. Arbaugh, Univ. of Maryland, March 2001

WLAN AND 3G: A COMPARISON

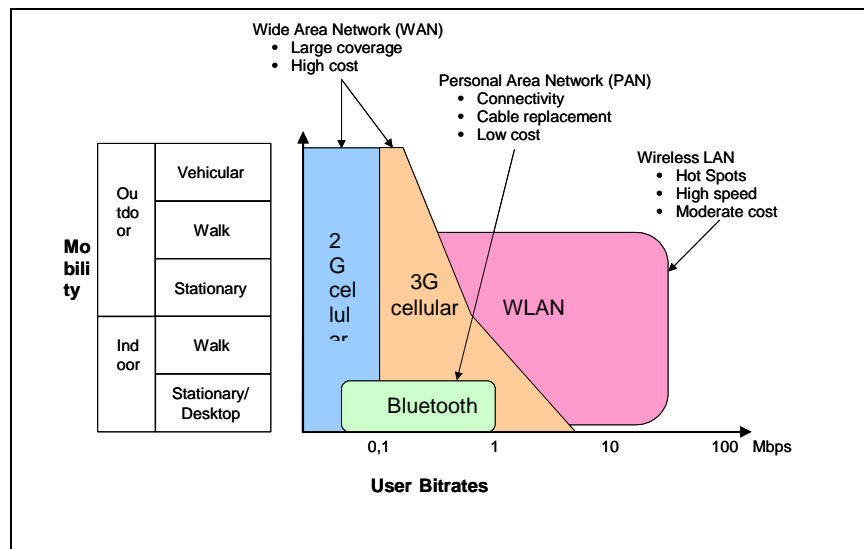
Though both 3G and WLAN are by definition wireless technologies, their differences are significant. As shown in Figure 2, the technologies vary significantly by two factors: level of mobility and user data rate. 3G provides wide area coverage to users moving even at high speeds whereas WLAN requires users to be essentially stationary. 3G user data rates exceed the data rates available through today's 2G and 2.5G service offerings. 802.11a and 802.11b WLAN provides even greater user data rates but can only be used within a limited service area

WLAN and 3G technologies differ primarily by their level of mobility and user data rate.

(measured in 10's of metres) and for a relatively small numbers of users per cell.

Figure 2. Level of mobility vs. maximum shared bit rates for PLMNs and WLANs.

Source: Ericsson and UMTS Forum, May 2002.



WLAN standards do not provide standardized implementations (as they exist in 3G) for the following features essential to networking operation:

- Billing
- User authentication (as opposed to radio link security and encryption)
- Fraud control
- Roaming methods (both technical and business) for interconnecting multiple WLANs
- QoS controls
- Radio resource management & network management

- Customer care systems

In general, the level of roaming has different scales:

- Intra-network roaming between cells within the same operator's network (typically as facilitating handover).
- Inter-network roaming between similar networks of different operators (e.g. WLAN to WLAN or UMTS to UMTS).
- Cross-network roaming between different network technologies (e.g. WLAN to UMTS).

3G provides extensive coverage and high mobility, meaning the user will be able to use the service anytime, anywhere within the coverage area and whilst on the move. As the user moves from one cell's coverage area to another, the cellular network transfers the user's service connection to the appropriate cell, thereby maintaining a seamless network connection for the user. The same is also true when changing from one operator's network to that of another operator, due to roaming agreements between operators.

WLAN, in contrast, provides nomadic access in terms of availability in more than one location, meaning that it requires the user to be essentially stationary while using the service. Although the WiFi standard (802.11b) does allow for roaming across access points within the same Ethernet network (intra-network roaming), the standard does not define an inter- or cross-network roaming protocol. This effectively limits the WiFi service area. Table 3 compares some of the significant characteristics of WLAN and 3G technologies.

Table 3.
 Different characteristics of WLAN and 3G technologies.

Characteristics	3G	802.11b (WiFi)	802.11a (WiFi5)
Typical End-User Bit Rate	< 2 Mbps	< 5 Mbps	< 10Mbps
Typical Range – Stationary User (1 cell or access point)	3-5 km (dense urban area)	50-60 metres ⁹	10-20 metres ¹³
Predictability of Data Throughput	High	Low	Low
Handover	Yes	Limited	Limited
Roaming	Yes (if networks using same 3G technology)	Planned	Not yet
Cross System Roaming	Planned	Not yet	Not yet
Security – Authentication	High	Medium – being improved	Medium – being improved
Security / Encryption	High	Medium – being improved	Medium – being improved
Potential for Interference	Low	High	Medium
Spectrum	Licensed	Licence-exempt 2.4 GHz	5 GHz
Device Power Requirements	Low to Medium	Low	Low
Devices Most Likely Used	Handsets, PDAs, other hand-held devices	PDAs, laptops	PDAs, laptops, other hand-held devices
Coverage	Wide area - contiguous	Hot spots / offices / homes – non-contiguous	Hot spots / offices / homes – non-contiguous
Deployment	Hierarchical Cell Structure	Ad hoc cells	Ad hoc cells
Mobility	High speed	Essentially stationary	Essentially stationary
Services	Voice and data	Primarily non-voice	Primarily non-voice

Source: UMTS Forum, May 2002.

However, a number of efforts are underway to facilitate roaming between WLAN networks and between WLAN and different 3G networks. Inter- and cross-network roaming solutions have been

⁹ Book 'UMTS and Mobile Computing', Artech House, Huber & Huber, Chapter 3, page 58

demonstrated and are expected to become commercially available in the second half of 2002. One of the most recent initiatives to address WLAN roaming is Pass-One; a WISP Association launched in April 2002.

Due to the different characteristics of WLAN and 3G, they are not one-to-one replacements. Instead, the inter-networking of WLAN and 3G systems will allow service providers and operators to leverage the unique and complementary advantages of each.

"Interworking between WLAN and 3GPP systems could be realised in different ways. WLAN could be made to be an integral part of 3GPP system or the two systems could be kept as separate but interworking systems. At network side in case of separate systems there could be one-to-one, one-to-many, many-to-one or many-to-many relationship between the WLAN access network and 3GPP network."¹⁰

The interworking alternatives between 3GPP systems and WLAN are sometimes referred as being either "loose" or "tight". In the former case, the normal IETF protocols are retained for WLAN mobility (e.g. Mobile IP) and QoS but using 3GPP protocols for authentication, authorisation and accounting. For "tight" WLAN/3GPP integration, the 3GPP protocols are used throughout including mobility, security and QoS but this requires additional changes to the specifications to introduce an Iu-like interface.

Finally, WLAN is primarily a data (non-voice) service while 3G supports both voice and data. Given the advances in voice-over-IP (VoIP) technologies, private WLANs can be designed to support voice also. In a August 2001 report,¹¹ Frost & Sullivan stated in their analysis that VoIP usage will increase dramatically as corporate acceptance and deployment of private WLANs grows."¹² A number of companies and institutions (such as Gate Gourmet Switzerland¹³ and the University of Arkansas at Pine Bluff¹⁴) are beginning to explore VoIP on their private WLANs.

¹⁰ "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Feasibility study on 3GPP system to Wireless Local Area Network (WLAN) interworking; (Release 6)," 3GPP TSG-SA WG 1 (Services) unpublished technical report (TR 22.934 v1.0.0), February 15, 2002

¹¹ "Enterprise Wireless Communications, Report #6325"

¹² "Unwiring the Enterprise – The Impact of Voice over WLAN," Frost & Sullivan website, August 8, 2001

¹³ "The Case for Voice over WLAN," 802.11Planet, Gerry Blackwell, March 11, 2002

¹⁴ "Developers Speak Out on the Future of Wireless VoIP," AllNetDevices.com, Ed Sutherland, January 14, 2002

But will VoIP on public WLANs be deployed to offer fully integrated voice/data services like 3G? We are doubtful for several reasons:

- The deployment of public WLANs for data-only applications is already hampered by issues (such as security/ privacy/ mobility/ QoS and data throughput) discussed previously.
- VoIP adds significant network design complexities in terms of bandwidth management and acceptable voice quality.
- VoIP/WLAN handsets are not yet ready for the mass market in terms of cost, design, and user interface.
- The regulatory implications of offering voice services via a public WLAN have not been addressed and are likely to be complex and time consuming to resolve.

Based on those reasons, we conclude that voice-over-WLAN does not play a significant role in our 3G/WLAN analysis.

INDUSTRY DYNAMICS

The possibilities for public WLAN deployment have emerged against a background of general economic downturn at a time when the mobile industry has been experiencing unexpected 3G handset shortages and 3G network deployment delays. Also, the basic voice service is already mature market in 2G; nevertheless this basic voice service is still growing. Simultaneously, industry interest in data services, and hence for WLAN has intensified, but has perhaps been overstated in some cases.

By meeting end-user needs today, WLAN has the potential to become the catalyst for stimulating the mobile data market.

Though the mobile data market has yet to accelerate, WLAN interest by users and suppliers seems to be growing. A number of factors exist which are accelerating the interest and deployment of 802.11b WLANs. The deployment of WLANs by companies for private networks is continuing to increase, with worldwide WLAN equipment sales reaching \$1.47B

(\$1.47 billion)¹⁵ in 2001,¹⁶ primarily for use in private networks.

With this increase in WLAN usage, the population of 802.11b-compatible devices (primarily PCs) is also increasing. WiFi-compatible WLANs are being deployed for a number of vertical industry applications, including health care, manufacturing, and logistics. Given the dual corporate and home use of the 802.11b standard, in contrast to proprietary technology used by the Metricom service and others, the available market for public WLAN services grows daily.¹⁷

WLAN is essentially a location-specific means to provide wireless access to IP networks in a hot spot. Companies, which are not currently service providers, such as hotels and cafés, have the ability to offer this access. They may see WLAN as a means of providing their customers with high-speed Internet access in order to differentiate their business location from competing businesses and to create a new revenue stream.

¹⁵ All currency amounts quoted in this report are in US\$.

¹⁶ "WLAN Market Hits Double-Digit Growth Rate", 802.11Planet.com news, Matthew Peretz, February 27, 2002

¹⁷ Metricom entered the public WLAN market in 1996 but failed in mid-2001.

WLAN PLAYERS

To date, the WLAN industry has been dominated by hardware vendors, supplying more than 200 different products for WLANs.

Start-ups will be innovators that launch the market, but acquisition of the successful startups may result in a WLAN market dominated by incumbent mobile operators.

Sales are expanding rapidly as an increasing number of enterprises see the value of WLANs. Growth has been helped by the Wireless Ethernet Compatibility Alliance (WECA), which provides conformance and interoperability testing. So far, this group of more than 130 companies has granted its "Wi-Fi" label of approval to more than 185 products conforming to the 802.11b standard.¹⁸

There are a number of WLAN players, each focusing on different aspects of the market. Initially, focusing on private WLAN products, these are:

- WLAN product (e.g. modem, access points, router) manufacturers.
- Semiconductor and component manufacturers.
- Networking software vendors.
- WLAN research labs.
- PC manufacturers (bundling WLAN modems with their products).

Two such examples are Microsoft and Intel.¹⁹ Microsoft launched its latest operating system, Windows XP, with embedded 802.11 support capabilities. Bluetooth support will be added in 2003. Microsoft also recently announced their "Soft Wi-Fi" concept, which "shifts the processing demands of 802.11 from the Access Point's radio to the laptop's software and CPU."

Intel is developing a new chip, codenamed "Banyan", that is optimised for 802.11 support and offers a 50% reduction in power consumption. Intel expects the chip (available in 2003) to be embedded in future Pentium 4 laptops.

¹⁸ "The ABCs of 802.11 standards", ZDNet Tech Update, Ian Keene, March 21, 2002

¹⁹ "Intel Unveils Plans to Support 802.11 Networking on the CPU," 802.11 Planet News, Ed Sutherland, April 22, 2002

As the public WLAN market grows, new players have emerged:

- Public WLAN service providers (including “micro-carriers” with between one and a few tens of sites to national players like T-Mobile Wireless Broadband²⁰).
- Roaming and settlement service providers.
- Hot spot property owners (i.e. small businesses, regional and national hospitality chains).

As discussed, the WLAN market has been plagued by a number of concerns, but these may be transitory. Tremendous resources across all facets of the value chain are working diligently, and are making progress, to establish WLAN (especially WiFi and WiFi5) as viable wireless access technologies, also capable of providing public access.

The various public WLAN services currently being offered around the globe are essentially real-time market experiments to determine:

- End-users’ willingness to pay.
- Optimal service propositions.
- Typical end-user use cases.
- Optimal business models and alliance strategies.
- Optimal wireless data service portfolio strategies.

As with the introduction of most new technologies, the initial market dynamics and industry structure for WLANs will evolve as market penetration increases. Table 5 compares the WLAN strategies and service offerings of three major players.

²⁰ Previously MobileStar.

Table 5. A comparison of three current WLAN service offerings.

Characteristic	Telia	T-Mobile International	Boingo
<i>Company Type</i>	Carrier	Carrier	Start-up
<i>WLAN Brand Name</i>	HomeRun	T-Mobile Wireless Broadband (previously MobileStar)	Boingo
<i>Geography Served</i>	Sweden – 350 sites; Norway – 25 sites; Finland – 25 sites; Denmark – 2+ sites	650 hot spots in the USA, including over 400 Starbucks locations	Over 500 hot spot locations (1 st phase rollout) in the USA, plus a few locations in Canada and the UK
<i>Business Strategy</i>	Primarily targeting business travellers	Targeting business travellers and consumers	Boingo purchases wholesale WiFi services from multiple WiFi micro-carriers to provide a single integrated service to business travellers and consumers

Source: UMTS Forum, May 2002.

Characteristic	Telia	T-Mobile International	Boingo
<i>Example Pricing (as of May 1, 2002)</i>	<p>Multiple plans:²¹</p> <p>Flat rate – unlimited usage, monthly fee \$144</p> <p>Base – monthly fee \$27, usage fee 24 cents per minute</p> <p>24 hour – User card with predefined user name and password, works for 24 hours from time of activation, \$9</p>	<p>Multiple plans:</p> <p>Unlimited Local – monthly fee \$29.99</p> <p>Unlimited National – monthly fee \$49.99</p> <p>Prepay 120 – 120 nationwide minutes @ \$20</p> <p>Prepay 300 – 300 nationwide minutes @ \$50</p> <p>Pay-As-You-Go - \$2.99 for 15 minutes, additional usage \$0.25/minute</p>	<p>Multiple plans:</p> <p>Boingo Pro – monthly fee \$24.95 for 10 Connect Days (24 hour periods), additional Connect Days \$4.95</p> <p>Boingo Unlimited – monthly fee \$74.95</p> <p>Boingo As-You-Go – \$ 7.95 per connect day</p>

A key WLAN player to watch in the coming months is Deutsche Telekom. VoiceStream Wireless Corp., which was acquired by Deutsche Telekom, itself acquired the MobileStar Network, a public WLAN (802.11b) pioneer. Prior to its closure in 2001, MobileStar had established numerous WLAN hot spots throughout the USA but is best known for its partnership with Starbucks Coffee to deploy WLANs in their coffee shops. The failure of MobileStar is often used as a real-world example of why the public WLAN service business model cannot succeed. But the truth may be that MobileStar was simply ahead of its time. In trying to achieve national coverage, MobileStar made considerable investments at a time when WiFi penetration had not yet reached a critical mass. There were too few potential users.

Now, Deutsche Telekom is working to integrate the Voicestream and MobileStar properties and will phase out the MobileStar and Voicestream brand names. The services of the newly combined companies will be re-introduced under the “T-Mobile International”²²

²¹ “Implementing a Public Wireless LAN Solution,” UMTS Forum presentation, London, Carlo Cassisa, March 2002

²² Founded in December 1999, T-Mobile International is a holding company for Deutsche Telekom's international (non-Germany-based) companies.

brand name by the end of 2002. This will make Deutsche Telekom one of the first service providers to offer WLAN services (using license exempt spectrum) and cellular services (using licensed spectrum) at the national level.

Telenor Mobil recently announced efforts to enhance the integration of GPRS/WLAN services.²³ BT²⁴ and NTT²⁵ have also recently announced major WLAN (802.11b and 802.11a) deployment plans.

In general, incumbent mobile service providers bring the following critical capabilities to the WLAN "game":

- Billing and customer care systems infrastructure and expertise
- Broader portfolio of wireless services (e.g. voice and data, true mobility)
- Public network operations experience
- Relationships with end users
- Roaming relationships
- Established brand name
- Established sales and distribution resources.

However, the market value of these assets for incumbent mobile service providers may decline as the efforts of Pass-One and others begin to make progress.

For most users, WLAN usage will only be a small fraction of their overall wireless data services usage. Therefore, a fully integrated voice/data/WLAN service offering will likely be more attractive than a "stand-alone" WLAN service. For example, Performance Technologies and Transat Technologies have developed a carrier-grade solution, MicroLegend, that allows GSM subscribers with WiFi-equipped devices, to connect to a WLAN and have authentication, authorisation and billing handled by their regular GSM account.²⁶ Nokia's Operator Wireless LAN technology provides a similar capability.²⁷

²³ "Telenor Mobil and Eterra sign WLAN agreement," Telenor press release, April 22, 2002

²⁴ "BT to offer WLAN, corporate mobile," Total Telecom, Anne Young, April 10, 2002

²⁵ "NTT Com to Launch Hotspot WLAN for Internet Access," NTT press release, April 25, 2002

²⁶ "MicroLegend® GSM Roaming Platform: WLAN and GSM Networks Integration Application," Performance Technologies web site, April 2002

²⁷ "Sonera and Nokia conduct the first Wireless LAN roaming using GSM technology," Nokia press release, October 17, 2001

Additionally, login and billing commonality between multiple hot spot operators will enhance end-user adoption. Incumbent operators are in a good position to make that happen (a kind of “credit card” strategy – “Visa accepted here” as opposed to a proprietary department store card). But the need to move quickly exists as players like Pass-One, GRIC Communications, and Boingo move to fill the void.

Finally, the case of MobileStar also provides valuable insight into the possible motivations of some public WLAN service providers. One can argue that the value of MobileStar to VoiceStream was not the estimated 11,000 MobileStar subscribers but the quantity and brand value of MobileStar’s hot spot locations. As the public WLAN market grows, the acquisition potential of established hot spot operators grows. To reach scale and broaden scope of coverage, “smaller” WLAN providers will likely be acquired by “larger” WLAN service providers or by non-WLAN service companies. The market may follow a consolidation path similar to that experienced by the wired Internet.

The net result is that while chances for profitability during this initial market growth phase may be slim, “some” public WLAN services companies may instead be focused on increasing their future acquisition candidate attractiveness.

THE MARKET FOR WIRELESS LAN

The addressable market for business use of public WLAN consists of mobile workers whose "portable" business activities can be conducted in hot spot locations.

The potential market for WLAN includes private and public environments, business and consumer segments, equipment and service sales for applications ranging from entertainment to corporate intranet. While recognising the potential for all these market segments, entertainment in particular, this report specifically focuses on the area of greatest current industry activity – business use of public WLAN hot spots. This section will describe the larger addressable market for business public WLAN users, define the most likely target segments within that addressable market, and provide

forecast estimates of public WLAN market size. Table 6 shows the various components that can be included in a market forecast, with the shaded areas indicating the focus of this report.

Table 6. Potential market segments comprising WLAN and the focus of this report.

WLAN Market Segments		Consumer	Business
Equipment Sales	Laptops, PDAs, Handsets	√	√
	Access Points	√	√
Service Revenue	Public WLAN Hot spots	√	√
	Private "in-building" networking	√	√
User Applications	Entertainment	√	
	Internet Access	√	√
	Intranet / Extranet Access		√

Source: UMTS Forum, May 2002.

The maturity of the 802.11 technology is now such that 802.11 devices are routinely shipped on new laptops and are widely available for under \$100. Consequently almost anyone who owns a laptop, or a WLAN-enabled PDA or a WLAN-enabled 3G handset is considered a potential user of WLAN services. However, the addressable market presented in this section is considerably less than this number. Additionally, as discussed in the previous section, public WLAN is ideally suited to a nomadic environment where communications needs are driven by specific events such as a

business trip rather than being spontaneous. Keeping these points in mind, we have segmented the market in terms of the communications needs of business users. The addressable market for public WLAN consists of data traffic coming from wireless workers:

- Including full-time and part-time teleworkers and remote workers, business travellers and other workers that must frequently work away from their main place of business;²⁸
- Who have mobile communications needs that are “portable and event driven” than truly “mobile”;
- Whose business activities can be conducted from hot spot locations such as hotels, airports, conference centres and restaurants;
- Who are located in developed countries or in developing countries with high mobile growth.²⁹
- Who need to exchange amounts of data when conducting business activity outside of their main place of business.

Occupation provides some insight into how much of the mobile workforce has needs that are “portable” rather than “mobile”. For example, mobile executives may travel frequently, and spend time in public locations such as airports and hotels where public WLAN hot spots can be located. Their communications needs are driven by specific events (e.g. need to visit a remote site) are less frequent than those of other travellers (perhaps several times per week or month), but for longer periods of time (e.g. an hour or two in each session). Their needs are more portable in that they conduct more intensive work in different locations, but are fairly stationary while conducting work.

On the other hand, mobile workers such as field sales, technical and engineering service workers more often work out of their homes or vehicles, or conduct their work activities in local, non-public areas (e.g. customer sites) and are therefore less able to use public WLAN hot spots. Field sales and service communications applications can be characterised as more frequent (perhaps

²⁸ Definitions adopted from ECaTT (Electronic Commerce and Telework Trends) “Population Survey”, June 2000 and “Benchmarking Progress on New Ways of Working and New Forms of Business across Europe”, August 2000. ECaTT is funded by the European Commission.

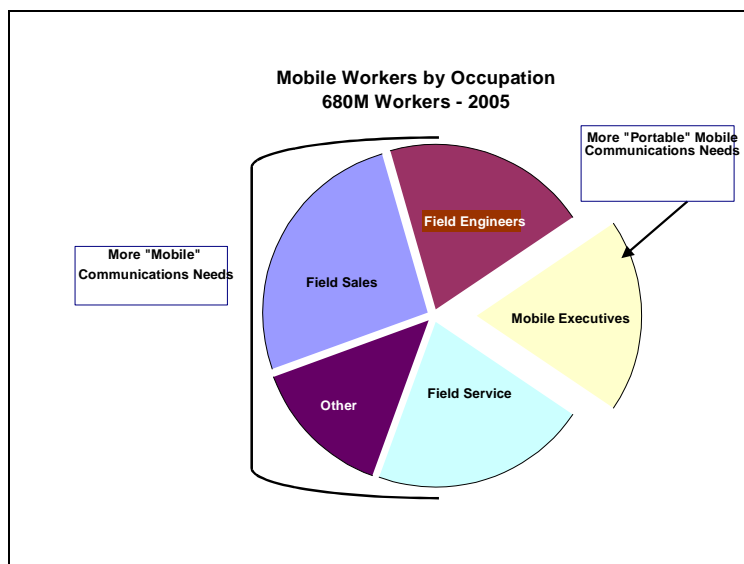
²⁹ Public WLAN operators are currently focused on developed countries such as the USA and Western Europe, but will soon include China and other emerging economies. The potential certainly exists for developing and emerging economies to use WLAN to increase Internet penetration via “Internet Cafés” and other public areas, but the lack of current industry activity in these areas makes their inclusion too speculative to include in this analysis.

several times daily) at many different locations, and are therefore considered more “mobile and spontaneous” rather than “portable”.

Figure 7 shows the estimated occupational breakdown of mobile workers and illustrates those occupations where communication needs are more likely to be “nomadic” rather than “mobile”.

Figure 7. Mobile vs. portable communications needs by occupation.

Source: UMTS Forum and
Telecompetition, Inc., May 2002

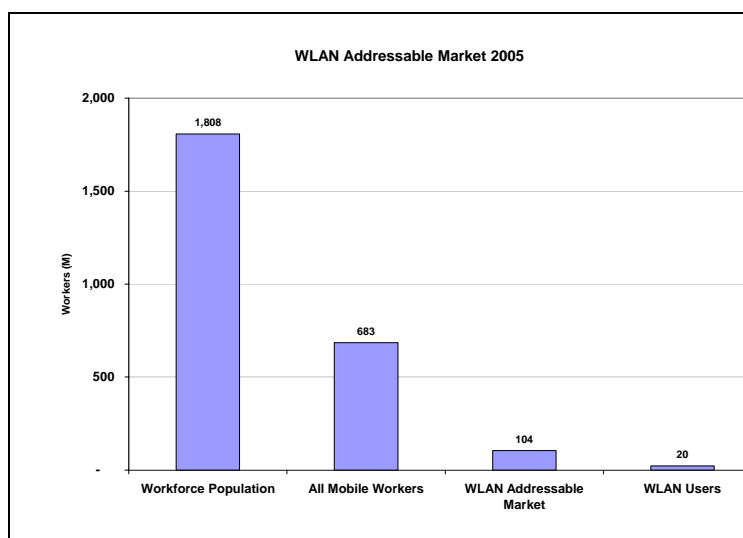


These categories are, of course, not mutually exclusive and mobile executives may have needs for mobile data communications outside hot spot areas just as a field sales representative may have out-of-town travel occasionally or stop at a public WLAN coffee house to download transactions at the end of the day.

Using our definition of the addressable market and analysis of the occupational profile of workforce population, our estimate of the business user base for public WLAN is shown in Figure 8.

Figure 8. Representation of the total workforce population to public WLAN users: 2005.

Source: UMTS Forum and Telecompetition, Inc. May 2002.



As shown in Figure 8, by 2005, approximately 680 million or 40% of workers can be expected to be at least occasionally mobile. Within this group of workers, about 104 million are frequently mobile and, therefore, comprise the addressable market for public WLAN services.³⁰ From this group, we have estimated that 20 million are likely to frequently use public WLAN hot spots. This estimate is discussed in detail later in this report.

³⁰ ECaTT Population Survey, 2000, and Telecompetition analysis

UMTS FORUM MOBILE INTRANET/EXTRANET ACCESS FORECASTS

Before discussing the quantitative implications of WLAN on 3G, it is helpful to review the underlying assumptions in the UMTS Forum 3G service revenue forecasts.

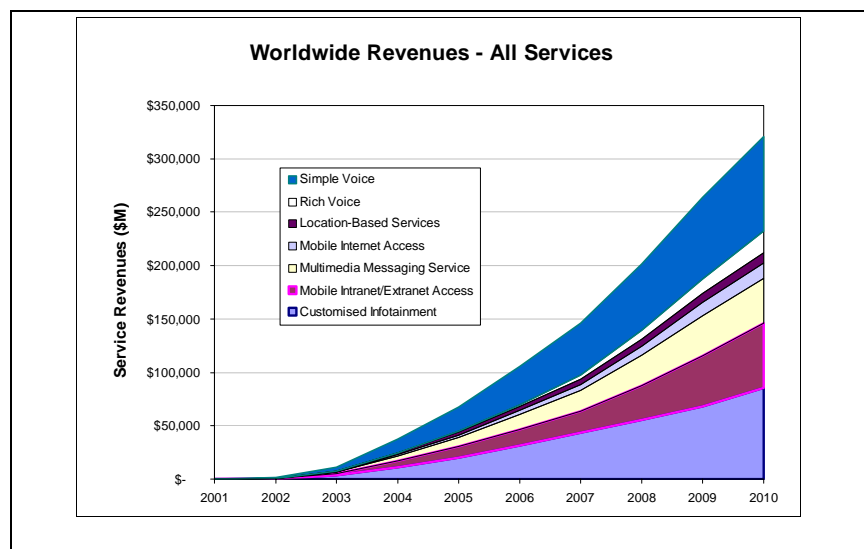
The UMTS Forum forecast for 3G Mobile Intranet/Extranet Access was based on very conservative assumptions and did not include several elements relevant to public WLAN.

The UMTS Forum has previously developed a revenue framework consisting of six service categories under which the majority of 3G mobile service demand can be forecast.³¹ Total 3G forecast service revenue is shown in Figure 9. One of these six categories, Mobile Intranet/Extranet Access, or 'Mobile Intranet', is specifically defined for mobile workers with a need to remotely access the corporate intranet or extranet as well as the public Internet, and is therefore most directly related to business use of public WLAN services.³²

Through 2005, Mobile Intranet is concentrated in the developed countries, especially the USA, but is expected to be available as a primary 3G service for businesses in all countries as they build out 3G networks.

Figure 9. Worldwide 3G service revenue: 2001 – 2010.

Source: UMTS Forum Report 17 and Telecompetition, Inc.



³¹ Details of these service categories and their associated revenue forecasts can be found in UMTS Forum Reports 9, 13, and 17 on www.ums-forum.org

³² Two other service categories, Customised Infotainment and Mobile Internet Access, also offer Internet access, but are defined for the consumer segment only.

As shown in Figure 9, Mobile Intranet contributes about 14% – almost \$10B – of the \$68B total 3G revenue in 2005. Over 90% of this \$10B comes from countries with high potential for public WLAN service. This is a relatively small portion of the total 3G service revenue, but it is significant because it is a primary service offering for business. Other business-related services such as Multimedia Messaging and Rich Voice are likely to be sold as “add-ons” to this primary business service. The forecasts for Mobile Intranet were developed using very conservative assumptions and based on demonstrated needs for mobile services in business. The forecasts did not include a number of elements that are relevant in comparisons to public WLAN service.

The Mobile Intranet forecasts included:

- Mobile access service revenues generated by mobile workers living in countries where 3G networks were built out.
- A penetration rate of 1% of the worldwide mobile subscriber base in 2005, growing to 11% by 2010.
- An average revenue per subscriber of \$31 per month in 2002, declining to \$28 in 2005, and \$20 in 2010.

The Mobile Intranet forecasts did not include:

- Mobile data service revenues from 2G/2.5G users, or service revenues from technologies not classified as 3G at the time of the forecasts, such as 1xRTT / 1X EVDO.³³
- Any value added services provided to end users or other service providers.
- Business use of mobile data by non-mobile workers.³⁴

Because of the conservative methodology, the narrow definition of “3G” used in the UMTS Forum forecasts, and the distinctive segments and needs addressed by public WLAN, we believe that most if not all of the potential WLAN service revenue is additive to the market demand forecast by the UMTS Forum for Mobile Intranet. This will be described in more detail in the next section.

³³ The UMTS Forum forecasts do not include any mobile data revenue from 1X technology. Therefore, in countries such as the USA and Korea where 1xRTT technology is commonly viewed as “3G”, some may view the UMTS Forum 3G forecasts as understating the revenue opportunity.

³⁴ For example, workers (not previously considered “mobile workers”) who can now choose to access the Internet for business purposes at a coffee shop in the public WLAN zone near their office would not have been considered part of the subscriber base for 3G Mobile Intranet in the UMTS Forum forecasts.

THE IMPACT OF WLAN ON 3G SERVICE FORECASTS

While both WLAN and 3G promise high data rate Internet access, the technologies address different segments of the mobile workforce

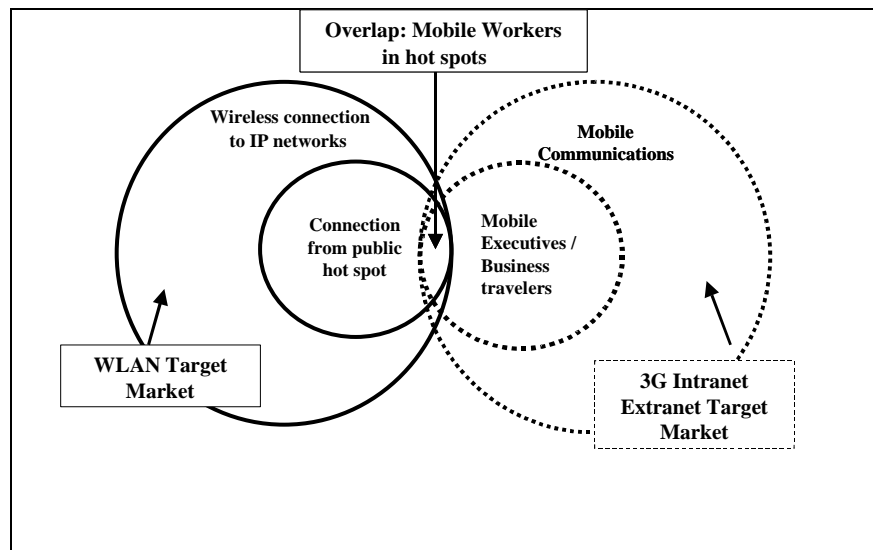
As public WLAN and 3G address different segments and different business users' need for "wireless access", public WLAN revenues will add \$2.8 billion to the market size opportunity in 2005.

population and their needs for "unwired access". As discussed earlier, WLAN is most useful for high data rate, nomadic applications, but is only accessible from designated hot spots and user has to be essentially stationary while using the service. 3G, on the other hand, delivers lower data rates, but is accessible from anywhere where 3G networks are deployed and user can use the service while moving. Therefore, we do not consider the two technologies as direct substitutes for each other. While there will be some overlap, the two technologies

to a large extent target different types of business applications and traffics. This illustrated in Figure 10.

Figure 10. Segment focus comparison – WLAN and 3G.

Source: UMTS Forum, May 2002.



Because of the conservative methodology used and because WLAN hot spots meet different user needs and activities (i.e. event and location driven rather than spontaneous and "always available") we believe that most, if not all, of the potential revenue generated through use of public WLAN hot spots is additive to the 3G Mobile Intranet revenue forecast in UMTS Forum Report 17. Table 11 shows our estimate of the market size for business use of public WLAN and the total market opportunity of 3G Mobile Intranet plus WLAN in the business segment. The very low numbers in 2002 reflect the small number of available hot spots and that only a small number of potential users have added WLAN capability into their

laptops or PDAs. A four-fold increase in hot spot availability is anticipated in 2003. This fact combined with a fast growing base of WiFi devices results in the 4.8 million users (primarily in Western Europe and US) in 2003.

Table 11.
Forecasted
worldwide public
WLAN market
size.

Source: UMTS
Forum and
Telecompetition,
Inc., May 2002

Units (millions) and Revenue (\$billions)³⁵	2002	2003	2004	2005
WLAN Total Public Users (millions) ³⁶	0.7	4.8	11.9	20.5
WLAN Users (who are also 3G Subscribers) using WLAN for services also supported by 3G (millions)	0.0	0.3	1.7	5.3
WLAN Users (who are not 3G Subscribers) using WLAN for services complementing 3G (millions)	0.6	4.6	10.2	15.2
Total WLAN Market (\$billions) ³⁷	\$0.15	\$0.9	\$1.9	\$2.8
Worldwide 3G Mobile Intranet Extranet Revenue (\$billions)	\$0.2	\$1.9	\$5.8	\$9.8
Total Market Opportunity (\$billions)	\$0.3	\$2.8	\$7.8	\$12.6

In 2005, worldwide operator-retained revenue for Mobile Intranet Extranet is forecast to be \$9.8B.³⁸ In those countries included in our analysis, we have estimated 20.5 million business users of public WLAN, of which 5.3 million are likely to use WLAN to access services that are also supported by 3G i.e. to be both WLAN users and 3G subscribers. These 20.5 million users are expected to generate \$2.8 billion in WLAN service revenue by 2005, for a combined market opportunity of over \$12 billion.

There is however some potential risk to 3G operators that choose not to participate in this market. While WLAN services will not be

³⁵ Numbers may not sum exactly due to rounding.

³⁶ WLAN targeted countries/territories only, which includes: Australia, Brazil, China, Hong Kong, India, Japan, S. Korea, Singapore, Taiwan, EU 15, USA.

³⁷ WLAN revenue per subscriber is based on current minimum WLAN subscription prices of \$25 per month, declining 15% annually. The average revenue per user also considers that WLAN hot spots will not be available to all users in 2005, that not all users will have WLAN enabled devices, and that many users will not subscribe for an entire year of full-time usage.

³⁸ Over 90% (\$8.9B) of the \$9.8B 3G Mobile Intranet revenues will be generated by countries included in the WLAN targeted countries for this report.

substitutes for 3G services, they can become an additional source of competitive differentiation.

WLAN service providers are fulfilling much-needed niche for wireless Internet access and they are able to offer it on technology that is available today. Additionally, the initial WLAN business users are foreseen to be early adopters of wireless Internet services and likely to influence adoption of these services by other users.]

We believe that most public WLAN users will continue to keep their mobile phones.

However, a positive customer experience in a WLAN hot spot may motivate some of them to use the 2.5G/3G mobile data services only outside hot spots and this could then slightly reduce the usage of 2.5G/3G mobile data services. Also, positive WLAN customer experience could delay upgrading from 2G/2.5G to 3G.

Research has shown that business users are willing to carry multiple devices. As such, many business users are likely to continue using their 3G handset for voice and integrated voice/data services and use their laptops/PDAs for public WLAN services. Table 12 illustrates possible revenue-at-risk scenarios for the loss of 3G traffic transferred to WLAN. While no one can say precisely how much traffic might be lost, if any, we evaluated two scenarios assuming 10% and 20% traffic loss from the small segment of 5.3 million users using WLAN for services that are also supported by 3G (i.e. 3G/WLAN subscribers).³⁹

³⁹ It is assumed that mobile business users will value the greater coverage of 3G services enough to keep their mobile Intranet Extranet Access service even when public WLANs are available to them. For example, at a recent Gartner Wireless Conference in Chicago (March 2002), less than 10% of those surveyed stated that wireless Internet and data services was the most important factor in choosing a mobile service provider, while over 75% of those surveyed said that national or international coverage was the most important criteria.

Table 12.
 Possible 3G
 business
 revenues-at-
 risk scenarios

Assumption	2002	2003	2004	2005	Cumulative 2002-2010 (% of total 3G rev.)
Business Users using WLAN for services complementing 3G (i.e. WLAN only users) (millions)	0.6	4.6	10.2	15.2	
Business Users using WLAN for services that are also supported by 3G (i.e. 3G/ WLAN users) (millions)	0.0	0.3	1.7	5.3	
Total 3G Business Revenue ⁴⁰ (\$ billions)	--	\$0.1	\$0.7	\$2.2	4%
Possible Scenarios – 3G Operator Revenue at Risk (\$billion)					
What if 10% of 3G/WLAN Users Dropped 3G traffic	–	\$0.01	\$0.1	\$0.2	0.4%
What if 20% of 3G/WLAN Users Dropped 3G traffic	--	\$0.02	\$0.2	\$0.4	0.8%

Source: UMTS Forum and Telecompetition, Inc., May 2002

These 5.3 million 3G/WLAN subscribers generate about \$2.2 billion of all forecast 3G revenues for business subscribers in 2005. These 5.3 million 3G/WLAN generate cumulative revenue through 2010 of \$47 billion (4% of the total cumulative forecasted 3G revenue of \$1.15 trillion). In the higher illustrative scenario, if 20% of the 3G/WLAN users changed their 3G service provider or discontinued service, this would represent a loss of \$450 million in 2005, and a cumulative loss of \$9.3 billion through 2010, or less than 1% of the total cumulative 3G revenue.

⁴⁰ Includes revenue from Business MMS, Location-Based Services, Mobile Intranet Extranet Access, Simple Voice and Rich Voice. In 2005, the \$2.7B total 3G business revenue includes \$1.4B for Mobile Intranet Extranet Access.

THE IMPACT OF PUBLIC WLAN ON THE MOBILE DATA MARKET

We believe WLAN also presents additional benefits to 3G operators that extend beyond the \$2.8 billion revenue in Table 11.

The upside opportunity for 3G operators that choose to participate in the WLAN market includes the following considerations:

- Participation in the WLAN market provides 3G operators an opportunity to develop the content partnerships and customer relationships required to serve the business market.
- The public WLAN venue may provide 3G operators with an opportunity to increase their competitive position with mobile data users that are not currently part of their subscriber base.
- 3G operators may provide back-office services to WLAN providers including, for example, roaming, billing, and customer service functions.

On the downside, the following factors need to be considered for the business plan:

- Wide area coverage is not economically feasible, may be difficult to achieve and may not work in all environments.
- The cost of backhaul is an important consideration.
- QoS cannot generally be guaranteed.
- The impact of the emerging Bluetooth technology in the 2.4 GHz band. Therefore the 5GHz bands should be identified for WLANs at WRC-2003.

The public WLAN market presents a market opportunity to 3G operators with advantages and disadvantages that should not be ignored. While the direct threat in terms of revenue loss may not be that great, the strategic implications of not participating in any way may be greater than any direct revenue impact. WLAN users of hot spots are more likely to be better educated with managerial responsibility and have higher income and professional qualifications than mobile users in general.⁴¹ This is a customer segment that an operator should nurture and protect from competitive inroads.

⁴¹ Based on demographic profile of teleworkers and mobile workers in "Telework Data Report, Population Survey", ECaTT.

WiFi or 802.11 has been called a “disruptive technology” by some analysts because it provides an immediate opportunity for new players to enter the wireless market with a seemingly lower cost and higher performance niche solution to the pressing need for wireless Internet access. Incumbent mobile operators should evaluate downside risk in terms of the competitive position it enables in a larger communications space that includes fixed (wireline), mobile, and Internet players and the total revenue loss that might include.

CONCLUSIONS

*...WLAN is simply
another source of
UMTS/3G traffic*

UMTS/3G and Wireless LAN are complementary rather than competitive technologies. We believe that WLAN will stimulate the overall mobile data services market, to the benefit of all players.

Operators have been assessing the opportunity for public WLANs for some time. Key elements of this market are now approaching critical mass. These elements include device cost, widespread acceptance and availability and applications for both consumer and business users.

We have explored the relationship between public WLAN and 3G services including the opportunity for 3G operators. While there are some potential applications of WLAN in the consumer market, we have focused here on the business market and the impact on the forecast 3G service revenue for Mobile Intranet. Overall, we believe the following:

- Public WLAN is a significant industry development because it:
 - Is available today,
 - Meets a specific user need,
 - Equipment are available today, with reasonable cost,
 - Networks are relatively easy to deploy.
- Public WLAN gives an opportunity to expand both overall market size and competitive position for data services, as it
 - Will add \$2.8 billion in 2005 to the market for 3G mobile data,
 - Introduces new, event-driven services to additional market segments,
 - Is not a substitute for 3G Mobile Intranet nor any other 3G mobile service, as WLAN-mobility is limited
- Public WLAN service may be an important source of competitive differentiation for 3G operators.

- The direct impact on forecast 3G Mobile Intranet revenues is likely to be less than 1% of total 3G revenues in 2005, but
- Public WLAN will be used by almost 20% of 3G business users in 2005 – a significant portion of the user base.

In conclusion, WLAN gives an opportunity to expand both overall market size and competitive position for wireless data services. WLAN can become a useful component of global or national mobile operator's service portfolio since WLAN is simply just another source of UMTS/3G traffic providing wireless access method to IP.

This analysis was prepared for the UMTS Forum by Telecompetition, Inc., which can be contacted at www.telecompetition.com.