

# **The Impact of Emerging WLANs on Incumbent Cellular Service Providers in the U.S.**

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A capstone paper submitted as partial fulfillment of the requirements for the degree of Masters in Interdisciplinary Telecommunications at the University of Colorado, Boulder, May 9, 2002. Project directed by Prof. Timothy X Brown.

This paper examines the impact of emerging Wireless Local Area Networks on incumbent cellular operators in the United States. It focuses on the incumbent service providers industry as a whole and does not address other operators in the data services arena.

## **1 Introduction**

Third generation wireless and Wireless Local Area Networks are the two main emerging technologies in the wireless broadband access landscape. Third generation or "3G," combines two powerful innovations: wireless communications and the Internet [1]. 3G is a radio communications technology that supports voice as well as provides high-speed mobile access to Internet-based services. Wireless Local Area Network (WLAN) is the second technology that is currently exploding in the wireless market arena, both on a corporate and a consumer-services front. A WLAN is essentially a network that provides high-speed wireless access in limited coverage areas called hotspots, such as airports, corporate offices, coffee shops, and hotels [2].

While 3G deployment will not occur in the US until 2004 [3], WLAN networks have gained a strong presence in the public arena as well as the private enterprise sector [4]. WLANs could be viewed as the near-term answer for high-speed data access, therefore could be perceived as a potential threat to future 3G services [5]. This paper will demonstrate that WLANs do not pose a threat to 3G only if incumbent service providers act now and enter the WLAN arena. Incumbents can turn this potential threat created by WLANs into a viable business case by embracing the technology. The WLAN market opportunity could bring in an additional revenue stream for incumbents, and potentially spur the adoption of 3G applications in the future.

This paper begins by comparing WLAN and 3G technologies and investigates their respective applications and markets. From there, it will be shown that a standalone WLAN market exists, irrespective of 3G, and that it impacts cellular operators' data revenues. The paper then examines the strategic positioning of cellular operators and addresses how they could enter this WLAN market based on technical and financial analysis.

## **2 Analysis of 3G and WLAN Technologies**

### **2.1 Technical Comparison**

Globally harmonized standards for 3G mobile communication systems known as IMT-2000 are defined by the ITU. In this paper, a 3G wireless network is defined as offering higher speed services than 2.5G based technologies (such as GPRS and 1xRTT) which can deliver actual throughput data of about 50-60kbps [6]. 3G networks will mainly be based on cdma2000 (successor of CDMA based networks) and WCDMA (GSM based networks). Based on this definition, 3G networks are currently not available. However, the evolution of 3G will be a two-

step procedure with most operators upgrading their existing networks to 2.5G and in the future to 3G [7].

IEEE has defined various WLAN standards under the 802.11 family of standards. It includes different physical and MAC layer specifications, e.g. 802.11b, 802.11a, 802.11g [5]. IEEE also has different task groups addressing issues such as quality of service (802.11TGe) and security (802.11TGj).

## 2.2 Business Considerations

### 2.2.1 WLAN Marketplace

According to the research company Analysys, more than 21 million Americans will be using public WLANs by 2007, up from 600,000 this year, in more than 40,000 hot-spots nationwide. Moreover the popularity of the service will generate over US \$3 billion dollars in

	<b>3G</b>	<b>WLAN</b>
<b>Data Rates</b>	144kbps (outdoor) up to 2Mbps (indoor). 2.5G can deliver theoretical data rates of about 171kbps with GPRS and about 144kbps with cdma1xRTT. However, the practical data rates will be about half the theoretical ones [6].	High data rates: 802.11b standard up to 11 Mbps and 802.11a up to 54 Mbps. The practical data rate is about half the theoretical data rate. [8]
<b>Security</b>	Provides a more secure environment than WLAN	Currently security provided with WEP (Wired Equivalent Privacy) security mechanism using RC4 encryption which is very insecure [9]. 802.11TGj will improve security using various mechanism like 802.1x, RADIUS, KDC, TKIP/ AES.
<b>Handoff</b>	Implemented as integral part of the specification.	Currently not implemented, however possible in the future with solutions like MobileIP or STP bridging..
<b>Cost of Network</b>	Expensive to install: 3G base station costs about \$250,000. [2]	Cheap to install: access point costs anywhere from \$1000 to \$5,000 [2]
<b>Coverage Area (per BS/ AP)</b>	~5 mile radius [8]	100-300 ft. radius [8]
<b>Spectrum</b>	Licensed [2]	Unlicensed (2.4GHz and 5GHz) [2]
<b>Supported Media</b>	Voice and Data	Primarily data. VoIP in future
<b>Connectivity</b>	Seamless (anytime, anywhere)	Interrupted; only possible in limited locations (i.e. hotspots)

**Table 2-1: Comparison of the two technologies WLAN and 3G**

service revenues by 2005. Analysys also claims that WLAN services will account for 25 percent of mobile data service revenues by 2007 [10].

Current operators in the WLAN market are small companies who have adopted different business models. The hotspot service originators, Wayport and MobileStar, for instance, built their own networks, acted as independent entities and stressed a subscription model [11]. On the other hand, new entrants such as Boingo Wireless and Wi-Fi Metro rely on the franchising model

to get hotspot coverage [12]. Such operators are currently acting as aggregators forming partnerships with other WLAN network providers and offer subscribers the choice of either a daily connection charge or a monthly subscription fee [13]. Both early entrants and new WLAN operators tried to launch their services in heavily trafficked public places such as airports, convention centers, and hotels. Early entrants initially targeted business customers but later shifted their focus to a more casual approach, deploying a massive presence in such locations as Starbucks coffee shops [14]. This resulted in them targeting multiple customer segments and, as a consequence, their marketing focus was diffused. Both early entrants and new operators were unable to acquire a sufficient customer base due to limited brand recognition and insufficient marketing efforts to promote their services.

Early entrants' business models proved to be unsuccessful in that they incurred very high deployment costs, and then shared 50% of their revenues with location partners [12]. New entrants did not incur these expensive build out costs due to their franchise model, allowing their business model to have more potential for success. However, even with the change in business models, the value proposition in terms of services provided was unsuccessful due to low hotspot build outs and no guaranteed quality of service to customers, all at a high subscription or connection fee. The price for unlimited access averaged \$50 per month [13] or \$8 per daily connection [15].

While new operators are starting to form peering agreements for carrying each other's data (i.e. Boingo and Wayport), the process of providing a clearinghouse solution to enable roaming capabilities and common billing platform between providers is still in its infancy stages.

### **2.2.2 The 3G Marketplace**

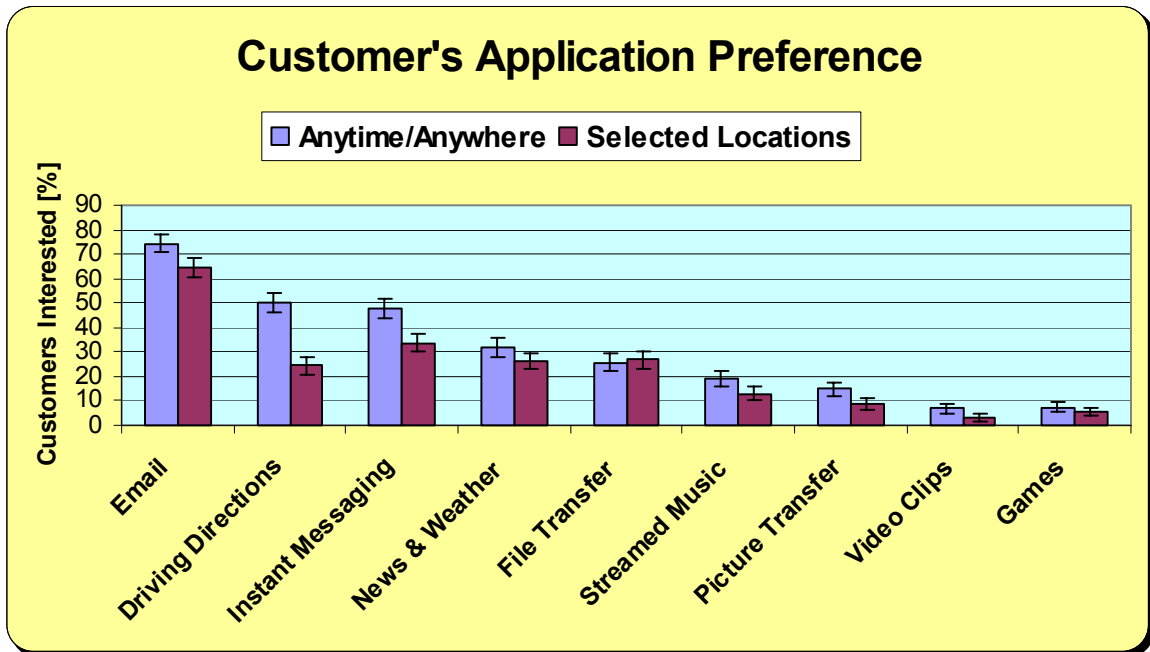
High infrastructure build out costs, unknown future demand for 3G services, and the unavailability of 3G spectrum in the US, have prompted many operators to take a precautionary approach towards 3G deployment. In order to estimate consumers' response towards high-speed Internet access, operators are currently deploying and testing responsiveness to 2.5G services which in turn could be the stepping stone for 3G [7]. Some market experts consider existing 2.5G technologies to provide adequate data rates to meet customers' needs and therefore eliminate the necessity to migrate to 3G technology [16]. However, it is the market acceptance of 2.5G services that will guide the future deployment of 3G. [17].

## **2.3 Applications**

3G networks will be designed to support both voice and data services, whereas WLANs are currently optimized for data applications. However, research for supporting real-time services like video and voice over IP (VoIP) is being extensively conducted and it is expected that WLANs in the future will be able to support voice. VoIP will mature in the next three years and operators are currently investigating this disruptive technology and looking at opportunities of integrating it into their data networks [5].

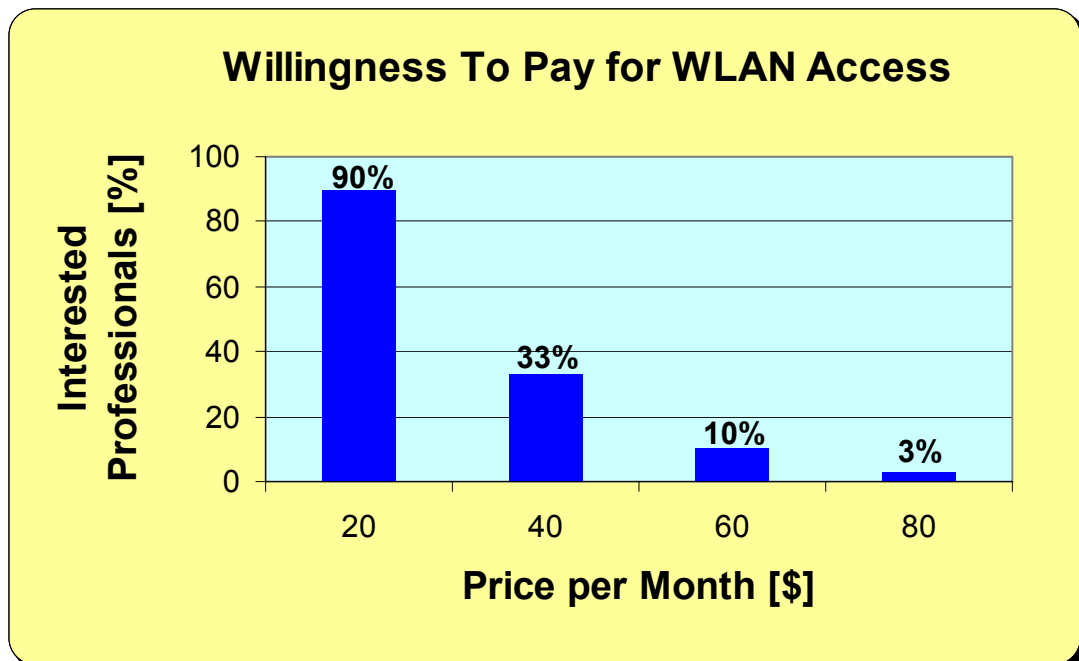
In order to estimate the demand for wireless data services, we conducted a survey to identify customer preferences for certain applications and their willingness to pay (see Appendix B for the questionnaire). The survey was targeted at individuals across all income levels. About half of the 160 respondents were between 21 and 30 years old and one third were students. The respondents were qualified to answer application related questions since 83% had a cellphone and 60% had both cellphone and PDA or laptop.

The following chart shows customer's preference for different applications and their respective location sensitivity.



*Figure 2-1: Ranking of applications based on customer's preference*

The graph compares two different access preferences, i.e. anytime/anywhere versus selected locations, which represent 3G access and WLAN access respectively. Respondents considered email, driving directions and instant messaging services the most important applications while on the move. Video clips and games were least demanded anytime and anywhere.



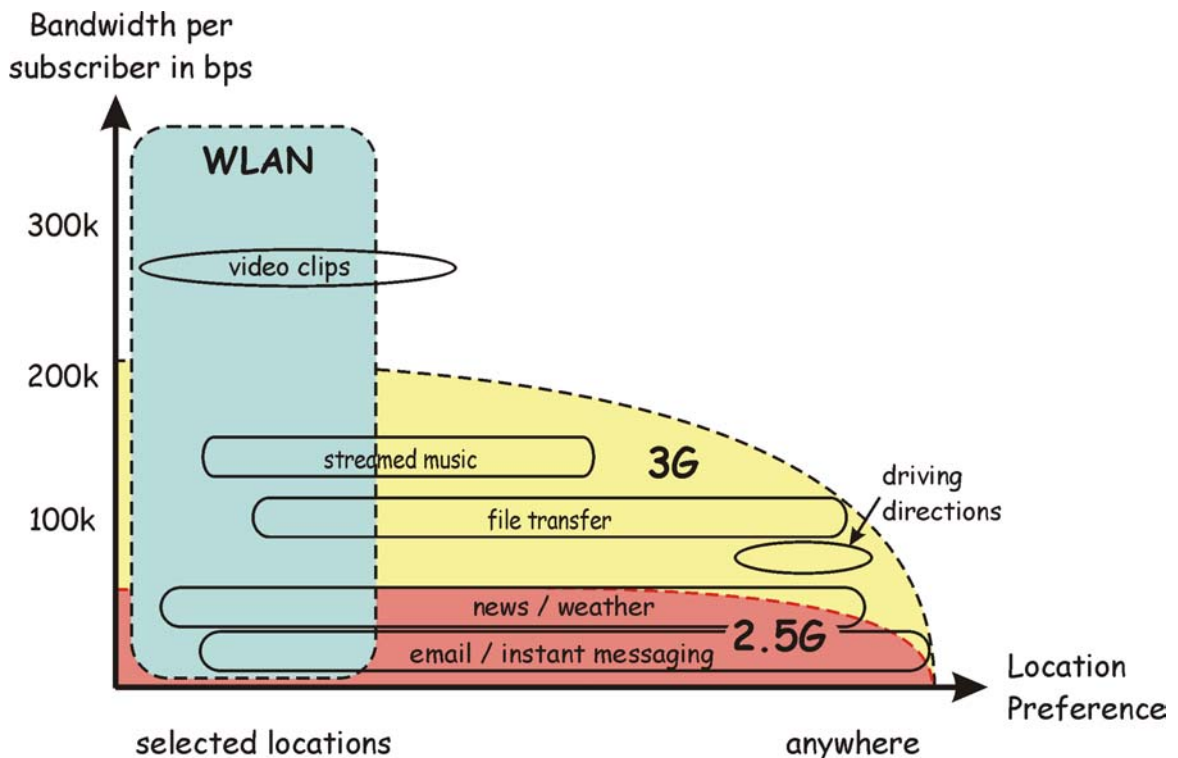
*Figure 2 - 2: Willingness to Pay for WLAN Access*

The largest difference in demand between the two location alternatives was indicated for driving directions, instant messaging and streamed music, making these applications especially attractive for mobile devices like advanced cell phones in a 3G environment. While all applications were most valued anytime/anywhere, respondents were still highly interested in these applications in limited locations.

Not only were respondents interested in applications in selected locations, but also were they willing to pay for WLAN access as shown in figure 2 – 2.

Figure 2-3 combines the different data rate requirements for each of these applications with a summary of the survey results on the respective location sensitivity of the sample population. The dotted lines delimit areas where 2.5G, 3G or WLAN service provisioning is possible, depending on the technical specification of each of the standards.

Since 3G and WLAN offer different data rate capabilities, certain applications like video clips will not be suitable for 3G when the bandwidth is shared among users. Moreover, customer preferences make certain applications such as driving directions more convenient for 3G networks. Although some applications can be technically supported by both 3G and WLAN, consumer preferences determine what network is best positioned to provide the respective applications. The fact that 3G and WLAN support different types of applications based on technological capabilities and customer preference leads to the conclusion that they serve different niche market segments. However, the interest and willingness to pay for applications offered via WLANs combined with the current unavailability of 3G services indicate the existence of a WLAN market.



*Figure 2 - 3: Application requirements compared to provisioning alternatives*

## **2.4 Regulatory Implications**

In the United States, the FCC has so far decided to adopt a laissez-faire policy upon WLANs unlike 3G, an approach that should spur competition in the industry as well as the massive adoption of WLAN technologies [18]. The key differentiations between 3G and WLANs are the following: 3G is a licensed spectrum which is expected to be allocated in 2004 [3] in which cellular operators are required to invest in.

It is costly and forces cellular operators to conform to certain regulations. WLANs operate in the free, unlicensed, and unregulated spectrum (2.4GHz or 5GHz) resulting in low barriers to entry, but hindering operators from providing guaranteed quality of service due to interference issues beyond their control. WLANs do not assure availability or reliability, and they are not required to. According to Dale Hatfield, former Chief of the Engineering Office at the FCC, it is highly unlikely that the spectrum used for WLAN services will be regulated in the United States at any point in time [19].

## **3 The Impact of Wireless LANs**

### **3.1 Cellular Operator's Proposed WLAN Market Entry**

As shown in section two, there is a market for offering WLAN services. Current WLAN operators in this market don't have an appealing customer value proposition nor a sufficient customer base to dominate the market. However, with technology advancements in WLAN and growing cooperation in the form of roaming agreements, WLAN operators could eventually capture the market, especially the attractive business customer segment. Universally available WLAN hotspots in highly frequented areas combined with a mature wireless Voice over IP technology and hybrid 3G/WLAN handsets could pose a threat to cellular operator's data and voice revenues. However, cellular operators could preclude this competition and bring in an additional revenue stream by entering the WLAN market. This strategy can also spur the adoption of future 3G wireless services. There are a number of factors that make a market entry attractive.

First, current cellular operators have a large installed customer base and have a good track record of serving these customers. Customers are more or less content with the current services and trust in cellular operators' execution capability. This constitutes a viable channel for selling new services such as WLAN access. It has been historically shown that establishing a sales channel is time consuming and the difficulty of doing so is generally underestimated [20].

Second, the inventor or early deployer of a technology usually underestimates the time for a new technology to become profitable [20]. During this time, no revenues are generated and a company needs lots of funds in order to stay in business. Cellular operators have a diversified product portfolio and can bridge this period, unlike pure WLAN operators.

Third, the existing product portfolios of incumbent operators allow for economies of scope when introducing new services. Partnerships that were established for current products can be leveraged to develop new contacts necessary for WLAN offerings. In addition, cellular operators already have a customer service infrastructure, such as billing, call centers, installation and maintenance, which can be leveraged to offer a pleasant customer experience.

Customers prefer a provider with a variety of service offerings over separate providers for each of the demanded service. Thus a bundling of WLAN services with cellular offerings can also greatly improve customer satisfaction.

Fourth, cellular operators have raised expectations beyond voice services, and by adopting WLAN technology they can deliver on the promise of high speed data access, reduce the risk of future regulatory and technological uncertainties, and can provide services sooner.

Recent declining prices in the WLAN equipment market as well as the trend of cafés to offer WLAN access as a complimentary offering for free [14], suggest that the pure WLAN access will soon become a commodity. Furthermore, third party research as well as survey results show that only a small percentage of private/residential users are currently willing to pay for WLAN access [13]. A market entry of cellular operators should therefore aim at charging business customers for value-added services provided at typical public business areas, like airports, convention centers and hotel chains. Distinctive features of an appealing service offering would include guaranteed high security, network management for reduced interference, guaranteed data throughput rates, customer support, and seamless connectivity anytime, anywhere via a 3G network in the future.

Moreover, with the introduction of hybrid handsets, vertical handoff mechanisms between heterogeneous networks [21] and advanced security mechanisms in WLAN, the integration of WLANs with future 3G networks is feasible. In fact, the research community is already conducting various studies to integrate various heterogeneous networks like cellular, WLAN, and HomeRF which will be known as 4G networks [22]. Integrated WLAN and 3G networks poses various technical challenges but can also provide some opportunities including advanced security mechanisms and improved in-building coverage.

### 3.2 Financial Considerations

Based on current estimates and future projections of the WLAN market growth and subscriber base, the cost-benefit analysis in Appendix A shows the WLAN market to be a profitable venture for cellular operators to pursue in spite of the conservative approach taken in estimating cost and revenue projections. As the following figure shows, the cellular operators will incur losses in the first two and a half years, will breakeven in early 2004, and generate profits shortly after.

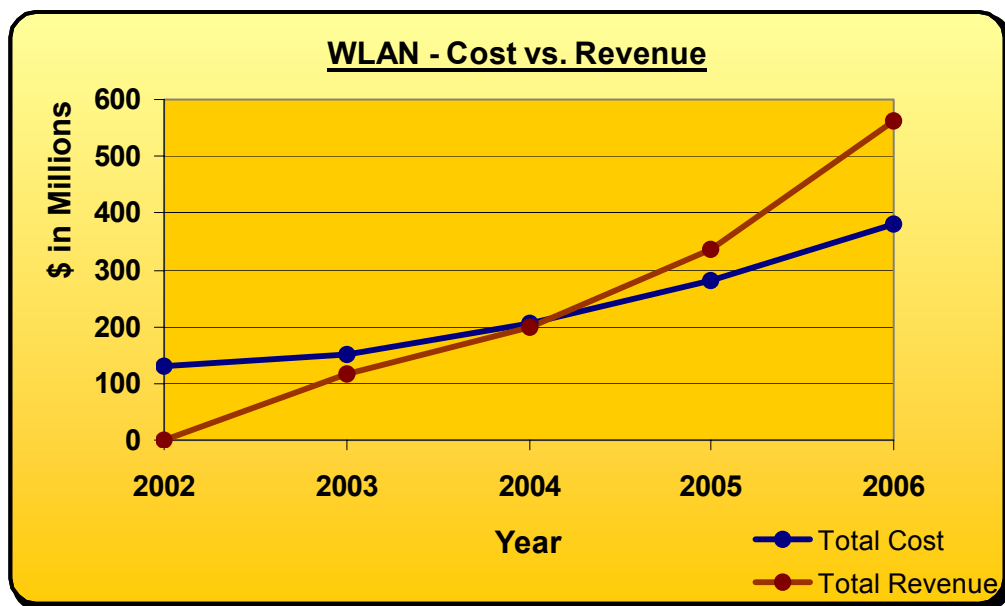


Figure 3 - 1: Cost-Benefit Analysis

Pure WLAN operators incur higher costs than cellular operators, since they don't yet have vertical relationships established, cannot leverage internal operations (e.g. marketing, legal expenditures) and face higher costs in financing their business. Furthermore, they generate a lower revenue stream due to their limited customer base and brand recognition, as well as their lack of distribution channels. Therefore one can expect that pure WLAN operators will break even later in time.

#### **4 Conclusions and Outlook**

The WLAN market provides a significant business opportunity that cellular operators should embrace. Despite taking a conservative approach, the revenue trajectory in the proposed cost-benefit analysis shows good growth in the WLAN access and services market in the near future. However, the total market size will not support the rapidly growing number of small pure WLAN providers once the dominant cellular operators enter the market. Cellular operators' fast entry into the WLAN market will enable them to capture a large segment of that market and preclude competition by leveraging their existing dominant wireless market presence. Moreover, value-added WLAN service offerings by cellular operators can increase both customer satisfaction and total usage, which in turn reduce churn rate, bring in an additional revenue stream, and potentially spur the adoption of 3G in the future.

Despite the promising future of wireless LANs provided by cellular operators, there are some developments that need further research. On the technology side, an integrated 3G/WLAN provisioning and a smooth transition from the current minute-based billing to a packet-based billing need to be examined. On the business side, emerging community networks and recently announced business models based on revenue sharing among private WLAN owners might influence the cost benefit analysis. Also a WLAN market entry of telephone companies or cable service providers who already have widely distributed infrastructure that could support WLANs is a possible scenario. A new and lucrative revenue stream could be seen in installing and maintaining enterprise-wide secure WLAN solutions and integrating a possible wireless VoIP in existing telephone infrastructure. This would save companies long-distance telephone costs as well as increase efficiency through true wireless flexibility. On the regulatory side, the implications of the allocation of 3G spectrum in the U.S. and a currently debated regulation of WLAN equipment by the FCC can change the feasibility of a WLAN service offering.

**Appendix A - Cost-Benefit Analysis**

<b>COSTS</b>	<b>Year</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Information Source and Assumptions</b>
<b>Fixed Cost</b>							
Locations Total		1000	1700	2890	4913	8352	Assuming 70% yearly growth rate
Additional Locations			700	1190	2023	3439	
*AP/Location		13	13	13	13	13	Assuming 2% are airport (100 APs per airport), 20% convention centers (20 Aps per CC), and 78% hotels (10 APs per hotel)
New AP to be installed		13000	9100	15470	26299	44708	
Total AP to be replaced		0	0	0	1000	700	Assuming the life time of AP to be three years.
Total AP installed in a year		13000	22100	37570	64869	109277	
Cost / AP		800	640	512	410	328	Assuming 20% yearly reduction in price
Total AP Cost		10.400.000	5.824.000	7.920.640	10.772.070	14.650.016	
+ Inst. Cost		20.800.000	11.648.000	15.841.280	21.544.141	29.300.031	Assuming that Installation Cost = 2*(Equipment Cost).
Total FC		31.200.000	17.472.000	23.761.920	32.316.211	43.950.047	
<b>Variable Cost</b>							
Leasing Charges/Month for Backhaul Connectivity		8000	6400	5120	4096	3277	Assuming that on an average one T3 will be required to be leased. Cost reduces at 20% year. <a href="http://www.tpeditor.com/contents/2001/galbi.htm">http://www.tpeditor.com/contents/2001/galbi.htm</a>
Net Access/Year		96000	76800	61440	49152	39322	
Net Access/Year/Loc		96.000.000	130.560.000	177.561.600	241.483.776	328.417.935	
Total Operations & Maintenance Employees		20	34	58	98	167	Assuming 1 Employee/ 50 Location
Salary/Employee		45000	45000	45000	45000	45000	
Employee Cost		900.000	1.530.000	2.601.000	4.421.700	7516890	
Incremental Marketing Expenditures		2.000.000	1.500.000	1.500.000	1.500.000	1.500.000	
Total VC		98.945.000	133.635.000	181.707.600	247.450.476	337.479.825	
<b>Total Cost/Year</b>		<b>130.145.000</b>	<b>151.107.000</b>	<b>205.469.520</b>	<b>279.766.687</b>	<b>381.429.873</b>	
<b>REVENUES</b>							
No. of Business Customer with Cellular Operators		31.000.000	35.000.000	38.000.000	41.000.000	44.000.000	US Wireless Market Forecast and Analysis ( 2000-2005), Charul Vyas, IDC, 2001.
Company WLAN adopt. rate		20%	26%	34%	44%	57%	Assuming 30% growth rate
Percentage Captured		2,00%	3,60%	5,40%	8,10%	12,15%	Assuming 80% increase in first year, 50% in the remaining years.
Total Subscribers		124.000	327.600	693.576	1.459.247	3.053.742	
ARPU/Month		0	30	24	19,2	15,36	Initial Price based on Survey Data. Assume reduction of 20%
ARPU/Year		0	360	288	230,4	184,32	
<b>Total Revenue/Year</b>		<b>0</b>	<b>117.936.000</b>	<b>199.749.888</b>	<b>336.210.601</b>	<b>562.865.748</b>	
<b>Profit</b>		<b>-130.145.000</b>	<b>-33.171.000</b>	<b>-5.719.632</b>	<b>56.443.914</b>	<b>181.435.875</b>	
*Note AP = Access Point							

**Appendix B – Questionnaire Used for Conducting the Survey**

**Survey – Wireless Applications**

**I. Please answer the following questions about Wireless applications**

1. Which of the following devices do you own?

- Cell phone       PDA       Laptop

2. Suppose your operator could provide you with all of the following services. Which of the following statements would be most appropriate to your situation when you are on the move? Please only tick one.

- I only need mobile voice service and don't care about Internet on the move
- I need mobile voice service and want to use Internet on my advanced cell phone or my PDA anywhere and anytime
- I need mobile voice service everywhere and I want to access the Internet with my laptop in certain locations, like airports, cafés, hotels, etc.
- I only want to be able to access the Internet with my laptop and don't care about cell phone or PDA's voice and data services in certain highly frequented public places
- I need to be always connected and need mobile voice services, as well as Internet access through my cell phone and Laptop

3. Assume you are offered the following wireless services on your advanced cell phone or PDA, how interested would you be while on the move? (Please circle one of the following options; ranking 0 for not interested to 5 highly interested)

<b>Application</b>	<b>Cell Phone/PDA (anywhere, anytime)</b>
(Mobile) Games	0 1 2 3 4 5
Email	0 1 2 3 4 5
News/Weather	0 1 2 3 4 5
Instant Messaging	0 1 2 3 4 5
Video Clips	0 1 2 3 4 5
Driving Directions	0 1 2 3 4 5
Streamed Music (mp3)	0 1 2 3 4 5
File Transfer	0 1 2 3 4 5
Picture Transfer	0 1 2 3 4 5

4. How interested would you be in a bundle of 4-5 of the above applications at the prices indicated below? (The prices below are in addition to voice subscription charges.)

If the monthly subscription fee was:

- a. \$100, I would be       Very Interested    Interested    Not interested
- b. \$80, I would be       Very Interested    Interested    Not interested
- c. \$60, I would be       Very Interested    Interested    Not interested
- d. \$40, I would be       Very Interested    Interested    Not interested

5. Now imagine you have access to the same applications, but in a number of limited locations only, such as airports, hotel lobbies, university campuses, cafés. How would your level of interest change? 0 – Not interested any more to 5 – Still very interested.

Application	Level of interest
(Mobile) Games	0 1 2 3 4 5
Email	0 1 2 3 4 5
News/Weather	0 1 2 3 4 5
Instant Messaging	0 1 2 3 4 5
Video Clips	0 1 2 3 4 5
Driving Directions	0 1 2 3 4 5
Streamed Music (mp3)	0 1 2 3 4 5
File Transfer	0 1 2 3 4 5
Picture Transfer	0 1 2 3 4 5

6. How interested would you be in a bundle of 4-5 of the above applications available nationwide at specific locations for the prices indicated below?

If the monthly subscription fee was:

- a. \$40, I would be  Very Interested  Interested  Not interested  
 b. \$30, I would be  Very Interested  Interested  Not interested  
 c. \$20, I would be  Very Interested  Interested  Not interested  
 d. \$10, I would be  Very Interested  Interested  Not interested

7. How interested would you be in accessing the Internet with your laptop in limited locations?  
 Very Interested  Interested  Not interested

8. How interested would you be in the above laptop access at the prices indicated below?

If the monthly subscription fee was...

- a. \$80, I would be  Very Interested  Interested  Not interested  
 b. \$60, I would be  Very Interested  Interested  Not interested  
 c. \$40, I would be  Very Interested  Interested  Not interested  
 d. \$20, I would be  Very Interested  Interested  Not interested

9. Any comments?.....  
 .....

**II. Please provide some information about yourself**

1. Age  15 - 20  21 - 30  31-40  41-50  over 50

2. Gender  Male  Female

3. Profession

- Student  Computer/IT  Marketing/Sales

- Engineering  Other profession: \_\_\_\_\_

- Finance/Accounting  Does not apply

4. What is your yearly income?

- 0 – 25k  26k – 50k  51k – 75k  76k – 100k  more than 100k

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