

Does it take a WISP to manage a wisp of hotspots?



- Analysis of the WLAN market from a WISP perspective

David Alvén
alven@kth.se

Reza Farhang
rezaf@kth.se

Stockholm
February 2002

Master Thesis
Department of Microelectronics and
Information Technology
Royal Institute of Technology
http://www.e.kth.se/~e96_rfh/wisp_analysis.pdf

EXECUTIVE SUMMARY

This report has been produced by David Alvéen and Reza Farhang as the last requisite in order to get a M. Sc. Diploma in Electrical Engineering, with a focus on Communication Systems Design, from the department of Microelectronics and Information Technology (IMIT) at the Royal Institute of Technology (KTH), Stockholm. The research has been carried out at Telia Mobile AB.

The focus of the report has been to try to predict where the WLAN (Wireless Local Area Network) is heading and furthermore to identify and clarify what new roles and opportunities will arrive with the advent of WISPs (Wireless Internet Service Providers).

We have identified different WISP categories that all have various incentives to why they should act in the WLAN arena. The predominant player today is the Mobile Carrier WISP and the Plain WISP (i.e. a WISP with public WLAN access as its core business). However, among the other categories that we have identified, we feel that the Single Point WISP (i.e. a WISP operating in only one location) will become increasingly popular and can be incorporated in a franchising network, operated by a Franchising WISP that shares the revenues with the Single Point WISPs. Another interesting WISP is the Operator Neutral WISP that gives the end user the freedom of choice of upstream Internet Service Provider.

In order to make WLAN access a mainstream service, we believe that it is of utmost importance to carefully segment the market. We have illustrated two different scenarios, one targeting the corporate market and one targeting the consumer market. The corporate market (i.e. SME / SoHo) should be approached by WISPs that today target the early adopters (the mobile professionals) and the consumer market (Homes, Small Shops, Chain Stores and Cafés) should be approached with a franchising model.

There's a need to develop services that are accessible and useful to consumers, whether they access them via WLAN or some WAN technology (e.g. 3G). Services that we think will be useful will fall under four different categories:

- Location based
- Entertainment
- Electronic Socializing
- File Sharing (Peer-to-Peer)

ACKNOWLEDGEMENTS

We wish to thank Telia Mobile AB, especially Mr. Stefan Hagbard and Mr. Roger Ekström, for their continuous participation, support and mentorship throughout the duration of this project. We are thankful to our academic advisor, Ass. Professor Lena Ramfelt, for her constant support throughout this project. Her participation, encouragement and feedback were invaluable to us. Furthermore, we are extremely grateful to Jenny Alvéen for producing our cover graphics.

We would also like to thank the following for their time and invaluable insights during our interviews with them:

- Mr. Michael Berglund (Systems Engineer Cisco Sweden)
- Mr. Per Björklund (Director StartupFactory)
- Mr. Carlo Cassisa (Director Business Development Telia HomeRun)
- Mr. Udo Dengel (MBA Student Imperial College Management School)
- Ms. Elin Elkehag (Business Developer Telia Research)
- Mr. Fredrik Hofgren (IDE Nätverkskonsulterna)
- Mr. Anders Hüge (Manager Technical Business Development Intel Swe)
- Mr. Rikard Kindlund (Sr. Product Manager Compaq Sweden)
- Mr. Magnus Lageson (Business Developer Columbitech)
- Mr. Alexander Latour-Henner (Senior System Architect Service Factory)
- Mr. Fredrik Liljebladh (Ph.D.-student KTH / IT-university)
- Mr. Mats Linder (VP Marketing 3Com Sweden)
- Mr. Nils Masgård (Managing Director Åkerströms Nowire)
- Mr. Östen Mäkitalo (Senior Vice President Telia Mobile)
- Mr. Stefan Nilsson (Business Unit Manager D-Link Sweden)
- Mr. Pontus Nord (Technical Business Developer Wirelessbolaget)
- Mr. Sören Nyckelgård (Senior Technical Consultant Telia Research)
- Mr. Philip Nyströmer (Business Development Manager Ericsson)
- Prof. Björn Pehrsson (KTH / IT-university)
- Mr. Jan Person (VP Marketing Dustin)
- Mrs. Maria Rossing (Manager Business Development Telia HomeRun)
- Mr. Peter Siljerud (Development Manager Intel Sweden)
- Mr. Wiktor Södersten (Managing Director DefaultCity)
- Mr. Fredrik Wester (Systems Engineer Cisco Sweden)
- Mr. Jonas Willén (Ph.D.-student KTH / IT-university)
- Mr. Nicolas ter Wisscha (Business Analyst, Edgcom)
- Mr. Jörgen Öhman (Project Manager E-street Mäkitalo Research Centre)

TABLE OF CONTENTS

1	INTENDED AUDIENCE.....	1
	READERS OF THIS REPORT WILL GAIN	1
	TELIA MOBILE WILL GAIN	1
2	INTRODUCTION.....	2
3	GOAL OF THE PROJECT.....	5
	WHERE IS THE WLAN MARKET HEADING?	5
	DISCLAIMER.....	5
4	APPROACH AND METHODOLOGY.....	6
	4.1 SECONDARY RESEARCH.....	6
	4.2 PRIMARY RESEARCH	7
	4.3 CONCLUSION.....	8
	4.4 LIMITATIONS TO THIS STUDY.....	8
5	CURRENT SOLUTIONS FOR WIRELESS DATA.....	10
	5.1 WAN – WIDE AREA NETWORK.....	10
	5.2 LAN – LOCAL AREA NETWORK.....	12
	5.3 PAN – PERSONAL AREA NETWORK.....	13
	5.4 WLAN – A COMPETITOR OR A COMPLEMENT	14
	5.5 CONCLUSION.....	20
6	WISPs.....	26
	6.1 MOBILE CARRIER WISP.....	26
	6.2 ISP WISP	28
	6.3 PLAIN WISP	30
	6.4 LOCATION SPECIFIC WISP	30
	6.5 SINGLE POINT WISP.....	31
	6.6 OPERATOR NEUTRAL WISP.....	33
	6.7 FRANCHISING WISP	34
	6.8 VIRTUAL WISP	36
	6.9 POWER POINT WISP	36
	6.10 SUBSCRIPTIONS & PAYMENT METHODS.....	37
	6.11 LOGIN PROCEDURES.....	38
	6.12 ROAMING.....	39
	6.13 CONCLUSIONS.....	41
7	CROSSING THE CHASM.....	46
	7.1 MARKET SEGMENTS FOR WISPs	48
	7.2 HOW TO CROSS THE CHASM – TWO SCENARIOS.....	53
	7.3 CONCLUSIONS	57
8	CURRENT & EMERGING MARKETS.....	59
	8.1 TERMINALS.....	60
	8.2 LOCATIONS.....	62
	8.3 APPLICATIONS & SERVICES	69
	8.4 CONCLUSIONS.....	75
9	FINAL CONCLUSIONS.....	77
	9.1 IS WLAN TO BE SEEN AS A COMPETITOR OR COMPLEMENT?	78
	9.2 WHO IS SUITABLE TO BECOME A WISP?.....	79
	9.3 HOW SHOULD THE MARKET BE SEGMENTED?	80
	9.4 WHERE SHOULD WISPs OFFER THEIR SERVICES?	81
	9.5 DOES IT TAKE A WISP TO MANAGE A WISP OF HOTSPOTS?	82

10	FURTHER RESEARCH.....	84
11	BIBLIOGRAPHY.....	85
11.1	BOOKS.....	85
11.2	REPORTS.....	85
11.3	INTERNET RESOURCES.....	86
11.4	ARTICLES.....	89
11.5	SEMINARS AND TRADE SHOWS.....	89
11.6	INTERVIEWS.....	89
12	APPENDIX 1 - ACRONYMS AND ABBREVIATIONS.....	91
13	APPENDIX 2 - TECHNOLOGY OVERVIEW.....	93
13.1	EXISTING WIRELESS LANs SYSTEMS.....	94
13.2	REPLACING WLAN TECHNOLOGIES.....	96
13.3	SECURITY.....	98
14	APPENDIX 3 - PLAYERS IN THE WIRELESS LAN MARKET	101
14.1	WIRELESS INTERNET SERVICE PROVIDERS (WISPs).....	102
14.2	OPERATOR NEUTRALITY	106
14.3	OTHER INTERESTING PLAYERS	108

1 INTENDED AUDIENCE

The intended audience of this report is our coaches from both Telia Mobile and the Royal Institute of Technology in Stockholm (KTH), Mr. Stefan Hagbard, Telia Mobile, Mr. Roger Ekström, Telia Mobile and Ass. Professor Lena Ramfelt, KTH/Stanford.

The report is also targeted towards people who are involved with organizations that strive to gain more understanding or to take a more active role in the WLAN market.

Readers of this report will gain

- An understanding of the wireless data market in general.
- An understanding of the existing as well as evolving players in the WLAN arena.
- An introduction to the WISP (Wireless Internet Service Provider) concept.
- Ideas about what future research to carry out in the wireless data markets.
- An insight into the opinions and concerns held by the leaders in this industry.

Telia Mobile will gain

Telia Mobile can get a better understanding of the evolving role of a traditional operator with the advent of new players in the WLAN market, such as WISPs and clearing houses for roaming.

Telia Mobile could use the recommendations to maintain their leadership in the fixed and mobile data markets.

2 INTRODUCTION

A number of trends can be detected in the world of communications. First of all, the number of different devices a person uses to communicate is increasing rapidly. A couple of years ago it was uncommon for people to have more than a PC. Today, people use a handful of devices, from stationary PCs and laptops to PDAs and mobile phones. Not only have the number of devices increased, but they have also decreased in size. More and more devices are small enough to carry with us, i.e. more of them are becoming mobile.

Second, the diminishing gap between telecommunication and data communication. The two worlds are converging and voice can be carried over a datacom network and data can be carried over a telecom network. New technologies are arriving from both worlds. From the telecom world the third generation (3G) of mobile telephony, UMTS, is being deployed primarily in Asia and Europe. From the datacom world, the increased demand and popularity of wireless data access has created a huge momentum for wireless LANs, primarily the IEEE 802.11b (also known as Wi-Fi) standard. We feel that those two technologies, as well as other technologies such as GPRS and emerging standards, all complement each other and create a mosaic multi access environment.

These trends are changing the structure of the market place. These changes affect the way we use communication devices and the arrival of new access technologies pave way for new players. There is a possibility that companies that have their base in today's technologies might lose substantial market shares if they cannot foresee or at least keep up with these trends. The bright side is that there is a vast amount of money to be made for the company or companies who do master this difficult task.

We believe that within a couple of years, we will have ubiquitous access via a wide array of devices, ranging from phones and PDAs to watches and house equipment. There are however a number of questions that need to be addressed in order to predict a successful business model based on today's trends and future visions.

In order to succeed, timing is critical. As with marketing of any new technology, you must see the window of opportunity and catch it. This goes for wireless LAN

access as well. Is now the time for ubiquitous access or will access in some specific areas be sufficient? In the latter case, in which areas? Or, is the window of opportunity two years from now? What business models can be successfully built on today's technology? While considering time, the chain of services must also be evaluated. There is no reason for high bandwidth if there are no applications or devices that can take advantage of it. Closely related to this are first mover advantages. A company might have to make sacrifices in the initial phase due to low usage in order to ensure being first on the market.

There are a number of questions regarding the cost – How much will it cost? Who will be willing to pay for this and how? How can profits be made? Can it be a stand-alone business, or will it just be an add-on to existing services?

What roles do different companies play in this model? Who delivers the services? Will it be carriers, telephone companies, the streets department, contracting companies, power companies, coffee shops, or even clothes manufacturers? Who will own the user data and user interaction?

Where is the market? Who will the users be? What are the presumptions of culture? Will people accept the system? If implemented, what would the impacts of the culture be? The cultural aspect is closely related to time and fashion. It is critical to know how long it will take for people to adapt. This can be clearly seen with mobile phones; they have become an important part of our image and are almost considered a civic right today.

Another issue that is related to people's acceptance is education. Will the system be easy enough for users? What resources will be needed to use, install and maintain the system? An ironic example of this today is mobile phone address books. There are a surprisingly large number of people who put stickers with handwritten phone numbers on the phone, instead of entering them into the phone's address book.

Last, but maybe the most important matter of them all, is technology. Technology is the basic foundation for the model. Advances in technology can either be forced by a need, or they can be achieved because the technology is possible. In the latter case, the hope is that the technology will drive the need. Some people claim that

there is no need for widespread network access; that the technology is possible, but that there is no need for it. This might be true at the moment, but on the other hand, the need might not emerge until the service is there. Take the Xerox machine as an example. There was no need for copying paper because no one had ever thought of it. We don't think anyone questions the need for the ability to copy paper today.

In this report we will focus on WLANs and the advent of the WISP (Wireless Internet Service Provider) and how this opportunity should be seized. Who should act as a WISP and what segment of the market should be targeted?

These are some of the questions that we will try to answer in this report.

This report is available to download at
http://www.e.kth.se/~e96_rfh/

3 GOAL OF THE PROJECT

The objective of our thesis project is to identify the trends and the potential market when it comes to the future need of wireless local area networks (WLANs). We have the intention of answering the following question:

Where is the WLAN market heading?

This can be achieved by addressing the following points:

- Market today? Tomorrow?
 - How should the market be segmented and what needs are unique for each segment?
 - What desires can be created and how is this accomplished?
 - How does the value chain appear for the players in the wireless arena?

- Technology today? Tomorrow?
 - Technologies today.
 - Replacing technologies.
 - Need for roaming and seamless handover.

- Security today? Tomorrow?
 - What are the problems and solutions of today?
 - What demands will the end user make?

- Competition today? Tomorrow?
 - What are the strategies of existing WISPs today?
 - Who are suitable to become a WISP tomorrow and why?

With all this in mind the goal is to present advice to Telia Mobile on how to act in the wireless market.

Disclaimer

We feel that most readers of this report already have sufficient knowledge of the enabling technologies of WLANs. However, for those that feel that they need, or want, to know more about the technology, there's an overview in section 13, "Appendix 2 – Technology Overview".

4 APPROACH AND METHODOLOGY

In order to achieve the goals of the project, our approach was to use several methods and several sources of information and opinions. Our research methodology has been to first take a snap shot of the current market to see what companies are working on practical applications of wireless technologies. After identifying these companies, we set up interviews with representatives from mostly marketing, but sometimes the engineering departments. We have also researched most written material in this field as well as attended several trade shows and seminars.

In this section, we shall describe our secondary and primary research methodology. In the end, we discuss the limitations of this study.

4.1 *Secondary research*

In the early phase of this project our work was focused on gathering secondary research material in order to avoid re-inventing the wheel. We've gathered this information from literature, articles, industry reports and written material from the Internet. There's a limited amount of WLAN literature available. Therefore, the books we've read have been more focused on how to market and sell high-tech products in order to make them adopted by the mass market and thus achieving a possibility to make a large profit.

We used several methods to the necessary background information for this project:

4.1.1 **Web Research**

We used the World Wide Web extensively to find information about various fields of interest.

We have continuously monitored the WebPages of IEEE and ETSI in order to stay on top of the latest development. We also subscribe to a number of different newsletters regarding WLAN issues. The Web helped us get up to speed with the differences between various existing technologies such as IEEE 802.11b and 802.11a, Bluetooth, HiperLAN/2 and others. We also researched the different players in the market to study their business models. Ongoing research at various universities has been studied to see if and how it is relevant to our project.

We have gathered market research that has already been done in this field to avoid re-writing work that has already been done.

4.2 *Primary research*

In addition to relying on the already existing research, we also conducted our own research at the grass-roots level:

4.2.1 Interviews

An interview can be quantitative, qualitative or a combination of them both. In a quantitative interview are the questions predetermined and presented together with multiple choice answers. Quantitative means that there must be measurable results, which is why the approach and guiding of the interview must be the same for all interviews. A qualitative interview is conducted in an investigating situation, which resembles an every day situation and an ordinary conversation. The interviewer tries to guide the interview as little as possible and only uses the biggest areas he/she wishes to cover written down. The answers to the questions shall be spontaneous and be a result of the interviewee's own opinions.

Quantitative and qualitative are each other opposites. In a quantitative interview the biggest work effort is put into the preparations, as opposed to the qualitative interviews where the biggest effort is needed for the following analysis.¹

We have used qualitative interview methodology, where our main interview support has been a few notes with the questions that we wanted the interview to revolve around. We choose this approach in order to create a discussion around our topics and to get both the opinions of the interviewee as well as the opinions of the company. We also wanted to be able to elaborate around the topics and not just get standard answers. Since we had questions about future scenarios it's difficult to have predetermined answers.

We conducted 25 interviews with representatives from various companies², and technology experts at universities. Being students at prominent universities and the fact that we're writing about an interesting topic were two factors that eased

¹ Patel, Runa & Davidson, Bo. *Forskningsmetodikens grunder*, p.60.

² Please see Appendix 3 – Players in the WLAN market for more information about the companies that we have interviewed.

the process of setting up interviews. Most of the companies we talked to were most forthcoming and helpful.

4.2.2 Brainstorming Sessions

In the end of every section there's a paragraph called "Conclusion" where we have, based on the knowledge we've gained during our research, drawn our own conclusions. The opinions of our interviewees have sometimes been diverse, and based on our own research we have drawn our own conclusion whether to agree or disagree with these opinions. These paragraphs are the essential part of our thesis and have required long brainstorming discussions. The thesis ends with an entire section of conclusions where we discuss the future of the WLAN market.

4.3 Conclusion

After the secondary and primary research, we gathered sufficient background knowledge and understanding of the WLAN market today to help us come up with our own conclusions as to how the market will develop.

4.4 Limitations to this study

Since secondary research is a compilation of someone else's information there is always a risk that the information contains insufficient knowledge or errors. This has led us to always try to conduct a critical discussion regarding the information we have gathered in this way. This critical outlook has also evolved along the course of the project, as we have become more competent in this field.

Primary research can also include propaganda or actual errors. There can be several reasons for this, e.g. the interviewee might not want to answer the question correct for business reasons.

In order not to undermine the credibility of this project it was crucial that we interviewed the right persons. This is especially true when more than one company within the same line of business are represented. That's why we've been careful to choose people with equivalent positions at the different companies. It has not always been possible to interview the equivalent position in every company, but we've tried to interview the VP of Marketing or someone in a management position in business development. This selection was done not only because people in these positions have extensive knowledge about corporate

strategies, but also because they have a technical knowledge of the enabling technologies.

With this in mind, there are however a few other limitations to this study:

- Narrow geographical focus. This is due to the fact that we had limited time and resources; and because Sweden and the USA are the current major innovation centers for WLAN services. Apart from these two countries, we also looked at some solutions in Finland.
- Not focused on security. Security of WLANs remains a big issue that needs to be solved. Though we have identified the problem, and suggested a few possible solutions, we have not attempted to solve the security issues.
- We have focused on viable and currently existing technologies for our research. Replacing technologies such as IEEE 802.11a and HiperLAN/2 are not available for mass deployment yet.
- After coming to our final conclusions, we've realized that there are a few technical implications of these conclusions. Such as "Will the AAA issues be solved?" "When will roaming between GPRS / UMTS and WLAN be solved?" "Will the end user be willing to pay for the hardware or does it need to be subsidized?" "How much interference will there be if IEEE 802.11b gets too popular?"

Since our main objective with this report is to investigate the possibilities for WISPs in the WLAN market, these limitations do not affect our conclusions on how the market should be segmented or which player is more suitable to seize the WISP opportunity. Nonetheless, the issues addressed above are still most important and we recommend them to be further investigated in future research.

5 CURRENT SOLUTIONS FOR WIRELESS DATA

Wireless networks can be broadly classified into Wide Area Networks (WAN), Local Area Networks (LAN) and Personal Area Networks (PAN). There are many different standards and technologies that can be used in more than one of the below listed wireless network types. We have tried to describe each of them with regards to the purpose that they were designed for.

5.1 WAN – Wide Area Network

A large network spanning a country or even the world is referred to as a Wide Area Network (WAN), with the Internet being the most famous WAN. In this section we'll discuss GSM/GPRS and 3G networks and their interaction with wireless LANs. One issue we have addressed is whether WLANs combined with GPRS is a competitor or complement to 3G.

There are several ways a user can access data services over a wide area network. Here we have chosen to mention only a few:

5.1.1 GSM³

Global System for Mobile communication (GSM) is worlds largest mobile communication system. In this section we will discuss two of the add-on services for GSM.

5.1.1.1 WAP⁴

The specifications of the Wireless Access Protocol (WAP) were originally drawn up back in February 1998 by leading handset suppliers - Ericsson, Motorola and Nokia - in conjunction with Unwired Planet. WAP has been designed to work across a whole range of mobile communication systems and was the first attempt in Europe to provide mobile Internet-like services from telecommunication operators.

To use WAP, you need a WAP-gateway that can handle Wireless Markup Language (WML), which is equivalent to HTML on the Web. This gateway is the bridge between telecommunication network and the data network. You also need a WAP enabled mobile phone. The transfer rate of data is based on what kind of

³ <http://www.gsmworld.com/technology/gsm.shtml>, available February 19, 2002

⁴ <http://www.wapforum.org/>, available February 19, 2002

communication system that is used. If GSM is used the theoretical maximum transfer speed is 14.4 kbps and if GPRS is used the speed is approximately 100 kbps.

5.1.1.2 GPRS⁵

General Packet Radio Service (GPRS) is a standardized packet-switched data service that is an extension of the GSM architecture. GPRS uses upgraded radio base stations linked to a new network based on "packet" technology.

With packet technology, the user will be connected to their home carrier data services via the subscribers handset, mobile phone, PDA or Laptop - typically a WAP server, a company LAN, or an Internet Service Provider - and then send and receive data as required. The GPRS network is only used when data is being transmitted, but the user retains a virtual connection to the chosen computer network until it's turned off.

Initially GPRS handsets will be capable of operating at speeds up to five times faster than on current GSM networks but eventually, when new handset are available, speeds will increase up to ten times faster than GSM network. The network is used far more efficiently than circuit switched networks. It is only used when data is being transmitted, which will reduce the cost of mobile data and the usage of the network. GPRS is based on the Internet Protocol (IP). This provides ease of connectivity from mobile data terminals to the Internet and to IP-based company intranets.

5.1.2 3G⁶

The third generation (3G) of mobile telephony, or UMTS (Universal Mobile Telephone Network) as it's also known in Europe, has been developed by ETSI (European Telecommunication Standards Institute).

UMTS will offer theoretical data speeds from 384 kbps up to 2 Mbps (the difference in speed is dependent on the software used in the base stations) on the frequencies 1885 - 2025 and 2110 - 2200 MHz.

⁵ <http://www.gsmworld.com/technology/gprs/intro.shtml>, available February 19, 2002

⁶ <http://www.umtsworld.com/technology/overview.htm#1>, available October 23, 2001

The core network is divided in both circuit switched and packet switched domains. Circuit switched connections handle voice and packet connection protocol is designed for data delivery. The ATM (Asynchronous Transfer Mode) is defined for UMTS core transmission. Most of the European countries and some countries around the world have already issued UMTS licenses either by beauty contests or auctions.

In the spring of 2001 NTT DoCoMo rolled out the worlds first operational 3G network for public service in Japan.

5.2 LAN – Local Area Network

Lately, there has been a lot of activity in this category. The most common way to access a wireless local area network is by inserting a network interface card (NIC) in the laptop (or PDA) which then communicates with a base station (Access Point) located in the vicinity. The most common protocols used for this are IEEE 802.11b and HomeRF, which are further discussed in section 13, “*Appendix 2 – Technology Overview*”. The user gets fast broadband (11Mbps) access to the complete Internet but the covered area is small – if the user moves more than 100 meters away from the access point, he is likely to lose the connection. There are several settings in which this solution is being used:

5.2.1 Public Hotspots

Wireless Internet Service Providers (WISPs) are setting up access points in places like airports, train stations, hotels and cafes, allowing their subscribers to browse the Internet at these locations. Most of the providers such as Telia HomeRun in Sweden, and MobileStar (recently acquired by VoiceStream) and Wayport in the US are targeting the business traveler, as they are likely to be the early adopters for this service. Rapid proliferation of these hotspots is currently underway.

Currently, the problem with this solution is that it is narrowly targeted towards the business travelers and hence other segments are not fully aware of its existence. Also, it is limited to the people who carry laptops and are willing to buy a wireless card (in some cases, the wireless cards are provided for free by corporations to their mobile employees). Some of these solutions are very expensive. A case in point is Telia HomeRun, which charges SEK 1500 (~\$150) per month for unlimited usage at any of their hotspots. As a comparison MobileStar charges \$60 per month.

5.2.2 Offices and Universities

Several small, medium and large sized corporations are installing wireless LAN access points within their premises, thus enabling their employees to access the Internet and the corporate database even while being away from their desk. They also provide free wireless cards to the employees. Some corporations buy mass subscriptions from providers like MobileStar and give them to their employees who can then access the Internet from hotspots covered by the provider. This is the market that most of the access providers are trying to target.

Several universities such as the Royal Institute of Technology in Stockholm and the Stockholm School of Economics are putting up access points on campus and are providing free broadband wireless access to their students, faculty and staff.

5.2.3 Free Networks – Home Networks

Several user groups, such as Elektrosmog in Sweden and the Bay Area Wireless Users Group (BAWUG) in the San Francisco Bay Area are installing access points at several locations with the aim of letting anyone use the networks for free. They generally set up access points in houses or on rooftops. Though the mission is very noble, we feel that this is not a scalable solution and these self-run networks will never be able to provide reliable service to people.⁷

Some people with wired broadband connections in their home are putting up access points for their own in-house use – this allows them to move around the house and even outside the house for a certain distance and stay connected all the time.

5.3 PAN – Personal Area Network

A personal area network typically covers the few meters surrounding a user's workspace and provides the ability to synchronize computers, transfer files and gain access to local peripherals like printers and a range of pocket hardware. A technology like Bluetooth may enable a wireless PAN.⁸ IEEE has a working group for Wireless PANs called 802.15.

⁷ This point has been validated by Brewster Kahle, founder of SF LAN, a wireless user group in San Francisco. "WLANs Hotspots – Connect the Dots for a Wireless Future", page 24.

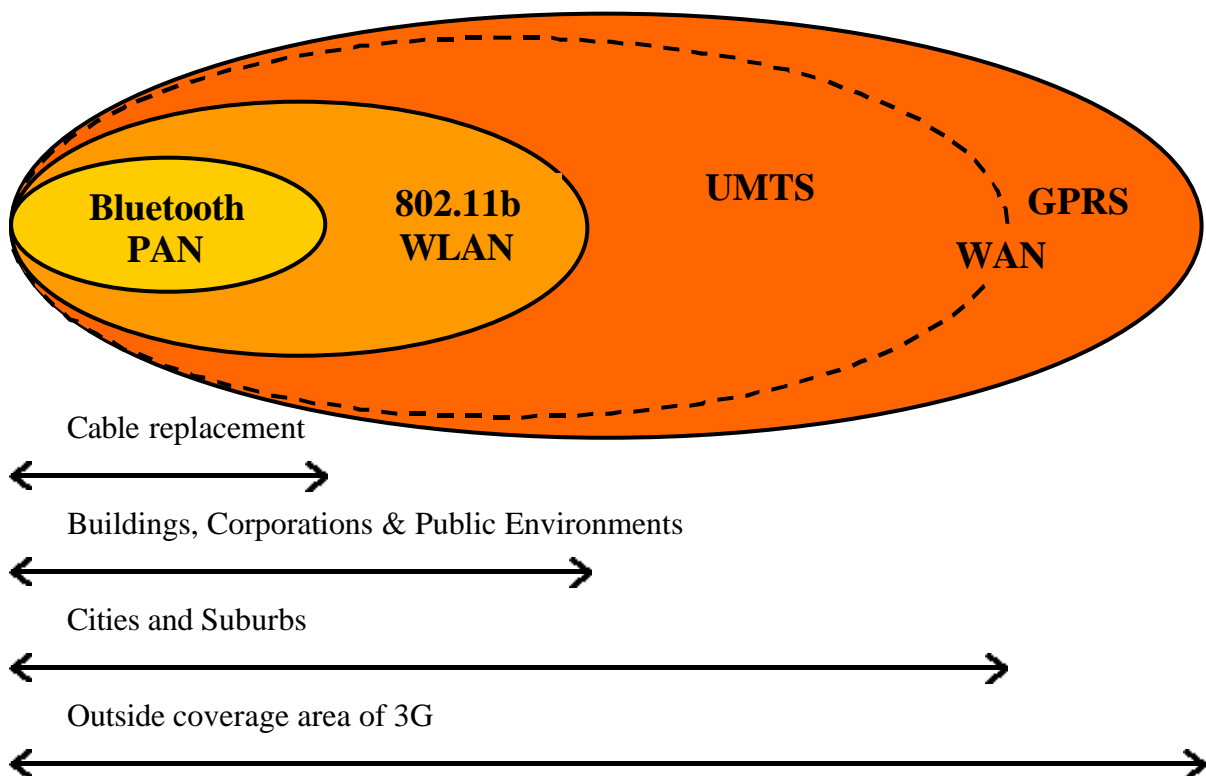
⁸ BrainHeart Magazine, nr 4, September 2001, p36-37.

5.3.1 BAN

There is even a smaller local area network than a PAN. According to BrainHeart Magazine⁹, a Body Area Network means wireless communication between various components attached to the body, such as data spectacles, earphones, microphones and sensors for medical applications and for work and leisure. It can also include the wearable electronics that Levi Strauss and Philips Electronics¹⁰ plan to produce as well as the fabric from ElekTex™¹¹. The fields of application of these products are yet a bit unclear and very futuristic.

5.4 WLAN – a Competitor or a Complement

During our research we have come across many different opinions regarding WLANs and it's position towards 3G and Bluetooth. In this section we'll discuss the impact WLAN combined with 3G, GPRS and Bluetooth will have. We will also discuss if there is a risk of WLANs becoming too hyped and not being able to live up to the expectations set by the end users, similar to what happened to WAP, since both technologies aim to offer mobile Internet.



⁹ BrainHeart Magazine, nr 4, September 2001, p36-37.

¹⁰ http://www.extra.research.philips.com/password/passw3_4.pdf, available November 22, 2001

¹¹ <http://www.electrotextiles.co.uk>

Figure 1: *WLAN in relation to other solutions for wireless data communication.*

5.4.1 WLAN vs. 3G

The question whether WLAN is to be seen as a competitor or a complement to 3G remains to be answered. However, the fact that WLANs will have an impact on 3G, be it as a competitor or as a complementary service, is a development cannot be ruled out by anyone. It's a combination of what application and what benefits the end user can make with the service that will be the driver. It's healthy competition for the mobile operators.

“3G was developed to solve two needs, the first one is to be always connected and the second one is to download with a higher bandwidth.”

Sören Nyckelgård, Senior Technical Consultant, Telia Research

The question is whether these two cases always occur at the same time? The answer to that question is no. A user can be always online with one technology, such as GPRS, and download with another technology, such as WLAN. I.e. an end user can be always on with GPRS and, as an example, read all the subjects on his/her e-mails. If he/she find something really interesting, then visit a hotspot to download that email. With many hotspots this solution becomes an interesting alternative to 3G. Always on with GPRS is free of charge, as will it be with 3G, but high capacity transfer on WLAN is much cheaper and faster than the promised price and speed of 3G.

Mobile operators haven't thought of how to charge for high capacity data services on the 3G network. As of today, they are all based on the same tariff as for voice and therefore they are too expensive to attract customers.

The reason for this is simple. Let's say a high bandwidth service requires ½ Mbps, which is equal to 40 voice calls. The alternative usage for the operator is 40 voice calls. A bit is a bit; whether it's used for voice or something else. You can't waste bits, there's a production cost per bit and as an operator you can't afford to subsidize a certain usage, i.e. high speeds. That will immediately lead to solutions with the same cost per bit for voice as well. That will lower the price range for voice services to the same level.

This is why a lot of people can see WLANs as a price worthy alternative to the expensive 3G-services. Telia HomeRun offers a time based charging scheme for WLAN of SEK 2.40 (~\$0,25) per minute. There is analogy to be made to the GPRS development in Sweden. When the services was first launched, no one used them. There were two reasons for this, firstly there were no terminals and secondly the per volume charging was very expensive. In order to prevent a total fiasco the prices where dropped to a low flat rate charging scheme or in some cases even offered for free.

“I don’t believe in 3G in Sweden. The only thing that can offer something similar is WLAN/GPRS. You can offer it over a wider area, but it’s not mobile Internet. It’s no more mobile Internet than GPRS.”

Wiktor Södersten, Managing Director, DefaultCity

This is a golden opportunity for a WISP to form an alliance with a GPRS-operator to provide services similar to those offered by 3G-operators. This can be rolled out now and attract potential 3G customers.

However, not everybody sees WLANs as a threat to mobile revenues from 3G. In order to get the services of 3G that demand high capacity going, the customers need to become accustomed to high capacity services through WLAN before craving them on 3G. The users will learn to appreciate a certain service for a reasonable cost while in a WLAN hotspot. Once accustomed to the benefits of the service, the user is more likely to want it elsewhere as well. Elsewhere in this case means via the 3G network. This should be seen as an incentive for service/application developers to develop services or applications that can be accessed both through WLANs and 3G. It’s at this point in time when 3G stands a chance and the end users are willing to pay for the services. But they need to get used to having the services first.

“WLAN need to change drastically in order to be a competitor to 3G. In the long run, it’s all about what abbreviation will last.”

Alexander Latour-Henner, Sr. System Architect, Service Factory

5.4.2 WLAN vs. Bluetooth

The opinions regarding if Bluetooth is to be considered a cable replacement technology with a limited field of application or a WLAN technology are diverse. Bluetooth might become a standard for communication between PDAs and computers or headphones and cellular phones.

We agree with the prevailing opinion that Bluetooth is only a cable replacement technology, mainly because the standard wasn't developed for networking, but also because of the limited range. The major players in the WLAN industry that consists of Intel, 3Com and others all believe that WLANs (802.11b) and Bluetooth will complement each other.

“One should not drive formula 1 in a VW Beetle. Bluetooth should not be used to build WLANs.”

Anders Høge, Technical Business Developer, Intel

“Bluetooth is only a craze.”

Anonymous

However, there are other opinions, such as this one from Magnus Lageson, business developer at Columbitech, who thinks that WLANs will not only be built on the IEEE 802.11b standard but also with Bluetooth. The advantage of Bluetooth is that there are already PDAs with built-in Bluetooth chips available. The most important advantage is that Bluetooth consumes up to four times less power compared to 802.11b products.

“WLAN will be big in corporate environments, while Bluetooth can fulfill a need in hotspots.”

Magnus Lageson, Business Developer, Columbitech

Furthermore, we believe that Bluetooth can get an upswing in years to come. The reason for this is that many new mobile telephones¹² and PDAs¹³ come pre-equipped with Bluetooth. This will enable a more extensive use of peer-to-peer

¹² <http://www.ericsson.com/bluetooth/faqtmp2/default.asp?action=show&id=16>, Ericsson, available November 27, 2001

¹³ http://www.compaq.se/pb_products/pb_family.asp?iFamilyId=1094, Compaq iPaq, available November 27, 2001

communications for pushed advertisements and information at for instance museums, but it will not be used for networking. However, there's an interference problem between 802.11b and Bluetooth. This problem needs to be addressed so the two technologies can coexist.

The Bluetooth controversy is different depending on what country you are located in. Since Bluetooth is an Ericsson invention from the start, there are more pro-Bluetooth companies in Sweden compared with the US.

5.4.3 WLAN vs. WAP

Both WLAN and WAP claim to offer mobile Internet. This is the main reason why we have chosen to compare the two technologies. We have asked all our interviewees if they think there's a risk that WLAN becomes over-hyped and fails to live up to expectations set too high. Is there something in the WLAN technology that can lead to the same hype that WAP had?

The responses we got were diverse and spanned from "yes" to "you can't compare WLAN with WAP".

Before WAP was introduced, most involved players in the telecom industry were hoping to repeat the success that NTT DoCoMo had had with i-mode. There were several issues they neglected to address.

Firstly, the two markets are totally different. The Internet penetration in Japanese homes was at that time only a fraction compared to Europe. This means that people in Japan didn't have the same opportunity to access the Internet and therefore they had to use their i-mode enabled phones to access some kind of Internet-like services.

Secondly, i-mode uses the ordinary HTML with only a few changes instead of WML that is used by WAP. The advantage of this is that they had a lot of web developers who could develop WebPages for i-mode and there was no need of special development kit and servers that is needed in WAP. These differences turned up to be devastating for the big success for WAP in Europe.

Once again there are some differences between WLAN and WAP that will make these two technologies to behave different in favor of WLAN.

The main reason WAP failed is that WAP was introduced on the GSM network. GSM offers a very limited bandwidth and it was not suitable for data communication. Furthermore, mobile phones had at that time a very harsh presentation environment with small screens and bad resolution. People using WAP was expecting a mobile version of the Internet they were used to at home or at work, when this wasn't the case they were disappointed. WAP could be a winner if it can present a form of information that does not exist in any other environment.

However, this might not mean that WAP is dead. It might be able to get an upswing with GPRS¹⁴ when there is an environment more suitable for data transfer and a better presentation environment on mobile phones. Even if some people don't have high thoughts about WAP:

“WAP – Wait And Pay”

Jörgen Öhman, Project Manager, E-street

When it comes to the hype of WLANs, it's a more difficult question to answer. Will there be a hype or will WLANs live up to the expectations of a true mobile Internet? We think that although there will be a hype around WLAN, it will live up to the expectations. There are several reasons for this:

- WLAN doesn't implement any kind of interaction or presentation technique. It's completely transparent.
- A WLAN terminal can be used in multiple environments. Multi-purpose applications are possible. I.e. a WAP terminal can only be used for WAP. A WLAN card can be used in the office, at home etc.

¹⁴ See section 13, “Appendix 2- Technology Overview”, for more information about GPRS.

- Mass market adoption and the fact that WLANs are more diverse than WAP. You can access “real mobile Internet”, i.e. do the same things that you are used to. E-mails, banking and remote corporate access to mention a few.
- High data transfer rates at a lower price.
- No new need for specially developed homepages and developers, i.e. more cost efficient for companies.

5.5 Conclusion

In summary, we can say that there are three types of wireless data solutions today:

- Wide area solutions that are slow speed, and sometimes give access to only limited content at a high cost.
- Local area solutions that are high speed and give access to the entire Internet but are limited in range.
- Personal area solutions that are relatively high speed with unlimited content, but a very short range.

With the convergence of the telecom and datacom worlds the rules of the game are changing. There's no longer the same clear difference between the two. Data can be transferred on a telecom network and voice can be transferred over a datacom network. In order to make mobile Internet successful, players from both the telecom world and the datacom world need to agree on an approach for future scenarios.

How should WLANs be considered with regards to 3G? Are WLANs to be considered a threat to mobile revenues or is it a complementary source of income? We do not know the answer, but we feel that it is a very hot topic that must be addressed.

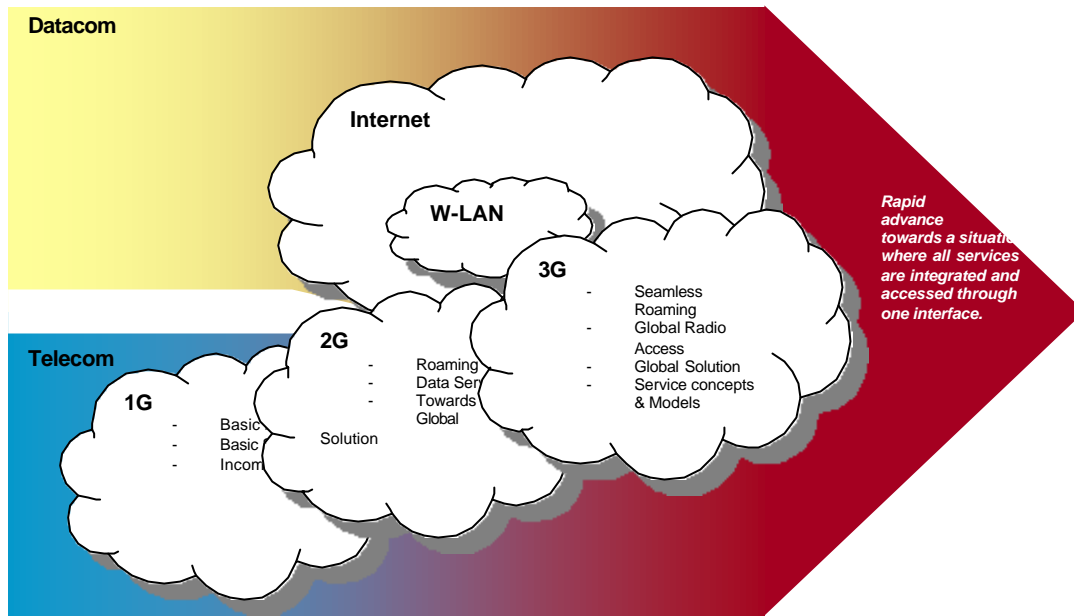


Figure 2: The convergence of datacom and telecom. (Source: Heikki Kaaranen et al¹⁵)

Of course, WLANs will take a market share from 3G, since both technologies offer wireless “broadband” access. Unless a need is created for high capacity services that can be accessed both via 3G and WLAN, 3G services will not be developed. Application Service Providers (ASPs) will not be interested in developing high capacity services that are solely for 3G. There is an ongoing discussion in Sweden right now about mobile operators charging too much for application providers to use their nets.¹⁶ Hence the margin for the ASP becomes too low. The operators need to lower their margins to allow ASPs to develop services for 3G. However, Telia recently signed a deal with application service providers on how much to profit to share and this will hopefully solve the problem.¹⁷ One more incentive for the ASPs to develop services should be the possibility to use the same service in both a 3G net as well as in a WLAN. WLANs will never be able to offer ubiquitous coverage and once an end user knows the benefits of a service in a hot spot he/she can now choose to pay more to access it somewhere in the 3G net. These services might become even more versatile when the next release of UMTS arrives with the promised 10Mbps.¹⁸

¹⁵ Kaaranen, H. et al, UMTS Networks - Architecture, Mobility and Services, John Wiley & Sons Ltd. 2001

¹⁶ Nygren, Martin & Sköldemar, Mikael, Innovative Charging Methods for the Interconnect Provider Role and Services

¹⁷ Telia will charge ASPs for the traffic their service generates as well as 20% of the amount the ASPs charges the end users for the service.

¹⁸ Release 6 of UMTS, <http://www.umtsworld.com>, available February 13, 2002

Due to the lessons learned during the “dotcom crash” new investments are harder to make, but no operator want to be left behind if the rest has bet on a new technology.

For some users, the combination of seamless roaming between WLANs and GPRS can be enough, and that they will not need 3G. There are several companies offering solutions for this roaming such as ipUnplugged, NetSeal and Columbitech. This is an offer mobile operators should bundle to their existing GSM customers. Especially for the operators who didn’t get a 3G license this is a golden opportunity to attract customers.

5.5.1 Replacing technologies

The bandwidth offered by 802.11b is more than enough to handle the needs of almost every user. There are no services today that demand more capacity, at least not in a public environment. For enterprise users, there’s a different story. If the number of simultaneous users increase and they all require a lot of bandwidth, then a migration to a replacing technology might be the solution.

“11 Mbps will take you very far. There’s a speed hysteria that’s not justified because the needs will not be fulfilled for many years to come”

Östen Mäkitalo, Sr. VP, Telia Mobile

On the other hand, 802.11b products are well renowned and widespread. This, in conjunction with the Wi-Fi-certification and the interoperability it leads to, will make large enterprises more likely to adopt this existing standard before being the first to adopt a new, albeit better standard. The battle between the American standard IEEE 802.11a and the European HiperLAN/2 is still being fought, but it seems like 802.11a will be the conqueror of this battle. In this section we’ll try to explain why we think this is the case.

We think that when 802.11a products become widely available in the US, prices on 802.11b products will go down. A price drop in the US will lead to lower prices worldwide. Lower prices on 802.11b products will lead to wider adoption of 802.11b products. This larger footprint on the market will pave way for an

easier 802.11a adoption.¹⁹ This will give 802.11a a momentum here in Europe and this will make it too hard for HiperLAN/2 products to catch up. Furthermore, since Ericsson has decided to start supporting 802.11a products as well as HiperLAN/2, the consortium supporting HiperLAN/2 lost a lot of credibility.

“HiperLAN/2 is a last twitch from an already half dead telecom industry.”

Anonymous

“A stricter standard, like HiperLAN/2, will make WLAN loose some of its charm.”

Jonas Willén & Fredrik Liljebladh, Ph.D.-students in IT, KTH

Software developers for QoS on the network will start develop products first for the first available technology. This will lead to availability of QoS tools for the 802.11a standard prior to availability of similar products for HiperLAN/2. We believe that sometimes it can be better to launch a product that might not be perfect rather than to launch a perfect product and let the market decide how the product should evolve. Launching a perfect product might be too late. Americans are usually at better timing when it comes to time to market compared with Europeans. In Sweden people are more focused on technology and a lot of people buy only high end products. Even though HiperLAN/2 is considered to be a superior technology for many different reasons, that alone is not enough to win the market.

However, if HiperLAN/2 is close enough with launching products when 802.11a products start being launched then they might have small chance. Today it looks like they won't have any products to launch until at least six months after 802.11a has launched and then can be too late. They might never catch up on the head start.

“The first technology doesn't necessarily need to be the best, compare VHS vs. BETA-MAX in the early 1980's.”

Peter Siljerud, Development Manager, Intel.

¹⁹ This opinion is shared with a majority of the interviewees we have talked to.

First-movers advantage to get a head start is most important because the first mover is more likely to achieve a dominant position in important market segments if they can offer an attractive product. Even if Europe says that they will support HiperLAN/2 here and the US says they will support 802.11a, there will still be imported products for 11a in Europe. There's a massive support for 802.11a from the computer industry. There are efforts right now between ETSI and IEEE to make the two technologies coexist. Today a license is required in Europe to broadcast with 802.11a products, due to radio regulations²⁰. To meet these regulations IEEE are developing an enhancement of 802.11a called 802.11h.

“Before IEEE has invented HiperLAN/2, the letters in the alphabet will have run out”

Peter Karlsson, Telia Research²¹

There are already dual band products on the market today supporting both 802.11a and 802.11b. Intel is one company that has both a dual band access point as well as PCMCIA-card for 802.11a for sale in the US.

5.5.2 Security

As always, there are considerations to be made regarding the balance between user friendliness and security. The security solutions can often cause limitations regarding the actual benefits of the service. In a public environment there's a need for a known balance between the two. There must be a way to handle the risk. There are always security risks for an operator, but there is no such thing as the secure net.

“Only the nonexistent net is totally secure.”

Alexander Latour-Henner, Sr. System Architect, Service Factory

When 802.1x evolve as interoperable standard between all different manufactures in the same way as the Wi-Fi-certification is today many of today's AA problems will solved. It will simplify security management in networks. Compared to the 802.11b standard security protocol, Wired Equivalent Privacy (WEP) which has proved to be insecure, 802.1x will enable security in a public environment. For

²⁰ Please see section 13, “Appendix 2 – Technology Overview” for more information.

²¹ Elektroniktidningen, Nr 19, December 7, 2001, Page 40.

more discussion and a detailed description of the security technologies, please see section 13, “*Appendix 2 – Technology Overview*”.

We believe that it’s better not to use a security solution at all, rather than using a poor security solution. This way the end user can take active measures in implementing a secure third party solution, such as a VPN (Virtual Private Network). The reason for this is that if you don’t have a security solution, you will not perform anything that requires a secure transaction. If you have a poor security solution, you might perform activities that would not be performed if you knew that the connection wasn’t secure. The only way to be completely secure today is by using a VPN-tunnel.

Another ongoing discussion is the discussion on insecure corporate networks where the access points are located inside the firewall. The simple solution to this is to put the access point it outside of the firewall and require a login procedure to get access to the corporate data as well as to the Internet. This might not be the only case with loss of corporate data. A classic example of this when employees lose laptops with classified material without encrypting the hard drives.

All enterprises should formulate a security policy for WLAN deployment now, even if they have no immediate plans to use the technology. This to prevent employees of putting up access points on their own.

Do you trust your ISP fully? Have you ever had suspicions that they monitor your Internet behavior, i.e. what sites you have visited, reads your e-mail etc.? If yes, then maybe the ISPs aren’t the right party to supply the security solutions. An ISP could possibly present different security options made by different companies. This way, the end user will get the freedom of choice to choose the level of security and from what company to buy it. The most important thing is to debit the right person for the usage of the net. That means all users must be identified with a secure solution. No one should be charged wrongly. In any case, if complete security is wanted, always put your own security, from a third party, on top of the solutions that are incorporated in the standard.

6 WISPs

We think that WISPs (Wireless Internet Service Providers) can be categorized into several different types. We have chosen to differentiate between the different categories depending on the characteristics of each WISP²². To get a better overview of how the different types work and what their drivers are, we will in this section discuss the advantages and disadvantages of that WISP category becoming a player in the WISP arena, compared with the other categories. We'll look at various attributes that differentiate the WISPs on the market from each other. We will also describe WISPs that doesn't exist today, but that we feel have a feasible business opportunity.

Some attributes are common for all different categories and are therefore not discussed here, such as the security issue.

Some of the companies listed below have more than one line of business, so we chose to put them into more than one category.

The last sections investigates the different payment methods, subscriptions, login procedures and roaming issues that are generally in use today by existing WISPs or could be used by emerging WISPs.

6.1 *Mobile carrier WISP*

As the name implies, a mobile carrier WISP is a mobile operator that has chosen to also offer wireless LAN Internet access. Some operators offer WLAN access only as an extended service to their existing customers, others offer it to anyone. This is the largest WISP category with players like Telia HomeRun (Sweden), Sonera wGate (Finland) and VoiceStream (Germany / US) with their recent acquisition of MobileStar in the US. As of today, the target groups for these companies are the high-end users with low price sensitivity. The preferred locations for the operators are places that are frequently visited by these users, such as hotels, airports and convention centers.

In the table below we have listed the main advantages and disadvantages for mobile carriers compared to the other WISPs to enter the WLAN arena.

²² For information about the existing WISPs, as well as other players in the wireless arena, please see Appendix 3 – Players in the Wireless LAN market.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Good market penetration for mobile customers and therefore a large customer base. 	<ul style="list-style-type: none"> ▪ Can outrive, or at least take market shares, from their own services and force a price drop on mobile telephony.
<ul style="list-style-type: none"> ▪ Billing system for mobile telephony that can lead to one bill for both mobile telephony and wireless LAN services. 	<ul style="list-style-type: none"> ▪ A need to protect the brand name, i.e. cannot risk low QoS.
<ul style="list-style-type: none"> ▪ Experience in mobile network development and deployment. Knows from experience densely populated areas. 	<ul style="list-style-type: none"> ▪ Large hierarchical enterprise that acts slowly in a rapidly emerging market.
<ul style="list-style-type: none"> ▪ Ability to bundle WLAN services with mobile telephony offerings. 	<ul style="list-style-type: none"> ▪ Might need to lease backbone.
<ul style="list-style-type: none"> ▪ Deep pockets, i.e. ability to have negative cash flow for a long time due to incentive to invest in future communication systems. 	
<ul style="list-style-type: none"> ▪ Used to protect brand name and to have a customer support department 	
<ul style="list-style-type: none"> ▪ People can more easily identify with a mobile carrier offering mobile services, compared to an ISP. Well-known brand name attracts customers. 	

6.2 ISP WISP

An ISP (Internet Service Provider) can extend the reach of their existing network and customers by offering WLAN access. The ISPs of today offer Internet access via fiber, xDSL, cable and other access methods to both companies and households. Their target group for WLAN services will be their existing customers.

There are currently not many ISPs offering wireless access to their services, but this is a potential player in this field since they already have the customer database as well as billing and other services in place. The only player in Sweden today is PowerNet, but they are struggling financially at the moment.

“Existing ISPs are more fit for the market. There’s a need for a financially strong company that has enough capital support to back up the investments needed. If Telia act with more power than they do at present, they’ll be hard to beat.”

Rikard Kindlund, Sr. Product Manager, Compaq

Since offering Internet access is the core business for an ISP, they have a competitive advantage over new players in offering wireless access to their services. This is because people are already used to getting Internet services from an ISP plus the ISP has experience in providing Internet access.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Large customer base for Internet access as well as good market penetration. 	<ul style="list-style-type: none"> ▪ Need positive cash flow quickly, due to the current economic situation and that they are still investing heavily in wired infrastructure

<ul style="list-style-type: none"> ▪ Billing system for Internet services that can lead to one bill and one login procedure 	<ul style="list-style-type: none"> ▪ Not targeting high end users. I.e. people are not willing to pay much more than they are paying for fixed broadband.²³ → Low profit
<ul style="list-style-type: none"> ▪ Access to the broadband cables to the Internet, and therefore access to good locations (if the location is a customer that is) 	<ul style="list-style-type: none"> ▪ Households are more price sensitive compared to high-end mobile professionals.
<ul style="list-style-type: none"> ▪ Experience in network development will lead to low costs to provide backbone for WISP service 	<ul style="list-style-type: none"> ▪ People can more easily identify with a mobile carrier offering mobile services, compared to an ISP
<ul style="list-style-type: none"> ▪ Bundling wireless cable modem (or similar access device for the broadband connection at home) enables many customers to be wireless. Can potentially lead to an increased demand for wireless access elsewhere, i.e. public hotspots. 	
<ul style="list-style-type: none"> ▪ Used to QoS issues and support in the Internet world. Net head vs. Bell head, used to Internet mentality 	

²³ According to end user survey with 600 respondents made for previous report, “WLAN Hotspots – Connect the Dots for a Wireless Future.”, end users in homes are not willing to pay more than an additional \$10-20 for wireless access.

6.3 Plain WISP

Companies in this section are WISPs as their core business. They are only focused on offering wireless Internet LAN access in densely populated areas. The sites vary from airports and hotels to cafés and restaurants. The type of location is irrelevant, as long as it is financially profitable.

Companies in this section include Wirelessbolaget and DefaultCity in Sweden and Wayport in the US.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Small companies that can adapt quicker to a developing/emerging market. 	<ul style="list-style-type: none"> ▪ No experience (this covers network deployment, lack of billing system)
<ul style="list-style-type: none"> ▪ Core business and are therefore able to act quickly to satisfy customers. 	<ul style="list-style-type: none"> ▪ Slow roll out rate due to lack of funding
	<ul style="list-style-type: none"> ▪ No brand name, small footprint on the market.
	<ul style="list-style-type: none"> ▪ ISP-dependent. Either as a partner or to lease Internet connectivity from.
	<ul style="list-style-type: none"> ▪ Expensive to offer QoS and support

6.4 Location specific WISP

WISPs in this category are focused on providing wireless access only in specific locations, such as only cafés, only airports. Companies in this section include: Surf n' Sip (focused on cafés in the San Francisco area), MobileStar (have many hot spots in the US, but the majority are at Starbucks Coffee shops) and Wirelessbolaget (targets high end users at hotels) as well as hospitals offering

redundant bandwidth to patients. This section can also include players like McDonald's that can strike a deal with a WISP or an ISP.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Exclusivity to a site, usually because they own the site, in case of a café, but can also be the “Official” WISP of a site. 	<ul style="list-style-type: none"> ▪ Small footprint
<ul style="list-style-type: none"> ▪ Becomes the expert of a certain type of location, knows the barriers and pit falls. 	<ul style="list-style-type: none"> ▪ Hard to attract customers that ask for other sites
<ul style="list-style-type: none"> ▪ Golden opportunity for roaming with other WISPs if they have achieved exclusivity at a site where other WISPs would like to be present. 	<ul style="list-style-type: none"> ▪ ISP-dependent for backbone access.
<ul style="list-style-type: none"> ▪ Knows the behavior of their customers and knows what different applications and services they crave. 	

6.5 *Single point WISP*

The WISPs in this section consider wireless Internet access a complementary service to their customers to get a competitive edge over their rival companies. The service can be offered free-of-charge to their customers. Such as a small café offering the service for free or charge a small time-based fee as an extra source of income to cover net administrative costs to attract customers. This means, the WISP business is not the core business of the location owner. There are only a few such sites today (mainly small cafés in the US), but we think that the

following sites/locations could benefit by having a wireless access as complementary service²⁴:

- Cafés/Restaurants.
- In-door shopping malls.
- Libraries and other public places.

A single point WISP can offer other WISPs to roam on his network free of charge in order to attract mote customers.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Absolute exclusivity to the site. 	<ul style="list-style-type: none"> ▪ Unable to offer QoS and support. Or expensive additional cost if outsourced.
<ul style="list-style-type: none"> ▪ Competitive edge over similar establishments. 	<ul style="list-style-type: none"> ▪ Maintenance of the network can be difficult and require skill and funding that wasn't anticipated
<ul style="list-style-type: none"> ▪ Most stores are already connected to broadband Internet services, this leads to a small investment to install WLAN. 	<ul style="list-style-type: none"> ▪ Customers not experiencing good QoS might damage good brand name
<ul style="list-style-type: none"> ▪ Cost efficient, since the wireless network can also be used by employees for administrative work. 	<ul style="list-style-type: none"> ▪ Lack of AAA (Authentication, Authorization, Accounting) can lead to abuse on the network
<ul style="list-style-type: none"> ▪ No need to implement a AAA-system. 	

²⁴ According to end user survey with 600 respondents made for previous report, "WLAN Hotspots – Connect the Dots for a Wireless Future.", 51% of end users would choose café A over café B, if café A offered WLAN access.

- Before a user can access the Internet, he/she has to go through a portal where the location owner can present advertisements.

Many property owners find themselves in an ambiguous marketing situation, torn between using a WLAN network in their premises to attract more clients (i.e. a hotel allowing a WISP to offer its services in the hotel) and deploying a WLAN network to their clients themselves. A location that chooses to offer the WLAN access themselves is by default a Single Point WISP.

6.6 Operator Neutral WISP

Instead of one entity running the network and owning the customer, there is an operator neutral alternative. In this case, a company owns an Internet eXchange (IX) to which several independent ISPs (or WISPs) are connected. Through the IX, several access points can be installed at various locations. At such a location, the end user is presented with a location specific start page that is surfable for free. For upstream Internet connection, an ISP must be chosen by the user from several that are present at that location.²⁵ The ongoing KTH project StockholmOpen.net is working on this and has already covered the City Hall and the House of Culture in Stockholm. Ongoing projects include Kista Galleria²⁶ (indoor shopping mall), a large housing complex as well as the archipelago²⁷ of Stockholm.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Attractive for the customers since freedom of choice of ISP is presented. Competition also leads to lower prices. 	<ul style="list-style-type: none"> ▪ Last mile solutions can be expensive

²⁵ Please see “WLAN hot spots - Connect the Dots for a Wireless Future” Section 12 – SwedenOpen, <http://www.hhs.se/cic/seamless/alven.pdf>, available December 7, 2001

²⁶ For a further discussion of the ongoing operator neutral projects at KTH, please see Appendix 3 – Players in the Wireless LAN market. <http://2g1319.ssvl.kth.se/~csd2002-kistaopengalleria/>,

²⁷ <http://2g1319.ssvl.kth.se/~csd2002-openarchipelago/>, login: guest, password: welcome

<ul style="list-style-type: none"> ▪ No need for customer stock, since the ISPs will provide that. 	<ul style="list-style-type: none"> ▪ AAA and revenue sharing requires good technical solution
<ul style="list-style-type: none"> ▪ Revenue sharing with ISPs connected to the Internet eXchange (IX) behind the access point. 	<ul style="list-style-type: none"> ▪ Can be hard to find unbiased independent entity to run the IX.
<ul style="list-style-type: none"> ▪ All ISPs can be “exclusively” connected to the same location (one AP, several ISPs). The advantage is that the usual interference with several different access points can be avoided. 	
<ul style="list-style-type: none"> ▪ Good for small ISPs, or Single Point WISPs, that can’t afford to put up their own access points. 	
<ul style="list-style-type: none"> ▪ A good alternative for locations where exclusivity can’t be allowed, e.g. City Hall etc. 	
<ul style="list-style-type: none"> ▪ No backbone for upstreams Internet connection needed. 	

Apart from StockholmOpen.net there are a couple of other interesting players such as Nora4U and KanalTierp.nu²⁸ (wired operator neutral network).

6.7 Franchising WISP

Another alternative in offering WLAN access is franchising. An existing WISP, be it any of the above described, can choose to enlarge it’s footprint on the market by allowing third parties to be a part of their network by franchising an entire concept. The franchisee can be a small company, like a café, or it can be a

²⁸ <http://www.kanaltierp.nu>, available December 7, 2001

household in an apartment building. The model is beneficial for all parties; the parent WISP can extend it's network for a low cost and the franchisee will receive some "kick-back" depending on the number of unique users on it's premises. If a revenue sharing model is implemented it will create an incentive for the franchisee to promote the existence of WLAN access. However, it remains to be proven if revenue sharing, QoS and cooperation with a large operator is a feasible business model.²⁹ Please see section 9 "*Final Conclusions*" for a further discussion on franchising.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Revenue sharing. Leads to positive word of mouth if successful. 	<ul style="list-style-type: none"> ▪ Support and QoS. If a node is shut down, what happens? Who's responsible?
<ul style="list-style-type: none"> ▪ Small investment to make a large foot print. 	<ul style="list-style-type: none"> ▪ AAA and revenue sharing requires good technical solution.
<ul style="list-style-type: none"> ▪ No need to pay location rent. 	<ul style="list-style-type: none"> ▪ Need to pay for installation of access points.
<ul style="list-style-type: none"> ▪ If a franchisee attracts neighbors, then customers who would not else have used the service becomes paying customers. 	<ul style="list-style-type: none"> ▪ If too successful, subsidizing of hardware can be expensive (pays off in the long run though).
	<ul style="list-style-type: none"> ▪ If only few franchisees, then no revenues to share which leads to no word of mouth.

²⁹ Please see our previous report, "*WLAN hot spots – Connect the Dots for a Wireless Future*", for an in-depth analysis of this concept.

6.8 Virtual WISP

A company that doesn't own its own network, but lease it from an existing WISP is a virtual WISP. In the mobile telephony world analogy can be seen with the virtual mobile telephone operator Campuz Mobile that lease capacity from existing mobile operator Europolitan/Vodafone. The US-based company Boingo is a virtual WISP that is just launching its services. The incentive for an existing WISP to allocate network resources to a virtual WISP is to maximize capacity utilization and the no-risk revenue opportunities from customers that are normally outside of their scope. The downsides are of course the increased competition and the forced price drop that can occur.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ No hardware cost. 	<ul style="list-style-type: none"> ▪ Revenue sharing.
<ul style="list-style-type: none"> ▪ Large deployment quickly. 	<ul style="list-style-type: none"> ▪ Hard to strike profitable deals with existing WISPs.

Wireless Internet customers do not care who owns the networks – they will go to where they get the best service to the lowest price. Virtual WISPs (or MVNO's, Mobile Virtual Network Operators) are in a good position to win these customers, since they are not hampered by high overhead costs, and can exploit their brands and focus on service.³⁰

6.9 Power Point WISP

The last category of WISPs is the Power Point WISPs. They exist today and as the name implies, all they have is a very good presentation of their business model, but nothing else. All WISPs start as Power Point WISPs, but most never make to become one of the above mentioned types.

Advantages	Disadvantages
Very good presentations.	<ul style="list-style-type: none"> ▪ Only a very good presentation.

³⁰ Ovum, "Wireless Internet Business Models: Global Perspective, Regional Focus", page 15.

6.10 Subscriptions & Payment Methods

Notwithstanding of who decides to seize the WISP opportunity, there are many different ways to offer subscriptions to various target groups. Depending on what target group an end user belongs to, be it a mobile professional or a student, and the location from which the user wants to get WLAN access, be it an airport or a café, there are different pricing schemes available.

There are different types of subscriptions in use today as well as different payment methods so it's difficult to make a true comparison between all. There are three main types of subscriptions in use as we see it:

- Flat monthly rate with unlimited usage. Prices range between \$60-150/month. (DefaultCity charges \$25/month, but can only offer a small number of access points in Stockholm)
- Limited monthly usage, either limited by volume or time. After reaching that limit, a time- or volume based charging scheme is used. The pricing schemes used are so diverse we will not list them all here.
- 24hr subscription. \$8-12 for 24 hrs unlimited usage. Allows for disconnection and reconnection within the same 24-hr period.

The monthly subscriptions are generally invoiced and the 24hr subscriptions (scratch cards) can be bought on various locations that have coverage. As of today the 24hr cards are valid for 24 hrs from the first time it's used.

We think it can attract more users if they're valid for 24hrs effective time. This means it's valid to use over a long period of time and at several different occasions, the total time that can be used is 24hrs. The value, or length, of these one-time cards should also be differentiated to include 1hr, 3hrs, etc. These cards should be refillable, either online or by purchasing a refill-code at various retailers, just like the refill cards for mobile telephones are today.

Another scenario that we think can be attractive is to offer a zone differentiated paying scheme. A user can choose to only pay for access within a certain zone, be

it within different cities or in certain locations only, such as only airports & hotels, only cafés etc.

“I have a hard time believing that it’s ever possible to, in a useful way, create an access net with wide spread coverage to a reasonable price. I do believe in location based charging.”

Östen Mäkitalo, Sr. VP, Telia Mobile

Other ways to attract customers are automatic subscriptions. Let’s say a user accesses a free portal with location specific information, e.g. in a mall. After a while the user wants to have upstream Internet connectivity to surf or check emails. The user can now be presented with a page where an existing username and password can be entered. If the user isn’t already a paying customer to a WISP he/she gets an inquiry if he/she would you like to become a subscriber to WISP. A credit card number need to be presented and then the user can start using the service and will either be invoiced or charged directly from the credit card.

There is also another alternative, and that is to offer WLAN access for free. There are some companies that use this non-existent pricing scheme during their pilot phases, or because of the fact that they don’t have a good AAA system in place (Surf n’ Sip didn’t start charging for their services until the beginning of 2002). However, unless offered as a complementary service (and not core business), free WLAN access is not a viable business idea for obvious reasons.

6.11 Login procedures

Authentication procedures shall be able to prohibit user session establishment prior to successful authentication, e.g. a user needs to be authenticated prior to an IP-address being allocated. The use of WISP services should be no more complicated than the use of mobile telephony services today. All the user needs to do is to remember a PIN-code when the mobile phone is switched on. Re-authentication if network connection is lost, is performed automatically. The login procedures to access a WLAN network can be either SIM-based or username/password based authentication.

Whatever solution is chosen, it’s important to make it as user friendly as possible for the end user. The end user shouldn’t be prompted to re-enter username and

password too often. There are several ways to implement this. One way could be the use of cookies that remember user information³¹, another way could be to use SIM cards.

The use of SIM cards can minimize the complexity of administration for AAA (at least for the scenario where a mobile carrier acts as a WISP). There are several options on how to implement this.

1. Dedicated SIM card reader within the WLAN card. Nokia has implemented this on their Wi-Fi products.
2. By WLAN device communicating with SIM card in phone (e.g. via Bluetooth or IrDA).
3. Other methods include an USB SIM card reader or storing of the SIM card data securely in software on the access device.

Not only AAA functions become easier, but also monitoring of the users to implement positioning services. It is also possible to store more information about the user on SIM-card, such as information about home network if a roaming scenario is considered.

Seamless roaming offers a user-friendly and nearly natural way of accessing broadband outside the network covered by the home WISP. It allows the WISP to offer a transparent service to the end-user. Avoiding unnecessary burdensome logon actions simplifies the action for the user. Therefore it is a key success driver to the expansion of wireless LAN as it offers the easiest access to broadband communication.

6.12 Roaming

There is an increasing need for roaming between different WISPs as the technology advances and the number of users increase and start to demand the roaming and ease-of-use of mobile telephony. You only pay one bill, but you can still use your mobile phone almost worldwide without worrying about what operator you use or remembering different usernames and passwords. One bill from one WISP is also important for the customer.

³¹ For further information, please see Cabellero, Juan & Malmkvist, Daniel, "Experimental Study of a Network Access Server for a Public WLAN access Network"

Roaming between hotspots belonging to different WISPs offers the end-user greater mobility and more hotspots. For the WISP, roaming offers the possibility to easily expand its footprint without investing in an infrastructure of their own.

Worth noting is that roaming is not necessarily limited to international roaming. WISPs in one country can allow end-users to use each other's network to offer a nationwide coverage.

A WISP acts as a different entity in a roaming scenario. It is at the same time a home network for its clients and a visited network for incoming roamers. By signing a bilateral roaming agreement WISPs allow their end-users to use each other's network. Thus they offer service to their own clients as well as external end-users. The visitor should be able to access all the services he/she is used to at his/hers home network, i.e. the network covered by their home WISP.

The clearinghouse for WLAN will work in the same as for the GSM market today. If you visit another country with your mobile telephone, your home carrier might have roaming agreements with one or two of the carriers in the country that you're visiting. If you get connected to another operator, a clearinghouse will arrange the payment with your home operator and you will get it your bill. Luxembourg-based company Excilan³² is trying to establish themselves as a clearinghouse for international roaming between WISPs.

“Seamless roaming is the key success driver to the expansion of wireless LAN as the easiest access to broadband communication. The more “natural” or “second nature” it is for the end-user to access wireless broadband the more likely it will be a success for the mass market.”³³

Lodewijk Cornelis, CEO, Excilan

Both in- and outbound roaming are revenue generators with low financial risk. In addition, this reduces the need for up front investment in network infrastructure whilst optimizing the capacity on existing hot spots.

³² See section 14, “Appendix 3 – Players in the Wireless LAN market”, for more details on Excilan

³³ <http://www.excilan.com> available December 5, 2001

Another interesting issue is roaming between different networks such as WLAN and WAN. Today we say that WLANs can provide mobile Internet but if we are precise WLANs only provide portable Internet. There is a huge difference between portability and mobility. The easiest way for a WISP to provide true mobile Internet is to sign a roaming deal with a mobile carrier.

There are many different ways to roam and to have seamless hand over from one carrier to the other. We feel that the most important roaming issues to discuss are between WAN and WLAN, where the WAN could be GPRS or 3G. It's also important to be able to roam between a LAN and a WLAN without loss of data. The trend right now is to enable multi access services, i.e. there's only a need to develop one service/application which can then be access via different networks. These trends opens the market for two new players, one is the interconnect provider and the other is a clearinghouse for roaming between WISPs.

An interconnect provider is a company that acts as the spider in web between different carriers, enabling an end user to use an application or service independent of access method. The Golden Gate architecture from Telia Mobile is one solution for this.³⁴

6.13 Conclusions

What entities are most suitable to enter the WISP arena and how can they be successful? The single most important advice to new players is the need to crystallize their own business, i.e. why and how are they specialized? Where is the business? How can they make money? It's more a business question how to become a WISP rather than a technical issue. Crystallizing a unique business opportunity is something that's often a long and hard way since there is a need to figure out something that doesn't already exist.

Almost every WISP today fall under one of the following five categories:

- Mobile Carrier WISP
- ISP WISP
- Plain WISP

³⁴ For further information on Golden Gate and the Interconnect Provider Role, please see Nyckelgård, Sören, *Telia Golden Gate* - Technical Overview*, available January 23, 2002 at http://www.telia.se/filer/cmc_upload/0/000/030/185/ResearchGoldenGateTec1Overv2.doc

-
- Location Specific WISP
 - Virtual WISP

As of today, the Mobile Carrier WISP has the undoubtedly largest footprint on the market, but the others are starting to pick up the pace. The remaining three categories

- Franchising WISP
- Operator Neutral WISP
- Single Point WISP

should however not be ruled out as too futuristic or too unlikely to happen. Our opinion is that the Single Point WISP will only make a marginal impact, unless incorporated in a franchising network, since they will mostly offer WLAN access as a complementary service to their ordinary customer base. However, the Single Point WISPs will benefit from the increasing popularity and awareness of WLANs and the free marketing they can get and this can work as an incentive for other locations to deploy networks of their own. As for the other two categories, existing WISPs should be aware that they are likely to emerge in the near future. When they do emerge, the expansion rate can be very fast due to the low threshold for deploying the network. The franchising concept will be further discussed in the next section. For the operator neutral WISP, there are a few facts that talk in favor of this concept. Small ISPs or WISPs can easily make themselves available to a large number of customers at a low cost, the deployment cost for hardware is shared by all participating parties.

Deploying a massive footprint in order to reach as many end users as possible is the business driver of all WISPs with wireless Internet access as their core business. An end user who has invested in a wireless LAN card and a subscription wants to have as many access points as possible. In order to offer the fullest mobility to its clients, a WISP concentrates its major investments in deploying as many hot spots as possible.

Another way to create this massive footprint is through roaming as we discussed above. Although it's crucial that for the WISPs that the roaming is mutually beneficial. There must be an incentive for WISPs to allow roaming. Creating a

larger footprint and therefore allowing their customers a more extensive use of their services could be one, but two WISPs that agree on roaming must have covered locations that are asked for by the customers and where new market shares can be acquired. From a WISP point of view today, we think that international roaming agreements are more likely to be stricken. This is because the customers today are mostly business travelers that have a need for international access. However, when the market is maturer for other segments, national roaming will become more important. Compare this with the roaming issues today for GSM operators in Sweden. The only type of roaming agreements that exist are international ones. There is no national roaming. The WLAN scenario is a bit different, since it's not economically viable for one operator to cover all potential hot spots by itself due to the price and short range of the access points, but more importantly from the fact that the frequency spectrum does not require a license.

The scale of WISP enterprise is debated. There is an interest to be a large-scale operator, such as Telia HomeRun to achieve a dominant market position and to utilize the large-scale advantages. This could include support, management and maintenance that can be rationalized while running the service and thereby reducing the production costs on the common parts of the network.

This is fundamentally different from the other option, which states that the WISP enterprise should be in a smaller scale. The arguments for this are profiling/branding, i.e. the ability to locally stimulate the end user and for the user to react to the stimuli. As an example, two different local WISPs can be compared, one at an airport and one at a café. The WISPs targets different segments and they can both offer local content that would be useless on the premises of the other WISP. This is a local phenomenon. You're always "local" wherever you are.

“If a Mini and a Porsche are at a red light. The Mini beats the Porsche in the first few meters because it's much lighter than the Porsche.”

Alexander Latour-Henner, Sr. System Architect, Service Factory

There's analogy for WISP startups as well. The threshold for a smaller WISP is lower. It's just to install an access point and start doing business. This is above all true if the WISP business is not the core business for the AP owner and that you're instead running it on behalf of your other business area, for example a café, i.e. the WISP is a Single Point WISP as we have described earlier. When the WISP business is only a margin, it's an enabler for other businesses and not business in itself. To refer to what said earlier with the Mini vs. Porsche comparison, a small WISP will get a head start over the larger WISP, but will later be overtaken since the WISP business is not core business. I.e. due to heavy investments the larger WISPs will take longer to become profitable. Profitability from the wireless Internet access might not even be important for a Single Point WISP, merely the soft benefits of marketing.

In addition, the fees negotiated between a property owner and WISPs are increasing alongside the popularity of the premise. High value premises such as hotels will not want to exclusively grant their property to only one network, but try to get as many network operators to operate in their area. This will lead to a price discussion that could mean a charging fee based on usage of the network in the premises. An airport lounge will i.e. want to benefit from growing variable revenues instead of a fixed (monthly) renting fee. With the increasing awareness of the benefits of WLANs, the property owners play a most important role in the development of the WISP market.

As mentioned above, there are several companies that fit into more than one WISP category. This might very well be the best way to seize the WISP opportunity. If several different entities can unite and together form a WISP where they all contribute with different skills a strong WISP can emerge. The different players will all take a smaller risk compared to if they were alone. Of course a shared risk also means shared revenues, but it also means that it's a shared loss if the business case is not successful. And shared revenue is better than no revenue.

“Sometimes you need your competitors to create a market. It’s better to have 33% of a market than 100% of no market. Once the market is established, you can start competing to get market shares.”

Östen Mäkitalo, Sr. VP, Telia Mobile

Large or small WISP set aside, according to BWCS the number of hotspots are predicted to 10-fold over the next four years. So there’s definitely a need for someone to seize the WISP opportunity.

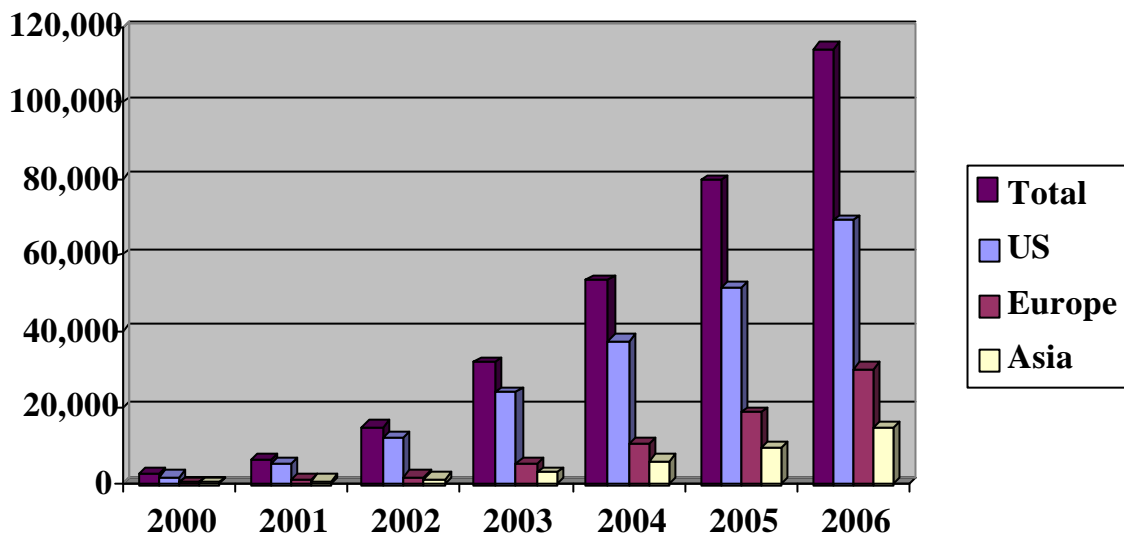


Figure 2: Growth of Public Access WLAN Hotspots 2000 – 2006. (Source: BWCS)

Is it possible to target any other market segment apart from mobile professionals? If yes, how can we target it? If no, how can we create one? Next section will investigate the market trends and how to segment the market in order to launch a strategic WISP operation.

7 CROSSING THE CHASM

WLANs are at the almost at the brink of becoming a mainstream product, at least to become a product used not only by the mobile professionals but also in homes and in other places. However, prior to achieving this status and hence the possibilities of large profits, there are several issues a WISP must consider. In this section we will try to address those issues.

Before we look into the different trends of the WLAN market, we must understand the behavior of the market for new technologies. According to Geoffrey A. Moore, author of “Crossing the Chasm – Marketing and Selling Technology Products to Mainstream Customers”³⁵ there’s a chasm over which new technologies must cross in order to reach mainstream markets. We’ll describe the theories presented by Moore and how and why they can be applied on WLANs from a WISP point of view.

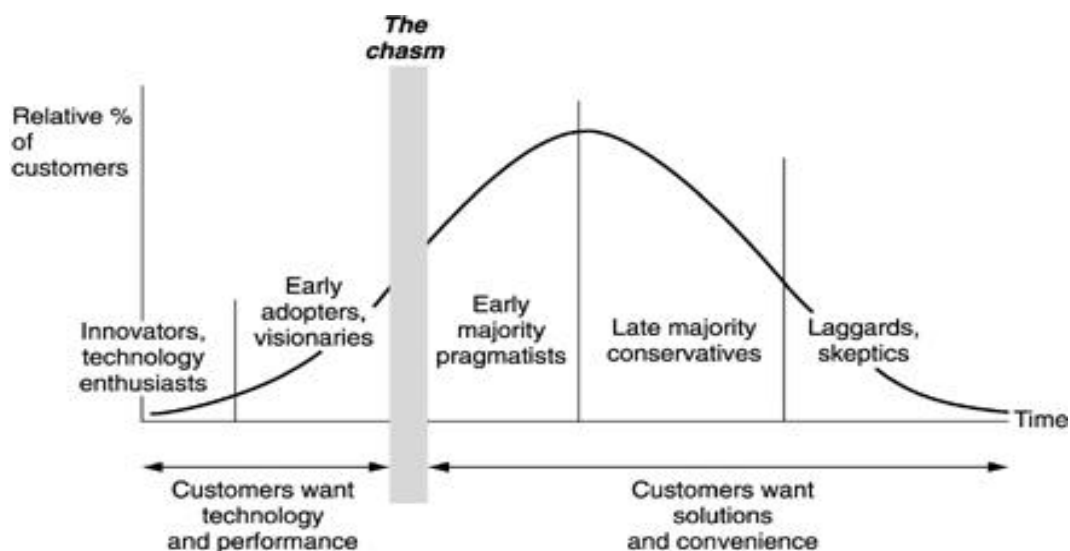


Figure 3. *The technology Adoption Life Cycle*³⁶

There are two types of new technology innovations, continuous and discontinuous innovations. Continuous innovations, does not require a change in behavior for the user, e.g. faster broadband connections doesn’t require change, you would still use the same Network Interface Cards (NICs) and the same login procedures. A discontinuous innovation, such as WLANs, require new NICs, access points and

³⁵ Moore, Geoffrey A, *Crossing the Chasm*. New York: HarperCollins, 1999

³⁶ http://www.nngroup.com/reports/life_cycle_of_tech.html

the general use of laptops in a mobile environment. Hence, the behavior in how the user has previously connected to the Internet has drastically changed. The user need to buy new hardware and is now able to get Internet access in new locations and can use the computer wirelessly in a more mobile or portable fashion, albeit for the power cord which is still needed occasionally. The technology adoption life cycle above is a marketing model developed to cope with this type of product.

As seen in the figure above, the total market is illustrated by a bell curve where the early and late majority falls within one standard deviation and makes a substantial amount of the total market, i.e. the mainstream market.

The groups are distinguished from each other by their characteristic responses to discontinuous innovations. In the following sections we'll discuss these responses as well as describe what type of customers a WISP can expect to find in the different segments.

7.1 Market segments for WISPs

As seen in the illustration above, there are five major different segments of customers:

	Description	Example	Motto
Innovators or Technology Enthusiasts	People who appreciate the technology for it's own sake.	Elektrosmog and BAWUG (Bay Area Wireless User Group).	"High-tech products should be available for free or at cost price."
Early Adopters or Visionaries	Looking for technology and performance. They are not looking for an improvement in how business is done, but a breakthrough.	Mobile Professionals	"The best way to save time is to use it!"
Early Majority or Pragmatists	Looking for a technical solution that offers reliability and convenience. Hard to win over, but loyal once won.	SME (Corporate) and SoHo markets as well as students.	"Evolution, not revolution."
Late Majority or Conservatives	Often "fear" high tech a little bit. Invests when market is really mature and prices are low.	John Doe ("Medel-svensson")	"Tradition is better than progress."
Laggards Or Skeptics	Don't believe in, nor want to buy, anything high tech. Will buy WLANs when it's pre-equipped in the fridge.	Too early to predict.	"We won't buy a new product until hell freezes over"

Table 1: Description of the different segments in the Technology Adoption Life Cycle.

In the Technology Adoption Life Cycle, each segment is divided by a line except for the transition between Early Adopters and Early Majority. This gap is referred to as the Chasm. In order to reach the mainstream market, and hence the possibility to make a large profit, the chasm must be crossed.

The reasons the chasm occurs is because the two groups on each side have different reasons as to why they adopt a new technology. The Early Adopters are looking for some kind of change agent. By being the first to adopt this new technology they expect to get a jump on the competition, be it from lower production cost or, as in the case of WLANs, to increase efficiency while away from the office. By contrast, the Early Majority is looking for an enhancement of the way they are used to work. They want evolution, not revolution and by the time they adopt a new product they want it to work properly. This calls out for a well thought through marketing strategy in order to be able to harvest the profits that lure within the mainstream market.

If the goal for a company is to become the dominant player within a certain market, then the best strategy according to Moore is to focus on one, and one only, niche market of the Early Majority segment. Once you have become the dominant players within that niche, the next can be approached. If the first niche market is chosen wisely, it can lead to a quick adoption of a product in a neighboring segment. This strategy can be compared to bowling. If the first niche market chosen as the first pin of bowling, and the neighboring niche market is the second pin etc. A bowling effect can then be achieved, where the first niche market (bowling pin) knocks down the next and so on. Worth noting is that it might not be the strategy of every company to become the dominant player within their market. Ferrari is a very successful car manufacturer, but nonetheless they are not the dominant player in that market.

Below we'll describe the characteristics of each segment and how to further subsegment them with regards to WLAN. We will also offer suggestions on what subsegment (niche market) to choose as a first bowling pin. The various segments all have different needs and demands for a new product.

We will not discuss the Innovators (which we consider to be WLAN user groups such as Elektrosmog and BAWUG) or the laggards for two reasons. We feel that

the WLAN industry is already beyond the point where the innovators make an impact and the laggards because they're so far ahead in time and we cannot predict what they will want. Also, by the definition by Moore, a Laggard is generally not worth the marketing effort. They will buy a new product only when it comes built-in in something else that they buy. This could, in the WLAN case, be when new cars come pre-equipped with WLAN technology.

In the following sections we'll describe the three most important segments, the Early Adopters, the Early Majority and the Late Majority. We will then describe two different strategies for a WISP to adopt in order to successfully cross the chasm.

7.1.1 Early Adopters

We feel that the mobile professionals, i.e. travelling business people that have a need to connect to both corporate data as well as the Internet while away from the office to increase efficiency, are the early adopters of the WLAN market. There are several reasons why this is a first group to target. Mobile professionals are not price sensitive, they quickly adopt new technologies that can make them more efficient during "grey time". Such as time spent in airports, hotels and the like. They were among the first to adopt laptop computers and mobile phones for those reasons.

WISPs targeting this group have realized the importance of a breakthrough among the mobile professionals before the consumer market is ready. As with mobile telephony, the high-end customers will be the driver of this new technology. The fact that most WISPs today target the mobile professionals, e.g. Telia HomeRun and WayPort validate this point.

7.1.2 Early Majority

This is the most important segment if you want to get a dominant position in the market. This section represents the bulk of the market volume for any technology product. Customers in this segment are looking for a technical solution that offers reliability and convenience. They are hard to convince and to win over, but loyal to their brand once won.

But just to get to some customers in the Early Majority with a product won't automatically lead to famousness and dollars. It's still most important to have a

well thought through marketing strategy as well as having selected an appropriate niche market to target.

There are many different ways to divide the early majority into different niche markets. There are several reasons for this. To mention a few:

- What type of WISP is doing the segmentation?
- Is the goal to become a dominant player or is the WISP content with just one niche market?
- Is the WISP already existing in WLAN market or are they just starting?

So how can this division of niche markets be accomplished? By differentiating services using QoS and features new user groups can be created. We think that the early majority segment can be divided into the following niche markets:

- Modern “urban” users in constant need of e-mail and Internet services.
- SME / SoHo (Small Medium Enterprise and Small office / Home office) to increase mobile efficiency. Framework agreement for employees to use WISP network can be stricken.
- Students that need network access at home, on the campus, in libraries and at the local café. Large potential customer base within a group that’s already used to the advantages WLANs
- Traveling salesman who doesn’t need to return to the home office as often
- Location based services in malls and such for the general public
- Service engineers in need of WLAN access in remote locations other than hotels and cafés.
- Franchising of a WLAN concept from a WISP

This segmentation can be used to make a selection of what niche market to use as the first bowling pin for a WISP choosing to enter the WLAN market. However, there are more possible segmentations of the market that will not lead to the same selection of first bowling pin depending on what company intends to become a player in the WLAN market.

The selection of the mobile professionals as the first niche market to address has up till now been the obvious choice. Since the mobile professionals are a very

large group of customers we think that they exist on both sides of the chasm and can therefore be considered to be both part of the early adopters as well as the early majority. This is why the logical choice of the next bowling pin for existing WISPs that has targeted the mobile professionals is possibly the SME or SoHo market which are described below.

It is in this section where most of the work lies. To succeed you have to carefully and strategically choose a niche market to be your first target group. You have to satisfy all their needs to get them to buy your product. But once you have won your first target group you will have a loyal group of people that will use your product as the de facto standard and buy your product and your product only. Once you have conquered the first target group you can start to market your product to all the immediate subsegments.

7.1.3 Late majority

Mathematics and the Technology Adoption life Cycle model says that for every person who belongs to the Early Majority category there is a person who belongs to the Late Majority category. This category of people is against discontinuous innovations. They believe far more in tradition than in progress. And when they find something that works for them, they like to stick with it. The truth is, people in this section fear high-tech a little bit. Therefore they tend to invest only in at the end of a technology life cycle.

Before this group can be addressed there's a need to develop more mobile applications and services that will attract the late majority. But one way to address this more conservative group, is to bundle modem offers (xDSL, Broadband and Fiber) with an access point. It can also be targeted in new buildings where WLANs is used instead of cabled LANs.

7.2 How to Cross the Chasm – Two Scenarios

We think that there are many different strategies for capturing market shares in the Early Majority segment. In this section we'll describe two different approaches that we feel are feasible in the near future. Existing WISPs that are targeting mobile professionals today should continue to focus on business users in the SME and SoHo segments. Emerging WISPs could focus on the consumer market by taking a franchising approach. There is a difference in mindset regarding what aspects are important for business users or consumer users as illustrated in the table below. These issues should be taken under consideration depending on what the target group is.

Relative Importance	Business Users	Consumer Users
Most Important	Wide Availability Reliability (QoS) Security VPN Access Seamless Connection Single Billing Relationship Data Transfer Speed	Cost Wide Availability Seamless Connection Reliability (QoS) Security Single Billing Relationship Data Transfer Speed
Least Important	Cost	

Table 2: Illustration of the different demands of what's important with WLANs for business and consumer users. (Source: Analysys³⁷)

7.2.1 A SME & SoHo scenario

The market segments Small Medium Enterprise (10-500 employees) and Small office / Home office (1-10 employees) is a large group that's very important to target. This group consists of people that are used to having wireless access at work and have learnt to understand the benefits and might want to implement wireless access at home as well. This group has almost the same incentives as mobile professionals in order to increase efficiency while in the office, but they lack the need for wireless access in airports and similar places. They are more price sensitive than mobile professionals but still not as price sensitive as other target groups.

³⁷ Analysys 2001, "Public Wireless LAN Access: A Threat to Mobile Operators?", page 8.

This group can be targeted through different value-added services, in excess to the usual services, such as QoS, roaming within the corporation, roaming between different networks (WLAN/WAN) or VPN tunnels for secure way to access corporate data. These services could include stock ratings, sport stadium features or pushed profiled advertising (see section 8 “*Current and Emerging Markets*”, for more examples). It’s still difficult to charge for content and services on the Internet, and not a unique problem for WLANs market and is therefore not addressed in this report.

A WISP that can offer a complete package of some kind of value added services as well as wide availability to their network stand a good chance of dominating this niche market.

This group can be chosen both as the first target group for new WISPs and as the second target group for already existing WISPs. If a new WISP chooses to enter this segment of the market, they must have a well thought through business idea in order to compete with the experience and the head start that mobile carrier WISPs and others already have in this segment.

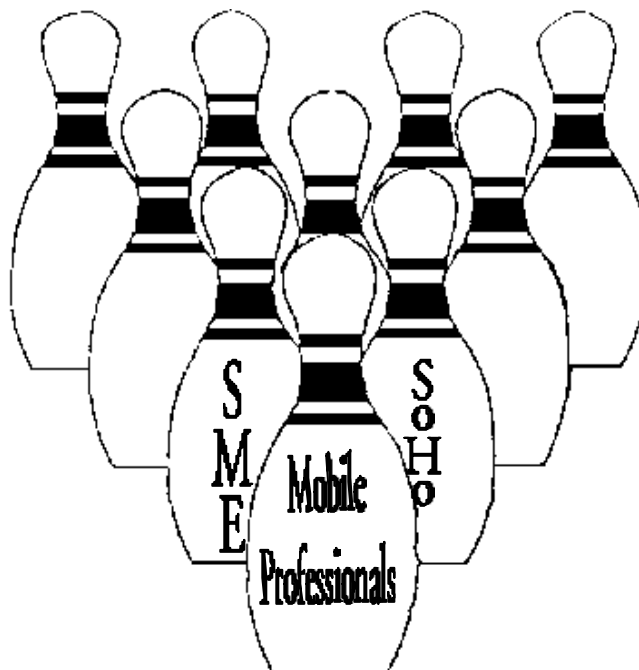


Figure 4: Illustration of the bowling alley model for a WISP targeting business users.

7.2.2 A franchising scenario

With the advent of new business models, such as franchising and operator neutral networks, there's an opportunity to choose a different niche market and hence a different first bowling pin but still be able to knock a substantial amount of pins down.

Franchising, or revenue sharing model, is another way to introduce WLANs services. This concept targets companies, small offices, cafes as well as homes. This idea is a way of building a large network without large investments from the WISP putting up sites or building the Internet backbone. In this case there has to be a three-way cooperation between the WISPs, ISPs and the site owners.

The role of WISPs in this model is mostly administrative i.e. to handle revenue sharing, brand marketing, QoS (together with the ISP), AAA etc. The role of the ISP is a passive one, they only have to maintain high QoS and allow multiple users for every connection. Site owners have to fulfill several obligations that are demanded by the WISP to be a part of the network. These demands include that they have to have a minimum capacity to offer, don't turn the base station off and promote the availability of the service.

The incentives for various locations to become franchisees differ. Here we will illustrate three different potential franchisees and what their drivers are.

- A café owner might want to install an access point simply to get a competitive advantage over other cafés and at the same time have an opportunity earn some money through the traffic he generates. This way, the administrative back end use of the network can be paid for by the customers.
- A chain of stores, such as ICA or Statoil in Sweden can use the franchise network to offer an extra service to their customers and at the same time get an administrative network that can be utilized for inventory and the like.
- A homeowner might put up an access point simply because he wants one at home. If he, at the same time, can convince his neighbors to sign up for

the service, he, too, has a chance to lower his own broadband cost. Most of the home users might not generate a lot of traffic but they will contribute to a better coverage of the network and should therefore not be excluded from the network.

The kickback that a public site owner (such as a café) can receive from the franchise company can either be from attracting new customers to subscribe to the service or from generating traffic through their access point. In the latter case, revenue sharing with the ISP must also be implemented.

By choosing a franchising concept, a large footprint on the market can be established for a small investment. This approach can be chosen by a new WISP wanting to enter the market.

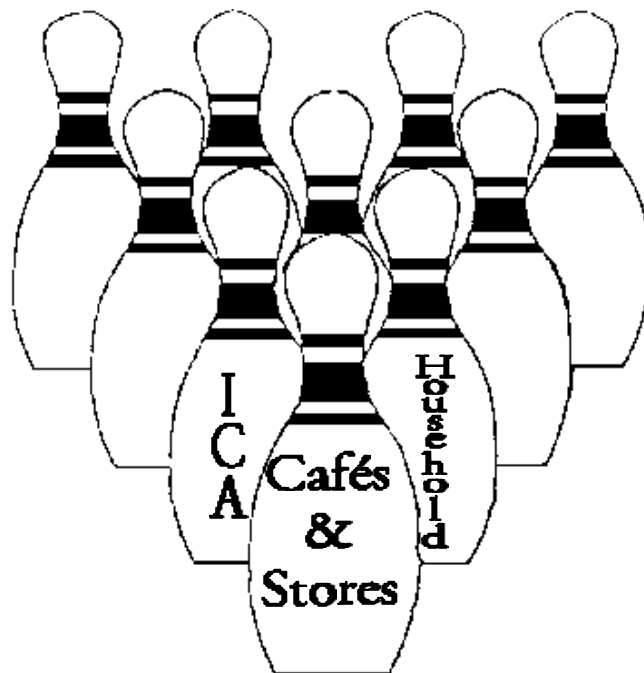


Figure 5: Illustration of the bowling alley model, if a franchising approach is chosen.

7.3 Conclusions

In order to successfully cross the chasm it is of outmost importance to focus on one, and only one, niche market at the time. If a dominant position in the entire market is sought after, another niche market can then be selected. By carefully choosing the niche markets, a bowling alley effect can be achieved.

“Trying to cross the chasm without taking a niche market approach is like trying to light a fire without kindling.”

Geoffrey Moore³⁸

We have only illustrated a few possible strategic first bowling pins, where we think that franchising and SME / SoHo are the two most feasible first niche markets at this point in time.

The same company should not focus on more than one niche market at the time. An exception of this rule is if a virtual WISP, fully owned by an existing WISP (“Mother WISP”), but not operated by the same management team, chooses to approach a different niche market than the mother WISP. This way, two independent and separate niche markets can be targeted. The two different services offered by the existing WISP and the virtual WISP don’t compete with each other. Valuable resources in, for example, network planning can be utilized by both companies. In comparison with the mobile telephony market, Telia Mobile and the MVNO (Mobile Virtual Network Operator) Halebop, which is owned by Telia with two different target groups, illustrate this point.

Companies should be very cautious when choosing a niche market. According to Geoffrey Moore, almost all successful crossings happen in business markets, where economic and technical resources can absorb the challenges of an immature product and service offering. This talks in favor of both our approaches. The mobile professionals of both sides of the chasm will make sure that it is successfully crossed and that the marketing efforts can be focused on both the SME / SoHo segments as well as adopting the franchising model.

³⁸ Moore, Geoffrey A, *Crossing the Chasm*. New York: HarperCollins 1991, 1998, 1999, page 65

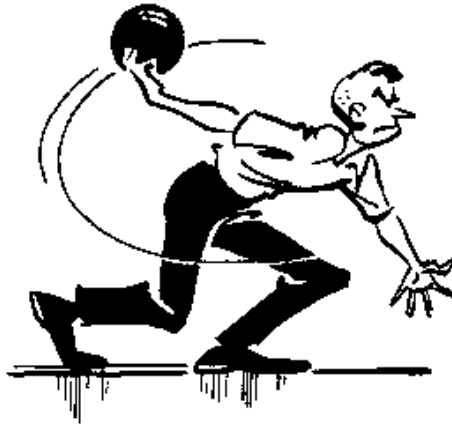


Figure 5: *Become a WISP. Select a strategic niche market (first pin) and Bowl Away!*

In this section we have discussed the importance of a niche market approach and how to select a strategic niche market as the first bowling pin. However, in order to do so, the trends of the market today and the future scenarios that can be expected must be analyzed. Is the time now to seize the WISP opportunity or is the market not yet ripe? This is what the following section will attempt to clarify, what are some the trends and emerging markets in the wireless world?

8 CURRENT & EMERGING MARKETS

WLANs is the word on everybody's lips at the moment. Every research and analytical firm worth the name produce WLAN-reports and prognosis by the dozen. Every stakeholder has an opinion on what will happen. In this report we have tried to analyze the market trends in the Scandinavian region, specifically Sweden.

Up till now the market has been targeted towards the early adopters, i.e. mobile professionals. WLANs have been considered a way to increase the efficiency of the workers while away from the office in locations such as airports, hotels and conference centers. So far the coverage has been limited, the prices have been high and there hasn't been any useful mobile applications except accessing corporate data.

However, as we've noted in the previous sections and as we'll see in this section, things are starting to change. Different locations, such as hospitals, convenient stores and airports are considering WLANs as a way to pay for their own administrative networks and at the same time offer something to their visitors.³⁹ Furthermore, public county council buildings such as libraries and the City Hall are installing WLANs as a public service offering. Prices are falling on both terminals and access points.⁴⁰ Small WISPs, such as DefaultCity⁴¹, offer WLAN services to a fraction of the cost from the larger operators. With the arrival of location based services, such as the E-street program in Luleå, Streetwise in Stockholm and Telias GSM service Friend Finder (all these services will be described later in this section), there is an incentive for location providers to implement WLAN services for their ordinary customer base.

Today, there is analogy to be made between WLANs and telephony. In the early days of telephony, one small community of summerhouses had only one public telephone kiosk. The telephone kiosk was located in the center of the village and this was where everybody went to make their phone calls. If that phone rang whoever was close to the kiosk answered the phone and found out whom they

³⁹ http://www.dagensit.se/pub/pub92_19.asp?art_id=16431, available December 6, 2001

⁴⁰ Interview with Jan Person, VP Marketing, Dustin AB. October 9, 2001.

⁴¹ See section 14, "Appendix 3 – Players in the Wireless LAN market".

were seeking. The person that answered made sure to get hold of the person that was wanted.

It worked then, and today we are somewhere in the telephone kiosk stage when regarding WLAN hot spots. If a person needs to have access to WLAN, he will go to a hot spot. The friendly neighbor that tells you have a call waiting can be an always-on instant messenger service via GPRS/3G that notifies you of new e-mail. You can then find a hot spot to download that e-mail. Some people wanted to have their own telephone and some people thought it was enough with a telephone kiosk, but after a few years fixed telephony became cheaper than using a telephone kiosk and everyone bought a phone. We believe that the same analogy applies to WLAN. Some people are content to have access only in certain hotspot locations, while others want to have their own equipment at home.

With the knowledge from the previous sections in mind, we're ready to analyze the current trends as well as try to predict the future of the WLAN market. This, being the million-dollar question, will be difficult to predict, but we feel that with our extensive research that we can make an educated prediction. In order to take in the trends of the WLAN market in general, we have chosen to look at the trends within three different segments:

- **Terminals** used to access WLAN services
- **Locations** from where WLAN services are offered
- **Applications and Services** that can be offered via WLAN

8.1 Terminals

The terminals used today to access wireless LAN services are either laptop computers, PDAs (Personal Digital Assistants) or wireless LAN enabled desktop computers. Currently the prices for WLAN enabled devices and PCMCIA cards are too high for mass market adoption, but they are falling.⁴² Predictions made from BWCS and others show that the number of wireless LAN enabled devices will almost increase 5-fold by 2006.

⁴² Interview with Jan Person, VP Marketing , Dustin AB. October 9, 2001

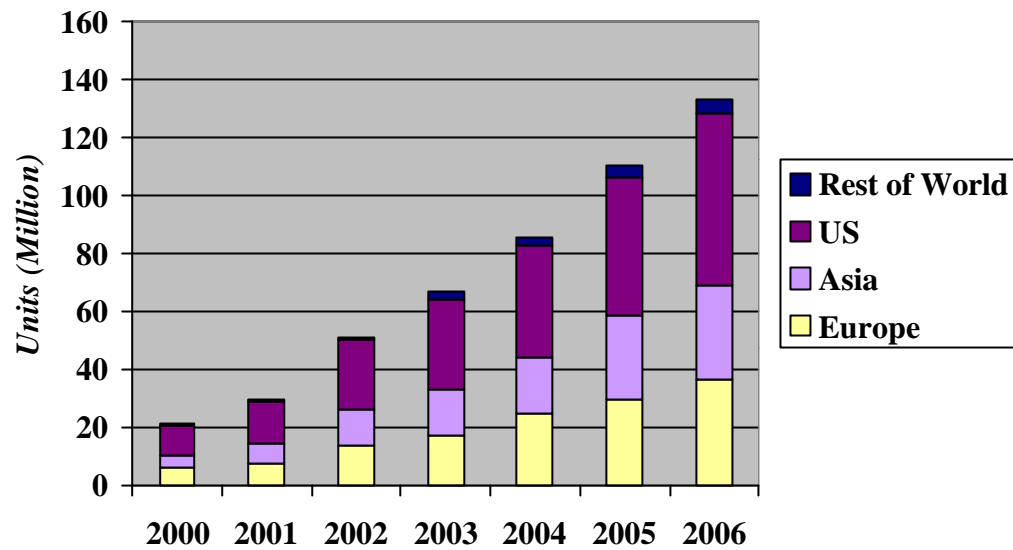


Figure 6: Wireless Enabled Laptops and PDAs. (Source: BWCS)

Laptops, PDAs and mobile telephones are all starting to come pre-equipped with either Bluetooth or 802.11b. One way of foreseeing the future of PDAs is that the technologies that we today see as PCMCIA cards will be built-in tomorrow. As soon as a technology is cheap and viable enough it will be built-in. In the near future it's likely that the distinct line between mobile phones and PDAs will disappear when the two will merge together as one.

Most laptops today use operating systems from Microsoft. With the advent of their latest version of Windows, called XP, an extensive support for WLAN has been implemented. It has simplified installation of PCMCIA cards, i.e. more plug-and-play, and also enables the user to easily switch from one available network to another. For example, a user can easily switch from the corporate network to the home network or a network from a WISP.

*"If any one technology has emerged in the past few years that will be explosive in its impact, it's 802.11"*⁴³

Bill Gates, Chairman and Chief Software Architect, Microsoft

Considering Microsoft's dominating position in the market, this development will further fuel the quick uptake of WLAN products.

⁴³ <http://seminars.internet.com/80211/spring02/>

There are two kinds of WLAN cards, PCMCIA cards (also referred to as NICs, Network Interface Cards, that go into the standard slot on laptops) and compact flash cards (a smaller version of PCMCIA cards that are developed for PDAs). The PCMCIA cards are made for laptops where not as much consideration to power consumption have been made as for the compact flash cards, which employ an advanced power management and throughput power scheme, for PDAs. The use of special drivers and new hardware will lower the power consumption even more for both types. There are several ways to lower the power consumption. The WLAN card can be in sleep mode and only broadcast intermittent, i.e. to send and receive only when needed. Furthermore automatic regulation of the output power depending on the distance to the AP can be implemented. Lower output on the WLAN can reduce battery consumption down to Bluetooth levels.⁴⁴ Battery technologies are also improving, both with regards to size and of course to lifetime.

Not only terminals are needed to access WISP services. There's also a need for a location from where these services can be accessed.

8.2 Locations

The number of locations covered with WLANs is increasing every month. Right now the main reason for choosing a location is to cover places where many people gather, such as an airport, a hotel or a café. In short, all locations where people have the time or need to "go online" are potential hot spot locations.

But apart from these obvious locations for hot spots, other places are realizing the benefits of WLANs. Below are both current and some potential locations described.

8.2.1 Airports

Airports are one of the first places, and still the main place of the traditional WISPs. The obvious reasons for this is that the primary target for WISP services, the mobile professionals, frequently spend a substantial amount of time there.

Since the whole idea of air travel is to fly from one airport to another, the need arises for the mobile professionals to have WLAN access at the visited airport as

⁴⁴ Interview with Rikard Kindlund, Sr. Product Manager, Compaq, October 22, 2001

well. This has created an incentive for WISPs to strike a deal with an airline to cover all their VIP lounges i.e. Telia HomeRun and SAS. If that doesn't work, international roaming agreements with WISP in other airports should be stricken. A third option for the user is to purchase a short term subscription with a foreign WISP.

Another trend among airlines, e.g. SAS, is to investigate the possibilities of offering WLAN access to their travelers while in-flight.

Several airlines are running pilots or have operated pilots where airline personnel can check-in travelers with WLAN enabled handheld computers. This is a way for airlines to avoid long waiting lines to check-in desks or take care of passengers arriving late to the airport.⁴⁵

8.2.2 Chain Stores and the like

Organizations that already have a high market penetration and a well spread customer base, such as Shell, ICA or even McDonald's, are well suited to become a WISP. They can instantly reach all their customers and if they at the same time build hotspots on all their points of presence they will quickly make a large footprint. This business idea can be made profitable by ensuring everyone that customers can use all the hotspots and make sure that the QoS is good. A third party, such as an ISP or a WISP can handle the AAA functionality needed to do this.

This scenario can either be adopted by the locations itself to offer an additional, maybe complementary, service to their customers, or it can be used by a WISP. The WISP can either be a location specific WISP or a franchising WISP wanting to incorporate these locations for their own network.

For gas stations, the arrival of automotive communications can be a reason to invest in a WLAN network on their premises. All car manufacturers develop automotive communications today. General Motors⁴⁶, in association with Delphi, recently presented a product platform based on IEEE 802.11a. This will enable a car owner to download a full-length movie in less than five minutes. Passengers in

⁴⁵ http://www.mobile.commerce.net/story.php?story_id=964&s=5, available January 4, 2002

⁴⁶ Elektroniktidningen, Nr 1, January 31 2002, page 10.

the back seat can then view the movie. Other services that can be implemented are of course music for download, but primarily, data from the car can be uploaded to service stations, alerting the driver of when a new service must be performed. Another scenario could include the possibility to download a game that can be played interactively between two cars using a WAN technology.

“A family with children downloads a game at the gas station using WLANs which can be played interactively with GPRS with another car.”

Östen Mäkitalo, Sr. VP, Telia Mobile

The offering of access to the patrons can be considered the base offering and different gas stations can offer different value added services at different prices. A possible future offering could be to offer a movie complementary when you buy gas for more than SEK300 (~\$30).

A chain store can either become a franchisee or take an active role as a location specific WISP.

8.2.3 Homes

It's becoming increasingly popular to install WLAN access in homes. Statistics from both Dustin and D-Link show an increasing amount of consumers, and not only companies, investing in WLAN equipment. Many home users have already put up base stations for their own use which allows them to move around the house and even outside the house for a certain distance and stay connected all the time.

The home market was one of the main areas where WLANs was expected by the HomeRF Working Group⁴⁷ to grow from the beginning of the standardization of WLANs products. HomeRF was thought as the key to success when it was introduced in early 1998, but it didn't turn out to be as successful as expected.

But things are about to change. The second wave of procurement for home-PCs in Sweden is under way. It was roughly three years ago when the previous deal was struck. In that deal employees were offered to buy a subsidized PC from their

⁴⁷ <http://www.homerf.org>, HomeRF WG consists of Compaq, Motorola and more.

employer. A certain amount was withdrawn from their gross income every month and after three years they were offered to buy out the computer at market value. This will be the second PC in the home. Many people, not all, will keep the old computer as well and give the new to the kids to play games on, or vice versa. This is possibly a more common scenario than one would think, since many of the games of today require very powerful processing abilities. In any case, there will now be two computers in the house and people will want to connect the two so they can use the same printer etc. This in itself will be a driver for WLANs.

“In the new deal there will be a bundled offer of a wireless LAN kit for home usage. The home kit will include a couple of NICs and a home access point. We estimate to sell 80 000 home computers in Sweden next year and we expect at least 25 % to choose the WLAN kit.”

Rikard Kindlund, Sr. Product Manager, Compaq

Another driver for the home market could be an offering an xDSL modem that is combined with a WLAN access point. ISPs already have to supply the cable modem to their customers and this could be a good way to attract more users. Actiontec Electronics is one company that recently launched such a product⁴⁸.

The needs and wants of WLANs are not confined to computers alone, but also to other home electronics such as TVs, VCRs, stereos etc. If a household has only one DVD, but several TVs, wireless gateways can be used to replace cables so more than one TV can be supported by the same DVD.

There are also wireless TV's available from Intersil⁴⁹ and others. These products are all based on various wireless technologies. Microsoft has a venture, called eHome⁵⁰, aimed at capturing this market.

⁴⁸ <http://www.80211-planet.com/news/article/0.4000.1481.952171.00.html>, available January 21, 2002

⁴⁹ http://www.intersil.com/pressroom/20010911_SharpFINAL_English.asp

⁵⁰ <http://www.microsoft.com/windows/ehome/>, available February 6, 2002

8.2.4 Hotels and Conference centers

The difference between a conference hotel, like Foresta⁵¹ on Lidingö outside Stockholm, and a “regular” hotel is that the guests of a conference hotel use the premises more as an “office”, rather than just a place to stay for the night.

Hotels used to make a big profit on telephone calls. Today that income is almost gone since most people use their mobile phones instead. It goes for dial up modems as well, many enterprises use a call back function so the hotel only makes a fraction. Some hotels have invested in ISDN subscriptions, but they too, remain unused for most times. The hotel owners are not willing to miss this opportunity and once again let the operators collect all the revenues. Therefore they can opt to be part of financing the installation of WLAN on their premises and thereby collecting revenues on subscription. According to Pontus Nord, Technical Business Developer at Wirelessbolaget, their statistics⁵² show that the customers using the WLAN can pay for the administrative network.

8.2.5 Hospitals

There’s a big potential for WLANs in medical care environments. If a hospital installs WLAN access points and equips the staff with wireless devices instead of fixed Ethernet stationary computers they will not only be more efficient, but they will also be able to admit more patients and have a possible extra source of income. Does it sound like utopia? It’s not.

The hospital Sunderby in the Northern parts of Sweden have installed WLANs throughout the premises, apart from the intensive care units and surgery sections, which is being used by doctors and nurses to handle medical records. A large hospital in Stockholm is currently installing WLANs from Wirelessbolaget. Their plan is to sell the redundant bandwidth to patients as well as to visitors. This way, the hospitals can use WLANs as a way to pay for their own administrative networks and at the same time offer something to their visitors.

The benefits of using WLANs for patient monitoring have been thoroughly investigated⁵³ and extensive testing at Karolinska Sjukhuset in Stockholm have

⁵¹ <http://www.foresta.se>, available December 5, 2001

⁵² Classified material from Wirelessbolaget that we are not allowed to publish.

⁵³ Dehlbom, Anna, “WirelessLAN Connectivity in Patient Monitoring”, Master Thesis KTH 2001

been conducted as a master thesis project from KTH⁵⁴, which have shown no interference between the WLAN and the medical equipment.

8.2.6 Specific WLAN spots

There can be a future incentive for companies to install wireless access points at specific locations, such as next to ATMs, at gas stations and similar places. If people can get used to wireless Internet access at certain locations it will become natural to use it there. Fill up your wallet as well as your PDA could be a scenario when you are at an ATM. Your device should automatically recognize accessibility to the Internet and depending on your personal settings, for example download your emails. There's analogy to be made with gas stations, fill up your car as well as your wireless device.

8.2.7 Sport stadiums

One way to utilize the high bandwidth capacity of WLANs is to broadcast streaming video. This has a wide range of applications, one is to broadcast sporting events in arenas and stadiums over 802.11b.

This is currently being investigated in the Arena program at Mäkitalo Research Center within the technical university of Luleå in Northern Sweden. The goal is to develop new services, applications and technologies that support different types of public events and enhance spectator experiences, mainly in sports, cultural and trade-fair contexts.

Players and referees in Luleå Hockey have been equipped with tiny helmet cameras and monitoring equipment for both pulse and breathing. Test pilots in the audience have been equipped with WLAN enabled PDAs (Compaq iPaq) and have been able to view the games from different angles and to get replays of goals in streaming video straight to the PDA. The test pilots could also watch concurrent games in real time and see how the results affected league standings, player points and other statistics. The rest of the audience was also able to watch the new angles of the game on the big screen in the arena.

⁵⁴ Håkansson, Peter & Marve, Therese, "Trådlösa tekniker i sjukvården", Master Thesis KTH 2002

“Allowing the audience to see the game from my perspective can help them to appreciate how difficult it is for a referee to see everything that happens on the ice.”

An impressed referee⁵⁵

WLANs can also be used to unload the coming 3G technology at arenas and similar places when they become overcrowded.

8.2.8 StockholmOpen.net

An ongoing collaboration between the IT university, the City of Stockholm and the civic administration of Kista have plans to cover the indoor shopping mall in Kista (suburb North of Stockholm, also known as the Wireless Silicon Valley of Sweden) with WLAN.⁵⁶ The project can be seen as an extension of the ongoing research project StockholmOpen.net⁵⁷, where an operator independent network is being deployed. The idea of the network is to enable broadband Internet access for students, employees and visitors with laptop or PDA wherever they move in Kista.

“Imagine that you’re waiting for a hair cut and whilst doing so, take the opportunity to read and reply to your emails and to receive other useful information right to your hand. Or if you’re strolling around in the Kista area and you receive lunch offers, information about conferences etc.”

Kurt Lundgren, Adj. Professor, KTH

The students will help in deploying the network in order to get a better understanding of how to build and manage large-scale networks. The possibilities of making the operator independent network a feasible business will also be investigated.

Apart from covering the Kista Galleria, the City Hall of Stockholm, the House of Culture and the archipelago of Stockholm are other places that are currently covered or under development.

⁵⁵ http://www.mrc.cdt.luth.se/mrc/programme_arena/intro.shtml

⁵⁶ <http://computersweden.idg.se/text/011015-CS9>, *Jätteprojekt gör Kista trådlöst*, available October 30, 2001

⁵⁷ <http://www.stockholmopen.net>, available November 15, 2001

The advent of new and unthought-of locations, create a need for new and innovative applications and services.

8.3 Applications & Services

Many applications of today are starting to become location based, be it via WLAN, GSM or GPS. All examples described below are not implemented using WLANs, but we feel they are important to illustrate to show the various trends of applications. Many of them can also be implemented using WLANs.

What kind of services is attractive to an end user when mobile? This question is one of the most important questions for WISPs today. In the mobile communication world the only application that has been successful apart from telephony is SMS. Is there such a thing as a killer application for WISPs apart from plain Internet access? That is a very difficult answer to try to predict, but in this section we'll discuss the trends as well as the potential services and applications for WLAN access. Two phenomenons, which we'll look further into, that are becoming increasingly popular are pushed advertising and location based services.

We feel that access and only surfing is not enough. There's a need as well as a must for something WLAN specific, i.e. some kind of service or application which gives the end user added value when mobile. With the arrival of roaming and seamless hand over between WANs and WLANs there's also a need that services are accessible independent of carrier. This will create an incentive for ASPs (Application Service Providers) to develop service that they can sell to all service providers, independent of access method. However, there are diverse opinions to the matter if WISPs should offer some kind of value added services or not.

“Only access will be the base offering. Services will be the only thing that can differentiate the operators.”

Rikard Kindlund, Sr. Product Manager, Compaq

“Don't mix access and services when you don't need to. ISP's shouldn't charge for content. Content is just extra work for us.”

Wiktor Södersten, Managing Director, DefaultCity

8.3.1 Entertainment

In all times and with all new technologies some form of entertainment has always been offered. For example, with mobile phones you can play interactive games with your friends or you can participate in quizzes. The fact that computers can be used for entertainment isn't really necessary to mention. With the advent of WISPs, how can the processing power of the computers, the bandwidth capacity of WLANs and the mobility aspect be combined to create some kind of entertainment for the end user?

Streaming audio and video could be an attractive kind of entertainment for WLANs. However, streaming audio and video already exists almost ubiquitously today, they are radio and TV as we know it. You can't offer the same things again, hence there's a need for unique offerings. Live coverage on multiple channels during a sporting event could be one way.

Today there are almost no offerings of entertainment from the existing WISPs. (Disclaimer: we had to narrow the scope of this report so we haven't investigated the area thoroughly.) However, there's one company we have come across and feel that it's important to mention. The Finnish company G-Cluster that offers a complex platform so that any game developed for PC's can be played over WLAN with a PDA. Other companies including Intel and Icomera also have research in this area.⁵⁸ As for games, the ability to play online simultaneously with several others while mobile could be enough for success.

Whatever services will be successful remains to be proven. But in any case, the access in itself must be cheap in order to profit on the services. This means that this is a price sensitive application. The prices must go down and the access in itself cannot be expensive. In the entertainment sector it's more important to lower the prices than to increase the security. There's no need for extreme security.

8.3.2 Electronic Socializing

With the success of SMS in memory, we agree with the prevailing opinion of the industry that instant messaging services will continue to play an important role in

⁵⁸ <http://www.computersweden.idg.se/text/011119-CS13>, available November 19, 2001, <http://www.g-cluster.com>, available January 15, 2002

mobile communications. With the promised features of MMS (Multimedia Messaging Service) in 3G, not only text messages will be exchanged, but also pictures and video clips can be sent and received.

Today there are several different instant messaging (electronic socializing) programs for Internet, with ICQ and MSN Messenger being two of the most popular ones. Using these services, the users can chat, send and receive files as well as meet new people. One problem today is that the different kind messaging programs can't communicate with each other. A possible killer application is when standardization between all these programs can be agreed upon. This standardization in combination with a positioning system as well as a program that's independent of carrier method can be very attractive to the end users.

Telia Mobile recently launched a service called Friend Finder⁵⁹. It's offered to their existing mobile subscribers and enables the user to locate other users or user groups using the positioning function in the GSM architecture. Messages can also be exchanged within the group. Someone using Friend Finder can also choose to become invisible and still use all other functions on their mobile telephone. The charging is based on a per-use scheme and the user receives the extra charge on their regular phone bill.

8.3.3 VoIP – Voice over IP

The opinions on IP-telephony are diverse. We feel that IP-telephony is not yet to be considered a killer application for WLANs. Due to the fairly low prices and the availability of fixed and mobile telephony services there's is no demand for IP-telephony yet. People are content with what is offered by the PSTN (Public Switched Telephone Network) and GSM networks.

In order to use IP-telephony today you either need to sit by your computer, which needs to have a high quality sound card with no delay, and a headset or you can buy a IP-telephone. However, both of these solutions are too expensive for most users. This scenario is more likely for people who make frequent long distance calls with long duration.

⁵⁹ <http://www.teliamobile.se/dsparticle.cgi?artid=13858>, available December 4, 2001

It will take a few more years before the mobile IP-telephony can achieve the convenience and quality of mobile telephony of today. When PDAs, or another access device, are small enough to compete with the mobile phones of tomorrow, then IP-telephony might become a killer app. People do not care what carrier method is used to relay their calls, as long as works. However, most importantly IP-telephony is of course dependent on the price of the WLAN access and the cost to relay the call must be comparable to future pricing schemes of mobile telephony.

8.3.4 Location based services

Location based services are becoming increasingly important. Imagine the following scenario:

It's Saturday, shopping day, and you're off to the mall. Don't forget to pick up a wireless flyer at the information kiosk on your way in. You'll need it to access all the location specials as you roam around the stores.⁶⁰

Neither the terms, nor the things that they describe exist yet. A wireless flyer could be a stripped-down PDA equipped with a Wi-Fi interface card. A location special is an electronic coupon or ad sent over WLAN to PDA-equipped patrons based on where they are in the mall.

This is a futuristic scenario, but similar projects are investigating the future of profiled advertising.

The E-street project in Luleå is based on pushed advertisements to consumers from the main street in the city. People who have signed up to be test pilots fill out a profile with age, interests, etc and are now ready to be part of E-street.

If a company sends out an offer via SMS, all registered test pilots with the appropriate profile will receive the message if they are in the vicinity of downtown Luleå. The offers can be from restaurants, clothing stores or from the local taxi companies. According to a market research conducted by Nokia⁶¹ end users

⁶⁰ Gerry Blackwell, "Location-based services in a WLAN world", http://www.80211-planet.com/columns/print/0..1781_925511.00.html, available November 28, 2001

⁶¹ <http://computersweden.idg.se/text/020131-cs4>, available February 6, 2002

are willing to receive advertisements through SMS if it beneficial for them, either by lowering the mobile telephone cost or by receiving discount coupons.

The project manager, Jörgen Öhman,⁶² describes the project as a success. Both the test pilots and the participating companies are pleased. An anecdote from the Brothers store (Men's clothing) tells the story of a pleased businessman and how to use the service. A sweater had been on sale all day for SEK 99 with a big sign outside the store. Not many sweaters were sold. When the manager then sent an SMS to the E-street participant matching his profile offering the same sweater for SEK 49 he sold all 200 sweaters in under 15 minutes!

A project similar to E-street, called Streetwise⁶³ was launched on Biblioteksgatan (a pedestrian outdoor shopping street) in Stockholm in October 2001. Streetwise enables targeted offers from participating stores and restaurants to consumers with profiles that match their preferences. In the initial phase, a pilot over two years with 200 users will be active. The end users are connected via WLAN, GPRS, SMS or Bluetooth. The project will evaluate:

- Location-based information and marketing
- Mobile payments
- E-ticketing
- E-signatures
- Streaming media

Participating companies include Bluegrid, Intel, Compaq, Columbitech and Aptilo.

With the advent of WISPs and the possibility to offer localized content, it's becoming increasingly important to brand the starting page in a smart way. This could be by offering information about the vicinity or with ads from local companies. It could also contain offers that are useless in another location. These local pages can possibly be free of charge for the end user to surf and a subscription is only needed to access the rest the Internet. This is a possible source

⁶² Telephone interview with Jörgen Öhman, Project Manager, E-street, November 23, 2001

⁶³ <http://www.bluegrid.se/streetwise/>, available December 6, 2001

of income for WISPs, to charge the companies in the vicinity for the local content on the starting page.

However, some users might be more willing to pay a high price to get uninterrupted Internet access, while others don't mind the ads if their connection is cheaper. For any user, the advertisement must never interrupt the service too much. A few years ago, trials with free PSTN-telephony were implemented. They were financed by commercials that interrupted the phone calls on a regular basis. This service turned out to be disastrous. The commercials overtook and prevented all normal use of the service. People couldn't talk on the phone as they wished.

“As a mobile professional, connectivity is more important than commercial advertisements.”

Magnus Lageson. Business Development, Columbitech

The devices for the satellite based global positioning system (GPS) are getting smaller and smaller and are beginning to become embedded in mobile telephones.⁶⁴ The US carrier Sprint PCS has announced they will begin selling mobile telephones equipped with GPS to more precisely pinpoint a user's location when they dial 911 for help. The reason for this implementation is due to federal regulations demanding improved location capabilities in an emergency.

This application is very interesting since it can be further developed when it comes to location based services, such as finding out where the closest pharmacy, post office or some other specific place is compared to a given location.

8.3.5 Peer to Peer

A type of application that has proven to be the killer app of Internet is the file sharing services like Napster, KaZaA and Morpheus. Although, as the legal systems of different countries have shown, the sharing of copy righted material is illegal, the number of users increase every week.

This type of application and the ability to download music and video is likely to continue to be popular among the users of WLANs. Worth noting is that these

⁶⁴ <http://www.zdnet.com/zdnn/stories/newsbursts/0.7407.2815617.00.html>, available December 4, 2001

applications all demand high bandwidth so it should be taken under consideration when planning sites to have enough capacity to offer. Certain sites are likely to be more popular for downloading both music and video. Those can be cafés, hotels and airports where users can sit down and stay for a longer period of time.

8.4 Conclusions

In this section we have tried to present a general overview of how the trends and the emerging markets in the WLAN arena will develop. We have covered several different areas in which we have been able to detect interesting trends.

The first section we looked into was the development of terminals. Of course the terminals will become smaller, faster, cheaper and better, but how can the number of users that have WLAN enabled devices increase? WISPs can invest a fortune in networks, but that is to no avail unless there are users with terminals to use the networks. One way of doing this can be to offer a subsidized terminal when users sign up for a subscription for a longer period of time, the same way as mobile telephones are subsidized today.

Another alternative can be to allow users to rent or borrow terminals at hotspot locations, such as airports or shopping malls. Perhaps in a near future a stripped-down WLAN enabled GameBoy can be an approach to the younger generation.

The field of application between mobile phones and PDAs are no longer as distinct as they used to be. It goes for PDAs and laptops as well. In a not too distant future, your mobile phone will be your PDA and your PDA will be your laptop. When this happens and the device is common enough the need for WLAN applications in various environments will boom.

As far as locations go, the existing locations of today will continue to be the main focus of existing WISPs. The attractive locations, i.e. where people have the time and need to go online, that have not yet been covered will be covered, for example remaining airports and hotels etc.

However, we see a few new potential locations that we think are very important to focus on, or for existing WISPs to be aware that they will emerge. Those are homes as well as the locations that are covered by operator neutral WISPs.

When it comes to services, the offering will vary depending on the location from which the end users want to access the network. The services could be to download a movie from the local gas station, finding your way to the nearest pharmacy or locating certain merchandise within a department store. How, and by who is this need best fulfilled? Any category of WISP that we have previously described can seize this opportunity and satisfy the need by offering location based services. In most cases, the content offered by WISPs on their start pages will be local. With the arrival of location based services and applications the future development is very interesting. In order to further propel the WLAN market, more services and applications that are unique for mobile users in certain locations need to be developed.

Apart from “ordinary” Internet usage, one of the primary fields of applications for WLANs will include personal communication, be it via e-mail, VoIP or some kind of electronic socializing program. The different means of communication will not necessarily be different programs, they can all be integrated to one. However, there are different opinions regarding peoples need to talk to each other. The datacom world considers voice to be noise, whereas the telecom world considers voice to be king. Both are right in their own way. As the amount of data transferred over Internet will increase, voice will only be a fraction of the total. However, voice is still likely to prevail as the number one choice for communication. As the capacity for downloading increases with the advent of broadband and wireless LAN services, file sharing of audio and video will also continue to increase.

It looks like WLAN, or Wi-Fi, has the "good enough" formula, and will break WLANs out of its traditional niches and propel it along the fast track to mass-market ubiquity. Wi-Fi sales boomed in the end of year 2000 or beginning of 2001, and falling unit prices fueled further uptake in 2001. 2002 promises to be a very interesting year.

In the final section we will try to summarize our findings and to high light the aspects that we feel are most important in order to understand the WLAN market from a WISP perspective.

9 FINAL CONCLUSIONS

The evolution of wireless high speed data access is definitely the most exciting phenomenon taking place in the IT market right now. In order to create a mosaic network with different access methods, be it via Bluetooth, 3G or WLAN, there's a need for different actors to emerge to take care of the various networks. These technologies all have different strengths and weaknesses, which is why it's important to realize that they are not to be seen as competitors, but rather as complements to each other. This report has focused on the advent of WISPs that are suitable to handle the WLAN market. It also illustrates how the WISPs should segment the market in order to seize the business opportunity that is rapidly emerging.

The early adopters of WLANs, i.e. the mobile professionals, were the first target group for the WISPs leading the mobile Internet revolution, but now it's time to turn to other segments of the WLAN market. It's time to let the early majority be part of that revolution. This can be achieved by turning new locations into "surf-able" zones by offering new services and location based applications. The target market for such services is huge, and there is money to be made. Competition is getting stiffer – a land grab is going on.

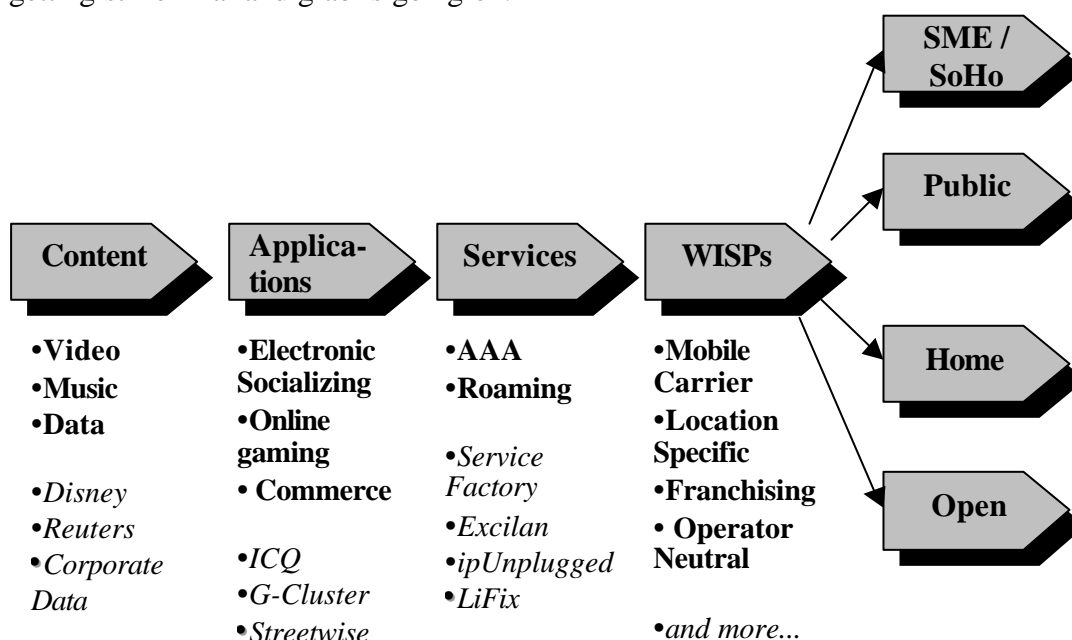


Figure 7: Value chain of the WLAN market with examples of companies already operating in different parts of the value chain from a WISP perspective.⁶⁵

⁶⁵ Idea from Dengel, Udo: "Investment Opportunities and Exit Potential for Venture Capitalists in the European Wireless LAN sector."

When we initiated this project we posed several questions which we have tried to answer. Here we will again present the highlights of our findings in answering the most important questions.

9.1 Is WLAN to be seen as a competitor or complement?

It is imperative that WLAN deployment by mobile operators does not simply result in a diversion of 2.5G or 3G revenues into WLANs. Cannibalization can be avoided by carefully planning WLAN deployment as a complement to 2.5G and, later 3G networks. It will not, however, be wise to try to prevent cannibalization by setting high prices for WLAN access. This will allow competing independent operators to carve for themselves a niche for low-cost access, which in due time may become sufficiently popular to attract a wider range of users, much like Hotmails email service did to companies that offered paid email accounts.⁶⁶

In order to truly be a complement, roaming and seamless handover must be developed for WAN technologies such as GPRS and 3G. Furthermore, roaming between WISPs is of outmost importance for the success of many different types of WISPs.

There's a need to create a need in order to get 3G services going. WLAN will drive the need for high speed applications for 3G. If applications can be developed that can be accessed with both 3G and WLAN technologies, a need can be created. E.g. if you have the ability to use a service easily and to a low cost over WLAN you will get so used to it that you'll want to use it in locations where there is no WLAN coverage. You'll know it'll cost you some to use the service with another access method, but so what? It will fulfill a need at that very moment on that location. Many people see WLAN as a competitor to 3G, when it's to see as a catalyst. It's important to get the WLAN concept migrated into the consumer mind.

⁶⁶ Analysys 2001, "Public Wireless LAN Access: A Threat to Mobile Operators?", page 13.

9.2 Who is suitable to become a WISP?

As the table below illustrates different companies have different incentives on why they should become a WISP.

WISPs	Advantage	Disadvantage	Example
Mobile Carrier WISP	Good market penetration	Outrival their own services	Telia HomeRun
ISP WISP	Good market penetration	Need positive cash flow	PowerNet
Plain WISP	Core business	No experience in network deployment	MobileStar
Location specific WISP	Recommended exclusivity to a site	Small footprint	Wirelessbolaget
Single point WISP	Absolute exclusivity to a site	Unable to offer support and QoS	Cafés
Operator neutral WISP	Freedom of choice of ISP	AAA and revenue sharing	StockholmOpen
Franchising WISP	Small investment to make a large foot print.	Support and QoS	No example today
Virtual WISP	No hardware and network deployment cost	Leasing the network	Boingo

Table 3: Comparison matrix with advantages and disadvantages of different WISPs.

The predominant WISP type of today is the mobile carrier WISP, but with the arrival of operator neutral networks and franchising WISPs the market place will change

How can the WISPs not only make ends meet, but also make the WLAN business profitable? One way to do this is to utilize the knowledge of other services and for one WISP to have multiple offerings. In Telia HomeRuns case, this could mean HomeRun Deluxe, HomeRun Economy, HomeRun Light etc. All offerings with different coverage, QoS etc. This could be offered as different services from the same WISP or offered by a virtual WISP owned by an existing WISP. This can be compared with First and Economy class on airlines.

As we have illustrated above, many different companies are suitable for different reasons to become WISPs.

9.3 How should the market be segmented?

According to our analysis of the WLAN market from a WISP perspective, there are five different segments, and each segment contains different subsegments or niche markets:

- Elektrosmog (Innovators)
- Mobile Professionals (Early Adopters)
- SME/SoHo, Students, Modern urban users, service engineers (Early Majority)
- John Doe (Late Majority)
- Laggards

The two most important segments to conquer are the two majority segments where the substantial number of customers is. This is where large revenues can be made.

In order to become a successful WISP it is of outmost importance to focus on one, and only one, niche market at the time. If, or when, a dominant position in the entire market is sought after, another niche market can then be selected. By carefully choosing the niche markets, a bowling alley effect can be achieved.

We have only illustrated a few possible strategic first bowling pins, where we think that SME / SoHo and Franchising are the two most feasible first niche markets at this point in time.

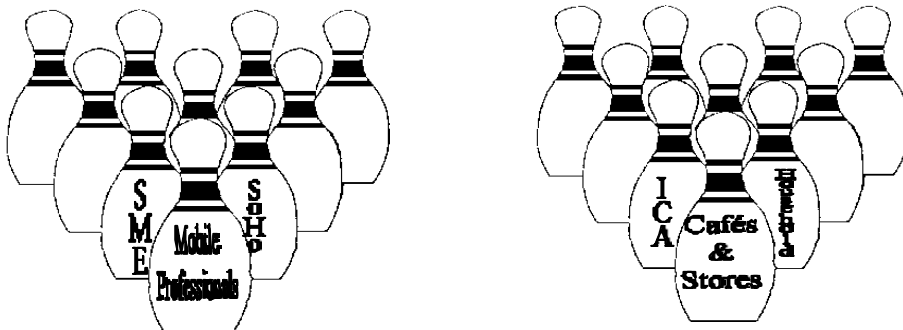


Figure 8: Different strategic first bowling pins depending on if Business or Consumer users are targeted. The left picture illustrates a possible scenario for a Mobile Carrier WISP and the right illustrates a scenario where a franchising approach is used.

9.4 *Where should WISPs offer their services?*

As we have shown, there are several location that could be potential hot spots with WLAN coverage. Certain WISPs are more suitable than others to try to cover a specific location.

- **Existing locations**

The existing locations of today will continue to be the main focus of existing WISPs. The attractive locations, i.e. where people have the time and need to go online, that have not yet been covered will be covered, for example remaining airports and hotels etc. The most suitable player to do this are the existing Mobile Carrier WISPs and Plain WISPs.

- **Chain stores / gas stations**

Most types of WISPs can target these segments, but preferably location based WISPs with roaming agreements with other types of WISPs.

- **Cafés, Small businesses, Homes**

We feel that in-house wireless access, for cafés, homes and small businesses is a big potential market and it's important to come out with a concept aimed at capturing this market. A WISP choosing a franchising concept can easily attract these different segments. The opportunity of providing extra services for customers and maybe make a small amount of money will be the driver for wireless public area access.

All the places that have been mentioned above can potentially be covered by an operator neutral WISP and thus enabling small ISPs or WISPs to make an impression on the market.

When it comes to services, the offering will vary depending on the location from which the end users want to access the network. In order to further propel the WLAN market, more location based services and applications, i.e. services that are unique for mobile users in certain locations, need to be developed. Depending on what niche market the WISP has chosen, the service offering will also be differentiated.

Corporate customers are likely to demand secure remote access to corporate data utilizing VPN-tunnels. Whilst the consumer market are likely to demand, apart from “ordinary” Internet, services for personal communication, be it via e-mail, VoIP, video conferencing, MMS or some kind of electronic socializing program like MSN Messenger or ICQ.

9.5 Does it take a WISP to manage a wisp⁶⁷ of hotspots?

As we have shown, there are several different types of WISPs that are suitable to manage various types of hotspots for many different reasons.

Among the WISP categories that we have identified, we feel that the Single Point WISP will become increasingly popular and can be incorporated in a franchising network, operated by a Franchising WISP that shares the revenues with the Single Point WISPs. Another interesting WISP is the Operator Neutral WISP that gives the end user the freedom of choice of upstream Internet Service Provider.

The biggest issue, however, is how can the WISP opportunity be made profitable? There are still thresholds over which the WISPs must take the WLAN market in order to make it a mass market service for the consumers. These thresholds includes the following bullets:

- WLAN products must be plug- and play, i.e. simple to install and to use for the consumer.
- The price for hardware must come down. This is not only a WISP issue, but also dependent on the rest of the value chain for WLAN products. WISPs can subsidize access points, NICs and terminals when customers sign up for subscriptions. If a franchising concept is chosen and prices fall to around \$200 for an AP with two NICs, then it’s likely for people to invest.
- There’s a need to develop location based content.
- Security is not an issue for the consumer market. The security awareness is generally quite low in the residential market. Private users rarely use firewalls and encryption, and are therefore an easy target for hackers.

⁶⁷ The Swedish translation of wisp is “Knippe”.

- For the corporate market a combination of roaming and security is needed before there will be a major breakthrough.

It remains to be proven which companies will remain Power Point WISPs and which will actually dare to seize the opportunity and to target other segments than just the mobile professionals.

On a more hypothetical level, we believe that when a WLAN enabled device can be offered for \$100, they will sell like hot cakes, or if they can be bundled with a subscription for \$20/month even more will be sold.

We will soon see more devices with in built WLAN and if the devices can related to a big event like the Olympic games, then we'll have the most popular present for next Christmas.

Buy a Happy Meal™ from McDonald's and receive a preview of the new Britney Spears video.

We believe that WLANs, which today are only targeted towards the mobile professionals, will evolve in the same way as mobile phones have. They, too, were not something for the general public in the beginning, but now the private use has exceeded the corporate use.

It's all about creating a need, if a parallel is drawn with mobile telephones an analogy can be seen with WLANs:

How do you use your mobile telephone indoors? You use it even if there is a fixed line available. You already have the need. You don't walk 5m to find a fixed telephone. You only pick it out of your pocket.

The key to success in the WISP market is to create a similar need for WLANs.

10 FURTHER RESEARCH

During this project we have come across a number of interesting issues in the field of wireless LANs. There are many things that can be researched further and that can be potential pit falls for WISPs. Since this thesis has been more focused on business aspects rather than technical issues, the topics that need to be further researched are in the same field.

- There are financial aspects that need to be thoroughly investigated:
 - Cost for network deployment.
 - Cost for running an operation with various subscriptions.
 - The end users willingness to pay.
 - Financing if a subsidizing of terminals is to be implemented.
 - Why WISPs are going bankrupt or struggling financially like MobileStar and PowerNet. What are they doing wrong?
 - Revenue streams, if a franchising model is used.

- Legal aspects. There is a legal aspect/commitment in offering Internet access in a public environment. Are there more obstacles in offering public WLAN access?

- On the technical side:
 - The debated insecurity of WLANs need to be addressed further.
 - The advent of a replacing technology, most likely 802.11a. What impact will this have on existing hard- and software both interoperability wise as well as price wise.
 - Roaming and seamless handover between various technologies. (However, many companies today are working on this).
 - How to plan WLAN cells and the interference from access points from different WISPs.

11 BIBLIOGRAPHY

11.1 Books

- Kaaranen, H. et al, *UMTS Networks - Architecture, Mobility and Services*, John Wiley & Sons Ltd. 2001
- Moore, Geoffrey A, *Crossing the Chasm*. New York: HarperCollins 1991
- Moore, Geoffrey A, *Inside the Tornado*.
- Schött, Kristina et al, *Studentens Skrivhandbok*, Stockholm: Liber AB 1998
- Patel, Runa & Davidson, Bo, *Forskningsmetodikens Grunder*. Lund: Studentlitteratur 1994
- Andersson, Jonas, *Miniprojekthandbok för elevprojekt och examensarbeten*. Stockholm: Avdelningen för Industriella Styrssystem 1997

11.2 Reports

- Alvé, David & Farhang, Reza et al, *WLAN Hotspots – Connect the Dots for a Wireless Future*. Stockholm & Stanford: KTH & Stanford University June 2001, <http://www.hhs.se/cic/seamless/alven.pdf>
- BWCS, *Wireless LANs and the threat to mobile revenues*, Ledbury: BWCS Ltd., 2001
- Cabellero, Juan & Malmkvist, Daniel, “*Experimental Study of a Network Access Server for a Public WLAN access Network*”, Master Thesis, IMIT KTH, January 2002, http://www.e.kth.se/~e97_dma/FinalReport.pdf
- Dehlbom, Anna, *WirelessLAN Connectivity in Patient Monitoring*, Stockholm: Master Thesis, Department of Signal, Sensors and Systems, KTH. March 2001.
- Håkansson, Peter & Marve, Therese, “*Trådlösa tekniker i sjukvården*”, Master Thesis KTH, 2002
- Kihlberg, Martin, *Reglering i en digitaliserad värld*. Lund: Examensarbete vid Juridiska Fakulteten vid Lunds Universitet, August 2001
- Lundkvist, Dennis & Söderlund, Mats, *En Marknadsstudie av Mobilt Internet*, Stockholm: Examensarbete för Industriell Ekonomi och Organisation, KTH 2001
- Lussanet, Michelle de, et al, *Should You become a MVNO?*, Amsterdam: Forrester Research September 2001
- Nomura, *The barbarians at the gate – Wireless LAN storms 3G citadel*, London: Nomura Equity Research, 15 March 2001

- Nygren, Martin & Sköldemar, Mikael, *Innovative Charging Methods for the Interconnect Provider Role and Services*, Stockholm: Master Thesis, Industrial Economics and Management, KTH 2001.
- Ovum, “*Wireless Internet Business Models: Global Perspective, Regional Focus*”, page 15.
- Paolini, Monica, *Public Wireless LAN Access: A Threat to Mobile Operators?*, Cambridge: Analysys Research Limited, 2001
- PriceWaterhouseCoopers, *The Scandinavian Mobile Internet Market*, March 2001

11.3 Internet resources

- 3G overview, available Oct. 23, 2001 at <http://www.umtsworld.com/technology/overview.htm#1>,
- 80211-planet, available Feb. 10, 2002 at: <http://seminars.internet.com/80211/spring02/>
- Actiontec, combined cable modem and AP, http://www.80211-planet.com/news/article/0,4000,1481_952171,00.html, available Jan. 21, 2002
- Airports using WLAN, http://www.mobile.commerce.net/story.php?story_id=964&s=5, available Jan. 4, 2002
- AmazingPorts, <http://www.amazingports.com/index-en.html>, available Nov. 28, 2001
- Arena, Mäkitalo Research Centre, Luleå University, http://www.mrc.cdt.luth.se/mrc/programme_arena/intro.shtm, available Nov. 15, 2001
- Aptilo, <http://www.aptilo.com>, available Nov. 29, 2001
- Blackwell, Gerry, “*Location-based services in a WLAN world*”, http://www.80211-planet.com/columns/print/0,,1781_925511,00.html, available Nov. 28, 2001
- Boingo, <http://www.boingo.com/marketoverview.html> available Jan. 3, 2002
- BrainHeart, <http://www.brainheart.com>, available Nov. 28, 2001
- Columbitech, <http://www.columbitech.com>, available Nov. 28, 2001
- Compaq iPaq, available Nov. 27, 2001 at: http://www.compaq.se/pb_products/pb_family.asp?iFamilyId=1094
- http://www.dagensit.se/pub/pub92_19.asp?art_id=16431, available Dec. 6, 2001

-
- DefaultCity, <http://www.defaultcity.net>, available Nov. 28, 2001.
 - Ericsson, available Nov. 27, 2001 at <http://www.ericsson.com/bluetooth/faqtmp2/default.asp?action=show&id=16>
 - E-street, Mäkitalo Research Centre, Luleå University, http://www.mrc.cdt.luth.se/mrc/programme_estreet/intro.shtml, available Nov. 15, 2001
 - Elektrosmog, <http://www.elektrosmog.nu>, available Nov. 28, 2001
 - Excilan, <http://www.excilan.com>, available Dec. 5, 2001
 - Foresta Conference center, <http://www.foresta.se>, available Dec. 5, 2001
 - Friend-Finder, available Dec. 4, 2001 at <http://www.teliamobile.se/dsparticle.cgi?artid=13858>,
 - G-Cluster, <http://www.g-cluster.com>, available Jan. 15, 2002
 - Golden Gate and the Interconnect Provider Role, available Jan 23, 2002 at http://www.telia.se/filer/cmc_upload/0/000/030/185/ResearchGoldenGateTec1Overv2.doc
 - GPRS, available Feb. 19, 2002 at: <http://www.gsmworld.com/technology/gprs/intro.shtml>,
 - GPS in mobile phones, available Dec. 4, 2001 at <http://www.zdnet.com/zdnn/stories/newsbursts/0,7407,2815617,00.html>,
 - GSM, available Feb. 19, 2002 at: <http://www.gsmworld.com/technology/gsm.shtml>,
 - HomeRF Working Group, <http://www.homerf.org>, available Feb 13, 2002
 - IEEE 802.1x, available Nov. 26, 2001 at <http://www.nwfusion.com/news/tech/2001/0924tech.html>,
 - IEEE 802.11e, available Jan. 02, 2002 at <http://www.nwfusion.com/news/tech/2001/0312tech.html>
 - IEEE 802.11h, available Jan. 02, 2002 at <http://www.zdnet.co.uk/itweek/analysis/2001/45/network>
 - Intersil, Wireless TV's, available Jan.12, 2002 at http://www.intersil.com/pressroom/20010911_SharpFINAL_English.asp
 - Intel develops Quake for mobile terminals, <http://www.computersweden.idg.se/text/011119-CS13>, available Nov. 19, 2001
 - ipUnplugged, <http://www.ipunplugged.com>, available Nov. 28, 2001
 - KanalTierp, Operator neutral network, <http://www.kanaltierp.nu>, available Dec. 7, 2001

-
- KistaOpen, <http://2g1319.ssvl.kth.se/~csd2002-kistaopengalleria/>,
login: guest, password: welcome
 - KistaOpen, <http://computersweden.idg.se/text/011015-CS9>, *Jätteprojekt gör Kista trådlöst*, available Oct. 30, 2001
 - Microsoft eHome, <http://www.microsoft.com/windows/ehome/>, available Feb. 6, 2002
 - MobileStar, <http://www.mobilestar.com>, available Nov. 28, 2001
 - MozambiqueOpen, <http://2g1319.ssvl.kth.se/~csd2002-mozambiqueopen>,
login: guest, password: welcome
 - OpenArchipelago, <http://2g1319.ssvl.kth.se/~csd2002-openarchipelago/>,
login: guest, password: welcome
 - PowerNet, <http://www.powernet.se>, available Nov. 28, 2001
 - PTS, RadioLAN i 5 Ghz-bandet,
<http://www.pts.se/dokument/getFile.asp?FileID=2589>, available Feb. 13, 2002
 - Nora4U, <http://www.nora-wireless.org>, available Nov. 28, 2001
 - <http://www.securecomputing.com/>
 - ServiceFactory, <http://www.servicefactory.se>, available Nov. 28, 2001
 - SMS-advertising, <http://computersweden.idg.se/text/020131-cs4>, available Feb. 6, 2002
 - SkellefteOpen, <http://2g1319.ssvl.kth.se/~csd2002-skellefteopen/>,
login: guest, password: welcome
 - <http://www.stockholmopen.net>, available Nov. 15, 2001
 - Streetwise, <http://www.bluegrid.se/streetwise/>, available Dec. 6, 2001
 - Sonera, <http://www.sonera.se>, available Nov. 27, 2001
 - Technology Adoption Life Cycle, available Nov 12, 2001 at
http://www.nngroup.com/reports/life_cycle_of_tech.html
 - Telenor, http://www.80211-planet.com/news/print/0,,1481_895081,00.html,
available Nov. 23, 2001
 - Telenor, http://press.telenor.com/PR/200110/835401_5.html, available Nov. 28, 2001
 - Telia HomeRun, <http://www.homerun.telia.com>, available Nov. 28, 2001
 - <http://www.nwfusion.com/news/tech/2001/0924tech.html>, available Nov. 26, 2001.
 - WAP, <http://www.wapforum.org/>, available Feb. 19, 2002
 - WayPort, <http://www.wayport.com>, available November 29, 2001

- Wearable electronics, ElekTex, <http://www.electrotextiles.co.uk>, available Nov. 22, 2001
- Wearable Electronics, Philips Research, http://www.extra.research.philips.com/password/passw3_4.pdf, available Nov. 22, 2001
- WEP-problems, <http://www.isaac.cs.berkeley.edu/>, available Nov. 22, 2001
- [Wireless@KTH](http://www.wireless.kth.se), <http://www.wireless.kth.se>, available Nov. 28, 2001
- Wirelessbolaget, <http://www.wirelessbolaget.se>, available Nov. 28, 2001
- Wireless LAN Forum, <http://www.wlan-forum.com>, available Nov. 23, 2001
- Åkerströms NoWire, <http://www.nowire.se/eng/sidor/main.htm>, available Nov. 28, 2001

11.4 Articles

- Andersson, Göte. “3G trimmas redan före starten”, *Elektroniktidningen*, nr 17, 9 November 2001, p 6.
- Andersson, Göte. “HiperLAN tappar mot amerikansk standard”, *Elektroniktidningen*, nr 17, 9 November 2001, p 8.
- Elektroniktidningen, Nr 19, December 7, 2001, Page 40
- Sandén, Marta & Wennersten, BG, “One Flew Over the Wireless Nest”, *BrainHeart Magazine*, nr 4, September 2001, p 36-37.

11.5 Seminars and Trade Shows

- Networks Telecom, Älvsjömässan, September 24, 2001
- Swedish Network Users Society, WLAN security meeting, Lecture hall N2 Electrum Kista. October 10, 2001
- The WISP Opportunity, BrainHeart Capital, Berns Hotel, Stockholm, October 11, 2001
- Internet World Sweden, Sollentunamässan, November 6, 2001
- Sony & Xpedio WISP workshop, Tornvillan, Nacka, November 13, 2001
- ipUnplugged, Release and demonstration seminar, Globen, November 22, 2001

11.6 Interviews

- 3Com, Mats Linder, VP Marketing, October 24, 2001
- Cisco, Michael Berglund & Fredrik Wester, October 12, 2001
- Columbitech, Magnus Lageson, Business Development, October 2, 2001
- Compaq, Rikard Kindlund, Sr. Product Manager, October 22, 2001

-
- D-Link, Stefan Nilsson, Business Unit Manager, October 23, 2001
 - DefaultCity, Wiktor Södersten, Managing Director, October 22, 2001
 - Dustin, Jan Person, VP Marketing, October 9, 2001
 - Edgecom, Nicolas ter Wisscha, Business Analyst, October 23, 2001
 - Ericsson, Philip Nyströmer, Business Development Manager, November 5, 2001
 - IDE Nätverkskonsulterna Fredrik Hofgren, , October 1, 2001
 - Imperial College Management School, Udo Dengel, MBA Student, October 12, 2001
 - Intel, Anders Hüge, Manager Technical Business Development, & Peter Siljerud, Development Manager, October 17, 2001
 - KTH / IT-university, Ph.D.-students, Fredrik Liljebladh & Jonas Willén, October 15, 2001
 - Mäkitalo Research Centre, Jörgen Öhman, Project Manager, E-street program, November 26, 2001
 - Service Factory, Alexander Latour-Henner, Senior System Architect, October 24, 2001
 - StartupFactory, Per Björklund, Director, November 9, 2001
 - StockholmOpen, KTH / IT-university, Prof. Björn Pehrsson, October 17, 2001
 - Telia HomeRun, Carlo Cassisa & Maria Rossing, October 2 & November 7, 2001
 - Telia Mobile, Östen Mäkitalo, Senior Vice President, October 31, 2001
 - Telia Research, Elin Elkehag, Business Developer, September 21, 2001
 - Telia Research, Sören Nyckelgård, Senior Technical Consultant, October 31, 2001
 - Wirelessbolaget, Pontus Nord, Technical Business Developer, November 5, 2001
 - Åkerströms Nowire, Nils Masgård, Managing Director, November 6, 2001

12 APPENDIX 1

- ACRONYMS AND ABBREVIATIONS

- **3G**, Third Generation Mobile Telephone System (UMTS).
- **AAA**, Authentication, Authorization and Accounting.
- **AP**, Access Point.
- **ASP**, Application Service Provider
- **BAN**, Body Area Network.
- **CSMA/CA**, Carrier Sense Multiple Access with Collision Avoidance
- **DECT**, Digital Enhanced Cordless Telecommunication
- **DSSS**, Direct-Sequence Spread-Spectrum technology, avoids excessive power concentration by spreading the signal over a wider frequency band. The transmitter maps each bit of data into a pattern of “chips”. At the destination the chips are mapped back into a bit, recreating the original data. Transmitter and receiver must be synchronized to operate properly.
- **ETSI**, European Telecommunications Standards Institute
- **FHSS**, Frequency Hopping Spread-Spectrum, spreads the signal by transmitting a short burst on one frequency, "hopping" to another frequency for another short burst and so on. The source and destination of a transmission must be synchronized so they are on the same frequency at the same time.
- **GPRS**, General Packet Radio Service
- **GPS**, Global Position System
- **LAN**, Local Area Network
- **IEEE**, The Institute of Electrical and Electronics Engineers
- **IETF**, Internet Engineering Task Force
- **ISDN**, Integrated Service Digital Network
- **ISM**, Industrial, Scientific and Medical, band, this frequency band (2.4GHz to 2.4835GHZ) is a global band primarily set aside for industrial, scientific and medical use, but can be used for operating wireless LAN devices without the need for end-user licenses
- **MAC**, Media Access Control
- **MAN**, Metropolitan Area Network
- **MMS**, Multimedia Messaging Service
- **MVNO**, Mobile Virtual Network Operator
- **NIC**, Network Interface Card

- **OFDM**, Orthogonal Frequency-Division Multiplexing, is a technology that resolves many of the problems associated with the indoor wireless environment. Indoor environments such as homes and offices are difficult because the radio system has to deal with a phenomenon called "multipath." Multipath is the effect of multiple received radio signals coming from reflections off walls, ceilings, floors, furniture, people and other objects. In addition, the radio has to deal with another frequency phenomenon called "fading," where blockage of the signal occurs due to objects or the position of a device relative to the Internet gateway. OFDM has been designed to deal with these phenomena and at the same time utilize spectrum more efficiently than spread spectrum to significantly increase performance.
- **PAN**, Personal Area Network
- **PCMCIA**, Personal Computer Memory Card International Association
- **PSTN**, Public Switched Telephone Network
- **PTO**, Public Telecommunications Operator
- **PTS**, (Sw) Post –och Telestyrelsen
- **PTP**, Point To Point
- **QoS**, Quality of Service
- **RC4** is a stream cipher designed by Rivest for RSA Data Security.
- **UMTS**, Universal Mobile Telecommunications System (3G)
- **UNII**, Unlicensed National Information Infrastructure, band is open in Europe, the United States and Japan.
- **VPN**, Virtual Private Network
- **WAN**, Wide Area Network
- **WECA**, Wireless Ethernet Compatibility Alliance
- **WEP**, wired equivalent privacy, mechanism covers station-to-station transmission. The standard specifies usage of the RC4 security algorithm. The scheme relies on a 40-bit key to encrypt the payload of data frames.
- **Wi-Fi**, Wireless Fidelity
- **WISP**, Wireless Internet Service Provider
- **WLAN**, Wireless Local Area Network
- **WML**, Wireless Markup Language

13 APPENDIX 2 - TECHNOLOGY OVERVIEW

We believe that for understanding this report, an investigation into existing technologies and relevant players is necessary. In this section, we present a brief overview of all the relevant WLAN technologies in the market. Please refer to previous section “*Appendix 1- Acronyms and Abbreviations*” for definitions of several terms used and explanations of acronyms.

Wireless LANs were first introduced in 1997. Initially, there were two different technologies enabling wireless LANs, one for corporate environments (IEEE 802.11) and the other for home networks (HomeRF). Different companies supported one of the two technologies.

In 1999, IEEE approved a revision of the IEEE 802.11 standard, called 802.11b or 802.11 “High Rate” that provides much higher data rates (5.5 and 11 Mbps), while maintaining the 802.11 protocols. At this time, several companies started to adopt this new “fast” technology for on-campus wireless networking. As time passes more and more users want to have wireless access at different locations such as home, hotels, airports, etc.

Today there are three major wireless LAN technologies: IEEE 802.11b, HomeRF and Bluetooth. We should clarify that Bluetooth has been recently elevated to the ranks of being a WLAN technology, however we don’t refer to it as a WLAN technology. Bluetooth started out as just a cable replacement technology and it was designed to offer point-to-point links. The ability of Bluetooth to support WLAN environments still remains to be proven. There is an ongoing discussion in the Bluetooth SIG (Special Interest Group) to support wireless LAN applications in the next generation of Bluetooth technology.

There are two coming replacement technologies: IEEE 802.11a and HiperLAN/2.

802.11a was approved as a standard by IEEE in September 1999 as a concurrent technology to HiperLAN/2. Today 802.11a is the only one of these two coming technologies, which is ready for delivery and several manufacturers are shipping it. At the same time we have to remember that 802.11a is approved only in the US and the Far East, but neither in Europe nor Japan. On the other side HiperLAN/2 is approved everywhere but haven’t yet been delivered as a working technology.

We believe that IEEE 802.11b was able to beat out HomeRF by the virtue of being the first on the market with a fast access of 11Mbps.

13.1 Existing Wireless LANs systems

Below is a brief introduction to some of the already existing technologies:

13.1.1 HomeRF

As the name suggests, HomeRF was developed from the beginning to bring wireless networking to the consumer in his home using RF (Radio Frequency). HomeRF products operate in the globally available 2.4 GHz ISM (Industrial, Scientific and Medical) band using FHSS (Frequency Hopping Spread Spectrum). First generation HomeRF products have peak data rates of 1.6 Mbps and cover virtually all homes and small offices with a 50-meter typical indoors range. HomeRF supports the DECT (Digital Enhanced Cordless Telecommunication) standard to really win the battle of the home consumers.

Second generation HomeRF products (HomeRF 2.0) were shipped in October 2001. This new version uses 10 Mbps peak data rates while still providing entire home coverage. HomeRF is fully backward compatible.

Motorola, Siemens and Proxim are some companies that work with HomeRF. Although Intel, one of the founders of HomeRF, recently announced strong support for IEEE 802.11b.

13.1.2 IEEE 802.11b

Prior to 1999, WLANs had a very bad reputation of being too expensive and too poor performance. It was not until several years after the introduction in September 1999 that the 802.11b standard was agreed upon. IEEE approved 802.11b to create a standards-based technology that could span multiple physical encoding types. This approval added two higher speeds, 5.5 and 11Mbps, to 802.11. The 802.11b standard is designed to have a transmission range of about 30 to 100 meters (300 feet) and operate in the 2.4-GHz ISM band using DSSS (Direct Sequence Spread Spectrum) Technology. The standard uses a CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance) and as Ethernet, 802.11b uses an identical MAC (Media Access Control).

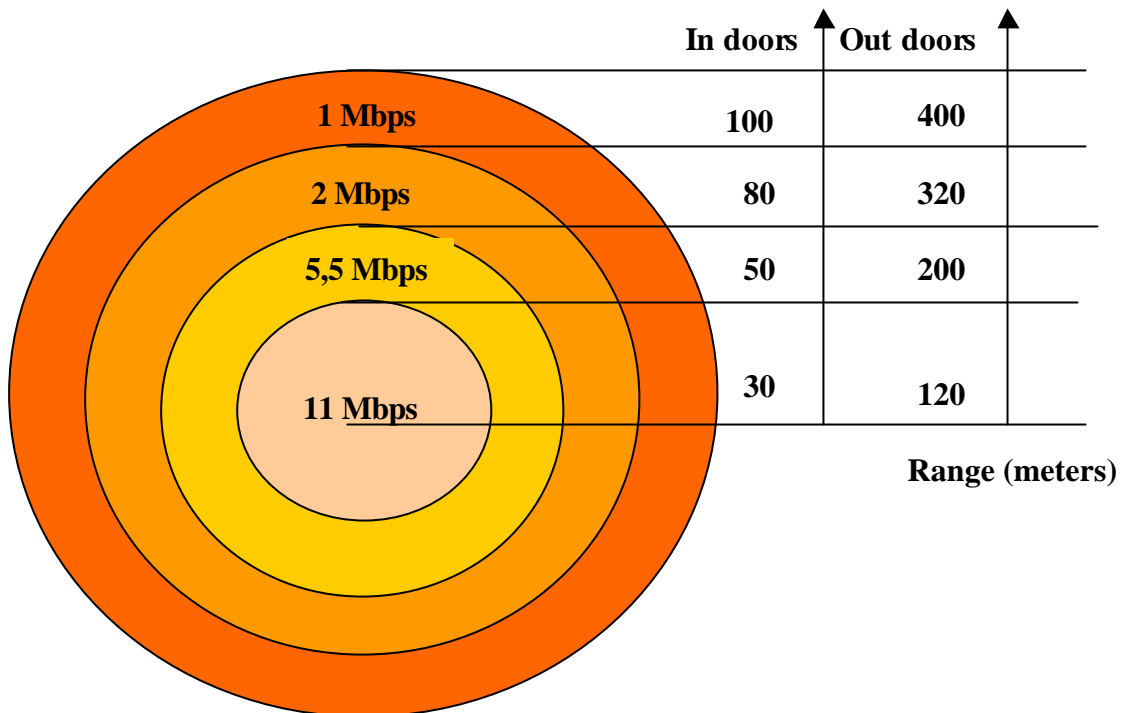


Figure 9: Theoretical relation between range and performance for IEEE 802.11b

Designers also included a shared-key encryption mechanism, called WEP (wired equivalent privacy), in the specification. The WEP mechanism covers station-to-station transmission. The standard specifies usage of the RC4 security algorithm. Read more about WEP in section 13.4.1 below.

Right from the beginning all the involved companies realized the importance of interoperability between their products. They established Wireless Ethernet Compatibility Alliance (WECA), which tests and promotes the interoperability between different vendors under the brand Wireless Fidelity (Wi-Fi). Wi-Fi-certification ensures that the system is interoperable with other Wi-Fi-certified products.

Efforts are underway to boost up the performance of 802.11b standard to speeds of 22 Mbps or even up to 54 Mbps, this new protocol will be called 802.11g.

Lucent Technologies, Intersil Corp, Cisco and Symbol are some of the major companies that support the 802.11b standard.

13.1.3 Bluetooth

Bluetooth is a low cost and low power wireless connection method with a small footprint that makes it very well suited for cable replacement. The idea that resulted in Bluetooth was to make a wireless PAN (Personal Area Network) with a transmission range up to 10 meters. Bluetooth was born in 1994 at Ericsson Mobile Communication. In February 1998 five companies, Ericsson, Nokia, IBM, Toshiba and Intel, formed the Bluetooth SIG (Special Interest Group).

Bluetooth communication occurs in the same unlicensed band as 802.11 and HomeRF, the ISM band at 2.4GHz. The transceiver utilizes frequency hopping to reduce interference and fading. The communication channel can support both data (asynchronous) and voice (synchronous) communications with a total bandwidth of 1 Mbps.

13.2 *Replacing WLAN technologies*

Further research is being carried out for a better and faster wireless LAN system. Here are five of the major solutions.

13.2.1 IEEE 802.11a

IEEE ratified the 802.11a at the same time as the 802.11b standard in 1999; the goal was to create a standards-based technology that could span multiple physical encoding types. IEEE 802.11a is designed to have a transmission range of 30 up to 100 meters and supports a data bit rate of 54Mbps. The IEEE 802.11a standard operates in the 5 GHz UNII (Unlicensed National Information Infrastructure) band, which also is free for the end users. Like IEEE 802.11b, 802.11a use MAC (Media Access Control). However, IEEE 802.11a uses an entirely different encoding scheme, called OFDM (Orthogonal Frequency-Division Multiplexing), which departs from the traditional spread-spectrum technology. The OFDM scheme was intended to be friendlier to office environments. Both security and QoS will be better in IEEE 802.11a based LANs.

Atheros, Lucent and Cisco are some of the companies that support this technology.

Due to the massive adoption of 802.11b, most of the manufactures will wait before they really try to market 802.11a.

“There is still a market for IEEE 802.11b products. As long as that market continues to grow I think that most companies have a mutual interest in waiting to launch the next version.”

Mats Linder, VP Marketing, 3Com

Today 802.11a isn't approved by ETSI in Europe mainly for two reasons, the lack of both DFS (Dynamic Frequency Selection) and TPC (Transmit Power Control). HiperLAN/2 has met these requirements.⁶⁸

13.2.2 HiperLAN/2

HiperLAN/2 (High Performance Radio Local Area Network type 2) is an ETSI (European Telecommunications Standards Institute) project called BRAN (Broadband Radio Access Networks), developing a new generation of standards. This standard will support both asynchronous data and time critical services (e.g. packetized voice and video) that are bounded by specific time delays to achieve an acceptable QoS.

The HiperLAN/2 Global Forum was launched in September 1999 and was supported by six founding members: Bosch, Dell, Ericsson, Nokia, Telia and Texas Instruments. HiperLAN/2 provides a flexible platform for a variety of businesses and home multimedia applications that uses the unlicensed 5GHz UNII band. It also supports a set of bit rates up to 54 Mbps and a transmission range of 30 up to 100 meters. To achieve 54Mbps, HiperLAN/2 makes use of a modularization method called OFDM. This network will support both authentication and encryption. HiperLAN/2 allows a seamless transfer of traffic between base stations and 3G mobile systems.

13.2.3 IEEE 802.11e⁶⁹

The IEEE's 802.11e draft specification creates the industry's universal wireless standard - one that offers seamless interoperability between businesses, homes and public environments, yet still offers features that meet the unique needs of each.

Unlike other wireless initiatives, this is the first wireless standard that spans home and business environments. And it adds QoS features and multimedia support to

⁶⁸ <http://www.pts.se/dokument/getFile.asp?FileID=2589>, available February 13, 2002

⁶⁹ <http://www.nwfusion.com/news/tech/2001/0312tech.html>, available January 02, 2002

the existing 802.11b, 802.11a and 802.11g wireless standards, while maintaining full backward compatibility with these standards.

13.2.4 IEEE 802.11g

Proposed standard for higher rate (20 – 54 Mbps) extensions in the 2.4GHz Band. The most important about this new standard is that it is fully backward compatible with the 802.11b. This standard is under development by task group G at IEEE.

13.2.5 IEEE 802.11h⁷⁰

IEEE 802.11h is an effort from IEEE to get 802.11a equipment certified by ETSI, owing to problems caused by interference with existing satellite communications in the same 5.15GHz to 5.35GHz wavebands.

To solve these difficulties 802.11h adds two functions to 802.11a; DFS (Dynamic Frequency Selection) and TPC (Transmit Power Control), designed to prevent signal interference. Proxim and other 802.11a vendors do not expect to ship products in Europe before the middle 2002.

13.3 Security

In February 2001 the computer science department of Berkeley University released a paper which, it claimed, detailed a series of alarming loopholes in the security of WLANs.⁷¹

The students showed in their tests that WLANs in offices are relatively easy to access from outside using a simple laptop with a NIC card. Since the report, the effort of gain back trust for WLAN product has been the number one priority for all the vendors.

In this section we'll discuss WEP and two of the alternative security solutions that exist.

13.3.1 WEP

As an extra feature, wireless solutions uses hardware encryption to provide added privacy to transmitted data. The traffic between the wireless device and access

⁷⁰ <http://www.zdnet.co.uk/itweek/analysis/2001/45/network> available January 02, 2002

⁷¹ <http://www.isaac.cs.berkeley.edu/>, available November 22, 2001

point will be encrypted in order to prevent eavesdropping. This added security option is called Wired Equivalent Privacy (WEP).

WEP is easy to administer. The device using the 802.11 card is configured with a key, which in practice usually consists of a password or a key derived from a password. The same key is deployed on all devices, including the access points. WEP use either a 40 bit or a 128 bit key.

WEP uses the RC4 encryption algorithm, which is known as a stream cipher. A stream cipher operates by expanding a short key into an infinite pseudo-random key stream. The sender and the receiver have a copy of the same key.

The idea of WEP was to protect the wireless communication from devices that do not know the key. As mentioned above, that proved to be wrong when the research group from Berkeley University thoroughly tested the WEP encryption. They implemented an attack against WEP by eavesdropping and storing all the transactions. They analyzed the data they had gathered and were able to break the key. By the attack they showed that the WEP standard uses RC4 improperly, and the attack exploits this design failure. As a result the ISAAC group recommended that anyone using an 802.11 products should not rely on the standard issue WEP for security, not even 128-bit encryption version of WEP is secure enough.

13.3.2 VPN

To really ensure a secure transaction in WLAN, a VPN (Virtual Private Network) should be used. A VPN uses the Internet as its transport mechanism, while maintaining the security of the data on the VPN.

There are several answers to what a VPN really is. The most common configuration is to have a single main internal network, with remote nodes using VPN to gain full access to the central net. The remote nodes are commonly remote offices or employees working from home. You can also link two smaller networks to form an even larger single network.

To make a VPN, you create a secure tunnel between a computer in a WLAN and home network or two networks and route the IP-traffic through it. The tunnel can be seen as a secure routed connection between the VPN-client and the VPN-server.

There are several different companies that develop software for VPNs and many companies offer VPN solutions for their nomadic users.

13.3.3 802.1x

802.1x is an IEEE standard that provides an authentication framework for 802-based LANs. This standard will let wireless LANs scale by allowing centralized authentication of wireless users or stations. The standard is flexible enough to allow multiple authentication algorithms, and because it is an open standard, multiple vendors can innovate and offer enhancements.

It is important to note that 802.1x alone lacks the components that 802.11-based LANs need for user-based authentication. A Task Group at IEEE is drafting amendments to the 802.11 specifications to incorporate 802.1x services.

802.1x authentication for wireless LANs has three main components: The supplicant (usually the client software); the authenticator (usually the access point); and the authentication server.

802.1x for 802.11 networks has the potential to simplify security management for large wireless deployments. It is important to remember that it is not the only piece of the security puzzle for 802.11 networks. Coupled with an authentication algorithm and data frame encryption, network administrators can provide scalable, manageable and mobile network services.⁷²

“Before something evolves as a standard it’s always a risk to bet on one of two emerging / competing technologies. There’s always a risk to bet on the wrong horse. That is one reason we are part of all 802 standardizing organizations.”

Rikard Kindlund, Sr. Product Manager, Compaq

⁷² <http://www.nwfusion.com/news/tech/2001/0924tech.html>, available November 26, 2001.

14 APPENDIX 3

- PLAYERS IN THE WIRELESS LAN MARKET

There are many interesting players in the WLAN market, ranging from chip manufacturers to Wireless Internet Service Providers (WISPs). Their products and services target everything from large enterprises to small homes.

We have interviewed industry leaders from all different segments, but the scope of this thesis lies on the future market for WISPs. In this section we will present some of the existing WISPs as well as other interesting players in the WLAN market, such as underground and operator neutral networks. Due to lack of resources and time we have a narrow geographical focus, therefore most of the companies presented below are active in the Scandinavian region.

The companies are only described briefly in this section in order to give the reader an understanding of their line of business. For further information, please see the homepage of each company. Respective URLs to the companies are footnoted at the bottom of each page.

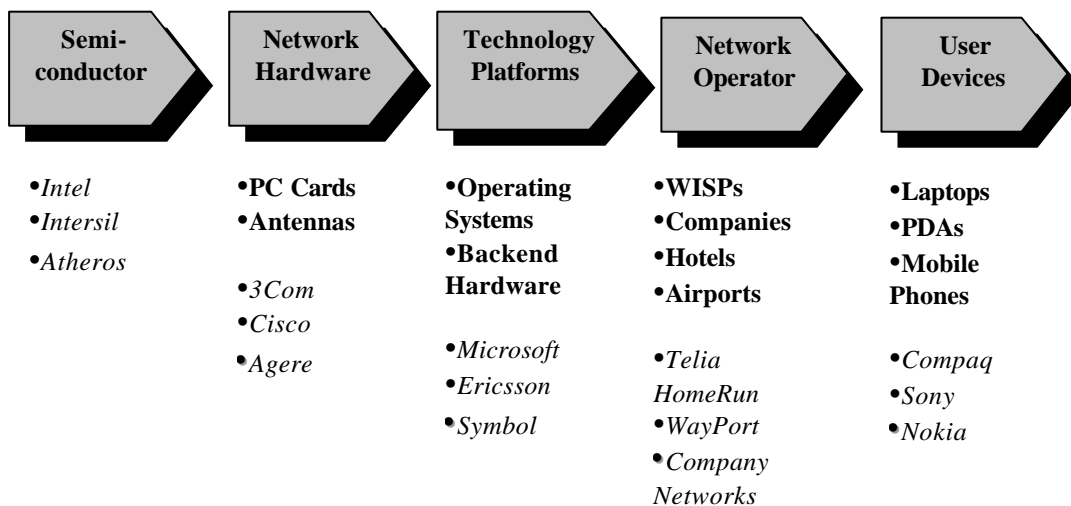


Figure 10: Value chain for players in the wireless LAN market with examples of companies already operating in different parts of the value chain.

14.1 Wireless Internet Service Providers (WISPs)

14.1.1 Amazingports⁷³

Amazingports' core business is to enable people to access Internet in public and semi public places. Amazingports want to provide Internet access to as many people as possible, therefore it will be possible to connect to their network not only through wireless means, but also by wires.

The purpose is to make broadband Internet access available to people and companies in Stockholm. During their start-up, 2001 and 2002, Amazingports will offer this service free of charge to the user. Amazingports will be an ISP WISP.

14.1.2 Boingo⁷⁴

Boingo is the first virtual WISP and probably not the last. Instead of deploying its own network infrastructure Boingo purchases redundant capacity from other WISPs on a wholesale basis, integrates these networks together and sells a single service to its customers.

They have 3 types of subscription, Boingo Unlimited: Unlimited monthly usage for \$74.95, Boingo Pro: For \$24.95 a month, you'll get 10, 24-hour sessions per venue and Boingo As-You-Go: \$7.95 per 24-hour period per venue.

Boingo has formed strategic partnerships with Wayport, Surf and Sip, HereUAre and others.

14.1.3 DefaultCity⁷⁵

DefaultCity is a Plain WISP that recently launched their first wireless LAN service. Their strategy is to roll out in a small scale with a "guerilla net" feeling, i.e. an underground network. Their target group is tech savvy people, which are more likely to be able to sort out potential problems themselves with no QoS or support. Right now DefaultCity is running a pilot and therefore only has six hotspots in down town Stockholm, but, according to their web site⁷⁶, they have more planned.

⁷³ <http://www.amazingports.com/index-en.html>, available November 28, 2001. We have tried to reach Amazingports to get more information, but not succeeded.

⁷⁴ <http://www.boingo.com/marketoverview.html> available January 3, 2002

⁷⁵ Interview with Wiktor Södersten, Managing Director, October 22, 2001

⁷⁶ <http://www.defaultcity.net>, available November 28, 2001

Monthly subscription for SEK 250/month flat rate paid via credit card for private users. SEK 300/month (plus tax) for corporate customers via credit card, SEK 400/month (plus tax) if invoiced.

14.1.4 MobileStar⁷⁷

MobileStar is one of the biggest wireless access providers in the United States. Their hotspots cover common hotel areas (lobbies, restaurants, meeting rooms, etc.), airport gates and terminal areas, airline lounges, coffeehouses and restaurants. They are targeting the mobile professional by primarily selling directly into big corporations, which enables them to sell several accounts in a single sales process.

MobileStar has covered more than 500 locations according to their website. They offer several pricing schemes ranging from \$2.50 per 15 minutes of use, to \$59.99 for unlimited usage per month. MobileStar is based in Texas, United States.

VoiceStream, a GSM operator in US backed by German Deutsche Telekom, recently acquired MobileStar.

14.1.5 PowerNet⁷⁸

The business idea of PowerNet is to offer wireless and mobile broadband services. They offer wireless solutions for indoor use, outdoor use and public surf zones. They also offer fixed Internet access, city networks as well as wireless corporate networks. They provide fixed broadband access wirelessly by using omni directional antennas, to transmit the signal to their customers'.

The home package cost SEK 2000 to sign up and then SEK 295/month for 24 months, which includes all the hardware needed. They have different pricing schemes when selling to corporate customers. They are located in Stockholm, Sweden.

PowerNet fall in under the ISP WISP category, but is currently suffering from financial problems and is under reconstruction.

⁷⁷ <http://www.mobilestar.com>, available November 28, 2001

⁷⁸ <http://www.powernet.se>, available November 28, 2001

14.1.6 **Sonera**⁷⁹

Sonera is Finland's former national Public Telecommunication Operator (PTO) and currently offers a full range of fixed, mobile and Internet services. Sonera is one of several European telcos, which have been busy rolling out wireless LANs in public places for business users. Its WLAN service, which is called wGate, was introduced in June 2000 and has since been made available in a number of Finland's largest cities.

Soneras wGate networks have been installed in several of the country's larger hotels, including Holiday Inn chain, as well as the national football stadium in Helsinki and a number of conference centers. In addition, via agreements with national air operator Finnair, wGate systems have been installed in business class lounges at airports in both Finland and Sweden.

Sonera wGate services are also available for installation in offices, allowing corporate users to create a wireless working environment.

14.1.7 **Telenor**⁸⁰

Telenor is Norway's former PTO and is still the country's dominant fixed and mobile operator. In April 2001 Telenor unveiled its first wireless LAN hotspot in a hotel in Oslo. Telenor plans to install equipment across a number of Norwegian hotel chains. However, Telenors WLAN operation is basically an extension of its mobile offering. The company plans to introduce WLAN access alongside its current and next-generation mobile networks in order to improve coverage and data transmission speeds for cellular users in crowded public areas.

The Wireless Internet Zone does not have its own, separate subscription fee and is billed strictly on the data use method. They will charge either by volume or by using a 24-hour subscription with unlimited volume.

⁷⁹ BWCS, *Wireless LANs and the threat to mobile revenues*, p 89-90.

<http://www.sonera.se>, available November 27, 2001

⁸⁰ http://www.80211-planet.com/news/print/0..1481_895081.00.html, available November 23, 2001,

▪ BWCS, *Wireless LANs and the threat to mobile revenues*, p 92-93.

▪ http://press.telenor.com/PR/200110/835401_5.html, available November 28, 2001

14.1.8 Telia HomeRun⁸¹

Telia HomeRun is a part of Telia Mobile and is focused on providing secure wireless Internet access to corporate customers. Their hotspots include airports, hotels, convention centers in Sweden, Norway and Finland as well as SAS lounges worldwide. They currently have at least 350 sites covered with their wireless Internet access solution.

They offer different pricing schemes, ranging from an initial fee of SEK 495 and monthly fee of SEK 1495 down to 24 hrs surf card for SEK 120. They have also a time based monthly subscription with an initial fee of SEK 495 and after that a minute fee of SEK 2.40.

14.1.9 Wayport⁸²

Texas based Plain WISP Wayport, has installed hotspots at hotels, airports etc. since 1997. They currently have around 450 sites covered with wireless Internet. Their locations are mainly in the US, but they also have a few hotels covered in European capitals. The target user group for Wayport is mobile professionals. Recently they have had a sales drive together with Microsoft where they offered all Microsoft XP users free access to all their sites.

They charge a pre-paid fee of \$49.95 for 10 airport connections or 6 hotel connections.

14.1.10 Wirelessbolaget⁸³

The Location Specific WISP, Wirelessbolaget is a spin off from the Stockholm based company InfraLAN. They provide wireless solutions for locations that attract mainly business customers, such as hotels and conference centers.

They have struck general agreements of WLAN installation with Scandic Hotels and Fielio to provide them with wireless access. The hotels rent all the equipment from Wirelessbolaget since the hotels don't wish to own the equipment themselves. They sign a three-year contract in which service and support are

⁸¹ <http://www.homerun.telia.com>, available November 28, 2001

⁸² <http://www.wayport.com>, available November 29, 2001

⁸³ <http://www.wirelessbolaget.se>, available November 28, 2001

▪ Interview with Pontus Nord, Technical Business Developer, Wirelessbolaget. November 5, 2001

included. Once the equipment is installed on a site, all personnel are educated in how to use and sell WLAN access. Wirelessbolaget doesn't handle the contact with the end users, but rather the owners handle this and sells the login information needed to access the net.

14.2 Operator neutrality

In this section we'll discuss the various players that are operator neutral. By operator neutral we mean entities that offer the freedom of choice of upstream Internet Service Provider to the end user.

14.2.1 The Royal Institute of Technology, KTH

There are several interesting ongoing projects at KTH. Two are working on operator independent networks, StockholmOpen.net and KistaOpen. There is also an interesting center focusing on wireless technologies called wireless@KTH⁸⁴.

The research issues addressed at Wireless@KTH are focused on the 4th generation wireless systems (4GW) to be deployed in the time span 2010 - 2015. In order to identify relevant research topics and assess their importance it is necessary to create plausible and consistent descriptions of future environments and settings for these wireless systems. The Wireless Foresight project aims at creating such scenarios. The main objectives of the project are:

- Create solid and consistent visions of future wireless systems and their settings
- Identify key research areas and drive research at the center.
- Provide PR, marketing and visibility for Swedish wireless research and the center including its industrial partners and other participants. The project was initiated on September 1, 2001, and will be completed on May 31, 2002.

14.2.2 StockholmOpen.net⁸⁵

StockholmOpen.Net is based on the idea that anyone can make singular (wireless or wired) access points, or local area networks, publicly available and provide connectivity to a server allowing each individual user to make an own choice of service provider to reach the Internet.

⁸⁴ <http://www.wireless.kth.se>, available November 28, 2001

⁸⁵ <http://www.stockholmopen.net>, available November 28, 2001

StockholmOpen.net provides access points on several different locations in the greater Stockholm area. The campus of KTH Kista is also part of StockholmOpen.net and includes a number of access points. The campus network has approximately 500 users.

Once at an access point, the user accesses a login page where he/she is prompted to choose an upstream Internet provider. At present, only students from KTH can use the services of StockholmOpen.net, but the idea is that customers from participating ISPs will be able to login using their ordinary usernames and passwords. The authentication will be handled by each ISP.

14.2.3 Open.net⁸⁶

As an extension of StockholmOpen.net, the IT-university, Metropolitan area committee of Kista and the city of Stockholm have plans to turn the Kista shopping mall⁸⁷ into a wireless area. The idea is to create an operator neutral network so that people in the mall can access the Internet as well as receive individual advertisements from stores and restaurants. The location owners can outsource support, etc. to ensure QoS.

Furthermore, several other “Open.net”-projects are underway:

- Open Archipelago⁸⁸. The goal for the Open Archipelago project is to investigate and evaluate the possibilities for an operator neutral net in the archipelago of Stockholm.
- SkellefteOpen⁸⁹ shall establish an operator neutral access network at the campus area in Skellefteå and in the center of Skellefteå in the north of Sweden.
- MozambiqueOpen⁹⁰, The Mozambique Open project aims at providing internet connectivity to student residences in Maputo, Mozambique

⁸⁶ <http://computersweden.idg.se/text/011015-CS9>, available November 28, 2001

For the open.net projects the username: guest and password: welcome can be used.

⁸⁷ <http://2g1319.ssvl.kth.se/~csd2002-kistaopengalleria/>, available February 19, 2002

⁸⁸ <http://2g1319.ssvl.kth.se/~csd2002-openarchipelago/>, available February 19, 2002

⁸⁹ <http://2g1319.ssvl.kth.se/~csd2002-skellefteopen/>, available February 19, 2002

⁹⁰ <http://2g1319.ssvl.kth.se/~csd2002-mozambiqueopen>, available February 19, 2002

14.2.4 **Nora4U**⁹¹

Nora4U, a non-profit organization that wants Nora to be the first town in Sweden with wireless public access is running a project called Nora Wireless to reach this goal. Nora Wireless is now successfully deploying a dedicated radio link that will provide 11 Mbps to a public school situated in Ås, a village outside Nora.

The goal of the project is to make the technology and know-how that comes from IT University/KTH and its research labs very early available for real use in Nora.

The sponsors for this project include two Universities: IT University/KTH and Örebro University, two private companies: Economic Software and Antennspecialisten together with Nora Municipality (Swedish: “Kommun”).

The results of this experience will be freely public available during the Christmas and hopefully will encourage others to learn from Nora Wireless experience and discover the possibilities of the unlicensed Wi-Fi technology.

14.3 *Other Interesting Players*

There are more companies than WISPs that are active in the WLAN arena. Roaming, security and underground networks are other interesting aspects. In this section we present a number of companies active in these different fields.

14.3.1 **Aptilo**⁹²

Aptilo Networks provides system solutions to operators of unlicensed local mobile networks such as Bluetooth and WLAN (802.11). The company is Stockholm-based, with an regional office for Asia-Pacific in Malaysia. Aptilo was founded after being spun off from the Mobile Internet division of Axis Communications. Aptilo's Mobile Access Server offers operators a convenient and effective way to integrate access points in an advanced public local mobile network. It enables payment via credit cards and also allows integration with mobile operators to pay with mobile phone subscriptions.

The international airport in Copenhagen, Kastrup, offers a WLAN connection to the Internet in the main transit hall using Aptilos solution. The airport owns the

⁹¹ <http://www.nora-wireless.org>, available November 28, 2001

⁹² <http://www.aptilo.com>, available November 29, 2001

access points, while Aptilo handles the login procedures and handles the payment issues via their Mobile Access Server in Stockholm.

14.3.2 BrainHeart Capital⁹³

BrainHeart Capital is one of the world's largest industrial venture capital funds dedicated to investments in the wireless sector. Their aim is to become a leading player in the Scandinavian IT industry and act as a catalyst for those companies which have the possibility of becoming world leaders in their field. They recently arranged a well-attended seminar to "kick-start" the WISP-industry.

Companies in their portfolio include Excilan, Service Factory and Åkerströms NoWire.

14.3.3 Columbitech⁹⁴

Columbitech is a Stockholm based company that develops software for secure wireless data communication. Their products are primarily intended for systems where a wireless connection is needed to a company's own internal network. Their products support seamless network roaming and are developed in the field of wireless VPN.

The vision of Columbitech is to seamlessly tie all different carrier forms (WLAN, GPRS, etc) together, independent of what application is used. This problem has been solved by implementing their software in the session layer and not in the network layer.

The main reason behind their mode of procedure is the fact that they don't rely on IPSec and TCP for handling flow control and session management. Columbitechs solution implements VPN and mobility functions at the session layer. This solution relies on recovery mechanisms at the session layer for fast transport connection re-establishment. No attempts are made at keeping transport level connections alive during network roaming.

⁹³ <http://www.brainheart.com> available November 28, 2001

⁹⁴ <http://www.columbitech.com> available November 28, 2001

14.3.4 **Elektrosmog**⁹⁵

Elektrosmog was founded in Stockholm on August 30, 2000, Elektrosmog is a discussion group for public, wireless access to the Internet over non-telecom networks, such as wireless LANs. The project grew out of a skepticism towards the claims of the telecom industry regarding the usefulness and success of the future third generation mobile telephone systems as the only means to implement the wireless Internet. This skepticism culminated in the fall of 2000 with the European telecom operators' applications for radio frequency bandwidth for the future UMTS networks. There are several similar networks like Elektrosmog around the world. One of the most famous is Bay Area Wireless Users Group (BAWUG) which is located in San Francisco.

Elektrosmog is not a network operator but some of the members are operating private access points that are open to Elektrosmog members.

14.3.5 **Excilan**⁹⁶

Luxembourg based Excilan is a newly established service company founded by BrainHeart Capital. Excilan established in April 2001 as a clearinghouse for wireless Internet roaming. (A clearinghouse's business model is to operate as a broker in roaming traffic by setting fixed tariffs on the network and handling the settlement of the roaming traffic.)

Excilan's objective is to play a role in the establishment of WLAN roaming by acting as the driving force behind the integration of seamless roaming standards. The goal is to enable end-users to travel and access mobile data anytime, anywhere. By offering the full service package of legal, end user and marketing solutions.

"Seamless Roaming is the key success driver to the expansion of wireless LAN as the easiest access to broadband communication. The more "natural" or "second nature" it is for the end-user to access wireless broadband the more likely it will be a success for the mass market."

Lodewijk Cornelis, CEO, Excilan

⁹⁵ <http://www.elektrosmog.nu>, available November 28, 2001

⁹⁶ <http://www.excilan.com>, available November 28, 2001

14.3.6 ipUnplugged⁹⁷

ipUnplugged is one of the leading developers of networking products for secure mobility that integrate any two networks, such as WLANs and GPRS. Their vision is to make it as easy for mobile users to start up and work on their laptops with exactly the same look, configurations and information as the office computers – as it is to turn on a mobile phone upon arrival in a foreign country. Their solutions enable mobile users to move freely from one network to another without having to reconnect, change settings or lose connection at any point.

In opposition to Columbitechs solution, ipUnplugged have implemented their software at the network layer.

14.3.7 Service Factory⁹⁸

The latest version of Service Factory's Orbyte Wireless concept is aimed at established operators, looking to offer their customers wireless Internet access. The new version supports ISP-to-ISP roaming and is ready for integration with GSM, GPRS and UMTS.

The system enables established operators to expand their product portfolios by giving mobile users WLAN Internet access in public locations, e.g. hotels, airports and conference halls. The system is also aimed at large scale pure wireless operators, WISPs. The fully scalable system is fast to implement and to develop, and allows operators to maintain the system, create and administrate services, and handle billing on their own. It also allows the operator to sell capacity and services to virtual operators. Billing and invoicing models are very flexible. It is possible to choose payment model - flat rate or per minute/bytes - as well as billing model - pre-paid or by invoicing. Orbyte supports both WLAN and broadband (cable, DSL) and enables the operator to customize innovative end consumer services.

Telia's HomeRun service is an example of an Orbyte-based service, currently offering wireless broadband connection at a speed of 11 Mbit/s in public areas.

⁹⁷ <http://www.ipunplugged.com>, available November 28, 2001

⁹⁸ <http://www.servicefactory.se>, available November 28, 2001

14.3.8 Åkerströms NoWire⁹⁹

Åkerströms NoWire is specialized in products and services relating to the creation of infrastructures using wireless technology. They work with WISPs and offer a complete package of products and services to enable WISPs to spread the Internet quickly to businesses and households. Their ambition is to become the leading integrator of wireless technology in Europe within the next few years.

NoWire offers complete packages including training, support, project management, infrastructure, and software for customer management and roaming. NoWire can support WISP businesses wishing to build and operate wireless networks.

⁹⁹ <http://www.nowire.se/eng/sidor/main.htm>, available November 28, 2001.
Interview with Nils Masgård, Managing Director, November 6, 2001