GLASGOW

Rabbit's Return: An Exploration of WiFi Business Models

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To my mother, who taught me how to get to 'per aspera ad astra'

Abstract

This thesis explores wireless LANs implementations for a public commercial use. 802.11b technology, known as WiFi has a character of disruptive innovation. Creating new markets and new business models, pushing established players to fight for their incumbent position and thus look for new opportunities. Research into business models, which adopting disruptive technology, requires a theoretical framework, thus a critical approach is developed along with necessary analytical tools such as value chains, business model diagrams and a mapping chart. A review of relevant literature is given along with the most acceptable definition.

Emerging business models are very dynamic in nascent state of WLAN industry. To understand the *'architecture of the revenue'*, three case studies are examined: Telia HomeRun, Starbucks/T-Mobile and Copenhagen Airport Wireless Internet Zone. After exploring each instance of wireless LAN implementation in depth, conclusions are offered along with further visions of wireless LANs evolution. The general trend of WLAN industry is to offer greater coverage along with deeper participation of venues in business models. Each business model has some internal contradictions between company's core business and WLAN. None of these models can be considered as an example for the future wide-scale deployment. The thesis outlines key features of each model, highlights contradictions and circle areas for further research.

Keywords: WiFi, wireless network, WLAN, 802.11b, 3G, business model, value chain, disruptive technology, HomeRun, T-Mobile, Copenhagen Airport, Starbucks

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List of Abbreviations

Note: For the full explanations of the thesis' terminology refer to Glossary

3G	**3**rd **G**eneration
AAA	**A**uthentication, **A**uthorization and **A**ccounting
AP(s)	**A**ccess **P**oint (s)
ARPU	**A**verage **R**evenue **P**er **U**ser
LSS	**L**ocation **S**pecific **S**ervices
BAN	**B**ody **A**rea **N**etwork
CAPEX	**CAP**ital **EX**penses
CPH	**C**o**P**en**H**agen Airport
DSSS	**D**irect-**S**equence **S**pread-**S**pectrum
ETSI	**E**uropean **T**elecommunications **S**tandards
FT	**F**inancial **T**imes
GHz	**G**iga**H**ert**z**
GPRS	**G**eneral **P**acket **R**adio **S**ervice
GSM	**G**lobal **S**ystem for **M**obile communication
IEEE	**I**nstitute of **E**lectrical and **E**lectronics **E**ngineers
ISM	**I**ndustrial, **S**cientific and **M**edical
ISP(s)	**I**nternet **S**ervice **P**rovider(s)
ITU	The **I**nternational **T**elecommunication **U**nion
KB	**K**ilo**B**ytes
Kb/s	**K**ilo**b**its per **s**econd
LAN	**L**ocal **A**rea **N**etwork
Mb/s	**M**ega**b**ytes per **s**econd
NIC	**N**etwork **I**nterface **C**ard
OFDM	**O**rthogonal **F**requency-**D**ivision **M**ultiplexing
OPEX	**OPE**rational **EX**penses
PAN	**P**ersonal **A**rea **N**etwork
PDA	**P**ersonal **D**igital **A**ssistant
PSTN	**P**ublic **S**w itched **T**elephony **N**etwork
QoS	**Q**uality **o**f **S**ervice
RF	**R**adio **F**requency (channel)
TCP/IP	**T**ransmission **C**ontrol **P**rotocol / **I**nternet **P**rotocol
TT	**T**otal **T**elecom
UMTS	**U**niversal **M**obile **T**elecommunications **S**ystem
UNII	**U**nlicensed **N**ational **I**nformation **I**nfrastructure
VAS	**V**alue **A**dded **S**ervices
VISP	**V**irtual **I**nternet **S**ervice **P**rovider
VoIP	**V**oice-**o**ver-**IP**
VPN	**V**irtual **P**rivate **N**etwork
WiFi	**Wi**reless **Fi**delity
WISP(s)	**W**ireless **I**nternet **S**ervice **P**rovider
WPA	**W**iFi **P**rotected **A**ccess
WEP	**W**ireless **E**quivalent **P**rivacy
WIZ	**W**ireless **I**nternet **Z**one
WLAN(s)	**W**ireless **L**ocal **A**rea **N**etwork(s)

List of Exhibits

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Chapter 1. Introduction

> *It was the White Rabbit returning, splendidly dressed, with a pair of white kid gloves in one hand and a large fan in the other: he came trotting along in a great hurry, muttering to himself as he came, `Oh! the Duchess, the Duchess! Oh! won't she be savage if I've kept her waiting!'* [Carroll, 1865:13]

Wireless networking is more than introducing new services and business models. Wireless is a freedom of being anywhere and still connected. Wireless changes the way people work and live. Members of society do not want simply transmit information from one place to another. They need to contact a person, a machine but not a place anymore. Only radio wireless network can give such possibility: Marconi[1] is clearly winning over Bell.

Among two extremes – connecting to a place and connecting to a person or machine, special type of services lie. This is so called location-specific services. In general this define a service, available for anybody on certain conditions in limited geographical locations. Conditions can vary from just some coins in the pocket to insert in phone-box till wireless enabled laptop or PDA.

Location Specific Services: from Payphone to Wireless LAN[2]?

Obviously, the first known type of such service is old payphones. They emerges very soon after the invention of telephone by Alexander Bell – the first public payphone appeared in Britain in 1884 [Beckett A., 11/11/2002]. Since then, anybody who can afford spending some coins can use communications service. But still users need to come physically to the same phone other people used before (and might not be very nice to equipment!) to call somewhere.

The evolution of this service was contradictory, from one hand, certain locations are more attractive in terms of possible profit of service (for example in train

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[1] In Russia, it is accepted that A.S. Popov achieved the first successful wireless transmission.
[2] Wireless LAN is a tautology somehow, it is more correct to say about wireless extension of wired LAN.

station), than other locations – for example, the Heathrow airport payphones generate more revenue than a rural village in Glencoe. Thus payphones were between two cliffs – operators wanted to make profit or at least receive some revenues and governments wanted them to fulfill political and social objectives.

All telecommunication industry was at the monopoly state and was run either state directly (like in UK) or national monopolist (like in US).

Payphones are static, so people don't see them as highly personalized service. Only the developments in wireless telephony (thanks to G. Marconi) helped to make such location based connection more personalized. With arrival of *'Rabbit'*.

From The History of Location-Specific Services in Mobile Communications: Rabbit Zone Project

Those who forget their history are condemned to repeat it. Therefore, it is important to know that everything started with a Rabbit.

'Rabbit' was one of four location-specific phone services given licenses in Great Britain in 1989. The others were Phonepoint, Mercury Callpoint and Zonephone. Subscribers to the service, backed by a new entrant, Hutchison Whampoa[3], could make mobile calls when they were within 100 meters of a Rabbit transmitter. The points were situated in *'popular places'* such as banks, railway stations, shopping centers or where there would be a large amount of people and a need for points.

Rabbit came to its demise circa 1993/1994. Although it worked extremely well in Hong Kong with more than 150 000 subscribers, it didn't quite take off over in UK and rather than throw good money at bad, Hutchison decided to withdraw it. At that moment Rabbit phones used about 10 000 subscribers [Brodsky, 1995:106].

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[3] History repeat itself - Rabbit was introduced by new-entrant (Hutchison) to compete with heavy-weight incumbent (BT). Just like happening now, Hutchison is rolling out 3G to avenge the Rabbit!.

The major reason for failure was poor timing for introducing these location-specific services. Rabbit was supposed to compete with BT payphones, old-fashioned red booths. However, exactly at the same time BT introduced payphones of new model with pre-paid card and credit card payment systems. This innovation attracted customers, so Rabbit never get enough subscribers for any significant take-off.

Although the system was withdrawn, there are still many people using Rabbit phones as ordinary domestic cordless phones, with the base station and one or more handsets used around the house.

This thesis is not intended to seek the reason behind Rabbit's failure. However, it should be noted that the combination of technology, business model and 'revenue architecture' contributed to its collapse. Hence, the Rabbit's story should be kept in mind, while approaching modern WiFi business models.

A location has its immense power – it stay there as long as anybody passes by it. Referring to the thesis' topic, location-specific services – payphones, Rabbit project and WLANs have something in common – they all base its propositions on a certain location yet each in different way. Telecommunications services are evolving in many ways, but property, where these services are available, is staying the same over time. In other words, location-specific services are consist of form – property, venues and essence – services, like voice communications (payphones, Rabbit) or data communications (WLAN). In fact, data are viewed as a new service to offer callers through payphones – BT installs new type of payphones - equipped with web-browsing capability. At this moment, convergence of telecom and datacom comes into play.

Appearance of the New Generation of Location-Specific Service

Many years back the upcoming convergence between telecom and datacom was a frequently debated issue and opportunity. In a way, 'convergence' is a buzz-word, which filled conferences rooms several years ago. Datacom vendors challenged telecom vendors in the infrastructure. There are several examples of such struggles: IP telephony in LAN and WAN was identified as one of the first battlefields; companies like Juniper was born as *'hybrids'* just in the middle between the telecom and datacom industries and datacom; vendors like Cisco challenged telecom vendors like Ericsson and Lucent publicly.

In practice the convergence is still a way ahead and the two industrie s are kept more or less intact but with some successful *'cross selling'*. New type of location-specific services, incarnated in WLANs is an opportunity where the two worlds – telecom and datacom – meet. Magnus Melander describes it in such way:

> *Two business logics, two approaches, two ways to market and two of almost anything all of a sudden compete head to head about the same customers for the same services. Both sides have their strengths and weaknesses. But the market is still the same.* [Melander, October 2002:2].

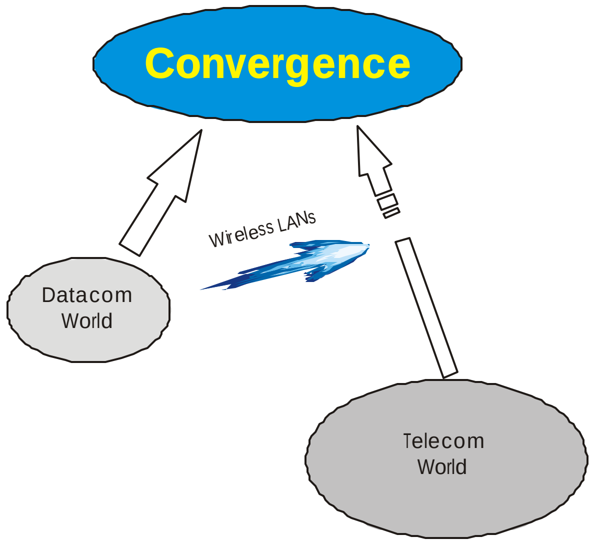
Wireless LANs come out of the data communications industry which is a by-product of the computer industry. Lehr and McKnight pointed on a crucial difference between business models employed by two camps. As for WLANs, they noted that:

> *The basic business model is one of equipment makers who sell boxes to consumers. The services provided by the equipment are free to the equipment owners. For the customers, the equipment represents a capital asset that is depreciated* [Lehr and McKnight, 2002:10].

A telecom's model is an opposite – users are paying for services as well as equipment to provide the service.

Public WLANs enters the area which is still a realm of traditional telecommunications – radio mobile and Internet. It is very similar to the way how IP telephony come to telecommunication world – as a disruptive innovation, together with de-liberalization, changed the industry's landscape. Indeed, WLANs are disruptive innovation, changing the way people work and socialize, as Nicolas Negroponte argued in his interview [Negroponte, 04/09/2002]. The Exhibit 1-1 shows that WLANs, born in datacom world, strive to come to datacom world, breaking the planned evolution. Chapter 3 will deal with it in more details.

Exhibit 1-1. Disruptive emergence of WLANs



Purpose of this Research and its Importance

It is extremely important to analyze the way, in which WLANs are implemented for public use. The business models are *'real battle ground'* of WiFi. Recently, this technology received a lot of attention in mass media and specialised publication. However, the way to make any money from this technology is far from being clear. Different companies are working out schemes, and *'the search is still on for the business model to justify the effort'* [McClune, 25/11/2002]. Therefore, the major thing in WiFi implementation is a business model. In fact, Bill Gates once mentioned that in digital economy:

> *'competition is not among products, but among business models'* [Fortune, 1998]

The best way to explore evolving business models is to search real life cases of public WLANs' implementations. In other words, how the early adopters of this new technology are making money. Three different cases are chosen to describe and then analyze business models emerged. These cases are:

- Case One: Telia HomRun;
- Case Two: Starbucks and T-Mobile Hotspots;
- Case Three: Copenhagen Airport Wireless Internet Zone (WIZ);

WiFi WLANs have also important meaning for whole society. The technology and even the idea, have a tremendous potential to bridge a *'digital divide'* – WLANs promises to bring broadband access with little investments to virtually anybody with a capability to *'accept it'*, as a payphone did, connecting people at the dawn of telecommunications. Such opportunities caught an attention from the United Nations General Secretary, Kofi Annan, recently appealing to the Computer Industry leaders:

> *We need to think of ways to bring wireless fidelity (WiFi) applications to the developing world, so as to make use of unlicensed radio spectrum to deliver cheap and fast Internet access. …Surely, experts can think of many more ideas along these lines.* [Annan, 2002]

The research into business models in this thesis is intended to answer following questions:

What are WLAN and what is a rationale behind their use for public service and revenue generation?

What type of theoretical framework is applicable to this specific research purpose. In particular, how value chain analysis can be applied to public WLANs? What is a business model and how it can describe WLANs?

How WLANs business models can be classified and mapped?

What are main elements of Business Models in observed Case Studies?

What are implications for the future developments in public WLANs?

Methods and Sources of Information

In order to achieve the goal of the project and answer mentioned above questions, the approach was to use two research methods and two types of information sources. The Exhibit 1-2 shows what type of sources were used in each Chapter of the Thesis in the each research method.

Sources, used in this thesis, can be classified into: Real World Sources (people, books) and Virtual Sources (Internet).

Research methods are: Secondary research (finding reports about somebody's else activity) and Primary research (recording accounts from immediate sources).

Exhibit 1-2 illustrates allocation sources form Real and Virtual World in primary and secondary research. However, some remarks must be made concerning primary and secondary research methodology.

Secondary research

This type of research is based on data acquired from any available published sources. However, due to nascent state of WLAN industry, there is a very limited amount of literature on WLAN available. For this reason, the necessary information was gathered from many types of on-line sources: newsletters, articles, industry reports, data bases, magazines, newspapers and others. Thus many materials used for theoretical framework study, Case Studies and further analysis are available on-line in Internet for further reading of any interested reader. For each entry into List of References, direct hyperlink provided.

However, many on-line materials such as Total Telecom, Financial Times, Hotspots Market and some others are accessible only upon payment and can not be retrieved directly.

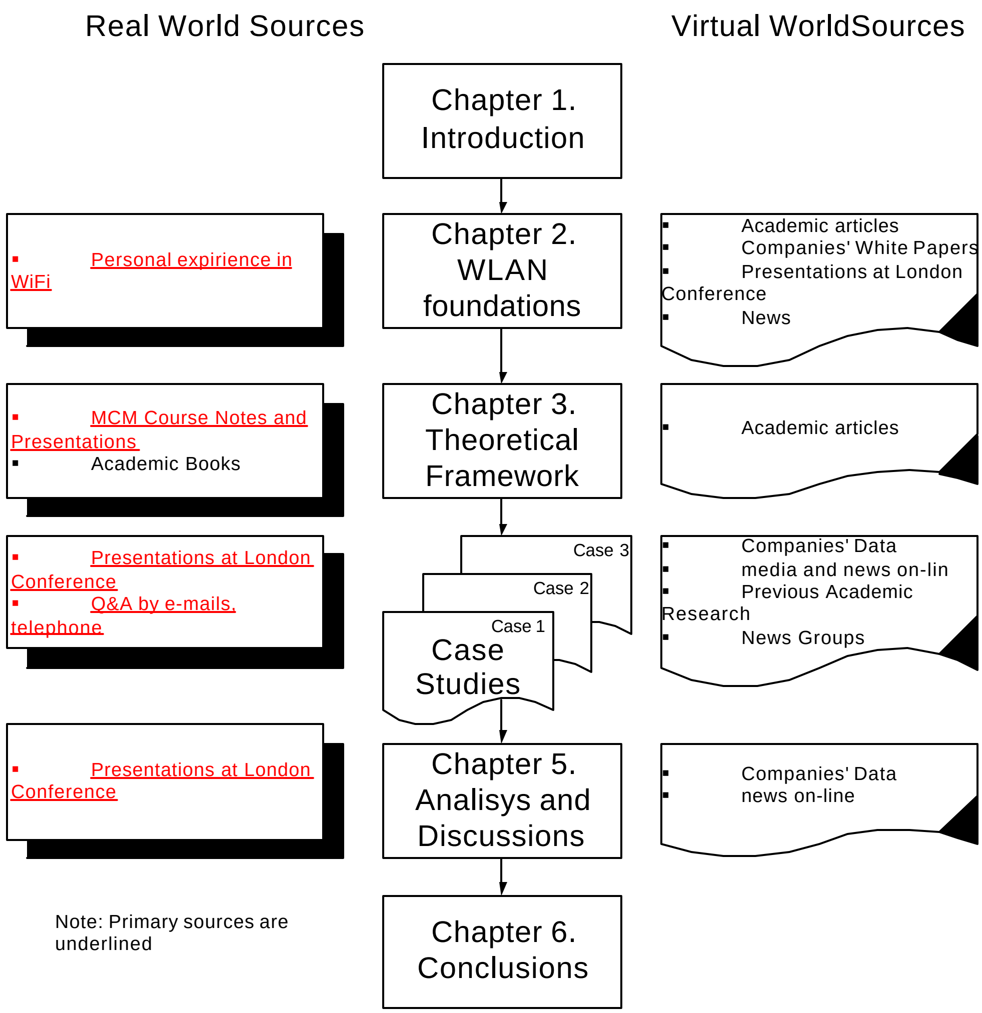
Another critical source of secondary data is Internet mailing lists and newsgroups – subscription was acquired to a number of different newsletters regarding WLAN issues. Members were offered questionnaire which help to get qualitative data about WLAN use.

Primary research

The crucial part of the thesis' research was the author's participation in the London Conference on '*Public Wireless LANs Deployment and Revenue Generating*' in September 2002. It made much easier to contact WLAN's implementators' immidiate representatives and establish personal contacts.

In addition to that, a few personal communications were carried out to help filling gaps of data. They give a chance to get a facts, not available in any published source, such as installation and operating costs of the Copenhagen Airport's Wireless Internet Zone (CPH WIZ).

Exhibit 1-2. The Thesis Outlay and Information Sources



Validity of primary and secondary research results was tested by 'triangulation' – the results acquired by one research method were tested by another method. For example, the figure of the reported average hotspot's coverage area was checked by a personal interview with a industry experts.

In general, facts, collected through secondary research were offered to interviewee to check their reliability. In each case, where such interviews or personal communications took place, the reference to a person and date is given in the foot note.

Limitations of 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. In order to ensure reasonable reliability of research, every attempt was made to find confirmation and cross-reference for every fact mentioned. Also, general industry common sense is applied to *'excavated'* material – for example, the operating cost of one Starbucks' hotspot can not be less than T1 line price in US, which is around £600 per month.

From other side, 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. More over, direct question to industry's representatives may not be answered, whereas secondary sources can indicate an answer. In a limited number of cases, the reference is made to anecdotic evidence – source of the information can not be disclosed.

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

Narrow geographical focus. This is due to the fact that only three prominent cases were selected for study, so geographical limit to the study is Sweden, US and Denmark.

The WLAN foundations in Chapter 2 are not focused on security issues. Security of WLANs remains a big issue that needs to be solved.

Focus only on viable and currently existing technologies for public WLAN. Replacing technologies such as IEEE 802.11a and HiperLAN/2 are not available for mass deployment yet. So their deployment cases and its impact on public WLAN is not considered.

Questions like "Will WiFi complement 3G?" "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?" are not answered in this dissertation and not intended to be answered. Since the main objective is to investigate the existing business models of WISPs in the WLAN market, these mentioned above issues do not affect overall conclusions

Project Structure

The Chapter One raises the subject and explains why it is important for a research. General introduction into the problems related to WISPs and the WISP industry is offered. From this the main purpose derivates and delimitations are discussed.

The Chapter Two gives technical and marketing overview of WLAN industry.

Chapter Three explains and discusses the theoretical framework. It starts with describing theories for value chain analysis. Then is explored in depth business models ontology and its possible applications to disruptive innovations such as WLANs. The chapter ends with a presentation of industry specific classification and mapping diagram.

Chapter Four presents empirical findings on chosen Case Studies of different Wireless Internet Service Providers (WISP).

Chapter Five analyzes chosen WISPs through introduced theoretical framework. The WISP's industry value chain is described and analyzed by suggested framework. Then business models are analyzed in the case studies. The next step is aggregating this analysis in order to see general patterns for the WISP industry. From there an attempt is taken to determine specific key developments for different WISP.

Chapter Six will present general conclusions. The conclusions will consist of answering the questions raised in the problem discussion. This chapter will also contain suggestions for future research within the area, related to the findings.

Notes on Currencies

For the readers' convenience, all currencies such as US dollars, Swedish and Danish Krones and Euros are arranged into common denominator – Pounds of Great Britain (£). Exhibit 2-3 shows exchange rates:

Exhibit 1-3. Currency Exchange Rates

Currency	Rate to GBP
1 Danish Krone	0.0850
1 US Dollar	0.6461
1 Swedish Krone	0.0691
1 Euro	0.6313

Source: www.bloomberg.com, 28/10/2002

Chapter 2. Foundations of public wireless LAN

If any one technology has emerged in the past few years that will be explosive in its impact, it's 802.11 [Gates, 2002]

The Buddha, the Godhead, resides quite as comfortably in the circuits of a digital computer or the gears of a cycle transmission as he does at the top of a mountain or in the petals of a flower [Pirsig, 1974:17].

Introduction

This thesis looks at WiFi WLANs as an example of a disruptive technology, breaking up the continuous innovation process. Thus, in a first place, it is important to understand what is a disruptive technology. Then, fundamental elements of Wireless Local Area Networks (WLANs) are discussed along with specific aspects of ***wireless fidelity*** (WiFi) standard, emerging as a disruptive technology. The next step is to explore how the relative position of LANs and WLANs among other types of networks defined by their functions. To make understanding of standards issues more clear, WLANs history and standards will be briefly observed.

A major part of this chapter discuss important *'internal'* aspects and definitions of WLAN, such as architecture, terminals, security, radio frequency, applications and roaming. The discussion of WLAN 'eco-system' will follow, covering regulations, environmental and cost/pricing issues.

Being at nascent scent, WiFi WLANs market tendencies are very difficult to be observed, yet a brief look over it will be undertaken.

Finally, disruptive aspects of WLANs will be highlighted.

What does 'disruptive technology' mean?

Intel calls WiFi *'the most disruptive technology since the Internet'* [Foremski, 21/10/2002]. Which criteria defines disruptive technology? Some academics, such as Michael E. Porter, argue whether Internet was a really disruptive technology [Porter, 2001:78] to general industry. Others, like Coffman and

Odlyzko [Coffman and Odlyzko, 2001:27], suggest that only world wide web was truly disruptive innovation in the Internet world:

…only the web can be said to have been truly disruptive…

According to Clayton Christensen [Christensen, 2000:67-76], disruptive technologies have following four characteristics:

1) They create new markets by introducing a new kind of product or service thus forever change consumer's behavior by satisfying fundamental needs.

2) The new product or service from the new technology costs less than existing products or services from the old technology.

3) Initially, disruptive technologies have poor performance at their introduction when judged by the performance metrics that existing mainstream customers value. Eventually, performance is catching up and overthrow the prevailing technologies by offering a better value proposition.

4) The technology should be open to everybody who want to exploit its advantages. So, such barriers as patents are low or non-existent.

Thus, a wireless technology can be quite enough disruptive in its impact on whole telecommunication industry, influencing all parties – venues owners, ISP, mobile carriers, vendors. Exploring fundamentals of WLAN will help to understand this.

Rapid Adoption of WLANs into wide area of applications

The rapid success of WLAN technology took most of the world by surprise. Even amid sluggish computer sales, users are buying up wireless networking equipment at a considerable rate. This is partly because, although wireless networking has been around for many years, it has only recently been available at an attractive price to consumers and businesses. WLANs have also found a particular market niche for households with several Internet users. By means of a WLAN access point/router, each member of a household can have access to the Internet simultaneously through a single Internet connection. The connected computers throughout the house can share files and printers just as if they were connected via a traditional local area network (e.g. Ethernet), such as those typically used in the workplace [ITU, 2002:2-12].

Businesses and other institutions are also rapidly embracing wireless LANs, notably in older buildings, convention centers, schools, factories, and other locations where installing wiring poses a challenge. WLANs are also ideal for temporary use by conference attendees, as they can be set up quickly in conference rooms without the need for additional wiring. Wireless networks also perform a very important function for employees on the move, enabling them to roam with their laptop computer, while maintaining a connection to the Internet and the corporate Intranet. In addition, not only do WLANs allow numerous users connection via a single access point, but, once installed, further users can be added easily and cheaply. This is particularly appealing in locations such as airports and cafés with high numbers of transient users [ITU, 2002:2-12].

Other, non-conventional business users are also finding wireless networks a valuable asset. For instance, shopping trolleys in grocery stores can be equipped with wireless devices that send signals back to the network and plot the course of shoppers as they make their way through the store. Managers can then adjust the placement of the most popular or profitable goods to the highest traffic areas [ITU, 2002:2-12].

The medical profession has also benefited from the growth of wireless technology. Doctors and nurses can carry personal digital assistants (PDAs) with wireless connections in order to access a patient's medical records, rather than carrying multiple medical charts. Any changes in a patient's status can be entered in the PDA at the patient's bedside and relayed instantaneously back to the network for timely reports and analysis [ITU, 2002:2-12].

Different Networks for Different Purposes

LAN and Ethernet

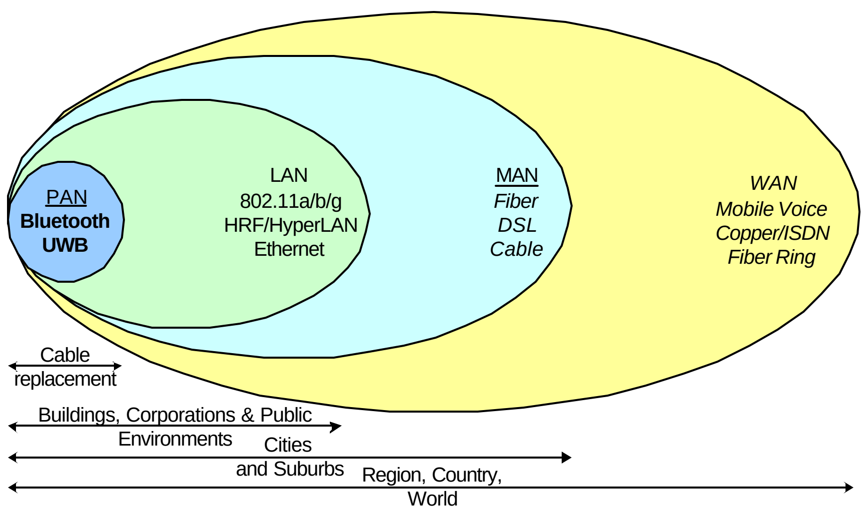
Local area networks (LANs) form the vanguard of the data access world, serving end-users in a communications network within a confined geographical area. LANs allow servers, individual workstations, peripheral devices, and network operating systems to communicate each other. LANs' users can benefit from numerous client/server network services such as printer sharing, file sharing, shared Internet access.

At this point, an assumptions has to be made to accept Ethernet, or, more technically, a IEEE 802.3 specification as the computer industry de-facto LAN standard. Therefore, in all references to LANs, further in this dissertations, it is presumed they are implemented on the Ethernet[4]. Typical bandwidth, available for Ethernet end-user range from 10 Mb/s to 1 Gb/s.

PAN, LAN, MAN, WAN

As one can see from Exhibit 2-1, LAN is between PAN (personal area network) and MAN (metropolitan area network).

Exhibit 2-1. The environment of LANs



Source: May, Hellman, Boruta, 2002:7. Note: not to scale

The various ranges make each network ideal for different types of traffic. The shorter-range PANs is ideal for cable replacement among peripherals, and other close point-to-point communications. LAN (also wireless) are better suited for local, high-speed networking of buildings or homes. Indeed, if PAN network provide connectivity between various peripheral user's devices (up to 10m),

[4] There are several Ethernet standards, but all of them are downward compatible and, in essence represent the same technology.

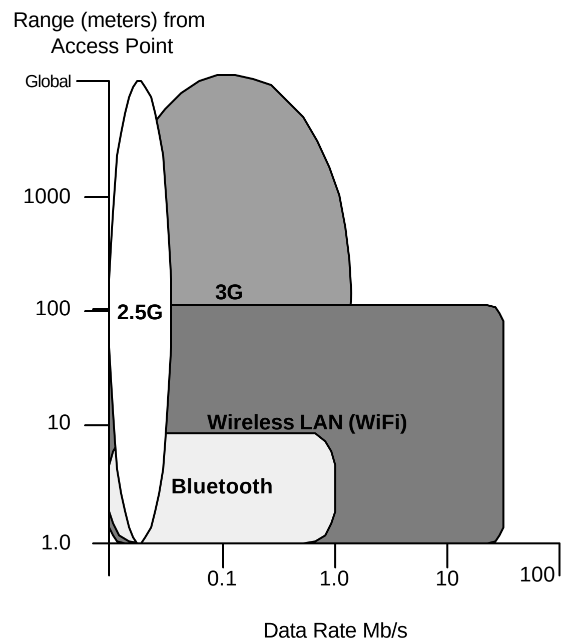
LAN delivers high-speed data to end-user's device over much longer distance. In other words, LAN is distributing broadband to end-users, whereas PAN is responsible for communications over various devices of single user (headset to mobile terminal and so on).

MAN – metropolitan area network – employ such technologies as xDSL, cable TV, Fixed Wireless Access and others to deliver high-speed data to end-user[5]. The technology inside this range of network is deployed to deliver external information content to LAN. The gap, bridged by MAN's access technologies is know as *'a last mile'*.

WAN – wide area network represents any technology, capable of reaching subscribers on wide geographical location, not confined with only one city. The PSTN, cellular networks or fiber optic rings are examples of such networks. The broadest coverage, offered by such mobile wireless WANs as 2G or 3G, is best for connecting away from buildings with WLANs, in more remote locations, or in transit.

[5] Which in turn can be just LAN

Exhibit 2-2. Mobile Data Radio Access Technologies



Source ITU, 2002:2-35. Note: not to scale

In general terms, the shorter the range, the faster the network and the cheaper the service will be. Exhibit 2-2 illustrates relative position of different wireless access technologies according to speed and range.

Brief History of WLAN

First WLANs were designed to replace wired LAN connections in offices. The early research by Motorola[6] in middle 80s, showed that the wired connection LAN costs were becoming exorbitant, specially in large office buildings [Brodsky, 1995: 125].

Wireless LAN were thought to represent a flexible data communication system that can either replace or extend a wired LAN to provide added functionality. Using radio frequency (RF) signals, wireless LANs transmit and receive data over the air, minimizing the need for wired connections. A special RF band was dedicated to such systems, called ISM (Industry, Scientific, Medical). The radio

[6] Motorola demonstrated that cable dusts and related structural support could add up to 10% of building cost.

frequency band was not regulated itself, but equipment manufacturers were restricted by power limitation conditions. Some countries also control over commercial use of WLAN [Brodsky, 1995: 125 and see below].

WLAN's Elements

There are significant disagreement among computer industry experts, what the definition of WLAN is. One group[7] believes that WLAN is any technology which allows computers and other electronic devices communicate without wires over short distance (less than 1 mile) [Brodsky, 1995: 124]. Another group suggest that WLAN definition must also reflect its connection to one of industry standards.

The definition, adopted in this thesis is given by ITU, describing a WLAN as a local area network of which at least one segment uses wireless technology [ITU, 2002:2-12]. Mobile devices access the 'wired' network by connecting to an access point (client-server)or each other[8] (peer-to-peer) on the network. This access point is physically connected to the wired network and acts as a receiver and transmitter, passing traffic back and forth between the wired network and mobile clients equipped with wireless cards. It is worth noting that the phrase *'wireless LAN'* is somewhat of a misnomer, given that the wireless network typically forms part of a *'wired'* LAN, to which it is connected. An assumption has to be made presuming that WLAN using wireless (radio) connection in ISM RF band and compatible with the industry's standard for LAN – Ethernet. Following this assumption, WLAN and 'radio-Ethernet' are equal in this dissertation. In fact, the common thing between them – compatibility of equipment and speed of data transfer. WLAN provides at least the same bandwidth to end-user as wired Ethernet and limited mobility.

At this point it is necessary to define wireless Internet service provider (WISP) – this is an entity/institution simply providing Internet services[9] (or just ISP) and using WLAN as one of access technologies.

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[7] This old discussion has also modern sequel in recent BAWUG discussion on what WiFi is. See BAWUG 20/11/2002-29/11/2002
[8] And at least one access point
[9] web, e-mail etc

Three types of technology are available for WLAN implementation: spread spectrum radio, narrowband radio, and infrared technology. Using spread spectrum technology, a signal is sent to the receiver over a range of frequencies to limit the interference distortion from other electronic equipment [Kane and Yen, 2002:6]. The signal should get through on one frequency if there is interference on another. There are two types of spread spectrum radio technology: frequency hopping (FHSS) and direct sequence (DSSS). In a frequency hopping system, the signal transfers along various frequencies in a specific sequence. The transmitter and receiver only know the pattern in which the signal changes. If the signal is synchronized for transmission, the end result is a single logical channel. In direct sequence transmission, each bit of transmission is sent over fixed, multiple channels. The bit pattern, called a *'chip'*, is prone to damage during transmission. If this occurs, statistical techniques can recover the original data without the need for retransmission.

Narrowband technology transmits and receives information on a specified frequency, which is as narrow as possible to transmit the information. Finally, infrared transmission uses high frequency light waves to transmit the data. This type of technology proves to be effective and inexpensive for short-range wireless communications and become gradually popular on PC and related peripherals.. The major weakness at the current stage is that the IrDA protocols have not been widely accepted by the industry and hence, it has not reached every corner of the embedded systems universe.

Following paragraphs consider major elements of WLAN based in ISM RF band in more detail.

Infrastructure and Architecture

The basic principle of WLAN operations resembles cellular networks –access point (AP) broadcast and receive over short distance (up to 100m) from users' terminal, equipped with network interface cards (NIC)[10]. Base stations are connected to Ethernet network backbone, in turn connected to MAN, WAN or

[10] '*Ad hoc*' mode of WLAN would be described further, yet it is not possible to build Public WLAN on such principle.

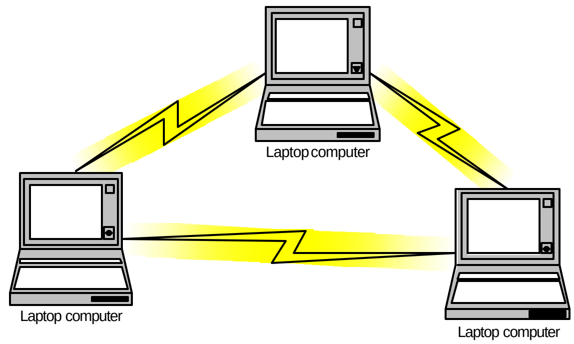
public Internet. The major benefit of such architecture is that user's experience of working is this wireless network resembles very much the work in wired environment – the speed of network can be up to 54 Mb/s[11], keeping mobility, limited only by the range of AP reach. A concentrated geographic area where high speed wireless LAN access is available is called *'a hotspot'*.

In general, WLAN of popular standards can operate in two modes: peer-to-peer and client/access-point[12]. Both types of architecture offering fully distributed data connectivity.

<u>Peer-to-peer</u> is a WLAN in its most basic form. Two PCs equipped with wireless adapter cards form a simple peer-to-peer network, enabling the PCs to share resources. This type of network requires no administration or reconfiguration, but also bypasses the central server, inhibiting client/server sharing. This type of independent or *'Ad Hoc'* wireless networking can be used for PCs communicating directly with each other. In such WLAN configuration, access points function as repeaters, which are used to increase the range of WLAN. Possible applications include: collaborative work groups; small/branch offices sharing resources; remote control of another PC; games for two or more players; demonstrations. It is important to note that at the moment peer-to-peer networks for public use are not wide-spread, however there are some research in this area. Vendors develop software, allowing to deploy WLAN based on *'ad hoc'* mode for public use [Fusco, 05/11/2002].

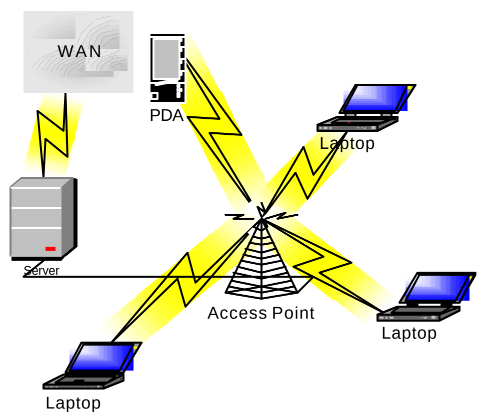
[11] Depending on standard. The most common speed is reflected at the Exhibit 2-2
[12] One should added multiple AP mode, which is also discussed below.

Exhibit 2-3. Peer-to-Peer WLAN mode



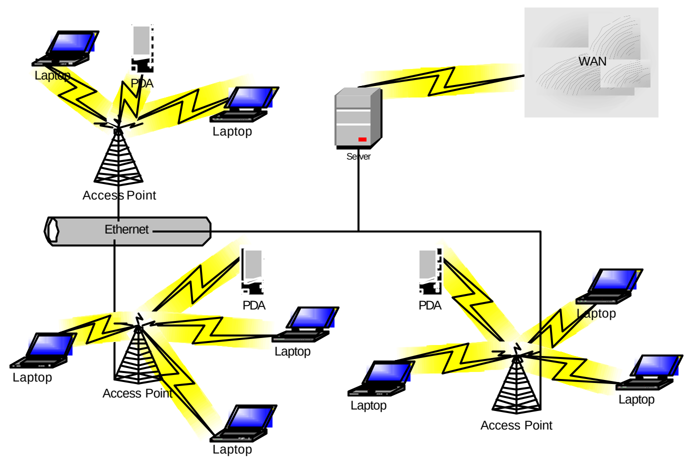
Client and Access Point A Client and Access Point network allows for extended range capabilities; they are also able to benefit from server resources, as the AP is connected to the wired backbone. The number of users supported by this type of network varies by technology and by the nature and number of the transmissions involved. Generally, client and access point networks can support between 15 and 50 users.

Exhibit 2-4. Single Access Point Mode



Multiple Access Points Although coverage ranges in size from product to product and by differing environments, WLAN systems are inherently scalable. As APs have limited range, large facilities such as warehouses and college campuses often find it necessary to install multiple access points, creating large access zones. APs, like cell sites in cellular telephony applications, support roaming and AP to AP handoff. Large facilities requiring multiple access points deploy them in much the same way as their cellular counterparts, creating overlapping cells for constant connectivity to the network. As network usage increases, additional APs can be easily deployed. This type of architecture is the most popular to build WLANs for public use.

Exhibit 2-5. Multiple Access Point Mode



Radio Spectrum and Standards of WLAN

Transmission radio frequency (RF) is a crucial element in WLAN. Historically, WLAN were allocated in ISM frequency band operating currently in three different unlicensed frequency ranges: 902 MHz, 2.4 GHz, and 5 GHz [Brodsky, 1995:129]. Even though this spectrum is used on licensed exempt basis, devices should be certified to ensure that they emit only low power radio waves – in most countries, ISM band devices should not emit more than 100mW indoors.

Each diapason of ISM spectrum has different characteristics and advantages. The basic trade-off with the frequencies involves range versus data rate—the higher the frequency, the higher the data rate, but the smaller the range, and vice versa. The 5 GHz unlicensed band has more than three times the spectrum as the 2.4 GHz band, providing an average of eight channels versus three channels in 2,4 GHz. But because of the shorter range of transmission in higher bandwidth, WLAN in the 5 GHz band may require more access points in a standard network in comparison to 2.4 GHz, increasing installation cost.

The evolution of the WLAN's spectrum use goes from more crowded parts till less crowded and less exposed to various interferences. First WLANs operated in

902-928 MHz band. This band, however, is shared with cordless phones and now equipment manufactures moved towards 2,4-2,5 GHz and 5 GHz bands. In middle of 90s, due to many proprietary solutions, impeding further development of WLANs, the industry seeks for unifying standard.

The IEEE (Institute of Electrical and Electronic Engineering) began to address the need for an interoperability standard among wireless LANs in early 90s [May et al, 2002: 29]. The 802.11 standard was ratified in June of 1997, specifying WLAN operation in the 2.4 Hz frequency range and in essence laying the foundation for each of the 802.11 family protocols [see Appendix A].

At present moment, there are several WLAN standards, which can be called 'wireless Ethernet'. The Exhibit 2-6 briefly specifies major WLAN standards.

Historically, IEEE 802.11a was developed earlier, but due to technical delays, another standard from IEEE, 802.11b was introduced to meet growing demand for wireless networking (see Appendix A). The IEEE 802.11b has enabled multiple vendors to enter the market, driving down manufacturing costs and improving equipment distribution. Major benefit of 802.11b is interoperability, possible between base stations and LAN cards from different manufacturers working to the same standard. This initiative created critical mass of 802.11b users.

The interoperability standardization of 802.11b is supported by inter-industry organization WECA (Wireless Ethernet Compatibility Alliance). This organization holds the Wireless Fidelity (WiFi) certification program, so 802.11b equipment and networks are sometimes referred to as WiFi networks. Further, we refer to 802.11b networks and equipment as 'WiFi' in this dissertation.

Exhibit 2-6. Comparison of Major WLAN Standards

Standard	Spectrum band	Transmission rate (max)	Data range (m)	Notes
IEEE 802.11b	2.4GHz	11Mbit/s	57	Most popular and widespread
IEEE 802.11a	5GHz	54Mbit/s	12	Newer, faster, higher frequency
IEEE 802.11g	2.4GHz	54Mbit/s	19	Fast and should be compatible 802.11b
ETSI HiperLAN2	5GHz	54Mbit/s	15	European standard, QoS, for voice/video
HomeRF	2.4 GHz	10 Mbit/s	100	QoS, better encryption, not widespread
Bluetooth	2.4 GHz	1 Mbit/s	10 m	Personal Area Network [not WLAN]
Infrared LAN	350'000 GHz	4 Mbit/s	~20 m	Same room only, no negative health effects

Adopted from Paolini and Kacker, 2002:5, ITU, 2002:2-13

At present moment, 2.4 GHz band is more popular than 5 GHz and therefore, more '*crowded*'. As Exhibit 2-6 illustrates four standards out of six radio WLAN standards operates in this part of ISM band. But as was mentioned above, this part of ISM is three times more narrow than 5 GHz.

As a result, several standards, namely the 802.11a and HiperLAN2, have taken advantage of the less-crowded 5 GHz band (see Exhibit 2-6). This band holds much promise because fewer devices operate in it, thereby avoiding some of the interference that affects the 2.4 GHz frequency. The 5 GHz band also has the advantage that the standards were developed later, and can accommodate faster speeds than earlier standards using the 2.4 GHz range. The quandary is, therefore, that the 5 GHz range standards are ideal, particularly given their capacity for higher speeds, but they cannot elbow their way to the top owing to competition from the proliferation of equipment and networks already operating in the 2.4 GHz band. Conversely, those operating in the 2.4 GHz band suffer from quality of service problems due to overcrowding.

The 5 GHz standards are also facing some competition from an old, revitalized foe. Just as 802.11a products (at 5 GHz) are coming onto the market, the IEEE is working on a standard known as 802.11g that offers the same speed as 802.11a, but which operates in the 2.4 GHz range. This standard will offer backward compatibility with the existing WiFi infrastructure. Notwithstanding WiFi's position as the most popular of these standards to date, it may be some time before an effective standard materializes as a global favorite.

The rest of the thesis is focused on implementation of WiFi technology in public WLANs.

To summarize, WiFi is the most popular wireless LAN technology in the world. The total majority of wireless NIC and AP shipment is WiFi [May et al, 2002:31]. As said above, interoperability is driving WiFi equipment costs down, making it available to broader base of consumers. In economical sense, equipment price is the most important advantage of WiFi over other standards. Cost structure of WiFi will be discussed in more details in appropriate section below.

Security issues

Many felt that security will be a problem for WiFi, claiming that this popular protocol has no serious built-in security, which makes it vulnerable to eavesdropping and easy to get unauthorized access.

There are two types of security issues on an 802.11b or WiFi network: authentication (deny unauthorized users access to the network) and encryption (preclude eavesdropping).

The 802.11b standard is equipped with a security measure called WEP (Wired Equivalent Privacy). WEP encryption is powerful, but many experts claim that it was implemented in a way that undercuts its security. In fact (see Appendix A), it was proven that WiFi transmission can be intercepted and as a result, network might be totally open to unauthorized access. Following this, American military banned completely the use of WiFi on strategic objects, such as nuclear labs [Total Telecom, 01/02/2002].

However, many experts believe that issues around insecurity of WiFi is overemphasized. Insecurity of WLAN is not so high compared to traditional LAN. According to Nick Hunn of TDK Systems, *'the presence of a wire does not make communication safe'* [Hunn, 2002:3]. In his opinion,

> *This whole attitude is reminiscent of what happened when companies discovered that documents could be stolen from dustbins – the solution is not to put the confidential documents in a black plastic bag and hope the dustbin lid is secure – the answer is to shred the documents first. So let's not blame wireless standards for security* [Hunn, 2002:3]

All this means that security issues unresolved in WiFi equipment itself, must be solved by other security add-ons. There are a few ways to get WLAN network more secure – for example, by running a VPN (Virtual Private Network) across it. However, VPN is proprietary solution and has to purchased additionally as a service from VPN service provider.

User's Terminals

At present moment, WLAN can be accessed with a wireless LAN card inserted in a PC (laptop or desktop) or PDA. Obviously, this is acceptable for those who regularly carry a laptop PC. This customer segment ranges from business travelers to students – laptops' prices starts from around £500 – mush broader segment of users can afford it recently.. A range of inexpensive WiFi-enabled Pads will be required for the mass market.

Now days, many laptop manufacturers such as IBM integrating 802.11 as standard into a larger portion of its product range. Toshiba is integrating 802.11 into PDA phone devices [Drury, 22/08/2002:]. Today, buying high-end laptop computer, user already expect built-in WiFi card. In 2002, approximately 10% of all portable PCs will be shipped with a wireless LAN included. Number of laptops with WLAN capability increases to 31% in 2004. By 2007, Gartner Dataquest forecasts 68% of all mobile PCs shipped will include a wireless LAN. In the corporate world the penetration will be even higher. Gartner Dataquest forecasts the penetration rate of wireless LAN into the professional portable PC installed base will grow from nine percent in 2000 to almost 50% by the end of 2003, and it is expected to surpass 90% by 2007 [Total Telecom, 19/09/2002]. Another consultancy BWCS reports that in 2006 there will be around 130 million wireless enabled laptop PCs or other mobile computing devices capable of hooking up to services offered at WLAN hotspots [Gustafsson, 2002:1].

Popularity of WiFi is also facilitated by the fact, that Microsoft Corp. has included 802.11b wireless networking drivers as standard *'zero configuration'* support in Windows XP, which WiFi proponents called *'major victory for WiFi'* [May et al, 2002:6].

Although PDAs such as the Compaq iPaq are being shipped with WLAN cards, the high-energy consumption of WiFi-enabled PDA is still a problem, making usage times very short – in best case no more than one hour. Using a laptop is to be preferred, and it will be several years before cellular phones will have the energy capacity required for WLAN. Another thing, limiting PDA's use in WLAN is little screen, just a bit larger than best models of mobile phones. This restrict user to a set of applications such as e-mails and instant messaging. Using PDA for more bandwidth and screen -hungry applications is not so easy as with laptop [Allied Business Intelligence, 2001:3].

Areas of WiFi's Applications

As was said before[13], the original applications of WLANs laid in industry, scientific laboratories and hospitals. This is still holds true, with addition of general public commercial access in private venues.

The 11 Mb/s bandwidth offered by WiFi 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 [Office of the e-Envoy, 2001:10].

There is significant discrepancy in opinions on what is *'killer application'* of WLANs. Townsend argues that

> *It is highly likely that context-awareness will emerge as the 'killer app' for mobile computing and communications devices. Location-awareness and location-based services (LBS) will comprise a key component of this context-awareness.* [Townsend, 2001:1]

Others [Bjoernsten , September 2002] consider access to corporate networks via Virtual Private Network (VPN) as major driving force for users, adopting

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[13] See Rapid Adoption of WLANs into wide area of applications

WLANs. They claims that today business executive *'have an office wherever he puts his laptop'* [Karmakar, September 2002], thus increasing corporate efficiency.

One can argue, that in case of WLAN, *'killer application'* mostly depends on venue where customer happen to log on. For example, an airport's WLAN *'killer application'* might be only access to a corporate network by VPN. In a bookstore, like Borders, *'killer application'* is an access to informational and edutainment resources, whereas a coffee shop user can enjoy e-mail downloading while streaming down a new single of Robbie Williams. However, the one common thing between all these application is that they are all bandwidth-sensitive. So true *'killer application'* of WLAN WiFi, can be a pure bandwidth and wireless connectivity with increased mobility.

One should not also forget plain *'voice'* which can be carried over WLAN using VoIP. This let travelers talk oversees almost no charge, diminishing their spending on voice communications.

An important role in a WLAN adoption plays various kinds of home and campus networking, helping consumers to connect various home PC in one network [WLANA, 2002]. Beyond immediate PC connectivity, wireless LANs can enable home entertainment centers to establish connectivity with other devices, communicate with PCs, and distribute content to wireless speakers and flat panel television screens [May et al, 2002:12]. Some other vendors goes even further, envisaging

> *…WiFi enabled kitchen gadgets such as refrigerators, and especially entertainment systems. Imagine beaming video and music over WiFi into different rooms at home* [or]*…the home computer system morphing into a much different device. It becomes more like a powerful server and network switch, with massive arrays of hard drives capturing rich media content over of fiber optic broadband connection and then using WiFi to distribute it all within the home. And why stop there? There might be opportunities for businesses. After all, one house in a street could offer a whole set of*

> *WiFi enabled services to its neighbours. Most people cannot program the time on their video recorders. Imagine the complexity of establishing and running a WiFi network? Your neighbourhood geek could provide such services, and through the magic of high-speed wireless connections, could offer all sorts of local media/entertainment services transparently*.[Foremski, 13/09/2002]

there are many benefits, WiFi can bring to corporations and end-users but as Negroponte argues, the most fundamental might be that working with computer at home is no more antisocial than reading a magazine [Negroponte, 04/09/2002].

Roaming

> *A golfer can go to the nearest golf club anywhere in the world, show his or her membership card, and say: "Look – I'm a member back home, I've paid my membership fee and I know the rules of the game. Let me play on your course." That's 'roaming' in the world of golf* [Gustafsson and Sandred, 2002:1]

Roaming is a big issue in mobile communications world. However, in application to WLANs, it is even much more complicated, because there are no billing standards meaning that every WISP (Wireless Internet Service Provider) believe that they are the biggest and soon dominated the world of WLAN, thus invoicing customers by its own proprietary billing system.

In fact, roaming is behind the great success of GSM in Europe – the ability to use your ordinary cell-phone number to make calls while you are abroad, and use different phone companies without ever noticing the difference [Gustafsson et al, 2002:4].

Every WISP use a different billing method to invoice customers. Some use per-minuet, others use per-traffic or flat rate or combine both. Finally, WISP can give access to the network in exchange for buying cup of coffee. One of the main barriers to the spread of public access WLAN services is a tendency for users to be invoiced by individual hotspots. There is just one solution to this problem in a world of millions of wireless islands: **roaming**.

There are two types of roaming agreements:

Bilateral roaming – roaming contracts signed between individual WISPs are referred to as bilateral. An example of a bilateral contract is the one signed between Telia HomeRun and Italian Megabeam, where customers of both WISPs can use the other network free of charge[14].

Multilateral roaming – in the GSM world, signing bilateral roaming contracts soon became tedious work as the carriers had to keep track of new companies starting services in a multitude of different countries. After a while a central entity was created, where all companies who signed agreements with the central hub can roam with each other. Excilan is a Luxembourg based company who aims to provide multilateral roaming and be the hub for WISPs to use. Besides not having to negotiate contracts with each and every WISP, an advantage towards using brokers is that the WISP will keep a larger part of the revenue itself.

Brokers[15] are companies that buy traffic minutes in bulk from WISPs and resell them to customers of their own. An example of broker is iPass. The user is enabled to access Internet at local rates wherever in the world he might be, and getting charged one bill by iPass in his home country. The business model is that iPass buys a bulk of minutes from WISPs, and resells it to their customers. The downsides for the WISP is that they receive significantly less for minutes sold to iPass than they would in a bilateral deal with another WISP or their own customers.

A typical interaction of a guest user with a local WISP followed this routine: a visitor switch on his or her WiFi-enabled laptop will access the local WLAN network. Then a visitor will be met by either the home page of the venue owner (the airport or hotel), the home page of the WISP to which the user subscribes, or even his or her company's home page directly. There are many possible

[14] Till the end of this year

[15] Often referred as roaming partners

solutions for user's payment options but one thing is certain: users can't take out a separate subscription for every hotspot they visit. Roaming solutions must be introduced to make easy for the hotspot visitor as it is for golfers to travel the world.

Regulations and External Environment

The major advantage of deploying WLANs, such as WiFi, in ISM band is no need to acquire a license from national radio frequency Regulation Authority. Thus the scarce resource of radio spectrum can be used by any interested party. This gives WLANs significant competitive advantage over WANs like 3G, which licenses cost €120 billions across Europe.

On the whole, the 2.4GHz band is deregulated across Europe [16], Americas and Asia. Most National Regulators place no distinction on public or private use of this band. This means that in most countries, it should be possible to operate public access wireless LANs using IEEE 802.11b technology i.e. WiFi. There are even some positive developments. In the spring of 2002 OFTEL granted permission to BT to build nation-wide WLAN WiFi network in UK without any kind of licenses [Total Telecom, 11/07/2002]. In late fall 2002 French telecoms regulator has made moves to open up the public wireless LAN market in France, becoming the latest European country to allow the use of unlicensed spectrum for the provision of public WLANs based on the WiFi standard [Young, 13/11/2002].

However, deregulation of ISM band has also some drawbacks impact on commercial WLAN services. First issue is the lack of quality of service guarantees. By definition, license-exempt spectrum is used by everything from TV remotes to microwave ovens and service degradation is possible. WiFi proponents answer to it with a fact that *'Internet is delivered over fixed-line, with little service guarantees and the consumer has adapted expectations accordingly'* [Drury, 15/08/2002]. Additionally, even with high interference, a

[16] With notable exception of Luxembourg, Italy, Spain, and Greece in Europe, where commercial use of WiFi is prohibited [Drury, 2002:1].

service delivered via 802.11b over 2.4GHz is likely to be far faster than 2.5G or 3G WAN networks.

The Exhibit 2-7 demonstrates the availability of ISM band in some European countries.

Exhibit 2-7. Examples of Regulations over ISM band and WLAN in Europe

Country	**2.4GHz**	**5GHz**	**Public WLAN Service**
Austria	License-exempt	HiperLAN2 may be used in the 5.150GHz to 5.350GHz band but restricted to indoors applications. 5.470GHz to 5.725GHz is reserved for military use.	Permitted
Denmark	License-exempt	License-exempt	Permitted
France	License-exempt, but with strong power and location caveats due to military use of the band	License-exempt	Permitted since fall 2002
Greece	License-exempt	Frequency spectrum already allocated to other applications	Not permitted
Italy	License-exempt	HiperLAN2 may be used in the 5.150GHz to 5.350GHz band but restricted to indoors applications. 5.470GHz to 5.725GHz may also be use, but with technical caveats.	Not permitted
Netherlands	License-exempt	License-exempt	Permitted

Source: [Drury, 2002:1]

Interference issues

Susceptibility to interference – as the systems work in unlicensed spectrum, there is always the danger of an unpredictable interference that could lower the transmission rates significantly. There are three major source of interference for WiFi transmissions devices – microwave ovens, Bluetooth systems and WiFi themselves.

Some old models of microwave ovens just generate background noise in the same frequencies, used by WiFi – 2,4 GHz [INTERSIL, 1998:1]. However, oven's interruption does not terminate WLAN transmission completely. Only the bandwidth, available for user, becomes more narrow, because AP automatically decrease the transmission speed. Also, it should be considered that microwave ovens are not very likely to appear in business environment near 1-2 m of AP, where its interference is the most significant [INTERSIL, 1998:16].

The more serious issue of interference and increased error rate is raised in environment where WiFi co-exist with Bluetooth. The research [Zyren, 1999:12] shows that in case of one Bluetooth picocell, WiFi may lose about 70% of its performance, but appearance of other Bluetooth picocells, drive this rapidly to 0. However, the same research suggest that a real performance depends very much on physical environment of hotspot and WiFi performance greatly increase in the presence of Bluetooth systems if user moves close to AP and further away from Bluetooth [Zyren, 1999:12].

The worst scenario is when WiFi hotspots are interfering with each other. This happens if several WiFi networks shares the same space like convention centers or big office building. WiFi can operate only in three different channels, meaning that only three different WLAN (and also WISP) can coexist in one particular venue. According to one account of recent Comdex exhibition in Las Vegas, such interference can be a nightmare. If there are many WiFi devices like APs and NIC (working in '*ad hoc mode*') in a proximity of a user, it is almost impossible for software to pick up the right network – WiFi card was keep switching from one network to another in uncontrolled way. A witness reported that situation resembled *'a sheep set between two loads of hay'* and this resulted in the fact that *'some systems were unable to latch on properly onto any access point in this environment'* [802.11 Planet, 21/11/2002].

The ideal wireless network consists of neighboring access points that operate on different channels. Using different channels allows workers to connect to the network without experiencing interference from other users or an unacceptable dilution of data rates [PROXIM, 2002:5].

In situations such as trade shows like Comdex or WLANs in multi-unit dwellings, the availability of only three channels can lead to blockages of service for individual networks.

This raises the issue of who has a right to set up and operate WLAN in the venue – owner or operator.

National regulators are unlikely to provide interference resolution above cases involving obvious illegal transmission.

Environmental impact

The general public is increasingly concerned about the health hazards posed by a radio systems emission. This may particularly apply to indoor systems and cause deployment difficulties. However, WiFi association WLANA [WLANA, 2002:9] doesn't particularly concern about it:

> *The output power of wireless LAN systems is very low, much less than that of a hand-held cellular phone. Since radio waves fade rapidly over distance, very little exposure to RF energy is provided to those in the area of a wireless LAN system. Wireless LANs must meet stringent government and industry regulations for safety. No adverse health affects have ever been attributed to wireless LANs.*

Nonetheless, there are concerns in hospitals when it comes to WLANs as monitoring devices and some medical devices (heart monitors and pacemakers) operate in the same frequency range[May et al, 2002:49].

Cost structure

Infrastructure cost

In case of WLAN deployment, wireless LAN equipment is very inexpensive, relative to other cellular infrastructure. The competition between WiFi vendors is constantly driving equipment costs down. The user's WiFi NIC is about £65 or below. Typical access points range in price from £130 to £1,300 [WLANA, 2002:12, Stevenson, 19/09/2002].

Complete solution for *hotspot* range in price very much. This depends on what kind of equipment is used – high-end or low-end. MobileStar[17] was putting access points in Starbucks costing £2,600 each [Koerner,10/10/2002]. Generally, typical *hotspot* can costs from £650 to £23,300 for connecting small rural community to the web [Newcombe, August 2002].

Large-scale metropolitan deployment of WiFi is also cheap compared to other wireless technologies. According to Financial Times, the entire London metropolitan district can be covered *'for as little as £26 million '* and *'the entire United States at about £2 billion',* [Foremski, 13/09/2002]. For example, with funding equal €120 billions spent on 3G licenses across Europe, it is possible to set up approximately 30000 hotspots – the forecast for 2006, according to Exhibit 2-9.

To summarize, the incremental cost of adding a user is low, the incremental benefit is high, so as WiFi advocates claim *'802.11 can grow virally'* [May et al, 2002:6].

Operating cost

However, though relatively cheap to install, WLANs can be expensive to operate.

> *The cost of the infrastructure is coming down all the time but WISP have discovered that the big cost is not the CAPEX* [Bright, 01/10/2002]

The operating cost has two components – fixed and variable. Fixed component consists of backhaul to backbone network of ISP, the customer support, billing and revenue gathering. Variable component depends on traffic each customer generate in WLAN. This fixed operational expenditure is going up, for example, on the high speed connection to the premises for example, and on supporting and delivering the service on an ongoing basis with reasonable quality. Opposite, once the hotspot operates, incremental cost of adding one more customer is very low. In fact, WISP don't need to do anything to add one more customer – no

[17] Went bankrupt and lately was acquired by VoiceStream/T-mobile

equipment set-ups like in DSL installation, for example. This situation maintains while users did not interfere each other with down-streaming applications over shared bandwidth – the weakest link of WiFi. Therefore, WiFi hotspots have high fixed operating cost and low variable operating cost, depending on number of customers and level of QoS.

User's cost

Payment models for end-users across European countries range from £85 per month for unlimited access to £20 for 300 minutes of access time [Blueprint, 15/08/2002:5]. In North America, users of T-mobile in Starbucks must create an account under one of five payment plans ranging from 20 cents per minute to £39 per month for unlimited time. Wayport charges a minimum rate of £3.23 for 24 hours of use in airports and £5.17 for 24 hours of use in hotels, with both rates relying on £32.5 prepaid debit accounts. Wayport users may also pay £32.5 a month for unlimited time in all venues [Fleishman, 01/11/2002].

Japanese NTT DoCoMo Inc. began offering commercial WLAN service in Tokyo on July 1, 2002, dubbed 'Mzone'. The initial Mzone fee has been established at £10.42 per month [May et al, 2002:18].

It may be interesting to compare other data service with WiFi. Such comparison done in Exhibit 2-8:

Exhibit 2-8. Table of Pricing Comparison of other Data Services

Service	Price £ per Mb
Cable TV/ADSL	0.00007
Dial-up	0.05
WiFi	0.17
3G	0.50
GPRS	1.0
i-Mode	15.0
SMS	3000.0

Sources: O dlyzko, Mobileinfo, MMO2, T-Mobile, Paolini et al

Market potential of WiFi

What is Public Wireless LAN?

Typical public access hotspot works along this algorithm – a WISP place APs at their hotspot, located in venue, available to public access. AP transmit a wireless signal to the wireless card in a user's computer and users can connect through a log-in page in their Web browser to Internet. Coverage extends over a 50- to 150 -meter radius of the access point. In order to cover all venue's territory, several AP may be needed.

In fact, all kinds of LANs, wired or wireless, based on several existing standards, protocols and architecture can be used for commercial public service offering. The customers of this public network can access internal organization information services as well as external networks, such as Internet. The examples of public services, run over wired Ethernet can be found in Russia, where Ethernet networks is used to deliver shared broadband to apartment buildings [18].

However, the wired network's deployment for *'external commercial'* services to *'outsiders'* is very limited in the technological sense, resulting only in niche applications. Users have to plug a network jack into his PC or other device and stay in certain location during connection time. Also, this system is not able to provide dynamic scalability – at any time it can serve only determinant maximum number of users. Each additional user will require a new cable socket.

[18] This phenomenon is called 'home networks' and represent the cheapest solution in 'broadband to home'

This explain why wireless LANs are world-wide phenomena, growing '*as mushrooms in august forest*'. In order to understand the spreading popularity of WLAN, we have to observe the demand side of WiFi.

Demand

Currently, the majority of WISPs targets the business travelers. According to the Yankee group [Mobilestar, 2001], in the US alone, 44 million employees take 243 million business trips each year. In money equivalent, that translates to £113 billion spent by corporations on business travel. Airport delays alone cost corporations £331 million in lost work time.

In a study by Andersen [Andersen, 2001], a two-hour morning meeting by their consultants, where overnight travel is needed between two US airports, on average this puts their people on the road for 26 hours. This is due to the unreliability of airlines, something that is likely to worsen with the increased security measures in place after September 11.

Cisco research found that using wireless networking in corporate environment can save up to eight hours over working every week [Sage, 2002]

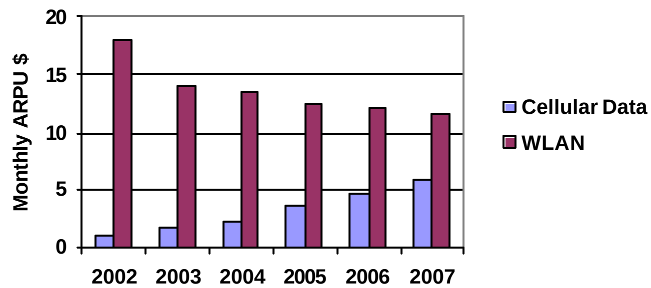
This creates several potential benefits with public WLAN, both for venues and business travelers. These include, in case of airport, early check-in or service such as notifications when flights are delayed, and increased revenues for venues, as customers are made aware of special offers at shops, hotels or restaurants.

There are numerous consultancy reports with hotspots growth figures and revenue forecasts. They differ very much in the numbers. According to the most recent report by Analysys [Paolini et al, 2002:1], in the US the public WLAN market forecast to include 21 million users and to generate £1,9 billion in annual revenues by 2007.

According to U.S. Bancorp Piper Jaffray report [May et al, 2002:22], half of the revenue opportunity for WLAN will be generated in North America, with growing pockets of strength in Europe and Asia Pacific. In the longer term, the geographic breakdown of WLAN sales will be: North America 46%, Europe 23%, and Asia 29%.

The Exhibit 2-9 shows that ARPU of WLAN in near future would be significantly over ARPU of cellular data, so on has a right to expect that WISP will grow as well as number of hotspots. The growth dynamic of hotspots numbers across Europe can be seen from Exhibit 2-10.

Exhibit 2-9. Forecast of ARPU WLAN and cellular data on world-wide scale



Source: [Linden and Paolini, 2002:1]

Exhibit 2-10. Wireless hotspots: Forecast of Number of Sites by Country in Europe

Country	2002	2003	2004	2005	2006
Finland	686	1,115	1,510	1,955	2,100
Sweden	1,162	1,770	2,130	2,675	2,890
Denmark	444	900	1,515	2,045	2,420
Norway	507	920	1,500	1,955	2,370
Germany	475	1,490	3,890	7,670	10,983
UK	20	260	828	1,335	2,020
France	370	940	1,820	2,906	3,925
Italy	250	615	1,210	2,045	2,965
Spain	250	750	1,460	2,160	3,185
The Netherlands	370	890	1,600	2,110	2,855
Belgium	159	400	765	1,180	1,515
Total	4,693	10,050	18,228	28,036	37,228

Source: [Total Telecom, 01/11/2001]

Conclusion: WiFi WLAN is a Disruptive Technology

Observing explored points, it is reasonable to conclude that WiFi WLAN is, in fact, a disruptive innovation in wireless broadband access technology:

WLANs create totally new marketplace of hotspots and their services, different from cellular, fixed wireless and wireless broadband access to Internet. Thus new market is introduced.

WLANs start as very cheap solution. In fact, from consumer side, WLAN's service can even be free without any significant subsidizes from provider' side. From provider's side, on the other hand, barrier of entry are extremely low. Thus WiFi differentiate on price and at the same time destroy entry barriers for wireless and even ISP business.

Initially, WLANs have inferior performance in some dimensions (e.g. coverage). As coverage gets better and better the disruptive technology finally overtakes the incumbent technology. Indeed, WiFi has a lot of problems to solve with most serious is interference from other WLANs.

WiFi WLAN is an open standard, meaning that anybody can produce an equipment, granted it is fulfil standards' requirements. This encourage very high level competition in the industry, driving prices down very hard. Therefore, any vendor can enter the market with some innovation.

New disruptive business models applied by Internet e-commerce sites will invade also the wireless communication service business [Brodsky, 1999:3]. According to Brodsky, it only takes one carrier in any given market to decide to make money in a new way to cause great anxiety among the conventional competitors. If one service provider find a new innovative way to do business with zero cost to consumers, like browsing Internet in WLANs for free in exchange for pop-up advertising,

> *"How many consumers would continue to pay for a service that they could get for free?" [Brodsky, 1999:3].*

This is very much true about WiFi.

Chapter 3. Theoretical Framework

`What do you know about this business?' the King said to Alice.

`Nothing,' said Alice.

`Nothing WHATEVER?' persisted the King.

`Nothing whatever,' said Alice [Carroll, 1865:129].

Introduction

As technological and market fundamentals were outlined in previous chapter, this chapter concentrate on necessary theoretical framework on which the further analysis will be based.

In order to perform thorough study of WLANs deployment cases, three aspects of theory are needed. First is the theory of business models or what Timmers [Timmers, 2000:31] called 'architecture of organization'. There is much controversy about the definition of 'business model'. Some academic developments in this field will be considered and the most suitable one will be taken for the use in this thesis.

A value chain theory is an analytical tool, illustrating roles' allocation in WLAN industry. Advantages and limitations of value chain will be discussed to outline its application in the thesis.

At the end of this chapter, the WISPs' categories will be introduced.

Two-dimensional chart will be used to map generic WISPs categories, measuring essential indicators relatively each business model.

Business Models to Harness a Disruptive Technology

Before approaching the task of building construction, an architect models in it schematic way, according to earlier drawings. This *'model'* doesn't reflect all features, *'real'* building contains. Rather it replicates only important ones, determining building's functions and beauty. Architect also can see whether the building disturb the harmony in environment.

As the building modeling is adopted in architecture to provide designers general view on what is ought to become a palace, church or warehouse, the business modeling refers to 'architectural' attitude. In other words, in the same manner designers use modeling to create an image of the future art object, business writers use 'architecture' term to refer to business models. What, for example, Timmers states when defines business model as:

> *An architecture for product, service and information flows, including a description of the various business actors and their roles; and a description of potential benefits for the various business actors; a description of sources of revenue* [Timmers, 2000:32]

Besides identifying sources of revenue, research into business models must define what is a value itself for a firm. Therefore, a first step in constructing a framework for business models is to examine the creation and exchange of value. Traditional economics considered tangible production factors such as land, capital, and labor to be the main assets for value creation. However, during the last decades, the importance attached to intangible assets such as knowledge, trust relationships, intellectual property, and leadership has risen considerably. These intangibles are more and more being incorporated into business models [Ballon, Helmus, van de Pas, 2001:5]. This is illustrated in Case Two when one of business actors pursue intangible benefits such as customer satisfaction, rather than simply cash revenue from WLAN service.

Nonetheless, product's or service's innovations may be feasible only if business model, or *'architecture of revenue'* [Chesbrough and Rosenbloom, 2000:3] will be changed accordingly. This is illustrated by the *'Xerox'* case.

Xerox innovative approach

One of the most famous examples of business model innovation required by a new product is an introducing a new photocopy machine by a company named 'Haloid' (re-named to Xerox later). The original *914 xerox*' model was very expensive – its manufacturing costs were much higher than existing machines, while its supplies costs were about the same as earlier technologies. Marketing analysts, invited for designing the launch of the new product, essentially assumed the 914 would be offered within the business model then extant in the office copy machine industry – which charged customers the full price of the initial equipment and charged them again for supplies as they need. They concluded:

> *Although it may be admirably suited for a few specialized copying applications, the Model 914 has no future in the office-equipment market.*

This conclusion was right in the previous business model, where copying equipment was purchased by customers. Also, the new machine's productivity was much higher that existing machines – although nobody could think that such productivity was needed.

However, Haloid changed the business model – it started to lease Xerox machines to offices. Companies paid a small rent (around £60 a month), which included fixed number of copies (2000) for free and then were charged extra-fee (£0.03) for each additional copy over monthly limit.

Once installed, the appeal of the machine was intense; users averaged 2,000 copies per day (not per month), generating revenues far beyond even the most optimistic expectations. The business model established for the 914 copier powered compound growth at an astonishing 41% rate for a dozen years, turning £20 million Haloid Corporation into a global enterprise. This was an early demonstration of a proposition now more widely recognized: that technologies that make little or no business sense in a traditional business model may yield great value when brought to market with a different model [Chesbrough et al, 2000:12]. In other words, innovation in product required innovation in business model.

Business models and Intellectual Property Rights

The vitality of business models to any industry is acknowledged also by the fact that in some countries it is treated as intellectual property and protected by patent copyright [Pavento, 1999]. In some countries (US is the most famous example), e-commerce *'business methods'*, such as *'one-click shopping baskets'* or *'reverse auctions'* can be patented [Caslon]. A famous example is the U.S. firm Priceline.com's patent on its buyer-driven system for direct Internet marketing. Buyers name the price they want to pay for air tickets and other goods on the

Internet, with sellers then deciding whether or not to accept the offered price. Payments for successful bids are made immediately by credit card.

Nevertheless, even after coming into a law medium, business models don't become more clear and there are arguments about possible definitions.

Academic Discussions on Business Model Ontology

There is a growing literature on business models by academics and consultants. Some speak of ' *Internet business models'* and others of *'business models for the web'*, but they all mean certain aspects of the business logic of a firm that have a strong IT-component. At the top of dot-com boom, the term 'business model' become a *'buzzword'*, when everybody used it but nobody can actually said to what it was referred [Osterwalder, Ben Lagha, Pigneur, 2002:2, Petrovic et al, 2001:1]. However, one has also to admit that every manager or entrepreneur has intuitive knowledge of what is business model and where it fits into the *'business universe'*.

This confusing definitions' array created a discontent among well-known academics, such as M. Porter, who stated that *'the definition of business model is murky at best'*. He pointed that:

> *Most often it* [business model] *seems to refer to a loose conception of how company does business and generates revenue. Yet…generating revenue is a far cry from creating an economic value…*[Porter, 2001:73]

Three Approaches to the Definition of Business Model

In [Osterwalder et al, 2002:4], an interesting survey of relevant academic writings can be found. From this survey one can see that the early authors had mainly written about the classification of models in different categories [Timmers, 1998; Tapscott, Lowi, Ticoll, 2000].

By contrast, the latest literature has started decomposing business models into their *'atomic'* elements as did Afuah and Tucci [2002:45] in their recent book on Internet business models. They separated business model into eight dynamically linked components: customer value, scope, pricing, revenue source, connected activities, implementation and capabilities.

In general, all academic approaches to defining business models falls into three categories, described below.

Revenue Approach

Some authors, such as Rappa [Rappa, 2002] provide a taxonomy of e-business models rather than an explanation of what elements such a model contains. For him a business model spells-out how a company makes money by specifying where it is positioned in the value chain. His classification consists of nine generic forms of e-business models, which are Brokerage, Advertising, Infomediary, Merchant, Manufacturer, Affiliate, Community, Subscription and Utility. These generic models essentially classify companies among the nature of their value proposition or their mode of generating revenues (e.g. advertising, subscription or utility model).

Tapscott, Ticoll and Lowy [Tapscott et al., 2000] provide a typology of business models that they call b-webs. They identify five generic b-webs, which are called Agoras, Aggregations, Value chains, Alliances and Distribution Networks. These five models are classified according to their degree of value integration (from self-organizing to hierarchical) and their degree of control (low/high) of the value creation process.

Business Actor and Network Aspects Approach

The probably best known classification scheme and definition of electronic business models is the suggested by Timmers [Timmers, 2000:32]. His '*architectural*' approach is quoted above. In addition to the taxonomy of business models, he acknowledges the necessity of providing a marketing strategy, in order to accomplish a business mission. Timmers classifications counts the eleven generic e-business models[19], according to their degree of innovation and their functional integration.

A quite rigorous business model approach is the one provided by Gordijn and Akkermans [Gordijn and Akkermans, 2001]. Their methodology is based on a generic value-oriented ontology specifying what's in an e-business model. This approach allows the graphical representation and understanding of value flows between the several actors of an e-business model. A graphical image of a business model is constructed from electric engineering symbols.

Afuah and Tucci offer another approach to business models that is value-centered and takes in account the creation of value through several actors. In such methodology one can find a list of business model components, from scope over pricing and revenue source to connected activities and capabilities. But it is less clear how the value is delivered to the customer; i.e. classical marketing problems such as channel design or conflict are not in the centre of this approach [Afuah et al, 2001].

Marketing Specific Aspects Approach

Another course to business model ontology has been provided by Hamel [Hamel, 2000]. For him a business model is simply a business concept that has been put into practice. He identifies four main business model components that range from core strategy, strategic resources over value network to customer interface. These components are related to each other and are decomposed into different sub-elements. The main contribution of this methodology is a view of the overall picture of a firm.

The business model approach by Petrovic, Kittl and Teksten [Petrovic et al., 2001] suggest that a business model can be divided into seven sub-models, which are the Value Model, the Resource Model, the Production Model, the Customer Relations Model, the Revenue Model, the Capital Model and the

[19] E-shops, e-procurement, e-malls, e-auctions, virtual communities, collaboration platforms, third-party market places, value-chain integrators, value-chain service providers, information brokerage (trust and other services) [Timmers, 2000:35-40]

Market Model. These sub-models and their interrelation shall describe the logic of a business system for creating value that lies behind the actual processes.

Positioning of Business Model

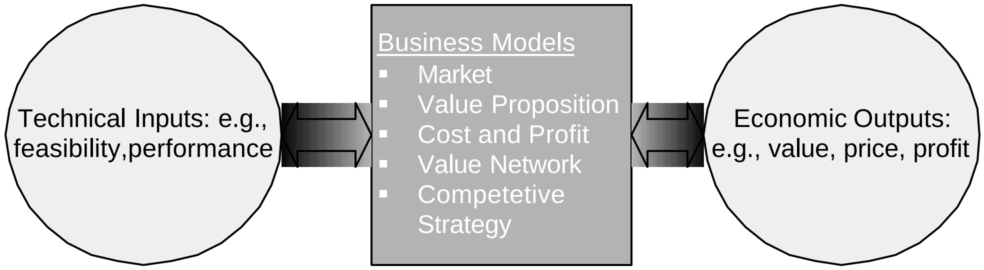
Another point to consider in business models is its position relatively other activities of a firm. Normann and Ramirez [Normann and Ramirez, 1998:7, Heijden, 2000:3] introduced concept of two worlds – the rational world of business and the processual world of management. One possible attitude is to see a business model as a *'missing link'* between these two worlds [Osterwalder et al, 2002:3]. Often, the gap between these two worlds is very significant. Enterprise's strategy position the company, define and formulate objectives and goals, whereas business process and information system designers have to understand and implement this information. In order to guarantee a smooth strategy execution, firms require a very clear communication of concepts between the implicated parties, such as partners, suppliers, customers and even firms own units. This is where rigorously defined business models come into play.

Business Model Definition

WiFi technology for public WLANs, as was outlined in previous chapter, is a disruptive innovation. Hence it is important to emphasize innovation technology aspects in business model definition to be applied in WiFi hotspots research.

Chesbrough et al [Chesbrough et, 2000:12] offer a way to depict business model as a mediator between technology and social domains. The essence of this definition (Exhibit 3-1) is linking the physical domain of technology, including features of products/services, their performance, cost etc and the social domain of economic outputs, including customer's value proposition, profit etc.

Exhibit 3-1. Business Model mediates between the technical and economic domain



Source: Chesbrough et al, 2000:32

In particular, business model specify following parallel functions[Chesbrough et al, 2000:32, Ballon et al, 2001:5]:

Articulate value proposition, that is, the value created for users by the offering based on the technology. In other words, what technology can offer new to a customer. In case of public WLAN, it is wireless broadband Internet connection within hotspot.

- Identify a market segment, that is, the users to whom the technology is useful and for what purpose. Different categories of customer can value a technology different way, for example business travelers need extension of their work/space dimensions, whereas techno-savvy people may enjoy watching movies using broadband connection to Internet
- Define the structure of the value chain within the firm required to create and distribute the offering. WISP, for example, can built own infrastructure or chose to be *'virtual provider'*.
- Estimate the cost structure and profit potential of producing the offering, given the value proposition and value chain structure chosen. In other words, a firm should decide how its offering within chosen value chain structure, justify costs involved. As one can see from the Case One, failure to do it, lead to bankruptcy, even though the other options were well sounded.
- Describe the position of the firm within the value network linking suppliers and customers, including identification of potential complementors and competitors. This is a critical factor, because it

defines relationship with third parties, e.g. venues, enablers. *'Positive alignment with the value network can leverage the value of a technology. Failure to align with a value network can dissipate potential value'* [Chesbrough et, 2000:12].

- Formulate the competitive strategy by which the innovating firm will gain and hold advantage over rivals.

Value Chains for WLANs' Analysis

Value chain is a tool. This concept was popularized by writings of M. Porter. The value chain by Porter [Porter, 1980] models a business as a series of inter-linked activities. In Porter's words, value chain is

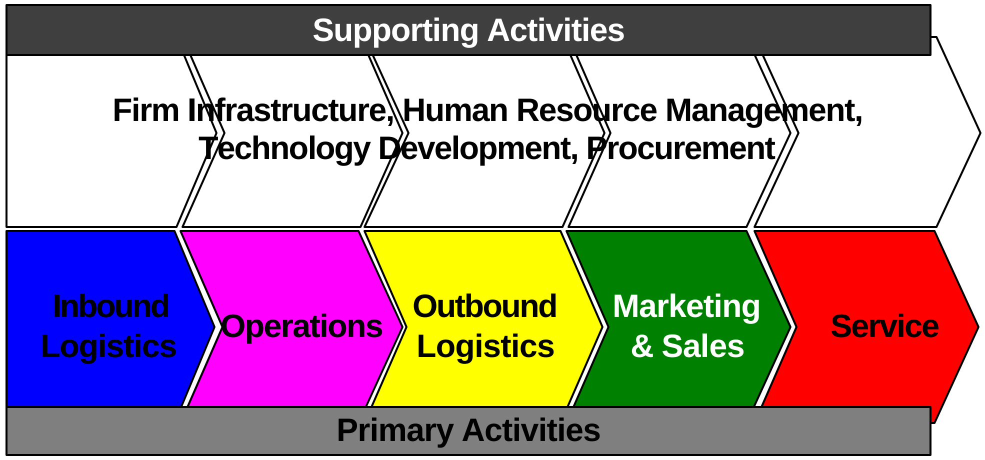
> *The set of activities through which a product or services is created and delivered to customers* [Porter, 2001:74].

The importance of the value chain to enterprise' business model is emphasized by Li and Whalley, stating that:

> *A particular strategy or business model formulated within the context of one value chain may at the same time be inappropriate or even harmful in the context of the other value chains of which these nodes are part* [Li and Whalley, 2002:19].

Each mediating activity, or chain, is an input to adjacent chain as well output from previous activity. Some activities are identified as primary activities and others as secondary or support activities. The primary activities are related directly to the production/creation of the business product or service. The secondary activities provide support to the primary activities. Examples of primary activities are marketing and logistics. Secondary activities typically involve procurement, R&D and management systems.

Exhibit 3-2. Generic Value Chain



Source: Grant, 1998

Albeit, being closer to clear definition than business models, value chains are still can be understood in many ways. Some authors, for instance as [Olla and Patel, 2002:556], goes even so far as placing on the same footing business models and value chains, claiming that *'a value chain is a form of business model'*.

Also, some researches indicates, the value chain's concept originally was designed to categorize the firm's own activity [Maitland, Bauer, Westerveld, 2002:488], the idea has since been broadened and is often used to describe an entire industry. It worth to notice, however, that Porter introduced also *'value system'* term, which he used to indicated industry level activity between sequence of value chains. Nevertheless, total majority of modern literature keep use a value chain concept to describe specific types of businesses between independent actors [Maitland et al, 2002:488].

Limitations of Value Chains

Value chain as industry's analytical tool has a significant limit. In the past, it was customary to think of the process of creating and exchanging value as a linear process. Now, this idea has largely been accepted as insufficient, resulting in a shift in terminology from value chains to value networks.

The traditional value chain is focused at the level of the firm or industry with the objective of linking business strategies to the characteristics of actual products. It describes the supply side activities (raw materials, inbound logistics, and production process) with demand side (outbound logistics, marketing and sales) in a linear way. With the growing use of ICT in production and business processes, interdependence between firms has become an important factor, leading to the rise of the so-called network economy. As a result, the value chain concept is focusing more and more on the value-added relationship between the different participants involved in the process of production and consumption.

Moreover, this relationship has in many ways become more dynamic and flexible. As the Internet, along with other digital information and communication means, allows production and business processes to become faster, more flexible and more transparent, this has rendered possible a higher complexity and flexibility of linkages [Ballon et al, 2001:5-6].

As was underlined by many researchers [Li et al, 2002:19, Maitland et al, 2002:488,], value chain is too flat to reflect firm's activity objectively: it masks the importance of horizontal aspects of a firm's processes, particularly their relations with other firms. For example, in [Maitland et al, 2002:488], authors note that in Porter's model *'dynamic forces in the course of production are ignored and the model implies that product and service development is necessarily a sequential process'*. Such criticisms have led to the development of alternative conceptualizations such as stakeholder value chains, value constellations and value nets.

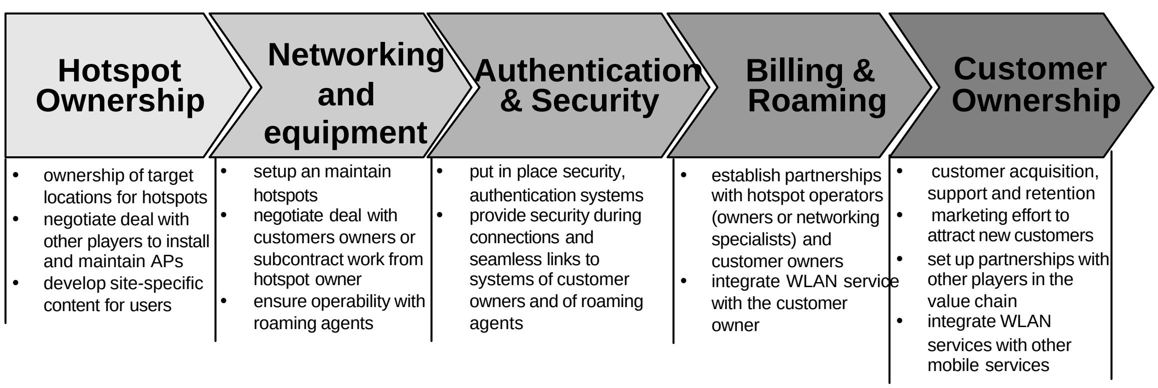
According to Normann and Ramirez [Normann et al, 2001], the value constellation perspective shares some characteristics with Porter's value system model but is potentially more flexible as it does not require the identification of a set of activities that will be performed by particular organizations in the first instance – the focus is on the customer and activities that define the offering or set of offerings. They argue that organizations should not simply focus on their direct customers but develop levels of analysis that include their customer's customer and even their customer's customer. By broadening the view from a value chain to a value constellation it may be easier to research where and how the value for the end customer is actually created.

Relevance of WLAN value chain

WiFi WLANs, according to the words of Anthony Townsend is *'where the Internet was in 1992, 1993'* [Chang, 06/11/2002]. Generally, the industry's value chain is shaped by the underlying technology (WiFi) and does not fully determine firm and industry structure. Rather it enables and constrains an individual firm's ability to design business models [Maitland et al, 2002:2]. All this applicable to business models, emerged in the WLAN industry, they are motivated by the value chain and actors' positions along it.

Due to the early stage of public WLAN's development, value chain approximate the industry dynamic. At this scale, the assumption of linear structure WiFi industry is justified. Further in this research value chain structure will be explored for each Case Study, based on the generic industry value chain. Exhibit 3-3 Below describes all parts of generic WLAN value chain:

Exhibit 3-3. WLAN Generic Value Chain



Source: Paolini et al, 2002

Hotspot Ownership

Inherently, public WiFi WLANs are provisioned via hotspot located in easily accessible place, called venue. Recently, observers started to call such public venues *'real battle ground'* for WiFi [Gardiner, 01/11/2002]. In a sense, venue owners are *'the sharks'* of WLAN market, because nobody knows better than they do, who comes and for what purpose to their premises. This knowledge determines the final price WISPs are bound to pay for the use of specific location. For example, no WISP posses a skill to gauge potential service usage in any location unless some degree of cooperation with venue is reached.

Venue, at the end, are initiators of this innovative service and actually regulators in certain sense. It is possible to accommodate only three WiFi WLANs in given hotspot (see Chapter 2). So, only venue owners have a power to negotiate and reach an agreements over potential interference issues. For instance, if operator set up a commercial public hotspot without the venue's consent, after a while the venue may decide to set up a hotspot on the same frequency, leading to mutual interference – nobody benefits and customers will run to other hotspots to find a service.

Another important venues' function is developing location based services and content. In US airports, WiFi users can see a map of the airport with facilities highlighted and duty-free promotions are popping-up on their screens. Starbucks plans to offer gaming and music streaming to its hotspots' users [Sauders, September 2002].

Network Provision

This is a technical core of WLAN business. This includes setting up and maintaining APs in hotspots, Internet backbone connection via leased line or DSL. At this part of value chain, actors can also negotiate with party, owning customers and subcontract work from hotspot owner ensure operability with roaming agents.

Depending on the business model, this part of value chain can be performed by WISP or outsourced to enabler. The latter case is illustrated in Case Three.

Authentication and Security

There are two general options of payment for public WLAN hotspot – 'for free' or 'for fee'. In former case, there is no need neither for authentication, security in this part of value chain nor billing and roaming provision in the next part. But in the latter case, somebody has to put in place security, authentication systems, provide security during connections and seamless links to systems of customer owners and of roaming agents.

Billing and Roaming

As was said above, billing and roaming emerged if reciprocal relationship between WISPs and users have place. The actions of this part include: establishing partnerships with other hotspot operators (owners or networking specialists) and customer owners, integrating WLAN service with other services, available from the customer owner. For example, Telia HomeRun offer WiFi service bundled with GSM offer, and customer pays for broadband usage with the same bill he or she pays for mobile calls.

Customer Ownership and Support

In this part WLAN value chain, the critical issues is who owns end-customer. In other words, which party perform customer acquisition, support and retention functions. In this chain is imperative to do a marketing effort to attract new customers and set up partnerships with other players in the value chain. In case of mobile operator WISP (see below), this is a moment to integrate WLAN services with other mobile services such as GPRS or 3G (future).

WISP Categorization

WISPs (Wireless Internet Service Providers) can be categorized into several different types according to their core activity, coverage and degree of service bundling. Introducing WISPs categories, one can see more clearly their relationship and dynamic within industry – how WISPs interact with venues. Also, categorization helps to map out WISPs according their core indications – coverage and degree of venue's integration into the service. The WiFi WLANs are very nascent field and it is likely that current classification will not reflect tomorrow's situation. However, the categorization offered here follows the pattern, suggested by Alvén an others [Alvén et al, 2002:26]. According to this classification, there are eight basic WISPs categories. The full list of eight WISP categories is given in Appendix B. It should be noted, that each real case of WiFi deployment can be attributed not only to one category of WISP, as shown in one of case studies (Starbucks and T-Mobile). The categories, relevant to Case Studies are described below:

Mobile Operator WISP

As the name implies, a mobile operator 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 Mobile in Sweden and T-Mobile 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 either places that are frequently visited by these users, such as hotels, airports and convention centers (see Case One) or *'branded'* places like Starbucks or Borders (see Case Two).

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), T-Mobile (have many hot spots in the US, but the majority are at Starbucks Coffee shops) and players like SoftBank in Japan, cooperating with McDonald's to offer WiFi broadband fast food chain's visitors.

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

Three categories will be considered in the Cases, explored in the thesis – Mobile Operator WISP (Telia HomeRun), Single Venue WISP (Copenhagen Airport) and Location Specific WISP (Starbucks/T-Mobile).

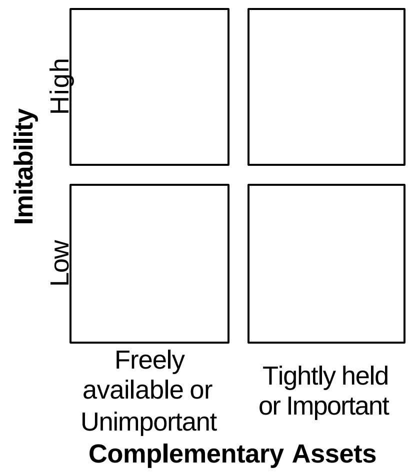
Graphical representation of WISP business models

There are many attempts to introduce graphical tools allowing to reflect all complexity of business models. For example, Gordijn and Akkermans, mentioned above introduced *'e^3 ontology'*, allowing to describe Internet business model with a set of graphical tools, borrowed from electrical engineering background [Gordijn et al, 2001]. Among other illustrative systems Toronto TOVE or Edinbourg Enterprise [Fox, 1998, Uschold, 2000]. Having many strong points, none of systems are suitable for describing WISP business models in elementary way. Thus, any of three Case Studies will be also presented with specific graphical model, reflecting facts described in cases.

Mapping WISPs categories

Afuah and Tucci introduced a two-dimensional matrix (see Exhibit 3-4), determining how a firm profits from its innovation and technological inventions. Two dimensions of the matrix are: imitability and complementary assets. Imitability is the extent to which the technology can be copied. Complementary assets are all other capabilities, that the firm needs to exploit the technology [Afuah et al, 2002:79].

Exhibit 3-4. ‘Profiting from Innovation’ Matrix



Source Afuah et al, 2002

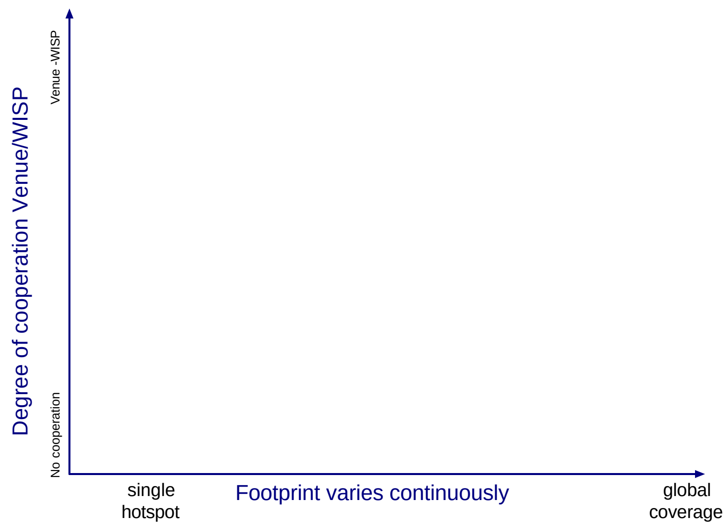
This matrix allows to position Internet business models relatively their value in these dimensions. Inspired by this example, it is justified to introduce a 2-dimension chart, which can help to map present categories and business models and then graphical illustrate possible evolution. As one of such possible charts, Exhibit 3-5 is presented below.

X-axis represent the WISP’s coverage. Zero-point reflect WISP with only one hotspot, like small café-shop, airport etc. The WISP at infinity has global coverage, like food-shop chains.

Y-axis shows the degree of cooperation between Venue and WISP. Zero mark corresponds to state where venue doesn’t participate in marketing activity and have no revenue stream from the service, satisfied with intangible benefits, but minimum risk. Infinity stands for the state where venue chooses to offer WiFi service itself, keeping all revenue and performing service marketing, but carrying all possible risk, may be outsourcing some auxiliary activity.

The difference between the Afuah and Tucci matrix and the chart, described above is that variables along X- and Y- axis in the chart vary continuously from minimal value to maximal, whereas the matrix allows only two values-grades on each of its axis, not reflecting continuous character of complementary assets, like hotspots coverage.

Exhibit 3-5. Mapping Categories according the degree of cooperation Venues/WISPs and Geographical Coverage



Summary

Theories and methods, examined in this chapter provide a basis for studying WLAN's deployment cases. Business models theory allows to consider cases on common basis. Firm's business model is viewed as a transforming tool between disruptive technology like WiFi and social domain with such elements as revenues and intangible benefits.

Value chain analysis permits to find a position for each individual actor in the industry. Comparing cases, one can see overall dynamic of each business model and its relative position. Yet, limitations of such analysis are circled – WiFi industry in its early stage and thus allows linear representation.

Empirical WISPs' categories introduced, allowing general classification. The last analytical tool considered in this chapter – 2-dimensional chart is used to map cases according their geographical footprint (coverage) and the degree of cooperation between Venue-WISP. Case study models will be put according to research to the chart and then in analysis part, general categories can be put into this chart following induction method.

Chapter 4. Real Life Business Models and Value Chains

'Explain all that,' said the Mock Turtle.

'No, no! The adventures first,' said the Gryphon in an impatient tone: 'explanations take such a dreadful time.' [Carroll, 1865:112]

Introduction

This Chapter presents cases studies of three different categories of WISPs, as these classification was introduced in previous Chapter 3. In each case the WLAN's deployment strategy, installation costs, actual use and prices are explored in sufficient depth, allowing further analysis and discussions.

As was said before in Chapter 2, a choice of location is a key for successful WiFi WLANs deployment. For this reason, it is important to scrutinize how WISPs pursue WLAN's deployment and which criteria they use to choose hotspots locations.

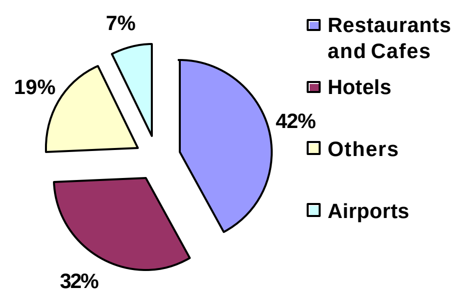
Choice of possible locations for installing public for-profit WLAN are limited. These types of locations and their shares in the current WLANs' markets are shown at the Exhibit 4-1.

Cafés and similar venues account the biggest shares but it doesn't mean that it is the most profitable places for hotspot installation. Forecasting the state of public WLAN market in 2007, Alexander Resources consultancy report says:

> *Although 80% of all public WLANs will be deployed in cafes, bars and restaurants these domains will only generate a small portion of the projected public WLAN service revenues. The majority of WLAN service revenues will come from business users in airports, business hotels and exhibition centres. In fact, use of WLANs in cafes, bars and restaurants will begin to decline, leaving 'dead spots' in revenue and service.*[Alexander Resources, 2002]

Selected cases illustrates how different WISP's attitudes towards hotspots in these WLAN implementations. Each WISP follows different strategy seeking for profitable hotspots. In fact, there are three such distinctive strategies: WISP targeting a particular customer segment strives to cover all possible types of locations where its customers may use WiFi service; alternatively, WISP can build a WiFi network along a network of branded locations, betting on customers' need to use the service in these locations. The last strategy is integrate WiFi hotspot with a venue, resulting in venue becoming WISP itself.

Exhibit 4-1.Distribution WLANs Venues according to type of venue



Source: BWCS, 2002

Case One. Mobile Operator WISP: Telia HomeRun

My office is wherever I put my laptop. [Karmakar, September 2002]

Introduction

Telia HomeRun is the Wireless Internet Service Provider (WISP), established by the Swedish incumbent telecom group Telia.

Telia AB Group (Market Capitalization £6.511mln, FT.com 08/11/02) has five main business branches: Telia Mobile (mobile services and development of integrated fixed/mobile services); Telia International Carrier (international fiber optic carrier network); Telia Networks (fixed network services and data communications services); Telia Internet Services (accesses, applications and portal) and Telia Equity (stakes and interest outside the Group's core businesses). Networks accounted for 54% of 2001 revenues; mobile, 29%; international carrier, 6%; Internet, 6% and equity, 5% [Financial Times, 24/10/2002]. Besides offering its services in Sweden, Telia Mobile is operating across Scandinavian region through its wholly owned subsidiaries in Denmark, Finland and Norway.

Telia Mobile has also had direct minority stakes in other mobile carriers[20] [Arcchart.com]. The WISP Telia HomeRun is part of Telia Mobile [Karmakar, September 2002].

At the end of 1999, Telia Mobile launched *'HomeRun'* service – first European nation-scale wireless Internet access service, based on WLAN and WiFi standard. The service was provided by Telia Mobile HomeRun subsidiary.

Marketing Strategy

HomeRun's customer is a business traveler. This is a foundation of their customer acquisition and service's roll-out strategy. The HomeRun targets users who need extension of their working time and space, maintaining working style expressed in following words: *'my office is wherever I put my laptop'*. For this reason, these customers willingly pay premium price for keeping connectivity and using true broadband in their *'portable office'*.

To attract such customers, HomeRun must establish a presence in all possible venues where such travelers likely to appear. Their roll-out's strategy can be summarized as *'following the business traveler wherever he may go'* [Karmakar, September 2002]. To meet this objective, HomeRun installs WiFi hotspots in hotels, airports and conference centers, as well as in railways stations, cafés and restaurants.

Service from the WISP's point of view

From the WISP side, requirements for using the service are standard – a customer has to buy one of HomeRun's different subscription types (see below) and have WiFi-enabled device (see Chapter 2).

How it works

In order to access HomeRun service, user need to have WiFi-enabled laptop or PDA and one of the HomeRun subscriptions. 24H prepaid card, for instance, contains user name and a password that is valid for 24 hrs after the first log on.

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[20] Also in other parts of the world, via Telia or Sonera.

The installation of HomeRun service on customer equipment is user-friendly. It is worth to mention that HomeRun service requires user to turn off built-in security like WEP (Wireless Equivalent Protocol, see Appendix B). Then user launches the web browser and goes to http://login1.telia.com. Once at the login page he enters the user name and password from the card.

After the identification procedure, validating the specified username and password in the HomeRun customer database, an access is granted and user is redirected to a location specific homepage called HomeRun@Location.

Because original WiFi WEP security is turned off, a user has total responsibility over security of wireless transmission. In order to tight it, a user may run VPN client over his Internet session. VPN client must be purchase additionally or supplied by a customer's corporate IT department.

Service from Customer's View

Requirements from customers' side are more specific – a business traveler has high expectations on QoS and ready to pay for it. This type of customers wants the service to work and if it doesn't they want to know whom to call for support. Hence, to meet such high expectations, Telia must control all activities along WLAN value chain.

To sum up, HomeRun offers to business travelers increasing efficiency and time saving enabling travelers working on locations, far away from home or office, with satisfying QoS. From customers in exchange, HomeRun receive payments for the use of service.

Types of Venues

Strategic choice of hotspots' locations –venues is defined by *'following business travelers'* strategy. In other words, HomeRun footprint repeat migration pattern of chosen segment of travelers. However, implementation of this strategy is based cooperation with certain types of venues or enablers. Vice-president of Telia Mobile, Jan Karmakar noted in his presentation [Karmakar, September 2002], that

HomeRun's business model is based on cooperation with either of four different parties: travel lodges, travel hosts, travel ports and travel enablers.

Three of them – travel lodges (hotels, conference halls etc), travel hosts (business plazas, consultancies, specializing in running conferences) and travel ports (airports, bus and rail stations) – in fact, are real estates, physical locations, buildings. The last party – travel enablers – represent travel service industry – travel agencies, such as American Express, Nyman & Schults etc [www.homerun.telia.com].

Types of HomeRun's venues and their proportional share in HomeRun' network coverage are illustrated in Exhibit 4-2. One can see that dominant type of hotspots are hotels or Conference centers, which classified as Travel Lodges and the next major segment of venues are Travel Ports. Other types of venues have less significant shares but they are growing rapidly – there are more Travel Hosts among recently installed hotspots than Travel Lodges, according to the News published on www.homerun.telia.com.

Exhibit 4-2. Distribution of Hotspots different types in Telia HomeRun

Hotspot Category	**Number of hotspots**[21]	**Class**	**Percentage**
Hotels and conference centres	298	Travel Lodges, Hosts	76.80%
Motorway services	29	Travel Ports	7.47%
Companies	18	Travel Hosts	4.64%
Exhibitions and sports grounds	14	Travel Hosts	3.61%
Restaurants and cafes	14	Travel Lodges	3.61%
Airports and train stations	9	Travel Ports	2.32%
Public places	6		1.55%
Total	388		

Source: www.homerun.telia.com

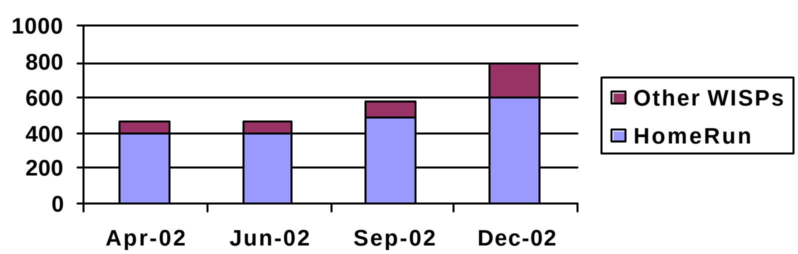
[21] 21 October 2002

Strategy of Rapid Growth and Footprint Dynamic

The service started in the end of 1999 with three sites, and Arlanda international airport in Stockholm among them. During 2000-2001 period, HomeRun pursued the strategy of the rapid expansion, adding in average on hotspot a day [Herslow et al, 2002:40].

At present, HomeRun is the only Scandinavian WISP with a quasi-region-wide coverage. The WISP currently has around[22] 350 public hotspots in Sweden, 25 in Norway, 20 in Finland[23], 5 in Denmark and 15 in SAS lounges world-wide. HomeRun's nearest target is 600 hotspots across Scandinavia by the end of 2002 [Roberts and Elliott, October 2002:9]. Therefore, the number of hotspots will be nearly doubled, compared with the last year, when HomeRun had only 280 hotspots by the end of 2001 [Herslow et al, 2002:40]. This development is only to increase HomeRun's dominance in Sweden, as Exhibit 4-3 illustrates:

Exhibit 4-3. Recent developments and projections in installed hotspots number in Sweden



Source: Hotspots Markets, 2002

Roaming is an essential tool to increase the WISP international footprint and service attractiveness – reaching critical mass of hotspots will generate critical mass of users. HomeRun has already roaming agreement with the Italian WISP Megabeam, allowing users to use WiFi networks in several Italian airports and major cities. Another roaming partner for HomeRun is British Telecom WLAN

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[22] Exact number of hotspots is constantly growing, so figures presented are slightly different across dissertation and depends on date and source.
[23] According to merger condition with Sonera, Telia Homerun service in Finland must be sold

project ‘OpenZone’ [Total Telecom, 27/11/2002]. Roaming implies that two providers agree on enabling their customers access to each other’s networks [Telia HomeRun Newsletter, Summer 2002].

The *‘Vicious Circle’* of HomeRun’s Hotspots Deployment

HomeRun’s strategy of covering with WiFi all possible locations and venues where business travelers are likely to show up, requires significant capital expenses. Pursuing chosen customer segment and creating ubiquitous WiFi network, HomeRun have to keep under control all activities such as network performance, billing and pricing issues. This let the WISP keep appropriate level of QoS in wired and wireless LANs in hotspots. Thus taking sole responsibility for the funding of the hotspots’ deployment, all risks and certainly, owning built infrastructure. According to Anders Lindqvist from Northstream Consultancy, estimated CAPEX for Telia HomeRun are £4,450,000 for 450 hotspots[24]. This gives approximate cost of installation around £10,000 per hotspot [Lindqvist, September 2002]. Besides, venue owners are very reluctant about investing anything in WLAN infrastructure – *‘they expect everything for free’* [Lindqvist, September 2002].

The advantage of Telia Group’s incumbent position help HomeRun save on OPEX: its hotspots connected to Internet backbone via Telia broadband network. Although, HomeRun still has to pay for these services to Telia Group companies, it doesn’t pay as much as an external provider would do.

Such high expenses made HomeRun set high service prices, constraining the growth of subscriber base [Roberts et al, October 2002][25]. This had lead to the situation of *‘a vicious circle’*, where the number of hotspots was not growing because there was no increase in customer base. But customer base was not increasing because coverage was not improving and hence not meeting demand. In other words, service was not available for many potential customers. Anna Lange, senior analyst in Northstream consultancy was saying:

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[24] September 2002
[25] Exact figures are not disclosed

I live in Sweden and don't know anybody who has used the service. They [HomeRun] *also have the problem that some of their sites are small hotels that do not attract many business users* [Lindqvis, September 2002].

According to another observer, HomeRun meet common problem where 'a subscription service can't get a lot of users until you get a lot of sites, but you can't get a lot of sites until you get a lot users' [Donegan, 20/05/2002].

Pricing Policy and its Recent Development

Up until recently, HomeRun was the most expensive WISP in the world. The explanation of this, according to Carlo Cassisa, Director of Business development at Telia HomeRun, mainly due to the 25% Swedish sales tax, which is one of the highest in EU[26] [Herslow et al, 2002:40-42]. However, there is another factor influencing HomeRun pricing – the lack of competition on the Swedish market. HomeRun is the only WISP can offer quasi-region-wide coverage, having far bigger installed base of hotspots than nearest competitors (see Exhibit 4-4). This lets Telia HomeRun to make good use of its dominant position and charge higher prices then it could do in case significant presence of competitors.

Exhibit 4-4. Price changes in HomeRun WLAN service

Subscription	**Original prices** [27]	**New prices**[28]		**Change**
		Non-GSM subscribers	**Telia GSM subscribers**	
Flat rate	£34.20 startup fee, £103.30/month.	£103.30/month	£96.39/month	No startup fee
Base	£34.20 startup fee, £20.73/mo., £0.17/min.	£13.82 startup fee, £10.37/month, £0.17/min.	£13.82 startup fee, £2.76/month, £0.14/min., 1 hour free	Startup fee less 60%, month fee less 50%-87%

Source: ***www.homerun.telia.com***

[26] Compared to 17% in UK, 16% in France, for instance

Nevertheless, in attempt to break 'a vicious circle', HomeRun has changed service prices drastically since October 2002. As Exhibit 4-4 below illustrated, the WISP has actually shifted marketing focus on broader segment of user by slashing prices up to 87%, compared to September 2002 level.

This price cut should stimulate market demand and increase customer base [Roberts et al, October 2002:8], breaking *'a vicious circle'* when high service charges blocked demand, which in turn hold spreading hotspots.

Exhibit 4-5. Subscription Cost Telia HomeRun on 1st of October 2002[29].

Prices without bundling with Telia Mobile GSM service		
Telia HomeRun Base		
Initial fee: £13.82	Monthly fee: £10.37	Traffic fee/min: £0.17
Telia HomeRun Base 12 month binding		
Initial fee: £0.00	Monthly fee: £10.37	Traffic fee/min: £0.17
Telia HomeRun Flat Rate		
Initial fee: £0.00	Monthly fee: £103.30	Traffic fee/min: £0.00
Prices with Telia Mobile GSM service bundle along HomeRun subscription		
Telia HomeRun Base		
Initial fee: £13.82	Monthly fee: £2.76	Traffic fee/min: £0.14, 1 hour free
Telia HomeRun Base 12 month binding		
Initial fee: £0.00	Monthly fee: £2.76	Traffic fee/min: £0.14
Telia HomeRun Flat Rate		
Initial fee: £0.00	Monthly fee: £96.39	Traffic fee/min: £0.00
Prices for 24H subscription and 'Starter Kit'		
Telia HomeRun 24h subscription £6.63		
Telia HomeRun Starter Kit £103.30		

Source: www.homerun.telia.com

[27] Prices to 30-Sep 02, not including VAT
[28] Prices from 1-Oct 02, not including VAT

Another recently introduced marketing innovation is bundling HomeRun WiFi service with cellular voice GSM service from Telia Mobile. According Peter Kjellin, Telia HomeRun's business manager, discounted pricing for its GSM subscribers is the first step toward offering integrated cellular-WLAN services. Next step is to offer an integrated GPRS-WLAN or GSM-WLAN package [Roberts et al, October 2002:8]. Full pricing scheme of Telia HomeRun presented in Exhibit 4-5.

Change in Usage Pattern

Before October price cut, most of HomeRun customers used the 24-hour prepaid cards (24H). According to Svante Andersson, Business Development Manager at HomeRun, this probably due to the fact that users still were *'in a trial and test phase'* [Herslow et al, 2002:41].

After HomeRun's prices dropped, usage pattern has changed – there are more customers now, using Base subscription instead of 24H. According to Peter Kjellin, this indicates more frequent use of service [Roberts et al, October 2002:8]. However, exact figures of usage are not revealed.

Relationship with Venues

At the initial roll-out stage, Telia HomeRun used the advantage of the seemingly high entry barrier and attracted venues, which could not set up WLAN themselves, because it was too expensive for them or venue's owners considered a project not profitable. According to [Herslow et al, 2002:42], HomeRun also exploit an ignorance of venues' owners of their real market value in relation to WiFi technology. The major business of a hotel is a hospitality (accommodating visitors) – a set of traditional services associated with this type of activity is very conservative. The same situation with travel ports and travel enablers. Venues' owners thought about WLAN as additional attraction to basic customers and a complement to their core business, the point of differentiation, rather then essential facility: *'If competitors' customers enjoy this service, our customers also should'.*

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[29] 25% sales tax is not included

Anecdotal evidences provides with accounts of stories of hotel owners contacting HomeRun and asking to install the WiFi WLAN because their customers were asking for it and they felt that they might loose customers if they could not provide this service. This vision did not encourage venues' owners to consider WLAN possibility deeply and moreover, encourage them to avoid investing in this innovative business. That lead to venues' owners failure to see their power over the WISP and HomeRun used it to its own advantage – it even did not pay any commissions to venue owners well up to 2002.

At the moment of writing this thesis, there are still no any known type of revenue-sharing scheme reported. In fact, in one described case, hotel stuff receives only four movie tickets for each 20^{th} 24H card sold! [Herslow et al, 2002:42]. The only example of HomeRun payment to the venue is fixed year fee to Arlanda international airport, which is £64610 [Herslow et al, 2002:41]. HomeRun also pays fixed fees to other premium venues, but figures not disclosed. The contracts with the venues generally span over five-year period. In most cases there is no exclusivity to the venue with no exceptions in airports' cases.

Summary

Telia HomeRun is a 'first comer' to WLAN market in Scandinavia, receiving all benefits and drawbacks of this position. The distinctive market strategy – '*following business traveler*' – let HomeRun focus on very lucrative segment of the market, establishing its dominant position. Another beneficial factor for HomeRun is the advantage of Telia AB incumbent position in fixed, mobile telephony and Internet in Sweden. Being a national wide but highly focused provider, HomeRun does not feel that niche players in other market segments are a threat as a competitor, as they occupy space that HomeRun do not desire, such as cafés. Instead, these actors are viewed as potential roaming partners for Telia.

A more serious issue would be if the venues' owners become more demanding in contracts and insist on revenue share schemes, or even more worse, becoming WISPs themselves. The most attractive venues are in that case most likely to go for that option, and would hence decrease overall quality of the HomeRun access footprint.

Case Two. Location based WISP model: Starbucks and Others

A high-speed wireless Internet connection to **my** *information in the comfort of Starbucks – third place between home and office.*

Introduction

Starbucks Coffee Company (SBUX:NASDAQ, Market Capitalization £5,755,809,330[30]) is the leading retailer, roaster and brand of coffee in the world. Being US-based enterprise, Starbucks runs a global chain of café shops in many regions. In addition to retail locations in North America, Europe, the Middle East and the Pacific Rim, Starbucks sells coffee and tea products through its affiliates and franchises, including the online store at Starbucks.com.

Starbucks's course of action is focused on long-term investment in store development. This results in constantly increasing North American and global footprint. At the present moment, there are almost 6000 stores worldwide; growing by 3 per day [Sauders, September 2002]. Starbucks forecast the number of stores to be over 10000 by 2005.

At present moment, most of Starbucks outlets are in the US. The exact proportion changes constantly, but the approximate distribution is shown on the Exhibit 4-6 (left).

The customer base of Starbucks is also impressive – it has around 60 million unique customers annually with absolute growth around 20 million a month [Sauders, September 2002]. Presumably, customer base is distributed the same way as the number of outlets – about 80% customers are North Americans.

US accounts for major (87%[31]) share of Starbucks' steady growing revenues, as one can see from Exhibit 4-6 (right).

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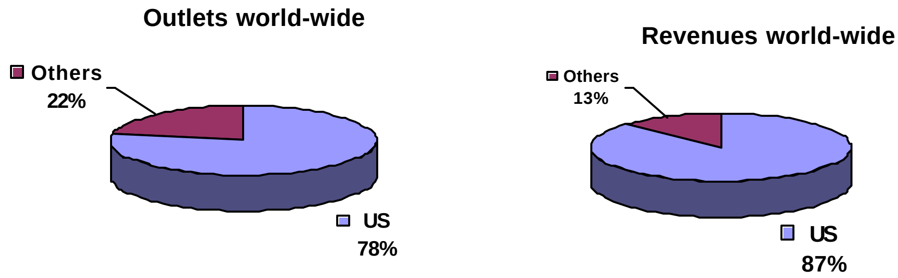
[30] quotes.nasdaq.com, 08/11/02
[31] 2001 financial year

Exhibit 4-6. Distribution of Starbucks outlets and revenues world-wide



Source: Customer's Support Department of Starbucks Coffee Company

As one can see, Starbucks' brand is very strongly positioned across the US[32] in terms of coverage (4609 outlets) and revenue. The company also increases global presence – its brand recognizable in all major markets[33] – Starbucks has a choice of 1329 world-wide locations.

However, café chains locations are not distribute evenly overseas. According to Starbucks' marketing statements, the international expansion strategy focuses on Japan and UK dominance, whereas they only started to enter Continental Europe market [www.starbucks.com].

The Starbucks' rule is to own their retail outlets in US. This gives the company a good control over choice of locations and prices. In this market Starbucks doesn't accept franchise. Nevertheless, when Starbucks enters, it prefers to rent or lease their outlets following the strategy of the minimum risk [Sibilski, 24/10/2002].

Matching profiles of café shops and WiFi hotspots

The underlying idea of Starbucks' wireless Internet service is matching profiles of '*coffee drinkers*' and Internet users. The natural conclusion from such assumption is an offering wireless Internet service to mobile professionals, while they drink their coffee and sit around Starbucks outlet. The press-realize, issued by Starbucks PR department rendered it in the following statement:

[32] Data acquired directly from Starbucks on 24 October 2002.
[33] Americas, EMEA, Asia and Australia

> [It] *keeps* [customers] *connected while they're away from the office offering them a familiar, comfortable location, with the benefit of a high-speed Internet connection* [Business Wire, 21/08/2002].

In other words, Starbucks believes that broadband Internet is a thing that their customers may need and prepare to pay money for this. Thus, in order to evaluate the feasibility of the assumption for the fundamental need for wireless broadband Internet in a café shop, the research first should focus on Starbucks customers' profile.

Selling coffee and cakes, Starbucks marketing targets people who crave for *'affordable daily luxury'* and lead active social life – interested in communication with each other – so they need *'third place'* between home and work. This is, in fact, a very fundamental thing. People who look for communication with each other in specific place – Starbucks – may use Internet in the same place to communicate in virtual way. It supplements their need of social and business communication.

Exhibit 4-7 presents a typical Starbucks' customer profile:

Exhibit 4-7. Customer's profile of Starbucks.

Average income	$80,000
Education	80% College Degree
Technical basis	90% are online, 40% have laptops
Gender	Over 50% females
Average Age	40

Source Sauders, September 2002

This profile confirms that Starbucks customers are ready to use wireless Internet in terms of their technical background (college degree, laptop use) and in terms of their social life style (enough money to pay, women are likely to socialize). In fact, the slightly female profile of Starbucks' customer base is even more encouraging for introducing data services. According to the recent Forrester consultancy research, young women, along with business users, are more likely early adopters of entertainment and business related data services [Total

Telecom, 07/11/2002]. This gives *'WiFi in Starbucks'* business proposition more stronger support.

Such technologically advanced customer' profile matches mobile workers' strong need to extend their working time and space by using WLAN service while sitting in and out of Starbucks' cafés. According to the Yankee Group 2002 Corporate Wireless Survey [Business Wire, 21/08/2002], almost 25 percent of all enterprise workers are considered mobile, spending more that 20 percent of their work time away from their workspace. This equates to approximately 40 million mobile professionals in the U.S. who still want and need access to their e-mail, the Internet, or their corporate intranet. Hence, this evaluation also justifies Starbucks' business proposition.

The First Trial of WiFi in Starbucks with MobileStar

Plain WISP at Starbucks

To deliver WiFi wireless Internet to its customers, Starbucks partnered with the venture backed start-up MobileStar. MobileStar was a plain WISP, according to introduced in Chapter 3 classification.

In January 2001, MobileStar announced a strategic deal with Starbucks, Microsoft, IBM and Compaq [Shostek, 2002:13] entailing them to provide broadband access in hotspots located over all US. Even though MobileStar planned to set WiFi WLANs in many different venues, their major marketing channel was partnership with Starbucks. They started trial services and soon deployed WiFi-based WLAN in 536 Starbucks stores in less than a year.

In accordance with a negotiated agreement with Starbucks, MobileStar took sole responsibility over deploying hotspots over US Starbucks café chain network in exchange for exclusivity rights and all revenues from service. MobileStar also supplied T1 line to every Starbucks hotspot it installed. MobileStar initial venture funding – only about £30mln [Shostek, 2002:14] – allowed MobileStar to succeed in building 650 hotspots across US in different locations, like café outlets, airports and hotels. The company's plans spanned till 7000 hotspots in 2003.

Similarly to early electrical telegraph, spreading in US along railroads [Standage, 2000], MobileStar, spread its own WiFi network across another distribution network – Starbucks. For MobileStar, wireless Internet in Starbucks coffee shops and other hotspots locations was a core business. But the Starbucks' core business is selling coffee and cakes. MobileStar based its business preposition on the idea that any '*WiFi-enabled'* customers might look for connectivity in hotspot to check e-mails '*at the same moment you're filling up your gas tank or yourself with caffeine?'* [Fleishman, 22/02/2011]. Pursuing such 'branded' location, MobileStar did not target any particular segment of customers, rather concentrating on '*putting hand'* on premium hotspots, where people likely to use WiFi.

Cost Structure

The average cost of MobileStar WLAN installation in Starbucks' outlets was about £2600 per hotspot [Koerner, 2002][34]. This lets conclude the total roll-out cost for 650 hotspots in the US – approximately £1,700,000.

As was indicated above in Chapter 2, WiFi WLANs have also quite high fixed operating costs. In case of MobileStar in Starbucks, the WISP had to install T1[35] line to each locations, costing in average £300-600 a month [Denison, 09/09/2002, Beaumont and Roberts, 2002:4]. And this had to be paid independently of usage. Even nobody logged into hotspot, the WISP had to pay for T1 line.

As for revenues, a hotspot customer usually paid modest £2 per 15 minutes, there were some other rates including flat rates, but the WiFi pricing in Starbucks will be considered more accurately later.

Controversial Results

The results of this trial were exciting for Starbucks (see below) and disastrous for MobileStar. The latter went bankrupt late October 2001. The company had failed to receive third-round venture funding to support ongoing operations. It later

[34] This gives total CAPEX for 650 hotspots - £1.7mln
[35] 1.5 Mb/s dedicated line to carrier backbone network.

filed for bankruptcy, and was eventually acquired by U.S. cellular operator VoiceStream.

Good news

According to Starbucks' marketing survey, 54% of customers would pay for in-store wireless access; 91% of customers expressed interest in in-store connectivity. Starbucks also received indications that WLAN service enhanced loyalty/satisfaction: customers themselves often reported increases in visitation and transactions. Starbucks' customers valued the convenience of WiFi in café and ability to access personal productivity data (e-mail, files, etc.). Such factors are enhanced by broadband speed of WiFi in *'a comfort of Starbucks'* locations. Starbucks' staff reported *'thousands of requests for in-store Internet access'*, thus creating positive incentives for café chain to continue with service and all these data assured Starbucks for keeping existing business in place and installing WiFi in new locations [Sauders, September 2002].

The initiative also get wide coverage in media – *'3-5 media inquiries on wireless access per week since January 2001'* [Sauders, September 2002] – which was basically free advertisement campaign.

Valuable information was acquired also on the network usage. There were approximately 20 000 accesses across the network monthly. 88% of the usage is after 9am. Average access is 1.06 users per hotspot per day with 46 minutes access per day. This seemingly low figure, was in fact, in Starbucks' opinion quite high, considering the fact they perform no marketing activity to promote WiFi service in cafés [Sauders, September 2002]. Total number of customers at the moment of MobileStar bankruptcy was around 11,000 [Parker, December 2001:9].

Observation lead to believe that the usage varies very much form location to location. A questionnaire, sent wireless mailing list BAWUG, reveals that in some locations a user never meet anybody else using T-Mobile Hotspot service, whereas others reported that more than 10 people use wireless Internet in Starbucks in Berkeley on the US West Coast[36].

All this data lead Starbucks' marketers to conclusion that WiFi hotspots were excellent service's differentiator, which can helps them to attract and/or retain more customers. The results showed that using WiFi networks across US Starbucks chain can significantly differentiate its core business on café shops market landscape.

It is important to note that with the demise of MobileStar, Starbucks did not stop service but evaluate reached results. In fact, even when MobileStar fired all employees and shut office's doors, the network did not stop running even for a short moment [Shostek, 2002:13].

Bad news

MobileStar's failure was caused by several reasons. Firstly, the poor general financial state of the telecommunications market and the following lack of capital to blame. MobileStar was also hit by 9/11 attack, yet indirect way – the WISP failed for Chapter 11 a month after a tragic event. Probably, reluctance of investors to *'pour'* more money in the start-up during *'troubled'* period played an important role. The MobileStar chose a good place (distribution channel) but wrong timing.

However, the lack of capital was not the only reason. Starbucks/MobileStar partnership was referred to as *'brain-dead'* by Intel's Head of Wireless Department Stephen Saltzman [Thorngren, 2002:1]**.** He remarked that it was *'a lesson on how not to do things'*. MobileStar agreed to install WLAN in hundreds of Starbucks café more or less simultaneously. All deployment cost was covered by MobileStar and in return WISP was supposed to receive all of the revenue. A consequence was that Starbucks had little incentive to market the service to its customers, since it had no money either to win or lose, and indeed, at that time, it was virtually impossible to detect whether there is WLAN available or not in

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[36] Author asked users of BAWUG mailing lists their opinion about T-Mobile service.

your average Starbucks outlet [Sauders, September 2002]. Anecdotal evidences says that often even the Starbucks' staff was unaware of the service.

The network's rollout was associated with high costs. This partially stems from the fact that the WISP could not benefit from economies of scale, usually benefiting cellular carriers:

> *…the cost of adding new hotspots does not decline substantially even with large volume. Therefore, providing ubiquity becomes expensive [Shostek, 2002:14].*

When MobileStar agreed to fully fund installation and support WiFi APs in hundreds of Starbucks locations, it did so without the realistic hope of additional economies of scale which would make the task more affordable – and with the near-certainty that many locations would lose money. Low revenues due to low usage, insufficient to cover the operating cost, added more financial stress on MobileStar suffering from general funding shortage. For instance, following MobileStar prices[37] and the usage pattern, described above, the average revenue per hotspot per month was around £180[38] which was not even enough to cover the cost of T1 line. (see Cost Structure in this section).

To summarize '*the trial stage'* experience, the initial business model of the WISP, acquiring customers through venues, without any revenue sharing and consequently no marketing support from venues, has been somewhat discredited.

New Era: Partnership with T-Mobile and HP/Compaq

Clear marketing targets

After a short *'romance'* with MobileStar, Starbucks articulated its marketing statement in WLANs more clearly. They believe that their customers need service because: it will differentiate significantly Starbucks brand, increasing customer loyalty. Also, a new service attracts new customers, creating new growth opportunities. Besides, WLANs and specially T1 line to each US outlet

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[37] £2 per 15 minutes

[38] This calculation agrees with another source [PW, December 2002:9], where average revenue per hotspot per month estimated as £200.

significantly improving 'back-house' infrastructure, increasing control over all production activities.

Three-party WISP

Willing to continue WiFi roll-out, Starbucks saw a partnership with *'right'* network and infrastructure providers as a key necessary condition – it could reach indicated growth targets only if they chose correct partners. Moreover, café chain wanted to become active player in the value chain benefiting[39] of revenue stream as well as creating additional service differentiation.

To meet these goals, Starbucks chose a three-party model in which each partner adds certain value to consumer with Starbucks' integrating role in WiFi project. Starbucks partners were: infrastructure and service provider (Operator) from one side and hardware and software provider from another (Vendor).

Operator

VoiceStream, the US mobile arm of Deutsche Telecom[40] acquired MobileStar in the end of 2001 for undisclosed amount (believed to be £1mln) after the latter went into bankruptcy [Shostek, 2002:14]. VoiceStream, the US' sixth largest mobile operator with 6.3mln customers [Parker, December 2001:9], had the right to all of MobileStar's assets and assume some or all of MobileStar's contracts[41]. VoiceStream was willing to continue roll-out WiFi network across US, so it was a natural solution for Starbucks to partnership with MobileStar's *'heir'*.

In the middle of 2002 VoiceStream was re-branded to T-Mobile (the US subsidiary of T-Mobile – mobile arm of Deutsche Telecom, DT:NASDAQ, Market Capitalization £30,376,276,700), and its WiFi service started to be called as *'T-Mobile Hotspot'*. Thus, T-Mobile is a Mobile Operator WISP, according to Chapter 3 classification.

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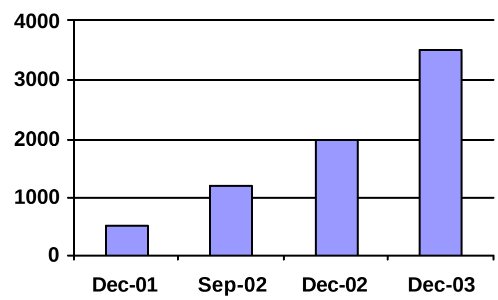
[39] Details of revenue sharing scheme are not disclosed officially, however some speculation will be presented in Chapter 5.
[40] VoiceStream was acquired by Deutsche Telekom for £22.5 billion in the end of 2001 [Riseborough, 21/08/2002]
[41] Besides Starbucks, Admiral Lounges in several US airports.

Official launch of *'new'* broadband service in Starbucks was 21 August 2002 [Business Wire, 21/08/2002].

Coverage strategy

T-mobile does not have a big footprint in the US (see Exhibit 4-9), so the coverage strategy is to go to these regions and install WiFi hotspots where other T-mobile services (GSM, GPRS) are also available. This can be illustrated by comparing coverage maps (Exhibits 4-9 and 4-10) of T-Mobile and Starbucks – at first, the provider (November 2002 in Exhibit 4-10) try to cover states where it already establish any significant level of presence.

Exhibit 4-8.Starbucks and T-mobile hotspot rollout plan



Sources: Starbucks, T-Mobile, Hotspots Markets

As one can see from the Exhibit 4-8, the roll-out, projected in the end of the 2002 year is hardly reaching half of all US's Starbucks outlets and total Starbucks coverage is well ahead. By the end of 2003, T-Mobile hotspots will be in only 75% of Starbucks shops in US.

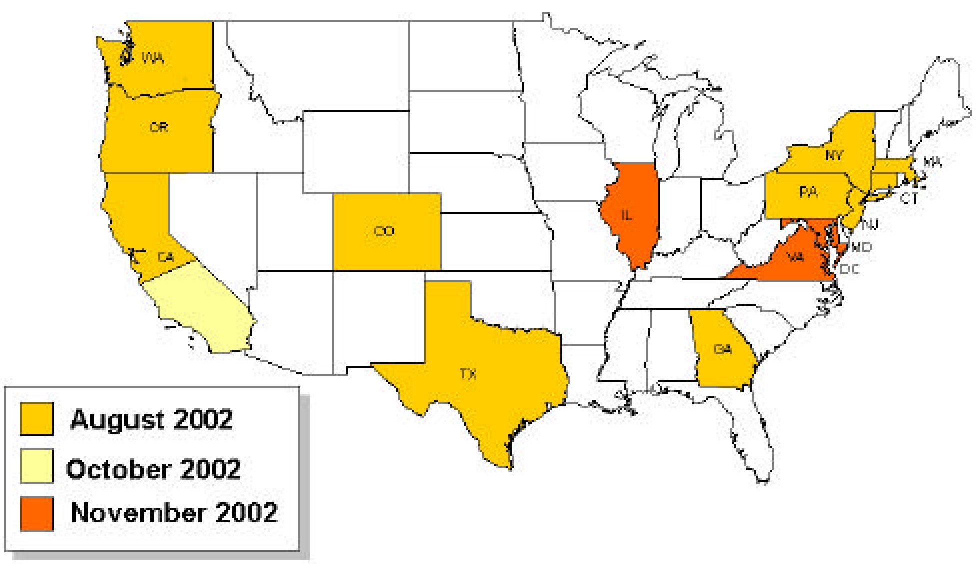
T-Mobile revenue

T-Mobile's revenue comes from usage of wireless Internet services by customers of Starbucks. In fact, T-Mobile owns customer completely, taking responsibility for customers' acquisition, billing, collecting fees (for details on prices see Cost structure of WiFi in Starbucks) and support. Then T-mobile shares part of revenue with a venue partner – Starbucks.

Exhibit 4-9. US Coverage Map of T-mobile GSM service. Coverage areas are highlighted

Source: www.t-mobile.com

Exhibit 4-10. Hotspots Coverage in Starbucks outlets across US territory



Source: [Sauders, September 2002]

On the other hand, T-Mobile has an exclusive right to offer wireless Internet on WiFi standard over all US territory in all Starbucks café outlets[42]. One can see a sign of T-Mobile Hotspot service in every Starbucks window (presumably , APs are installed there). Starbucks also offers wireless Internet information and links to T-Mobile web-site from StarBucks.com.

Exclusivity is a very important advantage, keeping in mind that all Starbucks outlets belongs to café chain directly. This means that chances of potential interference with other WLANs near-by are much smaller than it can be if buildings belong to other institutions.

T-mobile plans to introduce WiFi broadband service in other *'branded'* locations. Recently, T-mobile has announced an agreement with Borders book-shop chain to deliver wireless Internet via WiFi hotspots in its locations throughout the US [802.11 Planet, 10/10/2002]. According to another T-mobile's news account [Young, 29/07/2002], there is a plan to roll out public wireless LAN services to its German customers by the end of 2002.

This means that network value of T-mobile as WISP is increasing as it spreads across extended chains such as Starbucks or Borders.

Roaming

It is worth to stop on T-mobile hotspot roaming policy. At present moment, T-mobile closed its network for users of other WISPs. This policy can force other users to buy additional subscription from T-Mobile as supplement to existing subscription and eventually, with growth for T-Mobile WiFi network, lead to winning over these customers. Later, after reaching critical users mass, T-Mobile can open its network again [Beaumont and Roberts,October 2002:3].

Vendor

Starbucks WLAN deployment also involves partnership with a Vendor. This let Starbucks's consumer and T-mobile user at the same time to get its hardware and

[42] From the interview with Mss Saudlers (conducted in Q&A session in London's conference).

software pre-setup for work in WiFi hotspot locations, managed by Starbucks and T-mobile.

This approved vendor is Hewlett-Packard/Compaq. The customer can buy discounted hardware (NIC, PDA, laptop) from Hewlett-Packard/Compaq. To increase value for consumer, the necessary hardware (NIC – 802.11b card) is bundled with *'sniffing'* software (which can be downloaded also for free from Internet). This software program automatically detected wireless network settings in any T-Mobile hotspots. The hardware can be bought through Starbucks and T-Mobile web-sites. From each sell vendor's partner receive commissions.

Prices and Service of T-Mobile Hotspot in Starbucks

In order to use service, a user need WiFi standard NIC. As an addition, making use WiFi in Starbucks easier, user can install special wireless software manager, supplied by third partner – vendor (see below).

It worth to mention that users can have free day trial pass. A user have to fill up on-line subscription form with credit card details. T-Mobile will not charge for first 24 hours, but when the user next time log in, he will be asked to chose on the subscription types, presented below in Exhibit 4-11.

Exhibit 4-11.T-mobile Hotspot Service in Starbucks Café

Subscription Capacity	Cost	Fee/min	Other Information
Pay-As-You-Go 15 minutes	£1.61	£0.16	Metered access. 15 minutes included in initial fee. Each £0.16/min
Flat Rate, unlimited local access, month	£19.32	N/A	500 MB traffic included. Rate for minutes used outside your local area is £0.10/minute. Addl. data transfer is £0.16/MB.
Flat Rate, unlimited national access, month	£32.30	N/A	500 MB traffic included. . Addl. data transfer is £0.16/MB.
Prepaid voucher 120 minute	£12.92	£0.11	No formal contract
Prepaid voucher 300 minute	£32.31	£0.11	

Source:www.t-mobile.com

Summary

At present, WLAN-enabled Starbucks stores are located in New York, New Jersey, Connecticut and several large metropolitan areas such as San Francisco, Seattle, Boston and Dallas. Expansion to Los Angeles, Chicago and Washington, D.C., is planned by the year's end. According to [Bright, 01/10/2002], there are totally around 1200 café, where Starbucks customers can access WLAN. The number is expected to grow up to 2000 by the end of 2002.

Starbucks, using advantages of its extended customers' base and locations, sees WiFi networks as additional service differentiator, ideally suited to the customers profiles.

Further extensive deployment of WiFi network by T-Mobile is possible because already quarter of all Starbucks outlets is covered with APs. The acquisition of MobileStar doesn't cost T-Mobile very much, so the WISP can continue funding of network build-out.

The difference between trial stage and '*new*' launch is the revenue sharing agreement is presented and Starbucks is carrying marketing activity.

Partnership with hardware/software vendor let tailor offering better way, offering seamless handoff between different T-Mobile Hotspots.

Case Three. Single Point WISP: Copenhagen Airport

Introduction: Telecommunications services in airports

Fall of Payphone

Payphone industry is falling loose. Only in the US, the number of pay phones nationwide has decreased nearly 30% since 1996, from 2.6 million to 1.9 million, according to statistics from the Federal Communications Commission. [Barrick, 30/04/2002]. As payphone revenues plummeted, providers seek to get rid of lose-making units – BellSouth plans to sell its payphone network of 143,600 units in December 2002 [Henion, 02/09/2001].

Yet, it is imperative to say that payphones never goes away completely as was clearly shown in the 9/11 event – cellular network in several areas of NY city was down for hour and the only way for people to contact their relatives were *'old'* payphones [Barrick, 30/04/2002]

Just a few years ago, airports enjoyed high revenue stream from payphones, installed around passenger lounges by fixed-line telecom carriers. The US's payphone providers reported average revenue per unit was around £150-200 per month, whereas now it dropped to less than £100 [Kanell, 03/02/2001]

It was not uncommon to charge passengers exorbitant prices[43] for national and especially international calls and passengers had no other choice but only to pay. The demand for connectivity is extremely high in airports, as in other Travel Ports (following HomeRun terminology), when people move from place to place. Airport and carriers exploit this essential need to their advantage, receiving all benefits of lucrative payphone business.

Payphones are bound to specific location. The major advantage of payphone over other communications devices – one can use it when everything else fails. Only two requirements – one have to walk into the booth and pay for service[44]. Being bound to the location, payphone used all benefits of the specific venue –

[43] For example, price for Europe call from Moscow International Airport in 1997 was around $3-5

[44] Unless you call emergency

airports' authorities might had revenue's sharing agreements with payphone network operators, receiving not only a fixed fee from the number of payphones installed, but also commissions from outgoing traffic, generated by payphones in the airport.

The major reason for this dramatic change in telecommunications landscape is growing popularity of mobile phones and their quasi-global roaming[45] readily available to subscribers. Telephone deregulation led to the introduction in recent years of flat -rate plans and nationwide pricing that has made wireless phones more affordable. As a result, people use pay phones less and less. Indeed, despite the fact the payphones revenues are falling, the price for payphone call is only rising, because of rising cost of support and maintenance of equipment. Now, using a mobile is cheaper than a payphone. So, airport payphone' revenue plummeted drastically. Atlanta Airport alone, for example, lost £4.5mln in 2000 [Brewin R., 19/02/2001].

Airports and Cellular Carriers

Being a reason for decline of payphones, cellular communications are using advantage of airport location for their benefit. Moreover, it is very difficult to overemphasize the importance of airports to the roaming business – arrival lounge airport is a place where roaming starts. Every traveler knows that the best and clearest mobile phone reception can be found in airports' arrival lodges where travelers switch on their mobiles and pick up a roaming network. Most of mobile devices pick the network automatically and it is imperative for cellular carriers to have the best signal/noise ratio in these areas.

Unfortunately, for airports' revenues, the relationship between them and cellular carriers does not reflect the importance of the airports' location – a revenue from cellular communications never compensated lost revenue from payphones. A license gives cellular carrier right of access to set up equipment to cover specified territory. In fact, even if an airport denied such right to carrier by imposing barriers such as high rent price, a radio signal from nearest base station

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[45] The absence of common standard between US and Europe is a major barrier to truly global roaming.

outside airport territory can still reach out mobile subscribers in the airport's premises, and the airport's authority has no real possibility to stop it. This is why there never been revenue sharing agreements between airports' authorities/owners and cellular carriers. Commonly, airports only receive the fixed annual fee for using space where cellular masts, base stations and amplifiers installed.

WLAN to Fill the Gap?

The convergence of the datacom and the telecom worlds gives airports an opportunity to exploit their premium location and deliver new data services in the same way they provide voice communication via old-fashioned payphones. Data communications become as valuable for enterprise workers as their voice connectivity.

WLAN seems to ideally suit to this task. Besides serving so much needed data connectivity, WLAN turns to be an excellent solution to fill the gap in airports' telecommunications services portfolio. This is due to three reasons.

Low cost and presence of experts

Public WLAN in the Airport makes additional use of already existing infrastructure of wired LAN (*'a sunk cost'*) in the Airport and a broadband connection to the Internet backbone (which is likely to be present in all modern airports), so the cost of deployment will not be very high. In order to set up a WiFi hotspot, the Airport needs only APs and hardware/software for billing and customer support.

Another important advantage of airport in front of other venues, such as café shops or small hotel – it always has strong IT department with huge expertise in radio communications. Indeed, it is a must in airports – they use radio for navigation and other aeronautical services. IT people in airport are also more ready to deal with new kind of wireless computing due to support they give to other services and departments of airport, duty free shops, for instance.

Effective use of location

Hotspots can be called as *‘a new incarnation’* of old payphones – they make use of venue itself, rather then a spectrum, available to *‘outsiders’* – cellular carriers.

Hotspots for data services in airports are not a new idea at all. The passage from below was written more than 7 years ago, when even the term WiFi had not been even coined yet:

> *Imagine arriving at an airport and walking up to the nearest available pay phone. Instead of lifting the receiver and dialling from the keypad, you point your personal information appliance (PDA, personal communicator, or mobile companion) at the infrared port on the front of the phone. Then you tap on the "office" icon that appears on the screen of your device. Using an infrared link, your personal information appliance dials the i.phone[46] and automatically charges the call to your credit card.* [Brodsky, 1995:163]

Service differentiator

The third reason for public WLANs use in airports is an improving the quality of public telecommunications services in airports itself. Modern international and national airports have highly sophisticated telecommunications services to be used by passengers – payphones, business centers, cellular masts and so on.

International transportation organizations, such as IATA, have system of airport’s quality levels, valuing passengers’ satisfaction. Telecommunications services are not at the last place in this grading system. Every airport seeks to improve its overall grade by sustaing high quality services and installing new high-tech IT services for passengers and specially for business travelers. Hence, WLANs create new sort of competitive advantage for airports. In order to sustain high quality service and control pricing issues, airports need to brand the WLAN service themselves, owning public WLAN customers, instead of resorting to an external WISPs [Søe , September 2002].

[46] A kind of PDA, designed of the time of writing this text

Copenhagen Airport WIZ (Wireless Internet Zone)

Copenhagen Airports

The Copenhagen Airport is northern Europe's main airport. Airport handles transit air traffic between other parts of the world and serve as connection point between many national and regional airports in Scandinavia and the area south of the Baltic Sea.

The Airport is privately owned and operated by Copenhagen Airports A/S, a company listed on the Copenhagen Stock Exchange under the name Koebenhavens Lufthavne (KBLTF) [Financial Times, 28/10/02]. Total majority of shares (95%) belongs to Danish Government and the rest to a number of different minority shareholders [www.cph.dk].

In 2002, in an IATA (International Air Transport Association) survey of 80,000 passengers, Copenhagen Airport was rated the best airport in the world by such factors as services and travel times [www.copcap.com]. In 2001, the Airports Council International (ACI) ranks the Copenhagen Airport as the 7th European airport ahead of Hamburg, Stockholm and Oslo by total cargo on its world airport ranking. According to www.copcap.com, Copenhagen Airport is the largest in Scandinavia by volume of passenger traffic – last year traffic exceeded 18.1mln passengers [www.cph.dk].

The fact, that Copenhagen Airport is graded as Best in the World in passengers services prove that it has incentive to keep this grade further.

Why Implement a Hotspot

Three basic reasons for implementing hotspots are indicated above, however it should be seen how they might be applied in particular to Copenhagen Airport.

According to the words of Henrik Bjorner Soe, Head of Business Development Department of Airport, the major purpose of WLAN deployment was filling up revenue gap after payphones and increasing passenger (firstly, business travelers) satisfaction [Søe ,September 2002].

The Copenhagen Airport is profit oriented enterprise, so the driving force behind whole WLAN project is closing revenue gap, created by demise of payphones.

The Airport does not want to miss the opportunity of exploiting advantages of own location as it happen in case of cellular carriers.

The Copenhagen Airport had already had wired LAN and wireless LAN for its own needs. The hardware/software just had to be upgraded to allow public commercial offering [Søe , September 2002]. According to Søe, total installation[47] time took only two weeks, which is very short time and possible only if existing LAN is utilized [Søe , September 2002]. The all cost of WLAN installation was covered by the Airport, resulting in owning whole public WLAN infrastructure.

From the business travelers' point of view the benefits would be to shift the *'gray'* waiting time in the airports departure lounges to productive time, extending working time and space – the loses, associated with waiting time are high (see Chapter 2), underlining potentially high demand for WLAN in airports. This improve the overall service grade of the Copenhagen Airport.

BWCS report [BWCS, 2001] confirms this, stating that 93% of surveyed business travelers are 'interested' or 'very interested' in using public WLAN at airports. In average, business traveler currently spends 19.7 minutes working in airports per trip, but this time will raise to 30 minutes if WLAN service would be available o them, states the same report.

A marketing research undertaken by Business Development Department, reveals demand for broadband wireless services. Surveyors asked questions like *'who is actually going to use this service?', 'for what purpose they use this service?', 'how long they stay on-line?'.*

It was found that there was a demand for wireless broadband delivered to laptop or PDAs via WiFi WLAN only among business travelers who needed connectivity to organize their time efficient way, while they are away from their office. Opposing, leisure travelers do not have the same need to optimise their dwell time or surf the web. At least they were not ready to pay for the service.

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[47] Total cost is not revealed

Marketing research revealed what kind of the services business customers are interested. It turned out that access to the Internet is not essential – reading e-mails is basically the only possible application. The real value for this segment customers is an access to their home networks via VPN. Other possible applications like location-based services (where nearest duty-free, toilet etc) turned out to be not popular enough.

Partner's choice

In order to keep revenues and QoS under its control, the Airport's management decided that it must have a control over all vital parts of value chain. Therefore, the solution, where 'outside' WISP install infrastructure at own cost and retain all revenue doesn't suit the airport (see previous Case One and Case Two). They decided to provide services themselves, using outsourcing partner (enabler) for such parts of value chain as billing, authorization and customer support. This way it will stay in control of the costs charged and have all revenue from potentially lucrative service.

By studying supply side of the market, they found that notwithstanding abundance of vendors and solution suppliers as well as network operators, few can offer solution to suit the airport's interest. In the process of negotiations, service providers (WISPs and ISPs) tried to impose leading role: planning to run WLAN network similar to cellular network – provider take care about everything and then might share something with a venue. Or might not. This case is described above in HomeRun section.

Thus, potential providers demanded major revenue share and exclusive rights to operate WLAN in airport. This might lead to situation where provider **A**, for example, already run a network in airport **a**. If he set up WLAN in airport **ß**, he is not going to serve customers, who already subscribed to the service provider **B**. Each provider believed in its exclusive right to supply service and '*insisted that they can rule the world*'[Søe, September 2002].

This contradicted to the intentions of Copenhagen Airport management, reasonably suggesting that 'nobody can rule the world' and 'the market is and will continue to be divided between several providers of WLAN services and

VPN services' concluding that 'the service provider and Copenhagen Airports must have a common interest in high traffic volume'. [Søe, September 2002] Leaving airport the major partner, so the most revenue must end up in Copenhagen Airports' accounts.

Scalability of solution was also important for Copenhagen Airports. They wanted to continue exploit its own infrastructure and LAN, which gives them control of the service. Also, they need to be able to add services, such as blue-tooth, 802.11a, position based services and make partnerships with different VPN providers.

Airport business development department formulated set of requirements for solution provider: a partner must have WLAN access as its core business, but no own customer base, so no interference of interests. A partner must have the technical expertise to establish the service, provide the necessary costumer support, perform all billing functions. Also a partner must reveal commercial interest in establishing contacts to VPN providers.

Aptilo networks AB met all requirements of the Airport. According to the airport's manager, contract was made in two weeks because of 'the common interest'. Technical set-up was established also in two weeks. in the best seating area.

The next stage was marketing set-up, where 'signs and instructions was set up, a press release was made and the service staff in the terminals was informed'.

Costs, Pricing and Use of Services

According to Soe, the installation cost of hotspot, covering about 2000 sqm, was less then £10000 and operational cost is less then £800 a month.

The use of WIZ in Copenhagen Airport is very simple. As in previous cases, user needs a WiFi-enabled device (laptop or PDA with NIC). User opens browser and immediately redirected to WIZ homepage, where he/she choose one of three pricing schemes (Exhibit 4-13) and carry out payment by credit card. WIZ is available for free to SAS customers in SAS lounges. One can see that this scheme impose no technical barriers to access to the network. According to Soe, *'one barrier is way too much, resulting in fewer customers'* [Søe, September 2002].

At present, there are three pricing schemes in Copenhagen Airport, all based on per-minute basis (Exhibit 4-12):

Exhibit 4-12. Subscription Cost at Copenhagen Airport[48]

Subscription Capacity (minute)	Price	Fee/min
30 minute	£3.40	£0.11
60 minute	£5.10	£0.09
240 minute	£6.80	£0.03

Source: Copenhagen Airport, www.cph.dk

Roaming

There is no roaming for WIZ customers at present moment. This means that access bought in Copenhagen Airport could not be used in any other place. In other words, airport visitors will have to buy a separate subscription to the airport service on top of their current one. According to Soe, Airport negotiating roaming agreement with i-PASS and other roaming agents, however this still is not in place at the moment of writing this thesis.

Possible outcomes of this will be discussed in the next Chapter 5.

Summary

It is a logical choice for an airport to become a WISP as Copenhagen Airport Case shows. The strategic positions airports allow them to be highly attractive for data communication services, as few years ago they enjoyed significant income from revenue-sharing agreements with payphone operators. After failing to secure revenue from cellular carriers, airports will not miss their chance to be ahead of airport payphone's re-invention.

Conclusion

This Chapter gives in-depth description of three Cases of WiFi WLAN deployment, done by the Mobile Operator WISP, Location Specific WISP/Mobile Operator and Venue-WISP. Therefore, the knowledge base for

[48] 23 October 2002

further discussion of each case is established, allowing to apply analitical tools to the analysis of these cases and its possible outcomes.

Chapter 5. Analysis and Discussions

You look at where you're going and where you are and it never makes sense, but then you look back at where you've been and a pattern seems to emerge. And if you project forward from that pattern, then sometimes you can come up with something. [Pirsig, 1974:171]

Introduction

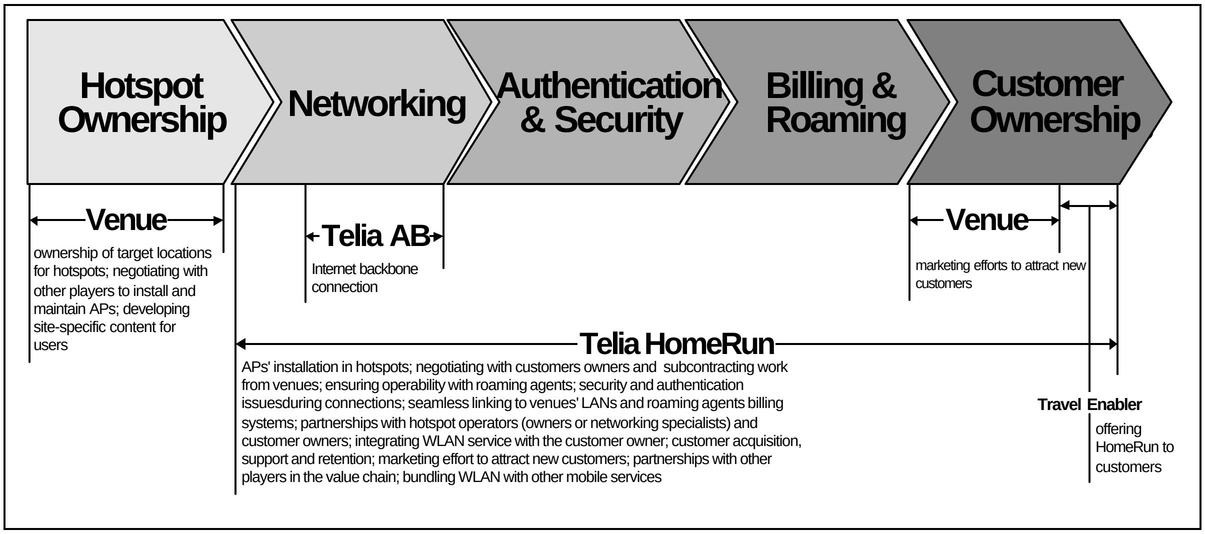
This Chapter is devoted to further analysis of described in the previous Chapter cases and resulting discussions. The first stage of the analysis is to look at the roles, which various actors play along the WLAN's value chain in each separate case. During this stage, each Case Study will be classified into one of the eight categories: Mobile Operator WISP, ISP WISP, plain WISP, location-specific WISP, single point WISP, operator neutral WISP, franchising WISP and virtual WISP. The next step then is to construct cumulative schemes of business models. Such graphical representations help to illustrate all essential flows of money and services. The third step is to compare the cases on the basis of costs and seven general indicators, highlighting specific characteristics of each Case. The fourth step involves some discussions about problems observed WISPs and venues are facing. The last point of analysis is to put Cases on the cooperation/footprint diagram and discuss possible evolution of business models.

Value Chains Analysis and Comparison

Case One

According to the introduced in Chapter 3 WISPs' classification, Telia HomeRun is a Mobile Operator WISP. Indeed, structurally, Telia HomeRun service is part of GSM service provider Telia Mobile. Besides that, HomeRun's coverage strategy is very similar to those pursued by a typical cellular carrier – it strives '*to put a hand*' on all possible hotspots' locations where potential users (business travelers) are likely to appear and use the service, rather only these hotspots were traffic is anticipated to be the heaviest. It is essential requirement, because HomeRun must meet high expectations of its major customers – business travelers – ensuring service availability region-wide.

Exhibit 5-1. Telia HomeRun Value Chain



Being in an essence mobile operator WISP, HomeRun tends to position itself along value chain in a similar way to cellular carriers[49]. Customers' sensitivity to QoS issues force HomeRun to control tightly all service provision, starting from such activities as APs maintenance and wired LAN monitoring in venues' premises and ending handling payments, billing, marketing and customer support. In fact, the only one activity out of Telia HomeRun' scope is a constructing of buildings to set up hotspots. Exhibit 5-1 illustrates allocation of roles inside the WLAN value chain. Some more details are also provided below:

Activities, controlled by hotspots' venues occupy only a small portion of value chain – they own hotspots, negotiate terms with Telia HomeRun, and at the end of value chain perform minor marketing activities, such as supplying customers with pre-paid '24 hours' cards.

The backbone connection to the Internet[50] is supplied by Telia AB Group cooperation. Obviously, this activity can not be considered independent – it is also controlled by Telia and moreover, gives HomeRun critical advantage in cutting operating cost.

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[49] For typical cellular value chain see for example in [Maitland et al, 2002:490]
[50] Usually E1 lines [Pixell, 2001]

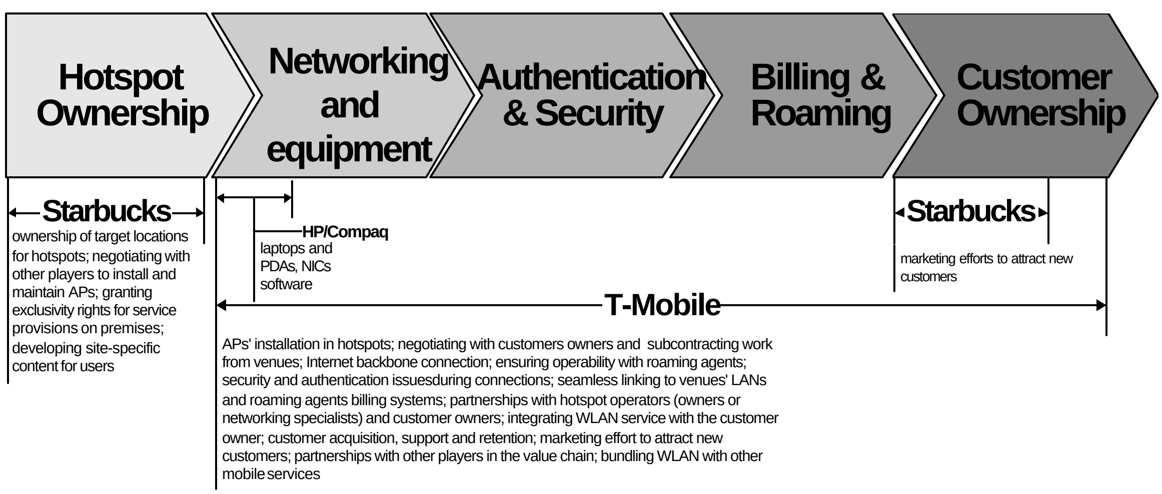
At the end of the value chain, travel agencies, or *'enablers'* for business travelers[51], acts as Telia dealers, supplying their customers with value-added service (HomeRun).

Case Two

The second Case Study doesn't belong to a single category, as HomeRun in the previous Case. In fact, the WISP – in this case T-Mobile – is a cellular carrier, pursuing WiFi deployment along specific locations such as Starbucks café shops. Starbucks itself is not a WISP, but, definitely, more active player in the WLAN value chain then venues in the previous Case – just to take the fact of its active participation in marketing WiFi service and granting T-Mobile exclusive rights to provide WiFi in its North America outlets. Therefore, it is justified to put this Case in two categories – mobile operator WISP and location specific WISP. The further proof of it – T-Mobile covers not just all possible hotspots, but 'branded' ones, like Starbucks, Borders and others.

Exhibit 5-2 shows how actors occupy parts of WLAN value chain.

Exhibit 5-2. Starbucks/T-Mobile/HP Value Chain



Value chain is composed by Starbucks, T-Mobile and HP/Compaq in a such way:

[51] In terms of arranging their travel routines

Starbucks owns their venues-outlets, consequently it is in their right to decide how to use in their premises available unlicensed spectrum – they are granting this exclusive right to the WISP – T-Mobile.

The Starbucks' marketing views WiFi as a possible service differentiator, thus allowing the WISP, T-Mobile to enter its premises to perform all activities of WLAN value chain. However, an important marketing factor is that Starbucks WiFi's users must be T-Mobile's Hotspot service subscribers, but not otherwise – T-Mobile service users may not like going to Starbucks.

Basically every activity in the WLAN value chain, which are not core business for Starbucks is handled by T-Mobile. These include wiring LANs[52] at outlets, a connection to backbone, issues of authentication, security, billing and roaming. At the end of the value chain, T-Mobile owns end-customers, dealing with payments and technical support. Here, Starbucks also plays important role in marketing new service to its customers – it promotes WiFi hotspots through an advertising campaign and a corporate brand web-site.

It must be noted a stronger presence of hardware vendor in this Case. Hewlett-Packard/Compaq provides the *'sniffing'* software[53] enabling customers easily log in into the T-Mobile hotspots and hardware such as NICs, WiFi-ready laptops and PDAs with pre-installed *'sniffing'* software.

Again, exclusivity of T-Mobile service in Starbucks is a very important feature, differs this Case from the previous. This gives evidence of stronger ties between partners and indirectly confirm revenue sharing between them[54].

Both parties benefits from provision of WiFi service, but different way – Starbucks only tangible benefit is a T1 line in every café with hotspot, other benefits are intangible and include repeated visits and increasing customers' satisfaction. From other side, T-Mobile had acquired *'ready-made'* WiFi network and started to offer innovative service through the biggest WiFi network in North America.

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[52] To connect APs and routers via T1 lines to backbone.
[53] Wireless Connection Manager
[54] No revenue sharing agreement between these parties are disclosed.

Case Three

In the third Case, the venue owner – the Copenhagen airport (CPH) chooses to become a WISP itself, providing services in Wireless Internet Zone (WIZ) constructed in departure lounge of the airport. Value chains' roles are distributed in a bit other way than in previous cases.

The airport posses and operate up-to-date wired network, which is also utilized to serve WIZ, connecting APs (Access Points, see Chapter 2 or List of Acronyms), thus ensuring the venue in a full control over network provision chain. The Airport also supplies a backbone connection to the Internet via *'outside'* ISP – in fact, the same Internet connection as other departments and units of the airport use. This ISP have no influence over WIZ and its WiFi services. In fact, the airport WIZ can change ISPs, without any significant problems.

Because the Airport has no expertise in such activities as wireless APs maintenance, wireless authentications, wireless security or roaming provision[55], all these *'un-core'* activities are out-sourced to a partner or *'enabler'*, Aptilo Networks.

Aptilo Networks, WLAN solution provider, maintains APs, deliver authentication, handles billing and roaming procedures. The last activity is performed in cooperation with specialized roaming agents, such as iPass. Technical support desk in WIZ also run by Aptilo. Therefore, Aptilo influence is also goes into customer support. The roles' allocation is illustrated at the Exhibit 5-3.

All key activities in customer's relationships are run by the Airport – advertisement, marketing, payment handling and customer's support. Customers pay for the service with credit cards via standard authorization centers – there is no difference between purchasing WiFi services and shopping in the airport's duty free.

Aptilo's role in the value chain can not be raised to a WISP's level, because even if there is any revenue sharing between the airport and Aptilo, the last one,

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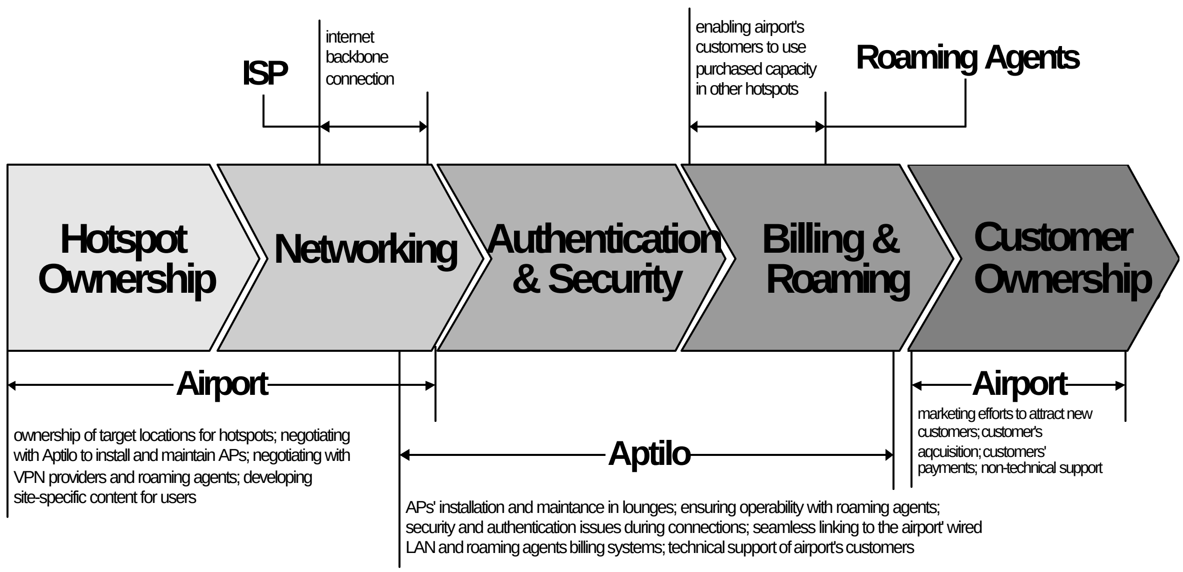
[55] In technical sense. Negotiation with roaming agents are done by the Airport

according to Soe words, receive minor part of the revenue [Søe, September 2002]. Also, all revenues from customers go directly to the Airport, strengthening its position as major player in the value chain.

Exhibit 5-3. Copenhagen Airport Value Chain



Business Models diagrams

As was shown in the Chapter 3 value chains analysis of WLAN deployment' cases is not a sufficient tool to reflect all complexity of value exchange relationships between WISPs and venues. To view the cases from a different perspective and overcome this shortcoming, simplified business models diagrams are used. Each case is described with help of graphical diagram – dotted arrows shows the direction of revenues, solid line shows services flow and broken lines represent customers' visits or satisfaction.

Telia HomeRun Business Model

There are four parties involved in this model: The Telia HomeRun, venues (all together three types – Travel Ports, Travel Hosts, Travel Lodges), Travel Enablers[56] and customers. Exhibit 5-4 gives the simplified image of interaction between involved parties.

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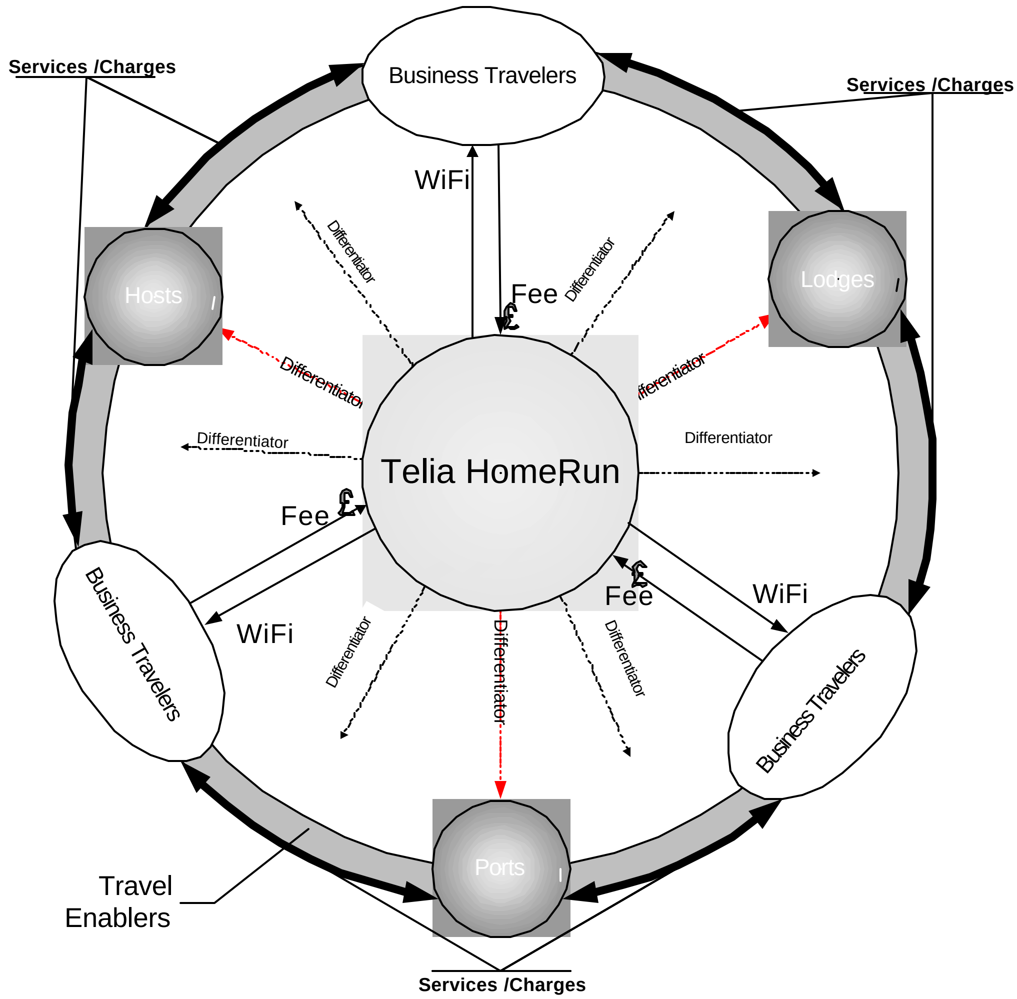
[56] Travel Enablers are Travel Agencies e.g. American Express (see Chapter 4)

According to the HomeRun's marketing strategy, WiFi hotspots are constructed in venues, where HomeRun's customers – business travelers – are more or less likely to visit. This activity has cycle character, thus all venues and business travelers are placed on the ring. This is similar to planets, orbiting their stars – planets-travelers have to visit all places in their orbits (here – venues) to finish a cycle around the star (here HomeRun) shining on them all the time. Continuing *'astronomic'* analogy, travel enablers are like gravity forces, keeping all parts of the solar system together and preventing planets from occidental motions.

HomeRun negotiates agreements with venues to provide WLAN services to customers, visiting all types of these venues on their business trips. HomeRun business proposition for venues is service differentiator (dotted arrows). T he ring express the idea of Travel Enablers, connecting venues and travelers together. Enablers also receive increasing satisfaction from customers, delivering them information about where HomeRun service is available. For example, while planning business trip, a customer may not be aware of such service in certain places and a travel enabler-agent can offer it in the same way, it offers swimming pools or sauna, essentially being travel lodge's additional facility. However, it is unclear whether the Enabler receives any commissions from Telia HomeRun for such offering.

Customers continuously visit Travel Ports, Lodges and Hosts (see Exhibit 5-4), and while staying there, they use WiFi, supplied by HomeRun to venues. For using the service customers pay directly to Telia HomeRun. Venues, in return, receive increasing customer satisfaction along with higher revenues, ability to add new features to loyalty programs and also decrease churn. However, they don't receive any revenue from service itself, as shown on the Exhibit 5-4.

Exhibit 5-4. Telia HomeRun's business model diagram



Starbucks/T-Mobile/HP Business Model

There are four interacting parties in the next model – the WISP (T-Mobile), the Venue (Starbucks), the Vendor (HP) and customers. Even though T-Mobile is a Mobile Operator WISP, as Telia HomeRun, it selects a different strategy. Instead of targeting a particular segment of customers, like Telia HomeRun does, it *'land-grabs'* on specific types of venues, like in this instance – Starbucks[57] café shops.

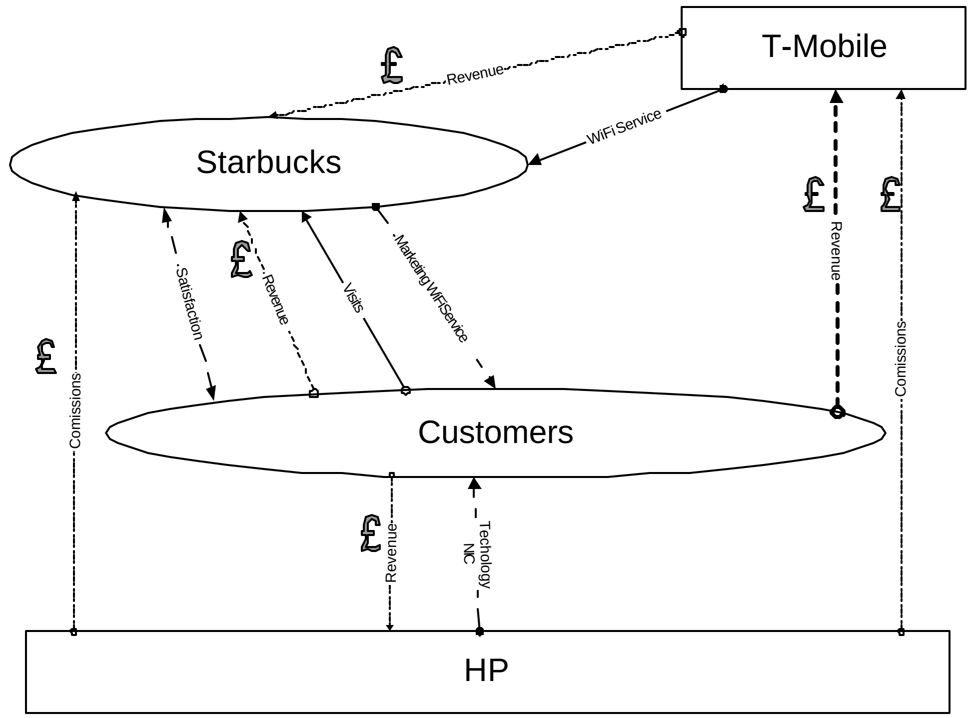
[57] Their other targets also 'branded' locations – Borders, for example

Exhibit 5-5 illustrates relationships inside the business model. T-Mobile owns customers – receiving their payments and handle customer support via tool-free number. Starbucks actively promotes T-Mobile service in its outlets, probably receiving some (undisclosed) commissions from T-Mobile. Customers visit café chain, buying coffee and receive WiFi service, backed up by T-Mobile. In fact, as said before, they must become T-Mobile subscribers to be able to use the service.

WiFi service creates additional attraction for customers and service differentiator for Starbucks. Customer's profile shows that there is strong need for in-store connectivity (see Chapter 4). Thus, an offering of such service increases customers' satisfaction and decrease churn rate. However, it is still to early to conclude that the 'need for in-store connectivity' will translate into a demand, resulting in cash flowing from customers to the WISP.

The third actor – the vendor, HP/Compaq, enables customers with necessary hardware and software. Generally, customer don't need to buy any HP products to use T-Mobile's hotspots, however, using 'recommended' hardware and software brings WiFi to a friendly *'plug and play'* level. If a customer wish to buy a hardware from the vendor, he can do it simply by clicking a link on T-Mobile or Starbucks web-sites and then being re-directed to HP *'e-shop'*. For each customer's purchase done through associate linking, Starbucks or T-Mobile receive commissions from HP.

Exhibit 5-5. Starbucks/T-Mobile/HP Business Model Diagram



Copenhagen airport WIZ business model

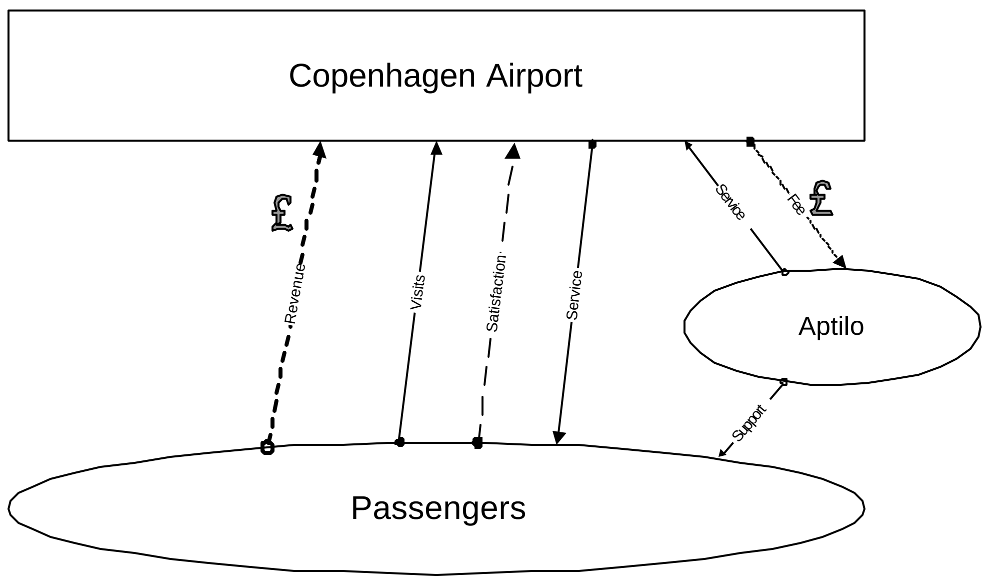
The last case has its own distinctive model, where the venue (Copenhagen Airport) choose to be a WISP itself. As was outlined in the Case Study the major driving force for their WIZ project was a fear that new innovative and probably profitable business may slip off the airport's control, as it happened in the past with payphones and cellular communications, when the venue had a re-active strategy, not responding to a technological challenge.

As was mentioned in the value chain analysis, the Airport controls all key activity, outsourcing un-core business to enabler, Aptilo. on fee-basis. However, it is worth to look closer on their relationship and value exchange between actors.

Passengers visits the airport to fly somewhere. While they are waiting for planes, they can use some of airport's facilities, and among them WIZ. Using their '*gray*' waiting time in departure lounges to increase productivity, business travelers pays for WiFi service to the airport. Thus, double benefit is created – passengers are happy with new service, occupying their time with something productive and the Airport is satisfied, because it receives not only material income but also reports increasing customer satisfaction. It was mentioned in the case study that the Copenhagen airport is the best in the world on quality of service available for passengers. Reasonably to suggest that it wants to keep this title longer, because it brings also intangible benefits – better deals with airlines, suppliers and eventually customers, who may prefer this airport as a stop-over point.

Exhibit 5-6 illustrates that revenues for WIZ service goes straight to the Airport, which has to share some profit with Aptilo for support to WIZ's customers and WLAN maintenance.

Exhibit 5-6. Copenhagen Airport Business Model Diagram.



Comparative Analysis of Business Models

Costs and Prices

Capital expenses

As was mentioned in Chapters 3, and 4, WLAN hotspot deployment doesn't follow the pattern of economy of scale – the cost of adding one extra hotspot doesn't fall significantly with number of hotspots. Thus its is logical compare studied cases on the basis of capital expenses per hotspot.

However, the cost of hotspot's installation in Starbucks outlet can not be equal to covering departure lounge of the airport or a conference center. Thus, a cost of installation should be measured in relationship of total effective square area, where the service is available to customers.

The evidence suggest that estimated square area in a simple hotel where HomeRun service installed is 12000sqm [Pixell, 2001, also see Chapter 4], an average hotspot area in Starbucks is assumed to be 200sqm [see Chapter 4]. This figure is based on the assumption, that customers are likely to sit in and around café, where facilities are presented (i.e. chairs, tables). Finally, it is know the total square area of WIZ in the airport – 2000sqm [see Chapter 4]. From this we receive following picture:

Exhibit 5-7. Comparison Table of Capital Expenses and Avearge Hotspots' Coverage Area

WISP	Cost per sqm	Average area of hotspot
Telia HomeRun	£1 per sqm	12000sqm
T-Mobile	£13 per sqm	200sqm
CPH WIZ	£5 per sqm	2000sqm

The conclusion, resulting from these findings is the bigger area to cover, the cheaper installation, measured by total effective area. The highest cost of installation measured per square meter has T-Mobile with , whereas Homerun has the smallest cost because it covers the biggest area. Therefore, it is more efficient to install WiFi in extended locations such as hotels and airports, rather than café shops.

Operating expenses

Operating expenses are compared on monthly basis. It seems rather difficult to compare all cases on the single basis of full operating cost, where such items as customer support included. However, the comparison below reflects *'best-effort'* approximation:

Exhibit 5-8. Comparison Table of Average OPEX per Hotspots

Telia HomeRun, DSL or E1, 2 Mb/s (customer support included)	£1000 per month
T-Mobile, T1, 2 Mb/s (customer support NOT included)	£600 per month
CPH WIZ, backbone connection (customer support NOT included)	£833 per month

Sources: Chapter 4

The reasonable conclusion from Exhibit 5-8 is that operating cost doesn't depend very much on the venues type – rather it reflects the cost of backbone connection. Operating a hotspot in the airport is not extremely expensive, compared to hotspot in a café shop.

Customer Price

Here the comparison is done on contract and pre-paid subscriptions.

Exhibit 5-9. Table of Prices Comparison

Case	Contract	Pre-paid
Telia HomeRun	£10 per hour	£6.5 per 24 hours
T-Mobile	£32 unlimited	£1.61 per 15min
CPH WIZ, backbone connection	N/A	£5,10 per hour

Exhibits 5-8 and 5-9 give an indication of the possible break-even points for each case.

Telia HomeRun needs at least 100 hours of usage by contract customers per hotspots. In fact, the 1 hour price for contract customer is £10. The OPEX for an average hotspot is £10000 a month. This gives 100 hours a month is necessary to make per a hotspot, covering OPEX and not losing any money.

T-Mobile has flat-rate and prepaid pricing, thus for flat-rate model it must have at least 20 (OPEX £600 divided by flat-rate cost £32) flat-rate customers using a certain hotspot per month or around 90 hours of usage by prepaid customers per hotspot. At this level T-Mobile can reach break-even level. Usage figures, presented in the Case Study Two are far below from this estimated break-even point. In fact, accounting 1.06 users per hotspot per month, a user have two spend more than two business weeks (5 days a week, 8 hours a day) in Starbucks, drinking coffee and surfing the web!

The Copenhagen Airport Wireless Internet Zone should have at least 163 hours of usage (£833 divided by £5.10) to reach the break-even point. As was discovered in Case Study Three, the total majority of the airport's subscriptions are 30 minuets capacity. Thus, in order to be break-even, the WIZ must accommodate at least 320 users a month, or 3840 a year or 10 a day. Taking into account 18 million of travelers each year coming to the Copenhagen Airport, and average waiting time is 45 minutes[58], it is reasonable to conclude that the WIZ has ability to reach a break-even point in near future (if not yet reached).

Exhibit 5-10. Estimated Usage to Cover OPEX

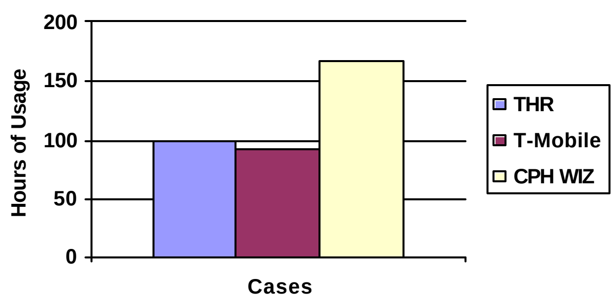


Exhibit 5-10 bring estimated break-even points together. One can see that the WIZ has highest point, due to its lowest hour usage price. However, it needs only 10 business travelers a day using wireless internet out of almost 50000 passengers flying in and out a day to break-even. Therefore, the last business model – the Copenhagen Airport WIZ is most likely to generate any positive cash flow in near term future.

Qualitative indicators

The Exhibit 5-11 shows comparison of the Cases by seven basic indicators, such as quality of service, degree of WLAN integration in core business, bundling with other services, whether actors use WiFi as differentiator, use of existing wired LAN, revenues, targeted segment.

[58] This evaluation was given to author by various contacts from European airports during the London Conference.

Exhibit 5-11. Cases Comparison Table

Issue	THR	Starbucks/TM		CPH WIZ
Increasing Quality of Service in core business	High, segment-oriented	High, segment-oriented		High, segment-oriented
Integration WiFi in core business	Highly integrated	Starbucks doesn't integrate WiFi in core business except using T1 lines, yet T-Mobile is mobile WISP with a possibility of high service integration		Parts of WiFi business are integrated into core structures, some important parts are outsourced to enabler
Bundling with other services	Originally no bundling, introduced bundling with GSM in October 2002	No bundling with any services		Heavily bundled – a user must be a passenger of the Airport and a customer of an airline
Use WiFi as a differentiator	Promote WiFi as differentiator for venues	T-mobile Promote WiFi as differentiator for venues	Starbucks The only driver is differentiation of core business	WiFi is a differentiator for the WISP
Additional revenue from existing infrastructure	Building network from scratch	Building network almost from scratch, original assets were bought from a failure.		Using existing infrastructure of wired LAN
Revenues	Pay-as-you-go, flat rate subscriptions	Pay-as-you-go, flat rate subscriptions		Only pre-paid pay-as-you-go
Targeted segment	Business travellers	Mobile professionals		Business travellers – passengers

Discussions on WiFi Business Models Dynamic

Telia HomeRun

Telia HomeRun is a mobile operator WISP, using all advantages of being a member of incumbent's telecom group Telia AB – *'deep cash pockets'*, a cheap connection to the Internet backbone and an expertise in roaming and billing mobile customers. Hence, HomeRun can afford to provide WiFi service without being cash positive for a longer time than other *'start-up'* competitors.

The key challenge for HomeRun is to break *'vicious circle'* of its subscription model. Mobile professionals and business travelers want an access not only in one location where they go once a year but also in all possible routes, not only in a conference hall of a hotel, but in every room. Thus to satisfy such high requirement, HomeRun must assigned a lot of hotspots. However, chosen model of relationship with venues doesn't encourage venues' owner to join HomeRun, unless they see immediate return or immediate threat from more *'technologically advanced'* competitors.

The possible solution is to increase a cooperation with venues, encouraging them to invest in a WLAN infrastructure, thus decreasing the overall cost of the deployment. This will shorten break-even period and gives Telia HomeRun more marketing flexibility in pricing issues.

However, much more serious issues is increasing awareness of venues of their own value as location for WiFi hotspot. Telia based its pricing on assumption of taking all costs and receiving all revenues. If venues start to demand revenue-sharing, such pricing becomes unsustainable. The most serious *'danger'* comes from such lucrative locations as airports. As was told above, airports are among few but most profitable locations. If all such locations follow the Copenhagen Airport example, Telia could not keep prices on that level, even being de-facto monopolist in Scandinavia and have to decrease its margins.

One of the reasons that airports are not rushing to be WISPs is a fact, that many of them are state's enterprises and they have small motivation to move into complementary activities such as WLANs, thus empowering others to deliver WiFi on their premises. The Copenhagen Airport is privately owned enterprise and its motivation is different from state's ones. This perspective of such challenge from venues is 2-4 years from now, because at that time already concluded agreements between the WISP and venues start to expire.

The only strong Telia's asset in such situation is universal method of access to the service. It makes the service very user-friendly. Venues-WISP are too fragmented to offer the same authentication and subscription method everywhere. In order to strengthen this asset, Telia has to develop unique offer of integration WiFi into WAN GPRS and 3G. Thus creating truly ubiquitous coverage over the region.

Starbucks/T-Mobile

T-Mobile's revenues are based on a flat-rate subscription model. In this model customers pay fees whether or not they actually use the service, only after they exceed certain limit (500 MB) they start to pay per use. This encourages the WISP to increase customers base as rapidly as possible[59].

However, things have changed since the MobileStar's demise. T-Mobile's mother company – Deutsche Telekom (DT) is under big financial pressure [Total Telecom, 14/11/2002], posting the national record of financial losses. The US' subsidiary of T-Mobile itself has big losses [Iwatani, 15/11/2002]. Thus, it is very likely that DT Group will focus on its core business and short-term profitability. There are even talks about possible merger of T-Mobile with one of the US cellular providers [Iwatani, 15/11/2002].

Under this conditions, short-term profitability of the WiFi service may be seriously questioned. Concluding from given by Starbucks usage figures [see Chapter 4], it is obvious, that WiFi in Starbucks is far from profitability and even break-even. In other words, in the state of tight financial pressure, T-Mobile might not have its major advantage – *'deep cash pockets'* and can not afford to run unprofitable business for a longer time than it takes to reach critical mass of coverage and subscribers. Even though having good perspective in the long-term future.

The one possible outcome in such case is to deepen a degree of cooperation between the WISP (T-Mobile) and venues[60]. Cooperation doesn't only mean sharing of revenues, it is also about risks and costs sharing. It would be very difficult to convince Starbucks to share costs and risks, as they used to receive

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[59] This is the reason behind MobileStar plan to roll-out nation-wide network fast – to gather as many subscribers as possible

[60] T-Mobile offers service in other locations such as Borders, Airports(see Chapter 4)

the service and all additional benefits for free[61]. Starbucks is satisfied as soon as the WISP pays for everything and keep their customers happy.

In such situation, an intermediate solution would be to have no revenue-sharing until the WISP will return all installation investments and then the WISP and the venues share operational costs and revenues.

The other outcome for T-Mobile is to sell its WiFi business altogether. It will make ill-fated MobileStar assets even more cheaper. There is no evidence of such moves yet – it is not enough information to make a certain conclusions on this. At present, T-Mobile management believes that WiFi investments are *'money well spent'* [McClune, 25/11/2002]. But their 'mother' company, DT may have another opinion, keeping in mind that DT market capitalization now is just around 30% more than DT paid for its US mobile subsidiary [Riseborough, 21/08/2002]. It should be noted in this scenario, that T-Mobile will face a seemingly high barrier of exit – it is very unlikely that any serious ISP will step into the same *'trap'* T-Mobile stepped before, thus there are very few buyers on this potential asset.

If T-Mobile faces serious financial problems and low profit due to low usage and slow up-take of WiFi service, Starbucks face also a serious problems in delivering wireless broadband to customers.

The first problem is interference with adjacent WiFi APs from other networks, especially so-called *'freenets'*[62]. Entry barriers are very low and anyone with DSL/Cable line and router can start broadcasting broadband over 100m area.

There are only three frequency channels in 802.11b wireless protocol, meaning that in one location only three different WiFi networks can co-exist. If a new network appears, it will significantly deteriorate service in this location, meaning people can not access service anymore [Charny, 16/09/2002]. There are already quite a few accounts of such interference with Starbucks networks and until now, T-Mobile basically side-steps simply ignoring issue [Denison, 09/09/2002, Fried and Charny, 21/08/2002]. Actually the only solution is that the WISP, Starbucks

[61] like T1 lines in outlets

[62] Grass-root movement, where broadband access via WiFi WLANs available to anybody free of charge. Specially popular in some metropolitan areas of the US

and other network owners/operators reach any kind of agreement on what channels their networks use.

However, more severe problem will come with a growth of customer base and wider adoption of WiFi. This problems roots in the nature of WiFi. It was 'born' in the computer industry and the business model adopted there is a very simple one – vendors sell boxes and users use their features and capacity without paying anything [Chapter 1 and 2].

As soon as people widely adopt home WiFi networking, they may expect this service for free in other places too.

Starbucks needs WiFi as a service differentiator, creating customer's satisfaction, but T-Mobile wants revenues, hence somebody must pay for service. In this case it is a customer who pays. This create an excellent opportunity for competitors to differentiate themselves on the price basis of WiFi service.

Competitors can offer and do already offer a similar service for less fee as 'Surf and Sip' for example [802.11 Planet, 12/06/2002]. This WISP position own WiFi service as *'customer acquisition tool'* compared to *'customer's satisfaction tool'* as Starbucks does. For such WISPs, increasing Starbucks customers' base only improve their chances to lure Starbucks customers to migrate into their network. Major advantage of Starbucks/T-Mobile is a good support of Quality of Service. For example, T-Mobile uses T1 line to connect to the backbone thus delivering high-speed reliable connection. 'Surf and Sip' uses cheap DSL lines, betting on customers who are ready to sacrifice QoS to saving money. Indeed, Starbucks poses outlets as *'third place between office and home'* and WiFi as a substitute for *'social connectivity'*. If people really value this, they can easily migrate to competitors seeking for a better deal. QoS is more important than a price only for particular category of customers – business/mobile professionals. And Starbucks/T-Mobile will likely to keep them. However, there is a danger of losing other customers not so sensitive to QoS and more sensitive to price. And for Starbucks there is no big difference between mobile professionals and students – coffee and cakes have the same price for everybody.

Other competitors can offer it even for free, as do Schlotzky Deli [Griffith, 08/11/2002]. This restaurant chain introduced WiFi service in a number of location and have a very positive feedback from customers. The only value, the restaurant receive from WiFi is pop-up screen on user's laptops with restaurant's advertisement. Interestingly, when one of the chain's hotspots overlapped with the Starbucks hotspot, Scholtzky's representative says that

> *'if the litigious Seattle-based beverage maker wanted to sue, that would be more good, subversive advertising' [Griffith, 08/11/2002].*

The situation was aggravated by the fact that Starbucks doesn't control any pricing issues and hence has no flexibility to react on such challenges. The company has to either take some risk along with the WISP or exit WiFi business, because the intangible benefit Starbucks receive from WiFi is far less than losses associated with customer churn.

Another latent problem is that actual capacity needed to check e-mail is not so high as WiFi can offer. Even more, if WiFi complements 'social connectivity', does Starbucks' customers want 11 Mb/s? The answer may lie in the future development of location-based content and infotainment services as streaming audio and video applications for customers who logged in Starbucks outlet. They can watch video and listen to music provided by Starbucks for marginal cost.

CPH WIZ

The market research by Alexander Resources reveals that even though in 2007 80% of all public WLANs will be deployed in cafes, bars and restaurants , the majority of WLAN service revenues will come from business users in airports, business hotels and exhibition centers [see Chapter 4]. Thus airports are extremely important venues for wireless LAN business. Even more important is the fact that airports are aware of this. An example of it is Copenhagen Airport.

Nonetheless, passengers are in an airport only for one purpose – to fly somewhere as soon as they can. Very few would agree to stay longer just to use WiFi and miss a flight. Therefore, there is a fundamental contradiction in the subscription-base model for an airport. The longer a passenger stays on-line, the more revenue the Airport has from WiFi WIZ but at the same time its core business demands passengers to leave airport as soon as possible. Hence, there is a fundamental limit to the growth of users in the WIZ. Indirectly, it is confirmed by Henrik Soe, who states that total majority of subscriptions sold in the Airport have 30 minutes capacity[63], the smallest the WIZ has.

However, being still a very lucrative hotspot (*'a sweet-spot'*), the Airport needs to develop a bigger footprint to other important locations and venues, where its passengers may go or come from. Taken the nascent level of the industry, the Airport will likely to seek bilateral roaming agreements with other WISPs and other venues-WISPs. In this manner the Airport will extend its footprint and make own location more attractive for users. For example, if a customer is a subscriber of another WISP, it may use WIZ service while waiting for an interconnecting flight in the Copenhagen Airport lounge. Or, customer may use subscription he purchased in the Airport in the hotel he arrives to spend a night.

The fact that CPH is a privately owned enterprise, possessing shares in other airports may help to extend its footprint by introducing WLAN's service to its subsidiaries.

It is worth to note that the most important roaming partners for the Airport are airlines with their natural venues – airplanes. During long intercontinental flights business passengers have nothing to do except traditional entertainments (small TV, music and reading) and the wireless Internet can be in a high demand (granted reasonable price). This passage is from Financial Times special issues on the Wireless Internet confirms that:

> *Mr Nembe is looking forward to having a wireless Internet connection on aircraft, especially on his 11-hour flights from Europe to San Francisco. 'It will make a huge difference,' he says. 'I can be productive on the flight, plane, make calls from my computer, stay in touch with my office and conduct conference calls. It will be tremendous.'* [Newing, 20/11/2002].

A trial WiFi service is already on its way with one British Airways aircraft and another from Lufthansa [Charny, 23/01/2002, Total Telecom 01/10/2002]. After landing in an arrival airport, passengers (now customers) go to hotels and then

[63] This answer was given during the telephone interview

use the same subscription again. Hence, such agreements can make customers to buy bigger capacity subscriptions and also bring roaming revenues to the Airport WIZ.

Mapping WISPs

The last point of discussion is mapping out business models into the diagram, introduced in Chapter 3. The diagram[64] at the Exhibit 5-12 has two independent axis – X-axis reflect a WISP's footprint like coverage, ranging from zero to global scale. Y-axis imitate the degree of cooperation between a venue and a WISP. This includes such factors as revenue and risks/costs sharing, venues' participation in marketing activities. Y-axis ranges from low level of cooperation (means venue doesn't care about WLAN at all – like it may not care about a near cellular bases station, just accepting the fact that WLAN is in place) to the highest level, where a venue turns to become a WISP, offering WiFi services to its core-business customers.

Therefore, a mobile operator WISP is building network from scratch and doesn't support high degree of cooperation with venues. The arrow show natural direction of mobile operator WISP evolution – increasing coverage, just like cellular carriers do.

Location specific WISP have bigger coverage and higher cooperation with venues (it may be venue itself!). Thus, it is justified to put it in the middle of Y and by the high end of X. However, the actual place of different location-specific WISPs along X-axis can differ a lot. Generally, such WISP also strive for better coverage and thus goes right along X.

Single hotspot WISP is either venue itself or WISP with high degree of cooperation with venue.

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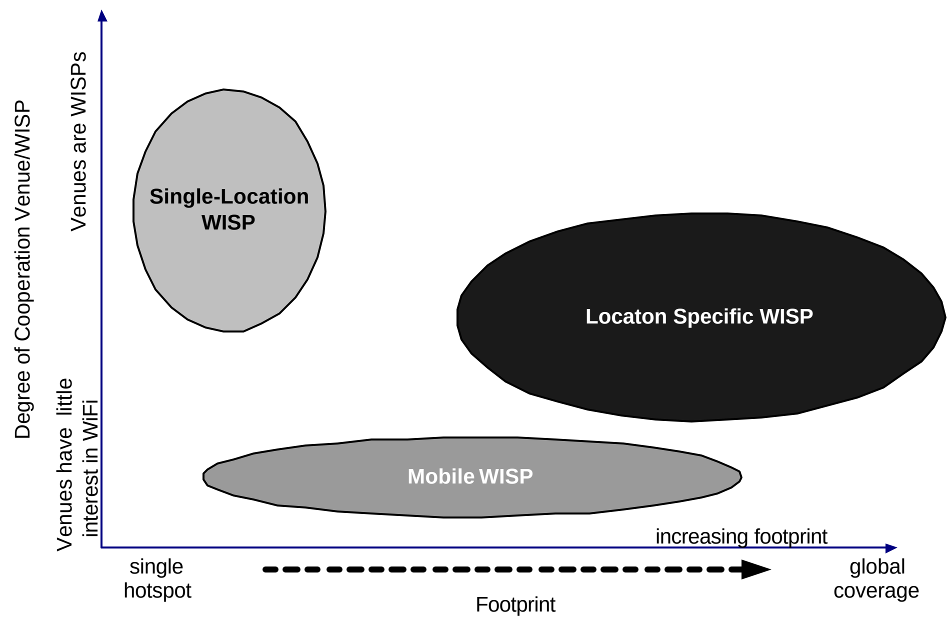
[64] Diagram doesn't reflect any scale, e.g. relative distance between placed objects has no meaning.

Exhibit 5-12. Mapping general categories of observed cases



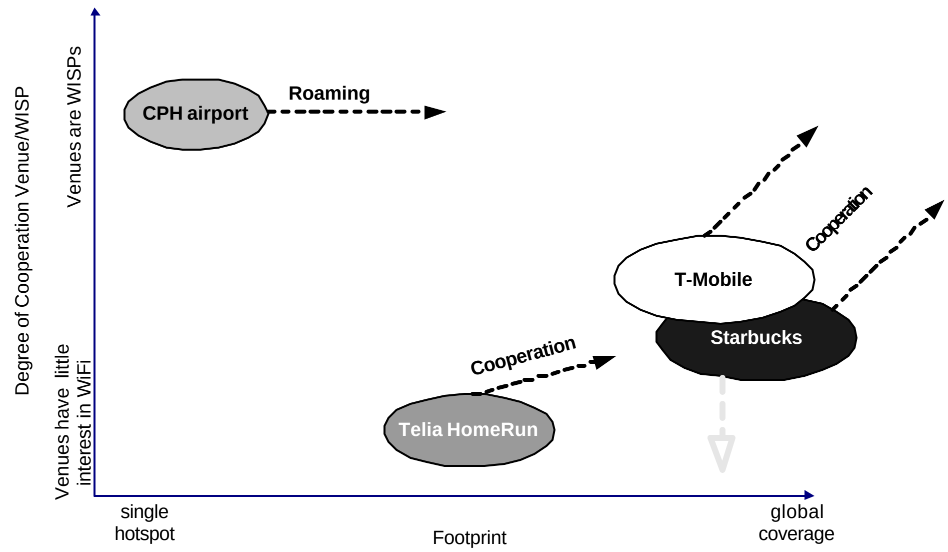
Note: Not to scale

Mapping Cases Studies

All cases are put at the mapping diagram at the Exhibit 5-13. Telia HomeRun doesn't support high level of cooperation with venues and its coverage is expanding from almost scratch (3 venues in 1999) to multiple locations across region and continent. Hence, it is reasonable to put it in the middle on X-axis and low at Y-axis.

Future development is depicted by dotted arrow – it shows that HomeRun has to increase its footprint and deepen cooperation with venues by introducing partnership schemes, sharing costs, risks and revenues in exchange for exclusive rights in these locations. Such move saves Telia from facing severe interference court battles when WiFi hotspots become more widespread.

Exhibit 5-13. Mapping Case Studies



Note: Not to scale

The Copenhagen Airport is a single location WISP, and it is justified to put it at the top of Y-axis and at the zero-level of X-axis. Future evolution is shown by dotted arrow – it is increasing footprint, by creating bilateral roaming agreements with other WISPs (airlines are the most important ones) and possibly with roaming agents.

T-Mobile is put at the further end of X-axis, reflecting its status as one of the world's largest WISP by the number of hotspots. It is put in the middle of Y-axis to show that T-Mobile have some higher degree of cooperation with the venue – Starbucks – but still not at the highest possible level (to reach it, T-Mobile must integrate with venue which is not possible).

At the moment, T-mobile's major challenge is to reach critical mass of users. In order to fulfill it T-Mobile should extend to all lucrative locations as Starbucks – bookshops, airports, carefully choosing venues for hotspot installation. T-Mobile has to be first-comer in each segment of locations and thus has no competitors.

However, Starbucks' interests, as was shown in the above discussion, might be contradictory to T-Mobile. Starbucks ultimate goal is to increase customers' satisfaction and this may not be in correspondence with T-Mobile ultimate desire to receive profit from service. Starbucks needs WiFi as long as it helps its core business, thus dashed arrow shows the direction along with T-Mobile – they continue cooperation in deploying and marketing WiFi hotspots. While T-Mobile will delegate more rights to the partner allowing to use WiFi as a marketing tool in Starbucks' core business of selling coffee and cakes.

In other scenario, however, Starbucks might become less interested in further WiFi deployment and eventually leave the idea of installing hotspots as the direction of thick-bright arrows. This is likely if competitors will have strong take-off based on differentiating service via WiFi.

Conclusion

By applying analytical tools, introduced in Chapter 3, three Case Studies were analyzed. Value Chains of WLAN is similar to cellular industry when deployment is done by cellular carrier, like in Telia and T-Mobile cases. Mobile operator WISP tends to control all activities to ensure sufficient QoS and meet customers' demand. However, the emerging trend is shifting focus more towards facilities' owners – venues. In case of the Copenhagen Airport, the single-location WISP controls all key activities, outsourcing complementary ones to the enabler.

Business models' diagrams illustrates the flow of services and revenues between WISPs, venues, vendors/enablers and customers. The graphical representations helps to display these relationship in more comprehensive and at the same time simple way.

Following discussion has revealed some trends and issues, the WLAN industry is facing in the short and long-term future:

Mobile WISPs have to seek to broaden the cooperation with venues, thus increasing marketing potential and decreasing their own costs.

Mobile WISPs follow the strategy of a 'land grab' – it is essential to seize an opportunity to use unlicensed spectrum WiFi in as many venues as possible.

Addressing profitability is essential for mobile WISPs, because they may loose their original strong financial position.

WISP and venues should address interference problems together, not delaying it to the moment, when QoS deteriorates.

Venues and WISPs can have a contradiction of interests if venue can not use the pricing mechanisms to differentiate it service as competitors.

In seemingly successful venues, such as the Copenhagen Airport, there is a contradiction between core business demand, requiring passengers to leave as early as possible and WISP marketing requesting customers to stay on-line as long as possible.

Right choice of roaming partners can boost profitability of single locations WISPs.

Mapping diagram helps to reflect all trends in clear and comprehensive way. It also helps to specify new WISPs and define their future evolution.

Chapter 6. Conclusion

Run, Rabbit, Run [Updike, 1960].

Wireless services are increasingly ubiquitous and essential components in the global communications infrastructure. The mobility, flexibility, and reconfigurability of wireless offer compelling complements, or at times, substitutes for wired infrastructure. They enable many new services and expand the usability of old services, extending the ability to stay connected anywhere and anytime we desire.

Being disruptive innovation, WiFi market is still at its early evolution stage. Even though the market is still small, important parameters such as Internet usage, indoor WLAN and laptop sales are increasing fast.

The question still remains open whether WiFi is *'The Next Big Thing'*. This thesis was not indented to answer this question – the major objective is to explore the ways companies are making money out of WiFi technology and discuss some possible developments.

Review of the Thesis' objectives

At this point it is necessary to review the thesis' objectives, formulated at the beginning in the Chapter 1. This is essential in order to asses whether the research has meet the goal. The list below indicates at which part of the thesis questions listed in Chapter 1 were answered:

- ✓ What is a Wireless LAN and what is a rationale behind its use for public services and revenue generation? This question was answered in Chapter 2.
- ✓ What type of theoretical framework is applicable to this specific research purpose. In particular, how value chain analysis can be applied to public WLANs? What is *'a business model'* and how it can help to describe WLANs' business? This question was answered in Chapter 3.
- ✓ How WLANs' business models can be classified and mapped? This question was answered in Chapter 3.

- ✓ What are main elements of Business Models in observed Case Studies? Chapter 4 is dedicated to Case Studies and description of the WISPs' *'architecture'*.
- ✓ What are implications for the future developments in public WLANs? Chapter 5 analyzes findings and Cases and propose the way to evaluate the future evolution of business models in wires LANs.

Summary of Findings

WiFi WLANs as was outlined in Chapter 2, is a disruptive technology innovation, breaking the planned way of introducing the mobile Internet via 3G cellular technology. WiFi creates whole new market for new breed of players – venues and gives them an opportunity to deliver broadband for low price to everybody on their premises.

Chapter 4 offers detailed cases studies which were basis for further discussions.

Chapter 5 contains analysis and discussion of business models' evolution in WLAN industry. By applying the value chain analysis, the undertaken research has explored the *'constructing'* of value over WLAN industry – what part of a value each player creates and adds to WiFi business proposition. Business models were re-constructed in the thesis thus allowing to illustrate the flow of values between players – where money and services comes from.

The general finding is the venues' increasing ability actively participate in WLAN value chain. Their responsibility ranges from active marketing to full control of value chain, outsourcing some un-core activity. Thus, a WiFi WLAN is an essential part of a venue and should be treated like part of its services, amenities or facilities. In other words, WiFi is close to be *'a public utility service'*, like electricity or water instantly available everybody inside the building. Thus WLAN business case becomes commodity, driving WISPs out of it, simultaneously increasing power of venues, property owners who control all utility, including WiFi hotspots.

In fact, in a way, WiFi WLAN can be a re-incarnation of a payphone – venues can adopt WiFi to provide the immediate *'on-spot'* connectivity – the same function, payphones did long time ago. There are two critical differences between payphones and WLANs – WLANs require technical capability whereas payphones need only some coins. Another point is WLANs can be private and public, and payphones are only public.

Nevertheless, the common thing – location-specific connectivity makes WLANs payphones successors. As the example of the Copenhagen Airport showed, venues who valued payphones long time ago, also appreciate WiFi. In fact, WiFi can be even installed into payphones as tells anecdotic evidence from Estonia, where nationa l ISP lights payphones with the combination of DSL, router and WiFi. Thus, broadband can be delivered to anybody around 100 m of payphone booth.

As for venue/WISP relationships – the main conclusion is that venue owners, should cooperate more actively in the financing of public WLAN deployment to improve overall efficiency and long-term profitability. This is also in the interest of WISPs, because it decreases roll-out costs and increase their profitability. Venues and WISP have both to change their way of thinking of WiFi as another *'mobile'* service and start to consider it as their wireless data utility, very specific to the location.

In this aspect, the coverage strategy, adopted by Telia and T-Mobile should be acknowledged as correct – both WISP seek to install as much hotspots as possible. In the very beginning of public WLAN history a few years ago, WISPs were competing fiercely in a land grab of the most attractive venues. WiFi works in unlicensed spectrum and thus being first is essential in deploying public WLANs, especially in attractive venues like an airports. However, this is ought to be changed in favor roaming agreements and wide participation of venues in public WLAN deployment.

As compensation for the increased business risk, ways of sharing the revenue stream generated should be evaluated. Even though the venues might feel comfortable in the short term with the avoidance of investment and business risks, such an option is inherently unstable in the long term as substantial revenue may be foregone. More two-sided business models are bound to prove more efficient and profitable for both actors involved.

Current business models, involving cooperation of venues and WISPs like cases One and Two (Telia and T-Mobile) lack flexibility in terms of venue control over service – with wider adoption of WiFi, venues can not use it as a marketing leverage. In other words, in the world of many micro-WISPs, it would be very difficult to differentiate service unless WISP delegates some control to venues. Failing to do it may lead to customer losses rather than increasing satisfaction.

Increasing financial pressure on telecoms also question profitability of WISPs' business. Every WISP agrees that customers demand it, but the business case for big WISPs seems faulty unless they change their relationships with venues, sharing risks and responsibilities, thus decreasing costs and boosting profits.

The mapping diagram, introduced in Chapter 3 and applied to Case Studies in Chapter 5 should be very useful in further research as making WLAN cases analysis more illustrative in terms of possible developments.

To sum up, Telia HomeRun model have a good potential in the Scandinavia, where it dominates the hotspots landscape. Recent price cuts helps to speed the take-off, but hardly critical mass of users will be reach without more deep cooperation with venues. Starbucks and T-Mobile are at risk to repeat MobileStar's path unless coffee maker get involved in WiFi more deeply, including costs and risks sharing. In return, T-Mobile has to give Starbucks a flexibility on WiFi pricing issues, allowing Starbucks actively differentiate itself. The Copenhagen Airport has to develop roaming agreements with other venues accommodating business travelers, including the most important venues – airplanes. The requirement of the airport's core business, make the Wireless Internet Zone a good *'selling point'* for the wireless Internet, but not actually a good place to surf the Internet.

Questions for the Further Research

There are several issues left beyond of this research which have to be explored in the future research.

The interesting question is a striking difference between take-up of 3G and WLAN service in Europe and Asia. For example, South Korea's Korea Telecom (KT) has 5,000 public WiFi WLAN access points, which is already 1000 more over than BT's three -year best-case goal. By the end of 2002 year, KT plans to install 25000 hotspots – more than sixty times more than BT's best goal for this year only – 400. As Townsend reports, there are 15000 for-fee hotspots in South Korea altogether [Urban Technologies and Telecommunications, 25/11/2002]. Even though, BT claims to have 30% of the UK market - so the total size is less than 1500 hotspots [Datamonitor, 22/11/2002]. In general, the question to answer is what geographical implications of WLAN deployment? What are differences in WLAN cases in Europe, North America and Asia? The answer may help to understand why Europe and North America lag behind in wireless and wired broadband to South Korea.

Another serious issue for scrutiny is an impact of grass-root *'freenets'* on commercial public WLAN business models. The number of hotspots, supported by altruistic networks in the US is growing almost the same speed as commercial hotspots. There are 167 free hotspots in New York City Area, which is comparable with number of for-profit ones [Denison, 09/09/2002].

Stemming from the previous issue is the impact of freenets on broadband deployments in developed countries – as Jason Smollok argues [Gardiner, 01/11/2002] *'WiFi steals business from DSL providers'* when users share their access with anybody in the 100m proximity. Will WiFi actually impede broadband roll-out?

Another question, waiting to be answered is a search for 'Holy Grail' of broadband – 'killer application'. Odlyzko argues that 'spending on connectivity is much more important for communication services than spending on content can ever be' [Odlyzko, 2001b:13]. Indeed, it is critically important for the future WLAN deployment to understand for what users should pay – for content or connectivity? It is obvious that 11 Mb/s provided by WiFi is enough for everybody, but enough for what? It is too much for e-mail downloading but it is not enough for streaming down World Cup Final Match video by many users sitting in one pub[65].

[65] Leaving along the question of laptop users going to pub!

Beyond the scope of the research are franchise WISPs' business models of like Boingo or Toshiba [Beaumont, October 2002]. It would be very interesting to see their take-off and further developments.

The impact of WiFi on broadband access in developing countries – how WiFi can help to bridge digital divide? The significance was underlined by Kofi Annan recently, but what are implications for business models? How public WLANs can be utilized to deliver broadband to places where it never goes by conventional 'last mile technology'? Some WiFi enthusiasts in BAWUG reports to cover 106km with WiFi transmission – is this a solution for areas, unprofitable for broadband access providers [BAWUG, 22/11/2002]? This has more meaning in the light of recent achievements of such research companies like Vivato, claiming to improve WiFi transmission range up to 4 miles [Fusco, 05/11/2002]. There are some interesting examples of unusual WiFi applications in countries such as Bulgaria [BBC, 04/10/2001] and Estonia [www.WiFi.ee]. But further research is much needed.

Some Visions of the WiFi Future

> *Everything assumed about telecommunications is about to change. N. Negroponte*

The future landscape of wireless networks might look like '*a pond with one water lily, then two, then four, then many overlapping, with their stems reaching into the Internet*' [Negroponte, 2002:1]. Data are frogs, leaping from one lily to another until they reach their final destination.

The whole idea of telecommunications infrastructure is changing in the world of WiFi lilies – infrastructure is built by people for people [Negroponte, October 2002:2]. In fact, WiFi can be set-up on '*do-it-yourself*' basis and open available for every passer-by for fee or for free.

The future will shoe how far MobileStar constructed WiFi network can be considered ill-fated. However the history of the US railways teaches that the fortunate people were not these who built them (those people got bankrupt very soon after finishing the construction), but those who bought their assets after them, like Carnegie and others[66].

In this aspect, the unlicensed spectrum available for WiFi has a very profound impact – with further development of equipment, more and more intelligence can be packed into smaller and lower-power devices, using ISM band of wireless spectrum far more efficiently.

Regulation is a source of great concern for the development of WiFi. It is similar to the Internet – start to regulate it too much and all *'charm'* will be gone. The real strength of WiFi is the unlicensed band of spectrum, compared to other wireless data networks such as 3G.

WLAN hotspots' market in lucrative venues such as airport and hotels will be divided among a few players – mobile operators WISPs, venues and roaming partners. However, small venues' market will be highly fragmented between venues, and WISPs of all different sizes. Therefore, it create many opportunities for roaming partners and vendors-integrators.

In the longer run, the wireless Internet will permit all public space and be available through a wide range of devices with different speeds, depending of applications.

The Future is bright, the future is WiFi. So, Rabbit, welcome back!

[66] Source at http://housatonic.net/faculty/ABALL/Industrial.htm

List of References

'4BA2: Network Project: Wireless LAN. 'What does the future hold?'' available at http://ntrg.cs.tcd.ie/undergrad/4ba2.02/wireless/futur.html last accessed 11/10/2002

802.11 Planet (12/06/2002) 'Can Public Hotspots Make Money?' available at www.80211-planet.com/news/article.php/1365071, last accessed 28/10/2002

802.11 Planet (10/10/2002) 'T-Mobile and Borders Bookmark 802.11' available at http://www.80211-planet.com/news/article.php/1480071, last accessed 10/10/2002

802.11 Planet (21/11/2002) 'Comdex Puts Wi-Fi Weaknesses on Display' available at www.80211-planet.com/columns/article.php/1546141, last accessed 21/11/2002

Afuah A. Tucci. ?., (2002) 'Internet business models and strategies : text and cases' (2nd edition), Boston: Irwin/McGraw-Hill

Alexander Resources (2002) 'Broadband Wireless LAN: Public Space and the Last Mile' Summary available at http://www.alexanderresources.com/reports/Report9/Summary.htm, last accessed 28/10/2002

Allied Business Intelligence (2001), 'Wireless LAN Public hotspots' , available at http://www.alliedworld.com/servlets/ResearchDetails?productid=WLPS01, last accessed 01/11/2002

Alvén D., Arjunanpillai R., Farhang R., Kansal S., Khan N., Leufvén U., (2001) 'Hotspots – Connect the dots for a Wireless Future Final Report for Ericsson Business Innovation and Telia Research' available at www.e.kth.se/~e96rfh, last accessed 12/11/2002

Andersen, Nortel (2001), 'Mobility in today's economy', 15/05/2001

Annan, Kofi (2002) 'U.N. leader lays down a challenge' in ZDNet 05 November 2002, available at http://zdnet.com.com/2100-1107-964556.html, last accessed 20/11/2002

Ballon P., Helmus S., van de Pas R. (2001) 'Business models for next-generation wireless services' in TNO Strategy, Technology, Policy,, 08 November 2001, available at www.stb.tno.nl/uploads/STB-01-49.pdf , last accessed 27/11/2002

Barrick D., (30/04/2002) 'Charting the payphone's demise, one quarter at a time' in CNS, available at http://www.jrn.columbia.edu/studentwork/cns/2002-04-30/511.asp, last accessed 13/11/2002

BAWUG, 'General Wireless List', archive available at http://www.bawug.org/

BBC (04/10/2001) 'Wireless Net Strides Mountains' available at http://news.bbc.co.uk/1/hi/sci/tech/, last accessed 23/11/2002/1575638.stm , last accessed 27/11/2002

BBC, (06/08/2002), 'History lessons for wireless networks' available at http://news.bbc.co.uk/1/hi/technology/2175804.stm, last accessed 19/11/2002

Beaumont D., (October, 2002) 'Toshiba eyes 10,000 hotspots by 2004', in Hotspots Markets, available at www.baskerville.telecoms.com/srwireless

Beaumont D., Roberts m., (October 2002) 'Starbucks, T-Mobile up sites despite low usage' in Hotspots Markets, available at www.baskerville.telecoms.com/srwireless

Beckett A., (11/11/2002) 'Remember the phone box?' in The Guardian, 11 October 2002, available at http://www.guardian.co.uk/Print/0,3858,4543749,00.html, last accessed 14/11/2002

Bjoernsten C., (September 2002) 'Presentation on London Conference: Spotting the Wireless Hotspot Opportunities' by. Intel Corp., Presentation in London Conference, September 2002

Blueprint (15/08/2002) 'BT's public WLAN trial kicks off' available at www.arcchart.com/wifi

Bowman L., CNET.com, 08/11/2002 'Want some Wi-Fi with that sandwich?' by available at http://news.com.com/2102-1033-965070.html, last accessed 13/11/02

Brewin R. (19/02/2001) 'Airports ground use of wireless' in Computer World, available at http://www.computerworld.com/printthis/2001/0,4814,57817,00.html, last accessed 13/11/02

Bright J., (01/10/2002) 'Where's WiFi going?', available at www.totaltele.com last accessed 01/10/2002

Brodsky I.,.(1995), 'Wireless: The Revolution in Personal Telecommunications', Artech House

Brodsky I., (1999) '3G Business Models' in Wireless Review, June 6th, 1999, Volume 16, Issue 12.

Business Wire (21/08/2002) 'Starbucks, HP and T-Mobile Rollout High-Speed Broadband Wireless Internet Access', available at www.businesswire.com/webbox/bw.082102/222330019, last accessed 25/10/2002

BWCS, (2001) 'The Spread of Wireless LAN Hotspots and the Threat to Mobile Revenues', Presentation by Graham Wilde, available at www.bwcs.com, last accessed 27/11/2002

Carrol L., (1865) 'Alice's Adventures in Wonderland', reprinted by Puffin Classics in 1994

Caslon Analytics Intelectual Property Rights web-site, available at http://www.caslon.com.au/ipguide8.htm, last accessed 08/11/2002

Chang R. (06/11/2002) 'To be wireless or not, that is the question' in Total Telecom, available at www.totaltele.com, last accessed 06/11/2002

Charny B., (23/01/2002), 'Airline industry grounds high-speed Net' in CNET.com, available at http://news.com.com/2100-1033-821562.html, last accessed 15/11/02

Charny B., (16/09/2002) 'WiFi "hot spot" in the fast lane?' in ZDnet.com, available at http://zdnet.com.com/2100-1105-958023, last accessed 15/11/2002

Chesbrough H., Rosenbloom R., (2000) 'The Role of the Business Model in Capturing Value from Innovation: Evidence from Xerox Corporation's Technology Spinoff Companies' Harvard Business School, available at www.hbs.edu/dor/papers2/0001/01-002.pdf, last accessed 29/11/2002

Christensen C., (2000) 'Meeting the Challenge of Disruptive Change' Harvard Business Review (March-April 2000)

Coffman K. G., Odlyzko A. M., (2001) 'The growth of the Internet'. available at http://www.dtc.umn.edu/~odlyzko/doc/networks.html, last accessed 25/11/2002

Datamonitor, (22/11/2002) 'Public WLANs: the still-wired, wired West' available at http://www.commentwire.com/commwire_story.asp?commentwire_ID=375, last time accessed 22/11/2002

Denison A., (09/09/2002) 'Hot spots Free and for-profit Net zones pop up everywhere' in Boston Globe available at http://www.boston.com/dailyglobe2/252/business/Hot_spots+.shtml, last accessed 15/11/2002

Donegan M., (20/05/2002) 'WLAN business models are up in the air' in www.totaltele.com, last accessed 20/05/2002

Drury J., (15/08/2002) 'EU champions commercial WLAN services in Europe' in Blueprint August 15, 2002 available at www.arcchart.com , last accessed 24/11/2002

Drury J., (22/08/2002) 'Piper Jaffray sees inflexion point in WLAN adoption' in Blueprint WiFi 22/08/2002, available at www.arcchart.com, last accessed 24/11/2002

Financial Times Investing Data and Tools, last accessed 28/10/02

Fleishman G., (22/02/2001) 'The Web, Without Wires, Wherever' in The New York Times

Fleishman G., (01/11/2002) 'Airports Press Ahead on Wireless Access' in The New York Times available at www.nytimes.com, last accessed 24/09/2002

Folkner D., (1995), 'International Strategic Alliances: Co-operating to Compete' Maidenhead: Mc Graw-Hill

Foremski T., (13/09/2002) 'Intel Considers WiFi Way' in Financial Times, September 13 2002, available at www.ft.com last accessed 13/09/2002

Foremsky T., (21/10/2002) ‘Intel Unveils New WiFi VC Fund’ in Financial Times, 21/10/2002, available at www.ft.com , last accessed 21/10/2002

Fortune (1998), Quoted from ‘Business models on the Web’ available at http://www.kellypeters.com/talks/tida/business.html, last accessed 02/11/2002

Fox M., Gruninger M., (1998) ‘Enterprise Modeling’, AI Magazine, vol. 19, no. 3, pp. 109–121

Fried I., Charny B., (21/08/2002) ‘T-Mobile sidesteps Wi-Fi interference’ in CNET.com available at http://news.com.com/2100-1033-954813.html, last accessed 27/10/2002

Fusco P., (05/11/2002) ‘Wi-Fi Switching Bravado from Vivato’ in 802.11 Planet, available at www.80211-planet.com/news/article.php/1494751, last accessed 20/11/2002

Gardiner J., (01/11/2002) ‘News Analysis: Wartalking’ in Total Telecom, available at www.totaltele.com last accessed 21/11/2002

Gates B., Quotation source at http://seminars. Internet.com/80211/spring02/ last access 25/11/2002

Gordijn J., Akkermans H., ‘Designing and Evaluating E-Business Models’ in IEEE Intelligent Systems, July/August 2001, Vol. 16, No. 4, pp. 11-17 available at http://www.cs.vu.nl/~gordijn/, last accessed 20/11/2002

Grant, R., (1998) ‘Contemporary Strategy Analysis’, (3rd edition), Blackwell Publishers.

Griffith E., (08/11/2002) ‘Schlotzsky's Warchalks a Stealth Ad Campaign’ in 802.11 Planet, available at www.80211-planet.com/news/article.php/1497411, last accessed 08/11/2002

Gustafsson P., Sandred I., (2001) 'The Golden WISP Opportunity' in BrainHeart Magazine, #4, available at http://dev.brainheart.com/images/uploads/issues/10/Strategy.pdf , last accessed 24/11/2002

Hamel G., (2000). 'Leading the revolution', Boston: Harvard Business School Press.

Heijden van der K., (2001) 'Business Models for the Information Economy' Strathclyde University Working Paper 2001-02

Henion A., (02/09/2001) 'Boom in cell phones curtails pay-phone use', in LSJ.com, available at http://www.lsjxtra.com/news/010902_payphones_1E_sunday.html, last accessed 24/11/2002

Herslow L., Navarro C. Scholander J. (2002) 'Exploring the WISP Industry' Master Thesis Lund University, available at www.lri.lu.se/strman/index.htm, last accessed 21/11/2002

Hunn N., (2002), 'The evolution of the wireless LAN', TDK Systems Europe. Available at http://b-informed.co.uk/download/pdf/EvolutionLAN.pdf last accessed 25/11/2002

INTERSIL Corporation, (1998) 'Effects of Microwave Interference On IEEE 802.11 WLAN Reliability' Submission to IEEE P802.11 Wireless LANs. IEEE P802.11-98/240 http://www.wlana.com/learn/microreliab.pdf, last accessed 21/10/2002

ITU (2002) 'Internet for a Mobile Generation' Iternational Telecommunication Union, Geneva, www.itu.int

Iwatani Y., (15/11/2002) 'T-Mobile USA posts large loss, but sales jump' in Total Telecom, available at www.totaltele.com, last accessed 15/11/2002

Kane J., Yen D.C., (2002) 'Breaking the barriers of connectivity: an analysis of the wireless LAN' in Computer Standards and Interfaces Vol.24, p5-20, available at www.elsevier.com/locate/csi, last accessed 21/11/2002

Kanell M., 03/02/2001 'As call for pay phones lessens, BellSouth to cash in its stake' in Atlanta Journal-Constitution, available at http://www.telephonetribute.com/tribute/payphones.html, last accessed 13/11/02

Karmakar J., (September 2002) 'Telia's Wireless LAN opportunity – Homerun' Presentation in London Conference, September 2002 available at http://tt.taiji.ru/london/JanKarmakar.pps last accessed 19/11/02

Koerner B., (10/10/2002) 'Sky Dayton's Long Road to Internet' 10/10/2002 available at http://www.wired.com/wired/archive/10.10/boingo_pr.html , last accessed 13/09/2002

Lehr W., McKnight L., (2002) 'Wireless Internet Access: 3G vs. WiFi?' 23 August 2002, MIT Research Program on Internet, available at itc.mit.edu/itel/docs/2002/LehrMcKnight_WiFi_vs_3G.pdf , last accessed 25/11/2002

Li Feng, Whalley J., 'Deconstruction Of The Telecommunications Industry: From Value Chains to Value Networks' Research Paper No. 2002/2, Strathclyde Business School Management Science

Lind J., (2001) 'Competing infrastructures – the machinery behind any Seamless Mobility' Presentation Abstract, available at www.hhs.se/cic/seamless/Portal/Documents/documents.html , last accessed 26/11/2002

Linden A., Paolini M., (2002) 'The WLAN opportunity for wireless service providers' , white paper by Analysys, available at www.analysys.com , last accessed 20/11/2002

Lindqvis A, (September 2002) ‘Northstream: Strategies for a wireless world’ Presentation at London Conference

Maitland C., Bauer J., Westerveld R., (2002) ‘The European market for mobile data: evolving value chains and industry structures’ in Telecommunications Policy #26, 485–504

May S., Hellmann E., Borate P., (2002) ‘The Wireless LAN Report’, US Bancorp Piper Jaffray, available at www.pcj.com, last accessed 10/10/2002

McClune E., ‘Hotspot business models fail to impress’ in Communication Week International, available at www.totaltele.com, last accessed 02/12/2002

Melander M., (October 2002) ‘WISP Chronicle #6’ , available at http://www.brainheart.com/wisp/presentationer/BrainHeart_WISP_Chronicle_no_6.doc, last accessed 24/11/2002

Melfi A., 19/03/2001 ‘Don't expect pay phones to disappear’, in Atlanta Business Chronicle, available at http://atlanta.bizjournals.com/atlanta/stories/2001/03/19/focus5.html, last accessed 23/11/2002

MMO2 web-site, available at http://www.mmo2.com/docs/media/pr_020618a.html, last accessed 22/11/2002

Modern History Sourcebook: ‘Andrew Carnegie: The Gospel of Wealth’ , available at http://www.fordham.edu/halsall/mod/1889carnegie.html, last accessed 03/12/2002

Mobileinfo.com web-site, available at http://www.mobileinfo.com/3G/PricingPlans.htm last accessed 22/11/2002

MobileStar (2001) ‘Presentation by MobileStar for WAA: Business models and relationships’, 19/01/2001

Negroponte N., (04/09/2002) ‘Nicholas Negroponte interview’ in Financial Times 04/09/2002, by London B., available at www.ft.com, last accessed 19/11/2002

Negroponte N., (October, 2002) ‘Being Wireless’ available at http://www.wired.com/wired/archive/10.10/wireless_pr.html, last accessed 23/11/2002

Newcombe T., (August, 2002) ‘Connection for all’ in Urban Technology and Telecommunications mailing list

Newing R., (20/11/2002) ‘Profile: Cisco. Hot spots on the hoof’ in Financial Times, 20/11/2002, available at www.ft.com , last accessed 20/11/2002

Normann, R, Ramirez R., (1998) ‘Designing Interactive Strategy’, London: John Wiley & Sons

Norris M., Golds A., (2001) ‘Mobile Data, mBusiness and Machiavelly’ Intercai Mondiale White Paper, available at http://www.intercai.co.uk/pdf/mobiledata.pdf, last accessed 20/11/2002

Odlyzko A., (2001a) ‘The history of communications and its implications for the Internet’ AT&T Labs – available at http://www.dtc.umn.edu/~odlyzko, last accessed 01/04/2002

Odlyzko A., (2001b) ‘Content is not king’ Revised version 03/01/2001, available at http://www.dtc.umn.edu/~odlyzko, last accessed 21/11/2002

Odlyzko A., (2002) ‘Content versus connectivity and the future of 3G’ available at http://www.dtc.umn.edu/~odlyzko, last accessed 21/11/2002

Office of the e-Envoy (2001) ‘UK online: the broadband future’ February 2001 available at www.e-envoy.gov.uk, last accessed 01/05/2002

Olla P., Patel N., (2002) 'A value chain model for mobile data service providers' in Telecommunications Policy #26 (2002) 551–571

Osterwalder A., Ben Lagha S.,, Pigneur Y. 'An Ontology for Developing e-Business Models' INFORGE, available at inforge.unil.ch/aosterwa/, last accessed 20/11/2002

Paolini M., Kacker A., Analysys, (2002), 'Assessing the WLAN opportunity'. August, 2002 by, available at http://www.analysys.com/articles/ standardarticle.asp?iLeftArticle=1033, last accessed 21/11/2002

Parker T., (December 2001) 'VoiceStream Bid for MobileStar is a Milestone' in Planet Wireless, available at www.blue.telecoms.com, last accessed 12/11/2002

Pavento, M. (1999) 'Patent protection for e-commerce business models', London: Jones & Askew.

Petrovic, O., Kittl, C., Teksten, R.D. (2001) 'Developing Business Models for eBusiness', International Conference on Electronic Commerce 2001, Vienna, October 31. – November 4.

http://piom.kfunigraz.ac.at/, last accessed 02/12/2002

Pirsig R., (1974) 'Zen and the Art of Motorcycle Maintenance' Vintage

Pixell R. (2001) 'Market Model Design and System Thinking as Decision Suport' Master Thesis in Stockholm School of Economics, summer 2001, available at www.pixell.net, last accessed 25/09/2002

Porter, M., (1980) 'Competitive Strategy: Techniques for Analyzing Industries and Competitors', New York: Free Press

Porter, M. E (2001) 'Strategy and the Internet.' Harvard Business Review. March 2001: 62-78

PROXIM Corp., (2002) '802.11a: The Clear Choice for Wireless LANs' available at www.proxim.ru, last accessed 12/11/2002

Rappa M., (2002) 'Business Models on the web' available at http://digitalenterprise.org/models/models.html, last accessed 02/11/2002

Riseborough S., 'Deutsche Telekom posts E2.1bn loss, mulls VoiceStream sale' in Total Telecom, 21 August 2002, available at www.totaltele.com, last accessed 21/08/2002

Roberts M, Elliot A., (October 2002) 'Telia cuts prices, drives Swedish hotspot rollout' in Hotspots Marke ts, available at www.baskerville.telecoms.com/srwireless

Sage (2002) 'WLANs: Improving Productivity and Quality of Life' by Sage Research, Inc. May 2002 available http://newsroom.cisco.com/dlls/corp_051701b.html, last accessed 22/11/2002

Sauders A., (September 2002). 'Starbucks WLAN Service' Presentation in London Conference available at http://tt.taiji.ru/london/Anna Sauders.pps

Shostek (2002) 'Lessons from Metricom and MobileStar' A Shostek Group White Paper, January 2002, available at www.shostek.com, last accessed 18/11/2002

Sibilski C., (24/10/2002) 'A wake-up call for Starbucks' Multex Investor Newsletter available at www.multex.com

Søe H.B., (September, 2002), 'Presentation of The Copenhagen Airport Wireless Internet Zone' at London Conference, 9-10 September 2002 available at http://tt.taiji.ru/london/henrik.pps, last accessed 19/11/2002

Standage T., (2000) ‘The Victorian Internet: The Remarkable Story of the Telegraph and the Nineteenth Century’s On-line Pioneers’, New York: Walker, 2000.

Starbucks (2001) ‘Fiscal Annual Report', available at http://www.starbucks.com/aboutus/ar01_narrative.pdf , last accessed 10/11/2002

Stevenson R., (19/09/2002) ‘Microsoft unveils hardware for wireless networking’ available at www.totaltele.com, last accessed 19/09/2002

Sweet P., (2001) ‘The Logics of Wireless Business Model & Service Offering Design: Identifying Techno-logics, Market-logics, Business-logics & Valuelogics for Wireless Consumer Services.’ Abstract submitted to workshop on seamless mobility, Stockholm 15-16 September 2001, available at www.seamlessmobility.org, last accessed 29/11/2002

Tapscott D., Lowi A., Ticoll D., (2000). ‘Digital Capital - Harnessing the Power of Business Webs’, Boston: Harvard Business School Press.

Telia HomeRun Newsletter (Summer 2002), available at www.homerun.telia.com, last accessed 21/11/2002

Telia HomeRun web-site www.homerun.telia.com

Thorngren B., (2002) ‘Profitable at any speed?’ available at http://www.hhs.se/cic , last accessed 21/11/2002

Thorngren B., (2002) ‘Wireless Venues or How to Do Things – and Not to’ BrainHeart Capital Magazine #6, available at http://www.brainheart.com/images/uploads/issues/12/BHM6_Wireless_Venues.pdf , last accessed 21/11/2002

Timmers P., (2000) ‘Electronic Commerce: Strategies and Models for Business-to-Business Trading’, New York:Jon Wiley and Sons

Total Telecom, (01/02/2002), 'Leading US nuclear lab bans Wireless LANs' www.totaltele.com

Total Telecom (11/07/2002) ‘BT breathes sigh of relief over public WLAN ruling’ available at www.totaltele.com, last accessed 11/07/2002

Total Telecom (19/09/2002) ‘Wireless LAN unit sales set for rapid growth’ available at www.totaltele.com last accessed 19/09/2002

Total Telecom (01/11/2001), ‘ Hotspots mean business’ in Communication Week International, available www.totaltele.com last accessed 01/11/2002

Total Telecom (07/11/2002) ‘Target women and businessmen, Forrester tells mobile firms’, available at www.totaltele.com, last accessed 07/11/2002

Total Telecom (14/11/2002) ‘Deutsche Telekom names new chief, posts $24.7bn loss’ by TotalTelecom staff, available at www.totaltele.com, last accessed 14/11/2002

Total Telecom, (27/11/2002), ‘Telia and BT in WLAN hotspot roaming deal’ by Total Telecom staff, available at www.totaltele.com, last accessed 27/11/2002

Townsend A., (2001) ‘The Science of Location: Why the Wireless Development Community Needs Geography, Urban Planning, and Architecture’ Position paper submitted for CHI 2001 Wireless Workshop, available at www.cs.colorado.edu/~palen/chi_workshop/papers/townshend.pdf, last accessed 23/11/200

‘Urban Technologies and Telecommunications’ mailing list, archives available at http://www.informationcity.org/telecom-cities

Uschold M., (2000)‘The Enterprise Ontology’, The Knowledge Eng. Rev., vol. Web), Springer Verlag, Berlin, vol. LNCS 1875, pp. 48–62.

WLANA (2002) ‘Introduction to WLAN’ www.wlana.com

WLANA (2002) 'Spotlight on Wireless in Use' http://www.wlana.com/spotlite.htm

Young A., (13/11/2002) 'French regulator gives green light to public WLAN' in Total Telecom, available at www.totaltele.com last accessed 13/11/2002

Young A., (29/07/2002) 'T-Mobile plans German WLAN services by year-end' in available at www.totaltele.com, last accessed 29/07/2002

Young A., (21/08/2002) 'T-Mobile expands U.S. WLAN network, starts Euro trials' available at www.totaltele.com , last accessed 21/08/2002.

Zyren J., (1999) 'Reliability of IEEE 802.11 Hi Rate DSSS WLANs in a High Density Bluetooth Environment' available at www.wlana.com , last accessed 23/11/2002

Glossary

3G — **3**rd **G**eneration

802.11 — A wireless LANs transmission standard and provides 1 or 2 Mbps in the 2.4 GHz band using either frequency hopping spread spectrum (FHSS) or direct sequence spread spectrum (DSSS).

802.11a — An extension to 802.11 that applies to wireless LANs and provides up to 54 Mbps in the 5GHz band. 802.11a uses an orthogonal frequency division multiplexing encoding scheme rather than FHSS or DSSS.

802.11b — An extension to 802.11 that applies to wireless LANs and provides 11 Mbps transmission (with a fallback to 5.5, 2 and 1 Mbps) in the 2.4 GHz band. 802.11b uses only DSSS. 802.11b was a 1999 ratification to the original 802.11 standard, allowing wireless functionality comparable to Ethernet (also referred to as 802.11 High Rate or WiFi).

802.11g — Applies to wireless LANs and provides up to 20 Mb/s at 2.4Ghz

AAA — **A**uthentication, **A**uthorization and **A**ccounting

AP(s) — **A**ccess **P**oint (s) A radio transmitter/receiver and antenna used in the wireless LAN.

ARPU — **A**verage **R**evenue **P**er **U**ser

BAN — **B**ody **A**rea **N**etwork

Bandwidth — The range of frequencies available to be occupied by signals. In analogue systems it is measured in terms of Hertz (Hz) and in digital systems in bit/s per second (bit/s). The higher the bandwidth, the greater the amount of information that can be transmitted in a given time. High bandwidth channels are referred to as broadband which typically means 1.5/2.0 Mbit/s or higher.

CAPEX — **CAP**ital **EX**penses

Cellular — A mobile telephone service provided by a network of base stations, each of which covers one geographic cell within the total cellular system service area.

Channel — One of a number of discrete frequency ranges utilized by a access point to transmit and receive information from cellular terminals (such as mobile handsets).

Churn — Term used to describe the turnover in the number of subscribers to a network, typically measured monthly. There are several different ways of measuring churn (for instance, based on the subscriber base at the start or the end of the month) which means that comparisons between companies or between countries are not always meaningful.

Coverage — Refers to the range of a wireless or cellular network, measured in terms of geographic coverage (the percentage of the territorial area covered by mobile cellular) or population coverage in case of WAN

CPH — **C**o**P**en**H**agen Airport

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.
E1	Leased line 2,048 Mb/s, European Standard
ETSI	European Telecommunications Standards Institute is a non-profit enterprise whose mission is to produce the telecommunications standards that will be used through out Europe
Footprint	See **Coverage**
FT	**F**inancial **T**imes
GHz	**G**iga**H**ert**z**
GPRS	General Packet Radio Service is a packed-oriented overlay to GSM network with a maximum transmission speed of 115 kBit/s.
GSM	**G**lobal **S**ystem for **M**obile communication
IEEE	**I**nstitute of **E**lectrical and **E**lectronics **E**ngineers
Incumbent	The (former) monopoly service and network provider in a particular country.
Internet backbone	The high-speed, high capacity lines or series of connections that form a major pathway and carry aggregated traffic within the Internet.
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
ISP(s)	**I**nternet **S**ervice **P**rovider(s). ISPs provide end-users access to the Internet. ISPs may offer their own proprietary content and access to online services such as e-mail.
ITU	The **I**nternational **T**elecommunication **U**nion is an international organisation within which governments and the private sector co-ordinate global telecommunications networks and services.
KB	**K**ilo**B**ytes
Kb/s	**K**ilo**b**its per **s**econd
LAN(s)	**L**ocal **A**rea **N**etwork(s). A computer network that spans a relatively small area. Most LANs are confined to a single building or group of buildings. However, one LAN can be connected to other LANs over any distance via telephone lines and radio waves. A system of LANs connected in this way is called a wide-area network (WAN). See also **WLAN**.
LSS	**L**ocation-**S**pecific **S**ervices. Services, available only in specific limited geographic location
Mb/s	**M**ega**b**ytes per **s**econd
NIC	**N**etwork **I**nterface **C**ard

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.
OPEX	**OPE**rational **EX**penses
PAN	**P**ersonal **A**rea **N**etwork
PDA(s)	**P**ersonal **D**igital **A**ssistant. A generic term for handheld devices that combine computing and communication functions.
PSTN	**P**ublic **S**witched **T**elephony **N**etwork
Public payphone	Typically supplied and operated by the incumbent carrier, public payphones have been a traditional method of encouraging widespread access to telecommunication facilities.
QoS	**Q**uality **o**f **S**ervice
RF	Radio frequency (see C**hannel**). A specified portion of the RF spectrum with a defined bandwidth and a carrier frequency and is capable of carrying information over the radio interface. mission and reception of signals over the radio interface.
Roaming	The ability of a user to access wireless telecommunication services in areas other than the one(s) the user is subscribed
SMS	**S**hort **M**essage **S**ervice. A service available on digital networks, typically enabling messages with up to 160 characters to be sent or received via the message centre of a network operator to a subscriber's mobile phone.
T1	Leased line 1,5 Mb/s, North American Standard
TCP/IP	**T**ransmission **C**ontrol **P**rotocol / **I**nternet **P**rotocol
TT	**T**otal **T**elecom
UMTS	**U**niversal **M**obile **T**elecommunications **S**ystem
UNII	**U**nlicensed **N**ational **I**nformation **I**nfrastructure, refers to 5 GHz unlicensed frequency band
VAS	**V**alue **A**dded **S**ervices are adding value to other (primitive) services. A value added service cannot be used alone, i.e. with another primitive service
Venue(s)	A public place such as a hotel, café or airport, where public WLAN could be deployed.
VISP	**V**irtual **I**nternet **S**ervice **P**rovider
VoIP	**V**oice-**o**ver-**IP**
VPN	**V**irtual **P**rivate **N**etwork
WEP	**W**ireless **E**quivalent **P**rivacy
WiFi	**Wi**reless **Fi**delity

Wireless	Generic term for mobile communication services which do not use fixed-line networks for direct access to the subscriber.
WISP(s)	**W**ireless **I**nternet **S**ervice **P**rovider
WIZ	**W**ireless **I**nternet **Z**one in the Copenhagen Airport
WLAN(s)	**W**ireless **L**ocal **A**rea **N**etwork(s). A network which has at least one part of it based on wireless technology.
WPA	**W**iFi **P**rotected **A**ccess, see Appendix A

Appendix A. 802.11: Technical Overview

This section presents a brief overview of all the relevant WLAN technologies. Please refer to previous sections – List of Acronyms and Glossary for definitions of several terms used and explanations of acronyms.

Modern generation of WLANs 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 only 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.

IEEE 802.11b beat out HomeRF by the virtue of being the first on the market with a fast access of 11Mbps.

Existing Wireless LANs systems

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

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 Mb/s 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.

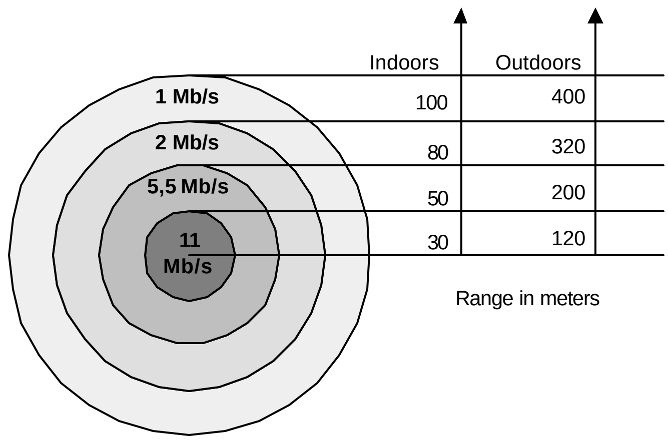
Major backers of this standard are Motorola, Siemens and Proxim. Although Intel, one of the founders of HomeRF, recently announced strong support for IEEE 802.11b.

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).

Relationship between the Range and available bandwidth of WiFi



Note: Not to scale

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 __________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 (WiFi). WiFi certification ensures that the system is interoperable with other WiFi-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.

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.

Replacing WLAN technologies

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

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.

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.

HiperLAN/2

HiperLAN/2 (**HI**gh **PE**rformance **R**adio **L**ocal **A**rea **N**etwork 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.

IEEE 802.11e

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

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.

IEEE 802.11h

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 communication 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.

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.

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 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.

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 been 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.

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.

WPA

WiFi Alliance announced an official replacement for the much derided Wired Equivalent Privacy (WEP) encryption in November 2002. The new solution, called WiFi Protected Access (WPA), is a subset of the still unfinished IEEE 802.11i security specification and will be usable by both home and enterprise wireless networks.

The way WPA will work in the enterprise is similar to the setup of any 802.1x authentication system. The clients and access points must have WPA enabled for encryption to and from an 802.1x with Extensible Authentication Protocol (EAP) authentication server of some sort, such as a RADIUS server with centralized access management.

Appendix B. Wireless Internet Service Providers Classification

This classification was introduced by Alvén et al, 2001

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. This can be a potential player in WLAN market since they already have the customer database as well as billing and other services in place. Offering Internet access is the core business for such WISPs (enough expertise), and they can reach a competitive advantage over new players in offering wireless access to their services – customers are already used to getting Internet services from them as an ISP.

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. A few such WISP went bankrupt offering WLAN services on large scale, like MobileStar and Metricom [Shostek, 2002]

Mobile Operator WISP

As the name implies, a mobile operator 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 Mobile in Sweden and T-Mobile 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 either places that are frequently visited by these users, such as hotels, airports and convention centers (see Case One) or 'branded' places like Starbucks or Borders (see Case Two).

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), T-Mobile (have many hot spots in the US, but the majority are at Starbucks Coffee shops) and players like SoftBank in Japan, cooperating with McDonald's to offer WiFi broadband fast food chain's visitors.

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

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.

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 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.

Virtual WISP

A company that doesn't own it's 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 Virgin Mobile that lease capacity from existing mobile operator T-Mobile. The US-based company Boingo is a virtual WISP that is just launching it's 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 the increased competition and the forced price drop that can occur.