NTNU
Norwegian University of
Science and Technology

Technical and Commercial Potential for use of Wireless Trondheim's Wi-Fi Network for Payment Terminals

Joar Ulversøy

Master of Science in Communication Technology
Submission date: June 2008
Supervisor: Steinar Andresen, ITEM
Co-supervisor: Lene Maria Myhre, Trådløse Trondheim
Thomas Asphaug, Trådløse Trondheim
Thor-Ragnar Klevstuen, SpareBank 1 Midt-Norge

Norwegian University of Science and Technology
Department of Telematics

Problem Description

Payment cards are very common in Norway. BankAxept is the Norwegian solution for debit cards. As of 2006, 5.5 million debit cards with BankAxept have been issued. In 2006, more than 200 transactions were on average executed with bank cards for each person in Norway. Payment cards provide a convenient payment solution for customers and businesses. Customers do not need to withdraw and carry cash, while businesses avoid large cash deposits. Wireless Trondheim has wireless coverage in large parts of the city center of Trondheim, and this coverage includes several cafés, restaurants, etc. The cafés and restaurants that use wireless payment terminals today often use the cellular network for communication and these costs are relatively high. Is there a technical and commercial potential in utilizing Wireless Trondheim's Wi-Fi coverage to offer wireless access to businesses which use payment terminals?

This thesis will consist of:

- A theoretical study of payment terminals using wireless communication.

- A description of existing payment terminals with Wi-Fi support.

- Testing of a payment terminal with Wi-Fi support in a café or restaurant on Wireless Trondheim's Wi-Fi network.

- An identification of commercial potential for utilizing Wireless Trondheim's network to be used by payment terminals.

- An identification of whether payment terminals using Wireless Trondheim's Wi-Fi network is a cost-effective solution compared to other wireless communication solutions.

Assignment given: 15. January 2008
Supervisor: Steinar Andresen, ITEM

Preface

This thesis is the final part of the study in Master of Science at the Norwegian University of Science and Technology. The work has been carried out from January 2008 to June 2008 at the Department of Telematics in cooperation with Wireless Trondheim.

I would like to thank Professor Steinar Andresen for his valuable input on the structure of this report. I have been so fortunate to have three co-supervisors and I would also like to thank each of them for their contribution to this report.

Foremost, co-supervisor Lene Maria Myhre at Wireless Trondheim has contributed with fruitful discussions on the commercial potential part of this thesis. Second, co-supervisor Thomas Asphaug at Wireless Trondheim has provided insights on the technical part of Wireless Trondheim. Finally, co-supervisor Thor-Ragnar Klevstuen has contributed with relevant information about payment cards and the payment system and also given valuable input on the business model from the perspective of a bank.

Trondheim, June 9, 2008

Joar Ulversøy

Summary

Wireless Trondheim is a company offering city-wide Wi-Fi network in Trondheim, seeking new ways to utilize the Wi-Fi network to increase the number of services offered, and also increasing the profits and total revenues. Payment cards are very popular in Norway, and merchants such as cafés or restaurants, or merchants at temporary events, may want to use wireless payment terminal in order to provide a convenient and easy way for customers to pay for their purchases. This thesis will address the technical and commercial potential of using payment terminal within Wireless Trondheim's Wi-Fi network.

A study of the technical potential of using payment terminals within Wireless Trondheim's Wi-Fi network reveals two companies importing and configuring payment terminals in Norway, and that currently two terminals exist with Wi-Fi support. However, the security related to using terminals with Wi-Fi is not yet approved by the Banks' Standardization Office, which means that it is not possible to use payment terminals with Wi-Fi until the security has been approved. The test of a payment terminal in Wireless Trondheim's Wi-Fi network was not possible to conduct for the same security reasons.

Among the two existing payment terminals with Wi-Fi, only one is available in Norway. This terminal is produced by Banksys and is called Xentissimo, and supports both GPRS, GSM and Wi-Fi. Ingenico 7810 is the other existing payment terminal with Wi-Fi, but this terminal does not have any other wireless communication option.

A cost comparison of the different wireless payment access alternatives from the perspective of a merchant shows that Netcom GPRS is currently the cheapest alternative. Telenor GPRS is the second cheapest alternatives for low estimates of number of terminals and transactions for a typical café in Trondheim, while Ventelo broadband Point of Sale is the second cheapest alternative for a similar high estimate. Based on this comparison, a competitive and attractive price for the service offered by Wireless Trondheim

has been determined and used to calculate revenues in the business model proposal.

The business model proposal provided in this study is based on the high level elements of Osterwalder's Business Model Ontology. The model explains how Wireless Trondheim, in cooperation with the local branches of banks, can offer wireless access to payment terminals using Wireless Trondheim's Wi-Fi network. The chosen target customers for this service are cafés, restaurants and merchants at temporary events in the city of Trondheim, and the cooperation with the banks has been chosen in order to utilize the bank's existing distribution channels towards these target customers. The business and technical risks that this business model face are identified and described.

Net present value calculations of the business model show negative results in the pessimistic and realistic scenario of market share, while the optimistic scenario gives a small positive net present value. These results suggest that the Wi-Fi connection offered by Wireless Trondheim is not cost-effective compared to Netcom GPRS, and that the business model proposed in this thesis does not have a commercial potential with the current customer estimates.

However, if the Wi-Fi coverage increases and the number of potential customer increases substantially, it could be interesting to pursue this business model proposal further. An interesting possibility could also be a combination of offering payment access to terminals and Internet connection to merchants. The number of potential customers would then in that case be considerably larger, as the target customers would include most merchants in Trondheim, and not only be limited to restaurants, cafés and merchants at temporary events.

List of Abbreviations and Acronyms

ADSL Asymmetric Digital Subscriber Line.

AES Advanced Encryption Standard.

BBS Bankenes Betalingssentral.

BSK Banks' Standardization Office.

DEA Data Encryption Algorithm.

DES Data Encryption Standard.

DSSS Direct Sequence Spread Spectrum.

DUKPT Derived Unique Key Per Transaction.

FHSS Frequency-Hopping Spread Spectrum.

GPRS General Packet Radio Service.

GSM Global System for Mobile communications.

IEEE Institute of Electrical and Electronics Engineers.

ISO International Standards Organization.

LAN Local Area Network.

MAC Media Access Control.

MAN Metropolitan Area Network.

NICS Norwegian Interbank Clearing System.

NPV Net Present Value.

NTNU Norwegian University of Science and Technology.

OFDM Orthogonal Frequency Division Multiplexing.

OSI Open Systems Interconnection Reference Model.

PIN Personal Identification Number.

PSTN Public Switched Telephone Network.

QoS Quality of Service.

RSA Rivest, Shamir, Adleman.

RTT Round Trip Time.

SMN Sparebank 1 Midt-Norge.

SSL Secure Sockets Layer.

TDEA Triple Data Encryption Algorithm.

TLS Transport Layer Security.

VAT Value-Added Taxes.

VPN Virtual Private Network.

WEP Wired Equivalent Privacy.

WLAN Wireless Local Area Network.

WPA Wi-Fi Protected Access.

Contents

List of Figures

List of Tables

Part I

Introduction and background

Chapter 1

Introduction

1.1 Motivation

The background for this thesis is the desire to explore new ways of utilizing Wireless Trondheim's Wi-Fi network, to increase the number of services offered by Wireless Trondheim and also increasing the profits and total revenues. Wireless Trondheim also want to be on the cutting edge of new services and usage of a city-wide Wi-Fi network.

Use of payment cards are very popular in Norway, and several potential customers for wireless payment terminals exist within Wireless Trondheim's coverage in Trondheim. Both temporary merchants (i.e. merchants selling goods or services at events) and fixed merchants, such as cafés or restaurants, may want to use wireless payment terminal in order to provide a convenient and easy way for customers to pay for their purchases.

1.2 Problem description

The aim of this thesis is, as stated in the title of this thesis, to investigate the *technical and commercial potential for use of Wireless Trondheim's Wi-Fi network for payment terminals.* The study will consist of the following tasks:

- A theoretical study of payment terminals using wireless communication.
- Describe existing payment terminals with Wi-Fi support.

- Test a payment terminal with Wi-Fi support in a café or restaurant on Wireless Trondheim's Wi-Fi network.
- Identify commercial potential for utilizing Wireless Trondheim's network to be used by payment terminals.
- Identify whether payment terminals using Wireless Trondheim's Wi-Fi network is a cost-effective solution compared to other wireless communication solutions.

The first three tasks address the technical potential of providing Wi-Fi access to payment terminals, while the two latter tasks identify whether there exist commercial potential for Wireless Trondheim by offering Wi-Fi access to payment terminals. The original problem description shown above, assumed that testing a payment terminal using Wireless Trondheim's Wi-Fi network would be possible. But as this solution is not yet approved (see Section 3.6), this could not be done. Professor Steinar Andresen and the co-supervisors are aware of this and that the chapter about testing will only be discussing why the test should be conducted and how, on a high-level basis.

1.3 Thesis outline

This thesis is divided into four main parts and a total of 9 chapters, excluding the appendices:

1. Introduction and background.
2. Technical study of payment terminals using wireless communication.
3. Commercial potential and cost-effectiveness.
4. Conclusion and further work.

The first part consists of the two chapters *Introduction* and *Wireless Trondheim*.

Chapter 1, *Introduction*, gives an overall introduction to this thesis, including motivation, problem description, methodology and the thesis outline.
Chapter 2, *Wireless Trondheim*, describes in detail what Wireless Trondheim is, which this thesis is carried out for.

The second part consists of three chapters which address the first three tasks in the thesis:

Chapter 3, *Payment card system*, describe how payment transactions are carried out and who is involved in these transactions. This chapter also describes the two existing terminals which support Wi-Fi, thus answering task two, in Section 3.5. The general security requirements for payment terminals will also be described.
Chapter 4, *Wireless access technologies for payment terminals*, present the different wireless access technologies which payment terminals currently support, including GSM, GPRS, Wi-Fi and Bluetooth.
Chapter 5, *Testing*, introduce the purpose of testing a payment terminal with Wireless Trondheim's network, and how the test was supposed to be conducted. This is where task three would have been described and answered if testing had been carried out.

The third part of this thesis identify the commercial potential and whether Wi-Fi is cost-effective compared to other wireless access technologies.

Chapter 6, *Wi-Fi cost-effective compared to other wireless solutions*, address the cost-effectiveness by comparing prices for a merchant of using GSM, GPRS and broadband in combination with Wi-Fi or Bluetooth access point.
Chapter 7, *Business model proposal - cooperation with banks*, proposes a business model in which Wireless Trondheim offers Wi-Fi access to payment terminals in cooperation with local branches of banks in Trondheim. These two chapters, 6 and 7, naturally answer the last two tasks described in the problem description above.

The fourth and final part consist of Chapter 8, *Conclusion*, and Chapter 9, *Further work*.

Chapter 8, *Conclusion*, summarizes and concludes on the tasks answered in this thesis.
Chapter 9, *Further work*, gives an outlook on possible future research and investigation, if the business model proposal suggested here is to be implemented.

Appendix A, *Derived Unique Key Per Transaction*, is a short description of a key-management technique which uses a unique key for each separate transaction. This technique is used in electronic commerce transactions, and may used in conjunction with symmetric encryption algorithms.
Appendix B, *Business model theory*, explain the structure of Osterwalder's business model ontology and gives a brief presentation of the relevant elements which are used as a basis in Chapter 7.

1.4 Methodology

In order to describe Chapter 3, *Payment card system*, literature have been found partly on web sites of relevant companies (i.e. Visa and BankAxept), and partly from reports from the Norwegian Bank and the Nordic Competition Authorities. In addition, information has been gathered through email correspondence with the two companies importing payment terminals to Norway, the Banks' Standardization Office and the co-supervisor of this thesis at Sparebank 1 Midt-Norge.

Chapter 4, *Wireless access technologies for payment terminals* have used literature from standards, books, articles and personal communication with the two companies importing payment terminals to Norway.

Chapter 6 on cost-effectiveness of Wi-Fi compared to other wireless communication solutions compares the cost of communication for the different wireless alternatives based on prices found on the respective company web sites and from email inquiries.

The business model proposal given in Chapter 7, is based on the structure of Alexander Osterwalder's Business Model Ontology introduced in [1]. This business model ontology was chosen because it is based on literature review of all literature on business models up until 2003 and gives a thorough description of the contents of a business model.

Cash flow analysis with net present value and sensitivity analysis have been performed on the costs and revenues in three scenarios. Net present value has been chosen instead of more rigorous methods such as real options and decision trees, because it is simple and satisfies the needs of calculation in this case. Sensitivity analysis show the relative importance of the different variables used in the calculation and is thus important to determine which variables to be extra careful with.

1.5 Contributions of this thesis

This thesis aims to evaluate the technical and commercial potential for Wireless Trondheim to offer Wi-Fi access for payment terminals. The study contributes to this evaluation by providing the following:

1. A description of the payment card system.

2. An introduction to the wireless access technologies which exist for payment terminals and are possible in the near future.
3. An overview of the high-level security requirements needed to provide wireless access to payment terminals.
4. An explanation of why a test of payment terminals using Wi-Fi should be tested and the initial high-level plans for testing.
5. A comparison of the wireless communication costs for merchants based on customer estimates in Trondheim.
6. Calculations which show that it is difficult to obtain profits by offering Wi-Fi access to cafés and restaurants using wireless payment terminals with the current potential customer base in Trondheim.
7. An identification of risks affiliated with offering a service with Wi-Fi access to payment terminals.

1.6 References

All non-published, online references and personal communication used in this thesis are provided as an attachment in DAIM at `http://daim.idi.ntnu.no`.

Chapter 2

Wireless Trondheim

The business model proposal and identification of cost-effectiveness of offering Wi-Fi access to payment terminals discussed in Part III is based on Wireless Trondheim's Wi-Fi network. This chapter therefore provides information about Wireless Trondheim and its city-wide Wi-Fi network, as part of the background for this thesis.

2.1 What is Wireless Trondheim?

Wireless Trondheim is a research and development project in the city Trondheim in Norway. The project was initiated in November 2005 by a joint effort of the Norwegian University of Science and Technology (NTNU), Trondheim municipality, the Sør-Trøndelag County municipality and Mid-Norway Chamber of Commerce and Industry. In October 2006, Wireless Trondheim held a private placement towards Adresseavisen, Trondheim Energi and NTNU [2]. The resulting ownership is shown in Table 2.1. The ownership of Wireless Trondheim is relevant to this thesis because it reveals some potential partnerships regarding offering Wi-Fi access to payment terminals. The potential partnership will be explored in Section 7.1.

Three main goals have been defined for the Wireless Trondheim project:

- To create a world class development laboratory for research and development of wireless technologies, products and services.
- Contribute to Norwegian businesses with expert knowledge of wireless technologies, products and services.

Owner	Percentage ownership
NTNU	35 %
Adresseavisen	25 %
SpareBank 1 Midt-Norge	10 %
Trondheim Energi	10 %
Sør-Trøndelag County municipality	10 %
Trondheim municipality	10 %

Table 2.1: Ownership of Wireless Trondheim

- Make Trondheim and NTNU more attractive for students and technology companies [3].

This thesis contributes to the first goal, namely to show whether the wireless coverage and connection are viable for use by payment terminals which are used both indoors and outdoors. Wireless Trondheim offers a service platform with ability to handle mobility, positioning and security, in addition to regular Internet access. The focus of Wireless Trondheim will be on nomadic and mobile communication, and not to compete with fixed resident Internet connections. Nomadic in this context mean that users have access to the network at several locations, while mobile means that the user can move between different locations and still use services without interruptions.

A payment terminal may be used in several different locations at e.g. a restaurant or café. And it is not given that the same access point will be communicating with the payment terminal at the different locations. Using payment terminals with Wireless Trondheim's Wi-Fi network, thus require nomadic access to the network.

The target users for Wireless Trondheim can be divided into three categories [3]:

- Research and development, and frequent users
- Service providers
- Private citizens

Research and development, and frequent users are defined as employees and students of NTNU and employees of Trondheim municipality and Sør-Trøndelag County municipality. When Wireless Trondheim's network is stable and has a reasonable operation and maintenance structure, the network will be open for service providers to provide commercial services. It will also offer telecommunication operators to resell network access to private citizens.

2.2 Wireless coverage

Wireless Trondheim has a long-term goal of covering all of Trondheim city with wireless broadband. In the beginning, wireless coverage will be limited to the inner city and campus at NTNU. Figure 2.1 shows the coverage of the inner city of Trondheim as of April 2008. The green balloons show cafés or restaurants with wireless coverage in all or almost all of the premises. The yellow balloons mean that most of the premises have wireless coverage.

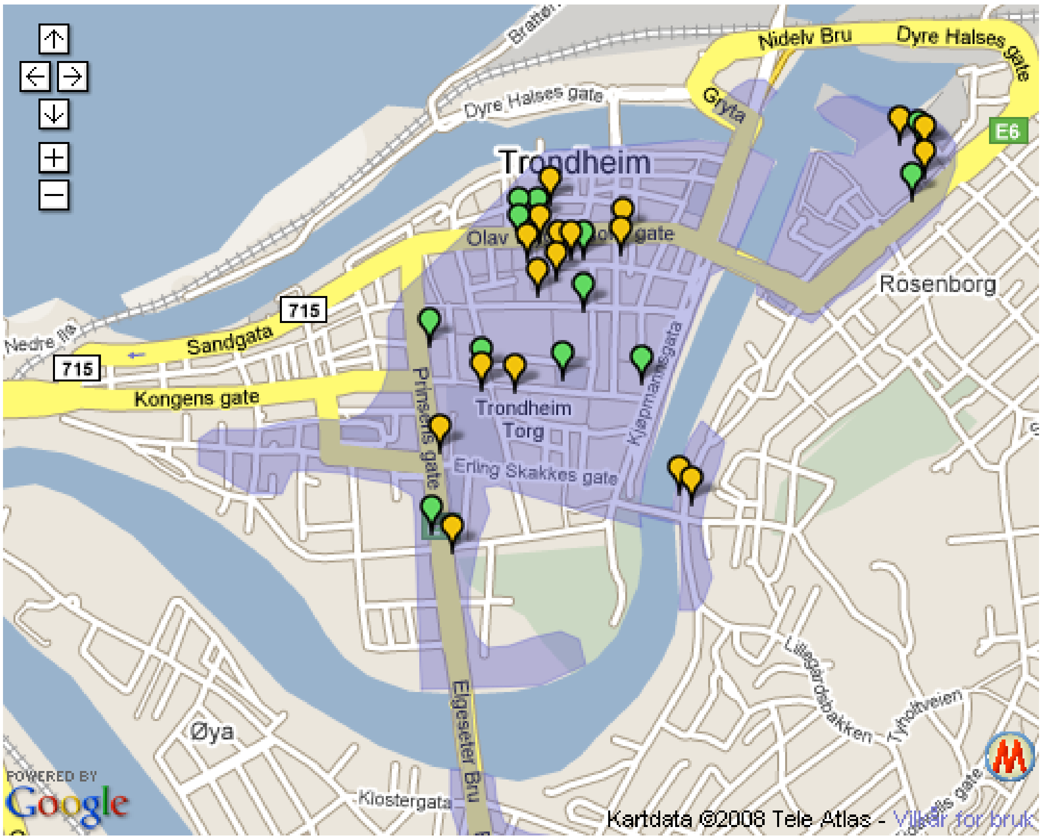


Figure 2.1: Coverage area of Wireless Trondheim from http://wirelesstrondheim.no/sec.php?page=sec_coverage&la=en

2.3 Wireless technologies

A wireless broadband network consists of two main parts: the wireless access network and a ”feeding” network, that is, a network that provides Internet to the wireless access points.

The access network is based on Wi-Fi and currently supports Institute of Electrical and Electronics Engineers (IEEE) 802.11a/b/g [3]. Wi-Fi will be described in Section 4.2. The equipment used until the beginning of 2008 is Cisco Aironet 1030 model. This access point supports dual 2.4 GHz and 5 GHz radios supporting IEEE 802.11a/b/g. The maximum data rates supported by this model are 54 Mbps for 802.11a and 802.11g, while 11 Mbps for 802.11b [4]. This is the same as data rate as specified by the 802.11a/b/g specifications as described in Section 4.2.

The Cisco Aironet 1030 model is no longer in sale, and as a result of this, Wireless Trondheim will in the near future replace the Aironet 1030 model with Aironet 1242 and 1252 for outdoor use and 1131 for indoor use. These access points also support IEEE 802.11a/b/g and will thus not affect Wireless Trondheim's ability to offer Wi-Fi access for payment terminals.

2.4 Feeding network

Several options exist as what to use as a feeding network to the wireless access points, dependent on the need for capacity, Quality of Service (QoS) requirements, and investment and operation costs.

The options considered are [3]:

1. Asymmetric Digital Subscriber Line (ADSL)/ADSL 2+.
2. Fiber optics.
3. Licensed radio solutions.

ADSL is easily accessible in the center of Trondheim city, but the capacity is limited to 8 Mbps downstream and 800 kbps upstream. ADSL 2+ is also available, and has a significantly larger downstream capacity (25 Mbps), but the upstream capacity is only about 1.5 Mbps [3].

Fiber optics has a much larger capacity than the other solutions. Fiber optics is widespread in the center of Trondheim city, but there are few connectors and the installation costs are quite high.

Licensed radio solutions, such as WiMAX or other solutions, can give capacities up to 622 Mbps for point to point links, but the costs are also here quite high.

Fiber is the preferred option if there is a connector available. In the short term, however, radio solutions and ADSL 2+ will be the most likely choice because of availability and the short time frame of development.

Part II

Technical study of payment terminals using wireless communication

This second part of the thesis will address the technical and theoretical background needed to understand how payment transactions can be carried out through wireless payment terminals. It will also address why and how to perform a test of using payment terminal in Wireless Trondheim's Wi-Fi network. This part consists of three chapters, in which the first describes the payment card system. This chapter includes the available payment terminals which have support for Wi-Fi in Section 3.5, which answer the second task of this thesis which is *describe existing payment terminals with Wi-fi support*.

The second chapter describes different wireless access technologies which can be used by wireless payment terminals. These technologies includes Wi-Fi, Global System for Mobile communications (GSM), General Packet Radio Service (GPRS) and Bluetooth. The first and second chapter in this part answer the first task, namely giving a *theoretical study of payment terminals using wireless communication*.

Finally, the last chapter in this part will describe why and how a test of a payment terminal within Wireless Trondheim's Wi-Fi network should have been conducted. Unfortunately, as stated earlier, this was not possible because the solution of using payment terminals with Wi-Fi is not yet approved. Hence, the answer to task three about testing a payment terminal in Wireless Trondheim's Wi-Fi network, is thus not as detailed and comprehensive as initially planned.

Chapter 3

Payment card system

Payment cards are popular in Norway. The Norwegian solution for debit cards is called BankAxept and as of 2006, 5.5 million BankAxept cards have been issued, according to [5]. These BankAxept cards are often combined with a debit function from international cards. Among the 5.5 million BankAxept cards, 4.6 million have a debit function connected to an international payment card system, e.g. Visa.

This chapter is the first of three which will give an overview of the technical and theoretical background for payment terminals using wireless communication. Specifically, this chapter will a) give a short description of the terminology used in the context of payment card systems, b) describe how a Visa payment transaction is executed and, c) explain the difference between an international payment card such as Visa and the Norwegian BankAxept card. Finally, in Section 3.5, the two available payment terminals with support for Wi-Fi will be described.

3.1 Payment card terminology

Before describing how a payment transaction is executed, each of the actors involved will be given a short description.

- *Cardholder*: A cardholder is a person with access to a payment card, e.g. with BankAxept and Visa. The card is issued by a bank, and the card is connected to the person's bank account [6].
- *Merchant*: The merchant is a business customer of the bank [7]. The

merchant sells products or services and offers its customers with payment cards to pay using a payment terminal.

- *Merchant bank*: The bank that has the merchant as a business customer.
- *Issuing bank*: The issuing bank is the bank issuing a payment card to one of its customer, who then becomes a cardholder [7].
- *Acquirer*: The acquirer ”owns” the relation to the merchant, and gives financial settlement guarantees [7]. Examples of acquirers in Norway are Banking and Business Solutions (Norwegian: Bankenes Betalingssentral) (BBS) for the Norwegian BankAxept solution, and Teller for Visa, MasterCard and American Express.
- *Clearing and settlement*: Clearing and settlement consist of calculating claims between the merchant and cardholder, and making settlement of these claims. Depending on whether a Visa card or BankAxept card has been used, this is done by Visa Settlement bank or Norwegian Interbank Clearing System (NICS). NICS is operated by BBS [5].

3.2 The generic payment process

According to [6], a payment transaction usually is carried out through three steps: control and authorization, clearing, and settlement. This is shown in Figure 3.1, and described below:

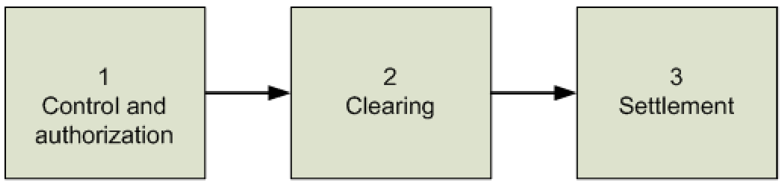


Figure 3.1: The three generic payment process stages

1. Control and authorization: At this step, the bank establishes the identity of the customer, the validity of the payment card and whether the requested amount for this transaction is available in the account.
2. Clearing: Two main functions may be performed during the clearing process:

- Exchange of relevant information about the payment between the cardholder's and merchant's banks.
- Calculation of claims for settlement. The result of this process is a fully processed payment transaction from cardholder to merchant. A claim is also made by the merchant's bank on the cardholder's bank.

3. Settlement: The net sums that banks owe one another after clearing. This can be done by having an account with a third-party financial institution acting as a settlement bank.

3.3 Visa payment transactions

In this section, the stages of a Visa payment transaction are described as an example of how a payment transaction is executed. Some minor differences may exist for other payment cards, but the content of the stages are generally the same. According to [8], a typical Visa transaction is composed by two stages, where the first stage is authorization and the last stage is a merge of the two latter steps in the previous section, namely clearing and settlement.

3.3.1 Visa transaction authorization

The authorization stage consists of deciding whether a transaction is accepted or not, based on some given criteria. The authorization process goes through seven steps [8] which are shown in Figure 3.2 and described below:

1. The first step occurs when a cardholder wants to use a Visa card for payment at the merchant. The cardholder uses the Visa card on the merchant's payment terminal, which read the magnetic stripe or chip on the Visa card.
2. The payment terminal then forwards the card information and transaction amount to the acquirer.
3. The acquirer generates an authorization request based on the transaction information, and the authorization request is then transmitted to Visa.
4. Visa forwards the authorization request to the payment card issuer for review. If the issuer's systems are temporarily unavailable, Visa may

review and decide whether the transaction is authorized or denied on the issuer's behalf.

5. The issuing bank or its third-party processor sends an authorization response message either denying or approving the transaction.

6. Visa forwards the authorization response to the acquirer.

7. The acquirer transmits the result of the authorization request to the payment terminal.

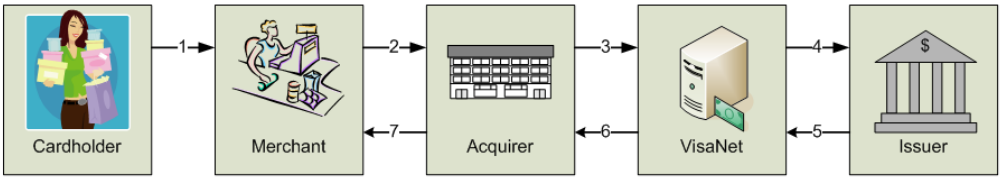


Figure 3.2: The 7 Visa authorization steps

3.3.2 Visa clearing and settlement

Clearing can be done in two ways, either as a single-message or as a dual-message. In single-message transactions, clearing occurs at the time of the authorization, and the amount is immediately entered on the account. In dual-message transactions, the first transaction is an authorization transaction, which checks the card and the account, and then reserves the amount on the account. The second transaction enters the amount on the account [9]. Settlement occurs on each business day, and all the transactions submitted since last settlement is conducted on a net basis [8].

Figure 3.3 illustrates the Visa clearing and settlement process which can be described as:

Clearing:

1. The merchant sends the transaction details with account numbers and transaction amounts to the acquirer.

2. The acquiring bank or its third-party processor uses the transaction details to generate a clearing message. The clearing message is then sent to Visa.

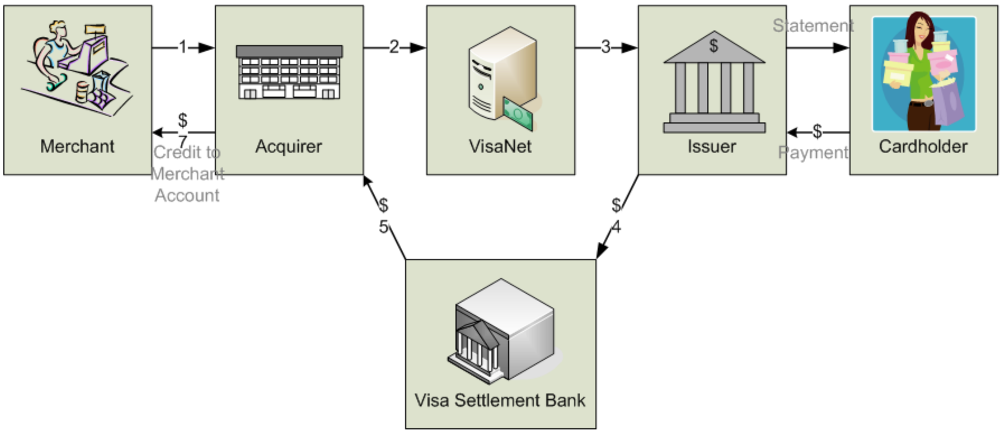


Figure 3.3: Visa clearing and settlement process

3. Visa forwards the clearing message to the card issuer. Further, Visa calculates the amount owed by the issuer to the Visa Settlement Bank and the amount owed by the Visa Settlement Bank to the acquirer, net of certain applicable fees and charges.

Settlement:

4. Each business day the issuer pay the Visa Settlement Bank the total amount owed for all Visa transactions.

5. The Visa Settlement Bank transfer the funds owed to the acquirer.

3.4 The Norwegian BankAxept solution

Visa and BankAxept transactions are quite similar to each other. The main differences however, are that a) while Visa performs clearing and settlement for Visa transactions, NICS performs this for BankAxept [5], and that b) BankAxept requires online access to be able to use the payment card [10]. However, in case of technical failures, merchants may use a backup solution which requires the cardholder to provide identification and sign a paper where account number and transaction amount are filled in. The backup solution has a maximum amount of 1500 NOK per transaction [10].

NICS is the banks' joint national system for payment transactions. Payment transactions such as ATM and payment card transactions are settled twice a day [6]. NICS is operated by BBS, the Norwegian banks' payment and clearing house, and is *a channel for transactional and informational exchange between the banks and the Central Bank of Norway's settlement system* [6] page 35. The Norwegian bank DnB NOR also has authorization to act as a clearing bank.

3.5 Payment terminals with Wi-Fi support

This section describes the available payment terminal with Wi-Fi communication as an option. There are two suppliers of payment terminals in Norway, Point and BBS. As of May 2008, only one payment terminal with Wi-Fi is available at the Norwegian market, namely Xentissimo manufactured by Banksys and which is imported to Norway by Point. BBS mainly uses another payment terminal producer, with the name Ingenico, which also has a terminal with Wi-Fi support, Ingenico 7810, but this is not offered in Norway yet. These two terminals will be introduced in the following sections.

3.5.1 Xentissimo from Banksys

Figure 3.4: The Xentissimo terminal, from http://www.point.no/templates/ProductLocal.aspx?id=623&t=4&img=625

According to [11], the Xentissimo terminal is 18.5cm long, 7.5cm wide and 4.0cm tall, and weighs 380g including printer, paper roll and battery. It has operating temperatures of -10 °C and up to 50 °C [11]. The rechargeable Lithium-Ion battery allows for 300 transactions a day with printed ticket, and the battery can be charged directly via an adapter.

The hardware of the Xentissimo terminal consists of two 32 bit ARM processor cores, 32 MBytes random access memory and 32 Mbytes Flash memory. It also has hardware accelerators for cryptography [11].

Among wireless options, the Xentissimo offers use of Wi-Fi, GPRS and GSM. Wi-Fi uses the IEEE 802.11b specification, which is described in Section 4.2.3. GSM and GPRS are supported in the 850, 900, 1800 and 1900 MHz band [11].

The Xentissimo terminal is capable of encrypting communication with the following encryption algorithms; Data Encryption Standard (DES), Triple Data Encryption Algorithm (TDEA), Advanced Encryption Standard (AES) and the Rivest, Shamir, Adleman (RSA) algorithm. The Secure Sockets Layer (SSL) implementation is of version 3 and it also supports Transport Layer Security (TLS) v1 [12]. It also has master/session Derived Unique Key Per Transaction (DUKPT) key management and some additional security schemes available [11]. The DUKPT key management scheme is described in Appendix A as it may not be as familiar to the reader as the other security mechanisms.

3.5.2 Ingenico 7810

The Ingenico 7810 consist of a payment terminal and a docking station used for battery charging. The terminal's dimensions are 20.9cm long, 9.6cm wide and 6.0cm tall, and weighs 600g. This terminal is bigger and weighs about 50% more than the Xentissimo terminal and the operating temperature of this terminal has a smaller range than that of the Xentissimo terminal, and only operates between 5 °C and up to 40 °C [13].

Figure 3.5: The Ingenico 7810 terminal, from [13]

The rechargeable Li-Ion battery of Ingenico 7810 holds for up to 200 transactions, which is only 67% of what the Xentissimo can achieve. Among hardware specifications, the terminal has one 32 bit ARM processor and 2 Mbytes static random access memory, and up to 8 Mbytes Flash. In addition, it is possible to use an optional MMC multimedia card slot [13].

This terminal offers two communication options, namely use of Wi-Fi and a v34 back-up modem which is on the base station. For Wi-Fi, IEEE 802.11b is used, as with the Xentissimo terminal.

Ingenico 7810 supports RSA, DES, TDEA, SSL, 128-bit Wired Equivalent Privacy (WEP) and Wi-Fi Protected Access (WPA). The following section will describe the security related to payment transactions.

3.6 Payment security

As wireless payment terminals transmit information about payment cards each time a transaction is carried out, it is crucial that this information is not revealed to anyone except the relevant financial institutions. Failing to provide a secure way of transferring information would destroy the trust and confidence this system and terminal have, which again could cause people to use other payment solutions. Since the information is sent by air between the terminal and the wireless access point, it is even more important to secure this information than in the case of a terminal using a fixed connection. The reason for this is that a wireless connection is easier to eavesdrop than a fixed connection. However, this does not mean that fixed connections should not be secured, or that a wireless connection can not be secure.

A way of securing information is to use encryption. Encryption is used to protect the integrity and confidentiality of the information represented by data during transmission or while in storage [14].

3.6.1 Security requirements

Payment terminals supporting Wi-Fi can not just be brought into an area within coverage and then be used. There are several requirements needed to be fulfilled in order to be able to use a Wi-Fi enabled terminal, and security is one of the most important requirements. The Banks' Standardization Office (BSK) is responsible for authorization of security solutions in Norway. The security requirement specifications for payment terminals are regarded as classified by the BSK and are thus not possible to present in this text [15].

However, a high-level description and some details have been obtained and will be introduced next.

A strict requirement within payment transaction security is end-to-end security. It must not be possible to intercept or alter the payment transaction information while in transmission from the payment terminal to the financial institution responsible for receiving payment transaction information, i.e. BBS in Norway. In order to have end-to-end security from terminal to BBS, the terminal software must support Wi-Fi. Currently, the terminal software from BBS does not yet have this support [16], while Point is currently testing the terminal software in combination with their own Virtual Private Network (VPN) solution, PointVPN [17]. Figure 3.6 illustrates the end-to-end encryption.

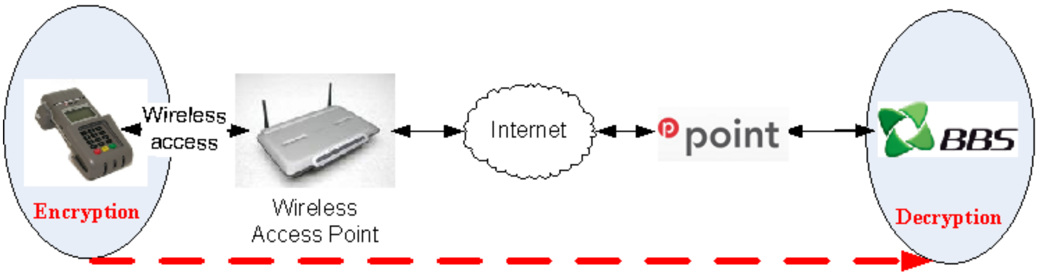


Figure 3.6: End-to-end security

The security requirements are the same independently of which communication solution is used. The security module in the terminal has as a minimum requirement to encrypt sensitive information with DES DUKPT, while TDEA DUKPT is recommended. The security module in the terminal must also encrypt the Personal Identification Number (PIN) and create a message authentication code according to BSK's requirements [15]. VPN has some additional requirements, but these are classified [15] and a description will therefore not be provided here.

However, if the PointVPN solution is approved by BSK, this means that there is no longer need for BBS Aksess[1] when using a payment terminal with VPN software [17]. Until BSK approves this solution or any other solution which allows the use of payment terminals with Wi-Fi, it is not possible to offer a commercial service with Wi-Fi access to payment terminals. This is also the reason for not being able to test a wireless payment terminal in the

[1]BBS Aksess is a Virtual Private Network connection dedicated to payment transactions which are sent to BBS.

Wi-Fi network of Wireless Trondheim, but this will be further described in Chapter 5, Testing.

A plausible explanation of why the Xentissimo terminal is available at the Norwegian market but not the Ingenico 7810, is that the Xentissimo terminal support both GPRS and GSM in addition to Wi-Fi. The Ingenico 7810 terminal is thus not possible to use yet, until BSK approves a security solution for terminals using Wi-Fi.

Chapter 4

Wireless access technologies for payment terminals

This chapter, in addition to Chapter 3, provide the answer to the task of describing the theoretical and technical potential of payment terminals using wireless communication. The following four wireless technologies will be described:

- Wi-Fi
- Bluetooth
- GSM
- GPRS

Before going into details on the wireless access technologies for payment terminals, the Open Systems Interconnection Reference Model (OSI) will be explained in order to clarify the different layers on which the wireless access technologies operate.

4.1 OSI Reference Model

The OSI Reference Model was designed in 1979 by a subcommittee of International Standards Organization (ISO), to be an architecture which could serve as a framework for the definition of standard computer communication protocols. The model consists of seven layers (which from top to bottom) are; *Application, Presentation, Session, Transport, Network, Data link* and

Physical layer [18]. These layers are described in Table 4.1 and an example of e.g. a payment terminal communicating with a server at a financial institution with two routers in between is depicted in Figure 4.1.

One of the main principles behind creating a specific layered structure is to enable changes of functions or protocols within a layer, without affecting the other layers. By creating a layer of easily localized functions, the layer could be *completely redesigned and its protocols changed in a major way to take advantages of new advances in architectural, hardware, or software technology without changing the services and interfaces with the adjacent layers* [18] page 429.

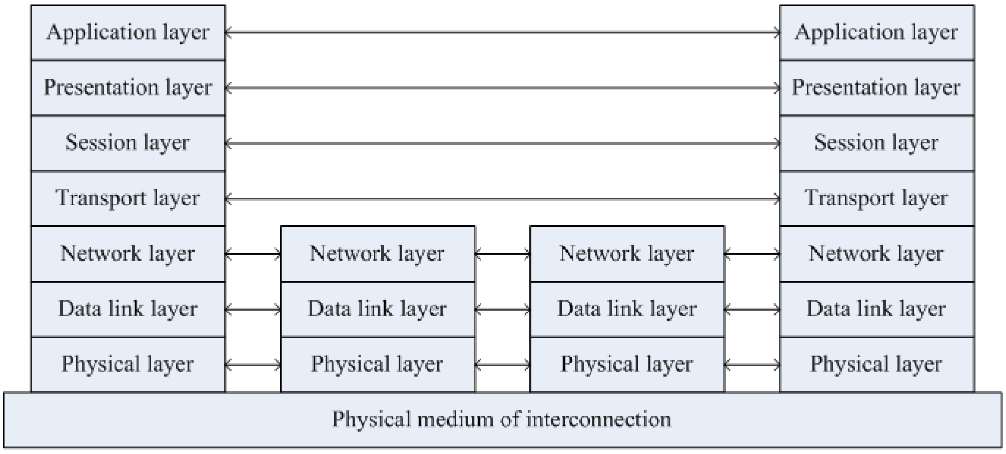


Figure 4.1: The 7 layer OSI Reference Model

In the following sections of this chapter, different technologies for providing the Physical and Data link layers in OSI Reference Model will be described.

4.2 Wi-Fi

The Wi-Fi Alliance is a global non-profit organization, formed in 1999 to promote a single standard for high-speed Wireless Local Area Network (WLAN). The Alliance tests and certifies wireless devices that implement the IEEE 802.11 standard [19], allowing only certified devices to use the Wi-Fi brand [20]. Wireless Trondheim has selected Wi-Fi access points to provide wireless access to Internet for users. Wi-Fi is at the data link layer in the OSI reference model. The access points used in Wireless Trondheim are based on the

Layer	**Description**
The Application layer	This is the highest layer in the OSI architecture. The protocols of this layer serve the end user by initiating, maintaining, terminating, and recording data concerning the establishment of connections for data transfer among application processes. The other layers exist only to support this layer.
The Presentation layer	The Presentation layer is located between the Application layer and the Session layer. The task of this layer is to enable the Application layer to interpret the meaning of the data exchanged.
The Session layer	The purpose of the Session Layer is to assist in the support of the interactions between cooperating presentation entities. To accomplish this, the Session layer provides two services, the first is to bind two entities into a relationship and unbind them. The second service is to control the data exchange, delimiting and synchronizing data operations between two presentation entities. The Session layer receives the data from the Transport layer.
The Transport layer	The Transport layer exists to provide a universal transport service in association with the underlying services provided by lower layers. This layer handles the details of how a reliable and cost-effective transfer of data is achieved. This layer also optimizes the use of available communications services to provide the performance required for each connection between session entities at a minimum cost.
The Network layer	The purpose of the Network layer is to provide functional and procedural means to exchange network service data units between two transport entities over a network connection. The Network layer handles the routing and switching of data packets.
The Data link layer	The Data link layer provides functional and procedural means to establish, maintain and release data links between network entities.
The Physical layer	The Physical Layer provides mechanical, electrical, functional, and procedural characteristics to establish, maintain, and release physical connections between data link entities.

Table 4.1: Description of the 7 layers in the OSI Reference Model

IEEE 802.11 standard with the amendments 802.11a, 802.11b and 802.11g [3]. This standard and each of these amendments are briefly described next.

4.2.1 802.11

IEEE 802 is a family of standards for Local Area Networks (LANs) and Metropolitan Area Networks (MANs) [21]. IEEE 802.11 is a standard for WLAN Media Access Control (MAC) sublayer and physical layer specifications. The standard was released in 1997 and clarified in 1999. IEEE 802.11 defines one MAC and several physical layer specifications for wireless connectivity for fixed, portable[1] and moving terminals within a local area [22]. The physical specifications given in 802.11, uses Frequency-Hopping Spread Spectrum (FHSS) and Direct Sequence Spread Spectrum (DSSS) in the 2.4 GHz band. A description of FHSS and DSSS can be found in [23].

The theoretical bit rate in this original specification is 1 Mbps and 2 Mbps [22]. Some details about the physical layer specifications used in Wireless Trondheim are given below. Table 4.2 summarizes some of the properties of IEEE 802.11a/b/g specifications [24].

4.2.2 802.11a

The IEEE 802.11a specification has the title *High-speed Physical Layer in the 5 GHz Band* and is an amendment to the 802.11 standard. It specifies use of the unlicensed 5 GHz frequency band and an Orthogonal Frequency Division Multiplexing (OFDM) system for modulation. A description of OFDM can be found in [23]. The highest theoretical bit rate achieved with this specification is 54 Mbps.

4.2.3 802.11b

IEEE 802.11b was released in 1999 and titled *Higher-Speed Physical Layer Extension in the 2.4 GHz Band*. It is an extension of the DSSS system used in the 802.11 standard. This extension enables 5.5 Mbps and 11 Mbps data rates in addition to 1 Mbps and 2 Mbps, and uses the same 2.4 GHz band as in the original 802.11 standard [25].

[1]By portable, it is meant that a terminal can be used at several locations.

4.2.4 802.11g

This specification is the fourth amendment to the 802.11 standard. The title is *Further Higher Data Rate Extension in the 2.4 GHz Band* and it was released in 2003. This extension supports data rates as high as 54 Mbps by the use of OFDM [26], which is the same modulation system as 802.11a.

Standard	**Frequency band**	**Theoretical data rate**	**Through-put**	**Range indoor** [a]	**Range outdoor** [b]
IEEE 802.11a	5GHz	54Mbps	23Mbps	~35m	~120m
IEEE 802.11b	2.4GHz	11Mbps	4.3Mbps	~38m	~140m
IEEE 802.11g	2.4GHz	54Mbps	19Mbps	~38m	~140m

[a]Depends on type and number of walls
[b]Loss includes one wall

Table 4.2: Properties of IEEE 802.11a/b/g

4.3 Bluetooth

Bluetooth is a wireless technology aimed towards voice and data applications. It is designed to use short-ranged, low-power, inexpensive wireless radios [27], and operates in the 2.4 GHz band with a range up to 100 meters [28]. Bluetooth technology uses a fifth of the power consumption compared to Wi-Fi, and costs about a third to implement [28].

Bluetooth has a gross data rate of 1 Mbps, and some of this is consumed by overhead [27], but this pose no obstacle for use of payment terminals since payment transactions require little bandwidth. With a range of 100 meters, Bluetooth may thus be viable for use by payment terminals in combination with a broadband connection.

The Bluetooth system has a basic unit called piconet, which is a master node and up to seven active slave nodes. Multiple interconnected piconets is called a scatternet.

The frequency band is divided into 79 channels of 1 MHz each. To allocate channels fairly, FHSS is used with 1600 hops/sec. All the nodes in a piconet hop simultaneously, with the master dictating the hop sequence. Since both 802.11 and Bluetooth operate in the 2.4 GHz band on the same 79 channels, they may interfere with each other. Bluetooth hops far faster than 802.11 and it is thus much more likely that a Bluetooth device will ruin 802.11 transmissions than the other way round [27].

Bluetooth is, as GSM, GPRS and Wi-Fi, capable of penetrating solid objects to a certain degree [28], and does thus not require line-of-sight between the terminal and the access point.

4.4 Global System for Mobile Communications (GSM)

GSM is a cellular system for mobile communications which was launched in 1991 [29], often referred to as second-generation mobile system, or 2G.

GSM uses frequency division multiplexing, that is, splitting a given frequency band into several smaller frequency channels, in this case, of 200 kHz each. Within a small frequency channel, time-division multiplexing is used to enable 8 users to use the same frequency channel. Each channel has a gross rate of about 270 kbps, or near 34 kbps per user. When overhead and error detection is subtracted, 13 kbps is left to use [27].

GSM is a circuit-switched network which, when a connection is started, makes the network reserve a predetermined amount of resources for as long as the connection is active [30]. This means that for each payment transaction made, the payment terminal must log on to the network, and is thus subject to start-up costs as well as the costs incurred for the time of the transaction. A payment terminal using GSM will typically use 10 seconds longer per transaction than a terminal using GPRS [31].

4.5 General Packet Radio Service (GPRS)

Most wireless payment terminals offered in Norway by early 2008, use GPRS as communication from the payment terminal to the financial institution handling payment transactions. GPRS is packet-switched, which allows radio frequency resources to be used only when sending and receiving data, as opposed to the circuit-switched GSM network, where the radio frequency resources are occupied for as long as the connection is established.

The maximum practical speeds of GPRS is about 100 Kbps. However, speeds of 40 Kbps or 53 Kbps are more realistic [30]. Chakravorty, Cartwright and Pratt [32] presented results of a series of GPRS performance testing, showing that Round Trip Time (RTT) is very large (> 1000 ms) and is highly variable. The same study also shows that the available bandwidth for GPRS is quite variable, and that packet losses are relatively rare.

However, a payment transaction does not require much bandwidth since one transaction is only 1000 bytes in size [33]. But the first transaction after a payment terminal has been turned on will use 10-15 seconds extra, because the terminal must log on to the system of the financial institution handling payment transactions [31].

4.6 Discussion

This chapter has briefly described Wi-Fi, Bluetooth GSM and GPRS. This section will compare the wireless communication solutions in the context of providing communication between a payment terminal and the financial institution.

The cellular network technologies GSM and GPRS have near nationwide coverage, while Wi-Fi and Bluetooth provide limited coverage as they are intended to be used as local area networks. The latter two technologies offer greater bandwidth than the currently used cellular technologies, and are thus faster to transmit the information. However, payment transactions are very small and hence does not require much bandwidth.

These local area networks are also always connected as long as the access point and terminal is turned on, and the same is true for a terminal using GPRS. A terminal using GSM however, needs to create a connection before transmitting and thus use considerably more time than GPRS, Bluetooth and Wi-Fi.

Comparing Wi-Fi and Bluetooth, the former consumes more power and is somewhat more costly to implement in the terminals than Bluetooth. With Wi-Fi it is easy to integrate wireless Internet provision and wireless payment terminals within the same access point, as opposed to Bluetooth which is less suited for this. Wi-Fi also enables roaming with payment terminals, which makes it possible to select among several access points dependent on which it receives the best signal from [34]. Although not having a major impact on most merchants, a Bluetooth piconet only supports 7 devices, while Wi-Fi theoretically only is limited by the number of IP addresses [34].

All of the wireless access solutions need to have end-to-end security that is approved by BSK. Currently, only GSM and GPRS are approved, but a Wi-Fi solution is being tested by Point and is likely to be approved at some point in the future [17].

It is not easy to prefer any of these wireless access technologies on a general basis based on the information in this chapter. Especially since no specific measurements of the time used by payment terminals using these technologies are available, nor studies of what times would be acceptable for a merchant and its customers. However, GSM distinguish oneself as the least preferred wireless technology since it use about 10 seconds more per transaction than GPRS and involve start-up costs in addition to cost per MB. Otherwise, the technologies are a trade-off for each merchant between area coverage, number of terminals within Bluetooth and Wi-Fi networks and costs. The latter will be looked into in Chapter 6, which examine the costs incurred by using a payment terminal with the communication solutions described in this chapter.

Chapter 5

Test of payment terminals using Wireless Trondheim's Wi-Fi network

This chapter describes how a test of a payment terminal using Wireless Trondheim's Wi-Fi network was supposed to be conducted. In this study, however, the test was, as mentioned earlier, not conducted because the solution of payment terminals using Wi-Fi is not yet available [16]. Point is currently testing a solution for payment terminals using Wi-Fi, but this solution is not yet approved [17]. This chapter consists of two sections, where the first section explains the goals of testing and the last explains, on a high level basis, how a test would have been conducted.

5.1 The goals of testing

In order to assess the commercial and technical potential of providing payment access to payment terminals with Wi-Fi, a test of Wireless Trondheim's Wi-Fi network and a payment terminal should have been conducted. The goals of the test are to:

1. Check whether the signal strength is sufficient.
2. Measure payment transaction time.
3. Evaluate Quality of Service (QoS).

Measurements of the indoor Wi-Fi coverage at cafés and restaurants have already been performed by Wireless Trondheim, and cafés and restaurants with coverage in large parts or whole of the premises are shown in Section 2.2. Still, it would be interesting to test a few typical cafés and restaurants with a Wi-Fi enabled payment terminal, since these only use IEEE 802.11b and may have different signal reception than the test equipment used to measure the indoor Wi-Fi coverage shown in Figure 2.1.

Another aspect of the test is measuring the time needed to establish a connection between the payment terminal and the financial institution handling payment transactions. A measurement of the time of a single transaction when using Wi-Fi should be evaluated to determine whether it is within an acceptable range for a payment transaction. It would also be interesting to compare the time against GPRS which, if a significant difference exist in Wi-Fi's advantage, could provide Wi-Fi with an advantage.

QoS is important when dealing with online payment transactions. Insufficient availability could lead to loss of sales for the merchant, and an adequate QoS must therefore be a requirement. A test would indicate whether the current QoS of Wireless Trondheim's Wi-Fi network is adequate for use by payment terminals.

The result of this test would then determine whether it is possible to offer payment access without new investments to improve coverage and QoS.

5.2 How to test

A test would include the premises of at least two merchants in addition to an outdoor test at the market in Trondheim. The first test would be a typical premise of a merchant with good signal reception in most of its premise, which corresponds to the cafés and restaurants with a yellow balloon in the coverage map in Section 2.2. The second test would be at a merchant with full or nearly full coverage, corresponding to a green balloon in the coverage map. These two tests would ensure results applicable to other merchants with similar signal reception. An outdoor test would also have been conducted at the market in Trondheim city, to check that also merchants using payment terminals outdoor have sufficient coverage and QoS.

The indoor test would preferably be conducted by merchants (e.g. café or restaurant) willing to perform test throughout at least a week. This would ensure test of signal strength and QoS as well as a test of customer satisfaction.

Part III

Commercial potential and cost-effectiveness

This part consists of two chapters; the first one will compare the costs for each of the wireless alternatives for payment terminals, and also suggest a competitive and attractive price for the Wi-Fi payment access service described in Chapter 7, based on the price of the existing alternatives.

The second chapter in this part, Chapter 7, contains a suggestion of a business model proposal for Wireless Trondheim. In this business model proposal, Wireless Trondheim offers Wi-Fi payment access to two target customers; cafés and restaurants, and merchants at temporary events in Trondheim city. The commercial potential of the business model proposal will be determined by a cash flow analysis, which also concludes on whether payment terminals using Wireless Trondheim's Wi-Fi network is a cost-effective solution compared to the other wireless solutions in this business model.

Together, the two chapters in this part will answer the following two of the five research questions:

- Identify commercial potential for utilizing Wireless Trondheim's network to be used by payment terminals.
- Identify whether payment terminals using Wireless Trondheim's Wi-Fi network is a cost-effective solution compared to other wireless communication solutions.

Chapter 6

Wi-Fi cost-effective compared to other wireless solutions?

This chapter will look at the prices of alternative wireless data solutions for merchants. These alternatives include using GSM, GPRS and a fixed broadband line with a wireless Wi-Fi or Bluetooth network. The aim of this chapter and the next, is thus to *identify whether payment terminals using Wireless Trondheim's Wi-Fi network is a cost-effective solution compared to other wireless communication solutions*. This will be done by comparing prices for a typical merchant for each of these alternatives, and determine the price which Wireless Trondheim should use in order to be offering an attractive and competitive price for its payment access service.

6.1 Cellular access

Among the three network operators in Norway; Network Norway, Netcom and Telenor, the former does not offer wireless access to payment terminals. Both Telenor and Netcom offers wireless payment access through GPRS, while Netcom also offers GSM. A brief description and overview over the communication costs for payment terminals are provided below.

6.1.1 Netcom GSM and GPRS

Netcom offers a subscription plan called Netcom Telemetri, which only allows data traffic. According to Netcom's web site [35], Netcom offers both GPRS and GSM, the latter having different prices to Netcom, fixed line and Telenor. The price of this subscription plan is depicted in Table 6.1, and is given in NOK and exclusive Value-Added Taxes (VAT).

Description	**Price excl. VAT**
Establishment fee	100
Monthly fee	20
GPRS (per MB)	16
Start-up cost (GSM)	0.39
To Netcom (GSM) per min.	0.56
To fixed line (GSM) per min.	0.71
To Telenor (GSM) per min.	1.95

Table 6.1: Netcom Telemetri prices in NOK exclusive VAT

6.1.2 Telenor GPRS

The subscription plan offered to payment terminals by Telenor is called GSM Alarm, although it uses GPRS [36]. The establishment fee is 100 NOK excl. VAT [37]. The prices for payment terminals using Telenor GPRS are described in Table 6.2. It should be noted that the price for the first MB per month has a much higher price than each successive MB.

Description	**Price excl. VAT**
Establishment fee	100
Monthly fee	16
GPRS first MB	59
After first MB (per MB)	20

Table 6.2: Telenor Mobile Payment Access - prices in NOK exclusive VAT

6.2 Merchants using a private Wi-Fi or Bluetooth access point

A last option for using wireless payment terminals is for the merchants to provide the wireless connection themselves. This option is not feasible for merchants at temporary events, but restaurants and cafés may consider this option.

A common property for using broadband and a private Wi-Fi is that it has a fixed monthly cost, in addition to the establishing fee. The cost of communication between the payment terminal and BBS is not dependent on the number of payment terminals nor the volume of traffic sent.

For a merchant to use a private access point is, as in the case of using Wireless Trondheim's Wi-Fi network, not determined yet because it is yet to be approved, as described in Section 3.6. Two solutions can be thought of; 1) either use of VPN in the terminal and use an Internet connection, which Point is currently testing, or 2) use BBS Aksess which is a dedicated VPN connection from the modem to BBS. The latter case is shown in Figure 6.1. In the following sections both alternatives will be compared with regard to the costs for a merchant.

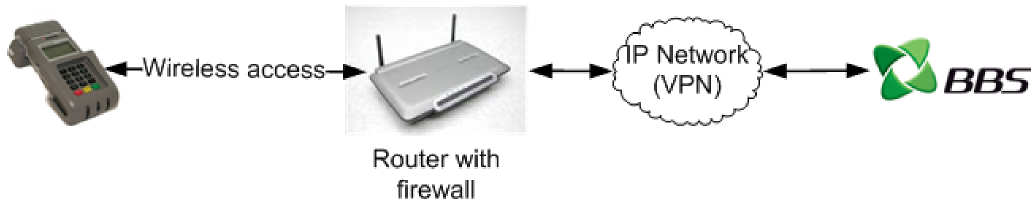


Figure 6.1: ADSL payment access and a private WLAN

Three BBS Aksess providers have been identified by searching in the Norwegian pages in Google for BBS Aksess. These providers are Ventelo, NextGenTel and Telenor, and the prices for access to BBS and the cheapest broadband line have been obtained from each of these Internet service providers.

6.2.1 Telenor

Payment access from Telenor requires the merchant to have a fixed Public Switched Telephone Network (PSTN) line, which is used by an ADSL modem to contact BBS. The ADSL modem includes an ICSA[1] certified firewall, and is installed at the merchant's premises. The ADSL line is dedicated for payment transactions, and is always connected to BBS. The PSTN line can still be used to telephony, fax or other telephone services. The availability for Telenor's network is at 99.92%, including maintenance time [38].

[1]International Computer Security Association, an independent division of Verizon, is the security industry's central authority for research, intelligence, and certification testing of products.

Table 6.3, obtained from [39] and [40], show the monthly price for Payment Access Internet, the cheapest alternative of ADSL broadband line and the establishment fee for Payment Access Internet. Telenor is currently, and until June 16 2008, offering 25% price reduction for the first year of a 12 months ADSL subscription, which is 374 NOK per month. Due to this limited offer, the full price will be used in the comparison calculations in Section 6.3. In order to have Payment Access Internet from Telenor, an ADSL broadband subscription from the same company is required [39].

Description	**Price excl. VAT**
Establishment fee	400
Monthly fee Payment Access Internet	99
ADSL 2000/400 Kbps	499
ADSL line without telephony	75

Table 6.3: Telenor ADSL and Payment Access IP - prices in NOK, exclusive VAT

6.2.2 NextGenTel

NextGenTel offers a similar product as Telenor. A VPN connection from NextGenTel secures the payment transactions by encryption between the ADSL modem and BBS. NextGentel VPN Point of Sales requires DSL access from NextGenTel [41]. Table 6.4, obtained from [42], reflects the establishment fee and monthly fees for access to BBS and for the cheapest Internet connection.

Description	**Monthly price excl. VAT**
Establishment fee NGT VPN Point of Sale	498
Monthly fee VPN Point of Sale	129
ADSL without telephone	60
Installation engineer (one time) for customers without telephone	499
Establishment fee for Internet (Bedrift and Mega Bedrift)	499
Bedrift Mini 500/250	299

Table 6.4: NextGenTel VPN Point of Sale - prices in NOK, exclusive VAT

6.2.3 Ventelo

Ventelo is the last of the three Internet service providers offering BBS Aksess in Norway. Their product is called POS, short for Point of Sale. As can be seen in Table 6.5, there are different establishment fees dependent on whether Internet connection is wanted in addition to POS or not [43]. Ventelo is the only one of these broadband providers that offers access to BBS Aksess without requiring ADSL connection. The establishment fee of Internet and POS, or only Internet, is given as 1990 NOK, which is about four times the establishment fee which Nextgentel has for ADSL establishment. However, at the time of writing (April 2008), there is a campaign which offers free establishment for POS and Internet.

Description	**Price excl. VAT**
Establishment fee POS	199
Establishment fee (POS and Internet)	1990
Monthly fee POS without Internet	149
Monthly fee POS with Internet	99
Internet Bedrift ADSL 512/256 Kbps	449

Table 6.5: Ventelo prices for POS and Internet - prices in NOK, exclusive VAT

6.3 Cost comparison of wireless payment access solutions

Among the alternative wireless solutions for payment terminals, the costs for access to BBS differ in being dependent on parameters such as number of terminals and transaction volume and monthly fee. Table 6.6 summarizes the different wireless alternatives, and display whether each solution has a monthly fee, or is dependent on number of terminals or dependent on the transaction volume.

The table shows us that the solution offered by Wireless Trondheim has some of the same properties from both the cellular solution and using a private Wi-Fi or Bluetooth access point.

Type of wireless communication	**Fixed cost**	**Cost dependent on number of terminals**	**Cost dependent on number of transactions**	**Monthly fixed fee**
GPRS	No	Yes	Yes	Yes
Wireless Trondheim's Wi-Fi	No	Yes	No	Yes
Broadband and a private Wi-Fi access point	Yes	No	No	Yes
Broadband and a private Bluetooth access point	Yes	No	No	Yes

Table 6.6: Overview of wireless alternatives with fixed and variable price

6.3.1 Cost comparison for fixed payment access

In this section, a cost comparison for the different alternatives of wireless communication for payment terminals in Trondheim will be given. This cost comparison will be viewed from that of a single, representative merchant in Trondheim, and the basis of this comparison is the different wireless alternatives described earlier in this paper. It should be noted that the price differences of leasing or buying a terminal with GPRS, Wi-Fi or Bluetooth has not been accounted for in this study.

The result of this comparison will determine the price in the business model proposal where Wireless Trondheim offers wireless access for fixed payment terminals in Chapter 7. Wireless Trondheim will offer a competitive price and use this as a basis for the calculation of revenues. If this competitive price gives Wireless Trondheim adequate profits then Wi-Fi in this case will be cost-effective compared to the other alternatives.

Since two of the possible alternatives are dependent on either number of terminals or number of transactions, an estimate for a representative customer is required. Thor-Ragnar Klevstuen at Sparebank 1 Midt-Norge has made an estimate based on recent data from an average café [44]. Although an average café might not represent an average customer of Wireless Trondheim, it is still one of the target customers in the business model proposal that will be described in the next chapter. The estimate of number of transactions per week and number of payment terminals for a typical café or restaurant in Trondheim is as follows:

- 1 or 2 payment terminals per café.
- 500-1000 transactions per week.

Based on the estimate for a typical café and the costs described earlier this chapter, four figures have been depicted to compare the costs for payment transactions based on the estimate for a typical café. In Figure 6.2 through Figure 6.5, the leftmost pillar on each provider shows the cost for the first month, which includes the establishment fee. The rightmost pillar on each provider shows the monthly costs without the establishment fee.

Figure 6.2 and 6.3 compares the costs if BBS Aksess is required with the low and high usage estimate, respectively. All four figures include the costs of GPRS and GSM from Telenor and Netcom in order to easily compare the costs.

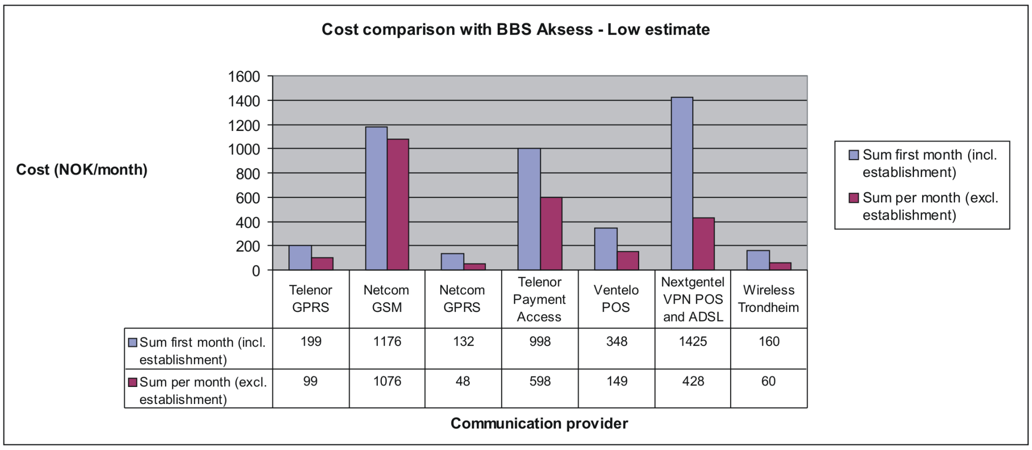
Figure 6.4 and 6.5 compares the cost for a merchant if it becomes possible to use a private Wi-Fi or Bluetooth access point and an ordinary ADSL line without BBS Aksess. Figure 6.4 shows a comparison based on low estimate, that is, one payment terminal per merchant and 2000 payment transactions per month, while Figure 6.5 shows a comparison based on a high estimate, in this case two payment terminals per merchant and 4000 payment transactions per month.

For Wireless Trondheim an establishment fee of NOK 100 and a monthly fee of NOK 60 per terminal have been used, because it is then the second cheapest alternative for both the low and high estimates of fixed payment access. The price chosen for Wireless Trondheim has also been included in the four figures to illustrate its price compared to the other alternatives.

6.3.2 Cost comparison for temporary payment access

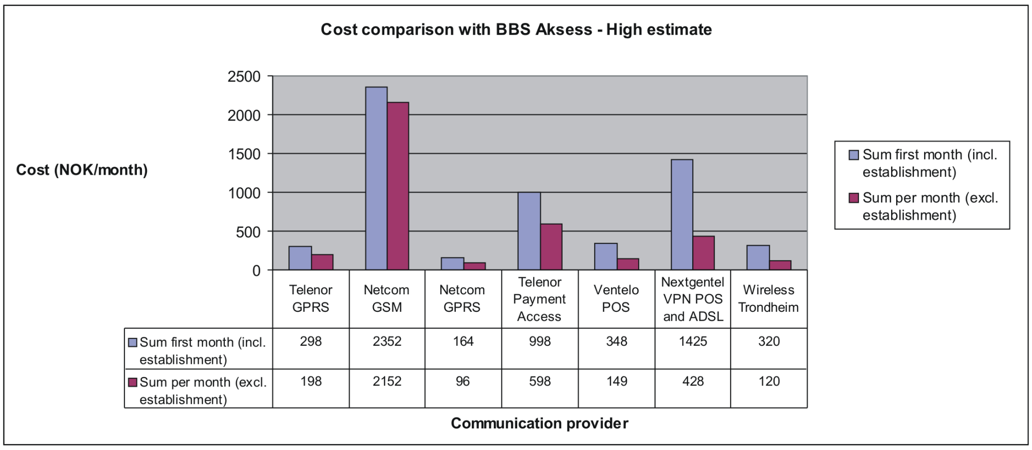
Comparing costs for temporary customers is somewhat more difficult than for fixed customers. The reason for this is that temporary customers have different needs in form of the lease period, number of terminals and number of transactions. Thus, in order to make an average estimate of costs, the total number of estimated temporary customers per year[2] is used to compare Telenor GPRS, Netcom GPRS and Wireless Trondheim. The prices used for

[2]See Section 7.3.2 for these estimates.



	Telenor GPRS	Netcom GSM	Netcom GPRS	Telenor Payment Access	Ventelo POS	Nextgentel VPN POS and ADSL	Wireless Trondheim
Sum first month (incl. establishment)	199	1176	132	998	348	1425	160
Sum per month (excl. establishment)	99	1076	48	598	149	428	60

Figure 6.2: Cost comparison for fixed payment access using BBS Aksess - low estimate



	Telenor GPRS	Netcom GSM	Netcom GPRS	Telenor Payment Access	Ventelo POS	Nextgentel VPN POS and ADSL	Wireless Trondheim
Sum first month (incl. establishment)	298	2352	164	998	348	1425	320
Sum per month (excl. establishment)	198	2152	96	598	149	428	120

Figure 6.3: Cost comparison for fixed payment access using BBS Aksess - high estimate

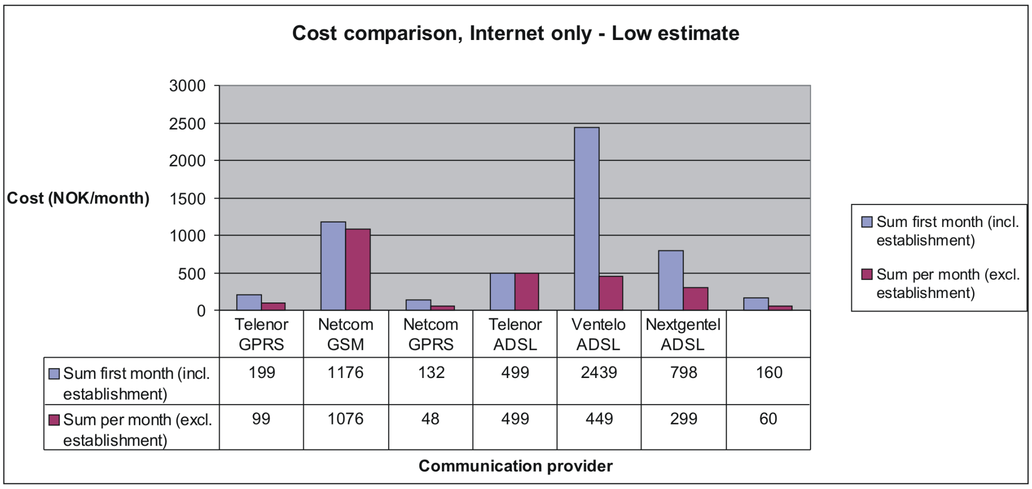


Figure 6.4: Cost comparison for fixed payment access using Internet - low estimate

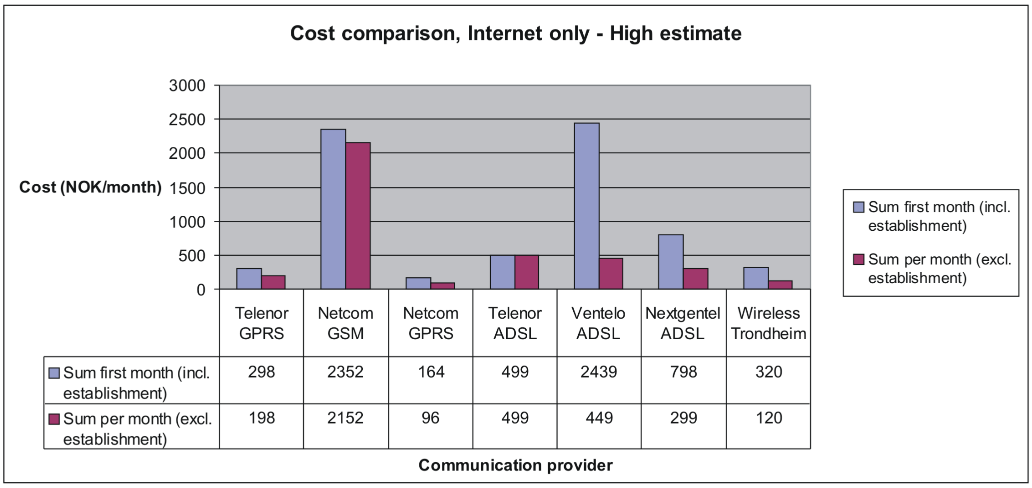


Figure 6.5: Cost comparison for fixed payment access using Internet - high estimate

Netcom and Telenor GPRS are the same as described in Section 6.1.1 and 6.1.2. Netcom GSM has been omitted due to the extremely high costs, which occur because of the start-up cost and the high cost per MB.

Figure 6.6 compares the total amount in NOK for a year if all customers chose one of the providers. The third through seventh column shows the cost of using Wireless Trondheim with the price per commenced week per terminal of 10 NOK, 20 NOK and so on up to 50 NOK. In addition, each terminal has an establishment fee of 100 NOK. The total amount for Telenor and Netcom GPRS is based on one month fee per terminal, the establishment fee per terminal, and the total number of transactions divided on number of terminals.

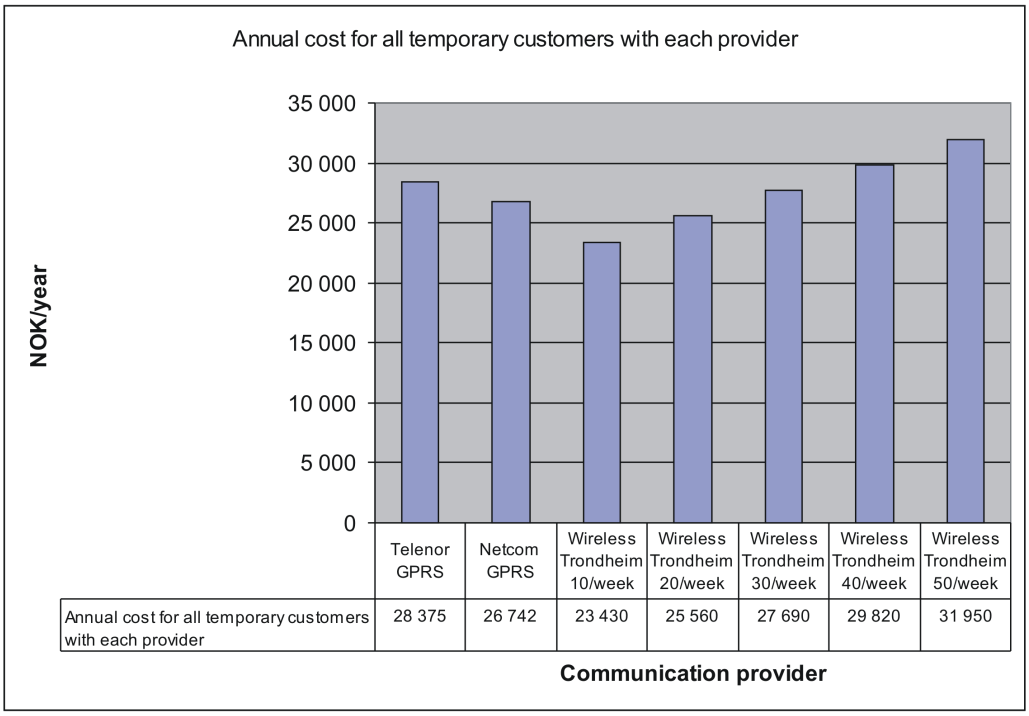


Figure 6.6: Cost comparison for the total number of customers for temporary payment access

6.4 Discussion

As described in Section 6.2, it is unknown whether using a private wireless access point with Wi-Fi or Bluetooth requires either BBS Aksess or Internet only, because this solution is yet to be approved. Regardless of this outcome, Netcom GPRS is the cheapest amongst the alternatives.

If it requires BBS Aksess, Figure 6.2 and 6.3 shows that Netcom GPRS is the cheapest, while Telenor GPRS and Ventelo POS is the second cheapest alternatives for the low and high estimate, respectively. A competitive price of Wireless Trondheim's service is here chosen to be a monthly fixed fee of 60 NOK and an establishment fee of NOK 100. This price is attractive both for the low and high estimate of use, having only Netcom GPRS as a cheaper alternative.

Similarly if BBS Aksess is not needed, Figure 6.4 and 6.5 shows that Netcom GPRS is still the cheapest alternative for fixed access to payment terminals. Now, however, Telenor GPRS is the second cheapest alternative with Nextgentel VPN POS and ADSL being third, when disregarding the potential service from Wireless Trondheim. It can be seen in Figure 6.4 and 6.5 that a price of 60 NOK per month and an establishment fee of 100 NOK will make Wireless Trondheim's service as the second cheapest alternative even if BBS Aksess is not required.

Netcom GPRS is also the cheapest alternative for temporary payment access, as shown in Figure 6.6. In this figure, the broadband connection alternatives have been omitted since these are inadequate for use outdoor and on temporary basis. Netcom GSM has also been omitted due to the high costs shown in the fixed price comparison, making it unlikely to be used for temporary payment access. The cost of Wireless Trondheim is in this case based on a weekly price of 10 to 50 NOK, and an establishment fee of NOK 100. As can be seen, to be the cheapest alternative, a weekly price of about 20 NOK or less must be introduced. A weekly price of NOK 30, which has been chosen as a competitive and attractive price if Wireless Trondheim would offer Wi-Fi payment access, place Wireless Trondheim's potential offer in between the GPRS offers from Telenor and Netcom.

This chapter show which prices Wireless Trondheim can charge for providing wireless access for payment terminals, and still be an attractive provider, compared to the other wireless alternatives. However, it remains to investigate whether these prices will be profitable for Wireless Trondheim. If not, then Wi-Fi from Wireless Trondheim, with the assumptions made and the potentially available customers, is not cost-effective compared to the other alternatives, especially GPRS. This will be further discussed in Section 7.4.

Chapter 7

Business model proposal - cooperation with banks

This chapter will try to identify the commercial potential of using Wireless Trondheim's Wi-Fi network, to provide communication between wireless payment terminals and the financial institution handling payment transactions. In order to do this in a structured and well defined way, the Business Model Ontology of Osterwalder [1] will be used as a framework to create a business model. This author has performed a literature review of existing literature on business models and defined a business model ontology containing nine building blocks. Each of these building blocks are mentioned by at least two other authors. The building blocks are described in Appendix B. Osterwalder defines a business model as:

> *A business model is a conceptual tool that contains a set of elements and their relationships and allows expressing a company's logic of earning money. It is a description of the value a company offers to one or several segments of customers and the architecture of the firm and its network of partners for creating, marketing and delivering this value and relationship capital, in order to generate profitable and sustainable revenue streams* [1] page 15.

Osterwalder distinguish between three types of business models, which has different purposes.

1. *Abstract business model*: This is a generic business model consisting of elements, components and relationships.
2. *Operating business model*: This is an instance of a generic business

model which has been implemented in a company.

3. *Scenario business model*: This is a virtual business model, and does not exist in the real world. The scenario business model can be used to foster innovation or simulating opportunities, and represent a virtual instance of the generic business model.

In this thesis, the business model will not comprise all aspects of the money earning logic of the company Wireless Trondheim, but rather identify whether offering Wi-Fi connection to merchants with wireless payment terminals is economically profitable and earns a satisfying return on investment. Thus, the business model proposed in this chapter can be classified as a scenario type of business model.

Currently there are different points of view when it comes to the difference between strategy and business models. Osterwalder look at strategy, business models and process models as different layers of addressing the same problem [1]. These layers can be depicted as in Figure 7.1. The business model proposal described below is only dealing with the business model layer, and neither the strategic layer nor the process layer. Thus, strategy and implementation of this business model is considered to be outside the scope of the business model presented here.

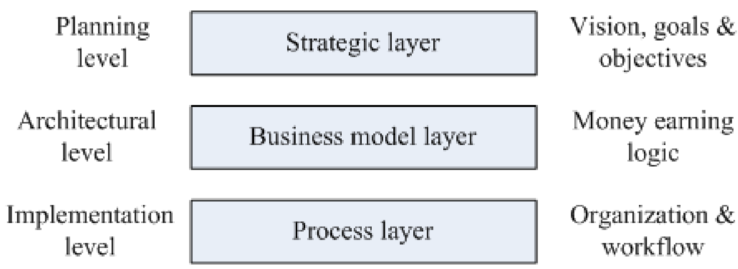


Figure 7.1: Business layers

Appendix B gives a brief description of the main components of the business model structure used in this chapter. This appendix should be read before the business model proposal below, if the reader is not familiar with the structure of the business model ontology introduced by Osterwalder in [1].

The following section describes the business model proposal, while Section 7.2 describes the risk and uncertainties which are relevant for this business model. Section 7.3 present a cost calculation, estimation of number of customers, a Net Present Value (NPV) calculation and a sensitivity analysis of the most important variables used in the NPV calculation. Finally, in Section 7.4, the business model proposal, including the business and technical risks and cash flow analysis, is evaluated.

7.1 Business model proposal

This business model proposal aims to identify whether Wireless Trondheim should offer Wi-Fi connection to payment terminals in cooperation with the local branches of banks. This proposal is just one possibility of a business model of this service, and there can be a lot of different business models applied, based on Wireless Trondheim and Wi-Fi connection to payment terminals, dependent on cooperations, value proposition, target customers and every other element within a business model.

The reasons for cooperating with the banks are to minimize Wireless Trondheim's costs by utilizing the existing customer relationship between the banks and the merchants and the banks' distribution channels, to contact potential customers and to lower the number of activities needed to be performed by Wireless Trondheim.

The business model elements presented below are not as detailed as the theoreticical business model ontology proposed by Osterwalder. The reason for using less details is that the business model with all details becomes too comprehensive for the purpose in this thesis, which is to determine whether Wireless Trondheim offering Wi-Fi access to payment terminals has a commercial potential.

7.1.1 Product

The product offered by Wireless Trondheim in this business proposal, is a communication service to merchants using payment terminals. By offering Wi-Fi connection to merchants using payment terminals, merchants can easily provide a convenient way of paying for goods. Today, merchants with wireless payment terminals often use GPRS, but when the solution of using payment terminals with Wi-Fi is approved, they might use their own private WLAN from their fixed broadband line or Wi-Fi from Wireless Trondheim.

Value Proposition:

The value proposition in this business model proposal is to offer payment terminals wireless access to BBS, which handles all the payment transactions in Norway. The wireless access is achieved by using Wireless Trondheim's Wi-Fi network from the wireless payment terminal to Wireless Trondheim's feeding network, and from there sending the transaction information to BBS. As mentioned in Section 3.6.1, Point is testing a solution with VPN connection from the payment terminal and via Point sending the payment transaction information to BBS [17], which is the solution assumed in this business model proposal.

This value proposition of this business model proposal is explicitly described in Table 7.1, and is offered to the target customers, consisting of cafés and restaurants and merchants at temporary events, described in detail below.

7.1.2 Customer interface

The customer interface pillar is about who the customers are (target customer), how to reach the customers (distribution channel) and what kind of relationship to have with them (relationship) [1]. To find out who the most likely customers are, it is useful to imagine who might need or want the value proposition offered by the company. By selecting the most likely customers, marketing efforts can be concentrated on a narrower base of customer and hence be more effective. The next section defines the target customers, followed by how to reach these customers in the distribution channel section.

Target customer

The most general distinction of customers is between business and consumers, often referred to business-to-business (B2B) and business-to-consumers (B2C) [1]. As the value proposition in this business model proposal offers Wi-Fi connection to be used by payment terminals, and payment terminals are only used by businesses, the target customers are within the B2B category. Furthermore, as described in Section 2.2, the Wi-Fi coverage is only covering parts of Trondheim city, and not all locations within this area have sufficient signal reception to use Wi-Fi from Wireless Trondheim. Thus, businesses in Trondheim within the coverage area and with sufficient signal reception are the present target segment for this business model proposal. More or less

Description:	This value proposition provides a data connection between the payment terminal and Wireless Trondheim's infrastructure, where the payment terminal can transmit transaction information to BBS.
Reasoning:	The reason why Wi-Fi connection offers value to the customer (i.e. merchant), is that providing wireless connection between the payment terminal and BBS is a convenient way for customers and merchants to exchange money through payment cards. With wireless payment terminals, cardholders may pay at any location near the merchant. As an example, people dining at a restaurant may be presented with a wireless payment terminal using Wi-Fi at their table, thus reducing the restaurant's customer need to walk over and enter a possible queue to a stationary payment terminal at the cash register.
Value level:	The value of this service may be characterized as a commodity. There is not much difference in the use of competitors alternatives of using GPRS or a private fixed broadband line with wireless access point for a merchant within Trondheim city.
Price level:	As there already exist several substitutes for wireless payment terminal communication (see Chapter 6), this service needs to be priced at the lower end of the price scale. In order to make it attractive to change existing communication service to Wireless Trondheim's Wi-Fi, it must be priced low unless some extra features or attributes of the value proposition gives it additional value, which currently is not the case.

Table 7.1: Value proposition - Wi-Fi connection to payment terminals

businesses will be included if the coverage area is expanded or is being reduced. This B2B customer segment can be further decomposed into several specific target customers:

Target customer 1: Cafés and restaurants. Cafés and restaurants often serve customers at their table, and with a wireless payment terminal the customer can also pay at the table. Figure 2.1 in Section 2.2 show the locations of cafés and restaurants with sufficient signal reception, and distinguishes between those with coverage at most parts of the premises, and those with coverage in all parts or nearly all parts of the premises. These cafés and restaurants will be the specific target customers with the current coverage area.

Target customer 2: Merchants at temporary outdoor market. Merchants coming to the city selling different kind of goods for a short period may want to use wireless payment terminals as they do not have any other options of receiving payments than cash. Since payment cards are widespread in Norway and very often used, it may increase the sale of these merchants. An example of temporary merchant are UKA - the largest cultural festival in Norway which is arranged every second year in Trondheim. Although concerts are not held within the coverage zone of Wireless Trondheim, tickets are sold both at NTNU's campus at Gløshaugen and Dragvoll, and in the city within coverage of Wireless Trondheim. For other potential temporary customers, see Section 7.3.2 on customer estimates.

Distribution channel

The distribution channel is the mean of getting in touch with the target customers, and each distribution channel consists of one or several channel links. Each channel link describe a specific marketing task [1]. This business model proposal suggests three distribution channels.

Distribution channel 1: www.wirelesstrondheim.no and www.tradlosetrondheim.no:

These web sites are hosted by Wireless Trondheim and will be one of the information sources for potential customers, describing the service, available coverage area and the process of buying Wi-Fi access to their wireless payment terminals.

Service information: At these web sites, services offered by Wireless Trondheim are described in detail. The service information contributes to awareness and evaluation of the service for customers.

Wireless coverage: A map displays the area within Trondheim city which is covered by Wireless Trondheim's Wi-Fi. It also describes whether restaurants and cafés have full coverage on the whole premises or if it is only partially covered.
Link to online order: Merchants find links to resellers which sell Wireless Trondheim's Wi-Fi connection for wireless payment terminals.

Distribution channel 2: Web sites of banks in Trondheim:

The web sites belonging to the banks which sell or lease payment terminals within Trondheim will be an important distribution channel, as many of the local branches of banks in Trondheim sell and lease payment terminals. A search on the Internet search engine Sesam[1] in April 2008 on banks in Trondheim showed six banks selling or leasing payment terminals; Selbu Sparebank, Nordea, DnBNOR, Fokus Bank, Sparebank 1 Midt-Norge and Handelsbanken[2].

Online order: Customers are presented with a list of payment terminals, both wireless and stationary. The wireless terminals are offered with either GPRS or Wireless Trondheim's Wi-Fi, at the customer's choice and need.
Service information: In the online order schema the customers are provided with a short description of the service offered by Wireless Trondheim.
Wireless coverage: As above, the customers are informed that the offering from Wireless Trondheim is subject to wireless coverage.

Distribution channel 3: Local branches of banks:

For those not using the Internet to buy or lease payment terminals, the banks also sell or lease payment terminals in their local branches.

Order: As in the case of the online order of websites above, the customers are here presented with a list of payment terminals, both wireless and stationary. The wireless terminals are offered with either GPRS or Wireless Trondheim's Wi-Fi, at the customer's choice and need.
Service information: Same as distribution channel 2 above.
Wireless coverage: Same as above.

Figure 7.2 show the relationship between the value proposition, target cus-

[1]The search engine Sesam was chosen because it is Norwegian and enables search on geographic locations.
[2]Banks not selling or leasing payment terminals have been omitted.

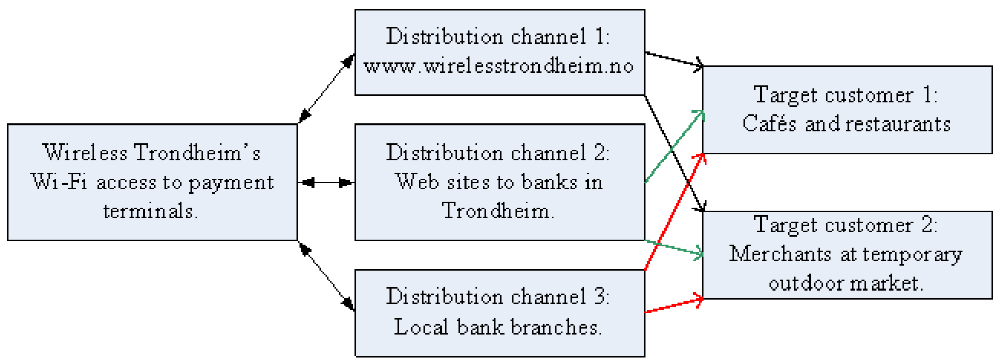


Figure 7.2: Relationship between value proposition, distribution channel and target customers

tomer and distribution channel in this business model proposal.

Relationship

The relationship building block describes the relationship between the target customers and the company regarding the service [1].

Relationship 1: Customers. Wireless Trondheim's focus will be on acquiring new customers, since this is a new service for Wireless Trondheim. For banks, the relationship could be both acquiring new customers and customer retention, because adding Wi-Fi connection as an option might be attractive for merchants that already are customers, as well as new customers.

7.1.3 Infrastructure management

The infrastructure management pillar describes how value is created by explaining the capabilities needed, the value configuration used and the partnerships formed [1].

Capability

The relevant capability in this case is connecting wireless payment terminals to BBS.

Capability 1: Connecting wireless payment terminals to BBS: To connect the wireless payment terminal with the financial institution handling the payment transaction, an Internet connection must be provided. Wireless Trondheim has a few years experience in delivering Internet to people in Trondheim, and should thus also be capable of providing Internet to wireless payment terminals. This capability is enabled by the resources Wireless Trondheim has in wireless access points.

When providing wireless connection to payment terminals, it is important to have high QoS on the connection. As the BankAxept requires online access to operate normally, this must have a high priority, and may require higher support and/or maintenance costs.

Value configuration

The value configuration building block describes the main activities and how they relate to each other. The value configuration of this business model proposal is value network, and as described in Appendix B, the value network consists of primary activities within three types: network promotion and contract management, service provisioning and network infrastructure operation. The primary activities in the value configuration of the proposed business model are described below and summarized in Figure 7.3.

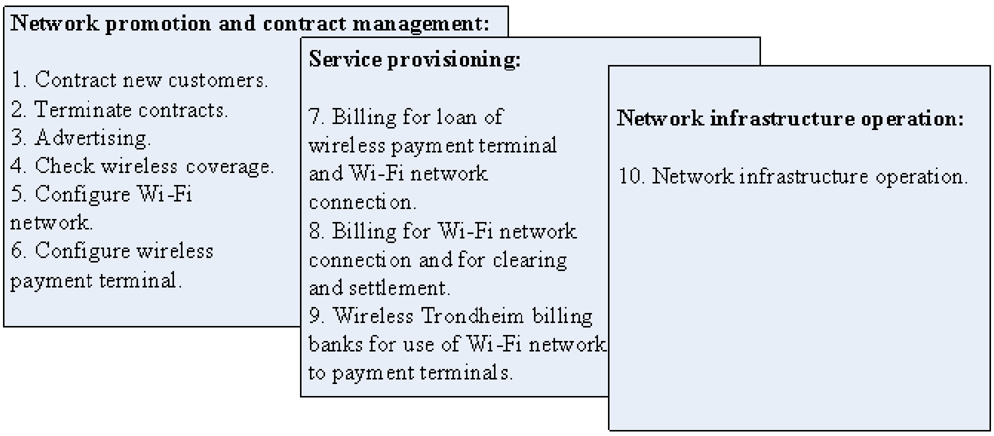


Figure 7.3: Primary activities in the value network

Network promotion and contract management:

Activity 1: Contract new customers. This activity involves signing contract with new customers. The contracts are available at the local bank branches and on the online order form on the bank's web sites.

Activity 2: Terminate contracts. If or when a customer does not want Wireless Trondheim's service any longer, the contract must be terminated and the account canceled. The re-configuration of wireless payment terminals are done by BBS or Point. Wireless Trondheim must remove the access granted to the MAC address of the wireless payment terminal when the contract is terminated.

Activity 3: Advertising. The web site of Wireless Trondheim can display information about the new offer to merchants with wireless payment terminals. Also, direct marketing through mail or email may be sent directly to the potential customers.

Activity 4: Check wireless coverage. In most cafés and restaurants, this is already done by Wireless Trondheim, and a check would then only consist of looking at the coverage map in Chapter 2. For merchants not already checked, a test would have to be conducted before signing contract and granting access and configuring the payment terminal.

Activity 5: Configure Wi-Fi network. The wireless payment terminals need to be granted access to the Wi-Fi network. This is done by allowing the MAC address of the payment terminal access to Wireless Trondheim's Wi-Fi network.

Activity 6: Configure wireless payment terminal. The wireless payment terminal has a list of allowed wireless access points which need to be configured before being used. This activity is done by either Point or BBS, after a lease or selling contract has been signed, and this activity is done regardless of the communication solution chosen and is included in the lease cost. Wireless Trondheim need to be involved in the selection of access points to be configured in the wireless payment terminal based on the assumed geographical location of use of payment terminal.

Service provisioning:

Activity 7: Billing for loan of wireless payment terminal and Wi-Fi network connection. When a merchant leases a terminal from a bank, the price of the lease includes Wi-Fi connection from Wireless Trondheim if this communication solution has been selected. This payment is handled by the bank. Wireless Trondheim will in activity 9 charge the bank for the access to the network based on number of leases and the time period for each lease.

Activity 8: Billing for Wi-Fi network connection and for clearing and settlement. For merchants that own wireless payment terminals using Wireless Trondheim's Wi-Fi network, billing for the network connection will be charged together with monthly payments to the bank. This billing covers clearing and settlement, and the cost for the account affiliated with the payment terminal. By including the communication cost on the invoice from banks, the monthly payment for terminals costs will be more convenient for merchants than receiving a separate invoice from Wireless Trondheim.

Activity 9: Wireless Trondheim billing banks for use of Wi-Fi network to payment terminals. Wireless Trondheim receives the sum for all of the merchant's use of the Wi-Fi network from each bank. Thus, Wireless Trondheim does not need to deal directly with merchants, which saves them from some additional administration and billing costs.

Network infrastructure operation:

Activity 10: Network infrastructure operation. The activity of operating the network infrastructure is currently outsourced to the company Ementor.

Partnership

Partnership is a *voluntarily initiated cooperative agreement formed between two or more independent companies in order to carry out a project or specific activity jointly* [1] page 89. This cooperation may involve sharing of resources, capabilities or activities.

Partnership 1: Local branches of banks in Trondheim:

The main reasons for choosing cooperation with the local branches of banks are:

1. Utilize existing distribution channels in banks.
2. Minimize costs for Wireless Trondheim.

Wireless Trondheim need to cooperate with the local bank branches, to incorporate the offer of Wi-Fi to wireless payment terminals into the existing leasing and selling orders, both at their web sites and at the local branch of the banks. In addition, Wireless Trondheim needs to produce invoices to the banks, according to the number of customers and time period which customers have used Wireless Trondheim's network for payment terminals.

It is much less costly to add Wi-Fi connection from Wireless Trondheim as an option to the products already sold, than establishing new distribution channels within Wireless Trondheim. The banks already sends invoices to the merchants using the bank as clearing and settlement bank, and adding data traffic costs to this invoice should be viable to implement at a low cost.

As described in Chapter 2, Sparebank 1 Midt-Norge (SMN) owns 10% of Wireless Trondheim. Thus, SMN has an extra motivation to use Wireless Trondheim's network when possible.

Partnership 2: Point and BBS. Payment terminals must be configured by Point or BBS with the address of the wireless access points before the payment terminal can be used. Hence, Wireless Trondheim need to send information about the wireless access points that will be in the area of use of wireless payment terminals.

7.1.4 Financial aspects

The financial aspect pillar in Osterwalder's business model ontology consists of two building blocks; revenue model and cost structure. Together the revenue model and cost structure determine the ability for the company to survive.

Revenue model

The revenue model measures *the ability of a firm to translate the value it offers its customers into money and incoming revenue streams* [1] page 95. The revenue model may consist of several different revenue streams, which can have different pricing mechanisms.

The revenue model of the business model proposed in this study consists of two revenue streams; temporary payment access and fixed payment access, which are presented below. Estimates for the number of customers for temporary and fixed access are given in Section 7.3.2.

Revenue 1: temporary payment access. This is the revenue obtained by selling Wi-Fi connection to merchants temporarily using wireless payment terminals. The Wi-Fi connection is sold with a fixed price, based on the number of weeks it will be used. The banks will collect the payment for the Wi-Fi connection at the same time they receive payment for clearing and settlement from the merchant, which is also done for corresponding GPRS communication today. Wireless Trondheim will send invoices to the banks on a monthly basis based on the number of wireless payment terminals and the number of weeks the terminals has been used.

The fixed price will be based on the cost comparison of the other wireless options for payment terminal in Chapter 6. The aim is not necessarily to be the cheapest alternative for all possible variations of use, but Wireless Trondheim's Wi-Fi access for payment terminals should be priced at the lower end of the price scale in order to be an attractive solution for customers. Thus, based on the alternatives shown in Chapter 6, the establishment fee is set to NOK 100 per terminal, and the price per terminal per commenced week is set to 30 NOK. I

Revenue 2: fixed payment access. This is the revenue obtained from merchants using the Wi-Fi network of Wireless Trondheim for payment terminals on a continuous basis. As in the revenue above, Wireless Trondheim will send invoice to the banks which has collected the payments from the merchants. The price is fixed price for each month based on number of payment terminals.

The price should also in this case be competitive compared to the alternatives shown in Chapter 6 to attract potential customers. In order to be a viable alternative, the price should be about 60 NOK per terminal per month and the establishment fee should be 100 NOK per terminal.

Cost structure

This business model proposal will distinguish between three categories of costs; fixed, variable and investment cost. Fixed costs are expenditures which occur independent of number of Wi-Fi connections sold and occur every month, or year. Variable costs involve expenditures which are related to the number of leases or sales. The last category is investment costs, and this category involves costs that occur once, and are needed before the service is up and running.

These cost structures will only show additional costs for Wireless Trondheim incurred by offering wireless access to payment terminals. The reason for this is that Wireless Trondheim already has made the investments to establish the network, and that these investments thus can be regarded as sunk costs.

Cost structure 1: Fixed costs

Account 1: Billing to the banks. This is a fixed cost that include producing invoices and sending them to the respective banks each month. For more details on this activity, see activity 9 in Section 7.1.3 above.

Cost structure 2: Variable costs

Account 2: Establishment of connection to a new wireless payment terminal, includes selection of which access points are best to use for each customer. This activity provides access to the network for the payment terminal, and is required before the payment terminal can be used. This cost corresponds to activity 5 in Section 7.1.3.

Account 3: Terminate connection from payment terminals no longer in use. This activity will only be performed when a payment terminal no longer requires access to the network, i.e. when the contract of a leased terminal ends or a fixed customer ends the subscription of Wi-Fi network access to payment terminals. This cost occurs in activity 2 in Section 7.1.3.

Cost structure 3: Investment costs

The investment costs described here are not included in the value network activities, because these activities only need to be performed once.

Account 4: Add information on Wireless Trondheim's web site. The web site of Wireless Trondheim should be updated with relevant information about the offer of payment access to merchants. The site should also include links to the local branches of banks, where potential customers may order payment access from Wireless Trondheim.

Account 5: Add routine for sending information about wireless access points to Point or BBS. The payment terminals that are to be used in Wireless Trondheim's network must be configured by adding which wireless access points the terminal can use. Wireless Trondheim need to establish the proper channels to inform BBS or Point about the wireless access point the terminal will use. The best solution will probably be sending an email for each new payment terminal that is to be used in Wireless Trondheim's network.

Account 6: Establish partnerships with banks. An important assumption for the business model proposal in this chapter is to achieve cooperation with the local branches of banks. Obtaining cooperation and partnerships with the banks probably requires several presentations and meetings with the banks.

7.1.5 Assumptions for this business model proposal

The business model proposed above has three important assumptions.

1. Successfully establish partnerships with bank, i.e. the banks are willing to cooperate and execute the activities required.

2. The security implemented in terminal software is approved.

3. The indoor signal reception is adequate for use by payment terminals without additional investments in equipment.

The first assumption involve successfully establishing partnerships with the banks. This assumption does not require all the local banks to make a partnership agreement with Wireless Trondheim, but at least one bank is required in order to enable this business proposal. With few banks cooperating with Wireless Trondheim, the total market share Wireless Trondheim gain access to through the banks distribution channels, is less than with full cooperation from all the banks.

This cooperation is needed in order to utilize the existing distribution channels that the banks have for marketing purposes. The activities that the banks perform include adding information on their web sites and in the local branches of the banks, and sending invoices to the merchants on behalf of Wireless Trondheim.

The result of not obtaining partnerships with the banks depends on the banks. If the banks decline to include the offer of Wireless Trondheim's network in their distribution channels, the result is that Wireless Trondheim will have to use time and money on attracting customers to the network. It is especially difficult to reach temporary merchants compared to merchants with fixed address in Trondheim, since it requires more effort to determine who the temporary merchants are and how to address them correctly.

It is easy to address the fixed merchants, since Wireless Trondheim already has an overview of which cafés and restaurants exist in Trondheim. Sending a brochure or letter to each of these fixed merchants may attract some customers. However, it is possible that a personal meeting with these merchants also is necessary to obtain more customers, since it is easier for merchants to ignore a letter than a personal meeting. It is also possible that the merchants are skeptical and requires some persuasion or clarification of possible ambiguities.

If the banks refuse to send a single invoice with the total amount for communication expenses and the bank services, it is not as important as a denial of utilizing the banks distribution channels. The result of the banks not sending a single invoice with communication expense will be increased costs for Wireless Trondheim, as the company then must send individual invoices to all the merchants using Wireless Trondheim's network. More invoices means more costs, which will reduce Wireless Trondheim's profit.

The second assumption is currently an obstacle for offering Wi-Fi access to payment terminals. But as Point already tests a solution, this should probably be available within a few years. This assumption is crucial for the business model proposal of Wireless Trondheim offering access to payment terminals. Without approved security, merchants are not allowed to use payment terminals with this solution. This business model assumes that the solution which is approved does not require a dedicated VPN connection such as BBS Aksess, and has consequently not added these costs into this business model proposal. If BBS Aksess is required, a new calculation with the added monthly cost (see Section 6.2) should be performed if this business model planned to be implemented.

The third assumption requires the signal reception between the payment terminal and Wireless Trondheim's network to be adequate, without new investments in wireless access points. A test should therefore be performed to ensure sufficient signal reception at merchant's premises before implementing this business model proposal. If the test shows insufficient signal reception, a new business model proposal with the investment costs of the extra equipment should be created if Wi-Fi access for payment terminals is of interest at that time.

7.2 Risks

This section will look at the possible risks associated with the business model proposal outlined in this chapter. These risks will be divided into two categories; business and technical risk. No effort will be made to quantify these risks, but the risks will be identified and discussed.

7.2.1 Business risks

The business model proposed in this chapter faces several business risks. This includes

- Lack of cooperation from banks.
- Merchants not willing to try a new service (i.e. gaining few customers).
- Some banks may not sell or lease terminals with Wi-Fi support.
- Decreasing prices on GPRS.
- Compensation to merchants if the payment access service fails.

The business model proposal offered in this chapter is dependent on cooperation with the local branches of banks in Trondheim. Whether this will be interesting enough for the banks is currently an open question, but if this offer is of value for the bank's customer and is not costly for the banks, it should be possible to obtain cooperation from the banks. If not, the banks should be offered some economic compensation for the few activities the bank will have to perform for Wireless Trondheim. This will need to be further investigated if this business model is to be implemented.

Launching a new option for communication might be met by general skepticism from merchants, especially if the merchants already are familiar with e.g. wireless payment terminal with GPRS. Although a transition from using GPRS to Wi-Fi is transparent to the merchant, it might be difficult to sell in a new solution if there is not too much to gain economically or in reduction of transaction time.

There is a slight risk that some banks do not sell or lease terminals with Wi-Fi support. As there are two wholesale dealers of terminals, Point and BBS, only Point currently sells or leases a terminal with Wi-Fi support to dealers. Dependent on whom the bank use as their wholesale dealer, the banks may not have terminals with Wi-Fi support to lease or sell. However, it is more likely that also BBS will distribute terminals with Wi-Fi support when this solution is approved since the main producer of terminals to BBS, Ingenico, already has a terminal with Wi-Fi support which is available in other countries.

Prices on GPRS have been decreasing the last few years, and this trend is expected to continue. This might pose a considerable threat to the revenues obtained by Wireless Trondheim in this business model.

The final business risk involve the case where Wireless Trondheim's Wi-Fi network fails to deliver the service at the rate of the agreements with the merchants, the merchants may require compensation for their loss of sales.

7.2.2 Technical risks

- Insufficient indoor signal reception.
- Inadequate QoS for payment terminals.
- Delay on approved secure solution for use of Wi-Fi in payment terminals.

Insufficient indoor signal reception may be caused by interference from private wireless access points using the same frequency. This can also be caused by obstacles such as walls. This can be compensated for by installing an extra wireless access point inside the merchant's premises. But this has an extra cost which in that case needs to be accounted for. It is possible to mitigate this risk by conducting a test as described in Chapter 5.

As payment transactions preferably are executed online, it is important to have satisfying QoS with very good availability on the regular opening hours for Wireless Trondheim's customers. Failing to do so will cause the customers to switch to the competitors. Whether the agreement with Ementor on the network infrastructure operation is sufficient for this kind of service, will need further investigation if this service is of interest.

As described in Section 3.6, a secure solution for use of Wi-Fi in payment terminals is not yet approved by BSK. It is not known when such a solution is available, but it could take a few years.

7.3 Cash flow analysis

This section will look at the cash flow of three scenarios of market share based on customer estimates. The scenarios are categorized into pessimistic, realistic and optimistic scenario. Although it is a low probability that exactly one of these scenarios are the result, the goal of these scenarios is to give an overview of within what range the revenues may fall into. A pessimistic scenario means that out of the potential market, only a low market share is obtained. The reasons for this lower market shares may be reflected in the risks described in Section 7.2 above. The realistic scenario is, as the name implies, the most realistic estimate given. Finally, the optimistic scenario represents a scenario in which the market share that Wireless Trondheim obtains is quite large.

7.3.1 Cost calculation

The cost calculation in this section is based on the business model proposal described in this chapter, and will be used as a basis for the costs of the Net Present Value (NPV) calculations for this business model in Section 7.3.3. Three cost calculations have been performed, one for investment costs one for annual fixed costs and the last for variable costs per terminal. The costs given here are estimates provided in cooperation with Lene Maria Myhre at Wireless Trondheim [45], and corresponds to the cost structures for investment, fixed and variable costs given in Section 7.1.4 above.

Table 7.2 shows an estimate of required investment costs. These costs occur only once, but must be invested before the service of offering payment access through Wireless Trondheim's Wi-Fi network is possible. As can be seen from the last row of Table 7.2, these costs are not of tremendous size, and it will thus not be made a financial plan of how to acquire these funds. It is assumed that it is possible to obtain this sum from the company's equity.

Activity	**Hours**	**Hourly wage**	**Cost**
Add information about this service on Wireless Trondheim's web site	3	500	1 500
Add routine for sending information about access points to Point or BBS	2	500	1 000
Establish partnerships with banks	80	500	40 000
Sum	85	500	42 500

Table 7.2: Investment cost calculation in NOK

The estimated fixed annual costs are shown in Table 7.3. These costs are independent of the number of customers, and hence also independent of the different scenarios. The fixed costs consist of producing and sending monthly invoices to the banks based on the number of fixed and temporary customers using Wireless Trondheim's Wi-Fi network for payment terminals the previous month.

It may be possible that support costs should have been added to the fixed costs, but as the terminals are configured by Point and BBS, the need for support is not clear and should be evaluated after a test performed by a merchant as described in Chapter 5. A minimum of support would involve receiving calls from merchants who report failures in the network, in addition, of course, to repair those failures. Ementor is already handling this activity and therefore no extra support costs have been taken into account here. However, if the business model proposal in this chapter is to be implemented, the level of support should be investigated further to determine if the current support offered by Ementor is sufficient.

Activity	Hours	Hourly wage	Annual cost
Produce and send invoices to banks	12	500	6 000
Sum	12	500	6 000

Table 7.3: Fixed annual costs - cost calculation in NOK

Due to dependency of number of customers and terminals, variable costs are given in the three scenarios; pessimistic, realistic and optimistic. As can be seen in Table 7.4, the variable costs connected to each payment terminal consist of establishment and termination of connection to the terminal. Each of these costs has been estimated to 40 NOK. For simplicity, due to the fact that it is difficult to estimate when or if any fixed customers decide to terminate this service, the cost of termination of terminals is only calculated for the leased terminals.

Activity	Hours	Hourly wage	Cost per terminal
Establishment of connection to payment terminal	5/60	500	40
Termination of connection (only included for leased terminals)	5/60	500	40
Sum	10/60	500	80

Table 7.4: Variable costs - cost calculation in NOK

7.3.2 Customer estimates

Customer estimates are needed in order to determine the revenues and variable costs for the NPV calculations of the business model proposal. Three scenarios have been chosen in order to display three different outcomes, namely a pessimistic scenario, a realistic scenario and an optimistic scenario.

The pessimistic scenario assumes near 10% market share, while a realistic estimate is given as about 25% market share, and optimistic near 50% market share. The latter assumption may be considered a little too optimistic, but it can be justified by taking into account that the coverage area of Wireless Trondheim probably will increase by time, and thus give a the company a larger potential customer base. This scenario is not discussed in further

Event	Potential merchants	Number of terminals per	Number of terminals	Event length in days	Number of transactions
Martna in June	100	1	100	3	30 000
Olavsfestdagene/ food festival	50	1	50	14	70 000
Blues festival	5	2	8	4	3 000
Kosmorama (film festival)	2	4	8	7	5 600
Uka (Cultural festival)	5	2	8	14	10 500
Miscellaneous market events	20	1	20	2	4 000
Other city events	20	1	20	2	4 000
SUM	**202**		**213**		**127 100**

Figure 7.4: Estimate of all temporary customers

Scenario	Pessimistic	Realistic	Optimistic
Number of customers per year	5	10	20
Total number of terminals	7	13	25

Figure 7.5: Estimate of number of fixed customers in each scenario

detail, but will be used to show how more customers affect the NPV calculations.

The customer estimates for merchants at temporary events have been suggested by Thor-Ragnar Klevstuen, Business developer within payment services at Sparebank 1 Midt-Norge [46], and modified to reflect that the event UKA is only held every second year. The estimate for the total number of potential temporary customers is shown in Figure 7.4.

The estimate for merchants using Wi-Fi on a continuous basis is based on the number of cafés and restaurants with Wi-Fi coverage from Wireless Trondheim in most or nearly all of the premises. The overview of these cafés and restaurants is shown in Figure 2.1[3] and, as of May 2008, 30 cafés and restaurants are potential customers. Figure 7.5 show the estimated number of fixed customers and terminals in the pessimistic, realistic and optimistic scenario, respectively. These numbers are assuming partnership with several of the local branches of banks, which in total gives Wireless Trondheim a part of the market share, dependent on which scenario is used. The revenues for Wireless Trondheim regarding payment access will be described in the following

[3]The names for each of these merchants can be found at http://wirelesstrondheim.no/sec.php?page=sec_coverage&la=en

section.

7.3.3 Net present value (NPV)

According to [47], the NPV may be used to determine whether an investment should be made or not. The NPV of an investment may be described as *the maximum amount a firm could pay for the opportunity of making the investment without being financially worse off* [47] page 43-44. The NPV is discounting the value of future cash flows to determine what the value of these cash flow represent today [48].

This method requires future cash flows to be known, which are often not easy to predict. This section take this into account by solving the NPV of three scenarios that represent the cash flows if the outcome of this business model proposal is pessimistic, realistic and optimistic.

The explicit assumptions for the NPV described in this section are:

The assumptions made in the calculations below are:

1. The cash inflows and outflows occur at the end of each period.
2. The cash flows are certain, and no risk adjustment is necessary.
3. A discount rate of 10%.
4. A life cycle of 10 years.
5. The calculations are exclusive taxes.
6. The establishment fee and variable costs of fixed customers occur at time period 1.
7. The estimates given in Section 7.3.2 are used as a basis for number of customers.

Figure 7.6 shows the annual net result in NOK from each of the three scenarios. The assumptions for these results are a weekly price of 30 NOK for temporary customers and a monthly price of 60 NOK for fixed customers. In addition, establishment fee and costs are included for temporary payment access, while both establishment fee and establishment cost for fixed payment access are omitted, since these will only occur once. The results show that each scenario gives a positive annual result, although the amounts are relatively low in a business context.

	Pessimistic	Realistic	Optimistic
Revenue fixed customers	5 040	9 360	18 000
Revenue temporary customers	2 769	6 923	13 845
Variable costs	1 704	4 260	8 520
Fixed costs	6 000	6 000	6 000
Net annual result	**105**	**6 023**	**17 325**

Figure 7.6: Annual net result in NOK from the three scenarios

The pessimistic scenario barely gives a positive result, and a cash flow of about 100 NOK is not nearly sufficient to cover investment costs of 42 500 NOK. The realistic scenario gives an annual result of nearly 6 000 NOK, while the optimistic scenario gives about 17 000 NOK.

A NPV of these two latter scenarios with the assumptions described previously in this section, have been depicted in Figure 7.7 and 7.8. These figures show the cash flow for each year and the sum of the NPV at the end of each year. The figures include the investment cost at time period 0, and the establishment fee and cost of fixed payment access in time period 1, in addition to the annual result from Figure 7.6.

As can be seen from Figure 7.7 and 7.8, the realistic scenario gives a negative NPV of -5 000 NOK, and the optimistic scenario gives a positive NPV of 65 000 NOK after ten years. This investment is thus not profitable in the pessimistic and realistic scenario with the chosen assumptions.

Figure 7.9 and 7.10 show the NPV values of the realistic scenario with different prices for fixed and temporary payment access, respectively. Given the other variables held constant, fixed payment access with a price of nearly 65 NOK per month must be used to make this investment break-even in NPV with a time period of 10 years. Temporary payment access, on the other hand, needs 45 NOK per week per terminal in order to be break-even, given all other variables held constant. It should be noted that it is highly unlikely that all other variables remain constant if the price of fixed and temporary payment access should be increased. For instance, with increased price, the estimated number of customers should be lowered, and hence would maybe not increase total revenues at all.

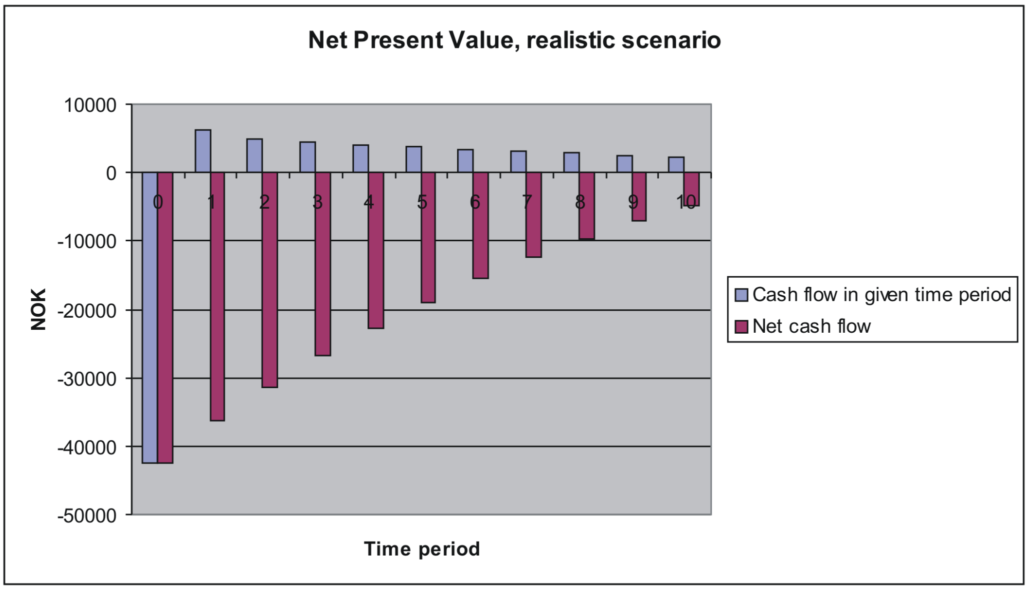


Figure 7.7: Net Present Value in realistic scenario

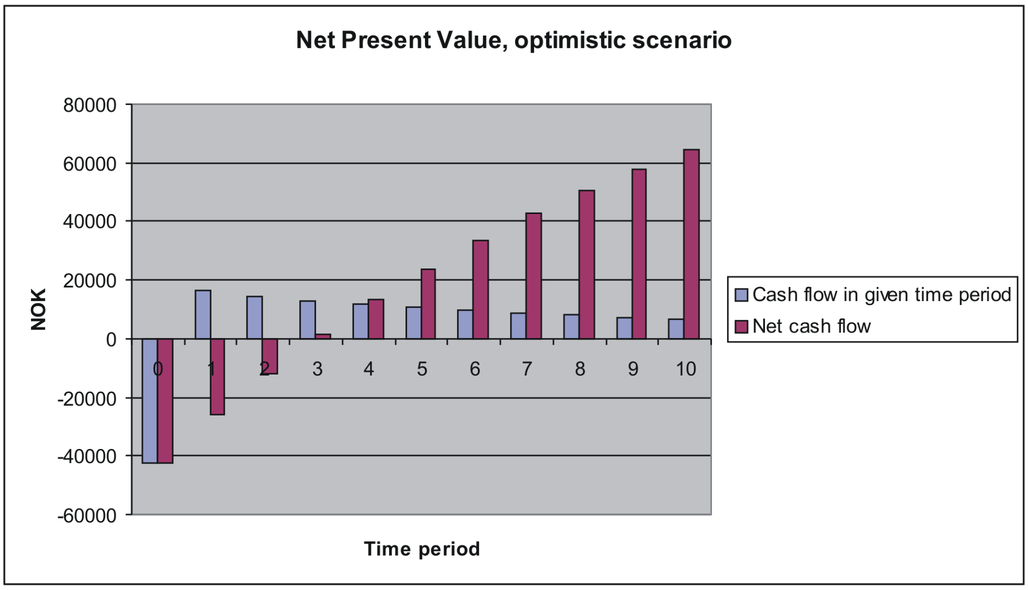


Figure 7.8: Net Present Value in optimistic scenario

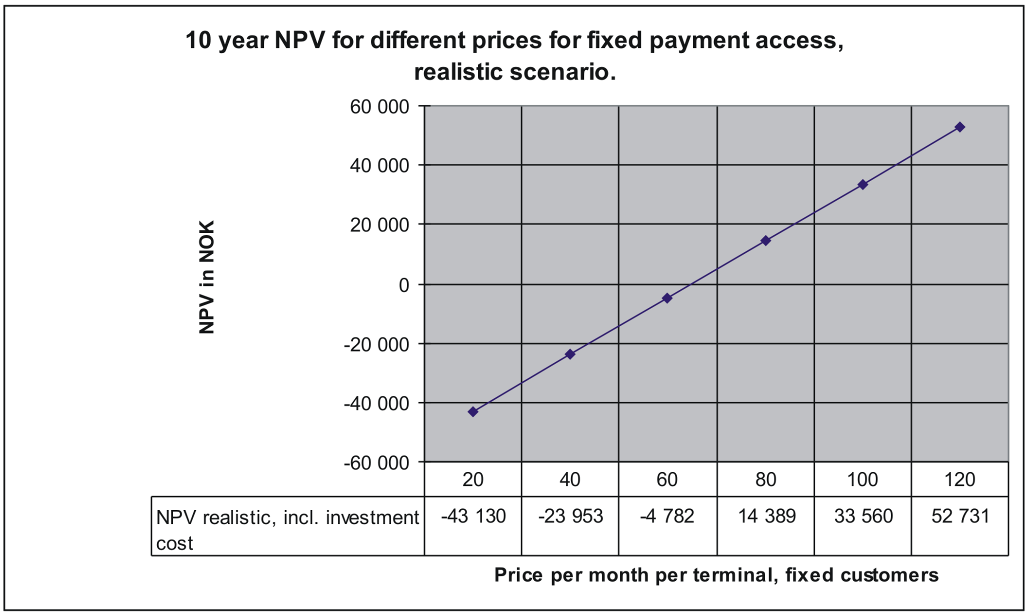


Figure 7.9: 10 year NPV with varying price for fixed customers

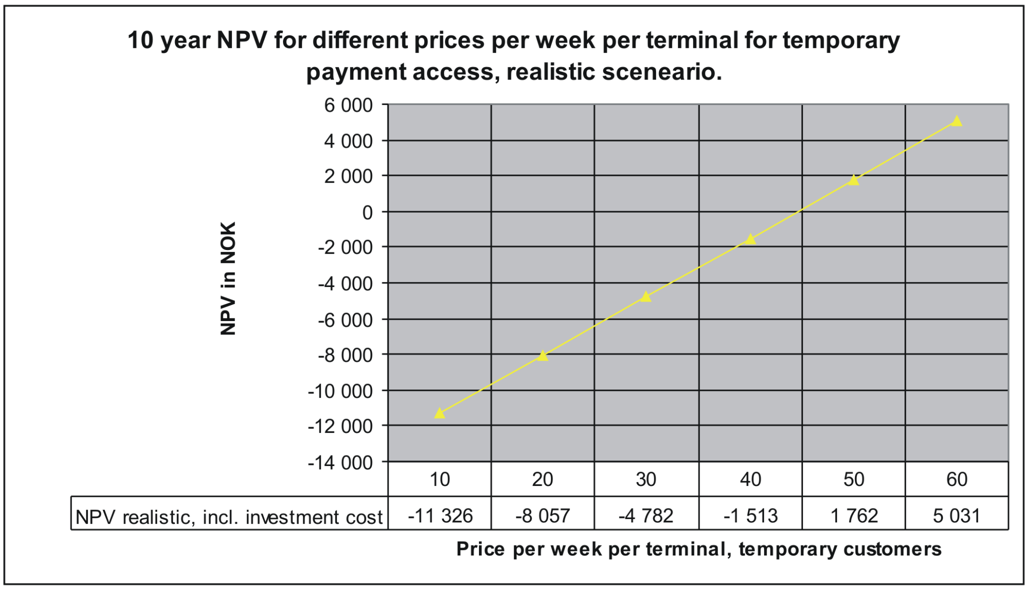


Figure 7.10: 10 year NPV with varying price for temporary customers

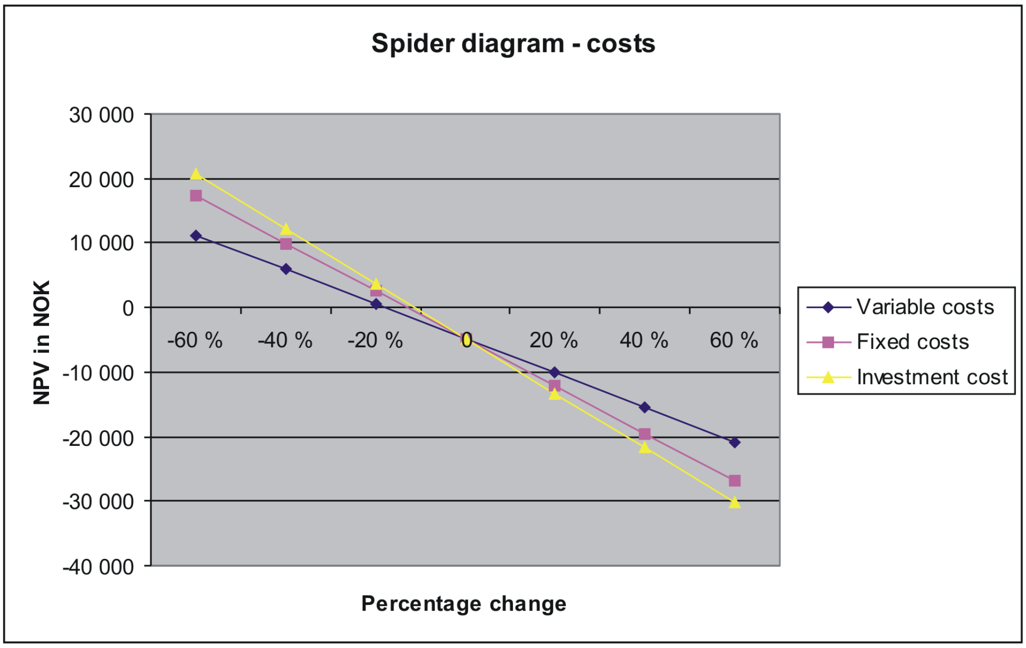


Figure 7.11: Spider diagram of costs

7.3.4 Sensitivity analysis

A sensitivity analysis examines how changes in underlying assumptions of variables affect the NPV, by using a range of values for the different variables [48]. In order to easily compare the relative changes in variables, the change in NPV can be depicted in a spider diagram. A steeper curve indicates more significant variable [48]. Figure 7.11 show the relative changes in variable, fixed and investment costs. It can be seen that a change in investment cost or fixed cost will affect the NPV the most. To obtain a break-even NPV, the fixed cost or investment cost must be reduced by more than 10% with all other variables held constant. The variable costs affect the NPV less than investment and fixed costs, and must be reduced by 20% to obtain a break-even NPV.

Figure 7.12 illustrates the relative changes in prices for fixed and temporary payment access, the NPV discount rate and the NPV time period. The price of fixed payment access is the variable with the greatest affect on the NPV, requiring 10% increase in order to be break-even with the NPV. The time period must be increased by more than 20% to reach a break-even NPV. It should be noticed that the negative NPV decreases more with reduced time period than it increases with a prolonged time period, due to the effect of

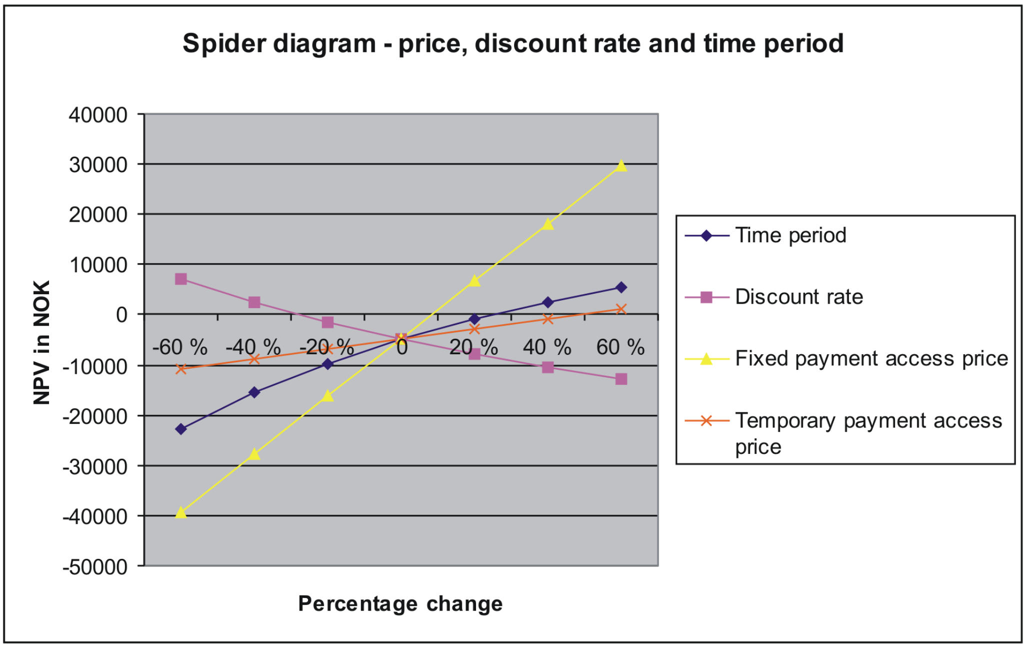


Figure 7.12: Spider diagram of prices, discount rate and time periods

the discount rate.

A weakness with sensitivity analysis like the one given above, is that it can only show change in one variable at the time. Another weakness is that it assumes that change in one variable will not affect the others. This is quite often unrealistic as, e.g. an increase in price often leads to a decrease in demand for the product [48].

7.4 Business model evaluation

The business model suggested in this chapter is designed to have low costs and few administrative tasks, in order to make the economic profit as high as possible. Nevertheless, the NPV of the business model is negative in the pessimistic and realistic case with the given assumptions. The prices for payment access via Wi-Fi must either be increased, or the costs decreased, in order to make the business model profitable. Thus, in this case, with the customer estimates used together with the business model proposal in this chapter, Wi-Fi is not cost-effective compared to GPRS, as described in Chapter 6. This may change, however, if the number of potential customers increase significantly, e.g. if a new target customer segment is identified[4].

Whether the prices of Wireless Trondheim's payment access service is attractive enough to encourage merchants to use this service is not known. It is probably more likely that Wireless Trondheim will need to decrease the prices in order to make the Wi-Fi service more attractive compared to GPRS than to have the opportunity of increasing the prices. Thus, the result will be even less annual revenues, and hence less NPV for each scenario. Even with a 20% increase in the fixed price, which would make a positive NPV of near 10 000 NOK for the realistic scenario if all other variables are kept constant, implementing this business model proposal would not offer enough profits compared to the risks that the business model faces. A cynical and cautios approach would require positive NPV even in the pessimistic scenario, which is not obtained in this business model.

Decreasing revenues is not the only possible outcome if this business model is to be implemented. Depending on the level of QoS offered by Wireless Trondheim today, there might be additional costs involved if additional measures must be taken to increase the level of QoS. Examples of such costs could be signing an improved service level agreement with the company maintaining and operating the network, in order to decrease repair time of the access points, or it could be installing extra equipment to provide redundancy around the merchants using the Wi-Fi network for payment terminals. Redundancy is one of the alternatives to increase availability of the service.

The assumptions made in this business model proposal are all very important. The assumption of cooperation with the banks and utilizing their distribution channels, is probably easier to achieve than also making the banks adding the costs of communication on Wireless Trondheim's behalf. There may be several reasons for this; first, it adds extra complexity to the invoices sent from the bank to the merchants, as the banks need to stay updated on the number of temporary and fixed customers with Wi-Fi from Wireless Trondheim. Second, to stay updated on the customers of Wireless Trondheim and manage the invoices do involve some extra resources, i.e. extra time used by employees in the banks. It might be possible that the banks will perform this task, as it is more convenient for merchants to receive one invoice instead of two, especially if the banks are compensated by i.e. a mark-up on the communication cost. Otherwise, producing invoices to the merchants must be performed by Wireless Trondheim.

Offering Wi-Fi access to payment terminals may be possible, although it did

[4] A suggestion will be given in Chapter 9, Further Work

not give positive NPV in the business model proposed in this chapter. For instance, if the coverage is increased and thus making the potential market larger, it may be possible that the business model proposal will yield profits, even in a pessimistic and realistic scenario.

Part IV

Conclusion and further work

Chapter 8

Conclusion

This thesis presents the payment card system and the wireless access technologies currently supported by payment terminals. The result of the analysis carried out in this study shows that it, as of May 2008, is not possible to offer Wireless Trondheim's Wi-Fi access to payment terminals in Trondheim, due to the fact that the security requirements have not been approved. However, Point is testing a solution which will be subject to approval at some point in the near future, though difficult to estimate.

Two payment terminals with support for Wi-Fi have been identified and described in Section 3.5, and the Xentissimo terminal which supports both Wi-Fi and GPRS is already available at the Norwegian market. Ingenico 7810 does not feature GPRS and GSM in addition to Wi-Fi, and this may be the reason why this terminal is currently not being available at the Norwegian market.

Testing a wireless payment terminal using Wireless Trondheim's Wi-Fi network has not been conducted, since this solution is not available yet. Nevertheless, the goals of testing and a brief description of how the test would have been conducted are described in Chapter 5, and show that 1) testing with a wireless payment terminal would determine whether the existing signal strength is sufficient. 2) Measuring the payment transaction time is important in order to ensure that it is within a acceptable range. 3) Evaluating whether the QoS of Wireless Trondheim's Wi-Fi network is adequate for payment terminals. A test was planned to be conducted at two merchants with different percentage of coverage, one with coverage in most parts of its premise, while the other having coverage in all or nearly all parts of its premise.

The business model presented in Chapter 7 proposes to offer Wi-Fi access to payment terminals in cooperation with the local branches of banks, in order to utilize the existing distribution channels which the banks possess. With a pessimistic and realistic market share of potential customers in Trondheim, it is not possible to obtain a positive net present value after 10 years. Even in the positive scenario, the amount earned after 10 years is only about 65 000 NOK. Hence, the NPV results found in Section 7.3.3 do not recommend Wireless Trondheim to offer Wi-Fi access to payment terminals in Trondheim with the business model presented in Section 7.

Given the business model proposed in Chapter 7, the prices found from alternatives in Chapter 6, and the number of potential customers estimated in Section 7.3.2, payment terminals using Wireless Trondheim's Wi-Fi network is not a cost-effective solution compared to GPRS from Netcom.

This thesis show that currently, the technical potential of offering Wi-Fi to payment terminals using Wireless Trondheim's Wi-Fi network is infeasible due to the unapproved security. The commercial potential of Wireless Trondheim providing Wi-Fi to cafés and restaurants and merchants at temporary events, as described in Chapter 7, is also limited, and is not recommended, with the current estimates of potential customers.

Chapter 9

Further work

Although the business model proposed in this thesis did not yield a positive result, other business models regarding Wi-Fi access to payment terminals may do so. An example could be to bundle Wi-Fi Internet access with Wi-Fi access for payment terminals. In that case, even other merchants than cafés and restaurants may be interested in the product. The number of potential customers would then include most merchants within Wireless Trondheim's coverage area in Trondheim city, which would add significantly to the revenues compared to those found in the business model proposed in this thesis.

However, several issues remain to be researched before implementing any business model involving wireless access to payment terminals. First, a business model with a commercial potential must be identified. Second, the current level of availability and other QoS parameters of Wireless Trondheim should be inspected. These parameters should be evaluated in order to verify whether they are sufficient, in order to offer wireless access to payment terminals, or if additional measures must be taken to increase the QoS.

Third, a test should be conducted to identify whether the existing indoor coverage for Wireless Trondheim's Wi-Fi network is sufficient for payment terminals, or if additional investments in wireless access points are required. Finally, it would be interesting to contact some of the potential target customers to ensure that the service is attractive and interesting to them.

References

[1] Alexander Osterwalder. *The Business Model Ontology: a Proposition in a design science approach.* PhD thesis, University of Lausanne, 2004. PhD Thesis.

[2] Press Release by Norwegian University of Science and Technology. Adresseavisen and Trondheim Energiverk becomes new co-owners in Wireless Trondheim AS (In Norwegian). URL: http://www.ntnu.no/pm/10.06/tradlosetrondheim_utvidelse.pdf, 2006.

[3] Thomas Jelle. Wireless Trondheim (In Norwegian). Norwegian University of Science and Technology, 2006.

[4] Cisco Systems Inc. Cisco aironet 1000 series. URL: http://www.cisco.com/en/US/prod/collateral/wireless/ps5678/ps6306/ps6315/product_data_sheet0900aecd8025708a_ps6306_Products_Data_Sheet.html, 2006.

[5] Svein Gjedrem. Annual report on payment system (In Norwegian). Norges Bank, 2007. URL: http://www.norges-bank.no/Upload/61410/betaling-hele-2006.pdf.

[6] Ann-Charlotte Dorange et.al. Competition in Nordic Retail Banking. *Report from the Nordic competition authorities*, 1/2006, 2006. ISBN: 91-88566-38-2.

[7] Thor-Ragnar Klevstuen (Business developer, payment services) at Sparebank 1 Midt-Norge. Payment cards (In Norwegian). Personal communication - powerpoint presentation received 20.02.2008.

[8] VISA. Understanding payment transactions. URL: http://corporate.visa.com/md/fs/corporate/transactions_print.jsp, Online; accessed 27.02.2008.

[9] Thor-Ragnar Klevstuen (Business developer, payment services) at

Sparebank 1 Midt-Norge. Concerning master thesis, a question about clearing and settlement (In Norwegian), Personal communication - email received 29.02.2008.

[10] Banks' Standardization Office. Information about the payment card system (In Norwegian). Url: http://www.bsk.no/kortsystemet.htm, Online; accessed 03.03.2008.

[11] Banksys. Xentissimo - innovation on the move. URL: http://www.banksys.com/bkscomwt/EN/Images/Xentissimo_tcm43-5321.pdf, 2005. Online; accessed 05.02.2008.

[12] Steinar Bloch at Point Transaction Systems AS. Re: A question about the xentissimo terminal (In Norwegian). Personal communication - email received 27.03.2008.

[13] Ingenico. Ingenico 7810. Url: http://www.ingenico.com/INGENICO_GALLERY_CONTENT/Documents/corporate/products/Wireless/i7810/datasheet-i7810-uk.pdf, 2007. Online; accessed 15.04.2008.

[14] National Institute of Standards and Technology. Data Encryption Standard (DES). URL: http://csrc.nist.gov/publications/fips/fips46-3/fips46-3.pdf, 1999.

[15] Geir Bonde at the Banks' Standardization Office. Re: Security requirements for payment terminals using wi-fi and bluetooth (In Norwegian). Personal communication - email received 22.04.2008.

[16] Jan Erik Secker (Vice President, IT Business Development & Global Sourcing) at Banking and Business Solutions (Norwegian: Bankenes Betalingssentral) (BBS) AS. Re: Question about bbs aksess (In Norwegian). Personal communication - email received 08.04.2008.

[17] Linn Fredriksen (Team Manager Tech Support) at Point Transaction Systems AS. RE: Question about Xentissimo and use of WLAN (In Norwegian). Personal communication - email received 08.04.2008.

[18] H. Zimmermann. OSI Reference Model–The ISO Model of Architecture for Open Systems Interconnection. *Communications, IEEE Transactions on [legacy, pre - 1988]*, 28(4):425–432, Apr 1980.

[19] Wi-Fi Alliance. Wi-fi alliance - get to know the alliance. URL: http://www.wi-fi.org/about_overview.php, Online; accessed 25.01.2008.

[20] Wi-Fi Alliance. Wi-fi alliance - certified products. URL: http://

certifications.wi-fi.org/wbcs_certified_products.php, Online; accessed 31.01.2008.

[21] IEEE standard for local and metropolitan area networks: overview and architecture. Amendment 2: registration of object identifiers. *IEEE Std 802-2001 (Revision of IEEE Std 802-1990)*, 2002.

[22] Information technology- Telecommunications and information exchange between systems- Local and metropolitan area networks- Specific requirements- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. *ANSI/IEEE Std 802.11, 1999 Edition (R2003)*, pages i–513, 2003.

[23] William C. Y. Lee. *Wireless & Cellular Telecommunications*. McGraw-Hill, third edition, 2006.

[24] Wikipedia. IEEE 802.11. URL: http://en.wikipedia.org/w/index.php?title=IEEE_802.11&oldid=189264466, 2008. Online; accessed 11.02.2008].

[25] Supplement to IEEE standard for information technology- telecommunications and information exchange between systems- local and metropolitan area networks- specific requirements- part 11: Wireless LAN medium access control (MAC) and physical layer (PHY) specifications: Higher-speed physical layer extension in the 2.4 GHz band. *IEEE Std 802.11b-1999*, pages i–90, 2000.

[26] IEEE standard for information technology- telecommunications and information exchange between systems- local and metropolitan area networks- specific requirements part ii: wireless lan medium access control (MAC) and physical layer (PHY) specifications. *IEEE Std 802.11g-2003 (Amendment to IEEE Std 802.11, 1999 Edn. (Reaff 2003)*, pages i–67, 2003.

[27] Andrew S. Tanembaum. *Computer Networks, fourth edition*. Pearson Education, 2003.

[28] Bluetooth. Compare with other technologies. Url: http://www.bluetooth.com/Bluetooth/Technology/Works/Compare/. Online; accessed 05.05.2008.

[29] GSM World. Brief History of GSM & the GSMA. Url: http://www.gsmworld.com/about/history.shtml. Online; accessed 04.04.2008.

[30] Clint Smith and Daniel Collins. *3G Wireless Networks*. New York: McGraw-Hill, 2002.

[31] Point AS. User manual Point Xentissimo (In Norwegian). Url: http://www.point.no/upload/Norway/Brukerh%C3%A5ndb%C3%B8ker/XENTISSIMO%20Brukerh%C3%A5ndbok%20Web%2014.pdf, 2007. Online; accessed 06.05.2008.

[32] R. Chakravorty, J. Cartwright, and I. Pratt. Practical experience with TCP over GPRS. *Global Telecommunications Conference, 2002. GLOBECOM '02. IEEE*, 2:1678–1682 vol.2, 17-21 Nov. 2002.

[33] Kim Paulsen at Point Transaction Systems AS. Re: A general question about payment transactions (In Norwegian). Personal communication - email received 21.01.2008.

[34] Ingenico Group. Wi-Fi vs. Bluetooth - Two outstanding radio technologies for dedicated payment application. Url: http://www.ingenico.com/INGENICO_GALLERY_CONTENT/Documents/corporate/whitepaper/Whitepaper-Wi-fi-vs-Bluetooth.pdf, 2007. Online; accessed 30.04.2008.

[35] Netcom AS. Netcom as - telemetri, m2m (In Norwegian). Url: https://netcom.no/abonnement/telemetriprivat.html. Online; accessed 03.04.2008.

[36] Telenor ASA. Cellular payment access (In Norwegian). Url: http://www.telenor.no/bedrift/produkter/mobil/betalingsaksess_mobil.html, Online; accessed 03.04.2008.

[37] Telenor ASA. Cellular subscription GSM Alarm Step 1 (In Norwegian). Url: http://www.telenor.no/bedrift/bestill/GSM_alarm/index.php, Online; accessed 01.06.2008.

[38] Telenor ASA. Payment access IP (In Norwegian). Url: http://telenor.no/bedrift/produkter/betalingsaksess_ip/index.html, Online; accessed 07.04.2008.

[39] Telenor ASA. Payment access Internet (In Norwegian). Url: http://telenor.no/bedrift/produkter/betalingsaksess_internett/index.html, Online; accessed 01.06.2008.

[40] Telenor ASA. Broadband prices (In Norwegian). Url: http://www.telenor.no/bedrift/produkter/internett_aksess/bredband/index.html, Online; accessed 01.06.2008.

[41] NextGenTel AS. VPN point of sales (In Norwegian). Url: http://www.nextgentel.no/ressurser/produktark/VPNPOS.pdf, 2006.

[42] NextGenTel. RE: Price for NGT VPN Point of Sales (In Norwegian). Personal communication - email received 28.04.2008.

[43] Ventelo AS. RE: Price for NGT VPN Point of Sales (In Norwegian). Personal communication - email received 28.04.2008.

[44] Thor-Ragnar Klevstuen (Business developer, payment services) at Sparebank 1 Midt-Norge. An important question before possible lease of terminal (In Norwegian). Personal communication - email received 08.04.2008.

[45] Lene Maria Myhre (Business manager) at Wireless Trondheim and Joar Ulversøy. Personal meeting - cost estimates, Meeting 06.05.2008.

[46] Thor-Ragnar Klevstuen (Business developer, payment services) at Sparebank 1 Midt-Norge. Customer estimate, short term lease (In Norwegian). Personal communication - Excel document received 07.05.2008.

[47] Jr. Harold Bierman and Seymour Smidt. *The Capital Budgeting Decision.* Macmillan Publishing Company, eight edition, 1993.

[48] Øyvind Bøhren and Per Ivar Gjærum. *Project analysis (In Norwegian).* Skarvet Forlag, 1991.

[49] Atis Committee PRQC. Derived unique key per transaction (DUKPT). Url: `http://www.atis.org/glossary/definition.aspx?id=7112`, 2007. Online; accessed 02.05.2008.

[50] Wikipedia. Derived Unique Key Per Transaction, 2008. Online; accessed 02.05.2008].

[51] Charles B. Stabell and Øystein D. Fjeldstad. Configuring value for competitive advantage: On chains, shops, and networks. *Strategic Management Journal*, 19:413–437, 1998.

[52] Michael E. Porter. *Competitive advantage: creating and sustaining superior performance.* New York: Free Press, 1985.

Appendix A

Derived Unique Key Per Transaction (DUKPT)

DUKPT is a key-management technique which can be used in conjunction with symmetric encryption algorithms such as e.g. Data Encryption Algorithm (DEA) and TDEA. This key-management technique uses a unique key for each separate transaction, and these unique keys are derived from a base derivation key using only non-secret data transmitted as part of each transaction [49].

According to [50], DUKPT is used to encrypt electronic commerce transactions, and the base derivation key is installed in e.g. a payment terminal together with an initial transaction key before being deployed at the merchants premises. The base derivation key, or any subsequent key derived from this key, is at no time exposed to possible interception. Only the encrypted message and a few bytes of terminal identification is sent. Once one transaction is completed, the two parties generate a new key derived from the key just used, and then discard the old key. This ensures that the security holds, even if one transmission is successfully intercepted and decrypted. There is no useful information obtained by a successful decryption on subsequent or previous transactions. This key-management technique, in combination with strong encryption, will make the time required to decrypt a transmission too long for any man-in-the-middle attack[1] [50].

[1] Man-in-the-middle attack is a form of active eavesdropping where the attacker makes the victim (in this case, the financial institution receiving payment transactions) believe that they are receiving information directly from the payment terminal when in fact the entire conversation is controlled by the attacker.

Appendix B

Business model theory

B.1 Business model structure

To make it easier to follow the business model proposed in Chapter 7, this appendix explain the structure and elements of the Business Model Ontology proposed by Osterwalder. The structure of the Business Model Ontology contain four pillars, which address different aspects of the business model ontology. The pillars are product, customer interface, infrastructure management and financial aspects, respectively. These are shortly described next:

- Product: This pillar contains information about the product or service and what value it offers to the customers.
- Customer interface: A description of the target customers, how to get in touch with them, and how to deliver the product or service to them.
- Infrastructure management: This pillar describes how the company creates value by describing what capabilities and resources the company has and partners have, and who executes each activity.
- Financial aspects: This pillar contains a description of the cost structure and the revenue model.

These four pillars can be decomposed into a total of nine building blocks. The relationship between the pillars and the building blocks, and a short description of the latter is provided in Table B.1. Each of the building blocks can be further decomposed into a number of elements. An overview of the building blocks and the pertaining elements, and a detailed view of how the building blocks and elements are related to each other are shown in Figure

B.1. This appendix will not describe all of the elements below the building blocks, as most of the detailed elements are not need in the business model proposal in Chapter 7 in order to communicate the business model.

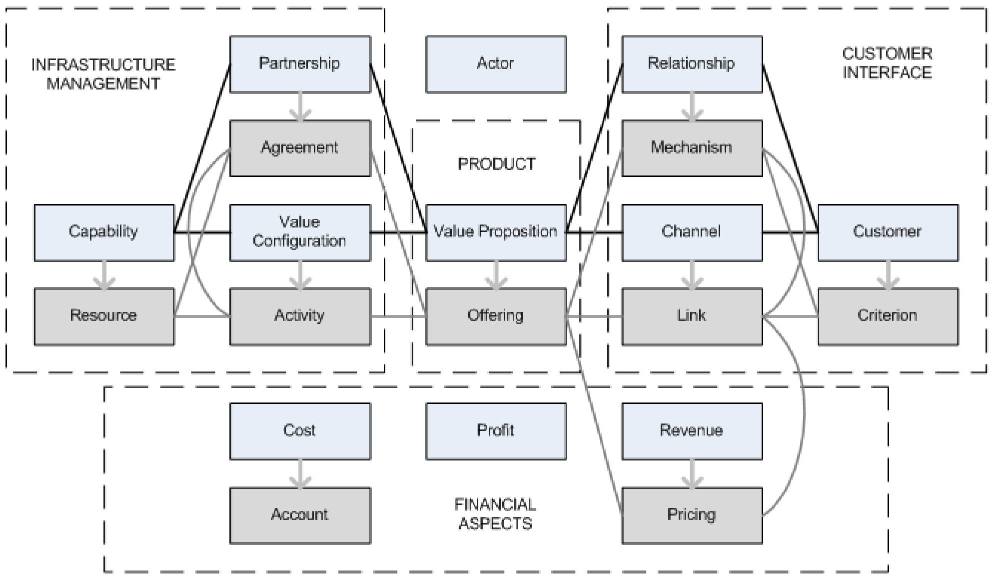


Figure B.1: Business model building blocks and pertaining elements

The following sections will explain each building block in more detail, starting with the product pillar and continuing with the other pillars and building blocks in the same order as Table B.1.

B.1.1 Product pillar

VALUE PROPOSITION:
The product pillar has a building block called value proposition. The value proposition is a *view of one of the firm's bundles of products and services that together represent value for a specific customer segment* [1] page 50. The value proposition outline the assumed value to the customer, and contain a description, a reasoning of the value to the customer, a qualitative value which relates to the value offered by competitors and a qualitative description of the price level compared to the competitors.

Pillar	Building Block of Business Model	Description
Product	Value Proposition	A Value Proposition is an overall view of a company's bundle of products and services that are of value to the customer.
Customer Interface	Target Customer	The Target Customer is a segment of customers a company wants to offer value to.
	Distribution Channel	A Distribution Channel is a means of getting in touch with the customer.
	Relationship	The Relationship describes the kind of link a company establishes between itself and the customer.
Infrastructure Management	Value Configuration	The Value Configuration describes the arrangement of activities and resources that are necessary to create value for the customer.
	Capability	A capability is the ability to execute a repeatable pattern of actions that is necessary in order to create value for the customer.
	Partnership	A Partnership is a voluntarily initiated cooperative agreement between two or more companies in order to create value for the customer.
Financial Aspects	Cost Structure	The Cost Structure is the representation in money of all the means employed in the business model.
	Revenue Model	The Revenue Model describes the way a company makes money through a variety of revenue flows.

Table B.1: The nine business model building blocks, quoted from [1] p. 43.

B.1.2 Customer interface

TARGET CUSTOMER:
Target customer is the first of three building blocks in the customer interface pillar. A target customer is the segment of customers that will be most attracted by the company's value proposition. Effective segmentation enables a company to concentrate investment resources on the customers most likely to buy the product or service [1].

DISTRIBUTION CHANNEL:
The distribution channel is the second part of the customer interface pillar and the purpose of the distribution channel is to connect and deliver the value proposition to the target customers. This can be done either directly or indirectly. Examples of direct distribution channels are a sales force and web site, while examples of indirect distribution channels are intermediaries such as resellers or brokers.

The distribution channel element is an aggregated view of how the a company reaches its customers, and can be decomposed into several channel links. Each channel link describes a specific marketing task [1].

RELATIONSHIP:
The final building block in the customer interface is the relationship building block. This building block describes the relationship between the target customers and the company. The relationship description is achieved through a classification of the customer equity goal, which are acquisition of new customers, retention of existing customers and add-on selling to existing customer [1].

B.1.3 Infrastructure management

VALUE CONFIGURATION:
Infrastructure management also has three building blocks; value configuration, capability and partnership. The value configuration describe the main activities and how they relate to each other. Osterwalder distinguish between three basic value configuration types, as do Stabell and Fjeldstad [51]; value chain, value shop and value network. The traditional value chain concept was developed by Michael E. Porter. The value chain is a way to present the collection of activities performed by a firm in order to design, market, deliver and support its product [52].

Value shop is the representation of value created by problem solving companies [51]. An example of this is a law firm, where the value is created by solving the customer's problems.

Value networks have a value creating logic of mediating, organizing and facilitating exchange between customers. The firm itself is not a network, but it provides a networking service through linking. This linking can be direct or indirect [51]. A telephone company is an example of direct linking, while a retail bank is an example of indirect linking. In the business model proposal given in this thesis, the value configuration of Wireless Trondheim is value network. This company facilitates exchange between users of the Internet. The value network concept is therefore described in this section, and is applied in practice in the business model proposed in Section 7.1.3.

Stabell and Fjeldstad [51] divide the activities into primary and support activities, which both can be split into a number of different types of activities. A list and description of the primary and support activities are given in Table B.2 and Table B.3, respectively.

Activity type	Description
Network promotion and contract management	Activities associated with acquiring potential customers to join the network. Some of these are selection of customers and initialization, management and termination of contracts governing service provisioning and charging.
Service provisioning	Activities dealing with establishing, maintaining and terminating links between customers and billing for value received. The links can be synchronous as in telephone service or asynchronous as in banking.
Network infrastructure operation	Activities associated with maintaining and operating a physical infrastructure and an information infrastructure.

Table B.2: Primary activities in Value network

CAPABILITY:
The capability building block in infrastructure management describes *the ability to execute a repeatable pattern of actions* [1] page 80. The capabilities are based on a set of resources from the firm or its partners. The pattern of actions uses resources to create, produce and/or offer products or services to the market. The resource or capability either come from the company itself, or from outside actors which enter a partnership and sign an agreement [1]. Osterwalder classifies resources in three categories, which are tangible, intan-

Activity type	Description
Firm infrastructure	The firm infrastructure facilitates operating the company. Examples of such activities are general management, financing and management information systems.
Human resource management	Activities of recruiting, hiring training, developing and compensating personnel. Human resource management is often quite different for infrastructure development and service development, relative to primary activities.
Technology development	In a value network, technology development can be split into network infrastructure development and service development. Network infrastructure development include activities such as design, development and implementation of network infrastructure. Activities within service development include everything from modification of customer contracts to development of new services.
Procurement	Procurement is related to the network infrastructure and service development, and is often specialized for these activities.

Table B.3: Support activities in Value network

gible and people-based skills. The first category, tangible, contains resources such as plants and equipments. The second category, intangible, contain patents, brands and similar resources. Finally, the third category include people-based skills which firms as hospitals, consultant firms and universities rely on.

PARTNERSHIP:
The final building block in infrastructure management is partnership. Partnership is a voluntarily cooperation between two or more independent companies involving coordination of necessary capabilities, resources and activities in order to jointly carry out a specific activity or project.

B.1.4 Financial aspects

COST STRUCTURE:
The financial aspect pillar consist of two building blocks; cost structure and revenue model. The cost structure measures all the costs a company has in order to create, market and deliver value to its customers. The cost structure consists of cost accounts which defines a specific type of expenditures [1].

REVENUE MODEL:
The revenue model is the second building block in the financial aspects pillar. The revenue model measures *the ability of a company to translate the value it offers its customers into money and incoming revenue streams* [1] p. 95.

For further details on the business model ontology by Osterwalder, see [1].