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Using Public Displays for the Presentation of User Statistics

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Problem Description

In Seoul Korea Telecom has established screens at selected spots in the city where information on the use of the local WiMAX network is used. This has given positive results, since people are interested in this type of information, and it has increased the usage. The assignment is to evaluate and suggest what statistics potential users might be interested in. This information shall then be collected from the infrastructure of Wireless Trondheim and presented in a reasonable way to the user.

Assignment given: 15. January 2008
Supervisor: John Krogstie, IDI

Abstract

The aim of the project has been to look at how the knowledge about statistics of use might influence the usage of a wireless network. The project has been conducted in cooperation with Wireless Trondheim. A public display was set up at a café that has the wireless network available. It showed different sorts of statistics collected from the network control system, in addition to news and advertisements.

No significant increase in use was experienced during the period when the screen was up, and the project needs to be conducted in a larger scale to see more obvious results. However, the project has provided Wireless Trondheim with insight on how public displays can be used to increase the awareness and hence the usage of the wireless network.

Keywords: Digital signage, public displays, wireless networks, awareness, context, XML-feeds

Preface

This report is a documentation of the project work performed in the Master of Science in Computer Science by Torborg Skjevdal Hansen. The project counts for 30 study points and is executed in the tenth semester of the Master of Technology education in computer science in The Norwegian University of Technology and Science, NTNU.

The project was defined by the Department of Computer and Information Science, represented by John Krogstie, my supervisor for the project. The project was initiated based on an idea by Thomas Jelle (Wireless Trondheim) and Nils Heldal (Adresseavisa), and intends to find out how a publicly available display of user statistics may cause an increase in the number of users active in Wireless Trondheim. A similar project has been successful in Seoul, Korea, but no written reports on the results have been produced yet, so this has only been used as an inspiration.

I would like to thank my advisors Thomas Jelle and John Krogstie for their support and feedback; and a great thank you to Lene Maria Myhre, Brage Rønning Tukkensæter, and Thomas Asphaug at Wireless Trondheim for supporting me in the project work by supplying me with anything from login access to Cisco WCS to XML feeds, for showing up with a ladder at Bare Blåbær to hang up the 40 inch screen in the window, and for bringing me along to the meetings with Adresseavisa. I would also like to thank Harald Amundsen and Robin Skoglund from Digiboards for giving me the opportunity to use their brand-new software in my project. If it wasn't for them, the screen would be far less attractive, and the project work load would be of a much greater extent. Arve Bremseth and his coworkers at Adresseavisa also deserve a great thank you for taking the time to meet with me and share their experience with regards to public displays. The fact that they showed interest in my project was a great motivational factor also. Last but not least, I would've never been able to find the motivation to succeed in this master thesis if it wasn't for Morten, who has supported me every single day, always so confident in my success that in the end I had to believe in it myself.

Trondheim, June 4th 2008

Torborg Skjevdal Hansen

CONTENTS

Figures

Tables

Chapter 1   Introduction

This chapter introduces the project work that has been done; it describes the motivation behind, gives the project context and definition, and gives an overview of this report.

1.1   Background and Motivation

Wireless Trondheim [ANDR2007] is a company residing in Trondheim that amongst other services delivers wireless Internet connection to people situated in the city centre of Trondheim. Until recently the service was only available for some of the residents, but it has now been made available to everyone. Wireless Trondheim is interested in finding new ways to gain more public interest in the Wireless network. Also, since Trondheim is the first city in Norway to become a "wireless city", there is also a great possibility that all ideas created and implemented in Trondheim can be adjusted and introduced to other cities as well.

KT, formerly named Korea Telecom, is an integrated wired/wireless telecommunication service provider. They were the first to deliver a wireless broadband service, named WiBro [WIBR_2008]. Through WiBro, people can share information wherever they are, even on the go. In the beginning of 2007, multiple displays were set up around the city, displaying statistics of user activity in WiBro.

The hardest challenge faced by someone trying to market a wireless network, is making it visible. The service itself is completely invisible, and unless people are made aware of it, they do not know, nor care about it. The result that was observed in Seoul was that the public displays made the wireless network more visible. I intend to find out whether a similar solution will help increase the use of Wireless Trondheim.

1.2   Problem Definition

The project goal is to create a greater awareness of the existence and availability of Wireless Trondheim and its services. This should, consequently, gain more users of Wireless Trondheim.

The project goal will be realized by developing and setting up public displays in public areas of Trondheim. Their content will be user statistics from Wireless Trondheim, and information on how to access the network.

1.3   Report Outline

Following is a short reader's guide to help giving an overview of the different chapters in this document.

Chapter 2 Prestudy is a study of state of the art today, and some existing technologies and solutions that will be helpful in the project work.

Chapter 3 Research and Technical Background looks at possible ways to perform the research, and also gives an introduction to the technology that will be used in the project work.

Chapter 4 Scenarios and Requirements Specification will introduce the scenarios representing the intended service, and the requirements that are elicited based on these.

Chapter 5 Design describes which choices are made for the implementation of the service and gives an overview of the design.

Chapter 6 Own Contribution describes how my own contribution was achieved, which choices were made and how the service evolved.

Chapter 7 Results gives an overview of the results of the project work, both the public display that was set up, on how the statistics of use were affected.

Chapter 8 Evaluation discusses the technical results achieved, and to what degree the research question was answered.

Chapter 9 Conclusions concludes this paper with a conclusion of the project work based on the evaluation.

CHAPTER 2   PRESTUDY

This chapter intends to introduce relevant research and trends that represent the state of the art. It will also describe the only similar, existing solution that I have been able to find. There might be more similar projects going on at the moment, but none of these have yet been analyzed and documented.

2.1   Digital Signage

It is, and has been for a very long time, common to advertise for one's products using billboards and posters at strategic places in people's environment. Some of the more popular commercial positions cost a lot, but they are seen and read by many people. Recently a new trend has emerged, digital signage, where dynamic commercials are set up, using big displays instead of billboards. Digital signage [WIKI2008] is electronic displays that are installed in public spaces. Their initial aim is to entertain, inform, or advertise for something. As prices on LCD and plasma screens continue to decrease, and the quality increases, many businesses find it interesting to use electronic displays for dynamic display of content in public places. Examples are screens in public transportation vehicles such as the airport express train and bus, and taxis, and in some cafes a screen has also been set up to display news or menus and upcoming concerts such as in Samfundet, a student house in Trondheim. An example of digital signage is shown in Figure 2-1. The displays are called public displays, and the new type of showing information is called digital signage.

Figure 2-1: Digital signage in the Warner Village in Taipei

2.2   Awareness Aspects

This section will discuss the concept of awareness as it is relevant to the project work.

2.2.1   Creating Awareness of something that's Invisible

People are aware of many things in their physical environment. Furniture, colors, other people and so on, are things that we are aware of when entering a new room, without even thinking about it. However, when technology has become a more natural, and for some people necessary part of our lives, researchers found that much awareness was lost [ERIC2002]. When chatting with someone in another place, we know a lot less about that person's current state of mind, than if we were looking into his/her face during the conversation. Another example that is mentioned in this paper is that when queues are moved from the physical to the virtual environment. When waiting to get through on a help desk, it is not possible to judge the situation to see how long it will take to get through. Even if there is an automatic update on the caller's current place in the line, the caller cannot look at the people in front of him/her to determine how slowly or effectively they will be assisted. Also, when tools and artifacts go from being physical to turn into technical services, it is not that obvious what services are available for us to use. For example, a post office is very visible, with a separate entrance and a sign above the door to indicate that it is a post office. And, immediately people know what they can use the post office for, since they have grown up knowing what post offices are for, and what services they provide. Now, it is not as easy to create this common knowledge about what a wireless network is to be used for, since most people do not know where it is, or if it even exists, and they do not know all the services that are available either.

2.2.2   Creating a Sense of Community

In addition to creating awareness, the public displays can also be responsible for creating a sense of community in that people are made aware of what is going on with other people around them. By showing what other people are interested in, for example, people can see that others are interested in the same things as they are, and they might find new interests as a result of this. An example is the biggest book stores in the US that are accessible through the internet. At Amazon.com, you constantly get tips on what similar customers also bought, based on what articles you have selected. This is a way of creating the same sense of community as that you have when shopping in grocery stores and such in real life. People see other customers' shopping carts and might get tempted to or reminded on what they shall buy.

2.2.3   Use of Displays to create Awareness of an Invisible Artifact

Wireless Trondheim is present in most of Trondheim, but still it is not visible. This creates a challenge with regards to making people aware of the fact that

it is there, and that it is available. The idea is that the installation of such public displays will gain more users, since more people will become aware of the existence of Wireless Trondheim.

2.3   Ubiquitous Computing

The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.

Mark Weiser [WEIS1991].

By this, Weiser meant that the technology eventually would become a natural part of our daily life, in such a way that we are not aware of the fact that we are using it. One of the visions researchers had for the future, was that we in the 21st century would be surrounded by computers, not even knowing that they were there. In many ways, this has happened, although there is still a long way to go before the technology is completely a part of our environment. However, ubiquitous computing is relevant to this project since Wireless Trondheim is slowly becoming a part of the people's environment, and if we became sufficiently used to having it available wherever we were, it would be used even more. For example, by having a PDA or iPhone connected to Wireless Trondheim constantly, a user can always have the latest updated weather forecast in his pocket, which is a rather handy gadget for someone living in Trondheim where the weather is rather unpredictable. As already mentioned, ubiquitous computing is not necessarily visible, it should rather not be, so that the people can focus on their actions and not on the act of using the technology. However, this is also what the problem for Wireless Trondheim: not everyone is aware of the fact that it is there.

2.4   Case study: Supporting content scheduling on situated public displays

Storz, Friday, and Davies published a paper named "Supporting content scheduling on situated public displays" in 2006 [STOR2006]. They looked at how issues regarding the implications of having networks of situated public displays could be handled. By developing the e-Campus project, they came up with a design that they present in this article. Although their main interest in the paper was to look at the content scheduling of what to show on public displays, this clearly gives an indication of the fact that public displays are becoming more common. They even predict that public displays will nearly take over for physical posters, only depending on the price of digital screens to get low enough.

The design proposed in this article is not that relevant to the aim of this master thesis, but will be very interesting at a later stage, since there will be many screens in different locations, and they need to be managed in the most autonomic manner possible.

2.5   A selection of suppliers of Digital Signage

This section will introduce some of the present suppliers of digital signage solutions.

2.5.1   NEC Display Solutions

NEC Display Solutions [NEC2008] develops, produces, and delivers display products and visual solutions. NEC is one of many companies that have created a separate division for the sales of public displays. Some of their customers in Norway are the Airport Express Train in Oslo, Spar shops, Vodafone, and several airports. In Figure 2-2 an example from the Airport Express Train is shown. The screens vary between showing news, stocks, weather forecasts, flight delays, commercials and so on.

Figure 2-2: Public display at the Airport Express Train in Oslo

2.5.2   MyTV Media from PSI Media Solutions

MyTV [PSI2008] delivers extensive solutions to companies that want to give their customers/employees massive information. Their aim is to better fit the information that is given to the respective persons. They participated in a pilot project for Estethique, a retail store that sells beauty products, where the whole store was packed with public displays of different kinds. They had some screens that showed commercials, some that showed featured products, some of the screens could read the price tags and give extensive information about the products, and some were set up to entertain the customers while they were waiting in line to pay. The pilot project has been so successful that Esthetique is planning to use the same solution in their other stores also. Other customers that have taken MyTV's solutions in use are Skeidar, McDonald's, and the Norwegian newspaper VG.

2.5.3   Digiboards

Digiboards AS [DIGI2008] is another company that delivers solutions for digital signage. They use web-based software. They make it possible for the owners of the displays to access and edit information through web interfaces,

and the information can also be dynamically updated from databases, RSS-sources, Intranets and so on. All maintenance of the displays and systems is conducted by Digiboards. Digiboards has previously cooperated a great deal with IDI at NTNU, with respect to the creation of their products. One of their customers is a bank in Trondheim, where they have set up a screen that gives information about the status of the bank at all times, to provide its customers with information.

2.5.4 Other providers of Digital Signage

The list is long of providers of digital signage, to mention a few more there is Pronto Display [PRON2008] and Scala [SCAL2008], where the first mentioned operates in the Norwegian market, and the second is more international, having customers like Warner Bros, Santiago International Airport, and IKEA.

2.6 The difference between Digital Signage and this project

Seeing that there is already a vast, up-and-coming market for digital signage, one may wonder what this project will bring to the table. Therefore it is necessary to look at what aspects are different in this project, compared to what existing solutions already provide.
- The goal of the solution is first and foremost to gain more users of the system, not necessarily making money.
- The solution will be the result of several different actors' interest, which is Wireless Trondheim, Adresseavisa, the owners of the places where the screens are set up, and the owners of the advertisements.
- The solution will provide users with information from a system that in the first place is only intended for those maintaining the wireless network.
- The screens will be set up at many different kinds of places, not only cafés or only airports, which is common for digital signage (they usually have a predictable audience).

2.7 A Similar Solution – Korea Telecom

It has been necessary to look at the previous results from Korea to see how these can predict the results in this project. Korean citizens are much more advanced in their use of technology, and therefore might be more open for and used to technological environments. Therefore I have seen it necessary to study the surveys with a critical eye, just as an inspiration for the project work to be done. However, no such information was found. Thomas Jelle in Wireless Trondheim has been in contact with several agencies in South Korea, without getting any specific information. Due to this, I have not had any guidelines based on how the project in Seoul was conducted.

CHAPTER 3   RESEARCH AND TECHNICAL BACKGROUND

This chapter discusses challenges related to the project, and looks at the technical background for the project.

3.1   Previous Research Results

Unfortunately, we have not succeeded in finding any information or statistics on how the screens in Seoul caused an increase in users. We only have oral statements from professionals working in KT saying they saw an increase in the user numbers.

3.2   Challenges

Several aspects come into play when discussing the observed interest for such an application. The display will create a greater **awareness** amongst the intended users in the city, since they will be informed about something that they on beforehand did not know about at all (except perhaps if the web surfing or use of services seemed to move slowly due to many users at the same time). Seeing the displays will spark some **curiosity** the first time they are seen and hopefully the result will be that a user gets interested and logs in to use Wireless Trondheim. If users are more aware of the fact that Wireless Trondheim offers a popular collection of services that many people are using, they might find themselves logging in more often.

It is not feasible to predict how users will react to the displays since the intended effect is not something that they might think about on beforehand. The displays are intended to create a greater awareness and perhaps a feeling of bonding between many people, since they become aware of the fact that other people are also using the services – thereby they might feel that they are missing out if they don't join themselves. For example, this effect is greatly seen if there is a crowd of people in an area looking at something – this causes more people to stop and see what is going on. Also, being at the Tivoli, a carousel looks far more fun and tempting if it is moving and there are people sitting in it, laughing and seemingly having fun. Similar events that happen in cyberspace cannot be seen by anyone else but those that are actively participating.

Wherever the displays are to be set up, it must be easy for people to log on to

use the services they are interested in at that exact place. If they just see the displays and are not given the opportunity to use the services immediately, they might think that they will log in at a later time, but they will most probably forget about it when they are in fact at an appropriate location. Also, there must be a fine balance between how much information is displayed, so that the displays don't suffer from information overload. In that case, people might find the displays un-informative or even disturbing, and they will lose the public's interest. Another issue is that the information that is chosen to be displayed must attract people's interest in some way. The information must learn them something new that they did not know about, and maybe did not care about knowing, before the information was given to them. Part of the main challenge of this project, is to find out what information this is. The first solution I come up with might not be the ultimate one, and by that I need to develop the solution so that it can be easily configured to match the unforeseen needs. In other words, there is need for a close evaluation of what information that shall be displayed, and the information that is to be displayed must be well represented.

Another issue that might become a challenge is the fact that public displays have not yet been introduced in a great scale in the city. This might cause suspicion and irritation if people do not find the displays interesting or helpful. While in Seoul, there were already many public displays covering the whole city when the user statistics were first introduced.

3.3   Technical background

This section describes the technical tools and systems that are relevant for the project work.

3.3.1 Wireless Trondheim

Wireless Trondheim is a research and development project started in the research environment at NTNU, also supported by the city of Trondheim, the Sør-Trøndelag County Council, SpareBank 1 Midt-Norge, Adresseavisa, and Trondheim Energiverk. Wireless Trondheim is now a separate company, still working closely to researchers and students at NTNU. Wireless Trondheim ltd delivers Wi-Fi network coverage in most of the Trondheim city centre, also expanding gradually to the indoors. Fig3-1 is found on Wireless Trondheim's information page on the Internet [TRAD2008] and shows what parts of Trondheim have coverage by Wireless Trondheim's network. The pins are each marking a café/library/restaurant and such that has coverage indoors. The red circle in the figure indicates the location of Bare Blåbær, which is the place where the public display will be set up.
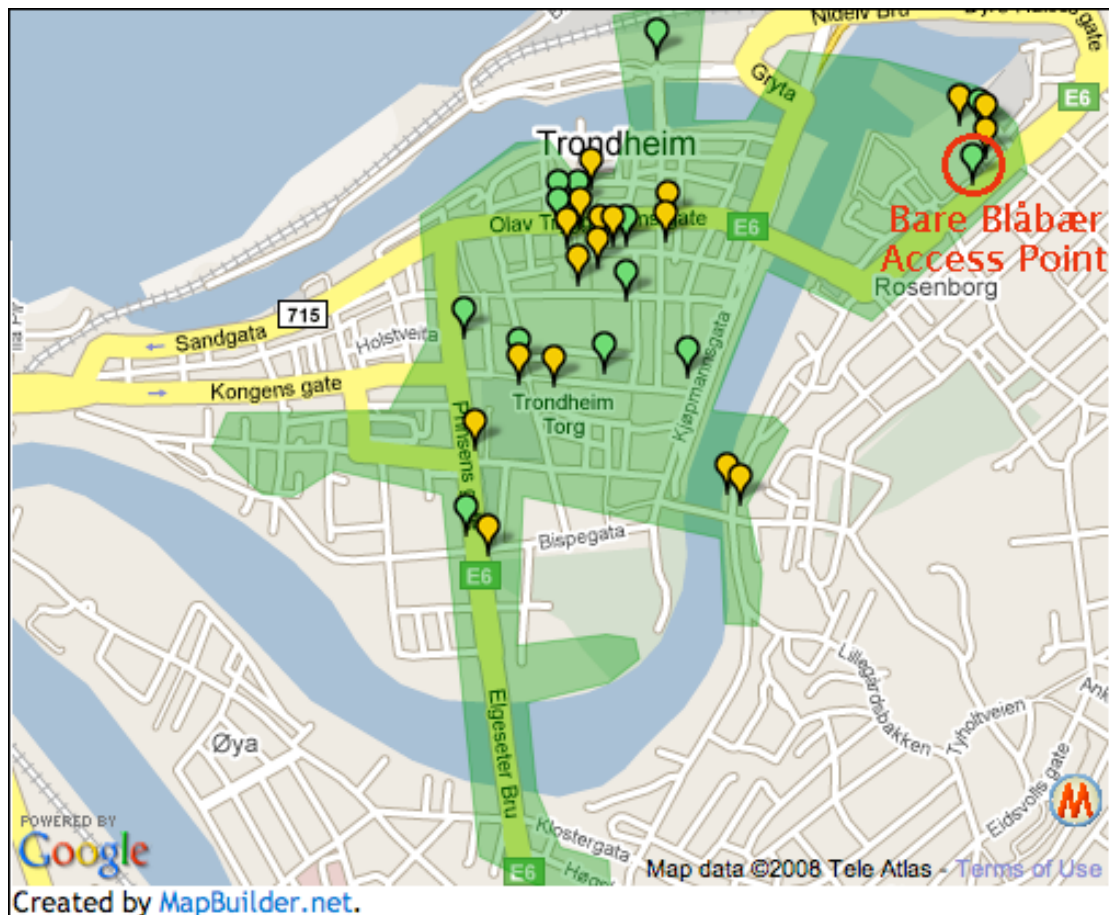
Figure 3-1: Map indicating wireless network coverage of Trondheim

3.3.2 Cisco Wireless Control System

The Wireless Control System (WCS) from Cisco [CISC2008] is a platform for wireless LAN planning, configuration, and management. Cisco WCS provides a powerful foundation that allows IT managers to design, control, and monitor enterprise wireless networks from a centralized location, simplifying operations and reducing the total cost of ownership. I will use the WCS to access information about statistics of use in Wireless Trondheim. As indicated in Figure 3-2, there is also an optional component called the Location Appliance. Wireless Trondheim uses this part for keeping track of locations of users in Trondheim, and GeoPos is a separate project initiated by Wireless Trondheim that develops a service for positioning users in Trondheim. So far, there are not enough services available by GeoPos to be relevant for use in this project, but this will definitely be an option at a later point in time.
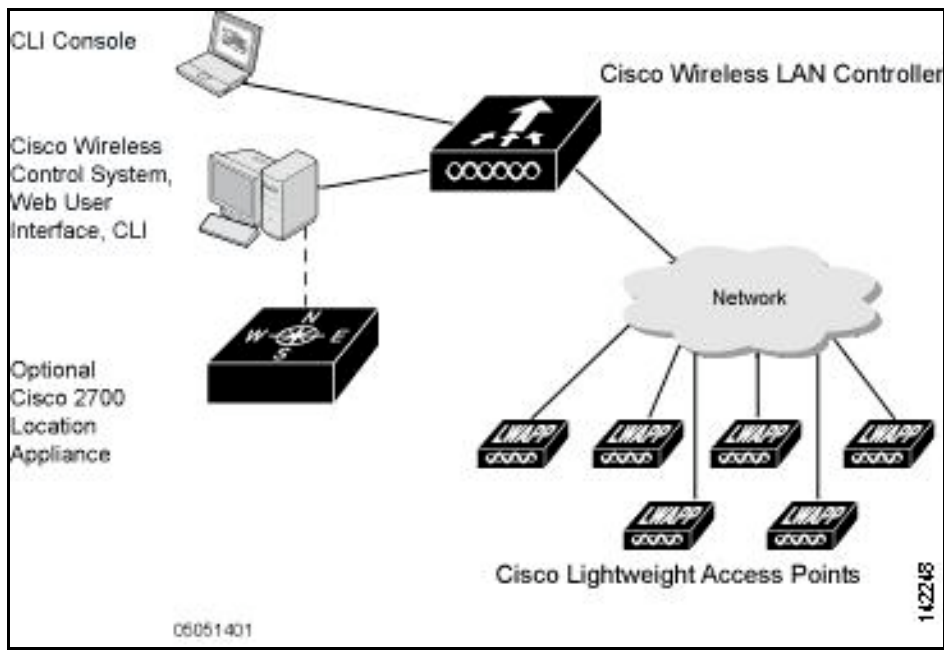
Figure 3-2: Cisco Wireless LAN Solution Components

Table 3-1 gives an overview of the available reports that can be made by the WCS. Reports can be made on demand or on scheduled time increments, and can be exported in two different formats; PDF[1] or CSV, Comma-Separated Values.

Table 3-1: Cisco WCS Report Summary

Cisco WCS Report Description	
Inventory	Inventory reports for wireless equipment deployed within the network (access points, controllers, and location appliances) can be generated for each hardware category or as a combined report for all categories. Reports can include the hardware type, software revision, and location by building or floor.
Performance	Memory and CPU usage can be tracked and reported at configurable intervals. Coverage hole alarms can be generated to provide a better view of the coverage hole problems experienced by client devices. Metrics for voice traffic streams are available to support Cisco Compatible Extensions clients running Version 4 and later.
Security	Security information can be downloaded as a report and the number of rogue devices detected by each access point per month can be automatically listed on the summary report. Intrusion detection system (IDS) reports display rogue devices and ad hoc events as a list or graph.

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[1] PDF – Portable Document Format is a file format created by Adobe Systems that is intended for document exchange independent of which platforms were used to create the initial file.

Clients	Reports on the roaming history of all clients, the busiest clients and a list of unique clients that accessed the WLAN in a specific area for a specified duration of time can be generated. Trends in client counts can be displayed in a graph.
Access Points	Traffic stream metrics for access points can be generated as a report or a graph. Access points can be reported by their location or SSID and the status of each access point by its profile listing can be reported. A listing of the busiest access points is available in a table format.
Mesh	A report on the number of alternate parents available to a mesh access point in case the parent is lost can be generated. Other mesh reports that can be generated for events overt time include: child and parent link statistics, node hop counts, packet error rate on the backhaul link, the number of transmitted neighbor packets, worst node hops, packet queue statistics, and worst SNR links.

3.3.2.1 Access Points Reports

For the display, I am interested in the Access Points reports, and the Clients reports. For the Access Points I can get information about what areas are the busiest with regards to the traffic in Wireless Trondheim network. I will use this to give people an indication on where Wireless Trondheim is used the most. This can, at a later time, become a possible way for cafés to get attention, if their name is often on the list of the most used places. Possibly, people will start thinking that the cafés are a nice place to sit if they want to get some work done on their laptop, for example.

3.3.2.2 Clients Reports

The Clients reports must be kept very confidential, since they can indicate personal information that is not supposed to be viewed by unauthorized people. I will only use a client report to get the number of clients that are connected to Wireless Trondheim. I will fetch the numbers from the last hour, and from the last day. This will give people an idea on how many users Wireless Trondheim in fact has. It would also be interesting to display a graph indicating what times of day, or what weekdays, that have the most traffic, but this is not easy to generate from the WCS, and will not be implemented in this trial version.

3.3.2.3 Comma-Separated Values, CSV files

As already mentioned, the reports generated in the WCS can be exported in either PDF or CSV format. The CSV format is most appropriate for automatic handling by other programs, if the intention is to extort and use the data. It is used for files that list some amounts of information. They are very similar to other files such as XML, but even simpler. They contain lines of comma-separated information. The first line in each file indicates what information that is listed in the file. The following is an example of the CSV file that is

generated when requesting a report of the five busiest Access Points in Wireless Trondheim.

File name: Busiest_Aps_20080420_202605.csv

```
AP Name,Map Location,RX Util (%) (avg),TX Util (%) (avg),Channel Util (%) (avg)
Fylkeshuset-B/AP3,Midtbyen > Sone06,0.00,0.00,27.25
Nimuser,Midtbyen > Sone06,0.00,0.00,26.50
Vitaltrekant,Midtbyen > Sone04,0.50,0.50,25.50
Fylkeshuset-AP2,Midtbyen > Sone06,0.00,0.00,25.00
RoyalGarden,Midtbyen > Sone03,0.00,0.00,22.75
```

The file name is given based on the name of the report that is generated, the date and the exact time the report was generated. As the first line indicates, the report gives information about AP Name, Map Location, RX Util (%) (avg), TX Util (%) (avg), and Channel Util (%) (avg). If this information is given to a regular person, he or she will only be interested in where the Access Point resides, for example what street it is in, since the percentages of utilization will not give any added value if he or she has no experience with these values. Therefore, these reports are handled and modified before the information is saved as XML feeds.

3.3.3 XML, Extensible Markup Language

XML [W3C12008] is not a language, but a specification on how to create markup languages. It is based on giving additional description to the information so that any machine can interpret it. It is highly extensible because it is allowing users to define their own elements. Due to this ability, it is convenient for the sharing of structured data across different information systems. The Internet is one great example of how this course of thinking has made it easier to share information.

3.3.4 PHP, PHP Hypertext Protocol

To generate XML feeds, I will use PHP [PHP2008] . PHP is a language used for making web pages. It is fairly simple, but has much more capabilities than HTML. I chose PHP because I have experience with using it, and the PHP functions available include functions for reading CSV files. Also, PHP has support for connecting to FTP[2] servers and performing necessary FTP commands for this project, which I will use to read the report files from WCS.

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[2] FTP, File Transfer Protocol is a network protocol used to transfer data from one computer to another through a network, such as over the Internet.

CHAPTER 4 SCENARIOS AND REQUIREMENTS SPECIFICATION

This chapter will explain the project in more detail, by first giving some scenarios to exemplify use, thereby elaborating on the problem definition by introducing hypotheses and listing the requirements for the service.

4.1 Scenarios

To get an understanding of the intended functionality of the service, this section will introduce some scenarios to describe how it will interact with a user's daily life.

4.1.1 Scenario 1

Birgit and Lisa have planned to meet for a cup of coffee at Dromedar café. Birgit arrives straight from school, somewhat early. She selects a cookie at the counter and gets in line to order a coffee also. While in line, her eyes glance lazily through the room, and she ends up reading the recent news on the display put up by Adresseavisa behind the counter. Next to the news, a separate column displays a graph indicating how many users are on Wireless Trondheim in Dromedar, and the rest of the city. Birgit didn't know that Dromedar had cover for Wireless Trondheim, but seeing the display gives her the information she needs to log on to the Internet and check her e-mail before Lisa finally joins her at Dromedar.

4.1.2 Scenario 2

It is Saturday and Lars has been dragged out of the sofa to go shopping with his wife, Anne. They are now in their fifth shop with women's clothes, and Lars sits down in the sofa at Karma to relax his feet. On the wall he notices a public display and he starts reading the news that are scrolling over the bottom part of it. He also notices something that is written about Wireless Trondheim. It is revealed to him that Wireless Trondheim offers a service that displays all the upcoming soccer games that will be shown in the pubs in his surrounding area. Lars gets excited, and logs in to Wireless Trondheim and accesses the service from his cellular phone. He gets even more excited when he finds out that Newcastle – Tottenham are playing on Three Lions in

half-an hour. By being very polite, he gets Anne into a compromise saying that they will have their lunch at Three Lions, before continuing the shopping spree.

4.1.3 Scenario 3

Andreas enjoys a latté at Choco Boco in Nordre Street, while trying to find inspiration to write on his master thesis on his laptop. He notices a public display in a corner, and reads about Wireless Trondheim, which he is already using. However, Andreas notices that some of the services listed on the "top five" list he has never heard about before. Andreas guesses that since the service listed as number one is so popular, it must be of some interest to him, so he checks it out. It turns out to be a service that positions the user and lists all the nearby places to get a cheap beer. He accesses the service, and within a few seconds he discovers a new place that he has never been to before, that has very cheap beer. He logs on to Facebook and creates an event, inviting all his classmates to gather for some beers at the newfound place the following Thursday.

4.1.4 Conclusions from the Scenarios

- The public displays must catch people's interest.
  - That is, they must be positioned and scaled in such a way that people notice them.
- The information displayed must be interesting and presented in such a way that it catches people's interest.
  - If not, people will not care about the displays, and will not act upon the information that is presented to them.
- The information that is displayed must be updated
  - Some people might use Wireless Trondheim solely in response to something they read on the display. If the reality is not synchronized with what they just read, Wireless Trondheim will lose some of its credibility.

4.2 Hypotheses

This section lists the hypotheses that I intend to verify in the project.
1. The introduction of public displays containing user statistics from Wireless Trondheim will cause an increase in the number of users.
2. The public displays will give people a greater insight to what Wireless Trondheim has to offer.
3. By showing the most popular sites amongst users of Wireless Trondheim, a trend will be created that causes the sites to become even more popular.

Comment: the third hypothesis is also related to the fact that at a later point, it will be relevant to display the most popular services in Wireless Trondheim, as indicated in Scenario 1 also. Then, the same point can be made regarding the most popular services.

4.3 Requirements Specification

In this section the requirements made based on the scenarios of the service are introduced. The requirements are grouped in functional and non-functional requirements. All requirements are classified with a priority of high, medium or low, and are somewhat based on the evaluation of the scenarios but for the most part they are based on what representatives from Wireless Trondheim and Adresseavisa believe will be important. The criteria for the priorities are specified in Table 4-1.

Table 4-1: Description of the different priority types

Priority	Description
H	High priority. The requirement must be fulfilled to be able to deliver an approved and functioning solution.
M	Medium priority. The requirement is not absolutely necessary for the solution to function. However, unless in a special occasion, the requirement must be fulfilled.
L	Low priority. The requirement should be fulfilled, but it does not have any real impact on whether the solution succeeds or not.

4.3.1 Functional Requirements

This section will list the functional requirements for the service.

Table 4-2: Functional Requirements for the public display

Number	Requirement	Priority
1	The displays shall show information about user statistics. a) Number of users b) Most popular services c) The areas with the most users	H
2	The information displayed shall be dynamic.	H
3	The information displayed shall be anonymous, that is, no personal information shall be displayed.	H
4	A part of the display shall have a section were news are scrolling.	M
5	A part of the display shall have a section were commercials are displayed and changed periodically.	L
6	The information displayed shall not be out-dated by more than 60 minutes. If no new information can be retrieved and displayed, an alternative view should be selected (or none at all).	M
7	The screen shall be able to connect to the wireless network available (in this case, Wireless Trondheim shall be used, and the screen must be able to stay connected even if reception sometimes is bad).	H
8	The solution shall be possible to implement in other cities as well.	L

9	It shall be possible to alter the type of information that is displayed.	M
10	It shall be possible to display context-sensitive information. a) Depending on which area the display is situated. b) Depending on the type of place the display is situated (café, book store, grocery store, clothing store, etc.) c) Depending on the people that frequent the place.	L
11	The people responsible for the place that sets up the display should have the ability to alter and decide what information is displayed. For example, commercials can be suited to the café or store within which the display is situated.	L
12	The code shall be documented.	M

4.3.2 Non-functional Requirements

This section will list the non-functional requirements for the service.

Table 4-3: Non-functional Requirements

Number	Requirement	Priority
13	The display content shall be displayed in such a way that it catches people's attention.	H
14	The screen shall be positioned in an area where it can be connected to Wireless Trondheim, and is clearly visible for the people nearby.	H
15	The size and resolution of the screen must be such that people can read the content of it, even at up to ten meters away.	M

4.4   Prototype of screen shot

Figure 4-1 shows the initial screen shot that has been made as an example of how the result should be.

Figure 4-1: Sample Screenshot

Chapter 5   Design

This chapter gives an introduction to and discussion of different choices to be made, and will in the end of the chapter reach a conclusion on what I will be using for the implementation of the service.

5.1   Figure illustrating the design

Figure 5-1 gives an illustration of how the solution looks, when using Digiboards' existing software for the display of information. Digiboards uses XMLs to display information in their broadcasting system. They also provide a web interface where the customers can select or change what information is to be displayed. By choosing this option, my object was to make XML feeds that would constantly supply the software of Digiboards with updated information.
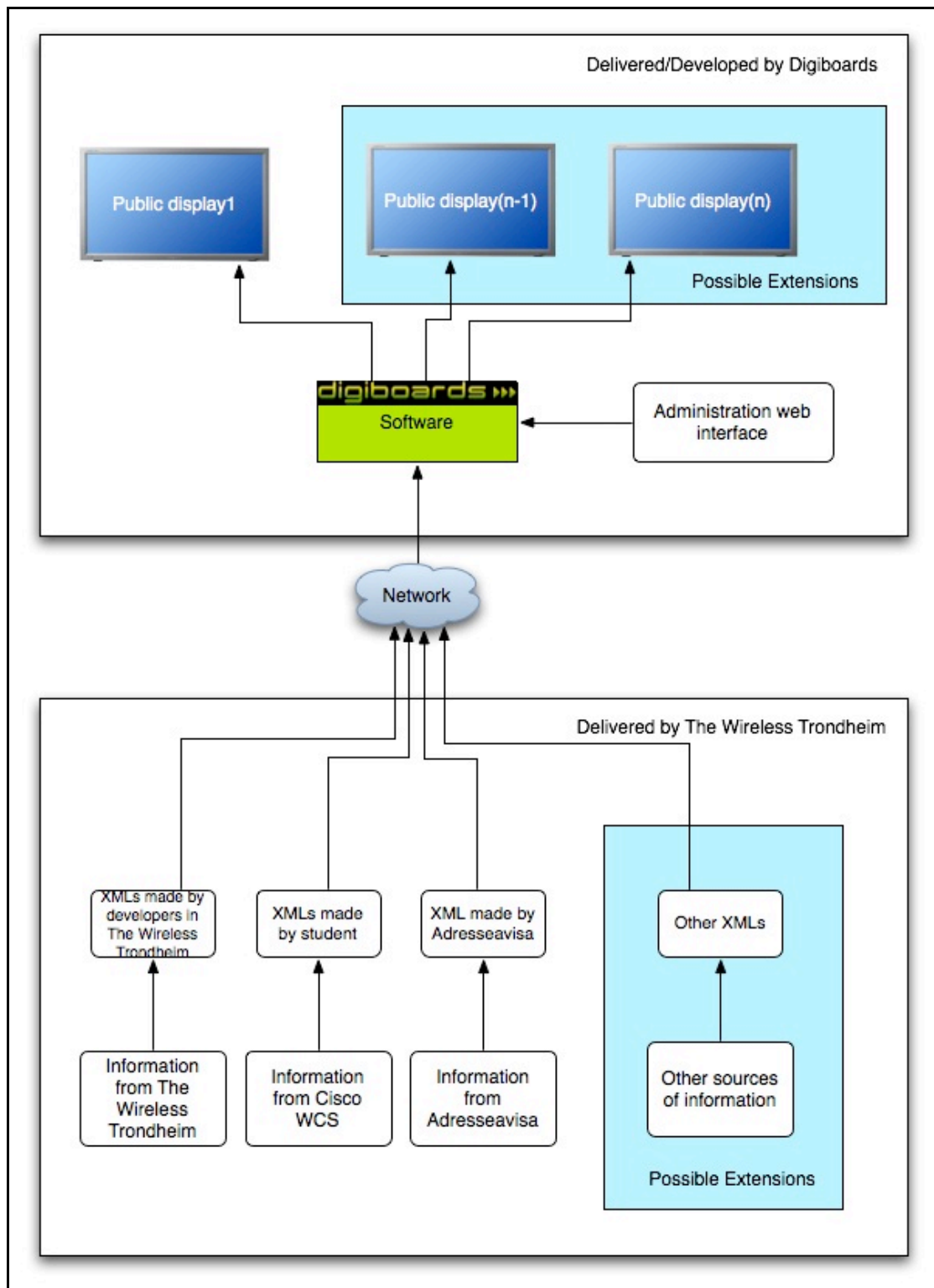
Figure 5-1: The solution with Digiboards

5.2 Design Choices and Discussion

Since I chose to work with Digiboards, they would supply the actual software on the display, and I was to provide XML-feeds. This made the design process easier, since I no longer had to worry about the installation of the

screen and how to get information to be displayed informatively and delicately on the screen. The software that Digiboards has developed provided me with a graphical web interface that I would log in to and submit the information to be displayed. It also allows for setting different degrees of security, so that some people can have access to only some of the information in the system. Figure 5-2 shows a screen shot of the web interface that I worked in. The Player Area is a section of the screen where predefined playlists are shown. The playlists themselves are created and modified in the Playlists tab in the top of the window.

Figure 5-2: The web interface for altering the information to be shown on the public display

TDT4900 Master of Science in Computer Science Spring 2008

CHAPTER 6   OWN CONTRIBUTION

This chapter outlines the contribution of my work, and how my solution was achieved. I will also describe the issues I encountered when developing the service.
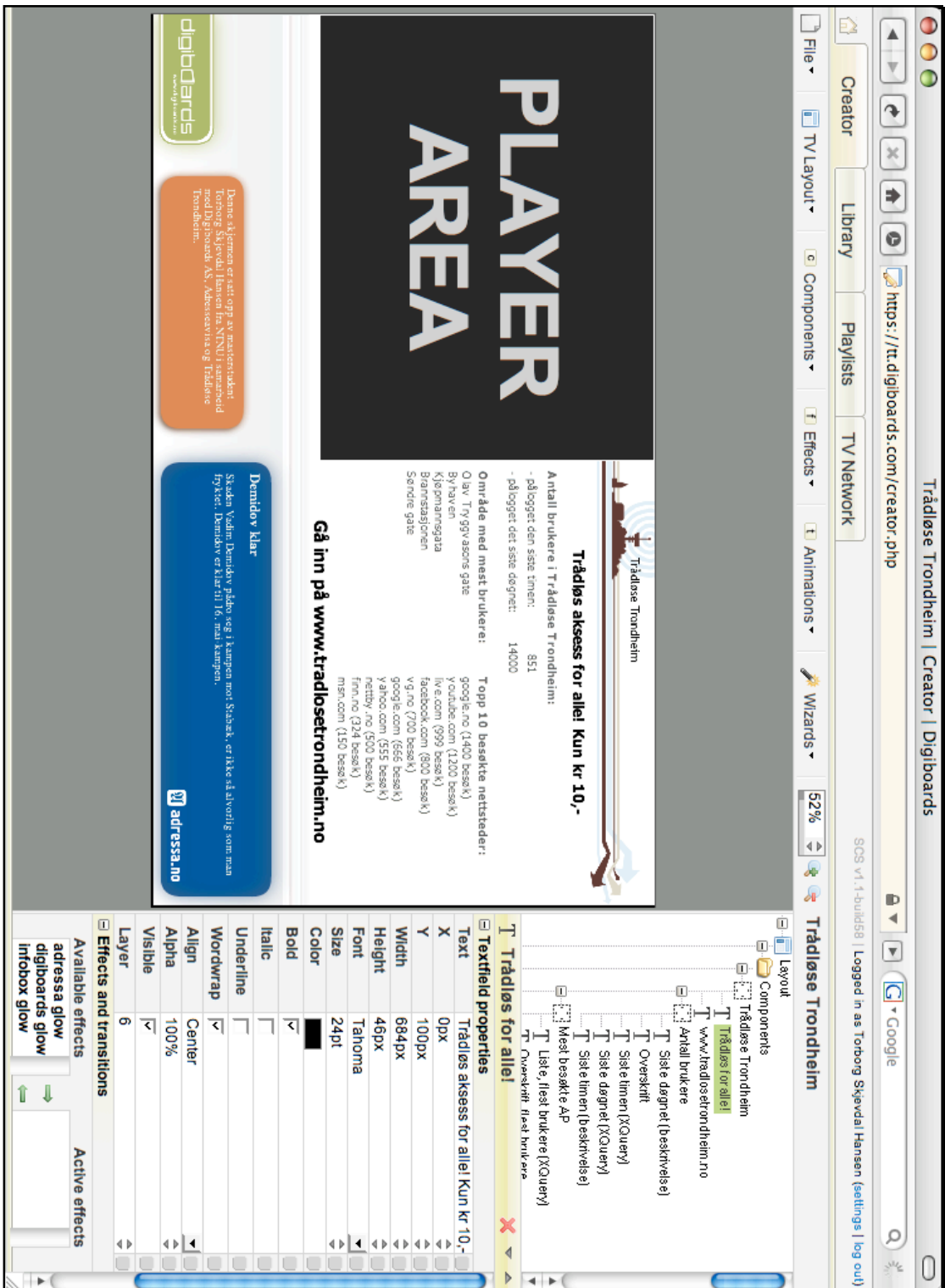
6.1   Digiboards

Digiboards was introduced in Section 2.5.3 and is a Norwegian company situated in Trondheim. They started their business a few years ago, and are now finished with a framework for distributing information to public displays, especially within the field of digital signage. They agreed to cooperate with me, so that I created XML-feeds that their system could use to display the information on a public display situated in Trondheim.

6.2   XML-feeds

In this section I will describe the different XML-feeds that are used in the project.

6.2.1   XML-feeds made by me

As mentioned, I made XML-feeds. By supplying the link to a PHP-page, the PHP-code created and updated the available XML-code whenever necessary. The PHP-code connects to the WCS-server of Wireless Trondheim to fetch the newest report of use that has been generated.

6.2.1.1   Number of users

This XML gives information about how many users have logged on to Wireless Trondheim. It gives a number for the last hour, and one for the last 24 hours. I used the Client Reports, and Client Association, to get this information. Since client information is very confidential, I only count the number of entries; without reading the data in any other way.
URL: http://folk.ntnu.no/torborgs/xml.php?selected=numUsers

XML Syntax for Number of users:

```
<ClientCounts>
      <Item>
            <Title> </Title>
            <Count> </Count>
      </Item>
</ClientCounts>
```

6.2.1.2 Areas with the most users right now

This XML gives information about which places in Trondheim have the most users connected to Wireless Trondheim. I have only made a simple version of this; an extension would be to check for greater areas to get a greater understanding of the situation instead of listing each access point. To get the data, I have used the Access Point Reports, and Busiest APs.

It is also possible to get information about the busiest areas during longer time periods, for example from the last 24 hours, but for the purpose of displaying it on the public display it is sufficient with one list on this matter.
URL: http://folk.ntnu.no/torborgs/xml.php?selected=top5APs

XML Syntax for Number of users:

```
<Access_Points>
      <Access_Point>
            <AP_Name> </AP_Name>
      </Access_Point>
</Access_Points>
```

6.2.1.3 Advertising feed

Ideally, Adresseavisa would have the responsibility for delivering an XML-feed with information and links to commercials that are to be displayed. However, since this project had a short time span, and Adresseavisa did not have the resources to create such a feed, I made a static feed that provided links to a fixed amount of advertisements. Since this was just for research purposes and not for making money, it was not a problem.
URL: http://folk.ntnu.no/torborgs/ads.xml

XML Syntax for Ads:

```
<Ads>
      <Item>
            <id> </id>
            <url> </url>
      </Item>
</Ads>
```

6.2.2 *News-feed supplied by Adresseavisa*

Adresseavisa had a news-feed in RSS that I could use to get constantly updated news. Since they did not have the ability to take the time to create a new feed, I used a feed that is already in use by the big screen situated

outside the shopping mall Torget in Trondheim. The RSS-feed gives a list containing ten news that are related to Trondheim. Each entry has a title and a short, explanatory text.
URL: http://www.adressa.no/storskjerm/?service=storskjerm&xml=true.

XML Syntax for news-feed by Adresseavisa:
```
<channel>
      <title> </title>
      <language> </language>
      <copyright> </copyright>
      <item>
            <title> </title>
            <description> </description>
            <cfi:id> </cfi:id>
            <cfi:read> </cfi:read>
            <cfi:downloadurl> </cfi:downloadurl>
            <cfi:lastdownloadtime> </cfi:lastdownloadtime>
      </item>
</channel>
```

6.2.3 XML-feed supplied by Wireless Trondheim developers: Most popular web pages

The developers of Wireless Trondheim have created a web interface for users to log on to the available network by an SMS-service. They have access to information about what site the users log on to, and this information was relevant for me to display, since it gives an indication of what pages on the Internet are more popular by the typical users of Wireless Trondheim.
URL: http://www.tradlosetrondheim.no/login_ma/popDomainsWeek.php

XML Syntax for most popular web pages:
```
<sites>
      <site>
            <domain> </domain>
            <visits> </visits>
      </site>
</sites>
```

6.3 Issues Regarding the Implementation

This section will describe some of the unforeseen issues that caused delays or changes in the project work.

6.3.1 Connecting to WCS from PHP to read reports

To collect reports from Cisco WCS it was necessary to connect to an FTP server that was set up to make the reports available to identified users. However, some problems occurred when trying to connect to the FTP server from PHP, probably due to some firewall troubles that we were not able to resolve. Due to this, the result ended up being dependent on continuous

updates being downloaded from the Cisco WCS system. There is a function in the WCS that makes it possible for mail addresses to subscribe to certain reports. By receiving and saving the necessary reports in a folder on my computer, the PHP code could get somewhat updated information, and the XML feeds somewhat succeeded in being dynamic.

6.3.2 Amount of displays available

Ideally, it would have been better for the project purpose if several screens were set up, also for this trial period. Then it would be easier to see results, since more people would discover the screens. However, there is only a limited amount of funds available for such a master thesis project, so we had to limit ourselves to only buying one screen.

6.3.3 Time issues

Since one of my collaborators was Adresseavisa, I had to collect information from them. However, since the developers in Adresseavisa have responsibility for all of their technology, and they are not being paid by Wireless Trondheim, I could not require an extensive amount of support. Also, they did not have the ability to work towards the same time limits as those I had. Therefore, I sometimes had to find other solutions instead, for example with that of the advertising feed.

6.3.4 Network trouble

Two days before I had planned to set up the public display in public and start collecting results, Wireless Trondheim network suffered from an error that caused most of the access points in the city to be shot down. Even the access point at the café I was to set up the display, was out. Due to this, I had to wait with the screen, since it would not work for its purpose if it could not give people the opportunity to connect to Wireless Trondheim after seeing the information. Therefore, I did not have the opportunity to see how the screen affected user numbers for an extended amount of time.

Chapter 7 Results

In this chapter, the results of the project work are presented. They will be related to the stated hypotheses for validation,

7.1   The Solution

Figure 7-1 shows how the resulting solution looks like on the screen. The rest of this section will give more details on the resulting solution.

Figure 7-1: Screen shot of the resulting display of information

7.1.1   The advertising feed was replaced by the playlist functionality of Digiboards

Since the Playlist functionality created by Digiboards had many possibilities, I chose to use this for advertising. It also makes it easy to change between different kinds of information in this field, such as advertisements specifically related to the area, or to the place where the screen is situated, or the time of day. Also, it is easier for the people working at for example the particular café to adjust what is to be shown on that display, since they can get admission to edit this area in the web interface.

7.1.2 *Pictures of the Solution*

Figure 7-2 and Figure 7-3 provide some photos taken of the screen after it was successfully installed in the café "Bare Blåbær". "Bare Blåbær" is a café situated at Solsiden in Trondheim, and it is very popular amongst the younger students in the city, as well as families taking a stroll wanting to stop by for some food or a coffee.

Figure 7-2: The screen at "Bare Blåbær"

Figure 7-3: The screen as seen in the window at "Bare Blåbær"

7.1.3 Periods where the Screen was Active

Due to some problems with the network configurations on the screen, and user errors caused by the employees at "Bare Blåbær" and such, the screen was not up and running for the whole period.

At 13:00 hours on Tuesday May 20th, the screen was online, turned on, and displaying the information as shown in Figure 7-1. It hung in the window turning inwards towards the tables, about 2.5 meters above the floor. However, when the evening came and it became dark outside, the employees at "Bare Blåbær" felt that the screen gave an annoying, fluorescent light in the café area, and felt they needed to turn the screen off to keep the nice atmosphere for their guests. This is, of course, understandable, but the effect was that the morning after the screen was not able to log on to the Internet, and therefore couldn't display the information. Due to the need for a ladder and wireless mouse and keyboard to be able to configure the Internet connection once again, I needed help from Wireless Trondheim to fix this, and they didn't have time until the next day. Therefore, the screen was turned off for another day. This is just one example of how small problems can become big in relation to the fact that the screen only needed an Internet connection, and this is what happened a few times. It is not possible to predict and avoid every happening when one is not present at the location 24-7.

Due to the situation described above, I will list a log of the times when the screen was actually displaying information – and there were people present (the opening hours of "Bare Blåbær" are: Sunday – Thursday: 11:00 – 01:30, Friday and Saturday: 11:00 – 02:30). The log is depicted in Table 7-1.

Table 7-1: Overview of up- and down periods of the screen

Date	Period on	Period off	Comment
Tue May 20th	13:00 – 22:00	23:00 – 00:00	Employees at "Bare Blåbær" turned off the screen due to annoying light.
Wed May 21st	Never	All day	The screen's computer did not succeed in connecting to the Internet when it was turned back on. Had to wait for Wireless Trondheim to be able to fix this.
Thu May 22nd	11:00 – 22:00	23:00 – 00:00	Employees at "Bare Blåbær" turned off the screen due to annoying light, even though we had tried dimming the light that was emitted from the screen.

Fri May 23rd	11:00 – 22:00	23:00 – 00:00	Employees at "Bare Blåbær" turned off the screen due to annoying light, even though we had tried changing fonts, sizes and colors on the screen's content.
Sat May 24th	11:00 – 22:00	23:00 – 00:00	Same as above.
Sun May 25th	11:00 – 22:00	23:00 – 00:00	Same as above.
Mon May 26th	11:00 – 22:00	23:00 – 00:00	Same as above.

The problems with the screen disappeared when the initial issues had been solved, and I came down to make sure that the screen was turned on properly every morning. However, I did not succeed in finding a setting for the brightness or colors on the screen, so it needed to be turned off every evening so that it would not interfere with the atmosphere. In the evenings, "Bare Blåbær" is populated by people that are having dinner or drinks, and therefore I believe that the most important period for the screen to be active is during daytime.

## 7.2 Statistics of Use – before, during and after

The statistics of use of the access point at "Bare Blåbær" will be presented, and I will discuss how the use was affected in the area where the display was set up.

When I started collecting reports in WCS to use the evaluation, I found that no data can be displayed for the dates between May 16th and June 2nd, even though the wireless network was functioning properly. A company named Ementor is employed by Wireless Trondheim to deliver such reports, and is therefore responsible for making these statistics available. They have not been able to find out what the problem was that caused the data to disappear. This has affected my available results severely, and I have had to use the statistics available in an attempt to reach a conclusion.

7.2.1 Client Counts

In Figure 7-4 a graph displays the client counts for Wireless Trondheim in the 4-week period from May 7th to June 4th. The straight line drawn between May 16th and June 2nd indicates that no data can be displayed during this period, due to the problem described in the above. In the graph we also see the problem that occurred on the date when the screen was initially intended to be set up. The client count drops to zero on May 8th when the wireless network became unavailable due to network problems. The graph shows the client count for the whole city. Due to this, it is not expected to see a remarkable increase in this graph. However, it is obvious that there has been an increase during the period that is not visible in the graph, as the number jumped from a peak of 160 before May 16th to 224 after June 2nd. It is more probable that this is caused by another incident than the appearance of the screen, since it was

only in one location, and as we will see later it did not cause the usage at "Bare Blåbær" to increase much in the period when it was up.
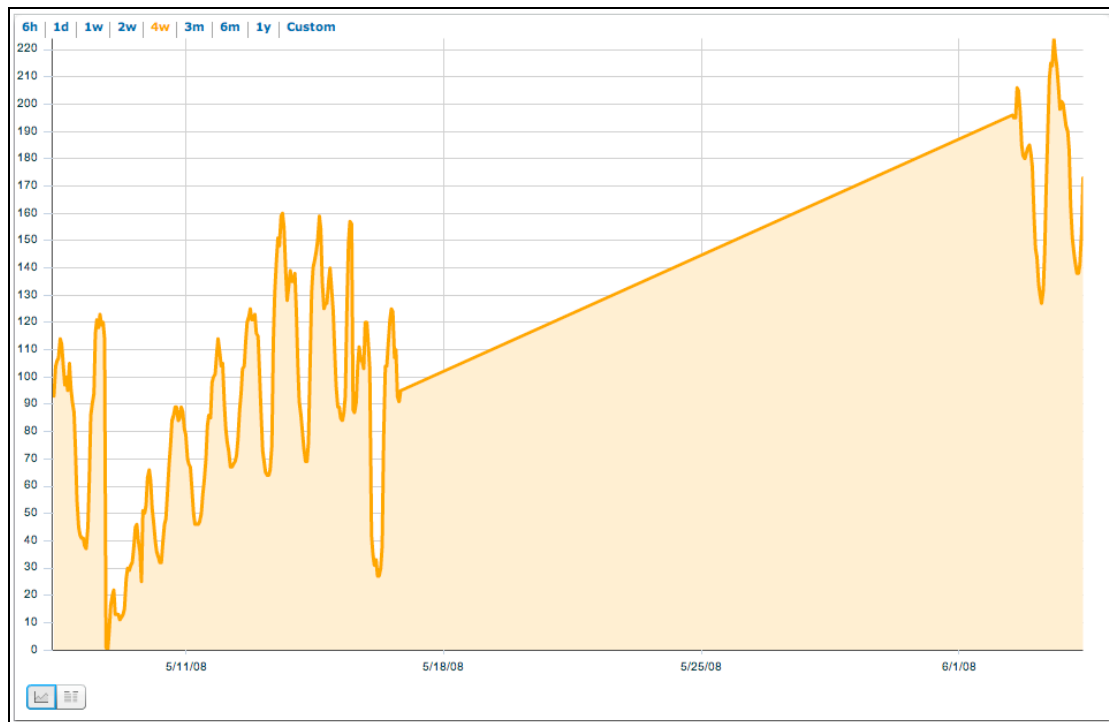
Figure 7-4: Graph indicating the client counts for Wireless Trondheim

In Figure 7-5 the client counts for the access point at "Bare Blåbær" are displayed, the report shows numbers for the four-week period from May 7th to June 4th. It is very unfortunate that the data for the period when the screen was active are not available. The only information that can be drawn in relation to this project, is that the one-week appearance of the screen did not cause a remarkable amount of new users, since the client counts around June 4th are not higher than those before the screen was set up. However, there might be several reasons why the numbers are lower around June 4th, for example the fact that Trondheim had fantastic weather those days, more people stayed outdoors, and many students had started their summer holiday and left town. However, this does not go along with the trend seen in the preceding figure, Figure 7-4, where we saw an increase in usage.
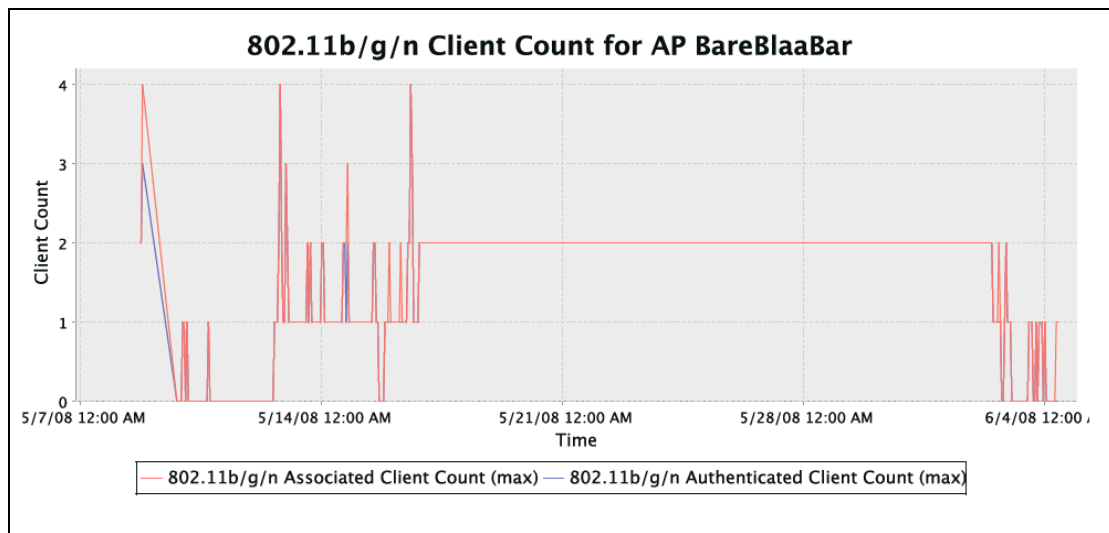
Figure 7-5: Graph indicating the client counts for "Bare Blåbær"

7.2.2 Busiest Access Points

Due to the lost data in WCS, I could not collect a report displaying the busiest access points before and after the pilot period as planned. Luckily, due to the subscription to hourly reports during the whole period where the screen was active, I have some information on busiest access points. These are not fully representative, since they only depict instants of time, and not the whole period. Therefore I will use the sum of five reports picked at times of day where it is most likely that the screen is visible to possible users. This modified list will be compared to a report collected from a period before the screen was set up (and while the data still exist in the WCS).

Table 7-2: Busiest access points before the screen was active, 9th – 16th May

	AP Name,Map Location,RX Util (%) (avg),TX Util (%) (avg),Channel Util (%) (avg)
1	BybroenScene-B,Midtbyen > Sone07,0.00,1.00,1.00
2	OlavTryggvasonsgt1,Midtbyen > Sone03,0.00,0.00,1.00
3	Ajo,Midtbyen > Sone04,0.00,0.00,0.00
4	BNBank-B,Midtbyen > Sone06,0.00,0.00,0.00
5	Brannstasjonen,Midtbyen > Sone07,0.00,0.00,0.00
6	BybroenScene-AP1,Midtbyen > Sone07,0.00,0.00,0.00
7	Byhaven-AP2,Midtbyen > Sone03,0.00,0.00,0.00
8	BareBlaaBar,Midtbyen > Sone04,0.00,0.00,0.00
9	Elgeseterbro I,Midtbyen > Sone10,0.00,0.00,0.00
10	ErlingSkakkesgt2,Midtbyen > Sone07,0.00,0.00,0.00
11	Fjordgata36,Midtbyen > Sone03,0.00,0.00,0.00
12	Fylkeshuset-AP1,Midtbyen > Sone06,0.00,0.00,0.00
13	Industri-B1,Midtbyen > Sone04,0.00,0.00,0.00
14	Jernbanen-AP1,Midtbyen > Sone03,0.00,0.00,0.00
15	Jordbar-AP1,Midtbyen > Sone06,0.00,0.00,0.00

Table 7-3: Busiest access points while the screen was active, 19ᵗʰ – 25ᵗʰ May

	AP Name,Map Location,RX Util (%) (avg),TX Util (%) (avg),Channel Util (%) (avg)
1	Kjopmannsgt5,Midtbyen > Sone07,0.00,0.25,0.75
2	Olav-AP1,Midtbyen > Sone03,0.00,0.00,0.25
3	Jernbanen-BAP,Midtbyen > Sone03,0.25,0.00,0.50
4	OrensKro,Midtbyen > Sone04,0.00,3.00,3.00
5	Brannstasjonen,Midtbyen > Sone07,0.00,0.00,0.00
6	Industri-B3,Midtbyen > Sone04,0.00,2.00,2.50
7	Sondregt10_B_AP1,Midtbyen > Sone07,0.75,16.00,17.50
8	ErlingSkakkesgt2,Midtbyen > Sone07,0.00,1.67,1.67
9	BNBank-B,Midtbyen > Sone06,0.00,0.00,0.00
10	BareBlaaBar,Midtbyen > Sone04,0.00,0.00,0.00
11	Ajo,Midtbyen > Sone04,0.00,0.00,0.00
12	ThomasAngel10,Midtbyen > Sone03,0.75,16.25,17.75
13	Nordre12-B2,Midtbyen > Sone03,0.00,1.75,2.00
14	Jomfrugt5-B_AP,Midtbyen > Sone02,0.00,1.00,1.25
15	REMA1000_B_AP1,Midtbyen > Sone03,0.00,0.00,0.25

As we compare these two tables, we see that the access point BareBlaaBar is at an eighth place in Table 7-2 and at a tenth place in Table 7-3. This is such a small difference that it can not be seen as significant enough to draw a conclusion on whether the public display had an effect. Also, in that case, the effect would be negative, since the activity at "Bare Blåbær" decreased.

CHAPTER 8   EVALUATION

This chapter will evaluate and discuss the results that were achieved, and I will discuss how the resulting service can achieve the scenarios described in 4.1. I will use this discussion to validate whether the project goal was reached, as a preliminary discussion to the conclusion.

8.1   Overall Evaluation

In the evaluation of the screen I will look at how the requirements were met, and how an example scenario is fulfilled. Third, I will evaluate the statistics results.

8.1.1   Fulfillment of the requirements

Requirements **1 – 5** indicated what information should be displayed. These were fulfilled and all of the information was updated as expected, although this had to be done manually. It never happened that the information was outdated by more than one hour; hence requirement **6** was also fulfilled.

Requirement **7** was also fulfilled, although I, along with Wireless Trondheim, faced some difficulties in the beginning, with the installation of the driver for the wireless port. This was only due to the fact that we had no experience on how to do this, and we needed help from Digiboards who is more experienced on installing items on a public display computer.

Due to the ability of Digiboards' software, requirement **8** can be met. It is possible to set up more displays in other cities, and they can show the same information, or the information chosen can be altered. A limitation to this possibility is the need for a similar wireless network to be available, and thus similar XML feeds will need to be generated from the information of that specific network. Due to this, requirement 8 is only partially met.

By logging on to the graphical user interface for administering the layout on the screen, it has been possible to fulfill requirement number **9**.

Requirements **10** and **11** are both fulfilled by the software that Digiboards has developed, but I did not have the time to experiment with these functionalities. Also, these would be more necessary if more screens were set up at different kinds of places.

Requirements **13 – 15** can only be evaluated on subjective grounds and are therefore hard to evaluate. However, based on feedback from employees at Bare Blåbær and employees in Wireless Trondheim, the screen content has been gradually changed in an attempt to make it easy to read, eye-catching and understandable. The location was also ideal, since it can be seen from most areas of the room, amongst others the area where customers are waiting in line.

8.2   Fulfillment of the Hypotheses

The following are the hypotheses listed in 4.2. I will look at how the hypotheses are satisfied by the solution that has been created. The evaluation is based on the

> 1. *The introduction of public displays containing user statistics from Wireless Trondheim will cause an increase in the number of users.*

As seen in the statistics given from the period before and during the screen; this hypothesis has not been fulfilled, not even at the single point where the screen was set up.

> 2. *The public displays will give people a greater insight to what Wireless Trondheim has to offer.*

Based on the fact that the display shows information about the availability of Wireless Trondheim, this hypothesis can be said to be fulfilled. However, since there were not many different kinds of information on the screen, people have not been informed enough about the variety of abilities of the network. An idea would be to switch between several screen shots displaying different areas of information. This was not done in this project since it would require extensive work.

> 3. *By showing the most popular sites amongst users of Wireless Trondheim, a trend will be created that causes the sites to become even more popular.*

Due to the fact that there was very few people that used the wireless network at the café, it has not been possible to see an increase in the most visited sites by the users.

Chapter 9   Conclusions

In this chapter I will reach a conclusion based on the previous chapter, and discuss further work.

9.1   Contributions

The project work has provided Wireless Trondheim with a starting point for further developing the concept of having public displays spread in Trondheim to create greater awareness of the possibilities of Wireless Trondheim. The project has also created the possibilities for collaboration between Digiboards, Wireless Trondheim and Adresseavisa, all of which are interested in the fruits of this cooperation.

The project work has further given a first indication of how public displays might be welcomed in a new city, since this is the first time they are used for this purpose. Hopefully the project will spur more research on this area, as it is clearly growing rapidly.

9.2   Conclusion

I have not been able to find a direct relationship between the availability of statistics and an increase in use. This is both due to technical problems during the test period that decreased the length of the screen's appearance and the disappearance of usage statistics when the results were collected. However, the project has provided Wireless Trondheim with insight on how public displays can be used to increase the awareness and hence the usage of the wireless network.

9.3   Further Work

This section will discuss what areas are remaining in this depth study. I will also introduce some suggestions on what can be done to further develop the service.

9.3.1   Remaining parts of this version

For the current version of the public display to be complete, it is necessary to make the fetching of reports possible from the PHP code. Now, someone has to manually collect and save the reports in appropriate folders with

appropriate names for it to be possible to display updated information.

9.3.2 Possible Extensions

During the course of the project work, I have found limitations of the existing solution that might be interesting to implementing at a later point. These will be described in the following section.

9.3.2.1 Context-Awareness

Since the amount of available information has become vast, it has been necessary to narrow it down in some cases, so that the information that is in fact given to people will be relevant for them. This is called context-specific information. Context can be relevant in several aspects, such as the people's age, interests, gender, and location. In this project, it would be interesting to make the information displayed context-specific with regards to the location, the kind of place within which the screen is situated, and perhaps the crowd that most likely frequents the place.

The commercials that are displayed should also be of relevance to the people that watch them. A possibility is to only show commercials regarding the shop/café within which the screen is situated.

9.3.2.2 Interaction with people nearby

By making it possible for users to interact with the public displays in some way, the interest might become even greater. This could be realized by having a message service that people could send text or images to, and a part of the screen could be updated with this information. This could be perceived as a way to leave behind short messages for people, or to amuse oneself/others. However, this would, of course, require monitoring to make sure that inappropriate messages/pictures could not be displayed.

Another possibility would be to make it possible for people nearby to request what is displayed. For example, if a person is interested in how many single people are in the area, he could text a request to the system to display this. However, this should already be possible for the user to do on his/her own cellular phone, and therefore this possibility might not be of interest.

9.3.2.3 Display Top 5 services

When more services have been made by Wireless Trondheim, it will be interesting to display the most popular ones on the screen, to make people aware of the fact that they exist, and that other people are using them. It will be in the same manner as the existing part that displays the most popular web pages visited by users of Wireless Trondheim.

Appendix A   References

[ANDR2007] Andresen, S., Krogstie, J. and Jelle, T., *Lab and Research Activities in Wireless Trondheim*, Proceedings of IEEE International Symposium on Wireless Communication Systems 16-19, 2007, pp 385 – 389.

[CISC2008] Cisco Systems, *Cisco Wireless Control System – Products and Services - Cisco Systems*, http://www.cisco.com/en/US/products/ps6305/, accessed March 1st 2008.

[DIGI2008] Digiboards, *Digiboards as*, http://www.digiboards.com/, accessed March 12th 2008.

[ERIC2002] Erickson, T., et. al., *Social Translucence: Designing Social Infrastructures that Make Collective Activity Visible*, IBM T.J. Watson Research Center, 2002.

[NEC2008] NEC Display Solutions, *NEC Display Solutions – Om NEC Display Solutions Europe*, http://www.nec-display-solutions.no, accessed February 9th 2008.

[PHP2008] PHP, *PHP: Hypertext Preprocessor*, http://www.php.net/ , accessed March 6th 2008.

[PRON2008] Pronto Display, *PRONTODISPLAY Information and Advertising Systems*, http://www.prontotv.no/, accessed February 10th 2008.

[PSI2008] PSI Media Solutions, *MyTV Brochure*, http://www.ohd.no/downloads/pdf/mytv/MyTv_brochure.pdf, downloaded March 12th 2008.

[SCAL2008] Scala, *Digital Signage Solutions from Scala – Narrowcasting, Networks and Menu Boards*, http://www.scala.com/, accessed February 10th 2008.

[STOR2006] Storz, O., Friday, A. and Davies, N., *Supporting content scheduling on situated public displays*, Computers & Graphics 30, 2006, pp 681-691.

[TRAD2008] Wireless Trondheim, Coverage map over Trondheim City Centre, http://www.tradlosetrondheim.no/sec.php?page=sec_coverage&la=no, accessed May 14th 2008.

[W3C12008] W3C, *Extensible Markup Language* http://www.w3.org/XML/, accessed March 14th, 2008.

[WEIS1991] Weiser, M., *The Computer for the 21st Century*, Scientific American vol. 264 issue 3, 1991, pp 94 – 104.

[WIBR2008] WiBro, *Portable Internet WiBro* http://www.wibro.or.kr, accessed February 10th 2008.

[WIKI2008] Wikipedia, *Digital Signage*, http://en.wikipedia.org/wiki/Digital_Signage, accessed February 1st 2008.

Appendix B   Source Code

xml.php

```php
<?php
    header("Content-type: text/xml");
    include("functions.php");

    $type = $_GET["selected"];

    //top5APs start
    if (strcmp($type, "top5APs") ==0){  //Checks if top5APs is
    selected
        $handle = fopen('csvFiles/Busiest_APs_top5APs.csv', 'r');
        //opens file to read
        if (!$handle)
            die("Couldn't open file $fileName");

        $xml = csv2xmlAP($handle, 'Access_Points',
        'Access_Point');
    }
    //top5APs end

    //numUsers start
    if (strcmp($type, "numUsers") ==0){ //Checks if numUsers is
    selected
        $handle = fopen('csvFiles/Client_Association_
        last1hour.csv', 'r');   //opens file to read
        if (!$handle)
            die("Couldn't open file $fileName");

        $r = "<ClientCounts>\n";
        $row1 = 0;  //start på rad 0
        while (($data = fgetcsv($handle, 1000, ',')) !== FALSE){
            $row1++;
        }
        fclose($handle);

        $handle = fopen('csvFiles/Client_Association_
        last1day.csv', 'r');    //opens file to read
        if (!$handle)
            die("Couldn't open file $fileName");

        $r = "<ClientCounts>\n";
        $row2 = 0;  //start på rad 0
        while (($data = fgetcsv($handle, 1000, ',')) !== FALSE){
            $row2++;
        }
        fclose($handle);
```

```php
        $r .= "<Item>\n";
                $r .= "\t<Title>Siste timen</Title>\n";
                $r .= "\t<Count>".$row1."</Count>\n";
        $r .= "</Item>\n";
        $r .= "<Item>\n";
                $r .= "\t<Title>Siste døgn</Title>\n";
                $r .= "\t<Count>".$row2."</Count>\n";
        $r .= "</Item>\n";
        $r .= "</ClientCounts>";

        $xml=$r;
    }
    //numUsers end

    echo "<?xml version=\"1.0\" encoding=\"ISO-8859-1\"?>\n";
    echo $xml;
?>
```

functions.php

```php
<?php
function getAdjustedTime()
{
    //find time - updates every 10 minutes
    //yyyymmdd>_<HHMMSS>.
    //get date, and go back to the last 10 minutes
    $timeNow = date(Ymd_H);
    $temp=date(i);
    $temp = $temp/10;
    $temp = floor($temp);
    $initialMinute=$temp;
    $timeNow.=$temp.'000'; //seconds
    return $timeNow;
}

function csv2xmlAP($handle, $container = 'data', $rows = 'row')
{
    $r = "<Access_Points>\n";
    $row = 0;    //start på rad 0
    $usedItems = array();
    array_push($usedItems, "Dummy");
    $ignoreList = array();
    array_push($ignoreList, "Johns_kontor", "ThomasKontor",
    "BNBank-B", "UKJENT", "TOBB");

    while ((($data = fgetcsv($handle, 1000, ',')) !==
    FALSE)&&($num<5))//hent ut en og en linje
    {
        if ($row>0)
        {
            $temp = $data[0];
            $temp = stripTextAP($temp);
            if ((!array_search($temp, $usedItems))&&
            (!array_search($temp, $ignoreList)))
            {
                $r .= "\t<Access_Point>\n";
                $r .= "\t\t<AP_Name>";
                $r .= $temp;
                $r .= "</AP_Name>\n";
                $r .= "\t</Access_Point>\n";
```

```php
                        array_push($usedItems, $temp);
                        $num++;
                }
            }
            $row++;
        }
    fclose($handle);
    $r .= "</Access_Points>";
    return $r;
}


function stripTextAP($text)   //removes illegal characters
{
    $text = str_replace("&", '&amp;', $text);
    $text = str_replace("<", '&lt;', $text);
    $text = str_replace(">", '&gt;', $text);
    $text = str_replace("'", '&apos;', $text);
    $text = str_replace("\"", '&quot;', $text);

    //endre på flg tre?? :
    $text = str_replace("(", '', $text);
    $text = str_replace(")", '', $text);
    $text = str_replace("%", '', $text);

    $text = trim($text);    //remove whitespace before/after text

    if (strcmp($text, "Brannstasjonen-B")==0){
        $text = "Brannstasjonen";
    }
    else if (strcmp($text, "BybroenScene-AP1")==0){
        $text = "Bybroen Scene";
    }
    else if (strcmp($text, "BybroenScene-AP2")==0){
        $text = "Bybroen Scene";
    }
    else if (strcmp($text, "BybroenScene-B")==0){
        $text = "Bybroen Scene";
    }
}
?>
```

Comment: The last function continues looking for other such Access Point names that need to be changed, here only the first four ones are included to indicate what is done, the others are handled in the same manner.