
MLS - Mobile Logbook System

Mobile devices and information
transmission from fishing vessels

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Abstract

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Today most skippers have to fill in the information required about their fishing activities manually in a logbook. An electronic logbook facilitating the daily routines of the skippers will provide the authorities with more reliable information, which in turn will improve the management of the fish stocks.

Several projects have been initiated in order to develop and implement an electronic logbook. Some of them have not yet been completed, whilst others have been stopped due to lack of funding. These are described in brief in the project report. Collecting and transmitting information from fishing vessels will have quite a lot of common denominators with a web log. Some of the web log systems available are therefore described.

In this project an electronic logbook for mobile phones facilitating the skippers daily routines, is introduced. There are different technologies and devices which are suitable when developing the electronic logbook and transmitting data from fishing vessels. Before selecting the technologies for this project, a brief description of mobile communication and technologies for wireless communication and devices, is given.

A framework called Mobile Logbook System based on the technologies and devices described, has been developed. The framework includes an application consisting of a logbook client, a logbook manager and a browser. A prototype of an electronic logbook for mobile phones used to reporting the fishing vessels activities has been implemented based on this framework and is used to carry out tests of entering and transmitting information. Based on the experiences from the tests performed by five fishermen, some advises concerning future work on the logbook client, logbook manager and the browser is given.

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Chapter 1

Introduction

The fisheries log book is one of the most vital parts of the fisheries management all over the world. As per today, skippers of Norwegian vessels which exceed 13 meters are required to keep logbooks with entries of their fishing activities [17]. Vessels less than 13 meters are not required to keep a logbook. If the vessel undergoes inspection in the open sea the respective log book lines have to be found filled in. The amount and type of fish on board must correspond to that declared on the log book.

Keeping logs are important and enables the fishermen to establish what happened and to determine what time they performed their fishing activities. It is also necessary for the fisheries authorities to be able trace back actions and activities. Hand written logs are often somewhat difficult to read, hence complicating the process of data management. In addition to reporting the activities to the authorities, it is important for the processing industry and marketing companies to know where the fish was caught, how much each haul contains and how much was caught by a certain vessel on any given day. Producers of fresh fillets and fresh special products are dependent on up to date and reliable information to supply supermarkets regularly getting the best prices. Logistics can be quite a challenge and information in advance of landing is advantageous. Customers these days also expect to know something about the product. A lot of meat products are labeled with information about origin, where it is produced etc. Fish products will also need to be labeled in a similar way.

With the development of the information technology, new electronic systems have been introduced in nearly all kind of industries. Most Norwegian fishing vessels have modern technical instruments in the pilot house and these are fundamental within navigation, communication, search for fish (sonar) and surveillance of machinery on board. Furthermore, several electronic systems are used by employees/staff on shore [33]. First, The Norwegian Raw Fish Organization use electronic

catch receipts, i.e. when a catch is delivered, a receipt has to be issued and forwarded onto The Norwegian Raw Fish Organization. The receipt specifies quantity as well as price. Next, there is electronic communication between The Norwegian Raw Fish Organization, The Norwegian Fishermen's Sales Organization For Pelagic Fish and about 90 ocean vessels fishing herring. Furthermore, there are electronic reports of catches between pure seiners catching saithe and The Norwegian Raw Fish Organization.

This winter The Norwegian Fishermen's Sales Organization will try electronic auctioning of white fish at Myre in Vesteraalen [4]. The vessels will report the catch while at sea but the auction of the catch can also be done upon landing at the auction hall. The buyers can use a web based interface. Introducing new electronic systems within other areas of the industry is important in order to improve communication between the participants. The main focus will be on deployment of an electric logbooks and further development of electronic auction systems. Mobile phones might also be an alternative concerning the reporting of catch.

The Norwegian fishing fleet can choose between several mobile communication systems. The main systems used by the vessels are Iridium, Inmarsat(C, minM, M, B), Emsat and Globalstar [33]. Furthermore, the use of mobile phones has become increasingly popular as the different nets has been built or upgraded.

The mobile phone system NMT 450 was introduced in Norway in 1981 and was soon implemented by the fishing fleet. NMT 450 closed down by the end of 2004. However, Telenor upgraded and further developed the GSM-net for approximately NOK 40 mill during last year in order to enhance GSM-coverage along the Norwegian coast line. Telenor's GSM coverage is presented in figure 1.1.



Figure 1.1: Telenor Mobil's GSM coverage.

As presented in figure 1.1 the GSM coverage will in average reach 50-60 kilometers off the coast line and in some regions up to 120 kilometers, hence covering approximately 99 percent of the major fishing grounds upon completion of the project.

Introducing an electronic logbook facilitating the skipper's daily routines is therefore quite natural with the technology now being available. Such a logbook can be developed for either desktop computers or mobile phones. Furthermore, the log data can be submitted directly from the vessels when the activities are performed or upon landing of the catch.

The mobile phone has now become an important part of everyday life for most Norwegian fishermen. It is easy to bring the phone with you on board and move from one deck to another checking the quality of the catch, reporting the quantities or doing some other work. Learning how

to use a mobile phone is also perceived as less difficult than learning how to operate a desktop computer. Mobile phones will probably be the best alternative in the future for the process of reporting activities for most fishermen, in particular for medium size coastal vessels and smaller boats. Based on the above-mentioned I have developed a logbook for mobile phones. As there still are fishing fields not covered by GSM, I have chosen submission of the logbook data upon landing of the catch.

During the project I will investigate and test whether it is possible to collect and transmit information from fishing vessels to a database on shore using mobile devices comprising Bluetooth devices providing and coordinating information automatically. A framework called Mobile Logbook System (MLS) based on wireless technology and devices is introduced involving the development of a prototype logbook client for a mobile phone and the introduction of a logbook manager. This will contain a database which stores the information received from the client. Furthermore, a browser interface will be developed and tested. The browser application will give access to the data stored in the database. On the basis of the tests performed one can draw conclusions about the framework and the implementation of the system.

In the project I have tried to answer the following questions: Is it possible to provide the authorities with more up-to-date and reliable information about fishing activities? Is it possible to use a mobile phone as an electronic logbook to collect and transmit such information? Is it possible to use peripheral devices as a GPS to obtain the required location data automatically? What are the fishermen's opinion about using an electronic logbook for mobile phones? Will such an electronic logbook facilitate the daily routines of the skippers?

The project is outlined in a report and chapter 1 is an introduction to the subject, giving the reader an overview. Several projects has been started in order to develop and implement an electronic log book. Some of them have not yet been completed whereas others have been stopped due to lack of funding. The most important of these are treated in chapter 2 in the report. Chapter 3 provides a description of different technologies and devices which are suitable for transmission of data from fishing vessels. Factors such as system capacity and security are of importance.

Chapter 4 contains a description of a framework for an electronic logbook called "Mobile Logbook System". The framework is an application consisting of three main modules i.e. a logbook client, a logbook manager and a browser. The implementation of the prototype is described in depth in chapter 5. Furthermore, real tests of entering and transmitting information are currently being carried out. These are important in order to get up-to date and reliable feedback from the users, to facilitate corrections and improvements leading to a conclusion of the project. The results of the

analysis and the conclusion are presented in chapter 6. In addition, there is a chapter 7 including advice on future work and development of the project.

This master thesis deals with several fields within computer science and some basic knowledge about the programming languages Java(J2SE and J2ME) and PHP is recommended. In addition, knowledge about the logbook in use today is advantageous to understand the logic and structure of the programme which is developed. Further prerequisites are not necessary.

Chapter 2

Related work

The current situation of numerous fish stocks is causing widespread concern, whilst efforts have been made to improve the management of the resources. Worldwide, the fisheries' logbook has become increasingly important. Today most skippers have to make manual entries in the logbook before handing it over to the authorities upon arrival at port.

In order to comply with fisheries legislation, skippers on most vessels have to make daily entries in the logbook during absence from port, whereas an electronic logbook would simplify these routines and hence becoming a useful tool for sales organizations or industries on shore due to all stored information [33]. In this section a brief description of related work within logbook systems and blogging will be given.

2.1 Logbook systems

Several projects have been initiated to develop and implement an electronic logbook. Some of them have not yet been completed whilst others have been stopped due to lack of funding. A brief description of AFMA's electronic logbook program [1], The SHEEL project [3], the lobster project of Maine Department of Marine Resources [24], Fisknett [5] and WinCatch [34] will be given in the following sections.

2.1.1 AFMA's electronic logbook programme

In 1999 the Australian authorities introduced "The Federal Governments Electronic Transaction Act" which is the legal framework for businesses and the community to use electronic communications for transactions with Government agencies [23]. Early in 2000 AFMA (Australian Fisheries

Management Authority) started looking at different options for electronic logbook reporting. The South East Trawl Fishing Industry Association (SETFIA) was among the first to take part in this, developing its E-boat technology for the South East Trawl Fishery. This system allows fishermen to record real time data at sea and to transmit the information to AFMA.

AFMA is not involved in the development of the software for the fishermen's business. However, AFMA has introduced a set of specifications, including standard formats for logbook data, which will be available to all software vendors interested in developing electronic logbook reporting systems. The specifications are based on standard technologies. First, communication between fishermen, fish receivers and AFMA are internet email. Next, extensible mark-up language (XML) for data formats is used to change data. Furthermore, authentication and privacy of returns is based on public key infrastructure (PKI).

AFMA has also developed specifications for the return of electronic logbooks which define reporting formats, authentication and privacy methods. In addition, requirements for record keeping information technology are defined. To ensure compliance with the Electronic Transactions Act [23], AFMA has developed a set of performance measures [1] which a software product must meet before AFMA will accept reports from this product. These are presented in table 2.1.

Table 2.1: Performance measures a software product must meet(From [1].)

Milestone	Requirements
Vendor registers intention to develop an e-log system with AFMA	Provide AFMA with their contact details so we can issue them a trial certificate Provide AFMA with a development plan and timetable
Successful e-log reception at AFMA and handling of rejections at Vendor	The sending software needs to be able to process the rejection messages as well as the accept messages from AFMA. Messages sent to AFMA may be rejected due to a number of reasons including: - incorrect file format - incomplete datalog data in file - data had been sent previously
Successful receipt by AFMA of encrypted message with digital certificate from Vendor	The sending software is able to encrypt a signed message which can be read by AFMA
Successful receipt by AFMA of correctly formatted XML data file from Vendor	The sending software correctly formats an XML data which matches the DTD and data discovery
Selection of participating trial boats	AFMA is notified by Vendor of the details of the trial participants Trial Digital Certificates(DCs) issued to participants
Software is installed and commissioned by Vendor	Test messages required to confirm that message transfer functions correctly 'Live' messages received from trial participants along with paper log book returns Messages received correspond to paper log book returns Trial with real DCs obtained from a registered CA
Trial concludes	AFMA confirms Vendor has met all the goals of the trial

AFMA requires that information is entered in the logbooks generally within one day of each fishing operation. This is necessary in order to achieve as accurate information as possible. Logbook returns containing those records of fishing operations are subsequently submitted to AFMA. In addition, the various fisheries have separate description of data elements, formats and type of logbook. However, efficient development requires as much commonalty across fisheries and as few formats as possible. The XML data format specifications are designed with this in mind. AFMA's electronic logbook report specifications have been developed and tested in the Northern Prawn Fishery and the South East Trawl Fishery.

2.1.2 SHEEL project "Secure and Harmonized European Electronic Logbook"

The main objective of the Sheel project is to develop, implement and demonstrate an electronic logbook for fisheries in the fisheries of the EU member states [3].

Most logbooks in use today exchange information manually. This system needs improvements to meet future demands for up-to-date and reliable information which is necessary to improve the management of the fisheries and to do proper scientific analysis. The manual submission of all this information is impractical and hard to deploy, hence the Member States and the Commission having initiated several activities to develop and implement a future European legislation on electronic logbooks for fisheries.

The project consists of a multi-national team with focus on demonstrating and testing several systems to transmit logbook data from vessels to shore. Software producers, national authorities of fisheries, communication suppliers and specialists on security of e-commerce are among the groups participating in the project. The phases of the project are presented in figure 2.1.

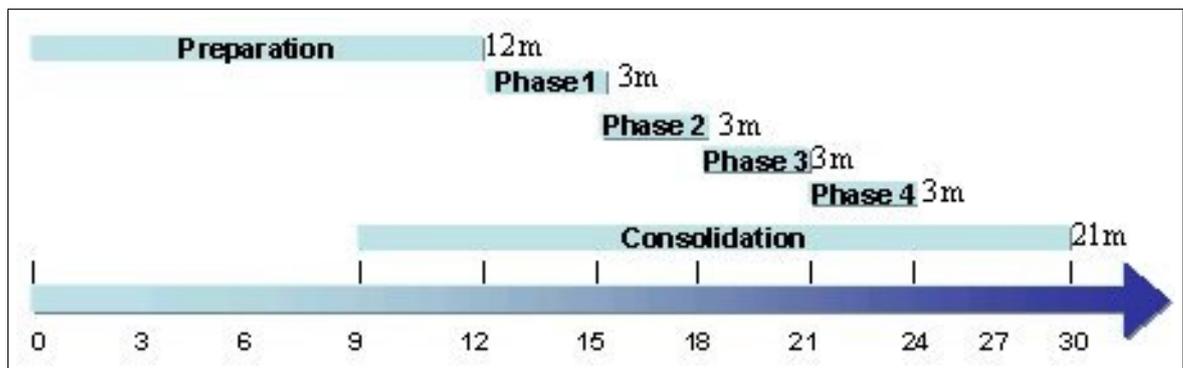


Figure 2.1: The phases of the Sheel project [3].

As presented in figure 2.1, the duration of the project is 30 months. The main thrust is on specification and four demonstrations. In the Sheel project, the electronic logbooks are clearly more than just an electronic version of the paper edition. It is part of a huge system involving vessels and inspectors of various nationalities. In addition, one must allow information to be passed on safely from the vessel to the appropriate authorities in real-time. Hence, authentication of information and crosschecks must also be allowed.

The Sheel project has published a technical report discussing the needs for an electronic logbook. The report also includes an analysis of what kind of information should be associated with each message.

The current reporting system is rather complicated. New requirements for reporting appear continuously and will make the procedures even more complicated. An electronic logbook system based on reporting the activities seems most realistic. The activities, defined by Sheel, to be recorded are presented in table 2.2 .

Table 2.2: Activities defined by Sheel

	Activities to be recorded
1	Departure from port
2	Arrival at port
3	Entry to region
4	Exit from region
5	Fishing Operation
6	Trans shipping
7	Joint operation
8	Processing of fish
9	Cumulative catch
10	Landing
11	Navigation/Searching

As presented in table 2.2, Sheel has defined a set of activities to be recorded in a logbook [12]. For each of these activities a set of information describing the activity has been filled in by the skipper as well as the location and time in which the activity was carried out. If we assume that each of these activities is a message, a header should provide information sufficient for the identification of the vessel and the skipper as well as the skipper's electronic signature.

The Sheel project has also published a document describing the communication systems available for the transmission of a European electronic fishing logbook. It examines the technical characteristics, communication costs and equipment prices of each system. It compares the systems in terms of cost per message of varying sizes and total annual cost for electronic logbook operations [7].

The document is designed to provide a technical overview of the systems which might be used to transmit a European electronic fishing logbook. This overview also includes the architecture and the operations of each system, with an additional description of the equipment required on board. Advantages and disadvantages of each system, for use in transmitting SHEEL, are also analyzed [7].

In the course of the next few months the project will focus on completing the security requirements and incorporate them into the final system specification document.

These are based on authentication and confidentiality. In addition, the first development phase involving installation of the systems' components on board and on shore will be completed, whereupon a plan for performing the trials will be established.

The first stage of development was completed by the end of 2004 providing the basic components for trials for phase 1 and 2. The trials should prove useful when assessing the cost-effectiveness as well as the interoperability of the systems, thus being able to draw conclusions on future use.

2.1.3 The lobster project

Thistle Marine in Lamoine, ME (USA), has developed an electronic logbook for fishermen catching lobster [24]. It is possible to submit information on catch type and quantity and to download this over the phone to a data store-house. In return, catch reports are available. The electronic logbook is a simple computer, installed on board, connected to a GPS receiver. During fishing activities, the quantity and type of lobster caught in each trap is recorded. When returning home from sea, data can be downloaded to Thistle Marine through the phone line, where it will be analyzed and returned to user in the shape of useful statistics and maps with details on the fishing efforts and success.

In August 2004, Thistle Marine was forced to close down due to lack of interest and funding. The state of Maine has sought other ways to keep an electronic logbook programme running, and it seems that the Gulf of Maine lobster foundation may assume responsibility for the company. If this transfer takes place, the logbook programme would most likely live on, although in a more research oriented manner [24].

2.1.4 Fisknett

Fisknett AS, was founded in August 2004 in Tromsø and has developed software and communication services for the fishing fleet [5]. Fisknett's system can handle electronic communication between The Norwegian Raw Fish Organization and The Norwegian Fishermen's Sales Organization For Pelagic Fish and fishing vessels using for example GSM, MiniM, Inmarsat and Iridium. Information such as the weather forecast is available. Furthermore, it is possible to send information about the catches directly from the vessels to auctions organized by The Norwegian Raw Fish Organization.

The communication services also provide the possibility for the the vessels to check quotas available with The Norwegian Directory of Fisheries. Information which is useful for management of the fishing vessels can also be collected directly from The Norwegian Raw Fish Organization and The Norwegian Fishermen's Sales Organization For Pelagic Fish. Fisknett's systems are suitable for different kinds of vessels such as ocean trawlers, pure seiners and coastal vessels.

2.1.5 WinCatch

The WinCatch software was developed by Marine Software AS in lesund and consists of a range of highly specialised software [34]. The WinCatch logbook, which has a lot of tools to simplify the daily routines for the skipper, is a part of this. As the software is connected to a GPS receiver; fishery zones (FAO, ICES, and Economical) are automatically stored along with positions and time of each haul line. Round weight of each species is also calculated, and reports can be printed for dated, week or an entire trip.

Furthermore, WinCatch also has its own built in map. This map contains fishery zones, economical zones, borders, depths and tow lines or line positions. In addition, it is also possible to filter the tow lines by catch, time (date, week, and trip), average size of catch, towing time etc. By clicking a tow line the production of that tow will be displayed along with all other stored information of that specific haul.

The WinCatch software also includes the possibility of registration of the production on board, reporting and traceability. Production data is stored in a database, thus making the WinCatch software a powerful tool for processing all this information. In addition, the software has been designed to comply with the TraceFish standard. The traceability standard is an EU standard and covers chain traceability for seafood products and provides traceability down to freezer level and labels each produced unit with a unique identifier.

The WinCatch offers more possibilities than the other projects described in this section. In addition, WinCatch is currently working with the Norwegian authorities to implement support of the new "SatRap" reporting tool for electronically reporting of catch.

2.1.6 Conclusion

The AFMA's electronic logbook programme is not involved in the development of the software. They have however developed a set of performance measures which a software product must meet before AFMA will accept reports from this product. This seems to be a very logical way for the authorities to work when trying to introduce new solutions for logbook returns and should be adapted by other countries. For instance, AFMA requires that the sending software formats an XML data file correctly, which matches the DTD and data dictionary. This principle will also be used in this project.

The Sheel project is a sizeable project which includes several countries and software producers. In this project transmission of data from fishing vessels will be done as simple as possible but the

Sheel's principle of an activity based electronic logbook seems rather logical and will be used in this project. The logbook developed by Thistle Marine for fishermen catching lobster, utilizes the same principle as it automatically records date, time and position from the GPS receiver on board for each entry in the logbook.

The WinCatch logbook has a number of tools to simplify the daily routines for the skipper and in addition possibilities for registration of production and traceability are included. WinCatch also has its own built in map containing fishing zones, economical zones etc. In fact, WinCatch offers more possibilities than the previously described systems. However, for most fishing vessels it appears that less complicated systems are suitable.

2.2 Blogging

Collecting and transmitting information from fishing vessels will have quite a lot of common denominators with a web log. A web log is a semi-interactive personal diary which the user keeps on their website. The so-called blog (short form of web log) is updated with small notes about what goes on in that person's life. Recently, the traditional blogs have been extended to handle richer content by adding multi-media elements.

Whilst regular blogs are usually operated from a personal computer, the trend is to extend the blogging activity to include messages from mobile phones [31]. The main point is still the same as people create posts about what is going on their everyday lives, take pictures of views and events which interest them and so on. The main difference is that everything is operated from the mobile phone, but the blog is still viewed from a personal computer. The concept is not widespread at the moment, but is apparently catching momentum. A brief description of NewBay Software, Nokia Lifeblog, Blogmapper and Been-There-Done-That will be given in the following sections as these blogging projects have some common factors with the transmission of information from the fishing vessels.

2.2.1 Newbay software

NewBay Software Ltd. has developed FoneBlogTM which takes the existing Internet phenomenon of blogging and applies it to the mobile phone market [22]. Using FoneBlogTM enables generation of content and updating a website from a mobile phone whereupon viewing it immediately either by using Wap or a regular web browser. FoneBlogTM is a complete server side solution and runs on mobile phone standards such as MMS, SMS and WAP which means that the users do not have to

download and install software on their mobile phone. FoneBlog™ even detects what device is viewing a blog and alters the display to fit the device's capabilities.

NewBay offers three different deployment models i.e. Software, Application Service Provider (ASP) and OEM [22]. In addition, FoneBlog™ can be integrated as a part of a portal. When users log into the portal they are automatically logged into their blog and vice versa. FoneBlog™ has furthermore been designed to be used by the typical mobile phone user i.e. it is easy to use and requires no technical expertise whatsoever.

2.2.2 Nokia Lifeblog

LifeBlog was developed by Nokia and is a multi-media diary software i.e. it allows the user to view multi-media items such as video, images, text messages etc. in a timeline view [21]. In addition, it enables the user to create a visual and audio record of the life from day to day [19]. Nokia Lifeblog does the work of organizing the items created and received.

Lifeblog is however not a blogging tool. The idea is that the mobile phone is used to capture the media which then goes in the Lifeblog. Material is transferred from the mobile phone by a synchronizing process i.e. it has its own conduit, but utilizes the programme for the mobile phone and a PC component. The PC component is the main storage and the user synchronize the two together in order to transfer images. The mobile phone programme may be regarded as a temporary storage unit in which media resides prior to being transferred to the PC. The mobile phone programme works in a similar way to the PC i.e. its main view is a timeline display.

Nokia Lifeblog version 1.5 is compatible with the Nokia 6630 imaging phone. The Nokia 7610 and 6670 imaging phones are compatible with both versions 1.5 and 1.0. Furthermore, version 1.5 enables back-up to CD and DVD.

2.2.3 Blogmapper

The Blogmapper lets the user associate blog entries with hot spots on the map and can be used to map and log anything anywhere including journeys and places and things of interest to the user [9]. The Blogmapper utilizes open format throughout. It operates by first transforming the RSS feed for the blog into RDF. During this process, the location information is scraped out of the posts and added to the RDF by using the RDF map vocabulary, whereupon the RDF mapping engine is employed to produce the final interactive map.

RDFMapper is a web service which searches an RDF or RSS file for resources on geographic

locations, and returns a map overlaid with dots representing the resources located. RSS is translated into RDF prior to being processed. The parameters to the web service specify which RDF file to be mapped, the form of the page into which the map will be embedded, what base map is to appear in the background, how to extract the relevant data from a RDF resource for mapping and how to generate Html associated with the mapped items.

2.2.4 Been-There-Done-That

Location-based services provide users of mobile devices with personalized services tailored to the current location. Misund and Lindh have developed a framework called "Been-There-Done-That" [20] for such a service. The framework consists of three main modules i.e. a client application installed on a mobile phone which is linked to a Bluetooth enabled GPS receiver, a dispatcher which processes the messages received and stores them, and a web browser interface where it is possible to gain access to the messages at a later point in time. As open standards and specifications are used, the modules should be easy to implement. The framework is presented in figure 2.2.

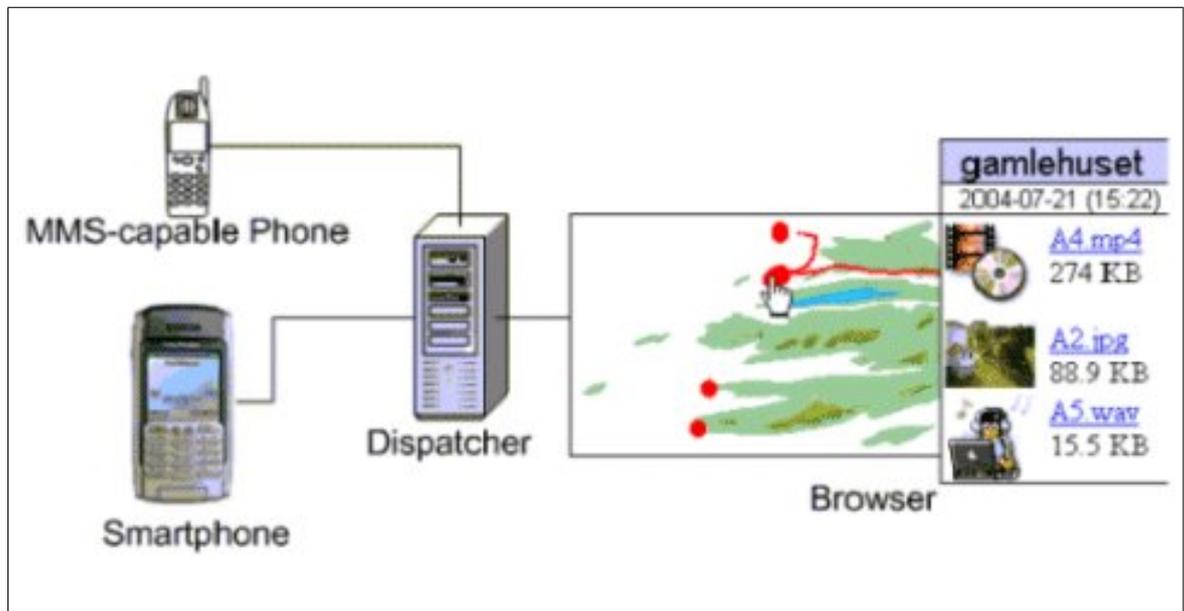


Figure 2.2: The Been-There-Done-That architecture [20].

The client consists of two applications i.e. an AMMS (Annotating Mobile Multi-Media Messages) manager, called BTDT, and a location acquisition programme called Where. The BTDT

application is responsible for composing the annotated message and the transmission to the dispatcher [20].

The location can be specified as a name or as for example coordinates obtained by the GPS. Date and time of day are either obtained from the operating system or from the GPS receiver. The Where application is responsible for the location data of the message. The software is tested on a Sony-Ericsson P900 [20].

The dispatcher is operating as a server and taking care of the storage of the messages. When the dispatcher receives a message, the location data is obtained from the meta elements. If the location is specified as a textual description, it is possible to get the positions by checking a gazetter service. The transportation can be effected by any regular TCP/IP-connection.

The browser is a web based map interface. It is possible for the users to check and get access to the contents of the messages stored through this interface.

”Areas that have messages assigned to them are highlighted. By clicking on a hot spot, the user will get a list of all messages from that particular area. If there are several local areas with information, they will be grouped into one larger area, depending on the size of the current view in the browser. [20]”

It is possible for the users to get access to the information they are looking for by selecting from the list. Furthermore, areas of special interest can be created in order to improve the navigation.

2.2.5 Conclusion

NewBay software and Nokia Lifeblog, which are software used to generate and update a website from a mobile phone, both have common denominators with this project. When transmitting information on the fishing activity from the vessel to for instance authorities on shore, mobile phone will be used. The information will be store in a database and it will be possible to inspect the contents through a web-based interface. In addition, it is important to spot the activities of the vessels on a map. As customers of fish products are focusing more on traceability it could prove useful to spot the position where the fish was caught. The blogmapper lets the user associate blog entries with spots on the map and log anything anywhere.

The project Been-There-Done-That is however the most relevant when comparing other project with this work. As a logbook will be based on information on the activities of the vessels a smart phone client, where the fisherman can complete and send required information, will be developed along with a dispatcher. This will work as a server towards the smart phone client and provide storage of the information. As in the case with the Been-There-Done-That, an application will be

developed which can give information about where the activity took place. Coordinates will be provided by a Bluetooth module, where date and time will be obtained by the operating system. At last the project will include a web browser interface where it is possible to inspect the information supplied by the fishermen and where it will be structured in an appropriate manner. Information about a vessel's quota is an example of information which will be available through a browser. In addition, some information will be available by using Wap.

Chapter 3

Wireless communication and devices

There are different technologies and devices which are suitable when developing an electronic log-book and transmitting data from fishing vessels. When deciding upon what technologies and devices to be used in the project, a factor such as system capacity is important. Factors such as security and functionality are crucial.

The technology is developing with increasing speed and systems which were available two - three years ago are no longer suitable for the latest electronic devices. Before selecting the technologies for this project, a brief description will be given on systems for mobile communication such as GSM, 3G standard and GPRS. In addition, technologies for wireless communication at short range such as infrared and Bluetooth will be described. Furthermore, as a mobile phone will be used to enter and transmit data about the fishing activities and a GPS receiver will obtain the positions, a description of a mobile phone and a GPS receiver will be given in this section. The mobile phone chosen is the Symbian OS which has triple band and is functioning in the 3G, EDGE and GSM(900/1800/1900) nets worldwide. The GPS is suitable for marine navigation, fleet management and mapping device applications and has 12 parallel satellite-tracking channels for fast acquisition and reacquisition. Furthermore, it supports active antenna connector to obtain enhanced signals.

3.1 GSM

GSM is a global system for mobile communication which was originally developed for the 900 MHz band. Later on it was modified for 850, 1800 and 1900 MHz bands. GSM is open and non-proprietary and differs from the first generation systems due to the use of technology. Transmission

of data is efficient and the network is very secure. All communication, both speech and data, are encrypted. The subscribers are identified by a SIM-card which holds their identity number, authentication key and algorithm. GSM is under constant development and the platform has become a successful wireless technology. Today there are more than 1 billion subscribers and the progress is continuous. GSM has also become a success in Norway and the net covers areas where 99,2 percent of the population is living. In addition, the GSM coverage is in average 50 - 60 kilometers off the Norwegian coastline and in some regions up to 120 kilometers, hence currently covering approximately 99 percent of the major fishing grounds along the Norwegian coast.

3.2 3G standard

The 3G standard, which is the third generation mobile communication system, was created by the International Telecommunication Union (ITU). The main advantage being increased capacity and data rates. In addition, the quality of the communication system has improved and 3G can now promise faster services including voice and fax. Internet and for example video on demand is also possible.

The first 3G network was opened in Japan in 2001 and the vision was to introduce 3G as a common worldwide standard for transmission. This has proved to be quite difficult and a standard called IMT-2000 has become a compromise and IMT-2000 now represents the following 5 various standards as presented in table 3.1:

Table 3.1: Various standards represented by IMT-2000

	Various standards
1	W-CDMA
2	CDMA2000
3	TD-CDMA/TD-SCDMA
4	DECT
5	UWC-136

As presented in table 3.1, IMT-2000 now represents five various standards. W-CDMA which is the 3G standard that has been agreed for Europe and Japan is known as UMTS. UMTS is an upgrade from GSM via GPRS or EDGE and will enable transmission of data 8 - 10 times faster than on the GSM-net. UMTS is also deployed in Norway. In December 2004 more than 70 Norwegian towns were covered and by March 2005 2,8 million Norwegians will have access to the UMTS-net. To gain access to the net requires a mobile phone which supports UMTS. The mobile phone will however

function as in the GSM-net while in areas not covered by UMTS.

3.3 GPRS

GPRS represents the first implementation of packet switching within GSM and offers maximum data speeds up to 172 kilobytes per second using all eight timeslots at the same time. It is a supplement to the circuit switched data and short message service which is in use. GPRS enables information to be transmitted faster and more efficiently. Furthermore, it facilitates instant connection where information can be sent or received immediately. This is critical for applications where time is of the essence. Remote credit card authorization is an example of such applications. Also, new applications which have not been available over the GSM-net are now introduced over GPRS. Other new applications are file transfer and the possibility of remote access and control for example in-house machines.

The GPRS coverage in Norway is more or less equal to the situation for the GSM-net. As the upgrading of EDGE is still under development there will be some local variations. When moving out of an area covered by EDGE the mobile phone will automatically switch over to the GSM-net. GPRS is also an essential precursor for 3G as it introduces the packet switched core required by UMTS.

3.4 Infrared

Infrared is electromagnetic energy with wavelength a somewhat longer than the wavelength than the red light. Infrared wireless is used for transmission of data at short and medium range and is reliable and cost-effective. TVs and VCRs communicate by using beams of light from the infrared spectrum. The infrared does however have some disadvantages; as it is line-of-sight, a sender must align with its receiver. Furthermore, as it is one-to-one, a device cannot send to multiple receivers simultaneously.

Infrared also has some advantages; interference can often be a problem in communication systems, but because infrared is line-of-sight, interference is uncommon. Furthermore, because it is one-to-one, message delivery is reliable. Each sent message goes to the intended recipient regardless of number of infrared receivers in a room.

3.5 Bluetooth

The Swedish phone equipment supplier Ericsson was the first to see the opportunities of the Bluetooth technology, originally as a way for mobile devices to communicate with each other at short range (i.e. up to 10 meters). In 1998, Ericsson, IBM, Intel, Nokia and Toshiba formed the Bluetooth Special Interest Group Consortium to develop the technology for short-range wireless connectivity.

Bluetooth offers a variety of other services and creates opportunities for new usage models. An example would be an apt technology for synchronizing devices. Bluetooth also works quietly and automatically, furthermore it Bluetooth enabled devices find each other automatically and initiates communication between each other without input from user if authentication is not required. Bluetooth is also cost-effective and handles both voice and data. The signal is omni-directional and can pass through walls and briefcases. Communicating devices do not need to be aligned and do not need an unobstructed line of sight. The ISM band which Bluetooth uses is regulated, but unlicensed and has a common standard i.e. it is possible to use the same devices virtually all over the world without having to obtain legal permission in advance. Bluetooth wireless technology can be used for applications dealing with transfer of files, synchronization of devices and mobile payments. The technology is also apt for networking when communicating devices spontaneously form a community of networks that persists only as long as it is needed.

Bluetooth enabled devices are organized in groups, so-called "piconets". A piconet consists of a master and up to seven active slaves. A master and a single slave use point-to-point communication. In the case of multiple slaves, point-to-multipoint communication is used. The communication is initiated by a master unit. A device in one piconet can communicate to another device in another piconet, forming a "scatter net". A master in one piconet can also be a slave in another piconet. The bluetooth protocol stack is presented in figure 3.1.

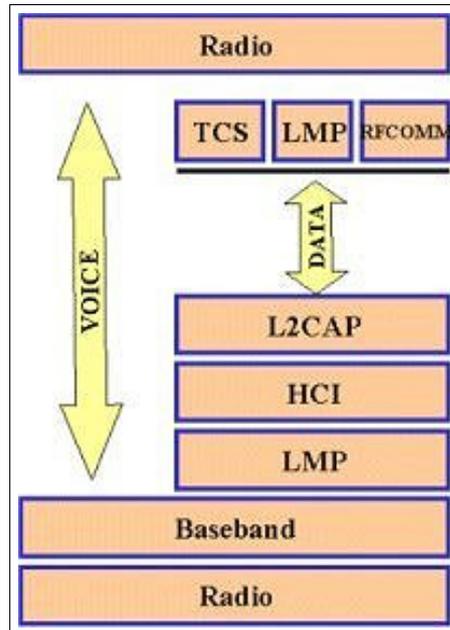


Figure 3.1: The Bluetooth protocol stack.

As presented in figure 3.1, the radio layer which is the physical wireless connection, is at the bottom of the stack. In order to avoid interference with other devices communicating on the ISM band, the modulation is based on fast frequency hopping. The standard wavelength range is 10 centimeters to 10 meters, and can be extended to 100 meters by increasing transmission power. Next is the base band layer which is responsible for controlling and sending data packets over the radio link. It provides transmission channels for both data and voice. The base band layer is followed by the link manager protocol (LMP) which uses the links set up by the base band to establish connections and manage the piconets. This layer is also responsible for authentication and security services. The link manager protocol is then followed by the host controller interface (HCI) which is the dividing line between software and hardware. On top of the host controller interface is the logical link control and adaptation protocol (L2CAP) which receives application data and adapts it to the Bluetooth format. The L2CAP and layers above are currently implemented in software whereas LMP and lower layers are implemented in hardware.

The range of Bluetooth enabled devices is increasing daily and applications such as sending captured location information from for instance the GPS receiver to a mobile phone are helping to build more business applications. Initiatives from Nokia and other companies in the industry will

give Bluetooth great influence on every day life in the future

3.6 Nokia 6630

The introduction of the Nokia 6630 represents a breakthrough in mobile communication as it is the first mobile phone to combine the advantages of 3G, EDGE and the smart phone platform Series 60. The Nokia 6630 is based on Symbian OS. It is also a tri-band phone for GSM 900/1800/1900, EDGE and WCDMA. Furthermore, Bluetooth wireless technology such as headset profile (HS), handsfree profile (HF) and basic imaging profile (BIP) are included. Local synchronization of contacts and calendar to a compatible PC is possible by using compatible Nokia PC Suite. It could also be used to send and receive images, video clips, graphics and business cards via Bluetooth wireless technology. In addition, it is possible to download Java MIDP 2.0, CLDC 1.1 applications. The Nokia 6630 is presented in figure 3.2.



Figure 3.2: Nokia 6630 mobile phone.

The Bluetooth wireless technology is quite useful when collecting information from activity on board a fishing vessel. The features of Nokia 6630 are in this way favourable. Reporting activity or using the mobile phone as an electronic logbook makes the mobile phone more like a portable office. The Nokia 6630 which is shown above also has the features to function more or less as a portable office for fishermen reporting activity to other parties in the industry.

3.7 GPS-receiver

When entering the activities in a logbook and reporting from the fishing fields it is necessary to include the positions where the activities took place. The GPS-receiver is used to obtain the position of the actual vessels. The Holux GR-230 smart wireless Bluetooth receiver is chosen as GPS-receiver in this project. This GPS-receiver has 12 parallel satellite-tracking channels for fast acquisition and re-acquisition and has an active antenna connector to enhance satellite signals. Furthermore it provides continue mode and power saving mode in compliance with the users requirements. The Holux GR-230 GPS-receiver is presented in figure 3.3.



Figure 3.3: GR-230 GPS-receiver.

As presented in figure 3.3, the Holux GR-230 is rather small and fits easily in your hand. It has 4 colors LED to indicate the status of the device. Furthermore, it has a Lithium-ion battery which is built-in and is rechargeable without external power supply. The Holux GR-230 is completely compatible with Bluetooth Serial Port Profile (SPP) and provides expanded terminal contact to other systems without Bluetooth devices. The GR-230 is therefore apt for system integration with mobile phone or PDA and the position application meets the necessary requirements with regards to car navigation, mapping, security etc. Only a clear sky and certain power supplies are necessary to the unit. It is also possible to install a testing program on a PC to test transmission of positions.

3.8 Conclusion

During 2004 Telenor upgraded the GSM-net along the Norwegian coastline. Approximately 99 percent of the major fishing fields are now covered. The upgrading of the GSM-net with EDGE is also progressing and most areas are now covered. There will however still be local variations. This is also the situation for GPRS which is now available in practically all areas on the main land. By December 2004 UMTS covered more than 70 Norwegian towns completely or partly. By March 2005 2,8 million Norwegians had access to UMTS.

When choosing devices for implementation of the logbook and field reporting from fishing vessels it was necessary to take into consideration the extent of the coverage of the different technologies in the actual areas. The plans for upgrading were also of great importance. The Nokia 6630 is chosen as device to serve as logbook as it is a triband phone for GSM and in addition the first mobile phone to combine the benefits of 3G and EDGE. Using Nokia 6630 will therefore not cause problems when the vessel moves from an area with UMTS coverage to an area with only GSM coverage. Furthermore, Nokia 6630 is Bluetooth enabled and it is possible to download Java MIDP 2.0, CLDC 1.1 applications. Nokia 6630 also has features to function more or less as a portable office. The Holux GPS-receiver is easy to integrate with the Nokia 6630 and these are well suited to function together when reporting activities from the fishing fields. A clever setup of the software developed in the project could further facilitate the daily routines for the fishermen.

Chapter 4

Mobile logbook system - MLS

Today most skippers have to manually fill in the information required about their fishing activities in a logbook [17]. This can be quite tedious for fishermen working under stress and sometimes very difficult weather conditions. Introducing a Mobile logbook system utilizing the technologies and devices described in chapter 3 would therefore facilitate the skippers' daily routines.

A framework called Mobile Logbook System based on these technologies and devices is being developed and will be described in the following subsections. A prototype of an electronic logbook used to report the fishing vessels' activities will be based on this framework and will be used to carry out tests of entering and transmitting information.

4.1 System architecture

The Mobile Logbook System is a framework which can be used when reporting the fishing vessels' activities. It includes an application consisting of a logbook client, a logbook manager and a browser. The logbook client is responsible for the transmission of data and provides a user interface. The possibility of obtaining information automatically was of utmost importance when developing a system for users working under difficult conditions. A GPS receiver is therefore linked to the logbook client providing information on the vessel's position. As the transmitted data should be presented and organized in a structured manner, a database is included in the logbook manager. The framework is presented in figure 4.1.

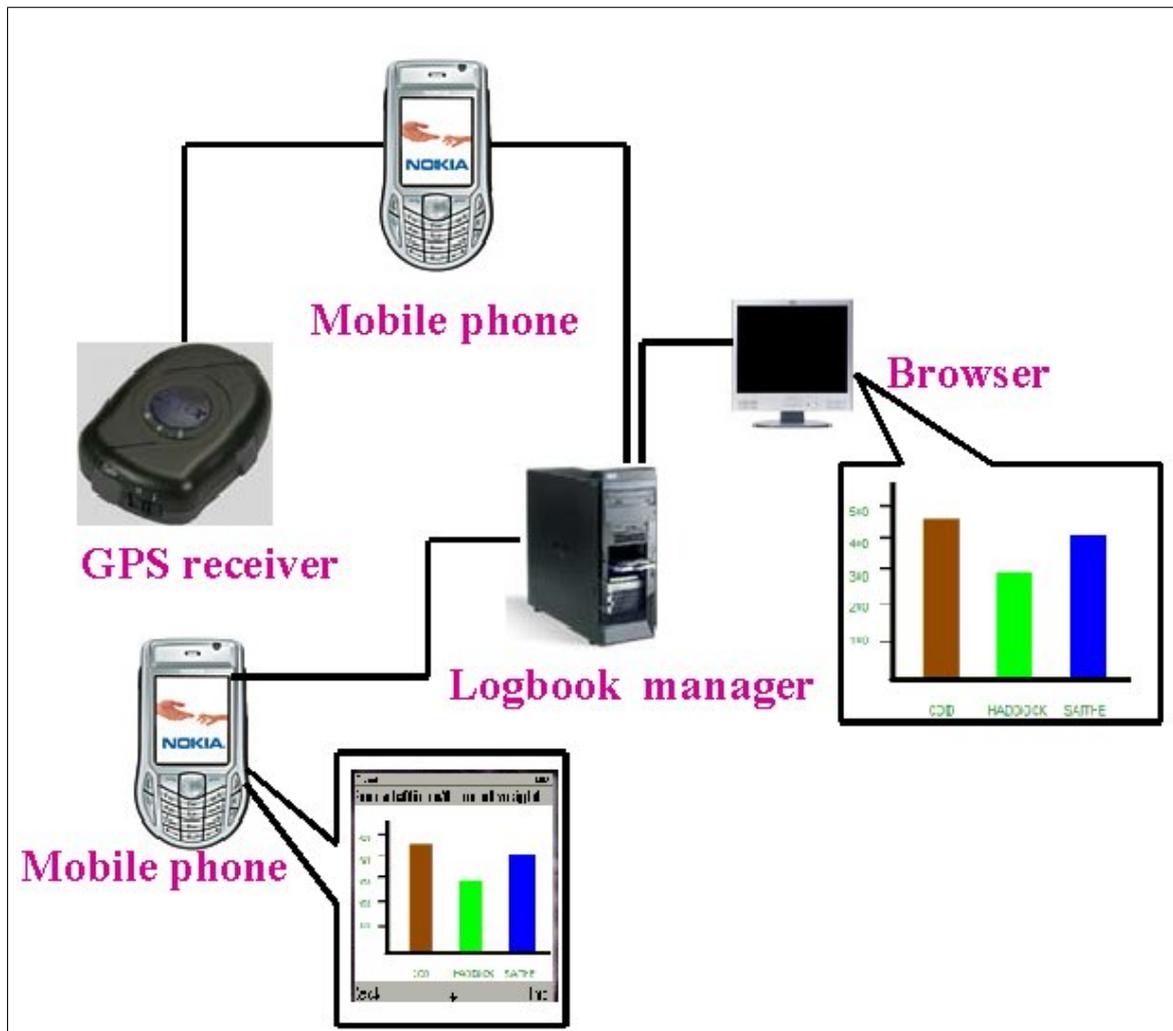


Figure 4.1: The system architecture for MLS.

As presented in figure 4.1, the application consists of three main modules, i.e. a logbook client, a logbook manager and a browser. The client application is running on a mobile phone linked to a GPS receiver and transmits the information to a server side logbook manager. The logbook manager parses and stores the information received in a database, whereupon the user can gain access to the information stored in the database through the browser application. It is also possible to access some key information, which is of great importance for the fishermen, through the mobile phone.

4.2 Logbook client

4.2.1 Data required

The client application is responsible for transmitting data from the mobile phone to the logbook manager. It also provides an interface where the user can enter and send the information. Furthermore, it is responsible for obtaining positions from the GPS receiver. Key information about the vessel and the skipper has to be included in the header of each message [17]. When installing the software onto the mobile phone, it is necessary to enter the skipper's name and the vessels's id. The vessel's id is included in the data transmitted to the logbook manager. Furthermore, for each vessel, the information presented in table 4.1 is stored in the database in the logbook manager.

Table 4.1: Key information about a vessel

	Information
1	Vessel's name
2	Radio Call Sign
3	Vessel's identification number
4	Skipper's name
5	Skipper's address

The logbook client should be as user-friendly as possible. As presented in table 4.1 key information about the vessel and the skipper has to be stored in the logbook manager in order to link the activity performed to the correct vessel and skipper. The skipper has to enter data when activities are carried out [17], for instance when the vessel is leaving port, arriving at port again and landing the catch. The authorities require the name of port for each of these activities and it is also important to report date, time and location at time of preparing the report to the authorities.

Furthermore, the weight of fish landed per species, the weight of the processed product and zones in which the fish is caught has to be reported upon landing. Using the positions where the activities were performed it is possible to decide the actual zones. A receipt has to be issued upon delivery at an auction hall or at a processing plant. The skipper also has to report the receipt number upon landing. Information is also required when the vessel arrives at the fishing fields at sea and during the catch. When arriving at the fishing fields the skipper has to report field name, date and time and location when preparing the report. Reporting the fishing operations is more complex and the information in table 4.2 is required by the fishing authorities [17].

Table 4.2: Information required in connection with fishing operations

	Information required in connection with fishing operations
1	Date, time and location at time of preparing the report
2	Type of gear
3	In dependency of the gear, Mesh size, No. Hooks, Gear length etc.
4	Date, time and location of gear deployment
5	Date, time and location of gear collection
6	Zones involved in the fishing operation
7	Live weight of full catch per species.

As presented in table 4.2 the authorities require information about the fishing operations [17]. I.e. each time the gear is deployed or collected data has to be entered into the logbook. Date and time is provided by the software and the positions are obtained by the GPS receiver. Furthermore, the zones involved in the fishing operations can be calculated on the basis of the position data. The user has to enter information concerning the fishing gear and the live weight of full catch per species. In this project the client is developed for vessels fishing with Danish seine or trawl. Therefore the possibility to enter information about the gears is not included in the user interface.

4.2.2 Environment analyzes

While developing an electronic log book for fishermen it is necessary to look into the environmental conditions. The fishermen are often working under pressure and this kind of work is often described as risky and unstable. On the other hand many fishermen appreciate the freedom and excitement in the profession. The fishing fleet is not at all an homogeneous group of vessels concerning size, comfort, fishing gear, technical equipment etc. A part of the fleet are ocean trawlers fishing far from the coast. These vessels are mainly 110-200 feet long and has more space on board, often very good facilities and working conditions compared to many coastal vessels 40 - 70 feet long fishing with long line, Danish seine or gill net along the Norwegian coast. On many vessels the fishing deck(the deck where the fish is processed, for instance headed and gutted) is built in so the crew get protection for the bad weather. While on other vessels this work has to be done on an open deck. To get an impression of the working conditions, the figures 4.2, 4.3 and 4.4 are showing fishing operations and fishing deck on board a vessel.



Figure 4.2: Fishing operations and fishing deck.



Figure 4.3: Pilothouse from two different vessels.



Figure 4.4: Hauling the catch.

Although the fleet is not an homogeneous group it has some common features. The conditions on board is affected of weather conditions as sea, wind, humidity, temperature etc. In addition when getting quite a lot of fish on board after for instance a haul(trawl) it is necessary for the crew to focus on taking care of the catch at once. The fish has to be cut, then gutted before for instance iced into boxes or tubes. There is a trend that there are fewer crew members on board now compared to 5 -6 years ago. I.e. the fishermen are working under more stress and pressure as demands for economical results are increasing. Even skippers often has to take part in cutting and gutting these days. Quite a lot of work has to be done within limited time. Therefore developing an electronic log book which make it easier and more handy to fill in the required information can make life easier for the crew. Such a logbook has to meet the demands listed in table 4.3.

Table 4.3: Environment analyses

Item	Demands
1	As few hierarchies as possible
2	As few steps/"click's" as possible
3	Use bluetooth technology to provide information
4	Easy to learn
5	Portable
6	Waterproof and stand humidity and cold
7	Shock-proof

As presented in table 4.3 the analysis of the environment raises certain demands for development of the user interface. Mobile phone is in use by most fishermen and it seems that threshold is lower learning to use phones than desk tops. It is easy to take the phone with you as you move within the vessel from one deck to another looking at the catch or doing some other work filling in

the required information. As Telenor will upgrade and build out the GSM-net covering 99 percent of the major fishing grounds along the Norwegian coast, mobile phones will be the best alternative in my opinion. However it is necessary that such phones are waterproof, shock-proof and stands humidity and cold.

The users of the system can be defined as fishermen obliged to keep and fill in a log book according to the Norwegian fisheries regulations. Fishermen is not a homogeneous group concerning education and work experience. Some has education from Maritime technical college which gives lectures in Fisheries legislation, for instance how to fill in the existing manually treated reports. Other fishermen have less education but learned through experience how to fill in the reports. However media have informed several times about fishermen having misunderstood what information is required or how to fill in reports and have risked prosecution.

The age of most fishermen is between 20 - 50 years. Some of them started their career early and others later, sometimes after working in other industries. The work experience can also be very different. For instance some may have experience from ocean trawlers while others have worked on medium or small coastal vessels using long line or gill net as fishing gear. The system will therefore not be designed for any special group of age or work experience but will focus on facilitating the work keeping the log book according to the regulations.

The working facilities may be very different from a vessel to another. For some vessels using desk tops can be an acceptable solution. Other vessels with rather limited space and facilities desk tops are not good at all. In addition using mobile phones is much more convenient. You can for instance just take the phone with you to the fishing deck on board and fill in the estimated weight while you are actually estimating this. Using desk tops on board, somebody write the weight on a sheet of paper and gives it to you in pilot house or tell you the estimation etc. It is much more convenient and secure to enter the information just at the time the estimation is done.

4.2.3 User interface

During the time at sea, the skipper has to enter and transmit quite a lot of information about the activities [17]. In addition to the amount of information, it is also necessary to take the working conditions into consideration. Furthermore, the display size of hand held devices is smaller and input devices do not always include pointing tools such as a mouse or pen input [15], hence the user interface provided by the logbook client having to be consistent [29] and certain guidelines have to be followed.

First, the positions of the items are pretty much the same on each form. Secondly, the information is grouped in more or less the same way as the logbooks in use today. This will make the fishermen familiar with the user interface and keeps the threshold as low as possible. Too much information may confuse the user. As entering alpha numeric data through a hand held device can be tedious a list of choices will be used if applicable. Moreover, there are few hierarchies which makes it easy to navigate from one form to another and it is possible to enter the required information with a few simple "clicks".

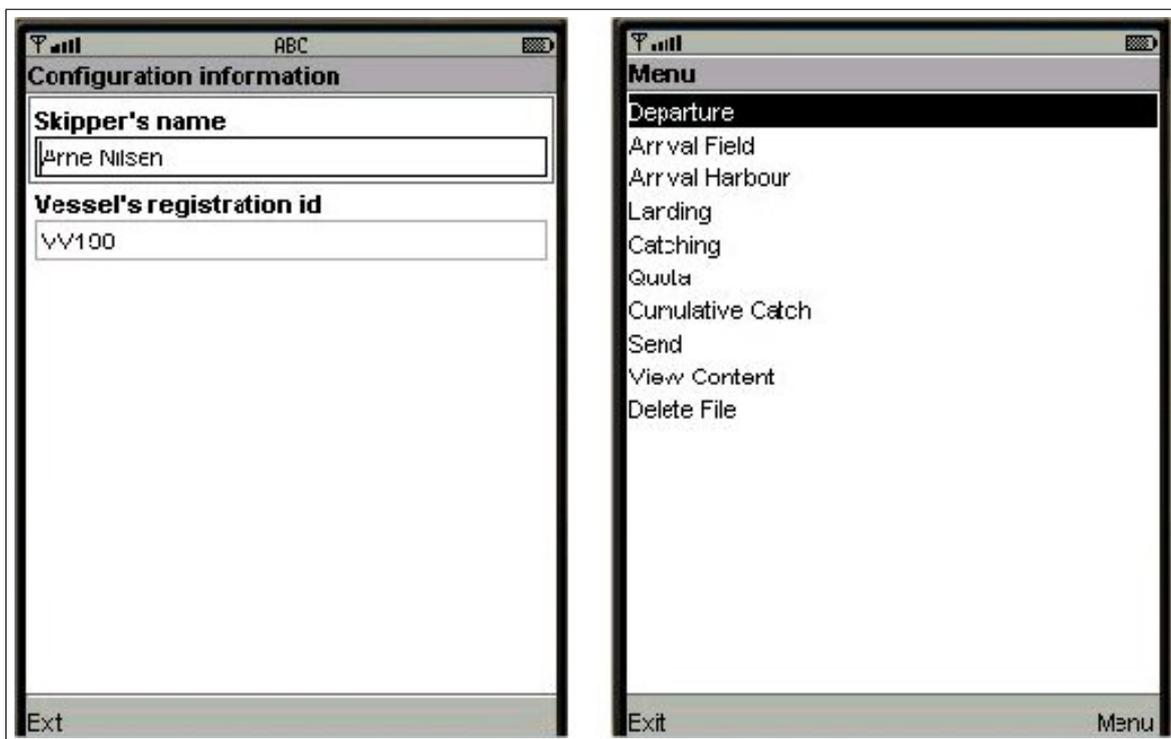


Figure 4.5: Configuration screen and the menu system from the user interface.

Figure 4.5 presents the configuration screen and the menu screen. A logbook for fishermen deals with sensitive data and protection of the MIDlet is necessary. The configuration screen is the first screen the user will see and skipper's name and vessel's id has to be filled in. Then the user can enter the MLS programme and the main menu will be displayed, enabling the user to select strings where information about the various activities should be entered.

In addition to entering and transmitting information about the activities, the user will be able to request information about outstanding quota and total catch of his vessel. Up-to-date information about the vessel's quotas is of the essence when choosing where to go fishing and enables the fishermen to act in accordance with the regulations. The logbook requires entering information in the correct order as presented in figure 4.6, which shows the work flow analysis of the user interface.

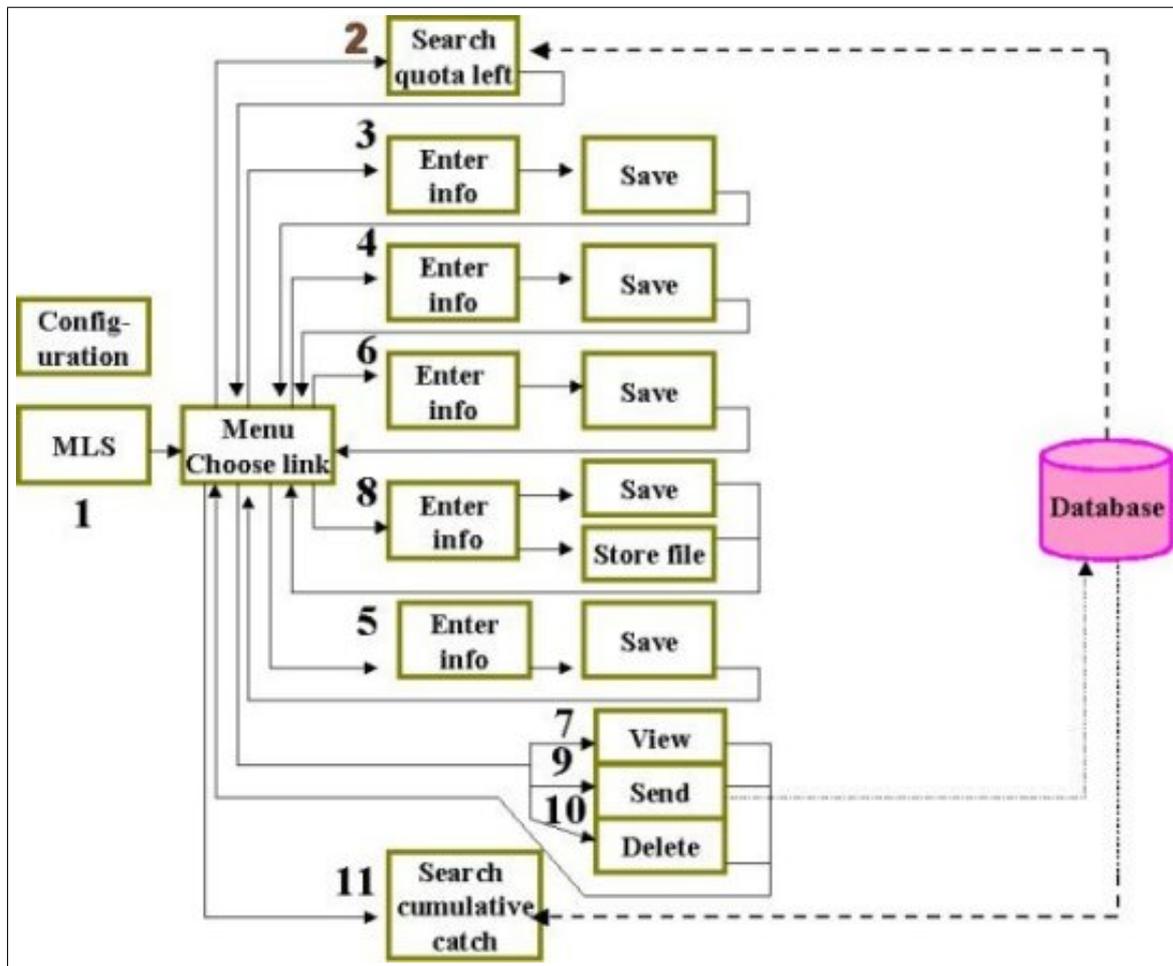


Figure 4.6: Work flow analysis.

As presented in figure 4.6, configuration is the first task when the programme is installed. After entering skipper's name and the vessel's id the user can choose the MLS programme and the main menu will be displayed. According to the work flow analysis of the interface in figure 4.6 the user will be able to carry out the following tasks when using the logbook:

1. When the MLS screen is displayed, press the Go button and the menu screen will appear.
2. From the menu screen, choose the link for quota to access data on outstanding quota. This should ideally be done prior to leaving the harbour. When outstanding quota is displayed, return to the menu screen.

3. From the menu screen, choose the link for departure. The departure screen will be displayed. Edit harbor and tour number when leaving port and press the save button. Return to the menu screen and press exit button.
4. From the menu screen, choose the link for arrival field. The arrival field screen will be displayed. Edit field when arriving at fishing field and press the save button. Return to the menu screen and press exit button.
5. From the menu screen, choose the link for catch. The catch screen will be displayed. Report deployment of gear and return to main menu. When hauling the catch, complete the catch report i.e. how much fish in round weight of the various species. Enter the quantity in the text fields and press the save button. Return to the menu screen and press exit button. The action is to be repeated for each deployment and haul etc.
6. From the menu screen, choose the link for arrival. The arrival screen will be displayed. Edit harbour when arriving at port again and press the save button. Return to the menu screen and press exit button.
7. If you would like to check the information stored, choose the link for view content. A screen showing the content stored in the file on device will be displayed. Return to the menu screen.
8. From the menu screen, choose the link for landing. The landing screen will be displayed. Edit harbour and receipt number when landing the catch and press the save button. Then press the store file button to store the information logged from the tour into a new file. Return to the menu screen and press the exit button if you do not wish to know your total catch or outstanding quota subsequent to landing.
9. From the menu screen, choose the link for send. Then the information stored in the new file will be transmitted to the database. A message from the logbook manager will be displayed. Then press confirm button and confirmation from the logbook manager will be displayed. Return to the menu screen and press exit button.
10. From the menu screen, choose the link for delete. The file original file will be deleted and it is possible to create a new file for logging data from next tour. Return to the menu screen.
11. If you would like to know the total catch, choose the link for cumulative catch to access up-to-date information regarding each species caught. Upon displaying cumulative catch screen, return to the menu screen and press the exit button.

4.3 Logbook manager

4.3.1 Server

When the user has entered the information required about the fishing activities and pressed the send button on the mobile phone, data will be transmitted to the logbook manager. The logbook manager consists of a server and a database management system. First of all, when transmitting information the logbook client connects with the server. Secondly, when the information from the mobile phone arrives at the logbook manager scripts are invoked. The data received is then passed on to the database for storage and information from the various activities is stored in tables. The server administrator controls the behaviour of the server through the directives in the configuration files and these can be altered easily. As a logbook for fishermen is handling sensitive data, protecting the information is of utmost importance. The regulations protect against abuse of logbook data by denying unauthorized users access.

4.3.2 Database

Most databases currently used, are relational databases with one table for each entity and columns for the attributes of the entities. The relation is described by keys. Each occurrence of an entity is stored in a row in a table, the so-called record. Most tables require a column for a primary key which is a unique identification for each record in the table. In addition to attributes and primary keys, the tables contain foreign keys which represent the relations between them. In this project the data model is developed for an ordinary logbook [17] used by fresh fish trawlers and seiners with a cod license. Figure 4.7 presents the data model for the database in which the information about the fishing activities is stored.

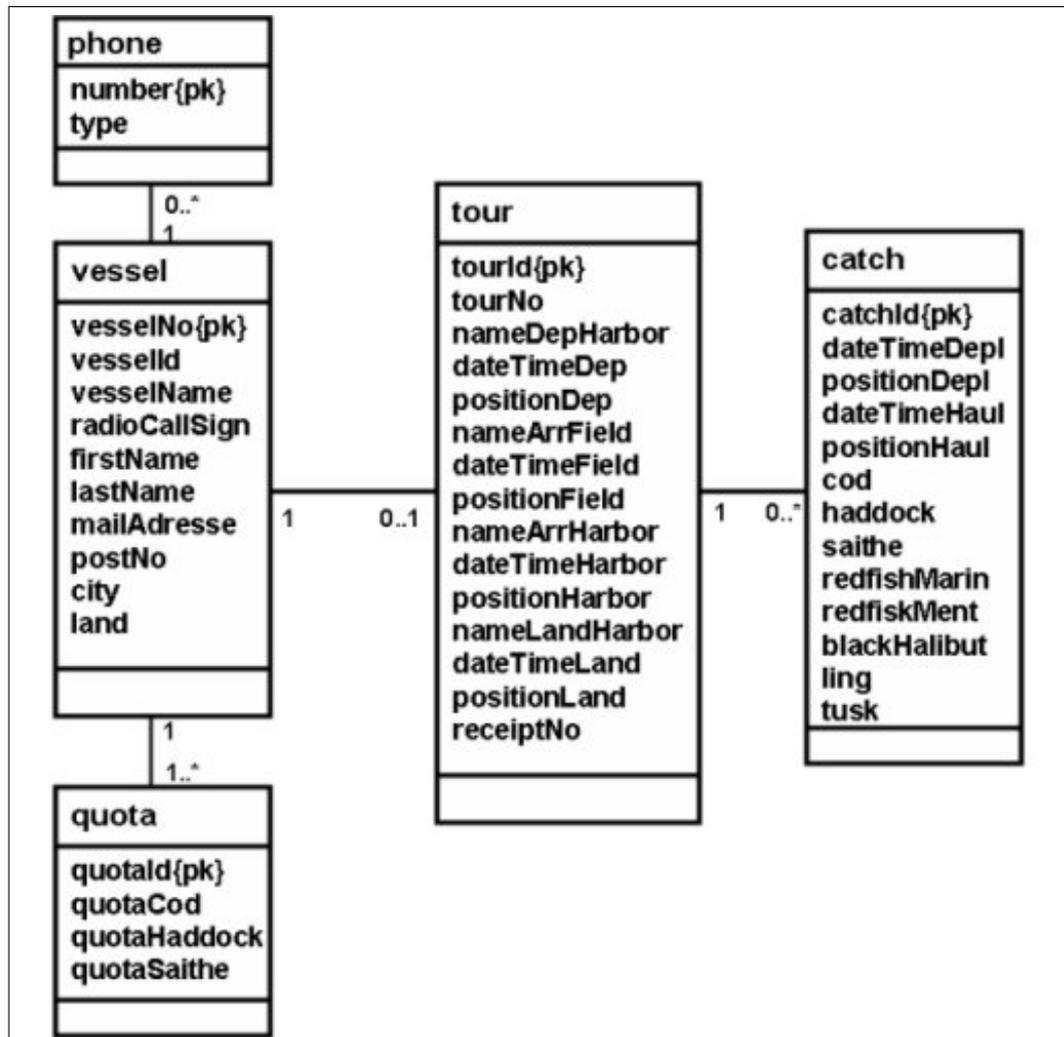


Figure 4.7: Data model.

The database in this project is a relational database. Figure 4.7 presents the data model for the logbook including tables, attributes and the relation between the tables. The UML notation is used.

As presented in figure 4.7, the table Vessel contains the vessel's identification number(id), name and the radio call sign. It also includes the skipper's name and address. The vessel's id is included in the header of each message sent by the skipper on board, to the logbook manager.

The vessel has a license with a fixed quota in metric tons for certain species of fish which it is allowed to catch [18]. A vessel with a license for cod could for example catch cod, haddock and saithe until the quota has been reached. It is also allowed to take some species as by-catch. The table Quota contains the quota in metric tons for cod, saithe and haddock for a specific vessel. This table is also necessary as it is possible to transfer licenses between vessels and since a vessel may have more than one license [18].

As presented in figure 4.7, the table Tour contains the tour number. It also includes date, time and position of departing port. This information is required when the vessel is arriving at the fishing field, when returning to harbour and when landing the catch. The table Tour therefore contains attributes for these activities. Also, when landing the fish, the buyer has to enter information about the quantities landed etc. in a catch receipt. The number on the catch receipt has to be entered into the logbook in order to link the delivery of the fish to the catch, hence the receipt number being included in the table Tour.

Whilst at sea, the skipper also has to enter the required information about the catch, thus the table Catch contains date, time and position for deployment and haul of the fishing gear. Furthermore, this table also contains attributes for the various species the vessel is fishing. The total catch is stored in this table.

Some of the information used in the applications is included in scripts. When installing the software onto a mobile phone the configuration requires vesselId and the skipper's first name and family name. This will facilitate the completion of the logbook and the reporting of information. Furthermore, information about the vessel, skipper and the quotas in the tables Vessel and Quota should be loaded into the database by the authorities. Due to the amount and the complexity of the data in the logbook manager, providing as much information as possible in advance, is of the essence.

4.4 Browser

In this project the browser is an application where the user, for example the fisheries authorities, get access to the information about fisheries' activities stored in the database. Different scripts have to be invoked when a user makes his requests. It is possible to query the database and to retrieve actual information about a certain vessel. When developing this application it is necessary to take into consideration the amount and the complexity of the data stored in the database. The information available with regards to a vessel's activities is presented in table 4.4.

Table 4.4: Information about a vessel's activities

Activity	Information
Departure	Data, time and position at departure from harbour
Arrival at fishing field	Date, time and position at arrival at fishing field
Arrival at harbour	Date, time and position at arrival at harbour.
Landing	Date, time and position at landing of catch.
Fishing	Date, time and position at deployment of fishing gear
Fishing	Catch per species
Fishing	Date, time and position at haul of fishing gear.
Planning the tour	Total catch and outstanding quota.

As presented in table 4.4, it is possible to get data about a vessel when departing from harbour and when arriving at the fishing fields. In addition, information about the fishing operations and the catch per species is also available. Furthermore, data about the vessel is available when arriving at harbour again and landing the catch. Information can be retrieved from one single vessel's tour. The catch data, including total catch, will be displayed as bar graphs. A vessel's outstanding quota is also of great importance and is accessible through the browser interface. This will also be displayed as bar graphs.

4.5 Conclusion

The logbook client is developed for mobile phones since most fishermen are more used to a mobile phone than to a desktop computer. One should also take the working conditions into consideration. It is easier and quicker to pick up and use a mobile phone on board while working under stress and pressure, than for example to go to the pilot house where the desktop is placed each time information have to be entered and sent. It is also important to automatically obtain as much information as possible. Linking a GPS receiver to the mobile phone, clever use of the software and proper configuration when installing the logbook client, will provide information to be sent every time a report is prepared, automatically.

The logbook manager consists of a server and a database. First of all, a database is chosen to store the information of the activities due to the amount and the complexity of the data. Secondly, the information stored has to be presented and analyzed in a proper way. Furthermore, the relationship between the data and the use of primary and foreign keys facilitate the searching, updating and modification of data. By using a database, it is also easier to control the data stored and protect access from unauthorized users.

The browser gives the user access to the data stored in the database in the logbook manager. The data has to be presented in various ways. Total catch and outstanding quota is one way of presenting the data. It is also necessary to enable the retrieval of positions and date/time of departing and arriving at harbour etc. Different scripts have to be invoked when a user makes his requests. The main browser application provides a variety of options concerning presentation of information. Furthermore, it is possible for the user to request outstanding quota and total catch for his own vessel from the mobile phone.

Implementing the mobile logbook system requires acting in compliance with some guidelines. The unavailability of services must be handled with care. Security also plays an important part. Data on the fishery activities can be sensitive and should not be available to unauthorized persons. Sound programming guidelines should therefore be followed. The implementation of the mobile logbook system will be described in detail in chapter 5.

Chapter 5

Implementation

A Mobile Logbook System - MLS is a kind of location-based services where the skipper enters and send information about the fishery activities tailored to the current location of the vessel. The implementation of the system requires following certain guidelines. First of all, even though Telenor has expanded the GSM-net coverage along the Norwegian coast, the unavailability of services must be handled carefully. The skipper can be cut off from the services because it is out of range. Secondly, the telephone companies could offer different coverage or the connection can be broken due to poor weather conditions. Furthermore, security is also an important factor. Data concerning the fishery activities may be sensitive and should not be available for unauthorized persons. Sound programming guidelines should therefore be followed and the security framework in MIDP should be used. The implementation of the logbook client, logbook manager and the browser will be described in the following subsections.

5.1 Implementation of client

5.1.1 J2ME and MIDP

Java is chosen as programming language for the MLS client in the project because it is popular and in use world wide. Its portability is also beneficial, i.e. the ability to take a Java program and execute it on various operating systems without having to recompile or otherwise re- target the program for each operating system. Furthermore, Java is also re-known for its security infrastructure. A Java programme downloaded and installed on a mobile phone will not cause any damage to other programmes installed on the device. Since the logbook client is developed for mobile phones,

the J2ME Wireless Toolkit 2.1 which is described as following at Sun's website: "Fully JTWI compliant emulation and support for MIDP 2.0, CLDC 1.1, WMA 1.1, MMAPI 1.1., as well as the new J2ME Web Services API (JSR-172)", is used. MIDP 2.0 support for the handling of files is included in the JSR-75 specification [26]. On devices which implement JSR-75, this package enables J2ME applications to create, read and write files and directories located on mobile devices. In this project, the mobile phone requires support by this package and access to the file system is provided through the FileRegistry class [13].

MIDP is a version of the Java platform based on CLDC and KVM which is aimed at small footprint devices, such as for instance mobile phones. Sun provides a reference implementation of MIDP which can be used on Windows, the Wireless Toolkit, which contains versions of MIDP for Windows, Solaris and Linux. The Mobile Information Device Profile is presented in figure 5.1.

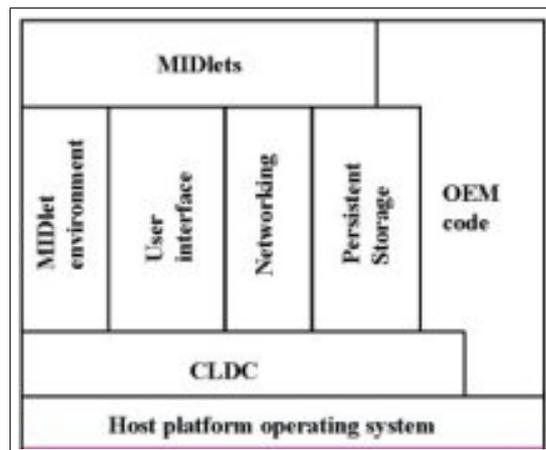


Figure 5.1: The Mobile Information Device Profile [32]

As presented in figure 5.1 The Mobile Information Device Profile(MIDP) adds networking, user interface and persistent storage to CLDC. The OEM code may use some combination of MIDP and CLDC services. This will also depend on the host platform's operating system. The software which implements MIDP runs in the KVM supplied by CLDC and provides additional services for the benefit of application code written using MIDP APIs.

5.1.2 Persistent storage

The data entered by the user interface have to be stored. Persistent storage in MIDP is centered on record stores which are small databases containing pieces of data, so-called records. Another alternative is storing the data which are entered into a XML file. First of all, XML is a standard method of representing structured data. Secondly, it is portable. Furthermore, it is rapidly becoming the most preferred messaging protocol for enterprise applications where the exchange of data is necessary. However, neither MIDP 1.0 nor MIDP 2.0 specifications provide any support for parsing or creating XML documents.

It is necessary to rely on third-party libraries and in this project KXML is utilized [8] [35]. KXML is specifically designed for KVM environments such as CLDC and MIDP, and compiles without modifications in a MIDP environment. KXML provides an optional KDOM package which is a simplified version of DOM optimized for space efficiency. Furthermore, KXML provides the XMLWriter class for writing XML. Using the writer ensures that any XML documents created adhere the XML escaping rules. In order to make KXML classes available to the application, a copy of the contents of the package has to be installed to the appropriate folder in the development system. Figure 5.2 presents the main principles used by the MLS client.

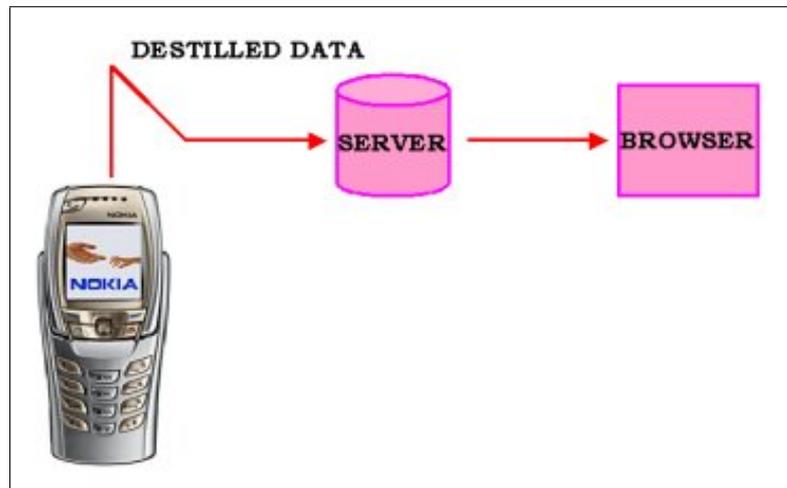


Figure 5.2: Parsing XML data.

As presented in figure 5.2, data stored in the XML document on device is sent to the dispatcher as distilled data. The server is connected to a database and through the browser interface it is possible to get access to these.

Using a DOM-based parser requires writing code to move through the tree-like data structure which the parser will create from the source document. "With DOM, the XML input processing is done in at least two cycles. First, the DOM parser creates a tree-like data structure, called a DOM tree, that models the XML source document, then the application walks through the DOM tree, searching for relevant information to extract and further process. This last cycle can be repeated as many times as necessary, since the DOM tree persists in memory" [8]. The process is presented in figure 5.3.

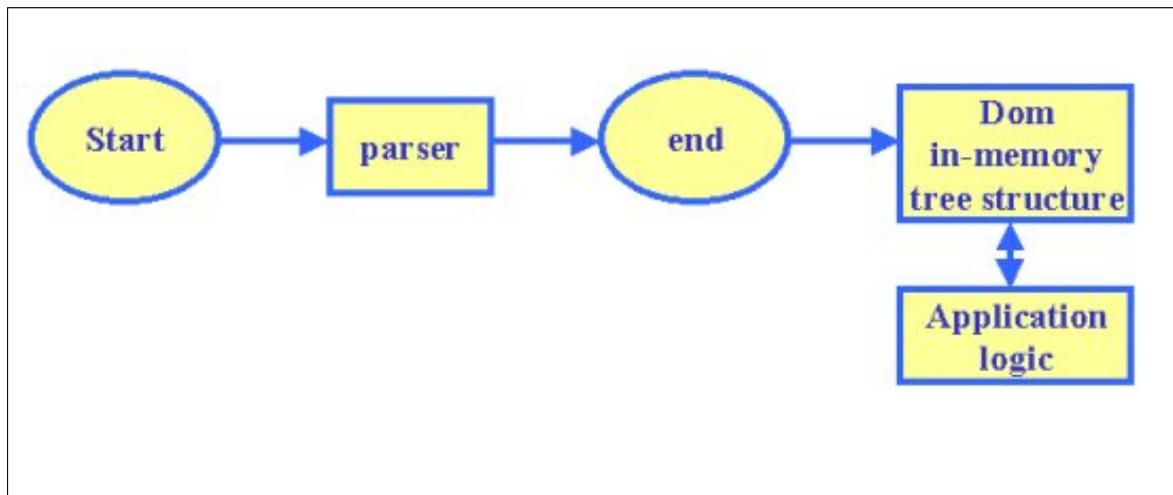


Figure 5.3: The Dom parsing process

As presented in figure 5.3, when the user has entered the data from the departure screen, this will be stored on-device in a XML document. This document will be opened and parsed when the user moves to the arrival field screen. Ie. the DOM parser creates a tree-like data structure and the next elements and data inserted will be linked to this structure. The new document created will then be stored on-device again. This action will be repeated every time information will be entered by the user interface. When the vessel arrives at port and lands the catch, all necessary data is entered and stored in the XML document. The data in this document will then be transmitted to the server and stored in the database.

5.1.3 Implementation of GPS

Reporting the activities from the fishing fields requires the inclusion of the positions where the activities took place. The GPS-receiver is utilized to obtain the necessary positions. The Global Positioning System(GPS) which is controlled by the US Department of Defense, uses a constellation of 24 satellites orbiting the earth. GPS determines the position of the device by calculating differences in time signals [16]. The GPS-receiver provides the positions for the MLS client. The MIDP suite supports Bluetooth through the JSR-82 extension [27] and enables the mobile phone to communicate with the GPS-receiver. The architecture for J2ME CLDC and Bluetooth is presented in figure 5.4.

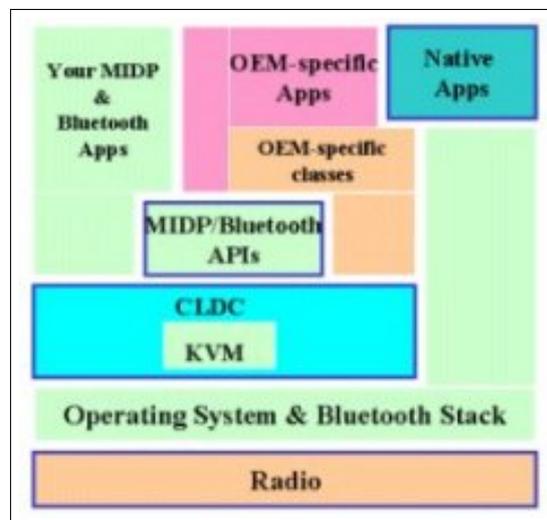


Figure 5.4: The architecture for J2ME CLDC/MIDP and Bluetooth.

As presented in figure 5.4, the hardware and the operative system is at the bottom of the stack followed by the Bluetooth stack. Then comes CLDC, profile and alternative package which in this case is Java API for Bluetooth [10]. The MIDP application is at the top of the architecture. When using the Java API for Bluetooth, the first process of getting a Bluetooth connection up and running, is taking the time to search for existing Bluetooth devices. This is done through a discovery process and is implemented through a DiscoveryListener. The connection is opened and closed. Furthermore, I/O is performed [14]. The flow in the process is presented in figure 5.5.

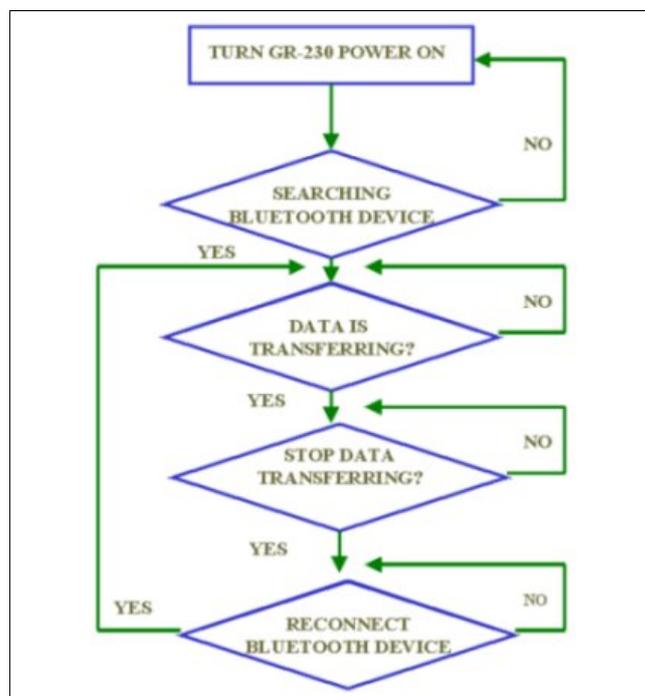


Figure 5.5: Bluetooth status.

As presented in figure 5.5, the power of the GPS-receiver is turned on. The search for bluetooth device is initiated and if device is discovered, data will be transferred. The transferring then stops and bluetooth device is reconnected again. The MLS client will receive a GPRMC sentence from the GPS-receiver when data is transferred. This sentence contains data about the position and time and has to be parsed and tokenized to extract the required information. Furthermore, to get the correct positions the data extracted have to be recalculated prior to inserting it into the XML file.

5.1.4 Transmission of data

There are several ways of implementing the transmission of data from the MLS client to the dispatcher. First of all, the information can be transferred from the client to the log book manager as the activities are performed by using the HTTP protocol. Secondly, the information can be stored in the Record Management System(RMS) which is a key subsystem of MIDP. When arriving at port or for instance upon landing, the information stored in RMS is transferred. Furthermore, a third alternative can be temporary storage of data on-device in a XML file. The HTTP protocol is a request-response application protocol in which the parameters of the request must be set before it is sent and this the

application can be run on any MIDP device [32]. HTTP has several advantages compared to other protocols. It is widely deployed, robust and simple - and it passes through firewalls.

Taking sound programming guidelines into consideration the best solution is entering the information into a XML file which is stored on-device, as activities are performed. Then by landing the XML document is transmitted to the database using the HTTP protocol. The vessel Id is necessary to link the logbook data to the correct vessel. As the vessel's id and the skipper's name is entered from the configuration screen and stored in record Store(RMS), the vessel's id should be available from this when transferring the data. However, for simplicity the vessel's id is hard coded in the Java files performing the network tasks.

A XML schema is used to describe the structure of the XML document [11]. Furthermore, the XML schema specifies which elements and attributes are valid for a certain document type and which elements and attributes are required and optional. When transmitting the information stored in the XML file an HTTP connection is opened and the XML document is converted into a String before sending it to the server by a HTTP Post request. When using HTTP Post the data is sent separately from the URL and is therefore not a visible part of the URL. Next, a Post request sends additional data to the Web server specified after the URL, the headers and a blank line to indicate the end of the headers. The data is stored in the XML file which has to be opened by a connection, read into a StringBuffer and then converted into a String.

The content-length and content-type headers are therefore essential since they inform the Web server about how many bytes of data to expect and what kind, identified by a MIME type. The content-type "application/x-www-form-urlencoded" is used in the MLS client to send name-value pairs. Furthermore, Post has no limit to the amount of data to be sent and the data can be in any format as it is sent as a separate stream. Upon setting the headers the code sends the data itself by an OutputStream. When the data is received by the server a message is displayed in an alert on the mobile phone and the connections are subsequently terminated.

5.1.5 Threading

Threads are an important part of the client application. User Interface responsiveness is of paramount importance on a mobile phone and UI lockup is one of the most annoying problems users can encounter. The best practice to avoid hick-up in the main UI thread is to put all lengthy or potentially blocking operations in separate threads. The threading model is presented in figure 5.6.

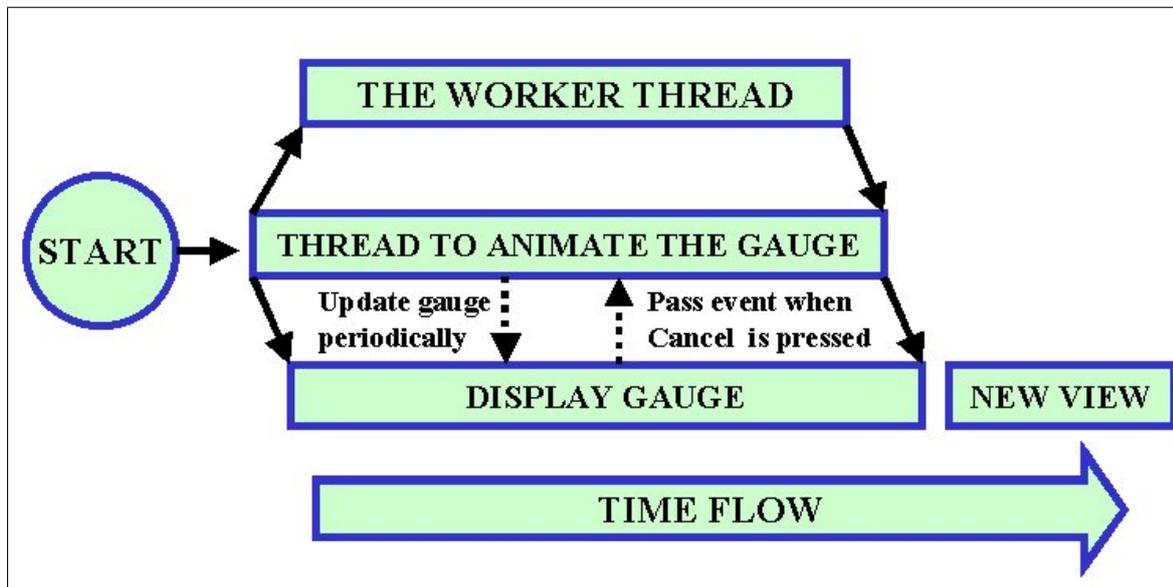


Figure 5.6: The threading model.

As presented in figure 5.6, the threading model of the client in MLS includes a worker thread, an animation thread and a UI front-end thread. All worker threads are derived from an abstract class.

Obtaining connection with a server can take several seconds from a mobile phone and it takes time for the server to respond and for the response to be received and processed. Therefore, displaying some kind of status message as the connection is made, would be preferable. In this project the gauge component is used to give the user feedback as the connection is made. The gauge object starts a foreground thread that displays an animated gauge. The gauge including a progress bar is presented in figure 5.7.

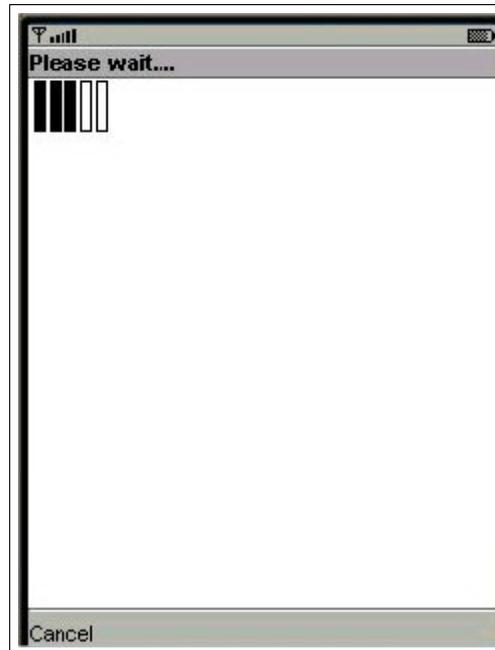


Figure 5.7: Progress Bar

As presented in figure 5.7 the gauge also features a cancel button. If the cancel button is pressed, the previous screen will be displayed. Furthermore, MLS is instructed not to update the display when finished and stopped.

5.1.6 Structure of client

When writing an application for a mobile phone the user interface(UI) has to be adapted to each device's form factor. A common technique for dealing with this problem is to separate the logic of the application from the code that controls the presentation. This is referred to as the model-viewcontroller(MVC) technique. The MVC technique factors an application into three different parts i.e. a model, a view and a controller. The model is the data held by the application and the code that deals specifically with the data [35]. The view is a representation of the model drawn on a screen and the controller interprets external input to modify the model or the view. Using this technique it is easier to adapt or rewrite the user interface code to work on different devices. The Main Menu screen is presented in figure 5.8.

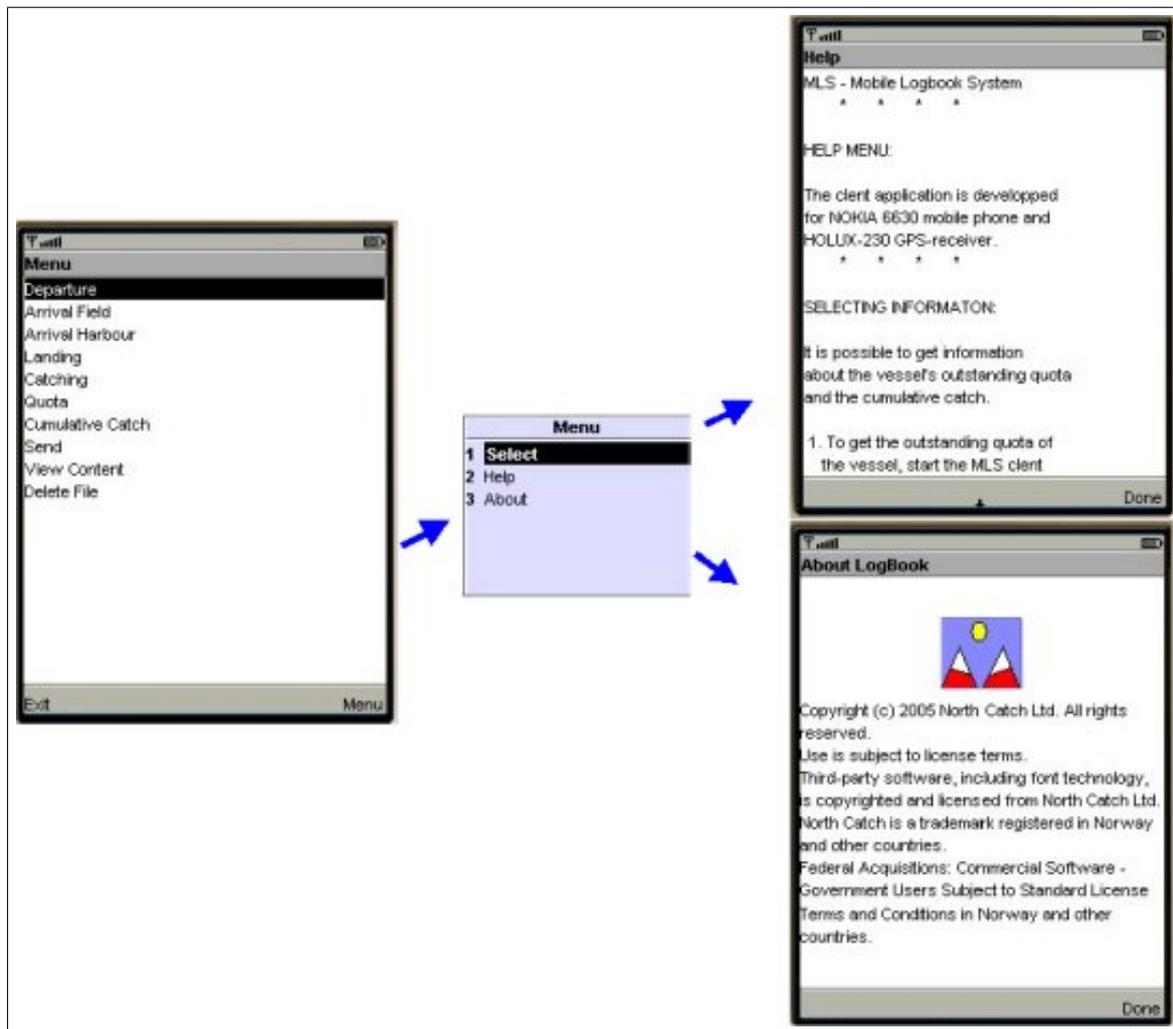


Figure 5.8: The Main menu screen

As presented in figure 5.8, the client application contains multiple screens interconnected by menu selection and soft button actions. Each screen is an independent functional unit with its own event handlers, transparent data and UI view generator. A mobile phone user often has little time for tedious operations. A user-friendly and easy to learn user interface is of great importance for the fishermen, thus being able to complete the required information with a few "clicks" is also of the essence. The structure and appearance of the user interface can be characterized as consistent with as few hierarchies as possible. Furthermore, the information is kept to a minimum and tasks can be carried out through a few steps in the menu and few clicks on the soft buttons. It is also easy to

navigate from a form to another.

The on device storage of data also reduces network traffic since transactions are enabled when the network is temporarily unavailable. Furthermore, judicious use of threads can improve user perception of the application performance and UI lockup, hence avoiding one of the most annoying problems for the users.

5.1.7 Error handling

MIDP clients must be robust and it is necessary to handle exceptions gracefully. In addition, keeping clicks and hierarchies to a minimum is important in order to make a user-friendly programme, thus tedious operations must be avoided. Therefore including too many warnings and validation of user input may therefore become too complicated. Alerts with warning are however included when entering the information about departure, arrival field, arrival harbor, catch and landing. If the required information is not entered or if the user tries to enter same twice during a tour, alerts will be displayed. These alerts contain a message which reminds the user to act correctly and are modal alerts which are displayed until the user dismisses them. All text fields, in which quantities of catch have to be entered, also include numeric flags.

When transmitting the information to the database, searching for information about the quota and the cumulative catch, or storing the information on device, a progress gauge will be displayed indicating the development of the process and giving the user feedback as the connection is made. The gauge object initiates a foreground thread which in turn displays an animated gauge. The gauge also features a cancel button. If the cancel button is pressed, the gauge displays the previous screen, instructing the thread not to update the display when finishing, and stops. Furthermore, if the connection is interrupted an alert containing a message will be displayed. These are also modal alerts which have to be dismissed by the user. Alerts with a message are also included when the information is successfully stored on device or when it has been transmitted to the database.

Accurate information is crucial when entering the catch. In fact, if there is too much discrepancy between the numbers in the logbook and the numbers when delivering the catch this may cause a problem for the skipper. The client therefore features a form where corrections can be made before the information is transmitted. This form can be selected from the list of choice displayed on the catching screen. Furthermore, as network connections on wireless devices are not tremendously reliable, it is necessary to be prepared for the worst case scenario. If it is impossible to transmit the information stored in the XML file on device, the client features the possibility to store this information in a new file. The filename will include a timestamp which makes it possible to recognize

and link the information stored in the file to a specific tour.

5.2 Implementation of web server

5.2.1 Configuration of server

The installation of MySQL, PHP and Apache web server will not be commented but I will briefly describe the configuration of my Apache web server. Concerning PHP following must be added in the configuration file:

- LoadModule php4_module c:/php/sapi/php4apache.dll
- AddModule mod_php4.c
- AddType application/x-httpd-php .php .phtml
- Action application/x-httpd-php "/php/php.exe" In addition Expat is installed to enable parsing of XML documents.

5.2.2 Creating the database

The database management system(DBMS) in the project is MySQL, This system is re-known for its suitability to applications which require velocity but low resource overhead [28]. A DBMS and a database provide data programme independence, the order of the stored information, and how the data is managed on disk are independent of the software to access it. MySQL also permits multiuser transactions.

There are five tables in this project: the table vessel, quota, phone, tour and catch. Creating the database and the tables is done by using a txt file.

5.2.3 Scripting language

In this project the PHP 4 version is used. PHP is independent of platform and can run under UNIX, LINUX, Windows and Mac OS X without any alterations. The programmes are executed quickly and demands few resources on the server machine [30].

The syntax in PHP is very similar to Java, C and Perl. Furthermore, it is very powerful and has support for all important database management systems, and known protocols like IMAP, NNTP,

HTTP. PHP is under continuous development and improvement. New libraries, such as graphic and XML, are being developed. The programmes in PHP are stored on the server machine.

When a user is opening a PHP page in the browser, this will be interpreted as a PHP script and run by server machine. The generated html code will be sent back to the browser and displayed there. If a user wishes to see the source code it seems to be pure html, but in fact it is a PHP script. Details in your program will not be exposed to everybody. You need to copy a PHP script in order to access to the script itself.

PHP is used by a lot of important web sites and the use is increasing rapidly. PHP has the same principles as Asp and Jsp. It is easy to transform knowledge of PHP to other programming languages. PHP scripts are therefore used to insert the transmitted data into the tables in the database.

5.3 Browser

First of all, when the client is sending the data from the mobile phone by a HTTP Post request, two PHP scripts are invoked receiving the information about the fishing vessel's activities and storing it in an XML file. The XML file then is opened and the data stored is parsed into an array before it is inserted into the different tables in the database by SQL statements. Max TourNo and max catchId are selected from the tables and increased with one to get the correct index when inserting the logged data. The MLS client receives a response from the Logbook Manager when the tasks are performed. DOM parsing is an alternative when parsing the XML file in the two PHP scripts. However, DOM is unstable in PHP version used in the project.

The browser interface is used to gain access through PHP scripts to the data stored in the database. Key information about the vessels such as vessels id, radio call sign, skippers name and address is registered in the database in advance and by using SQL select statements in a PHP script the actual values will be retrieved and displayed in tables when the user is pressing the search button.

Information about a vessel's quotas is also vital and is registered in advance in the database since the quotas are granted by the authorities. By inserting the vessel's registration(vesselId) number and then pressing the submit button, a SQL select statements in a PHP script will be effected and a figure with the actual vessel's quotas will be displayed. The figure is created with assistance of the GD library [30]. Using the GD library, PHP can create dynamic images to display results as for example bar graphs. It requires specifying shape, position and size accurately. The GD used supports PNG and in this project the images created are PNGs as they are supported by all major browsers. PNGs

are also the only image encoding format which MIDP devices are required to support [32]. The vessel VV192's quotas are presented in figure 5.9.

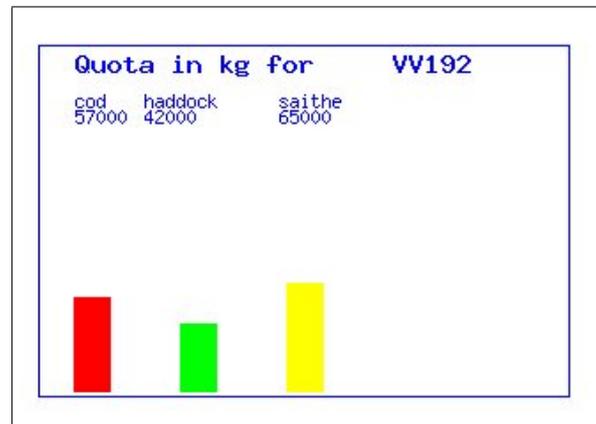


Figure 5.9: The quota for the vessel VV192.

As presented in figure 5.9, the vessel VV192 has a quota of 57.000 kg cod, 42.000 kg haddock and 65.000 kg saithe. This information can also be displayed on the mobile phone since the figure is presented as a PNG image.

A vessel's cumulative catch is also of great interest. As the fishing activities and the catches will be entered into the tables in the database, up-to-date information will be accessible through the browser interface. By inserting a vessel's registration number(vessel id) and then pressing the submit button a SQL select statements in a PHP script is invoked displaying a PNG image. The cumulative catch is displayed as bar graphs. The vessel VV190's cumulative catch is presented in figure 5.10

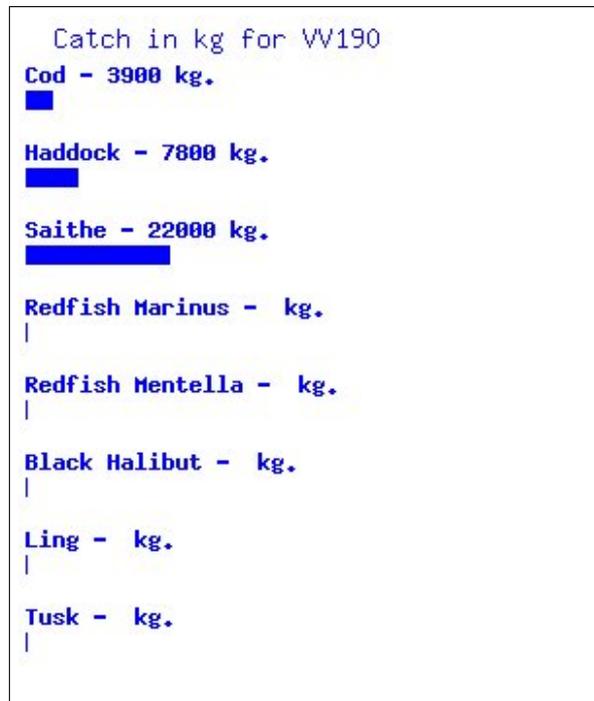


Figure 5.10: The cumulative catch for vessel VV190.

As presented in figure 5.10, the vessel VV190's cumulative catch is 3.900 kg cod, 7800 kg haddock and 22.000 kg saithe. This information can also be displayed on the mobile phone as the figure is presented as a PNG image. The same procedure can be used to obtain information about a vessels outstanding quota. This information is rather useful for the skippers when planning the next tour. By inserting a vessel's registration number(vessel id) and then pressing the submit button a SQL select statements in a PHP script is invoked displaying a PNG image. The outstanding quotas are displayed as bar graphs. The vessel VV890's outstanding quota is presented in figure 5.11.

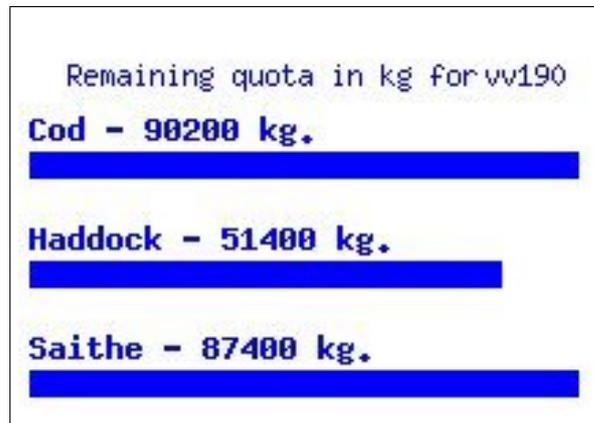


Figure 5.11: The outstanding quota for vessel VV890.

As presented in figure 5.11 the vessel VV890's outstanding quota is 33.100 kg cod, 19.200 kg haddock and 23.000 kg saithe. Furthermore, it is possible to obtain information about a specific tour by inserting the vessel's registration number(vessel id) and tour number and then pressing the submit button. A SQL select statements in a PHP script is invoked displaying a PNG image with the catch linked to that specific tour number of the actual vessel. The vessel VV190's tour number 2 is presented in figure 5.12.

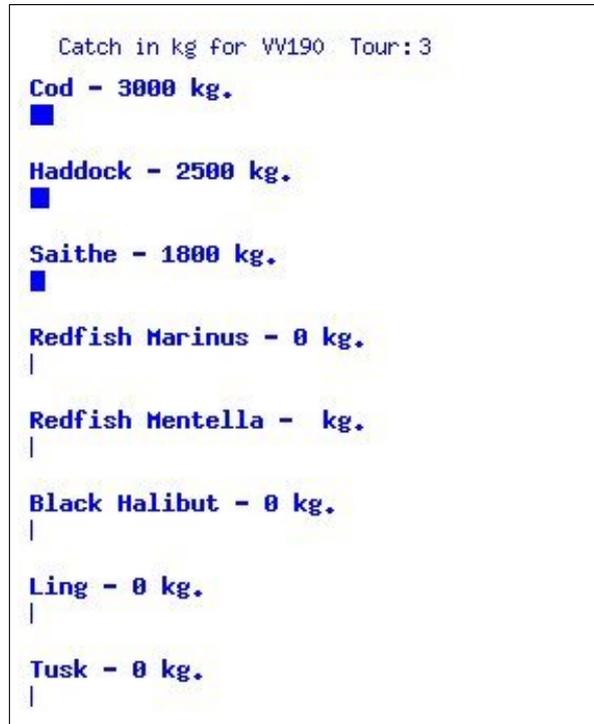


Figure 5.12: Information about a specific tour for vessel VV190.

As presented in figure 5.12 the image displayed shows the catch per species as bar graphs and as text for a specific tour for vessel VV190. As can be seen from the different figures, storing the information in a database enables the option to retrieve and display this in a proper way. Using the GD library in combination with PHP also makes it possible to display this in PNG format as bar graphs. The PNG format is also implemented on the NOKIA 6630 mobile phone and if necessary all the information retrieved from the database can be implemented to be displayed on the MLS client as well.

5.4 Conclusion

When implementing the Mobile Logbook System - MLS it was of great importance to take into consideration the amount of required information and the fishermen's working conditions. Hence the MLS clients requiring a user-friendly user interface which is easy to learn and entering the required information about the fishing activities simply by pressing the soft buttons. Furthermore, the client is robust as the logic of the application is separated from the code that controls the presentation. On device storage of data also reduces network traffic and transactions are enabled when network is temporarily unavailable. Even Telenor recently expanded the GSM-net coverage along the Norwegian Coast, the unavailability must be handled carefully.

Responsiveness of user interface is also a crucial factor for the MLS client. All potential blocking operations are therefore in separate threads, and the gauge component is implemented to give feedback to the user simultaneously with making a connection. Furthermore, the MLS client is also robust when it comes to handling errors. The user get feedback when information is stored on device, transmitted successfully and when a new file is created. If these task are not completed successfully, alerts with error messages will be displayed. Alerts will also be displayed to check file content or if certain information is not completed or if the information is duplicated. For instance, it is not possible to store information twice into the same file from departure screen, arrival field screen, harbour screen or landing screen. A robust MLS client is crucial to get acceptance from potential users.

When the information is sent from the MLS client, a PHP script is invoked receiving the data and storing it in a XML file. This is then opened and the content is parsed into an array prior to inserting it into the tables in the database. PHP is used as scripting language as many important web sites deploys this today and the use is increasing heavily. Furthermore, SQL statements in PHP scripts will give the user easy access to all information stored about the vessels and their activities as this will be displayed in an organized fashion which is easy to understand. Information such as quota, outstanding quota, cumulative catch and a specific tour can be retrieved and be displayed as bar graphs in PNG format. PHP can create dynamic figures in PNG format in combination with the GD library. This can also be done for the MLS client since the NOKIA 6630 has implemented the PNG format.

The Mobile Logbook System - MLS allows the skipper/user to enter, store on-device and transmit to server key information about their vessel's activities. Introducing the MLS will therefore

facilitate the skipper's daily routines since the log data can be submitted directly from the vessels when the activities are performed or upon landing of the catch. Data can be retrieved from the database through the browser interface and all information can be displayed in an organized fashion. By using MLS the information accessible will be up-to-date and more reliable than the information collected from the currently logbooks. This can be of great significance for future management of fish stocks.

Chapter 6

Usability testing

Usability testing is a process where participants whom are representative of the target population evaluate the product's ability to meet specific usability criteria [29]. When developing a software product it is important to ensure that it is easy to learn and use and it provides utility and functionality that are highly valued by the customers. Hence usability testing being a vital part of the project and five fishermen were contacted to test the software. First, the test group was introduced to the project. Next, it checked that the programme functioned by performing the tasks, whereupon each participant was interviewed.

Observation is a good method when testing a prototype, since it provides more specific feedback by comparison to just conducting an interview. It also gives high scores in the usability metrics [29]. Producing relevant questions which provide useful answers is rather time-consuming. The best solution is to combine both observations and interviews which is done in the project.

6.1 Observations and evaluations

6.1.1 User specifications

The purpose of the observations and testing of prototype is to disclose problems in the design of the user interface and programming bugs which may occur. On the basis of these tests and observations, further improvements can be done. Choosing participants for the tests whose background and abilities are representative, is therefore a crucial element. In fact, the test results will only be relevant if the people performing them are typical end users. There are five male Norwegian end users involved in the testing of prototype and the interviews. They have different backgrounds from

the industry with regards to type of vessel, type of gear, experience, education etc. Furthermore, they are also from different groups of age. A brief information on the participants' background is presented in table 6.1.

Table 6.1: Information about the users participating in the tests

Age	Profession	Fishing experience	Experience manual logbook
30	fisherman	Danish seine net	some experience
58	fisherman	trawl, Danish seine	some experience
25	fisherman	trawl	some experience
59	teacher fishery college	trawl	experience
21	fisherman	trawl	some experience

As presented in table 6.1, selecting participants for the tests involves identifying and describing relevant knowledge of the 5 individuals. The users of the system can be defined as fishermen required to keep and fill in a log book according to the Norwegian fisheries regulations. Fishermen is not a homogeneous group concerning education and work experience, hence it being important to select persons with quite different backgrounds when performing the tests.

6.1.2 Scenario

When setting up the scenario for testing the software it is important that the users will be able to conduct the tasks completely realistic. The task scenario is also sequenced in the order in which they are most likely to be performed. Even though all the users had experience from entering information manually in a catch diary, the scenario is rather complex as a variety of tasks have to be performed. The scenario was therefore explained to them in-depth. Furthermore, the first time the users performed the tasks I sat beside them one by one to be sure they understood what to do.

The MLS client is installed on a Nokia 6630 mobile phone. When performing the real tests the users got the mobile phone one by one during some days. Then fishing, they followed the task list to enter and send the required information to the database. They also checked the outstanding quota. In this way the scenario should represent reality and reliable test results.

6.2 Usability tasks and interviews

6.2.1 Usability Tasks

What is really being tested when performing usability tasks, is the relationship of the product to the user which in this project are fishermen or skippers. The tasks developed for the tests need to reflect

this relationship and as much as possible, enable the tests to expose the points which the product becomes a hindrance rather than a help for completion of the tasks. Taking this into consideration a task list is developed. The task list is comprised of the tasks the participants will perform during the tests and the list is presented in table 6.2.

Table 6.2: Tasks to be performed

Task no	Task
1	Signing in
2	Fetching outstanding quota
3	Entering information about the departure
4	Entering information about the fishing field
5	Entering information about deployment of gear
6	Entering information about the catch
7	Viewing the file content and effect corrections of catching figures
8	Entering information about the arriving harbour
8	Trying to enter information about the arriving harbour once moored
10	Entering information about the landing harbour
11	Sending the file containing the information
12	Cutting off when sending the file containing the information
13	Creating a new file in which information can be stored
14	Deleting the transmitted file

As can be seen in table 6.2, the task list consists of tasks which will be performed during ordinary use of the software. How to measure success is important to evaluate the results, hence establishing success criteria and usability metrics.

First, the time required to complete the task will be measured, whereupon number and type of error per task will be noted. Furthermore, the number of users making a particular error is a criteria. The number of users completing the tasks successfully is also of great importance. The electronic logbook must be easier and less time-consuming to use. The time required to complete the different tasks when filling in information must be less than time required to completing it manually. Use of bluetooth technology and entering basic information when software is installed will save considerable work and time.

6.2.2 Observation technique

Observations of tests provide immediate feedback concerning the functionality and impression of the software which in turn can help to develop the product further. When conducting the observation, best practice is to watch the test through electronic observation from another room through one-way mirror. However, as the tests will be performed in a pilot house on board a vessel at sea, this is

not feasible. Anyhow, in order to get useful information from the observations it is necessary to be as in-conspicuous as possible and not make any comments or ask questions to the user while performing the tasks [29]. The only exception would be if there are technical problems and the tests need to be interrupted or revised. The closer that the scenario represents reality, the more reliable are the observations.

The observations are carried out according to the sequenced task scenario. First impression is always important. After entering the application, what is the focus of the user? All comments and impressions were noted. Navigation is crucial and how is navigation from a form to another. Is it easy to find information about the quotas? What about finding the required form and filling in information which has to be sent? Is there too much information to fill in? All comments and impressions were noted again. The layout is also of significance. The users' impression of the layout is important for the final opinion of MLS. All the comments from the users about the layout were noted along with some other comments the users had about the programme.

Total impression is also of great importance. Did the user like the product or is MLS easier to employ than logbook in use today which is filled in manually?

Observations of the tests helps the development of the product since it provides direct feedback from future customers and often brings a positive change in perspective towards user-centered design which can be very useful for further development.

6.2.3 Analyzes of observations

Upon giving a brief introduction of the programme the participants got the mobile phone and performed the various tasks in table 6.2. During the first tests, the users were observed one by one. The observations were noted and as presented in table D.1 in Appendix D all five participants found the MLS icon on the mobile phone and signed in. However, one of them had problems with the size of the soft buttons and had to try several times before he succeeded.

All five users were of the opinion that it is very important that the menu is well organized and that it is easy to navigate from one form to another. Furthermore, the menu should not be overloaded with information but contain the most important i.e. the links to the other forms. When performing the tasks all five participants thought it was easy to enter information about the departure and arrival at the fishing field. As presented in table D.1 in Appendix D, when entering information about the deployment of gear and the information about the catch, two participants asked about the functionality of the choice list. After getting the explanation, they managed to enter the information correctly. However, one of the participants thought the catching form should include a label informing the

user to enter the catch in kg round weight. The catch in round weight should also be recalculated to the weight of the fish headed and gutted or head on gutted. This information is advantageous for the fishermen as the fish is mainly sold headed and gutted or head on gutted. It is then possible to compare the figures entered in the logbook to the real sales weight and the figures reported in the logbook will be more reliable.

As few hierarchies as possible and few steps/"click's" is also appreciated by the five users. Furthermore, a consistent layout is important. The users could get confused if the layout changes to a great extent between the various forms. Colours and icons do not seem to be of any importance to the users. Having a simple layout is more important than being overloaded with colours and icons. The tests showed that the layout, the navigation from one form to another and the organization of the logbook was appreciated by all five participants. Furthermore, the five participants also appreciated that it is possible to enter the required information with as few steps/"click's" as possible. However, it is possible to improve the MLS clients's structure and reduce the number of steps/click's further. Automatic storage of the text and figures, creation of new file and transmission of the logged data is possible and will improve the functionality.

Use of peripheral devices such as GPS to obtain longitude and latitude automatically is of great importance. Information such as the vessel's name, radio call sign, external and internal identification number, the skipper's name and address should be filled in the database in the logbook manager in advance. This information has to be completed in each sheet when using today's manually logbook. It is of great importance for the users that the amount of information to be entered must be kept at a minimum. Vessels delivering fresh fish often keep their catch iced in boxes. A label on each box and use of bar code reader can provide the catching figures for the MLS client automatically and improve the programme considerably.

Statistics are important. Bar graphs showing the vessel's outstanding quota are important in order to improve management of the vessel. Furthermore, bar graphs showing the cumulative catch is also of great interest. As presented in table D.1 in Appendix D, the five participants managed to retrieve information about their vessel's outstanding quota. However, two of them had to ask which access point to use. The tasks presented in table D.2 in Appendix D, such as checking file content, entering information about arriving harbour, landing and corrections of catching figures, were also performed by all the participants without any difficulties. The five participants also managed to create a new file in which to store the information on device and to delete the transmitted file without assistance. Sending the information about the catch to the Logbook Manager did however take more time than anticipated. The network operations should therefore be improved and the MLS client

should run faster when retrieving information about the quota or sending the information about the activities.

As previously mentioned, two users had difficulties with the soft buttons. Ordinary soft buttons are too small for some of the fishermen used to doing labour at sea during tough conditions. A larger keypad with bigger soft buttons would therefore be advantageous. Input devices including pointing tool such as pen input could also be a solution to avoid problems with the size of the soft buttons when entering text or catching figures. The Nokia 6630 has a basic keypad to be found on most mobile phones as presented in figure 6.1.



Figure 6.1: Nokia 6630 mobile phone.

As presented in figure 6.1, the Nokia 6630 has a typical mobile phone keypad which provides relatively easy numeric input. However, they require slightly more work when typing alphabetic characters, and there are almost no special characters available. When reporting the activities, the text input is limited to the departing harbour, fishing field, arriving harbour and landing harbour. The amount of textual input is therefore not a major problem for the user interface of the MLS client.

The keypad also contains a navi roller used for navigating on menu. The navi roller also allows scrolling up and down as well as selecting by clicking the roller. When entering information from the catching screen there is a choice list where the user has to choose deployment, haul or corrections according to the activity is performed. This caused difficulties for two users as they thought the navi roller on the device to effect the movements in the choice list and press the selected item, was a bit small. To avoid the problems with the choice list, the catching screen could be divided into two screens, i.e. one screen for deployment and one screen for haul. However, too many screens may confuse the user and use of pointing tool such as a pen can be a better alternative when selecting from the choice list.

6.2.4 Interviews

After the testing of the software was conducted, interviews can give additional feedback which is very useful for further development of the project. An interview will give the participant of the tests the opportunity to explain things which are not visible and the thought process and the rationale behind each action will be exposed [25]. When interviewing the participants, it is important that they do not feel defensive about their actions and opinions [29]. Furthermore, to get the correct feedback, reactions on the participants answers one way or another must be avoided. The questions are formulated on the basis of obtaining the user's general impression, what is most important to improve and if electronic logbook for mobile phones - MLS - can be an alternative to logbook in use today. The questions were posed to the users one by one and notes were taken. The list of questions is presented in table 6.3.

Table 6.3: Questions for open interview

Question no	Questions
1	What was your first impression?
2	What did you like about this programme/user interface?
3	What did you not like about the programme/user interface?
4	Was there something you did not understand?
5	How is the structure?
6	How was the navigation part?
7	How was it to fill in necessary information?
8	How is the layout?
9	Was it difficult to learn?
10	Would you use electronic logbook instead of the traditional catch diary?

As presented in table 6.3, the questions begin with general high-level issue and then move on to more specific issues. Furthermore, the focus is on understanding the problems and difficulties and not on problem solving. Ideally, one should understand why every error, difficulty and omission occurred for any user performing the test. Interviews give feedback on why the different problems occurred and can therefore bring together points which were unclear or confusing during the test.

6.2.5 Analyzes of interviews

The interviews started by allowing the participants to describe their general first impression of the MLS logbook and they all thought that developing an electronic logbook was a good idea since it could simplify the paperwork for the skippers. Furthermore, as presented in table D.3 in Appendix D, all the participants thought the programme was easy to learn and employ as the logic is similar

to that of the logbook in use today.

Then more specific questions were posed and the participants explained what they liked and did not like about the programme. As presented in table D.3 in Appendix D, all of them said they liked the programme and thought everything functioned well, in general. However, one of them asked for the possibility to enter more information such as the ground conditions on the fishing fields. The ground conditions should then be displayed on maps on the MLS client. Another participant, with experience from ocean trawlers, asked for the possibility to enter information when fishing on different fishing fields and when landing the catch in different harbours. Two participants also asked for a Norwegian version of the programme as they thought that some of the older skippers may not have sufficient knowledge of the English language.

Furthermore, all the participants thought the structure was simple and logical and that it was easy to navigate from one form to another while entering the required information. However, as presented in table D.3 in Appendix D, three participants thought that the keypad and the soft buttons were too small. Ordinary soft buttons are not suitable for some of the fishermen used to doing labour at sea under tough conditions. In turn, use of navi roller when selecting from the choice list on the catching screen also caused problems for one of them. The layout was acceptable but use of colours and icons could improve the general impression.

As presented in table D.3 in Appendix D, the participants also thought it was easy to retrieve information about the vessel's outstanding quota and cumulative catch. Sending the file with the logged data to the logbook manager did however require more time than one of them had expected and the participant became impatient even though a progress bar was displayed meanwhile. The possibility to view the content stored in the file on device was very much appreciated by all the participants. The quantities are estimated when entering information about the catch. If there is too much deviation from actual weight this may cause a serious problem for the skipper. Checking the content and the possibility to make corrections from the catching screen is therefore of great importance for the functionality of the MLS client. Three participants thought the application provided useful feedback when tasks were performed and when errors occurred. Two participants also asked for user interface in Norwegian as they thought insufficient understanding of the English language may be a problem for some of the skippers. However, as presented in table D.3 in Appendix D, all five fishermen taking part on the testing programme would without any doubt employ electronic logbook instead of the traditional ones in use today.

6.3 Conclusions

The purpose of the project is to develop an electronic logbook for mobile phones. Testable problems are made to test the functionality, structure, error handling and performance of the application. Five fishermen were chosen to perform the tasks presented in table 6.2. The participants were interviewed upon completing the tasks. The interviews were necessary in order to reflect on and obtain extended information on the experiences made. The questions were formulated to get feedback on the most important functions and some of them are to some extent overlapping. Information is therefore in some cases repeated. Posing questions is non the less important in order to obtain extensive information from the users.

Feedback from the interviews and the performance of the tasks showed that the menu structure seemed to be successful. Furthermore, all the users said it was easy to navigate from one form to another. It also seemed that they enjoyed using the programme and that it was easy to fill in information. The feedback from the interviews and the performance of the tasks also showed that the electronic logbook is organized in such a way that it is easy to learn for fishermen used to manually filling in the logbook. Although some of the users thought that the layout is quite simple, colours, fonts or use of icons seems to be of less significance than filling in information as efficiently as possible.

The MLS client has a well structured menu and few hierarchies which makes it easy to navigate from one form to another. Saving just one click/step is of significance. However, two users had problems with the soft buttons and the navi roller when selecting from the list of choices on the catching screen. This problem is of great significance and must be taken into consideration in connection with further development of the project. A larger keypad with bigger soft buttons would therefore be advantageous. Furthermore, input devices including a pointing tool, such as pen input, could be a solution. Use of the navi roller can then be avoided. Voice input is also a possibility for the client and will improve the functionality further. The participants also appreciated the use of peripheral devices such as GPS to obtain longitude/latatitute automatically. A bar code reader can also be used as peripheral device and can provide the catching figures for the MLS client automatically. Automatic storage of the text and figures, creation of new file and transmission of the logged data is also possible and will improve the MLS client's functionality considerably.

Even if the five fishermen were quite satisfied with the structure, this can also be developed further. Instead of selecting the different forms from a menu, the departure screen should be the first screen to be displayed when entering the MLS client. After the departure screen is completed and

the information is stored automatically, the next screen to be displayed should be the arrival field screen. Upon completing the arrival field screen, the catching screen should be displayed etc. Organizing the structure of the programme in such a way and using automatic storage of the information will save the number of steps/click's necessary and the functionality would be improved.

The feedback from the interviews and the performance of the tasks showed that it was easy to retrieve information about the vessel's outstanding quota even if two of the participants had to ask which access point to use. Once they got the information they managed the task on their own. This problem is therefore not of significance. However, sending the file with the logged data to the manager required more time than they expected and one of the participants became impatient even though a progress bar was displayed meanwhile. Faster transmission of the data is of significance as impatient users must be taken into consideration. The network operations should therefore be improved.

The possibility to view the content stored in the file on device was very much appreciated by the participants. One of the participants also asked for the possibility to enter more information such as the ground conditions on the fishing fields. This is also significant as logging more information could be of interest to other potential users of the programme. Furthermore, entering textual information to describe the catch or link photos to the catch could also be beneficial. Future development of the MLS client should therefore also include the possibility to log more information.

A mobile phone can be very handy and along with a clever set up of the software, use of blue-tooth technology and well organized menus, the participants all thought the application will be useful especially for the coastal fleet where the skippers are carrying out a wide variety of tasks on board. The ocean trawlers have more comfort on board and there is more space in pilot house and a system on a desktop can be an alternative for them. Anyhow, mobile phone or desktop, all five participants would use electronic logbook rather than filling in the information manually and thought an electronic logbook will make it easier to meet the authorities' future requirements for information from the fishing vessels' activities. However, further development of the programme is necessary in order to improve structure, functionality and network operations. This will be described in the following chapter.

Chapter 7

Discussion, Future work and Conclusions

Based on the framework described in chapter 4, a prototype of a logbook system(MLS) including a logbook client for vessels fishing with Danish seine or trawl, a logbook manager and a browser has been implemented and tested. Usability testing is an important part of the project and provided useful feedback on structure, layout, functionality etc. from potential buyers of the product. Furthermore, the test group gave feedback on the amount of information to be logged and how to present this. This chapter contains a discussion based on the feedback from the interviews and the experiences from the tests performed by five fishermen followed by some advice concerning future work of the logbook client, logbook manager and the browser leading to conclusions of the project.

7.1 Discussion

In chapter 1 the object for this thesis was expressed and some important questions concerning the introduction of an electronic logbook for mobile phones were raised. In the light of the tests performed of the MLS application I have tried to answer these questions:

Is it possible to provide the authorities with more up-to-date and reliable information about fishing activities? Today there is widespread concern about the management of fish stocks in the most heavily fished areas. Efforts have been made to improve the situation for what up-to-date reliable information about fishing activities is necessary. Today most skippers have to fill in the information required about their fishing activities manually in a logbook. When delivering the catch

the skipper has to sign a receipt containing the weight, size and price per species. This receipt will then be handed over to The Norwegian Raw Fish Organization.

When testing the Mobile Logbook System the skipper entered and stored on device the required information about the activities. Upon landing the catch the receipt number of the delivered quantity was entered on the landing screen and then the information from the last tour was transmitted to the database. The data stored in the database could then be accessed by the browser interface.

The best solution concerning up-to-date information would of course be transmission of the logged data to the manager just after performing each task. Even though approx. 99 percent of the major fishing grounds are covered by the GSM net along the Norwegian coast, there are still zones which are not covered and problems with the connection may occur. However, all the actual harbours in the area are well covered and I therefore chose transmission upon landing, as the data would then be more reliable.

By using MLS it is possible to provide the authorities with more up-to-date and reliable information. However, if the coverage of the fishing grounds would be increased to 100 percent, a logbook system transmitting the data just after the tasks were performed, would be the best solution and provide the authorities with the best data for management of the fish stocks.

Is it possible to use a mobile phone as an electronic logbook in order to collect and transmit such information? When performing the tasks the skippers entered and stored the required information on device. Upon landing of the catch, the logged information was transmitted to the logbook manager. Even though some of the participants had problems with the soft buttons and the navi roller they all managed to perform the tasks according to table 6.2 and the information sent was successfully received by the logbook manager. All the required information about the activities was entered and stored on device. However, the transmission required more time than expected and some performance tuning should be included in future work on the MLS client. It is therefore possible to use a mobile phone as an electronic logbook, even if some modification of the functionality would be advantageous.

Is it possible to use peripheral devices such as a GPS to automatically obtain the required location data? Reporting the activities from the fishing fields requires the inclusion of the positions where the activities took place. A GPS-receiver was utilized to obtain the necessary positions when the MLS client was tested by the fishermen. When performing the tasks according to table 6.2, the positions were received successfully after some trials. The first trials were done without installation

of the antenna and no positions were obtained as the participants were inside the pilothouse when they tested the MLS client. When moving out on the deck, the signals were obtained. However, after using the antenna for the GPS receiver they could be in the pilothouse receiving the positions without any problems. The skippers are primarily in the pilothouse when a vessel is at sea. A peripheral device such as a GPS must work inside a pilothouse and can be used to obtain the required location data automatically, only if the antenna is used.

What are the fishermen's opinion about using an electronic logbook for mobile phones? The mobile phone is chosen as it is very handy and used by most fishermen. All five participants thought the MLS application will make it easier to meet the authorities' future requirements for information from the fishing vessels' activities. Even though some of the participants had problems with the soft buttons and the navi roller, they thought the MLS application functioned well and would facilitate their daily routines. However, a larger keypad with bigger soft buttons and navi roller for people used to labour at sea under tough weather conditions, would be advantageous. Furthermore, the possibility to store information such as textual information about the catch or photos of the catch and key information about the ground conditions on the fishing fields, should be included in such a logbook. However, as presented in table D.3 in Appendix D, all five fishermen taking part on the testing programme would without any doubt employ the electronic logbook for mobile phones instead of the traditional ones in use today.

Will such an electronic logbook facilitate the daily routines of the skippers? When using an ordinary logbook, key information about the vessel such as radio call sign, skippers name and address, vessel id etc. has to be completed in each sheet. Furthermore, every time an activity is performed the accurate position has to be checked and noted on the the logbook's sheet. This is a rather tedious operation. By using an electronic logbook it is possible to store the key information in the database in the logbook manager. When testing the MLS client it was necessary to configure the programme after installation on the mobile phone i.e. the skipper's name and vessel id was entered in the configuration screen and stored on device. This was done to link the information transmitted from the client to the database to the actual vessel. In addition, when the activities were performed the positions were obtained automatically. An electronic logbook will therefore facilitate the daily routines for the skippers.

7.2 Future work

7.2.1 Mobile client

Security issues

The information about a vessel's fishing activities is sensitive and should not be available for everyone. Furthermore, mobile phones are easy stolen or lost. On device information security is therefore important and it is necessary to prevent unauthorized persons from accessing the data stored on the mobile phones. These data can be protected by strong password-based encryption. Furthermore, the data should also be protected when transmitted to the logbook manager. Digital signature can guarantee message integrity and authenticity in an open network environment. The signer must have a private key which is used to create the signature. A corresponding public key can be used by anyone to verify that the signature really originated from the signer. A digital signature is created as presented in figure 7.1.



Figure 7.1: Generating a digital signature.

As presented in figure 7.1, generating a signature first of all requires calculating the hash of the message. The hash is then encrypted by the private key in order to generate the signature. The verification of the signature at the receiving end is presented in figure 7.2.

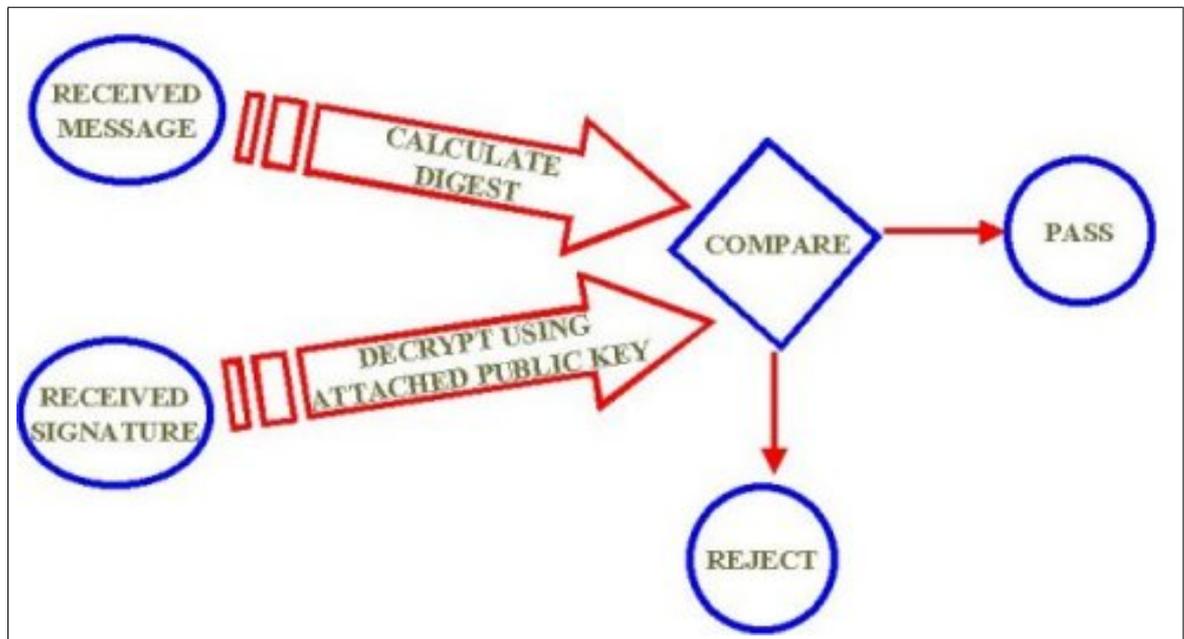


Figure 7.2: Verification of a digital signature.

As presented in figure 7.2, the receiver first decrypts the signature into a hash by using the public key. The hash from the message is subsequently calculated. If the two hashes match, the message originates from the signer. If someone attempted to change the message during the transmission, the public key algorithms guarantees that this can not happen without knowing the actual private key. Future mobile applications will demand more flexible security schemes, as on device security is one of the most important challenges today.

Performance tuning

Users of mobile phones have relatively short attention spans and the MLS client must run fast and efficiently. The testing of the MLS client provided some useful information about the structure and the network operations. Even though the participants of the tests appreciated the structure, layout and logic of the MLS client, future work should include improvements of the functionality.

Automatic storage and feedback when the required information is entered and automatic sending with confirmation should be considered in future development as this will simplify the user interface and reduce the number of selections from the main menu. The departure screen should be the first screen to be displayed when entering the MLS client. When the required information about the

departure is obtained and entered this should be stored on device automatically. Next time the user enters the MLS client, the arrival screen should be displayed as the required information upon arrival at the fishing field now should be entered. This information should then be stored automatically on device. The next screen is the catching screen etc. Such a structure will reduce the numbers of steps/clicks's considerably, and the information will be entered in the correct order. The problems with the size of soft buttons and navi roller will also be reduced to a minimum.

Obtaining information about the quota, the cumulative catch and sending the information about the catch took longer than anticipated. One way of improving the network operations is to avoid reading or writing single bytes. Reading and writing the network data in chunks or whole arrays full of data should make the client run faster. Future development of the MLS client should therefore include improvement of the network operations. Releasing the resources as soon as the various tasks are completed can also improve the performance of the MLS client.

MIDP devices are also characterized by small displays and keypads. Furthermore, input devices do not always include pointing tools such as a mouse or pen input. The ordinary soft buttons are also often too small for fishermen used to doing labour at sea. A larger keypad and soft buttons would be advantageous for the functionality of the MLS client. However, use of peripheral devices such as a bar code reader to obtain the weight per species and using pen input to make the selections from the menu, press the soft buttons i.e. will reduce the problems with the size of the buttons and the navi roller and will provide a better user interface.

Voice navigation

On the MLS client, the skippers have to use both hands in order to enter text or make selections from the menu. Voice-navigated information service can be an alternative for the client, making it possible for the users to talk to the phone while performing other tasks on board. VoiceXML [2] is the leading technology enabling voice-based information navigation. VoiceXML [6] can present information, take input from the users and move to another screen based on such input. The architecture for a MLS client using both voice and common GUI components is presented in figure 7.3.

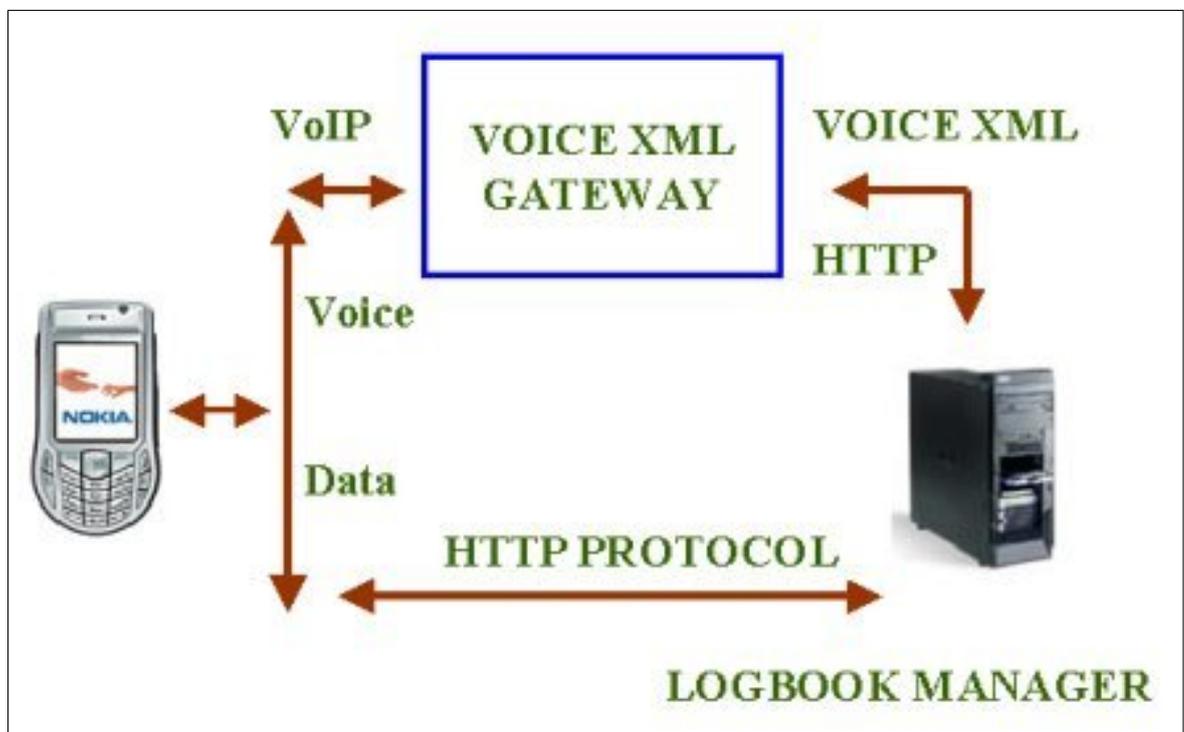


Figure 7.3: The architecture of MLS client using voice.

As presented in figure 7.3, it is possible to integrate voice into TCP/IP network-based applications through Voice over IP (VoIP). The VoIP specifies how to transport voice on a data network. Future development of the MLS client should include voice-navigated information service. Using voice-navigation could solve the problems with the soft buttons being too small. Furthermore, the users will be able to perform other tasks while employing the MLS client.

Enhanced logging of information

Most of the fishermen testing the MLS client thought that the information available such as the vessel's quota and the cumulative catch was of great importance. However, logging key information about the fishing grounds could also be very helpful and should be taken into consideration in future development. More information about the catch such as how much each haul contain or how much was caught by a certain vessel on any given day is important for the processing industry and the marketing companies. A description of the quality of the fish should also be included in future work. Photos linked to the catch can provide useful information about the quality, size etc. and should be a part of an improved MLS client.

Client for passive fishing gears

The user interface of the MLS client for a vessel fishing with gill net or long line will differ from that of a vessel fishing with trawl or Danish seine. As the MLS client implemented in this project was developed for small trawlers or Danish seiners with cod license, future work should also include developing a client which can be used by vessels fishing with other kind of gear. When for instance fishing with gill net or long line, the deployment of the gear can take place on several locations one day and they may be collected later same day, next day or even later, hence the structure of the MLS client having to be different. A screen which should be included in such a client displaying a map labeling where the gill net or long line are deployed is presented in figure 7.4.

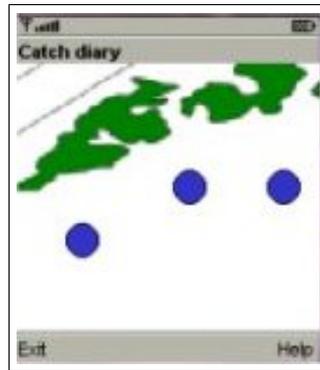


Figure 7.4: The user interface of MLS client for passive fishing gears.

As presented in figure 7.4, the spots on the map are displaying where the gear is deployed. When the gear is hauled and the catch is collected, the spots should disappear and the figures should be entered in text fields and stored on device as implemented in the MLS client for trawlers and Danish seiners. Even if there will be some differences in the structure, the main principles should be followed when implementing a MLS client for vessels using gill net or long line.

7.2.2 Manager

The logbook manager consists of a server and a database management system as described in chapter 4. The information about the vessels and their activities are stored in the tables in the database. Concerning future work, more information about the fishing grounds and the catch should be logged and the database should be expanded accordingly. Furthermore, it should be possible to create maps by making use of previously stored information regarding the vessel's position of the performed activities. The database should therefore contain tables with necessary information to create maps of the actual fishing grounds. The vessels' positions should then be labeled to the maps.

Developing a client which can be used by vessels fishing with gill net and long line will require a logbook manager with a database which can handle deployment of the gears on several locations one day and collection later same day, next day or even later. The database should therefore also be modified to handle the activities of vessels using passive fishing gear.

7.2.3 Browser

The browser interface is used to gain access through Php scripts to the data stored in the database as described in chapter 4. Information such as quota, outstanding quota, cumulative catch and a

specific tour can be retrieved and displayed as bar graphs in PNG format by using the GD library with PHP. It is possible to retrieve more information if necessary, but the key information is already accessible by the browser interface. However, displaying maps with the logged positions of the vessels tours should be taken into consideration in future work. Logging the ground conditions on the fishing fields should also be included. Based on this information, maps should be displayed and areas with for instance rocky conditions or old shipwrecks etc. should be labeled in order to avoid damage or loss of fishing gears. Furthermore, using the positions stored in the database makes it possible to link these to the quantities caught at a certain longitude and latitude. Creating maps indicating the areas in which the catching has been successful is useful when planning the fishing tours and should also be included in future development of the browser interface.

SVG(Scalable Vector Graphics) is an application of XML which makes it possible to present graphic information in a compact portable form. Vector graphic work by describing the grid points at which lines or curves are to be drawn. Vector objects can change their shape and colour and can also be used in simulating events. Mapmakers and meteorologists are using SVG to create highly detailed graphic images in a truly portable format. PHP scripts can generate the SVG map which makes it possible present graphic information in a compact portable form. Another aspect of SVG images is one they share with Flash animations. Since they are vector-based, you can zoom in and zoom out with no loss of quality. Text which is part of a SVG image is also available for copying onto the clipboard. The combination of MySQL as database management system and PHP as scripting language to generate SVG maps should be used to create maps from the browser interface.

Mobile SVG profiles are also available and should be considered as these will make the different maps available on the MLS client as well. A single profile is not sufficient to deal with the variety of mobile devices, because each mobile device has different characteristics concerning CPU speed, memory size, and color support. To address the range of different device families, two profiles are defined i.e. SVG Tiny (SVGT) which is suitable for highly restricted mobile devices and SVG Basic (SVGB) which is targeted for higher level mobile devices. Using mobile SVG profiles to create maps will make all maps available for the browser interface as well for the MLS client and should be included in future development of the MLS application.

7.3 Conclusions

The prototype of the MLS application presented in the project was developed for vessels fishing with Danish seine or small trawl. The software was tested thoroughly by five fishermen and advice has been given for further development. The participants of the tests gave positive feedback on the structure, layout, navigation etc. of the MLS client. However, some of them thought that more information such as textual information about the catch or photos of the catch and key information about the ground conditions on the fishing fields should be included. Linking a photo of the catch to a specific haul may tell something about the size, colour and quality of the fish. Producers of fresh fillets and fresh special products depend upon up-to-date and reliable information in order to supply supermarkets regularly and getting the best prices. It may therefore be advantageous to include some other information in the MLS logbook as well.

Furthermore, the structure can be improved. Instead of selecting the different forms from a menu, the departure screen should be the first screen to appear when entering the MLS client. After the departure screen is completed and the information is stored automatically, the next screen to be displayed should be the arrival field screen. Upon completion of the arrival field screen, the catching screen should be displayed etc. When the information about the tour is completed, the data should be transmitted automatically to the logbook manager. Organizing the structure of the programme in such a way and using automatic storage and transmission of the information will reduce the number of steps/"clicks" considerably and should be included in future development of the MLS client. Furthermore, use of more input devices and peripheral devices, for example pen input and bar code reader, should also be included. Use of the soft buttons and navi roller can then be reduced to a minimum. Voice input is also a possibility for the client to improve the functionality and should also be taken into consideration.

The user interface of the MLS client for a vessel fishing with gill net or long line will differ from that of a vessel fishing with trawl or Danish seine. When fishing with gill net or long line, often referred to as passive fishing gears, the deployment of the gears can take place on several locations one day and they may be collected later on the same day, next day or even later on. Using Danish seine or trawl, referred to as active gears, the gear is deployed and hauled after some hours or even earlier if the catch is sufficient. Future work should therefore also include MLS client which can be used by vessels fishing with gill net or long line.

The information about the vessels and their activities are stored in the tables in the database in the Logbook manager. Concerning future work, more information about the fishing grounds and

the catch should be logged. The database should also include tables with necessary information in order to create maps of where the activities took place and the fishing grounds.

The browser interface is used to gain access through PHP scripts to the data stored in the database. Information such as quota, outstanding quota, cumulative catch and a specific tour can be retrieved and displayed as bar graphs in PNG format by using the GD library with PHP. SVG (Scalable Vector Graphics) is an application of XML which makes it possible to present graphic information in a compact portable form. Future work should consider use of SVG rather than the GD library to display information as bar graphs or maps. Furthermore, maps describing the ground conditions on the fishing fields should be included in the browser interface. Using the positions stored in the database also makes it possible to link these to the quantities caught at a certain longitude and latitude. Creating maps displaying the areas where the catching has been successful should also be included in future development of the browser interface.

Developing an MLS application which can be used by most of the fishing vessels should be the main focus of future work. Furthermore, it is also important to improve the structure and the performance of the programme by including automatic storage and transmission of the logged data. Use of more peripheral devices and even voice input should also be part of future development of the application. Logging of more key information and using SVG to display maps, the MLS application should provide utility and functionality highly valued by the customers and thus become a competent alternative to logbooks in use today.

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Appendix A

Tables in the database

Table A.1: Tables in the database

Table	Column	Data type	Comments
Vessel	vesselNo	integer	primary key
	vesselId	varchar	
	vesselName	varchar	
	radioCallSign	varchar	
	firstName	varchar	
	lastName	varchar	
	mailAdresse	varchar	
	postNo	integer	foreign key
	city	varchar	
land	varchar		
Phone	number	integer	primary key
	type	varchar	
Quota	quotaId	integer	primary key
	quotaCod	varchar	
	quotaHaddock	varchar	
	quotaSaithe	varchar	

Table A.2: Tables in the database

Table	Column	Data type	Comments
Tour	tourId	integer	primary key
	tourNo	int	
	nameDepHarbor	varchar	
	dateTimeDep	Date	
	positionDep	varchar	
	nameArrField	varchar	
	dateTimeField	Date	
	positionField	varchar	
	nameArrHarbor	varchar	
	dateTimeHarbor	Date	
	positionHarbor	varchar	
	nameLandHarbor	varchar	
	dateTimeHarbor	Date	
	positionLand	varchar	
	receiptNo	integer	

Table A.3: Tables in the database

Table	Column	Data type	Comments
Catch	catchId	integer	primary key
	dateTimeDepl	Date	
	positionDepl	varchar	
	dateTimeHaul	Date	
	positionHaul	varchar	
	cod	varchar	
	haddock	varchar	
	saithe	varchar	
	redfishMarin	varchar	
	redfishMent	varchar	
	blackHalibut	varchar	
	ling	varchar	
	tusk	varchar	

Appendix B

Schema for a logbook's page

```
<?xml version="1.0" encoding="iso-8859-1"?> <!-- Schema for Logbook
Claus Schive 2005 --> <lg:schema
xmlns:lg="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified" attributeFormDefault="unqualified">
  <lg:complexType name="fishingTour" mixed="true">
    <lg:sequence minOccurs="0" maxOccurs="unbounded">
      <lg:element ref="tourId"/>
      <lg:element ref="nameDepHarbor"/>
      <lg:element ref="dateTimeDep"/>
      <lg:element ref="positionDep"/>
      <lg:element ref="nameArrField"/>
      <lg:element ref="dateTimeField"/>
      <lg:element ref="positionField"/>
      <lg:element ref="nameArrHarbor"/>
      <lg:element ref="dateTimeHarbor"/>
      <lg:element ref="positionHarbor"/>
      <lg:element ref="nameLandHarbor"/>
      <lg:element ref="dateTimeLand"/>
      <lg:element ref="positionLand"/>
      <lg:element ref="Receipt_no"/>
    </lg:sequence>
  </lg:complexType>
  <lg:element name="tourId" type="lg:integer"/>
  <lg:element name="nameDepHarbor" type="lg:string"/>
  <lg:element name="dateTimeDep" type="lg:dateTime"/>
  <lg:element name="positionDep" type="lg:string"/>
  <lg:element name="nameArrField" type="lg:string"/>
  <lg:element name="dateTimeField" type="lg:dateTime"/>
  <lg:element name="positionField" type="lg:string"/>
  <lg:element name="nameArrHarbor" type="lg:string"/>
  <lg:element name="dateTimeHarbor" type="lg:dateTime"/>
```

```

<lg:element name="positionHarbor" type="lg:string"/>
<lg:element name="nameLandHarbor" type="lg:string"/>
<lg:element name="dateTimeLand" type="lg:dateTime"/>
<lg:element name="positionLand" type="lg:string"/>
<lg:element name="receiptNo" type="lg:integer"/>
<lg:complexType name="catch" mixed="true">
  <lg:sequence minOccurs="0" maxOccurs="unbounded">
    <lg:element ref="catchId"/>
    <lg:element ref="dateTimeDepl"/>
    <lg:element ref="positionDepl"/>
    <lg:element ref="dateTimeHaul"/>
    <lg:element ref="positionHaul"/>
    <lg:element ref="cod"/>
    <lg:element ref="haddock"/>
    <lg:element ref="saithe"/>
    <lg:element ref="redfishMarin"/>
    <lg:element ref="redfishMent"/>
    <lg:element ref="blackHalibut"/>
    <lg:element ref="ling"/>
    <lg:element ref="tusk"/>
  </lg:sequence>
</lg:complexType>
<lg:element name="catchId" type="lg:integer"/>
<lg:element name="dateTimeDepl" type="lg:dateTime"/>
<lg:element name="positionDepl" type="lg:string"/>
<lg:element name="dateTimeHaul" type="lg:dateTime"/>
<lg:element name="positionHaul" type="lg:string"/>
<lg:element name="cod" type="lg:integer" default="0"/>
<lg:element name="haddock" type="lg:integer" default="0"/>
<lg:element name="saithe" type="lg:integer" default="0"/>
<lg:element name="redfishMarin" type="lg:integer" default="0"/>
<lg:element name="redfishMent" type="lg:integer" default="0"/>
<lg:element name="blackHalibut" type="lg:integer" default="0"/>
<lg:element name="ling" type="lg:integer" default="0"/>
<lg:element name="tusk" type="lg:integer" default="0"/>
<lg:element name="fishingdata">
  <lg:complexType>
    <lg:sequence>
      <lg:element name="fishing" type="fishingTour"
        maxOccurs="unbounded"/>
      <lg:sequence>
        <lg:element name="catching" type="catch"
          maxOccurs="unbounded"/>
      </lg:sequence>
    </lg:sequence>
  </lg:complexType>
</lg:element>

```

```

</lg:schema>

<?xml version="1.0" encoding="iso-8859-1"?> <!-- Claus Schive 2005
--> <?xml-stylesheet type="text/xsl" href="logbook.xsl"?>
<fishingdata xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="logbook.xsd">
  <fishing>
    <tourId>1</tourId>
    <nameDepHarbor>Stamsund</nameDepHarbor>
    <dateTimeDep>2005-03-22T10:01:06</dateTimeDep>
    <positionDep>69.01,13.11</positionDep>
    <nameArrField>Moskenesgrunnen</nameArrField>
    <dateTimeField>2005-03-22T17:01:33</dateTimeField>
    <positionField>69.23,12.45</positionField>
    <nameArrHarbor>Stamsund</nameArrHarbor>
    <dateTimeHarbor>2005-03-25T14:01:33</nameTimeHarbor>
    <positionHarbor>69.01,13.11</positionHarbor>
    <nameLandHarbor>Stamsund</nameLandHarbor>
    <dateTimeLand>2005-03-25T17:01:33</dateTimeLand>
    <positionLand>69.01,13.11</positionLand>
    <receiptNo>1</receiptNo>
  </fishing>
  <catching>
    <catchId>1</catchId>
    <dateTimeDepl>2005-03-22T17:21:33</dateTimeDepl>
    <positionDepl>69.23,12.45</positionDepl>
    <dateTimeHaul>2005-03-22T19:01:33</dateTimeHaul>
    <positionHaul_x>69.25,12.52</positionHaul>
    <cod>1000</cod>
    <haddock>5000</haddock>
    <saithe>3700</saithe>
    <redfishMarin/>
    <redfishMent/>
    <blackHalibut/>
    <ling/>
    <tusk/>
  </catching>
  <catching>
    <catchId>2</catchId>
    <dateTimeDepl>2005-03-22T17:21:33</dateTimeDepl>
    <positionDepl>69.23,12.45</positionDepl>
    <dateTimeHaul>2005-03-22T19:01:33</dateTimeHaul>
    <positionHaul>69.25,12.52</positionHaul>
    <cod>4000</cod>
    <haddock/>
    <saithe>3700</saithe>
    <redfishMarin/>
    <redfishMent/>
  </catching>

```

```
<blackHalibut/>  
<ling/>  
<tusk/>  
</catching>  
</fishingdata>
```


Appendix D

Tasks and Interviews

Table D.1: Tasks to be performed

Tasks	User 1	User 2	User 3	User 4	User 5
Sign in	Selected MLS from Menu. Pressed choice button and opened the programme. Then pressed new choice button and selected Go. No problems with soft buttons.	Selected MLS from Menu. Pressed choice button and opened the programme. Then pressed new choice button and selected Go.	Selected MLS from Menu. Pressed choice button and opened the programme. Then pressed new choice button and selected Go. No problems with soft buttons.	Selected MLS from Menu. Pressed choice button and opened the programme. Then pressed new choice button and selected Go. Had problems with soft buttons.	Selected MLS from Menu. Pressed choice button and opened the programme. Then pressed new choice button and selected Go.
Fetch outstanding quota	Selected Quota link from Main menu. Pressed Yes button and chose Telenor WAP as access point and after some seconds an image was displayed.	Selected Quota link from Main menu. Pressed Yes button and chose Telenor WAP as access point and after some seconds an image was displayed.	Selected Quota link from Main menu. Pressed Yes and asked which access point to use. Chose Telenor WAP and after some seconds an image was displayed.	Selected Quota link from Main menu. Pressed Yes button and asked which access point to use. Chose Telenor WAP and after some seconds an image was displayed.	Selected Quota link from Main menu. Pressed Yes button and asked which access point to use. Chose Telenor WAP and after some seconds an image was displayed.
Enter information about the departure	Selected Departure link from Main menu. Pressed Ok button and entered tour no and harbour. Then pressed Save. No problems with soft buttons.	Selected Departure link from Main menu. Pressed Ok button and entered tour no and harbour. Then pressed Save.	Selected Departure link from Main menu. Pressed Ok button and entered tour no and harbour. Then pressed Save. No problems with soft buttons.	Selected Departure link from Main menu. Pressed Ok button and entered tour no and harbour. Then pressed Save. Had problems with soft buttons.	Selected Departure link from Main menu. Pressed Ok button and entered tour no and harbour. Then pressed Save.
Enter information about the fishing field	Selected Arrival Field. Pressed Ok button and entered field. Then pressed Save.	Selected Arrival Field. Pressed Ok button and entered field. Then pressed Save.	Selected Arrival Field. Pressed Ok button and entered field. Then pressed Save.	Selected Arrival Field. Pressed Ok button and entered field. Then pressed Save. Had problems with soft buttons.	Selected Arrival Field. Pressed Ok button and entered field. Then pressed Save.
Enter information about deployment of gear	Selected Catching. Pressed Ok and catching screen displayed.	Selected Catching. Pressed Ok and catching screen displayed. Asked about the functionality of the choice list. Then pressed save.	Selected Catching. Pressed Ok and catching screen displayed.	Selected Catching. Pressed Ok and catching screen displayed. Asked about the functionality of the choice list. Then pressed save. Had problems with soft buttons.	Selected Catching. Pressed Ok and catching screen displayed. Then pressed Save.

Table D.2: Tasks to be performed

Tasks	User 1	User 2	User 3	User 4	User 5
Enter information about the catch	Selected Catching. Pressed Ok and catching screen displayed. Had problems selecting haul. Entered the figures and pressed Save.	Selected Catching. Pressed Ok and catching screen displayed. Had problems selecting haul. Entered the figures and pressed Save.	Selected Catching. Pressed Ok and catching screen displayed. Had problems selecting haul. Entered the figures and pressed Save.	Selected Catching. Pressed Ok and catching screen displayed. Had problems selecting haul. Entered the figures and pressed Save. Had problems with soft buttons.	Selected Catching. Pressed Ok and catching screen displayed. Selected haul from choice list. Then entered the figures and pressed Save.
View the file content and effect corrections of catching figures	Selected View content. Pressed Yes twice and file content displayed.	Selected View content. Pressed Yes twice and file content displayed.	Selected View content. Pressed Yes twice and file content displayed.	Selected View content. Pressed Yes twice and file content displayed.	Selected View content. Pressed Yes twice and file content displayed.
Enter information about the arriving harbour	Selected Arrival Harbour. Pressed Ok button and entered harbour. Then pressed Save.	Selected Arrival Harbour. Pressed Ok button and entered harbour. Then pressed Save.	Selected Arrival Harbour. Pressed Ok button and entered harbour. Then pressed Save.	Selected Arrival Harbour. Pressed Ok button and entered harbour. Then pressed Save.	Selected Arrival Harbour. Pressed Ok button and entered harbour. Then pressed Save.
Try to enter information about the arriving harbour once more	Selected Arrival Harbour. Pressed Ok button and entered harbour. Then pressed Save. Error message displayed.	Selected Arrival Harbour. Pressed Ok button and entered harbour. Then pressed Save. Error message displayed.	Selected Arrival Harbour. Pressed Ok button and entered harbour. Then pressed Save. Error message displayed.	Selected Arrival Harbour. Pressed Ok button and entered harbour. Then pressed Save. Error message displayed.	Selected Arrival Harbour. Pressed Ok button and entered harbour. Then pressed Save. Error message displayed.
Enter information about the landing harbour	Selected Landing and pressed Ok button and entered harbour and receipt no. Then pressed Save.	Selected Landing and pressed Ok button and entered harbour and receipt no. Then pressed Save.	Selected Landing and pressed Ok button and entered harbour and receipt no. Then pressed Save.	Selected Landing and pressed Ok button and entered harbour and receipt no. Then pressed Save.	Selected Landing and pressed Ok button and entered harbour and receipt no. Then pressed Save.
Send the file containing the information	Selected Send link from Main menu. Pressed Yes button twice and chose Telenor Wap. Received a message when data was received by server.	Selected Send link from Main menu. Pressed Yes button twice and chose Telenor Wap. Received a message when data was received by server.	Selected Send link from Main menu. Pressed Yes button twice and chose Telenor Wap. Received a message when data was received by server.	Selected Send link from Main menu. Pressed Yes button twice and chose Telenor Wap. Received a message when data was received by server.	Selected Send link from Main menu. Pressed Yes button twice and chose Telenor Wap. Received a message when data was received by server.
Cut off when sending the file containing the information	Selected Send link from Main menu. Pressed Yes button and then Cancel and Avbryt. Then connection was cut off.	Selected Send link from Main menu. Pressed Yes button and then Cancel and Avbryt. Then connection was cut off.	Selected Send link from Main menu. Pressed Yes button and then Cancel and Avbryt. Then connection was cut off.	Selected Send link from Main menu. Pressed Yes button and then Cancel and Avbryt. Then connection was cut off.	Selected Send link from Main menu. Pressed Yes button and then Cancel and Avbryt. Then connection was cut off.
Create a new file to store the information	Selected Landing and pressed ok button. Then pressed Store file.	Selected Landing and pressed ok button. Then pressed Store file.	Selected Landing and pressed ok button. Then pressed Store file.	Selected Landing and pressed ok button. Then pressed Store file.	Selected Landing and pressed ok button. Then pressed Store file.
Delete the transmitted file	Selected Delete File and warning displayed. Then pressed Delete.	Selected Delete File and warning displayed. Then pressed Delete.	Selected Delete File and warning displayed. Then pressed Delete.	Selected Delete File and warning displayed. Then pressed Delete.	Selected Delete File and warning displayed. Then pressed Delete.

Table D.3: Questions for open interview

Questions	User 1	User 2	User 3	User 4	User 5
How was the first impression?	Seems easy to employ	The system is ok	Easy to use	Easy to employ	Easy to use
What did you like about this program/ user interface?	Functioned fast and well organized. Features as outstanding quota and cumulative catch is important	Functioned well. Could have had more features as the possibility to enter information from different fields/harbours	Functioned fast and easy to understand	Ok, could have had more features as the possibility to enter information about the ground conditions	Less paperwork and better control. Features as outstanding quota and cumulative catch is important
What did you dislike about the program? user interface?	The text on the screens should have been Norwegian and too small soft buttons	Nothing special	The text on the screens should have been Norwegian and too small soft buttons	The soft buttons should have been bigger and the choice list caused problems	Catching form should have been more informative. Took too long time to send the data.
Was there anything you didnt understand?	No, understood everything	No, understood the logic	Easy to understand	No, seems ok	No, easy to understand and useful feedback from the program
How is the structure?	Simple and ok	The structure is ok	Ok	The structure is ok and logic	The structure is ok
How was the navigation part?	Easy to navigate for people used to mobile phones	Easy to navigate	Easy to navigate for people used to mobile phones	Easy to navigate	The navigation is ok
How was it to fill in necessary information?	Easy. Useful feedback when tasks were performed	Easy. Useful feedback when tasks were performed	No problems. Useful feedback when tasks were performed	Easy, but the soft buttons should have been bigger	Easy to enter information
How is the layout?	Ok, not necessary with more colours or icons	The layout is ok	The layout is ok	Ok, no special comments	The layout is ok
Was it difficult to learn?	Easy to learn, only 2-3 minutes	Easy to learn	Easy to learn and understand, only a few minutes	Easy to learn	Easy to learn, useful feedback when doing mistakes
Would you have used electronic logbook instead of traditional catch diary?	Yes, without any doubt	Yes	Yes	Yes, at once	Yes, without any doubt

Appendix E

Glossary of Terms

AFMA: Australian Fisheries Management Authority

API: Application Programming Interface

BIP: Basic imaging profile

CDC: Connected Device Configuration

CLDC: Connected Limited Device Configuration

DBMS: DataBase Management System

DOM: Document Object Model

DTD: Document type definition

EDGE (EGPRS): Enhanced Data rates for GSM Evolution

EMSAT: Was initially developed to provide a communications service for fishing boats from European Union countries while at sea, covering regions in which it is not possible to access cellular networks or the GSM system. Since then it has been extended to cover all maritime industries, offering data transmission services, SMS messaging and GPS map-based positioning.

GLOBALSTAR: Delivers satellite voice and data services worldwide to over 120 countries and key maritime passages

GPRS: General Packet Radio Services

GPS: Global Positioning System

GSM: Global System for Mobile Communications

HF: Handsfree profile

HS: Headset profile

HTTP: HyperText Transfer Protocol

IDE: Integrated Development Environment

ITU: International Telecommunication Union

INMARSAT: Provides telephony and data services to users world-wide, via special digital radios called "terminals".

IRIDIUM: Is the only provider of truly global satellite voice and data solutions with complete coverage of the Earth (including oceans, airways and Polar Regions).

JAD: Java Application Descriptor

JAR: Java Application archive

J2EE: Java 2 Enterprise Edition

J2ME: Java 2 Micro Edition

J2SE: Java 2 Standard Edition

JPEG: Joint Photographic Experts Group

JSR-75: File Connection Optional Package

JSR-82: Java APIs for Bluetooth
JSR-172: J2ME Web Services API
JVM: Java Virtual Machine
KVM: Kilobyte Virtual Machine
L2CAP: Logical link control and adaptation protocol
LMP: Link manager protocol
MIDlet: Java application that run on MIDP devices
MIDP: Mobile Information Device Profile
Navi Roller: Soft button which allows navigating the menu, scrolling up and down and selection by clicking.
NMT 450: Was the first public, automatic mobile service, and was launched in Norway in 1981.
OS: Operating System
OTA: Over-The-Air
PDA: Personal Digital Assistant
PNG: Portable Network Graphics
RDF: Resource Description Framework
RF: Radio Frequency
RMS: Record Management System
RSS: Really Simple Syndication
SHEEL: Secure and Harmonized European Electronic Logbook
SPP: Bluetooth Serial Port Profile
SVG: Scalable Vector Graphics
UI: User Interface
UML: Unified Modeling Language
UMTS: Universal Mobile Telecommunications System
URL: Uniform Resource Locator
USB: Universal Serial Bus
VoIP: Voice over IP
WAP: Wireless Application Protocol
WCDMA: Wideband Code Division Multiple Access
WMA: Wireless Messaging API
WML: Wireless Markup Language
XHTML: Extensible HyperText Markup Language
XML: Extensible Markup Language