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Smart phone apps for military situational awareness

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Abstract

The text of the abstract; typically, 2–5 sentences.
What it is all about?? Title page, abstract, ... testtest2
TESTESR

Preface

This thesis was written as a part of my Masters degree in Informatics at UiO. Most of the work was done in the period from August 2016 to May 2017. The thesis was done in collaboration with the FFI.

The thesis is the original and independent work by the author, Ida Marie Frøseth and supervised by dr. Frank Trethan Johnsen and dr. Trude Hafsøe Bloebaum.

INCLUDE: How literature have been examined and where the publications have been found

Acknowlegement

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Chapter 1

Introduction

This thesis investigates how Commercial off-the-shelf (COTS) products, in the form of handheld smart devices, can be used as a cheap and powerful tool for situational awareness in military operations. Traditionally, military information systems are proprietary and expensive due to various special requirements, but there has been a shift towards using COTS the last couple of years due to the concept of NATO Network Enabled Capability (NNEC).

The main focus in this thesis has been on usability, and how to best represent rich and complex content in a simple and intuitive way. The thesis also addresses other related issues like power consumption and network considerations through a requirements analysis. The findings are implemented in a working prototype which is evaluated through a Heuristic Evaluation (HE) and a real world user test. The results shows that the implemented solution .....

**MA KANSKJE INKLUDERE AT ARBEIDET BYGGER PA SMART...

1.1 Background and motivation

En robust og samhandlende styrke er et maÌl for aÌ oppnaÌ operativ effektivitet. Dette er spesielt et uttrykt maÌl i nettverksbasert forsvar (NbF) [1, 2] og Nato network enabled capability (NNEC) [3].

In the concept of NNEC, or the Norwegian equivalent Network Centric Defence (NBF), military sovereignty is achieved through network centric collaboration. The concept emphasizes information sharing, doctrinces, policy and procedures as key enablers for effective command and control.

information and technology.

The correct information to the correct time.

Military operations are usually very dynamic, and to be able to effectively share a common operational picture. — have the current situational picture is often crucial for leaders to make good decisions.

the main task is not to know the current situation details, but act on them.

In this concept

with people, doctrines and procedures as the main drivers, and technology as the key enabler

NNEC - NBF => The correct information to the right time.

Situational awareness is a key enabler for military sovereignty.

Military communication and information systems have special requirements regarding functionality, security and robustness which have lead to expensive proprietary solutions. At the same time, there is a need for powerful communication and sensor systems even at the lowest level to achieve good situational awareness. With the emerge of smart technology and the Long-Term Evolution standard, the consumer can get multi-sensor devices at low cost. These technologies have, over the last couple of years, gain a growing interest within the military community.

((ALTERNATIV1)) The SMART project by the Norwegian Defence Research Establishment (FFI) investigated how mobile smart devices can be used as a simple and cheap tool for situational awareness to mobilization units in military operations. This thesis is a continuation of this work and involves analyzing the requirements for such apps, investigating frameworks, tools and techniques to meet these requirements, and evaluating the implementation through various tests.

((ALTERNATIV2)) This thesis investigates how mobile smart devices can be used as a simple and cheap tool for situational awareness to mobilization units in military operations. Since the mobilization units have very limited time for training, the primary focus has been on the design of an easy to use and content rich user interface. Another concern when developing smartphone apps, and especially for use in military operations, is battery consumption, and the thesis investigates some techniques to optimize the battery lifetime.

((DETALJENE ANG HVA DENNE OPPGAVEN DEKKER KOMMER KANSKJE TIL AA BLI ENDRET LITT ETTERVHER))

* NBF = informasjonsbehov
* Mobilization units
*

Military Command and Control Information System (C2IS)s have special requirements regarding functionality, security and robustness, and many operations are executed in areas with no communication infrastructure or in areas where you can not trust the provider of the infrastructure. These issues are reasons why smart technology is not fully adopted in military operations yet, however there is a growing number of experiments and even commercial products[**dina**] which try to customize smart technology to fit these requirements.

The research in the area is diverse from trying to solve connectivity issues with Long-term Evelution (LTE) or WiFi direct [1] [4][8], to adding security. Apart from publicly available work, there are also several restricted project whose details cannot be included in this thesis. Furthermore, the commercial available situational awareness apps are built for the professional soldier and uses jargon and includes features which require train-

[1]During the North Atlantic Treaty Organization (NATO) exercise Bold Quest 2013, multiple nations deployed their own LTE network see https://www.dvidshub.net/news/113548/military-tests-4g-lte-technology-during-bold-quest-132

ing[7]. This makes these apps less suited for typically mobilization units which may train only a week a year, which is what the SMART project at the FFI tries to solve.

The SMART project by the FFI is an Concept Development and Experimentation (CD&E) activity which examines how mobile smart technology can be used as cheap but powerful devices to provide situational awareness for mobilization units with low resources and training[7]. Through the project a demonstrator was developed consisting of a security component, a sever back-end system and an smartphone app based on the Android platform. The system was tested through real world user tests, and the results shows that the system has great potential for such application. Due to the limited time of the activity, little focus was put on the optimization and the design of the system. This thesis will analyze the current solution of the SMART demonstrator and the domain which will form a set of prioritized requirement for such an app. A selected will give a set of requirement, propose a set of changes to the SMART prototype to meet these requirements. Some selected requirements will be implemented, tested and the impact will be measured to propose some basic guidelines when developing smart apps for military operations.

1.2 Problem statement

NOTES

- This thesis will continue the work in the SMART project and investigate further how the Android platform can be optimized to fit in military application.
- Requirements
- Design guidelines
- Optimizing

1.2.1 Goals

ProsessmÃ¥l

ResultatmÃ¥l

- Develop a working prototype
-
-

1.3 Premises

1.4 Scope and Limitations

1.5 Research Methodology

Computer science can be described as an interdisciplinary field with three different paradigms [2, 3]: *Theory, Experimentation* and *Design*. While the first two paradigms are concern with building broad conceptual frameworks and models within the entire field or a domain [3], the third paradigm is about *Constructing computer systems that support work in given organizations or application domains* [3]. The work within this thesis fit within the last paradigm.

Design is usually performed as an iterative process with the four steps [2] listed in bold typeface in the listing below. The work performed in this thesis that maps to each of the steps are found in regular typeface to the right of the listed step. Within the scope of this thesis only one iteration was performed, however, since the work continues the SMART project it can be viewed as a second iteration.

State requirements: During the first phase the business case and current solution was analyzed. This work ended in a prioritized list of requirements found in chapter 2.7.

State specification: Based on the priority of the requirements found, a subset was chosen and a study of related work and state-of-the art were investigated to form a foundation for the specification of a new design and is covered in chapter 2.7 to 3.

Design and implement: Based on the findings in phase one a new design were proposed and implemented. This work is described in chapter 3.

Test the system: Qualitative methods have been used to evaluate the system. First an HE was performed using mobile specific heuristics and secondly a user test with questionnaires and interviews. The user test was performed as close as possible to a real world situation, by having 50 soldiers from the Home Guard (HV) using the system as a tool during a regular military exercise.

1.6 Contribution

1.7 Thesis outline

The rest of this thesis is organized as follows: In chapter 2 the reader will get familiar with the background for the work, including related work, an requirement analysis and relevant technologies and frameworks. Then the

design of the developed prototype is described in chapter 3 using a top-down approach. In chapter 4 the prototype is evaluated based on a user test and an HE. Chapter 5 concludes the work and propose some future work to be performed.

Chapter 2

Related work, requirement analysis and state of the art

This chapter covers the requirements analysis blalblabla:-)

2.1 SMART project overview

2.2 Analyzing the TITANS

The analyzis of the Titans form the basis for the direction and work in this thesis, and also uncover the requirements for a smart phone hosted Blue Force Tracking (BFT) application. I have used three different approaches when analysing the system. First the data gathered by FFI was analyzed, then a heuristic evaluation of the current solution were conductet before performing some benchmark test in order to get an overview of the system current solution.

The rest of this chapter will first go through the findings from analyzing the user feedback, performing the heuristic evaluation and doing performance tesing. In each section a set of derived requirements and their priority will be stated. At the end of this chapter a summary of the findings is included to give the reader a overview of all the identified requirements.

2.3 User experience

The results form the questionnaires revealed that the users were very positive to both the application and the project, and all the questions regarding the idea or concept got more than 80 percent positive votes. On the question on the reason for adding information in the CAGED app, the alternative it took focus away from their main task.

The users also addresses some additional requirements to the application which can be categorized in the following categories:

- Map
- Power consumption

- Information architecture
- Location strategy

2.3.1 Map

The users basically mentioned two main problems with the map of the current version:

- The fidelity of the map
- The format of locations

Map fidelity

The first issue relates to the map used in the current solution, which is OpenStreetMap (OSM). OSM lacks a lot of information in some areas, and the users mentioned amongst others, contours, roads and building as examples of information which were not present. Multiple users mentioned the Norgeskart app, which uses Kartverkets open map database[1], as an example of a good map. The derived requirement is as follows:

Requirement 2.1. The map for such application needs fidelity similar to Norgeskart 1:50000 data set or better.

The consequences of not having an accurate map might be navigations errors, lack of trust in the system and that user rather uses other mapping applications for navigation. The consequences are crucial for the application to be used therefor this requirement should be assigned **high** priority.

Location format

The current solution displays locations using latitude and longitude, while the soldiers are used to the Military grid reference system (MGRS), which is also the coordinates displayed on their physical map. Since the squads still uses physical maps to navigate and the operation order usually refer to location in MGRS, the efficiency and synergy by using the application is not as high as it could be. Since this is not a critical part of the application, but would make the soldier more efficient the following requirement should be assigned a **low** priority:

Requirement 2.2. The location of a observation or a user should be displayed using the MGRS format.

[1] http://www.kartverket.no/Kart/Gratis-kartdata/

2.3.2 Power consumption

About one out of three users commented in the open-ended questions that their device quickly ran out of power. The devices were fully charged and each squad were given a powerbank at the start of the exercise. The duration of the tests were also relatively short compared to a real world scenario[2]. The duration of one operations usually rarely last for more than 24 hours, but the soldiers can be days without getting access to a facility with power. Often squads use vehicle for transportation, but since they were not provided with a charger for vehicles, they were not able to charge the device. The consequences of not having a device with power is crucial, and the following two requirements should have a **high** priority.

Requirement 2.3. The smart phone app should last for at least 24 hours without the need to recharge.

Requirement 2.4. The user need to carry power resources to last for at least ***one week before returning to a facility with corded electricity.

2.3.3 Findability

2.3.4 Information architecture

The users have through the open-ended questionnaire and in conversation pointed out multiple issues related to information architecture. There were both

The issues can be grouped into the following categories:

Finding new information 1 * Filtering 2 * Feed of what is new (as of facebook being chronological)? - findability 3 * How to organize the information of an event

- Notifications
- Filtering information
- Visualize the situation

Notifications

Multiple users called for a feature to be notified when there is a change in the system. Without any notification the user have to periodically check the map or the list of observations for new or updated information. This brings the soldiers focus away from their main task and are both inefficient and dangerous. If the user were notified whenever there is a change they will get a better and faster situational awareness. At the same time, if the users are constantly notified for every small change in the situation it can also draw the user attention away from their main task. In other words, the

[2]During the first two tests the users returned their devices every 24th hour for recharging and update. While for the two last the test execution duration were only about 40 hours, see table **??**

user should only be notified when the information is relevant to the user. The derived requirement is as follows:

Requirement 2.5. The user should be notified whenever relevant information[3] is added or updated.

The above requirement will give an better situational awareness to the user faster, which is a core goal with the application and the requirement should have a **high** priority.

Filtering information

Multiple users mentioned that they had problem filtering out relevant information, and this is despite the short time frame the app was used (with longer exercises more and older information would be present). In the current solution, the idea is that an administrator (typically an user of Metis) should remove information when it gets irrelevant[6]. However in conversations with different users and through the interview with the Metis operator it is clear that different users with different roles have a different view of what is relevant information and not. For example would the S-2 (Intelligence) personnel of the Area Command need 'historic' information in order to analyze how the situation is evolving, while a soldier in a squad would only be interested in the information that can influence the current situation. On the other hand it is obvious that information left out (filtered) without the soldier being aware of it can be very dangerous, hence a filtering mechanism has to be user initiated and not necessary remove the information completely from the map but make it visually less important.

Whether information is relevant or not depends on multiple factors, and using only time is not adequate; An enemy observed passing in a vehicle may only be valid for hours or minutes, while information about the location of an enemy command post would be relevant for maybe weeks, and even moths or years. The user should therefore be able to select some information to never be filtered.

Requirement 2.6. The application should support user initiated filters which makes it visually easy to see what information is relevant.

Visualizing the situation

This requirement is highly related to the previous requirement about filtering information, however this requirement is more related to how information is displayed. Users mentioned that they had problem seeing the view fast enough. The current solution uses clustering to avoid information overload. However the user has to zoom in to get more details about each

Relevant information What is the last updates

[3]Whether information is relevant or not depends on the physical distance from the user, if the user have marked the observation as a favorite and if the user is the creator or editor of the observation with updated information.

2.3.5 Location preciseness

What type of information do they have to share: * Blue force tracking * Observations

* In general positive to the project and the application (more than 80 percent) * The reason for not using the app was mainly because it took focus away from their main task *The open-ended questions and in conversation with the user, the following issues were addressed.

2.4 Heuristic evaluation

2.4.1 Why Heuristic evaluation

HE is a informal method to evaluate the usability of a user interface design. It is conducted by simply looking at the interface and evaluate it based on some chosen design principles[12]. The advantage of the technique is that it is effective, can be used early in the development phase, is cheap and does not require to much resources [11][1]. The method also have some shortcomings as it could be biased by the current mindset of the evaluators[12]. HE should be performed independently by three to five persons as pointed out in Nielsen and Molich in [12], however the resources available for this thesis only allowed one evaluator.

2.4.2 Choosing heuristics

Nielsen 10 usability heuristics [10] are well known and tested. Since touch-screen based mobile interfaces have some different Human Computer Interactions (HCI) challenges compared to traditional computers interfaces, different set of mobile specific heuristics have been proposed[9] [1] [5]. [9] propose a way to interpret the Nielsens 10 heuristics to better suit map based mobile application, and this interpretation is used when performing the HE.

2.4.3 Problems discovered through heuristic evaluation

2.5 Performance testing

2.6 The domain

* How many observation has to be supported? * How should

The bachelor thesis [6] shows that when exceeding 200 observation, some devices start having problem rendering the observation. When this limit was tested, all the observation were fetched from the server every time, and since then versioning have been added, so only changed observations has to be updated. rendering of the observations start having problems. They assumes this is sufficient, how

2.7 Summary of requirements with prioritization

Chapter 3

Design of an enhanced solution

3.1 Overview

3.2 Improving performance

3.3 Improving usability

3.3.1 Map

3.3.2 More precise location

Chapter 4

Evaluating the results

4.1 Evaluating the user experience

4.2 Evaluation the performance

Chapter 5

Conclusion

5.1 Future work

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5.2 Change log