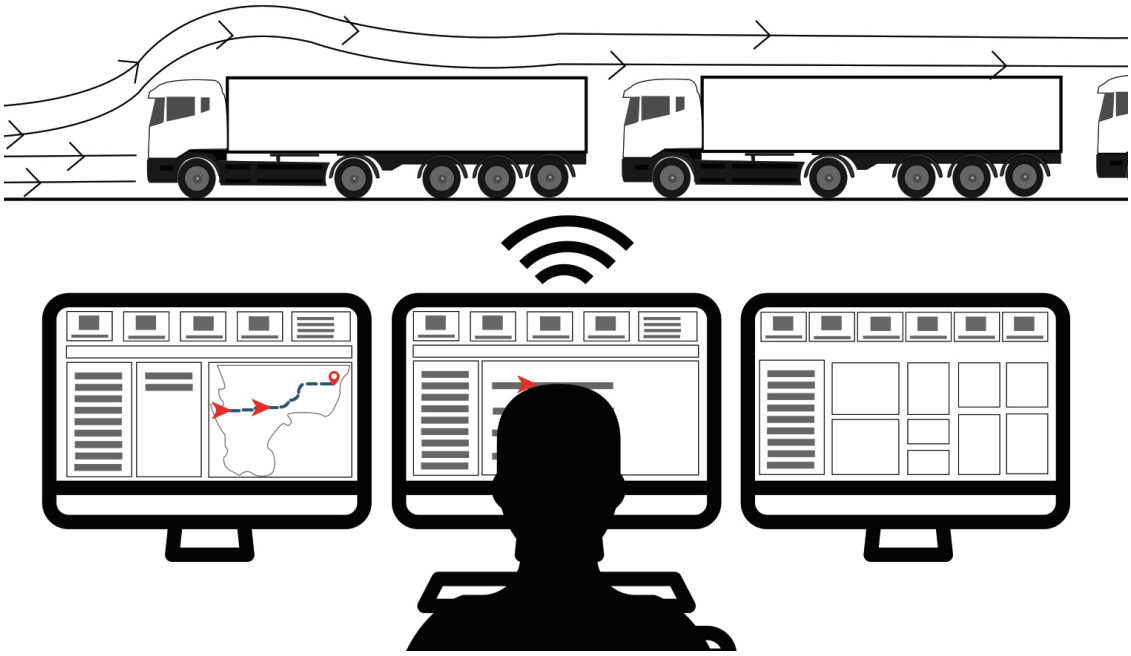

Designing a Back-Office System for Platooning

Master's thesis in Interaction Design and Technologies

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Gothenburg, Sweden 2018

Master's thesis 2018

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Abstract

Platooning is a term used to describe trucks that drive close behind one another to reduce fuel consumption by making use of the reduced air drag. Moreover, in order to be able to do so effectively a number of technologies need to be fully functioning. It is also not a new subject, and has been researched extensively with the hope of applying the technology on public roads in the future. Although, despite the technologies possibilities it is still unexplored in certain areas one of them being the so called "back-office system" responsible of managing platooning. Compared to other systems, there are several requirements that a Back-Office system for platooning needs to be able to fulfill. For this reason, the aim of the study is to explore the required functions as well as what is going to be required of the user for managing a Back-Office as well as what future design challenges are.
Furthermore, the outcome of this study is a set of requirements of functions required of a future Back-Office system, a suggestion of possible end-users and a list of future design challenges. These were found by utilizing a set of methods within the design-thinking methodology while also creating a low and high fidelity prototype of a Back-Office system.

Keywords: Platooning, Back-Office, Requirements, Back-Office Manager.

Acknowledgements

We wish to express our appreciation toward the following people who provided us with guidance during this master thesis.

***Mikael Söderman** & **Claudia Wege** who were our supervisors at Volvo's human behavior and perception department. For providing us with constructive criticism throughout the work and always being there to answer any of our questions.*

***Fang Chen** who was our supervisor at Chalmers University of Technology. For valuable feedback throughout the beginning and end of the project.*

***Everyone** who took their time to be a part of our interviews and usability tests.*

Anes Abdulahović and Fredrik Edlund, Gothenburg, June 2018

Dictionary

Geofencing - A technology allowing tracking within a predetermined or individually created zone.

V2V - is an acronym for Vehicle to Vehicle a technology allowing vehicles in a platoon to communicate with each other.

V2I - is an acronym for Vehicle to Infrastructure a technology allowing vehicles with the technology to send back data gathered by the vehicles to another information hub.

FTS - is an acronym for Fleet Telematics System enabling communication between vehicles and a central office.

FMS - is an acronym for Fleet Management System, an interface accessing vehicle data of connected vehicles

DSS - is an acronym for Decision Support System, a system aiding users in decision making.

ACC - is an acronym for Adaptive Cruise Control. a system enabling vehicles to automatically adapt their speed to a set of conditions

ITS - is an acronym for Intelligent transportation system. a system used for traffic management.

BO - is an acronym for Back-Office. A system over-looking or managing vehicles.

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1
Introduction

This thesis has been carried out within the field of interaction design and technologies at Chalmers University in Sweden. The foundation of this study stems from Volvo Group Trucks Technology (Volvo GTT) human behavior and perception group within vehicle automation. Volvo GTT assists with long-term research for development as well as final delivery of complete vehicles for production. Additionally, Volvo GTT also supports the finalized products in the aftermarket with the vision of becoming world leaders in sustainable transport solutions. Our research topic, provided by the department of Human Behavior and Perception at Volvo GTT was to explore functions, tasks and communication needed in a Back-Office system for platoons. Furthermore, we were also asked to consider how interface design could be applied to a Back-Office system for platooning. The scope of the project was to consider the following topics:

- Fuel - How much fuel has been saved due to driving in a platoon, how fuel savings are affected by vehicle configurations and other parameters.
- Navigation - How to set routes for platoons, find platoons on roads and traffic conditions.
- Geofencing - Display specific information that can affect platoons such as road work, weather, platoon allowed roads.
- Match-making - Coordination of trucks that are part of the platooning service network.

The subject was chosen due to the area being unexplored and directly correlated to our research field within interaction design. Moreover, the questions in this study are associated with a Vinnova FFI project called Sweden 4 Platooning which is a cooperation between Volvo Technology Corporation, Scania CV AB, CICS Sweden ICT, Kungliga Tekniska Högskolan, Schenker AB and Trafikverket.

1.1 Background

A side effect of globalization is an increasing demand in road transportation as more goods are being transported every day (Xiaoling, 2013; Goel, 2008). To face this challenge, haulage contractors need to increase their transportation efficiency. Subsequently, the European Union (2011) has noted that future transport efficiency is an integral part in the expected ability to keep up with new environmental constraints. One prominent way of combating this issue has been by having haulage contractors acquire Fleet Telematic Systems (FTS) for managing their vehicles (Goel, 2008). FTS enable drivers to share information such as positioning, route, breaks and un-

necessary interruptions back to a dispatcher. Regarding the management of this information, it is then sent to a stationary system offering efficient data presentation. The dispatcher can then provide real time support using the data regarding for example road accidents and time management (Goel, 2008). These types of systems are also often referred to as Fleet Management Systems (FMS) or Decision Support Systems (DSS) (Regan, Mahmassani Jalliett, 1998; Turban, Aronson Liang, 2005). DSS are systems supporting decision makers judgement (Turban, Aronson Liang, 2005), while FMS aid dispatchers in managing vehicle coordination.

Following the use of FTS, DSS and FMS is the development of a more efficient method for trucks to transport their goods, referred to as platooning. Platooning is a term used to describe trucks that drive close behind one another to reduce fuel consumption with up to 20% by utilizing the reduced air drag (Robinson, Chan Coelingh, 2010). However, the vehicles in a platoon need to communicate to understand each other's actions on the road which can be achieved through Vehicle to Vehicle communication (V2V). V2V enable transmission through a common protocol of speed, position and actions wirelessly (Liang, 2014). When the trucks are connected V2V they can safely align and keep a relative distance from each other using radar and lidar. V2V allows synchronized vehicles to break, accelerate and decelerate to adjust their speed with regards to each other. Moreover, Vehicle to Infrastructure (V2I) communication is another condition vital for enabling platooning. By using the communication technology and sensors within the vehicles, a platoon can report information via V2I to a centralized information hub often referred to as "Back-Office" (Liang, 2014). A dispatcher can then analyze the data and provide direct management of the vehicles, like a dispatcher using a FMS. The trucks are connected and can then communicate in multiple ways, through either V2V or V2I.

1.2 Aim and purpose

Using a Back-Office system for platoons has been mentioned in several studies including Bergenheim, Coelingh, Johansson and Tehrani (2012), Levy (2015), Liang (2014), Janssen, Zwijnenberg, Blankers and Kruijff (2015) and Goel (2008). Although there is limited information about what functions and tasks the Back-Office system should carry out, which makes it important to investigate further. Moreover, we were also unable to find information regarding what qualifications that are required of the person managing the Back-Office. Therefore, the purpose of this thesis was to identify functional requirements and investigate what is required of a user for managing platoons within a Back-Office. Our aim was to develop a prototype of a Back-Office concept supporting the Back-Office manager.

1.3 Research questions

To find more information about what tasks and functions that the Back-Office should carry out, as well as gain an understanding of what qualifications that are required of the user for managing a Back-Office the following research questions will be used:

What are the required functions of a Back-Office system for platooning?

What qualifications are required of the user for managing a Back-Office system for platooning?

What are the design challenges for creating a Back-Office system for platooning?

1.4 Limitations

- The laws and regulations which are likely to heavily influence the possibility of platooning on common roads are not within the scope of this thesis. This is due to our field of research being interaction design.
- While considered in terms of communication, we have excluded investigating what or how information could be displayed to drivers. Reason being that displaying of information is its own research topic as it requires knowledge regarding how to display information without distracting the driver.
- This thesis is also limited by not designing hardware while focusing on software due to Volvo wanting us to investigate software specifically.
- We have only considered platooning in Sweden since this thesis was carried out there.

2
Theory

This section presents theory regarding platooning and the methods which were used in this thesis as well as the design principles.

2.1 Platooning

Platooning is not a new concept and was first proposed in 1979 by Shladover (Shladover, 1979; Dao Huisson, 2013). Shladover discussed the potential gains from creating automated vehicle road-trains in the form of economical as well as environmental effects by reducing workload and fuel consumption (Shladover, 1979). Afterward, several studies have been carried out testing the possibility of platooning. In 2010, Robinson, Chan and Coelingh stated that platoons can reduce the fuel consumption by as much as 20%. It is also argued that the society would benefit from platooning since it can lead to safer traffic and less accidents (Janssen et.al., 2015; Alam, 2011; Liang, 2014). However, since the benefits of platooning are greater when trucks drive behind one another at close distances (0,5 -1s) to maximize the reduce air drag (Alam, 2011) platooning requires automated driving technologies such as Adaptive Cruise Control (ACC) and wireless vehicle-to-vehicle communication (V2V) to allow the vehicles to communicate with each other. Furthermore, vehicle to infrastructure (V2I) communication is also important, as it enables platoons to share their information to a Back-Office, capable of managing platoons. Without these technologies platooning would not be feasible as it would be impossible for human drivers to safely drive so close to each other relying only on human reaction time (Alam, 2011; Janssen et.al., 2015).

2.1.1 V2V Communication

Wireless Access in Vehicular Environments (WAVE) is a communication standard that's used for vehicular environments that has been approved by IEEE Standards Association (2016) which supports the data exchange between vehicles and thus supports Vehicle to Vehicle communication (V2V). WAVE is based on a wireless standard called IEEE 802.11 which is used in ordinary Wi-Fi-technology that can be found in homes and workplaces (Alam, 2011; Janssen, et.al, 2015). WAVE is an ad-hoc based standard, which means that the communication within WAVE is directly carried out between nodes and that no base station is required (Bergenheim, Hedin Skarin, 2012). With sensors local data can be shared among vehicles in the vicinity (Alam, 2011). V2V communication between two or more vehicles also makes

it possible to reduce the distance between the trucks driving in a platoon. With Adaptive Cruise Control (ACC) together with V2V communication the trucks can adapt their speed and distance to the vehicle ahead of them (Liang, Alam Gattami, 2011).

2.1.2 V2I Communication

Intelligent transport systems (ITS) is a general term to describe an application that uses technology to handle communication, control and information processing to vehicular networks (Paul, Chilamkurti, Daniel Rho, 2017). This includes vehicles, users and transportation infrastructure (Liang, 2014). An important prerequisite for platooning is vehicle-to-infrastructure (V2I) communication which allow vehicles to exchange information about, for example current conditions and regulations, points of interest, weather (Goel, 2008), traffic flow, accidents and road work (Picone, Busanelli, Amoretti, Zanichelli Ferrari, 2015). With GPS it is possible to locate the exact position if a vehicle and report it to Back-Office system through V2I communication (Goel, 2008).

2.2 Back-Office

Goel (2008) describes Fleet Telematic systems (FTS) as real-time management systems used for planning commercial vehicle operations, identical to Intelligent Transportation Systems (ITS). Geofencing, is a technology capable of aiding with monitoring the vehicles. Based on new technology it is made possible to build a virtual fence (geofence) that allow tracking of specific conditions within a predetermined or individually created zones. By using geofencing, the Back-Office system can send a notification when for example a platoon deviates from its allocated route (Ieeexplore.ieee.org, 2009).

Moreover, Goel (2008) categorizes the information provided by FTS into pre-trip (information to plan a transport) and on-trip (information about changing conditions during a trip). Nevertheless, management systems such as a Back-Office has several activities that need to be monitored, controlled and planned. Routing schedules and transport plans should be available to the dispatcher for coordinating on-the-fly platooning and route guidance (Janssen et al., 2015). The Back-Office also requires information regarding positioning of the vehicles always to be able to carry out the previously described actions. Additionally, information such as fuel consumption, engine data and vehicle weight are also important when planning and forming platoons (Liang, et al., 2011). Fleet Management Standard is an open standard that allow access to such vehicle data (Goel, 2008).

Janssen et al. (2015) mention that platooning will have a huge impact on logistics and supply chain networks involving all stakeholders within transportation. Collaboration between different haulage contractors will be necessary to exploit the advantages and benefits of platoons. For this reason, platooning will require new ways to plan logistics. A new type of service can emerge from this, which Janssen et

al. (2015) call Platooning Service Provider (PSP), with comparable responsibilities to the previously described Back-Office.

2.3 Design Thinking

Design Thinking is a human centered methodology that integrates business and technological factors into problem forming, solving and design (Meinel Leifer, 2011). Design Thinking relies on designer's ability to construct functional ideas with emotional meaning, recognizing patterns, being intuitive and expressing himself in different types of media other than words and symbols. This can be achieved by not using conventional problem-solving methods, rather looking for work-arounds and improvised solutions that can be incorporated into the design that is created (Brown Wyatt, 2010).

The Interaction Design Foundation (2018) describes Design Thinking as a non-linear process with five stages, emphasizing that the five stages not always are sequential and thus making Design Thinking an iterative or agile method. The five-stage model is constructed of five different stages called *Empathise*, *Define the problem*, *Ideate*, *Prototype* and *Test*.

In the *Empathy* stage the designers set aside their own assumptions to gain insight into users and their needs. Or, in other words gain an understanding of the problem that needs to be solved. *Define the problem* concerns analyzing the information gathered during the *Empathy* stage. The *Ideate* stage is used for generating as many ideas as possible which can help solving the problems defined in the previous stages. *Prototyping* is used as an experimental activity to identify solutions for the defined problems gathered from previous stages.

During the different iterations in the design thinking process features can be added to the prototype. The final stage in the five-stage model is *Testing*. Since design thinking is an iterative process different result from testing can be achieved during the prototype development. In early evaluation of prototypes, the results from the test can be used to redefine problems and learn about the understanding of the users, mainly what they are thinking and feel towards the product or service. In later stages of the prototype development the prototypes are evaluated to ensure users requirements and needs are met.

2.4 Method theory

2.4.1 Brainstorming

Kelly (2000) mentions that brainstorming is a useful tool for generating innovative ideas for solving a problem and that it can be carried out in several different ways. According to Kelly (2000) seven techniques can be used to improve the outcome of a brainstorming session, three of these are: *Sharpen the focus* where you set a clear problem statement such as "What functions are central to x", *Playful rules* which implies that you shouldn't be negative toward ideas and *Number your ideas* where you give each idea you have a separate number to be able to reference it more easily (Kelly, 2000).

2.4.2 Benchmarking

Benchmarking is often referred to as a method to investigate best practices from other solutions with the goal of improving the performance of a system (Jean-Luc, Vincent Maurice, 2005). Many other definitions of benchmarking can be found, and the goals of benchmarking can vary (Anand Kodali, 2008). For example, benchmarking can not only be used for investigating best practices but also for comparing and identifying system functionalities (Anand Kodali, 2008).

2.4.3 Observations

Observations allow researchers to study human behavior in a systematic way to gain an understanding of the environment, tasks and interactions carried out in their everyday environment. It can be useful for understanding user's context, tasks and goals in each context. For example, a truck driver driving a truck from point a to point b as a part of their daily work (Kothari, 2004: Baker, 2006). They can also be used for evaluation, by viewing how well a current prototype carries our similar tasks and goals (Rogers, Sharp Preece, 2011).

2.4.4 Semi-structured interviews

In a semi-structured interview, a set of predetermined questions is used to allow for follow-up questions to be asked (Patel Davidsson, 2011; Wadsworth, 1997). This allow the interview to resemble a natural conversation rather than a rigid one, which often limits the respondent's answers (Wadsworth, 1997).

2.4.5 Scenarios

Rogers, Sharp Peerce (2011) describe scenarios as stories of human activities and tasks as the basis for discussions and exploration of contexts, needs and requirements. Similarly, Carroll (2000) describes scenarios as stories about users and their activities when interacting with a system. Scenarios are also useful for expressing proposed or imagined situations in conceptual design (Rogers, Sharp Preece, 2011)

and can be used as manuals or templates for user evaluations of prototypes (Rogers et.al., 2011).

2.4.6 Prototyping

Low-fidelity prototypes are useful when exploring ideas in the early stages of development or during conceptual design. Low-Fidelity prototype tend to be simple and quick to produce allowing for flexibility and encourages exploration and modifications of design concepts (Rogers et.al., 2011). Low-fidelity prototypes can be used to show how a system may look like (Rudd, Stern Irensee, 1996) and the intended functionality and interactions in the system (Rogers et al., 2011).

2.4.7 Use cases

Use cases are a collection of possible interactions related to specific goals between a system and its actors (Cockburn, 1997). They are used to describe the requirements of a system and can also be used for creating and validating design to ensure it meets the requirements (Schneider Winters, 2011). The word "actor" is used to represent a category of users that have similar behaviors when interacting with a system (Lee Xue, 1999). An actor does not necessarily need to be human, it can be an organization, software or machines (Larman, 2012). Actors can also be primary or supporting actors (Larman, 2012), where the primary actors are related to the main goals which they only can reach by the assistance of the system. Supporting actors assist the primary actor in reaching its goal (Cockbun, 1997). For example, a user needs to login to a service, the primary actor is the user, if the user has forgotten the password, the password database can be a supporting actor as it sends a link to the user to reset its password. A basic flow in a scenario describes a path of successful actions in a use-case which uninterrupted by alternative conditions reaches a goal. This is referred to as the normal course (Rogers, et al., 2011) or main scenario (Larman, 2012). Alternative flows, on the other hand are paths from the main scenario that due to not meeting ideal conditions have longer and complex paths toward the end goal than the main scenario (Larman, 2012). According to Larman (2012) there are three common use case formats. The 'brief' use case is a one-paragraph summary which usually is the main scenario. 'Casual' use cases are multiple paragraphs summaries that covers various scenarios. The 'fully dressed' use case describes all the steps and variations in detail.

2.4.8 Usability testing

Usability testing is carried out to identify problems with the use of a product or a system while striving to ensure that the user and functionality requirements are achieved in the design of a product or system. Moreover, usability tests can be conducted in an iterative design process by for example using a series of short tests depending on what the designer wants to test in a product or system (Rubin Chisnell, 2008). Standard items which normally are tested include placement of buttons and icons or navigation in the interface to ensure enough feedback is given to

the user. A common technique for gathering feedback from the people participating in a usability test is to ask them to "Think-aloud" while completing a series of predetermined tasks within a system. This allow the designers to understand the users thought process which is useful for finding design flaws (Rubin Chisnell, 2008). Usability tests also enable discussions to be had by asking user of how they understood a task after observing their actions within a product or system.

Before conducting a usability test with real participants, it can also be wise to perform a pilot test with users knowledgeable of the systems intentions while not being directly involved in its design (Rubin Chisnell, 2008). This is useful since it may result in finding unintentional flaws in a system or product before taking up a "real" participants time.

One prominent way of testing a design before running a final test with possible end-users is to use a Cognitive walkthrough. A cognitive walkthrough is a test used early in the design process to identify usability issues related to completing tasks within a system (Rubin Chisnell, 2008; Polson, Rieman Wharton, 1992, Interaction Design Foundation 2018; Green et al. 2000; Mahatody et al. 2010). It's done by giving users a set of tasks to complete within an interface and after each task is completed prompt the user to answer the following four questions (Blackmon, Polson, Kitajima Lewis, 2002):

- Can you achieve the right outcome?
- Do you notice that the correct action is available?
- Can you associate the correct action with the outcome you are expected to achieve?
- If the correct action was preformed: can you see that progress is being made toward the intended outcome?

Van der Laan, Heino and Waard (1997) present method for assessing user's acceptance of a system on two dimensions: Satisfaction and Usefulness The method a consists nine items of pairs and a five-graded Likert scales:

1. Useful - Useless
2. Pleasant - Unpleasant
3. Bad - Good
4. Nice - Annoying
5. Useful - Useless
6. Pleasant - Unpleasant
7. Assisting - Worthless
8. Desirable - Undesirable
9. Raising Alertness - Sleep-Inducing

2.5 Design Principles

Several design principles can be considered regarding ease of use, usefulness, pleasantness and effectiveness when designing an interface concept. The following design principles served were used as design guidelines to aid the design of the user interface design (UID) for the Back-Office concept.

Nielsen's 10 suggested usability heuristic principles for evaluation served as a design guideline for creating a usable UID in this thesis and not as a principle for evaluating a UID as suggested by Nielsen (1994).

1. Visibility of system status: The users should always be informed by the system through appropriate feedback of what is going on with the system.

2. Match between system and the real world: The system should communicate with the users' in a language that is used by the user, meaning that words, phrases and concept should be familiar to the user. Information in the system should appear in a natural and logical order by using real-world conventions.

3. User control and freedom: The system should support undo and redo functions since users can make mistakes. These functions should be clear without having to go through an extended dialogue to achieve the outcome.

4. Consistency and standards: Following platform conventions is recommended, words, situations or actions should be similar.

5. Error prevention: Preventing problems from occurring in the first place is better than good error messages. Eliminate error-prone conditions or check for them and make users confirm before commit to the action.

6. Recognition rather than recall: Minimize the user's memory load. Instructions should be visible and easily retrievable when needed.

7. Flexibility and efficiency of use: The system should cater to booth novice and expert users by allowing users to tailor frequent actions. By using hidden accelerators experts can speed up the interactions in the system.

8. Aesthetic and minimalist design: Display only information which is needed and relevant to the current dialogue with the system.

9. Help users recognize, diagnose and recover from errors: Error messages should be clear and precisely indicate the problem and suggest solutions.

10. Help and documentation: It may be necessary to include documentation to provide help to the user. Such information should be easy to search and focused on users and how to achieve these tasks.

"Overview first, zoom and filter, then details on demand" (Shneiderman, 1996) was used as a guideline in information seeking tasks in the system. By using this design guideline users are expected to be able to explore an interface more freely while beforehand gaining enough information to know where to look for details. Craft and Cairns (2005) suggest that "Overview first, zoom and filter, then details on demand" serves as a useful guideline when developing a novel prototype for problems regarding initial design dilemmas.

3
Method

This section describes how we used the theory presented in our framework to reach our aim and purpose by answering our three research questions:

What are the required functions of a Back-Office system for platooning?

What qualifications are required of the user for managing a Back-Office system for platooning?

What are the design challenges for creating a Back-Office system for platooning?

The section starts with a brief description of where the methods from our theoretical framework were utilized in the five different stages in the design thinking methodology. Then, the five iterations (see figure 3.1) of our design process are presented chronologically.

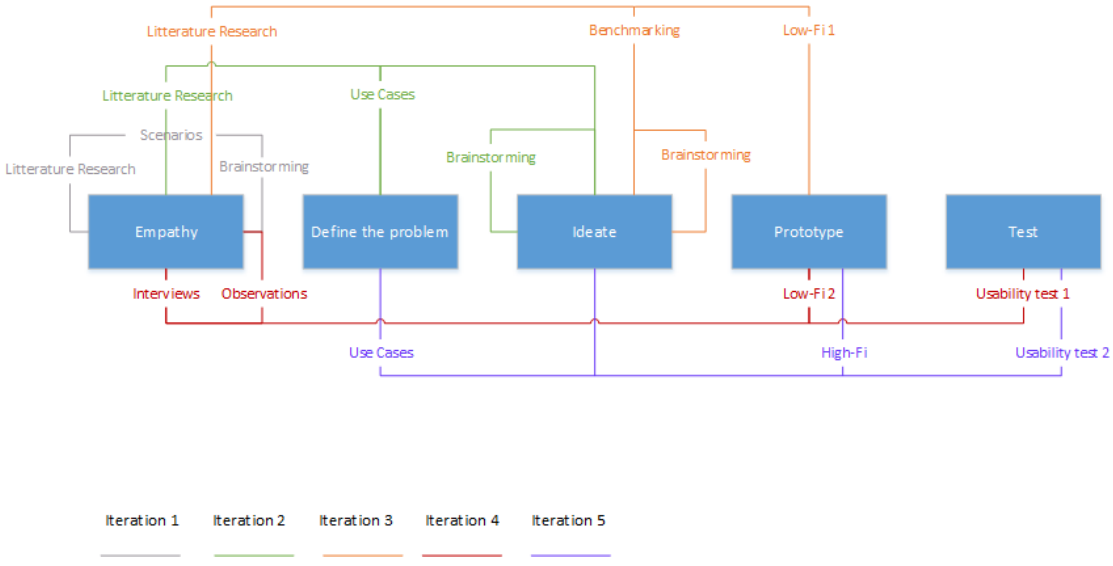

Figure 3.1: Our application of design thinking.

This thesis was carried out using the iterative design thinking methodology. The *Empathy* stage was employed by performing literature research, consulting experts, observing users and systems, creating scenarios and interviewing users working within systems with similar responsibilities to the Back-Office such as monitoring, planning

and managing. The goal was to gain as much information as possible to be able to *define the problem* in the next stage.

In the *define the problem* we initially worked with an initial thesis statement from Volvo GTT which gave us a brief understanding of the research topic. Afterwards, we conducted a literature review and engaged in semi-structured interviews at various companies. During the thesis, we also had conversational interviews with several persons within Volvo where we discussed the subject. To narrow down the interface design scope and take a stance on the different problems regarding platooning, we also made assumptions regarding several topics.

In the following stage: *ideation*, we used methods such as brainstorming, scenarios and sketching enabling fast prototyping on a whiteboard. We also looked at other systems outside of our focus area for inspiration by conducting a "benchmark", collecting functions from the different systems.

In this thesis, we used the normally forth stage of the design-thinking method *prototype* at the same time as *ideate* to easily explain thoughts and get a shared understanding of the defined problems. However, low-fidelity and high-fidelity prototypes were also created later in the process allowing for the last stage *testing*.

Before our final design concept, we conducted usability tests with people unfamiliar with the topic of platooning by using a cognitive walkthrough and a low-fidelity prototype. Using the gathered feedback, we then developed a high-fidelity prototype and conducted usability tests with users who were more familiar with the topic of platooning.

4
Design Process

4.1 Iteration 1

Throughout the first iteration we focused on gaining an initial understanding of which tasks that are central for a Back-Office to be able to manage platoons. Literature research was performed during the beginning of the project to gain knowledge of platooning in general, while also familiarizing ourselves with different Back-Office systems. We used Google scholar and Chalmers internal database for research material as well as internal documents provided by Volvo GTT. The information which emerged during the research was later used as an aid for further discussion during scenarios and brainstorming.

Initially, scenarios were created based on the topics provided by Volvo GTT: fuel, navigation, geofencing and match-making. Using these topics, we then sketched on a whiteboard to simulate different situations that the Back-Office would need to solve. Writing down scenarios we managed as Rogers et.al (2011) describes, to create topics aiding us in exploring contexts, needs and requirements of the Back-Office system. These topics were later carried onto the brainstorming session.

The aim in the first brainstorming session was to conceptualize the central tasks required of a Back-Office system for platooning. To reduce the extent of possible variables affecting scenarios for different Back-Office tasks, assumptions were made by using the understanding that was gained from the literature research as well as our judgment. These assumptions were written down in a separate document to keep track of the assumptions made. The brainstorming session was based on open communication and sketching on a whiteboard to elaborate and explain ideas.

4.1.1 Iteration 1 - Outcome

Upon completion of the first iteration, we had gained an initial understanding of which functions that are central to the Back-Office for managing platoons. We also found that there is an ambiguity in literature of what tasks the Back-Office should be able to carry out. This motivated our scenario-based sketching which later continued onto our open discussion in the brainstorming session. Finalizing the iteration, we have found that the following functions are central to the Back-Office:

- Create platoon: Being able to create a platoon ahead of time or in real time is one of the main tasks of the Back-Office.

- Maintain platoon: Once a platoon is created, it must be maintained or monitored over its lifespan.
- Guide vehicle to platoon: If a there are vehicles available for platooning but not currently connected to one, it should be possible to join vehicles together to form a platoon.
- Planned simulations: Before scheduling a platoon, it should be possible to simulate and try out different alternatives.
- Statistics (big data): Data from the vehicles connected to platooning can be presented by the Back-Office.

These functions were based on the following assumptions which emerged during the scenario and brainstorming session:

- Truck drivers decide themselves if they wish to join a platoon if they already are on the road.
- If a platoon needs to be dissolved the drivers in a platoon needs to be notified ahead of time.
- Trucks who are shown in the Back-Office all have the required prerequisites for platooning.

4.2 Iteration 2

As a continuation of the previous iteration we began by further researching the topic of platooning. Previously from before, we chose to focus on examining prior and ongoing projects working with platooning focusing on their mentioning's of a Back-Office. We found similarly to before, little information regarding its functionality. However, our research revealed several use-cases from the SARTRE project. Yet, the discovered use-cases were divided into Platoon Use-Cases (PUCs) involving platooning technicalities and Back-Office Use-Cases (BUCs) (Robinson et al. 2010). We then chose to translate the PUCs into Back-Office use-cases focusing on functionality and interface design. This was done since the technical (PUC) use-cases easily could be readjusted and connected to the Back-office instead. For example; "Joining procedure" could be the same as “join a platoon” within the Back-Office.

Our secondary brainstorming session was carried out similarly to our initial one: by discussing possible Back-Office tasks required for managing platoons. However, our goal was to further develop the previously found tasks. Important to note is also that we chose to state problems with different tasks required of the Back-Office. These were later solved by making assumptions since there was no answer to these problems in literature. During the brainstorming session, we also used Kelly (2000) techniques: Sharpen the focus and Playful rules.

The work with the use cases started with defining the most obvious actor in the system. The name Back-Office Manager (BOM) was chosen as the primary actor. Another actor that was defined was the Back-Office Database (BOD) which served

as an external actor. We saw the database as a separate entity from the Back-Office System (BOS). The base functionality found in iteration 1 as well as the translated Back-Office use cases from the SATRE project (Robinson et al. 2010) was used to create the first use case diagrams and brief use-case descriptions.

4.2.1 Iteration 2 - Outcome

The result of the second iterations literature research was use-cases from SARTRE's platooning project (Robinson et al. 2010). From this, the following use cases were identified:

- Create platoon
- Maintain platoon
- Leave platoon
- Join platoon
- Dissolve platoon
- Guide to platoon
- Charge platoon
- Register
- Handle platoon status

These use-cases were then used as inspiration during the upcoming brainstorming session which resulted in a division of the Back-Office system into three different sections: Planned, Live and Statistics, each named after their responsibility. The Planned section of the system is responsible of managing planned platooning, Live "real-time" platooning and Statistics is for displaying various data gathered by platoons for example fuel consumption and route.

4.2.2 Assumptions

We stated problems related to platooning that needed to be solved to be able to continue developing the Back-Office functionalities and its design. They were solved by making assumptions of the outcome as we were unable to find answers to these problems during research.

- **Problem 1:** It needs to be clear whether the Back-Office should be able to haulage contractors to reschedule their starting times to benefit being able to create more platoons.
- **Assumption 1:** The Back-Office manager can reschedule the starting times of vehicles within an allowed timespan. The vehicles are provided with a latest arrival time by the haulage contractor allowing the Back-Office manager to have more flexibility in planning platoons.

Comment: Without this assumption it would be more difficult for vehicles to be scheduled for platooning.

- **Problem 2:** Pre-planning of platoons may require interest points for joining platoons, or it could be up to the Back-Office personnel to choose where a platoon starts.
- **Assumption 2:** The Back-Office automatically selects the most optimal join-point for the vehicles who either wish to create or join a platoon.

Comment: Without this assumption it would be more difficult for vehicles to be scheduled for platooning.

- **Problem 3:** There's an uncertainty in how long ahead of time a platoon needs to be planned to notify the haulage contractor in time (daily, weekly or monthly).
- **Assumption 3:** Platoons will be planned on a weekly basis where the same vehicle can be displayed multiple times for all the days that it is available to platoon. When a vehicle has no matches, the Back-Office manager can reject it from platooning that day.

Comment: There needs to be way for the Back-Office manager to reject vehicles unable to find a platoon to join at a certain date. Without this function, it becomes difficult for the Back-Office to know when as many platoons as possible have been created for a certain date and to then be able to move onto another date.

- **Problem 4:** The management of IDs of vehicles and platoons is uncertain.
- **Assumption 4:** Each vehicle will have a unique ID and each platoon will have a unique ID. When a platoon completes its route, the ID is used and cannot be obtained again.

Comment: Without the use of unique ID's it becomes difficult to track data of the vehicles and platoons.

- **Problem 5:** If a truck weighs more than another in a platoon, it needs to be clear if the truck is required to be the lead vehicle if it joins the platoon.
- **Assumption 5:** The heaviest truck is always the lead vehicle.

Comment: This disregards the need of looking further into details regarding where to place a vehicle when it joins a platoon as the heaviest should be first and the lightest last.

- **Problem 6:** Truck drivers need special training to drive a lead vehicle.
- **Assumption 6:** Any driver connected to the platooning system will be able to take on the role as follower or lead vehicle.

Comment: If there is a requirement for lead vehicle training, there are going to be less opportunities for vehicles to join platoons if they are driving a heavier truck.

- **Problem 7:** There is currently no limit as to how many vehicles that can be in a platoon.

- **Assumption 7:** A maximum of five vehicles has been set.

Comment: Allowing creation of platoons with more than five vehicles would not impact the Back-Office way of creating a platoon.

- **Problem 8:** Unknown which roads that are available for platooning.
- **Assumption 8:** Only highways are used as platooning roads.

Comment: Only affects drivers since their route is adjusted. If more roads were available, it wouldn't impact the design of the Back-Office.

Upon finalizing these assumptions and using the division of the system into Planned, View and Data as our future concept which we later want to prototype, we chose to describe the functions of the systems different parts with the following use-cases:

4.2.3 Planned Use Cases

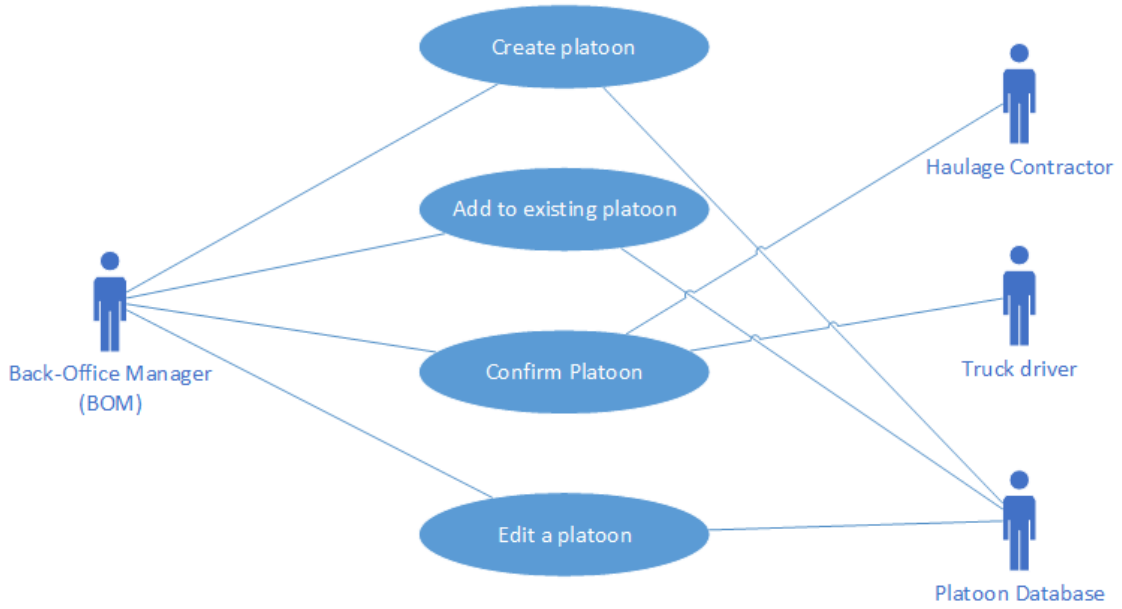

Figure 4.1: Planned use cases.

Use Case Planned – Create a platoon
The Back-Office Manager (BOM) navigates to the planning view in the system. The BOM browses the list with vehicles available for platooning sent from the haulage contractors. The BOM selects a vehicle. The system shows the route displayed on a map and filters the list to show matches for the vehicle. The BOM selects another vehicle. The system adds the current vehicle to the map and displays information about the potential platoon. The BOM clicks on create platoon. The system displays a message that a platoon is created.

Use Case Planned – Add to existing platoon
The BOM clicks on an already created platoon. The system displays the route of

the platoon and the vehicles starting destination on the map. The vehicle list is filtered displaying vehicles that can be included in the platoon. The BOM selects a vehicle and click on join platoon. System displays a message that the vehicle has been joined to the platoon.

Use Case Planned - Confirm Platoon
The BOM has created a platoon and want to send it to the Haulage contractor. The system displays all created platoons in a list. The BOM clicks on the lock all button. System locks all platoons and the Send button is now available. The BOM clicks on the send button. The system displays a summary of the platoons and the vehicle's in them. BOM clicks on Confirm. System displays a message that the platooning list is sent to Haulage contractors.

Use Case Planned – Edit a platoon
The BOM selects a platoon that needs an edit. The system displays the route of the platoon and the vehicles starting destination on the map. The BOM clicks on the details button. The system displays details about the platoon and the vehicles. The BOM clicks on the edit button. The system displays the editing options position, remove vehicle, remove platoon. The BOM selects an editing option.

4.2.4 Live Use Cases

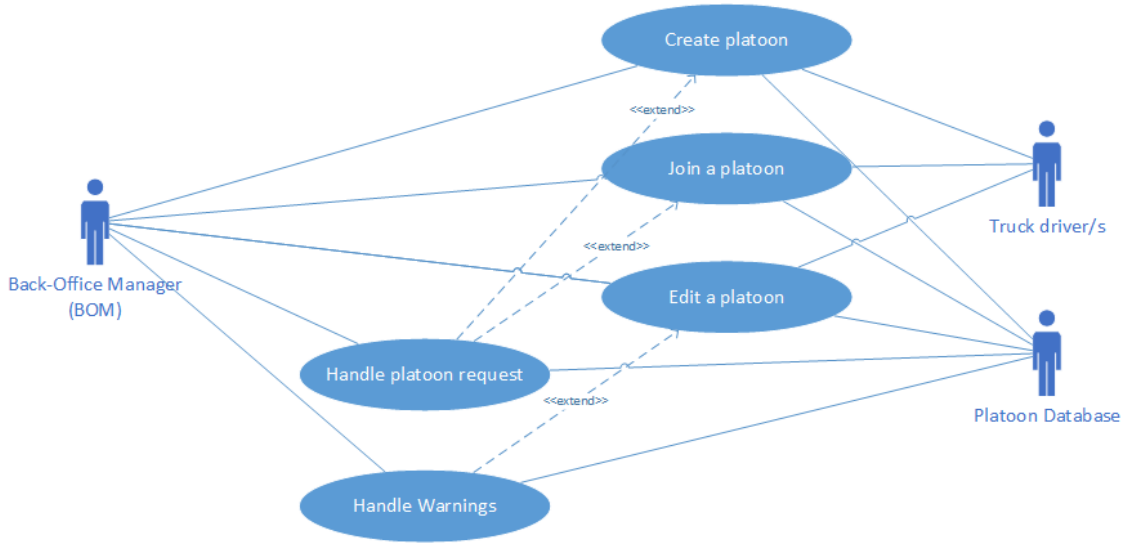

Figure 4.2: Live use cases.

Use Case Live - Create a platoon
The BOM finds a potential match by searching the map for vehicles to create a platoon with. BOM selects a vehicle. The vehicle displays the route of the vehicle and some additional information. The system shows another vehicle in the list which indicates that there is a possibility to create a platoon. BOM clicks on the other vehicle. The system shows both vehicles information side by side as well as

additional information about catch-up distance and possible distance for them in a platoon. The BOM reads the information and decides to create a platoon. The system sends instructions to the drivers.

Use Case - Join a platoon
The BOM finds a potential match by searching the map for a vehicle to join a platoon with. BOM selects the vehicle. The vehicle displays the route of the vehicle and some additional information. The system shows a platoon in the vehicle list which indicates that there is a possibility to join the platoon. BOM clicks on the platoon. The system shows the vehicles and the platoons information side by side as well as additional information about catch-up distance and possible distance for the vehicle in the platoon. The BOM reads the information and decides to join the vehicle to the platoon. The system sends instructions to the vehicle and to the platoon.

Use Case Live - Edit a platoon
The BOM selects a platoon or a vehicle that needs an edit. The system displays the route of the platoon or the vehicle and current position on the map. The BOM clicks on the details button. The system displays details about the platoon or the vehicle. The BOM clicks on the edit button. The system displays the editing options for platoons: position, remove vehicle, remove platoon and for vehicles: guide vehicle to platoon. The BOM selects an editing option.

Use Case Live - Handle Platoon Request
The system displays a message about a pending platoon request. The BOM can't ignore the request and therefore must click on it. The system shows two vehicles on the map and displays information about the request. The BOM reads the information displayed about their routes and additional information. The BOM decides to approve the request based on the information and the system recommendation. The system sends a message to the drivers with instructions.

Use Case Live - Handle Warnings
The system displays a warning that an accident has been reported on the route of a platoon. The BOM clicks on the warning. The system shows the affected platoon and display known information about the accident. The BOM reads the information and takes appropriate action by clicking on the details button on the platoon and selecting an editing option.

4.3 Iteration 3

During the literature review a list of keywords was written down. The idea was to include keywords that were relevant to Back-Office functionality for fleets of vehicles or trucks. Keywords such as real-time tracking, real-time positioning and fleet management was used to find management systems for vehicles with Back-Office tasks such as monitoring, planning and controlling functions. The search yielded a new set of keywords of systems such as traffic management, fleet management, fleet telematics and intelligent transportation systems.

A brainstorming session was then formed to discuss the keywords found in the literature research. Using Kelly (2000) techniques: Sharpen the focus, playful rules and Number your ideas.

It was done by first writing down the keywords found in the literature review and placing them on sticky notes on the wall. The keywords from the literature review served as a base for the brainstorm. Then new sticky notes were added containing new ideas. The next step was to group similar keywords and ideas by placing them close together, distancing them from other groups. If it was unclear where a sticky note belonged, it was placed in its own group. When all the sticky-notes had been grouped, new sticky-notes were created to name each group. After that a review was done of the groups and their items. The next step was to discuss each groups relevance to users, functions and data. Finally, the groups were then placed in the three areas: Planning, Live and Data which were derived from the previous iteration.

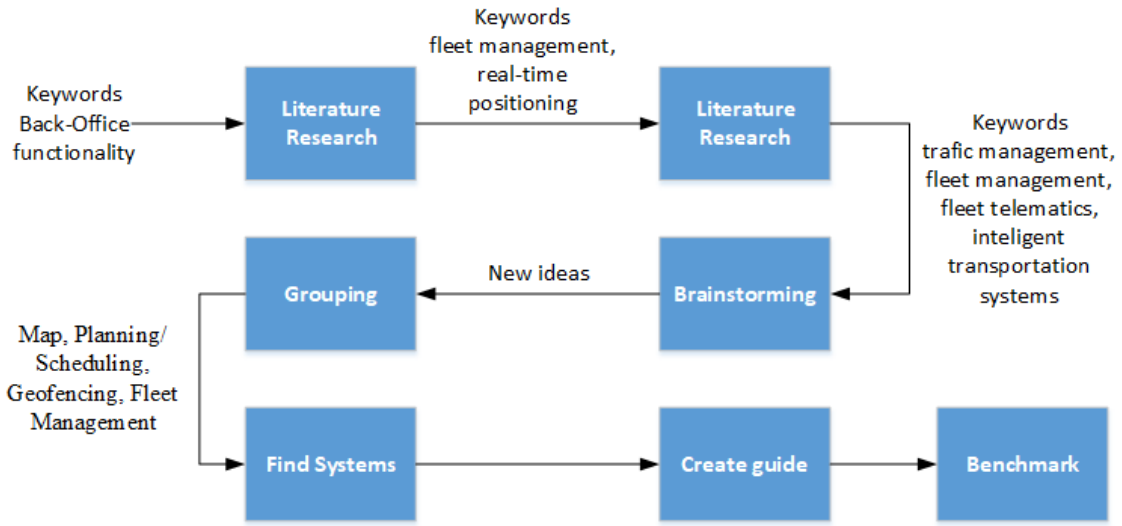

Figure 4.3: Process to find systems for benchmarking.

The functions found within the groups were then used to find systems or applications to benchmark. The following group topics were used in the search: Map, Real-time positioning, Progress tracking, Notification/Alerts/Actions/History, Planning/Scheduling, Geofencing and Fleet Management. The benchmark focused on finding functionality and data that could be adopted into the design of the Back-Office system and not on comparing the systems with each other (Anand Kodali, 2008).
Below are the grouped topics derived from brainstorming and literature research which were applied as a guide in the benchmark for finding functional and data requirements.

Guide benchmark						
Maps	**Notifications**	**Alerts**	**History**	**Planning**	**Geofence**	**Data displayed**
Overview of the map	Display of notifications	Search for alerts	Search for events that has occurred?	Create a route	Search for geofence	What vehicle data is displayed?
Menus	What kind of notifications are displayed?	Read alerts	How events in the history are linked?	Edit Route	Create	What driver data is displayed?
Search		Filter alerts	How history is displayed	Display routes	Edit	What map data is displayed?
Result display		Handle alerts	How to see changes made?	Destination planning	How geofence is displayed?	How data is displayed
Map options				Follow up on planned results	Assignment of geofence	

Figure 4.4: Guide created for benchmark.

The findings of the systems benchmarked were put in an excel document (Appendix F) under corresponding category from the guide (Figure 3.3) with the addition of the name of the system as a topic. Some of the benchmarked systems had functions and data for more than one category. This was solved by color coding the topics to their respective category.
The possible data requirements found in the benchmarked systems was written down in a separate list and divided into the following categories:

- Vehicle data: Data containing information about the vehicle such as model, fuel type.

- Driver data: Data relevant to the person driving the vehicle, information such as name and contact information.

Some of the data found in the benchmark was removed as it was not deemed to be relevant to the Back-Office Manager. This was data that could be relevant to a haulage contractor e.g. data concerning service of vehicles (next service date, km remaining until service, fault codes).

After finalizing the benchmarking process, initial development of our first low-fidelity prototype began. This was done by using an online prototyping software called Balsamiq where we created three main screens for Planning, Live and Data using the benchmark and previously gathered material for functional requirements.

4.3.1 Iteration 3 - Outcome

The third iteration resulted in data requirements from the benchmark which in conjunction to the previously gathered data from iteration one and two were used to create our first low-fidelity prototype.

4.3.2 Data requirements found in benchmark

The outcome from the benchmark and the previous iteration (Iteration 2) where use cases were created, resulted in four tables for data requirements and a table for functional requirements. The data requirements displayed in the table below uses inheritance and association between the different data tables. For example, "Vehicles in Platoon Data" inherits from "Vehicle Data" and "Platoon Data" is associated to "Vehicles in Platoon Data".

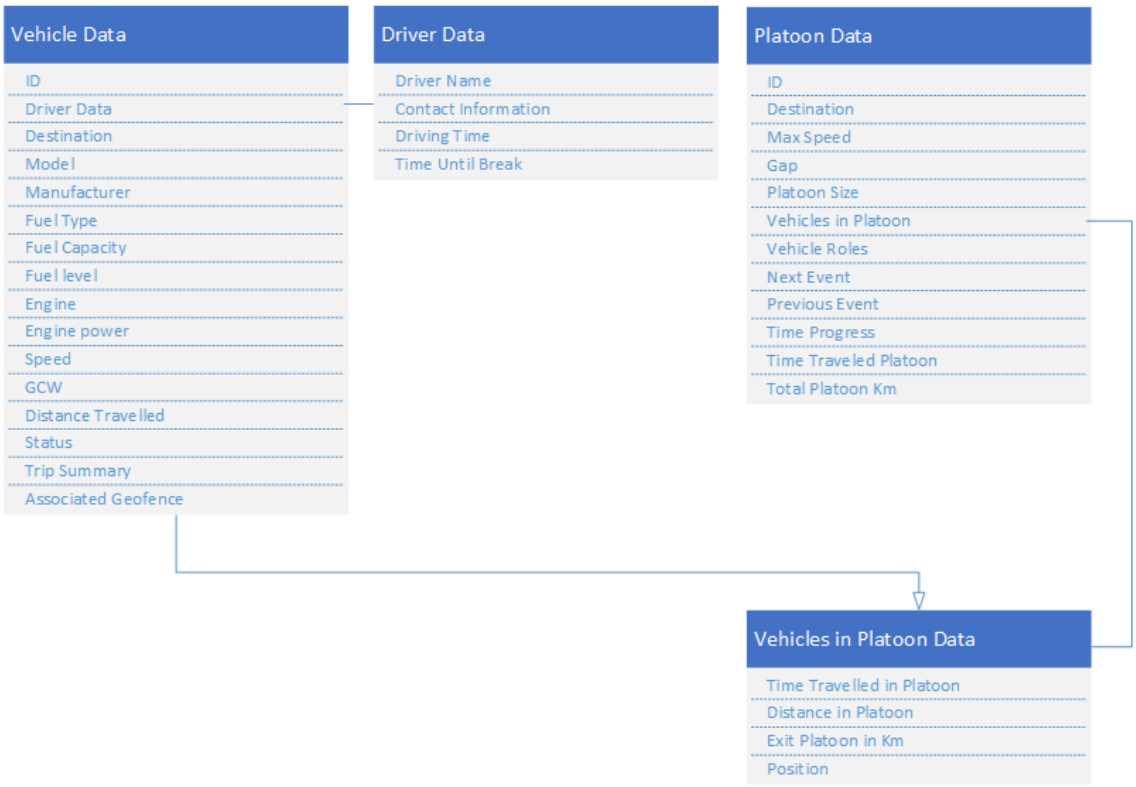

Figure 4.5: Data requirements found in benchmark.

A short explanation of the data in the tables are given as well as an example on what kind of information the data contains.

Vehicle data
Vehicle data contains general information about the vehicles in the system.

- ID: Every vehicle in the system should have a unique identifier e.g. V12 for (Vehicle 12).
- Destination: Shows the vehicles start and end destination e.g. Gothenburg – Stockholm.
- Model: The model of the vehicle: e.g. FH16.
- Manufacturer: The vehicles manufacturer e.g. Volvo.
- Fuel type: The type of fuel the vehicles uses e.g. Diesel.

- Fuel Capacity: The volume of fuel the vehicle has capacity for e.g. 300 liters.
- Fuel level: The vehicles fuel level e.g. 90% (270 liters).
- Engine: Engine model e.g. D13K420.
- Engine Power: The engine power e.g. 420 hp.
- Speed: The current speed of the vehicle e.g. 80km/h.
- GCW: The maximum allowed combined mass of the vehicle e.g. 40 tonnes.
- Distance traveled: The distance the vehicle has traveled from start to current time e.g. 124 km.
- Status: The status of the vehicle e.g. driving, on break, waiting.
- Trip summary: A summary of the trip e.g. Distance, average speed and time.

- Associated geofence: Shows a specific geofence associated with the vehicle e.g. Alert when vehicle has reached a certain destination.

Driver Data
Driver data is the information that the system knows about the driver.

- Driver name: The name of the person driving the vehicle e.g. John Smith.
- Contact information: Contact information of the driver of the vehicle e.g. phone number.
- Driving time: Total driving time e.g. 3 hours.
- Time until break: Time until driver must take a break e.g. 1 hour 15 minutes.

Platoon Data
Platoon Data contains information about the platoon as well the vehicles in the platoon and therefore also Vehicle Data and Driver Data.

- ID: A unique identifier for the platoon e.g. P01.
- Destination:
- Max Speed: The max allowed speed of the platoon e.g. 100 km/h.
- Gap: The distance between the vehicles in the platoon e.g. 0,8 seconds.
- Platoon Size: The current size of the platoon and the maximal number of allowed vehicles in the platoon e.g. 2/5.
- Vehicles in platoon: (See below).
- Vehicle roles: Displays what vehicle is leader and what vehicles are followers in the platoon.
- Next event: The next planned event occurring in a platoon e.g. Vehicle 21 leaves platoon in 15 km.
- Previous event: A previous event that affected the platoon e.g. Platoon recreated after dissolve.
- Time progress: Displays if the platoon is keeping its schedule e.g. On time, early, late.

- Time travelled platoon: The amount of time the platoon has been driving e.g. 2 hours
- Total Platoon Km: The total distance the platoon has driven e.g. 160 km.

Vehicles in Platoon Data
Vehicles in Platoon Data contains additional information that Vehicle Data has when a vehicle is in a platoon.

- Time travelled in platoon: The amount of time the vehicles has been driving in the platoon e.g. 1 hours.
- Distance in platoon: The total distance the vehicle has driven in a platoon e.g. 100 km.
- Exit platoon in km: Km left until the vehicle leaves the platoon e.g. 25 km.
- Position: The vehicles position in the platoon e.g. position 2/5.

4.3.3 Functional requirements from benchmarking

The following functions was found in the benchmark: geofencing, real-time positioning, alerts/notifications/warnings, and dashboard.

Geofence
- The geofence should have basic CRUD capabilities. Create, Read, Update, Delete.
- Quickly find a specific geofence by searching.
- Set different geofence types. Grouping geofences into different categories where global settings could be applied.
- Freehand drawing of a geofence should be option to quickly create a geofence, as well as very exact geofences where coordinates and size of geofence are manually inputted.
- Ability to choose different shapes as well as choosing a color to differentiate geofences.
- Creating a geofence should be available directly from the map.

Real-time positioning
- Direction of moving vehicle should be displayed to quickly judge if a vehicle is relevant when looking at the map.
- Quickly find a vehicle on the map by searching for it.
- A list with all active vehicles to quickly navigate between vehicles. A sorting function should exist to narrow down the list if needed.
- Clicking on a vehicle in a list should filter the map to the location of the vehicle.
- The map should be zoomable and filter the list accordingly to the zoom level of the map.

- Map layers or different map views should exist to enable the user to switch between views and filter the map.
- Hover function on vehicles on the map could be helpful to quickly provide details about the vehicle.

Alerts/Notifications/Warnings
- Grouping events in the system.
- Specifying the level of the event/alert/warning.
- See history of events/alerts/warnings.
- Listing all events/alerts/warnings with a more detailed view to read more about a specific event/alert/warning.
- Set reminders.

Dashboards
- Dashboards provide summaries of information and serve as quick access or links to other functions.

4.3.4 Functional requirements from Use cases

The following functions was derived from the Use cases in Iteration 2: Create a platoon, add vehicles to platoon, confirm platoons, edit Platoon, join to a platoon, handle platoon requests and handle warnings.

Create a platoon
- Select one or more vehicles.
- Show information about vehicles.
- Show routes.
- Filter to only relevant vehicles.

Add vehicles to platoon
- Add vehicles to a created but not confirmed platoon.

Confirm Platoons
- Lock changes.
- Display summary of planned platoons.
- Confirm before sending platoons to haulage contractor.

Edit platoon
- Edit position of vehicle in a platoon.
- Remove vehicle from platoon.
- Remove platoon.
- Guide vehicle to platoon.

Handle Platoon Requests

- Show alert that there is a platoon request.
- Display information about platoon request.
- Handle the platoon request.

Handle Warnings

- Show alert that there is a warning.
- Display information about warning.
- Handle the request by using editing platoon.

4.3.5 Events

Events are actions that are logged in the system. These are the following event types: Warnings, Alerts and intermissions. Warnings are critical events that can have a major effect on a vehicle or platoon. Vehicle problems, accidents, road condition and driver behavior are considered critical events. Users cannot avoid looking at warnings as they are displayed as a pop-up message when they occur. Alerts are events that are not as critical as warnings are recommended to look at e.g. traffic density, geofence alerts and road work.

Events that occur for a platoon are called intermissions. The following intermissions have been identified as relevant to log in the system: *Platoon created*, *Platoon dissolved*, *Platoon recreated*, *New lead vehicle*, *Vehicle left platoon*, *Vehicle joining platoon* and *Vehicle joined platoon*. The system logs the time, vehicles and the coordinates of the intermissions. When a platoon is created the first time by two or more vehicles, the intermission is *Platoon created*. When a platoon needs to dissolve into individual vehicles the intermission is called *Platoon dissolved*. When a platoon is dissolved and then recreated the intermission is called *Platoon recreated*. When a vehicle leaves the platoon, the intermission is called *Vehicle left platoon*. When a vehicle starts the join to the platoon the intermission is called *Vehicle joining platoon*. *Vehicle joined platoon* is the intermission when the joining vehicle becomes a part of the platoon. *New lead vehicle* is the intermission when the platoon gets a new lead driver, this can occur when a lead vehicle leaves the platoon before the other vehicles.

4.3.6 Low-fidelity prototype 1

The result of our first low-fi prototyping was three views, each one representing the fundamental tasks for either planning, live or data views. These were completed to serve as a basis for continued low-fi prototyping. For this reason, we chose not to consider Nielsen (1994) design principles when creating the first three views in the prototype.

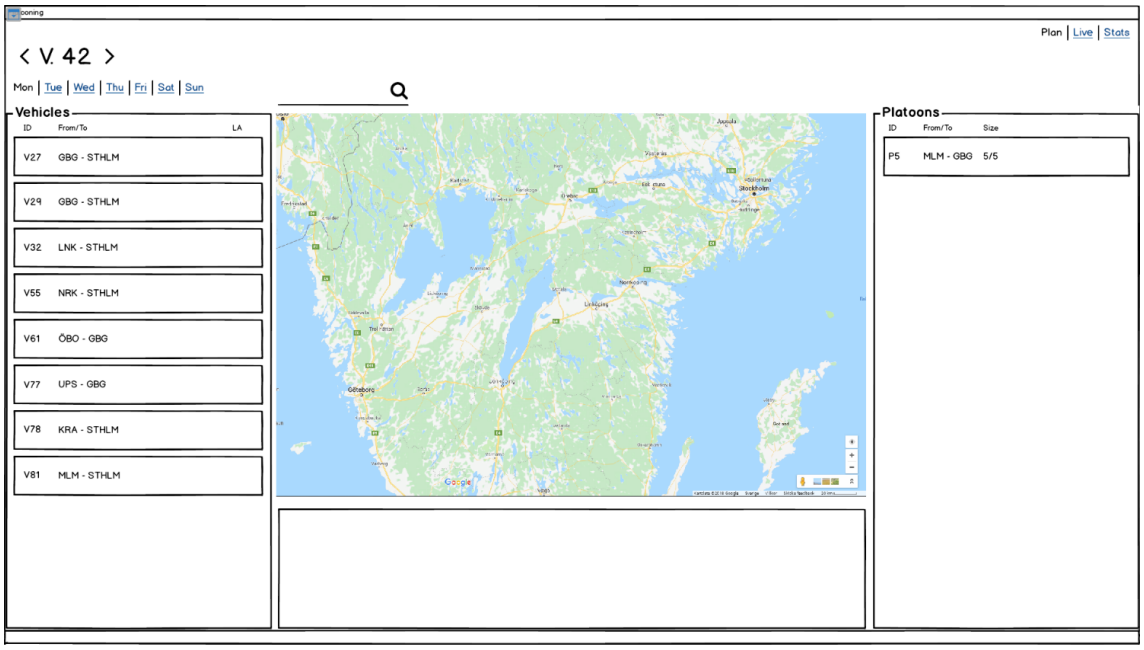

Figure 4.6: Low-Fi prototype of planned view.

The planned view was made up of a list of available vehicles and a list of already planned platoons, a map, search and weekdays. Other details included the ID of the vehicles or platoons as well as their starting point and destination. We also chose to include a size of how many vehicles were currently in a platoon with the maximum being five.

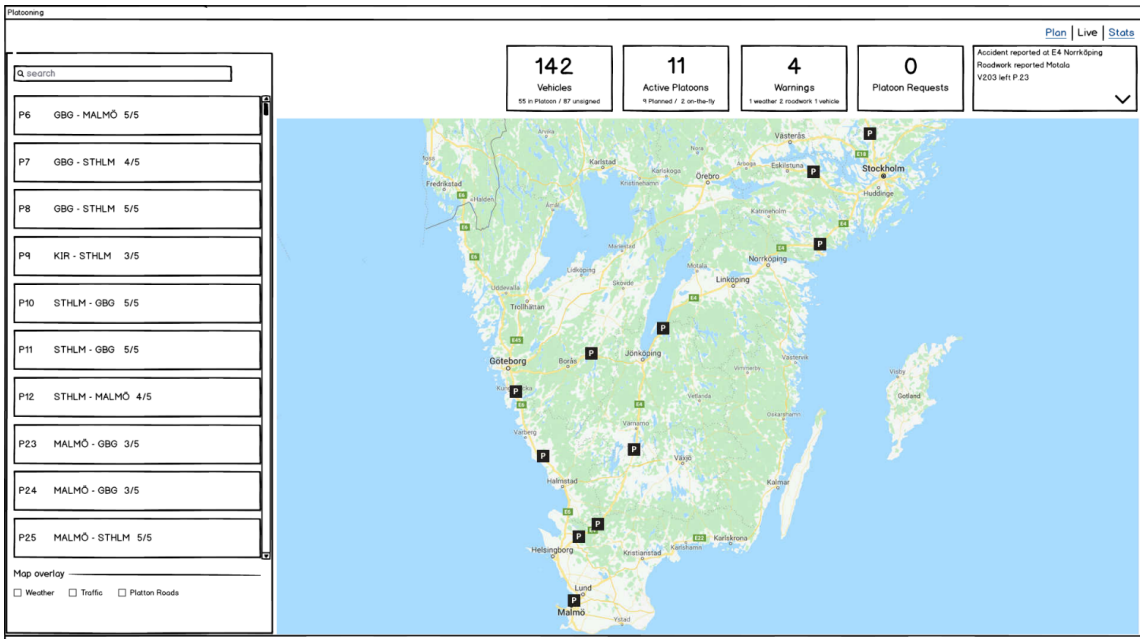

Figure 4.7: Low-Fi prototype of live view.

Our low-fi prototype of the live-view was made up of a list taking up the left-hand side of the interface displaying the currently active platoons. The top-bar also gave additional information regarding how many vehicles that currently are active. How many of those that are in a platoon, how many warnings that are affecting these platoons and if there are any platoon requests awaiting approval. In the top-right corner there is also a live-feed giving information about the latest events related to the vehicles and platoons that currently are actively driving on roads. Lastly, the map also provides an overview of where the current platoons are located with filtering being available for viewing either weather, traffic or platoon roads simultaneously.

Figure 4.8: Low-Fi prototype of data view.

The last view, we chose to call data which is where we prototyped possible statistics that could be interesting to follow up on for the Back-Office regarding platoons. Furthermore, like the previous views, the left-hand side of the prototype provides a list of platoons while also allowing for filtering between individual vehicles. There is also the possibility to view platoons from a certain day, month or year and to select a region of interest. In the data view, the top-bar serves as quick to access information of key performance indicators which were deemed to be the most interesting to follow-up on. This included: the number of platoons created, kilometers driven, average speed, fuel consumption, CO2 emission and road intermissions. It was also intended for the data to be presented in numerous ways depending on the interest of the person viewing the data.

4.4 Iteration 4

4.4.1 Interviews and observations

Overall, five interviews were carried out, all with different companies or municipal entities working with systems concerned with observations of vehicles. The first respondent was a managing director with seven years of experience working within public transportation and logistics. Similarly, the second respondent was a consultant with eight years of experience working with systems managing transportation logistics. Our third respondent worked within regional monitoring of vehicles and had four years of experience doing so. The fourth respondent was a manager and developer of telematic systems across multiple countries with thirteen years of experience within the field. Lastly, our fifth respondent had four years of experience working with the development of a monitoring and vehicular transportation system. Moreover, four of the interviews were carried out in person at their workplace and

one via Skype due to provincial limitations. Keeping the interviews at their workplace was convenient for being able to view their system in real life. The length of each interview was approximately 60 minutes.

The interviews were carried out in a semi-structured manner and served as a complement to the observations made during the interviews. Since the observations were considered as more important, we followed a set of predefined questions while allowing flexibility by being able to ask follow-up questions. During the interviews we wanted to focus on having a specific question answered which itself regularly had the respondents answer the other questions as well. During each interview, we took turns being the facilitator since our goal was to gain an overall impression of their systems functionalities by observation. Nevertheless, the main question asked during each interview was “Could you describe the systems functions?” which often allowed a wide range of follow-up questions to be asked. This question was especially important for increasing our own understanding of what we were observing within the systems. The interviews were also audio recorded and transcribed for further analysis. After analyzing the transcriptions, we correlated the responses during the different questions into categories that can be correlated to functionalities. These were functionalities which we found to be useful in many of the similar systems and likely to be included in our Back-Office prototyping concept.

4.4.2 Low-fidelity prototype development and test

The data gathered from the interviews and observations was later used as knowledge for continuing our low-fidelity prototyping. We created several screens and an ideal scenario of how a user could potentially navigate through the interface using a set of ten predetermined tasks. This ideal scenario, of how we wanted the users to navigate through the prototyped interface can be found in appendix A.

These were tasks that we deemed fundamental to enable a Back-Office to manage platoons. Furthermore, after the low-fidelity prototype was ready and the tasks described we conducted our first usability test by using the method "cognitive walkthrough" (see 2.4.8). However, before doing so we ran an internal pilot test to find unintentional flaws in the prototype.

The cognitive walkthrough was performed with 9 users who had no prior knowledge of platooning. One user was a Human Machine Interaction expert, five were interaction design students and three were everyday people working within pharmacy, store management or sales. Common to all users was that this was their first interaction with the system and that they had no experience using similar systems.

Our goal was to attempt to catch early usability issues in the design to improve it at an early stage before testing with end users. This was done by giving the users ten different tasks to complete within the prototype which were:

1. Schedule a platoon for Monday week 42.

2. Add a vehicle to your newly created platoon.
3. Reject vehicle 55 from planning.
4. Send the scheduled platoons to the haulage contractor.
5. Navigate to the live view.
6. Handle the platoon request.
7. View all the vehicles on the roads.
8. View all the platoons on the roads.
9. Find out the details about platoon 8's route and the vehicles in the platoon.
10. Go to the location of the "Norrköping traffic accident".

Upon completion of each task the respondents were asked to answer the following questions:

- Can you achieve the right outcome?
- Do you notice that the correct action is available?
- Can you associate the correct action with the outcome you are expected to achieve?
- If the correct action is performed, can you see that progress is being made toward the intended outcome?

The feedback gathered from the cognitive walkthrough was then analyzed and summarized. Additionally, we then used the provided information to directly improve the planned view of the low-fidelity prototype of the Back-office interface.

4.4.3 Iteration 4 - Outcome

The following are the categorized functionalities that were found by analyzing the transcriptions and considering our own observations from the interviews. They are functions that we found to be useful in systems with similar responsibility to our Back-Office low-fidelity prototyping concept.

Geofencing
Only one of the companies used geofencing in their systems, but it was very limited. Plans are to expand the capabilities in the system by adapting more geofencing functions in the future. Geofencing was used to map certain zones to give priority for certain vehicles. It was also used to log when vehicles leave a certain area or to create an alert if a vehicle deviated from an assigned route.

Users
One strong commonality in the five companies was that the user themselves decided how much information they want to see. The users could arrange the systems information however they wanted by dragging moveable windows and placing them where they deemed fit. Most of the users in the four companies usually have three monitors to support them in their everyday tasks. Some users have two monitors and it's very rare that anybody uses only one monitor. In one company it was stated that even if the teams or individual users had similar tasks, the workflow of individual users and their workplace setup was usually unique.

Statistics and monitoring
One company had an external database which was tailored to their needs. The data from the external database could be downloaded into a couple of different standardized formats and imported into other tools if needed. There was a lot of capabilities to analyze data and since every event was logged very specific information could be extracted. Mostly, it was used to look at routing history, show where routes of where vehicles had traveled and at what specific time. One company did not have the opportunity at all to follow up on task done in the system in an efficient way. Even if they system logged every user interaction, alerts and other events. The problem was that all this data was raw and they did not have a good tool to analyze and visualize all the logged information.

Events/Alerts/Warnings
All the companies logged almost everything in the system, what the user is doing, tasks, events occurring and other external factors. Each system had their own definitions of what an event, alert, warning, alarms was. For example, in one system alarm was something critical and alerts was something that could be considered as an important event but not critical to the user. In another system alerts were something critical and events was important but not critical to the user. Some of the systems used color coding to display different levels of severity on the events, one system had only two levels: critical and not critical events. The amount of different levels was also different in each system. Mostly depending on how the events were categorized in the system. The commonality in all the systems was that the critical events was displayed clearly as pop-up on the screen which forced the user to act.

Real-time positioning
Two of the companies have systems where the real-time positioning is event based which means that the positioning of a vehicle updates when a vehicle creates a new event. These events range from a vehicle accelerating, stopping, idling, turning and braking. The position can also be set by a time basis e.g. update position every 30 seconds. The vehicle's position updates more in city traffic than on highway driving, therefore setting a timer-based update is more common on more static roads such as highways. Color coding vehicles was used to differentiate vehicles that were early, late or on time. Vehicles that were on time was shown as smaller because they were considered less important than vehicles that were early or late. The map was considered worthless in a big overview were all the vehicles were displayed, because it was hard to differentiate vehicles and positions. Although, the map was

frequently used in a zoomed view where it allowed the user to see more details about the environment and the specific vehicle. The map also filtered other list and windows in the system according to the zoom level. In another company the real-time positioning was provided by an application on the driver's phone. This worked well according to them since the driver does not leave the phone behind when going on trips. Alternative views to the map was also a feature in some of the systems. Usually displayed as a linear progress bar to allow the user to see how much progress the vehicle has made during the time frame expected from the route.

4.4.4 Low-Fidelity prototype 2

Using the above gathered information from the interviews and observations while considering our prior three main screens from our first low-fidelity prototype: planned, live and data we decided to exclude data from further low-fidelity prototyping. Reason being that the interviews uncovered that the data displayed in such views, normally are personalized to satisfy certain users. This suggested that prototyping a view that is going to be highly customized to display certain types of information would simply be a waste of time. We then continued prototyping the planned and live view of the Back-Office interface. This was done with focus being on prototyping the most basic functionalities and interactions that the Back-Office needs to provide for platooning.

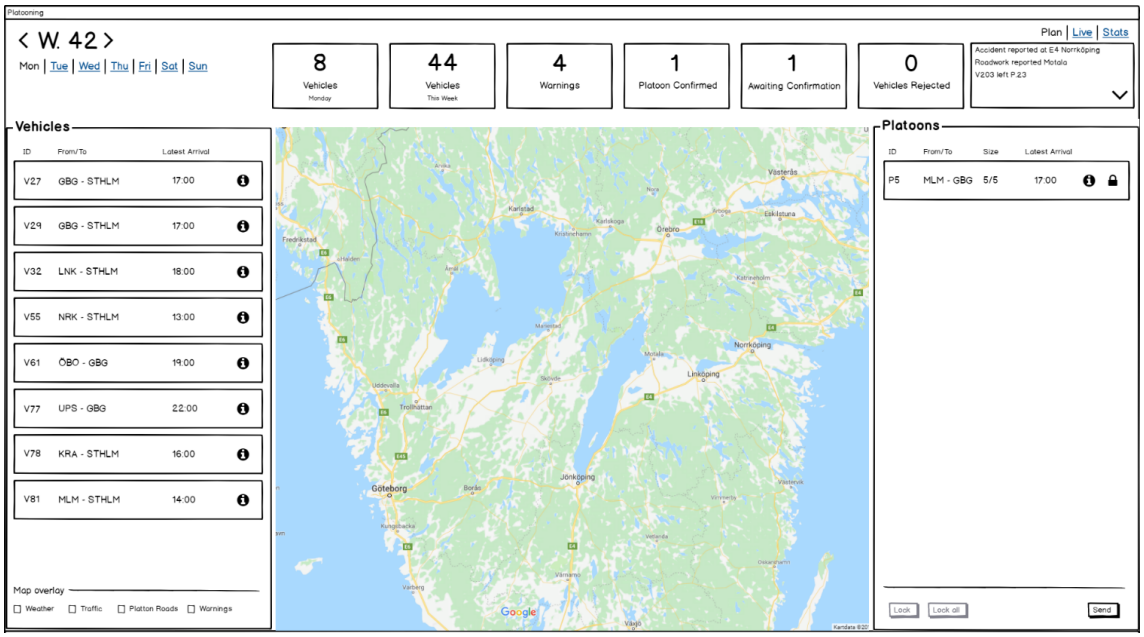

Figure 4.9: Low-Fidelity 2 of planned view.

The planned view of the Back-Office is used for planning platoons of vehicles connected to the system. By connected to the system we mean that any vehicle which has the technology installed will show up in the Back-Office system and be eligible for platooning.

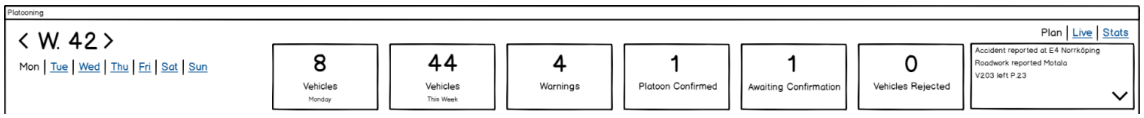

Figure 4.10: Dashboard of planned view.

The top view is a dashboard which provides quick to view information regarding: how many vehicles that are available for platooning, how many that currently are in a platoon, warnings related to those platoons, how many platoons that have been confirmed, how many that are awaiting confirmation and the number of vehicles rejected from platooning. There's also a display in the top-right corner that provides information regarding the latest events. Above that there is also links that allow navigation to the different views: Live and Statistics. Warnings include any events that may affect the planned platoons negatively such as vehicles not functioning properly, routing issues due to road work or weather conditions. Once a platoon has been planned, it also needs to be confirmed by the Back-Office manager before the information regarding its route and included vehicles are sent to the haulage contractor. Furthermore, there is also a chance that a vehicle won't be able to fit a platoon which is when it is required of the Back-Office manager to reject the vehicle from platooning for a specific date, informing the haulage contractor.

Figure 4.11: Vehicle and platoon list in planned view.

The planned view also consists of two lists, the leftmost one displaying the vehicles

available for planning including information such as the vehicle's ID. Where they are traveling from and to and their latest time of arrival. Moreover, the rightmost list displays the platoons which have been planned for platooning. Platoons are given a unique ID and has a maximum size of five vehicles. We have also chosen to include a lock-button for confirming the platoons before they can be sent to the haulage contractor. This was done since we viewed it to be important that the Back-Office manager is sure of a platoons planning, making them less prone to the errors.

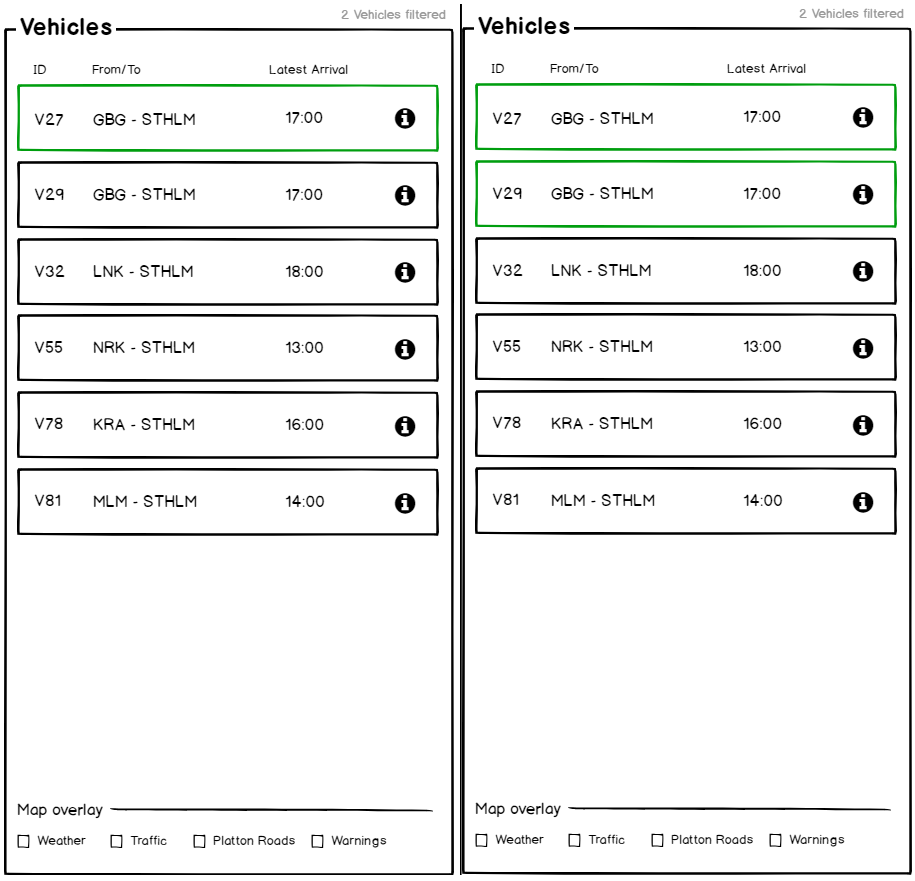

Figure 4.12: Vehicle and platoon list in planned view selected.

To create a platoon, the Back-Office manager begins by selecting a vehicle from the list of vehicles available for platooning. The list will then automatically filter vehicles that are able to match with the initially selected vehicle. This makes it possible for the Back-Office manager to find a matching vehicle to create a platoon.

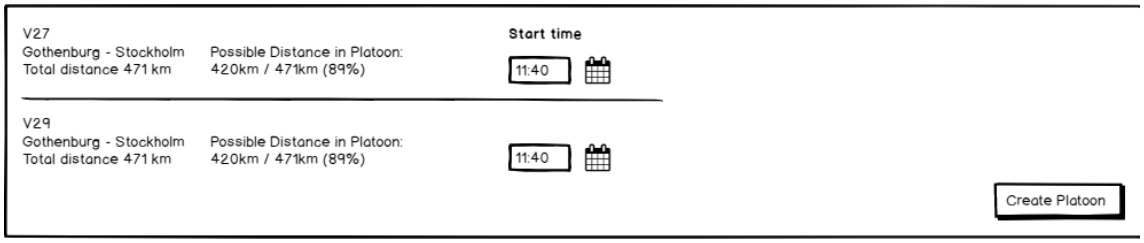

Figure 4.13: Platoon information.

Once two vehicles have been selected the following information appears beneath the map of the interface, together with an option of creating a platoon.

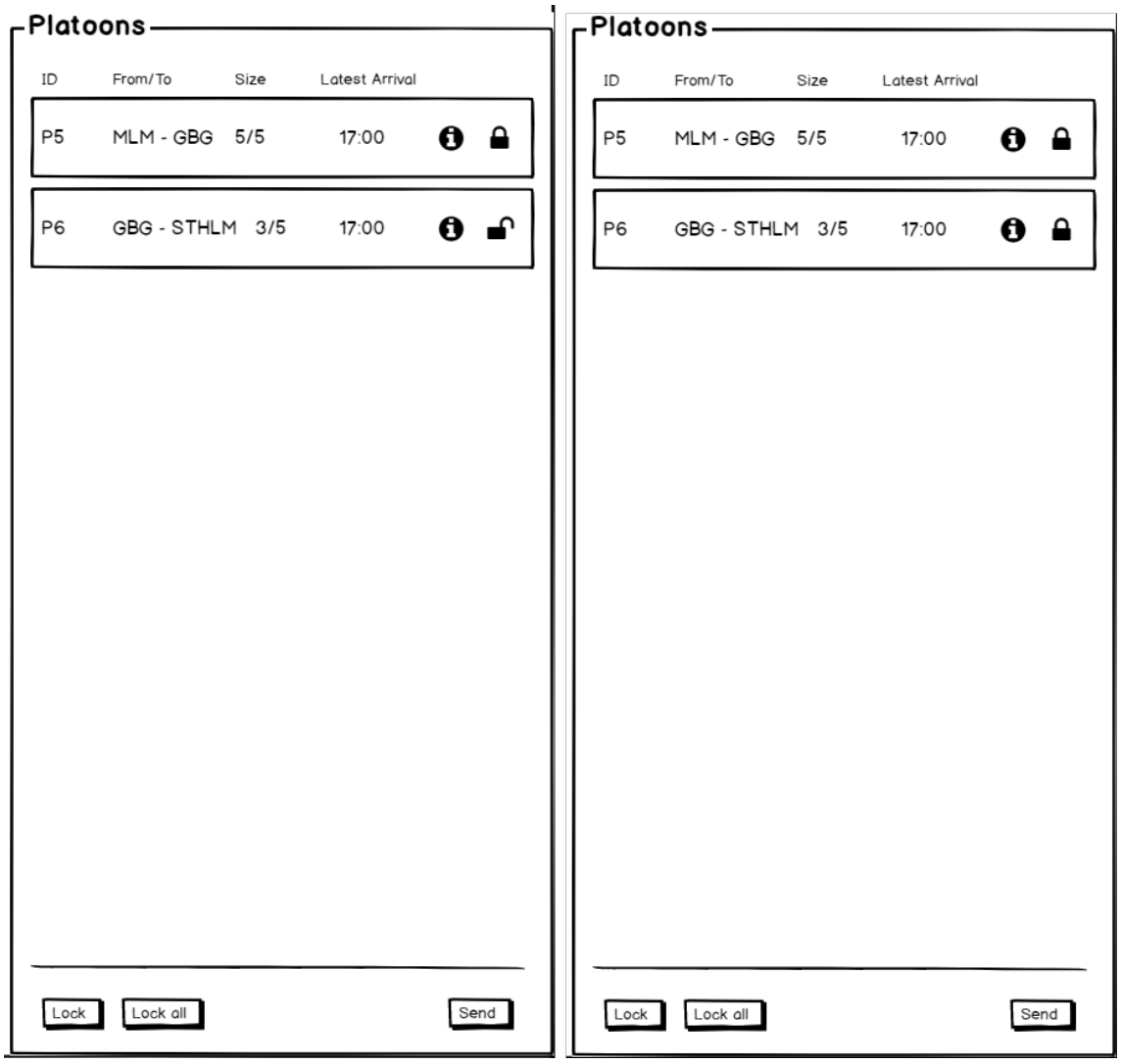

Figure 4.14: Locking platoons.

The created platoon then requires to be locked before the information regarding its route and included vehicles can be sent to a haulage contractor. When all platoons are locked, the send button is no longer greyed out and the Back-Office manager can press send.

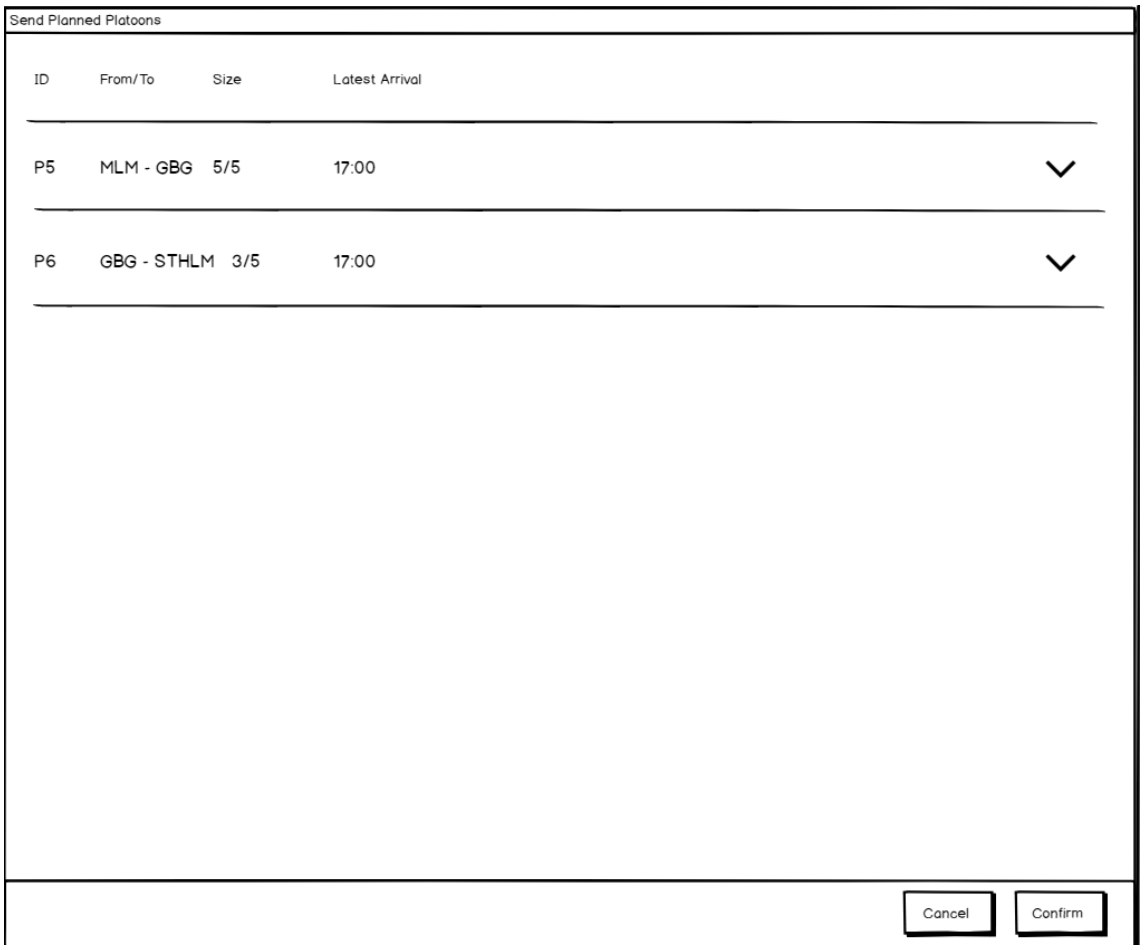

Figure 4.15: Confirmation window before sending to haulage contractors.

As a final step, this window then appears before the information is sent to the haulage contractor. This allows the Back-Office manager to see if any mistakes have been made regarding the about to be scheduled platoons.

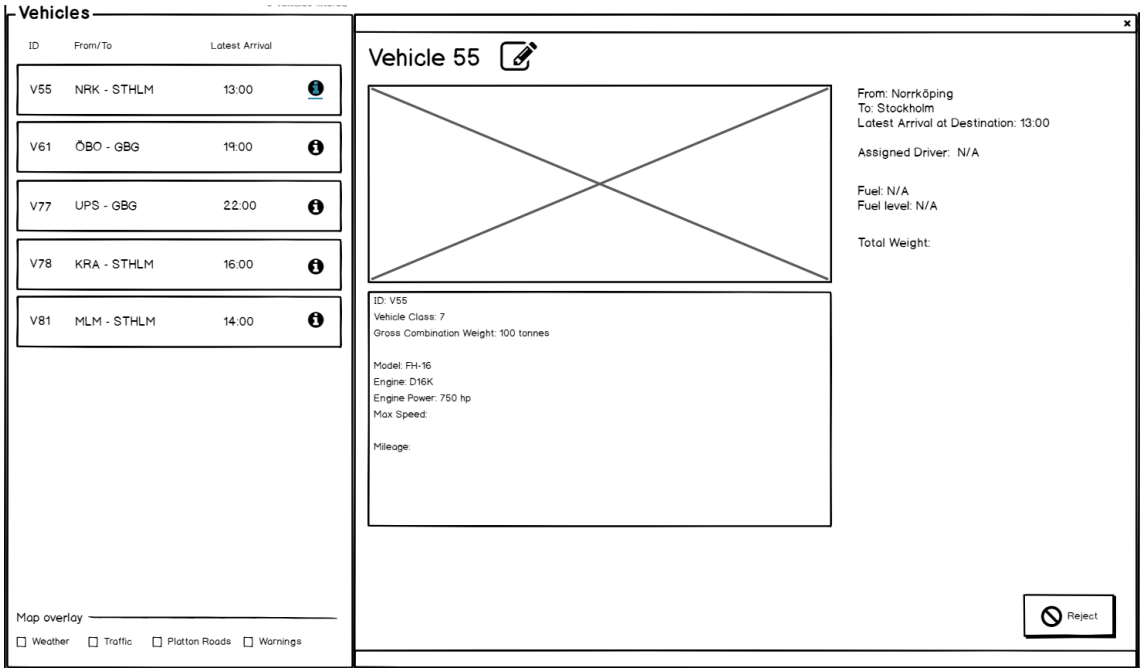

Figure 4.16: Vehicle details.

If a vehicle is unable to be added to a platoon the Back-Office manager needs to reject it to inform the haulage contractor that there is no opportunity to platoon that day. This is done by clicking the information sign which opens a new window with information regarding the vehicle and a reject button.

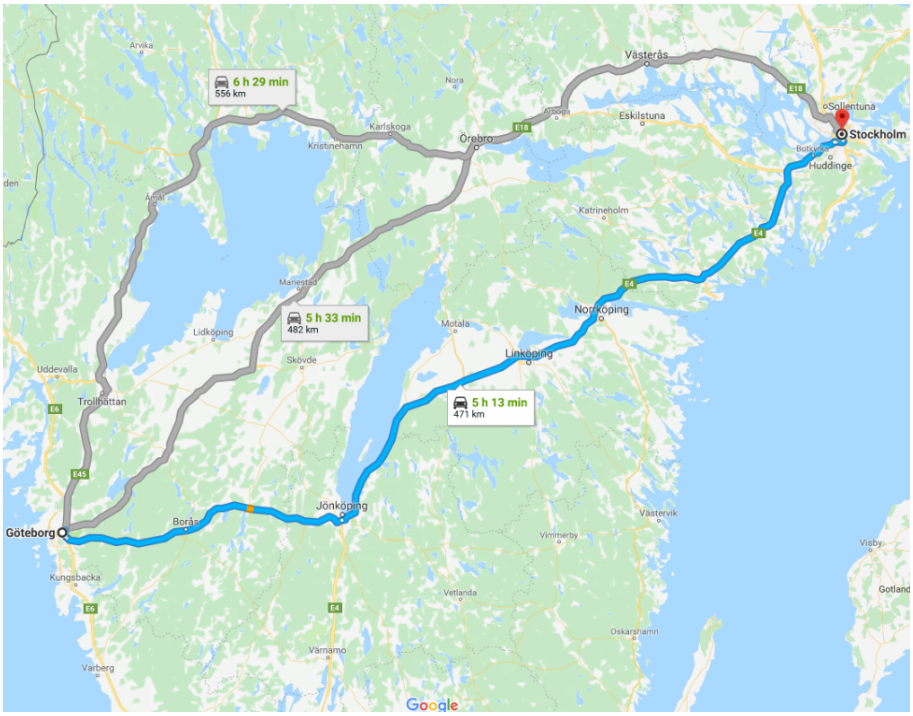

Figure 4.17: Map in planned view.

There is also a map included in the planning interface which functions as an aid

to the Back-Office manager for scheduling platoons in the planned-view. This map is displayed when a vehicle is selected in the list, it shows the route and possible alternative routes for the vehicle to take to reach its destination.

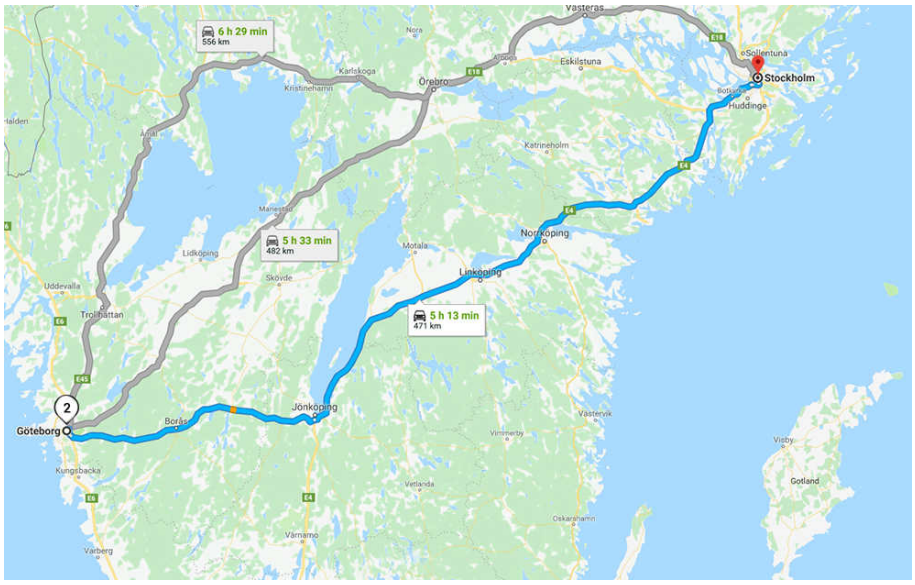

Figure 4.18: Map displaying two vehicle from same position.

When two vehicles have been selected, the map displays where the "join" would happen, or where the vehicles would form a platoon shown by the icon on the map. It also shows how many vehicles that are going to connect at that destination by displaying a number.

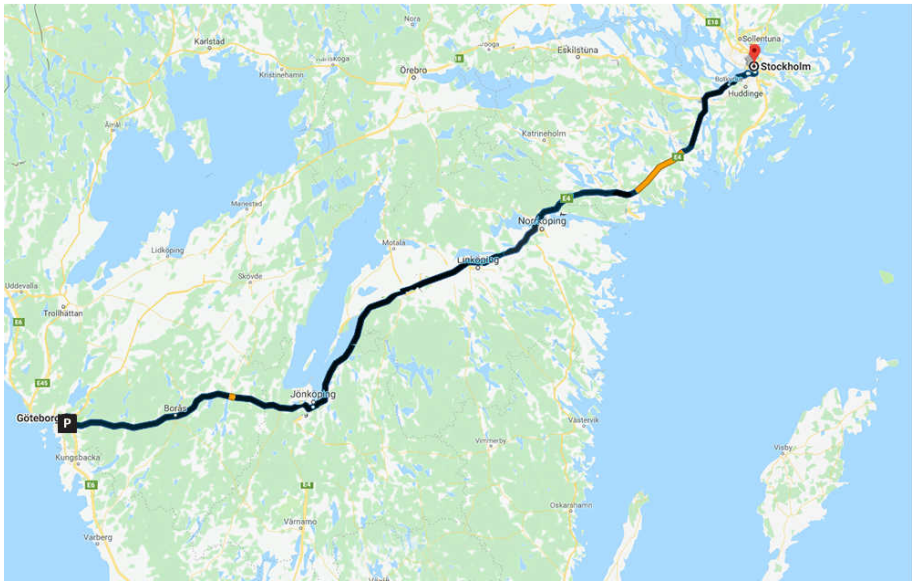

Figure 4.19: Platoon route on map.

Once the platoon has been created, it is also possible to go back and view the platoons route. The colored lines are meant to be black for platoon roads and orange for non-platoon roads.

4.4.5 Low-Fidelity 2 of live view

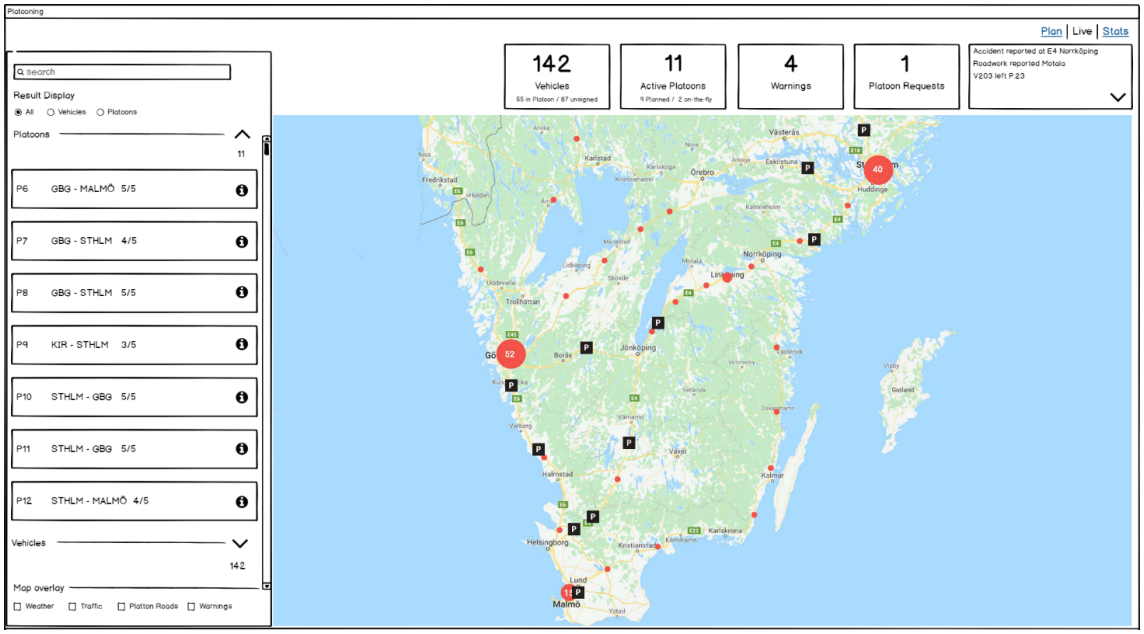

Figure 4.20: Overview of live view.

The live view of the Back-Office is used for managing platoons and vehicles connected to the system that currently are active. Our low-fidelity prototype of this view had the following screens and interactions:

Figure 4.21: Dashboard in live view.

At the top of the live-view is also a dashboard, same as the one in the planned view but with different information. It displays the number of active vehicles and platoons, active warnings and incoming platoon requests. Moreover, it uses the same live-feed functionality as the planned view although the information is related to the current happenings. They are also clickable where the action directs the user to the related information or reveals additional information regarding the selected item.

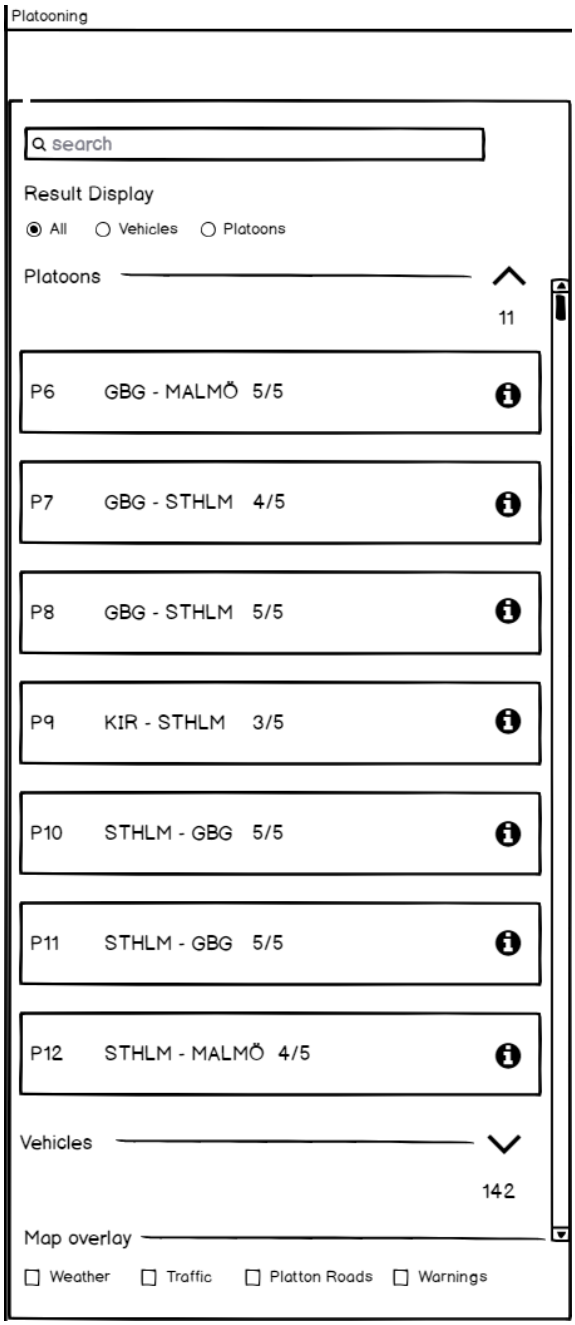

Figure 4.22: Vehicle list in live view.

There is also a list displayed in the leftmost part of the screen containing the platoons and vehicles which currently are active. It also includes a search function and a filtering function as well as options for the overlay of the map.

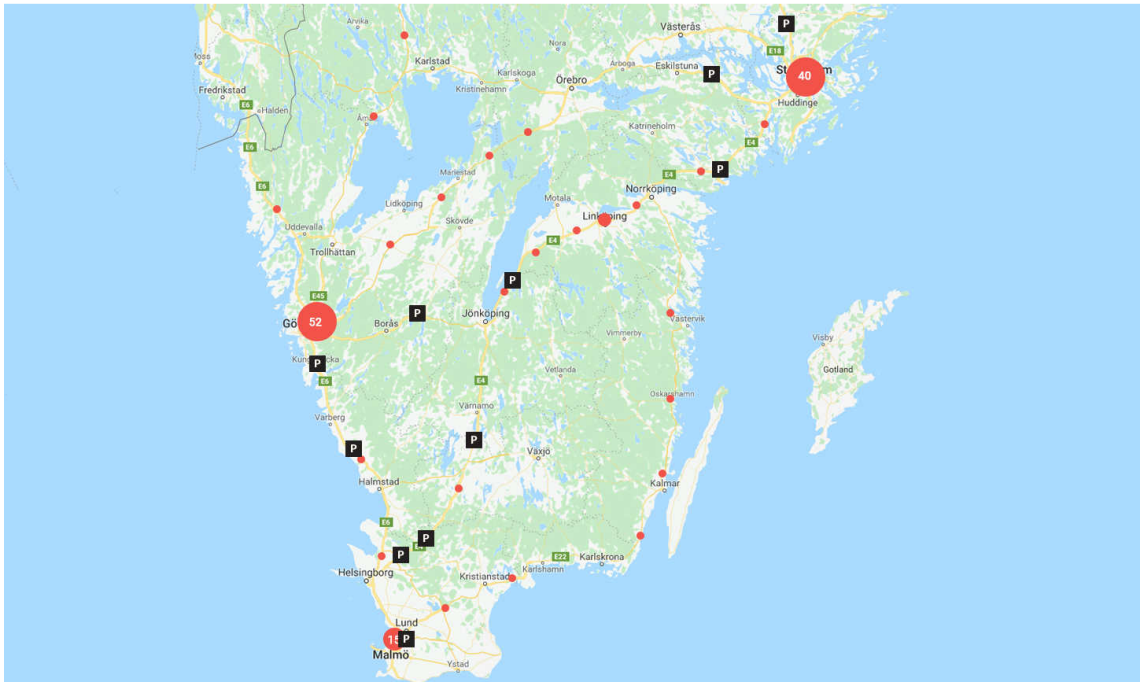

Figure 4.23: Map showing platoons and vehicles.

The map of the live view displays where the current platoons are by using the "P" symbol. Small red dots or big red circles show where the vehicles currently not connected to a platoon are located.

Figure 4.24: Platoon information on hover.

By hovering over a platoon on the map more information is displayed as an alternative to using the left-hand side list to find out information regarding a certain platoon.

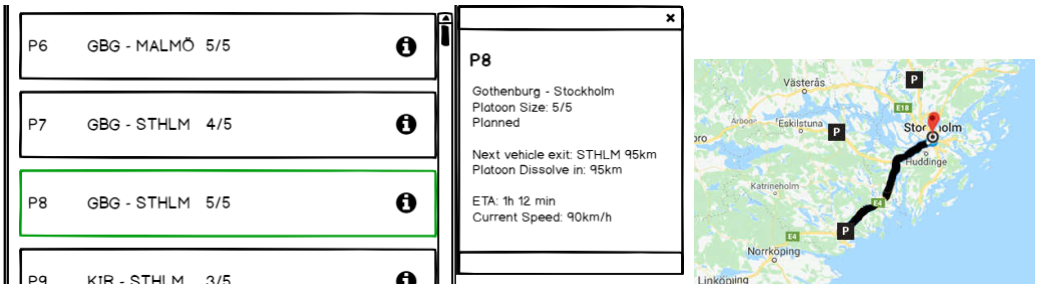

Figure 4.25: Summary of Platoon details.

Another alternative to view more information regarding a platoon is by selecting it in the list, revealing a window with similar information to the hover. Moreover, the map also displays the platoons current route and end destination on the map.

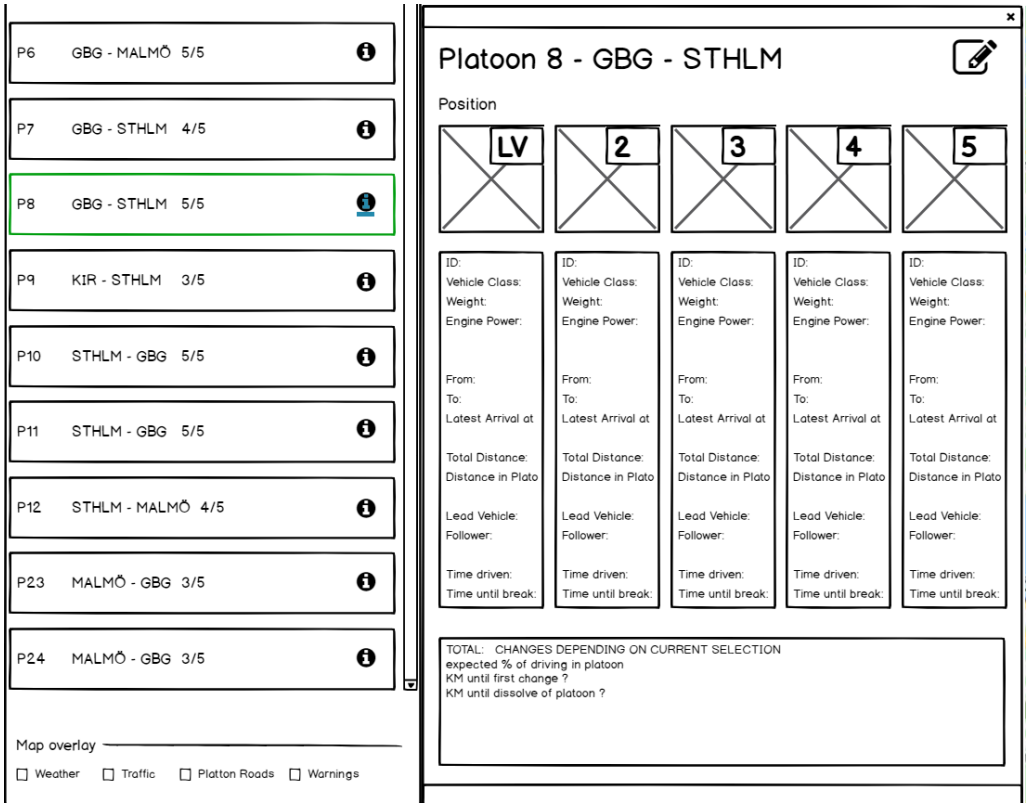

Figure 4.26: Platoon details

There is also the option of selecting the information-button in the vehicle list to show which vehicles that currently are in that platoon along with additional material showing the positioning of those vehicles. Moreover, the option to edit these platoons is also thought of to be available in later prototypes.

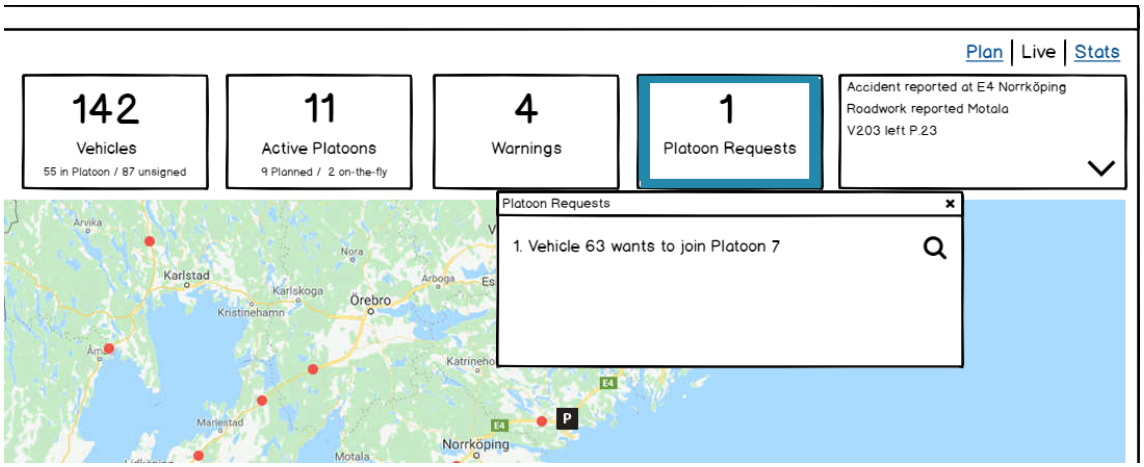

Figure 4.27: Platoon request on the dashboard.

One task required of the Back-Office manager is to handle incoming platoon requests. This is done by selecting the platoon request which displays a box where there is an option to consider the information regarding the request.

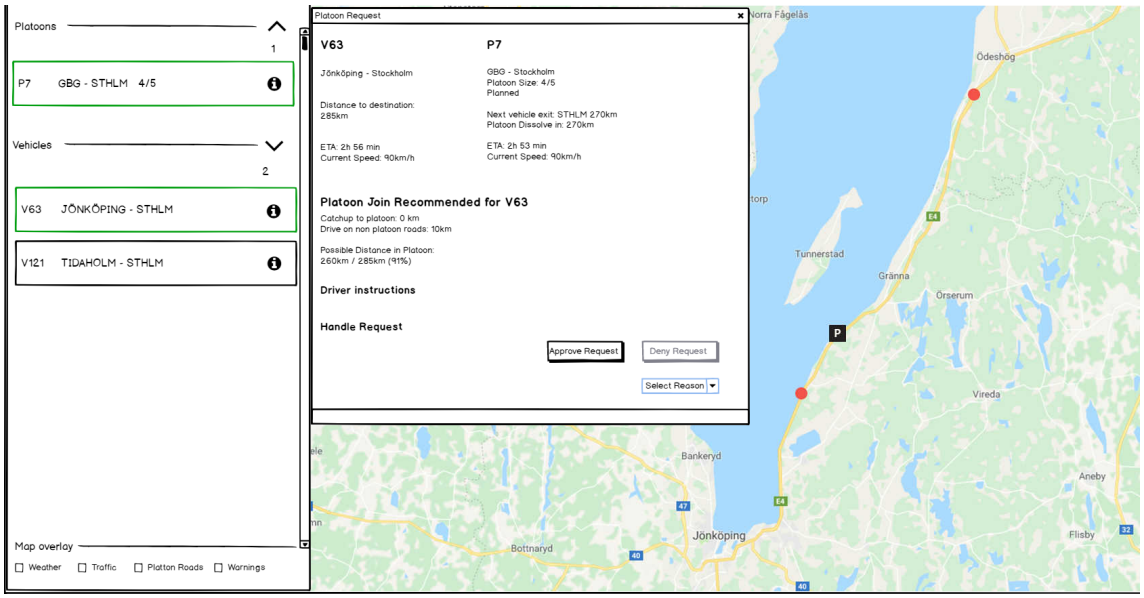

Figure 4.28: Platoon request detailed information.

The map then zooms in on the location of where the vehicle and platoon are located. Additionally, there leftmost list displays which vehicles that are affected. There is also a new dialogue box displaying additional information regarding the request with the option of either approving or declining it.

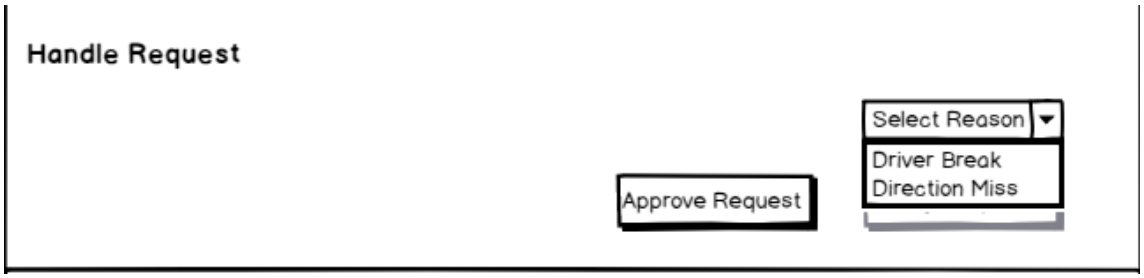

Figure 4.29: Approving or declining a platoon request.

If the Back-Office manager wants to decline the request, an option must be chosen as to why.

Figure 4.30: Dashboard displaying approved and denied platoon requests.

After the request has been handled, the information in the dashboard is updated displaying how many requests that have been approved or declined during this day.

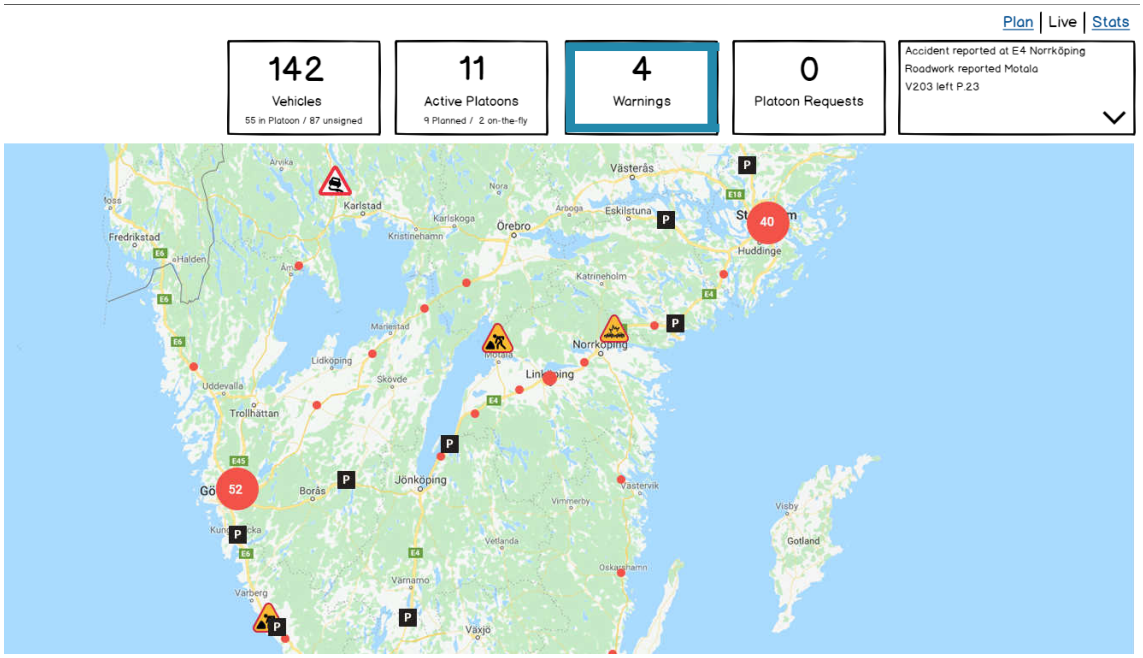

Figure 4.31: Map showing warnings

There are warnings active which are affecting platoons, they will be displayed in the dashboard.

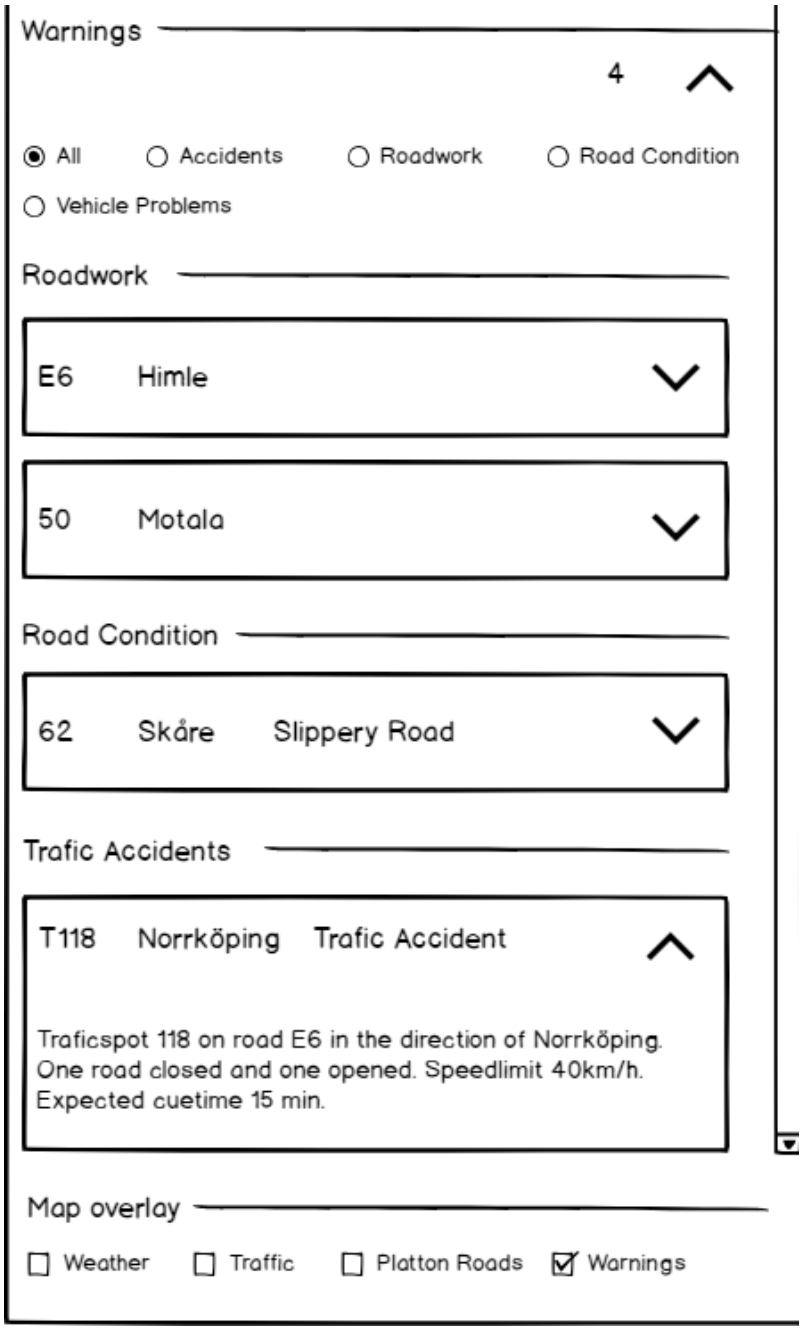

Figure 4.32: Warnings displayed in the list.

When the warnings are selected, the left-hand side list is also filtered to displaying the current warnings affecting platoons.

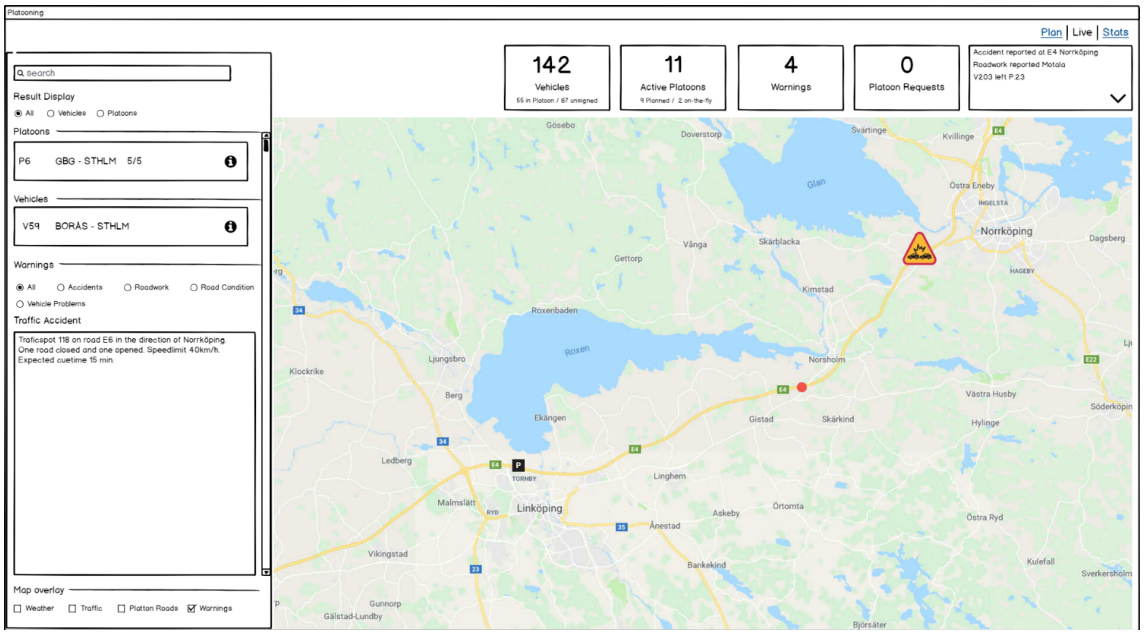

Figure 4.33: Location and information about warning.

If a specific warning is selected on the map by clicking on a symbol, or selecting one using the left-hand side list the system zooms in on the affected location. The list also accommodates this by displaying the affected platoons along with a text containing information regarding for example, accidents or road work.

4.4.6 Usability test 1

Working with the feedback from the cognitive walkthrough, we found many issues in our design to address. The following is the result gathered from the first usability test, which is presented by first describing the preformed task and then the answers provided to the four evaluative questions. To aid us in viewing how the users attempted to navigate through the interface we had beforehand created an ideal scenario of how the tasks could be completed within the prototype (see appendix A).

Task one: Schedule a platoon. Our respondents found it difficult to complete the task due to placement of buttons as well as inadequate feedback once a button had been pressed. Some noticeable comments were:

"I clicked join platoon and something happened in the right panel, some additional feedback wouldn't hurt"

"Is there a difference between schedule and plan? Is schedule the send button? Do I need to have more than 2 vehicles? how many?"

"Would like more feedback that vehicles are selected, hard to see that button is clicked"

"Was not obvious that the vehicles were being filtered, or that they are going to be filtered. Could be more visible"

Task two: Add vehicles to a newly created platoon. The respondents were able to complete the task but were overall unable to associate the action with the expected outcome. Some were also unable to see that progress had been made toward the intended outcome. Noticeable comments were:

"not very intuitive and easy to select a platoon to the right, go to the left and select a vehicle and then go to the bottom and join the platoon. Why isn't this happening in the center of the screen. Once selected a platoon and a vehicle, is the route really the focus at this point? If not, I would prefer to have the important stuff more accessible"

"More of a description on vehicle headline, more precise filter and, bigger text showing filtered on specific platoon"

"Hard to see that the platoon number has been updated"

Task three: Reject vehicle 55 from planning. Many of the respondents were unable to find the information related to be able to complete the task. It was not clear that the information-button would enable them to reject a vehicle from platooning. Following comments captured the issue:

"Could not find the correct action"

"Don't know how to reject a vehicle, I try to select the vehicle, but I don't see any option"

"Didn't understand that I was expected to click the information-button to be able to reject it."

"Strange that by clicking on a platoon I remove a vehicle. I expected another step where I can see which vehicles are in the platoon and then remove vehicle 55"

"Colors would be really helpful, for example a red button on the reject"

Task four: Send the scheduled platoons to the haulage contractor. Everyone but one respondent was able to complete the task. However, they found it difficult to understand that a platoon needed to be locked before it could be sent.

"Didn't know that i had to lock them before pressing send"

"Not at first but then I understood that you should lock the platoon and then send it"

Task five: Navigate to live view. All the respondents were able to complete the task and too few comments were made to display them. Due to this, no changes regarding the navigation to live view were made for our final design.

Task six: Handle the platoon request. Most of the respondents could complete this task without any issues. A remark was made regarding the feedback given by the interface.

"I didn't get a confirmation if the request is resolved or not. I didn't know which actions I have to take other than pressing the "platoons requested button""

Task seven: View only all vehicles on the roads. All but one respondent was able to complete the task without running into any issues. A comment was made regarding the scroll-bar not fully functioning to the respondents needs.

"In the left scroll bar, I can only see V6 to V25. I cannot scroll down. The bar-function doesn't work. Or the arrow is too big to actually scroll down"

Task eight: View only all the platoons on the roads. Similarly, to the previous task, all but one respondent was able to complete it. A comment was once again made regarding the scroll-bar.

"Same as with the vehicles. I can only see P6 to P25 but not activate the scroll bar on the left side"

Task nine: Find out details regarding platoon eights route and the vehicles in the platoon. Everyone was able to complete the tasks; a single comment was made regarding having to click on the info icon again when asked if they noticed that the correct action was available.

"Clicked on P8 then had to click again on info icon"

Task ten: Go to the location of the "Norrköping" traffic accident. Only one respondent ran into issues when trying to complete the task, some of which should already be addressed in the prototype. It is possible that the person clicked outside of the clickable field and thus were unable to achieve the expected effect.

"I want to click on the traffic accident in the top right corner, but I'm not able to"

"Had to navigate to all vehicles and then click on warnings"

4.4.7 Changes made to low-fidelity prototype 2

After reviewing the feedback from the cognitive walkthrough, we decided to make additional prototypes of improvements to the planned and live view before creating a high-fidelity prototype.

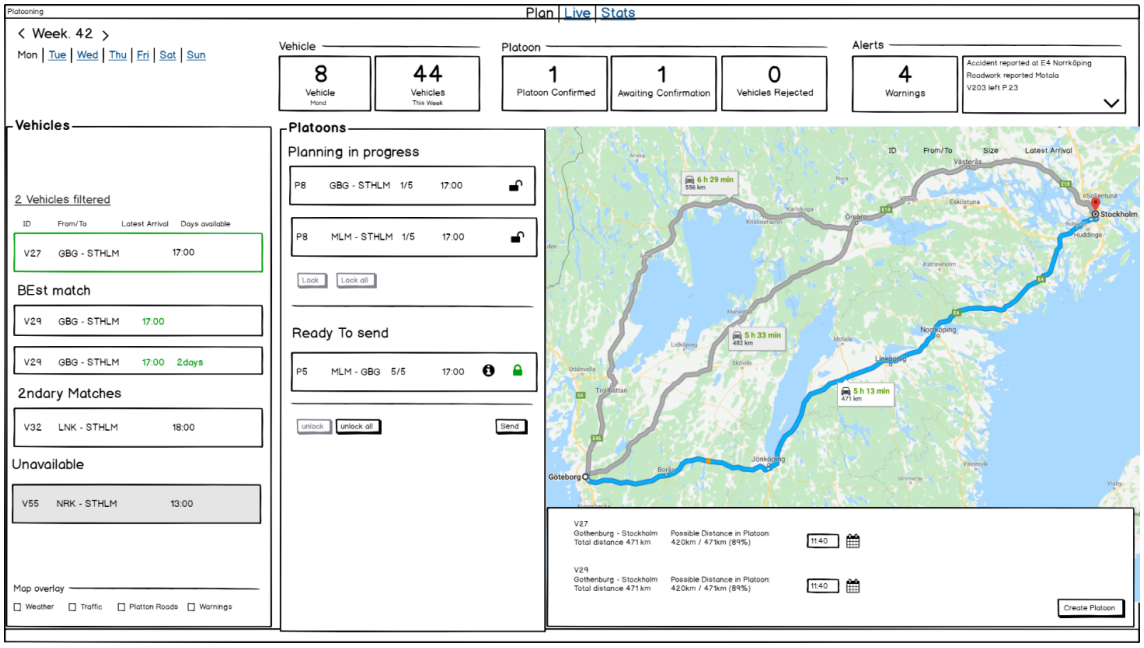

Figure 4.34: Changes to prototype 2

The most important change was made to the planned view's location of lists of vehicles and platoons. Many of the respondents thought that it was difficult to relate the two lists, so we decided to move them closer together. Furthermore, the dashboard at the top was also divided into categories to provide an easier overview of what the information displayed is related to. We also added additional feedback for the "lock" process of platoons by making the locks turn green to symbolize that they were ready to be sent. Yet, the feedback from the heuristic walkthrough also revealed a need for a more realistic representation of the interface as many of the respondents wanted it to be more interactive. For this reason, we chose to create a high-fidelity prototype in the next and final iteration.

4.5 Iteration 5

The use cases from iteration two were reviewed and extended into ‘fully dressed’ use cases, that are more detailed and describes variations to the main scenario. Four new use cases were added:

- Guide to platoon
- Prepare vehicle for platooning
- Haulage Contractor prepares a platoon
- Driver delay

The use cases "Prepare vehicle for platooning" and "Haulage Contractor prepares a platoon" were created to explain how the Back-Office system receives vehicles from haulage contractors to enable planning of platoons. Driver delay was made as an option to allow the lead driver in a platoon to delay a new vehicle joining the platoon. This was done since there may be circumstances were a platoon needs to be delayed which the system cannot predict. Guide to platoon was a use case that was found during literature research in iteration one but was not taken into consideration until this iteration.

The new use case that were created during iteration five are shown below. Their fully dressed versions can be found in appendix B.

- Guide to platoon
- Prepare vehicle for platooning
- Haulage Contractor prepares a platoon
- Driver delay

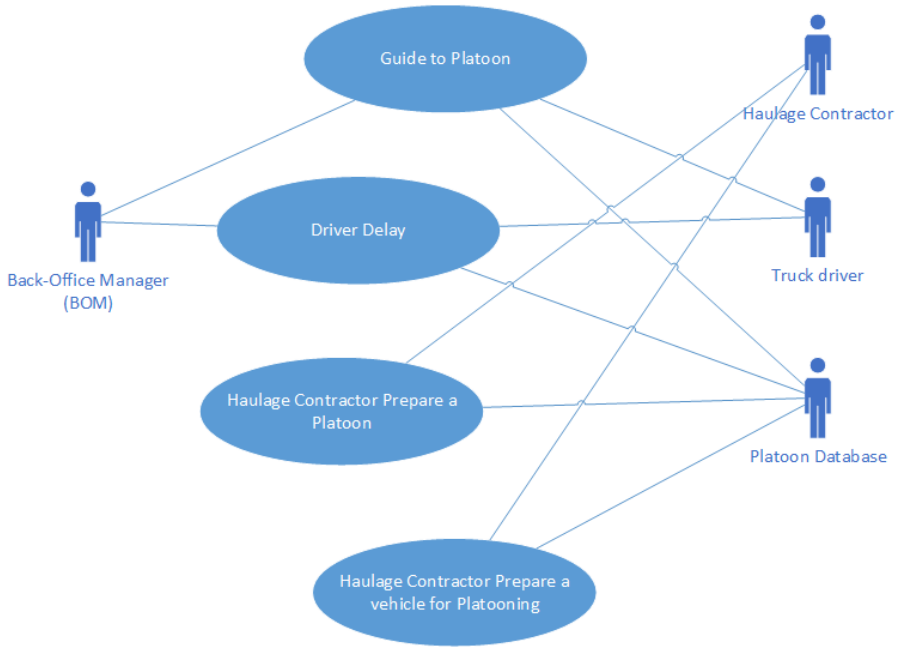

Figure 4.35: New use cases

Use Case Live – Guide to platoon

BO Manager finds a potential platoon to match with the selected vehicle. BO Manager clicks on the vehicle menu icon. BO Manager selects the manage option. System displays a detailed view of the vehicle. BO Manager selects the edit route option. BO Manager selects the reason: reroute to platoon. System shows a platoon as a possible match and provides information about the vehicle and the platoon side by side. BO Manager reads the information and clicks on calculate join point. System displays potential join points. BO Manager selects option A and drags a new route to the platoon. BO Manager saves changes. System asks for confirmation. BO Manager confirms new route. System informs drivers. Route of vehicle is changed and drivers are informed. Status of vehicle changed to joining platoon.

Use Case Live – Driver delay

Drivers in platoon gets instructions from system that a vehicle is joining the platoon. Before the join has started. Lead driver finds a reason for delaying the platoon. Lead driver selects reason for delaying join. System registers the reason and informs the BO Manager. BO Manager reads the information from the driver. BO Manager approves the reason.

Use Case - Haulage contractor prepare a platoon

Haulage contractor selects a vehicle in the available for platooning list. System shows information about the vehicle. Haulage contractor selects another vehicle. System shows information about the vehicles side by side. Haulage contractor groups the vehicles together. System displays a message that vehicles are grouped. Haulage contractor clicks send button. System ask the Haulage contractor to confirm. Haulage

contractor confirms. System sends the information to the Platooning Back-Office and shows a message to the haulage contractor.

Use Case - Haulage contractor prepare a vehicle for platooning

Haulage contractor selects a vehicle. System display a dialog box with options. Haulage contractor sets destination, latest time of arrival and days available. Haulage contractor marks vehicle as available for platooning. Haulage contractor saves changes. System asks for confirmation. Haulage contractor confirms. System displays confirmation message. System moves vehicle to platooning list. Haulage contractor selects the same vehicle in the platooning list. System displays information and options. Haulage contractor clicks send. System asks for confirmation. Haulage contractor confirms. System sends the information to the Platooning Back-Office and shows a confirmation message to the haulage contractor.

4.5.1 Icons for intermissions

Icons for intermissions were created to visualize platooning events. These icons were used when, for example reviewing a completed platoon.

Figure 4.36: Icons created for intermissions.

Platoon created (P), **Platoon dissolved** (D), **Platoon recreated** (R), **Vehicle left platoon** (L), **Vehicle joining platoon** (R), **Vehicle left platoon** (JP), **Vehicle joined platoon** (J), **New lead vehicle** (LV)

4.5.2 High-fidelity prototype development and test

Prototype
The final prototype was created in a software called Axure. This software is more suitable for high-fidelity prototyping than Balsamiq. Axure allowed the prototype to use logic such as if/else statements, hovers and other interactive functions. The screens were based on the previous prototype with modifications gathered from the feedback of the user test in iteration four.

Usability test 2
Our second usability test was carried out using the "think-aloud" technique while having the respondents preform a set of eleven different tasks within the system. The goal was to evaluate our high-fidelity prototype of the system. Because of this, the respondents were four people with prior experience in similar systems or experts in platooning as we wanted to target possible end users. The first respondent was a technology specialist in driver behaviour with more than ten years of experience

within the field. The second respondent was a human factor specialist with six years of experience. The third respondent was a project manager within IT with over ten years of experience working with different projects. The fourth and last respondent was a group manager within human behavior and perception that had over ten years of experience as a specialist.

A scenario was given to the respondents prior to performing the tasks:
You are a newly employed Back-Office manager "Congratulations" where you managed to get the job due to your previous qualifications working with similar systems. This is your very first day at work and your employer wants to test your ability by giving you a set of tasks to carry out using the system.

Each respondent was given eleven tasks similar to the ones used in prior testing to carry out. During the test the screen and audio was recorded to allow the information to be reviewed. The tasks were the following:

1. Create a platoon.
2. Add another vehicle to your new platoon.
3. Reject vehicle 61 from platooning.
4. Send your scheduled platoons to the haulage contractor.
5. Navigate to the live view.
6. Handle the platoon request.
7. Go to the location of the road accident.
8. View the alerts.
9. Find information about the completed platoon.
10. Find platoon 17. Find the details and the route.
11. Filter between platoons and vehicles.

After the user test was completed, each user was asked to fill out Van der Laan, Heino and Waard (1997) form for evaluating user acceptance.

My assesment of the system as a whole							
		1	2	3	4	5	
1	Useful						Useless
2	Plesant						Unpleasent
3	Bad						Good
4	Nice						Annoying
5	Effective						Superfluous
6	Irritating						Likeable
7	Assisting						Worthless
8	Undesirable						Desirable
9	Raising Alertness						Sleep-inducing

Figure 4.37: English version of form for evaluating user acceptance

Although, since our users are Swedish a translation is required when asking them for their judgement using the scale. Söderman (2014) presented an updated translation, to be used for our final usability test:

Min bedömning av systemet som helhet							
		1	2	3	4	5	
1	Använbart						Oanvändbart
2	Behagligt						Obehagligt
3	Dåligt						Bra
4	Tilltalande						Störande
5	Gör nytta						Onödigt
6	Irriterande						Angenämt
7	Stödjande						Värdelöst
8	Önskvärt						Icke önskvärt
9	Stimulerande						Tröttande

Figure 4.38: Swedish translation of form for evaluating user acceptance

5
Final Result

Our final prototype was created with the data gathered from all the previous iterations. Many of the respondents attempted to use functions not yet implemented in the low-fidelity prototype to attempt and complete a task. This served as a warrant for our choice of making a high-fidelity prototype that more closely represents interactions that a real interface would allow.

5.1 Planned View

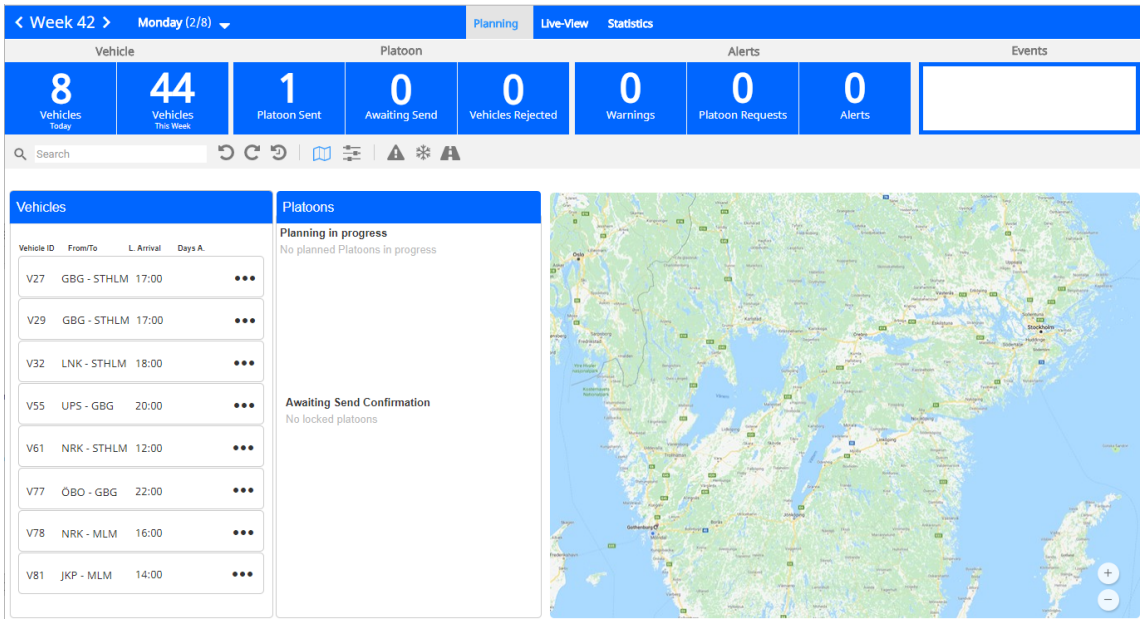

Figure 5.1: Dashboard planned view.

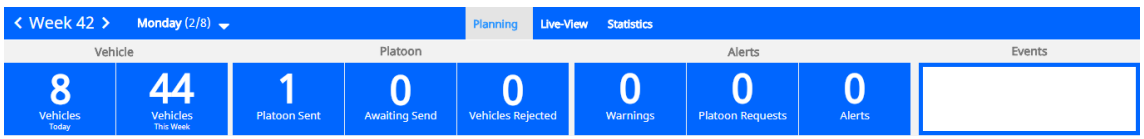

Figure 5.2: Dashboard planned view.

The top of the user interface serves as the main navigation between the three main views Planning, Live-view and Statistics. On the top left of the navigation the

user can change the week and the weekday that is currently in view. In the top right corner, the events are displayed chronologically as they occur. This was not implemented in the prototype.

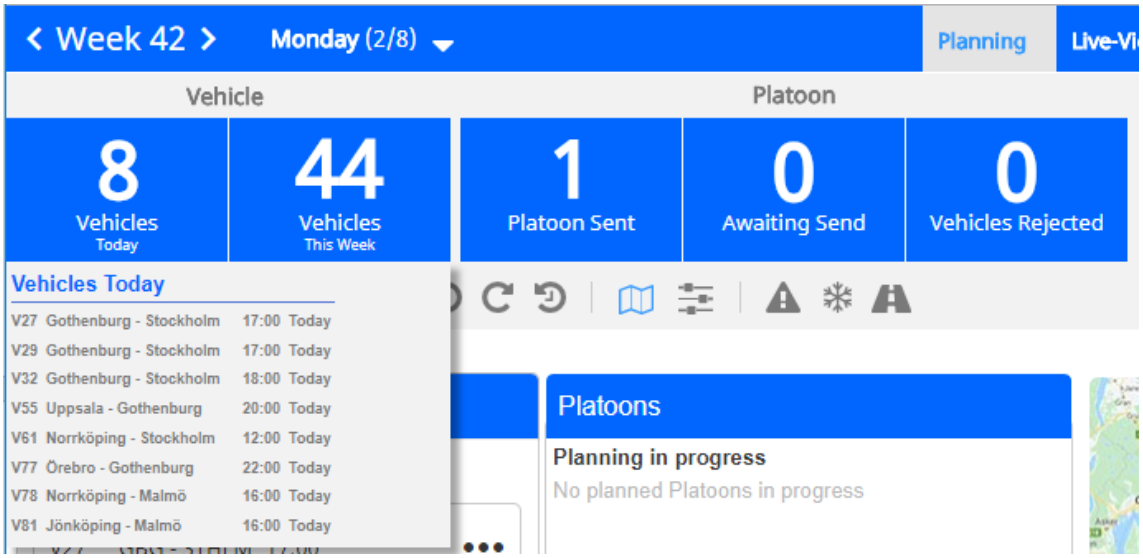

Figure 5.3: Dashboard details.

The dashboard consists of squares that shows relevant information to the current view. In the prototype the dashboard was different in planned and live-view.

In the planned view the dashboard consisted of: Vehicles today (all vehicles that are available for planning on the current day), Vehicles this week (all vehicles that are available for planning the current week), Platoons sent (number of platoons sent to haulage contractors), Awaiting Send (Platoons created and ready to send to haulage contractor), Vehicles rejected (Vehicles removed from planning), warnings (All the warnings that can affect a platoon), platoon requests (pending platoon request) and alerts (alerts that can affect a platoon).

When hovered over it gives a quick view of the information. When a square is clicked, a new window opens with more detailed information. The information in the dashboards can be customized by the user to fit their needs, although this was not implemented in the prototype.

Figure 5.4: Toolbar.

A button is active when its highlighted in blue e.g. Map view. The undo button allows the user to undo an action performed and the redo button allows the user to redo an action that has been undone. Show all events opens a new window that shows all the events logged in the system. The Map view shows vehicles on map

whereas the progress bar view shows the vehicles in a time-line view. The warnings but shows warnings/alerts on the map e.g. road work and accidents. The weather icon shows road conditions that can affect a platoon e.g. slippery road. The platoon roads icon overlays the map with roads that platoons can travel on.

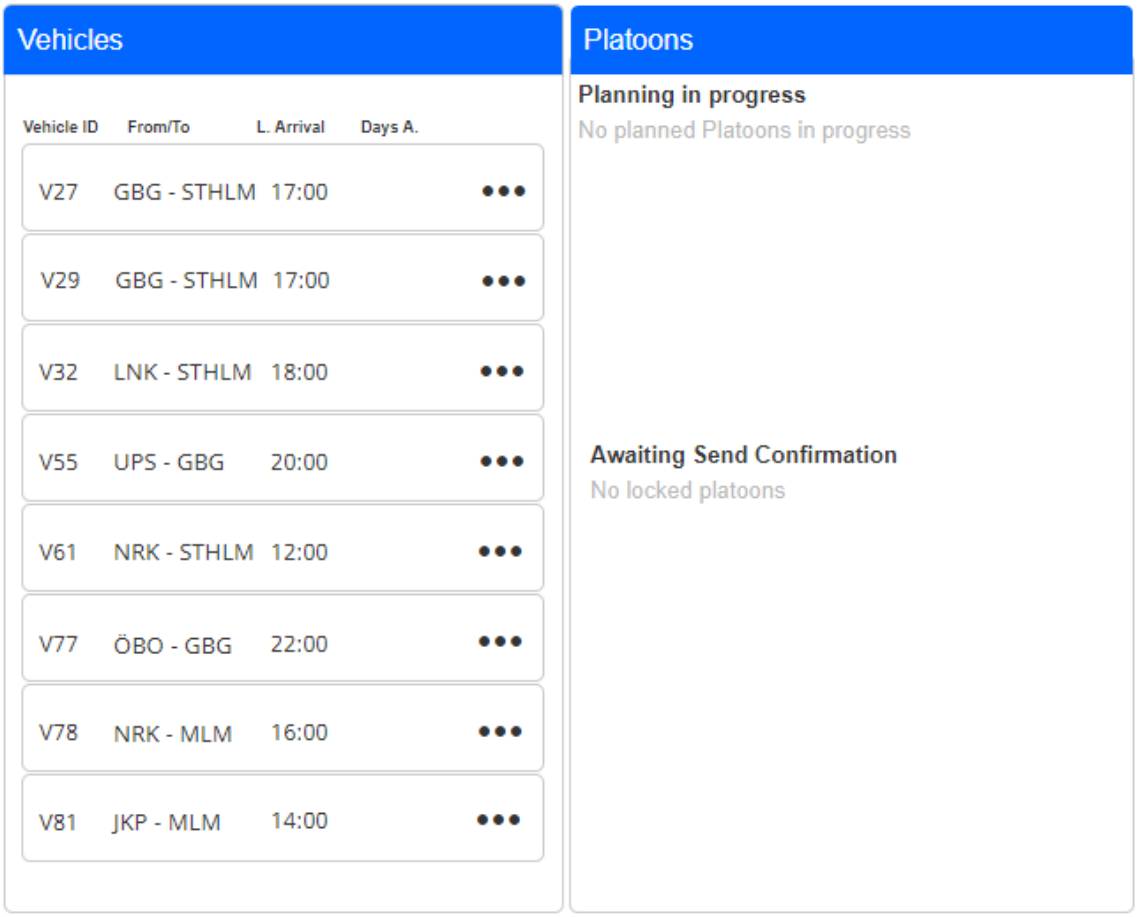

Figure 5.5: Vehicle and platoon-list

The vehicles list contains all the vehicles that the haulage contractors has made available for platooning. Each row corresponds one vehicle and displays the unique id of the vehicle, where the vehicle starts and where it stops (From/To). The latest arrival (L. Arrival) is the latest set time for the vehicle to reach its destination. This is set by the haulage contractor. Days available (Days A.) is the time-span the vehicle has for planning. Days A. was not implemented in the prototype.

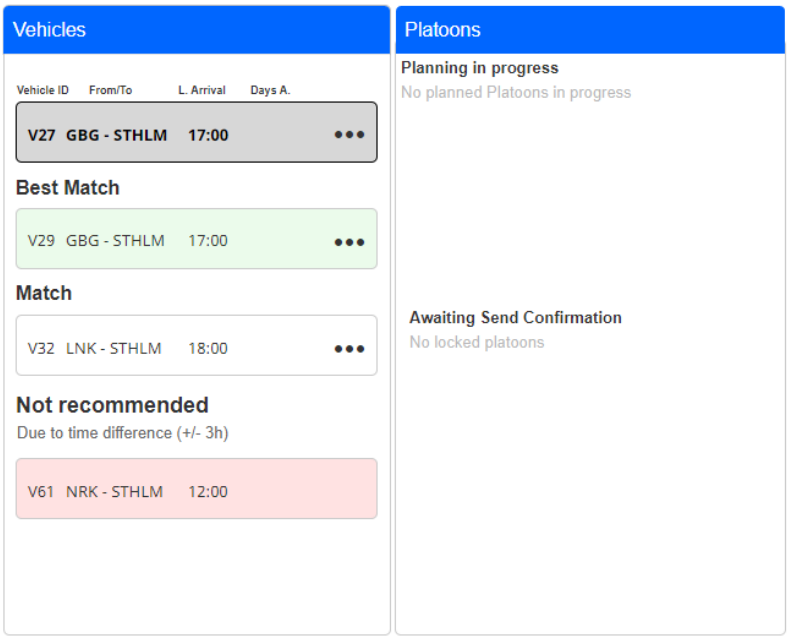

Figure 5.6: Selecting a vehicle in the list.

When selecting a vehicle, the vehicle list is filtered and shows only vehicles relevant to the selected vehicle. A selected vehicle gets a grey color. The best match for the selected vehicle is displayed in green. Not recommended vehicles are displayed as red.

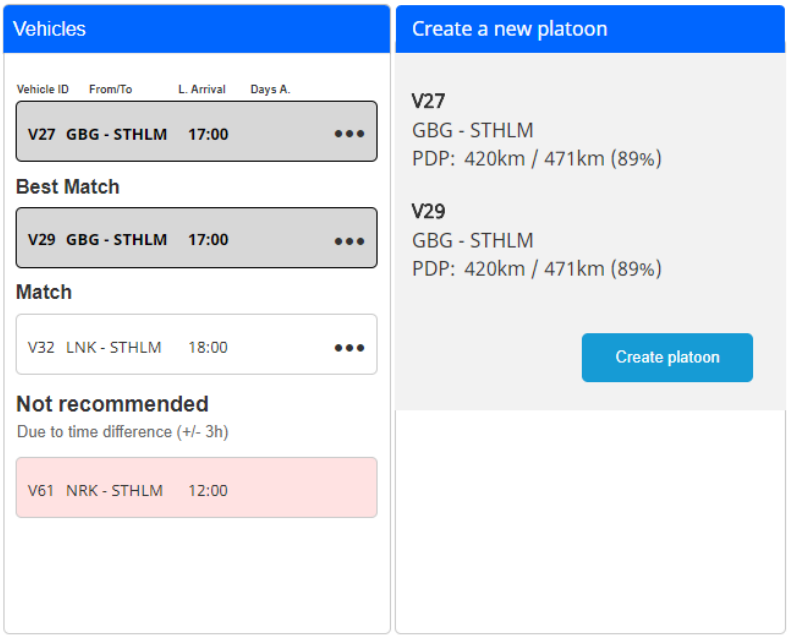

Figure 5.7: Drop-down appears to create platoon.

When two vehicles are selected a new window drops down. The drop-down window displays information about the two vehicles selected: The ID, the destination and Possible Distance in Platoon (PDP). By clicking on the button, a platoon is created.

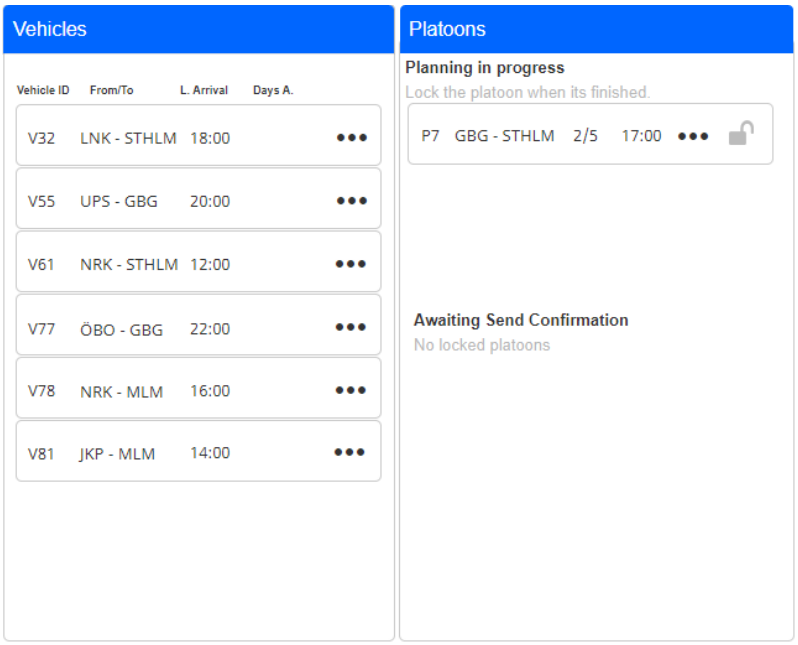

Figure 5.8: Platoon created and shown as planning in progress.

A created platoon appears in the platoon list under the section planning in progress. When the planning of a platoon is finished, clicking the lock moves the platoon to the section awaiting send confirmation.

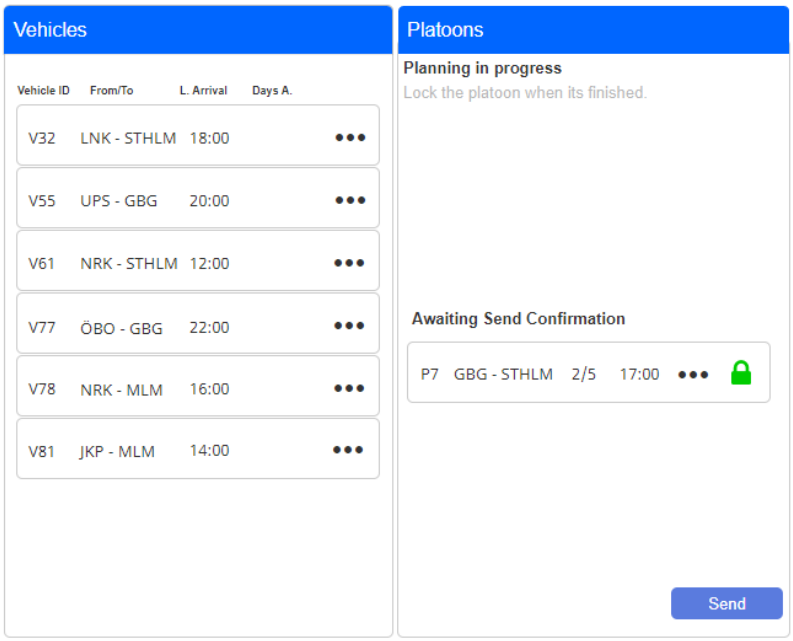

Figure 5.9: Platoon awaiting send confirmation.

A send button appears when there is a platoon in the awaiting send confirmation section in the platoon list. Clicking on the send button confirms the planned platoon and a message is sent to haulage contractors.

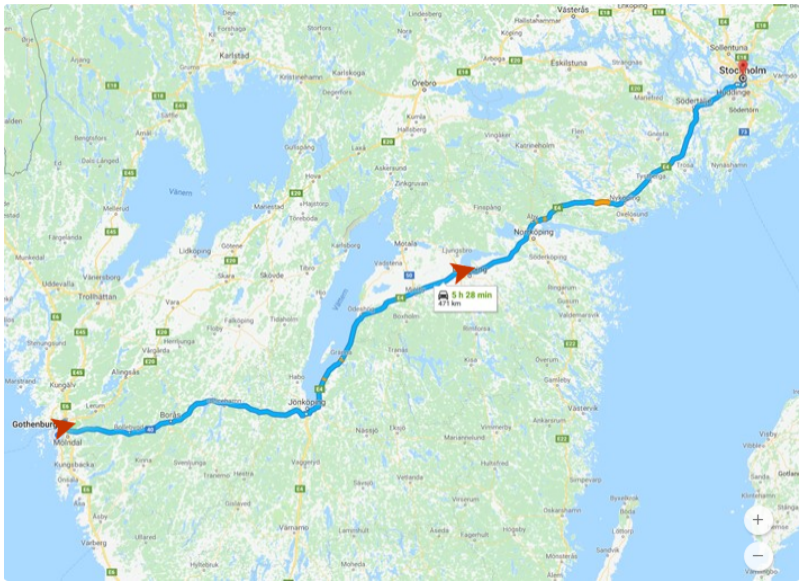

Figure 5.10: Map view in planned view.

The map view in the planning view is used as an aid to the user when creating platoons. Vehicles are displayed at the starting location and the route to the end destination is shown. With the map in the live-view the user can track vehicles in real-time.

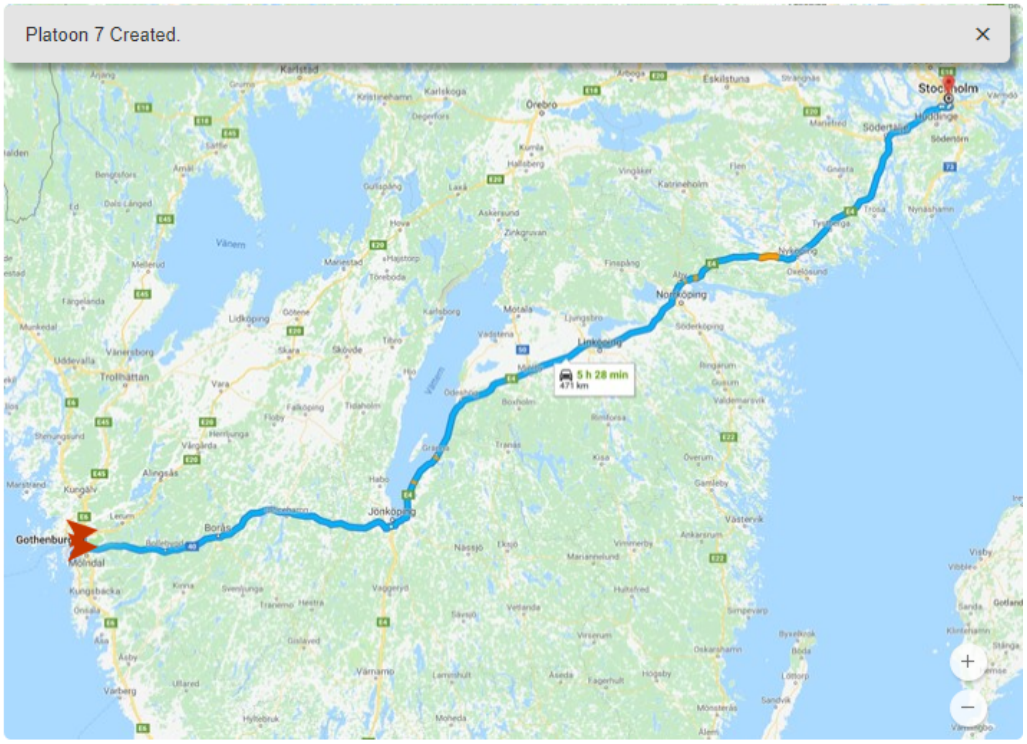

Figure 5.11: Map view in planned view with feedback.

Feedback to the user is shown as a pop-up message that fades away e.g. when the user for example, creates a platoon.

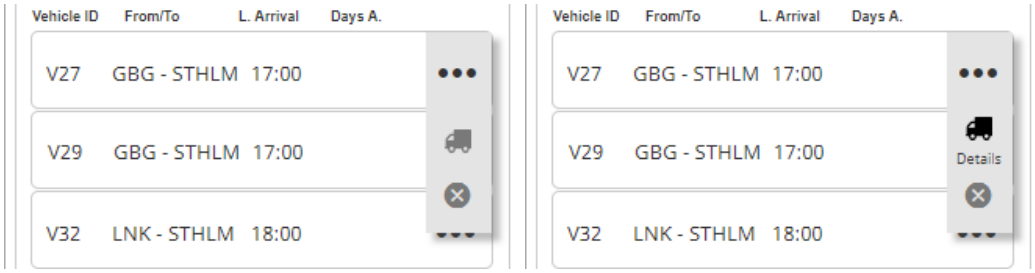

Figure 5.12: Vehicle menu.

The three dots are a menu for the vehicles, which in the prototype in the planned view, contains two options: Details and reject vehicle. Details opens a new window where the vehicle details are displayed. Reject vehicle removes a vehicle from the Back-Office system

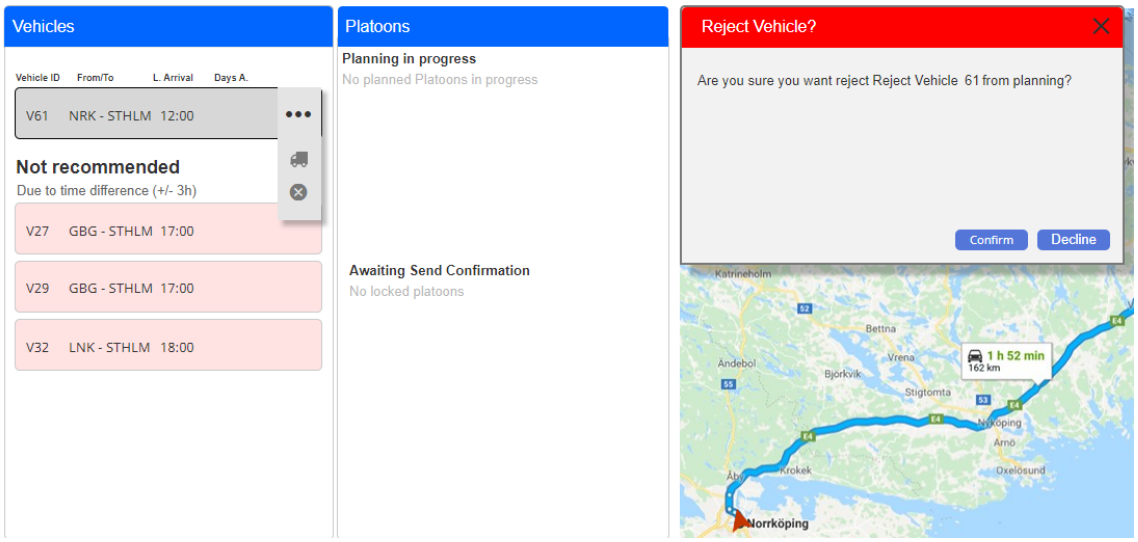

Figure 5.13: Rejecting a vehicle from planning.

When a vehicle does not match any other vehicles in planning it should be rejected from planning. This allows the users to remove the vehicle from planning and inform the haulage contractors that no match has been made. If the vehicle is available for more than one day, the vehicle is sent to the next day available day for planning.

5.2 Live View

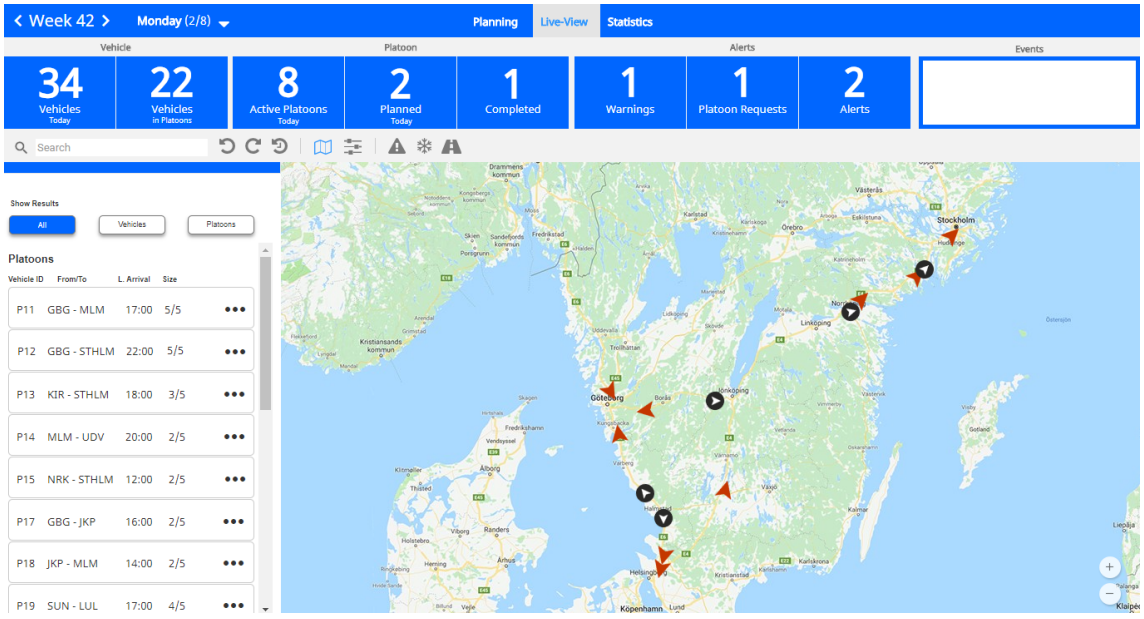

Figure 5.14: Live overview

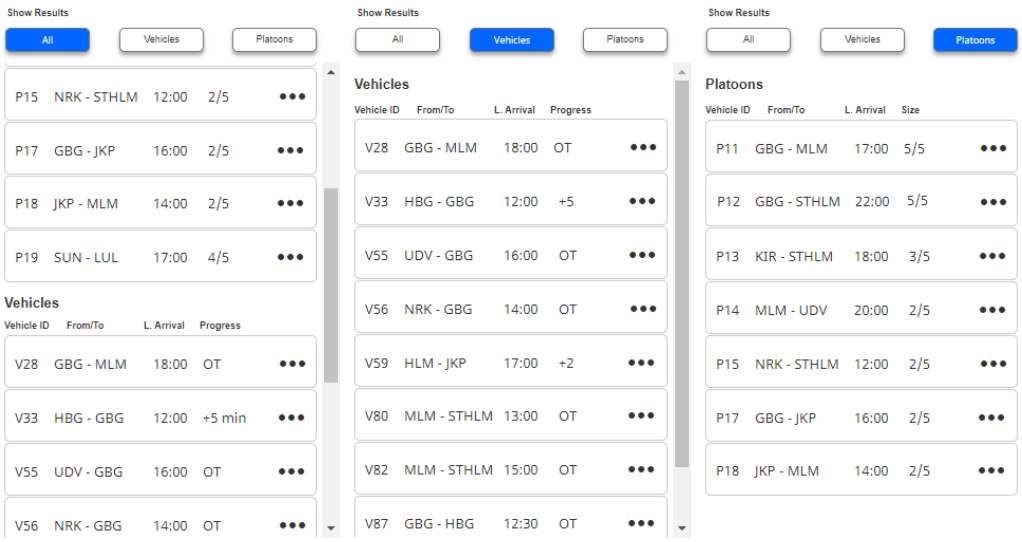

Figure 5.15: Vehicle list filtering.

The vehicle list in Live-view differs from the vehicle list in the planned view. The vehicle can be filtered to show platoon and vehicles, only vehicles or only platoons. The map is also affected by the vehicle list. If only platoons are showed in the list only platoons will be seen in the map as well.

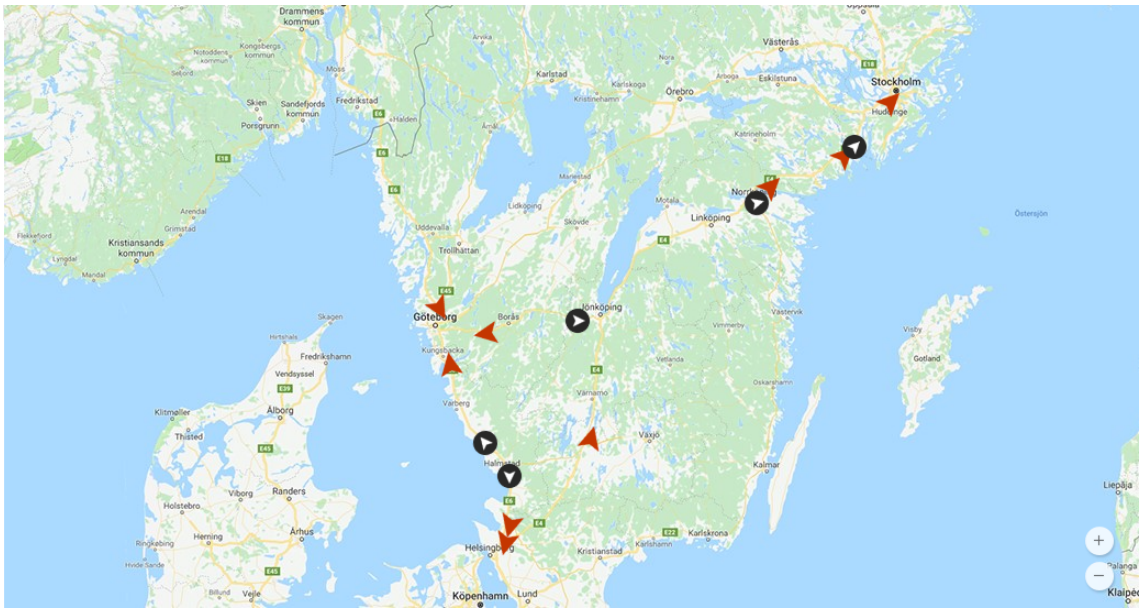

Figure 5.16: Real-time positioning of vehicles and platoons.

Platoons are displayed with a white arrow showing the direction of the platoon with a black circle around the arrow. Vehicles are displayed as a red arrow.

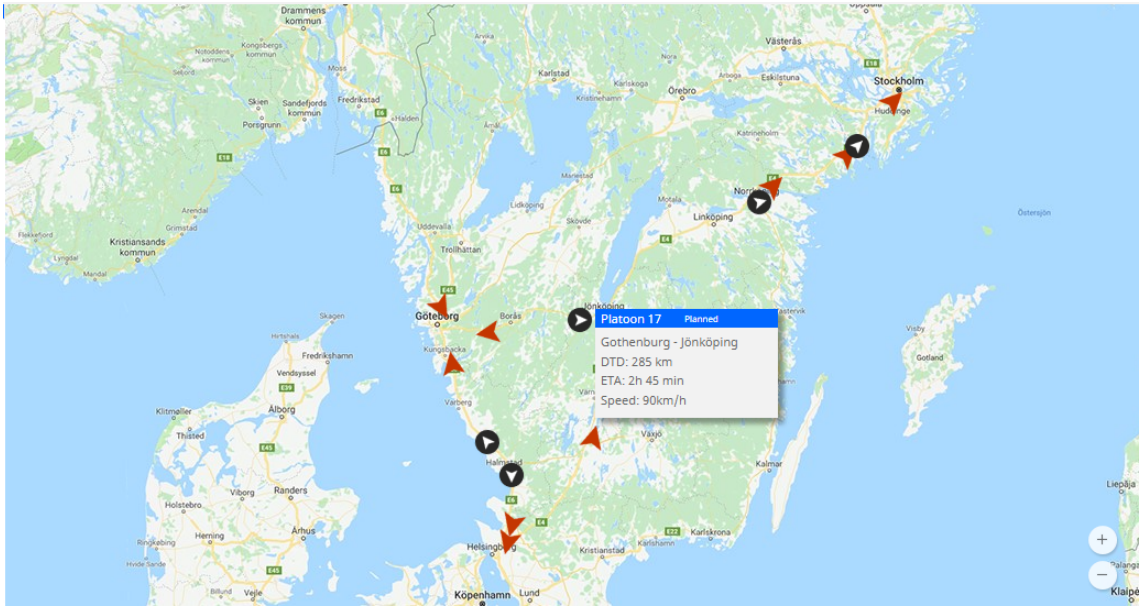

Figure 5.17: Hovering on a platoon.

When hovering over a vehicle or a platoon a small box appears with information that displays: The ID of the vehicle or platoon, the destination, distance to destination (DTD), estimated time of arrival (ETA), current speed.

Figure 5.18: Platoon request pop-up.

Platoon Request is a pop-up message that informs the user that there is a request from a driver to join a platoon. In the prototype this message was utilized by clicking on the corresponding square in the dashboard, although this message should be automatic and pop-up when a platoon request appears.

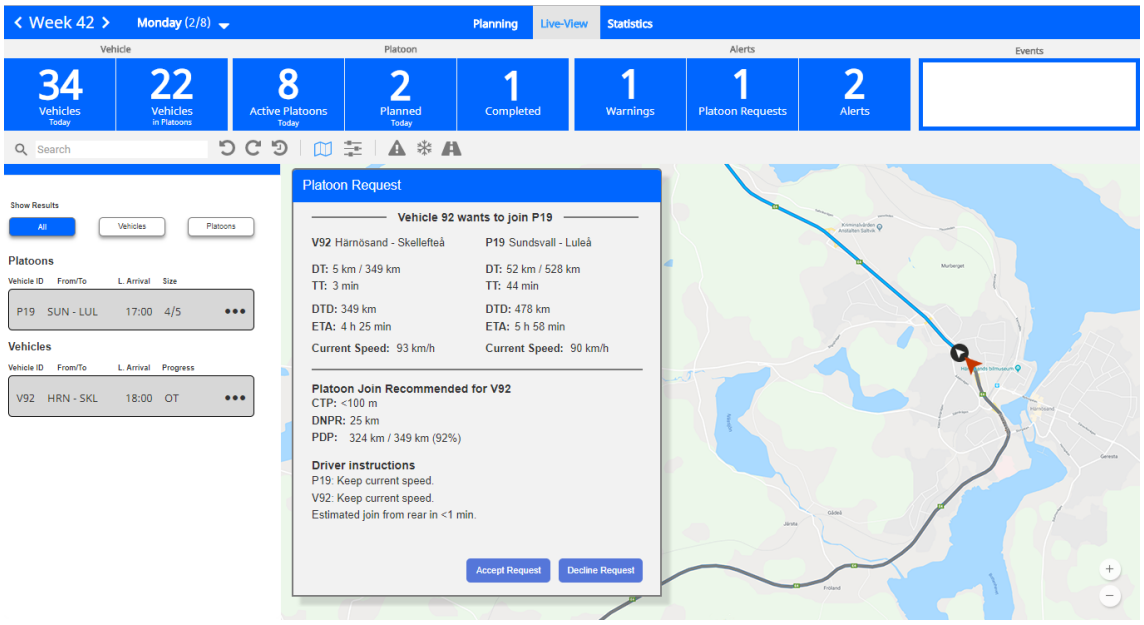

Figure 5.19: Platoon request location.

By clicking on the platoon request the user is taken to the location of the request. The vehicles that are involved are selected in the vehicle list and the list is filtered to only show the vehicle affected by the platoon request. A window containing information about the vehicles and the platoon request appears.

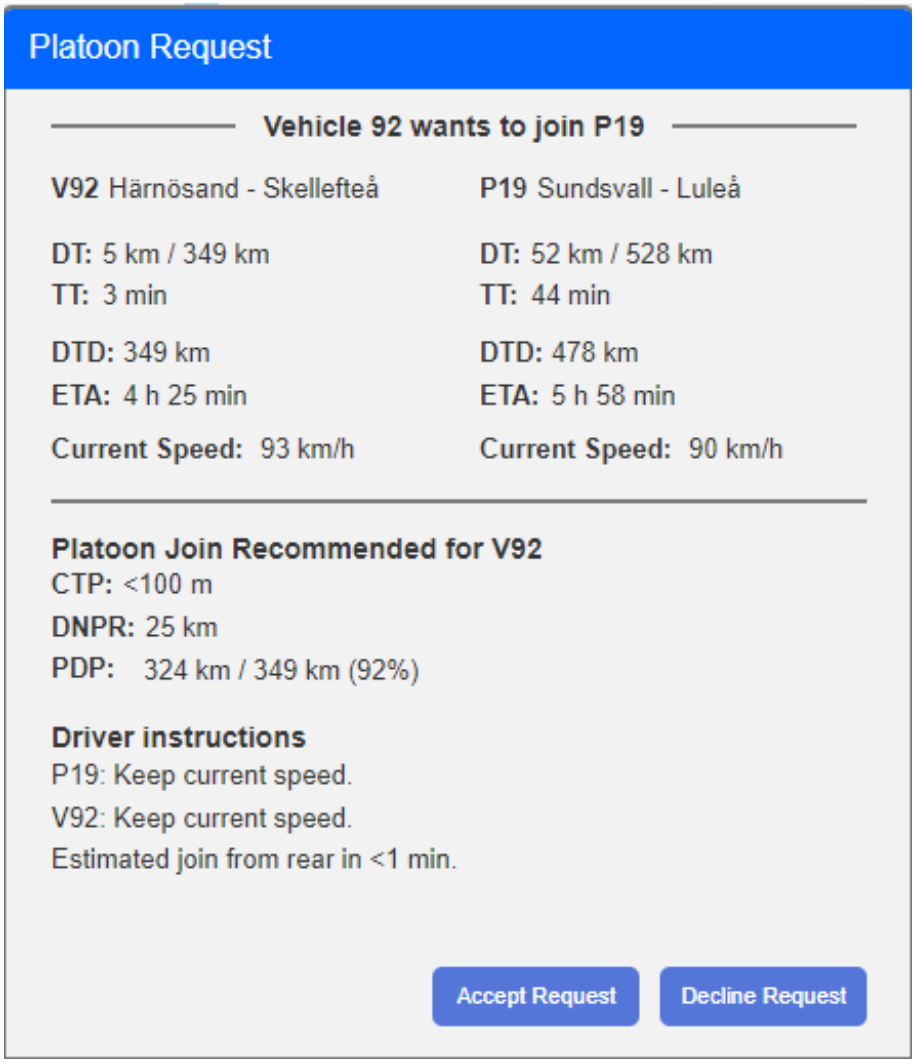

Figure 5.20: Detailed view of platoon request.

The information window displays some general information such as: ID and destinations, Distance Traveled (DT), Travel time (TT), Distance to destination (DTD), Estimated time of arrival (ETA) and current speed. The systems recommend a join for vehicle 92 based on the parameters that the vehicles are going in the same direction and the catchup to platoon (CTP) is low and the Drive on non-platoon roads (DNPR) is low which results in that the possible distance in platoon (PDP) is 92% of vehicle 92 route. Driver instructions are the message that is going to be sent to the drivers which is a summary of speed instructions and estimated join time and where the join is coming from. Based on this information a platoon request can be either accepted or declined.

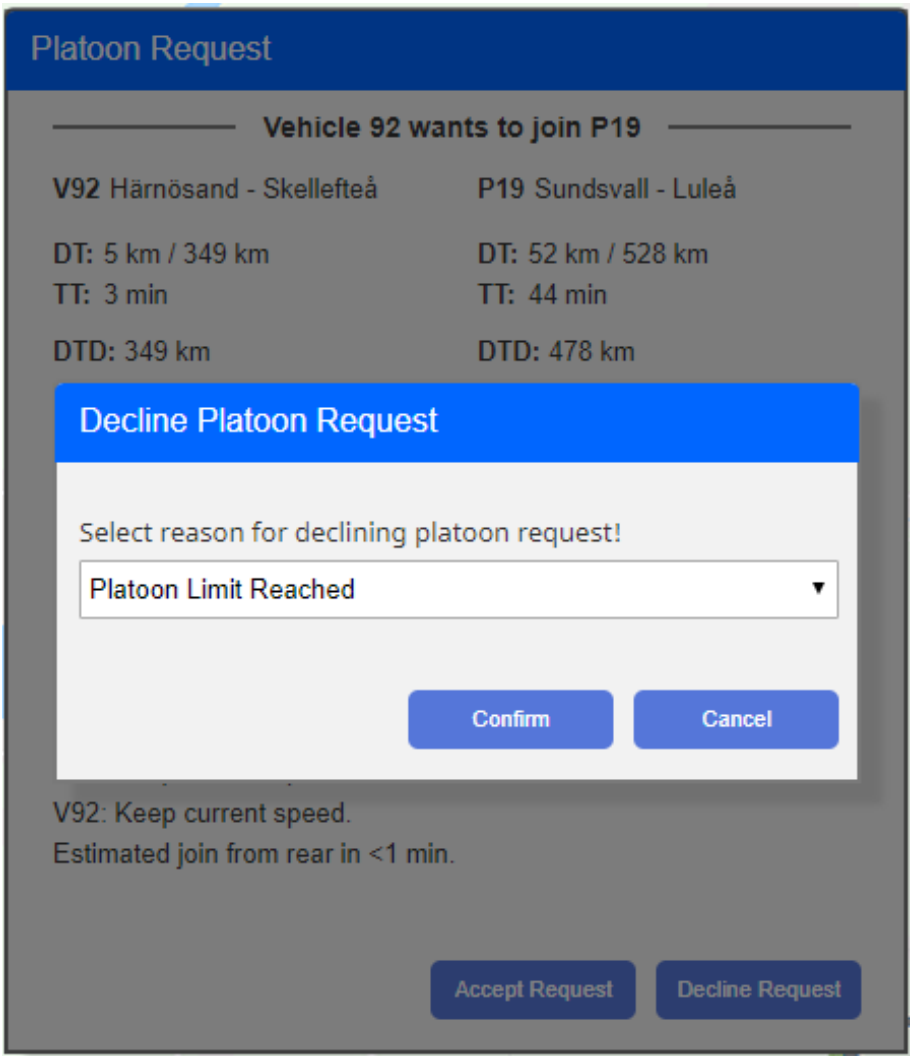

Figure 5.21: Declining platoon request.

Clicking on decline request opens a dialog box where the reason for declining the request needs to be submitted.

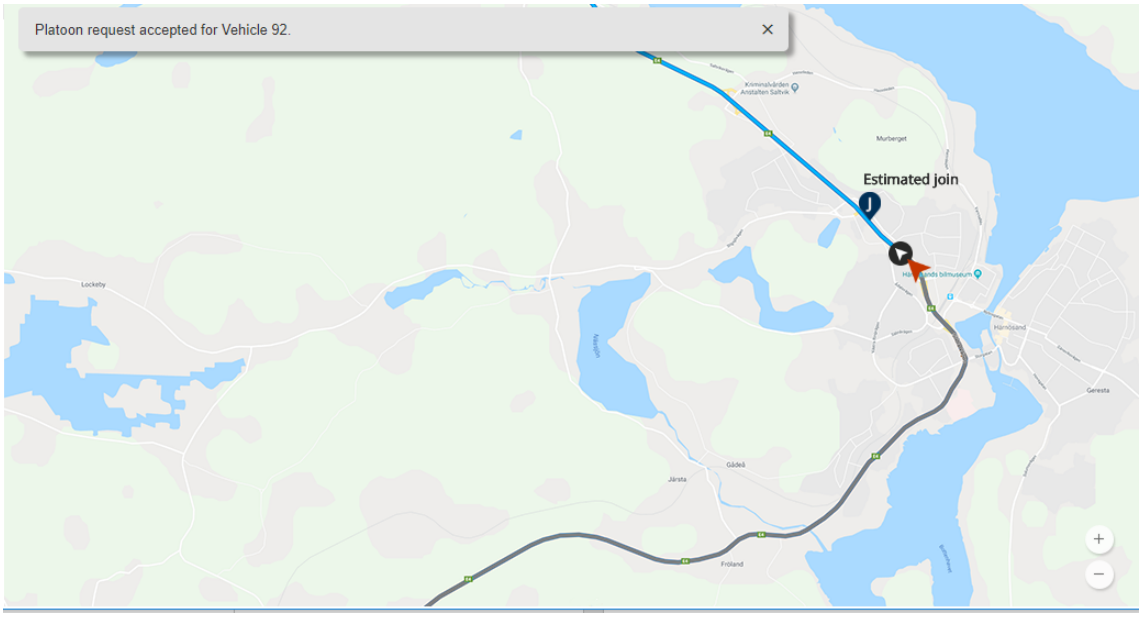

Figure 5.22: Feedback for accepted request and an estimated join point appears.

When accepting the platoon request a message is displayed confirming that the platoon request has been accepted and an estimated join point appears on the map.

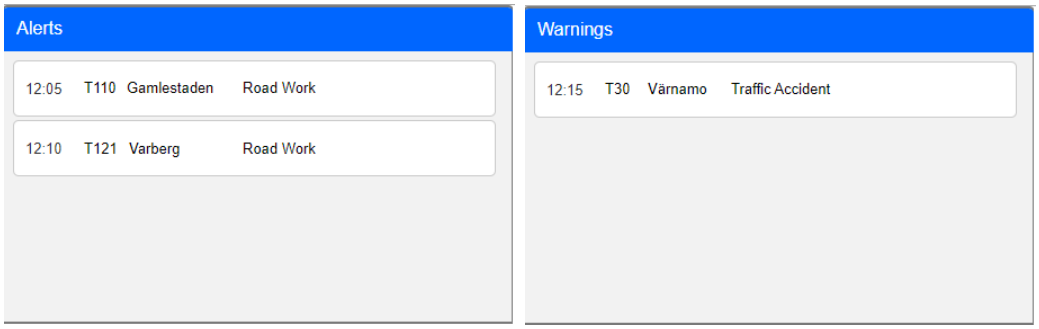

Figure 5.23: Alerts and warnings.

Alerts and warnings are shown as pop-up messages. By clicking on an alert or a warning the user is taken to the location of the alert or warning.

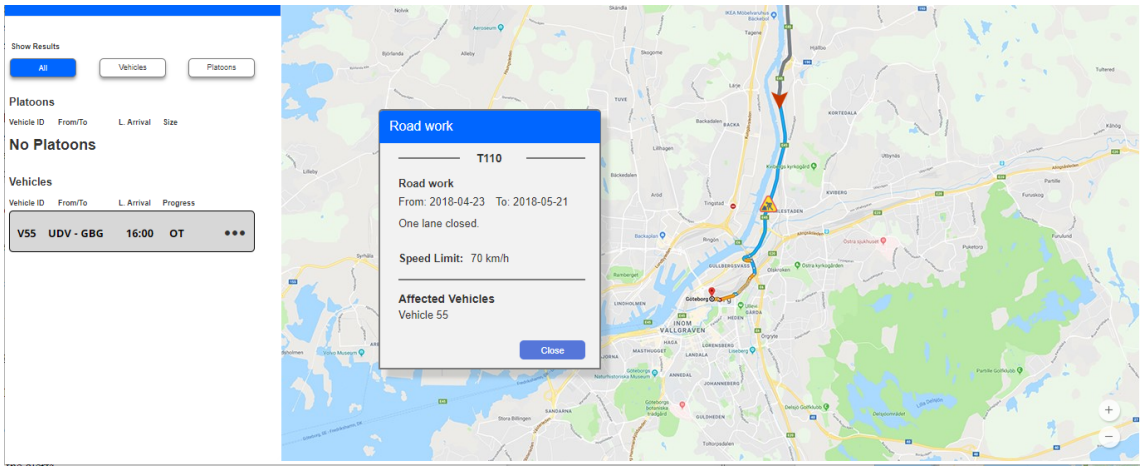

Figure 5.24: Location and information about the warning.

The system displays information about the warning and what vehicle or platoon is affected by it.

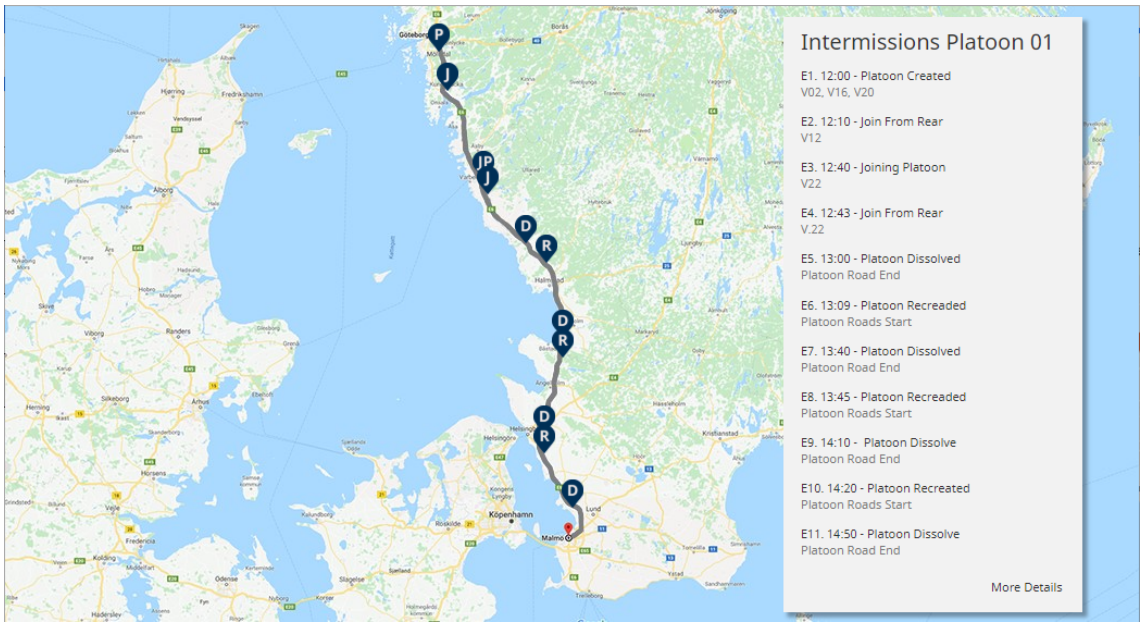

Figure 5.25: Details for a completed platoon trip.

Platoons that have completed a route can be accessed from the dashboard. The information provided here shows all the platoons intermissions (platoon events) that occurred during a trip. The intermissions are time-stamped and the vehicles involved in the intermissions are displayed in the list. On the map it is possible to see where the intermissions occurred.

5.3 Usability test 2

Usability test 2 is presented as a summary for each task bellow followed by an average of the users' acceptance of the system.

Task one: Two of the users would like to have a drag and drop function. One user doesn't take his time to read the left panel and because of that the user can solve the task. After receiving instructions, he mentions it being "logical". Another user can't find the "create platoon" button and wonder if the arrival time is when it's supposed to arrive or start. The user says, "I wish I could see this earlier!". One user has a difficult time completing the task at first and asks for help after a while. The user had difficult to see which vehicles going toward the same direction. After being informed the respondent says "Ahh, but that is smart I understand how you are meant to do it now". One user noticed a list of vehicles and that two are going to the same destination. But he didn't know how to get the two vehicles to be added into a platoon and asked about it. After being asked about how the first vehicle was selected, the user quickly attempts to click on the best match and notices that it is now possible to create a platoon: "Aaaah of course".

Task two: All the users completed the task but with various difficulty. One user had problems at the beginning and clicked at the detail view first, but then the user clicks at match and completed the task without issues. One user notices that the task already is completed "Oh, perhaps I was meant to take more time before adding the other vehicle to the platoon".

Task three: Even though all the users completed the task, they had some issues in understanding why the needed to reject the vehicle. One user wonders where vehicle 61 can be found. After looking around the user sees the drop-down menu and reject the vehicle. The same user wonders why the vehicle needs to be rejected since it wasn't clear that there were no matches available. One user wonders why the vehicle is going to be rejected since it hasn't been looked at. The user wants more information and click at the vehicle and sees that there are no matches available. The user tries to reject the vehicle directly from the platoon, once back at the vehicle list, the respondent quickly selects the drop-down menu, notices the reject and rejects the vehicle successfully.

Task four: One user completed this task quickly without any problems. Two of the other three users had some struggles with the task. One user asked for help to complete the task. The users did not understand what the lock symbol was for and it was often ignored at first. The headers in the section was not clear to them and a user expressed that they could not understand what awaiting send confirmation implied.

"Oh, yes of course they have to be locked first I think this is smart otherwise you can make mistakes, but it is unclear for the first time"

"oh, I did it? whoops, that was hard and now I still don't know which three vehicles that I am sending".

Task five: No user had any comments or problems to navigate to live view.

Task six: All the users completed the task without any help. One user was very quick and noticed where to click right away. One user was confused and did not yet understand that live view was different from planned view. After an explanation the user found the right option. One of the users found the platoon request quickly but got stuck at the information provided in the platoon request. The user did not know what the abbreviations meant and what type of information the user should know to find out if it's the right decision to approve the request.

"This is useful, but there has to be more notifications for the user so that they are alerted when a request is pending".

"Should be more of a pop-up or highlighted apart from everything else so that you notice it"

Task seven: All the users completed the task without any problems. One user was wondering what the difference is between a warning and an alert and one that that it was good that it was so easy to find.

Task eight: None of the users had any problem completing this task. One user mentions that warnings are usually are viewed as softer and warnings are more crucial. Another user agrees and mentions that an alert is something that you need to be alerted-of while warnings usually are more severe.

"perhaps you wouldn't want to go back all the way when you have selected alerts and is done with one of them it might be easier to be able to navigate to the second alert straight away ".

Task nine: 2 of the four users completed this task quickly by clicking on the dashboard section which contained completed platoons. The other two users did not find the information right away. "Completed platoons, do I have any of those? I do not know" was one of the user saying while navigating and searching for the solution. When finding the right option, the user expressed: "Oh this is really cool, but I do not know what the abbreviations mean but I suppose that you will have some training before doing this job". One user was a little confused and was wondering if the completed platoons had something to do with confirmation from the haulage contractors. When finding the right option, the user noticed that it was something else but wondered what the intermissions mean.

Task ten: Three of the four users first tried to click on the square in the dashboard that displayed active platoons. Even though that solution was right it did not work in the prototype. This was explained to the users as well as that they need to find another way to solve the problem. One user finds the alternative directly by clicking on the vehicle list and filtering to platoons.

"I didn't quite get it first, but it is understandable that details are in the drop-down menu".

Task eleven: Filtering between platoons and vehicles was easily completed by all the four users. Three of the four users had used the filtering function to complete previous tasks.

My assesment of the system as a whole							
		1	2	3	4	5	
1	Useful		X				Useless
2	Plesant		X				Unpleasent
3	Bad				X		Good
4	Nice		X				Annoying
5	Effective		X				Superfluous
6	Irritating			X			Likeable
7	Assisting		X				Worthless
8	Desirable		X				Undesirable
9	Raising Alertness		X				Sleep-inducing

Figure 5.26: Average of the user acceptance of final prototype.

The result of user test two is shown in the table above. The answers in the summary are an average of the four user tests conducted. The individual results can be found in (Appendix E) When a mark is placed in the middle of a box the number translates to the exact value. Marks that are not directly placed in the middle are leaning toward the next value in the boxes.

6
Discussion

Future needs of a Back-Office system was shown by Bergenheim et.al (2012), Levy (2015), Liang (2014), Janssen et.al (2015) and Goel (2015) as they mentioned its use in literature. One could then also expect to be able to find extensive research regarding the systems functionalities, tasks and responsibilities. However, our literature study revealed that there has been limited research regarding this area. Our results uncovered a set of functions required to be included in a Back-Office system for managing platoons. It also included information regarding what is required of users to be able to work within this Back-Office system along with an explaination of design challenges. To reach the result, we used a wide range of methods which we applied using design thinkings five stages (Interaction Design Foundation, 2018) where we created one low-fidelity and one high-fidelity prototype which then was tested in two different usability tests.

In literature, we found that a cognitive walkthrough is mostly used as a cognitive expert evaluation of an interface. Yet, there is also literature that suggests preforming cognitive walkthroughs with non-experts as well (Interaction Design Foundation 2018; Green et al. 2000; Mahatody et al. 2010). This was argued in favor of since evaluators with no familiarity to the topic are helpful in uncovering errors with basic interactions in an interface, which is what our goal with the first usability test was. Strengthening this argument is the fact that our nine users uncovered the same basic problems in the initial interface. Therefore, using only experts was not required and allowed us to get more users to evaluate the prototype.

In order to create our prototypes we used two tools: Balsamiq and Axure. Balsamiq was used very early on in our process for creating low-fidelity prototypes since its easy and quick to use and therefore found as ideal to explore user interface elements placement and navigation. However, the issue with Balsamiq was that a new screen had to be created for each interaction in the interface. This resulted in an issue for displaying certain functions in the interface such as filtering vehicles. For one simple list with eight vehicles, we counted that we needed to create at least 64 screens to be able to show the full interaction. Therefore, the initial tests were limited to only allow basic navigation within the system. For this reason, we then chose to use a more advanced tool in Axure to be able to instead of creating multiple screens for each interaction, use programming logic to be able to prototype a more interactive interface. With Axure, it was easier for our respondents to become familiarized with the systems interface and functionality by exploring it.

The first user test was done using a cognitive walkthrough (Rubin Chisnell, 2008; Polson et al. 1992; Interaction Design Foundation 2018; Green et al. 2000; Mahatody et al. 2010) where we noticed that it was hard for the respondents to get a clear understanding of the Back-Office system as a whole, while interacting with a low-fidelity prototype. Moreover, it was the look and feel that bothered some of the respondents, but mostly they expressed that they felt limited by insufficient feedback provided by the system after they preformed an action.

From the user testing we found that creating a platoon was one of the harder tasks to complete without any prior knowledge of the system. One major reason was that many respondents believed that the vehicles could be drag and dropped into the platooning list. Although, there were some respondents that understood the interaction and could easily complete the task. For the future, it could be interesting to do an A/B test to compare the success rate between a drag and drop functionality versus the selection method used in the prototypes. However, we believe that the current way of creating a platoon would be difficult to preform using drag and drop since the list automatically filters to find matching vehicles. When a drag and drop is preformed, you are usually expecting to be working with the same list of vehicles all the time, which in our prototype is not the case due to the filtering.

Finally, even though we addressed all of the issues found in our first usability test by for instance adding more feedback to the final prototype some users felt as if more feedback was still required. This would be a possible improvement to address in a future prototype. That said, all of the users testing our low and high-fidelity prototype expressed that it did not require a steep learning curve and that how to preform a task was easy to recall after having done it once.

7
Conclusion

To conclude the result presented in the iterations above we will connect the gathered result to each of the research questions.

What are the required functions of a Back-Office system for platooning?

From the five iterations, the following requirements have been found using literature research, benchmark, use cases, interviews and observations.

- Create a platoon
- Manage a platoon
- Pre-plan platoons
- Reject platoon
- Guide vehicle to platoon
- Handle warnings
- Manage platoon requests
- Real-time positioning of vehicles and platoons
- Geofencing
- Log all data (events) related to platoons and vehicles in the system
- Display statistics of key performance indicators
- Receive and send data to haulage contractors
- Use draggable windows
- Communicate with drivers

What qualifications are required of the user for managing a Back-Office system for platooning?

The answer to this question emerged during the interviews and observations at various companies working within systems with similar functionalities to the Back-Office. We found that the future users are going to be required to be proficient in the area of platooning. This is due to the system being complex and the fact that Back-Office managers need to be able to take executive decisions. Furthermore, it is also going to be required to have analytical skills for managing the data gathered from vehicles connected to the system and to effectively plan platoons. Lastly, strong cooperation skills are necessary for being able to communicate with drivers and colleagues working within different regions.

What are the design challenges for creating a Back-Office system for platooning?

There are a lot of uncertainties about the platooning technology today that makes it a challenge to design a Back-Office system for platooning. The technology itself is still in the process of being applied in real traffic environments, therefore there are a lot of unknown factors regarding laws and regulations. Worth noting is also that we have not considered business cases in this thesis but that they are important to recognize as one of the major challenges for platooning. One important factor in this regard, would be how to share and visualize fuel savings derived from driving in a platoon. It would also be required to decide how to distribute these savings since its well known in literature that fuel savings are dependent on the positioning a vehicle has had in a platoon. Furthermore, this thesis has also uncovered that the future Back-Office manager will play a major role in the coordination and management of platoons. Although, it is unclear what decisions these managers are going to be allowed to take. Finally, it is also unclear how much influence major haulage contractors will have on the Back-Office system as they will be the major providers of vehicles to the platooning system. Among these challenges, we believe that the uncertainty in future laws and regulations will have the biggest impact on the future development of platooning. This is because all of the above listed challenges will likely be forced to comply with these future laws and regulations. As a result, we therefore also believe that the laws and regulations will affect technology, fuel savings, the Back-Office Managers decisions and businesses influence.

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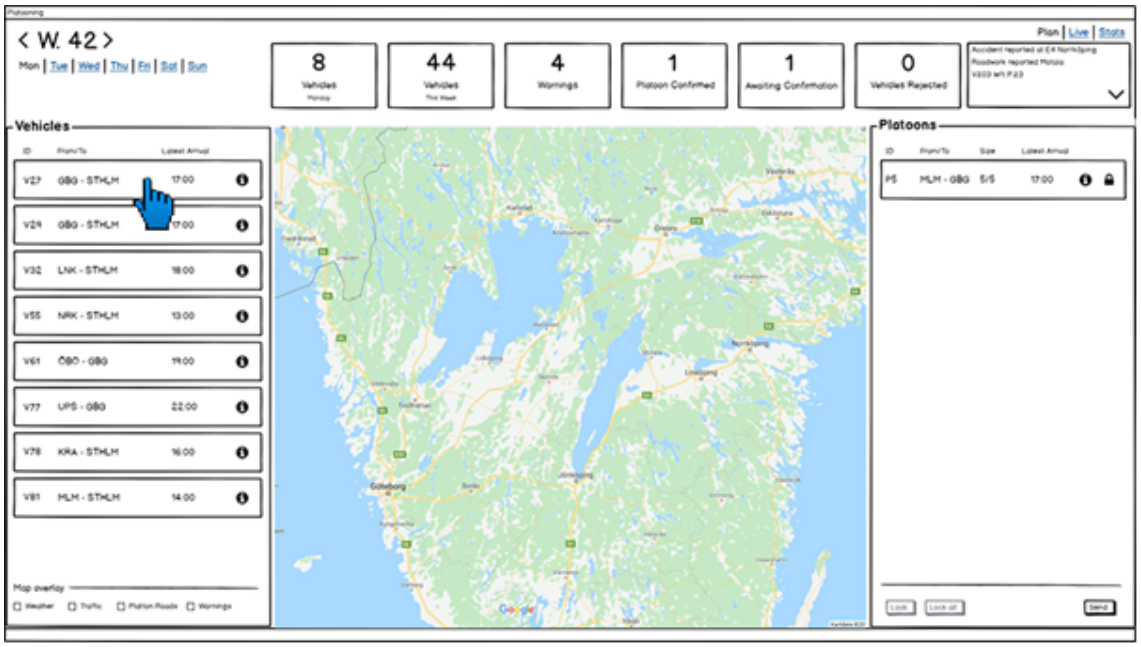
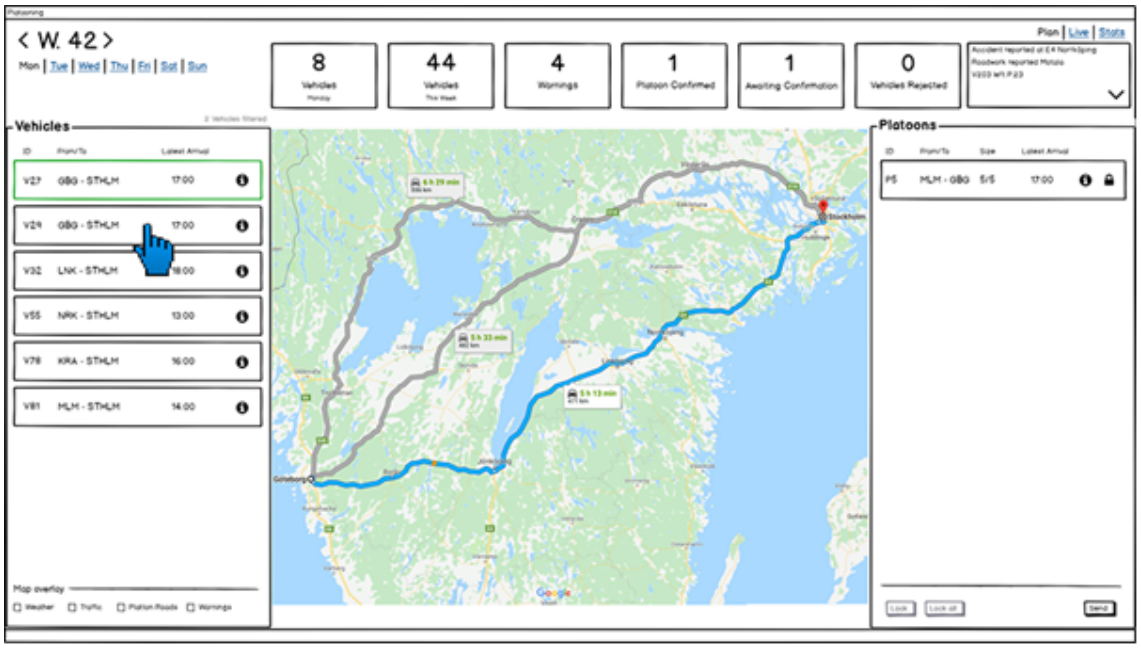
A

Ideal Scenario

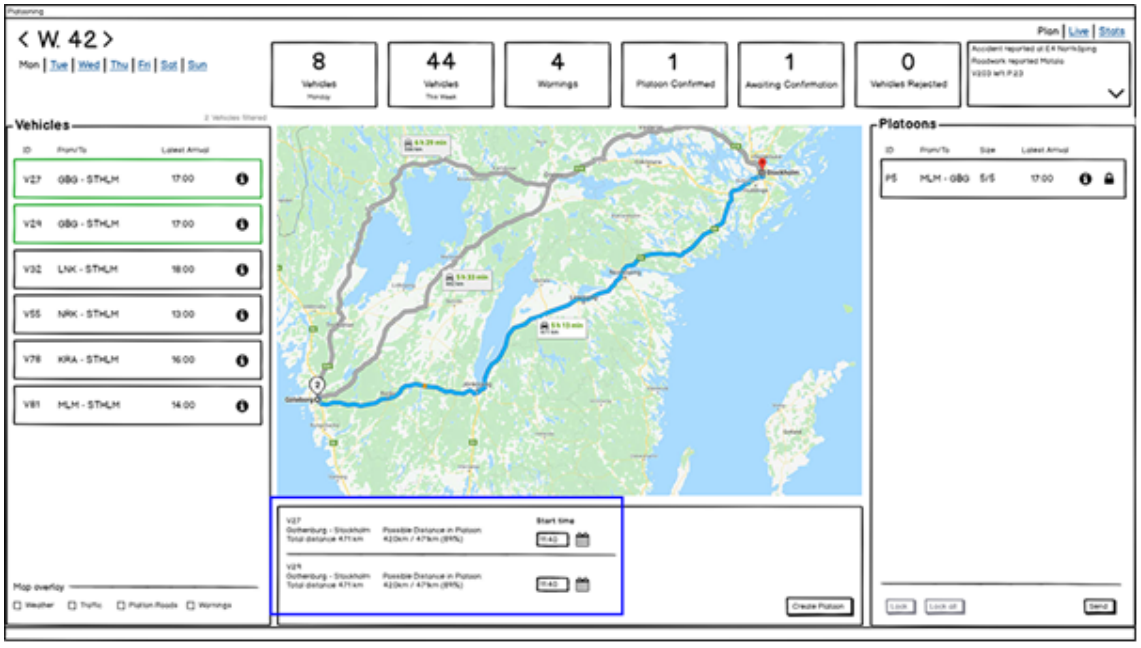
Task 1: Schedule a platoon for Monday W 42.



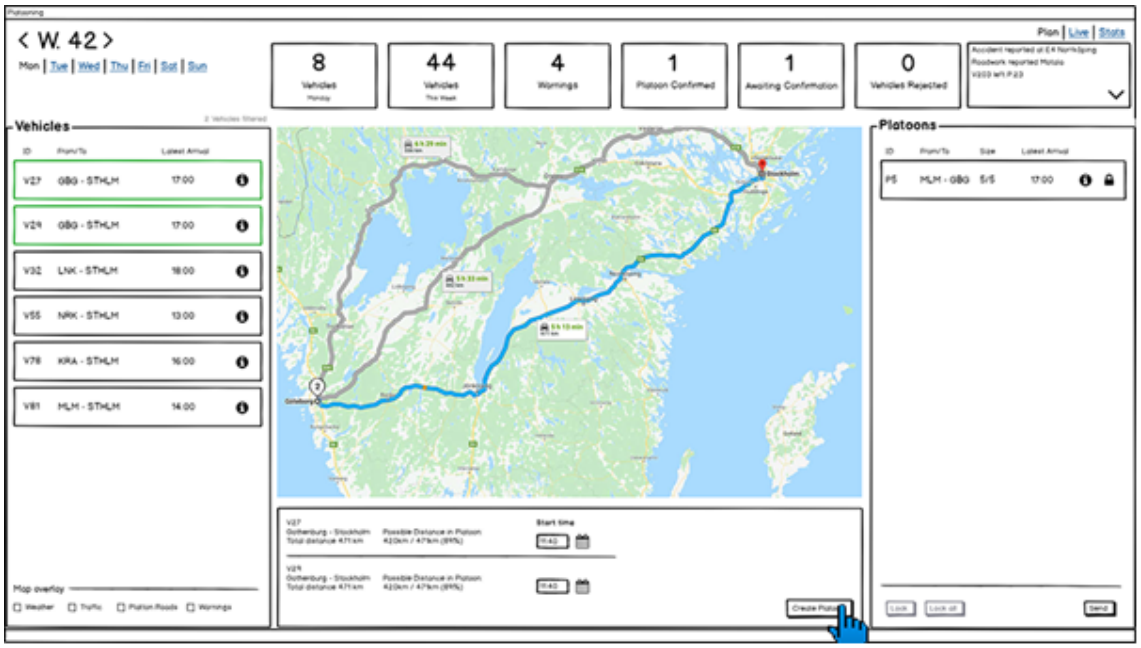
1. Click on a vehicle in the left-side list.



2. Click on another vehicle in the list.

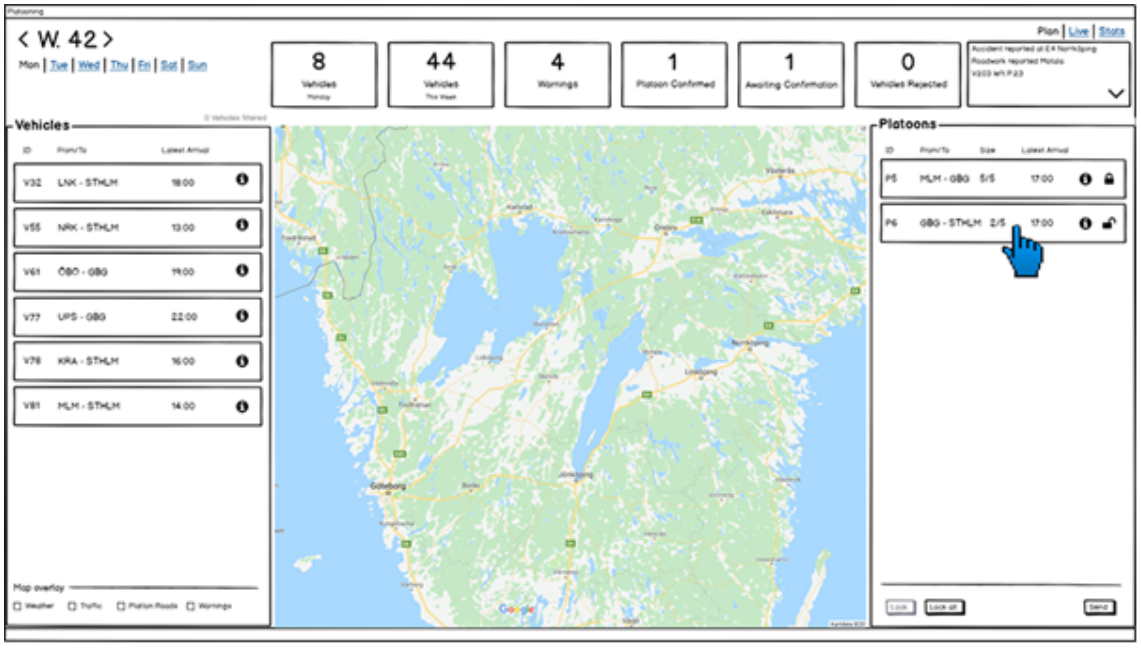


3. View the information appearing at the bottom of the screen.

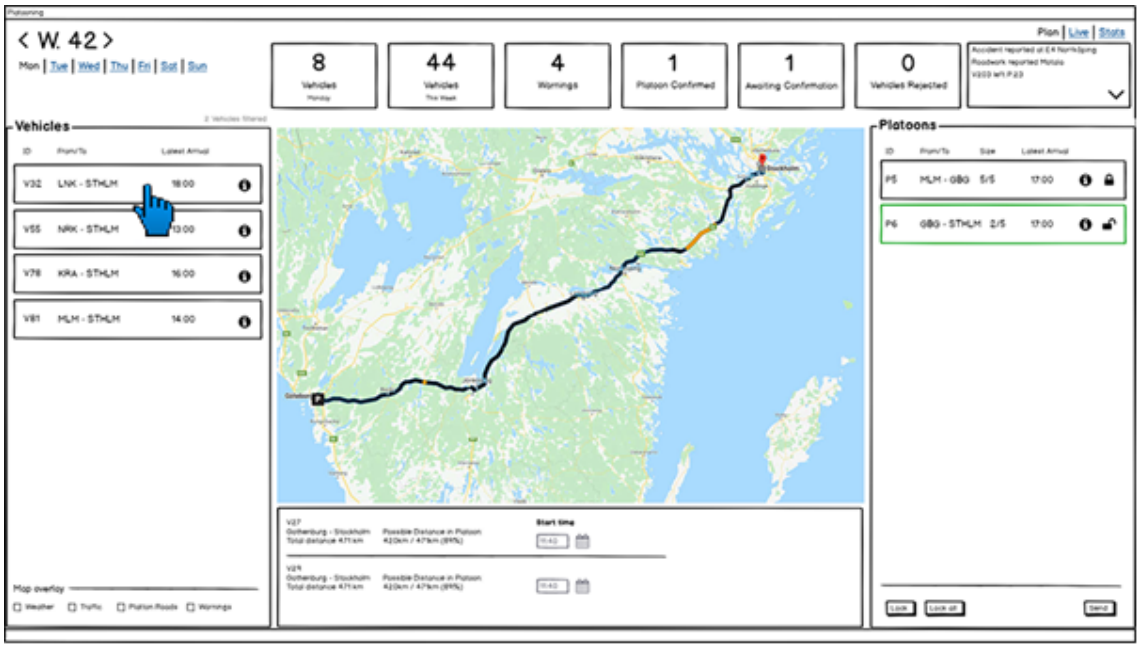


4. Click the "Create platoon" button.

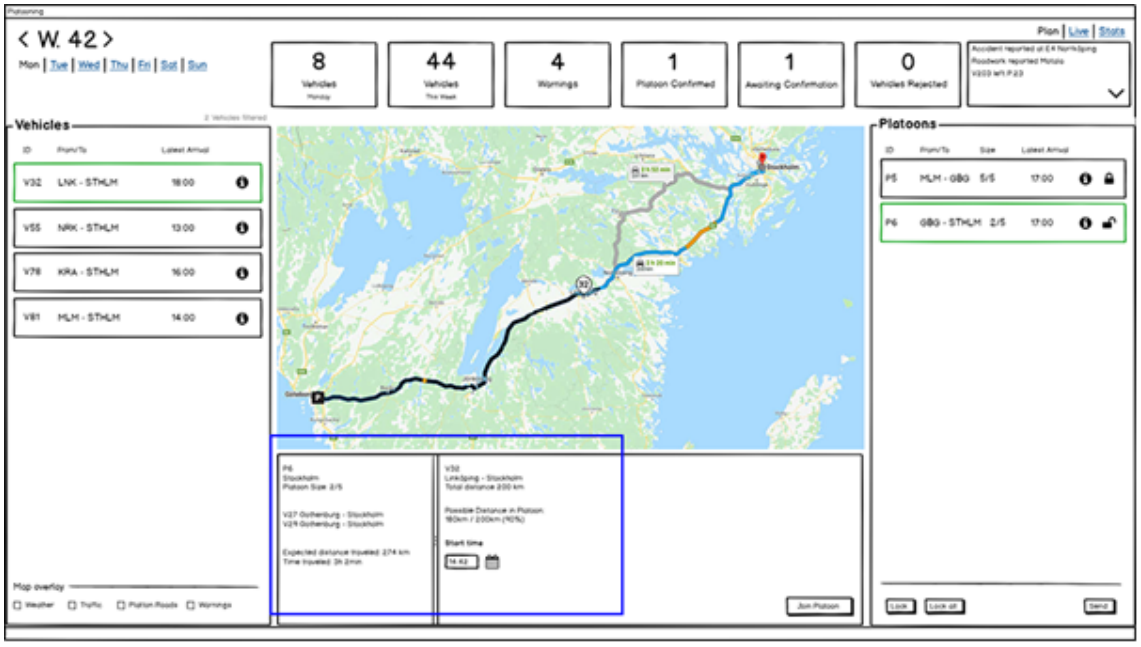
Task 2: Add vehicles the newly created platoon.



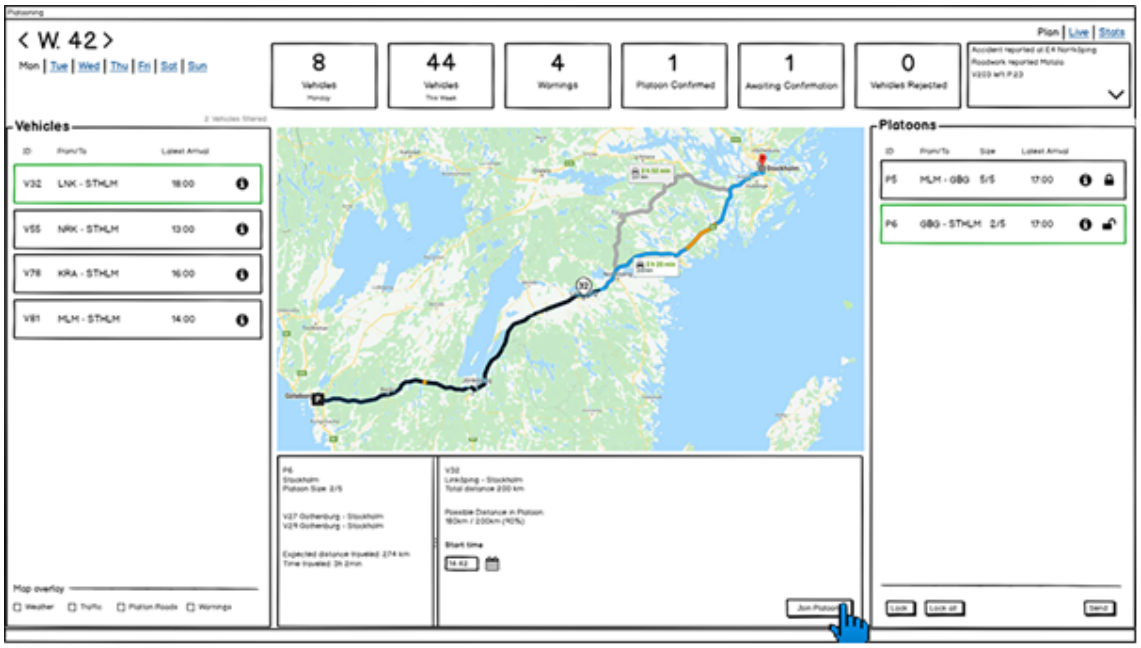
1. Click on a platoon in the right-side list.



2. Click on a vehicle in the left-side list.

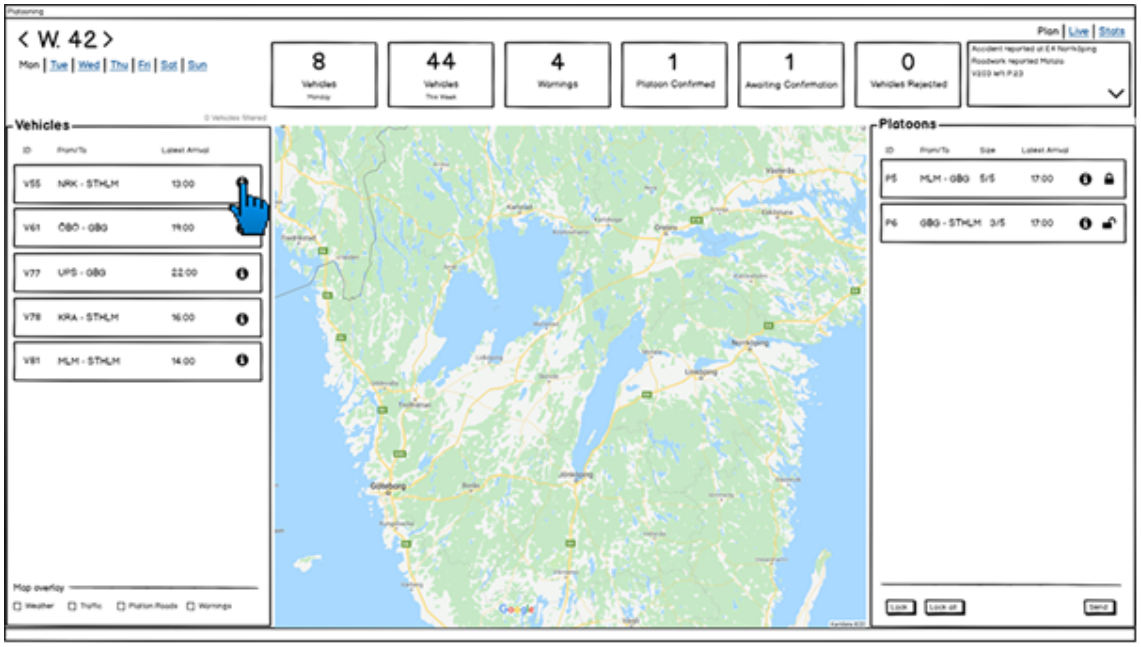


3. View the information appearing at the bottom of the screen.

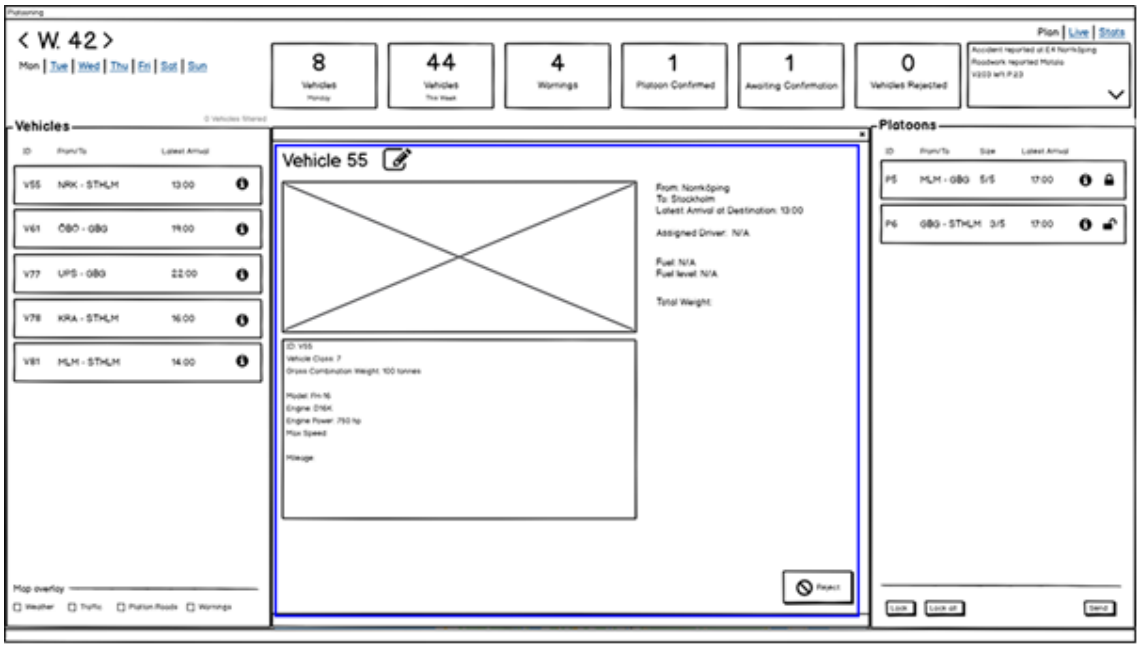


4. Click the "Join platoon" button.

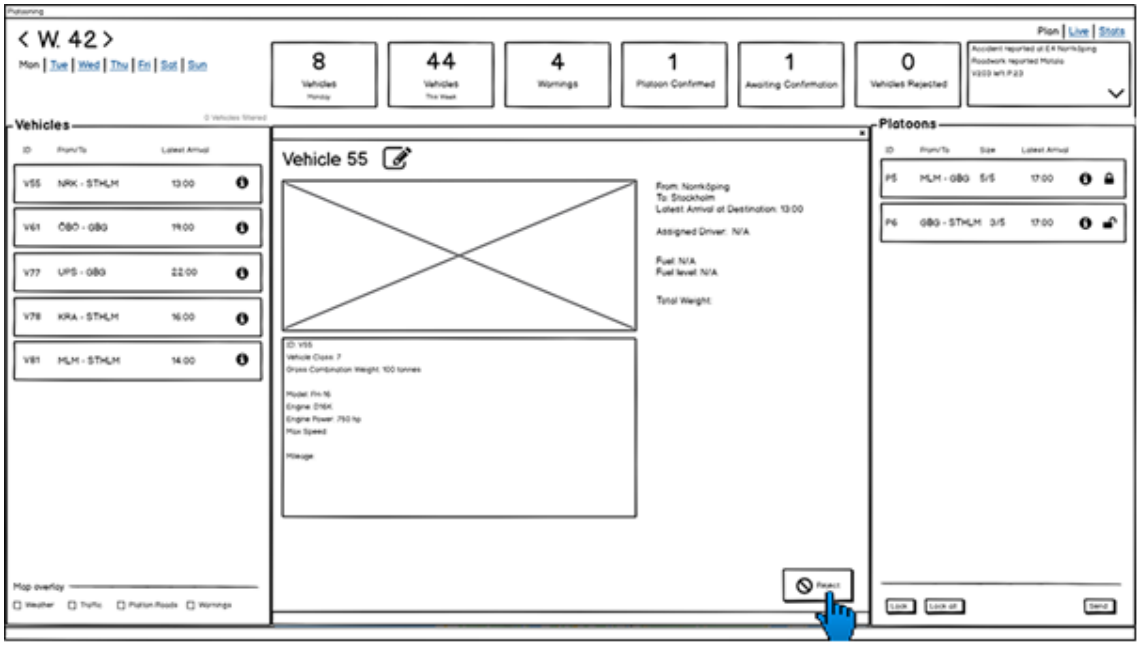
Task 3: Reject vehicle 55 from planning.



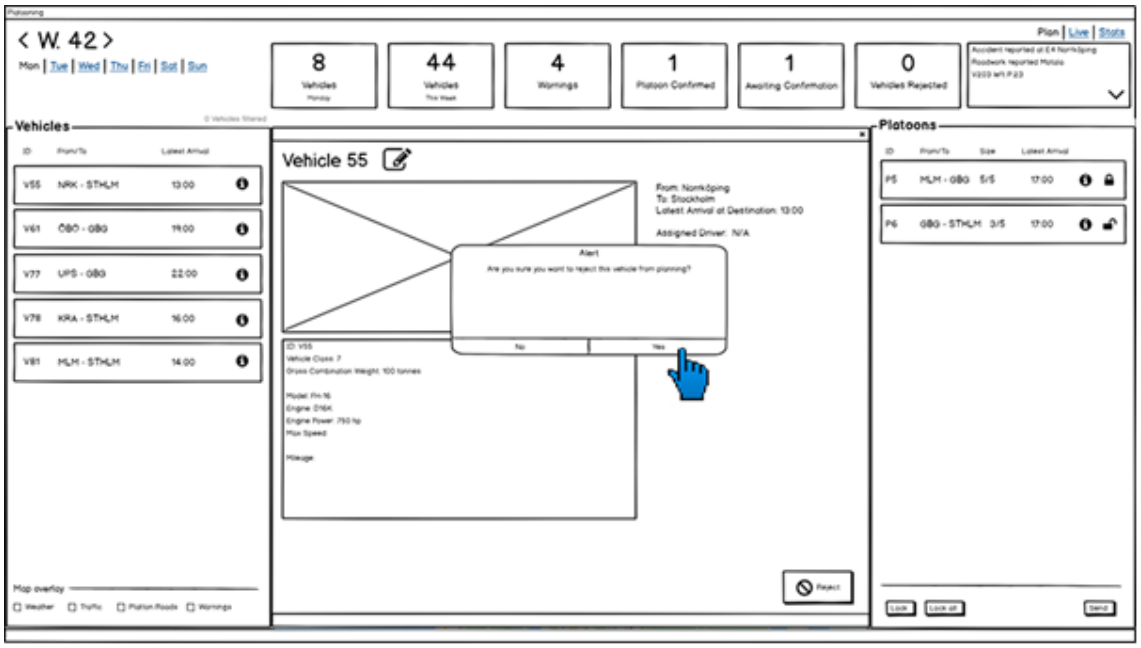
1. Click the information icon in the left-hand side list.



2. View the information.

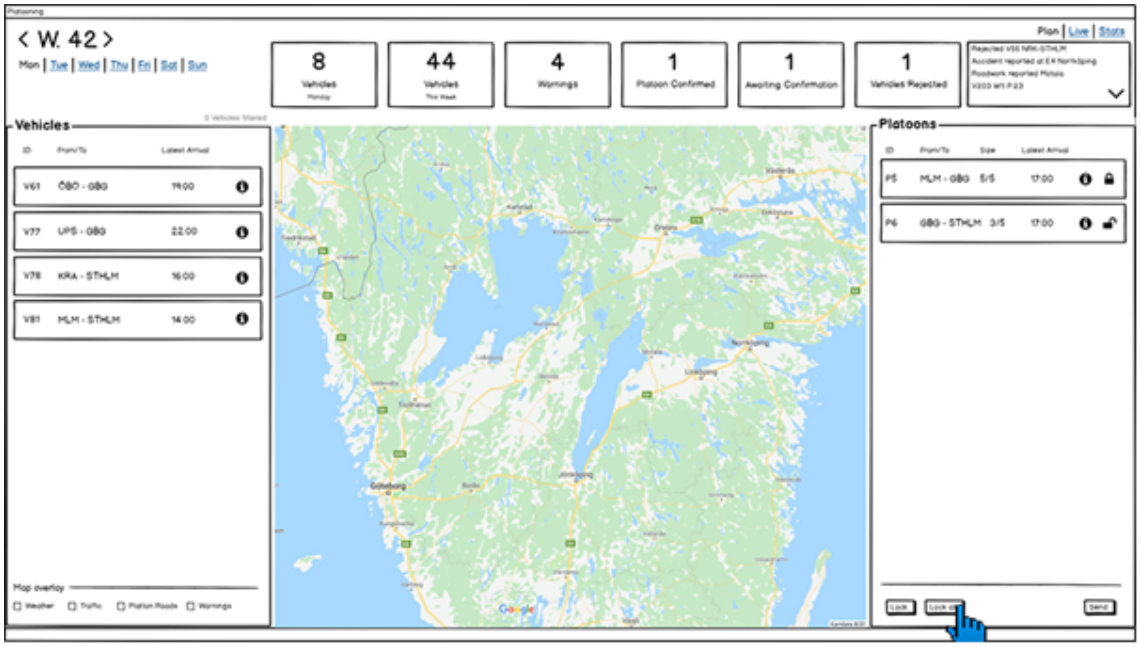


3. Click the reject button.

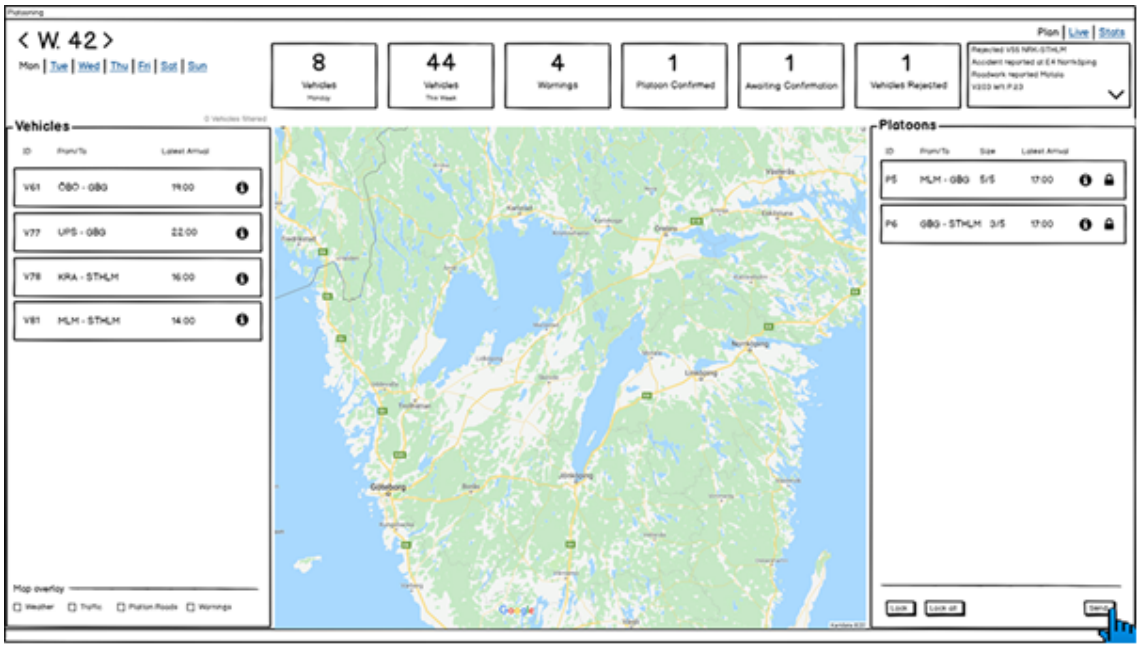


4. Click yes on the pop-up window.

Task 4: Send the scheduled platoons to the haulage contractor.

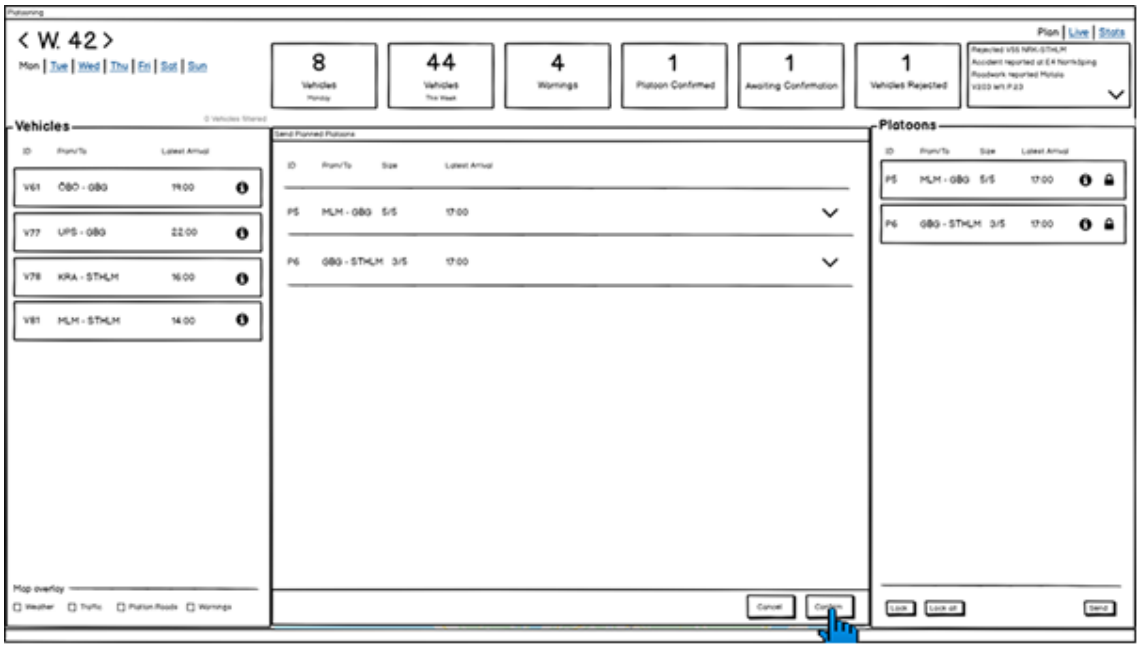


1. Click on the lock all button or individually press each lock in the window.



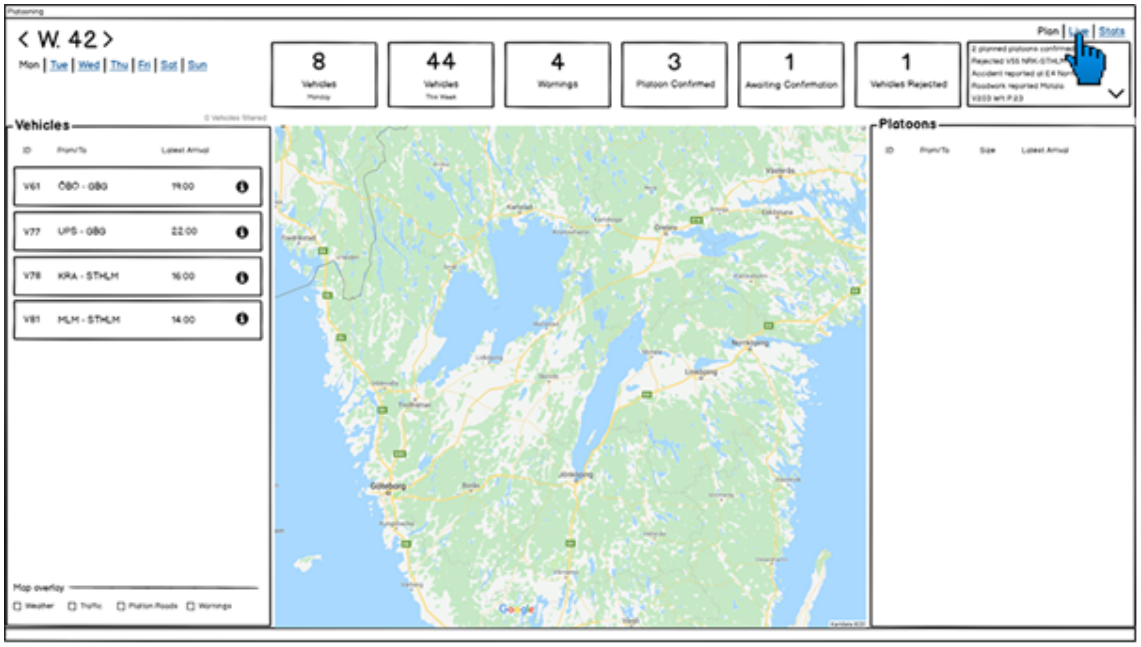
2. Click the "Send button"

3. View the information regarding the scheduled platoons.



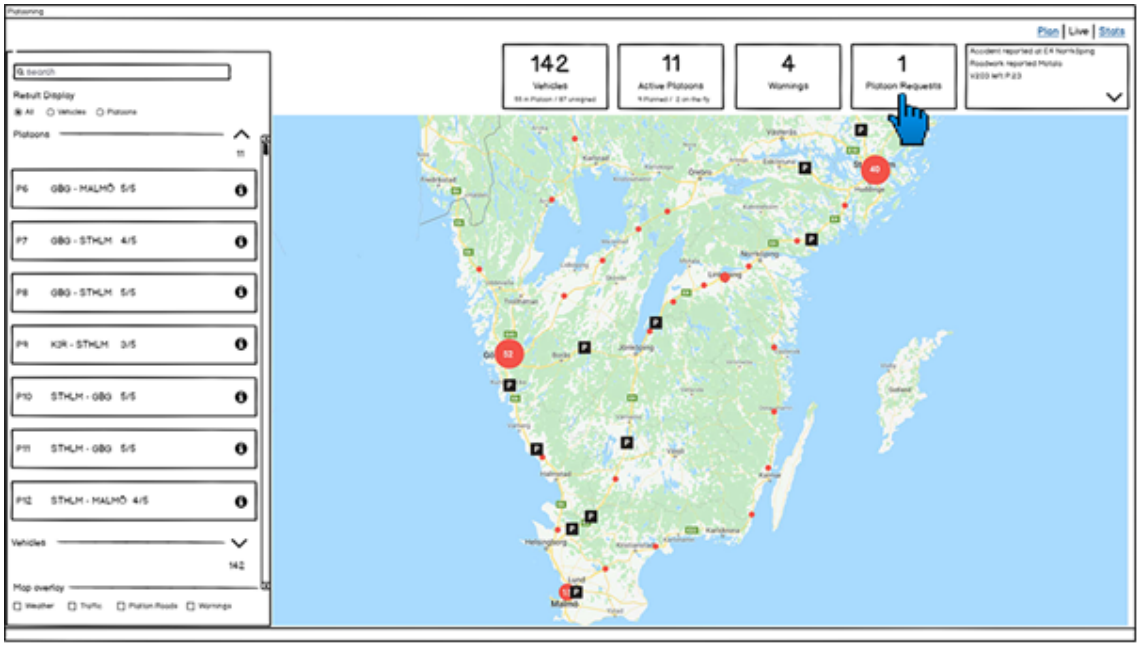
4. Click the "Confirm button"

Task 5: Navigate to the live-view.

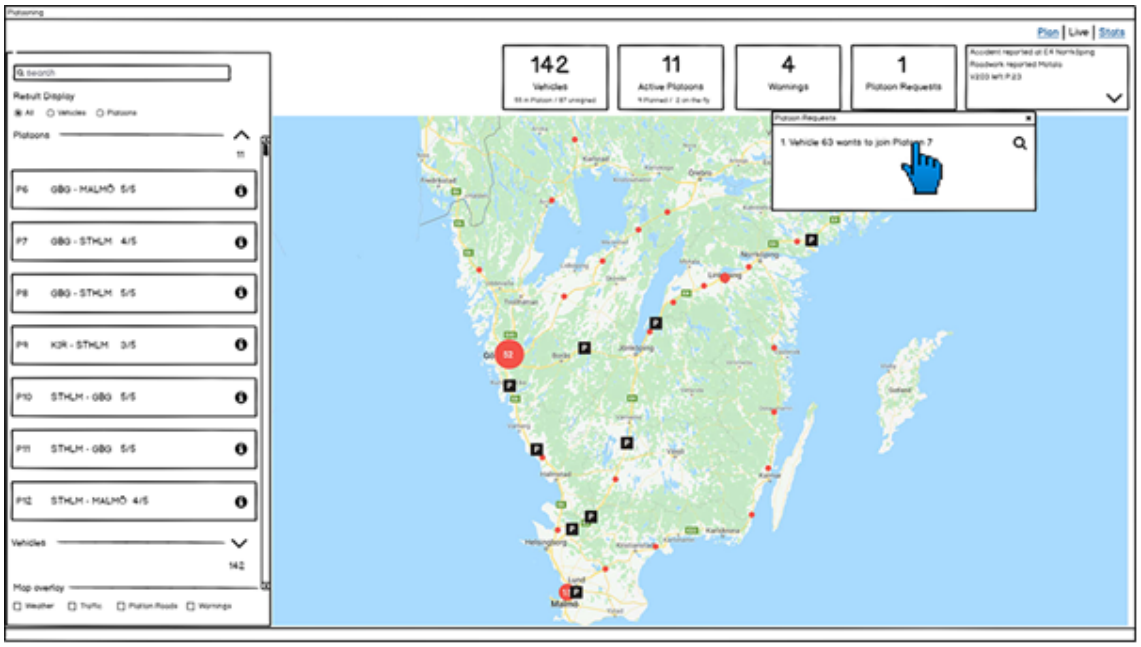


1. Click the "Live" link in the top-right corner.

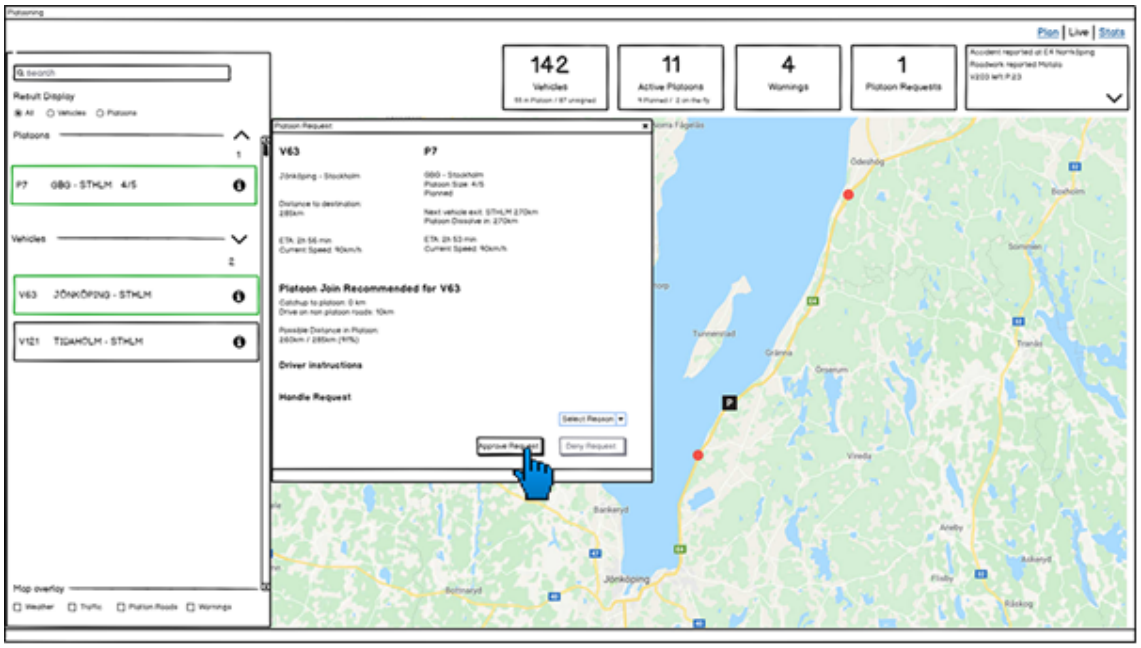
Task 6: Handle the platoon request.



1. Click on the platoon request.

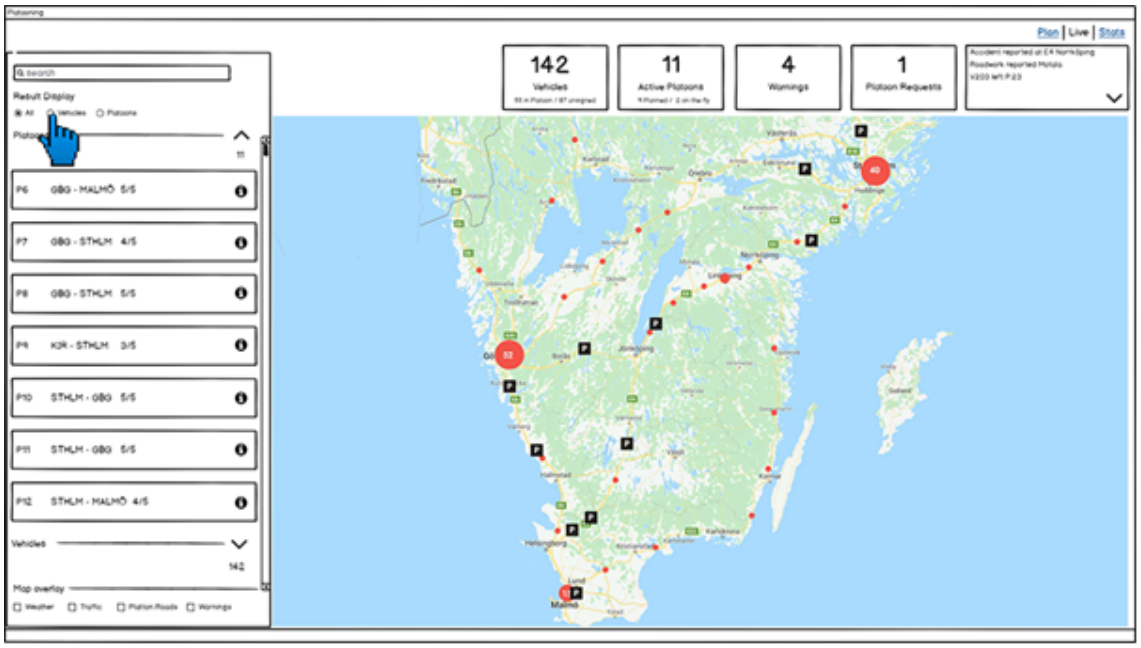


2. Navigate to the platoon request by clicking on the window



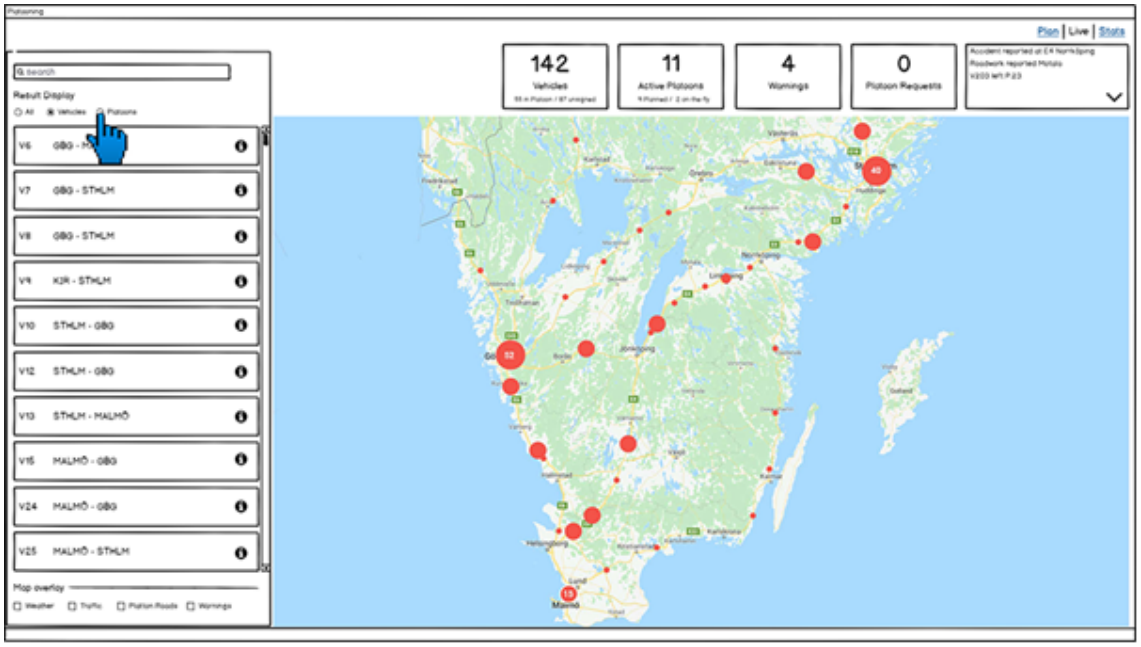
3. Approve or deny the platoon request.

Task 7: View all the vehicles on the roads



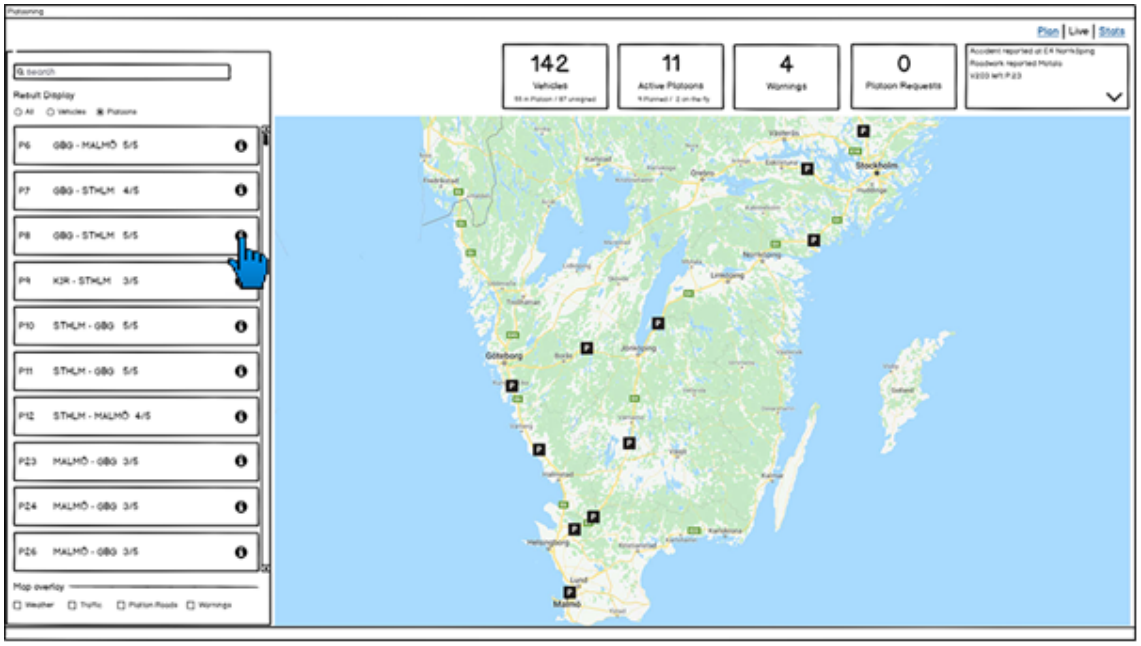
1. Filter the result display to "Vehicles".

Task 8: View all the platoons on the roads.

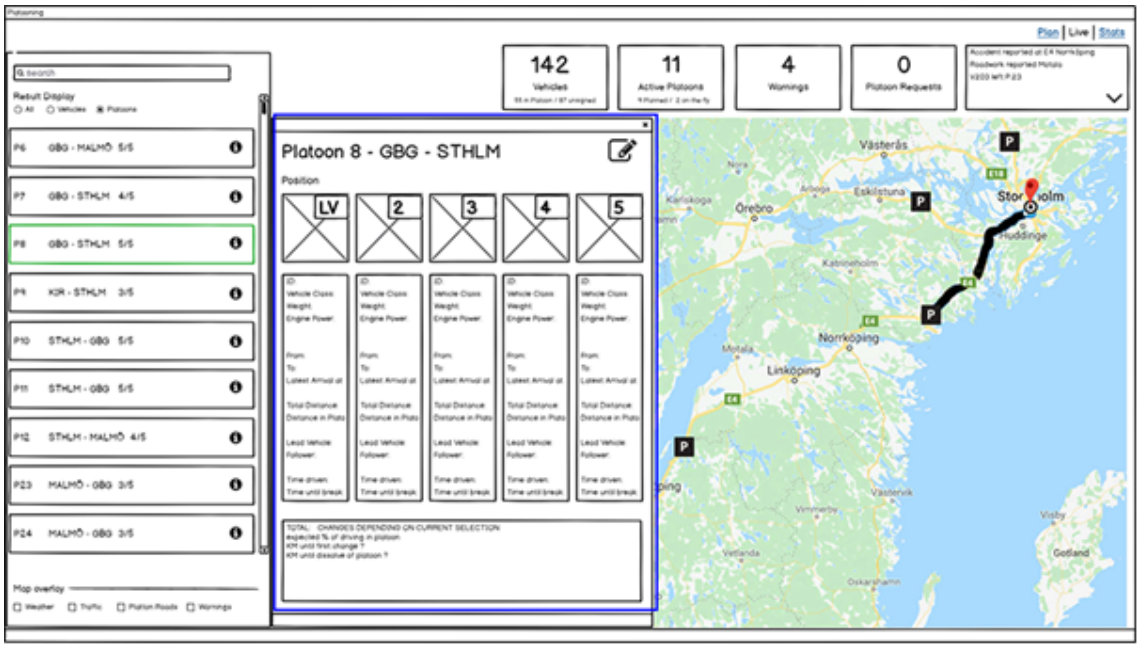


1. Filter the result display to "Platoons".

Task 9: Find out the details about Platoon 8's route and the vehicles in the platoon.

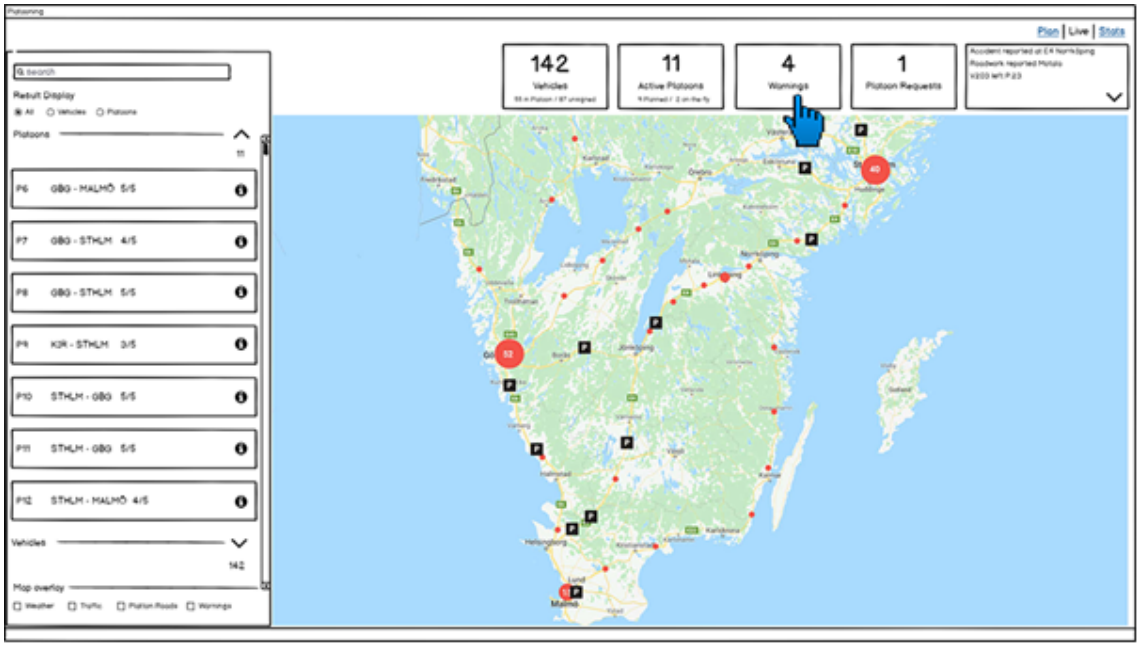


1. Select the "information-button" to view the vehicles from the platoon.

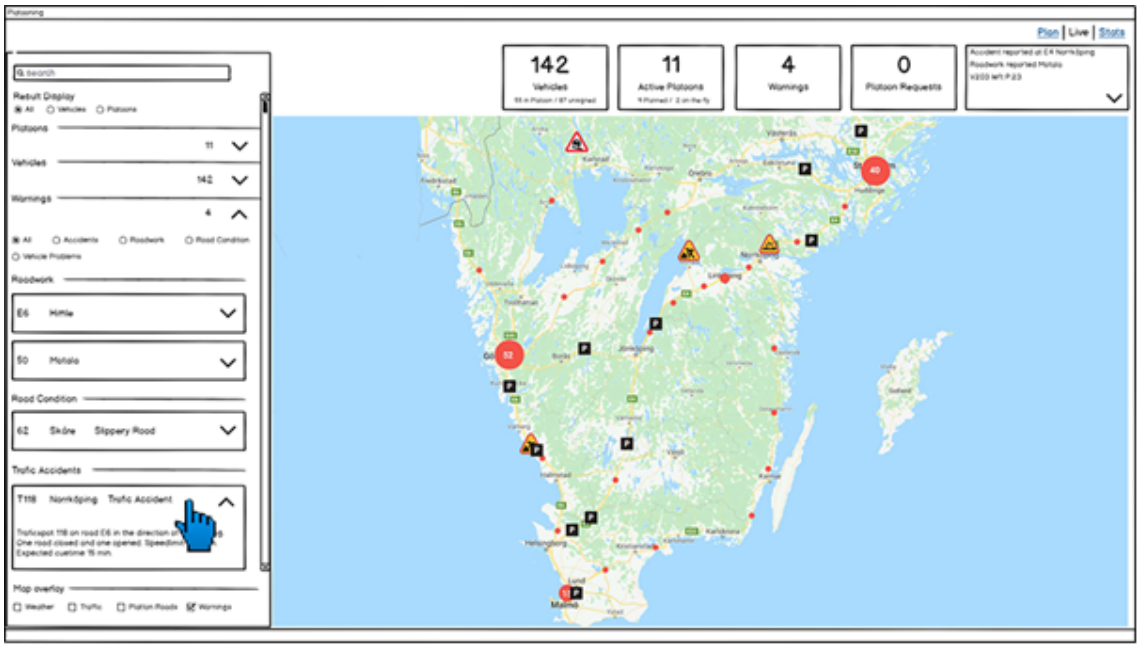


2. View the information.

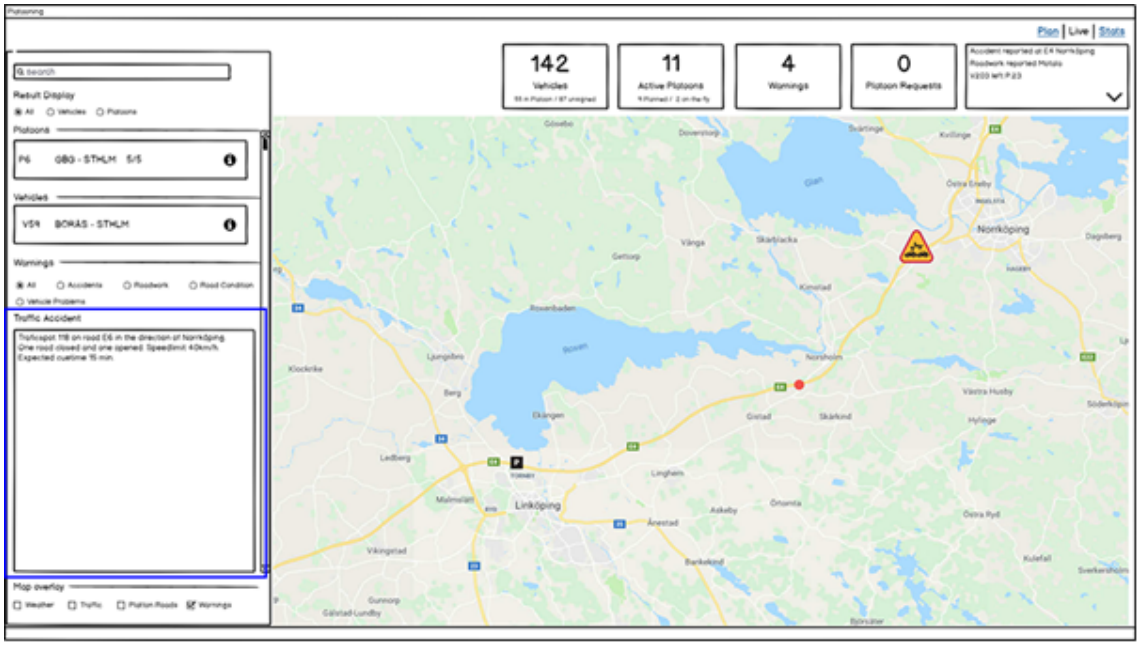
Task 10: Go to the location of the "Norrköping" traffic accident.



1. Click on warnings.



2. Select T118 traffic accident in the left-hand side list.



3. View the information

B

Use Cases

Name	Create a platoon in planned view.	
ID	UCP_Create_Platoon_1	
Description:	This use case is invoked when the BO Manager wants to create a new platoon in the planned mode and haulage contractors have sent information about trucks that are available for sheduled platooning.	
Goal:	Creation of platoon in planned mode.	
Trigger	A truck needs scheduled platooning.	
Risk	No suitable trucks to create a platoon with.	
Involved Actors	BO Manager, Platoon Database	
Main scenario sequence	**Step**	Action: Main Scenario
Main	1	BO Manager Selects a truck
	2	System shows the route of the truck displayed on a map, filters the list to vehicles on the same path or destination.
	3	BO manager Selects another truck
	4	System shows the route of the first and the second truck displayed on a map, updates the list to vehicles on the same path or destination. System displays information about the trucks. A create platoon button is available.
	5	BO Manager selects create platoon
	6	System adds the platoon to the platoon-list and keeps the vehicle selected.
	7	System displays a message that a platoon is created.
Main End State		A new platoon is created.
Exception M3.E	**Step**	Exception: No matching vehicle (UCP_Reject_Vehicle_1)
M3.E End State		Vehicle is removed from planning, message is sent to Haulage contractor
Comments		

Name	Add vehicles to platoon in planned view.	
ID	UCP_AddVehicles_Platoon_1	
Description:	This use case is invoked when the BO Manager wants to add a new vehicle to an already created platoon in the planned mode	
Goal:	Add a vehicle to a platoon.	
Trigger	A suitable platoon to join is available.	
Risk	No suitable platoon to join.	
Involved Actors	BO Manager, Platoon Database	
Main scenario sequence	**Step**	Action: Main Scenario
Main	1	BO Manager selects a platoon.
	2	System shows the route of the platoon displayed on a map, filters the list to vehicles on the same path or destination.
	3	BO Manager selects a truck.
	4	System shows the route of the platoon and the selected truck displayed on a map, updates the list to vehicles on the same path or destination. System displays information about the platoon and the truck. A join platoon button is available.
	5	BO Manager clicks the join platoon button.
	6	System shows a message that the vehicle has been added to the platoon.
	7	System adds the truck to the platoon.
	8	System displays a message that a platoon is created.
Main End State		A vehicle is added to an already created platoon.
Alternative M1.A	**Step**	Alternative: Join Platoon
	1	BO Manager selects a vehicle.
	2	System shows the route of the vehicle displayed on a map, filters the list to vehicles on the same path or destination.
	3	BO Manager selects a platoon.
	4	System shows the route of the platoon and the trucks in the platoon are displayed on the map. System displays information about the platoon and the vehicle. A join platoon button is available.
	5	BO Manager clicks the join platoon button.
	6	System shows a message that the vehicle has been added to the platoon.
	7	System adds the truck to the platoon.
	8	System displays a message that a platoon is created.
M1.A End		A vehicle is added to an already created platoon.
Exception M3.E & M3.A	**Step**	Exception: No matching vehicle (UCP_Reject_Vehicle_1)

M3.E & M3.A End		Vehicle is removed from planning, message is sent to Haulage contractor
Comments		

Name	Reject Vehicle from planned view.	
ID	UCP_Reject_Vehicle_1	
Description:	This use case is invoked when a vehicle does not have a matching vehicle to either create a platoon with or to join.	
Goal:	Send information to haulage contractor that a vehicle is not going to be scheduled for platooning.	
Trigger	No matching vehicle or platoon.	
Risk	BO Manager makes a mistake and rejects a vehicle that has matches.	
Involved Actors	BO Manager, Platoon Database	
Main scenario sequence	**Step**	Action: Main Scenario
Main	1	BO Manager clicks on vehicle menu.
	2	BO Manager clicks on reject icon.
	3	System ask for confirmation.
	4	BO Manager clicks confirm.
	5	System displays a message that the vehicle has been rejected.
	6	System sends message to haulage contractor.
Main End State		Vehicle is removed from planning, message is sent to Haulage contractor
Exception M3.E	**Step**	Exception: No matching vehicle (UCP_Reject_Vehicle_1)
M3.E End State		Vehicle is removed from planning, message is sent to Haulage contractor
Comments	If a vehicle is ignored or forgotten by the BO Manager, there should be an automatic reject for that vehicle from the system if the deadline for planning has passed.	

Name	Manage Platoon in planned view.	
ID	UCP_Manage_Platoon_1	
Description:	This use case is invoked when the BO Manager wants to edit a platoon (position, truck or platoon)	
Goal:	Edit appropriate changes to platoon when a platoon has been created.	
Trigger	A change is needed in the platoon.	
Risk		
Involved Actors	BO Manager, Platoon Database	
Main scenario sequence	**Step**	Action: Main Scenario
Main	1	BO Manager clicks on the Platoon menu icon.
	2	System displays menu options
	3	BO Manager selects the manage option
	4	System displays a view of the vehicles which currently are in the selected platoon.
	5	BO Manager selects an editing option.
Main End		BO Manager chooses an editing option.
Alternative M5.A	**Step**	Alternative: Edit Position
	1	BO Manager sets new positions for vehicles in the platoon.
	2	System asks for confirmation.
	3	BO Manager confirms new positions.
M5.A End		Truck positions in platoon are changed.
Alternative M5.B	**Step**	Alternative: Remove truck from platoon.
	1	BO Manager selects a vehicle in the platoon.
	2	BO Manager clicks on remove.
	3	System asks for confirmation.
	4	BO Manager confirms
	5	System removes vehicle from platoon. The vehicle is placed in the vehicle list.
M5.B End		Vehicle is removed from the platoon and is available in the vehicle list.
Alternative M5.C	**Step**	Alternative: Remove Platoon
	1	BO Manager selects remove platoon.
	2	System asks for confirmation.
	3	BO Manager confirms removal
M5.C End		Platoon is removed and vehicles are available in the vehicle list.
Comments		

Name	Create a platoon in Live mode	
ID	UCL_Create_Platoon_1	
Description:	This use case is invoked when the BO Manager wants to create a new platoon in the planned mode and haulage contractors have sent information about trucks that are available for sheduled platooning.	
Goal:	Creation of platoon in planned mode.	
Trigger	A truck needs scheduled platooning.	
Risk	No suitable trucks to create a platoon with.	
Involved Actors	BO Manager, Platoon Database	
Main scenario sequence	**Step**	Action: Main Scenario
Main	1	BO Manager finds two vehicles that could pontentially match to create a platoon.
	2	BO Manager selects a vehicle.
	3	The system zoom in on the location of the vehicle and updates the vehicle list to match the current zoom level and potentiall matches to the vehicle.
	4	BO Manager selects another vehicle.
	5	System displays information about booth vehicles.
	6	BO Manager reads the information.
	7	BO Manager clicks the create platoon button.
	8	System sends instructions to the drivers.
Main End State		A platoon is created.
Exception M5.E	**Step**	Exception: No matching vehicle.
	1	BO Manager clicks on vehicle to deselect.
M5.E End		No changes made.
Comments		

Name	Manage Platoon in planned.	
ID	UCP_Manage_Platoon_1	
Description:	This use case is invoked when the BO Manager wants to edit a platoon (position, truck or platoon)	
Goal:	Edit appropriate changes to platoon when a platoon has been created.	
Trigger	A change is needed in the platoon.	
Risk		
Involved Actors	BO Manager, Platoon Database	
Main scenario sequence	**Step**	Action: Main Scenario
Main	1	BO Manager clicks on the Platoon menu icon.
	2	System displays menu options
	3	BO Manager selects the manage option
	4	System displays a view of the vehicles which currently are in the selected platoon.
	5	BO Manager selects an editing option.
Main End		BO Manager chooses an editing option.
Alternative M5.A	**Step**	Alternative: Edit Position
	1	BO Manager sets new positions for vehicles in the platoon.
	2	BO Manager saves changes
	3	System asks for confirmation.
	4	BO Manager confirms new positions.
M5.A End		Truck positions in platoon are changed. Drivers are informed.
Alternative M5.B	**Step**	Alternative: Remove truck from platoon.
	1	BO Manager selects a vehicle in the platoon.
	2	BO Manager clicks on remove.
	3	BO Manager selects reason.
	4	BO Manager saves changes
	5	System asks for confirmation.
	6	BO Manager confirms
	7	System removes vehicle from platoon. The vehicle is placed in the vehicle list.
M5.B End		Vehicle is removed from the platoon. Information is sent to drivers.
Alternative M5.C	**Step**	Alternative: Dissolve Platoon
	1	BO Manager selects dissolve platoon.
	2	BO Manager selects reason.
	3	BO Manager saves changes
	4	System asks for confirmation.
	5	BO Manager confirms dissolve.
M5.C End		Platoon is dissolved. Drivers are informed.

Alternative M5.D	**Step**	Alternative: Reroute Platoon
	1	BO Manager selects edit route.
	2	BO Manager selects reason.
	3	BO Manager drags a new route.
	4	BO Managaer saves changes.
	4	System asks for confirmation.
	5	BO Manager confirms new route.
	6	System informs drivers.
M5.D End		Route of platoon is changed, drivers are informed.
Exception M5.E	**Step**	Exception: No edit made
	1	BO Manager does not make any changes or does not make any changes.
M5.E End		No edits made to the platoon.
Comments		

Name	Join a vehicle to a platoon.	
ID	UCL_JoinPlatoon_1	
Description:	This use case is invoked when the BO Manager wants to add a new vehicle to an already created platoon in the live mode	
Goal:	Join a vehicle to a created platoon.	
Trigger	BO Manager finds a match for a vehicle to join a platoon.	
Risk	BO Manager does not see a match.	
Involved Actors	Haulage contractor, Platoon Database	
Main scenario sequence	**Step**	Action: Main Scenario
Main	1	BO Manager finds a vehicle that could pontentially match to a platoon.
	2	BO Manager selects the vehicle.
	3	The system zoom in on the location of the vehicle and updates the vehicle list to match the current zoom level and potentiall matches to the vehicle.
	4	BO Manager selects a platoon
	5	System displays information about the truck and platoon.
	6	BO Manager reads the information.
	7	BO Manager clicks the join platoon button.
	8	System sends instructions to the drivers.
Main End		A vehicle is added to an already created platoon.
Alternative M2.A	**Step**	Alternative: Join starting with selecting a platoon.
	1	BO Manager selects a platoon.
	2	The system zoom in on the location of the platoon and updates the vehicle list to match the current zoom level and potentiall matches to the platoon.
	3	BO manager selects a truck.
	4	System displays information about the truck and platoon.
	5	BO Manager reads the information.
	6	BO Manager clicks the join platoon button.
	7	System sends instructions to the drivers.
M2.A End		A vehicle is added to an already created platoon.
Exception M3.E	**Step**	Exception: No matching platoon
	1	BO Manager clicks on vehicle to deselect.
M3.E End		No changes made.
Exception M2.AE	**Step**	Exception: No matching vehicle
	1	BO Manager clicks on platoon to deselect
M3.AE End		No changes made.
Comments		

Name	Platoon Request	
ID	UCL_PlatoonRequest_1	
Description:	This use case is invoked when a truck sends a request to the BO Manager to create a platoon with another vehicle or to join an already created platoon	
Goal:	Join a platoon or create a platoon with another vehicle.	
Trigger	A driver wants to create or join a platoon.	
Risk	Joining or creating parameters does not match.	
Involved Actors	BO Manager, Platoon Database, Driver	
Main scenario sequence	**Step**	**Action:** Main Scenario
Main	1	Driver sends a request to BO Manager.
	2	System displays an alert for a platoon request.
	3	BO Manager selects the request by clicking on it.
	4	System Zoom's in on the location and highlights the trucks in question.
	5	BO Manager approves join.
	6	Drivers are informed that it's approved and instructions are sent on how to proceed.
Main End		Request accepted and instructions sent to drivers
Exception M5.E	**Step**	**Exception:** BO Manager denies request.
	1	BO Manager denies request.
	2	BO Manager chooses reason for denying platoon request.
	3	System sends information to drivers.
M5.E End		Drivers are informed why the request is denied.
Comments	Reasons for denying a platoon request could be that one of drivers has reached their drive limit, destinations does not match, platoon limit reached. More reasons should be explored.	

Name	Handle Warning/Alerts/Events	
ID	UCL_HandleWarning_1	
Description:	This use case is invoked when the system displays an important alert/warning that needs to be handled or the Back-Office Manager decides to look at less important alerts/warnings.	
Goal:	Handle alerts/warnings to make appropriate changes to the platoon.	
Trigger	An internal or external event occurs that affects the platoon.	
Risk	No appropriate changes can be made to the platoon.	
Involved Actors	BO Manager, Platoon Database	
Main scenario sequence	**Step**	**Action:** Main Scenario
Main	1	System displays a dialogbox with an alert.
	2	BO Manager clicks on the alert.
	3	System takes the BO Manager to the location of the alert.
	4	BO Manager reads the information about the alert.
	5	BO Manager finds a way to handle the alert.
	6	See (UCP_Manage_Platoon_1) for options.
Main End		BO Manager handles the alert.
Exception M5.E	**Step**	**Exception:** No viable option to handle the alert
	1	See (UCP_Manage_Platoon_1) Exception M5.E
M5.E End		No changes made to the platoon.
Alternative M1.A	**Step**	**Alternative:** Less important alert
	1	System displays a notification in the events view.
	2	BO Manager sees the event and clicks on it.
	3	System takes the BO Manager to the location of the alert.
	4	BO Manager reads the information about the alert.
	5	BO Manager finds a way to handle the alert.
	6	See (UCP_Manage_Platoon_1) for options.
M5.B End		BO Manager handles the alert.
Alternative M1.B	**Step**	**Alternative:** Not important event
	1	System displays a notification in the events view.
	2	BO Manager sees the event and decides it not important.
M5.C End		No action taken.
Comments	Alerts and warnings should have different levels of importance. This could be color coded or some other way to distinguish them. Important alerts/warnings should force the BO Manager to take action, less important alerts/warnings should be displayed but not forcing the BO Manager to take action. Events are common occuring and should be displayed but not action is necessary. eg. Warning (Vehicle Porblems, Road Condition, Driver behaviour in platoon), Alerts (Road work, Traffic density, Geofence)	

Name	Guide to Platoon or vehicle.	
ID	UCL_GuideToPlatoon_1	
Description:	This use case is invoked when the Back-Office Manager finds an potential match for joining a vehicle to a platoon or matching two vehicles that can create a platoon.	
Goal:	Guide a vehicle to a platoon for a join or guide a vehicle to an another vehicle to create a platoon.	
Trigger	Back-Office Manager finds a potential match for platooning.	
Risk	No match found or the distance for the match is to long.	
Involved Actors	BO Manager, Platoon Database	
Main scenario sequence	**Step**	**Action:** Main Scenario
Main	1	BO Manager finds a potential platoon to match with the selected vehicle.
	2	BO Manager clicks on the vehicle menu icon.
	3	System displays menu options.
	4	BO Manager selects the manage option.
	5	System displays a detailed view of the vehicle.
	6	BO Manager selects the edit route option.
	7	BO Manager selects the reason: reroute to platoon.
	8	System shows a platoon as a possible match and provides information about the vehicle and the platoon side by side.
	9	BO Manager reads the information and clicks on calculate join point.
	10	System displays potential join points.
	11	BO Manager selects option A and drags a new route to the platoon.
	12	BO Manager saves changes.
	13	System asks for confirmation.
	14	BO Manager confirms new route.
	15	System informs drivers.
	16	Route of vehicle is changed and drivers are informed. Status of vehicle changed to joining platoon.
M5.D End		Vehicle status changed and a new route is set for the vehicle. Drivers are informed.
Exception M8.E	**Step**	**Exception:** No platoons available to guide to.
	1	System shows no platoon or vehicles as a possible match.
	2	BO Manager exits editing mode.
M8.E End		No changes made.
Exception M8.E2	**Step**	**Exception:** Platooning not recommended
	1	System shows a platoon as a possible match and provides information about the vehicle and the platoon side by side.

	2	BO Manager reads the information and clicks on calculate join point.
	3	System shows a message that a reroute to this platoon is not recommended due to catch-up distance.
	4	Bo Manager decides to take the systems recomendation and exits the reroute edit.
M8.E End		No changes made.
Comments		

Name	Driver delay of join	
ID	UCL_DriverDelay_1	
Description:	This use case is invoked when the lead driver in a platoon suggests a delay of vehicle joining a platoon.	
Goal:	Delay vehicle joining platoon.	
Trigger	A vehicle is joining a platoon.	
Risk	Not warranted join delay.	
Involved Actors	BO Manager, Platoon Database, Driver	
Main scenario sequence	**Step**	**Action:** Main Scenario
Main	1	Drivers in platoon gets instructions from system that a vehicle is joining the platoon.
	2	Before the join has started. Lead driver finds a reason for delaying the platoon.
	3	Lead driver selects reason for delaying join.
	4	System registers the reason and informs the BO Manager.
	5	BO Manager reads the information from the driver.
	6	BO Manager approves the reason.
Main End		Join is delayed and system is waiting for Lead driver to start the join when possible.
Exception M6.E	**Step**	**Exception:** BO Manager disagrees with Lead driver
	1	BO Manager does not approve the Lead drivers delay and approves the join.
	2	System informs the Lead driver is informed.
M6.E End		Join is not delayed and occures as planned. Lead driver is informed.
Comments	Reasons for join delay could be (Join during uphill, Cut-in, Traffic density). Delays of join should be explored more.	

Name	Haulage contractor prepare a vehicle for platooning	
ID	UCP_HaulageContractor_PrepareVehicle_1	
Description:	This use case is invoked when a haulage contracor wants a vehicle to be available for platooning.	
Goal:	Prepare vehicle for platooning.	
Trigger		
Risk		
Involved Actors	Haulage contractor, Platoon Database	
Main scenario sequence	**Step**	Action: Main Scenario
Main	1	Haulage contractor selects a vehicle.
	2	System display a dialog box with options.
	3	Haulage contractor sets destination, latest time of arrival and days available.
	4	Haulage contractor marks vehicle as available for platooning.
	5	Haulage contractor saves changes.
	6	System asks for confirmation.
	7	Haulage contractor confirms.
	8	System displays confirmation message.
	9	System moves vehicle to platooning list.
	10	Haulage contractor selects the same vehicle in the platooning list.
	11	System displays information and options.
	12	Haulage contractor clicks send.
	13	System asks for confirmation.
	14	Haulage contractor confirms.
	15	System sends the information to the Platooning Back-Office and shows a confirmation message to the haulage contractor.
Main End		Vehicle avialable for platooning, information sent to platooning service.
Alternative M12.A	**Step**	Alternative: UCP_HaulageContractor_PreparePlatoon_1
	M.3	
M5.A End		Vehicles avialable for platooning, information sent to platooning service.
Comments		

Name	Haulage contractor prepare a platoon.	
ID	UCP_HaulageContractor_PreparePlatoon_1	
Description:	This use case is invoked when a haulage contracor has at least two vehicles that should be in the same platoon.	
Goal:	Assign at least two vehicles for platooning.	
Trigger	Haulage contractor wants at least two of its vehicles to be in the same platoon.	
Risk		
Involved Actors	Haulage contractor, Platoon Database	
Main scenario sequence	**Step**	Action: Main Scenario
Main	1	Haulage contractor selects a vehicle in the available for platooning list.
	2	System shows information about the vehicle.
	3	Haulage contractor selects another vehicle.
	4	System shows information about the vehicles side by side.
	5	Haulage contractor groups the vehicles together.
	6	System displays a message that vehicles are grouped.
	7	Haulage contractor clicks send button
	8	System ask the Haulage contractor to confirm.
	9	Haulage contractor confirms
	10	System sends the information to the Platooning Back-Office and shows a message to the haulage contractor.
Main End		Vehicles avialable for platooning, information sent to platooning service.
Exception M7.E	**Step**	Exception: Ungroup Vehicles
	1	Haulage contractor selects group and click on options.
	2	System displays editing capabilities.
	3	Haulage contractor selects ungroup.
	4	System ask the Haulage contractor to confirm.
	5	Haulage contractor confirms.
	6	System ungroups the vehicles.
M7.E End		Vehicles are separated from the group.
Comments		

C

Cognitive walkthrough template

Welcome to our cognitive walkthrough test!

Thesis Background: This system is supposed to be a so called "Back-Office-system" for managing platoons. Platoons is a term used to describe trucks that drive close behind one another to save fuel by utilizing the reduced air drag. Once automation is in full effect, it can be expected of these trucks to simply follow a lead vehicle while the other are driverless.

Cognitive walkthrough: is an evaluation method used for examining the usability of a product, usually the user-interface of a system. The idea is that you will be given a set of tasks to carry out in different parts of our designed prototype-interface. After each task is completed or uncompleted we'd like you to answer four questions regarding the usability.

These are the tasks:

1. Schedule a platoon for Monday W 42.
2. Add vehicles to a newly created platoon.
3. Reject vehicle 55 from platooning.
4. Send the scheduled platoons to the haulage contractor.
5. Navigate to live view
6. Handle the platoon request
7. View only all vehicles on the roads.
8. View only all the platoons on the roads.
9. Find out the details regarding Platoon 8's route and the vehicles in the platoon.
10. Go to the location of the "Norrköping" traffic accident.

Follow-up questions for each task:

- Can you achieve the right outcome?
- Do you notice that the correct action is available?
- Can you associate the correct action with the outcome you are expected to achieve?
- If the correct action is preformed; can you see that progress is being made toward the intended outcome?

D

Usability test 2 template

Thesis Background: This system is supposed to be a so called "Back-Office-system" for managing platoons. Platoons is a term used to describe trucks that drive close behind one another to save fuel by utilizing the reduced air drag. Once automation is in full effect, it can be expected of these trucks to simply follow a lead vehicle while the other are driverless.

During the test, we would like to ask you to please **think aloud** or **verbally express** your thoughts as you use the system. While we are testing how well you can complete a given task, we would like to stress the that if something breaks or doesn't work it is the systems fault. What we are extra interested in is your thoughts about the task you are trying to complete, specifically your reasoning as well as any confusions the system may have caused.

Scenario
You are a newly employed Back-Office manager "Congratulations" where you managed to get the job due to your previous qualifications working with similar systems. This is your very first day at work and your employer wants to test your ability by giving you a set of tasks to carry out using the system.
These are the tasks:

1. Create a platoon
2. Add another vehicle to your new platoon
3. Reject vehicle 61 from platooning.
4. Send your scheduled platoons to the haulage contractor
5. Navigate to the live view
6. Handle the platoon request
7. Go to the location of the road accident.
8. View the alerts.
9. Find information about the completed platoon.
10. Find platoon 17. Find the details and the route.
11. Filter between platoons and vehicles

Swedish version

Bakgrund till studien:
Det här systemet är uppbyggt för att likna ett så kallat "Back-Office system" för att hantera platoons. Platoons är ett begrepp som används för att beskriva lastbilar som kör nära varandra för att spara bränsle genom att utnyttja det minskade luftmotståndet. När automatisering når sin fulla potential kan platoons förväntas endast följa en ledarbil medan de andra lastbilarna som följer efter är förarlösa.

Under testet skulle vi vilja be dig att **tänka högt** eller **verbalt uttrycka** dina tankar när du använder systemet. Vi vill även säga att vi testar systemet och inte dig. Om någonting inte fungerar eller hänger sig så är det systemets fel. Vi är extra intresserade av att höra vad du tänker när du försöker utföra en uppgift, speciellt ditt resonemang samt om någonting oklart eller förvirrande har hänt i systemet.

Scenario
Du har blivit anställd som Back-Office manager "Grattis!" där du lyckades få jobbet på grund av dina tidigare erfarenheter från att arbeta inom liknande system. Det här är din första dag på jobbet och din arbetsgivare vill testa din förmåga genom att ge dig en mängd uppgifter att utföra i systemet.
Det här är dina uppgifter:

1. Skapa en platoon
2. Lägg till ett till fordon till din nya platoon
3. Avböj fordon 61 från platooning
4. Skicka dina planerade platoons till åkeriet
5. Navigera till live view
6. Hantera platoon förfrågan
7. Navigera till en plats där en olycka har skett
8. Visa alla alerts
9. Hitta information om den färdiga platoonen.
10. Ta reda på platoon 17's rutt samt detaljer om platoonen.
11. Filtrera mellan platoons och lastbilar.

E

Individual user assessments

User 1 Result

My assesment of the system as a whole							
		1	2	3	4	5	
1	Useful		X				Useless
2	Plesant		X				Unpleasent
3	Bad				X		Good
4	Nice		X				Annoying
5	Effective		X				Superfluous
6	Irritating				X		Likeable
7	Assisting		X				Worthless
8	Desirable		X				Undesirable
9	Raising Alertness		X				Sleep-inducing

User 2 Result

My assesment of the system as a whole							
		1	2	3	4	5	
1	Useful			X			Useless
2	Plesant		X				Unpleasent
3	Bad				X		Good
4	Nice			X			Annoying
5	Effective	X					Superfluous
6	Irritating		X				Likeable
7	Assisting			X			Worthless
8	Desirable	X					Undesirable
9	Raising Alertness		X				Sleep-inducing

User 3 Result

My assesment of the system as a whole							
		1	2	3	4	5	
1	Useful		X				Useless
2	Plesant	X					Unpleasent
3	Bad				X		Good
4	Nice	X					Annoying
5	Effective		X				Superfluous
6	Irritating					X	Likeable
7	Assisting		X				Worthless
8	Desirable		X				Undesirable
9	Raising Alertness	X					Sleep-inducing

User 4 Result

My assesment of the system as a whole							
		1	2	3	4	5	
1	Useful		X				Useless
2	Plesant		X				Unpleasent
3	Bad				X		Good
4	Nice		X				Annoying
5	Effective			X			Superfluous
6	Irritating				X		Likeable
7	Assisting		X				Worthless
8	Desirable		X				Undesirable
9	Raising Alertness			X			Sleep-inducing

F

Benchmark notes

Fleetio

View	Functions	How it works
Overview Dashboard	Access Vehicles, Service Reminders, Service Cost, Open Issues, Fuel Costs, Vehicle Renewal Reminders, Active work orders, Contact Renewal Reminders, Inventory, Recent Comments, DTC Alerts	One click to reach a new section
Menu Overview	Admin, Dashboard, reports, help, user	Click on menu to get to new page
Menu Quick Add	Add vehicle, Add service entry, add fuel entry, add issue, add work order, add part, add purchase order, add multiple service remiders, add multiple vehicel renewal renewal reminders, add contact, update odometer, improt data	Access by clicking the quick add menu and then on a specific item
Search	search for vehicles, parts, contacts	type directly in searchbar, automatic suggestions while typing
Flyout menu	Vehicles, Service entries, issues, work orders, parts, Service Remidners, Renewal reminders, contacts, vendors, trips	Always visible, one click to get to specific item
Vehicle detail view	Linking vehicles	click on plus, new modular window with search, click on vehicle and the save
Service Reminders	Email and notifications to drivers, sheduled service, dates and filtering	Pick who you want to notify about what and the notifications are sent via email
Renewal reminders	Registration, insurance, permitting	
DTC Alerts	Report problems with vehicles, resolve, edit issue, add issue, comment, photo, label	Pre-trip inspection & post-trip inspection
Work orders (Overview) / Schedule	View All, Open, Pending, Completed	Clicking on menu selects an option
Word order details	Issue date, Status (Open, Pending, Completed), Vehicle type (Choose option), Start date, labels,	Form layout where the user manually selects and edit all the values

Odoo

View	Functions	How it works
Menu (Overview)	Discuss, Contacts, GeoEngine Backend, Freights, Purchases, Inventory, Repairs, Accounting, Employees, Fleet, Apps, Settings	One click to reach a new section
Menu sidebar (Freights)	Waybills, Travels, Fuel Voucher, Advances, Travel Expenses, Reports Travels, Configuration (Settings, Drivers, Retentions, Units, Routes, Products, Custom Hours)	Click on menu to get to new page
Travels	Create, Import, Filter, Group by, Favorites	Table list shown
Travels create	Dispatch, Cancel	Assign vehicles, drivers, route
Travels create Route	Google map integration to calculate distance & travel time	Form opens, user sets departure and arrival locations, new view opens to see map, option to see ful view in google maps with directions

WebNMS

View	Functions	Hur fungerar det
Menu	Dashboards, Fleet Overview, Fleet Tracker, Geofence, Route Planner, Alarms, Reports, Assets, Admin	One click to reach a new section
Overview (Dashboard)	Vehicles (On transit, idle, fault, due for maintenance), Vehicle Maintenance (Vehicle Name, Km remaining for next service), Assets under management (Branch, Vehicle, Driver) Company cost summary, Recent Alarms, Trip Summary, Driver utilization Scale(Drivername, Driving hours, NO of Trips), Aggregated summary All vehicles (Total Trips, Total Distance, Total Fuel Consumed, Total Cost Summary) Driver Behavaiour Stats (Overspeeding, Harsh Braking, Sudden Acceleration), Vehicle Trip Summary (Weekly No Of trips/distance), Top Drivers (Filter on Trips, Distance Fuel, Run Hours)	Graphs, tables and quick information that Links to detailed view of ech item
Fleet Overview	Divided by regions (Country) expandable list shows regions in country, Clickable map, google based, Displays Vehicles (on transit, idle off transit)	Click on different regions, vehicles not clickable, no information about specific vehicles.
Fleet Tracker	All vehicles in a list, Searchbar to search vehicles in list, Livetrack, playback	
Fleet Tracker Livetrack	Displays vehicle on map, vehicle information (Summary [Temperature, Humidity, Last halt, Duration, Location], Geofence, Alarms, Vehicle Statistics - Opens in another view)	
Fleet Tracker Playback	Track vehicle, choose option [15, 30 min 1 hour, today, last 7 days], Displays trips and route	Choose an option an it simulates on the map, no way to stop playback, Specific route can be selected in list
Geofence	Search, Create, Edit, Delete, Overview	Menu options to select by clicking
Geofence Overview	Shows clickable list, directs to that position, Shows seperate view of vehicles within a geofence area	Click on list to get to location of geofence
Geofence Create	Create a route, region, point	Menu option

Geofence Create Route	Enter source and destination	Dialog box to enter two values, option to create route or see route
Geofence Create Region	Enter a region	A square is created over region. No way to resize, or manually add
Geofence Create Point	Enter a point	Cirlce around point is created, No way to resize, or manually add
Route Planner	Clickable list displays planned routes, Option to create new route	When clicked in list map displaying routes, km and time, Next Scheduled time, Plan type (once, daily, weekly, Monthly)
Route Planner New Plan	Date and time picker, Search for avialable vehicles, pick vehicles from list, Choose route, add waypoint, Create plan, cancel, back	New form opens. Choose repeat, company, date and time for start, vehicle type, Choose vehicle from List of available vehilces, Click next, enter source (start), enter destination, pick from avialble routes
Alarms	Events, alerts, pick specific event/alert to display (Status, Source [Vehicle], Date/Time, Event Details)	Choose events or alerts in menu, pick a specific event/alert
Alarms Events		In detailed view of event, display specific information
Alarms Alerts	General, Annotation & History, Related alarms	In detailed view of alert, display specific information
Assets Fleet	List vehicles (Status, Name, Manufacurer, fuel type)	Select a vehicle and get more detailed information. No search bar
Asset Fleet Specific Vehicle	Map, box with past trips (Today, Yesterday, last 7 days), Trip Summary as list (Drivername, Distance, RunHour, Avg Speed), Reminders, Assosiated geofence, Recent alarms (Vehicle alarms [date, description, status]), Vehile information (Model, Fuel type, Vehicle type, last service date, Last service ODO, Driver name, fuel capacity, vehicle capacity, next service date, device EMI,), Vehicle Parameters (Distance traveled, fault codes, geofence alarms, OBD alarms, engine hours)	Displays information about vehicle

Fleet Complete

View	Functions	Hur fungerar det
Overview menu	Fleet, Reports, Orders, Dispatch, Activities, Billing, System	Each view is opened in a new seperate tab
Points of interest (Geofence)	List all points of interest (Branch, description, POI types, code, other, adress, contact information)Add, edit, delete, export, import, print/export	Seperate view, with a toolbar for POI, list displaying all POI
Create POI	Search (adress), Save, Close, notes, category, buffer (area), description, choose icons, Details (Working hours, Email details)	Divided in General and details tab, Create opens new dialog window
Fleet Tracking	Zoom, map layers (road, street, satellite), Search, Vehicle information, Vehicles + name on map, traffic information, direction vehicle is moving, Cluster close object, Follow in new window, Trip replay (Start date, End date, Play, pause, Map, ignition on to off, speed adjustment), Assign preplaned routes, Locate cloasest asset, Truck details (Name, Vehicle type, date, speed, sensors), Right Click to add POI (New Dialog Window)	Alert window, Search for Assets, Resources, POI, seperate view for locations, Map items (Assets, Vehicles, POI, Custom Layers) When truck selected information is displayed about the truck (Speed, Direction, Adress, POI, Vehicle type, Sensors)

Fleet Up

View	Functions	Hur fungerar det
Map tracking	Live traffic, satellite view, filter (online vehicle, offline vehicle, licence number)	Big map, with options to select satelite view, vehicle list, color coded vehicles (green online - offline white), on clickicking vehicle show current location on map, ETA
Vehicle	Vehicle (Name, licence No, Last know location)Detail, Search, Trip replay,	Table showing information about vehicle, icons for trip replay (displayed as table [stop time, start time, end time, hours, start location, end location, distance]), When trip replay is selected map shows and trip is displayed, play/pause controls, speed, Speed of vehicle, RPM
Vehicle Stats	Display graphs	Number of vehicles in operation per day, total mileage per day, total driving hours per day, total fuel consumption per day, trip efficiency per day, top vehicles (operational days), Top five vehicles (mileage), top five vehicles (fuel consumed), top five vehicles (trip efficiency))
Driver status	filter (on-duty, off-duty), Search, update	table displaying (Driver name, contact, vehicle, status, violations, break, driving, shift, cycle)
Alerts	Search, datepicker	Display (Vehicle, Licence No, Speeding, Rpm, idling, View all) When selecting an alert more detailed information is shown at another screen (Time, Location, type of alert, description, Point on map)
Geofence	Searchbar, draw tools, color picker, save, erase geofence, list geofences, edit geofence	Find location via map or search, select shape, circle or polygon, draw the size and place it on map, save, assign color and name. Geofence options (description, email, group, vehicles, alarms [enter, leave], speed limit)