Aalborg University

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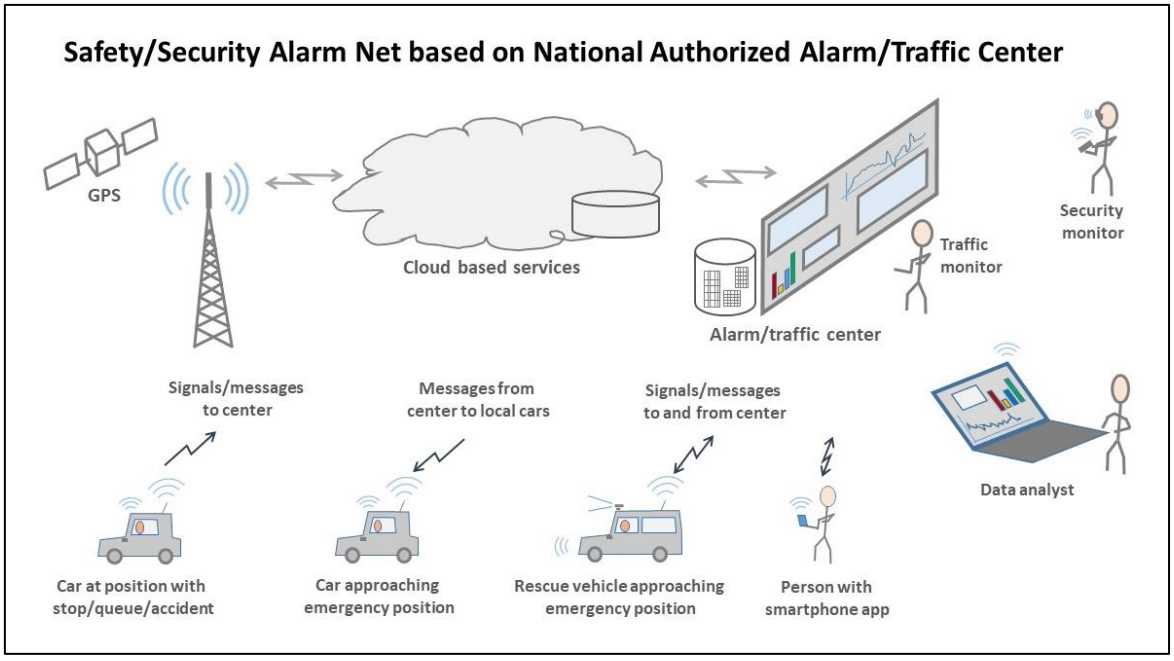
Project proposal:

Security Alerts via Public Alarm/Traffic Center

Traffic accidents represent a considerable social cost. For example, the Danish Engineering Association (IDA – Ingeniørforeningen i Danmark) has estimated that lost lives and material damage cost 10 billion annually. So, the potential is enormous. If all travelers can be warned and informed electronically, as soon as an accident occurs, many accidents will undoubtedly be avoided or have less harmful effects. This proposal focuses primarily on reducing the impact of various types of accidents and other dangerous situations in highway traffic.

Project Idea

Some safety technologies are already included in new cars and many more will be developed in the future. However, almost all automotive producers and subcontractors in the area have their own electronic infrastructure and the transmission of signals/messages from the technical units in phones or cars are widely different and not standardized. It will therefore be of great societal significance, if all travelers via an authorized public or private alarm/traffic center can receive and send relevant location-specific and well-defined signals/messages on accidents, rescue vehicles, roadworks, casualties, etc. Various projects of similar kind are under way (see, for example, the NordicWay (NW) project[1]), so a more thorough study will be necessary.



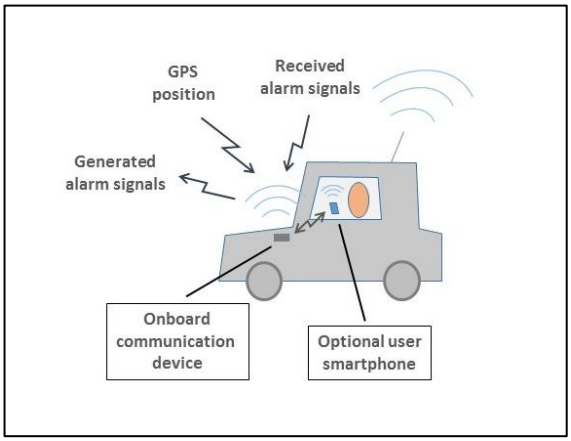
A European eCall standard has been developed and includes current automatic and manual calls from cars / passengers to a 112 alarm center. Compared with this functionality, it is thus thought of in a broader application that a necessary and sufficient solution at a time may be made mandatory in all vehicles and that a dedicated unit can be developed for new as well as "old" vehicles. Reduction of fatalities and injuries, as mentioned above, will be vital, but furthermore one

[1] www.NordicWay.net

can imagine that such a solution can reduce or eliminate the need for hard shoulders on the highways, thus giving huge gains to society in the field of road development.

Overall Functionality

When a vehicle is on a highway, the relatively higher speed always requires increased attention. This applies to several conditions, such as reduced visibility, bad road conditions (ice, snow, oil spill, etc.), objects on the road, or occurred accidents. All such situations should trigger a signal/message to the alarm/traffic center as soon as possible. Certain events such as all types of stops (or very slow driving) can subsequently cause accidents and should therefore automatically generate a signal/message (even though there may be many signals/messages over a short period). Received signals/messages should therefore immediately lead to a warning to other travelers approaching the location, even before this can be seen (see appendix 1). Such messages from the center will have critical importance, both for those, who are already involved and for those, who are at risk. It will be natural for the alarm light to be switched on (possibly automatically) in an appropriate time before reaching that location. If a rescue vehicle is approaching from behind, it is equally important that the travelers be warned electronically.



Signals/messages sent from the vehicles must therefore be able to provide precise coordinates via GPS, and correspondingly, signals/messages from the central station should be received with information on coordinates and interpreted in relation to these, so that only the relevant signals/messages are send out and untouched travelers are not affected. In addition, it would be useful to define several event types to supplement the signals/messages. In an expanded form, data from the car's electronic systems can be included as further clarification of the events, for example sudden drop in speed, airbag release (at collision), etc.

The intended device must therefore always be switched on and ready to transmit and receive signals/messages. A connection between the device and a local smartphone via an app (e.g., BlueTooth or WiFi) may be useful (but not necessary) for additional display of the message type, typically indicating position and other information on the screen (maps, graphs, driving book, etc.). However, if such a connection cannot be guaranteed, it is crucial that the device can be operated independently with a few buttons (possibly also with spoken instructions) and vice versa display some simple signals: LEDs and sounds (sirens) depending on the type of alarm. This will be enough for use in older car models, thus enabling the device to be made mandatory.

Communication and Infrastructure

Of course, the alarm/traffic center must be able to receive and process data rather fast, and it must have a secure and well-defined wireless communication protocol. At European level, the DATEX II standard is defined for the exchange of information between alarm/traffic centers, vehicles and others. This standard is thus established as a European promotion in intelligent traffic systems (ITS). DATEX II is used in the NW project as part of a specific cloud-based solution. However, a more comprehensive study of the DATEX II standard is necessary.

Vejdirektoratet (VD) has participated in the NW project from the Danish side, primarily on the sidelines, but has helped shape the content of NW. The DATEX II standard will be used for the future. VD has also established an Amazon cloud-based solution (access point) for data retrieval (for example by way of road coils/radar/cameras) and has also purchased data from the company INRIX[2]. A new service is expected to be used in the future, and this trend in data collection and organization is expected to grow explosively in the future and provide a basis for many applications (BIG data). VD has initiated the dissemination of data from this access point, including the publicly

[2] http://inrix.com/

available Danish Traffikinfo smartphone app[3], but many more options can of course be utilized. By entering into separate agreements, other applications may be developed based on the access point data, which should also be included in this project. Several independent actors have built similar independent cloud-based solutions, for example. AutoPi[4], Saphe[5] and Ooono[6]. The functionality of this project should include the Saphe-like solutions, so that there should be a significant incentive.

As stated, data sent between the device and the center must be formatted covering the various types of messages. Typically, the formats can be specified as an XML document (XML Schema). Likewise, the received data must be organized in a database (cloud solution), which can also be specified using XML. A further study is necessary.

An important topic to be investigated is security, partly regarding communication and partly regarding the protection of data content. Thus, encrypted data connections and good transmission/reception conditions should be used. A further study is also necessary here.

Additional Options/Extensions of Functionality

Some further steps in the development could be that temporary road changes, roadworks, track changes and the like are updated via the central communication system and that speed limits are regulated dynamically, e.g. in relation to the weekly day cycles. It could also cause the proposed device in each vehicle to receive a message whenever a speed limit is exceeded and without the need for a smartphone app to be connected. This means that road signs will be needless and significant costs can be saved.

Finally, one can imagine that the dedicated device should collect and upload to a cloud solution various data, which can thus form the basis of analyzes (driving behavior, emergency tracking data, etc.) as known from AutoPi and other known devices[7].

Project Planning

As stated, several signals/messages can be exchanged between the dedicated device and the authorized alarm/traffic center (see a selected list in appendix 2). Safety/security issues must be supported and maintained by the authorities on different levels, but, in addition, some signals may be proprietary and handled by a company, generated from this project. Consequently, the functions must have most possible commercial value.

However, authorities, security organizations and insurance companies should be persuaded to support the most important safety/security related functions. This should be considered in line with the fact that the society already enforce many rules and requirements, such as insurance policies, authorizations, etc.

Therefore, a first step of the project should be to develop a prototype with which the basic functions can be demonstrated (see appendix 3). Such initial proof of concept should raise interest and demands from test persons and enable the necessary support.

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[3] Se: http://www.vejdirektoratet.dk/DA/trafik/apps/Sider/Trafik-på-din-mobil.aspx

[4] Se: http://www.autopi.io

[5] Se: http://www.saphe.dk

[6] Se: https://ooono.dk/da/

[7] Se: https://www.obdautodoctor.com/obd-adapters

Appendix 1 – Signals/Messages

The following list include possible signals/messages to be transmitted by vehicles or received by vehicles.

Overview over types of signals/messages

The following types of signals/messages may be relevant to format and transmit:

1. Reduced visibility: mist, fog, smog, heavy rain, snow
2. Lowered road conditions: ice, snow, oil leaks
3. Otherwise reduced conditions: storm, tornado
4. Obstacles on road, type of obstacle
5. Congestion and queues, various degrees
6. Vehicle stopped a) outer side, b) inner side, c) in track, d) over multiple tracks
7. Accident a) only material damage, b) with injured person, with heavy injured or dead person
8. Rescuing vehicles approaching a) from behind, b) from ahead, c) from both directions
9. Speed limit, current setting
10. Temporary track limit, keep in track
11. Road narrowed
12. Road closed a) because of accident, b) otherwise
13. Speed/traffic controller ahead

The signals/messages must be further specified and formatted, preferably by use of the DATEX II standard.

Appendix 2 – Use Cases

In the following, the most important use cases are described. They are divided into two groups

1. Safety/security related use cases and
2. Additional use cases

These two groups of use cases are related differently to business models. The safety/security issues primarily must be financially supported and maintained by the authorities on different levels, whereas other use cases may have commercial value.

Safety/security related Use Cases

These use cases are related to safety/security issues, where alarm signals/messages are transmitted to and from vehicles and, most importantly, via an authorized alarm/traffic center. Additional cloud-based solutions may also be established.

Receiving alarm signals/messages in vehicles

Common to all types of signals/messages, the vehicle must be able to receive them either by a build-in part of the car or by a separate dedicated device. In the simplest form, visual indicators must be available, and, in addition, different forms of siren sounds must be generated. Further information may be made available on connected smartphone screens. Based on the provided information, the driver must be able to take proper action.

Generating alarm signals/messages from vehicles

These are the most important safety/security use cases, which may be generated from vehicles on roads. As a minimum, a dedicated device must be available, and this device should have an extremely simple and clearly identifiable button interface. As a supplement, a voice recognition interface may be available. If a smartphone is connected, the signals/messages can become additionally specified.

Emergency situations including accidents

In case of serious emergency situations, like accidents, an immediate action must be taken, and an alarm signal/message must be transmitted so that people in approaching vehicles can be warned. From directly involved vehicles, the signal may be generated automatically, if for instance an airbag is triggered, or a crash is registered somehow, solo or by a collision. Otherwise, the signal may be send manually. Persons, who may be indirectly involved (just passed or approaching from behind), should immediately generate a proper signal/message.

The traditional mandatory alarm signal should be switched on, preferably as an automatic operation. Depending on available new technologies, the car may perform a proper automatic braking operation.

Alert situations

Besides emergencies, several other situations may occur, which can be of great importance for drivers: vehicle stopped, road/track blocked/closed, rescue vehicle approaching, reduced visibility, congestions, etc. Such signals/messages may be generated from vehicles and some from authorities, e.g. blocking and rescuing operations. In vehicles, some of the in-built sensors may assist in generating signals/messages, e.g. decreased road conditions and reduced visibility. Some situations may be handled by the dedicated communication device, e.g. vehicle stopped and congestions.

Additional Use Cases

Besides the safety/security issues, described above, some use cases may be developed in addition and either based on the dedicated device or on smartphone apps. These use cases should have commercial importance.

Speed/Traffic Control

This use case is already represented by other actors and it has shown substantial economic importance. However, there are no limitations against the number of solutions offered to customers. Therefore, functionalities of this kind must be included in the dedicated device and, optionally, with a connected smartphone.

Vehicle Data Tracking

Based on the data, which can be generated from and received by the dedicated device, a series of data records may be collected and made available to the user or owner of the vehicle. These data may support the driver and automatically generate tracking overviews, e.g. driving records/books. For instance, it may be important to demonstrate good driving behavior (insurance issues). Data tracking may have insurance implications in relation to various events and potentially solve some delicate problems.

Exploitation of publicly available Data

Alarm/traffic centers like the Danish Vejdirektoratet collects and organize various data from different sources. Some data are made available for the public use. Furthermore, second level service providers may mix the data with additional proprietary data to offer more value to users. Typically, data collected over a longer period may be analyzed with the purpose of finding valuable patterns. An example could be recommendations of how to avoid bottlenecks.

Preventive Maintenance

Based on tracking data over a longer period, important data may be produced to prevent unplanned break down and maintenance.

Appendix 3 – Prototypes

As described in appendix 1 and 2, different functionalities can be developed and implemented in a dedicated device and a connected smartphone app. As also indicated, it is important to provide demonstrations of some basic functionalities, so that the most significant stakeholders can be encouraged to invest.

The following prototype versions are proposed beginning with the simplest functionalities. General for all versions, the device must have a battery included and the following components must be available:

- Indicators (light diodes) of different colors, e.g. green, yellow and red
- GPS module to register position
- Wireless module for two-way transmission to/from alarm/traffic center
- Siren module to generate a set of signals, at least a signal for 'low battery'

Prototype v. 1

In this first prototype version, the device must be able to receive signals from the alarm/traffic center regarding accidents, which are somehow observed. Likewise, the device must enable signals to be sent regarding a) events, which may lead to dangerous situations or b) visible occurred accidents. In this version, two simple push buttons must be available for sending signal a (perhaps yellow) and b (perhaps red).

Whenever the alarm/traffic center has registered an accident somehow relevant to travelers, it must be released, sent out and received by the devices and a proper siren signal must be generated. In this first version, it is proposed that the center generates the signal continuously (with small intervals, e.g. every second) until the accident status is cancelled. The alarm signal must provide proper GPS location of the accident and, comparing this location with the vehicle's locations, the signals can be filtered, and a siren signal is only generated if the vehicle is approaching and within a certain distance from the accident. The siren signal may be designed (repeat interval and loudness) according to the distance.

When one of the buttons are pushed, the GPS location is added to the signal, which is sent to the alarm/traffic center. When multiple travelers are approaching the accident or perhaps see that is has happened, different locations will be send over a short time interval. Therefore, these signals must be interpreted, and an algorithm must be developed to calculate the accurate position – or the most likely.

Prototype v. 2

In this prototype, the same two possible signals can be send from the device, but multiple signal/message types may be received by the device:

- Road narrowed, or highway track closed
- Rescuing vehicle approaching
- Reduced visibility

This means that the signal/message types must be formatted to contain more information and interpreted by the device software. In addition, one or two extra siren signals may be necessary in order to cover also the less important alerts/warnings.

Prototype v. 3

In this prototype, an optional connection to a smartphone app must be available (BlueTooth or WiFi). This means that all functionalities can be illustrated on the smartphone screen and that the push buttons can be cloned there.

There are many ways that a smartphone screen can be designed, especially because it is touch-based and graphical. Consequently, various forms of maps can be illustrated.