Ambient Traffic Services Based on the Use of Agile Warning and Notification System Radio-Help

Jan Skrbek, David Kubat, Tomas Zizka, Jiri Kviz, Klara Antlova
Department of Informatics
Faculty of Economics, Technical University of Liberec
Voroněžská 13, Liberec, Czech Republic
jan.skrbek@tul.cz, david.kubat@tul.cz, tomas.zizka@tul.cz, jiri.kviz@email.cz, klara.antlova@tul.cz

***Abstract* - The paper describes an efficient way on how to reduce the number of car accidents caused by collision with damaged vehicles. It aims at assessing the current situation and to identify weaknesses and influence of planned or proposed solutions. The agile "System for Automated Forewarning of Vehicle Crashes" is introduced. The input data are collected from eCall system. Distribution of warning information is provided through Radio-Help broadcasting that ensured distribution of warning messages to drivers arriving to the place of an accident. With respect to the existing warning systems and its weaknesses, the ambient traffic warning service would allow us to get proper information on time during any kind of road problems.**

Keywords-agile; eCall; crashes; warning; information; Radio-Help

I. INTRODUCTION

One of major problems of the contemporary world is a steady increase in numbers of vehicles and the associated increased load of roads and motorways. Large society of car drivers demands such kind of ambient traffic services that could efficiently reduce the risk of serious traffic accidents. Among most common causes of serious traffic accidents associated with injuries and in adverse event with deaths of their participants are accidents caused by collision with damaged vehicles. Timely distribution of relevant information is a key to reduce the number of traffic accidents and economic and human losses in such situations. Unfortunately existing warning systems are not capable to cover such requirements.

As a case study model a recent event was used. On November 5th, 2011, around 6 p.m., a huge crash involving 34 vehicles on a highway in Southwestern England killed at least seven people and injured 51 [3]. The crash involved explosions, and cars and tractor trailers burning "literally to the ground." Police expected the death toll to rise and they feared they may find more bodies in the wreckage. It was not immediately clear what caused the collision on the M5 highway, but police said foggy conditions and wet road surfaces were partly to blame. The affected section of the busy highway was closed in both directions as police removed all vehicles for forensic examination.

Chain car crashes are a typical example of situations with high demand for crisis communication. Crisis communication can be broadly defined as the collection, processing, and dissemination of information required to address a crisis situation [2][11]. Let us consider these situations as our case study model and compare their real progress with the one that would have happened if eCall and Radio-Help systems were implemented.

Currently, the information about a traffic accident is reported verbally to the emergency operations centres via mobile phones, either by those involved in accidents or their witnesses (Fig.1). However, this is associated with problems when attempting to explain the given situation and determining adequate intervention (the exact position and direction of the vehicle, the scope of damage, elimination of repeated reports of the same accident, etc.). The speed of intervention is a key factor for its success, whereby any possible delays influence negatively the outcome of the entire rescue operation and the health status of injured persons.

Currently, there are several projects [1][4][10] in various stages of development aiming to solve the current traffic problems in order to reduce damage to property and to protect health and lives of road users. The core of many of them is geographical positioning of traffic accidents. This data can be used for warning and noticing drivers prior the place of traffic accident.

Next section brings information of current solutions and identifies its weaknesses. Section III provides information related to proposed solution. Last section brings conclusion and our plan for future work.

II. DESCRIPTION OF SELECTED TELEMATICS SYSTEMS

A. Variable information boards

In Czech Republic, information displayed on the boards on motorways is received from the Unified Traffic Information System, a joint project of the Ministry of Transport, Directorate of Roads and Highways and several other bodies and organizations.

Currently, there are about one hundred of these variable information boards installed on motorways in the Czech Republic, representing coverage of approximately one board per 20 kilometers of a highway or a motorway [5]. There are either no or very few smart boards on other roads and streets.

 ISBN: 978-1-61208-235-6

For example, in extreme traffic conditions during a normal working day an average number of 1,400 cars per hour passes the 96 kilometers of the D1 motorway. Delayed distribution of information in a matter of minutes, which is caused by time required for the processing and publishing of this information, brings danger for many motorists who can never receive information about the event in front of them via the variable information boards.

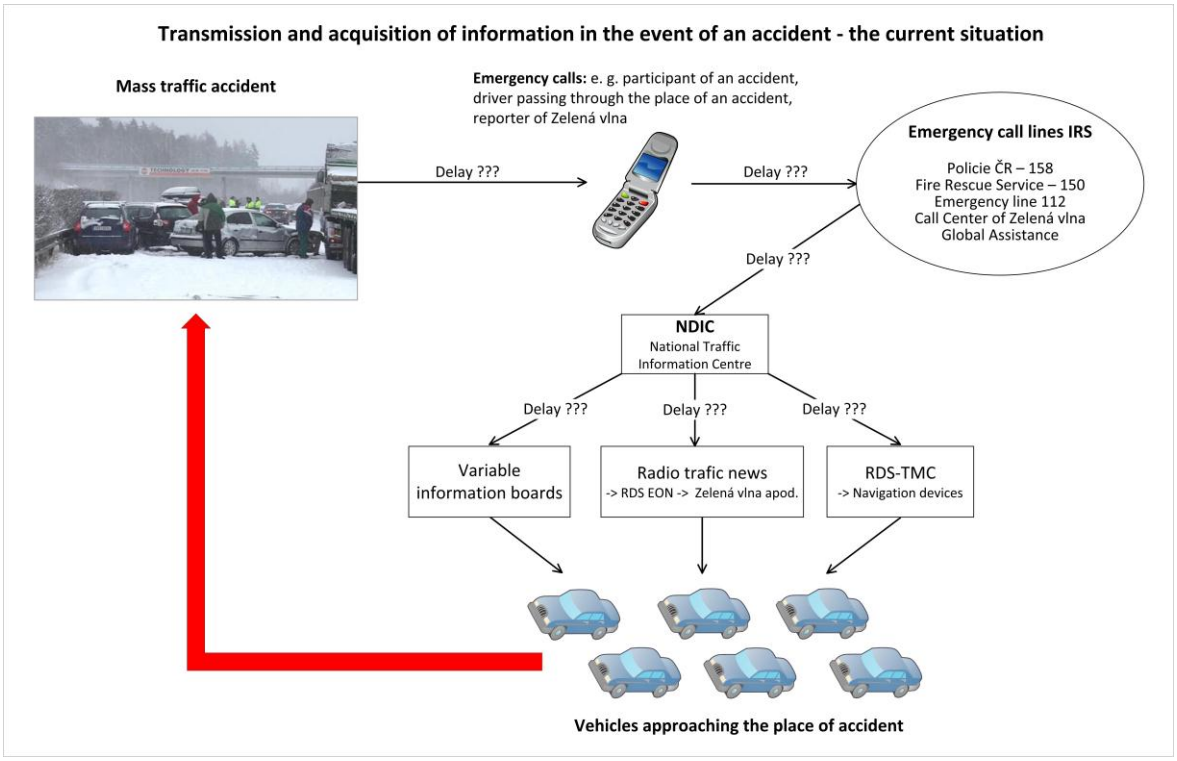

Figure 1. Transmission and acquisition of information in the event of an accident (Source: Authors)

B. RDS-TMC

RDS-TMC (Radio Data System - Traffic Message Channel) is a service that provides the drivers with traffic and travel information before and during their journey. This service integrates all relevant information and gives the driver a possibility to optimise the journey. The aim of the RDS-TMC is to provide traffic information within the FM broadcast band using RDS technology. Information is coded using an independent ALERT-C protocol and later on transmitted to the users as a silent part of FM broadcasting and further processed by the navigation device. According to national and international studies the main system benefits encompass significant improvement in traffic continuity and lower environmental impacts.

The disadvantage of this system is that a warning symbol appears in case a traffic problem occurs anywhere on the preselected route. For more information, the driver must manipulate the navigation device, which requires his attention. In addition, if there are further problems occurring on the given route, the warning icon remains unchanged despite the possibility that this newer traffic incident may have occurred in a location which is even closer in route than the originally reported traffic problem.

C. eCall (Emergency Call System)

Project co-funded by the European Union aims to create a system that enables automated reporting on accidents to the European-wide emergency line 112, including accurate information about its location. When the eCall device installed in a car detects an accident by means of sensors, it automatically sends a message to the nearest emergency centre, indicating the exact geographical location of the accident as well as other data. This system can be activated either manually by pressing a button on the dashboard by the vehicle passengers or automatically by the vehicle sensors triggered during an accident. After the system is activated, a connection with the nearest emergency call centre (PSAP) is established transmitting both sound and data flows. The sound connection enables vehicle passengers to communicate with professionally trained call operators while at the same time data channels are used to transmit data messages (MSD) to these same operators. Each message contains 43 details about the accident; such as time, exact location, car identification, eCall system status (whether the eCall was activated manually or automatically) and information about possible service providers. Based on this information, the operator will liaise with the integrated emergency services to direct them to the exact accident

 ISBN: 978-1-61208-235-6

location, as well as provide them with an exact description of the accident's severity and the number of injured [12].

Manual use of the system can be useful when we witness a traffic accident [4]. eCall systems should be installed in all new cars, at the latest, by 2015 and possibly also installed in older cars.

Although this system brings a clear improvement of the current situation in terms of saving lives and providing quick health care during accidents, it does not provide a solution for distributing information about the accident to the drivers approaching the place of accident, i.e., who are potentially in danger. When using existing information channels, the acquired accident data could be made available in some 5-10 minutes via motorway information boards, RDS-TMC messaging and radio travel news. However, each of these distribution channels has specific limitations and based on current traffic density, the above-mentioned reporting times are clearly insufficient.

D. Smart Road Restraint Systems

The project aims - in addition to addressing timely reporting of accidents – at eliminating loss of life and property through timely preventive distribution of warning information. The proposed system obtains information about the current situation using existing visual and sensory infrastructures (highway camera system, radar system and weather condition monitors) and distribute such information to drivers. It also seeks to find opportunities for new materials to decrease safety hazards (such as better energy absorption through deformation zones of transport). This project is one of three priorities of the EU on the issue of transport in 2020 and is also co-financed from EU funds [10].

III. AGILE SYSTEM FOR AUTOMATED FOREWARNING OF VEHICLE CRASHES

Agile approach is based on new practices and techniques that make product development more cyclical and incremental. It relies on lean governance (management) as opposed to more traditional techniques that rely on heavyweight governance. Agility is also about empowering the team and getting closer to what the customer wants. In place of rigorous upfront planning and the phase-based process, it offers a dynamic, iterative build-and-test cycle, where a change is handled well. One of Agile's hallmark features is that it drives the decision-making process lower in an organization, making that organization more responsive and adaptive.

For better and particularly early distribution of warning information, a system called "System for Automated Forewarning of Vehicle Crashes" (the System), which has a data connection to the receiver systems-vehicle emergency call (e.g., eCall) could efficiently help. The principle consists in full automation of generation and transmission of all relevant information about the accident to vehicles moving in its vicinity. The process of warning is initiated by the crashed vehicle, which generates data about the accident using eCall immediately after the collision happens together with the exact location of the accident. Information is received by the central office of the System which immediately generates data and/or voice information about the incident, including the positional code of the accident. Data are immediately broadcasted via radio session to car receivers [1].

System receivers (mobile phones, car radios, navigation devices) must be equipped with GPS receiver and a positional code comparator of an accident positional data generated by the positioning system receiver. If the comparator evaluates that the position code of an accident coincides with the position code of the receiver and vehicle movement will be evaluated as being directed to the scene of the accident, it will be forced to activate the data reception and/or voice session. In practice, we may be able to automatically inform road users according to their current position and direction of the danger which is coming, almost immediately. The system is functional and usable for any kind of road or street, thus, not only on highways and motorways.

The System uses HD radio broadcast technology or generally any digital radio broadcasting system, supplemented by determining the position through GPS or Galileo. If we consider data acquisition for warning from eCall, in the event of a major expansion an addressable warning system that would significantly limit the creation of public transport accidents could be a very effective. Transfer of information in the case of using "System for Automated Forewarning of Vehicle Crashes" is shown in Fig. 2, where solid lines show the flow of information the driver will receive in real-time or with minimal delay.

Detailed principle of radio broadcasting of warning information is described in [7] under the working title RADIO-H (Radio-Help). It is based on simultaneous application of analogue broadcasting technology with superposition of digital content (HD RADIO or DRM) or full-digital broadcasts with the possibility of defining the positional coordinates via GPS [7][8][9]. HD Radio technology company iBiquity Digital Corporation was selected in 2002 in the U.S. as a key technology for the digitization of radio broadcasting. Currently, this technology carries a large percentage of U.S. radio stations.

 ISBN: 978-1-61208-235-6

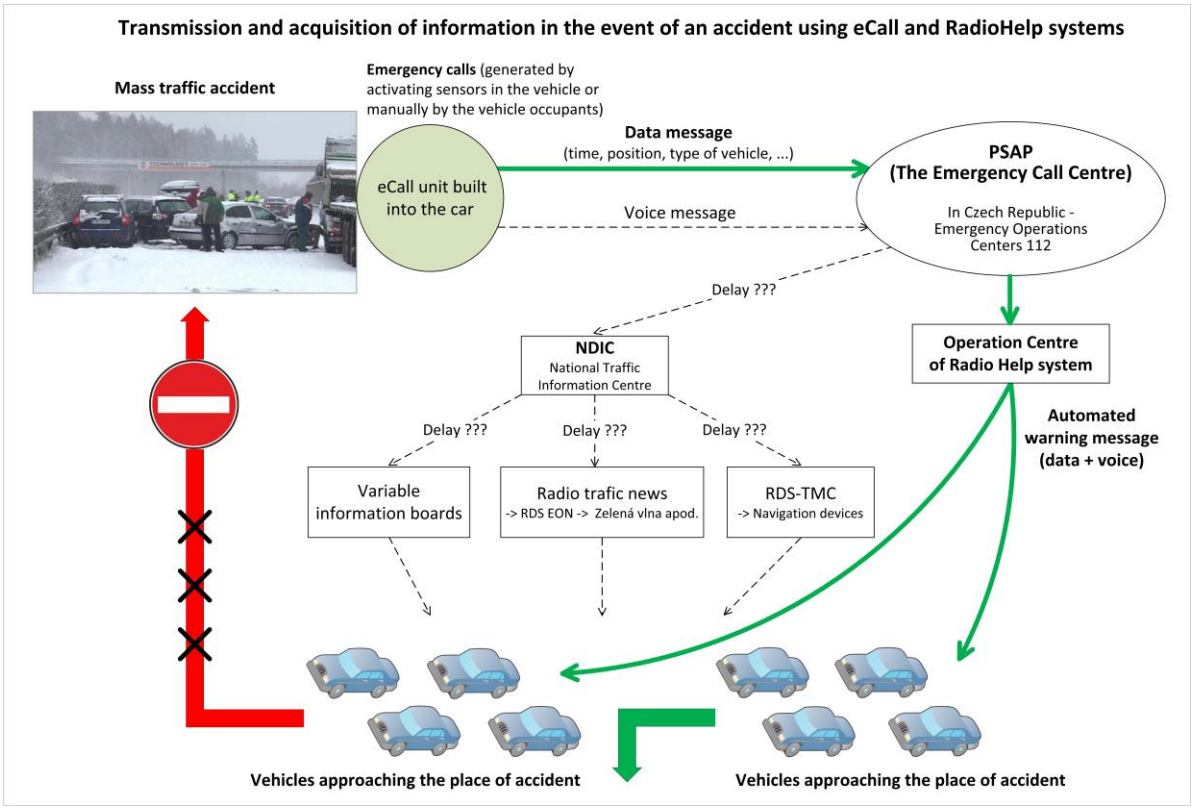

Figure 2. Transmission and acquisition of information in the event of an accident with the use of eCall and Radio-Help (Source: Authors)

HD Radio technology uses the principle of superposition of the digital signal to analogue signal. „Today, there are in the USA more than 2,100 stations with HD Radio Broadcast Technology… HD Radio™ Technology is available or has been announced to be available on 28 different brands of new vehicles (Acura, Audi, Bentley, BMW, Buick, Cadillac, Chevrolet, Ford, GMC, Hyundai, Jaguar, Kia, Land Rover, Lincoln, Mazda, Mercedes-Benz, Mini, Porsche, Ram, Rolls Royce, Scion, SRT, Subaru, Tesla, Toyota, Volkswagen, Volvo). These announcements represent 148 different vehicles with HD Radio Technology, a total of 74 which will come with HD Radio Technology as a standard feature during 2012 [13].

The transmitted relation of Radio-Help uses positional codes for identifying areas of compulsory income, i.e., where the broadcast is directed. The receiver in the area is maintained in a standby mode and captured broadcast on fixed rate compares its position according to GPS coordinates with areas included in the broadcast. If there is compliance, it activates forced broadcast reception session. After the broadcasting code ends, the receiver goes into standby mode again. Subscribers of Radio-Help that are outside the defined zone will not be disturbed by warning broadcast sessions.

This principle implies that it is possible to transmit separate sessions to more areas simultaneously. Long wave radio transmitters, which with new higher quality broadcasting channels gradually lose their utility, could be used for the broadcast. In such a case, it would suffice to cover the whole Czech Republic just by one central long wave radio sender.

Due to the development of IT where circuits for terrestrial broadcasting and positioning GPS are now equipped with most new mobile phones, it should not be technically demanding to use it for these purposes.

There are often doubts about privacy with respect to the positional information. It needs to be said, that the distribution of such information is done by the eCall system itself. From that perspective, as the eCall system has been already approved, the discussion of privacy would be redundant.

The System for Automated Forewarning of Vehicle Crashes is a novelty idea based on some previous work. Compared with other systems considering traffic (car accidents and similar issues) – only this approach allows fully automated warning limiting the influence of human factor. This fact provides shorter response time therefore better functionality.

 ISBN: 978-1-61208-235-6

IV. CONCLUSION AND FUTURE WORK

While the RDS-TMC has long been in operation and eCall should be installed in new cars from 2015, a project of Smart Road Restraint Systems is still under development. Automatic emergency call system eCall is designed especially for accelerating action of rescuers and other components of IRS (Integrated Rescue System). The availability of accurate information about the accident, particularly the place of it and some additional information like a type of car or extent of the damage, without any significant delays will undoubtedly be very beneficial. It follows that the introduction of eCall may help reduce human losses and reduce the consequences of accidents by early intervention emergency services.

The prevention of subsequent accidents may at least have an equivalent effect. If the data from eCall is also used for early warning of other potential participants in an accident, it can lead to significant lowering of life, health and economic losses that could follow in the event of traffic accidents. Combining eCall together with the use of "System for Automated Forewarning of Vehicle Crashes" can ensure real-lime distribution of warning messages to drivers coming to the accident. Drivers should have relevant warning information in time in case of approaching the accident, so they could respond in time. The described combination can provide direct transfer of relevant information with minimum delay. The system is functional and usable for any kind of road or street. In addition, information is sent only to specifically defined geographical area - for example, only to drivers of vehicles that are closer to the accident than 15 km and also go towards this accident. The combination of the System with car navigations could deliver the necessary information only to drivers approaching the place of the car accident. The System has also an ambition to be an ambient service for improving the first aid to injured persons.

As a next step proving the quality of the system there have to be done a modeling of the situation with the System implemented. It should provide reliable data needed for a quality analysis.

ACKNOWLEDGMENT

The presentation of the paper was supported by the project No. CZ.1.07/2.2.00/28.0327 Innovation and support of doctoral study program (INDOP), financed from EU and the Czech Republic funds. Other support was SGS project Agile Approach of Information Support by Solving Non-Standard Situations.

REFERENCES

[1] M. Brunclík and J. Skrbek, 2010. "Systém automatizovaného kritického varování před místem dopravní nehody" [online], [retrieved: June, 2012], Available from WWW: <http://spisy.upv.cz/Applications/2010/PPVCZ2010_0415A3.pdf>.

[2] W. T. Coombs and S. J. Holanday, 2010 (ed.). "The Handbook of Crisis Communications", Willey-Blackwell, Chichester, 2010, p. 20, ISBN 978-1-4051-9441-9.

[3] Conservative Refocus News, 2011. "Fiery Chain-Reaction Accident Results In 34 vehicle Pile-Up in United Kingdom", [retrieved: May, 2012], Available from WWW: <http://www.conservativerefocus.com/blog5.php/2011/11/05/fiery-chain-reaction-accident-results-in-34-vehicle-pile-up-in-united-kingdom-at-least-7-dead-scores-injured-video>.

[4] European Commision, 2010. "eCall – saving lives through in-vehicle communication technology", [retrieved: May, 2012]. Available from WWW: <http://ec.europa.eu/information_society/doc/factsheets/049-ecall_july10_en.pdf>.

[5] Ředitelství silnic a dálnic ČR, 2012. "Proměnné dopravní značky (PDZ) a zařízení pro provozní informace (ZPI) ", [retrieved: June, 2012], Available from WWW: <http://portal.dopravniinfo.cz/promenne-dopravni-znacky-a-zarizeni-pro-provozni-informace>.

[6] SafetyNet, 2009. "eSafety", [retrieved:May, 2012]. Available from:<http://ec.europa.eu/transport/road_safety/specialist/knowledge/pdf/esafety.pdf>.

[7] J. Skrbek, 2011. "Advanced Ways and Means of Civilian Notification in Crisis Situations". In A. KOCOUREK (ed.). Proceedings of the 10th International conference: Liberec Economic Forum 2011. 1st edd. Liberec: Technical University of Liberec, 2011. pp. 419–426. ISBN 978-80-7372-755-0.

[8] J. Skrbek, 2009. "New Possibilities of Information Services for Special Situations", in 17 – th Interdisciplinary Information Management Talks, Proceedings (IDIMT-2009), pp. 123–130, Trauler Verlag, Linz, ISBN 978-3-85499-624-8.

[9] J. Skrbek, 2011. "Radio-Help as a Smart Early Warning and Notification System". In Proceedings of the 55th Annual Meeting of the International Society for the Systems Sciences, 14 p, University of Hull Business School, UK, 2011, http://journals.isss.org/index.php/proceedings55th/issue/view/11, ISSN 1999-6918.

[10] SMART Road Restraint Systems, 2010. Innovative concepts for SMART Road Restraint Systems to provide greater safety for vulnerable road users, [retrieved: May, 2012]. Available from: <http://smartrrs.unizar.es/up_files/file/WORKSHOP/folleto_smartrrs3.pdf>.

[11] K. J. Tierney, M. K. Lindell, and R. W. Perry, (2001) (ed.) "Facing the Unexpected", Joseph Henry Press, Washington, 2001, p. 13, ISBN 0-309-06999-8.

[12] J. Vávra, 2010. "Systém eCall v konfrontaci s alternativními systémy nouzového varování", DP-EF-KPE-2010-105, EF-TUL, Liberec.

[13] iBiquity Digital, "What is HD Radio Broadcasting?", [retrieved: May, 2012], Available from WWW: <http://www.ibiquity.com/hd_radio>.