The TN-ITS Platform: Creating a seamless data-exchange on changes in critical road network related spatial data between road authorities and map providers in Cyprus

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Abstract

Moving to the era of connected and autonomous vehicles there is an increasing demand for quality of road data in order to meet a high level of safety in vehicles' movements. Most automotive and technology companies are focused in real time data capturing from vehicles, to adjust their route. However, quality navigation maps with static geographic data regarding the road infrastructure are also needed. Consequently, map providers are working constantly to collect field data to keep their maps up to date. It is a fact though, that the static road network characteristics, such as speed limits and restrictions are changing by road authorities in each country flowing several regulation changes. Therefore, the lack of communication between road authorities and map providers is causing delays in updating the digital of map providers. Sixteen EU member states through a Connecting Europe Facility (CEF) fund are working to develop a platform for seamless data-exchange ensure that any change in the road network is published. This paper introduces the implementation of the TN-ITS platform in Cyprus and demonstrates how it can provide a near-immediate update of the digital maps in end-user devices and the potential benefits for the society.

Keywords: TN-ITS, road network, digital maps.

1 Introduction

Geographic Information Systems (GIS) are widely used in transportation and special models were developed for sharing data between GIS and Transportation Systems (Bajpayee and Mathur, 2015). At the same time, the need for road data collectors and quality road network databases is constantly increasing considering the support that Autonomous Vehicle (AV) need to be safely deployed in the roads (Goodchild, 2018). Some of the tasks an AV has to execute are: observing the environment, make decisions, guiding dynamically and planning route (Vafaeinejad, 2017). Focusing on guiding and planning, it is important that the AV has accurate and timely information regarding the road network infrastructure. This information is given by digital maps created by map providers for navigation systems. However, road authorities, following policies and regulations, are constantly changing the road network infrastructure. These changes are recorded to road authorities' databases, but this information is not transmitted to the map providers (Lewis et al., 2018). The map providers are using several techniques to keep their maps up-to-date; however, the need to increase the update speed of any change in the road network is crucial for the deployment of AVs (Fang et al., 2016; Vafaeinejad, 2017; European Committee for Standardization, 2018).

Intelligent Transport Systems (ITS) are advanced applications, which without embodying intelligence as such aim to provide innovative services relating to different modes of transport and traffic management and to guide users for safer, more coordinated and "smarter" use of transport networks (Directive 2010/40/EU). Working towards this direction, "Transport Network ITS" (TN-ITS) spatial data exchange platform has the mission to provide support to the EU Member States and map providers for the implementation of EU regulations for the elements related to static road data.

The Commission Delegated Regulation (EU) 2015/962, supplementing the ITS Directive 2010/40/EU of the European Parliament and Council regarding the provision of EU-wide real-time traffic information systems, sets out the requirements for road authorities, road operators and service providers (European Committee for Standardization, 2018). Thus, TN-ITS aims the accessibility, exchanges, re-use and provision of updates of static road data, road status data and traffic data for each involved Member State by setting up a pilot or live service which eventually will close the gap between road authorities and map providers.

The main goal is to make the data on the TN-ITS pilot service in each EU Member State available through an existing national access point, or to contribute to setting up such a national access point.

The main objective of this paper is to introduce the implementation of the TN-ITS pilot platform in Cyprus. The rest of the paper is organized as follows. Section 2 is referring to background information; Section 3 is devoted to the description of the pilot system and the software architecture. In Section 4 the status and challenges are discussed while the

Section 5 includes discussions and conclusions. In the closing Section 6 further work aspects are described.

2 Background

The TN-ITS consortium includes Sweden and Norway with a fully functional service with the aim to help other countries with their implementations. Then Finland, Flanders, UK, Ireland and France have already a pilot service running, and they are working to improve it. Also, Netherlands, Hungary, Lithuania, Portugal, Greece, Slovenia, Estonia, Spain, Cyprus are included in the consortium with the aim to develop a pilot service publishing updates of at least one road network attributes for a part of their road network. Lastly, HERE and TomTom as representatives of the map providers are working with the EU member states to ensure that the data produced by their TN-ITS services, are consistent and usable.

Each country has its own road network database with unique characteristics which are usually maintained by the local road authority. Regarding Cyprus, the operation and management of the main public road network (Motorways, 'A' roads and Urban roads) is under the responsibility of the Department of Public Works (PWD) of the Ministry of Transport, Communications and Works. PWD provides a balanced and integrated transport policy for the safe, efficient, cost effective movement of citizens and goods by road network. As such, they have the full responsibility of management and oversight of the main road network as well in legislative and policy terms.

The rapid development in the ITS industry, as well as the European obligations regarding management and dissemination of spatial data and information, have increased the need of accurate management of the public road network and the necessity to bring innovation to the PWD.

2.1 Speed limit data availability in Cyprus

Considering all the road network attribute data, the speed limit is the one, which is considered the most important in terms of safety (Laflamme and Vaez, 2007). Therefore, it was decided that the pilot TN-ITS implementation for Cyprus would be focused on speed limits. The only speed limit database was created in 2011 for the motorways in Cyprus. The data were collected by observations from a vehicle equipped with cameras and a satellite positioning system. The data were not updated ever since. However, during the last year, the PWD is working on improving and expanding its speed limit database and the TN-ITS implementation would be able to strengthen these efforts.

3 TN-ITS pilot system

The TN-ITS service was implemented as a web service where map providers and other users can access incremental road network updates regarding safety features in the form described in the "ITS – ITS spatial data – Data exchange on changes in road attributes" (European Committee for Standardization, 2018). The primary objective of this project was to create a reliable service, to provide accurate information regarding the road network safety through attribute changes.

For developing the pilot service of TN-ITS, the "Nicosia – Limassol Motorway" (A1) is used (Fig.1) that comprises of a 73km network data. The A1 Motorway is part of the Primary Trans-European Transport Network (TEN-T) in Cyprus. The TEN-T is a European Commission policy directed towards the implementation and development of a Europe-wide network of roads, railway lines, inland waterways, maritime shipping routes, ports, airports and rail-road terminals (Regulation (EU) No 1315/2013).

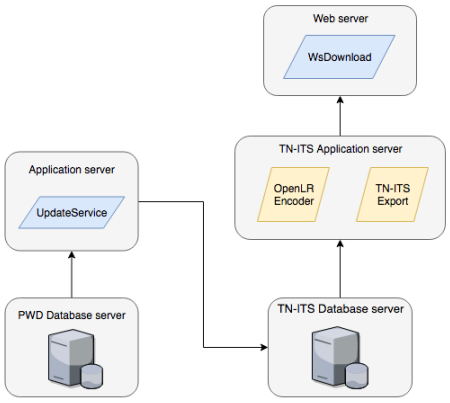
Figure 1: Selected motorway for the TN-ITS service prototype

The 'A1' Motorway selected for the pilot system as it is one of the two main and longer motorways in the TEN-T in Cyprus which includes an extended list of safety attributes, that in future stages can be used for expanding the pilot.

3.1 Specifications and design

In the context of the TN-ITS pilot, a software service was implemented to publish safety feature updated from the local road network database. Figure 2 demonstrates the architecture of this service, where the system consists of a PWD database server, an application server, a TN-ITS database server, a TN-ITS application server and a web server.

Figure 2: System architecture diagram



The PWD GIS-specialists are responsible to keep the database up to date. Any changes that might occur in the physical network has to be recorded in the PWD database on the same day. These changes may concern updates on the geometry of the road network or the road network attributes.

At the end of each day, the Update Service module checks the PWD Database for any attribute updates, and a list of those is sent to the TN-ITS Database server. Then, TN-ITS Application Server requests the updates from the TN-ITS Database manager and the locations of the updates are encoded to the OpenLR™ Location Referencing protocol along with the attribute change and included in an XML file in format specified by the "ITS – ITS spatial data – Data exchange on changes in road attributes" (European Committee for Standardization, 2018). The XML file is accessible through a website where map providers and users can download them.

4 Status and Challenges

Currently, an off-line version of the service has been created. However, the PWD is currently working on updating its database and GIS system, thus, the service will be live once the PWD finishes with these updates.

The main challenges expected to be faced once the service is live, are:

- The adoption of a new process from the side engineers of the PWD for reporting updates of the road network changes,
- The accuracy of the data provided.

Regarding the adoption of the new process of reporting any changes in the road network, it was decided that training will be placed to inform the side engineers about the new reporting process. Additionally, an executive engineer will be assigned to monitor this process.

Considering the accuracy of the data, a quality management process will be established which will include validation of the data received with the planed works assigned to the side engineer.

5 Discussion and Concluding remarks

The TN-ITS service can bring great impact to the further development of Intelligent Transport Systems in the EU increasing the safety in road movements. Moreover, the TN-ITS service can close the gap between road authorities and map providers, which is very important for the deployment of AVs.

Additionally, the new EU vehicle safety standards, which are now in the final stages of being agreed, include a requirement for Intelligent Speed Assistance to be fitted as standard from 2022 (European Transport Safety Council, 2019). The TN-ITS service is under consideration to be a part of this new safety standard to further assist drivers to maintain their speed within the speed limits.

Regarding the challenges of the TN-ITS implementation, it is noted that the quality of the service is strongly connected to the internal processes of the road authority. Currently, the PWD updates of the road network attributes within a month from the actual change. However, with the introduction of the TN-ITS service, these updates should be added to the main database by the within 24h from the actual change. To achieve the requested update frequency, strong internal policies should be introduced in the PWD.

6 Future Work

The pilot service is expected to be live and open to the public before the end of 2019. Then there is a plan for further expansion of the service regarding both the length of the road network covered and the attributes offered by the service. Thus, the expansion of the service will be as follows:

- Include all motorways (2020)
- Include additional attributes in the TN-ITS Service (2020)
- Include 'A' roads (2021)

Moreover, in order to expand the database and cover the whole road network of Cyprus, it is important that the proper policies are established in country level which will include all the municipalities (who are responsible for the maintenance of the local roads). Each municipality could be responsible for keeping a database with all the changes in their road network and share it through the TN-ITS service with all the stakeholders.

Additionally, during the implementation of the pilot, it was noted that similar system architecture can be used to exchange spatial and other data with different public and private entities such as municipalities, enabling better data exchange for everyone.

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