The role of telecommunications in development of New-Generation Intelligent Transport Systems

Boris Drilo, Dinko Saric, Renato Filjar
ICT for Government/Enterprise Segment
Ericsson Nikola Tesla d.d.
Krapinska 45, 10000 Zagreb, Croatia
E-mails: {boris.drilo; dinko.saric; renato.filjar}@ericsson.com

Abstract – **Transport is one of the pillars of modern society, and as such, exposed to growing demands for efficiency, security, reliability, cost-effectiveness and care for environment. Solution for satisfaction of all above-mentioned demands is generally seen in multi-layered infrastructure usually referred to as the Intelligent Transportation System (ITS). ITS is a result of synergy between several existing technological components, integrated through carefully suited process in order to reach solution for general transport control and transport information services provision.**

Recent developments show the re-thinking of the ITS concept is under way, that foresees the high-level system that enables interactions between vehicles, road infrastructure, drivers and traffic controllers in a way that raising demands for new transport can be fulfilled. In such new-generation ITS, telecommunications have been merely considered a reliable bearer of information.

Here we argue that telecommunications are capable and will take more pro-active approach in definition and deployment of the new-generation ITS. The fundamental strength of telecommunications for ITS lays in the mobile awareness embedded in telecommunication networks by their nature. Recent advancements in provision of means and systems for exploitation of mobile awareness embedded in telecommunication networks offer prospects for adding new value in efficiency, security, reliability and cost-effectiveness of the ITS. This paper presents several means for provision of traffic-related data for development of seamless and reliable Traffic Information System (TUS), based entirely on the already deployed telecommunication network infrastructure. Establishment of the Traffic Information System will provide a backbone for further developments aimed to obtain national- and regional-level efficient, safe, climate-friendly and clean Intelligent Transport Systems.

Keywords – modern transport; ITS, positioning methods; traffic-data provisioning; Traffic Information System

I. INTRODUCTION

Modern transport is exposed to numerous challenging demands and requirements. The need for efficient, cost-effective, climate friendly and environment-safe transport is additionally shaped by requirements resulted from the global recession, all of them calling for a new approach in optimising transport-related technologies and business processes (Kutz, 2004).

For some time already, the Intelligent Transport System (ITS) has been foreseen as a solution for growing demands for modern transport system, although deployment of such a system remained rather partial. The new-generation ITS concept has been discussed recently, with extended number of technologies and stakeholder engaged in order to satisfy the needs for reliable, robust, safe and clean transport (Kutz, 2004).

After brief introduction in modern prospects of Intelligent Transport System (ITS) development, the role of telecommunication systems and technologies in development of the new-generation ITS is addressed in this paper. It is argued that modern telecommunication systems provide a robust and reliable framework for the new-generation ITS development, as seen from both technological and business perspective. Various improvements provided by telecommunication systems are presented, and their benefits for the new-generation ITS discussed. Concepts are illustrated using the presentation of the Traffic Information System prototype, that heavily exploits so-far unexplored resources of telecommunication networks in the ITS development. Paper concludes with the substance of ITS improvements provided by telecommunication systems, and plans fro near-term developments.

II. MODERN TRANSPORT AND INTELLIGENT TRANSPORT SYSTEM

Transport is in a foundation of every human civilisation. Goods and people should be transferred from on place to another in safe, efficient and reliable way. Modern affairs put additional demands to transport, emphasising:

- efficiency
- safety
- reliability
- climate and environmental concerns.

Achieving acceptable level of performance cannot be done by optimising the vehicles and transport networks only. Happily, numerous modern technologies are identified as potential or already operational for the purpose of building the Intelligent Transport System, among them:

- Satellite navigation systems (GPS/ Galileo/ Glonass/ GNSS)
- Information and communication technologies (mobile communication systems; positioning, navigation and tracking (PNT) algorithms and methods; distributed computing) (Farell, 2008; Filjar et al, 2008)
- Radars
- Advanced sensor elements (state of the road detection, either embedded within the vehicle, or distributed along the road infrastructure).

Additional subject affecting the performance of transportation processes are getting involved,a among them:

- road network operators
- other transport network operators (trains, rivers etc.)
- police
- customs
- telecommunication operators.

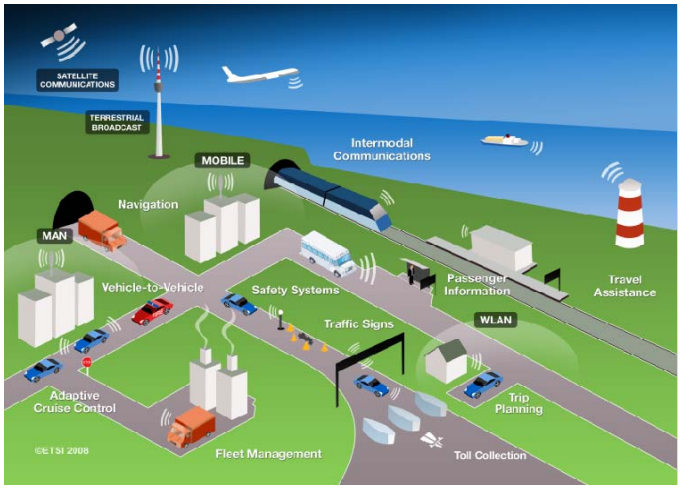

Figure 1. General concept of the Intelligent Transport System (courtesy ETSI)

So far, Intelligent Transport Systems had been built with the aim to integrate several above-listed stakeholders of transport business process using very selected above-mentioned technologies. New concept of the Intelligent Transport Systems developments calls for smart synergy of all business process stakeholders with all related technologies engaged. The new-generation ITS approach (COMeSafety, 2009) has already been agreed upon within related decision-making and standardisation communities (such as, the European Telecommunications Standardisation Institute, ETSI, who established the concept of the new-generation ITS, as presented on Fig 1).The main issue in the new-generation ITS development is the introduction of co-operativeness, which increases the importance of telecommunication systems involved (COMeSafety, 2009).

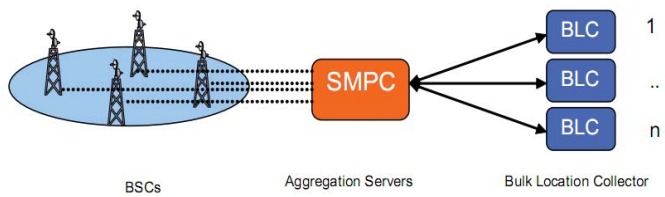

Figure 2. The Anonymous Bulk Location Data unit by Ericsson

III. MOBILE AWARENESS EMBEDDED IN TELECOMMUNICATION NETWORKS

Telecommunication systems has always been assumed a fundamental component of the ITS. However, its role has usually been recognised in conveying the information in robust reliable and safe way only.

Telecommunication systems collect and store numerous data related to whereabouts of their users (Filjar et al, 2002). Mobile communication systems must do that by the sole nature of the means of working. At least an approximate estimate of mobile user's position must be known to support the activities like hand-over, charging etc. Simple methods and procedures have been deployed in mobile communication systems from their beginnings in order to support network operation, such as Cell-ID and Timing Advance (TA) positioning methods. Providing data in a rather raw format, these methods and collected data have been so far rather un-exploited and left deeply within the core mobile communication network. However, modest additional activity can transform the un-used data into valuable information about the network user's mobility. Being in line with privacy and safety standards, the above-mentioned data sets can be anonymous and then used in creating the mobile situation awareness.

IV. PROVISION OF TRAFFIC – RELATED DATA FROM TELECOMMUNICATION NETWORKS

The prospect of mobility-related data collected by its nature in mobile communication network has been recently identified. Raw data (Cell-ID and TA readings in appropriate time-steps) are converted anonymous in a way that the real identification of the mobile communication network user is intentionally dismissed, and an anonymous ID assigned to data (Fig 2) (Ericsson AB, 2008). This process forms a set of anonymous particles with known essential parameters of movement, that can be further exploited in creation of near-real time situation status (Liu et al, 2008). Additional integration with geospatial database systems and utilisation of advanced positioning methods (GPS/Galileo/GNSS) can focus the efforts toward continuous monitoring of road network status (Taylor and Blewitt, 2006). It is important to emphasise that the market

penetration of GPS-enabled mobile units steadily grows, and that telecommunication networks already provide the means for exchange GPS-related data collected on mobile units with the appropriate mobile communication network elements.

V. TRAFFIC INFORMATION SYSTEM

A case of provision road traffic status based on co-operative systems and traffic-related data from telecommunication system is presented here as a case-study of the new-generation ITS (Fig 3). Traffic Information System (TIS) collects anonymous mobile user mobility data sets (Cell-ID and TA in regular intervals) from mobile communication network. Then, a dedicated algorithm extracts particles (anonymous mobile users) travelling by vehicles. Sub-groups of travelling particles are then related to pre-defined road segments, and knowledge-based algorithms estimate the road traffic status based on current data and historical data of the same road segment.

Road traffic status estimates are stored in geospatial database, and used for road traffic status presentation (Fig 4) in various forms (web-site, mobile phone content etc.).

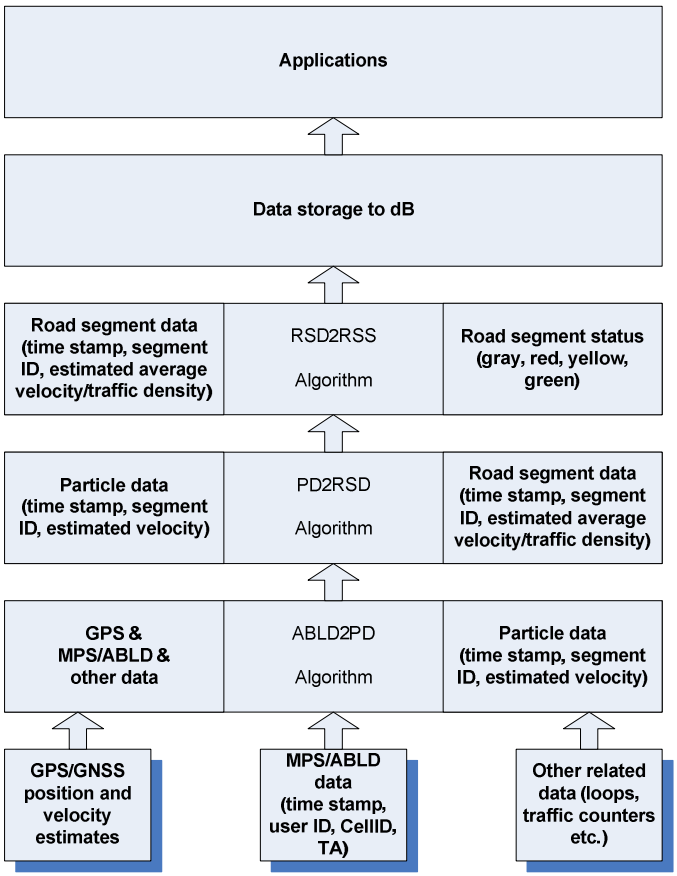

Figure 3. Traffic Information System

VI. CONCLUSION

The new-generation ITS based on co-operative systems offers huge opportunity for more pro-active contribution of telecommunication networks. Along with provision of reliable, robust and safe data transfer, telecommunication networks provide extremely useful mobility-related data, thus allowing for far more reliable and accurate estimation of road traffic status. Road traffic status can be seen as a foundation for a plethora of related ITS activities aiming to inform road users (Filjar et al, 2008), charge for the road use or control traffic on various levels (city, county, country).

Further activities will focus on improved integration of various positioning sensor data (GPS(GNSS) with mobility data embedded in telecommunication networks, and development of advanced algorithms for road traffic status estimation.

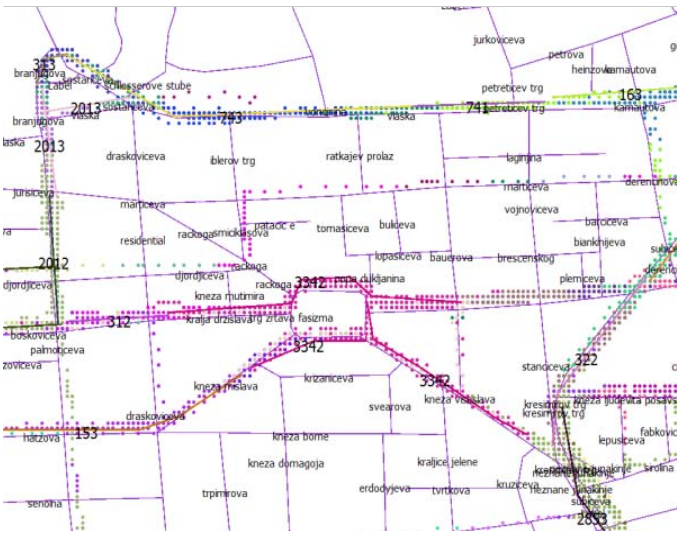

Figure 4. Road traffic status (Zagreb, Croatia)

REFERENCES

[1] COMeSafety. (2009). European ITS Communication Architecture – Overall Framework – Proof of Concept Implementation (V2.0). Contract No. FP6-027377. Munich, Germany. Available at: http://www.comesafety.org/index.php?id=109, accessed on 26 February, 2009.

[2] Farell, J A. (2008). Aided Navigation: GPS with High Rate Sensors. McGraw-Hill. New York, NY.

[3] Filjar, R, G Jezic, M Matijasevic. (2008). Location-Based Services: A Road Towards Situation Awareness. J of Navigation, 61, 573-589. Cambridge University Press.

[4] Filjar, R, D Huljenic, S Desic. (2002). Distributed Positioning: A Network-Supported Method for Satellite Positioning Performance Improvement. J of Navigation, 55, 477-484. Cambridge University Press.

[5] Ericsson AB. (2008). Mobile Positioning System (MPS) 10.0 – Learning Solutions – Package Description.

[6] Kutz, M (ed). (2004). Handbook of Transportation Engineering. McGraw-Hill Handbooks.

[7] Liu Ch, X Meng, Y Fan. (2008). Determination of Routing Velocity with GPS Floating Car Data and WebGIS-Based Instantaneous Traffic Information Dissemination. J of Navigation, 61, 337-353. Cambridge Universty Press.

[8] Taylor, G, G Blewitt. (2006). Intelligent Positioning: GIS-GPS Unification. John Wiley & Sons. Chichester, UK.