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An Ancillary Review of ICT based Technologies in the Road Safety Paradigm

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ABSTRACT

Globally, governments are pitching forward for a novel initiative of decreasing the number of road accidents. Large Scale Introduction of Information and Communications Technologies(ICTs) in the road sector provides a platform for reducing societal losses from vehicle crashes as well as providing a path for streamlining the flow of traffic and hence increasing traffic reliability to a great extent. This paper highlights the need for ICT infrastructure concepts as well as various technologies involved to deploy a smart road network and thereby leading to a conception of safety by means of design and modification resulting in a much reliable, secure and an efficient road network.

Keywords: *Information and Communication Technology(ICT), Intelligent Transport System (ITS),Minimum set of data (MSD)*

I. INTRODUCTION

Effective road transportation provides a medium for facilitating the movement of goods as well as populace and thereby brings enormous benefits to societies in particular and also provides the platform for national as well as global trade [1]. Globally road traffic growth has been surpassing the growth in economy and population. This exponential trend of motorization coupled with road network expansion has brought with it many challenges such as streamlining the peak hour traffic and also keeping in check the number of road accidents. According to a UN estimate more than a million people are killed globally due to road accidents. This figure is expected to double by the end of the year 2020. During the year 2011, in India itself, there were around 4.98 lakh road accidents, which killed 1.42 lakh people and injured more than 5 lakh persons, many of whom are disabled for the rest of their lives [2]. Figure 1 shows the variation of number of road accidents and fatalities from 2002 to 2011.

Introducing a flexible and secure traffic policy in the country encompassing stricter traffic laws better road traffic management, modification in the design and quality of road infrastructure, safer vehicles, law enforcement, provision of accident care, etc has played a stalling effect on checking the increasing trend of road accident fatalities. Although the situation of road safety has been improved rapidly, the pressure of surmounting road accidents still exists. Taking cue from the increasing role of Information and Communication technologies in the advancement and operations of many

fields such as manufacturing, entertainment, government departments, medical science businesses of all sizes and shapes and many other sectors, deployment of ICT in the smart road network realization by introducing intelligent transport systems can to a fair extent meet increasing traffic requirements, reduce negative effects on environment and ensure safety of road traffic participants. ICTs offer a broad array of possible safety applications in road transportation. Such applications could provide collision avoidance warnings or interventions, for example, as well as warnings of lane departures and traffic clutter [3]. With continual up-gradation and modifications these technologies will produce more and better results that will provide more flexibility and new opportunities to improve the results. Intelligent car safety systems employing ICTs abate the proportion of accidents due to the human factor. In the pre-crash phase these systems provide solutions for improving road safety in particular. These systems operate either autonomously on board the vehicle or co-operatively through vehicle-to-vehicle or vehicle-to-infrastructure communications. ICT systems make it possible to ensure safe speed, lane support, safe following, pedestrian protection, improved vision, driver monitoring and intersection safety [4].

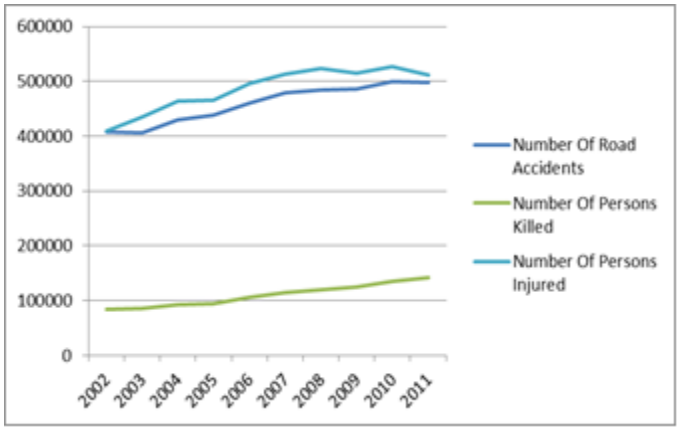

Figure 1. Variation of number of road accidents and fatalities from 2002 to 2011 in India

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II. CONCEPTUALIZATION OF ICT BASED ROAD SAFETY SYSTEMS

Safety of traffic participants is one of the most important consequences of the intelligent transport system (ITS's) implementation, providing a regulatory and a societal impetus to the program with a national backing. The main objective of providing an ITS interface is to set up a national, multi-modal surface transportation system that features increased connectivity of transportation environment among vehicles providing the infrastructure, and portable devices to serve the public good by leveraging technology to maximize safety, mobility and environmental performance. This study conducted divides the ITS deployment into two phases taking into account both the pre accident as well as the post accident response scenario, as shown in figure 2. Various technologies that are a part of ITS deployment have been studied to give the readers a comprehensive view of the Intelligent Transport Systems.

Figure 1: Variation of number of road accidents and fatalities from 2002 to 2010 in India

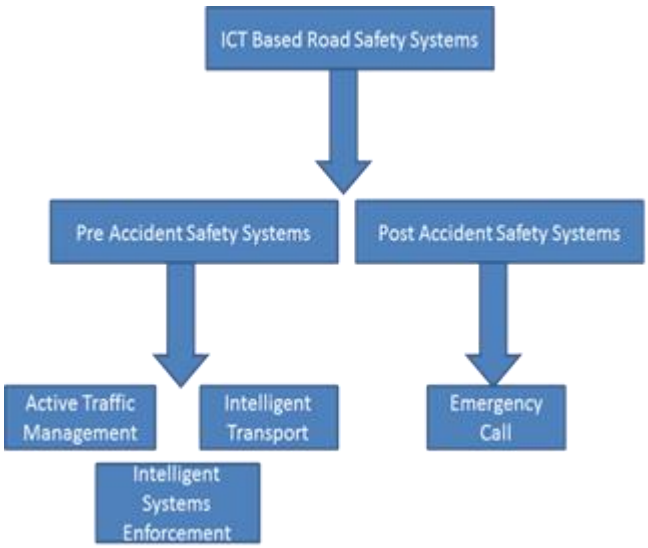

Figure 2. System Overview

A. Collision Avoidance Systems

1) Intelligent Vehicle and Vehicle Integration System

Intelligent vehicle interface provides vehicles with a platform to communicate with the infra-structure (V2I) and with other vehicles (V2V). V2V safety applications particularly focus on collision avoidance technologies so that two vehicles predicted to be on a collision course have the ability to take the best possible evasive measures [5]. Collision avoidance systems are capable of receiving a continuous flow of data from sensors or radars attached to the vehicles, consequent processing of the data obtained and finally application of the data to activate the mechanical and electrical systems of the vehicle to take evasive measures and hence avoid a collision as shown in figure 3. The concept of an intelligent vehicle consists of equipping the vehicle with an optimum number of sensors such as radars in order to perceive the surroundings and hence ensure an automatic guidance control of the vehicle and maintain communication with the external environment. Such a framework is more secure if communication between nearby vehicles is established and maintained. This enables, for example, the driver of a car to be aware at an early time of the emergency breaking of the preceding vehicle (in case of the presence of an obstacle in front of this vehicle) and so to avoid a collision. Thus the collision avoidance system is an information–communication technology system for early warning and collision avoidance on roads and motorways using special sensor network, which is spanned over the moving vehicles and road obstacles – transmitting automatically warning signals to the back of a column and enables distant drivers to stop in time or to do such operations automatically. V2I safety applications (figure 4) include a broad range of capabilities from the transmission of the status of traffic signals on the road ahead in order to alert drivers of the need to apply their brakes, to driving conditions (low visibility or icy pavements), to variable speed limits[6]. Intelligent Transport Services (ITS') are multi- modal and the platform can be easily set up for carriers, transit, passenger and freight rail, pedestrian and bicycle thus offering mobility enhancement and environmental improvement as other benefits. One of the most significant benefits of intelligent transport services broad scope is a motivated increase in the number of stakeholders involved.

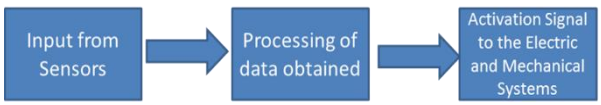

Figure 3. Signal flow

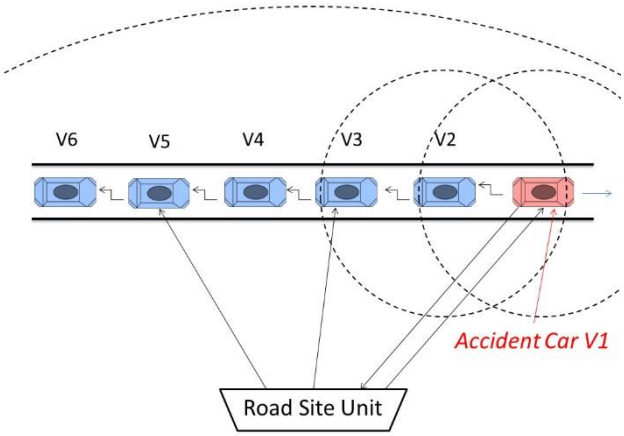

Figure 4. V2V and V2I Communication Protocols

2) Active Traffic Management

Traffic congestion is a problem found in industrialized countries worldwide, and every year the congestion problems grow. Since the 1980s, European countries, including Germany and the Netherlands, have started to evaluate the effectiveness of measures designed to increase capacity and safety on motorways without having to widen them [7]. These measures include shoulder use, speed harmonization, queue warning, dynamic merge control, dynamic rerouting, and dynamic truck restrictions. A positive ramification of introducing of ITS (intelligent transport systems) with a potential of safety is an Active Traffic Management system (Figure 5). This approach to congestion management is more holistic and is considered the next step in congestion management of freeway corridors. ATM is a general term consisting of many technologies working harmoniously or on their own to offer the participants a means to better understand and hence take decisions based on current traffic conditions. The system associated with ATM uses overhead lane signs or overhead gantries to provide advance notice of the traffic conditions and thereby decreasing last second avoidance maneuvers and panic braking, primary factors contributing to collisions.

- Presence of variable speed limit signs direct drivers to maintain the most effective and safe speed.
- Symbols direct drivers to change their lanes whenever a lane a blocked.
- Overhead message signs warn drivers of slowdowns, backups and collisions ahead.

Basic understanding of the Active Traffic Management is essential before its deployment on the road. Actually ATM is the capability to manage recurrent and non-recurrent congestion progressively based on the traffic conditions prevailing at the time. Taking into account trip reliability, maximizing efficiency has to be a very important criteria. Using an integration of new systems with technology there is always a tendency to increase thorough put and safety, as well as the automation of dynamic deployment to optimize performance quickly and without the delay that occurs when operators must deploy operational strategies manually [8]. This congestion management approach consists of a combination of operational strategies that, when implemented in concert, fully optimize the existing infrastructure and provide measurable benefits to the transportation network and the motoring public. These strategies include but are not limited to speed harmonization, temporary shoulder use, junction control, and dynamic signing and rerouting.

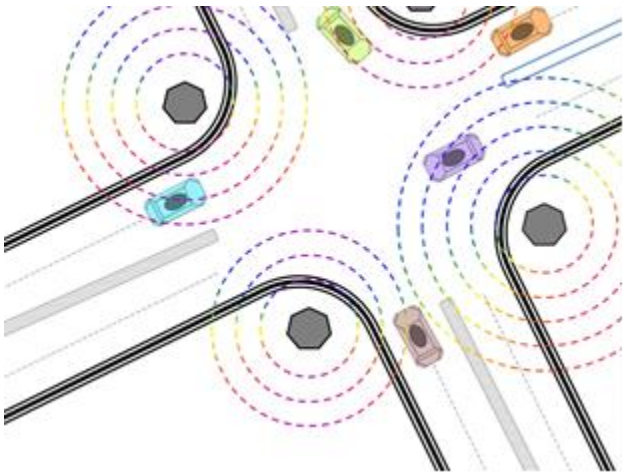

Figure 5. ATM at intersections

3) Intelligent System Enforcement

Intelligent Vehicle enforcement involves the adoption of some traffic enforcement systems, notably systems that photograph vehicles that run red lights or exceed speed limits and issue traffic tickets. Most drivers believe red light running is both "problematic and dangerous," yet the practice is common (20% of those interviewed in a 2001 study) [9].

Traffic enforcement systems use cameras that are aimed at vehicle tags. In some deployments, systems photograph both drivers and tags. Photos are taken only when a violation occurs. If a review of the photographs substantiates the violation, the system generates a citation to be mailed to the vehicle owner of record.

Forms of enforcement:

a) Police Patrolling

Police patrolling is when Police officers record traffic offences in road traffic from the roadside and stop the offenders immediately for sanction. Depending on the seriousness of the offence, different forms of sanction follow, as described earlier. Road traffic offences can also be recorded from Police vehicle, helicopter, or dedicated planes. In such cases, various modern technologies, that enable to record the offence, are used [10]. The physical presence of police officers on the roads has a positive deterrence effect on road users. A direct confrontation between an offender and a police officer has a value in enhancing the educational effect and allowing for the fair treatment of an offender, given the particularity of the traffic situation.

b) Automatic Enforcement System

Although this has been used for almost three decades, automated traffic enforcement has mainly been applied to speed and red light violations. In recent years, however, there has been an extension to other violations, e.g. tailgating, lane keeping, seat belt use or toll payment violations [11]. The increased use of digital video and image processing technology, as well as the electronic

identification of vehicles, has paved the way for extending the applications to a still wider spectrum of violations, as well as making enforcement considerably more efficient in the future. As regards the registration of offences, the concept of an on-site registration or information system includes one or more of the following functions:

- On-site detection of a traffic offence
- On-site registration of a traffic offence.
- providing information to the driver about the fact that they are committing an offence and that this offence has been registered.
- Feeding the recorded information into an automated offence processing system.

Various technologies have been used in automatic enforcement of various traffic rules. They include radar, video, laser, loops, piezoelectric cables and many others. All these have been used to detect various types of offences.

Post Accident Systems

In the study while as assumption is made that the Intelligent Transport Systems can to a large extent provide a means to avert accidents and hence fatalities, there is a fair bit of probability that even after introducing Intelligent Transport Systems in the road network, accidents will happen and hence there is a dire need of understanding the application of ICTs in the post-accident scenario.

Ancillary services like the 'emergency Call' aim to provide the automatic notification of a road traffic accident, based on precise GPS-based positioning and provision of emergency Call prioritization within the mobile communication network. The introduction and use of in-vehicle emergency Call for deployment of emergency assistance can save lives and reduce social burden by improving the notification of road accidents and speeding up emergency service response.

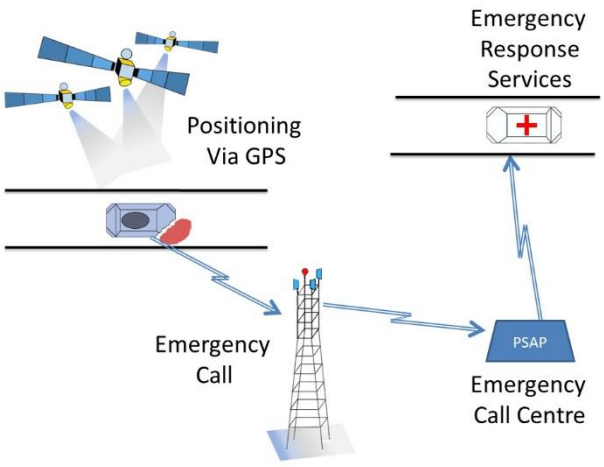

Figure 6. Emergency Call System Overview

1) Emergency Call System Overview

The emergency call refers to an in-vehicle call and emergency response activation system for the quick deployment of emergency response systems at the crash site leading to an improvement in the deployment of the emergency assistance and improving the notification of road accidents. In the event of a car accident, or by manually activating the emergency call distress button, the intended solution can automatically establish an emergency voice call via the cellular network to the local emergency agencies, i.e., the Public-Safety Answering Point (PSAP) [12]. Aside from enabling two way voice communication between the In-Vehicle System (IVS) and the PSAP operator, the emergency call also allows for transfer of a data message from the In- Vehicle System (IVS) over the cellular network (emergency call flag) to the PSAP which is referred to as emergency call Minimum Set of Data (MSD) (Figure 6). The emergency call modem allows transferring a data message from the in vehicle interface over the cellular network (emergency call flag – call discriminator) which is denoted as emergency call MSD (Table 1). The MSD can include, e.g. vehicle location information, time stamp, number of passengers, Vehicle Identification Number (VIN), and other relevant accident information [13].

Table 1: MSD in Emergency Call

S.NO.	Attributes	Description
1	AccArea	Specific area of an accident
2	AccType	Accident collision type
3	AccCouse	Immediate cause of an accident
4	AccK/K	Sub city where an accident occurs
5	AccTime	Time of an accident
6	AccDay	Day of accident
7	AccSeverity	Severity of the accident

III. CONCLUSIONS

While as the paper focused on the review of ICT based technologies that can be deployed for the inception of a safe and efficient road transport mechanism it is often helpful to understand that the little guy in the little car also has concerns for his safety. ICT can provide a solution for a complete overhaul of the road network and the transition from the traditional road network to the smart road network can occur only after addressing the needs of the general populace.

This paper analyzed the need of introducing ICT based road safety technologies and also presented a general introduction of their prospects. Also while as this general study can be used to motivate a more intricate research related to application of information architecture concepts of road safety it can also act as a pioneer to establish an

information communication and technology based network in general and a road safety domain in particular. Also this paper can act as a foundation for further research that can be conducted on the feasibility of the application of ICT technologies in certain particular pilots whose case study has to be conducted separately.

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