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An integrated data exchange platform for Intelligent Transportation Systems

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ABSTRACT

Intelligent Transportation Systems (ITSs) make use of advanced detection, communications, and computing technology to improve the safety and efficiency of surface transportation networks. An ITS incorporates a variety of equipment and devices all working in mutual harmony. However, each piece of equipment or device has its own data format and protocol so they cannot exchange data with each other directly. In this paper, a platform of data exchange in an ITS is proposed that can receive data from several types of equipment external to automobiles, repackage the received data, and then dispatch the data to different devices inside the vehicles.

1. Introduction

Intelligent Transportation Systems (ITSs) make use of advanced detection, communications, and computing technology to improve the safety and efficiency of surface transportation networks. ITS consists of technological applications and integration that allow system operators and users to better manage and optimize the capacity of a transportation system [20]. ITS allows for the use of information technologies to collect data on the status of highways, traffic signals, transit vehicles, trucks, and trains; and integrates data in ways that affect and improve the operation of the system.

ITS has been developed since the beginning of 1970s, which makes human, vehicles, and roads united and harmonic and establishes a wider range, fully efficient, real-time and accurate information management system [11]. The ITS has received much attention in the past few years. That is due to the problems of growing traffic congestion and the need for a synergy of new information technology for simulation, real-time control, and communication networks. Traffic congestion has been increasing worldwide, the result of increased motorization, urbanization, population growth, and changes in population density. Congestion reduces efficiency of transportation infrastructure and increases travel time, air pollution, and fuel consumption [10].

ITS applied varying technologies from basic management systems, such as car navigation systems, traffic signal control systems, and container management systems, as well as variable message signs, automatic number plate recognition and speed cameras, to monitoring applications, such as security CCTV systems [6]. There are more advanced applications that integrate live data and feedback from a number of other sources such as parking guidance and information systems, weather information systems, bridge deicing systems, and so forth. Additionally, predictive techniques are being developed in order to allow advanced modeling and comparison with historical baseline data.

Interest in ITS stems from the problems caused by traffic congestion and the need for a synergy of new information technology for simulation, real-time control, and communications networks [6,10]. Traffic congestion has been increasing worldwide, the result of increased motorization, urbanization, population growth, and changes in population density. Congestion reduces efficiency of transportation infrastructure and increases travel time, air pollution, and fuel consumption.

With ITS, devices and equipments are working together. However, each device and piece of equipment has its own data format and protocol, such as GPS, TMC, Wi-Fi, or Bluetooth [8,9,16]. They cannot directly exchange data; therefore, a framework has been designed herein to exchange messages between devices and communication systems [6]. In addition, this framework can consolidate variant communication protocols, similar to the web service. Therefore, it can adapt any kind of device for use in a multi-communication system, as well as collect varied information from devices, and send all information to the ITS center for data analysis or for transmission to another vehicle [8].

This research employed ITS to design an Integrated Data Exchange Platform (IDEP for short) that includes physical, security, processing and interfacing as its four layers. Each layer includes components working in conjunction to exchange data between equipment and devices in the framework.

The second part of this paper deals with underlying challenges and methods; the third part introduces the method and framework of this research; and the fourth part consists of the conclusion and suggestions for future research.

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Table 1
Generations of Intelligent Transportation System (ITS) [11].

Generation	Period	Technology
First generation (ITS 1.0)	2000	One way infrastructure based
Second generation (ITS 2.0)	2000–2003	Two way communication technology
Third generation (ITS 3.0)	2004–2005	Automated vehicle operations and automated interactive system operations and system management
ITS (ITS 4.0)	2006–2011	Multi-modal incorporating personal mobile devices, vehicles, infrastructure and information networks for system operations as well as personal contextual mobility solutions.

2. Literature review

The term ITS refers to efforts to add information and communications technology to transport infrastructure and vehicles in an effort to manage factors that typically are at odds with each other. The technologies applied by ITS vary, from basic management systems to monitoring applications, and more advanced applications that integrate live data and feedback from a number of other sources. Some of the constituent technologies typically implemented in ITS are described in the following sections [10].

2.1. Intelligent Transportation System

ITS provides solutions for cooperation and reliable platform for transport [11]. Major areas of ITS in metropolitan deployments are Arterial and Freeway Management, Freight Management, Transit Management Systems (TMS), Incident and Emergency Management Systems, Regional Multimodal and Traveler Information Systems, and Information Management (IM) Systems. In these applications, different types of transmission work: some applications work on long-distance transmission and some work with short-distance communication and some systems work on radio modem transmission for the collection of computerized information for analyzing and reporting. Table 1 shows the generation of Intelligent Transportation System with periods.

2.2. Wireless communications

Various forms of wireless communication technologies have been proposed for Intelligent Transportation Systems. Short-range communications (less than 500 yards) can be accomplished using IEEE 802.11 protocols, specifically WAVE or the Dedicated Short Range Communications (DSRC) standard [1,2,14] being promoted by the Intelligent Transportation Society of America and the United States Department of Transportation [10]. Theoretically, the range of these protocols can be extended using mobile ad-hoc networks or mesh networking [6].

Long-range communications using infrastructure networks such as WiMAX (IEEE 802.16) [5,15], Global System for Mobile Communications (GSM) [12,13], or 3G have been proposed. Long-range communications using these methods are well established, but unlike short-range protocols, these methods require extensive and very expensive infrastructure deployment. There is a lack of consensus as to what type of business model should support this infrastructure [17].

2.3. Computational technologies

Recent advances in vehicle electronics have led to a move toward fewer, more capable computer processors in a vehicle. A typical vehicle in the early 2000s had between 20 and 100 individual networked microcontroller/programmable logic controller modules with non-real-time operating systems. The current trend is toward fewer, more costly microprocessor modules with hardware memory management and real-time operating systems. The new embedded system platforms allow more sophisticated software applications to be implemented, including model-based process control, artificial intelligence, and ubiquitous computing. Perhaps the most important among these for Intelligent Transportation Systems is artificial intelligence.

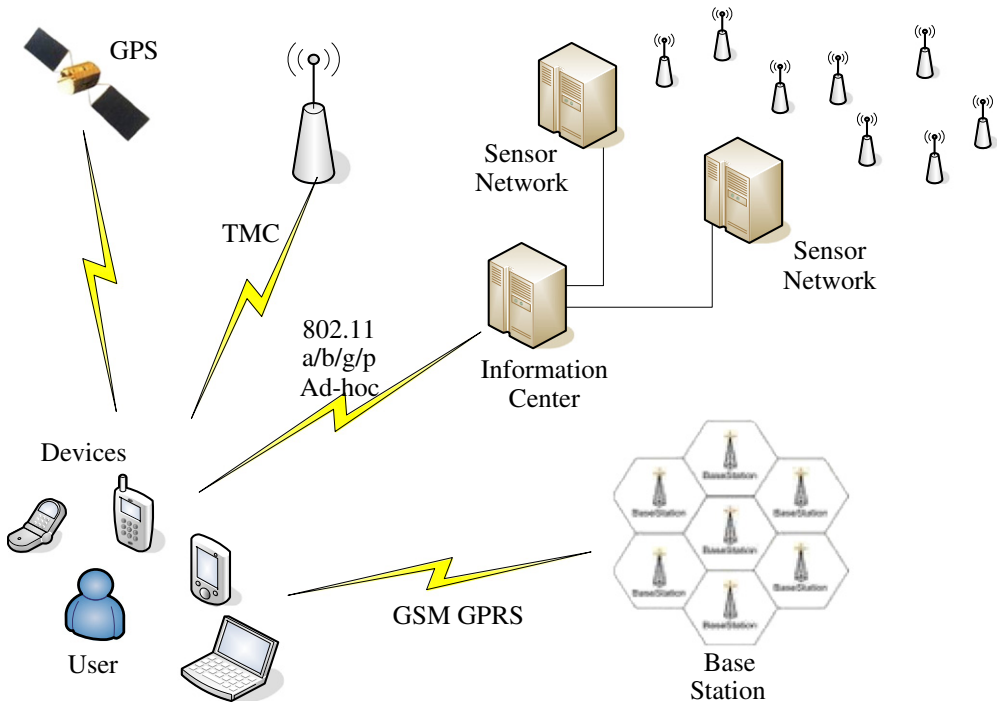

Fig. 1. Equipment and devices in an ITS environment.