Intelligent transportation systems: Past, present and look to future by using Grid technology

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Abstract

Existing technologies in ITS proposed and will be checked. Their advantages and disadvantages are compared. Restrictions have been gradually lower but still exist. Grid computing limitations related to computational memory is solved and provide better performance but still some restrictions such as lack of access to comprehensive traffic information and the lack of support from a number of applications there. Knowledge Grid can be responsive to these needs.

Key words: ITS, IVC, VANET, Grid computing, Knowledge Grid

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1. Introduction

With the community development, developing and in progress countries are facing with the common but important and considerable problems. Traffic congestion increasing seriously and accidents occur much more than common. According to statistics taken in different regions of the world millions of injured and died in highways and roads of the world occurs annually, traffic density have wasted a significant amount of time and fuel. All these problems are growing as a major obstacle for the development of societies. To solve these problems not require a return to using horses and carts but by providing relevant information to the vehicle or i drivers has been solved. Therefore it makes roads safer and more efficient for drivers and lower costs to governments. Intelligent traffic systems (ITS), sometimes called intelligent transportation systems, apply communications and information technology to manage traffic flow, encourage drivers to use alternate forms of transport, and enable people to find the services and information which they need to drive safely, avoid traffic jams, and perform their daily routine with fewer hassles and with more peace of mind. The necessity of the avoiding traffic congestion, accidents and the dangers that they are creating, caused saving much time, fuel and the large capital be restored. Vehicle Ad-hoc Network (VANET) is promising a technology which will provide safety aspects of road, Public and private services that increase of the security and comfort for passengers will be capable. This application are requires a communication model for their development. Previous study [1],[2] is divided vehicle communications to vehicle to Infrastructure (V2I/I2V) and vehicle to vehicle (V2V), which is visible in (Figure.1). Both of communication requires a secure and reliable configuration for establishing and maintaining

security of final consumers (vehicles). VANET is an example of mobile network that is created for communication between nearby vehicles (IVC: Inter Vehicle communication) and also vehicles with fixed equipment nearby (RVC: Roadside to Vehicle communication) which usually are roadside equipment. The main purpose of VANET is providing security and comfort for passengers. To reach this goal a particular electronic device embedded in each vehicle to established ad-hoc communication. It is clear that the network should be implemented without structure limitations of client - server network communication. Each vehicle equipped with a device can receive and send messages to others via the wireless network like a network node. Road's traffic signs and observes that can transmit through such a network each moment, which provide the necessary tools for choosing the best path by the driver. Also the Multimedia Communications and wireless Internet in every vehicle will be provided. Automatic payment of road side costs and parking costs is example of the other Vanet applications. InVanet or Intelligent VANET actually is a Intelligent technique in networks between vehicles that integration several classification of ad-hoc network technologies such as WiFi IEEE 802.11blg, WiMAX IEEE802.16, Bluetooth, IRA, and ZigBee to provide the communicate easily, accurately and effectively between the vehicles in the wireless environment. This type of network uses the available communication technology such as DSRC (Dedicated Short Range Communication) which is actually kind of WiFi, cellular and satellite communications.
In this paper types of existing ITS methods proposed. With the reviews, compare of improvements, reduce restrictions of them and looking at the future of ITS, a combination approach is considered.

2.Data and Material

2.1. Traditional ITS

A series of project based on traditional ITS in several countries are running and testing

2.1.1. TravTek, In America in 2005 under the Traffic Equity Act of 21st Century (TEA-21) framework, proposed the project includes TravTek. This system has three basic part:
I. TISC: Traffic Information Service Center
II. TMC: Traffic Management System
III. TravTek vehicles
Functions such as navigation information, route guidance, real-time traffic information and information on local services are available in the vehicles [3].

2.1.2. VICS (Vehicle Information & Communication System), In Japan in 2005,VICS is one of the most successful ITS projects. It have an ability to provide real-time information for drivers of traffic conditions via the FM multiple broadcasting, radio waves, signs and optical beacons [4].
Technically VICS is sometimes like TravTek. Both of the projects unable to collect and process large amounts traffic data and not providing any value-added services, only can broadcasting traffic information through radio.

2.1.3. Trafficmaster, In 2005, in Europe, established a technical group that focuses on the satellite navigation system and digital traffic information service. In trafficmaster Radio Data System_Traffic Message Channel (RDS_TMC) service broadcasting traffic data over the RDS sub-carrier on FM radio which can be used by the satellite navigation system to provide dynamic routings. Originally it is just a kind of advanced Global Position System (GPS) and can only provide solitary services. [5]

2.1.4. Limitation of traditional ITS

ITS projects have showed their benefits for solving traffic problems, but two limits have remained that prevent them from providing better services. Lack of high performance computing platform, unable to provide processing and integrating massive multi-sensor data that cause real-time on-demand traffic services can hardly be provided. Possible solution to resolve this is using of emerging advance information technology means grid technology. In the experimental system Urban Traffic Information Service Application Grid (UTISAG), efficiency and effectiveness in dealing with data traffic has been study. The second limitation, they are usually organized in a centralistic way as well as UTISAG. Multi-sensor data traffic initially are transmitted to Traffic Information Centre (TIC: Traffic Information Center) then they are analyzed until traffic information acquire or TIC sent them to other computing platforms for more processing. Finally, traffic information is broadcasted to all drivers via the RDS or according to requests will be transferred through the wireless infrastructure network. The centralized service method has several disadvantages:

I. Hot spot problem: A great deal of traffic sensor data and request needs to be processed by a TIC meanwhile massive data needs to be communicated between TIC and millions of users. Too much computing, storage and communication capacity is demanded for TIC. As a result, the TIC is overloaded and congested soon, and the performance of the ITS is then deteriorated.

II. It is not suitable for security applications of V2V(Vehicle to Vehicle), which require rapid exchange of information between the vehicles.

III. High operational costs.

2.2 The system based on inter-vehicle communication networks

To solve the problems the system based on Inter vehicle communication (IVC) networks may provide a decentralized solution and alleviate the problem to a great extent. IVC networks are an instantiation of a mobile ad-hoc network (MANET), however, have its unique characteristics and challenges. IVC characteristics compared with MANET:

I. Rapid topology changes: Because of the high relative speed of vehicles, the IVC network experiences very rapid changes in topology.

II. Frequent fragmentation: Due to the low deployment of vehicles having IVC, The IVC network will be subject to frequent fragmentation.

III. Small effective network diameter: Due to weak communications, network diameter and range of influence is really bad.

IV. Predictable topology changes: Vehicle usually moved along the pre-built roads. Thus, given the average speed, current position, and road topology, the future position of a vehicle can be predicted.

There are various projects based on IVC [7], [6]. FleetNet, about developing an IVC network tries to improve the comfort and safety of passengers and the drivers [8]. VGrid, was introduced to solved the vehicle traffic flow control problem autonomously [9]. TrafficView, defines a framework to disseminate and gather information about the vehicles on the road based on IVC. AutoNet, Ad-hoc Peer to Peer information intends to attain a comprehensive distributed transportation management system [10]. ACAHS reduce traffic accidents, increase safety, improve efficiency and reduce the complexity of transportation for drivers. AHS, examines how the vehicle technology can automatically be used to quell traffic congestion [11]. Entitled Zero-Information, to introduce and study a completely decentralized traffic information system based on data exchange only by equipped vehicle and does not need any infrastructure support [12].

The system completely based on inter-vehicle communication also has its limits:

I. The vehicle lacks great capacity of computing and storage, so complicated traffic information processing is hard to carry out.
II. Vehicles can't be a general overview of the situation is the network path.
III. Some of the essential services are not supported. The present ITS based on IVC mainly focuses on providing the service of neighboring route status, some other important services such as urgent regional traffic control messages are not supported.

2.3 ITC hybrid systems and Grid Computing (Grid computing)

2.3.1. VGITS system

Other proposed ITS systems that use Grid Computing technology is called VGITS (Vehicle Grid ITS) [13]. This system has hybrid architecture. The vehicles have IVC networks. In the IVC networks, vehicles send GPS data of their own, and meanwhile receive other vehicles' GPS data. Then by analyzing these data, some important traffic services are provided to drivers. At most cases, these services can satisfy drivers and if necessary, vehicles can also sent their request to traffic center for more operation. This unit, provided the services by packing massive traffic data and sending them to grid nodes for further processing. Grid technology has been introduced to provide high performance to execute large traffic data and existing real-time traffic services. IVC computing and communication capabilities developed to provide decentralized traffic services for drivers. In this system, the system computational load is in balance with the grid nodes and in-vehicle terminals and better performance is achieved. VGITS configuration and its resources are shown in Figure 2.

2.3.2. System architecture and function

In accordance with traffic system requirements, VGITS architecture is divided into four layers as illustrated in Figure 3.

2.3.2.1. Service on-demand and presentation layer

This layer provides some interfaces of on-demand services for users. There are two users in VGITS, TIC administrators and drivers. The TIC administrators can manage the request traffic services via web browser. For the response to Drivers, specific application software is installed on the vehicles.

2.3.2.2. Application service layer

This layer divided the traffic services application in to two categories. The first group mainly consists of traffic management services, simulation of a regional hybrid traffic flow, Dynamic route status service, Public facility inquiry service and optimum dynamic travel scheme service that have been considered for ITC manager. The second group is the Traffic services for drivers that mainly include neighbor route status service and safe warning service.

2.3.2.3. Service support layer

In order to support application service layer, this layer not only provides complex grid computing-based services such as grid task scheduling, data management, but also provides relatively simple IVC computing-based services such as in-vehicle computing resource management, GPS data management, etc.

2.3.2.4. Resource layer

In this layer, there are storage devices, computers and necessary software which required by the Grid nodes and IVC. Also, valuable resources for support any communication traffic service is required.

2.3.3. VGrid system

There is another example of the use of Grid Computing technology in the vehicular network which is different from proposed systems. In this case, a new configuration that use the vehicle to vehicle communications and distributed computing, can use as a platform for some services such as traffic control, user infotainment application and internet services. With the increases of data density, computational resources that means vehicle are naturally increased and the system will not be in trouble. Accident warning and speed limit variables (VLS) are two important applications of this system that cause VGrid could improve driver’s safety and traffic flow smoothing. [14]

3. Research Methodology

As the research process shows, limitations of ITS has been gradually more pale but still some restrictions remained that make us to resolve them or make them less. One of the limitations of ITS is the lack of overall control and access in vehicles. At first, Dominance was at the neighbor's routes and then increased. This advantage is also ideal for drivers and managers because they can analyze the comparative works and the statistics works simply and more accurate than before. Our system will not have the limitation of storage capacity, calculation and communication routes.

So in addition to support the past services, answering can be extended to the further and future requests. The proposed scheme which reduce the more restrictions is using of Grid technology more than the previous schemes. So that the management and integrating of traffic control centers will be perform through Knowledge Grid. For better coverage of receiving traffic information roadside equipments, sensors, etc have been installed. For avoidance of traditional ITS limitation the IVC network will be exist so that it will accountable a series of on-demand service, except that result of the calculations will be send to both, the vehicle and control centers. Other services that IVC cannot response them (because of their limitation) will be send to control center. Control center packed the requests and send them to Grid nodes which are provider of computational capacity and storage of control center, then the results after processing resend to the center control. Traffic control centers in each city is subsidiaries of the country's traffic control center and information will be send to the database of country traffic center and at the same time will archive in database (For more cautiously and according to the needs, the history of the Urban Traffic Control Center are stored). Each country's traffic control centers are connected together by using the Knowledge Grid environment. In this mode, once the sending information from city's traffic control centers to country's traffic control center this data in grid application have been updated in environment that Grid make it possible and with using the related graphic supported these data becomes the graphic map. This map is global and as soon as the traffic information post will be updated. It will be supported all features and route of roads. Above all, requester does not need to being closed the desire path and he has a global domination. Then, according to the required grid software and graphic interfaces wich have been installed on each vehicle, accessing to this map is possible in the vehicles (Figer.4) show the scheme clearly. This plan creates a global view of all road surfaces and paths. It should be noted that the implemented of smaller-scale size of this scheme in the country area is possible. The result, a graphical map of the national traffic road that will be coverage all cities and roads surfaces.

5. Conclusions

Because of the importance of communication and driver's need to become aware about road's near or far conditions to avoid undesirable conditions such as collision and road density which waste the time and cost, the intelligent transport system considered. In this paper, development trend of ITS systems types from past to present along their characteristics were investigated And the scheme was proposed that taking advantage of the Grid technology causes to less restrictions will be available. That Resulting in improved performance and more ease of access to the ITS services.

6. Future Work

We are working on scheme's architecture layer and the knowledge Grid environment for the best result.

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Figures

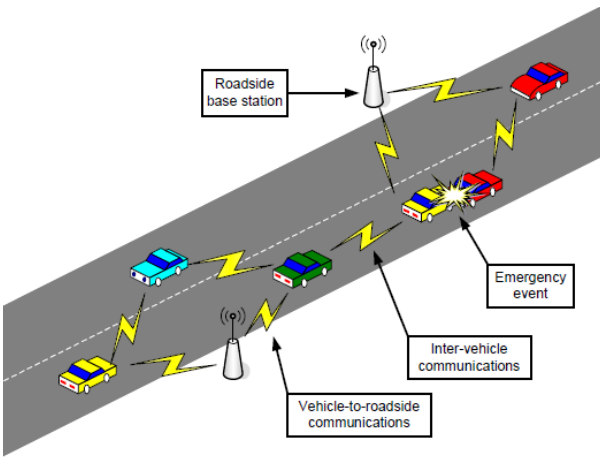
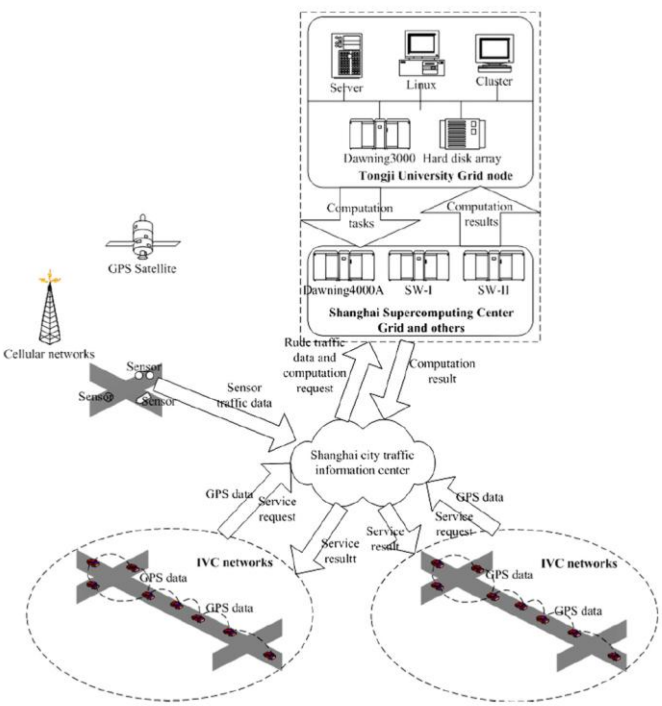


Fig.1. V2V,V2I/I2V



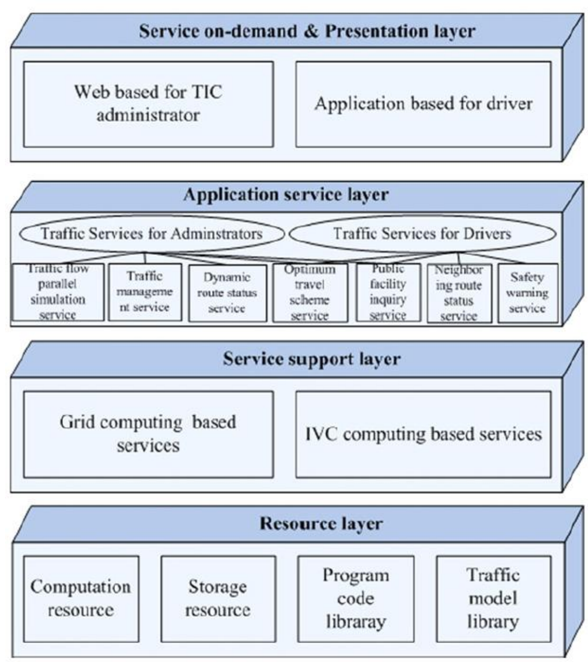


Fig. 2. VGITS framework.

Fig. 3. Architecture of VGITS

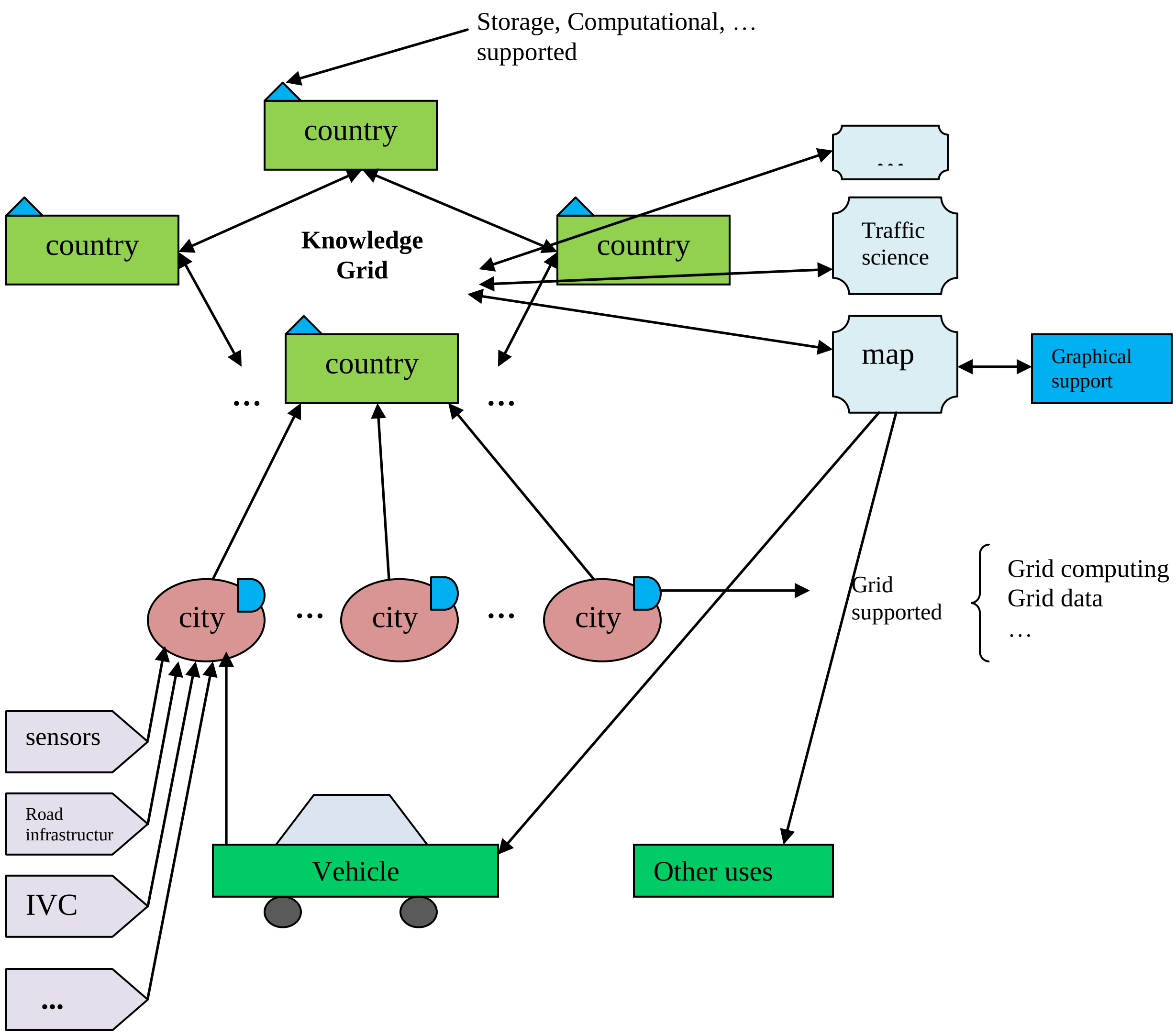


Fig.4. Scheme's configuration