Intelligent Transportation Systems using IoT Service for Vehicular Data Cloud

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Abstract

Cloud computing is a style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet. To resolve the challenges caused by the increasing transportation issues, we present a novel multi-layered vehicular data cloud platform by using cloud computing and IoT technologies. Two innovative vehicular data cloud services such as an intelligent parking cloud service and a vehicular data mining cloud service. The advances in cloud computing and internet of things (IoT) have provided a promising opportunity to further address the increasing transportation issues, such as heavy traffic, congestion, and vehicle safety. A new vehicular cloud architecture called ITS-Cloud was proposed to improve vehicle-to-vehicle communication and road safety. A cloud-based urban traffic control system was proposed to optimize traffic control.

Keywords: Automobile service, Cloud computing, Intelligent Transportation Systems (ITS), Internet of Things (IoT), Service-Oriented Architecture (SOA)

I. INTRODUCTION

Cloud computing is a style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet. Users need not have knowledge of, expertise in, or control over the technology infrastructure in the "cloud" that supports them.

The concept generally incorporates combinations of the following:

- Infrastructure As A Service(IAAS)
- Platform As A Service (PAAS)
- Software As A Service(SAAS)

Cloud computing customers do not generally own the physical infrastructure serving as host to the software platform in question. Instead, they avoid capital expenditure by renting usage from a third-party provider. They consume resources as a service and pay only for resources that they use. Many cloud-computing offerings employ the utility computing model, which is analogous to how traditional utility services (such as electricity) are consumed.

To resolve the challenges caused by the increasing transportation issues, we present a novel multi-layered vehicular data cloud platform by using cloud computing and IoT technologies. Two innovative vehicular data cloud services such as an intelligent parking cloud service and a vehicular data mining cloud service are also presented as reviews.

The advances in cloud computing and internet of things (IoT) have provided a promising opportunity to further address the increasing transportation issues, such as heavy traffic, congestion, and vehicle safety. In the past few years, researchers have proposed a few models that use cloud computing for implementing intelligent transportation systems (ITSs). For example, a new vehicular cloud architecture called ITS-Cloud was proposed to improve vehicle-to-vehicle communication and road safety. A cloud-based urban traffic control system was proposed to optimize traffic control. Based on a service-oriented architecture (SOA), this system uses a number of software services (SaaS), such as intersection control services, area management service, cloud service discovery service, and sensor service, to perform different tasks. These services also interact with each other to exchange information and provide a solid basis for building a collaborative traffic control and processing system in a distributed cloud environment. As an emerging technology caused by rapid advances in modern wireless telecommunication, IoT has received a lot of attention and is expected to bring benefits to numerous application areas including health care, manufacturing and transportation. Currently, the use of IoT in transportation is still in its early stage and most research on ITSs has not leveraged the IoT technology as a solution or an enabling infrastructure.

II. EXISTING SYSTEM

The original idea is that the roadside infrastructure and the radio-equipped vehicles could communicate using wireless networks. To make networking operations such as routing more effective, researchers had developed a dynamic inter-vehicle network called vehicular ad-hoc networks (VANET). Cloud computing has been proposed to reshape vehicular software and services in the automotive domain. As more and more cars are equipped with devices that can access the internet. Existing vehicular networks, various sensors, on-board devices in vehicles, and cloud computing to create vehicular clouds. They suggest that vehicular clouds are technologically feasible and will have a significant impact on the society once they are built. Thus, both existing automobile software and a variety of information resources are being virtualized and packaged as services to build vehicular clouds.

Different vehicular services are often combined and used to implement the mapping, encapsulation, aggregation, and composition and allow vehicles to interact with various hosted services outside the vehicles. The integration of sensors and communication technologies provides a way for us to track the changing status of an object through the Internet. IoT explains a future in which a variety of physical objects and devices around us, such as various sensors, radio frequency identification (RFID) tags, GPS devices, and mobile devices, will be associated to the Internet and allows these objects and devices to connect, cooperate, and communicate within social, environmental, and user contexts to reach common goals.

III. PROPOSED SYSTEM

By integrating various devices such as sensors, actuators, controllers, GPS devices, mobile phones, and other Internet access equipment, and employing networking technologies (wireless sensor network, cellular network, satellite network, and others), cloud computing, IOT, and middleware, this platform supports V2 V and V2I communication mechanisms and is able to collect and exchange data among the drivers, vehicles, and roadside infrastructure such as cameras and street lights. The goal of this platform is to provide real-time, economic, secure, and on-demand services to customers through the associated clouds including a conventional cloud and a temporary cloud (vehicular cloud). The conventional cloud is composed of virtualized computers and provides SaaS, PaaS, and IaaS to interested customers. For example, cloud management services and many traffic administration applications can be hosted on the conventional cloud. The temporary cloud is typically formed on demand and is composed of under-utilized computing, networking, and storage facilities of vehicles and is designed to expand the conventional cloud in order to increase the whole cloud’s computing, processing, and storing capabilities. The temporary cloud supports a compound of SaaS, PaaS, and IaaS and primarily hosts highly dynamic vehicular applications which may have issues running on the conventional clouds. For example, traffic-related applications and smart parking applications are suitable for the temporary cloud. The temporary cloud often needs to communicate with the conventional clouds and there is a frequent exchange of data and services between the two clouds. Based on the layered architecture in Fig. 1, heterogeneous IoT-related devices, network, community technologies, and cloud-based services on different layers can be integrated to exchange information, share resources, and collaborate on the clouds.

IV. RELATED WORK

A. Vehicular Networks

Wireless technology leads to the development of vehicular networks in the past decades. The original idea is that the roadside infrastructure and the radio-equipped vehicles could communicate using wireless networks. To make networking operations such as routing more effective, researchers had developed a dynamic inter-vehicle network called Vehicular Ad-hoc Networks (VANET). VANETs were primarily designed to support the communication between different vehicles (V2V) and the communication between vehicles and the roadside infrastructures (V2I) [9]. VANETs possess hybrid architecture and integrate ad hoc networks, wireless LAN and cellular technology [10] for intelligent transportation system (ITS). Furthermore, many VANET applications were developed by numerous vehicle manufacturers, government agencies and industrial organizations. Initially most VANET applications were focused on improving drivers’ safety and offered functions such as traffic monitoring and update, emergency warning and road assistance [11]. In recent years, many non-safety-related VANET applications such as entertainment and gaming applications have been developed.

B. Cloud Computing in the Automotive Domain

Cloud Computing has been proposed to reshape vehicular software and services in the automotive domain. As more and more cars are equipped with devices that can access the Internet, Olariu, Khalil, and Abuelela [11] propose to integrate existing vehicular networks, various sensors, on-board devices in vehicles, and cloud computing to create vehicular clouds. They suggest that vehicular clouds are technologically feasible and will have a significant impact on the society once they are built. Thus, both existing automobile software and a variety of information resources are being virtualized and packaged as services to build vehicular clouds. Different vehicular services are often combined and used to implement the mapping, encapsulation, aggregation and composition and allow vehicles to interact with various hosted services outside the vehicles. Currently, using the modular approach, multi-layer and service-oriented architectures to integrate various vehicular resources and services appears to be the most promising model and framework for building vehicular cloud service platforms. By using the modular approach to decompose a complex system into smaller subsystems according to their functions, we can divide a vehicular cloud service platform into a number of functional services and subsystems such as traffic administration, service routing, information processing, vehicle warranty analysis and mining, and so on. As cloud computing includes three distinct services - platform as a service (PaaS), infrastructure as a service (IaaS) as well as the popular software as a service (SaaS), a compound of SaaS, PaaS and IaaS should be leveraged for building vehicular cloud service platforms. Furthermore, clouds can also be divided into private, public and hybrid clouds. Thus, vehicular cloud service platforms can also be designed to be a hybrid cloud where some services such as user information query services can be hosted on public cloud platforms and other missing-critical services such as traffic administration should be hosted on private cloud platforms [12]. Taxonomy was developed to classify VANET-related clouds into the following three types: Vehicles using Clouds, Vehicular Clouds, and Hybrid Clouds [13].

Multi-layer approaches and service-oriented architecture [14, 15, and 16] have been proposed as the main architecture to construct various vehicular cloud service platforms. Iwai and Aoyama [1] propose to develop a cloud service system for automobiles (a.k.a., the DARWIN system) using SOA (Service-Oriented Architecture) as an enabling architecture [17, 18]. DARWIN contains key service components such as Service Process Manager and Service Space and these components interact with various services both inside and outside of vehicles to form a comprehensive vehicular cloud. DARWIN also provides protocols to support interoperability between existing vehicular software and cloud-based services. Wang, Cho, Lee and Ma [19] propose a vehicle cloud computing architecture composed of three functional tiers: cloud service, communication and device tiers. By using cloud computing techniques such as SOA, the three-layer architecture allows heterogeneous devices, network and services to exchange information and collaborate in a real time manner. Three-layer V-Cloud architecture was proposed [10] to combine vehicular cyber-physical systems with cloud computing technologies to offer essential services for drivers. The V-Cloud architecture includes three layers: in-car vehicular cyber-physical system, V2V network, and V2I network. Each layer has numerous sub-components. The ITS-Cloud proposed by Bitam & Mellouk [3] includes three layers: cloud layer, communication layer and end-users layer. In particularly, the cloud layer was divided into both static and dynamic cloud to support different services needed by various stakeholders of the vehicular clouds. Thus a new architecture named Vehi-Cloud was developed .

C. Internet of Things in the Automotive Domain

The integration of sensors and communication technologies provides a way for us to track the changing status of an object through the Internet. IoT explains a future in which a variety of physical objects and devices around us such as various sensors, radio frequency identification (RFID) tags, GPS devices, and mobile devices will be associated to the Internet and allow these objects and devices to connect, cooperate and communicate within social, environmental, and user contexts to reach common goals [24,25]. As an emerging technology, the Internet of Things (IoT) is expected to offer promising solutions to transform transportation systems and automobile services in the automobile industry. Speed & Shingleton [26] propose an idea to use the "unique identifying properties of car registration plates" to connect various things. As vehicles have increasingly Powerful sensing, networking, communication and data processing capabilities, IoT technologies can be used to harness these capabilities and share under-utilized resources among vehicles in the parking space or on the road. For example, IoT technologies make it possible to track each vehicle' existing location, monitor its movement and predict it future location.

By integrating with cloud computing, wireless sensor network, RFID Sensor Networks, satellite network and other intelligent transportation technologies, a new generation of IoT-based vehicular data clouds can be developed and deployed to bring many business benefits such as predicting increasing road safety, reducing road congestion, managing traffic, and recommending car maintenance or repair. Some preliminary work of using IoT technologies to improve intelligent transportation systems has been conducted in recent years. For example, an intelligent informatics system (iDrive system) developed by BMW used various sensors and tags to monitor the environment such as tracking the vehicle location and the road condition to provide driving directions [27]. Leng and Zhao [12] propose an intelligent internet-of-vehicles system (known as IIOVMS) to collect traffic information from the external environments on an ongoing basis and to monitor and manage road traffic in real time. Lumpkins [28] discusses how intelligent transportation systems could use IoT devices in the vehicle to connect to the cloud and how numerous sensors on the road could be virtualized to leverage the processing capabilities of the cloud. Qin, Long, Zhang, and Huang [27] propose a technology architecture that uses cloud computing, IoT and middleware technologies to enable the innovation of automobile services. Zhang, Chen, and Lu [29] designed an intelligent monitoring system to track the location of refrigerator trucks using IoT technologies.

V. PROPOSED A VEHICULAR DATA CLOUD PLATFORM IN THE IOT ENVIRONMENT

Customers through the associated clouds including a conventional cloud and a temporary cloud (vehicular cloud) [3]. The conventional cloud is composed of virtualized computers and provides SaaS, PaaS, and IaaS to interested customers. For example, cloud management services and many traffic administration applications can be hosted on the conventional cloud.

Table – 1
Novel Services for IoT-Based Vehicular Data Clouds

New services	Description
Network and Data Processing as a Service, i.e., Infrastructure As A Service (IAAS)	Vehicles provide their networking and data processing capabilities to other vehicles through the cloud
Storage as a Service (SAAS)	Some vehicles may need specific applications that require large amount of storage space. Thus, vehicles that have unused storage space can share their storage space as a cloud-based service
Platform as a Service (PAAS)	As a community, vehicular data clouds offer a variety of cooperative information services such as traffic information, hazardous location warning, lane change warning and parking availability

The temporary cloud is typically formed on demand and is composed of under-utilized computing, networking and storage facilities of vehicles and is designed to expand the conventional cloud in order to increase the whole cloud's computing, processing and storing capabilities. The temporary cloud supports a compound of SaaS, PaaS, and IaaS and primarily hosts highly dynamic vehicular applications which may have issues running on the conventional clouds [26]. For example, traffic-related applications and smart parking applications are suitable for the temporary cloud. The temporary cloud often needs to communicate with the conventional clouds and there is a frequent exchange of data and services between the two clouds [13]. Based on the layered architecture in Fig. 1, heterogeneous IoT-related devices, network, community technologies and cloud-based services on different layers can be integrated to exchange information, share resources and collaborate on the clouds. Fig. 1 shows the layered architecture of our proposed IoT-based vehicular data cloud platform. By integrating various devices such as sensors, actuators, controllers, GPS devices, mobile phones and other Internet access equipments and employing networking technologies (wireless sensor network, cellular network, satellite network and others), cloud computing, IOT, and middleware, this platform supports V2V and V2I communication mechanism and is able to collect and exchange data among the drivers, vehicles, and roadside infrastructure such as cameras and street lights. The goal of this platform is to provide real-time, economic, secure and on-demand services to customers through the associated clouds including a conventional cloud and a temporary cloud (vehicular cloud) [3].

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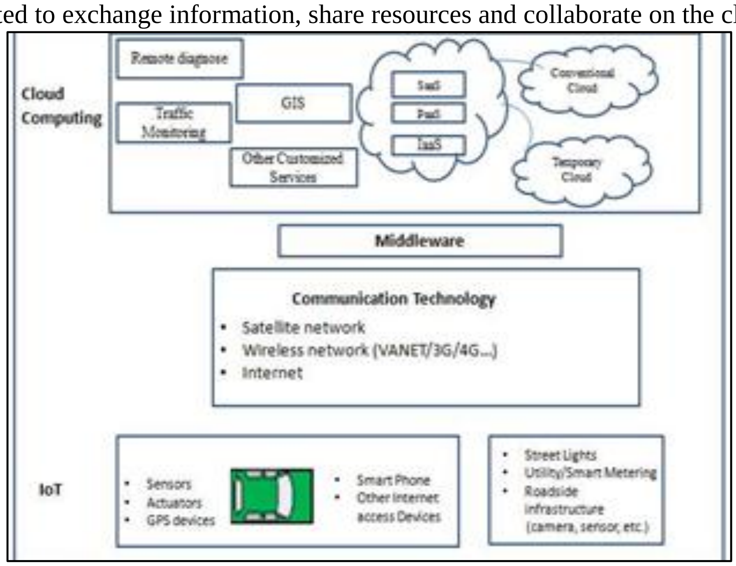

Fig. 1: Vehicular Data Cloud Platform

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VI. VEHICULAR DATA MINING CLOUD SERVICE

As vehicular data clouds contain a variety of heterogeneous data and information resources, effective data mining service must be developed to quickly detect dangerous road situations, issue early warning messages, and assist drivers to make informed decisions to prevent accidents. Data mining services can also be used to assess drivers' behaviour or performance of vehicles to find problems in advance. The core of any data mining service is the data mining models. So far, few models were developed and tested for mining vehicular data collected from vehicular networks or data clouds. Below is a specialized data mining service for car warranty early-warning analysis. We applied the models that we developed in Section IV-C to design and develop the data mining service. In vehicle manufacturing process, sometimes, some quality issues can be hidden for a long time without being identified. Due to a lack of events or signals to correlate several discrete issues, potential problems may not be investigated at all. To avoid accidents, it is important to develop new techniques that reveal these hidden problems in advance. By using the two modified data mining models (Naive Bays Classifier and Logistic Regression Classifier) to cluster and classify the real car warranty and maintenance data we collected from a local automobile company, we demonstrated how data mining cloud service could be used to identify potential issues that could become a problem later. This experiment assumes a new product that is under development and has some potential but unknown issues. As a result of applying the two data mining models, we were able to acquire some preliminary results. We found that the precision in column cross dropped dramatically.

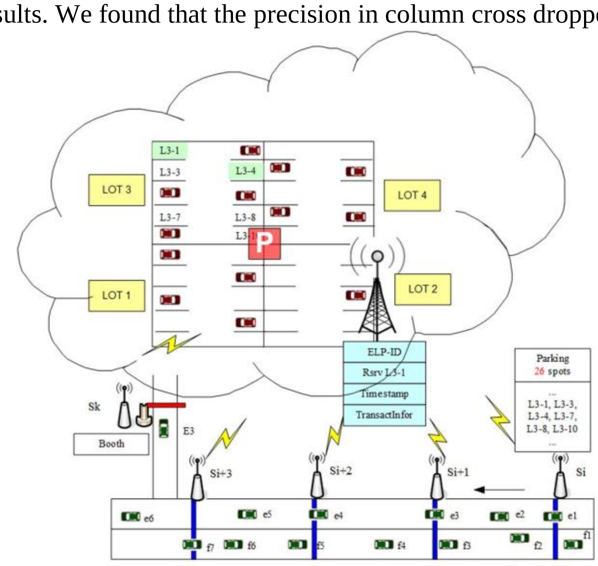

Fig. 2: Parking Cloud Service

VII. COMMUNICATION FROM VANET TO CLOUD

In this section we will create a registration form for drivers, who have to register in the cloud. Registration of diver is compulsory then only the driver can take car from networking side. Once the registration process is done and updated to cloud, diver will provides his details for verification. Once the verification forces done successfully, and then the driver chooses the car brand and model and current location. After choosing this system automatically generates the values, he/she wearing seat belt or not and alcoholic or not. And for every few sects he will be keep on moving to some other place in between this the jerk level for that road. All this details where updating in to cloud.

VIII. INTELLIGENT PARKING CLOUD SERVICE

- Background subtraction
- Decision Process
- Web server process
- Android application service

A. Background Subtraction

Background Subtraction is a computational vision process of extracting foreground objects in a particular scene. A foreground object can be described as an object of attention which helps in reducing the amount of data to be processed as well as provide important information to the task under consideration. Often, the foreground object can be thought of as a coherently moving object in a scene.

Fig. 3: Background Subtraction Process

1) Pseudo Code for Background Subtraction Algorithm

Start

Input Sequences of Video Frames

Perform Frame Separation

Calculate Image Sequence

Perform Separation of Image Sequence in Current Frame

Display Image and Background Frame Image

Perform Background subtraction

Stop

Fig. 4: Pseudo Code For Background Subtraction Algorithm

B. Decision Process

The Car Parking Area, parked by cars, means it is defined as “Occupancy”. The car parking area has a free space means it is defined as “Vacancy”. This decision updated to server part. Finally, in decision step, the mixed feature is compared with pre-defined threshold.

C. Web Server Process

All the processes are updated to the web server which receives the value from the DB via MATLAB. We send SMS and MAIL (1 per day) to monitor the delayed car duration (12 hours above) based on the Validated information.

D. Android Application Service

Android application collects all information from server through web server, and it calculates total no of slots, encaged and free slots. It shows graphical view for encaged and free slots via apps. It validating information’s continuously to the web server.

IX. CONCLUSION

Thus, a new vehicular cloud architecture called ITS-Cloud was proposed to improve vehicle-to-vehicle communication and road safety. A cloud-based urban traffic control system was proposed to optimize traffic control. In this security, which concerns every networked environment is a major issues for cloud IoT. Indeed both its IoT side and cloud side are vulnerable to number of attacks. In IoT context, encryption can ensure data confidentiality and integrity. Full Implementation of Vehicular cloud will provide the better vehicular network. Currently there is on-going research in the field of VANET, for several scenarios such as traffic scenarios, mobile phone systems, sensor network and future combat system.

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