Data Storage and Management in Vehicular Cloud Computing

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Abstract: Vehicular cloud computing (VCC) is an emerging technology providing real time data. VCC is providing a new experience to travellers. VCC enables users to store the data on the move. It helps them to enjoy the cloud applications without investment. Uploading data into VCC offers maintenance free and easy access from anywhere. It provides complete set of resources for storing data for various applications. Huge amount of data is transferred, stored and processed every day. In vehicular cloud, data is distributed among many nodes. It is challenge to maintain, manipulate process and analyse very large amount of data. Due to multiple service providers, the privacy of the data needs to be provided. The goal of this paper is to give a broad overview of data storage and management in vehicular cloud environment and demonstrate the cloud setup using Sim ITS framework.

Keywords: Wireless Sensor Networks (WSNs), Trust-Aware Routing Protocols

I. INTRODUCTION

The rapid development of connected vehicles offers great opportunities to intelligent transportation system (ITS). Vehicular Cloud Computing (VCC) has created a whole new helpful functionality to travellers. VCC provides technology to connectivity to the cloud while vehicles are on move without compromising on security. Information collected by vehicles is and sent to VCC. In VCC all uploaded data are normalized, stored, aggregated and combined with information from other sources. This data is distributed (in part or in full) to the VCC applications and users who have been granted the relevant access rights. The fine grained access control makes it possible to only expose the precise subset of information needed by the subscribing service, for instance an analytics system [1].

The data that is being created and collected are going to be of huge volume. VCC should manage both structured and unstructured data. In the digital era, security is an on-going concern. Users need to trust that the data they provide to VCC remain in a secure place. VCC features dynamic data management allowing users to interact with their vehicle and access services from any type of device, such as tablets, computers, smartphones and the vehicle head unit [2]. All communication is encrypted and authenticated using certificates distributed by a Certificate Authority. It provides a Public Key Infrastructure (PKI) with certificate based mutual authentication between vehicle and cloud. Mutual authentication ensures that both vehicle and cloud (i.e. server side) can verify authenticity of each other. Access can be revoked or suspended if any anomaly is detected [3].

Storage service in VCC is not identical to traditional cloud storage service. In commercial cloud system, storage facility available to users will be unlimited and at low cost as well. Commercial cloud storage is powered and managed with security and software’s. Storage space in VCC, will be limited as it depends on the movable nodes for resources.

The objectives of paper are as follows.

1. List the issues and challenges of data processing in VCC.
2. Management of data storage in VCC.
3. Allocation and sharing of resources.
4. To discuss the online query in VCC and measure performance.
5. Ability to operate on encrypted data.
6. Ability to run in a heterogeneous environment.

The paper is organized as follows. Section II presents the Related Work. Section III discusses the VCC architecture. Section IV presents results and discussion. Conclusions are provided in section V.

II. RELATED WORK

Rasheed Hussain [6]. put forth the scheme of classification of Vehicular cloud computing technology and communication pattern of Vehicular cloud stack. VANET based cloud architecture is divided into three categories. Vehicular clouds (VC), vehicles using clouds (VuC), and hybrid vehicular clouds (HVC). Each framework is particular designed for performing specific task by itself. The nature of dynamic changing topology helps to provide long range traffic information and also provide network as a service to other nearby vehicles. Cooperation as a service helps other vehicles to know the traffic and safety related information.

KAZI MASUDUL [7]. Proposed work on Social IoT. They proposed how vehicles can be used for application of IoT. How the underutilized physical resources in vehicular cloud environment and create a model of well guiding and messing service for travellers. The proposed model will be used for both safety related and entertainment applications. Proposed system uses the SAE J2735 message set.
Eltoweissy [8] proposed and promoted a most adaptable and comprehensive model of Vehicular Cloud computing. They explained how advancement of embedded system, wireless sensor network and vehicular ad hoc network can form a cooperative cloud service for betterment of society. Distinguishing usual cloud computing from mobile cloud environment, they showed that they can be used for applications like mobile analytics laboratory, sharing services on terrestrial, aerial, or Aquatic pathways or theatres of operations in addition to general purpose applications.

SoffieneJelassi [9]. Explained technique to transform data to a form where it can be processed as a steady and continuous stream using cloud based VANET architecture. This model composed of vehicular cloud, central cloud and roadside units. This can be done in moving vehicles, static vehicles or passengers present in moving vehicles. The Virtual Machines present in cloud service acts as servers to the roadside video streaming.

Torzo [10]. proposed a new architecture for vehicular cloud environment, to improve travelling experience. It enables optimal usage of RAM memory of each node. They explained collection of vehicular information, traffic routing decision, continuous traffic monitoring with the help of IoT to benefit the users and help them to access service at low cost and less time.

The underutilized computing power, memory, sensing and internet connectivity, of large number of autonomous vehicles on roads, parking lots and streets can be coordinated and allocated to other authorized users. Internet access, computing power and storage capabilities can be rented to drivers and other customers exactly as similar to usual cloud computing service [14].

### III ARCHITECTURE OF VEHICULAR CLOUD

In VANET cloud service architecture which is popular as Network as a Service (NaaS), Storage as a Service (STaaS), and Cooperation as a Service (CaaS). Platform as a Service (PaaS) is not very popular in Vehicular clouds. Figure 1 shows the different layers of service architecture of VCC. Network as a Service or NaaS provides internet access to other vehicles which need that facility. Storage as a Service or SaaS is similar to having virtual network hard-disk. Some users prefer to have backup of their data on an external harddisk for safety. Data as a service or DaaS works as a virtual data provider to other vehicles. So vehicular cloud acts as data provider for travel related things like, nearest fuel stations, hotels, etc for requesting drivers [11]. Applications mainly deal with various announcements, information upload/down load, mp3 download or sharing between V2V and V2I. Information about nearest fuel stations, hotels their services and prices, tollgates etc. are shared [13].

As the usage of vehicular cloud service increases the security requirements increases. Major thearts for vehicular cloud services are: denial of services, identity spoofing, modification repudiation, repudiation, Sybil attack, and information disclosure [4].
VCC need to be copied and saved back, before it is moves. This process is quite costly and time consuming. Also updating data base frequently and providing security and trust to the users is also challenging. Following are the data management tasks:

- Challenge of data processing in VCC.
  In VCC systems, the data is generated by mobile vehicles and RSUs, using sensors. In real time data processing VCC system requires data synchronization which brings tremendous challenges to the wireless network transmission. Indexing and filtering of enormous data is difficult.

- 1) Management of data storage in VCC
   Huge Data on daily basis is proceed, stored, and transferred over the VCC. There are some issues related with security of data and how to manage the data. Data security and data residency are the key concern of vehicular cloud.

- 2) Allocation and sharing of resources.
   Size of the data centre and services involved in it will decide the resource sharing in VCC.

- 3) Ability to run in a heterogeneous environment
   In VCC different vehicles have various make and different software's. So to run cloud virtual machine in such heterogeneous environment is a challenge.

- 4) Data Segregation
   It is the process of grouping the data available on cloud on the basis of similar properties. This process helps in accessing the data easily whenever they are needed.

- 5) Data back up
   It is the process of duplicating data. It helps to recover data when it is lost or corrupted by some problems. In VCC duplication of data is very important.

- 6) Data security
   To provide secure environment for vehicular cloud services following requirements should be considered:
   - Confidentiality
   - Integrity
   - Availability

- 7) Data Recovery
   It is the process of retrieving the unavailable data. Data may be corrupted, lost or damaged during storage or segregation or encryption process. Data is recovered from duplicate storage device.
   Secure data erasing or deletion is also a task of storage system.

V. RESULTS AND DISCUSSION

This section depicts the results which are obtained by running the sim ITS, an open-source simulator for dynamic vehicular cloud. It performs vehicle to infrastructure communication using IEEE 802.11p standard. The simulation includes urban and highway scenario and vehicles moving in single one way road. Distance between each vehicle is less than 30 meters. Simulation parameters are as follows: time slot duration 160 Micro second, number of vehicles 10/ 20, information size 20/30 bytes and data rate of 6 Mbps. Figure 4 shows the graph obtained throughput per channel for 20 users in urban scenario. Simulation is carried for 65secs of time slot.

![Throughput per channel](image)

**Fig.4. Throughput per channel for 20 users**

Figure 5 describes no of data transmitted from nodes to cloud.

![No transmissions](image)

**Fig.5. No transmissions for 20 users**

Figure 6 describes the throughput per channel for urban scenario for 10 users.
Figure 7 describes the number of data transmitted from nodes to vehicular cloud in the urban scenario for 10 users.

![Throughput per channel](image1)

**Fig. 7. No transmissions for 10 users**

Figure 8 describes the throughput per channel for the highway scenario for 20 users.

![Throughput per channel](image2)

**Fig. 8. Throughput per channel for 20 users**

Figure 9 describes the number of data transmitted from nodes to vehicular cloud in the highway scenario for 20 users.

![Throughput per channel](image3)

**Fig. 9. Throughput per channel for 20 users**

VI. CONCLUSION

Paper first briefs about SaaS for VCC. Then VCC architecture details are discussed. The paper focused on data segregation, access management, availability and backup, data security, secure data deletion, and data recovery. We have simulated storage system of VCC using SimITS simulator and analyzed dynamic cloud.

REFERENCES


