IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, July 2023

Intelligent Transport System in the Vehicular Cloud Era

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Abstract: *The adding number of vehicles on the road has led to traffic, accidents, and pollution. Intelligent Transportation Systems (ITS) offer implicit results to significantly reduce these problems. Norms like IEEE 802.11 p and IEEE 1609 have been established to enable effective communication between vehicles and the structure. Still, vehicular ad- hoc networks (VANETs), which round ITS and aim to ameliorate transportation with the help of Information and Communication Technologies (ICTs), present significant challenges in wireless communication. While VANETs are a technical form of mobile ad- hoc networks (MANETs), protocols that perform well in MANETs may not be suitable for VANETs due to high mobility, intermittent connectivity, and diversity. To address this, pall computing provides an occasion to discharge original coffers to a participated pool, offering an ideal result for cipher and memory- ferocious operations. Accordingly, the conception of vehicular shadows has been introduced to grease VANET operations efficiently, offering rapid-fire plainness and a pay- as- you- go business model*.

Keywords: Intelligent Transportation Systems

I. INTRODUCTION

1.1 Intelligent Transport System

Intelligent Transportation Systems (ITS) use the communication technologies to connect vehicles, people and any installation for further secure, safer, and largely mobile transportation in a civic terrain. Intelligent transportation systems aim at the betterment of transportation in cooperation with the Information and Communication Technologies (ICTs)(1). Intelligent Transportation Systems(ITS) is a combination of leading- edge information and communication technologies used in transportation and business operation systems to ameliorate the safety, effectiveness, and sustainability of transportation networks, to reduce business traffic and to enhance motorists ' gets . Data collection is an important aspect in ITS, which can effectively serve online transport systems with the aid of Vehicular Cloud (VC)(2).

1.2 VANET

VANET is basically a subset of Mobile Ad Hoc Network (MANET) developed to establish the wireless communication system with the vehicles. The Dedicated Short Range Communication (DSRC) protocol was developed to support the vehicular communications.

The basic elements of VANET include the Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), Vehicle-to-Grid (V2G) and the Vehicle-to- Anything (V2X) modes of communication[SM]. Latest applications developed related to VANET are online file sharing, real time video updates and entertainment via connection to the internet through Vehicle to Vehicle type of connections. The VANET applications are categorized as safety and comfort applications[3].

Safety Applications

These applications aim to save human lives on the road. The aim of these applications is to deliver the safety related information to the required receiver in time to avoid any accident. The safety related applications are shown in Table 1 and some are described as follows:

- Information Messages (1M): IMs consist of work zone messages while driving on the highway, toll collection point and speed limit messages etc.

- Assistance Messages (AM): This is the kind of information which will assist the driver during the journey. AM includes the messages related to the lane switching, cooperative collision avoidance (CCA) and navigation. CCA message considered to be the most critical in terms of helping the driver by warning him or her to reduce the speed for avoiding any uncertain condition
- Warning Messages (WM): WMs include information like traffic signal ahead, toll point or any bad road condition warnings.

1.2 Comfort Applications

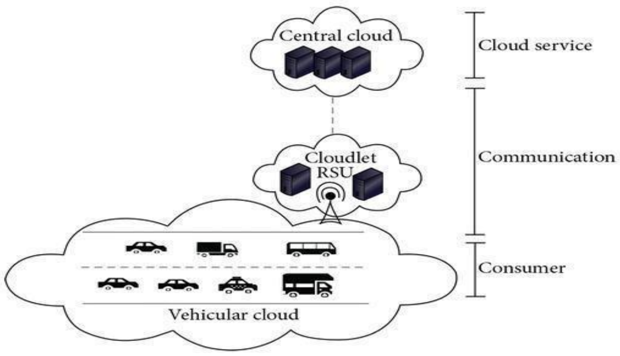
The main objective of these applications is to give passenger/driver comfort and traffic efficiency. Moreover, aforesaid applications can be called as value added services. These applications include an automatic toll collection, site based services like location of shopping malls, restaurants etc. and internet connectivity facility. Some of the applications related to the comfort of the users.

1.3 Vehicular Cloud Computing

Vehicular Cloud Computing(VCC) is a new paradigm which takes advantage of pall computing to serve VANETs with several computational services, in order to meliorate our quotidian driving by minimizing accidents, trip time and business business. ultimately, the thing of VCC is to give on demand results for changeable business events, where operations can adapt according to the dynamic environmental changes with the aid of a Vehicular pall(VC). A Vehicular pall can offer the most applicable and effective operations that meet the conditions of ITS, by enabling vehicles to partake their business gets on demand. This way, vehicles can descry business business and directly assess the business flux condition in municipality surroundings(2). Vehicular Cloud Computing gives a tone- organized model of vehicular surroundings, by effectively forming a pall within which services are produced, maintained, and consumed. The pall is constructed by using the collection of vehicles ' calculating resources, in order to extend the capability of relations among vehicles. A primary thing of Vehicular Cloud(VC) is to give on- demand results to events that can't be handled by centralized approaches or visionary operations(2). Vehicular pall has different but complementary functionalities in comparison with the Internet pall. Vehicular murk discharge the Internet murk from tasks that the ultimate can't perform efficiently. Benefits of using Vehicular Cloud rather of Internet pall are reduced communication detention, reduced spectrum costs, and expanded range of business operation.

II. RESEARCH METHODOLOGY

The main aim of the proposed framework, is to provide assistance for the management services of intelligent transport systems and mechanisms for the storage of the information. This allows heterogeneous communication between multiple devices simultaneously by managing the mobility of vehicles, together with the information flows that are generated. This framework is based on the work of Whaiduzzaman et al. [8]; however, it improves the communication between vehicles and vehicles with roadside units. Furthermore, this framework is divided into three components: consumer, communications, and cloud. Figure 1 illustrates the abstraction of the framework.



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2.1 Cloud Services

The data center where services to customers are delivered is referred to as a cloud service. A conventional fixed data center (such as Amazon, Google, or Microsoft) and mobile devices such as vehicles or individuals (smartphones) that temporarily belong to a cloud make up the cloud server. The central cloud, cloudlets, and vehicular mobile cloud are the three sub layers of this layer. The conventional cloud consists of a fixed data center that is virtualized and includes the computing infrastructure, while the central cloud consists of a fixed data center that is virtualized and includes the computing infrastructure.

The cloudlets are a set of devices linked to the roadside unit (RSU) that help manage resources shared by the central cloud. This means that the cloudlets can help with resource management in the central cloud.

The vehicular mobile cloud is made up of a set of mobile computing tools and vehicles that aren't often associated with cloud computing. Through the vehicular network, these resources are connected. The mobile cloud for vehicles can be fixed or mobile. In the first example, automobiles, RSUs, and/or passengers can rent computing resources from other consumers who are located outside of the state (e.g., cars in parking lots or passengers waiting for a bus). The vehicular mobile cloud in this case is made up of vehicles that share their idle energy with the vehicles around them. When vehicles do not have contact with each other, this type of vehicular mobile cloud is commonly used.

2.2 Communication

The aim of this layer is to ensure that the link between customers in the lower layer and the cloud in the upper layer can be created. This layer includes vehicular networks, wireless sensor networks, and 3G/4G networks, among other networking devices and networks. This layer defines and determines all technical relations (physical layer, data link layer, medium access control, routing protocols, and so on) in relation to the communication device. The type of user influences the technologies used in the lower layer. This layer will have to deal with a hybrid mode of communication, which means it will need to create communication between vehicles in order to disseminate relevant data. It will also have to deal with connectivity between the vehicle and roadside units in order to receive planned data from the cloud. With regard to communication between the central cloud and ordering services, the vehicle will also have to communicate not only between vehicles but also with a roadside unit that may be a cell tower or Wi-Fi Hotspot.

For this to occur the vehicle will have work with more than one network interface at the same time, as well as with the mobility of the vehicle.

For communication between vehicles and better dissemination of data presented in [9], a algorithm is proposed which would suggest each node that the message need to be stored or not. The propagation efficiency is used to control the transmissions of a given vehicle; that is, if it is below an acceptable threshold, the node broadcasts the information; otherwise it does not. Periodically, the vehicle calculates the efficiency of its message delivery:

$$\text{Efficiency} = \frac{\text{Transmission}}{\text{Beacons}}.$$

Beside from propagation performance, the message lifetime, which will restrict data distribution, is another factor that can affect message propagation. The calculation of the propagation efficiency used to determine whether or not to propagate a message is shown in Algorithm 1. The node stores the packet using this mechanism until its efficiency exceeds a threshold or one of the other criteria is met, allowing message transmission even in the presence of network partitions. The threshold Down and threshold Up efficiency percentages reflect the vehicle's lowest and highest thresholds, respectively, that must be respected for data dissemination to take place.

```
p ← getNumberofPacket()
b ← getNumberofBeacons()
ef ← p/b
if (ef > thresholdDown) or (ef < thresholdUp) then
    return true
else
    return false
end if
```

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When an incident that needs to be communicated happens, the vehicle that identifies it sends out a warning to all vehicles inside the region of interest (AoI). Each node checks to see if it is within the AoI after receiving the message. If this is not the case, the received message is discarded by the node. Otherwise, the node checks to see whether it is inside the transmitting node's sweet spot, calculates the waiting period, and schedules the message retransmission. This algorithm can be used for services that require data dissemination close to an event or a possible event that has produced a traffic jam. However, this algorithm does not address issues of allocation and search resources between vehicles.

2.3 Consumer

The consumer layer is made up of end users (consumers), who may be humans or vehicles who need cloud services. The user can be defined as having some degree of environmental mobility. Consumers can create service requests to adjacent layers through a manager and search resource mechanism using communication and computing devices such as smartphones, onboard computers, and GPS. The user receives a resource response from the higher levels through the manager and search resource mechanism in order to accomplish this.

III. PROPOSED SYSTEM (SMART PARKING SYSTEM)

The smart parking system is derived from the idea of IoT [13], [14]. The system uses the WSN [15] consisting of RFID technology to monitor car parks. Each car park's percentage of free parking spaces is counted using an RFID reader. The usage of RFID allows for the low-cost implementation of a large-scale system.

The technology serves as a preventative measure in the parking lot, as well as a means of reducing lost time spent hunting for a parking spot. The user can select an appropriate parking space after logging into the system. The user will receive confirmation of the specified parking place via notification. The system then changes the status of the parking place to pending, which prevents other customers from reserving it during that period. If the algorithm decides that no car is parked in that space after a given amount of pending time, the status is changed to available. When a new automobile joins the system, the system will update the status from the WSN node (the state of car park spots). As a result, the entire parking system status is always updated in real time.

3.1 Architecture of System

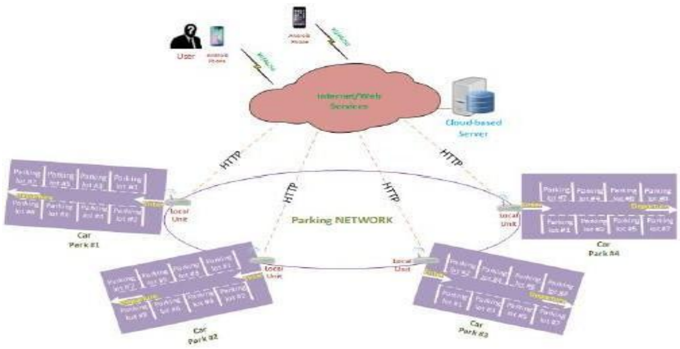

Figure 2: Architecture of the proposed system.

Cloud-Based Server:

This is a Web entity that keeps track of the resource information offered by local units at each parking lot. By immediately accessing the cloud-based server, a driver can search for and obtain information on parking spaces from each car park without having to access the local server node.

Software Client:

This is a software application system. Users will download the app to their cellphones, which will run on the Android operating system, and use it to reserve parking spaces. The system is accessed over 3G/4G mobile connections.

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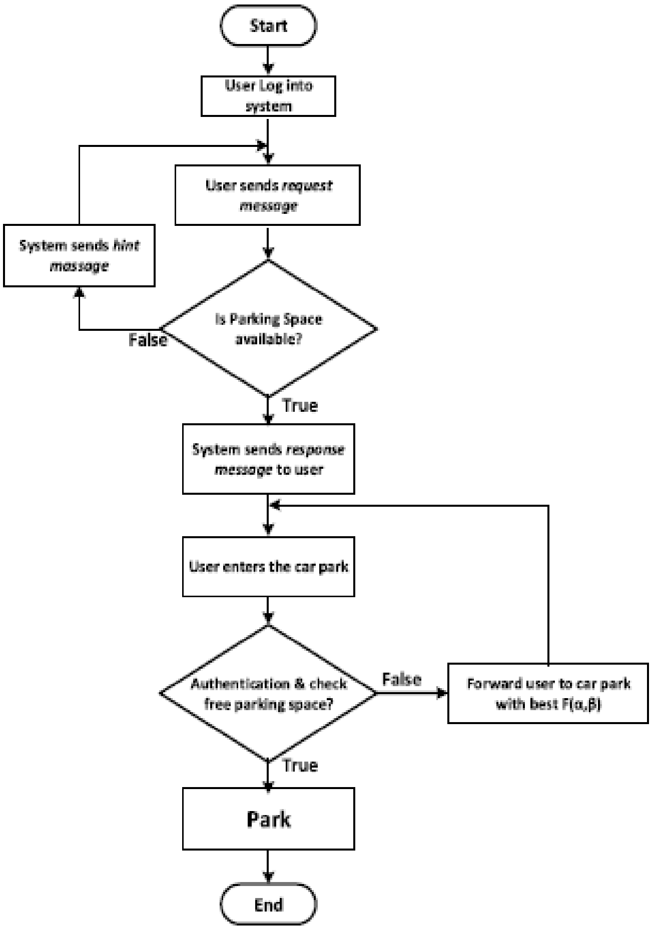
Local unit:

This unit is located in each car park and stores the information of each parking space, it consist of control unit, RFID card, screen.

Parking Network:

The car parking Network is the backbone of this architecture. Routers serve as the infrastructure for linked clients in this type of parking network. Sensor networks can be connected to the CPN infrastructure/backbone via wireless radio technology.

3.2 Algorithm of Proposed system operation:



IV. SOLUTIONS

To avoid problems in a smart parking system implemented using cloud technology, consider the following measures:

Scalable and Robust Infrastructure:

Ensure that the cloud infrastructure supporting the smart parking system is scalable and capable of handling a large number of parking spaces and users concurrently. Employ redundant servers, load balancing, and failover mechanisms to ensure system availability and reliability.

Network Connectivity:

Ensure reliable and uninterrupted network connectivity between the cloud infrastructure and the parking spaces. This may involve using robust communication technologies, such as Wi-Fi, cellular networks, or dedicated connectivity options.

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Real-time Data Updates:
Implement mechanisms to ensure real-time data updates in the cloud system. This includes using sensors or occupancy detectors at parking spaces to detect availability and occupancy status and transmit this information to the cloud infrastructure without significant delay.

Data Security and Privacy:
Implement stringent security measures to protect user data and prevent unauthorized access. Utilize encryption techniques for data transmission and storage, implement strong access controls, and comply with relevant privacy regulations to safeguard user information.

Efficient Data Processing:
Employ efficient algorithms and data processing techniques in the cloud system to handle real-time data updates and provide accurate parking availability information to users. Optimize data processing pipelines and algorithms to minimize latency and response times.

User-Friendly Interfaces:
Design user interfaces that are intuitive and easy to use, allowing users to quickly find available parking spaces and complete their parking transactions. Provide clear and updated information on parking availability, location, pricing, and any relevant restrictions.

Regular Maintenance and Monitoring:
Implement a system for regular maintenance and monitoring of the cloud infrastructure and the smart parking system. This includes proactive monitoring of system health, addressing any issues or failures promptly, and performing regular updates and patches to ensure system stability and security.

Backup and Disaster Recovery:
Implement backup and disaster recovery mechanisms to protect against data loss and system failures. Regularly backup critical data and have contingency plans in place to restore services quickly in the event of an unforeseen event or system failure.

Collaboration and Integration:
Foster collaboration and integration with other stakeholders in the transportation ecosystem, such as navigation systems, city authorities, and transportation management systems. This allows for better coordination and utilization of parking resources and can help alleviate potential problems.

User Education and Support:
Provide clear instructions and user support to educate users on how to use the smart parking system effectively. This includes providing user guides, tutorials, and responsive customer support channels to address any queries or issues users may encounter.
By considering these measures, you can mitigate problems associated with a smart parking system implemented using cloud technology and ensure a seamless and efficient parking experience for users.

V. CONCLUSION

We have studied Vehicular Cloud computing, its principle and architecture and how Vehicular Cloud Computing is used for Intelligent Transport System. We have also learned about Ad hoc Networks and Vehicular Ad-Hoc Networks (VANET) and how VANET's are used in Intelligent Transport System. We have seen the applications of VCC in fields of Traffic Management, Urban Surveillance, and Data center and how does VCC helps to develop applications in those fields. In future work can be carried out in field of designing a efficient algorithm for communication and data collection in vehicular environment by considering data access issues.

In conclusion, vehicular cloud data collection plays a crucial role in enabling intelligent transport systems (ITS) to enhance transportation efficiency, safety, and sustainability. By collecting real-time data from vehicles on the road and leveraging cloud infrastructure, valuable insights can be derived to optimize traffic flow, manage congestion, improve road safety, and enable smart mobility services. However, to ensure the success of vehicular cloud data collection for ITS, several factors need to be considered.

Firstly, a reliable and scalable cloud infrastructure is essential to handle the large volumes of data generated by numerous vehicles simultaneously. The infrastructure should be capable of processing and storing data efficiently, while also providing real-time feedback to drivers and stakeholders.

Secondly, establishing robust communication networks is critical to facilitate the transfer of data from vehicles to the cloud infrastructure. Whether utilizing cellular networks, dedicated short-range communication (DSRC), or emerging technologies like 5G or vehicle-to-everything (V2X) communication, a reliable and secure communication network is necessary to ensure seamless data collection and transmission.

Privacy and security are paramount in vehicular cloud data collection. Implementing stringent measures to protect data privacy and ensure data security during transmission and storage is crucial. Anonymizing or aggregating data can help protect individual privacy while still enabling valuable analysis and insights.

Moreover, ensuring the quality and accuracy of collected data is essential. Validating and filtering data to eliminate inaccuracies and errors ensures that the derived insights and decisions based on the data are reliable and meaningful.

Continuous monitoring, evaluation, and improvement of the system are necessary to address any issues or shortcomings. Regular maintenance, updates, and the implementation of data governance policies and frameworks contribute to the overall success and sustainability of vehicular cloud data collection for ITS.

By considering these factors and implementing appropriate solutions, vehicular cloud data collection can revolutionize the transportation industry, leading to safer, more efficient, and sustainable transportation systems.

VI. ACKNOWLEDGMENT

The completion of this paper would not have been possible without the support and contributions of various individuals and organizations, whom we would like to express our sincere gratitude.

First and foremost, we would like to thank our academic institution for providing us with the resources and environment conducive to conducting this research. The guidance and mentorship from our faculty members have been invaluable in shaping our understanding of the subject matter and refining our research approach.

We extend our heartfelt appreciation to the participants who willingly shared their experiences and insights during the data collection process. Their willingness to contribute their knowledge and perspectives has greatly enriched the findings of this study.

We would like to express our gratitude to the researchers, engineers, and innovators who have contributed to the development and implementation of vehicular cloud data collection for intelligent transport systems (ITS). Their dedication and efforts have paved the way for advancements in transportation technology and have the potential to revolutionize the way we perceive and interact with transportation systems.

We would also like to acknowledge the organizations and institutions that have supported research and development in this field. Their investment in infrastructure, resources, and expertise has enabled the progress and success of vehicular cloud data collection for ITS.

Furthermore, we extend our appreciation to the individuals who have participated in pilot projects, shared their data, and provided valuable insights and feedback. Their contribution has been instrumental in improving the accuracy, reliability, and effectiveness of vehicular cloud data collection systems.

Lastly, we would like to acknowledge the role of open-source communities and the availability of research publications, academic journals, and conferences that foster knowledge sharing and collaboration in the field of vehicular cloud data collection for ITS. The collective efforts of the research community have accelerated advancements and have propelled the field forward.

This acknowledgment would not be complete without expressing our gratitude to all those who have contributed directly or indirectly to the development and implementation of vehicular cloud data collection for ITS. Your

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dedication and commitment are shaping the future of transportation and have the potential to create safer, more efficient, and sustainable mobility solutions for all.

Thank you all for your invaluable contributions and support.

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