Cloud Computing Based Remote Sensing Architecture for Tracking Vehicular Networking

Bushra Muneeb, Mrs. A. Bhagyasree, Mrs. T. Sruthi, Madhavi Latha Munipalle

Assistant Professor, Department of CSE, Princeton Institute of Engineering and Technology for Women, Hyderabad.
Assistant Professor, Department of CSE, Princeton Institute of Engineering and Technology for Women, Hyderabad.
Assistant Professor, Department of CSE, Princeton Institute of Engineering and Technology for Women, Hyderabad.
Assistant Professor, Department of CSE, Princeton Institute of Engineering and Technology for Women, Hyderabad.

Abstract: A new paradigm called Integrated Vehicular Cloud Computing Networking (IVCCN) has the potential to completely change the way smart transportation systems operate. IVCCN integrates edge, cloud, and vehicular networking to support intelligent decision-making, smooth connection, and effective data processing in vehicle contexts. This essay examines the foundations, difficulties, achievements, and potential of IVCCN, clarifying its crucial role in determining the direction of transportation services and infrastructure in the future. In order to provide dependable and effective car services, the growing number of vehicles and their many resource-hungry applications present new computing and storage issues. In order to employ the irregular and accessible resources for mobile application offloading from vehicles, we suggest a new architecture in this study that combines the remote central cloud server, edge computing server, Software Defined Network (SDN) controller, and vehicular cloud in a reasonable manner. The vehicular cloud acts as a backup cloud service provider for automobiles in our suggested architecture, where SDN controllers modify the offloading procedure and network flow based on the resource utilization conditions of cloud servers and the network. Furthermore, we introduce the updated architecture and elaborate on the current issue and its resolution.

Keyword: SDN, computing, integrated vehicular cloud computing networking, wireless sensor networks, remote sensing units.

I.INTRODUCTION

Our everyday lives are becoming more and more engrossed in various multimedia services due to the rapid development of social network services (such as video conferencing, chatting with friends on Wechat, reading email, and viewing videos) and numerous mobile Internet applications [1]. In addition, a growing number of individuals live in automobiles due to rising motorization and urbanization. As a result, more people try to use their vehicles to access online multimedia resources. In the meanwhile, industry and academia are paying more attention to intelligent transport systems in an effort to cut down on needless travel time, carbon emissions, and safety risks. As a result, having Internet-connected cars has a significant impact on our daily lives by improving comfort, safety, and efficiency of transportation.

Even though vehicles' computing, storage, and communication capabilities have been gradually improving due to the emergence of ever-more-advanced applications (such as image processing, natural language processing, augmented reality, and so forth), they are still unable to meet the demands of computation-intensive mobile applications. In the actual world, it will still be very difficult to access colorful applications and services in moving automobiles without robust support from hardware resources. As such, addressing the issue is essential [2]. cars can leverage the wealth of resources available on cloud servers to increase the effectiveness of mobile application execution in their cars. Offloading is a sort of new technique that helps cloud servers use their resources more efficiently by reducing resource constraints caused by mobile devices. It moves some of an application's responsibilities to cloud servers with lots of resources [3]. This issue has led to the development of technologies that allow cars to offload mobile apps in order to save energy and accelerate program execution. Offloading helps to enable fair resource allocation in addition to improving the performance of mobile application execution.

To improve the efficiency of mobile application execution, Mobile Cloud Computing (MCC) [4] combines cloud computing and mobile computing. Owing to MCC's benefits, Internet of Vehicles (IoV) is currently combining mobile Internet with MCC to create an integrated platform for processing, storing, and exchanging information [5]. Cloud services enhance appropriate and effective resource allocation in addition to speeding up the execution of mobile applications and saving energy for automobiles. Vehicular Cloud compute (VCC) looks prospective as one of the most attractive options since it is anticipated that IoV would be able to supply compute, storage, and communication resources for various mobile applications in fast-moving cars based on the new architecture. Via the core network, network administration, processing, and storage tasks are consolidated in the data center in VCC. While VCC enhances computing performance and resource usage, there may be significant overhead associated with long-distance mobile application transmission between mobile cars and distant cloud servers. Moreover, the transmission delay fluctuation may severely reduce the offloading efficiency.

However, a new trend that has emerged recently is the placement of cloud resources closer to the network edges as a result of people's desire for a positive user experience [6]. They are linked to cellular base stations or roadside units (RSUs). They are able to facilitate effective cloud services and reduce the time it takes for centralized mobile devices and the cloud. It is anticipated that in the near future, a large number of edge devices with potent processing and storage capabilities will be placed next to mobile devices. Rather than sending computation-intensive and latency-critical jobs over a core network to distant data centers, the edge devices can handle them. Mobile Edge Computing (MEC) is the term given to this paradigm [7]. In contrast to the protracted communication delays associated with cloud computing, MEC is commonly regarded as a promising solution for the quick and easy execution of various mobile apps. Vehicular Edge Computing (VEC), which combines MEC with IoV, is presented [8]. Because of their close proximity, VEC servers can guarantee a reasonable interactive delay during the compute offloading process, improving the user experience for applications that are sensitive to delays. However, because VEC servers are constantly limited in terms of processing power, they are unable to completely match the demands for vehicle offloading within the given delay restrictions, particularly in cases of high traffic volume [8].

Autonomous cars on the road make up the "vehicular cloud" [9]. Their storage, communication, and idle computing resources might be synchronized and dynamically distributed to nearby other cars that lack the capacity to handle upcoming computation-intensive tasks.

Vehicular clouds will be crucial in adopting application offloading as a supplement to remote central cloud servers and edge computing servers, particularly when cars are not within the range of remote sensing units (RSUs). To determine whether tasks should be performed locally or offloaded from a mobile device to a cloud server, many offloading policies have been proposed for mobile applications. The majority of research, however, focuses mainly on the scenario in which mobile apps can be transferred to a cloud server—such as a vehicle cloud, edge computing server, or central cloud. A single cloud server may not always be able to handle customers' demands for offloading, in which case the cloud services will be rendered ineffective. There are now several of offloading locations to choose from. In order to increase the scalability of cloud services for automobiles in accordance with the features of mobile applications and resource utilization conditions, it is required to make use of various idle resources in clouds. After several cloud resources are combined and used, there will be a few offloading locations to offer offloading services. Other offloading locations may be available for mobile applications if one offloading location is unable to meet the offloading requirements from those applications. Consequently, mobile applications from cars can still access the cloud services. Furthermore, many unloading destinations may satisfy offloading requirements at the same time. Then, deciding which offloading location would allow the program to run as efficiently as possible will be crucial.

In order to increase the amount of cloud service that is available for mobile applications from automobiles, we suggest a new architecture in this work that integrates the vehicular cloud, the edge computing server that is nearby, and the remote central cloud. The proposed architecture divides the cloud into three areas: the vehicle cloud, which serves as a cloud service provider, can offload some mobile applications of vehicles in one-hop neighbors by vehicle-to-vehicle (V2V) mode; the centralized cloud, which has enormous computational and storage resource, but large communication delay and overhead; and the edge computing server, which is connected to the RSU and is in the vicinity of vehicles, but has limited computation and storage resource. It can be very difficult to locate and make reasonable use of idle resources in different offloading destinations (such as distant central clouds, nearby edge computing servers, and vehicular clouds) in order to finish offloading mobile applications when the vehicles themselves are unable to meet the computation requirements.

II. INTEGRATED VEHICULAR CLOUD COMPUTING NETWORKING (IVCCN)

Integrated Vehicular Cloud Computing Networking (IVCCN) is the result of the confluence of edge computing, cloud computing, and vehicular networks. Vehicles can now access a multitude of cloud-based services, more computational capacity, and improved communication capabilities thanks to IVCCN. IVCCN aims to improve transportation systems' ease, safety, and efficiency while opening the door for new services and applications by utilizing the synergies between these technologies. Vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-cloud (V2C) communication are made possible by IVCCN through the use of Vehicular Ad hoc Networks (VANETs) and Cellular Vehicle-to-Everything (C-V2X) communication.

Cloud Computing: To offer storage, processing, and analysis of vehicle data, IVCCN makes use of the elasticity, scalability, and computational power of cloud platforms. Edge Computing: Low-latency data processing, real-time analytics, and edge caching are made possible by edge computing infrastructure installed at base stations and roadside units (RSUs). This lowers latency and improves responsiveness in automotive applications.

III.SDN BASED NETWORKING

Network infrastructures may now be more flexible, scalable, and manageable thanks to the emerging paradigm of software-defined networking, or SDN. SDN presents special chances to enhance resource efficiency, facilitate dynamic network reconfiguration, and optimize communication in the context of vehicle-based architecture. This study examines the use of SDN in automotive networks, stressing its advantages, difficulties, and potential applications. We explore several SDN-based approaches and architectures designed for automotive settings and how they may transform intelligent transportation networks. Dynamic Resource Allocation: SDN allows for the optimization of bandwidth usage and the improvement of Quality of Service (QoS) by enabling the dynamic allocation of network resources depending on current traffic circumstances.

Network Virtualization: SDN makes it possible for network slicing, which enables isolation, customization, and effective resource sharing across several virtual networks to coexist on a single physical infrastructure.

SDN-based algorithms for traffic engineering can dynamically redirect traffic flows to reduce congestion, strengthen network resilience, and improve overall performance of the network. Global network optimization and policy enforcement are made possible by the centralized controller that oversees the whole automotive network in the centralized SDN architecture.

Distributed SDN design: This type of design allows for fault tolerance, scalability, and a reduction in control plane latency by distributing control functions among several controllers.

Hybrid SDN Architecture: By combining distributed and centralized control planes, hybrid designs overcome the drawbacks of each and maximize the advantages of each.For improving connection, scalability, and management in vehicle-based design, software-defined networking, or SDN, has strong benefits. SDN opens the door for novel applications and services in smart transportation systems by separating the control and data planes. This allows for dynamic resource allocation, traffic engineering, and network virtualization. SDN-based solutions are still developing because of developments in edge computing, communication technologies, and standardization initiatives, even if they still face issues with scalability, security, and latency. SDN will be essential in forming the upcoming generation of intelligent transportation infrastructures as we get closer to a future of autonomous and networked mobility.

IV.RELATED WORKS

Research on integrated cloud computing networking in vehicles has been conducted. The concept of "vehicular fog computing," which combines fog computing and IoVs, was first out in [2]. Autonomous cars are performing an increasing number of computing and communication activities as near-user infrastructures. In order to maximize the utilization of vehicle computing resources, vehicular fog computing is suggested as a means of enhancing cooperation between stationary and slow-moving vehicles. An ideal offloading plan is suggested in [10], where servers are taken advantage of to provide processing resources for offloading services with little interaction latency. This plan takes into account both the servers' resource limitations and the compute workloads' tolerance for delay. There is comparable work in [8]. When vehicle delay-tolerant networks are implemented for data distribution in smart grids, MCC is also utilized as a crucial technology [11]. The majority of computing tasks for choosing whether to charge or discharge are carried out locally with little latency and quick reaction times when using MCC. Reputation management was suggested in [12] as a way to enhance network performance while providing security protection for vehicle edge computing.

They suggested a distributed reputation management system in which local reputation management for cars is carried out by vehicular edge computing servers. Efficient resource allocation for computation in vehicle cloud computing networking is the subject of several research [13]. A Bayesian coalition game is suggested in [13] as a means of lowering energy usage and promoting the prudent use of computer resources. They investigate the issue of how to divide resources intelligently across virtual machines (VMs) in order to effectively use processing power and balance load. The allocation of computer resources in [14] is designed to effectively manage the regular modifications in data center topology. The pooling of bandwidth and computer resources, together with resource management to support cloud-enabled vehicular networks for mobile apps, were all taken into consideration in [15].

SDN, or software-defined networking, has drawn a lot of interest as a potentially effective way to enhance the flexibility, efficiency, and administration of network infrastructures. SDN has a lot of promise to help with the problems of dynamic communication settings, resource limitations, and changing mobility patterns in the context of vehicular networks. This study report offers a thorough summary of SDN architectures that are currently in use for automobile networks. It examines the main SDN-enabled applications, deployment scenarios, communication protocols, and architectural elements in the automotive sector. The study also covers future goals, outstanding research questions, and obstacles in SDN-based vehicular networking. An Introduction to Vehicular Networks Overview of the features, difficulties, and uses of vehicular networks with a focus on the demand for effective management and communication solutions. Described as an overview, software-defined networking (SDN) summary of the SDN paradigm, emphasizing its tenets, benefits, and possible uses in a range of industries, including automotive networks. An overview of the survey's major conclusions that emphasize the value of SDN designs in meeting the needs and difficulties of vehicular networks. a focus on the advantages, future possibilities, and possible uses of SDN in the developing field of smart transportation.

V.METHODODOLOGY

The suggested SDN-based integrated vehicle cloud computing architecture is shown in Fig. 1. A distant central cloud server, several edge computing servers, multiple SDN controllers, multiple RSUs, a vehicular cloud, and many cars make up the architecture. On the highway, cars go in opposing directions. A vehicular cloud may arise from the cars. Through V2V connection method, some programs in one vehicle with a lot of computing duties may be moved to other cars with less computing tasks. Cloud computing and vehicular networks are combined in vehicular cloud. Vehicular cloud's primary goals are to maximize the use of idle resources in cars to better support a range of applications and services and to expand the amount of cloud computing power that is accessible to automobiles. Vehicle-to-infrastructure (V2I) communication is the means by which vehicles and RSU exchange information. RSUs are wiredly connected to an edge computing server and an SDN controller nearby, and they are connected to the faraway central cloud server over the Internet. Real-time resource occupancy reports from the distant central cloud server and edge computing server are sent to SDN controllers. Vehicles with computation-intensive apps will use RSU to submit offloading requests to the SDN controller.

Next, based on the resources occupied by cloud servers and the features of mobile applications, the SDN controller will assign communication, storage, and compute resources to mobile apps. Lastly, cars move these apps to an edge computing server or a faraway central cloud based on the response from SDN controllers. The resource conditions for various offloading destinations vary, including factors such as processing power, memory capacity, network connectivity, bandwidth, and so forth.

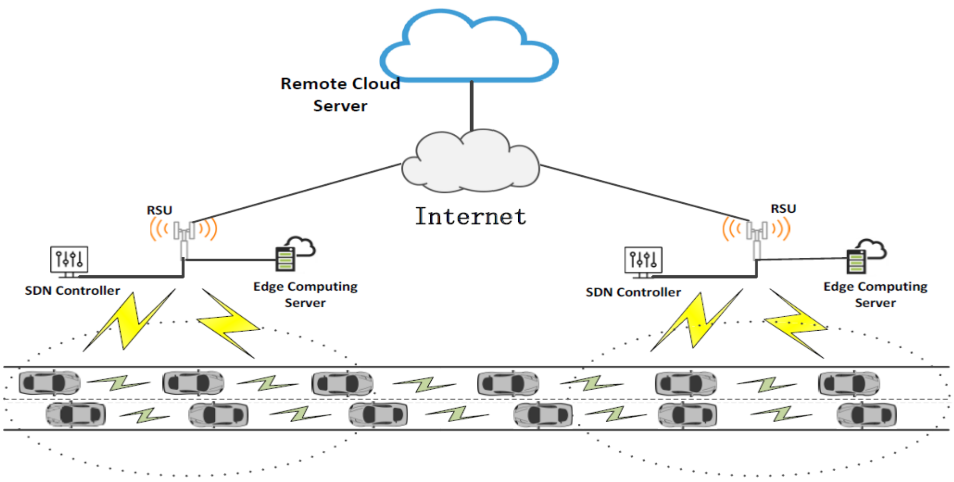

Figure 1. SDN-based Architecture for Integrated Vehicular Cloud Computing Networking.

A centralized cloud often has a large amount of computing and storage capacity, but because of transmission distance, it has a high data connection latency. Due to their use of a wireless local area network (WLAN) for data transmission, the close edge computing servers have reduced latency even if they have fewer processing and storage capacities. In the meanwhile, because of their ease, edge computing servers have a high resource consumption rate. A vehicular cloud's computing and storage capacity is constrained for each vehicle. On the other hand, vehicular cloud has abundant resources. The vehicle cloud has low usage and distributed computing and storage resources. Device-to-device (D2D) or vehicle-to-vehicle (V2V) connections fuel the vehicular cloud [15].

We provide the following assumptions based on the resource characteristics of various offloading destinations. The distant central cloud server has infinite resources. The servers used for edge computing have constrained resources. Should an excessive number of requests for offloading mobile applications arise, the edge computing server's resources can become inadequate.

VI.RESULTS AND DISCUSSIONS

Based on the assumptions and system architecture, we address the following issues: determining when to offload a mobile application, deciding which offloading destination to use, and identifying a suitable vehicle to run the mobile application in the event that the vehicular cloud is chosen as the offloading destination. A mobile application does not need to be offloaded if it can run locally; otherwise, it has to be offloaded to the proper location in order to run. A mobile application should be offloaded even if it can run locally if it uses excessive resources. Selecting a server to serve as the offloading destination is necessary if both the edge computing server and the centralized cloud server satisfy the offloading criteria. As the offloading destination, the vehicular cloud should take over if neither the centralized cloud server nor the edge computing server are able to match the criteria. Vehicles and RSU/vehicles do not have a solid link because of the mobility of vehicles in the architecture. A mobile application's data transfer cannot be properly finished if the connection is too short or restricted. As a result, upon offloading, we should choose the proper RSU or vehicles.To carry out offloading assignments for the complex architecture, we must create an ideal offloading policy.

We must build a controller inside every vehicle in order to determine when to unload the mobile apps. Applications like facial recognition that need a lot of backend data must be offloaded to a distant cloud server or edge computing server. For additional apps, we must configure an appropriate controller to determine whether to offload them based on the amount of memory, network bandwidth, and processing cycles that they demand. Mobile apps need offloading if the resources for computing and storage cannot meet their demands. Alternatively, the mobile application may require offloading; in this case, it should be offloaded to a cloud server if it requires excessive processing or storage resources. As a result, we must create a suitable and adaptable offloading strategy.

We must create an intelligent resource statistics approach and an appropriate offloading policy in the SDN controller in order to determine where mobile apps need to be offloaded. The resource use circumstances in the edge computing server and distant central cloud server may be obtained and analyzed by the SDN controller. In this manner, the SDN controller may enhance resource management and get a better understanding of the state of the network. The SDN controller uses offloading policy to determine which destination to offload the mobile application to based on the request from the mobile application. Vehicular cloud is the sole unloading location when a vehicle leaves the RSU's coverage area. According to the traveling direction, velocity, and resource circumstances, vehicles must choose which vehicle is the most suitable destination.

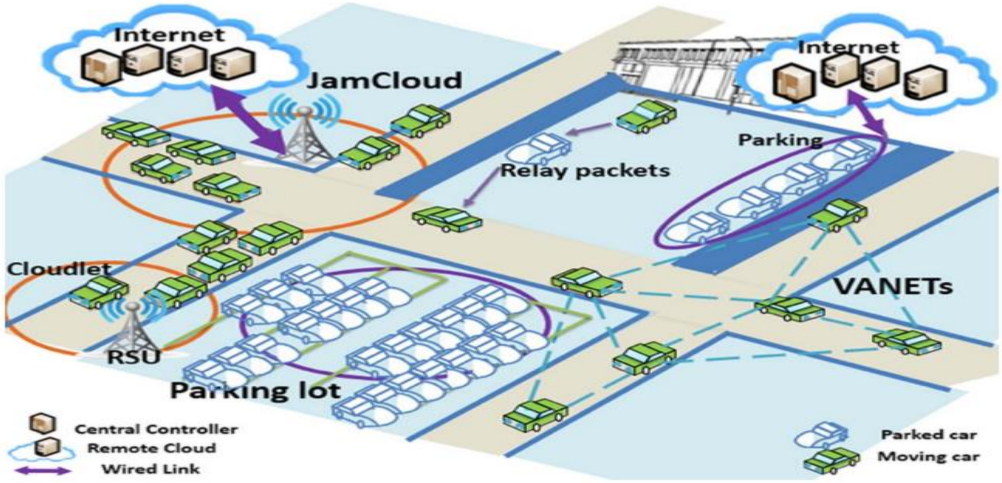

Figure 2. System overview of four types of scenarios for VFC

In this paper, we provide a summary of the revolutionary vehicle-as-infrastructure (VFC) paradigm's potential capabilities and remaining issues. We specifically take into account all four situations, which include using parked and moving cars as the respective infrastructures for computing and communication. One way that moving and parked cars may enable higher flow capacities as communication infrastructures is via improved packet delivery delays and improved vehicle-to-vehicle connectivity. To improve communication, we may use the vehicles' regular movement patterns. Alternatively, automobiles may be used as computing infrastructures, moving and stationary, to optimize the use of each vehicle's computational capacity. For instance, a collection of adjacent cars linked via wireless vehicle-to-vehicle communication may create a vehicular mobile cloudlet, which is made up of crowded automobiles.

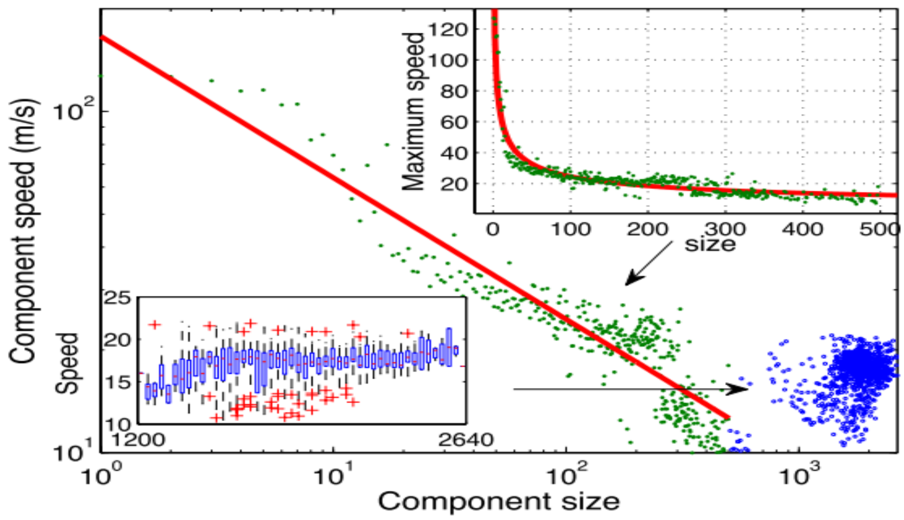

Figure 3. Scatterplots based on the Shanghai trace representing the component speed versus component size.

Our work examines automotive mobility and connectivity in urban settings by focusing on two large-scale urban vehicular traces found in real-world settings: Shanghai and Beijing. The Shanghai Grid project gathered the mobility trace data from more than 4000 cabs in Shanghai over the course of the whole month of February 2007 to create the

Shanghai trace. General Packet Radio Service (GPRS) sent information back to the data center in this trace. More specifically, when a cab carried passengers, the frequency of reports was every minute; otherwise, it was every fifteen seconds. The data supplied included the taxi's identification number, its location's longitude and latitude, its speed, and other variables including heading angle and status.

We preprocessed the data set in our investigation in the following manner.We need the precise position of each taxi at a multitude of time periods in order to study the mobility and connectedness of the vehicles. To acquire the real-time topology, it is crucial to sample the relevant timepoints at a set frequency.

The biggest known urban city vehicular data trace is the Beijing trace. We utilized the mobility track data from 27, 000 participating Beijing cabs with GPS sensors in May 2010 to compile the Beijing trace. In particular, we used the GPRS modules to transmit the data every 15 seconds for moving taxis and the GPS devices to gather the time stamps and positions of the taxis. Time stamps, immediate speed, direction, the taxi's ID, and the longitude and latitude of its position are among the exact details included in such a report. In a similar vein, the data collection is suitably preprocessed before to analysis.

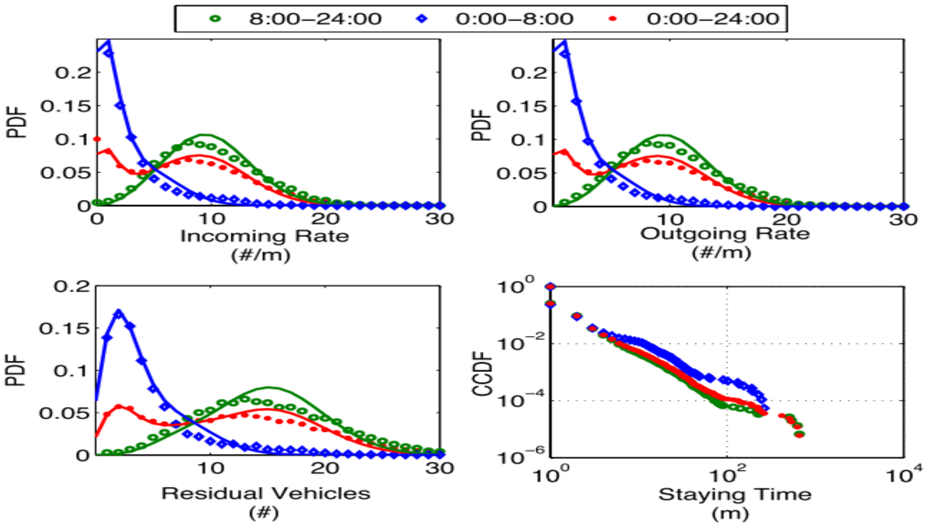

Figure 4. Distributions of incoming and outgoing numbers of vehicles per minute.

We sampled the data every 10 minutes since GPS reports were collocated in discrete time at time intervals of either 15 s or 1 min. As a result, a fresh real-time topology is generated every ten minutes, allowing us to gather 144 topologies in a day. We determined after processing empirical data that it is a reasonable sampling frequency since, in only ten minutes, the majority of the sampled topologies show no discernible change.

We may conclude that there are comparable dynamic shifting patterns in the communication capacity and connection since both variables represent the fundamental information-transferring capability. More precisely, the power-law fitting model reproduces the real connection between the component size and associated maximum component speed when the component speed is greater than a certain threshold speed A. As previously said, the component size shows the network's connectedness, whereas the component speed defines mobility. According to this power-law connection, the mobility degrades the connectivity with a power-law degradation for component speeds greater than average. A vehicle's communication capacity decreases with speed since it can interact with fewer cars, resulting in smaller components. In contrast, this connection becomes uniform when the component speed is less than A. This suggests that the component speed may correspond to any component size, from the smallest to the largest.

Stated differently, the connectivity, or communication capacity, of the network is unaffected by mobility below a certain level. We are able to estimate and evaluate connection and, therefore, communication capacity based on mobility indicators like vehicle or component speeds, thanks to the previously described study. In addition to giving us pertinent guidance for designing related vehicle applications, this helps us better grasp the communication features in vehicular networks.

VII.CONCLUSION

Numerous factors need to be taken into account for integrated vehicle cloud computing. On the one hand, topography is always changing and cars move quickly. Channel state is not steady as a consequence. In both V2V and V2I communication modes, channel state is a crucial factor to consider throughout the application offloading process. However, in most cases, many offloading destinations might be contenders, so it's important to consider carefully which mobile application should be offloaded to in order to save energy. We have provided an overview of the new paradigm known as VFC vehicles serving as the infrastructures for computing and communication—in this work. As the number of vehicle terminals rises, this paradigm presents both significant potential and difficulties. All four of the situations where parked and moving cars are used as computing and communication infrastructures have been covered. The vast potential improvement in communication and processing capability that VFC can provide has been shown by our investigation. More specifically, more connection and packet relaying options may be attained with the aid of VFC, resulting in more dependable and capacious communication. Because VFC makes the maximum use of each vehicle's presently unused computing capacity, it also significantly increases computational performance when compared to traditional systems. More sophisticated advancements in mobile cloud computing and automotive applications will follow as connectivity and processing power are increased. This paradigm is a promising model that, despite its early stages of development, has the potential to drastically alter automotive networks and a range of future vehicular applications.

REFERENCES

[1] B. Li, T. H. Luan, B. Hu, and S. Chen, “Efficient MAC Protocol for drive-thru Internet in a sparse highway environment,” IET Communications, vol. 11, no. 3, pp. 428–436, 2017.

[2] X. Hou, Y. Li, M. Chen, D. Wu, D. Jin, and S. Chen, “Vehicular fog computing: A viewpoint of vehicles as the infrastructures,” IEEE Transactions on Vehicular Technology, vol. 65, no. 6, pp. 3860–3873, 2016.

[3] S. Ou, K. Yang, and A. ‘Liotta, “An adaptive multi-constraint partitioning algorithm for offloading in pervasive systems,” in IEEE International Conference on Pervasive Computing and Communications, 2006, pp. 10 pp.–125.

[4] D. Huang, T. Xing, and H. Wu, “Mobile cloud computing service models: a user-centric approach,” IEEE Network, vol. 27, no. 5, pp. 6–11, 2013.

[5] M. Whaiduzzaman, M. Sookhak, A. Gani, and R. Buyya, “A survey on vehicular cloud computing,” Journal of Network & Computer Applications, vol. 40, no. 1, pp. 325–344, 2014.

[6] D. Huang, T. Xing, and H. Wu, “Mobile cloud computing service models: A user-centric approach,” IEEE Netw., vol. 27, no. 5, pp. 6–11, Sep./Oct. 2013.

[7] Ravindra Changala, "Sentiment Analysis in Social Media Using Deep Learning Techniques", International Journal of Intelligent Systems and Applications In Engineering, 2024, 12(3), 1588–1597.

[8] Ravindra Changala, "Integration of IoT and DNN Model to Support the Precision Crop", International Journal of Intelligent Systems and Applications in Engineering, Volume 12, Issue 16s), February 2024.

[9] Ravindra Changala, "UI/UX Design for Online Learning approach by Predictive Student Experience", 7th International Conference on Electronics, Communication and Aerospace Technology (ICECA 2023), DVD Part Number: CFP23J88-DVD; ISBN: 979-8-3503-4059-4.

[10] F. Bonomi, "Connected vehicles, the Internet of Things, and fog computing," in Proc. VANET, Las Vegas, CA, USA, Sep. 23, 2011, pp. 13–15.

[11] N. Kumar, S. Zeadally, and J. J. P. C. Rodrigues, "Vehicular delaytolerant networks for smart grid data management using mobile edge computing," IEEE Communications Magazine, vol. 54, no. 10, pp. 60–66, 2016.

[12] X. Huang, R. Yu, J. Kang, and Y. Zhang, "Distributed reputation management for secure and efficient vehicular edge computing and networks," IEEE Access, vol. PP, no. 99, pp. 1–1, 2017.

[13] N. Kumar, S. Zeadally, N. Chilamkurti, and A. Vinel, "Performance analysis of bayesian coalition game-based energy-aware virtual machine migration in vehicular mobile cloud," Network IEEE, vol. 29, no. 2, pp. 62–69, 2015.

[14] Ravindra Changala, "Evaluation and Analysis of Discovered Patterns Using Pattern Classification Methods in Text Mining" in ARPN Journal of Engineering and Applied Sciences, Volume 13, Issue 11, Pages 3706-3717 with ISSN:1819-6608 in June 2018.

[15] Ravindra Changala "A Survey on Development of Pattern Evolving Model for Discovery of Patterns in Text Mining Using Data Mining Techniques" in Journal of Theoretical and Applied Information Technology, August 2017. Vol.95. No.16, ISSN: 1817-3195, pp.3974-3987.

[16] T. K. Refaat, B. Kantarci, and H. T. Mouftah, "Dynamic Virtual Machine Migration in a vehicular cloud," in Computers and Communication, 2014, pp. 1–6.

[17] R. Yu, X. Huang, J. Kang, J. Ding, S. Maharjan, S. Gjessing, and Y. Zhang, "Cooperative resource management in cloud-enabled vehicular networks," IEEE Transactions on Industrial Electronics, vol. 62, no. 12, pp. 7938–7951, 2015.

[18] Ravindra Changala, "Optimization of Irrigation and Herbicides Using Artificial Intelligence in Agriculture", International Journal of Intelligent Systems and Applications in Engineering, Volume 11, Issue 3), July 2023.

[19] Ravindra Changala ,"Development of Predictive Model for Medical Domains to Predict Chronic Diseases (Diabetes) Using Machine Learning Algorithms And Classification Techniques", ARPN Journal of Engineering and Applied Sciences, Volume 14, Issue 6, 2019.

[20] M. Aazam and E. N. Huh, "E-HAMC: Leveraging Fog computing for emergency alert service," in Proc. IEEE Conf. PerCom Workshops, Mar. 2015, pp. 518–523.

[21] M. Aazam and E. N. Huh, "Dynamic resource provisioning through Fog micro datacenter," in Proc. IEEE Conf. PerCom Workshops, Mar. 2015, pp. 105–110.

[22] Ravindra Changala, Framework for Virtualized Network Functions (VNFs) in Cloud of Things Based on Network Traffic Services, International Journal on Recent and Innovation Trends in Computing and Communication, ISSN: 2321-8169 Volume 11, Issue 11s, August 2023.

[23] Ravindra Changala, Block Chain and Machine Learning Models to Evaluate Faults in the Smart Manufacturing System, International Journal of Scientific Research in Science and Technology, Volume 10, Issue 5, ISSN: 2395-6011, Page Number 247-255, September-October-2023.

[24] Ravindra Changala, AIML and Remote Sensing System Developing the Marketing Strategy of Organic Food by Choosing Healthy Food, International Journal of Scientific Research in Engineering and Management (IJSREM), Volume 07 Issue 09, ISSN: 2582-3930, September 2023.

[25] J. Sousanis, "World vehicle population tops 1 billion units," in WardsAuto.com. Web Portal, Aug. 2011. [Online]. Available: http://wardsauto.com/ar/world-vehicle_population_110815