A survey on Vehi-cloud Computing Networks (VCCN) its research issues and challenges

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***Abstract*---Vehicular Clouds (Vehi-cloud) are envisioned and most likely to be incorporated in future development with the help of existing vehicular adhoc networks (VANET's) to access value added services, location based services, traffic analysis and road safety Supplications, conventional clouds are fixed data centric, due to high mobility of vehicles the communication between stationary (road side) clouds and vehicles and inter-vehicle communication becomes heterogeneous and challenging to compute remote execution of data-intensive tasks during run-time which needs dynamic offloading and resource provisioning schemes and a need for efficient Vehi-Cloud operational model to proffer better QoS requirements with minimum service latency and service cost. In this article we unveil a brief survey of vehicle cloud computing networks and highlighted its research issues which have worked on it and challenges to be met.**

Index terms: VANET, VCCN, RSU, VM, Vehi-Cloud

I. INTRODUCTION

In the world of internet of things (IOT) the generation becoming smarter so as the technology a new paradigm shift vehicular adhoc networks to vehicular cloud (Vehi-Cloud) computing networks becoming essential and a need for extended VANET Supplications [1] through online computation and storage through vehicles interacting with stationary roadside clouds and central clouds on the move, giving rise to 'pay as you use' and the technology called as Vehi-Cloud computing networks (VCCN). Today an auto industry is spectating an epoch of transformation with the unification of mobility/computing and services. Recently vehicles are coming with smarter embedded dashboards and displays should be extended to static Supplications like parking lots such as airports, shopping malls data centers [4] and dynamic supplications such as location based interactive user Supplications [5], detect gesture controls, traffic signal detection, path mapping, [3] and real time video surveillance by using interactive application software's exploits for storage and computations [7].

It is also prognosticated that hereafter car buyers are looking for greater importance in auto cloud infotainment and on demand service computing facility and on-board resources are under-utilized.

Drastic growth in vehicles leading to data traffic a spiky drop in the quality of service provision [7]. To provide efficacious service quality (QoS), the most efficient and reliable solution is to proliferate the cellular networks by adding more base stations with a smaller cell size or by deploying 4G/LTE networks [8] to meet the rapid growing end-user demand for better QoS such as higher bandwidth and faster connectivity on the go.

However, although 4G or LTE networks provide better QoS, when vehicular capabilities are combined with these networks, the widespread adoption of advanced vehicular supplications, such as video sharing, location based services, cloud Supplications and big data services, will further increase data traffic. An experiment on 4G/LTE connection has expedited 15% more traffic data than non-4G/LTE [6].

II. MOTIVATION TOWARDS VCCN

VANET's provides tremendous potential Supplications like traffic management and road safety and significance added services when VANET's are collaborated with clouds to form Vehi-Cloud computing networks (VCCN) can be considered by unique advantages delegated by wide range of potential cloud computing Supplications in the areas such as Cloud-assisted vehicle communications by using language translation

tool, computational services for real-time navigation, vehicular social networks, vehicle traffic analysis through Vehi-Clouds, Video surveillance with storage and resource sharing, cloud infotainment, [3] Proposes adaptive offload vision based computing for vehicular supplications such as gesture control detection, traffic light detection, path mapping the scenario has been implemented in a private cloud, it should be extended to hybrid Vehi-Clouds in a dynamic way. [8] Proposes an idea of collecting information through sensors where vehicles use a camera sensors to record all image and videos from the surroundings such as car accidents while propelling can relay it to the nearby clouds through web. Thereafter, Internet agents and/or cops search the vehicular network for evidence or any testimonies as part of their investigations. [2] Proposes a CarSpeak Supplication that validates a vehicle to access sensors on its own and also its neighboring vehicles to form an autonomous driving Supplication using the sensor collection this can be done using Vehi-Cloud networks.

III. Collaboration of Cloud computing and VANET's

Cloud computing refers to executing or computing the service requests from different sources and delivering the corresponding services over the web with the help of datacenters that provides both hardware and software support. Cloud computing offers services like Infrastructure as a Service (IaaS) deals with hardware and networking resources, Platform as a service (PaaS), deals with allowing the users to execute and command Supplications and Software as service (SaaS) deals with software licensing through SLA and functions using web interface. Cloud computing paradigm overhauled VANET's to form a vehicular cloud due to wide variety of Supplications like network on wheels high speed tolling, Telemedicine, vehicular social neyworking, E-banking, movies on demand IPTV [12]. VANET embodies inter-vehicle (V2V) and vehicle-to-fixed foundation (V2I) communications used widely for traffic management. In support of traffic-related communications, In US Federal Communications Commission has allocated 75 MHz of bandwidth in the 5.85 to 5.92 GHz band specially allocated by the FCC for dedicated short-range communications [37]. Contemporary automobiles like cars, traveler buses, Multi utility vehicles are provisioned with persistent internet existence, featuring remarkable on-board computational, sensing and storage capabilities that ought to be thought as a massive plantation of computers while their considerable piece of time spend on streets. Hence these stupendous computing capabilities can be multi utilized rather than keeping it in idle on the streets to enable pay-as-you–use service facilities and applications giving rise to vehicles as potential commodities in a vehicle cloud computing layout. One prime significance advantage of conventional cloud computing is, it can be scalable to access computing resources. With cloud computing evolvers do not need large principal disbursement in hardware to posit their service for web supplications and services. Keeping the noble benefit of cloud computing, the idea of Vehicular Cloud (Vehi-Cloud) comes into gleam.

A. Parked vehicles as stationary cloud

Vehicles can act as tremendous utility for storage and computing when parked in airports, railway stations for longer period of time.

Fig-1 Storage as a service

The vehicle owners can rent out their onboard processing resources for storage as a service (SaaS) as shown in fig-1.

B. Moving vehicles as hybrid dynamic cloud

Vehicles acts as dynamic nodes and serves as network service providers as shown in fig-2, a faction of vehicles forms a network topology by using IEEE 802.11p WAVE and DSRC with nearby vehicles and roadside units and gets communicated to local cloud servers or central clouds for complex data processing. One of the best examples of dynamic clouds is traffic lights scheduling [9][10].

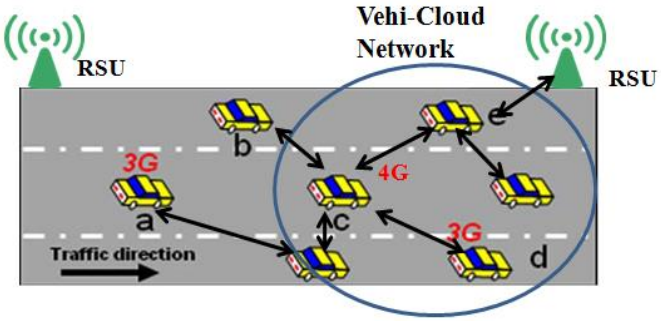

Fig-2 Network as service

C. Vehicular-Cloud communication

This is also familiarly apprehended as inter-vehicle (V2V) communication. In this category, the vehicles can communicate among each other to share the information through onboard equipments like camera, sensors, and radar any valuable information collected from sensors on a vehicle, or communicated to a vehicle, can be accessed to neighboring vehicles within range. [39] Propounds two customized categories Generalized Vehicular Cloud Customization (GVCC) with the help of centralized cloud controller responsible for *creation*, *maintenance* and *deletion* and registers the virtual resources they are connected with cloudlets and Specified Vehicular Cloud Customization (SVCC) does not have centralized cloud controlling they make vehicles as cloud sites.

D. Vehicles to local road side clouds

This is also familiarly apprehended as vehicle-to-infrastructure (V2I) communication. In this category, the vehicles can use wireless gateways and wireless fidelity access points to incorporate the Internet and enable light weight computing vehicular Supplications. [39] Propounds a concept called as *transient cloud* due to its dynamic serving nature for the vehicles passing by will be added and deleted by RSU and handoff's the control to next cloudlet of RSU. [38] Propounds, A vehicle uses two interfacing modules Virtual migration base and Virtual Migration-overlay for resource recording and customizing resource requirements for choosing the Virtual machines and then it can be used synchronously between roadside cloudlets.

E. Vehicle to central clouds

Due to emerging cloud Supplications vehicles and online computing services Vehicles can use hardware and software resources for heavy online computing tasks using public cloud for free and private infrastructure depending upon their Service level agreements (SLA) through dynamic provisioning mechanism either in single-hop or multi-hop vogue relying on their whereabouts during motile or stationary. This architecture includes inter-vehicular information.[11] Propounded three different precisions viz vehicular clouds, vehicles using clouds and hybrid vehicular clouds. Firstly Vehicular clouds are further classified into static and Supplications like storage as providing fixed infrastructure acting as a datacenters and dynamic Supplications involves which possess certain Supplications like video on demand and dynamic traffic light scheduling but needs a global standard for formation of vehicle clouds and efficient mobility management to conquer the heterogeneous topologies, secondly vehicles using cloud suggests it can be used for remote configuration, big traffic data analysis and locality based Supplications it requires strong data center internetworks and dynamic resource provisioning schemes for better management Thirdly hybrid vehicular clouds propounds Supplications using peer to peer communication for renting the user resources which needs encouragement and motivation in the form of incentives and pricing policies for resources. [16] propounded Virtual Migration (VM) to utilize resources forming interactive clouds by virtually processing the queues of request with top speed mobility needs to be addressed [17] propounded certain VM approaches between inter-vehicles only using hot spots with shorter period sessions.[19] Implements in his dissertation work converges multiple radio access networks with heterogeneous networks with high band connectivity but this concept creates latency in Vehi-Clouds.[20] Scrutinizes the implementation of two wireless accessess viz, LTE and IEEE 802.11p, long term evolution slightly hinders when number of vehicle density or network load increases where as other one gives best effort services with sparse networks.[21] assuming static Road side Unit (RSU) for investigations with fixed resource pools using MDP gives better results but under highly dynamic road traffic entities is the major concern.[22] propounds pooling the resources with admission control for every user having own SLA creates continuous invoking between datacenter and clients makes vulnerable condition to memory conflicts.[23] implements cloud resource with converging multiple networks efficiently with minimum time to allocate resources without negotiating the cost factor. [24] Propounded DSL based resource pooling to

specific group of networks increased buffering of service requests gets lost. [28] Propounded k-anonymity schemes for group of VANETs only uses a multi-hop messaging using PN imposes connecting issues for new dynamic vehicle entries and resource service environments. [29] Discusses on data centric schemes which detects false vehicle by information is not suitable with Vehi-Clouds. The term "*resource provisioning"* was coined in the context of Grid computing. Cloud resource provisioning is a challenging task due to unavailability of the adequate resources [13]. The purveying of pertinent resources to cloud workloads depends on the QoS requirements of cloud Supplications [14]. To provision the suitable resources to workloads is a difficult job and based on QoS requirements, identification of foremost workload–resource pair is a paramount research issue in vehicular cloud. Cloud computing provides dynamic allocation of resources and delivers pay as you use based guaranteed and reliable services. Various different cloud consumers can demand number of cloud services concurrently in cloud computing the same can be augmented to Vehi-Cloud computing based on application demands the provisioning could transform into new paradigm dynamically all the resources should be apportioned based on context to requesting consumer in a well-organized way to fulfill their requirements.[30] Propounded an approach to analyze the behavior of submitted Supplications through clustering technique after exploring the consumption of resources. Based on historical records, future behavior of phase can be forecasted correctly. [31] described a resource provisioning approach which scrutinized the Map Reduce processing scheme and cost function used to make a relationship among complexity of the Reduce function, input values and available resource infrastructures. This approach reduces the consumption of resources and executes the user Supplication within desired deadline and budget, [32] described an SLA-aware architecture which integrates market-oriented strategies of resource provisioning and the idea of virtualization to provision the required resources to corresponding workloads. [33] Propounded a deadline-aware resource provisioning technique for Aneka, considering QoS constraints of scientific Supplications and resources from different cloud providers to reduce Supplication execution times by proficiently allocating resources from different cloud providers. [34] Presented a platform on which Aneka is used to develop cloud Supplications (scalable) and provisions the resources from various cloud providers for execution of different user Supplications. In year 2013, [35] proposed resource provisioning mechanism based on rules for the hybrid cloud environment to minimize the execution and cost improve dynamic scalability.[36] propose using per-flow Valiant Load Balancing, which can cause bandwidth losses due to long-term collisions as demonstrated in this work. A scheme of that aims at minimizing the number of recruited participants while achieving a given level of coverage for an area of interest can be found in [18]. Although the recruitment schemes proposed for utilizing the resources of smart phones cannot be directly applied to vehicles due to the different design considerations, a study of potential adaptation of such schemes is worthwhile

IV. OPEN RESEARCH ISSUES

Vehi-Cloud computing is still at infant stage than practical currently. The existing technology makes most of the applications are visionary and conceptual. This survey was aimed to provide an in-depth understanding the concept of Vehi-Cloud computing which remains an emerging area of research for automotive industry and academicians. The following are the distinguishing research issues found from literature needs to be still tackled in Vehi-Cloud Computing Networks (VCCN).

1) Virtual Migration (VM)

[15] Coined robust architecture for Vehicular Clouds (VC) lacks virtual migration among vehicles Poor mobility management service drops needs efficient algorithms for VCCN [16], VM is between V2V only and Lacks allocation of physical resources [17], Uses co-alition partion for network selection leads to high latency [18] LTE shows inability to handle increased network load and 802.11p has lack of coordinated channel access and distributed congestion control [19].

2) Resource Provisioning

It uses static network of RSU with fixed resources using Markov decision process but not suitable for highly dynamic road traffic entities and lags in handling network scalability [21] Based on admission control with different user SLA but does not handle memory conflict efficiently [22], [23] proposed workflow tasks on heterogeneous cloud resources to minimize time but cost is increased Domain-Specific Language (DSL)-based RPM specifying QoS constraints and functional requirements but fails to handle queues at run time [24].

3) Data Center Networks

Addresses about scalability using bandwidth bottleneck using high end switches to incurs cost factor but doesn't validates the proposed work under commodity switches [26], [18] Discusses implementation of broker daemon, virtualization agent, resource manager & task scheduler but doesn't have fault tolerance and load balancer, Bandwidth losses due to long term collision [36].

4) Security & Privacy

Propounded k-anonymity schemes for group of VANETs only uses a multi-hop messaging using PN imposes connecting issues for new dynamic vehicle entries and resource service environments [28], Discusses on data centric schemes which detects false vehicle by information is not suitable with Vehi-Clouds [29].

V. EMERGING SUPPLICATIONS OF VCCN

A. Web- scale communications through Vehi-Cloud Technology

Lot of possible Supplications which are most intermittent on the move are listed below

1) E-commerce
2) Distance Education
3) Telemedicine
4) Digital Government
5) Vehicular Social Networking
6) Traffic safety and Management

B. Distributed Storage Supplications

1) Airport, Malls as datacenters
2) Massive data processing

VI. CHALLENGES IN VCCN

From the survey we have listed out the challenges to be tackled in Vehi-Clouds.

1) Need for a novel architecture

VCCN needs a globally standardized architecture model and API's to enable same software infrastructure to interact with public and private clouds at hence needs flexibility in SaaS level to avoid mitigating data lock-in problems keeping SLA considerations and needs an efficient VM migration between vehicle to cloud infrastructure and its vulnerabilities should be addressed to fulfill user requests on demand and should have auto reconfiguration upon workload variations.

2) Data center interconnection networks

Thousands of simultaneous user's uses internet searches and user-driven web Supplications on the move designing a data center in VCCN play's a significant role the following are the challenges need to be addressed.

1) To support modular growth of increasing servers which makes large scale data centers.
2) To provide high throughput computation by upgrading to high speed network based computing to meet the network requirements like low latency, low cost , high bandwidth and fault tolerance by providing multipath by replicating mechanism and redundant servers.
3) To support Map and reduce functions at high speed to support various traffic patterns demanded by users Supplications.
4) Datacenter with vehicle cloud network topology should be designed to support load balancing and data movement among servers.

3) Network Scalability and interoperability

In today's era the number of vehicle number is increasing drastically networking scaling is a big issue currently there is no global standardization for the network hence requires governing authority to have a good range of communication.

4) Resource provisioning

Resource provisioning plays an important role when user requests for complex computing service a well structured resource scaling mechanism and to handle offloaded data efficient algorithms for Virtual resource migration is needed.

5) Pricing and incentives for resource provider

Online monetary transactions should be encouraged to the resource provider several questions need to be tackled, [34] propounded a demand model with theoretical results and experiments on several real-world P2P topologies. and compared against existing models ignoring network effects dependent on nodes, but still the questions are unanswered How the credit is handled in vehicle cloud? How it should be done in secure way? How the dynamic monetary pricing is made for resource utilization?

VII. CONCLUSION

In this paper we had an insight over an emerging conviction on Vehi-Cloud computing networks and put forth a brief survey of VCCN and its potential Supplications and highlighted the research issues to be tackled and Challenges to be met towards utilizing the tremendous storage and computing facilities available from the surroundings by merging VANET's technology and Cloud computing technologies to engender a new VCCN. Its system model and architectural framework is needed to address the dynamic accessing the hardware resources to compute and proffer value added services and huge autonomous traffic data analysis and further work should be extended to Vehicular cloud synchronization and data aggregation methods to dynamically access the hybrid and community clouds.

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