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Vehicular Cloud Traffic Infrastructure Generation Using SUMO

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ABSTRACT: In the recent years, wireless technology becoming pervasive and cheap, so its uses are exponentially increasing in different areas. This technology is also widely used in Vehicular ad hoc Network (VANET) due to the growth in the number of vehicles on the road has put great stress on transportation systems.Smooth, safe, secure, seamless movement with all type of day to day facilities available on the road in real time is the requirement of the VANET. To provide such facilities, researchers, car manufacturers and governments are taking attention in this direction to fulfill the demands of the current requirement and future trend of the VANET. Inculcation of vehicular cloud has given further added advantage in providing different type of communication and services in different potential application of VANET. In this paper, we propose a model of a vehicular cloud traffic system and its working protocol is proposed. For implementation of this protocol,this paper deals with vehicular cloud traffic infrastructure generation of proposed model using SUMO.

KEYWORDS: Wireless Technology, Pervasive computing, VANET, Vehicular Cloud, SUMO

I.INTRODUCTION

In the recent years, wireless technology becoming pervasive and cheap, so its uses are exponentially increasing in different areas. This technology is also widely used in Vehicular ad hoc Network (VANET) due to the growth in the number of vehicles on the road has put great stress on transportation systems. Smooth, safe, secure, seamless movement with all type of day to day facilities available on the road in real time is the requirement of the VANET. To provide such facilities, researchers, car manufacturers and governments are taking attention in this direction to fulfill the demands of the current requirement and future trend of the VANET.Vehicular cloud provides an essential pillar to vehicular system and takes advantage of cloud computing resources for better service to end user in terms of providing low cost without the need to buy additional resources. In vehicular cloud can communicate with each other and with RSU using the DSRC in the range up to 1 km.The infrastructure can act as wireless access point for authentication and authorization purpose.In this paper, we have proposed a vehicular cloud architecture and protocol for providing better communication, traffic control and different type of services in real time on the road. Our main contribution in this paper will be:

1) To create a vehicular cloud architecture using VANET and cloud computing.
2) To proposed a protocol to provide different type of cloud services to the said architecture.
3) For working on this protocol, vehicular cloud traffic infrastructure generation of proposed model using SUMO was created.

II. RELATED WORK

In [1], Efficient traffic management, vehicular cloud communication system and interoperability among vehicular cloud had been discussed.The concept of vehicular cloud computing (VCC) had a remarkable impact on traffic management. The architecture, several interesting application scenarios, formation of VCC was discussed. In [2], A CROWN protocol was proposed. In this protocol, the registration of the vehicles was done only at the nearby RSU. The RSU maintained the following information i) Registration of vehicle ii) Road side service information and act as a gateway

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for global communication. Some vehicles which had the facility of cloud known as STAR, It could hold different types of services like STaaS, NaaS and DaaS. In [14],SUMO was for generating traffic mobility files for VANET. In [15] authors were proposed a novel algorithm for VANET using cloud computing.It accomplished processing, routing and traffic control in a centralized and parallel way by adding one or more server to the network. Each car or node was considered a Client, in such a manner that routing, traffic control, getting information from client and data processing and storing were performed by one or more server in different bases.

III. PROPOSED ARCHITECTURE OF VEHICULAR CLOUD SYSTEM

Vehicular ad hoc network is different from other ad hoc networks because of their hybrid architecture and node movement. Though ad hoc network, wirelesses LAN, cellular technology for intelligent transport system – all work together in VANET, address routing is the most important of all. VANET can employ vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications for advanced notification of traffic events. In support of traffic-related communications, the US Federal Communications Commission (FCC) has allocated 75 MHz of spectrum in the 5.850 to 5.925 GHz band specially allocated by the FCC for dedicated short-range communications [3].
In the proposed architecture, the roads are divided into cells of 1 km where all vehicles will form a vehicular ad hoc network and can communicate with each other. Each cell consists of the following entities: Static vehicle registration office, Road Side Unit (RSU), Vehicle equipped with cloud, normal vehicle likes car, bus, truck, motorcycle, pedestrian, vehicular static cloud, vehicular dynamic cloud, road infrastructure with traffic lights and other road side facilities like motel, hotel, fuel station, ATM, bank, post office, police station etc. as shown in the figure.

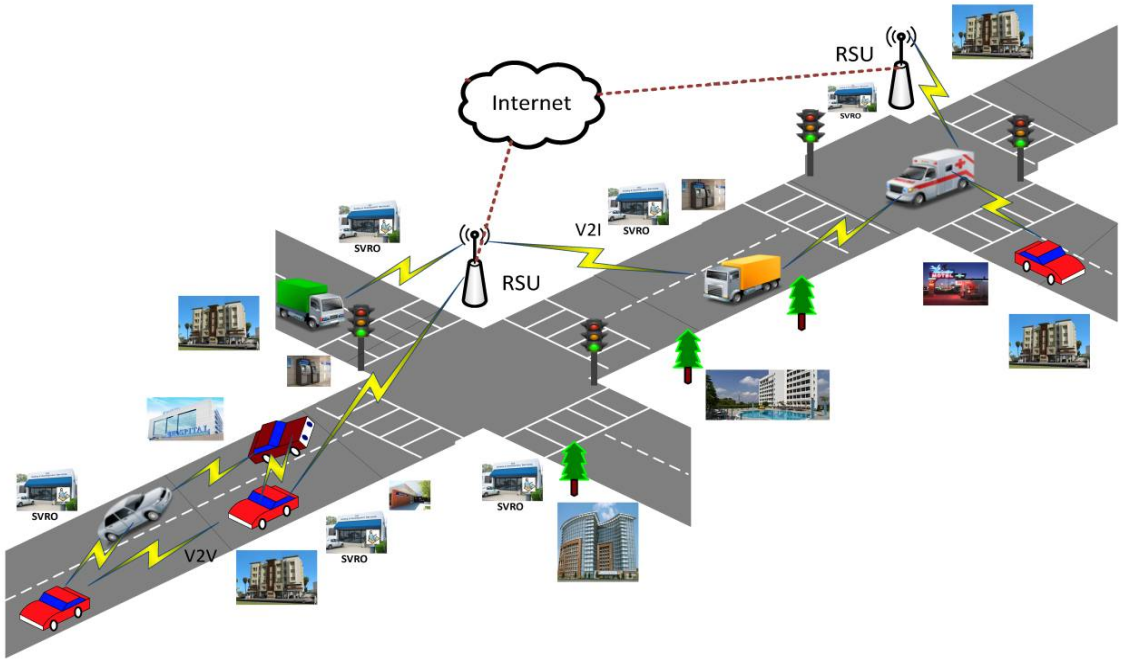

Figure 1 Architecture of Proposed Model

IV. PROPOSED PROTOCOL

1) Roads are divided into logical cells.
2) Each cell has one Static vehicle registration office(SVRO).
3) Every vehicle entered into a logical cell, initially requests for its registration to the SVRO.
4) SVRO first authenticates the vehicle, then store the vehicle service information according to the registration format shown in table 1.

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Table 1: Vehicle Registration details at SVRO

Vehicle _Id	Vehicle_Registration_ Number	Vehicle_Type	Time of Registration	Service Availability	Service Type
V001	#VC001	Car	10:30:15 AM	Yes	NaaS
V002	#VC002	Car	10:35:20 AM	No	NIL
V003	#VB001	Bus	11:12:25 AM	Yes	STaaS
V004	#VC003	Car	13:12:12 PM	Yes	PaaS
V005	#VC004	Car	14:16:35 PM	No	NIL

5) All types of local services, free cloud services and static cloud services based on pay as you go model present outside the road can be registered at RSU as per the registration format shown in table 2 and will be provided through directory look up procedure.

Table 2: Service Type description at RSU

IP_Address	Service In the Cell	Charge
10.0.0.1	NaaS	10 Rs/KB
10.0.0.2	STaaS	5 Rs/MB
10.0.0.3	PaaS	50 Rs/Hour
10.0.0.4	SaaS	Complex Software:100 Rs/Hour Utility Software: 80 Rs/Hour Other Softwares: 50 Rs/Hour

6) The RSU can also act as a gateway to provide internet service and ubiquitous global communication.
7) SVRO multicast the updated information regardingregistered vehicles (beacon) to all other vehicles in the cell periodically (default every 2 Sec).
8) Each vehicle saves updated registration information for its use.
9) Based on the requirement, Consumer vehicles(CV) can send request packet to the desired vehicular cloud (VC) for its service.
10) VC exchange service agreement information with consumer vehicle for its static and dynamic services based on pay as you go model as per the format shown in table 3.1,3.2 and 3.3.

Table 3.1: NaaS Agreement between VC and CV

Ip_Address	Type of Service	Service Parameter		
		Bandwidth	Access Delay	Charge
10.0.1.1	NaaS	2 Mbps	100 ms	10 Rs/10 Kb
10.0.1.2	NaaS	4 Mbps	100 ms	40 Rs/10 Kb
10.1.1.2	NaaS	5 Mbps	50 ms	50 Rs/Mb

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Table 3.2: STaaS Agreement between VC and CV

Ip_Address	Type of Service	Service Parameter		
		Time Duration	Max Storage	Cost/Storage Unit
10.4.1.1	STaaS	5 min	1 GB	100 Rs
10.4.1.2	STaaS	4 min	512 MB	50 Rs
10.4.1.4	STaaS	2 min	200 MB	30 Rs

Table 3.3: DaaS Agreement between VC and CV

Ip_Address	Type of Service	Service Parameter		
		Type of Data	Max Data Capacity	Cost/Unit
10.0.1.5	DaaS	Video	1 GB	100 Rs
10.0.1.7	DaaS	Audio	512 MB	60 Rs
10.1.1.8	DaaS	Text/Image	300 MB	25 Rs

11) The consumer vehicle, after validation of exchange service agreement information requests for service from the desired VC.
12) The VC provides the desired services to the said CV.
13) For roadside services and global communication with outside the world, Consumer vehicles request to RSU as per the format shown in table 4.1 and 4.2.

Table 4.1: Consumer vehicles requests

RequestID	Vehicle_Id	Vehicle_Type	Service_Type
#REQ001	V006	Car	NaaS
#REQ002	V002	Car	NIL
#REQ003	V003	Bus	STaaS
#REQ004	V004	Car	DaaS

Table 4.2: Consumer vehicles Response

ResponseID	Ip_Address	Vehicle_Type	Service_Type
#RES001	10.0.1.1,10.0.1.2,10.1.1.2	Car	NaaS
#RES002	10.4.1.1,10.4.1.2,10.4.1.4	Bus	STaaS
#RES003	10.0.1.5,10.0.1.7,10.1.1.8	Car	DaaS

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V BRIEF DESCRIPTION OF SUMO

"**S**imulation of **U**rban **MO**bility", or "SUMO" is an open source, microscopic, multi-modal traffic simulation. Traffic simulations facilitate the evaluation of infrastructure changes as well as policy changes before implementing them on the road. For example, the effectiveness of environmental zones or traffic light control algorithms can be tested and optimized in a simulation before being deployed in the real world [6].
SUMO is a free and open traffic simulation suite which is available since 2001. SUMO allows modelling of intermodal traffic systems including road vehicles, public transport and pedestrians. Included with SUMO is a wealth of supporting tools which handle tasks such as route finding, visualization, network import and emission calculation.
Its main features include collision free vehicle movement, different vehicle types, single-vehicle routing, multi-lane streets with lane changing, junction-based right-of-way rules, hierarchy of junction types, an OpenGL graphical user interface (GUI), and dynamic routing. SUMO can manage large environments, i.e., 10 000 streets.

*Features:*The simulation platform SUMO offers many features:

- Microscopic simulation - vehicles, pedestrians and public transport are modeled explicitly
- Online interaction – control the simulation with TraCI
- Simulation of multimodal traffic, e.g., vehicles, public transport and pedestrians
- Time schedules of traffic lights can be imported or generated automatically by SUMO
- No artificial limitations in network size and number of simulated vehicles
- Supported import formats: OpenStreetMap, VISUM, VISSIM, NavTeq
- SUMO is implemented in C++ and uses only portable libraries.

The SUMO package contains the following applications:

- SUMO: command line simulation
- GUISIM: simulation with a graphical user interface
- NETCONVERT: network importer
- NETGEN: abstract network generator
- OD2TRIPS: converter from O/D matrices to trips
- JTRROUTER: routes generated based on turning ratios at intersections
- DUAROUTER: routes generator based on a dynamic user assignment
- DFROUTER: route generator with use of detector data
- MAROUTER: macroscopic user assignment based on capacity functions

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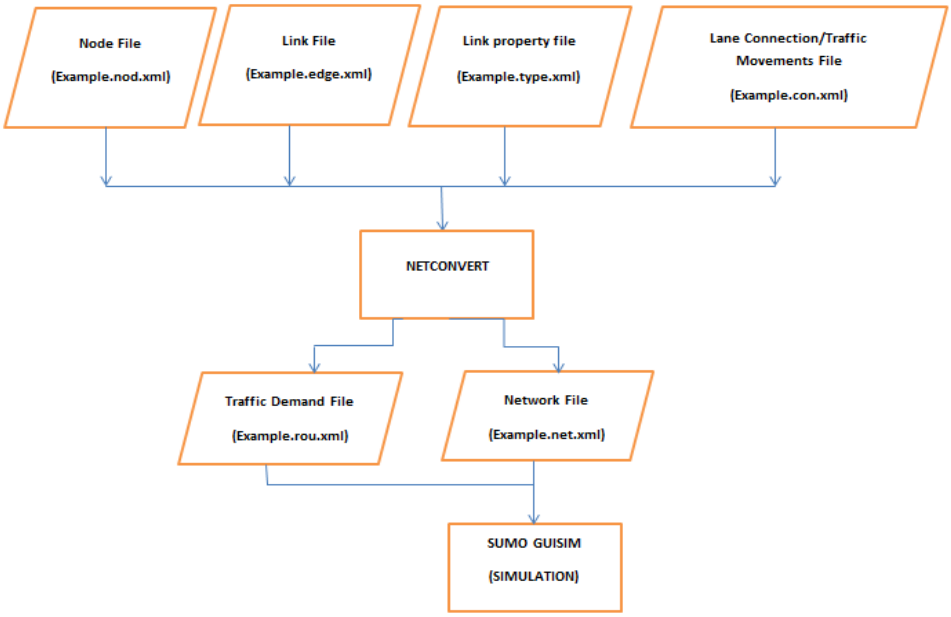

Figure2 Simulation input/output flow in SUMO

To build a network in SUMO a street network consists of nodes i.e junctions and edges (streets connecting the given junctions) are necessary.
A **SUMO** network file describes the traffic-related part of a map. It mainly contains the network of roads/ways, intersections/junctions, and traffic lights in a map

Network Format: At a coarse scale, a SUMO network is a directed graph. "Nodes" represent intersections/junctions, and "edges" roads/streets.

A SUMO network contains further traffic related information:

- Every street (edge) as a collection of lanes, including the position, shape and speed limit of every lane,
- Traffic light logics referenced by junctions,
- Junctions including their right of way regulation,connections between lanes at junctions (nodes).
- Also, depending on the used input formats and set processing options, one can also finddistricts,roundabout descriptions.

Files used in SUMO to make a Road Map:

- Node file(.nod.xml)
- Edge file(.edg.xml
- Route file(.rou.xml)
- Network file (.net.xml)
- Configuration file(.sumo.cfg.xml)

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VI. TRAFFIC INFRASTRUCTURE GENERATION OF PROPOSED MODEL USING SUMO

Section IV discusses the detailed methodologies, how to generate traffic infrastructure of any fictitious model . Based on those methodology cum steps, the following snapshots of the vehicular cloud traffic generation of the proposed model are as given in the below figure 3 and figure 4 respectively.

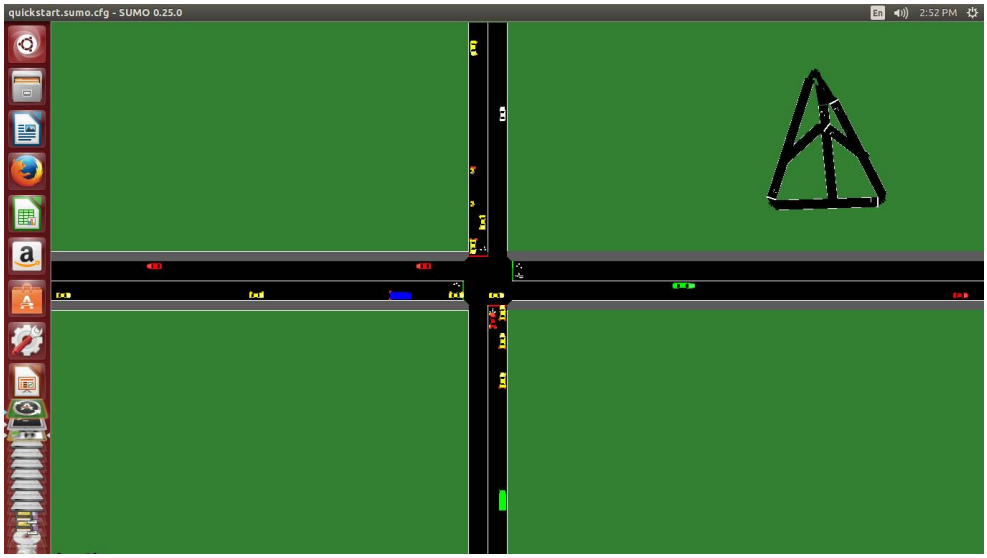

Figure 3 Infrastructure with roadside services

In the below snapshot, the different icons represent different roadside units of the roadside infrastructure as given below.

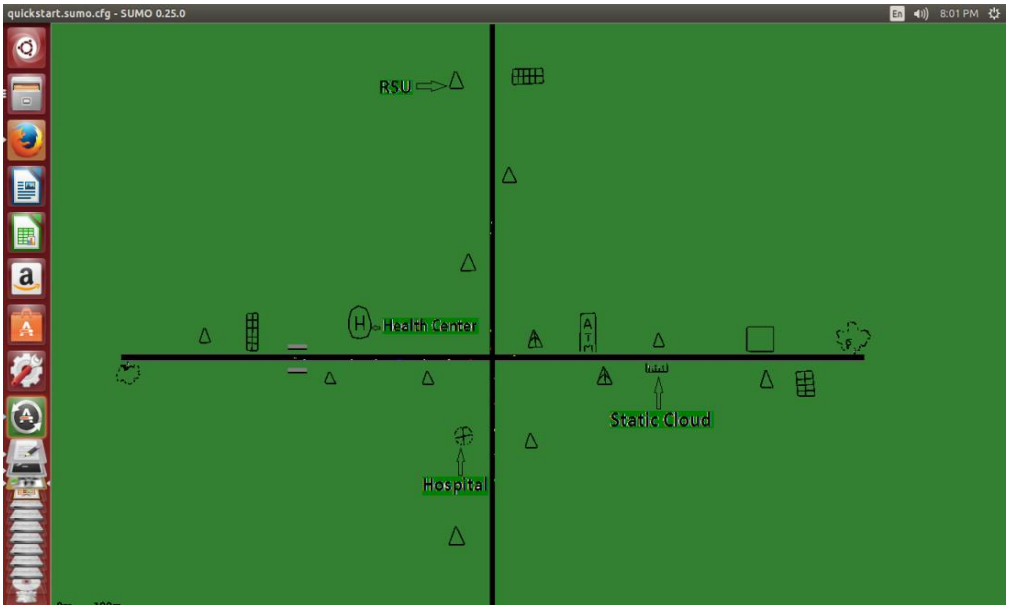

Figure 4 Road side infrastructure with traffic movement

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Table 5: Simulation parameter Description

Parameters	Values
SUMO version	0.25.0
Simulation Start time	0
Simulation End time	1000
Delay	50
No of vehicular Nodes	20

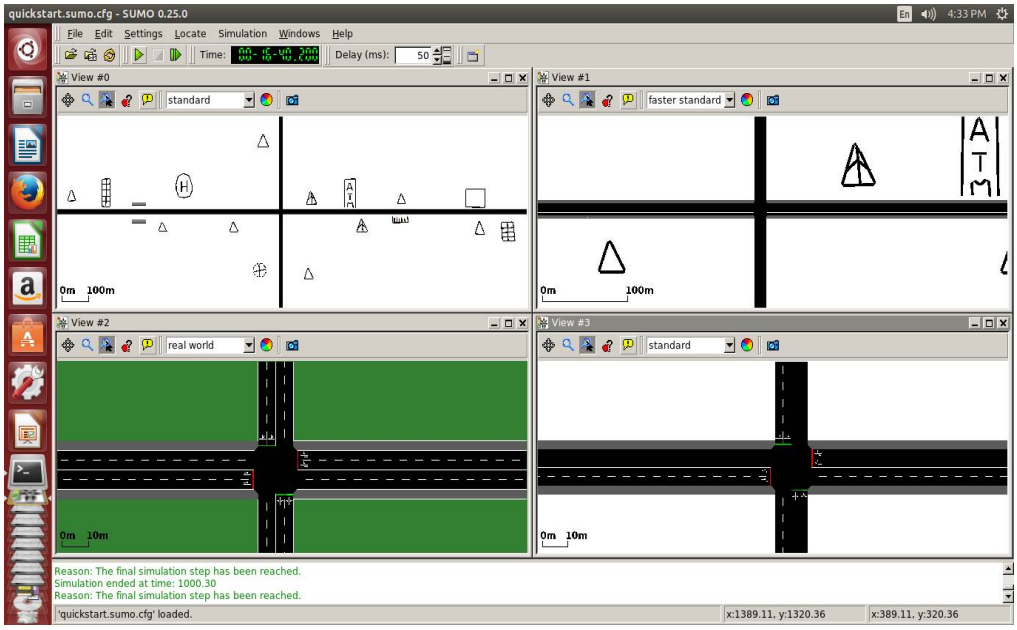

Figure 5 SUMO road infrastructure in different simulation mode

VII. CONCLUSION AND FUTURE WORK

In this paper, wehave designedthe vehicular cloud infrastructure with traffic light according to the proposed protocol using SUMO. It provides various types of services like pay as you go model services (NaaS, STaaS,DaaS,PaaS),free services (Ambulance service,crane service,police service,route broadcast service,VIP movement information etc.),static cloud service and road side service information like ATM,Hospital,Hotel, Motel,Fuel station etc. presented at RSU.Traffic simulation is performed in various modes like standard, fast standard, real world and custom as depicted at figure 5 and its simulation parameters and values are depicted at Table 5. The proposed vehicular cloud network communication protocol design has been given in this paper and its simulation canbe taken as future work.

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BIOGRAPHY

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