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Traffic Simulation of Vehicular Cloud Network Using Sumo

Amit Kumar Amar
Centre for Computer Science (Mobile Computing)
Central University of Jharkhand, India

Sanjay Kumar
Computer Science and Engineering
RanchiNIT Jamshedpur, India

Abstract- ***Due to the advent of wireless technology and cloud computing, the vehicular cloud network (VCN) have vast potential of real life application which results in growing demands among researchers. VCNs are highly dynamic wireless ad-hoc networks-nodes with high mobility. Due to improvement in vehicular technology, the vehicles are equipped with different types of on board communication (OBU) equipments, sensors, GPS system for efficient communication with different vehicles on the road or outside the road. The vehicle can also be equipped with cloud which can provide different types of services on the road to different vehicle based on pay as you go model. While people on the move, VCN plays a vital role in vehicle to vehicle (V2V)and vehicle to infrastructure (V2I) communication. It provides different types of services available on the road through the vehicular cloud (static and dynamic) andoutside the roadthrough fixed infrastructure like Road Side Unit (RSU) ubiquitously. There are variouspotential applications of VCNsused in Intelligent Transportation System (ITS).GNSS (Global Navigation Satellite System)is used for geographic location of vehicles for its different types of management. This paper is aimed to examine thereal life traffic light simulation ofvehicular cloud network traffic of two cities using SUMO.***

Keywords- VANET, VCN, OBU, GNSS, Cloud computing, ITS, RSU.

I. INTRODUCTION

Today, is the age of information. Sharing of information is very essential for day to day activity while people are at home or at move while in the train, airplane and elsewhere.Which is possible today with the advent of wireless technology. The advancement and wide deployment of wireless communication systems have transformed human lifestyles. Researchers have abstracted the idea of Vehicular Ad hoc Networks (VANETs), in which vehicles, equipped with wireless devices, communicate for safety and luxury purposes. While people are on move on the road, information can be shared, utilized, generated with the help of the vehicular cloud network.Vehicular cloud computing follows the concept of pay as you- go- model instead of buying resources and infrastructure.

VANETs allow vehicles to connect to roadsideunits (RSUs), which are fixed infrastructure equipped withpowerful computing devices. RSUs connect with vehiclesvia wireless communications and with each other via a wirednetwork. It is expected that future vehicles will be equippedwith advanced resources such as powerful computing andstorage devices, and sensor nodes [1].Such vehicles will become powerful computing machines roaming the streets. This fact motivates the idea of making use of these vehicles' resources in a cloud computing environment that exploits the capabilities of such vehicles as mobile cloud servers.Cloud computing is ubiquitous on-demand services of computing and it uses resource pooling according to users need. It provides heterogeneous services like storage, platform, software, infrastructure, etc.

The basic idea behind cloud computing is to allow usersto make use of the idle resources that reside on powerfulnetwork servers. Businesses may rent the infrastructure andsometimes the needed software to run their applications [2].In VCNs, Vehicular Clouds are distinctive in that cloudservers are mobile vehicles that have high resources and/orInternet access capabilities, whereas consumer vehicles are a normal vehiclethat desire to access these resources or gain Internet access on a paid basis. Toachieve this, consumers need to discover the mobile cloudservers, know their resources, and to communicateandrequest resources from them[3].The rest of the paper is organized as follows: A brief overview of Vehicular cloud computing is presented in section II. The description of SUMO is presented in section III. In section IV real life traffic simulation of vehicular cloud network using SUMO is presented.

II. OVERVIEW OF VEHICULAR CLOUD NETWORK

A group of vehicles whose corporate computing, sensing, communication and physical resources can be coordinated and dynamically allocated to authorized users[4].Vehicular cloud has different characteristics like autonomy, mobility, etc. Vehicles are connected to each other through an ad-hoc network. In a vehicular cloud network, nodes have high mobility and network topology are also rapid changes overtime. The main supports of vehicular cloud are from fixed infrastructure. Real time data exchange is performed among the moving nodes and fixed infrastructures.Network size is not fixed, it may be increased or decreased depend on traffic density. Vehicular cloud can be formed on the basis of static and dynamic nature of nodes. If some nodes that is vehicles are parked inthe parking area or garage then they can make a static cloud, but when vehicles moving along the roadside, they can share information and cloud facility then it acts as dynamic clouds. Parked vehicles and running vehicles have different types of unutilizedresources.

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A. Architecture

The vehicular cloud network consists of road infrastructure,road side unit infrastructure, vehicles either moving on the road or static at the parking area with cloud infrastructure and without cloud infrastructure is as shown in the fig 1.

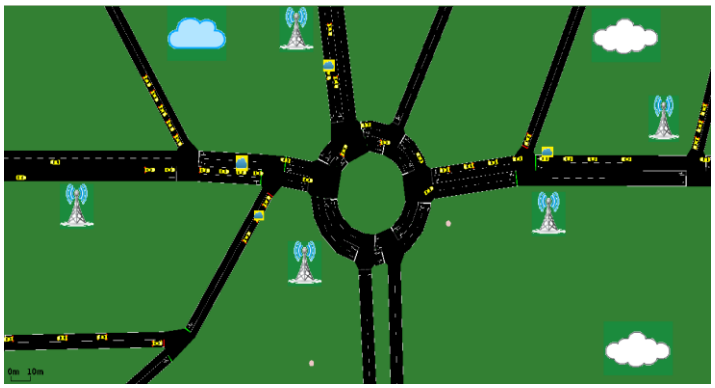

Fig 1 Vehicular cloud network (VCN) architecture

B. Services

Cloud computing has a facility to compute and store information without any fixed infrastructure for a client. There is no need to buy or invest on to purchase of infrastructure for a vehicular client rather than it would be provided by the cloudas a pay as you go model. There are two types of services 1. Paid services like. Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Network as a Service (NaaS), Storage as a Service (STaaS) etc. 2.Free services like ambulance service, police service, route broadcast service/traffic diverts information, VIP movement information, crane servicesetc. are provided by the government to assist the administration for better and quicker services to the vehicular client.

*Communication of vehicles:*Communication plays a crucial role in information sharing. There are two types of communication inthe vehicular cloud network. (i)Vehicle to vehicle communication (V2V): Vehicle to vehicle communication on the road for getting and providing the services according to their term and conditions.(ii)Vehicle to infrastructure (V2I): Vehicle to infrastructure communication is used to get roadside services and internet services to communicate with the outside world ubiquitously.GNSS (Global Navigation Satellite System) is used for finding its position on different geographical position in case of any adverse condition.

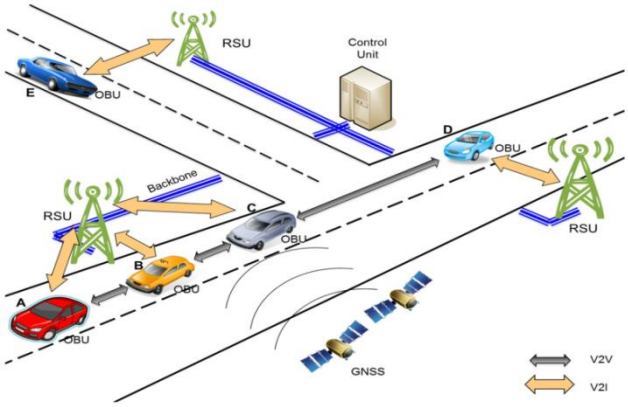

Fig 2 V2V and V2I Communication [11]

III. BRIEF DESCRIPTION OF SUMO

"Simulation of Urban MObility", 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 [5].

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.

*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.

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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.

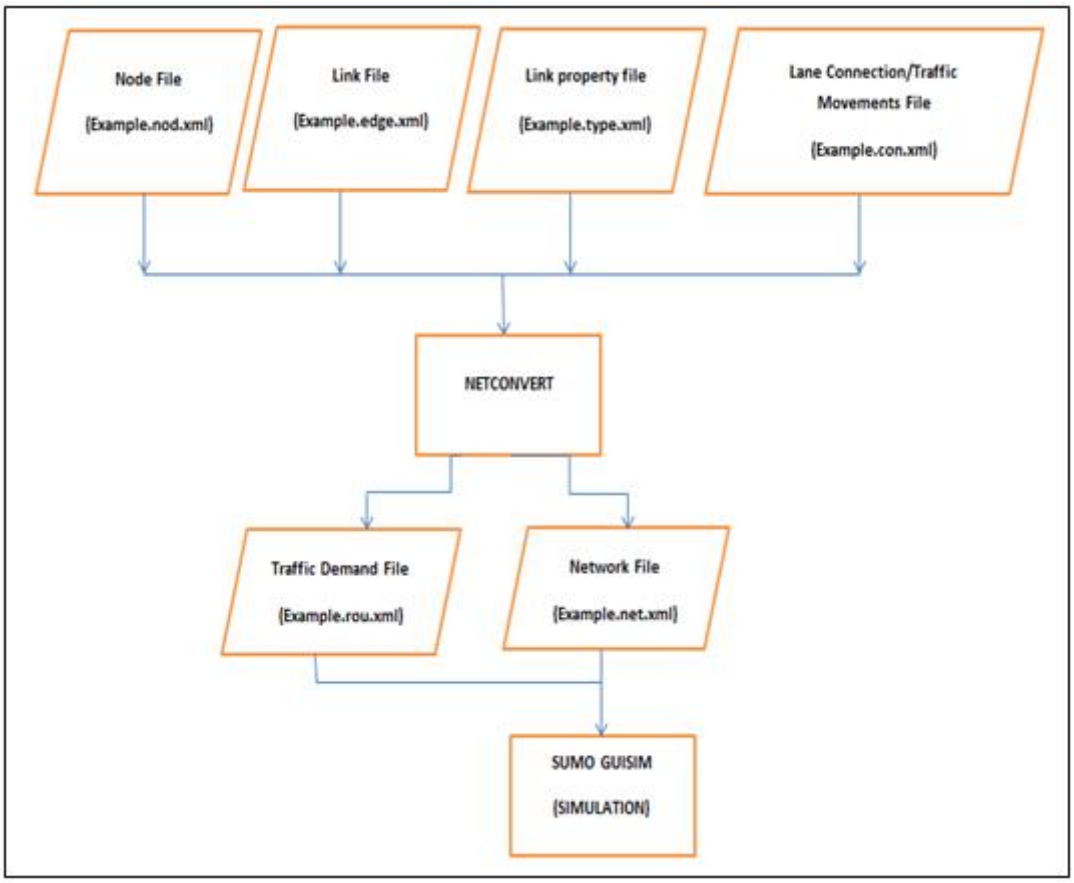

Fig 3 Simulation input/output flow in SUMO

IV. IMPLEMENTATION OF TRAFFIC LIGHT SIMULATION

The evaluation of developed traffic light programs or algorithms for making traffic lights adapt to the current traffic is one of the main applications for microscopic traffic flow simulations.The first investigations were performed by implementing the traffic light algorithms to evaluate directly into the simulation's core [6].

A SUMO network file describes the traffic-related part of a map [9], the roads and intersections the simulated vehicles run along or across. At a coarse scale, a SUMO network is a directed graph. Nodes, usually named "junctions" in SUMO-context, represent intersections, and "edges" roads or streets. Note that edges are unidirectional. Specifically, the SUMO network contains the following 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.

SUMO-Networks can be represented by two ways:

(i) A set of plain-xml files which describe the network topology and geometry

(ii) The .net.xml file which is loaded into the simulation. This contains lots of generated information such as structures within an intersection and right-of-way logic.NETCONVERT can convert freely and without information loss between these two formats. Only the plain-xml format is meant to be edited by the users. In contrast, the .net.xml format has lots of subtle interdependencies between its elements and should never be edited by hand. The plain-xml format is described below.

It is possible to load a net.xml file along with plain-xml patch files into NETCONVERT to modify some aspects of an existing network.

To define a network at least two files are needed: one file for nodes and another one for the streets between them. Note that herein, "node" and "junction" mean the same as well as "edge" and "street" do . Besides defining the nodes and edges, we can also join edge attributes by type and set explicit connections between edges or lanes.

Some xml sample codes are as follows:

Normal Edges:

A "normal" edge is a connection between two nodes ("junctions").

```
<edge id="<ID>" from="<FROM_NODE_ID>" to="<TO_NODE_ID>" priority="<PRIORITY>">
    ... one or more lanes ...
</edge>
```

Lanes:

Each edge includes the definitions of lanes it consists of. The following example shows a single edge with two lanes. Note, that coordinates may be 2D as well as 3D coordinates.

```
<edge id="<ID>" from="<FROM_NODE_ID>" to="<TO_NODE_ID>" priority="<PRIORITY>">
<lane id="<ID>_0" index="0" speed="<SPEED>" length="<LENGTH>" shape="0.00,495.05 248.50,495.05"/>
<lane id="<ID>_1" index="1" speed="<SPEED>" length="<LENGTH>" shape="0.00,498.35,2.00
248.50,498.35,3.00"/>
</edge>
```

Traffic Light Programs:

A traffic light program defines the phases of a traffic light.

```
<tlLogic id="<ID>" type="<ALGORITHM_ID>" programID="<PROGRAM_ID>" offset="<TIME_OFFSET>">
<phase duration="<DURATION#1>" state="<STATE#1>"/>
<phase duration="<DURATION#1>" state="<STATE#1>"/>
</tlLogic>
```

Polygon type file:

```
<polygonTypes>
<polygonType id="natural.land"name="land" color=".98,.87,.46" layer="-4"/>
</polygonTypes>
```

Route file:

```
<routes xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="http://sumo.dlr.de/xsd/routes_file.xsd">
<vehicle id=”0” depart=”0.00”>
<route edges=”234 456 1223 3435435/>
</vehicle>
</routes>
```

Configuration file:

```
<?xml version="1.0" encoding="iso-8859-1"?>

<configuration xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="http://sumo.sf.net/xsd/sumoConfiguration.xsd">
<input>
<net-file value="ranchi.net.xml"/>
<route-files value="ranchi.rou.xml"/>
<additional-files value="ranchi.poly.xml" />
</input>
<time>
<begin value="0"/>
<end value="1000"/>
<step-length value="0.1"/>
```

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```
</time>
<time-to-teleport value="-1"/>
</configuration>
```

Additional file:

```
<additional xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="http://sumo.dlr.de/xsd/additional_file.xsd">

<poly id="287428884" type="amenity" color="237,199,199" fill="1" layer="-1.00" shape="845.97,454.60
869.70,514.85 876.64,545.32 836.80,562.68 805.60,472.51 807.75,468.68 814.87,468.04 845.97,454.60"/>

</additional>
```

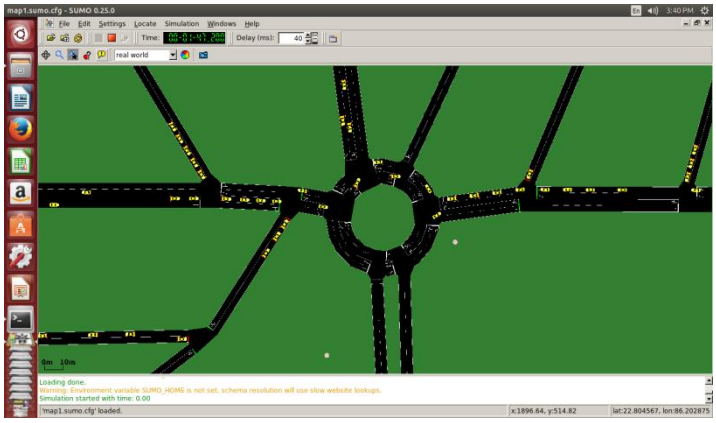

Fig 4 Snapshot of SUMO simulation of Sakchi Square of City Jamshedpur (India)

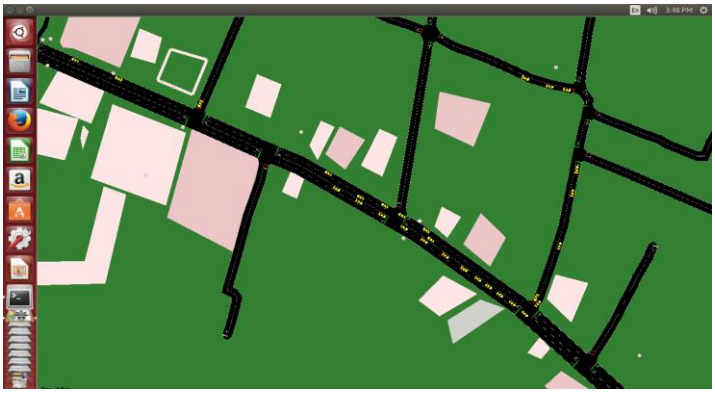

Fig 5 Snapshot of SUMO simulation of Lalpur Square of City Ranchi (India)

V. CONCLUSION AND FUTURE SCOPE

The vehicular cloud network will support Intelligent Transportation System (ITS). It will providethe services ubiquitously as per request of the vehicular clients. In this paper,road infrastructure creation and traffic light simulation of two real life road network of the specific location of the cities Jamshedpur and Ranchi, India are being presented using SUMO. For future work, We will study the network simulation of the VCN using AODV routing protocol and different performance graph will be plotted based on different network metrics like packet delivery ratio, throughput, goodput , data transfer rate and end to end delay etc.

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