Cloud Computing Model For Vehicular Ad Hoc Networks

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Abstract- *Cloud computing has become a significant network access model due to its transparent and ubiquitous sharing environment with a large number of computing resources. Cloud computing services have the potential to improve vehicular network services through its flexible and valuable services. These cloud network services improve the performance of the vehicular application by advance communication, traffic management, standardization and safety systems. In vehicular ad hoc networks, vehicle nodes carry more information by adopting cloud computing services and improve their sensing power, storage capabilities, and onboard computing services. Vehicular cloud computing is one of the emerging solutions to address the vehicular networks communication barriers with new hybrid technologies and remarkable storage features for traffic management and road safety by instantly using vehicular resources. We proposed a dissemination protocol for urban VANET scenarios. Each vehicle must build a subgraph to identify the relay node to continue the dissemination process. Based on the local graph, it is possible to select the relay nodes based on complex networks' metrics. Simulation results show that our model offers high efficiency in terms of coverage, number of transmitted packets, delay, and packet collisions compared to well-known data dissemination protocols.*

Keywords- Cloud Computing, data dissemination, packets, subgraph, VANET, Vehicular applications

I. INTRODUCTION

Recent advancement in communication technologies has introduced new and emerging vehicular communication systems with unlimited features to provide safety and comfort in the transportation sector. Vehicular Ad hoc Networks (VANETs) are based on a set of communication systems in which the moving vehicle nodes are able to communicate with each other for different applications. The main aim of these networks is reducing the traffic accidents which are caused by deaths and injuries. These communication systems are equipped with smart and digital traffic navigation, congestion control, and management systems to improve traffic conditions in the network. Due to high the mobility and dynamic nature of traffic in these networks, the communication systems have been suffered from dis-connectivity, delay, packet dropping and limited storage challenges. Furthermore, the environmental obstacles attenuate radio signals and disturb data transmission. Some costly adopted services also make these networks and communication systems more complex. The pervasive roadside infrastructure offers high-speed internet access by advanced wireless communication technologies (3/4/5 G, WiMAX, LTE) and brings innovative and divergent benefits for travelers.

Mobile Cloud Computing (MCC) offers various services for VANETs in which the data processes anytime and anywhere in the network. In MCC, the drivers are using mobile devices for communication, which are connected with the cloud through the internet. The MMC dispenses the requisite environment to incorporate with other technologies for monitoring the road safety by processing the data with the help of divergent mobile cloud architectures such as Platform as a Service (PaaS). Although, the mobile devices have restricted due to limited battery life, limited processing capabilities, limited data accessing and other computing resources. These types of services are time consuming and costly due to real-time data processing such as traffic jam data processing, accident detection messages transmission. Vehicular Cloud Computing (VCC) utilizes desired features to serve drivers more precisely. The main aim of VCC is providing low-cost computational services and improving the performance of VANETs applications. VCC also minimizes the traffic congestion issues with better Quality of Services (QoS) and manages traffic conditions in the network. New solutions of VCC are technically expedient for ITSs to improve traffic management services in VANETs.

II. RELATED WORKS

Bitnam.S, Mellouk.A, Zeadally.S proposed a system based on two sub-models: permanent and temporary clouds. The VANET-Cloud model consists of three layers. The client layer is formed by different cloud end users. The cloud layer is based on stationary data centers and mobile ones such as vehicular resources. To ensure communication between the client layer and the cloud layer, a third communication layer is proposed. The proposal provides digital services such as software, computational infrastructures, and platforms to VANET users at a High cost. We aim at low cost.

Ryangsoo Kim et al devise a vehicle route-based data prefetching scheme, which maximizes data dissemination success probability in an average sense when the size of local data storage is limited and wireless connectivity is stochastically unknown. We propose a greedy algorithm and an online learning algorithm for deterministic and stochastic cases, respectively, to decide how to prefetch a set of data of interest from a data center to roadside wireless APs.

Nicholas S. Samaras et al presents a novel mobile applications and services in vehicles and transportation infrastructures. The development of inter/intra-vehicle and infrastructure-to-vehicle communication is one of the most challenging and critical issues for the ITS industry and data dissemination is crucial to the successful development of such systems. In this paper, we attempt to establish a basic framework on how pertinent is the use of some well-known Mobile Ad Hoc Networks (MANETs) routing algorithms in the analysis of data dissemination in VANETs.

Joahannes Costa et al proposes a VANET application can detect, control and reduce traffic congestion based on data that describes traffic patterns. However, disseminating data in VANET is a challenging task, due to its particular characteristics, i.e., heterogeneous density, short-range communication, and node mobility. Since, existing protocols for data dissemination do not effectively address the high overhead, in this paper, we proposed a Data Dissemination protocol Based on Centrality (DDBC) for urban scenarios.

Xiao Chen et al presents a trusted data dissemination claims our high attention. Besides the traditional public key scheme, this paper explores security issues of data dissemination through associating drivers' social relationships with vehicles in order to construct a trusted vehicular social network. Furthermore, a compositional formal approach on Performance.

Inshick Kim et al considers a data dissemination problem for vehicular cloud systems, in which delivery services from a data center provide data to vehicles through roadside wireless access points having local data storages. We propose a greedy data prefetching algorithm; by exploiting the completely predictable route information and the stochastic characteristics of the communication with APs, the algorithm predetermines how to distribute a set of data from a data center to local data storages, and minimizes the amount of data dissemination.

Yuanzhi Ni et al investigates data dissemination in hybrid vehicular networks, where messages generated at vehicles should be uploaded to the roadside unit (RSU) assisted by vehicle-to-vehicle (V2V) communications, using vehicles traveling in both directions as relays. The objective is to optimize the resource utilization and reduce the data delivery delay. We first analyze the data uploading capacity and delivery delay in hybrid vehicular networks with the store-carry-and-forward mechanism. Applying the analytical results and given the traffic and data information, a distributed multisource scheduling algorithm is proposed. Extensive simulations are conducted to verify the correctness of the analysis.

Tobias Meuser et al proposes a prediction-based assessment of the relevance of events without requiring prior route knowledge. Relevance is modeled based on the street network and spatio-temporal characteristics of events. We evaluate our approach in a realistic city setting, relying on the SUMO vehicular mobility simulator.

Revati et al proposes an approach which uses fuzzy logic, with the help of fuzzy logic tool box in MATLAB software, to choose the forwarding nodes and uses network coding to reduce the number of retransmissions. By means of fuzzy logic, the best forwarding nodes are selected which further transmit the messages. By integrating network coding with the fuzzy logic based forwarding, we significantly reduce the number of required transmissions and thus enhance the efficiency for disseminating messages in VANET system.

Muhammad FaranMajeed et al proposes a proactive data dissemination scheme for pushing critical content to one-hop neighbours in VNDN. Producers of critical content first send a beacon message containing metadata about tentative new chunks. Upon receiving the beacon message, neighbors make temporary pending interest table entries, allowing them to subsequently store new chunks once received.

Chen Chen et al proposed a new data dissemination scheme in this paper. Our scheme aims at disseminating the shopping information cached in RSUs. We adopt the Information Centric Network (ICN) in forward mechanism and take both pull-based and push-based in to account. At the same time, our communication model combines V2V and V2I. In this way, our scheme improves the performance of traditional data dissemination and makes in-car shopping a reality. In addition, in order to avoid broadcast storm and the waste of resources, Distance Based Forwarding (DBF) is employed in broadcasting when vehicle desire a content unit. A computing method of XOR is also adopted in RSUs to avoid information redundancy.

III. PROPOSED SYSTEM

The vehicles form a mobile adhoc network called VANET. Every vehicle will be connected in the temporary network and the real time information about their positions and basic surrounding things are sent to the cloud. All the information is stored in the Cloud computing model and it computes for any nearby accidents or predicts for collisions. If any accident occurs it informs the other nearby travelling vehicle in that region to stop and go slow, thus preventing further more collisions.

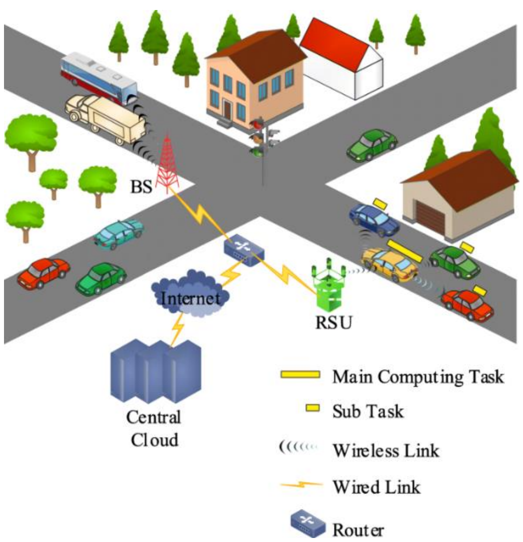

Fig 1: VANET using Cloud

A. Assumptions and Requirements

VANET requires the consideration of three different models: road layout, mobility, and communication. For the urban road layout, we consider a realistic city map. For vehicular communication, we assume a vehicular environment where each vehicle is equipped with On-Board Unit (OBU).

An OBU is a communication device that consists of a processor, memory resources for data storage and retrieval, a user interface to visualize communication, and a network device based on IEEE 802.11p. An OBU logically consists of NIC (physical and MAC layer), networking layer and application unit. Each vehicle can directly communicate via its OBU with vehicles within its transmission radio range. We also assume the existence of a navigation system based on Global Positioning System (GPS) to provide location information for each vehicle. Messages are in the form of WAVE Short Messages, according to the IEEE WAVE standard for Wireless Access in Vehicular Environments. In the following we define the basic terms used:

- Broadcast Initiator: is the vehicle which originates a new message and intends to distribute it to nearby vehicles.
- Relay Vehicle: is the vehicle which updates traffic condition before rebroadcasting a message that was originally initiated by another vehicle.
- Area of Event (AoE):is the road or intersection where an event occurs and a message is initiated to indicate that event.
- Area of Interest (AoI): is a wide area in the selected map where data should be delivered with the highest possible ratio.
- Approaching Vehicle: is the vehicle which is moving towards the relevant AoE.
- Receding Vehicle: is the vehicle which is moving away from the relevant AoE.

B. Message Format

Data messages are WAVE Short Messages defined according to Wave Short Message Protocol (WSMP), which facilitates communication among vehicular safety applications.

The message has the following structure:

<Message ID, Timestamp, Broadcast Initiator ID, Broadcast Initiator's Coordinates, Sender ID, Sender Road ID, Sender's Coordinates, Traffic Condition Factor, Data, Number of Hops>

A data message requires 100 bytes when neglecting the size of the data field, which depends on the application. IEEE 802.11p standard allows for a maximum message size of 2312 byte. A unique Message ID, Timestamp, Broadcast Initiator ID and Coordinates are attached to every message upon creation. These fields refer to message identification and broadcast initiator information that never changes, such that receiving vehicles can distinguish different messages with their relevant AoE. In specific, the combination of message ID and Broadcast Initiator ID enables receiving vehicles to uniquely identify different messages, while Broadcast Initiator's Coordinates field indicates the geographical coordinates of the initiator when the traffic event has occurred. Therefore, it is utilized by receiving vehicles to refer to the relevant AoE at any time instance. Sender ID filed identifies the ID of the direct relay vehicle, which is updated at each hop along with Sender's Coordinates field. Dynamic traffic information can be extracted from the sender's coordinates such as its current road and direction, in addition to static data related to the road itself.

Moreover, receiving vehicles rely on the latter field to determine their distances to the sender. Each forwarding vehicle provides an indication of the traffic condition and attaches it to the Traffic Condition Factor field, such that receiving vehicles can adapt their broadcast suppression accordingly. Traffic data to be delivered is included in the Data field. Whenever a message is relayed, the number of hops is incremented and the related field is updated to reflect the propagation distance.

C. Data Dissemination

The proposed system is a delay-based data dissemination protocol that offers multi-directional broadcast mitigation in multi-hop manner, in order to support different types of applications in the context of urban vehicular environments. The broadcast suppression allows for selecting fewer vehicles as relay nodes to forward data further, by assigning vehicles to different timeslots according to traffic condition. A timeslot can be defined as the period of time during which a scheduled broadcast waits before disseminating the scheduled message or discarding it.

The broadcast initiator originates a broadcasting session and sends data messages to all one-hop neighbors. Receiving neighbors utilize the traffic condition data included in the received message to set the total number of timeslots accordingly. Each receiving vehicle can then determine its waiting delay based on its timeslot. A relay vehicle attaches traffic condition from a local point of view to the message to be forwarded, such that the receiving vehicles would be able to assign their broadcasting delays consistently.

Relay vehicles are most likely the farthest vehicles, since they always have the shortest delays. It operates on top of the MAC layer, as follows: A broadcast initiator creates a message and broadcasts it to its one-hop neighbors. Upon receiving a message, a receiving vehicle checks if it has already received a copy of the same message. If so, it checks if it has already scheduled an instance of it. A receiving vehicle suppresses a scheduled broadcast if any of these three conditions apply: receiving a duplicate from the same road it is currently driving in, receiving a duplicate while approaching the relevant AoE, or receiving a duplicate while receding the relevant AoE from a farther relay. This way, the integrated broadcast suppression does not prohibit broadcast in different directions.

If a receiving vehicle with a scheduled broadcast overhears the dissemination of the same message in another direction, it does not suppress the scheduled broadcast, so as not to prevent data dissemination in its direction. Whenever a new message is considered, the receiving vehicle calculates the total number of timeslots by utilizing the road condition data, and then it determines to which timeslot it belongs, using location information. After that, it schedules a rebroadcast with delay timer that is convenient with its timeslot. Delay calculations are explained later in this section. The farthest vehicles have the shortest waiting delays as they belong to the first timeslot and therefore they have the highest priority to act as relays. Vehicles assigned to other timeslots have longer waiting delays such that they have sufficient time to suppress their scheduled broadcasts if any suppression condition applies. Whenever a vehicle acts as a relay, it attaches an indication of the traffic condition to the forwarded message, such that receiving vehicles can estimate traffic condition accordingly. This way, traffic condition is updated by relay vehicles at each hop.

To reflect the impact of queuing in urban intersections, it considers a square area around intersections defined as Intersection Zone (IZ). Vehicles entering IZs decelerate until stopping at a traffic signal or stop sign, while vehicles exiting IZs accelerate until driving at the maximum possible speed. Therefore, vehicles driving at IZs do not report their speeds, because it accommodates the road layout and does not reflect traffic condition.

D. Neighbourhood Knowlegde Discovery

The protocol takes advantage of beacons that are already exchanged by vehicles to obtain the contextual knowledge of its neighbors, avoiding extra overhead. Specifically, each vehicle vi transmits periodic beacons by default containing its id id and other information, where it includes the information about its current position Li(x, y), and its 1-hop neighbors N(vi). Upon receiving such beacon, vehicle saves/updates such information on its list of neighbors list N(vi), constructing an edge-induced subgraph G_E_u_ with contextual knowledge about 2-hop neighbors for each nearby vehicles u ∈ list N(vi). This represents the connection links between the vehicle vi with its 1-hop and 2-hop neighbors since building a subgraph with a global knowledge increases the overhead and inaccuracy, due to the topology changes caused by moving vehicles.

E. Relay Selection

In the relay node selection step, it considers two complex networks' metrics: i) degree centrality, and ii) betweenness centrality. The degree centrality reflects the popularity of a given vertex in the graph in terms of the number of neighbors computed based on Equation.

$$G(i) = \sum_{j=1}^{n} a_{ij}$$

Where, i means the vehicle that wants to find its degree centrality, j represents all other vehicles, n is the total number of vehicles, and a denotes the adjacency matrix, in which the cell $a_{ij}$is set to 1 if there is connection to the nodej and 0 otherwise.

F. Subgraph Operation

Input: MSG // Message received
Output: // Retransmission of MSG
begin
if v is inside in AoI then
if new message then
if v ∈MSG.relays then
list(Nvi); // Neighbors list
idRelays ←processGraph(list(Nvi));
addidRelays in MSG.relays;
st ←simTime() + uniform(0.0, 0.05);
scheduleAt(st, sendMessage(MSG));
else
ifMSG.isScheduled() then
cancelEvent(sendMessage(MSG));
discard MSG;
else
discard MSG;

Introduces the processing of a data message required for the operation, where the protocol selects only the vehicles that are inside the AoI to relay the message MSG. Besides, a vehicle only performs there transmission as soon as it is the first time it is receiving MSG and has been indicated as a relay node in the fieldrelays contained in MSG which decreases the number of redundant messages and packet collisions considerably. Hence, the list of neighbors is used to create the subgraphG_E_u _ to select the best neighbors used to continue the retransmission process., The selected relay node identifiers ids are included in the field MSG.relays, and then a relay scheduling time st that follows a uniform distribution (st∈[0.0, 0.05]) is established.

IV. PERFORMANCE ANALYSIS

We have compared our model with the existing model i.e. EDDP in various parameters such as density vs coverage, density vs relay nodes, End to End latency, Packet Delivery ratio and Throughput. We have used Xgraph to show the efficiency of our model in the above mentioned aspects. The screenshots of the comparisons have been attached below.

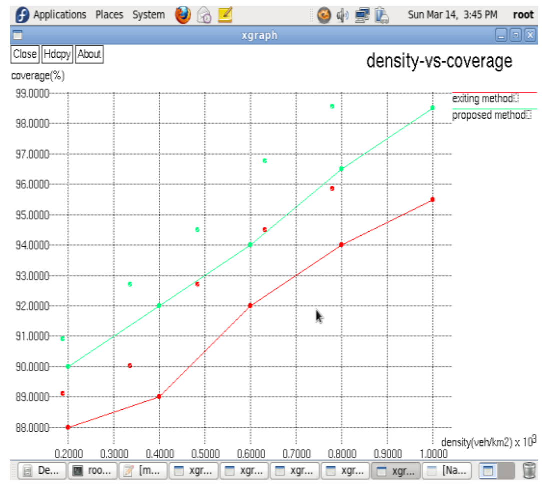

Fig 2: Densiyvs Coverage

Fig 3: Densiyvs Relay nodes

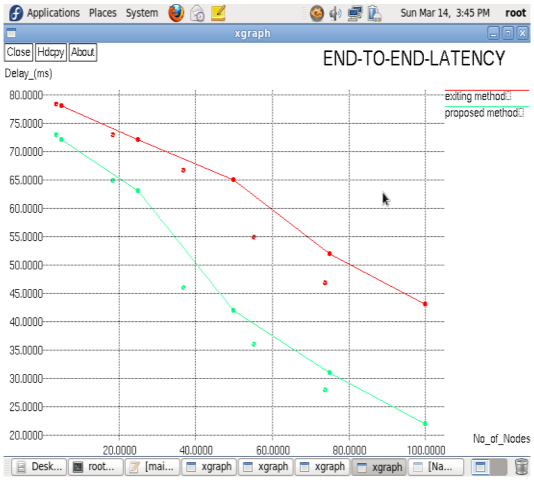

Fig 4: End to End Latency

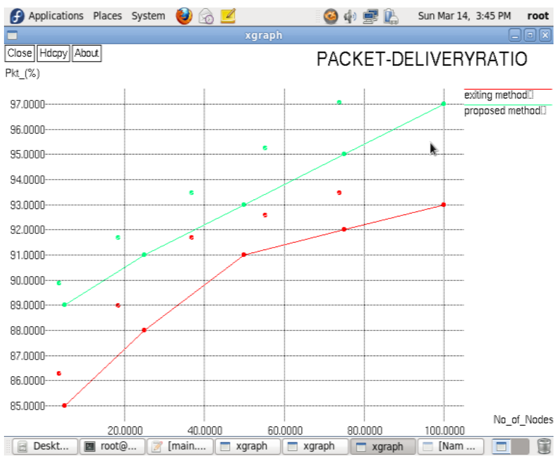

Fig 5: Packet Delivery ratio

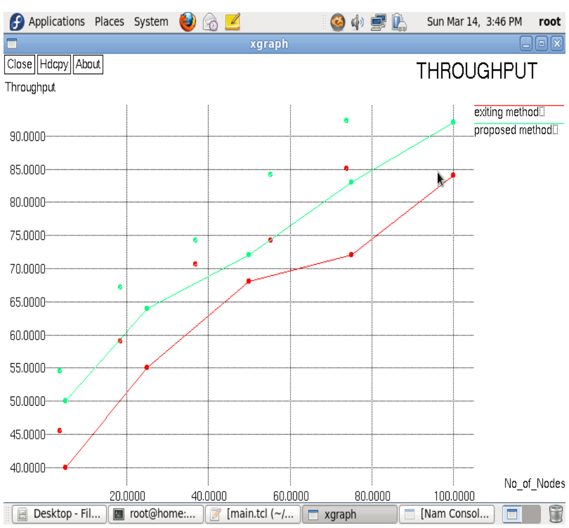

Fig 6: Throughput

V. CONCLUSION

The Vehicular cloud model has made only the source nodes, which are selected accordingly and they alone are used for sending and receiving data into the cloud in our case i.e. the road side units, all the other nodes will send and receive data to the source nodes making it more flexible than the existing systems. It provides cloud services to vehicular users to avail low cost computational and other services. It can also enhance the traffic management services and improve road safety by gathering and sensing traffic data from vehicles and roadside units. The proposed model can help the drivers and passengers to avail their computing needs during travel. The model can support various services allowing road users to avoid road accidents and collisions.

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