Mobile Agent Based QoS Provision with Bee Communication in Vehicular Network

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Abstract - The vehicular ad hoc network (VANET) is one of the most favorite models for intelligent Transport System (ITS) to provide safety and comfort on road. The high speed mobility and the intermittent connection features of the VANET make Quality of Service (QoS) provisioning a challenging task for the delay sensitive applications. In this research, we use intelligent mobile agents to improve the efficiency of VANET traffic and ensure sustainability of the network. The propose scheme is inspired by the concept of biological paradigm of communication between bees when searching for food. The mobile agent architecture is used to exchange status information among the nodes for high quality data transmission. These are achieved by calculating the corresponding QoS provision values based on QoS metrics before selecting the optimal, reliable and stable route between the source and the destination. Simulation results show the proposed scheme can robustly improve the routing performance in term of network throughput, packet loss rate and effectively reduces the network delay.

Keywords - QoS routing, Bee Communication, Mobile Agent, VANET.

I. INTRODUCTION

Vehicular Ad Hoc Network (VANET) is a cornerstone of the envisioned areas for improvement that has been identified as the model technology and favorite network design for Intelligent Transportation Systems (ITS). It makes use of mobile vehicles, as a wireless router to connect in a wider range (approximately 100 to 300 meters) in order to form a mobile network. Many injuries and loss of lives on roads worldwide are being reported due to car crashes. These perhaps provide the potentials that are meant to improve vehicles communication, and to increase road safety [1] [2], traffic efficiency and convenience. It should therefore be upon implementation, gather and disseminate safety information by warning drivers about the danger before they actually face it [3]. Use of multimedia applications for real-time communication in vehicular network has created the demand for QoS provision and ensures reliable route to meet QoS requirements [4].

The concept of biological bee communication in the past decade has trends to invade vehicular network domain. The rationale behind VANET was for driving comfort and safety of passengers on road. Due to the nature Inter-Vehicle Communication (IVC), transmission of real-time safety messages in VANETS is crucial and time sensitive. The real-time messages from source to destination need to be transmitted within due time with less delay bound. Data packets that surpass the transmission time limit will be discarded, thus resulting in packet loss. To improve packet delivery ratio as well as optimizing data packet transfer in these applications is challenging task in VANET.

Several researchers embark on this research to preserve the evolutional pace in networking breakthrough. The motivation behind this effort is to devise new methodologies and tools for managing communication system to utilize the dynamics and understand the essential model of biological system. These provide such environment with network information that are intrinsically adaptive, scalable, self-healing, and heterogeneous as well as service applications. A service could be stamped by certain set of constraints impose on the prior to path selection. The features are supported by yet another essential area of interest; the mobile agent. Agent-based schemes which consist of static or mobile agent have been proposed for flexibility, scalability and efficiency to the distributed computing [5, 6, 6]. Due to the dynamic topology variations, high vehicle mobility, unpredictable driver's behaviour that leads to frequent intermittent link connection and limited wireless channel bandwidth make provision of QoS complex and challenging task. The difficulties in predicting link states in such network tend QoS studies to focus only on several constraints. Among the constraints is packet loss, end-to-end delay or bandwidth. Packet lost and end-to-end delay are inversely proportional to each other in this mechanism.

However, one of several challenging tasks from the implementation of VANETs is the design of routing protocol with guaranteed quality of service (QoS) constraints. QoS provisioning is to attain more deterministic network behavior making the network information to be delivered better as well as to utilize the network resources. However, there still remains a significant challenge to provide QoS solutions and maintain end-to-end QoS in routing message in high mobility vehicular environment. Routing is a key factor that determines how much of the ideal performance could be realized. QoS routing is an imperative difficult task for data packet routing among VANET nodes to guarantees quality delivery to delay sensitive applications terms of bandwidth and delay.

At this extent, AODV with QoS extensions were presented in [7] to provide Quality of Service (QoS) for high quality data delivery. The extension intensifies the service requirements needed by nodes during route request/route reply broadcast/rebroadcast. Ultimately, it specifies to ensure a minimum delay or to ascertain available network capacity (bandwidth) exist long a route between any communication end points. More so, [8] proposed a QoS routing protocol utilizes bandwidth as QoS metric on the identified route based on AODV routing strategies. However, mobile agents can better address these issues in VANET.

In this paper, we propose an intelligent agent based network that can provide three (3) different forms of agents based on bee communication paradigm, as describe in section III. The communication systems of this next generation however, deem to be envisioned as a complex system involving several communication devices. These devices differ in certain capability with wireless sensors equipped to mobile vehicle as well as wireless access devices.

II. QOS ROUTING GUARANTEES

The term Quality of Service (QoS), as its name implies, describes how a user is satisfied with a service offered by a provider [9]. There is an example in reference [10] for the notion of QoS with lively description: Because the frequency of eye blinking is one fiftieth of a second, if the video series appear on the monitor (such as CRT) at the rate of 25 to 30 frames per second, the viewer will sense the automation of the picture. But if the some frames are interrupted by the packet loss or delay on Internet, the human eye's receiving system will sense the non-continuity of the pictures. The human ear receiving system has the anti-jamming ability against the minor distortion of the signal. . The loss rate of the audio signal less than 5% to 10% is acceptable, according to different coding system. Information loss is due to the no periodic noise or loss of syllable. As for IP telephone, the long end-to-end delay will make the receiver wait a long time to speak. In some audio double-way communication, the high delay causes the communication failure.

Routing is a key factor that determines how much of the ideal performance could be realized. However, routing is the main function of a router, and an important part of whole process of communication. Routing a packet is also called Path Determination [11] that occurs at network layer, and enables a router to evaluate the available paths to destination, and to establish the preferred handling of a packet. Routing services use network topology information when evaluating network paths. It consists of two basic tasks: the first is to collect the state information and maintaining up-to-date information about the network behavior. The second is to find a feasible path to destination based on QoS requirements [12].

QoS Routing guarantees QoS of traffics in the form of routing algorithm. Apart from the correct transmission of data, the QoS routing algorithm is also responsible for the guarantees that meet the QoS constraints of traffic. It requires a routing algorithm that can intelligently efficiently identify the urgency of the traffics and treat them separately.

One of the major properties of efficient routing is the ability to provide end-to-end guarantees, such as delay and packet loss rate. This depends greatly on scheduling, policy and service discipline applied in the nodes. Such disciplines are characterized by bounds on the maximal delay that any node can acquire and hence a corresponding bound on the end-to-end delay can be derived. Such bounds provide a valuable tool for quantifying the quality of a path in terms of its ability to meet the QoS delay requirement. In this case, the routing problem is to identify the route that has the best minimal guaranteed and various QoS requirements. The actual QoS metrics of interest are likely to vary from one application to another, but are projected to inc1ude such measures as packets loss, delay, delay jitter and bandwidth guarantees. For example, the best route through a network for a voice call may not be the best for a file transfer [13].

Therefore, an appropriate routing algorithm is essential for communication networks. In this paper we propose a new QoS routing algorithm inspired by bees' foraging behaviors.

III. CONCEPT OF BIOLOGICAL BEES IN NATURE

The bees are considered as domestic insects in a cluster of colony that has the ability to move and sufficiently flexible to innumerable changes within the forage sequence by having a decentralized and complicated communication and control system. They shared a communication language based on dance performance by the scout which employs stochastic principles depending solely upon neighborhood information. The strengthening and self-healing behavior aims to recruit others by means of transmitting the distance information along with direction of food while the quantity of compiled food is optimized in a decentralized manner. Making use of such principles through a multi agent system (MAS) this is generally referred to as swarm Intelligence [14]. The reader is refered to [15] [16] for more details on the biological background.

However, bees with the intelligence of a hive have been inspired by several researchers in communication environments. For instead, the BeeSensor in [13] which is a bee-inspired power routing algorithm that implements a basic bee-agent model. The bee agents however do not transmit rather it uses the idea of incorporating three types bee agents as scouts, foragers and packers. A packer is responsible for receiving /sending data packet within the application layer.

Moreover, the concept of BeeHive has also been motivated to further research improvements in communication environment. Similarly [17] produces a BeeHive routing algorithm that is inspired from the communicative techniques and operations of honeybees. The structure of BeeHive however, makes it possible for the intelligent bee-agents to explore more about the network regions (known as foraging zones) and subsequently acquire information that could be transferred to neighborhood routing tables.

Ultimately, most of the existing QoS routing protocols in VANETs are node-based approach. The QoSBeeVanet [18] utilizes honey bees’ behavior to find a route with better QoS in VANETs. MURU [19] uses the expected disconnection degree (EDD) to estimate the probability that a route will fail during a given time period. MURU utilizes EDD to obtain an optimal path. But MURU only uses local map information and it may lead to the local optimum problem.

Conversely, to solve the issues of VANET, we use intelligent mobile agent (described in Section IV) to improve the efficiency of traffic and ensuring sustainability of vehicular environment. As explained in Section I, the scheme is based on the concept of biological paradigm of communication between bees when searching for food and details is explained in our previous work [20]. Table 2 of the Section V defined the three intelligent agents used in the propose scheme that offers different messages type as an agent.

IV. MOBILE AGENTS QOS ROUTING IN VANET

In this section, we present the overview of propose QoS routing process for VANET using mobile agents. This however, represents the basic idea of phenomenon of bee communication paradigm. Thereafter, data packet and route cache structure are also discussed along with the distinct stages of the scheme.

A. Mobile Agent in VANET

As mentioned earlier, vehicular network is self-created, self-organized and a short-lived organization of high speed mobile nodes which often control themselves individually that are associated with a predetermined supporting infrastructure (could possibly be connected to fixed infrastructure nodes but do not affect network management decisions). Therefore providing service management and information distribution in VANETS especially for multimedia applications is inherently difficult.

A mobile agent refers to an application or program in a communication network that represents a user which is also adequate of remitting the self-healing between nodes to perform computational activities behalf of the user. It can however, append the execution of host node and handover itself to a different agent-based host node and intelligently continue its execution on a new host node.[5]. Quite a number of applications utilize the mobile agent technology for collaborative and managerial purposes. It has being a potential application in mobile computing particularly in the wireless networking environment for the support of asynchronous communication and intelligent query processing.

However, mobile agent has some distinguished features as compared to the conventional distributed computing [21, 22]. Figure 1 illustrates some of the benefits of using agents in the proposed vehicular information ad hoc networks.

Also, as shown in [23] and in some cases [23], mobile agent reduces the network traffics and increases the network performance in wireless communication as compared with the conventional approach. Therefore, our proposed scheme integrates the use of mobile agents in vehicular network with the rationale of bee communication paradigm to provide basic response to the frequent topology changes.

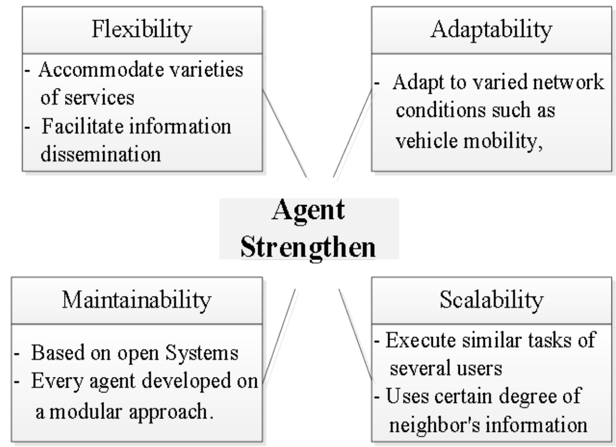


Fig. 1 : Benefits of using Agent Technology in VANET.

A. Mobile Agent System model

This Section describes the system model employed for the proposed scheme. The following assumptions are considered for the proposed scheme.

- Assumptions
  - A network consist of nodes is analogous to a bee hive that incorporates bee agents, operating accurately like bee scout
  - The scouts provide information regarding propagation delay as well as queuing delay of the paths to the nodes they visit
  - The bee agent determines whether a route satisfies QoS requirements analyzed against a threshold that depends the on number of hops.
  - The route cache is considered as dancing floor with stored information on QoS paths.
  - Data frames are considered as the foragers having access to visited node route cache to discover QoS paths.

Conversely, for these assumptions made by the beehive, there are two standards for either the dance is for recruitment; causing the packet transmission delay or the queuing delay of that the scout traverses. However, [17] estimates the round trip delay time Tdt for the data packet of current node i that is within the transmission range of next adjacent node j:

$$Tdt_{ij} \approx q_{ij} + tx_{ij} + pd_{ij} \quad (1)$$

q_{ij} is the node i queuing delay, and the link between the transmission delay and the propagation delay are represented by tx_{ij} and pd_{ij} respectively. Moreover, q_{ij} depends on the queue size and data packet traffic load as well as the link bandwidth of i and j. The $pdij$ determines the delay that data packet encounters during transmission between the nodes [24].

Consequently, for the neighbouring node j to reach the destination d as in [17], is determined by a function $f(dj)$ of propagation as well as queuing delays.

$$f(dj)=\frac{\frac{1}{p_{jd}}(e^{-\frac{q_{jd}}{p_{jd}}})+\frac{1}{q_{jd}}(1-e^{-\frac{qjd}{pjd}})}{\sum_{k=1}^{N}\frac{1}{Pkd}(e^{-\frac{qkd}{pjd}})+\frac{1}{qkd}(1-e^{-\frac{qjd}{pkd}})} \qquad (2)$$

The packet switching is obviously performed in stochastic sampling approach with replacement to make sure that adjacent node *j* with goodness *gjd* is chosen as next hop to destination *d* at node *I*, with at least the probability defined as: β_{jd}^{i}

$$\beta_{jd}^{i}=\frac{gjd}{\sum_{k=1}^{N}g_{kd}} \qquad (3)$$

B. Mobile Agent QoS Routing with Bee Communication Paradigm

Vehicular ad hoc network is considered platform with beehive representing the source vehicle and food corresponding to the search food. Worker bees (workers) are considered as the intermediate vehicle which is neither the source vehicle (beehive) nor the destination vehicle (food). To reduce overhead and increase stability, one of the workers is chosen as the cluster head to manage the cluster activities.

Algorithm: Q_RReq Process at Intermediate node
/* Here OBA sends Q-RReq to RA*/

```
BEGIN
1.    Generate n scout bees as initial member size
2.    Select routing location
3.    Determine the neighborhood size
4.    Place SA within the network && Count nodes
5.    Recruit forager bees within transmission range
6.     For hop = 1
7.         Remove Routing Agent  and
8.         Enter: A Q_RREQ packet with  minimum bandwidth
                &  maximum delay
      IF (Node == routing agent in the cluster)  {
9.            IF QoS_RREQ with the same {source ID, sequence
                 number}   received before
               Remove and decrease hop count of mobile agent
10.   THEN    discard  packet;
11.   ELSE
              Convey information to all adjacent RA via forward  scout
12.   IF {  node lifetime <  threshold
13.          Compute Cost function from the source to
14.              this node; path  available bandwidth Delay,
15.            End if
16.    IF route = True && QoS requirements = True
17.        Success triggers a QoS_RReq (each node knows the
                location of  the RA & closest SA based on inform
                from QoS_RReq received from scout)
18.        Update Q_RREQ
19.        Broadcast QoS_RReq
        ELSE {
21.        Broadcast Q_RReq other Routing Agents via Smart
           Agent;
22.   End for
23.        END if  }
END
```

In this algorithm, whenever the source vehicle (beehive) wants to transmit packet and does not have a route to destination (food), it first generate *n* scouts with a unique *id* and initializes it to determine the population size. Vehicles that are within the communication range of the nearest smart agent (SA) are connected together as shown in Fig.3. The scout agent can directly communicate with members if the distance of the scout to RA is 1-hop.

During the route discovery, the source vehicle chooses suitable foragers from the route cache that determine which route to follow to destination. The frequent link update by each node to its neighbours, keeps the link active. This is intended to estimate the available bandwidth and minimum link delay for QoS requirements. Since the RA is linked to the forager, the scout is discarded if the same id and sequence number received before or if is out of its communication range. The RA then can provides information and available resources regarding the path, or otherwise collect the required information about the network for routing and decrease its hop count. The RA chooses a unique path id from the received forward scout, converts it to a backward scout and then transvers to the source vehicles (Beehive).

Each intermediate member node in the colony (cluster) associates a cost with its neighbouring nodes, therefore the information transvers and convey to all adjacent RAs through the forward scout. When the route and location of RA is found along with the satisfied level of QoS, it triggers a QoS broadcast to other RAs via the closest SA. However, each of any members has its own routes table that stores different routes, available QoS requirement as well as node location. The source node will begins with checking its resources availability where optimum route is chosen in storage cache, reserve the resources and transmit data packets. When there is no any valid route with sufficient QoS requirement is stored in cache, and then forward the packet to worker (Routing Agent) based on the algorithm above.

C. QoS Packet Types Based on Bee Communication Concept

The scheme uses two agents as its main packet types for QoS rout discovery; namely scout and forager. The scout agent which could either be forward or backward scout; is lunched by the source vehicle to discovery QoS route to destination and transverses back the route reply to the source. The packet is periodically refreshed to keep update of the route list and the available QoS information (delay and packet loss) and its packet format is shown in table 1 below

Table 1: QoS Bee Packet Format

C_ID	Cluster ID to which requesting node belongs
Bv_ID	Beehive ID
Fd_ID	Food Id
Required Data	Identifies the requested data
Traffic Class	Type of data traffic for Transport protocols
PV_Time	Packet arrival time
Path_list	List of addresses of visited nodes
Life time	defines the expiration of the requested packet

Avl_Bw	Defines the required amount of traffic generated available bandwidth.
Del_bnd	Delay bound
St_Fd	Stamp Field

1) Scout

This type of packet is the control packet that is used to discover QoS route to destination upon demand. It is referred to as forward scout that initiate route request (from source) until food is reached (destination) in bee-inspired protocols. Thereafter, it transvers back to the beehive (source) to inform the members the found food; refers to as backward scout.

1.1) Forward Scout Agent

This kind of scout guarantees the exploration of the network to discover route to destination as well as collecting routing information (experience delay). It makes a temporary registration in its route cache to store the visited node to be used on its way back. The present of beehive identifier and food identifier in the control packet format from Table 1, prevent route request duplication when receiving the same scout. To ensure loop-free of the route request, the life-time field limit number of hops by each packet. If received, it will be discarded by the forward scout. The life-time field is expanded when the beehive does not obtain any response for the waiting period. More so, the stamp field determines the computed available bandwidth and delay bound as well as to decide on QoS guarantees. Therefore, whenever a source node discovers a food and doesn't have a valid path with QoS requirements to destination, it triggers a forward scout agent and stores the information using propagation principles [25] to all neighbouring nodes.

Ultimately, the forward scout agent in our scheme contains three elements (details in section III): (i) Smart agent (SA), (ii) Routing agent (RA) and (iii) Onboard agent (OBA), illustrated in Figure 3. To avoid flooding the entire network overhead, the Smart agent produces forward agents in accordance to an on-demand (e.g. a new route is needed), details in [26].

1.2) Backward Scout Agent

Squeal to the discovery of QoS route, the node transmits the packet in backward scout to beehive (source). It also has similar control packet format with forward scout indicated in table 1 with stamp field to inform beehive about available bandwidth and delay bound. Backward scout uses the life-time field to represent the time route reply scout packet received with valid route. Usually whenever the backward agent features are been launched, the situation inherits almost all the information collected from the forward one along with transvers its route to the source node.

2) Forager

This kind of packet determines the data packets forwarding used to broadcast the communication data. The data packets will be in a queue until route discovery of the target path is terminated. To achieve the level of QoS, messages would be sent using strict priority queue (SPQ) order [27] until the entire packet frames with the same priority are sent. However, it contains a module agent which deals with forwarding data packet and ensuring data are routed through the optimal route. It tends to make utilization of the information established by the agents which makes it available in the route cache repository. The detailed description of the proposed intelligent agents is presented in table 2 below in Section V.

V. Proposed Working Procedures

This section highlights the working procedure employed in the protocol design for effective integration of mobile agent into QoS routing.

The vehicular network considers all moving vehicles as part of the network for the role of intelligent agent nodes. The RA is responsible for managerial role within the cluster as well as route discovery to nearby clusters as indicated in table 2.

Table 2: Intelligent Agents Descriptions

Mobile Agent	Characteristics
Smart Agent (SA)	Potable agent situated along the intersection and streets
	Maintains traffic database & routing information
Route Agent (RA)	Route discovery
	Establish connection between cluster members
Onboard Agent (OBA)	Transceiver (sensor) agent inside vehicles for communication
	Collect vehicle status and location from GPS

SA is a potable agent situated along the intersection and streets which could also be connected to the neighboring RA within maximal number of hops. The next task is to establish path between source node and destination node which is done by the routing agent. However, the SA accumulates the network behavior information according to a uniform probability distribution. The vehicles are situated on the road with an equipped sensor (OBA) agent to provide wireless communication for vehicles. The bee Hive in this context is the nodes consisting of bee agents that determine the information on QoS route to destination. Meanwhile the bee agents decide on the QoS path information based on threshold value. The proposed mobile agent model is illustrated in the Fig. 1 below.

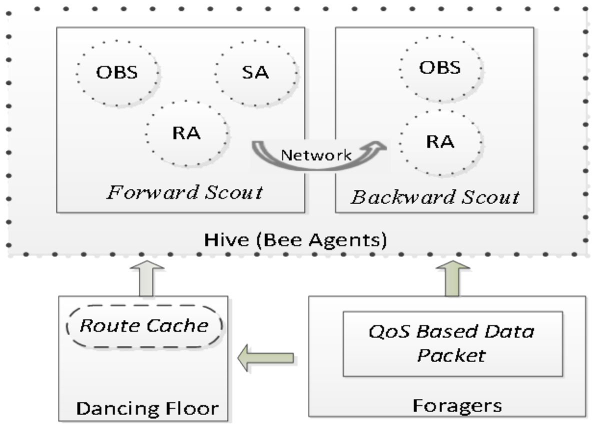


Figure 2: Mobile Agent System Model

The routing cache is considered the bee dancing floor that provides the actual routing platforms meant for agents along with packet data, in addition to feasible supplementary data components. In addition to sustaining statistics of interest regarding vehicle nodes and the network behavior that can be useful for route evaluation.

The propose algorithm is a reactive protocols which investigates a QoS routing using clustering approach and is similar to BIMAS [28] approach. BIMAS considers clustering mechanism so that only the cluster head nodes communicate with the mobile agent.

In cluster-based routing approach, mobile nodes that are within a radio transmission range to form a cluster area with a node being elected as the head as shown in Fig.3. The concept has been effectively employed in MANET environments that minimizes rebroadcast issue and gives a better delivery ratio. However, control messages are sent between clusters to keep reliable and stable connections which mostly causes overhead problem for routing algorithms.

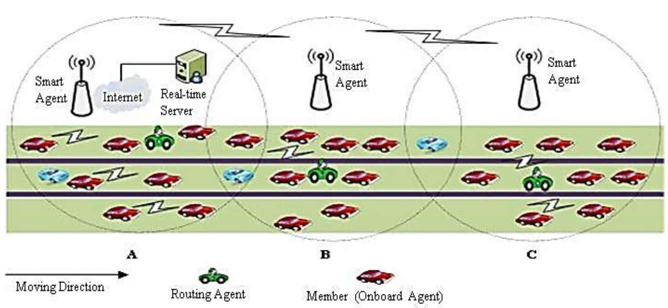


Figure 3: Mobile Agent Communication Scenario

In the route discovery process, QoS route is broadcasted and routes reply transverses either by the destination (backward agent) or by the cluster head node (routing agent) with an available route.

Conversely, VANET are considered in this scheme as a network of vehicles on wheel and some intelligent smart agents (SA) strategically deployed on the roadside or intersections. As in section III, we assumed each vehicle to be equipped with GPS receiver and a radio transceiver. These ensure frequent update on vehicle location and moving parameters like speed and direction. However, each SA is assumed to be connected to the internet via high capacity wired cable such that data packet could be routed among the SAs with less delay bound. Subsequently, the SAs and the vehicles can also communicate only if they are within the same transmission range *R*. The SAs in the scenario constructs a weighted graph $G(V,E)$, where $V = V - U\{z\}$, U is the information update for the mobility and location.

Every vehicle node $x \in V$ represents either the SAs or OBA of a member node with changing link between the vehicle nodes $e = (x, y)$ such that $x \in V$ and $y \in V$ for x or y to be vehicle and $dist(x, y) \leq R$.

When a vehicle has data to send to the Internet or to another vehicle and does not have a cached route, it first initiates the route discovery process by forward the route request (RREQ) packets to the RA. When the RREQ packet is received by an RA, it selects a route for the source node using the algorithm presented III-B, based on the weighted communication graph that it maintains, and signals the other SAs that this route request has been processed.

The RA selected by the routing algorithm will then include the computed route in the transverse Route Reply (RREP) message and return it to the OBA. In addition, the new route selected by our routing algorithm may go through another SA because the communication graph G usually includes multiple SAs in the transmission area.

VI. SIMULATION EXPERIMENT

A. Simulation Setup

For the purpose of implementing and evaluating our proposed scheme, we used the NCTUns-6.0 simulation environment. In this paper, we model and simulate two (2) network scenarios which are considered in an urban-like environment with respective variable number of vehicles. Vehicle speeds decreases as congestion on road increases with addition of more vehicle nodes on the road. The simulation parameters that are used for the experiments are specified and listed in Table 3.

TABLE 3: Simulation Parameters

Parameter	Value
Number of nodes	50, 100
Transmission Area	500m ×500 m
Transmission range	250 m
Packet size	1000 bytes
Simulation time	400 seconds
Node's mobility speed	0-20 m/s
MAC Specification	IEEE 802.11p
Channel bandwidth	2 Mbps
Traffic Type	CBR/UDP
Pause Time	0, 40, 80, 120, 160, 200, 240, 280, 320, 360 & 400 Sec.s
Propagation Model	Two Ray Ground Model
Examined routing protocol	AODV/DSR
Traffic rate (packets/s)	10
Maximum delay (s)	0.1

At this extent, initial results obtained in the city scenario with 50-100 nodes at random within the roads segments were presented. We comply with the DSRC's seven-channel bandplan, as defined [11] each spanning 10 MHz bandwidth.

To show the effective performance of the proposed scheme, we simulate two scenarios by generating CBR/UDP packets flows with particular packets size distribution and inter- transmission time distribution. The scenarios are presented in that table 4 below.

TABLE 4: PARAMETERS OF SIMULATION SCENARIOS

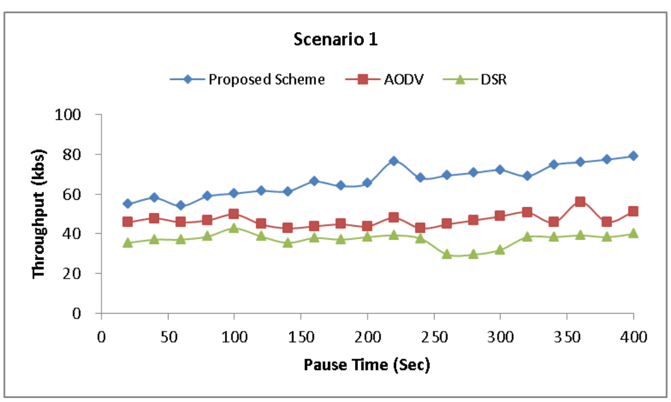
Grid Scenario	No. of Nodes	Highest Node Speed
3x3 grid_Scenario1	50	36 m/s
5x5 grid_Scenario 2	100	18 m/s

B. Simulation Result

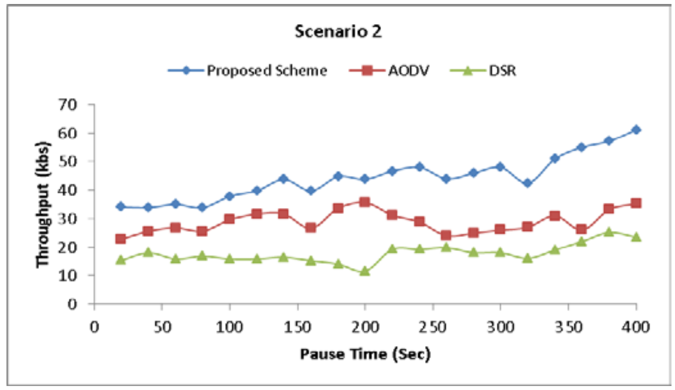
The performance shown in the graphs below is measured in terms of network throughput rate packet loss rate and Average delay for UDP protocols flows.

Two CBR flows are sent to have identical scenarios between hierarchical AODV and DSR. The nodes are grouped based on their moving direction and to clearly show the available bandwidth obtained using throughput (Kb/sec) and simulation time (Sec). Each node stops for a duration defined by the *'pause time'*. The parameter pause time reflects the degree of mobility. The pause time is time taken in a network where all nodes become static while transmission continued.

We used different pause times of 0, 40, 80, 120, 160, 200, 240, 280, 320, 360 and 400 seconds to determine the mobility degree. VANET attain it high degree of mobility when all the nodes are moving and the pause time is 0 seconds. However, when pause time reaches 400 seconds, it means that all nodes are static during the simulation. We therefore established an implementation for the proposed scheme and evaluate the design as well as implementation results with some noble QoS routing approaches. The performance evaluation of the propose scheme is dispatched in Figure 5 to 7.



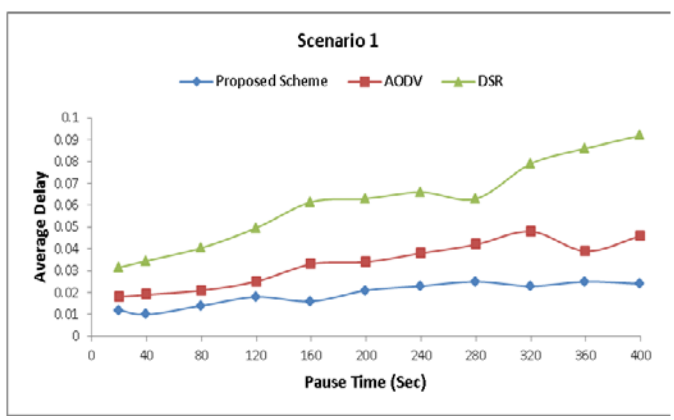
a)



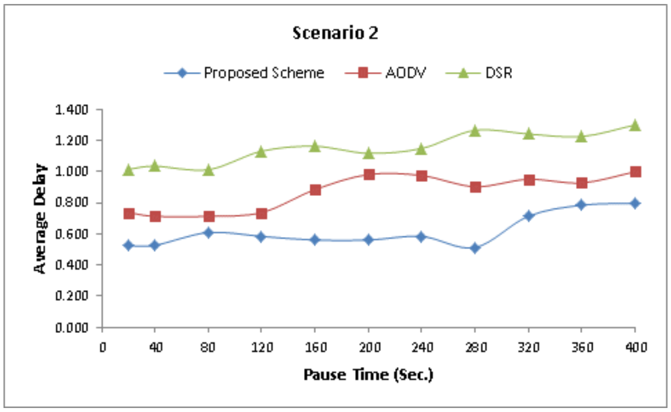
b)

Figure 4: Effect of Network Throughput Performance for both the two Scenarios

Figure 4 a) and b) show the effects of nodes mobility pause time on throughput for both of the two scenarios aimed at the proposed schemed, AODV and DSR routing protocols. The simulations experiment runs 100 seconds for both the scenarios. However, UDP was used as the real-time traffic which indicates the network performance. CBR flows of 1000 bytes packets were transmitted for every five seconds and randomly selects some packets per session. This defined the entire network throughput of CBR flows which gradually increase at higher speeds. At the duration of higher mobility, each protocol displays minor degradation in throughput as a result of high-link break. The proposed scheme exhibits about 8% improvement in throughput above the two prominent protocols. However, the larger the pause time is, the more each node continues to be stable before the next movement. Therefore the Overall throughput is significantly high with the proposed scheme connection as in comparison to the AODV and DSR.



a)

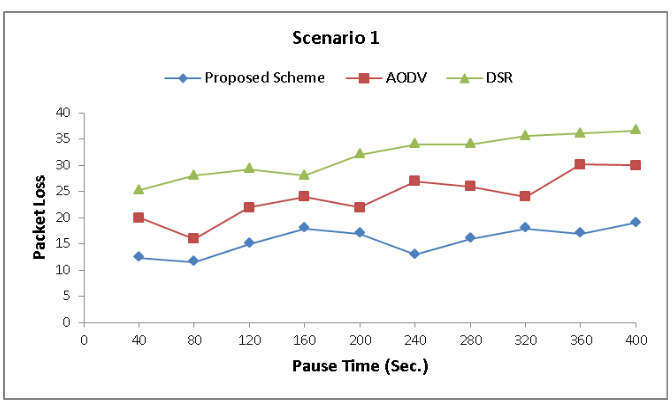


b)

Figure 5: Effect of Network Average Delay vs Pause Time for both the two Scenarios

However, the experienced delay in *ms* for the reception of real-time safety messages for both environments is shown in Fig. 5. It is observed that the delay for both cases begins with a low and gradually increase with mobility of the vehicles number increases. Figures 5 show the effect of average network delay on pause time for the two scenarios. As the network density increase, they increase in larger topologies and DSR tend to show increasing delay for the scenario2. The proposed scheme shows relatively smaller delay values as expected.

More so we analysed the packet loss rate as a function of pause time for the real-time flow UDP communication simulated against the two scenarios. As the node density become large, the packet loss rate increases as a result of the number of mobile nodes contending for the same channel in both scenarios (as seen from Figure 6 a) and b)). This leads to higher packets loss rate in the DSR and AODV in scenario 1 than the proposed scheme as compared with the scenario 2, due to the increase in congestion level and topology changes, thus decreases the network throughput as well.



a)

b)

Figure 6: Effect of Packets Loss Rate vs Pause Time for both the two Scenarios

I. CONCLUSION

The QoS routing is considers as a difficult task which could be address using the concept of bio-inspired network routing design. This paper presents cluster based routing used to tackle the issue. Coupling with the sensitive transmission of the real-time safety messages, this paper proposes a model that uses intelligent mobile agents aim to improve the efficiency of traffic and ensure sustainability of network. The model provides three (3) different forms of agents inspired by the concept of biological paradigm of communication between bees when searching for food. Subsequently, the network throughput, average delay and level of packet loss rate are the metrics used for the purpose of evaluating this study. The results obtained indicate that the proposed scheme performed more adequately to the applications that required QoS guarantees as compared to the conventional AODV and DSR routing protocols.

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