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Bio inspired Slug Routing Protocol for Urban VMesh Milieu

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ABSTRACT

Background: VMesh milieu is an impulsive ad hoc network fashioned over moving vehicles on the road. In this paper, we propose the Bio inspired Slug Routing Protocol (BSRP) for the urban VMesh milieu. BSRP selects an egress vehicle based on the different pertinent metrics for proficient routing in the urban VMesh milieu. The behavior of slug seeking for the source of food in their area is considered as an objective function for selecting an egress vehicle. The BSRP heuristically solves the routing issues such as delay, packet loss, retransmission, gridlock and routing overhead. We assess the performance more expansively using pragmatic vehicular traces and nakagami fading model optimized for urban VMesh milieu set-up. The contribution stands out through their novelty, clarity and leads the way for new interesting application. The simulation outcome illustrates that the BSRP outperforms the existing routing protocol in terms of packet delivery ratio, average transmission delay and routing overhead in typical urban circumstances.

INTRODUCTION

Wireless Ad hoc Networks (WAN) are pervasive, ubiquitous, infrastructure-free without any centralized authority (James, 2009), (Eiman, 2012). A VANET is a decentralized network where each node is proficient to frontward data packets between the nodes dynamically. Wireless ad hoc networks are classified as mobile ad hoc network, wireless sensor network, wireless mesh network and vehicular ad hoc network. Vehicular Ad hoc NETwork (VANET) is a nascent technology, would let the vehicles on roads to form a self-organized network without the permanent infrastructure. In VANET, a node can be a bus, train, taxi, subway, train, or tram. Vehicles acquire a broadband access by using the IEEE 802.11, IEEE 802.16 (WMAN, WiMax), UMTS and LTE wireless technologies (Garcı´a, 2010), (Gustavo, 2012), (Zhenxia, 2012). VANET communicates among vehicle to vehicle and vehicle to infrastructure (base station). Vehicles are becoming more sophisticated with powerful on-board computing capabilities such as tons of on-board storage and short or medium range wireless transceiver with no power limitations (Haopeng, 2012). A Wireless Mesh Network is a multihop communication network in which the nodes are self organized without a central coordinator. VMesh is a hybrid network, which combines the features of VANET and WMN. VMesh milieu is the communication environment between the vehicles made up of radio nodes organized in a mesh topology (Dharanyadevi, 2015). VMesh generates a loop among moving vehicle. In the loop we can add, update or remove the nodes. Advancement in wireless networks crafts the access to the Internet from vehicles (Yuh, 2010), (Wang, 2012), (Moustafa, 2009) (Iman 2010), (Jama, 2012). Governments and high-flying industrial corporations such as Daimler-Chrysler, BMW and Toyota have initiated research on Inter Vehicle Communications (Hamed, 2012). California Partners, Crash Avoidance Metrics Partnership, FleetNet, Advanced Driver Assistance Systems, Chauffeur in EU, CarTALK 2000 and

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DEMO 2000 are petty distinguished projects, which are stepping towards the grasp of intellectual transport services.

Definition 1:

As symbolized in Eq.1, an urban VMesh milieu consists of ‘x’ number of vehicles in the milieu.

$$\{Vh_1, Vh_2, Vh_3, \ldots\ldots Vh_y\} \in UV_m \qquad where,\ 1 < y < x \tag{1}$$

where,‘UVm’ is the urban VMesh milieu, ‘Vh’ is the vehicle and 'x' is the maximum number of vehicles in the urban VMesh milieu.

Definition 2:

An ingress vehicle (IV) is the vehicle which transmits the packet over the network links. Ingress vehicles, neighbor vehicles and base stations communicates based on the mesh topology. Ingress vehicle upholds a neighboring record based on the up-to-the-minute information received from the periodical beacon messages. In an urban VMesh milieu any vehicle can perform ingress operation. As symbolized in Eq.2, the ingress vehicle is represented as the,

$$\{IV_1, IV_2, IV_3, \ldots\ldots IV_q\} \in UV_m \qquad where,\ 1 < q < w \tag{2}$$

where, ‘w’ is the maximum number of ingress vehicle in UVm.

Definition 3:

The egress vehicle (EV) which receives a series of packets from the ingress vehicle’s and transmits the packet to the base station. The main purpose of an egress vehicle in the urban VMesh milieu is to permit only a least amount number of vehicles to commune with the base station. Certainly, if all vehicles in an urban VMesh milieu directly communicate with the base station, it results in a bottleneck at the base station. In proposed BSRP, the egress vehicle is selected based on the relevant metrics such as received signal strength, buffer intensity and distance. In an urban VMesh milieu any vehicle can perform egress operation. As symbolized in Eq.3, the egress vehicle is represented as the,

$$\{EV_1, EV_2, EV_3, \ldots\ldots EV_e\} \in UV_m \qquad where,\ 1 < e < t \tag{3}$$

where, ‘t’ is the maximum number of egress vehicle in the urban VMesh milieu.

The urban VMesh milieu is still infancy for the research community. Karp *et al*. proposed a routing model and dubbed as greedy perimeter stateless routing. It makes use of greedy frontwarding to frontward the packets primarily. If the packet reaches a local optimum, it will switch to the perimeter mode (Karp, 2000). However, it is not suitable when the velocity is high. And also due to the frequent disconnections, this method is not capable to hold the subsequent hop information. The perimeter model frequently consequences in longer routes, thus extends the delay. Naumov *et al*. proposed a routing model and dubbed as connectivity aware routing. Connectivity aware routing deals with the above calamity by choosing the route with the least network disconnection probability and minimize the delay. The probability is computed by the probabirecordic model based the traffic information (Naumov, 2007). Yang *et al*. proposed a routing model and dubbed as adaptive connectivity aware routing. Adaptive Connectivity Aware Routing is an on the fly density collection model, is proposed to perk up the precision of CAR (Yang, 2010). Lee *et al*. proposed a routing model for urban milieu and dubbed as land mark overlays. Land mark overlays solves the disconnection problem in the network (Lee, 2008). Poonam *et al*.used the ant colony procedures to propose an algorithm and to design a bio-inspired protocol that performs well in the dynamics of VANET. DYMO and ACO routing protocol has been combined to progress the routing and to avoid the congestion in VANET milieu (Poonam, 2012). Guangyu Li *et al*. proposed the routing protocol for vehicular networks and it is based on ant colony optimization. The routing protocol is based on both proactive and reactive components. The routing between source and destination is based on the record of intersections (Guangyu, 2013). However, in ant based algorithm only shortest path from the source to destination is considered and no centralized processor to guide the ant system towards better solutions. Jamal *et al*. proposed a mechanism for VANET milieu based on the parallel swarm intelligence. This mechanism uses the master-slave pattern to assess the swarm in parallel. This mechanism decreases the delay and enhances the performance over PSO chronological method (Jamal Toutuh, 2012). However, in this method uniform initialization is used to allocate the swarm particles over various areas of the search space, it's not germane in real time scenario. In our exertion, we propose BSRP which opts the routes from source to destination via an egress vehicle with the lower transmission delay and higher connectivity. By selecting an egress vehicle based on relevant metrics, the routing overhead and delay could be significantly reduced. The numerical results demonstrate that our BSRP is very apt for real time VMesh application and outperforms the existing protocol on average transmission delay, packet delivery ratio and routing overhead.

As depicted in Fig.1, this paper spotlights on the urban VMesh milieu. In an urban V Mesh milieu, more problems should be considered in the devise of the routing procedure such as the increasing vehicle density, dynamic topology, high mobility and uneven vehicle distributions. Even though the existing protocols ensures the vehicle to vehicle communication in the majority cases, these routing protocols are usually designed with the assumption that vehicles are randomly or uniformly scattered on the roads. Underneath such an assumption, the vehicle density is in point of fact averaged over the discussed area which is sometimes not constant with the real case.

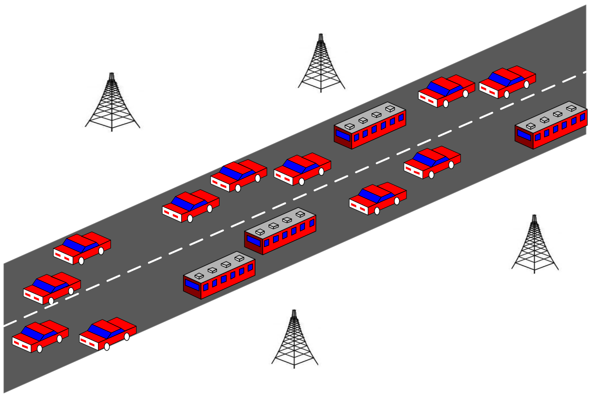

Fig. 1: Urban Area Scenario.

The key contributions of BSRP are as follows: Discovering an egress vehicle to avoid the bottleneck in the urban VMesh milieu. The key idea lies in the truth that the routing uses the fitness value in selecting an egress vehicle to overcome unreliable wireless communication. Furthermore aims at enhancing the packet delivery ratio, minimizing the transmission delay and routing overhead in the urban VMesh milieu. The rest of this paper is organized as follows: In Section 2, we present the BSRP for the urban VMesh milieu. Section 3 shows the meticulous simulation results and analysis. Conclusions and prospective work are given in Section 4.

Proposed Bio inspired Slug Routing Protocol for VMesh Milieu:

Fig.2, gives a picture of slug procedure and Bio inspired Slug Routing Protocol (BSRP) procedure. The BSRP transmits the packet from source to destination via an egress vehicle. Selecting an egress vehicle is based on the behavior of slug seeking a path between their area and a source of food. Slugs have a strong sense of smell. A slug's organs of smell are in its tentacles which enable it to detect the food in fastidious range. They do not travel far from where they are hatched; often take the route of only a few meters in search of food. The slug attracts towards the food which has a high smell. The unique idea of bio inspired slug algorithm can unravel various discrete problems.

Slug Procedure	Bio inspired Routing Protocol

Begin
Search for food in the coverage area
{
For each food
Acquire smell;
Calculate the smell entitlement;
If the present smell entitlement is better than the previous smell entitlement;
Replace with present smell entitlement;
End For
Return maximum smell food;
The slug attracts towards the food which has the maximum smell;
End
}
	Begin
	Search for the neighbor vehicle in the coverage area
	{
	For each neighbor vehicle
	Acquire relevant metrics;
	Calculate the fitness function;
	If the present fitness function is better than the previous fitness function;
	Replace with present fitness function;
	End For
	Return neighbor vehicle which has a maximum fitness value, is the egress vehicle;
	Transmit the packet to an egress vehicle;
	From an egress vehicle packet will reach the destination;
	End}

Fig. 2: Slug Procedure and BSRP.

As depicted in Fig. 3, each vehicle is equipped with transceivers, which support 100% market penetration ratio. The satellite navigation system is fixed on each vehicle to construct the coverage area. Each vehicle consists of Unique ID and IP address. Human machine interface is outfitted in each vehicle via which the VMesh user can frontward and receive their requirement. Each vehicle is equipped with the buffer. The buffer stores the transmitting and receiving packets. Event data recorder is outfitted in each vehicle to record the event occurring in the specific vehicle. The sensor is outfitted in each vehicle to sense the received signal strength, buffer intensity and distance of the neighbor vehicle.

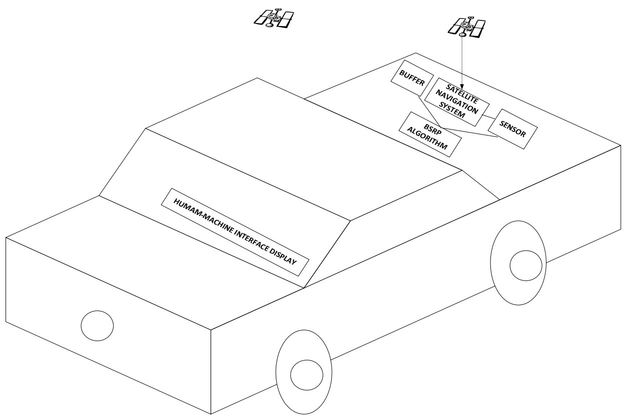

Fig. 3: Vehicle Devise for BSRP.

Definition 4:

Slug senses the food smell and attract towards the food which has the high smell within the range. As expressed in Eq. 2, each ingress vehicle broadcast and transmits the packet within the coverage area. The coverage area is IEEE 802.11p wireless transmission range. As expressed in Eq.4, the coverage area of an ingress vehicle (service requester vehicle) is computed as follows:

$$Ca = WTR.(1-\alpha) \quad (4)$$

where, 'Ca' is the coverage area, 'WTR' symbolize the maximum transmission range of IEEE 802.11p based vehicle and 'α' reflects the channel fading circumstances in the ingress vehicle location. For case in point, α can be set to small values when there is no major hindrance such as highway and takes high values in an urban milieu with elevated buildings [5]. As expressed in Eq.5, the attenuation model for decay of the signal is computed by the non-linear formula:

$$A_{rs}(d) = Ca / d^{\alpha} \quad (5)$$

where, 'd' is the distance from the ingress to egress and 'α' is the path factor whose value lies between 2 and 6 and 'Ars (d)' is the amplitude of the received signal in the distance (d).

The center point is the position of an ingress vehicle. As shown in Fig. 4(a), from the center point the line is drawn from the top, bottom, left and right of the ingress vehicle of radius which is equal to Ca. The four lines are equidistant from the center point. Top-bottom stipulates the north-south position on the surface and right-left stipulates the east-west position on the surface. As shown in Fig. 4(b), the arc is drawn for each position using the formula:

$$\hat{A}l = \frac{r^0}{360^0} * 2 * 3.142 * Ca \quad (6)$$

where, 'Âl' is the arc length and 'r0' is the arc degree. Fig. 4(c) depicts the constructed coverage area.

The BSRP selects the egress vehicle based on the metrics such as, the received signal strength, buffer intensity and the distance. The impetus behind using the received signal strength (Srss) lies in its better consistency. However, the faster a vehicle travel towards the base station, the faster will be the increase in its Srss. Correspondingly, the faster a vehicle travel away from the base station, the faster will be its decline in the Srss. This is characterized by the rate constant β. As expressed in Eq.7, in case a vehicle is moving towards the base station, the Srss of the vehicle at a time instant T can be expressed as follows:

$$S_{rss(T)} = S_{rss(T-1)} + \left(1 - e^{-\frac{\left|v(T) - v(T-1)\right|}{\beta}}\right) \quad (7)$$

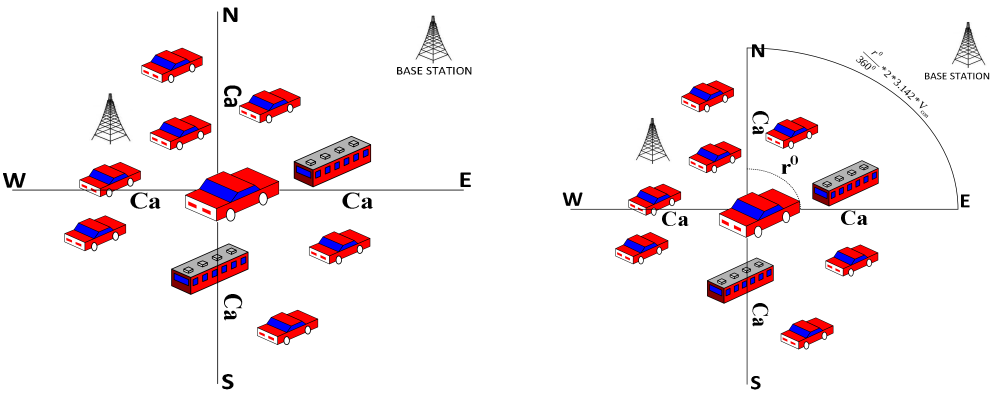

Fig. 4: (a) Construction of Four Lines. **(b).** Construction of Arc.

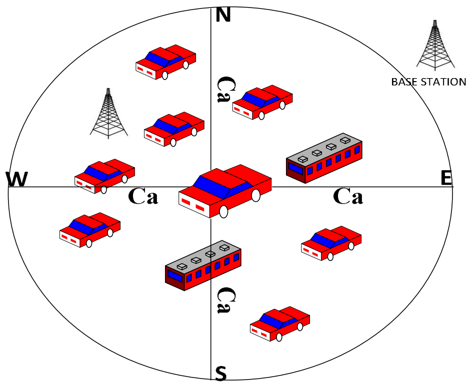

Fig. 4c: Constructed Coverage Area.

Similarly, as expressed in Eq.8, in case a vehicle is moving away from the base station, the $1-e^{-\frac{|v^{(T)}-v^{(T-1)}|}{\beta}}$ of the vehicle at an instance t is given by:

$$S_{rss(T)} = S_{rss(T-1)} - \left(1-e^{-\frac{|v^{(T)}-v^{(T-1)}|}{\beta}}\right) \tag{8}$$

where, $S_{rss(T)}$ and $S_{rss(T-1)}$ denote the values of the received signal strength at time instances T and (T−1), respectively. $v^{(T)}$ and $v^{(T-1)}$ denote the values of the mobility velocity of the vehicles at time instances (T) and (T-1) such that 0 < $v^{(T-1)}$, $v^{(T)}$ < vMAX, where vMAX is the maximum velocity of the vehicle. $|v^{(T)}-v^{(T-1)}|$ represents the magnitude of the difference in the mobility velocity of the vehicle at (T) and (T-1). $1-e^{-\frac{|v^{(T)}-v^{(T-1)}|}{\beta}}$ is the function denoting the variation in the received signal strength by the corresponding variation in the mobility velocity of vehicles and β is a constant that defines the rate of variation of the received signal strength for a unit decrease or increase in the mobility velocity, in a specific movement direction, relative to the position of the base station. The impetus behind considering shortest path is to reduce the time delay and to increase the performance. As expressed in Eq.9, the distance (D) between source (s) to the destination (d) is calculated by using Haversine Formula.

$$D_{s,d} = C_a * c \tag{9}$$

where,

$$D\lambda = \lambda_2 - \lambda_1$$

$$D\gamma = \gamma_2 - \gamma_1$$

$$a = (sin(D\gamma/2))^{\wedge}2 + cos(\gamma_1) * cos(\gamma_2) * (sin(D\lambda/2))^{\wedge}2$$

$$c = 2 * atan2(\ sqrt(a), sqrt(1 - a)\ ).$$

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λ is the longitude and γ is the latitude. The impetus behind considering the maximum buffer intensity is to shun the transmission delay, packet loss, retransmission and gridlock. The buffer intensity is defined as the free space in the buffer. As expressed in Eq.10, the buffer intensity of the vehicle is determined by:

$$Bin = (BMax - (Np * PS * 1e - 6)) \tag{10}$$

where, 'Bin' is the buffer intensity of the vehicle in terms of GB, 'Bmax' is the maximum buffer size of the vehicle in terms of GB. 'Np' is the number of packets at the moment in the buffer (read-only) and assumes the maximum packet size (PS) is 64 KB.

As illustrated in Algorithm.1, the progression of BSRP consists of the following three maneuvers such as, egress vehicle selection, egress vehicle broadcast and selecting on-hand egress vehicle.

Egress Vehicle Selection: As illustrated in Fig. 5, an ingress vehicle dynamically scans for the neighbor vehicle (NV) in its coverage area and send the beacon message to the each neighbor vehicle. And get the up-to-the-minute information from the each neighbor vehicle such as the received signal strength, buffer intensity and the distance between ingress vehicles and neighbor vehicle, received from periodically beacon messages. Furthermore an ingress vehicle calculates a fitness function for each neighbor vehicle as given in Eq.11. If an ingress vehicle does not receive the periodical beacon messages from the neighbor vehicle during a certain period, subsequently the link is considered down. The neighbor vehicle is discarded.

The fitness function for the neighbor vehicle (f(NV)) is calculated by the equation:

$$f(NV) = \frac{(S_{rss} + B_{in})}{D_{i,n}} \qquad \forall NV , NV = 1,2,3,.....,g \tag{11}$$

where, 'Srss' is the received signal strength of the neighbor vehicle in terms of dBm, 'Bin' is the buffer intensity of the neighbor vehicle, 'Di,n' is the distance between ingress vehicle and neighbor vehicle and 'g' is the maximum number of neighbor vehicle in the coverage area of an ingress vehicle. Among all possible neighbor vehicles $NV \in F \subset V_{con}$, we want to determine an egress vehicle that optimizes (maximum) the function f:

$$EV = arg \max_{NV \in F \subset Ca} f(NV) \tag{12}$$

where, 'F' is the feasible solution. As expressed in Eq.12, among the neighbor vehicle, the neighbor vehicle which has the maximum fitness function value is chosen as an egress vehicle.

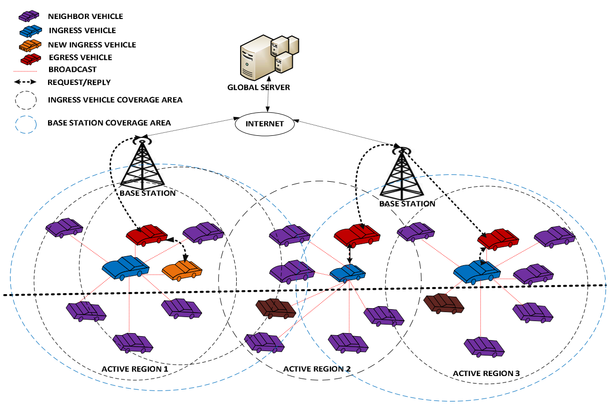

Fig. 5: Progression of BSRP in Urban VMesh Milieu.

Egress Vehicle Broadcast: The chosen egress vehicle broadcasts the periodic egress vehicle advertisement messages (EADV) within its coverage area for specific TTL value.

Selecting On-hand Egress Vehicle: The new ingress vehicle checks for an on-hand (existing) egress vehicle in its coverage area. If there is an on-hand egress vehicle in its coverage area, the ingress vehicle will transmit the packet to an on-hand egress vehicle else go to maneuver 1.

From an egress vehicle, the packet will reach the base station (BS).

From the base station the packet will reach the global server via the internet. The service provider processes the request and frontwards the response. The response follows the same request-path.

Performance Evaluation and Result Analysis:

In the real world scenario, the cost of deployment and testing of urban VMesh milieu is high and simulators provide a fundamental substitute for conducting reasonably priced and repeatable evaluations prior to actual deployment. The proposed BSRP is implemented on a vehicular communication test bed combining Matlab and

NS2 on Linux platform. The performance of BSRP is compared with the ACO-DYMO (Poonam, 2012), VACO-Hybrid Routing Protocol (HRP) (Guangyu, 2013), and PSO-AODV (Jamal Toutuh, 2012). The street layouts used for evaluation are loaded from Topologically Integrated GEographic Encoding and Referencing (Sperling, 1995). Details of the general simulation parameters are given in Table 1. The positions of the 250 vehicles are determined by the IDM_LC mobility model. Ever since the unit of the vehicle density is vehicles/km, a longer segment will consist of more vehicles and vice versa. Correspondingly, the packet generation speed (PGS) i.e., the request rate is remnants at 5 packets/s while the density changes.

Algorithm 1. BSRP in Urban VMesh Milieu.

Source: $\{ IV_1, IV_2, IV_3, ...IV_q \}$ Intermediator: $\{ EV_1, EV_2, EV_3, ...EV_e \}$ Destination: BS
Process: Route Discovery Output: Optimal route from an ingress vehicle to the BS

Construct Coverage Area{
Center Point=Ingress Vehicle
From the center point draw line on four sides of radius, where radius= Ca
For each side draw arc using the formula

$$Âl = \frac{r^0}{360^0} * 2 * 3.142 * Ca$$

End For
}

Egress Vehicle Selection{
Ingress vehicle dynamically scans for the neighbor vehicle in the coverage area
For NV ←1 to g do
Acquire Srss, Bin , Di,n
Calculates $f(NV) = \frac{(S_{rss} + B_{in})}{D_{i,n}}$
End For
$EV = arg \max_{NV \in F \subset Ca} f(NV)$ //*The neighbor vehicle which has the maximum fitness function value is chosen as an egress vehicle*//
Return EVID;
An ingress vehicle frontwards the packet to an egress vehicle;
From the egress vehicle the packet is transmitted to the base station;
}

Egress Vehicle Broadcast{
The chosen egress vehicle broadcasts the periodic EADV within its coverage area for TTL value.
}

Selecting On-hand Egress Vehicle{
The new ingress vehicle checks for an on-hand egress vehicle in the coverage area
If there is an on-hand egress vehicle in the coverage area then
A new ingress vehicle will transmit the packet to an on-hand egress vehicle
From an on-hand egress vehicle the packet will be transmitted to the base station
Else
Goto Egress Vehicle Selection;
End If
}

Table 1: Simulation Parameters.

Simulation Parameters	Value
Simulation Area	1700m x 1000m
Number of Nodes	250
Base station	7
MAC Protocol	IEEE 802.11
Real Time Environment Model	Rayleigh Fading Environment
Propagation Loss Model	nakagami fading model
Simulation Time	1800 Sec.
Connection Type	CBR or UDP
Packet Size	64 kb
Data Rate	1 Mbps
CBR Interval	10 Sec.
Nodes Velocity	20-160 Km/hr
Beacon message size	20 bytes
Broadcast Timer	1 Second
Interface queue	Priority Queue
Channel capacity	2 Mbps

The existing techniques and BSRP performance are evaluated using the average transmission delay, packet delivery ratio and routing overhead. The intricate descriptions of these indexes are as follows:

Average Transmission Delay (ATD): ATD is the average difference between the time a request data packet is originated by an application and the time the response data packet is received.

Packet Delivery Ratio (PDR): PDR is defined as the number of response packets received at the base station over the number of packets sent by the source vehicle.

Routing Overhead (RO): RO is defined as the ratio between the number of bytes of control packets and the cumulative size of data packets which are not delivered to the destinations to the number of control packets and the cumulative size of data packets sent.

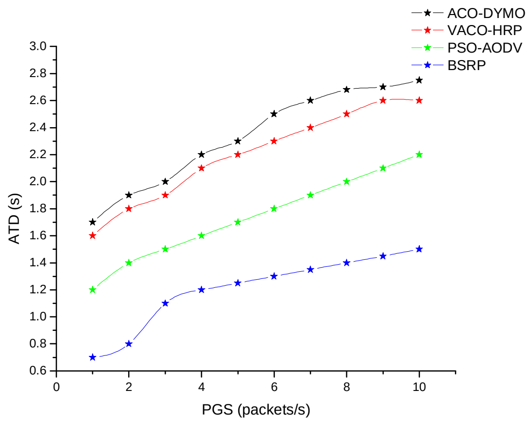

Fig. 6: Impact of packet generation velocity on average transmission delay.

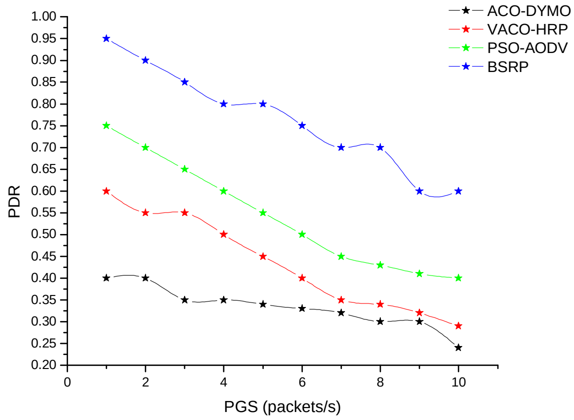

Fig. 7: Impact of packet generation velocity on packet delivery ratio.

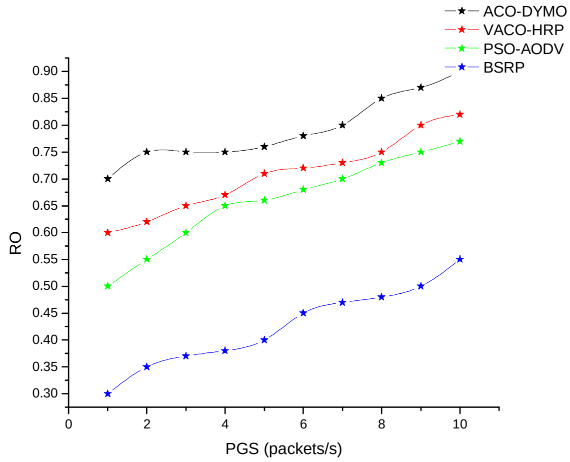

Fig. 8: Impact of packet generation velocity on routingoverhead.

The ATD for different PGS in the case of ACO-DYMO, VACO-Hybrid Routing Protocol (HRP), PSO-AODV and our proposed BSRP are plotted in Fig.6. It can be figured out from this figure that ATD increases while the PGS raises. This outcome is rational and shows that high data rate may simply saturate the channel because no differentiated service is being used. In our proposed BSRP we have used the Enhanced distributed channel access configuration. Compared to ACO-DYMO, VACO-HRP and PSO-AODV, the BSRP demonstrates the superlative ATD owing to its route selection concern which combines experienced delay estimation and path connectivity simultaneously. The brunt of obstacles blocking on signal dwindling which may result in packet drop thus increasing the ATD. It could also be observed that BSRP is more effectual compared with the existing techniques, particularly when data rate is high since more good, but could be obtained within a given communication period, which in turn will reduce the packet collision probability and the channel load thus leading to a less average transmission delay. This result demonstrates that the BSRP outperforms the ACO-DYMO, VACO-HRP and PSO-AODV and make a lower average transmission delay. The impact of various PGS on PDR is depicted in Fig.7. It can be figured out from this figure that PDR decreases as the PGS raises. Owing to the introduction of route selection based on the relevant metrics such as received signal strength, buffer intensity and distance, the probability of disconnections between platoons, shows an improvement in BSRP over to ACO-DYMO, VACO-HRP and PSO-AODV. Thus the packet delivery ratio of the BSRP outperforms the ACO-DYMO, VACO-HRP and PSO-AODV. Consequently, we just evaluated the RO performance of BSRP, ACO-DYMO, VACO-HRP and PSO-AODV with PGS varying in Fig.8. It can be construed from this figure that RO increases as the PGS raises. Additionally, by virtue of egress vehicle, BSRP is more likely to find a route from source to base station, and hence resorts to route discovery less frequently than ACO-DYMO, VACO-HRP and PSO-AODV. Thus the BSRP outperforms the ACO-DYMO, VACO-HRP and PSO-AODV in terms of lower routing overhead.

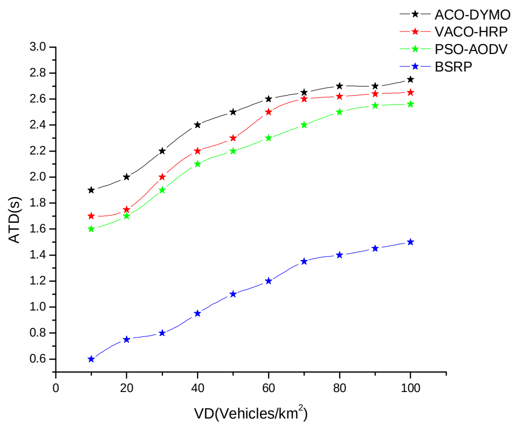

Fig. 9: Impact of vehicle density on average transmission delay.

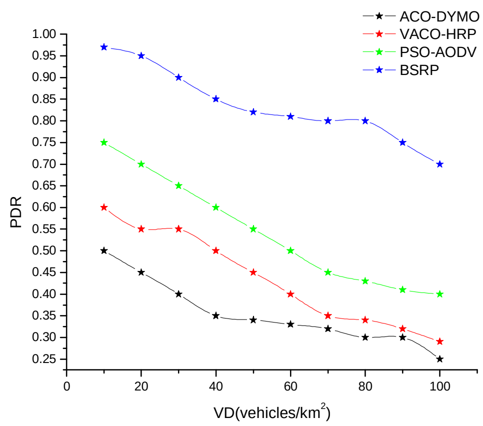

Fig. 10: Impact of vehicle density on packet delivery ratio.

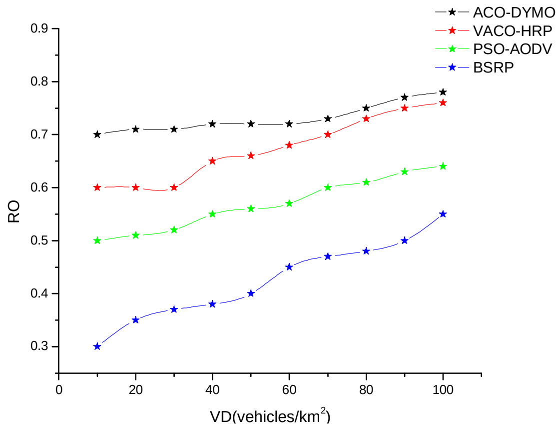

Fig. 11: Impact of vehicle density on routingoverhead.

Fig.9. along with the incessant increase of vehicle density, the ATD's of ACO-DYMO, VACO-HRP, PSO-AODV and BSRP is begins to increase. By selecting the qualified egress vehicle, ATD's of BSRP outperforms the ADT of ACO-DYMO, VACO-HRP and PSO-AODV. The influence of vehicle density on PDR of ACO-DYMO, VACO-HRP, PSO-AODV and BSRP is plotted in Fig.10. Fig.10 shows that the impact of vehicle density on PDR is more apparent than that of PGS. ACO-DYMO, VACO-HRP, PSO-AODV and BSRP generally show diminishing trend in the growth of vehicle density. However, a large vehicle density will introduce more retransmissions and collisions on the IEEE 802.11p MAC layer, ACO-DYMO, VACO-HRP, PSO-AODV and BSRP experience a dropping PDR when vehicle density is bigger. As in BSRP owed to the usage of real connected paths between source and base station via an egress vehicle, can easily tolerate MAC collisions, thus still outputting better PDR when vehicle density is higher. The RO comparisons among ACO-DYMO, VACO-HRP, PSO-AODV and BSRP are depicted in Fig.11. It is worth noted that ACO-DYMO, VACO-HRP and PSO-AODV, BSRP shows an increasing RO with vehicle density increasing, which will bring more collisions on MAC. The rationale behind is that more packet loss, retransmission and collision on the MAC cause routing layer to use additional beacons. In BSRP the collision and retransmission are handled by electing an egress vehicle. Thus the RO of BSRP outperforms the ACO-DYMO, VACO-HRP and PSO-AODV.

Conclusion:

This paper has proposed a Bio inspired protocol, namely, Bio inspired slug routing protocol for the urban VMesh milieu. In urban VMesh milieu, an egress vehicle is selected based on the relevant metrics, to avoid the bottleneck at the base station. The simulation outcome shows that BSRP achieves better in terms of delivery ratio of packets at the cost of less transmission delay and routing overhead. Even though the presented outcome of BSRP for urban VMesh milieu is very promising, there are various problems we crave to address in prospective work like localization schemes and security. Finally, we are planning for out-of-door test using vehicles in order to bear out the simulation result.

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