Volume 8, No. 3, March – April 2017
International Journal of Advanced Research in Computer Science
RESEARCH PAPER
Available Online at www.ijarcs.info
ISSN No. 0976-5697

vAnt-ITS: Ant-based mobility aware routing for intelligent transport systems

Paramjit Singh Waraich
PhD Research Scholar, CSE dept.
MMEC, M. M. University
Ambala, Haryana, India

Dr.Neera Batra
Associate Professor, CSE dept.
MMEC, M. M. University
Ambala, Haryana, India

Abstract: VANETs offer data exchange capabilities at very high speed. Due to variations in the vehicle's velocity, it is quite challenging to ensure the reliable communication. In a mobile environment, the network topology is frequently updated, thus causes packet loss at intermediate nodes, generate extra control overhead for routing as well as it may also lead to congestion/contention. It is necessary to manage the mobile environment, in order to ensure reliability and scalability. Researchers have developed various solutions for V2I and V2V but still, thee are some open issues related to communication over high-speed networks. In this paper, a Swarm Intelligence (SI) based routing for VANETs is proposed, called vAnt-ITS. Simulation results show its performance in terms of improved network efficiency.

Keywords-VANET, Wireless, Mobility, ANTnet, AI, Swarm Intelligence, ITS

I. Introduction

Communication over transport system is quite complex because of following issues:

- Network availability
- Transmission Range
- Network size
- Infrastructure Dependency
- Resource sharing

Artificial intelligence based communication can improve the performance of VANET's applications. In the case of SI, Ants can be used to learn the frequent changes in routing paths and can select the most reliable paths. In order to establish new routes, previous experience with existing routes can be used as feedback, to build more suitable roués. Ants can easily adopt the mobility patterns and offer more reliable and compatible network environment [1]. Location of each vehicle is changed according to the road topology and velocity. Routing tables must be updated to adopt all these changes otherwise, it may result in link breakage, packet loss and extra control overhead [17] etc. In the case of the mobile environment, following parameters may vary [16]:

- Intermediate distance between vehicles
- Network topology
- Road Topology
- Unfair channel utilization
- Link's Quality
- Routing Table
- Traffic load

Following applications suffer from mobility [19]:

- Vehicle Tracking
- Location based services
- Real-time Content Delivery
- Safety Application
- Road Assistance

VANET applications have the Following application domains [20]:

- Military
- Medical
- Education
- Gamming

II. Literature Survey

K. Manjappa et al. [1] investigated the impact of mobility on the ad hoc network's performance and developed a bio-inspired solution which can adopt the high mobility environment. It builds the reliable and stable paths and maintains the pheromone value for each route. Node's stability is monitored by calculating the difference of packet transmission and reception time. Neighbor distance is estimated through cross-layer interaction between PHY and Network layer. Simulation results show that it can retain the stable and long terms routes and thus reduces the probability of frequent link breaks. It performs under the QoS constraints i.e. Throughput, Delay, control overhead and Packet Drop Ratio etc.

L.Zhang et al. [2] proposed a location-based mobility aware routing solution which can exploit the history vehicle connectivity and communication between source to destination. History if further used to build the routing strategies thus can reduce the transmission delay. It supports Delay Tolerant Network (DTN) and performs efficient buffer management method which can set the Message's priority and duplicate Messages are discarded. Simulation results show its performance in terms of Latency, efficient Queue management and Packet delivery ratio etc.

M. Wang et al. [3] explored the scalable V2I communication over VANET and proposed an analytical model for data transmission under mobility constraints. V2I based communication may degrade the quality of data transmission because wireless link's frequencies being used by RSU and vehicles might differ. Authors proposed a scheme for reliable packet delivery for VANETs that can adopt the compatible propagation model as per the mobility constraints. Data travel tine is predicted using the current distance between vehicles if it is relevant, only packets are forwarded to next Hop. If vehicles are moving in same direction and velocity, than there will be a minor delay in transmission but if vehicles are moving in opposite directions, thus results in excessive delay because the relevant distance of vehicles will increase. Simulation results show that optimal deployment of RSUs can enhance the network performance.

S. K. Bho et al. [4] proposed a self-organized fault detection based routing for VANETs in which each vehicle evaluates its performance itself and does not participation in route discovery if it cannot support the fault free communication. Finally, fault free routes are built and shortest path is adopted used for data transmission. Simulation results show its performance under mobility constraint, in terms of Throughput, Delay, optimized path selection as compared to other routing protocols i.e. GSR, GyTar, A-Star and P-Gedir etc.

S. M. Bilal et al. [5] investigated the performance of different location based routing strategies for VANETs under various constraints i.e. mobile environment, obstacles, and error-prone wireless links etc. The study shows that greedy approach performs well as compared to other approaches (Prediction based/Direction based). Simulation results show that location-based routing can increase the network performance but suffers from the junction selection methods and there is need to optimize it.

C. Bouras et al. [6] did a performance analysis of GPSR protocol under the constraints of Urban mobility. For analysis purpose, various constraints were considered i.e. Obstacles, link range, Grid Topology and Velocity etc. Simulation results show that GPSR can manage the PDR while minimizing the energy consumption, at the cost of minor Delay. Proposed analysis can be extended to develop a mobility prediction logic for VANETs.

P. Manzoni et al. [7] explored the impact of mobility models on the performance of VANETs under the various constraints i.e. network topology, traffic conditions, driver's behavior and user requirements etc. The study recommends that mobility model should be compatible with the behavior of routing protocol and it should adopt all above factors to fulfill the needs of the application.

D. Laanaoui et al. [8] enhanced the greedy forwarding approach that forwards the packets when vehicles are moving at relevant slow speed and have a small distance between them. Routes are subdivided into multiple road segments and shortest paths are used for further transmission. Simulation results show its performance in terms of improved PDR as compared to GyTAR protocol.

A. Oliveira et al. [9] did a survey of low power networks and proposed a solution for mobility extension that can fulfill various constraints i.e. Mobility, QoS, communization trade-Offs, and scalability etc. The analysis shows that frequent updates of routing table can cause extra control overhead. Low powered networks must be operated on small data rates and fair distribution of spectrum is also essential. Proposed solution can be extended for other mobility models.

S. Wang et al. [10] identified the issues related to scalable communication over VANETs under the constraints of vehicle density and mobility etc. Due to variations in these parameters, data traffic is overloaded on the channel that causes performance degradation. To fulfill the QoS requirements, a data offloading method was introduced which supports data offloading capabilities for Wireless channel (being used for VANETs), using multi-objective combinational equation. Simulation results show that it can ensure QoS provisioning for VANETs.

K. N. Qureshi et al. [11] presented a solution for location based routing protocol which suffers from frequent topological updates, due to high mobility. Proposed solution uses beaconless routing approach and link quality is maintained by assigning unique weights to them and packets are forwarded using the combination of greedy and directional methods. Handshaking mechanism is performed by using RTS/CTS frames. Proposed solution can easily recognize the mobility patterns and the topological changes and offers improved PDR with minimum Delay. Simulation results show that it can be utilized for data sharing and real-time communication etc. It can be extended for Urban and Highway topology also.

F. A. Silva et al. [12] developed a solution to transfer the data over multiple geographically locations. Frequently used data is replicated for location-based users. Simulation results show that it is able to maintain the ratio of content delivery over network thus reduces the data transmission cost. Proposed solution can be extended to provide the support to Delay Tolerant Networks. It can also be used to deliver the data priority wise.

M. Zareei et al. [13] proposed a cross-layer solution that can interact PHY layer to estimate the channel capacity and after that, it can reschedule the packet at MAC layer, under the constraints of mobility. As per the availability of channels, multiple clusters are formed to minimize the impact of the mobile environment. Simulation results show that for low network density, minimum 5 channels are needed for a single cluster and if density is higher than 3 channels are sufficient to handle the node's mobility. Proposed scheme can be integrated with routing tables also.

S. Ilarri et al. [14] considered the various aspects of mobile environment i.e. Vehicle mobility, user mobility, data mobility, traffic conditions and impact of dynamic topology and proposed a framework for ITS, to resolve the issues related to the high mobile environment. It can acquire the information about all above parameters, for decision making and after observing the vehicle and user movements, data transmission takes place. In real time scenario, results show that this framework is suitable for scalable networks but data mobility is still a major issue, yet to be resolved.

L. Ghout et al. [15] proposed a mobility aware scheme which can learn the frequent changes in network topology and can build the strategies to handle mobility. It can also predict the node movements to ensure the QoS for end users. GPS is used to detect current node's location and according to the movements, a knowledge base is prepared to learn changes in topological patterns and finally this data is utilized for topology control and packet transmission, in order to minimize the packet loss. Simulation results show its performance in terms of reliable communication and it can be used to learn the behavior of routing table, in order to preserve network resources.

T. Suzuki et al. [16] developed a resource aware scheme that considers various parameters, in order to build the routes and these are channel capacity, node's velocity, current location, direction and transmission range etc. As per the dynamic characteristics of nodes and mobile environment, the channel is allocated and multi-hop routing paths are used to avoid delay. Simulation results show that it can reduce the End-to-End Delay and improves the network performance.

K. Park et al. [17] considered the impact of mobility on VANET's performance and introduced the mobility information into beacons which are being used for communication purpose. Highly stable and reliable intermediate nodes are used to predict the mobility patterns and to acquire the current location of nodes. Simulation results show that it can improve the PDR by reducing the packet loss.

O. M. H. Rehman et al. [18] investigated the impact of the mobile environment over communication links and developed a bidirectional link aware solution which can ensure the link's quality being used for data transmission. It selects the quality links according to the packet forwarding ratio under the constraints of mobility. Incompatible links are isolated from routing table. Simulation results show that it offers reliable communication and it can be further extended to provide the data retransmission support for packet loss situations.

III. PROPOSED SCHEME

Ant based routing builds the routing path and selects the optimal routing paths for communication purpose. A weight is assigned to each route, called Pheromone. It can vary along with time. In order to select fresh routes, it is necessary to update its value at some time interval but due to high velocity, VANET's network topology is dynamically updated and new routes are established for communication purpose, under the constraints of road topology. Vehicles can adopt lengthy paths, if Pheromone is outdated thus may lead to broken links. It is quite complex to maintain the Pheromone value in high speed environment, as it is faded out. Route discovery cannot be initiated using a single Ant, a group of Ants is required to explore unfamiliar briefest ways inside the longest way.

In this paper, Ant-based mobility aware routing for intelligent transport system was proposed, called vAnt-ITS.

According to vAnt-ITS, initial Pheromone value is set for each vehicle in the network and a fading factor is also initialized to avoid the dump routes (routes having less Pheromone). Whenever vehicles move, if there is any update in routing information, Pheromone is updated and depends upon the collected feedback, current routes may be ignored. High speed vehicles can frequently update the Pheromone value and current route may be congested, as other Ants may adopt the same route due to its high Pheromone value, to avoid this situation, Pheromone is managed in such a way that no route can have the Pheromone more than allowed limit. To keep the Pheromone alive, it is updated using route feedback, if it is +Ve, Pheromone is refreshed otherwise Pheromone is faded out. If vehicles are moving randomly, extra time is required to update the faded Pheromone as compared to Alive Pheromone. This time difference is monitored using different variables:

a. Acceleration Factor Pheromone: used to monitor changes in Pheromone
b. Refresh Factor Pheromone: Pheromone update interval (both a & b should have similar value otherwise current path is ignored).
c. Pheromone Fading Factor: indicates the obsoleted Pheromone values, for a particular route

Time difference indicates that some routes are frequently updated while other routes are in starvation stage and those routes must be avoided from routing. Using Pheromone Fading Factor, +Ve or –Ve feedback is generated and finally, it is used to make routing decisions.

vAnt-ITS Algorithm

```
Next Hop: r
Source Node: S
Destination: D
Routing Probability: Rp
Pheromone_Fading_Factor: pFf
```

Ant's Response

```
Pheromone_Feedbackl {
        Init_Fbk:=iFbk;    // initial Feedback
        pv_Fbk:=pFbk;    // +Ve Feedback
        ng_Fbk:=ngFbk;  //-Ve Feedback
}
```

Ant's Pheromone

```
Pheromone_Val {
Init_Pheromone:=P;  // initial Pheromone
MAX_ Pheromone:=;mxP  // Max. Pheromone
Min_Pheromone:=mnP;  // Min. Pheromone
Refresh_Factor_  Pheromone:=rfP  //  Pheromone  Update Interval
}
```

Velocity

```
Velocity {
MAX_ v:=;mxV // Max. Speed
Min_v:=mnV;     // Min. Speed
Acceleration_Factor_  Pheromone:=afP  //  Change  in Pheromone due to Mobility
}
```

For initial route establishment

```
1. Initialize (Source, Destination)
2. for each node Ni
        {
                Initialize (Anti,  Ni, P);
        }
3. Build_Route()
{
        Get-next(p);
        If (Ni , r, S,p) ;
        (Rp++, r, n, destination d);
}
```

Route management

```
If (pFbk)
{    If ( p < mxP)
        {   P++;
        afp=rfp;
        }
```

```
} else {
        P--;
        afp--;
}
If ( p< mnP)
{ dump_route(Ni, p);
}
If (afp != rfP )
{
pFf ++;
}
If (pFf)
{
dump_route(Ni, p);
}
```

IV. SIMULATION ANALYSIS AND RESULTS

TABLE I. SIMULATION CONFIGURATION

Parameters	Configuration Value(s)
Routing Protocol	Annet
Wireless Terrain	1300x1300
Node's Density	30
Velocity	20ms, 40ms, 80ms
MAC Protocol	MAC 802.11p
Traffic Type	CBR
Ifq length	50
Propagation Model	Nakagami
MAC	802.11p
Sampling Interval	2.5ms
Simulation Time	10 seconds
Network Simulator	NS-2.35
Simulation Scenarios	vAnt, vAnt-ITS

A. Performance Analysis

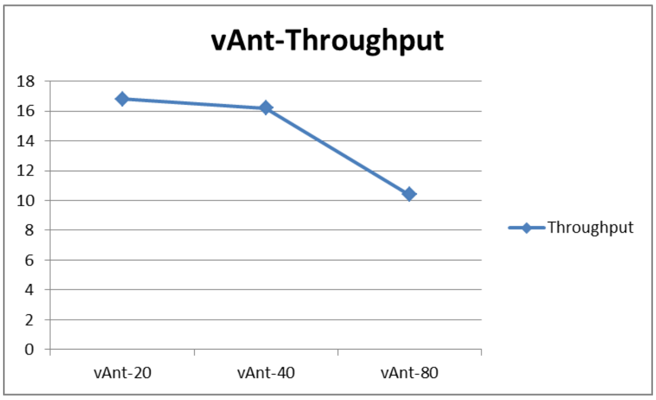

Figure 1. vAnt-Throughput

Figure 1 above shows that variations in Throughput of vAnt as it continues decreasing due to high velocity. If speed is 80ms, it reaches up to its minimum level.

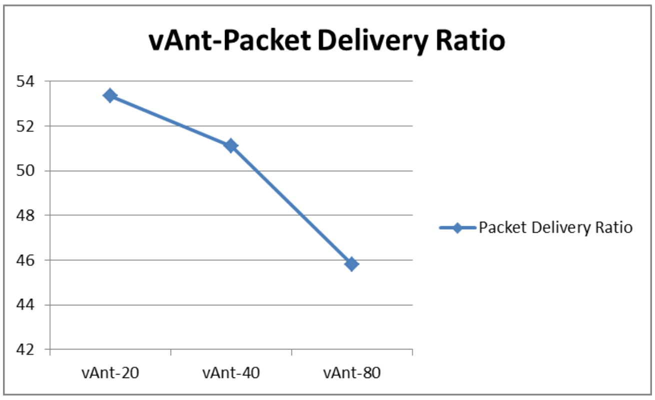

Figure 2. vAnt-Packet Delivery Ratio

Figure 2 above shows that variations in PDR of vAnt. It continues decreasing when speed reaches up to 40ms. For speed 80ms, it reaches up to its minimum level.

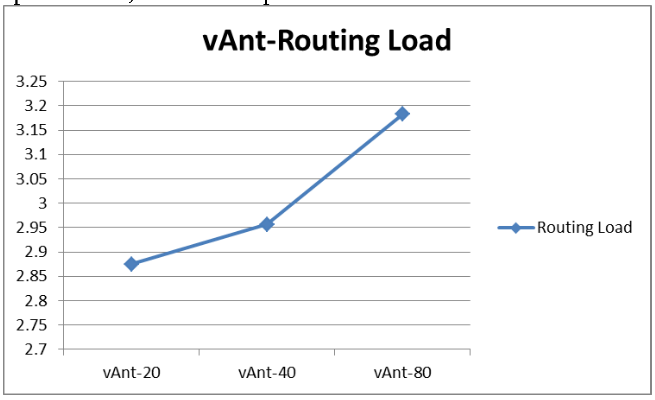

Figure 3. Routing Load

Figure 3 above shows that variations in Routing Load of vAnt. It is continues increasing when speed reaches up to 40ms. For speed 80ms, it reaches up to its peak value.

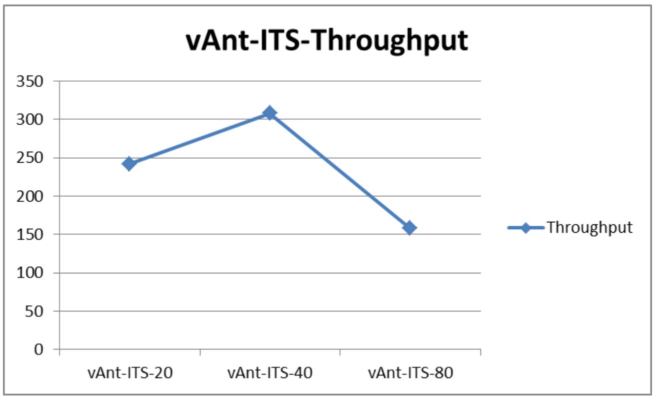

Figure 4. vAnt-ITS-Throughput

Figure 4 above shows that variations in Throughput of vAnt-ITS. it is continues increasing, even speed reaches up to 40ms and after that for speed 80ms, it reaches up to its minimum level, due to high velocity.

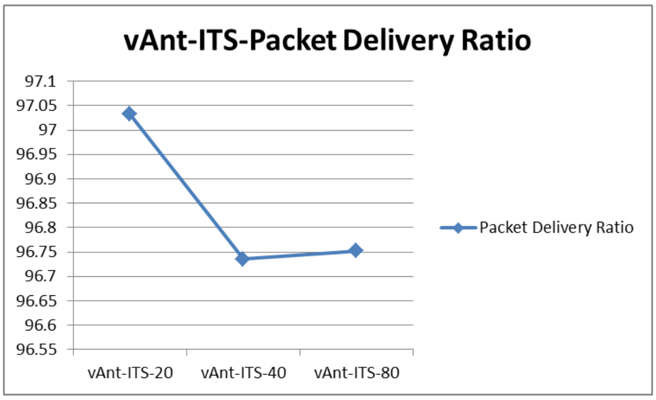

Figure 5. vAnt-ITS-Packet Delivery Ratio

Figure 5 above shows that variations in PDR of vAnt-ITS. It is highest when speed is 20ms but as speed is increasing up to 40ms, there is a sharp downfall but for speed 80ms, there is a minor improvement in PDR.

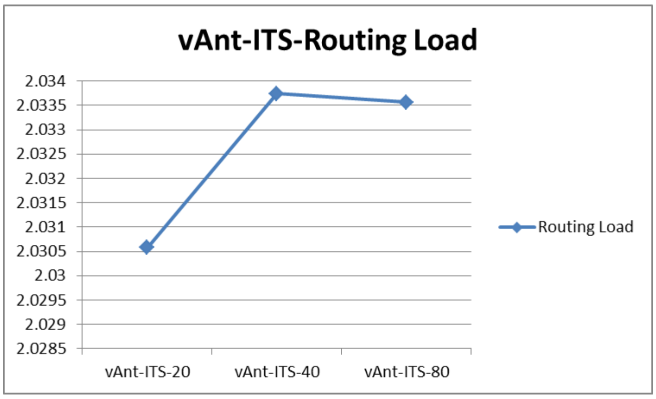

Figure 6. vAnt-ITS-Routing Load

Figure 6 above shows that variations in Routing Load of vAnt-ITS. If speed is 20ms, it is at its minimum level but It continues increasing when speed reaches up to 40ms and for highest speed (80ms), it reaches up to its peak value but after that, it starts decreasing.

B. Performance Comparision

Simulation results show that vAt and vAnt-ITS both suffer from the high mobile environment but now we will compare their performance.

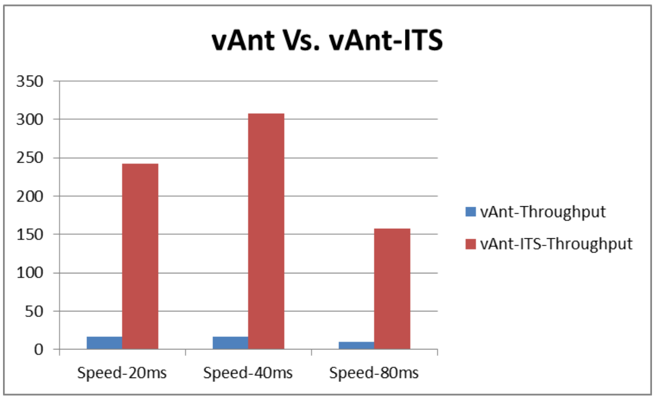

Figure 7. vANt Vs. vAnt-ITS (Throughput)

Figure 7 above shows Throughput comaprison of At and vAnt-ITS. It can be observed that there are variations in Throughput but vAnt-ITS outperforms.

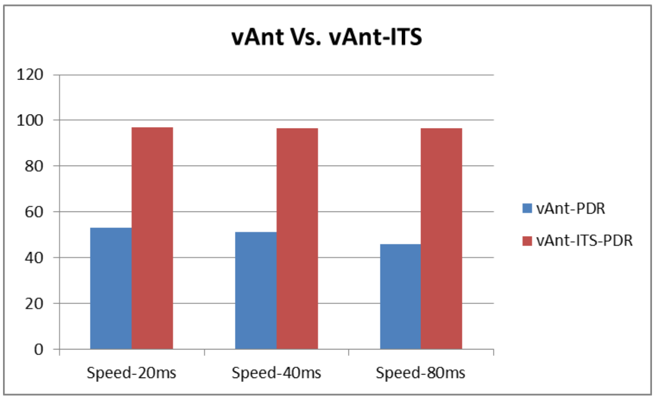

Figure 8. vANt Vs. vAnt-ITS (PDR)

Figue 8 above shows that PDR is varying for vANt but vAnt-ITS offers higher PDR as compared to vANt and managed its value until the end of the simulation.

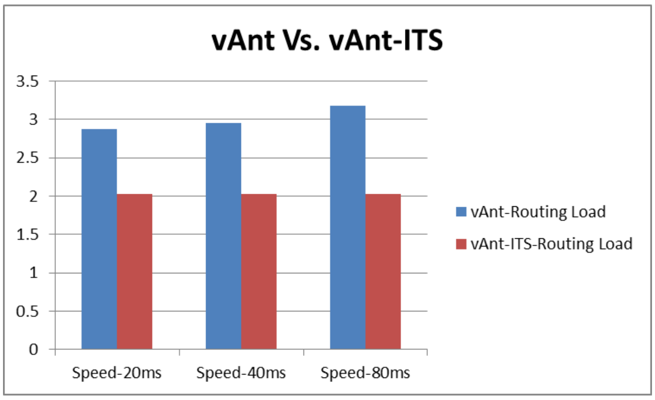

Figure 9. vANt Vs. vAnt-ITS (Routing Load)

Figure 9 above shows that routing load for vAnt is increasing due to the mobile environment and vAnt-ITS can easily adopt the mobility variations and offers less routing load as compared to vAnt.

V. Conclusion

In this research work, the performance of Ant-based routing over VANETs was analyzed under the constraints of the mobile environment. The analysis shows that conventional ant based routing is not suitable for high-speed networks and there is need to enhance the existing algorithms so that these methods can be integrated with VANETs, in order to enhance the network performance. vAnt-ITS method was introduced to achieve this goal. In contrast with vANt, vAnt-ITS performed well under the mobility variations. It improves Throughput, PDR while keeping the Routing Load under control. Simulation results show that if mobility is increasing from 20ms to 80ms, vAnt does not perform well whereas vANt-ITS maintains its performance by managing the extra control overhead.

Comparison of vAnt and vAnt-ITS shows that performance of vAnt suffers due to variation in mobility and routing load. vAnt-ITS deals with mobility variations and regulates the Routing load and tolerate the variation in Throughput and PDR. Finally, it can be concluded that vAnt-ITS adopts the high mobile environment but it requires some improvement in proposed routing logic. vAnt-ITS can be implemented for other wireless networks.

REFERENCES

[1] K. Manjappa, Ram Mohana, Reddy Guddeti, "Mobility aware-termite: a novel bio-inspired routing protocol for mobile ad-hoc networks", IET Networks, Vol. 2 (4), IEEE-2013, pp.188-195

[2] L.Zhang, Boyang Yu, Jianping Pan, "GeoMobCon: A Mobility-Contact-Aware Geocast Scheme for Urban VANETs", IEEE Transactions on Vehicular Technology, Vol. 65 (8), IEEE-2016, pp.6715 – 6730

[3] M. Wang, Hangguan Shan, Tom H. Luan; Ning Lu, Ran Zhang; Xuemin Shen, Fan Bai, "Asymptotic Throughput Capacity Analysis of VANETs Exploiting Mobility Diversity", IEEE Transactions on Vehicular Technology, IEEE-2015, pp.4187 – 4202

[4] S. K. Bho, Pabitra Mohan Khilar, "Self soft fault detection based routing protocol for vehicular ad hoc network in city environment", Wireless Networks, Vol. 22 (1), Springer-2016, pp 285–305

[5] S. M. Bilal, Atta ur Rehman Khan, Shahzad Ali, "Review and Performance Analysis of Position-Based Routing in VANETs", Wireless Personal Communications, Springer-2016, pp. 1–20

[6] Christos Bouras, Vaggelis Kapoulas, Enea Tsanai, "Performance Evaluation of Routing Mechanisms for VANETs in Urban Areas", Algorithms, Probability, Networks, and Games, Vol. 9295 of the series Lecture Notes in Computer Science, Springer-2015, pp 133-153

[7] P. Manzoni, Marco Fiore, Sandesh Uppoor, Francisco J. Martínez Domínguez, Carlos Tavares Calafate, Juan Carlos Cano Escriba, "Mobility Models for Vehicular Communications", Vehicular ad hoc Networks, Springer-2015, pp.309-333

[8] D. Laanaoui, Said Raghay, "New routing process in VANET", 4th International Colloquium on Information Science and Technology (CiSt), IEEE-2016, pp.880 – 885

[9] A. Oliveira, Teresa Vazão, "Low-power and lossy networks under mobility: A survey", Computer Networks, Vol. 107, Part 2, 9 Elsevier-2016, pp.339-352

[10] S. Wang, Tao Lei, Lingyan Zhang, Ching-Hsien Hsu, Fangchun Yang, "Offloading mobile data traffic for QoS-aware service provision in vehicular cyber-physical systems", Future Generation Computer Systems, Vol. 61, Elsevier-2016, PP.118-127

[11] K. N. Qureshi, Abdul Hanan Abdullah, Omprakash Kaiwartya, Fasee Ullah, Saleem Iqbal, Ayman Altameem, "Weighted link quality and forward progress coupled with modified RTS/CTS for beaconless packet forwarding protocol (B-PFP) in VANETs, Telecommunication Systems, Springer-2016, pp. 1–16

[12] F. A. Silva, Azzedine Boukerche, Thais R.M. Braga Silva, Linnyer B. Ruiz, Antonio A.F. Loureiro, "Geo-localized content availability in VANETs", Ad Hoc Networks, Vol. 36, (2), Elseview-2016, PP.425-434

[13] M. Zareei, A. K. M. Muzahidul Islam, Nafees MansoorSabariah BaharunEhab Mahmoud MohamedSeiichi Sampei, "CMCS: a cross-layer mobility-aware MAC protocol for cognitive radio sensor networks", Wireless Com. Network, Springer-2016, pp.1-15

[14] S. Ilarri, Dragan Stojanovic, Cyril Ray, "Semantic management of moving objects: A vision towards smart mobility", Expert Systems with Applications, Vol. 42, (3), Elsevier-2015, pp.1418-1435

[15] Lahouari Ghout, "Mobility prediction in mobile ad hoc networks using neural learning machines", Simulation Modelling Practice and Theory, Vol. 66, Elsevier-2016, PP.104-121

[16] T. Suzuki, Takeo Fujii, "Joint Routing and Spectrum Allocation for Multi-hop Inter-Vehicle Communication in Cognitive Radio Networks", International Journal of Intelligent Transportation Systems Research, Springer-2017, Vol. 15 (1), pp 39–49

[17] K. Park, Hyundong Kim, Sukyoung Lee, "Mobility State Based Routing Method in Vehicular Ad-Hoc Network", International Conference on Mobile Services, IEEE-2015, pp.473 – 474

[18] O. M. H. Rehman, Hadj Bourdoucen, Mohamed Ould-Khaoua, "Forward link quality estimation in VANETs for sender-oriented alert messages broadcast", Journal of Network and Computer Applications, Vol.58, Elsevier-2015, pp.23-41

[19] Felipe Cunha, Leandro Villas, Azzedine Boukerche, Guilherme Maia, Aline Viana, Raquel A.F. Mini, Antonio A.F. Loureiro, "Data communication in VANETs: Protocols, applications and challenges", Ad Hoc Networks, Vol. 44 (1) Elsevier-2016, pp. 90-103

[20] Cristofer Englund , Lei Chen, Alexey Vinel, Shih Yang Lin, "Future Applications of VANETs", Vehicular ad hoc Networks, Springer-2015, pp.525-544.

