PERFORMANCE ANALYSIS OF DIFFERENT COMPONENTS OF ANTHOCNET ROUTING ALGORITHM IN VANETS

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Abstract: Vehicular Adhoc Networks (VANETs) are a class of highly dynamic networks where vehicles are acting as nodes and contributing high mobility with continuously changing topology as major constrained for any routing protocol. In previous work, we have analyzed swarm based algorithms being used in VANETs to solve complex optimization problems and considered AntHocNet as the new algorithm to be implemented in VANETs. The general architecture of AntHocNet has similarities with architecture of ACO implementation used for routing. But AntHocNet has new elements apart from ACO routing such as use of both proactive and reactive components, using composite pheromone metrics and combination of bootstrapping process with ant based path sampling. Moreover, incorporating 802.11p in AntHocNet can further affect the performance of swarm based algorithms. In this paper, different element of AntHocNet is discussed with multiple challenges offered by VANETs, thereby introducing evaluation of components and effect on the performance of routing strategy of AntHocNet.

***Indexterms*- VANET, AntHocNet, Hybrid routing protocol**

I. INTRODUCTION

Vehicular Ad hoc Network (VANET) is a wireless network where vehicles on the road act as nodes and all the nodes communicate with each other using a Dedicated Short Range Communication (DSRC), an IEEE 802.11p (Al sultan et al., 2014). VANET are similar to MANET but mobility characteristic of VANET makes them different from MANET (Jing and Yuhao, 2011). The main components of a node in VANET are OBU (On Board Unit) and AU (Application Unit). OBU is responsible for providing services to the driver. Applications related to VANET can reside either on Roadside Unit (RSU) or on OBU. WAVE is used as medium to have communication between vehicles; between vehicles and RSU. RSU are often fixed along the road as separate device. Communication between vehicles is done through Vehicle-to-Vehicle (V2V) communication using IEEE 802.11p standard and between vehicles and RSU using Vehicle-to-Infrastructure (V2I) communication through long range wireless technologies (Jabarpour et al., 2014). VANET technology provides an opportunity to develop vehicles which are capable to collect, process and distribute information and are thus used by various applications like post accident information, safety related applications, blind crossing, turning assistance and traffic congestion (Al sultan et al., 2014; Mane and Kulkarni,).

There is vast number of routing protocols proposed for VANET scenarios. Few basic routing protocols are Adhoc On Demand Distance Vector (AODV), Ad hoc On Demand Multipath Distance Vector (AOMDV), Optimized Link State Routing (OLSR) and Dynamic Source Routing (DSR). The evaluation of routing protocols is often done through simulators as it is very complex and expensive method to manage and operate vehicles in real world problem.

Nature inspired algorithms provide beneficial solution towards optimization of complex problems in ad hoc networks. Ant Colony Optimization (ACO) is sch an algorithm which can be efficiently used in routing problems (Kochar and Mandoria, 2015; Afsar, 2007). This algorithm helps in finding the shortest path between source and destination and also in reducing the routing overhead. In this paper, AntHocNet environment, a hybrid strategy has been created for VANET scenario using MOVE and analysis us done using simulator ns 2.34. It should always be kept in mind that alogorithm applicable in MANETS does not show the same and effective performance for VANET scenario because of high mobility of vehicles and frequently changing topology.

AntHocNet is inspired by ACO routing, but its composite design makes it different from ACO. It comprises bootstrapping mechanism, an innovative way towards network problems. The combined use of proactive and reactive ant generation along with composite pheromone metric does not provide any novelty, but the use of these schemes in AnyHocNet is original.

The purpose of the paper is to study different design components of AntHocNet and to analyze a few through simulations. The effect on performance by using bootstrapping, proactive and reactive components, varying the routing exponent and MAC type is observed in this paper. The general effectiveness of integrated approach is provided in this paper and can be assessed in technical report (Shen et al., 2004).

The rest of the paper is organized as follows. In Section II a brief description about AntHocNet is provided. The reader can consult mentioned references for more details. Section III describes simulation environment used along with the parameters used to conduct the experiments using MOVE and ns 2.34. In Section IV results related to experimental analysis is done and are discussed in concise manner.

II. ANTHOCNET: META HEURISTIC ROUTING ALGORITHM

AntHocNet is a hybrid algorithm as it comprises both proactive and reactive strategies for establishing routing paths. The reactive strategy starts as soon as node starts gathering routing information between source and destination; a local traffic session starts communicating with destination and routing information is absent. It terminates into proactive session once the communication starts and nodes proactively update the routing information with network changes. Thus, both the number of paths and the costs used by each running flow reflects the status of network.

The phase of path setup is done by reactive component and uses the ACO strategy to initiate an initial path. Routing information is encoded in pheromone table of each node. Path improvement and maintenance are done proactively during the path session. This is achieved by combining slow rate pheromone diffusion and ant path sampling; The ant path sampling spreads the routing information between nodes of VANET; the bootstrapping scheme updates the routing table which in turn provides guide to ant path exploration.

In case of link failure, a local path repair process is done via explicit notification messages. Ant exploration and data packet distribution over multiple paths is achieved through stochastic decisions. In coming subsection, a concise description related to each component is provided excluding components dealing link failures.

2.1 Metrics to Define Pheromone Tables Along with Path Quality

The tables of pheromone variables define the path implicitly. The estimated goodness of going from node i to destination d over neighbor n is indicated by an entry $T_{nd}^{i} \in R$ of pheromone table T^i. The information about those destinations which are active during communication session is maintained only and node's neighbors' change continuously, hence fall in pheromone table is dynamic and sparse. The goodness of path is determined by different metrics such as end-to-end delay, number of hops, congestion etc.

2.2 Reactive Technique to Setup the Path

If a source node's' wants to start communication with destination node'd', initially's' does not have any routing information for 'd'. So 's' broadcast a reactive forward ant. The ant is either broadcast or unicast at each node, in accordance whether the current node contains pheromone information of 'd' or not. The ant chooses its next hop n upon the availability of information, with probability P_{nd}. This probability depends upon relative goodness of 'n' as next hop. This probability is expressed in the pheromone table T_{nd}^{i} as:

$$P_{nd} = \frac{\left(T_{nd}^{i}\right)^{\beta}}{\sum_{j \in N_d^i}\left(T_{jd}^{i}\right)^{\beta}} \quad , \beta \geq 1 \qquad (2.1)$$

Where N_d^i = set of neighbors of 'i' over which path to 'd' is known

β = parameter controlling exploratory behavior of ants.

The ant is broadcasted; if no pheromone is available. To avoid excessive ant proliferation, high values of β is used, as it may happen that no pheromone is found along some paths. Destination'd' receives duplicate copies of same ant due to subsequent broadcast. The node receiving multiple copies f same ant accepts the first copy and discards other copies. Hence, a single path is set up initially. As the communication session progresses, proactive strategy adds more path while maintaining and exploration mechanism.

The list of node visited by each node is kept by that node itself. When a forward ant reaches the destination 'd', it is converted into backward ant. The backward ant retraces the path upon travelling back to source. The entry T_{nd}^{i} is updated by ant, at each intermediate node 'i', in the pheromone table of 'i', while coming from neighbor 'n'.

Path quality metrics that is used to define pheromone variables determines the way to update the entry. If the number of hops is used to express pheromone so as to measure the goodness of path, the backward ant increments an internal hop counter at each hop and the inverse of this value is used to assign the value τ_d^i locally that is further used to update the pheromone variable T_{nd}^{i} as:

$$T_{nd}^{i} = \gamma T_{nd}^{i} + (1-\gamma)\tau_d^i, \gamma \in [0,1] \qquad (2.2)$$

If delay is used to express pheromone, ant increments the calculation at each node to estimate the expected delay to reach at the destination. Different metrics are used to calculate τ_d^i but with increase in complexity, though they follow the same logic.

2.3 Path Exploration and Maintenance Using Proactive Approach

Proactive forward ants are periodically sent out by source nodes to update the paths and try to find better paths. Pheromone tables are updated in the same as reactive forward ants do. Thus continuous proactive sampling of path can be observed here. There is a need to check the ant sending frequency due to constant changes in the network. Blind exploration or broadcasts should be done in excess to find new paths. So, ant sending rate should be low and action of ants should be integrated by combining bootstrapping and pheromone diffusion.

Existed paths are maintained by the process of bootstrapping.

2.4 Data Routing Using Stochastic Approach

Pheromone value determines forwarding of data stochastically through nodes. A node selects next hop for the destination'd' randomly with probabilityP_{nd}, if multiple next hops are available for destination. P_{nd} is calculated using equation 2.1. This implies that routing of data can have a mesh of multiple paths and selection of path is done dynamically and automatically as a function of estimated quality. The effect of varying parameter controlling exploratory behavior of ants will be done in section IV.

III. SIMULATION ENVIRONMENT TO CONDUCT EXPERIMENTAL METHODOLOGY

For the study of the performance of AntHocNet, we use simulation experiments. Table 3.1 provides a parameter which are used during the simulation. Concerning the AntHocNet parameters, if not stated differently, the value of β in Eq. 2.1 is set to 20, the maximum number of entries in the pheromone diffusion messages is set to 10, and the sending interval for the proactive ants is 2 seconds.

The performance of AntHocNet is done by using simulators, a common approach to carry out experiments in ad hoc networks. The complexity of such networks make difficult to carry out analytical evaluations and configuring and purchasing the hardware increases the cost of project. in order to carry out the testbeds. We have used MOVE to generate VANET scenario and network simulator ns2.34 to perform the simulation run of VANET scenario.

The simulation test runs for 1000 seconds. An open space scenario is constructed using MOVE for a city scenario to carry out the evaluations of AntHocNet. Table provides parameters which are used during the simulation of VANET scenario.

Table 3.1: List of parameters used during simulation

S.No	Values
No of Nodes	140
Area	652 x 752
Mobility model	Using MOVE [Fig 5]
Speed of vehicles	40 m/s
Radio propagation model	Two ray ground
Simulation time	1000 ms
Phy/ Mac Layer	802.11
CBR	0.2 Mbps
UDP is used	Yes
Beta	2, 5, 10, 20
Max entries in pheromone diffusion message	10
Sending interval of proactive ants	2 sec

Performance of AntHocNet is evaluated by measuring Packet Delivery ratio (PDR) and End-to-End (E2E) delay. These are considered as standard measures of effectiveness of VANETs. Other metrics considered are average throughput and normalized routing load. Efficiency is measured using routing load.

IV. EXPERIMENTAL ANALYSIS OF ANTHOCNET IN VANET SCENARIO

Effect of β influences the performance of algorithm to a certain effect. In this section, β exponent for data packets has been varied as per equation 2.1. β is used to spread the data by controlling amount of multiple paths. E2E delay and PDR are drawn in Fig 1 and Fig 3 respectively with respect to β. It can be seen that there is a need to have deterministic greedy policy to select next hop. But it also does not implies the use of single path to forward data packets. It can be seen from Fig 3 and Fig 4 that increasing the value of β though decrease the PDR but the normalized routing load increases, hence it can be predicted that excessive use of multiple paths bring the performance of algorithm down. This fact arises due to the fact that simultaneous us of two paths for same flow often results in the interference with degradation in performance.

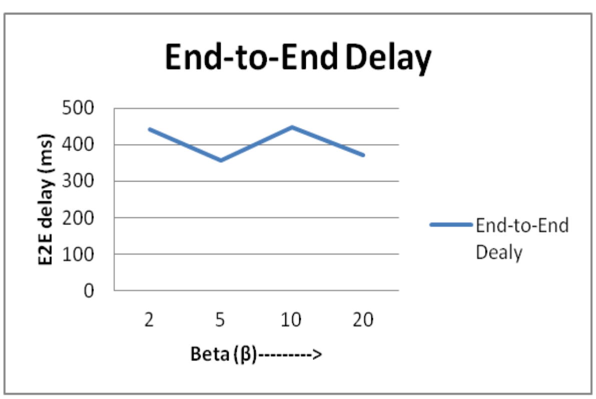

Fig 1: Delay vs β

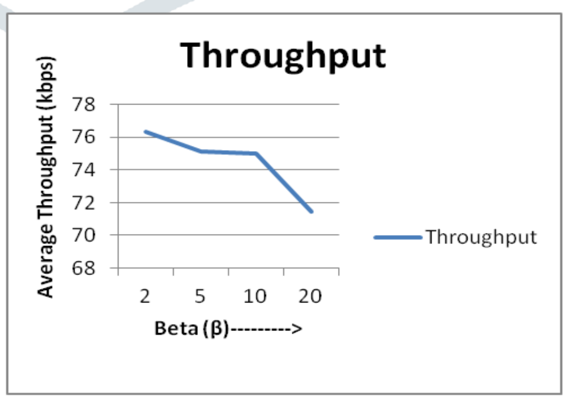

Fig 2: Throughput vs β

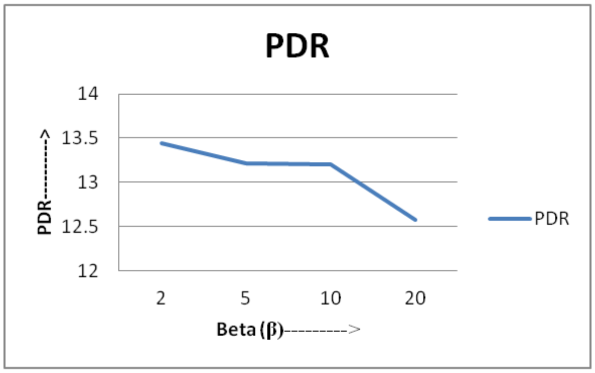

Fig 3: PDR vs β

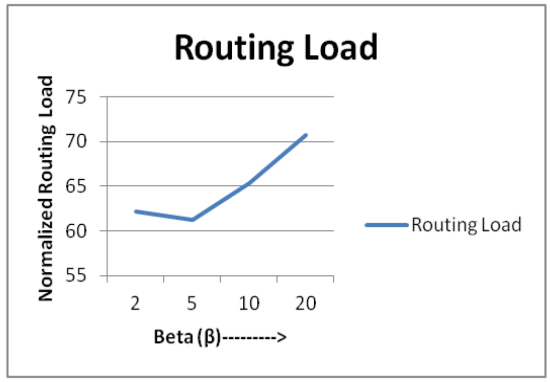

Fig 4: Routing load vs β

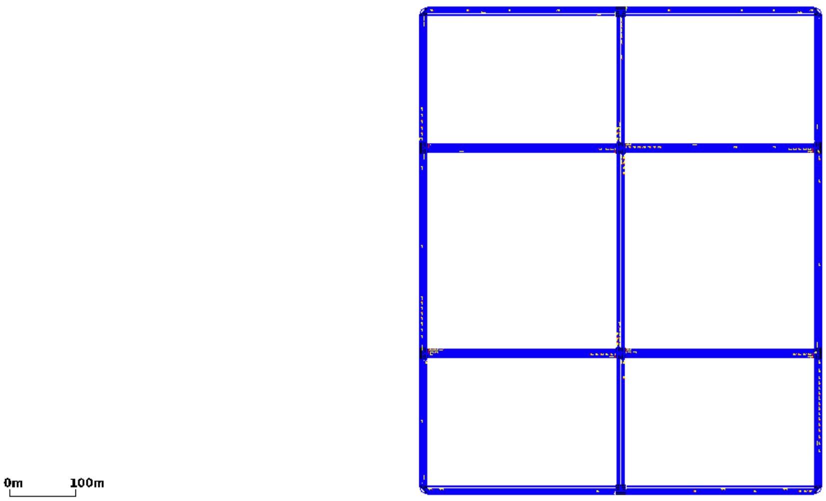

Fig 5: VANET Scenario constructed using MOVE

V. CONCLUSIONS

In this paper, different challenges with AntHocNet in VANET scenario is addressed. AntHocNet was described in the previous work and performance analysis was done with other state-of-art algorithm in VANET scenario. It is shown in this paper the innovative designing of AntHocNet, based on proactive and reactive components and the integration of sampling mechanism. It has been investigated in the paper about the role of different components in the algorithm theoretically. The experimental analysis of β on the overall performance of algorithm is also done. The multiple challenges in VANETs are dealt by using composite design and sampling using pheromone bootstrapping. It can be pointed out here that there is a need of adopting low overhead and less PDR for data forwarding and exploration of new paths. Also the composite pheromone metric by using different multiple aspects of network environment boost the performance of AntHocNet algorithm.

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