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Comparison of Stack Implemented AODV (ai-sAODV) with Queue Implemented AODV (ai-dqAODV) for VANET in Signal Fading Scenario

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Abstract:
A recent upcoming smart traffic is Vehicular ad hoc network (VANET) is also considered as a sub-set of mobile ad hoc network (MANET). It provides wireless ad-hoc communication in between vehicles and vehicle to roadside equipments. Based on this technology traffic network is classified into two types 1. vehicle to vehicle interaction, 2. vehicle to infrastructure interaction. The objective of VANET is to provide safe, secure and automated traffic system. For this automation of traffic technique is different types of routing protocols have been developed. But routing protocols of MANET are not directly applicable to VANET. VANET is designed on IEEE 802.11b wireless standard. This helps to communicate vehicle to vehicle and vehicle to trafic communications. According to Federal Communications Commission (FCC) suggests for VANET frequency spectrum of 75 MHz in the range of 5.850 GHz to 5.925 GHz. It communicate from one vehicle (source) to another vehicle (destination) through different vehicles (intermediate nodes). A numbers of different routing protocols for communication, ie multimedia data, text data etc. from one vehicle (node) to another vehicle are existing. The Ad hoc On-Demand Distance Vector (AODV)[1] routing algorithm is one of the popular routing protocols for ad-hoc mobile networks. AODV is used for both unicast and multicast routing. Earlier we have modified AODV with stack and dqueue, where we have find a considerable amount of betterment of result with respect of AODV. In this paper, we propose and implement in the NCTUns-6.0 simulator neural network based Modified AODV on dqAODV(dqueue implemented AODV)[2] and sAODV (stack implemented AODV)[3] routing protocol considering Power, TTL, Node distance and Payload parameter to find the optimal route from the source station (vehicle) to the destination station in VANET com-munications. Further we compare both neural network optimized dqAODV (dqueue implemented AODV) and sAODV (stack implemented AODV) performance on a signal fading model (Rayleigh). This gives us a better result in ai-sAODV(Neural network optimized Stack implemented AODV) compared to queue implemented AODV (ai-dqAODV).

Keywords: *VANET, dqueue, stack, AODV, Neural network, Rayleigh signal fading, NCTUns-6.0.*

1. Introduction

Vehicular Ad-hoc Networks (VANETs) [3]-[4] identifies an emerging technology, particularly challenging a class of Mobile Ad Hoc Networks (MANETs). VANETs are distributed; self-organizing communication networks built up by moving vehicles, and is thus characterized by very high node mobility with limited degrees of freedom in the mobility patterns. Hence, ad hoc routing protocols must adapt continuously to these unreliable and unethical conditions; in the event of growing effort in the development of communication protocols which are originated to vehicular networks. One of the critical aspects when evaluating routing protocols for VANETs is the employment of mobility models that reflect as closely as possible to the real behaviour of vehicular traffic. This notwithstanding, using simple random-pattern, the graphs constrained mobility models is a common practice among researchers working on VANETs. There is no need to say that such models cannot describe vehicular mobility in a realistic way, since they ignore the peculiar aspects of vehicular traffic, such as cars acceleration and retardation in presence of nearby vehicles, queuing at roads intersections, traffic bursts caused by traffic lights, and traffic congestion or traffic jams. All these situations greatly affect the network performance, since they act on network connectivity, and this makes vehicular specific fundamental performance evaluations at the time of studying routing protocols for VANETs.

Wireless technologies [1]-[5] are extended to ad hoc networks like Mobile Ad Hoc Network (MANET) and Vehicular Ad Hoc Network (VANET) [6]-[8]. Ad hoc networks are one type of network that offers communications within a certain range of areas; even connect to wide areas via basic mobile network and Internet. One of the authors has already published his useful and important findings of various routing protocols [5], mainly many variants AODV applicable in MANET. This study is the modest approach towards the justification for application of AODV routing protocol of MANET in Vehicular Transmission [7]-[8].
Thus total connectivity in a VANET is assured. VANETs are also known under different name like Dedicated Short Range Communications (DSRC), Inter Vehicle Communications (IVC), etc. Number of projects have been launched for VANET, e.g., FleaNet in USA, FleetNet in Germany, ITS in Japan, etc. [1], [5].
The motivation of a VANET project is to create a new algorithm or protocol or modify the existing one for use in vehicular environment. Thus VANET helps the drivers of vehicles to communicate the information in form of voice, data, image, multimedia, etc. Also it ensures safe journey by minimizing road accidents, diverting or instructing the vehicle's direction in less populated roads avoiding traffic jam, etc. Vehicles in a VANET are having high degree of mobility, i.e., the vehicles are moving very fast, especially in high ways. As a result the two vehicles are in a direct communication range staying about one minute time only, i.e., two vehicles remain in one cell about one minute time when they are moving parallel direction or even less than one minute when they are in opposite direction [3]-[5]. For this, VANET cell configuration and number of nodes present in a particular cell with applicable routing technique is changing in nature.
An advanced artificial intelligence (AI) based Modified Ad hoc On-Demand Distance Vector (aiAODV) routing protocol applying fuzzy neural network algorithm is proposed in this paper. Generally the scientists may not be able to provide error free data or knowledge using fuzzy logic system. For that a neuro fuzzy system can be used to tune the system and reject unnecessary or redundant fuzzy rules. A neuro fuzzy system has multi layers that embed the fuzzy system. By applying this fuzzy neural network in aiAODV routing protocol we able to determine the optimum route (path) from the source vehicle to the destination
To implement VANET in traffic system, there are various type of routing protocol already developed [Fig 1].

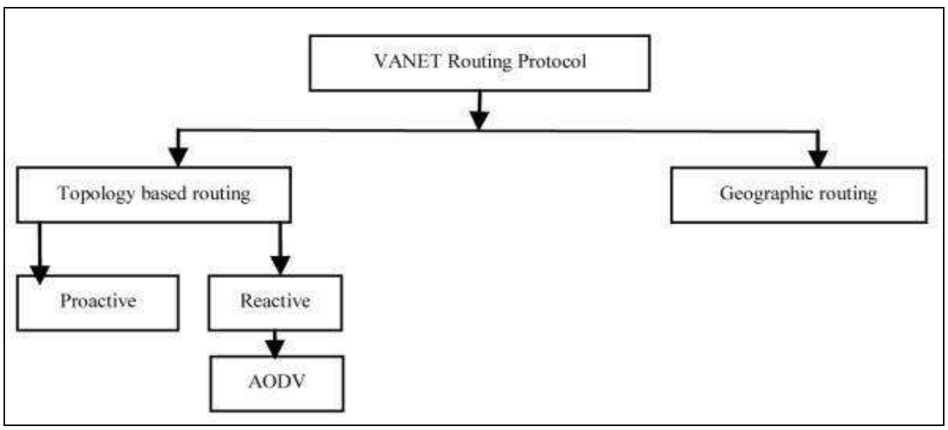

Figure 1: Classification of routing algorithms in VANET [2]

1.1. Proactive Routing Protocol

In proactive routing protocol, routing information i.e., next hop forwarding technique is maintained in the back ground irrespective of communication request. As this routing information schedule is maintained by routing table, it does not required route discovery process. It is an advantage of proactive routing protocol and the disadvantage is that it provides low latency in real life application. The various type of proactive routing protocols are FSR, OLSR, etc. [1], [3]

1.2. Reactive Routing Protocol

For Reactive routing protocol, routing information i.e., next hop forwarding techniques performs dynamically. If it is necessary to communicate with other nodes then it needs to create route discovery with the help of broadcasting a message and this process continues until the destination is found. The various types of reactive routing protocols are AODV, DSR, etc. [1], [3]

1.3. AODV Routing Protocol

Ad hoc on-demand Distance Vector (AODV) [1] routing protocol is an important routing protocol used in VANET system. It is known that AODV is reactive routing protocol, that is based on topology based routing protocol. The AODV routing algorithm enables dynamic, multi-hop, self starting, routing between participating moving nodes wants to establish and maintain an ad-hoc network [3]. As AODV routing algorithm is dynamic in nature, so it also allows highly mobile nodes to create routes very quickly to find new destination, nodes which are not connected, is not necessary to maintain this routes. As AODV used in VANET system, therefore it allows the nodes to break a link from a network and can connect this node to another network. But during packet delivery time AODV does not allows the loop (closed path) and the shortest path is measured by Bellman-Ford algorithm counting to infinity problem‖. [Fig-2]

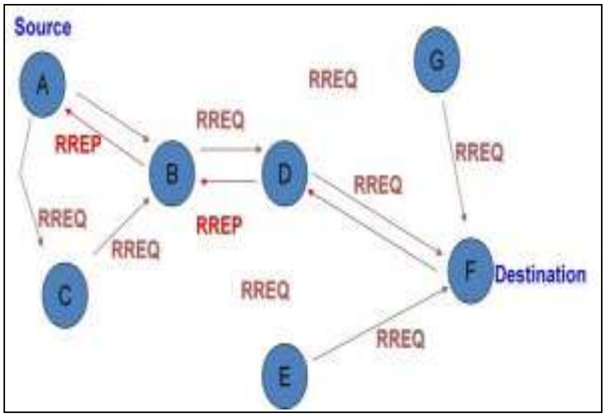

Figure 2: AODV working mechanism [2]

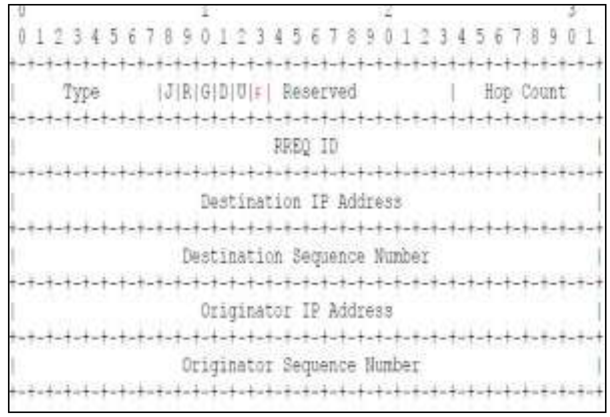

Figure 3: Modified RREQ packet format [1]

We have modified Route Request (RREQ) [1] header [Fig 3] with a new flag F. If an F is set the discovered Destination IP address is preserved in a dqueue. During unicast if link breakage occurs, according to flag F it pick neighbour node address (nearest originator IP) from dqueue. As the dqueue is implemented the insertion and pickup is less complex to stack [2].

We have modified earlier AODV-RREQ header [Fig 4] with a new flag F. If an F is set the discovered Destination IP address is preserved in a dqueue. During unicast if link breakage occurs, according to flag F, it pick neighbour node address (nearest originator IP) from dqueue. As the dqueue is implemented the insertion and pickup is less complex to stack [2].

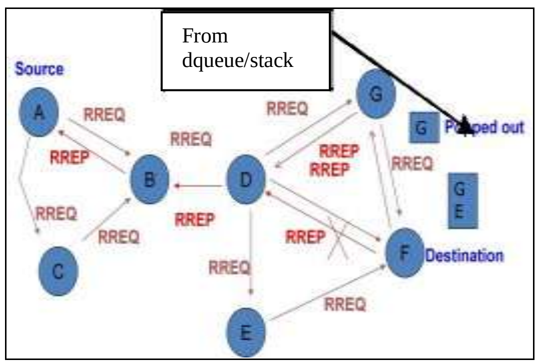

Figure 4: On error [2]

D. Performance Analysis Parameter:

Throughput is average number of successfully delivered packets on a network or network node. In other words throughput describes as the total number of received packets at the destination out of total transmitted packets [5]. Throughput is calculated in bytes/sec or data packets per second. The simulation result for throughput in NCTUns6.0 shows the total received packets at destination in KB/Sec, mathematically throughput is defined as:

$$\text{Throughput (kb/sec)} = \frac{\text{Total number of received packets at destination*packet size}}{\text{Total simulation time}} \text{ kb/sec} \quad (1)$$

2. Related Work

Aswathy M C et. al [9] in 2012, proposed for improving the performance of AODV by modifying the existing protocol by creating table clusters and perform coming by clusters nodes and gateway nodes.

Dharmendra Sutariya et. Al[6] in 2012, proposed a routing protocol AODVLSR(AODV Limited Source Routing) it ensures to give timely and accurate information to drivers in V2V communication compare to AODV protocols in city scenarios of vehicular ad-hoc networks and AODV is defined as limited source routing up to two hops for network nodes. The performance on proposed AODVLSR protocol is compare with basic AODV protocol in terms of Packet Delivery Ratio , Avg. End-to-End delay, Dropped TCP packets and normalized routing load.

Annu Mor [7] in 2013, proposed cross layer technique that find channel security at link layer to AODV routing protocol to improved communication in vehicles for safety.

Gulhane S.P. et. al [8] in 2012, proposed a typical routing protocol that the ad-hoc on demand routing protocol (AODV) in mobile ad-hoc networks and the optimized protocol AODV-OBD for AODV.

Uma Nagaraj et. al[10] proposed the advantages/disadvantages and the applications of different routing protocols for vehicular ad-hoc networks. This explores the motivation behind the designed, and trace the evolution between routing protocols. They also proposed to compare four well-known protocols AODV, DSR, OSLR and DSDV by using three performance metrics packet delivery ratio, average end to end delay and routing overhead. V.P.Patil [10] in 2012, proposed a new approach to deal with the problem of traffic congestion using the characteristics of vehicular ad-hoc networks. The system is developed and testing was done using AODV protocol of ad-hoc mobile network to work with the problem of vehicle traffic congestions in vehicular ad-hoc networks. The performance is measured in terms of number of packet in broadcasted, percentage of packet delivery and percentage of packet diverted and overhead to manage the problem of data traffic congestion in Ad hoc networks.

Rakesh Kumar et. al [12] in 2011, proposed an extended AODV routing protocol proposed for AODV networks which typically suits to resolve the realistic model problems. This proposed protocol improved the performance of regular AODV routing protocol. It has features of AODV routing protocol, at is follows all the steps of the discovery algorithm of AODV routing protocol.

Neeraj Sharma et. al [13] in 2013 performed analysis the AODV and GPSR routing protocol used in VANET and concluded over them.

Considering the all above work we found the major problem is how to improve AODV routing protocol to get more realistic result.

We previously done a comparative study based on different scenario on Ad-hoc routing protocols [14]. There we found City Scenario [Mesh Structure] is most appropriate for VANET [14]

Next we found AODV is best for dense city scenario compared to other routing protocol [14].

Next we have proposed a modification of AODV with the help of stack (sAODV) [3]. But we found the result is not satisfactory as it is time and space complex. Therefore we propose another approach of AODV modification using dqueue (dqAODV). These results is compared with city scenario and we got a satisfactory result.

3. Proposed Work

In AODV protocol, a source station (vehicle) initiates a Route Request (RREQ) [1] in the network for connecting to a destination station (node), the route is determined considering the four attributes or parameters like the distance (D), the overload or overhead (O), the consumption of electric power (P), and the expected time (T) to remain the route in alive (active) condition. First three attributes (D, O, P) [15], [16] are acceptable for lesser or minimum value and the fourth attribute expected time is accomplished for larger value, i.e., longer period. Therefore, the normalized expected time period is deducted from one (1) to bring homogeneity among all attributes. There may be different routes under AODV protocol available from the source station to the destination station having one set of values D, O, P, and T for each route. Now the best AODV route is selected among the different routes by applying fuzzy neural network algorithm [16], [17] [18].

Hence we try to simulate those optimized routing algorithms on a fading signal model scenario. For this purpose we choose well popular Rayleigh [19-21] propagation model is most applicable to instances where there are many different signal paths, none of which is dominant. In this way all the signal paths will vary and can have an impact on the overall signal at the receiver. The Rayleigh fading model is particularly useful in scenarios where the signal may be considered to be scattered between the transmitter and receiver. In this form of scenario there is no single signal path that dominates and a statistical approach is required to the analysis of the overall nature of the radio communications channel.

Rayleigh fading is a model that can be used to describe the form of fading that occurs when multipath propagation exists. In any terrestrial environment a radio signal will travel via a number of different paths from the transmitter to the receiver. The most obvious path is the direct, or line of sight path [21].

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B. Sklar have proposed [22] the received power expressed in terms of transmitted power is attenuated by a factor, $Ls(d)$, where this factor is called *path loss* or *free space loss*. When the receiving antenna is isotropic, this factor is expressed as [1]:

$$L_s(d) = \left(\frac{4\pi d}{\lambda}\right)^2 \qquad (2)$$

In Eq. 2, d is the distance between the transmitter and the receiver, and l is the wavelength of the propagating signal. For this case of idealized propagation, received signal power is very predictable.

Y. R. Zheng, et. al. Had proposed new sum-of-sinusoids statistical simulation models are proposed for Rayleigh fading channels [23]. These new models employ random path gain, random initial phase, and conditional random Doppler frequency for all individual sinusoids.

3.1. Simulation result and Analysis

In this study, we used NCTUns-6.0 for simulation. We have chosen this simulator because [24],

1. Highly integrated and professional GUI environment
2. Support for various network protocols.
3. Support for various important network.

4. Same configuration and operations as for real life networks.
5. High simulation speed and repeatable simulation result.
6. High fidelity simulation results.

3.2. Simulation Scenario

We have taken a mess scenario (city scenario of New Delhi[14-15][Fig 5]) as it was earlier studied, where it gives best performance of AODV routing algorithm[] as our proposed algorithm for routing based on AODV, for dense traffic.

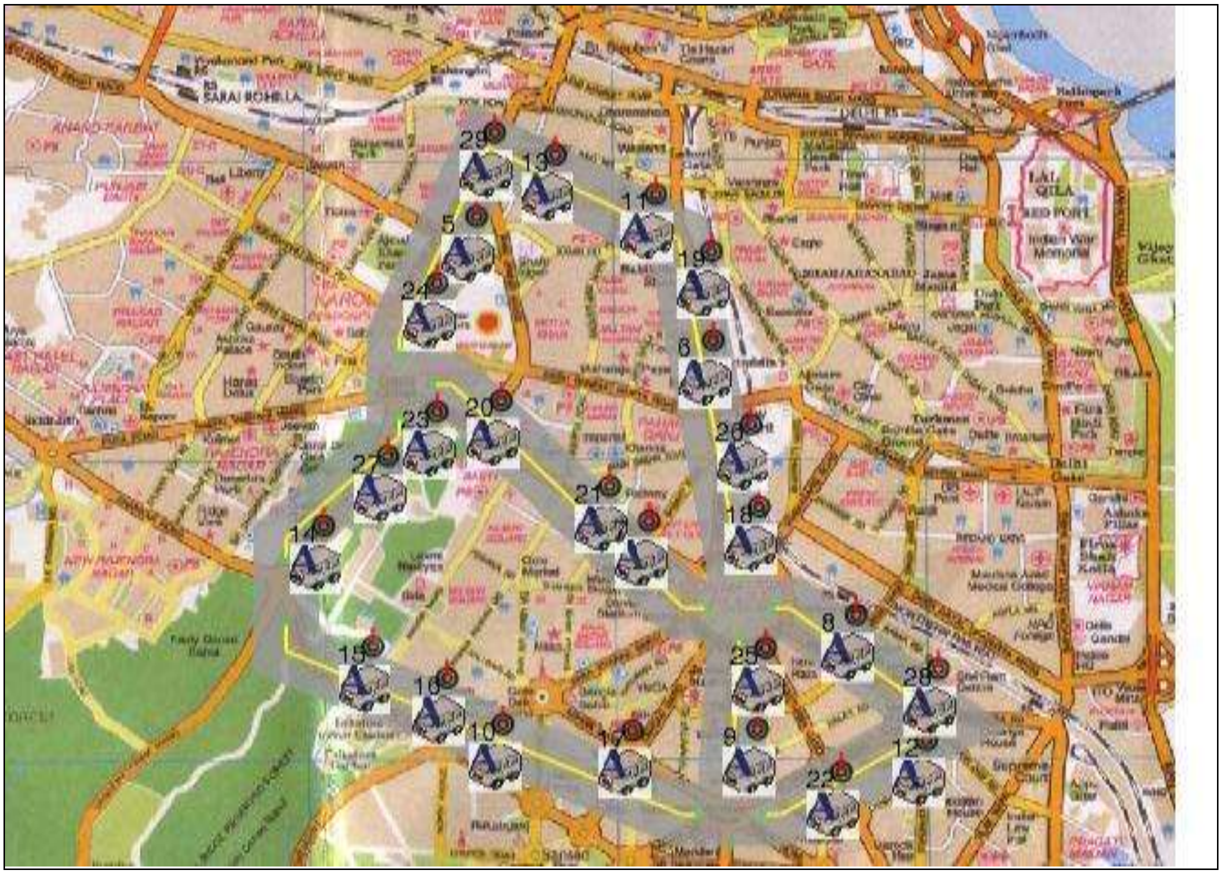

Figure 5: Delhi road map based city Scenario [25]

Parameter	Settings
Transmission mode	TCP/IP
Lane Width	20m
Simulation time	400sec
RTS threshold	4000bytes**(O)**(increase)
The car profile (Taken five)	18km/H, 36km/H, 50km/H, 60km/H, 80km/H
Number of lane	2
The protocol	ai-dqAODV, ai-sAODV
Standard used for each vehicular node	IEEE802.11b
Cars are selected for three different scenarios	10,15,20,25**(D)**
Transmission power used, TTL, Frequency Channel	7dbm **(P)**(reduced) , 3**(T)**(reduced), 6(increase)
Path loss model, Hello Interval, Route Timeout	Free space and shadowing, 2000(increase), 4000(increase)
Fading model, Hello loss, Link Bandwidth	Rayleigh, 4(increase), 7db(reduced)

Table 1: Input Parameter for Testing Scenario

3.3. Results

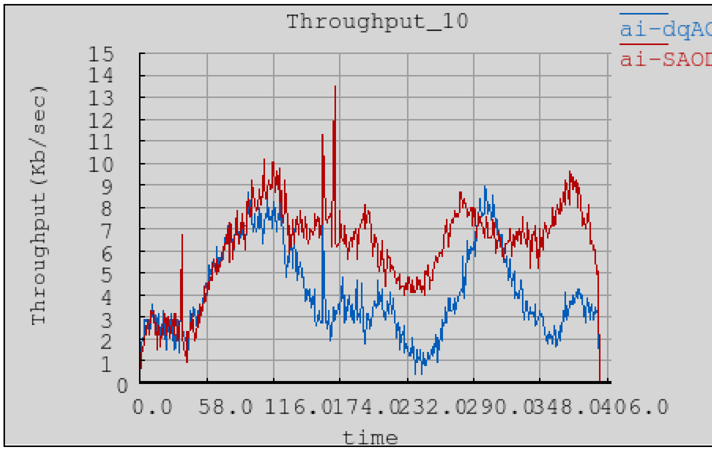

Figure 6: Throughput vs. Time in Sec for 10 car

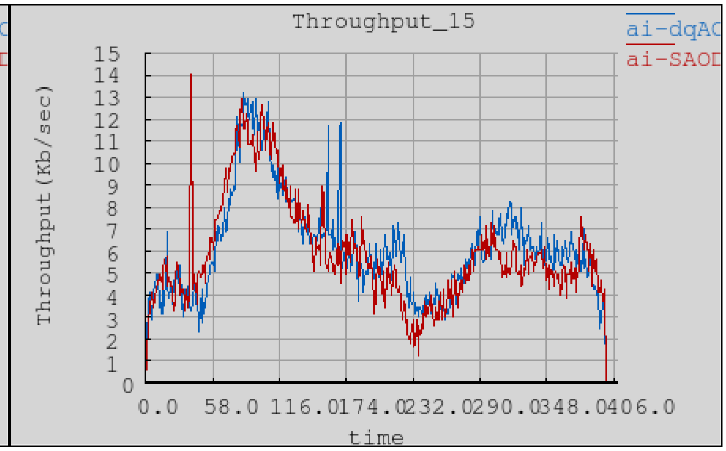

Figure 7: Throughput vs. Time in Sec for 15 car

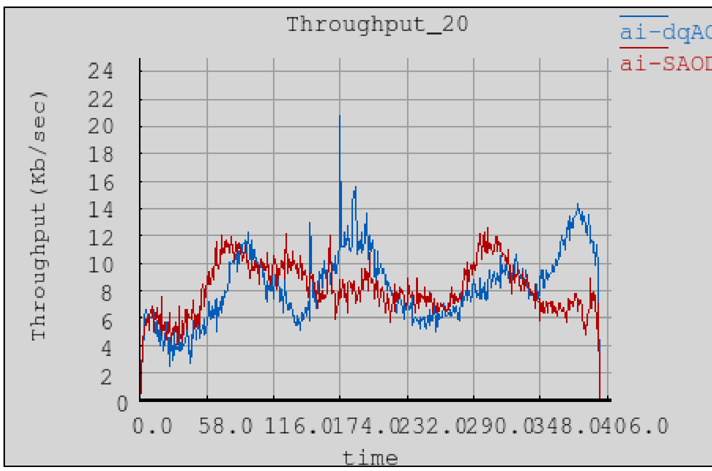

Figure 8: Throughput vs. Time in Sec for 20 car

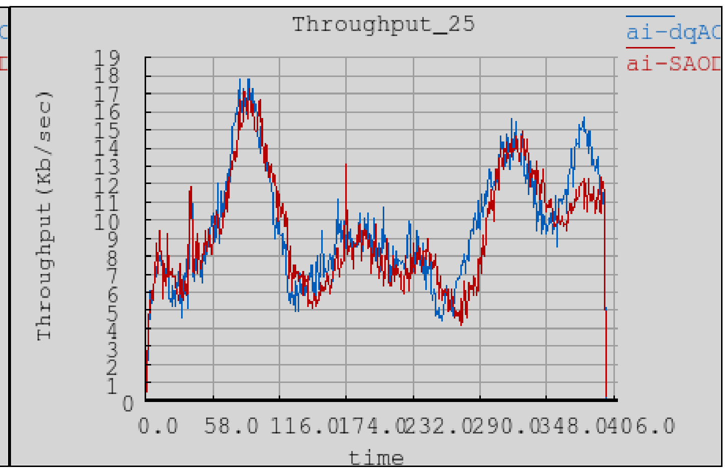

Figure 9: Throughput vs. Time in Sec for 25 car

Complexity is less than stack data structure. The reason behind is, hear the packet loss due to only for collision among different node traffic. It causes some time a heavy usage of data structure of dqueue and stack. It leads to slow down of performance in stack compared to dqueue. But when a signal fading is present in dance scattered traffic situation, the collision will reduce as signal is faded out. Further we have optimized the signal strength, TTL (T), Transmission power (P) and RTS threshold is increased. These leads to less collision and less packet loss. Therefore the data structure of dqueue and stack usage is reduced. This cause better result on ai-sAODV than ai-dqAODV. Hear stack usage is easy and less iteration need compared to dqueue.
We find best result in less car dense situation [Fig.6] (less traffic with less signal and optimized routing parameters) than other more traffic situations [Fig. 7, 8, 9]. It also supports our analysis.
Therefore we observe ai-sAODV is better than ai-dqAODV with respect of number of packet transmission to complete routing.

3.4. Analysis

Here we found in all four situations [Fig6-9] the ai-sAODV is distinctly ahead of ai-dqAODV. According to our proposal both the algorithms works better in heavy link breakage situation [26], [27]. When link break is large the both dqAODV and sAODV will perform better. It starts route recovery rather than discovery. We found earlier adAODV is better that sAODV [2] in city scenario with ideal signal condition as dqueue time

4. Conclusion and Future Work

Another major drawback of ad-hoc network is security. Therefore our future work will be on security on transmitted packets.

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