A Reliable Solution to Load Balancing with Trust Based Authentication Enhanced by Virtual Machines

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Abstract—Vehicular Ad hoc network is the most fast growing which shape fresh engineering opportunities like controlling traffic smartly, optimal resource maintenance and improved service for customers. Vehicular Ad hoc Network (VANET) is one of the most popular ad hoc networks. A vehicular ad hoc network generally faces the problems like trust modeling, congestion, and battery optimization issues. If the nodes are comparatively less than it can handle the traffic well when it comes to transferring the data at a rapid rate. But, when it comes to high-density traffic than a Vehicular network always faces congestion problem. This paper tried to find the reliable solution to the traffic management by adding up the virtual gears into the network and optimizes the congestion problem by using a trust queue which is updated with the broadcast concept of the hello packets in order to remove the unwanted nodes in the list. The network performance has been measured with QOS Parameters like delay, throughput, and other parameters to prove the authentication of the research.

Index Terms—VANET, Load Balancing, Reliability, QOS, Virtual Gears.

I. INTRODUCTION

VANET (Vehicular Ad hoc Network) has attained an extraordinary popularity in the prevailing century because of the wide collection of the prospective applications [1]. The Vehicular Ad hoc Network has a significant application that enhances the technologies in the recent years by improving the vehicle performance in terms of jitter and battery utilisation [2]. The utilization of VANET has been risen due to this improvement, and new application is being produced that does not utilize battery provision and can analyze the delay from the environment.

Basically, throughput, delay minimization, and latency are supposed to be spontaneous and there is a swapping with these parameters [3]. The foremost intention of VANET is to accumulate the data from the surroundings and delivers the data to the position where the analysis and inspection of the data can take place. The Vehicles are self-conscious in the regards of computation, power, memory and the communication potential, due to the monetary and technical reasons. That is why most of the VANET analyses had concentrated on the latency scheme and the protocols with the algorithms [4]. Dynamic latency can also be computed as:

$$Jitter = A.C.v^2.f \qquad (1)$$

where:
A = active gates
C = capacitance load
v^2 = supply voltage
f = frequency

Then it can be written as:

$$Jitter\ Dynamic = \Sigma j_{Dynamic}.\Delta t \qquad (2)$$

where:
Jdynamic = dynamicJitter
Δt = dynamictime

The applications of the VANET are extremely explicit, for instance, military applications, health info, environmental monitoring, Smart Home [5]. But now, the protocols that are emerging depends basically on some special applications that bring immense problem in VANET designing with function, customizable designing following VANET reconfigurable network structure.
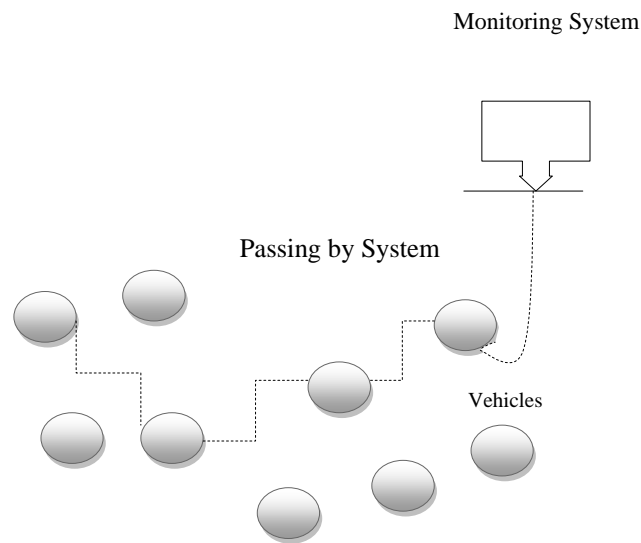
Monitoring System

Fig.1. Vehicular Adhoc Network

VANET possesses moving devices, known as vehicles are positioned in a particular pattern and area [6]. They can interact with each other through the transmission of the data as depicted in fig. 1. This network has "Base station" where the collected data is broadcasted [7]. The Base Station is further connected to the device that observes the entire system that can be a server/mainframe. This development has not only created an innovative prospect, but also raised number of challenges for the investigations in the sensor vehicles such as to support multi-hop communication when the constraint is being set up in radio operation for conserving the power, challenges in geographic routing, monitoring and preservation of dynamic, resource limited systems with the clarification of the challenge [8].

VANET comprises the power management as a necessary standard. A VANET can be very small consisting of 10 vehicles or it can be very big consisting of hundreds/ thousands vehicles (Large geographical monitoring). In the real time industry, the sensor readings may face failure or drop or a very long latency due to congestion [9]. This paper has attempted to solve the following problems in VANET which are:

- Reliability
- Congestion
- Packet Delivery on Timely fashion.

II. RELATED WORK

Virtual machines are considered as an approach which is employed to reduce that load on the network. There are number of solutions proposed by the researchers in the past regarding the load balancing by using virtual machines. Each solution has its different results as compared to other solutions. Each researcher has adopted a different technique in order to reduce the load. Some of the studies related to this are presented below:

Deepa Das et al, [1], attempted to calculate the performance of cognitive radio in VANET through the describe metrics taking into account the spatial correlation in the decisions taken by vehicular secondary users which are local to network in the existence of primary user emulation attack. With the proposed algorithm the energy efficiency has been maximized as the vehicular secondary users were allocated proper power allocation. This proposed algorithm was based on the genetic algorithm under a constraint of power control which helps in restricting the negative impact of the attacker. The energy efficiency (EE) maximisation problem was resolved by the parametric transformation which is dependent on the Dinkelbach method and the second problem of non-convex constraint was solved by making use of adaptive methods or algorithms. The results showed that EE was improved by including the constraint as power control.

Xinming Zhang et al,[2] proposed an abiding geo-cast protocol that is based on the carrier sets. The uncovered vehicles which were passing by the destination region can have abiding messaged from the nearby vehicles at one-hop delivery. This process avoid a lot of overhead which is produced by multi-hop broadcast. Hence, the receiving probability was enhanced through this whole network. The results showed the efficiency and reliability of the network.

Yu Wang et al,[3] proposed an analytical model to analyze the connection within the average delay while presenting road condition information and the gap among two neighbour RSUs that are stationed beside the road in a beeline expressway situation. The vehicle speed, vehicle density, likelihood of an incident, and the distance between two RSUs are the factors that are taken into consideration by the proposed model. The effectiveness of the model can be verified from the simulation results. If the delay confinement of the time-determined purposes, then this model can be adopted to predict the average gap permitted within the two neighbour RSUs, which further provides a reference for the stationing of the RSUs in before-mentioned situations.

III. SIMULATION MODEL

The proposed algorithm is divided into four parts:

A. *Setting up the network*
B. *Broadcast*
C. *Development of trust Model*
D. *Load Balancing*

A network is setup having the following parameters:

Table 1. Network Parameters

Network width	1000 m
Network height	1000 m
Vehicles	50, 100, 200
Coverage Length	20 % of width
Coverage Parameter	Distance Between the vehicles
Delay Model [14]	Random Delay Model

A. Setting up the network

The set-up phase consists of three different vehicle counts: 50,100 and 200. All the wireless sensor vehicles have been deployed randomly [10]. To maintain uncertainty into the network, the delayvehicle has been provided with random values of delay, battery units and consumption unit. Now, as in real-time scenario, it is apparent that some of the vehicles will be in sleep state due to:

- Power management mode
- Critical due to battery issues
- Dead due to environment conditions

The active and sleep states have been designed as follows:

Active-Sleep state of the vehicles   // description: input;
    Function act [f]=Activesleep(n)
    n=total vehicles
    For i=1:n
    output:K=round(rand)
    f: state of the vehicle [active or sleep]
    f[i]= "sleep";
    else
    f[i]= "Active"
    endif

Now, the vehicles will be deployed in the network with random locations to maintain the uncertainty in the network.There would be source and destination which would be involved in the data packet communication. A path is required through which the data packets would be transferred. If a situation is considered when the data has to be transferred for the first time and no vehicle is involved in any communication previously. In such a situation, it is very difficult to choose a path which is secure and fits in the budget.

B. Broadcast

To resolve the problem occurred at stage 1, the proposed algorithm uses the concept of broadcast when the communication link is broken or there is no communication link [11].

In figure 2, Vehicle A wants to transfer the data to the Vehicle B, but the information cache of A is empty. UN denotes unknown vehicle and hence, 'A' cannot directly send the data to unknown vehicle. Here, as per the algorithm, there is no channel of communication. Vehicle A will broadcast the requirements and will transfer a Welcome Packet(WP) into the network. If it receives any acknowledgement within a time frame t_{wait}, then it follows method A else it follows method B as explained below.
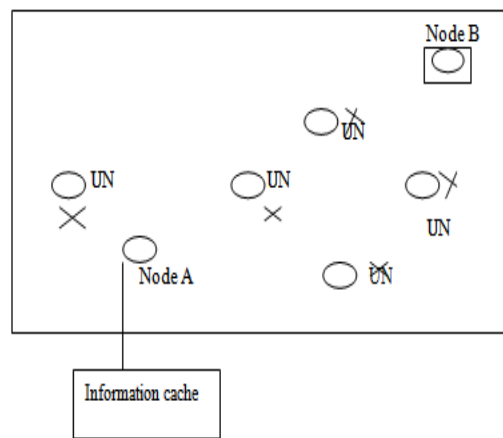

Fig.2. The first communication situation

Method A: List up all the responders and calculate the delay with the help of radio delay model [RDM]. As per RDM,choose the least delay consuming vehicleand transfer the data through that vehicle.
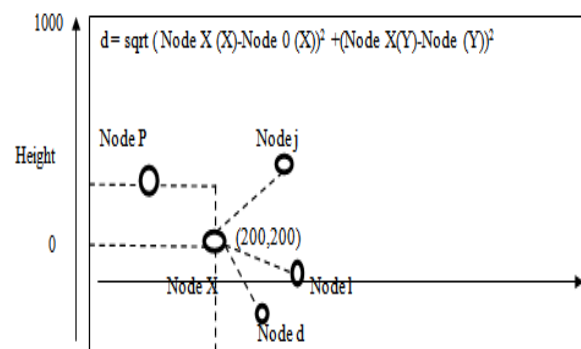

Fig.3. Coverage Set calculation

Method B: Find the coverage set of the current transmitting vehicle and choose any element in the coverage set. Store the element into the cache memory and proceed till the destination is not attained. For the next iteration, it again start from method A.

The mathematical description of both method A and B is as follows:

Method A

T_N= Transmitting vehicle:
T_n. broadcast ("hello") = true;
R_{sq} = Response queue
Wait for a time frame of t_{wait}
Rqcounter=0;
If response.positive==true
Rsq [rqcounter]=Responder.Address
Rqcounter=rqcounter+1;
Endif
If request>0
Initialize REM
$T_{XS=}$ Transmitting Delay consumption in Joules of the current sender
$R_{XS=}$ ReceivingDelay consumption
For each n_d in the r_{sq}
Find min($T_{XS} + R_{XS}$);
Add min_vehicle_id to pathlist ();
Continue making path length till the destination is not attained;
End for
End if

Method B

Let λ be the coverage distance of any vehicle
λ= width * 25/100;
Co_list=[ ]; cov_dist =[ ];
For each n_d in vehiclelist
x_i= xloc (n_d);   // finding the xlocation of the vehicle
y_i= yloc (n_d);   // finding the ylocation of the vehicle;
Covcount=0;
For each n_j in the vehicle list
If n_d != n_j // if both the vehicles are not same
x_p= xloc (n_j);
y_p= yloc (n_j);
$d = sqrt((x_i - x_p)^2 + (y_i - y_p)^2);$
if d<=λ
cov_list [n_d,covcount]=n_j; cov_dist [n_d,covcount]=d;
covcount=covcount+1;
end if
end for
end for
Cov_list = [Vehicle d, Vehicle p, Vehicle j, Vehicle l]-Vehicle x
Cov_dist = [220,240,250,245];

Now X will transfer the data to the vehicle which is nearest to Vehicle X that is Vehicle d. Furtheron, Vehicle d will follow the same procedure as that of vehicle X. the chain will continue till the destination is not attained. Method B will be followed only when the broadcast response list is empty.

C. The Trust Model

Wireless network faces latency and load balancing problem due to absence of a trust model.The network has to select the path every time to transmit the packet data. In this procedure, the network has to look for available vehicles without considering the fact that whether the vehicles would be trustworthy or not. The search and solution process consumes a lot of time and delay, thus, increases the battery consumption if the data packet not delivered properly. To avoid such delay in addition to the broadcast concept a trust model is proposed. The key aspects of the trust model are as follows [12]:

a. If a vehicle X delivers a packet successfully between source S, and destination D,then the proposed algorithm put the vehicle into the trust list for the path P(S, D). The vehicle remains in the trust list as long as it does not start consuming delay more than ΔE for the packet transfer.

b. The proposed architecture in world involve a monitor system deployed into the network to check the following specification:

- If the vehicle X is changing its position from the co-ordinates (Xx,Yy) to (X $\bar{x}$,Y $\bar{y}$), but still remains in the coverage set of transferring vehicle as per method B.
- If the vehicle X is consuming delay less than ΔEor not is deleted from the trust list.

D. The load balancing algorithm

The mathematical description of the VM creation and sharing of load are as follows [14]:

VM Creation algorithm

VM_N=function   create   VM(Node_Id, Node_E,NSink_space,VM_list_N,VM_req<pcount,Node_prop)
// Input Parameters   Node_Id: Node at which VM has to be constructed
// Node_E   Available Energy at the physical node
// N_Sink_Space   Space available in nodes personal sink
// VM_List_N   It is an array which contains the list of VMs which the physical node contains. If the permittable VM count is already attained then the VM cannot be created
// P count   Permittable count of VMs at physical machine
// VM_req   VM requirements list
If (VM_req [e_required]<(Node_E_10)
If (Nsink_space>VM_req[s_required])
If (VM_List_N.count<Pcount)
Add_VM_to_VM_List (VM_Id,VM_req,Node_Id,VM_list, node_prop);
End if
End if
End if
End function
Function   Add_VM _to_VM_List(VM_Id,VM_req,VM_Id,VM_list)

Count=VM_List[count];   //total member of VMs already in VMlist
VM_List[count+1] =VM_Id;
VM_List[VM_memory_taken]=VM_req[VM_Id.memory];
Node_prop[memory]=Node_prop[Memory]-VM_req[Memory];
Reduce the physical node memory upto the memory taken by VM_memory
Node_prop[totalspace]=Node_prop[totalspace]-VM_space;
Endfunction

As soon as the VM will be considered, the memory and the space occupied by the VM will be reduced from the physical memory.

The Mathematical representation of VM algorithms in reference to Anton et.al [13], has been shown below;

Algorithm 1: Modified Best Fit Decreasing (MBFD)

Input_In: hostList, vmList;Output_Op: allocation of VMs where HL= Host list, VL= VM List and ML= Migration list

VL→ decreasing_ utilization_sort
For each VM →VL
Find Minimum_power→maximum
Allocation of Host→NULL (0)
For each Host →HL
Do, Host = max_ resources
Find Power→ (Host, VM)
Power <min_power
allocated_Host→host
min_Power→power
ifallocated_Host≠ NULL (0)
RETURN

Minimization of Migration (MM)

Input: HL Output: ML, where HL= Host list, VL= VM List and ML= Migration list
For each Host →HL
For each VM →VL
VL→ decreasing_ utilization_sort
hUtil→h.getUtil()
Find best HL
For each VM →VL
if VL>HL− THRESH_UP then
t←VL− HL+ THRESH_UP
if t <best HL then
Best util fn.→t
bestFit VM→vm
else
best Fit VM→vm
break
RMOVE
best Fit VM
GET Migration List
RETURN
ML

Node Substitute Solution

Increasing number of nodes will support a substitute methodology in the proposed work. When number of node increases, in case of failure the network will have more number of options to choose and to select transferring node rapidly [14]. This will support the improvement of the battery life as the search space will be reduced[15]

IV. SIMULATION RESULTS

For the design of this approach, broadcasting method is being considered for quality of service (QoS) parametersparameters. The main goal of the proposed algorithm is to have the minimum energy consumption and optimum QOS parameters. There are different simulation parameters used by distinct authors to propose their theory in balancing the load in the network by using the virtual machine (VMs). The main purpose of the parameters are to evaluate the results of the algorithm or technique proposed in a way that the values can be defined in the graphical or mathematical way to prove our point of accuracy of the algorithm then the earlier proposed techniques.

The various simulation parameters used in the research are: Throughput, energy, Delay and collisions. The numbers of nodes used are 50, 100 and 150 in 1000* 1000 networks. The detailed simulation parameters are shown in Table 2:

Table. 2. Simulation Parameters

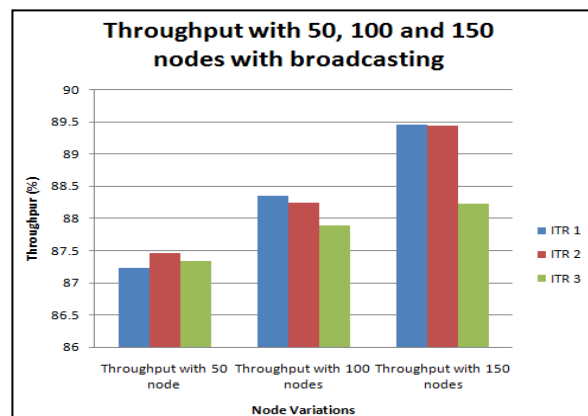| Number of nodes	50, 100, 150
Network length	1000m
Network Width	1000m
Source node	20
No. of rounds	3

Fig.4. Throughput with 50, 100 and 150 nodes with broadcasting

In the figure 4, the graphical representation of the throughput of the network with the variant nodes i.e. 50, 100 and 150 is described.The table 3, depicts the static value of the maximum and the minimum throughput attained by the broadcasting algorithm. The maximum throughput attained by broadcasting algorithm is 87.46,

whereas the minimum throughput is 87.23 measured for 50 nodes. Similarly, the maximum throughput attained by broadcasting algorithm is 88.34, whereas the minimum throughput is 87.89 for 100 nodes and the maximum throughput attained by broadcasting algorithm is 89.45, whereas the minimum throughput is 88.22 for 150 nodes. Throughput must be high for the good working algorithm and in the proposed work the average throughput is 88.17. A high throughput reflects the good performance of the proposed technique.

Table 3.Throughput with broadcasting

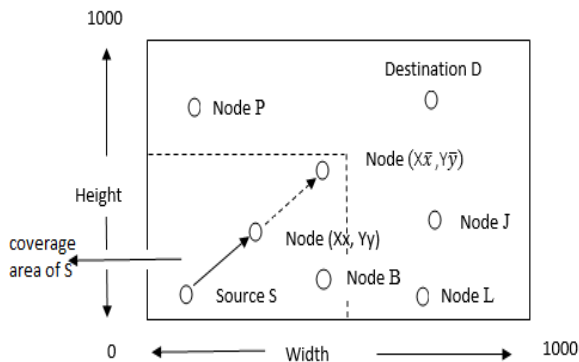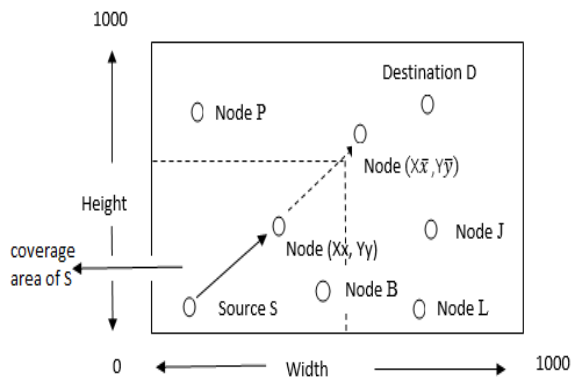| No. of Iterations	Throughput With 50 Nodes	Throughput With 100 Nodes	Throughput With 150 Nodes
1	87.23	88.34	89.45
2	87.46	88.23	89.43
3	87.34	87.89	88.22

Fig.5. (a).Vehicle inside coverage area

Fig.5. (b).Vehicle outside coverage area

Figure 5(a), shows that vehicle $X\bar{x}$ has vehicle to different position but still coverable by Vehicle X*x*, in this case Vehicle $X\bar{x}$ will remain into the trust list as per the trust model. In Figure 5(b), the Vehicle $X\bar{x}$ move to a new position and it is now it's out of the coverage area of Vehicle X*x* in such a scenario it will be deleted from the trust list.

Insertion into the trust list

Function create trust list = new function ()
If(Packet .transferred == true)
If (E.transfer< ΔE)

Trustlist(trustcount,1) = Sid
Trustlist(trustcount,2)= Did
Trustlist(trustcount,3) = Xid
trustcount = trustcount + 1
End if
End if

Deletion from the trust list

Function deletefromtrustlist = new function(Sid,Did,Xid)
K = find((trustlist(:,3)==Xid) && find((trustlist(:,2)==Did)&&(trustlist(:,1)==Sid))
If !isempty(k)   //Searching that whether there is any trust connection between the Sid,Did and Xid. If the search result is not empty then it means that there exists a trust connected which has to be deleted as the trust condition is violated.

The Monitoring algorithm

Function monitorvehicles = new function(Xloc,Yloc,Vehicles,Transmitting,Sources,Destination)
Watch_timer();
Foreachnd in Transmitting Sources
If isactive(nd)// if the transmitting vehicle is active or ready to transfer the data
tn=find(trustlist(:,1)==nd);
// find all the vehicles which are present into the trustlist connected to the transmitting vehicle.
For i = 1:numel(tn)// if there exists any trust connection with that source
Kp = find(trustlist(tn[i].Id),2);
If Kp = Destination//if this trust connection has same destination as in the calling function
Scr = tn[1][1].Id;
Dcr = tn[1][2].Id;
Active Connection[account]= ConnectionId
account = account +1;
Xcr = tn[1][3].Id;
End if //finding all the active connections with the existing source and destination
End for
For s = 1: account
If(connecting.Vehicle.displacement == true)
Valid = 0;
Valid = check coverage of current transmitting source:
Valid2 = 0;
If (valid == Δ)
Valid2 = check(ΔE)
End if
End if
If (valid1==0 || valid2 == 0)
Deletefromtrustlist(Scr,Dcr,Xcr);
End if;
End for;
End if
End function;

With the implementation of the trust model, the proposed algorithm has assured that the network

consumes least amount of delay. The performance of the system is enhanced as their will be guaranteed reduction in the delay, so the throughput of the network will be high. The network may also suffer from heavy load as the virtual machines are occupied by many tasks or jobs at one time. The proposed algorithm adds a load balancing mechanism which utilizes the concept of virtual machines to share and reduce the load on the network. The load is shared among the working virtual machine on the network to lessen the congestion of jobs on the network.
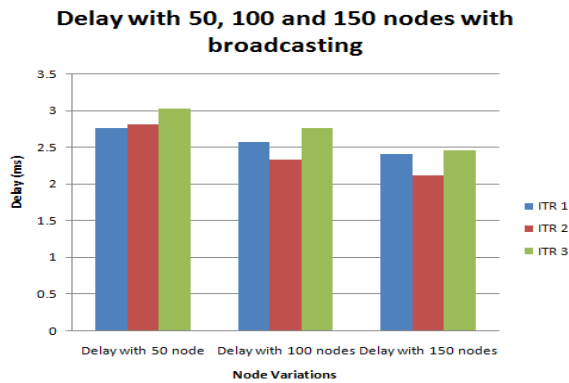

Fig.6. Delay with 50, 100 and 150 nodes with broadcasting

Table 4. Delay with broadcasting

No. of Iterations	Delay with 50 node	Delay with 100 nodes	Delay with 150 nodes
1	2.76	2.57	2.40
2	2.81	2.32	2.11
3	3.02	2.75	2.45

The above figure 6 represents the delay in millisecondsduring simulation with variant nodes i.e. 50, 100 and 150. Further the table 4 describes the average delay in the variant nodes in the network. Average delay in broadcasting protocol is 2.86 ms for 50 nodes. An average delay decreases have been recorded during simulation with 100 nodes and value is 2.54 ms and the average delay through broadcasting protocol is 2.32 ms for 150 nodes. Form the above observations; the delay slightly decreases with increase in number of nodes with broadcasting. It shows that as we increase the number of nodes in the network the delay is declined.
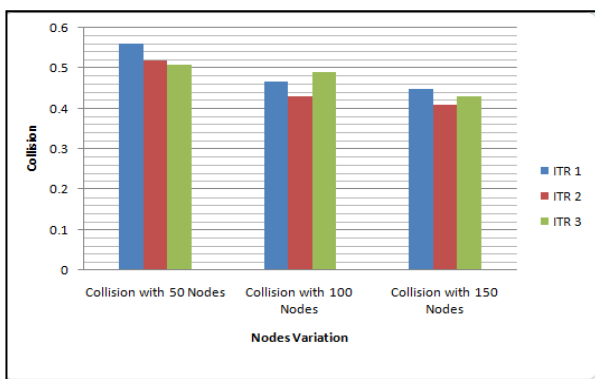

Fig.7. Collision with 50, 100 and 150 nodes with broadcasting

Table 5. Collision with broadcasting

No. of Iterations	Collision with 50 node	Collision with 100 nodes	Collision with 150 nodes
1	0.56	0.46	0.45
2	0.52	0.43	0.41
3	0.51	0.49	0.43

Duplicate MACs doesn't cause collisions. Collisions are the result of race condition i.e. transmission race between data packets from source to destination. From proposed method the figure 7 depicts, the Mac collisions for 50 nodes has found to be min. = 0.51 and max= 0.56. Similarly, Mac collisions for 100 nodes has found to be min = 0.43 and max = 0.49 and for 150 nodes has found to be min. = 0.41 and max= 0.45. It has been observed that the probability of collision is decreased with the increase in the number of iterations and number of nodes.
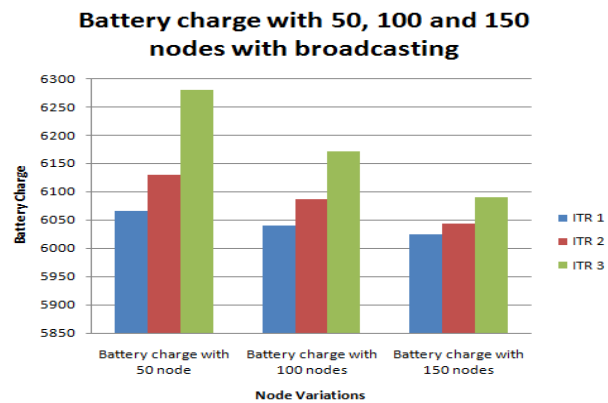

Fig.8. Battery charge with 50, 100 and 150 nodes with broadcasting

Table 6. Battery with broadcasting

No. of Iterations	Battery charge with 50 node	Battery charge with 100 nodes	Battery charge with 150 nodes
1	6065	6040	6025
2	6130	6087	6043
3	6280	6170	6089

Battery life is a measure of battery performance and prolonged existence, which can be enumerated in several ways. It is measured using percentage in proposed work. From result simulations, the battery life has found to be ≅ 6103 for 3 rounds and for 50, 100 and 150 nodes. From the above observations; the battery life slightly decreases with the increase in number of nodes with broadcasting.

V. Conclusion

In recent years, the various number of VANET based real applications have been increased rapidly. In real time environment, basically, some features are required i.e. high throughput, less energy consumption, reduced delay, high network lifetime and a decent battery lifespan. The proposed research work has tried to optimize the lifetime and reliability by introducing the concept of broadcast and

cache memory to it. The proposed algorithm has also included a trust model due to which the extra time and to search nodes for the transfer of data is saved. The proposed algorithm is also focused on load balancing and for that well knownconcept of VM allocation and migration has been adopted. The overall architecture is compared under different scenarios and it has been observed that the proposed algorithm has solved the discussed problems to a great extent.

The current research work unwraps a lot of gates for the future research workers. The future research workers may try their hands in improvising the trust model in order to prevent more energy. It would be also interesting to see the impact of Artificial Intelligence in the proposed algorithm.

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