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Security Analysis in Vehicular Ad Hoc Network (VANET) Protocols Upon Implementing Blackhole Attack Using Tracegraph

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Abstract:* A Vehicular Ad-Hoc Network, or VANET, is an illusion of Mobile ad-hoc network, to adjust communications amid wide vehicles and between vehicles and nearby unit, described as roadside unit. VANETs are a sub group of Mobile Ad hoc Networks (MANETs) in which the mobile nodes (i.e. vehicles) communicate using various routing protocols. In this paper, two VANET routing protocols (Destination sequenced distance vector and temporarily ordered routing algorithm) are analysed for performance on the basis of security. The performance parameters considered for evaluation are packet delivery ratio and average end to end delay.

Keywords:* VANET routing protocols, Route Creation, Maintenance and Erasure, Tracegraph, Constant Bit Rate.

I. INTRODUCTION

In today's world, the sheer volume of road traffic influences the safety and efficiency of traffic management. Every year, around 1.2 million people killed on the road accidents. In traffic management the major issue is road traffic safety. Now days the road accidents are of serious concern and we must do something about it. What if, we could provide the traffic information to the vehicle half a second before collision?

For this purpose we use VANET. It stands for Vehicular ad hoc networks.

VANET is basically a digital communication system between different types of vehicles. The scope of VANET is not only limited up to vehicle to vehicle communication but also, it is advantageous in vehicle to roadside and inter roadside communication.

The main attention is given to vehicle to vehicle communication. For developing a VANET system every engaging vehicle must be capable of imparting and receiving wireless signals within the range of three hundred metres. Though, its broadcast range is up to one thousand metres .In VANET, the vehicle or node moves at an average speed of 120 kilometer per hour. Due to high packet loss rate it is not possible to communicate among vehicles beyond one thousand meter. There are many challenges for VANET such as high speed of vehicle, dynamic route finding, roadside objects, different directions of vehicles, security of data, sharing of multimedia services etc. The main application of VANET is to provide safety management, traffic management and internet services.

Generally routing protocols consist of :-

- Topology Based Routing
- Geographic Routing

The Topology based routing protocol is classified into two categories: Proactive table driven routing protocol and Reactive On demand routing protocol.

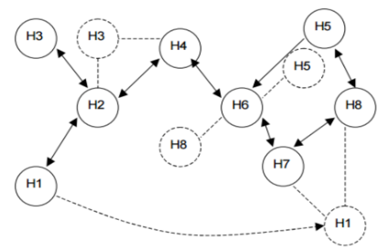

Fig 1. Example of Ad-Hoc Network System

II. DESTINATION SEQUENCED DISTANCE VECTOR

DSDV stands for the Destination Sequenced Distance vector Routing Protocol. It is an extension of Distance Vector Routing Protocol. It comes under the category of Proactive table driven protocol. In this protocol, each and every entry of the route has a sequence number which is derived from the destination. It demonstrates how old the root is. The nodes can distinguish stale routes with the help of sequence number and, thus prevent the formation of routing loops. The sequence number is controlled by its own node, giving it a value two greater than the old one. Therefore, if a link is present then the sequence number is even, else an odd number is used. If there is a different route with the same sequence number then we use the route with better metric. If there is any significant topology change is detected then the updates are transmitted periodically or immediately. Every node sends a message to its directly connected neighbors. If any of the recipients of the information from the node find that the node is advertising a sequence number smaller than the neighboring node, they update their list to give the new sequence number. In case, if a node is no more reachable, then increase sequence number of this node by one and set its metric to infinity. Paths to all the destination in the network is always available which shows that less delay is required in the path set up process..

III. Temporally Ordered Routing Algorithm

TORA stands for Temporally Ordered Routing Algorithm. It is also known as Distributed Routing Algorithm. TORA is known as distributed because this algorithm is run by each and every node present in the system. There is no centralized node to perform the operation. It comes under the reactive On Demand Routing Protocol. A Directed Acyclic Graph (DAG) is build which is rooted at the destination. In TORA the information between the two nodes can be transferred according to the level of their heights .The information flows from the node with higher height to the node with lower height.

This protocol performs three basic function :

Route Creation: This is used to create a route between the source and destination if, not present yet.

Route Maintenance: This is used only if there is any link failure between the source and destination then we have to maintain or update the route.

Route Erasure: This is used to erase the invalid routes.

IV. Experimental Setup And Simulation Parameters

The experimental setup is used for performance evaluation of the TORA and DSDV routing protocols. It measures the ability of protocols to adapt to the dynamic network topology changes while continuing to successfully deliver data packets from source to their destinations. In order to measure this ability, different scenarios are generated by varying the number of nodes. We use following scenario generation commands for generating scenario file for 50 nodes: ./setdest –v 1 –n 50 –p 2.0 –M 10.0 -t 200 -x 500 -y 500.

The trace file is created by each run and is analyzed using a variety of scripts, particularly one called file *. tr that counts the number of successfully delivered packets and the length of the paths taken by the packets, as well as additional information about the internal functioning of each scripts executed. This trace file is further analyzed with Tracegraph tool. Simulations are run by considering TORA and DSDV routing protocol. In order to get realistic performance, the results are averaged for a number of scenarios. We tried to measure the protocols performance on a particular terrain area of 200m x 200m from real life scenario at a speed of 10 m/s. The simulation time was taken to be of 20 seconds for Constant Bit Rate (CBR) traffic type with an average packet size of 550 Bytes. Also, we have considered nodes with Omni-Antenna and Two Ray Ground Radio Propagation method. Simulation parameters are appended in Table.

Table 1. Simulation Parameters

Parameter	**Value**
Channel	Channel/Wireless Channel
Propagation Model	Propagation /two Ray Ground
Antenna	Antenna/Omni Antenna
Simulator	NS-2.35
Number of nodes	10
Routing Protocols	DSDV and TORa
MAC Layer	802.11.EEE
Simulation Time	12s

V. Performance Metrics

We evaluated the DSDV and TORA routing protocols for following performance metrics:

- Packet Delivery Fraction
- Average End to End Delay

Packet Delivery Fraction: It is the ratio of the data packets delivered to the destination to those generated by the source. Mathematically, it can be expressed as:

$$P = \frac{1}{c} \sum_{f=1}^{e} \frac{Rf}{Nf}$$

Where, P is the fraction of successfully delivered packets, C is the total number of flow or connections, f is the unique flow id serving as index, Rf is the count of packets received from flow f and Nf is the count of packets transmitted to f.

Average End to End Delay: It includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times. It can be defined as:

$$D = \frac{1}{N} \sum_{i=1}^{S} Ri - Si$$

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Where N is the number of successfully received packets, i is unique packet identifier, Ri is time at which a packet with unique id i is received, Si is time at which a packet with unique id i is sent and D is measured in ms. It should be less for high performance.

DSDV:

Simulation information:	
Simulation length in seconds:	149.9632274
Number of nodes:	10
Number of sending nodes:	10
Number of receiving nodes:	2
Number of generated packets:	9196
Number of sent packets:	9167
Number of forwarded packets:	255
Number of dropped packets:	30
Number of lost packets:	0
Minimal packet size:	0
Maximal packet size:	1060
Average packet size:	534.9318
Number of sent bytes:	5067364
Number of forwarded bytes:	123260
Number of dropped bytes:	14840
Packets dropping nodes:	0 1 2

Simulation End2End delays in seconds:	
Minimal delay (CN,ON,PID):	0.001985141 (1,0,775)
Maximal delay (CN,ON,PID):	4.928359303 (0,1,43)
Average delay:	0.1233956921

Fig. 2 Before Implementing Black Hole Attack in DSDV

TORA:

Simulation information:	
Simulation length in seconds:	8.999606924
Number of nodes:	10
Number of sending nodes:	10
Number of receiving nodes:	10
Number of generated packets:	3532
Number of sent packets:	2778
Number of forwarded packets:	369
Number of dropped packets:	1148
Number of lost packets:	0
Minimal packet size:	24
Maximal packet size:	1078
Average packet size:	258.8164
Number of sent bytes:	229422
Number of forwarded bytes:	376380
Number of dropped bytes:	1081524
Packets dropping nodes:	0 1 2 3 4 5 6 7 8 9

Simulation End2End delays in seconds:	
Minimal delay (CN,ON,PID):	0.143773263 (1,8,572)
Maximal delay (CN,ON,PID):	2.87896618 (1,8,338)
Average delay:	1.321391069

Fig. 3 Before Implementing Black Hole Attack in TORA

Table 2. Node: 10, Pause Time: 2.00 Sec., Max Speed: 10 m/s.

Routing Protocol	**Total Packets Sent**	**Total Packets Received**	**Packet Delivery Ratio**	**Avg. End to End Delay**
DSDV	9167	9137	0.993	0.123
TORA	2778	1630	0.461	1.321

DSDV as Follows:

Simulation information:	
Simulation length in seconds:	149.9632274
Number of nodes:	10
Number of sending nodes:	10
Number of receiving nodes:	2
Number of generated packets:	9196
Number of sent packets:	9167
Number of forwarded packets:	255
Number of dropped packets:	30
Number of lost packets:	0
Minimal packet size:	0
Maximal packet size:	1060
Average packet size:	534.9318
Number of sent bytes:	5067364
Number of forwarded bytes:	123260
Number of dropped bytes:	14840
Packets dropping nodes:	0 1 2

Simulation End2End delays in seconds:	
Minimal delay (CN,ON,PID):	0.001985141 (1,0,775)
Maximal delay (CN,ON,PID):	4.928359303 (0,1,43)
Average delay:	0.1233956921

Fig. 4 After Implementing Black Hole Attack in DSDV

TORA:

Simulation information:	
Simulation length in seconds:	8.996269773
Number of nodes:	10
Number of sending nodes:	10
Number of receiving nodes:	6
Number of generated packets:	2923
Number of sent packets:	2196
Number of forwarded packets:	295
Number of dropped packets:	897
Number of lost packets:	0
Minimal packet size:	24
Maximal packet size:	1078
Average packet size:	260.2073
Number of sent bytes:	88196
Number of forwarded bytes:	300900
Number of dropped bytes:	841130
Packets dropping nodes:	0 1 2 3 4 5 6 7 8 9

Simulation End2End delays in seconds:	
Minimal delay (CN,ON,PID):	0.057972997 (2,8,192)
Maximal delay (CN,ON,PID):	2.547763117 (2,8,183)
Average delay:	1.309801405

Fig. 5 After Implementing Black Hole Attack in TORA

Table 3. Node: 10, Pause Time: 2.00 Sec., Max Speed: 10 m/s.

Routing Protocols	**Total Packets Sent**	**Total Packets Received**	**Packet Delivery Ratio**	**Average End to End Delay**
DSDV	1621	1618	0.97587	0.23580
TORA	2196	1299	0.444	1.30980

VI. CONCLUSION

We have evaluated the performance of DSDV and TORA routing protocols for ad hoc networks using NS-2 event simulator keeping packet size of 550 Byte. DSDV uses the proactive distance-vector routing strategy whereas TORA uses the reactive on demand routing strategy with different routing mechanisms. Experimental results showed that TORA perform better for Packet Delivery Fraction as well as End to End Delay. Also, TORA apply the sequence numbers and contains one route per destination in its routing table whereas DSDV uses source routing and route caches and maintains multiple routes per destination. The other observation from the experiments on DSDV and TORA protocols, with an increase in number of nodes for a fixed area of 200m x 200m illustrates that even if the terrain area of the network scenario is kept constant, the behaviour of these routing protocols changes. It has been found that the overall performance of TORA routing protocol for performance matrices, Packet Delivery Fraction as well as Throughput is better than that of DSDV routing protocols. In our experimental evaluation we have taken up comparison of DSDV and TORA protocols with varying number of nodes. We shall consider the comparison of DSDV and TORA by varying packet size and speed of node.

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