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Design Implementation Framework for Intrusion Detection System for Mobile Adhoc Networks

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Abstract: *The demand for speed in wireless networks is continuously increasing. Recently Most existent protocols, applications and services for mobile Adhoc networks(MANETs) assume a cooperative and friendly network environment and do notaccommodate security. Cooperative communication has emerged as a new dimension of diversity to emulate the strategies designed for multiple antenna systems, since a wireless mobile device may not be able to support multiple transmit antennas due to size, cost, or hardware limitations. By exploiting the broadcast nature of the wireless channel, cooperative communication allows single antenna radios to share their antennas to form a virtual antenna array, and offers significant performance enhancements. This promising technique has been considered in the IEEE 802.16j standard, and is expected to be integrated into Third Generation Partnership Project (3GPP) Long Term Evolution (LTE) multi-hop cellular networks.*
Keywords: *Wireless Sensor networks, Design issues, Routing protocols, Applications*

I. INTRODUCTION

In MANETs, intrusion prevention (IPS) and intrusion detection(IDS) techniques need to complement each other to guarantee a highly secureenvironment,such as encryption and authentication, are more useful inpreventing outside attacks. Once the node is compromised, intrusion preventionmeasures will have little effect in protecting the network. Therefore, an intrusiondetection system is serving as the second line of defense in Adhoc network. In this First layer is a local intrusion detection module, which identifies the friends quickly and second layer is a global detection module in which intrusion behavior is checked rigorously before declaring the node as a trusted node oran intruder node. Finally, it adds a voting mechanism to generate the trust level for eachnode. This proposed model is fast responsive, light weighted and better than theconventional model available in Adhoc network environment.In this well-known securityattacks are applied to the mobile Adhoc environment. Statistics are from raw data set, and rule sets are induced for well-known attacks like Denial of Service attack, Black Hole attack and Wormhole attack.Accuracy of the detection engine for Denial of Service (DoS) attack is observed to be 100%. For black hole attack observed accuracy is near to 99%, and for wormholeattack is 100% for given conditions and simulation environment. Observed accuracy ofattacks is improved from the available conventional models. A detection engine basedon statistics has been designed for Adhoc network environments.

II. STATEMENT OF THE PROBLEM

It is challenging to design an intrusion detection system for mobile Adhoc networks. The lack of pre-defined infrastructures and monitoring points make it difficult to collect data for the entire network. MANET's should be considered while designing the IDS framework. In MANET it is more difficult to differentiate between false and true positives.

- Here problem can be divided into following sub problems:
- Design framework for monitoring the mobile Adhoc environment.
- To monitor the detection based on the statistical security features.
- MANET intrusion detection systems areto evaluate the performance of the validation.

III. ATTACK MODELS IN MOBILE ADHOC NETWORK

A node can prevent other nodes in the network from getting transparent share of thetransmission channel. This activity can be considered as a denial of service (DoS) attackagainst the neighbors which are participating in a fair competition for allocation oftransmission channels in a contention based network

a. Ignoring the MAC protocol:
Protocols like 802.11 uses request for transmission (RTS) and clear for transmission(CTS) mechanism to notify the neighbors that how long the transmission channel will bereserved by the node for successful transmission. This imposes along delay at the output queues of the nodes and finally packets are timed out and getremoved.

b. Jamming the transmission channel with garbage
Garbage can consist of packets of unknown formats, violating the proper sequence of atransaction (e.g. sending a data packet without exchanging RTS and CTS) or simplyrandom bits used as static noise by misbehaving nodes..

c. Ignoring the bandwidth reservation scheme
Nodes in a multi hop wireless network reserve a slot for transmission channel beforeinitiating a flow. If enough bandwidth is not available, new flow should not be admitted toavoid choking. A misbehaving node may not abide by this rule and try to push out packetswhen there is not enough bandwidth.

d. Malicious flooding
Deliver unusually large amount of data or control packets to whole network or sometargeted nodes. We can distinguish two kinds of flooding attack. First one is the routerequest (RREQ) flooding attack. It ignores the network limitations for sending RREQmessages and sends a large number of RREQ packets with a maximum time to live (TTL)value addressing nodes that do not exist in the network.The second is called data flooding attack.

IV. PACKET FORWARDING IN ANOMALIES

Anomalies in packet forwarding take the following forms:

a. Packet Drop
A malicious node may disrupt the normal operation of a network by dropping packets.This type of attack can be classified into two types: (a) Black hole attack and (b) Gray holeattack.

b. Blackhole Attack
In blackhole attack, a malicious node uses its routing protocol in order to advertise itselffor having the shortest path to the destination node or to the packet it wants to intercept[6], [10], and [7]. In this way attacker node will always have the availability in replyingto the route request and thus attract the whole traffic on the network and intercept the datapacket and further it may retain it or drop it.

c. Gray-Hole attack
An attacker selectively drops data packets.

d. Delay in Packet Transmissions
A node can give preference to transmitting its own or friend's packets by delayingothers' packets. As a result some flows may not be able to meet their end-to-end delay andjitter requirements.

e. Wormhole Attack
A tunnel is created between two nodes that can be utilized to secretly transmit packets.In a MANET, wormhole [7] is a term adopted to describe an attack against the routingprotocol in which two cooperating malicious nodes create a tunnel between two points ofthe network. The attack is possible even if none hosts were compromised and even attackednetwork introduced a strong authentication and encryption algorithms.

V. PROPOSED N - TIER ARCHITECTURE FOR IDS

We propose a N- tier Architecture for IDS in a MANET that improves the efficiency ofexisting MANET IDS architectures and is conceptually based on [4], [10] and [5]. Themain idea of the system is to provide reliable IDS that can detect any kind of intrusionattempts and at the same time able to reduce the number of false alarms raised by thesystem. With the focus of improving the detection strategies, only a simple responsemechanism is deployed in the system. Inglobal IDS rules are applied to normal intruder detection threshold for rigorous checkingbefore declaring the node as the trusted node.

VI. PERFORMANCE EVALUATION METRICS FOR NETWORK TRAFFIC [BASED ON 10]

6.1 Throughput:

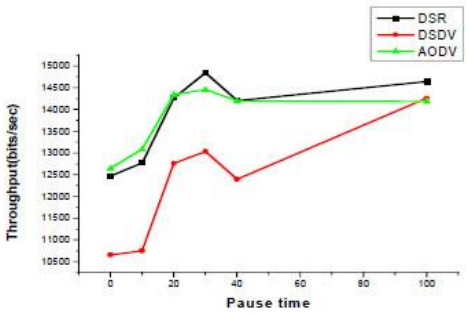
Throughput is the measure of sent packets through the number of packets delivered to the receiver provides the throughput of the network. The throughput is defined as the total amount of data a receiver actually receives from the sender divided by the time it takes for receiver to get the last packet [10].

Throughput = Pr/Pf

Where Pr is the total number of Received Packets and Pf is the total number of Forwarded Packets. [11].

Pause Time Vs Throughput (bits/sec)

Pause time (sec)	Throughput (bits/sec)		
	DSR	DSDV	AODV
0	12472	10657	12642
10	12769	10749	13082
20	14261	12756	14343
30	14841	13032	14452
40	14203	12391	14187
100	14641	14254	14181



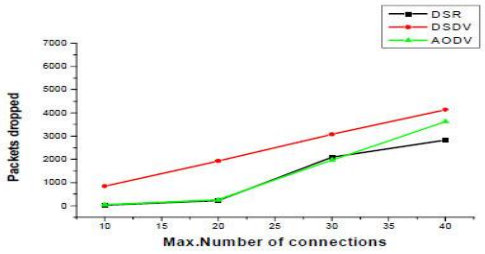
Pause Time Vs Throughput

6.2 Packets Dropped:

Some of the packets generated by the source will get dropped in the network due to high mobility of the nodes, congestion of the network etc.

Pause Time Vs Packets Dropped

Pause time (sec)	Packets Dropped		
	DSR	DSDV	AODV
0	2805	4319	2328
10	2270	4224	1884
20	720	2206	692
30	148	1898	584
40	769	2566	783
100	386	736	885



Max. Number of Connections Vs Packets Dropped

Packet Loss % = (1-Pr/Ps)*100

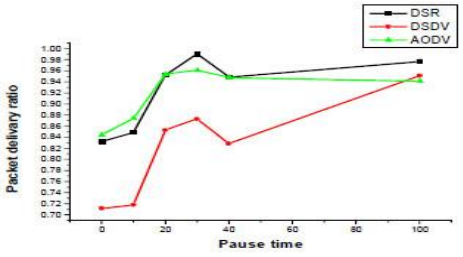
Where Pr is total number of Received Packets and Ps is total number of Sent Packets.

6.3 Packet Delivery Ratio :

The ratio of the data packets delivered to the destinations to those generated by the CBR sources. It is the fraction of packets sent by the application that are received by the receivers [6].

Pause Time Vs Packet Delivery Ratio

Pause time (sec)	Packet Delivery Ratio		
	DSR	DSDV	AODV
0	0.8324	0.71163	0.84454
10	0.84911	0.71792	0.87416
20	0.952	0.85261	0.95403
30	0.99019	0.87292	0.96122
40	0.94869	0.82849	0.94776
100	0.97698	0.95096	0.94131



Pause Time Vs Packet Delivery Ratio

PDF = (Pr/Ps)*100

It is calculated by dividing the number of packet received by destination through the number packet originated from source. Where Pr is total Packet received & Ps is the total Packet sent.

6.4 Normalized Routing Overhead:

The number of routing packets transmitted per data packet delivered at the destination. Each hop-wise transmission of a routing packet is counted as one transmission. The routing overhead describes how many routing packets for route discovery and route maintenance need to be sent in order to propagate the data packets [7].

Pause Time Vs Packets Dropped

Pause time (sec)	Packets Dropped		
	DSR	DSDV	AODV
0	2805	4319	2328
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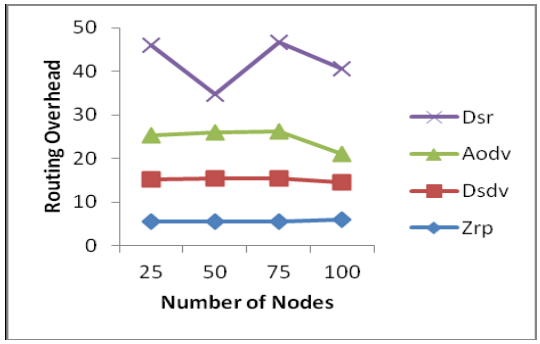
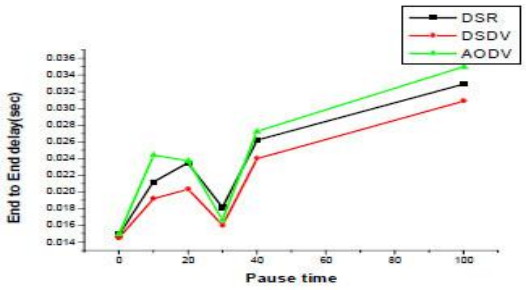




Pause Time Vs End-to-End Delay

Overhead = number of RTR packets (or)
NRL = Routing Packet/Received Packets

6.5 End-to-End Delay:

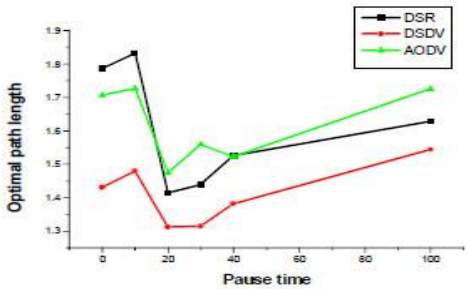
End-to-End delay indicates how long it took for a packet to travel from the source to the application layer of the destination. [7]. i.e. the total time taken by each packet to reach the destination. Average End-to-End delay of data packets includes all possible delays caused by buffering during route discovery, queuing delay at the interface, retransmission delays at the MAC, propagation and transfer times

6.6 Optimal Path Length :

It is the ratio of total forwarding times (depends on number of hops) to the total number of received packets. Optimal path length increases as the number of hops on optimal path increases.

Pause Time Vs Optimal Path Length

Pause time (sec)	Optimal Path Length		
	DSR	DSDV	AODV
0	1.78615	1.43066	1.70628
10	1.83209	1.47935	1.72687
20	1.4137	1.31173	1.47379
30	1.43930	1.31457	1.55866
40	1.52515	1.38126	1.52317
100	1.62812	1.54367	1.72510



Pause Time Vs Optimal Path Length

VII. CONCLUSION

We recap the thesis contributions as follows:

(a) We identified that Incentive based approach is bestsuited for the mobile Adhoc environment.
(b) The model proposed is incentive based, fast responsive and light weighted which isindependent from any central authority and easy to detection for individual nodes.
(c) Incremental approach is used for designing the detection system as soon as anyspecific attack is identified. It is easy to add additional attacks in the detection engine.
(d) This work is not only based on specifickinds of attack but also all known attacks possible in the network layer for Adhocenvironment are investigated including packet drop, false cache poisoning, delay inpacket transmissions, routing loop and selfishness.
(e) For the network layer denial of service (DoS) attack, The black hole, The wormhole attacks are investigated. From raw dataset important features are extracted. The accuracy of the detection engine is observedto be 99.20%, and this is better than the detection engines available for DoS attack inAdhoc network.

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