Different Methods and Approaches for the detection and removal of Wormhole Attack in MANETS

Samiksha Suri

***Abstract*— Mobile Ad hoc NETwork (MANET) makes it exposed to a variety of network attacks. MANET due to its wireless transmission nature contains more security issues as compared to wired networks .These security issues are very important to deal with so as to make network secure. Wormhole attack also called as tunnelling attack is very difficult to detect. wormhole generally possess two properties In this paper we have studied the wormhole attack along with its properties and various method have been discussed for identification , removal, and prevention of wormhole attack and then they have been compared to one another so that effective methods should come forward .This study aims to combine some methods or to modify the one.**

***Index Terms*— MANETS,VANETS ,wormhole attack**

I. INTRODUCTION

MANET is an autonomous transitory association of mobile nodes that communicate with each other over wireless links. Nodes that lie within each other's send range can communicate directly and are responsible for dynamically discovering each other In MANET, every device works as a router and free to move in any direction. Using this property, we can send data over a long distance. It provides high mobility and device portability's that enable to node connect network and communicate to each other. connections among nodes are limited to their transmission range, and cooperation with intermediate nodes is required for nodes to forward the packets to other node outside of their transmission range. These properties make security of MANET vulnerable to attackers, and an attacker can modify the routing protocol and disrupt the network operations such as packet drop, selective forwarding, and data fabricating. Most previous ad hoc networks research has focused on problems such as routing and communication, assuming a trusted environment. However, many applications run in untrusted environments and require secure communication and routing such as military or police networks, emergency response operations like a flood, tornado, hurricane or earthquake. However, the open nature of the wireless communication channels, the lack of infrastructure, the fast deployment, and the Environment where they may be deployed, make them vulnerable to a wide range of security attacks Security attacks are basically classified as follows :

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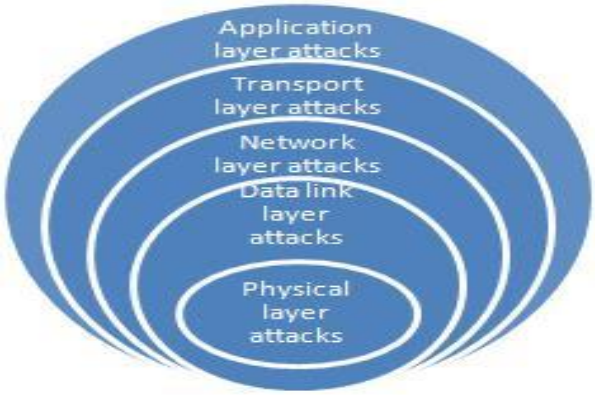
Samiksha Suri (Lect. in Computer Applications), J & K, India.

a. ***Active and Passive Attacks:*** In passive attack there is not any alteration in the message which is transmitted. There is an attacker (intermediated node) between sender & receiver which reads the message. The information which is routing through the nodes in MANET is altered by an attacker node. Attacker node also streams some false information in the network. Attacker node also do the task of RREQ (re request) though it is not an authenticated node so the other node rejecting its request due these RREQs the bandwidth is consumed and network is jammed.

b. ***Internal and External attacks:*** Internal attacks are from compromised nodes, which are actually part of the network. Internal attacks are more severe when compared with outside attacks since the insider knows valuable and secret information, and possesses privileged access rights.External attacks are carried out by nodes that do not belong to the domain of the network.

c. Layer Specific attacks: The attacks can be further classified according to the five layers of the Internet model.



a) Application layer attacks: Repudiation , Data corruption

b) Transport layer attacks: Session hijacking, syn flooding

c) ***Network layer attacks:*** Worm hole , Black hole , Byzantine attacks
d) ***Data link layer attacks:*** Traffic Analysis ,WEP weakness
e) ***Physical layer attacks:*** Jamming , Eavesdropping

The foremost concerned security issue in mobile ad hoc networks is to protect the network layer from malicious attacks, thereby identifying and preventing malicious nodes. A unified security solution is in very much needed for such networks to protect both route and data forwarding operations in the network layer. There are various attacks at network layer out of them Worm hole attacks is difficult to detect and deal with so in this paper we are listing various methods that can be used for the detection and removal of worm hole attacks.

This paper we are firstly discuss the vulenrabities of mobile adhoc networks then introduce details of worm hole attack, then list various methods for detection of worm hole attack and finally removal methods.

II. VULENRABILITIES OF MANETS

a. ***Dynamic topology:*** In MANETs, nodes can join and leave the network dynamically and can move independently. Due to such type nature there is no fixed set of topology works in MANETs. The nodes with inadequate physical protection may become malicious node and reduce the network performance
b. ***Wireless links:*** As the nodes in such networks are interconnected through wireless interface that makes it highly susceptible to link attacks. The bandwidths of wireless networks are less as compared to wired networks which attracts many attackers to prevent normal communication among nodes.
c. ***Cooperativeness:*** In MANETs, all routing protocols assume that nodes provide secure communication. But some nodes may become malicious nodes which disrupt the network operation by changing routing information etc
d. ***Lack of clear line of defence:*** There is no clear line of defence mechanism available in the MANETs; attacks can come from any directions. Attackers can attack the network either internally or externally
e. ***Limited resources:*** The MANETs consists of different set of devices such as laptops, computers, mobile phones etc. All of such devices having different storage capacity, processing speed, computational power etc. This may attracts the attackers to focus on new attacks.

III. WORM HOLE ATTACK

Network layer is the third lowest layer of OSI reference model. The function of network layer in OSI layer model is to provide the services for exchanging the individual piece of data/information over the network between identified end devices. The network layer in MANET uses ad hoc routing and does packet forwarding. In MANET nodes act as host and router. Therefore router discovery and router maintains in the MANET is effectively concern. Thus attacking on MANET routing protocol not only disrupt the communication on the network even worst it paralyzed the whole communication all over the network. Therefore, a security in network layer plays a vital role to ensure the secure data communication in the network. The wormhole attack is one of the most efficient and merciless attacks, which can be executed within MANET. Therefore two collaborating attackers should establish the so called wormhole link connection via a direct low-latency communication link between two separated distant points within MANET[12]. As soon as this direct bridge (wormhole link) is built up one of the attackers captures data exchange packets, sends them via the wormhole link to the second one and he replays them.

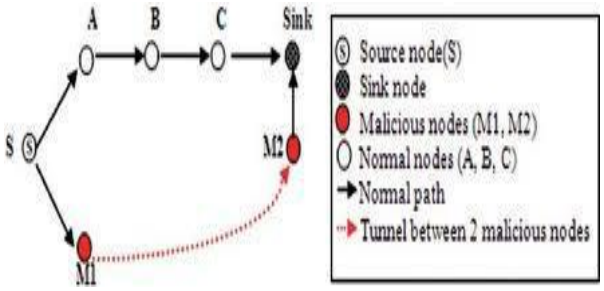


Figure 3 Description of wormhole attack

In a wormhole attack, malicious node m1 first captures routing message from a neighboring node, and then sends the message to another malicious node, m2, by means of a secret tunnel, m2 then broadcasts or propagates the message received. In this way, a tunnel-like channel is formed between the two malicious nodes.

Even though the tunnel has a very long distance, other normal nodes may mistakenly think that there is only a distance of a one-hop count.

A. *Wormhole Attacks Types :*

By categorizing the attacks into its types makes it easier for its prevention and detection so here wormhole attack has been classified as

a. ***Open Wormhole attack:*** In this type of wormhole, the attackers include themselves in the RREQ packet header following the route discovery procedure. Other nodes are aware that the malicious nodes lie on the path but they would think that the malicious nodes are direct neighbours.
b. **Closed Wormhole Attack:** The attackers do not modify the content of the packet, even the packet in a route discovery packet. Instead, they simply tunnel the packet form one side of wormhole to another side and it rebroadcasts the packet.
c. ***Half open wormhole attack:*** One side of wormhole does not modify the packet and only another side modifies the packet, following the route discovery procedure.

B. *Wormhole Attacks Modes:*

Worm hole attack can be launched using several modes they are described as under

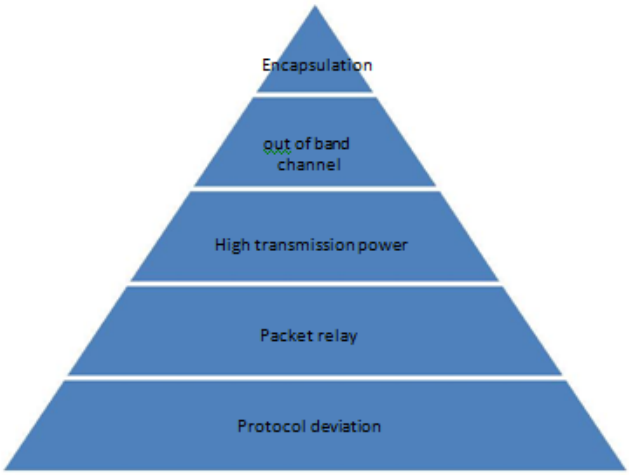


Figure 4 Description of wormhole attack modes

a. Worm hole attack using Encapsulation: When the source node broadcast the RREQ packet, a malicious node which is at one part of the network receives the RREQ packet. It tunnels that packet to a second colluding party which is at a distant location near the destination, it then rebroadcasts the RREQ. The neighbours of the second colluding party receive the RREQ and drop any further legitimate requests that may arrive later on legitimate multihop paths. The result is that the routes between the source and the destination go through the two colluding nodes that will be said to have formed a wormhole between them. This prevents nodes from discovering legitimate paths that are more than two hops away.

b. Worm hole attack using out of band channel: This channel can be achieved, for example, by using a long range directional wireless link or a direct wired link. This mode of attack is more difficult to launch than the previous one since it needs specialized hardware capability.

c. Worm hole attack using high transmission power: Another method is the use of high power transmission. In this mode, when a single malicious node gets a RREQ, it broadcasts the request at a high power level, a capability which is not available to other nodes in the network. Any node that hears the high-power broadcast rebroadcasts it towards the destination. By this method, the malicious node increases its chance to be in the routes established between the source and the destination even without the participation of a colluding node.

d. Worm hole attack using packet relay: Another mode of the wormhole attack is by using packet relay. In this mode a malicious node relays packets between two distant nodes to convince them that they are neighbours. This mode can be launched by even one malicious
node. It involves the cooperation by a greater number of malicious nodes, which serves to expand the neighbour list of a victim node to several hops

***e. Worm hole attack using protocol deviation*:** During the route request forwarding, the nodes typically back off for a random amount of time before forwarding. This is motivated by the fact that the request forwarding is done by broadcasting and hence, reducing MAC layer collisions is important. A malicious node can create a wormhole by simply not complying with the protocol and broadcasting without backing off. The purpose is to let the request packet it forwards arrive first at the destination and sit is therefore included in the path to the destination .The advantage of this mode is that the control packet arrive faster. The challenge for this mode is that there is a possibility of collision to occur between transmissions of malicious nodes

IV. METHODS FOR WORMHOLE DETECTION

This section represents the various methods to detect and remove wormhole attack.

In [1] debdutta barman roy proposed a method based on countermeasures for clusters .In this method a two layer approach is used for detecting whether a node is participating The layered approach is introduced to reduce the load of processing on each cluster heads. From security point of view, this will also reduce the risk of a cluster head being compromised. The presented algorithm states that initially network is divided into clusters then cluster with minimum id is chosen as cluster head . once the cluster head for both clusters is selected then node nearest to the both cluster heads is chosen as guard node. source sends hello packet to the data to be compared . depending upon these calculations wormhole attack is detected .This technique is implemented on AODV.

In [2] Anil kumar proposed an approach to prevent the wormhole attack using digital signatures .This method is divided into two phases In the first phase delay/hop count and verification of digital signature information is collected. And in the second phase analyzes the collected information obtained in first phase to detect whether there is any wormhole attack present or not. The reason behind is that under normal situation ,the delay a packet experiences in propagating one hop should be similar along each hop along the path. However, under a wormhole attack the delay may unreasonably high or low, since there are in fact many or no hops between them. Therefore, if we compare the delay per hop of a legitimate path with the delay per hop of a path that is under wormhole attack, we should find that the delay of the legitimate path is smaller. Therefore, if path has distinguishable high or low delay value, it is likely to be subjected to a wormhole and another technique is used for pin point detection of wormhole digital signature technique, it is assumed that each legitimate node shares the digital signature of every node in the network and the malicious node does not have its own digital signature.

Our mechanism is designed specifically for AODV routing pr otocol in mobile ad hoc network.In [3] P.anitha proposed an approach based on path tracing method. Path Tracing (PT) algorithm for detection and prevention of wormhole attack as an extension of AODV protocol. The PT algorithm runs on each node in a path during the AODV route discovery process. It calculates per hop distance based on the RTT value and wormhole link using frequency appearance count. MASK is based on a special type of public key cryptosystem, the pairing based cryptosystem to achieve anonymous communication in MANET.In [4] Once the route is defined in between source node and destination node, the next step is to authenticate the sender and receiver. To authenticate the sender and receiver, here we use the double encryption technique to increase the security level against the wormhole

attack. In proposed technique, session key and generated time will be stored in the token. This token is issued by the issuer, if issuer is convinced about the security level of sender or subject node. This token is encrypted with the Receiver's public key and the whole token is encrypted with Sender's Private key, if the sender's private key is authorized that token will be decrypted by the sender's public key. Now the whole token is decrypted by the receiver's private key. In [5] Shalabh jain proposed a method based on channel characteristics In this paper, we devise a novel scheme for detecting a wormhole by utilizing the inherent symmetry of electromagnetic wave propagation in the wireless medium. We demonstrate the loss of this symmetry in case of a wormhole attack and propose a method to detect and flag the adversary. We modify the insecure neighborhood discovery to incorporate authentication. In [6] Phuong Van Tran proposed an approach based on Transmission time based mechanisms. In our mechanism,when a node establishes a route to another node, we will try to check whether there is a wormhole link in that route or not by calculating every Round Trip Time (RTT) between two successive nodes along the route. In [7] Saurabh Upadhyay proposed an approach for avoiding wormhole attack using statistical analysis. Th e proposed wormhole attack model method works without any extra hardware requirements,the basic idea behind this work is that the wormhole attack reduces the length of hops and the data transmission delay. In [8] A.Vani et al. proposed 3 different methods for Detection scheme has three techniques based on hop count, decision anomaly, neighbor list count methods are combined to detect and isolate wormhole attacks in ad hoc networks. That manages how the nodes are going to behave and which to route the packets in secured way. Hybrid routing algorithm is used to provide the common solution to three different techniques. This protocol is based on On-demand ad hoc routing protocol (AODV).In hop count based method one hop neighbors are calculated . Based on the received replies, he will create a list of his one-hop neighbors that excludes the next hop along the route. In anomaly based detection method. In [9] Vandana CP proposed a method for detecting wormhole attack based on hop count latency and adjoining node analysis .In this method wormhole detection is two step process :a. b.In observation phase round trip time of all nodes is calculated which are between source and the destination and the link with maximum round trip time is marked as wormhole link(which exceeds the threshold value) and corresponding nodes are marked as suspicious nodes. The principle of WARRDP is to allow neighboring nodes of a wormhole node to notice that the wormhole node ha extreme capacity of competition in path discovery. In the path discovery of WARRDP, an intermediate node will attempt to create a route that does not go through a hot neighbor node, which has a route-building rate higher than the threshold. Thus, not only are wormhole nodes gradually identified and isolated by their normal neighboring nodes. In neighbor discovery method secure neighbor discovery from source to destination obtained by neighbor list and detect the anomaly if attack is present. The steps are a. b.c. d.Each node sends a hello message for the neighbor discovery immediately after the deployment of the mobile nodes. Each node that receives a hello message sends a reply. Each node builds its neighbor list which could include remote neighbors connected by a wormhole. The neighboring nodes exchange their neighbor lists. Each node will compare its neighbor list with its neighbors' neighbor list. If they are similar, either these nodes are close enough or are connected by a wormhole. Next, both of these nodes and their neighbors will reconstruct their neighbor lists which will remove these two nodes and their neighbors. Finally, to secur e the data Here round trip time is defined as the difference between request and reply packet propagation node. In confirmation phase the suspicious wormhole peers identified in the previous stage are confirmed by verifying if any adjoining node (intermediate node) exists between the wormhole peers.In [10] khin sandar win proposed a new technique based on link frequency analysis and trust based model.

a) One-hop neighbor discover y;
b) Initial route discovery
c) Data dissemination and wormhole detection, and
d) Secure route discover y against a wormhole attack.

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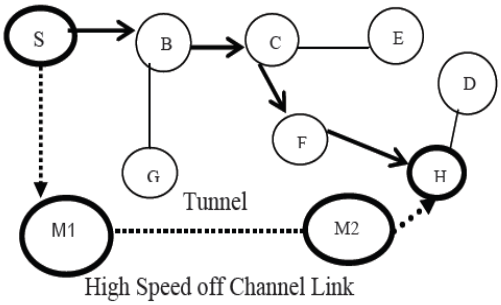
V. APPROACHES AND EFFECT OF WORMHOLE ATTACK IN MANET

Commonly ad hoc routing protocols are of two categories: proactive routing protocol, which based on the periodic broadcast of routing packet updates, and on-demand routing protocols that look for routes whenever required. A wormhole attack is uniformly worse for both proactive and on-demand routing protocols .When a proactive routing protocol are in use, ad hoc network nodes send periodic HELLO messages to others signify their participation in the network. In Figure 2, when node S sends a HELLO message, intruder M1 forwards it to the other end of the network, and node H listens to this HELLO message. Since H can take notice of a HELLO message from S, it assumes itself and node S to be direct neighbors. Therefore, if node H needs to forward something to S, it may accomplish so innocently in the course of the wormhole link. This effectively permits the wormhole attackers for full power during communication.



In case of on-demand routing protocols, for instance AODV , when a node wishes to communicate with another node, it floods requests to its neighbors, trying to determine a path to the destination. In above figure 2, if node S wants to

communicate with H, it sends a request. A wormhole node, once more, forwards these requests without change to the other end of the network, may be directly to destination node H.A request moreover travels along the network in a systematic way; as a result H goes ahead to believe that it has a feasible route towards node S through the wormhole attacker node. If this route is selected in route discovery, once again wormhole attackers get full control of the traffic among nodes S and H. Once the wormhole attackers obtain control over a link, attackers can drop the entire packets, a random fraction of packets, or particularly some specific packets. Attackers can also forward packets out of order or 'switch' their link on and off.

In this paper, we have proposed an approach where wormhole attacker has been detected effectively using concepts of reference node and relative velocity. The AODV routing protocol is used as the underlying network topology.

VI. Conclusion

As wormhole attack is one of the harmful attack in MANETS so we have studied many methods for its detection ,removal and the prevention. Also we have compared these methods .Wormhole attack or tunneling attack can also occur in the VANETS so we can discuss various methods for the detection of wormhole in VANETS .we can also compare the two that is wormhole attack in MANET to that of VANET .The other scope can be to study and compare various other attacks and evaluate their performance metrics accordingly. other attacks that can be studied similar to this context are jellyfish attack, sinkhole attack, gray hole attack and many more.

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