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Distributed Packet Filtering Firewall for Enhanced Security In Mobile Ad-Hoc Network

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ABSTRACT
The nodes in MANET are free to move in a limited grid layout without the presence of vision of the superior authority or administration. The nodes in network are free to move in any other network at any time. That means the nodes are join or leave the network at any instant, that's why the security is the major issue in MANET. Routing protocols are not able to handle the malicious activities of attacker because their function is to provide the path in between sender to receiver and route data from the path which is selected for transferring information. This paper proposed the distributed security scheme for providing reliable path and secure communication. The proposed bloom filtering technique is not only filtering the unwanted infected packets of routing attacker. It's also recovered the modified data and protects IP modification with the help of new route establishment mechanism. The proposed bloom filter is provides the secure communication and stop the attacker infection. The Bloom filter removes the IP modified packets that shows the presence of malicious routing attacker in dynamic network. The normal routing performance and proposed bloom filter is almost equivalent. The performance of network is measured through performance metrics and proposed distributed security scheme provides better performance.

***Keywords*:** Security, Routing attacker, IP modification, Bloom filter, MANET

I. INTRODUCTION

Mobile Ad-hoc Networks (MANETs) are increasingly employed in both military and commercial network situations where fixed infrastructure is too costly or dangerous to deploy, or has been rendered inoperable[6]. MANETs are fundamentally different from the other network because all peers act as both sources and routers using the other participants to relay packets to their final destination. MANETs are susceptible to both insider and outsider attacks. Even a small number of misbehaving nodes can successfully render the entire MANET inoperable: malicious peers can abuse the network exhausting all network and power resources[6]. In traditional networks, malicious nodes and traffic are kept away from a set of nodes belonging to an organization or a group using firewall*[9]*. This is feasible because of the existence of a well defined network perimeter[6].All incoming and outgoing traffic needs to transit through these firewall nodes, which enforce the policies at the perimeter. Within the perimeter, smaller sub-groups can have more stringent policies by deploying their own firewalls. Unfortunately, the concept of a network perimeter does not exist in MANETs, and policies need to be enforced in a distributed manner while taking into consideration node mobility. To address this, recently, paper proposed a deny-by-default architecture [9] that enforces trust relationships and traffic accountability between mobile nodes through a distributed policy enforcement scheme for MANETs.

In that architecture, extended the network capability framework [10] and tailored it to the resource-constrained MANET environment. A capability is a token of authority that has associated rights[13].The capabilities propagate both access control rules and traffic shaping parameters that should govern a node's traffic[9]. In the deny-by-default, model nodes can only access the services and hosts they are authorized for by the capabilities given to them[9]. The enforcement of the capability is done in a distributed manner by all the nodes in the path from the source to the destination. Compromised or malicious nodes cannot exceed their authority and expose the whole network to an adversary[9].Upon detection, paper tells how to prevent a compromised node from further attacking the network simply by revoking its capabilities[9].Moreover, that architecture helps mitigate the impact of denial of service(DoS) attacks because excess or unauthorized packets are dropped closer to the attack source. Thus, it avoid unnecessary data processing and forwarding at the target node and the network .

II. RELATED WORK

Ali A. Ali, Saad M. Darwish, and Shawkat K. Guirguis[1]"An Approach for Improving Performance of a Packet Filtering Firewall Based on Fuzzy Petri Net". As a major measure to implement enterprise security, firewall technique ensures the security of local network. Traditional firewall technologies have their own weaknesses in architecture, configuration, monitoring and management that affect to firewall performance. Furthermore, it lacks to deal with vague and uncertainty associated with filtering packets from outside. Architecture of a new kind of firewall, that is intelligence firewall was presented in that paper.

Harleen Kaur, Omid Mahdi Ebadati E and M. Afshar Alam [2]"Implementation of Portion Approach in Distributed Firewall Application for Network Security Framework" Author described that Firewalls are typically utilized in the main layer of network security framework. The research presented the particular segment of the proposed framework that DPFF based on the developed iptable firewall to be the layers of defense, which is protected front and backend of the framework with a dynamic security and policy update to control the framework's safeguard through proposed portion approach algorithm that utilize to reduce the traffic and efficiency in detection and policy update mechanism. The policy update mechanism for DPFF is given the way of its employment.

Salah Alabady [3] "Design and Implementation of a Network Security Model for Cooperative Network" Author had designed and implemented network security model which was presented using routers and firewall. It emphasis on the network security weakness in router and firewall network devices, type of threats and responses to those threats, and the method to prevent the attacks and hackers to access the network. It provides a checklist to guide in evaluating whether a network is adhering to best practices in network security and data confidentiality. The main aim is to protect the network from vulnerabilities, threats, attacks, configuration weaknesses and security policy weaknesses.

Jozef Filipek, Ladislav Hudec [**4**] "Distributed Firewall in Mobile Ad Hoc Network".Author describe distributed firewall architecture that is designed specifically for MANET networks. This design is using the concept of network capabilities and is especially suited for environment which lacks centralized structure and is composed of different devices. The model denies all communication by default and nodes can access only services and other nodes that they are authorized too. Every node contains a firewall mechanism which includes intrusion prevention system and compromised node will not necessarily compromise whole secured network. In this approach they add additional security features for MANETs and help them withstand security threats which would otherwise damage, if not shutdown unsecured MANET network. In this simulation shows, that the solution has minimal overhead in terms of bandwidth and latency, works well even in the presence of routing changes due to mobile nodes and is effective in containing misbehaving nodes.

Ting Zhang, Dale Lindskog[**5**] "Full Function Firewalls on MANETs" Author propose a routing storage and query mechanism for the ROFL firewall scheme, a mechanism that combines a hierarchical routing storage structure with a fast routing query method. ROFL, which stands for Routing as the Firewall Layer, is a firewall scheme designed mainly to prevent insider attacks on Mobile Ad Hoc Networks (MANETs). The proposed mechanism also extends the filtering capabilities of ROFL, allowing packet filtering based on most any traditional packet filtering criteria, e.g., source IP address, source and destination port numbers, TCP flags, etc.

Mansoor Alicherry Angelos D. Keromytis Angelos Stavrou [**6**] "Evaluating a Collaborative Defense Architecture for MANETs" Author describe that this solution incurs minimal overhead in terms of network bandwidth and latency even in the presence of cryptographic operations. Furthermore, author show that the protection remains effective even in the presence of misbehaving nodes and routing changes due to mobility. While further work is needed to fully evaluate the scheme, author believe that the notion of collaborative security in MANETs is a promising direction for future research.

Mohammad M. Masud, Umniya Mustafa, Zouheir Trabelsi [7] "A Data Driven Firewall for Faster Packet Filtering" Author propose a data mining based technique for packet filtering. Author consider each rule in the rule set a class. A classifier is first trained with labelled training data. Each such labelled data point contains a packet header info and the corresponding class label (i.e., rule number with which the packet matches).Then the classifier is used to classify new incoming packets. The predicted class (i.e., rule number) is checked against the packet to see if this packet really matches the predicted rule. If yes, the corresponding action (i.e., accept or deny) of the rule is taken. Otherwise (if prediction of the classifier is wrong) go back to the traditional way of matching rules. The advantage of this data mining firewall is that it offers a much faster rule matching. Author have proven both analytically and empirically that even with millions of real network traffic packets and hundreds

of rules, the classifier can achieve very high accuracy, thereby making firewall six times or more faster in making filtering decision.

Zouheir Trabelsi, Liren Zhang, Safaa Zeidan[8] "Dynamic rule and rule-field optimization for improving firewall performance and security" The proposed approach is based on the calculation of the histograms of packet matching rules and of packet not matching rule-fields. These histograms are able to effectively monitor firewall performance in real-time and to predict the patterns of packet filtering in terms of rules order and rule-fields order.Furthermore, the proposed approach becomes even more significant when firewall is heavily loaded with burst traffic. A comparison of the proposed approach and the other conventional approaches, including static rule order approach and dynamic rule order approach is presented. The numerical results obtained by simulations demonstrate that the proposed approach is able to significantly improve the firewall efficiency in terms of cumulative processing time compared to other conventional approaches. Furthermore, the proposed scheme also has the capability to significantly reduce the effect of many common network attacks on firewall performance.

III. PROPOSED WORK

Mobile Ad-Hoc network is a self organized network, where node independently works, but MANET is more vulnerable because insider and outsider attacks are easily capture the data and modified it. The design of distributed firewall for secure data delivery using unwanted packet filtering in MANET. As a prerequisite studied various research papers in the field of security or firewall under mobile ad-hoc network were made but overhead were greater in network protection. In this proposed work, create various mobile nodes and at least two or more preventer nodes are design, which watch the miss-activity of the network. Where attacker node receives the data packet from sender and modified the sender IP or receiver IP address and flooded the modified data in the network, those data receives by the unauthorized node and increase the network rush with corrupted packets. So in this distributed filtering methodology has discarded unwanted packets and defends the network. Distributed firewall collaboratively work, where one firewall receives the packets from outside network and analyze the incoming data, while he found modified or corrupted IP address than discard the data packet and filtered data sends to the next hop, those process name as a detection process, where unwanted data are block and identifies the attack activity, so further low overhead required for filtering or identifying existing attacks. Next firewall re-process are apply because some data are corrupted which are not identified by first firewall, so maximum reliability provide for communication. In this proposed work filtering method will also work as a prevention and recovery of data, while data packet incoming in any of firewall than its check the data and its IP address, while he found the data is correct but IP addresses are corrupted so that packet discarded and block the path or route and firewall send the negative acknowledgment (warning message) to sender through alternative reverse path for new route establishment from sender to firewall. While the sender receives the warning (negative acknowledgment) than re-search path and send data through secure path, similarly proposed distributed firewall treat like recovery managers whose manages that data recovery, while data comes through the intermediate nodes with unsecure path same time data part are modified by the any attacker node but header part is not modified. Those packets while comes in any firewall nodes than firewall execute the recovery managers and reconstruct the original data and forward to destination node, that recovery process minimized the delay and improve the data receiving percentages.

IV. PROPOSED ALGORITHM

In this section describe the proposed algorithm for enhanced security using packet filtering in mobile ad-hoc network ,through that proposed algorithm our network architecture are work and improve the network communication with secure manner.

Input:

M← Mobile nodes
S← Sender nodes
R← Receivers nodes
I← intermediate nodes
A← Attacker nodes
A_b← modification behaviour (data, ip)
F← set of firewall
t ← modification threshold
∂←modified variable

Output: Packet delivery ratio, Throughput, Delay, Modified-ip and Modified-next-hop

Routine:

RP← AODV
Broadcast(rp, s, r, ip_s)
While I receives data && I != R **do**
Forward(next-hop, r, ip_i)
I← store route info
End do
If I == R **then**
R← create reverse route (r, s, ip_r, ip_s)
Send ack to S (r_{ip} , s_{ip})
Data(s, r)
End if
While I == A**do**

Capture data
New-data ← data + ∂
Modified ip by A
End do
Data(S,R)
Sender generate data
Send (Data, S_{ip} to R_{ip})
While A receives Data **do**
A_b←modified (Data && S_{ip}, R_{ip})
Bind(data+ ∂ && $S_{ip+\epsilon}$, $R_{ip+\epsilon}$)
Send updated packets to next hop or R node
End do
Firewall-module(I, data, S_{ip}, R_{ip})
F← receives data from I
Check (data, I_{ip}, S_{ip}, R_{ip})
While F identifies I as a A_b **do**
If (A_b←$S_{ip+\epsilon}$, $R_{ip+\epsilon}$) **then**
Discard ← packet
Else if A_b←(data+ ∂ && ∂ < t)**then**
F← execute recovery process
End if
A←I
Send n-ack to S
Re-execute(Route)
End do

V. SIMULATION ENVIRONMENT

The simulator been used is to simulate the ad-hoc routing protocols in is the Network Simulator 2 (ns) [12] from Berkeley. To simulate the mobile wireless radio environment that used a mobility extension to ns that is developed by the CMU Monarch project at Carnegie Mellon University.

5.1 The Simulation Parameter

The subsequent parameters for case study shown in table1.

Table 1 Simulation parameter of case study

Terrain Size	800×800
Network Protocol	AODV
Analysis Time	100
Transmission Range	550m
Transport Layer Protocol	TCP, UDP
Attack Type	IP-Modification
Prevention Type	Firewall
Application Data	FTP, CBR
Data Size (bytes)	512
Number of nodes	50
Maximum Speed (m/s)	Random

5.2 Network Simulator

Network simulator 2 is the result of an on-going effort of research and development that is administrated by researchers at Berkeley. It is a discrete event simulator targeted at networking research. It provides substantial support for simulation of TCP, routing, and multicast protocols. The simulator is written in C++ and a script language called OTcl2. Ns uses an OTcl interpreter towards the user. This means that the user writes an OTcl script that defines the network (number of nodes, links), the traffic in the network (sources, destinations, type of traffic) and which protocols it will use[12]. This script is then used by ns during the simulations. The result of the simulations is an output trace file that can be used to do data processing (calculate delay, throughput etc) and to visualize the simulation with a program called

5.3 Network Simulation Procedure

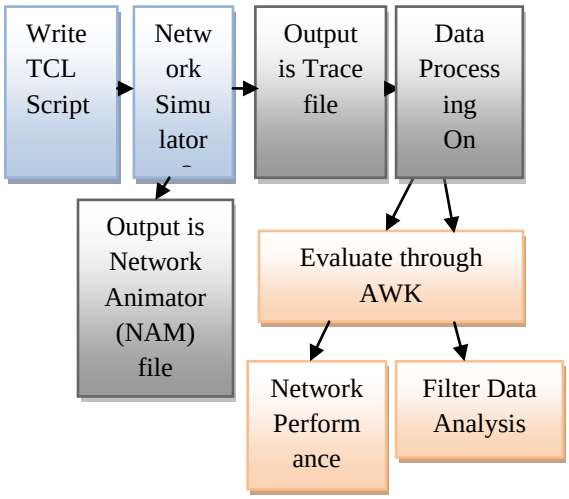

Figure 1: Network simulation steps

NAM is a very good visualization tool that visualizes the packets as they propagate through the network. An overview of how a simulation is done in ns is shown in Figure 1
The whole network performance is store in .tr (trace file) and the AWK is the "abstract window toolkit" that retrieves the particular network information store in trace file[12].

5.4 *ABSOLUTE SUMMARIZED ANALYSIS*

In MANET the complete performance analysis is in three scenarios that is mentioned in table below. The three scenarios are Normal routing, Bloom detection and bloom prevention. In normal routing no routing IP address is modified but in Bloom detection, the attacker is accomplished routing misbehaviour detected by bloom security filter. In third scenario the performance of bloom protection is measured and IP modification and next hop modification is completely detected zero in dynamic network, because the bloom filter is provides the reliable path for data sending.

Parameters	Normal data	Bloom Detection	Bloom Prevention
IP Address Modified	0	163	0
Next Hop Address Modified	0	548	0
Send	7453	6277	9363
Recv	6745	3836	8361
Routingpkts	2928	2918	2538
PDR	90.5	61.11	89.3
Average E-E Delay(Ms)	0.87	1.2	0.72
NRL	0.43	0.76	0.3

5.6.Throughput Performance Assessment

The network performance is vigorous because of better data receiving at destination. In dynamic network it is very crucial to maintain link in between sender and receiver. In dynamic network the performance is also affected from heavy load, battery power depletion and attacker data modification. In this graph,throughput performance of normal routing, bloom detection and bloom prevention is evaluated and observe that the bloom filter not only detect the presence of attacker which affect the performance of routing but also provides the secure route between sender and receiver.

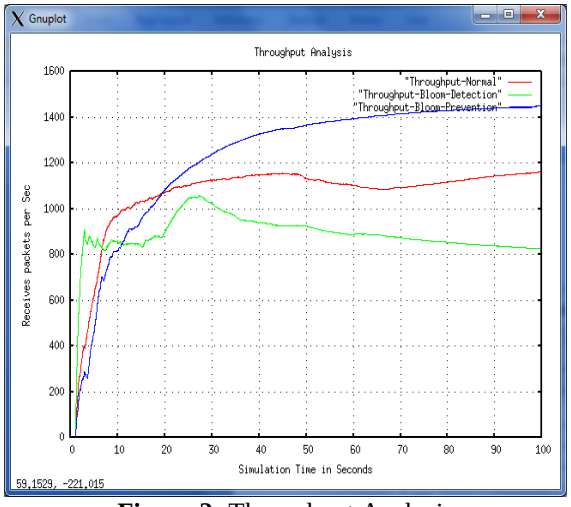

Figure 2: Throughput Analysis

5.7Attacker Loss Analysis

The attacker is not only modified the actual data packets in network but also drop or consumes the packets, depends on the attacker behaviour. The attacker malicious activities are only possible to detect by filters and firewalls. The dynamic network MANET is easily affected from attacker malicious infection. In this graph the false IP and False Next hop information is detected and confirm the presence of attacker through bloom filter.

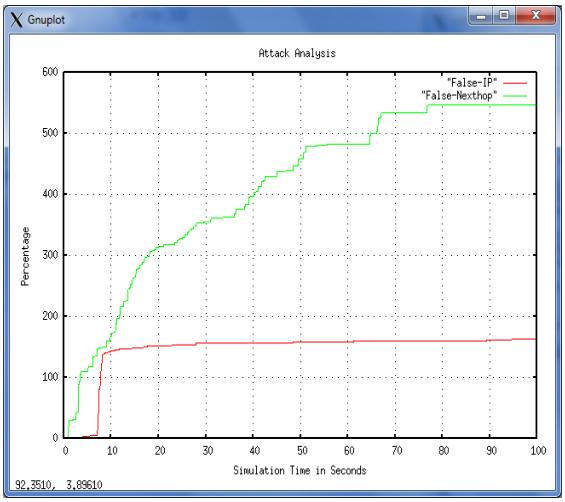

Figure 3: Attacker Loss Analysis

5.8 PDR Performance Assessment

The proper data receiving in network is also provides the better PDR (Packet Delivery Ratio) performance. The more packets receiving at destination is provides the better PDR and less packets receiving is provide the less PDR performance. In this graph represents the percentage ratio of normal routing, Bloom Filter detection and Bloom prevention.

PDR=(Packet received/Packet send)*100

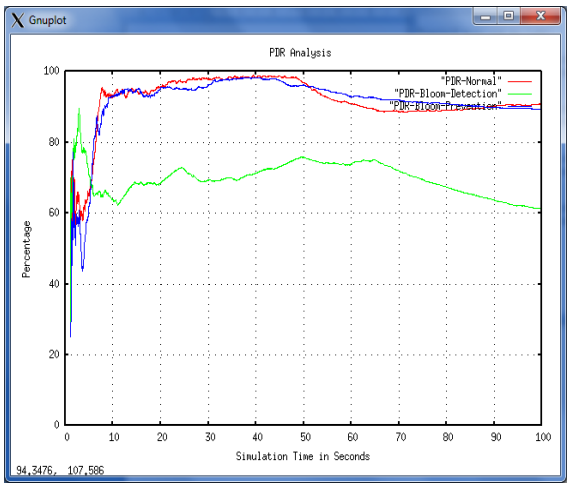

Figure 4: PDR Analysis

5.9 Routing Performance Assessment

The routing packets flooding in network is essential to finding the destination in wireless network. In MANET every sender is first sends route request packets to neighbours and these neighbours are flooded these packets to next nodes till the destination is not found. In this graph the routing packets flooding analysis of Normal routing,

Bloom detection and prevention is evaluated. The routing packets flooding in presence of filtering of modified data is more because of data retransmission

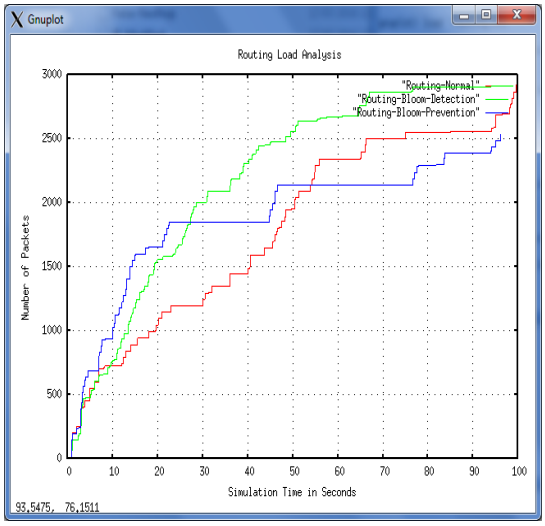

Figure 5: Overhead Analysis

VI. CONCLUSION

MANETs are flexible in the sense that any node can come and join the network without having to register itself to a central administrator. The ease with which any node can join or leave a network introduces a number of security attacks. In this defined the various types of attack and the ways in which the attacker can harm the network. The attacker is always the intermediate node that perform the malicious activities and do the routing misbehavior by modified the actual IP. The IP modification is infected the number of data packets that's why packets receiving at the destination is reduces and network performance is degrades. In this paper the distributed security scheme i.e. proposed Bloom filter is identified the modified IP and filter that modified IP from the network. The proposed Bloom filter is provides the secure path to sender to reduce the possibility of routing attacker existence in network and also removes the prospect of IP modification. The proposed security scheme is provides the better throughput and PDR with minimum routing overhead. This scheme is also completely removes the attacker presence i.e. not exist in proposed security scheme. The proposed scheme is provides the secure communication and removes attacker infection in network.

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