Detection and Prevention Against ARP Poisoning with DHCP Server

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Abstract

The client that uses the local network to map the network IP address connected to the MAC address is defined by the Address resolution protocol. It is well known that the ARP is determined and works correctly if there is no malicious client in the LAN, but in a practical way it is impossible. It is a primary and stateless protocol. ARP maps an IP address to a MAC address. The main reason for an attacker is to search for a strategy that is then implemented to create different attacks. ARP gives this responsibility the unfounded that allow attacker to launch the most serious attacks. In this paper, an attempt is made to reduce or resolve the attacker's exertions by providing proper validation using the DHCP (Dynamic Host Control Protocol) server. By introducing DHCP, so that if an attacker applies the IP address of a host that is not on the network, it may be forbidden. By the DHCP response, the correct match between IP and MAC can only respond. Mechanism that uses the primary and secondary caches to check the input of respective MAC-IP pairs of the system in the LAN. So, poisoning attack can be observed and successfully protected.

Keywords – MAC, Address Resolution Protocol, DHCP, LAN, IP

1 Introduction

The Address Resolution Protocol is a communication protocol used by the IP, to map with MAC. ARP cache table handles the correlation.

1) ARP Request
2) ARP Reply

16 bit		16 bit
Type of Hardware		Protocol Type
Length of Mac Address	Length of Protocol Address	OP-Code Number
MAC Address of Sender		
IP Address of Sender		
MAC Address of Receiver		
IP Address of Receiver		

Table 1: ARP Message Format.

2 Background

The ARP is suspended at the edge of networks. It is a very simple protocol compared to upper layer protocols that allows it to disrupt the network.

A. ARP Protocol

Suppose host A wants to communicate with host B on a local network. Host A requires the MAC address of host B. So, host A will look in its ARP cache table for host B's MAC address. If pair is found, communication will continue, else host A will broadcast ARP request to obtain the MAC address of host B. This ARP request is illustrated in Figure 1. When B receives this ARP request, it will respond with an ARP response with the MAC address of host B. The ARP response is illustrated in Figure 2. When host A receives this response, the communication will start and the IP-MAC pair will be stored in the main ARP cache of host A for a specified duration and are used together for knowing the IP-MAC mappings of the entities in communication. The ARP request is usually a broadcast message, which is sent to retrieve the MAC address of a mapped IP destination. In response, one of the hosts sends a unicast ARP response containing the required MAC address of host. After receiving the ARP response, the host creates an entry for this IP-MAC pair in the primary ARP cache table for a specific time. Later, this entry is removed.

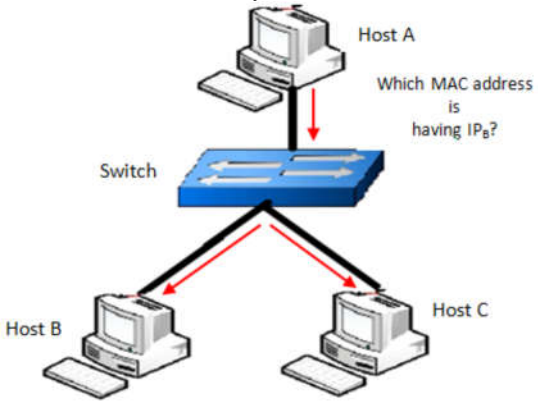

Fig. 1: ARP Request for Host B from Host A

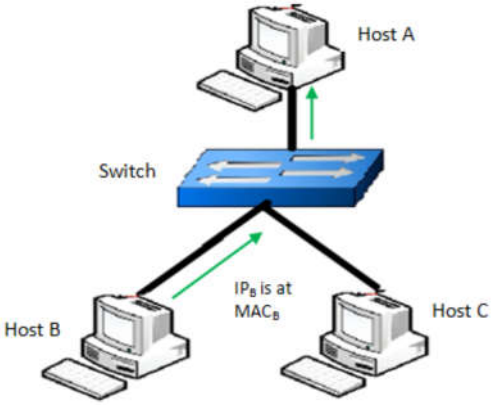

Fig. 2: Host A receive unicast ARP reply from Host B

B. ARP Scenario

When a device communicates with another device on the local network, the source follows the next logic. First, check the entry in the ARP cache whether the address of the destination is present or not. If MAC address is present, it will be used for communication. If MAC address is not found in

cached, the source will inserts into the column details such as the source IP address and the own MAC address. MAC address of destination will be empty and will attempt to obtain it. Finally, the source broadcasts the ARP request over network.

Every device receives the data and check with its IP address. If pair is found, then generated ARP response is unicast. Packet will be dropped on Other devices, The destination device updates its ARP cache entry. The ARP cache table will be reset after every 20 minutes.

C. ARP Poisoning

ARP poisoning is the predominant attacks in the local network. It is a LAN attack that exploits the transition from the network layer to the data link layer address. The impact of this types of attack is obviously malicious. An attacker can modify traffic or stop it on the LAN. An attacker can also modify, block, or stop the data being transmitted.

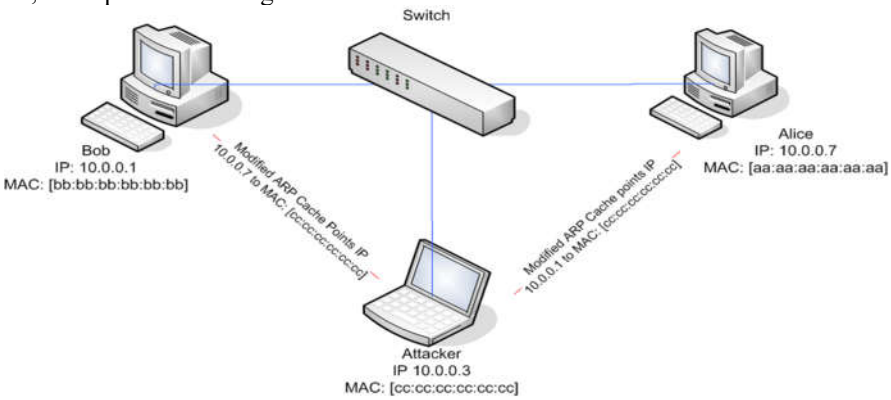

Fig. 3: Scenario of ARP Poisoning

In Figure 3, The victim's ARP request and the router's ARP response are displayed. In this scenario, an attacker can easily obtain the MAC address of the target computer. It's not difficult to take advantage of ARP poisoning, gain access, and use sensitive data from authorized people.

ARP Poisoning is a mechanism used to manage traffic flow between any host on the LAN. Because LAN is the smallest unit of the network infrastructure, the rule for transferring data between very popular hosts is TCP / IP, which is used over the Internet. Mac addresses of all hosts in the subnet are mapped to dedicated IP addresses by the ARP protocol. A central server is not required for every host list. Address resolution protocols stick to the edges of most networks. .

3 Related Work

There are many mechanisms is used for prevent ARP poisoning. Now you can use many of the latest devices for a few days and you might call it a secure port. The restricted MAC address is used on the actual switch port. Therefore, when a new address is provided, it is blocked by the switch. This solution is well planned because it does not prevent all planned ARP attacks, but better, but not implemented. The equipment is also very expensive.

A. ICMP-based cache approach

The ARP message entry checks the ARP secondary cache for validity. Check ICMP echo request for check process to see if previous IP-MAC mapping is valid. The ARP Center server checks the ARP table entries on all hosts. Other hosts also maintain secondary cache. However, it has the disadvantage of SPOF.

ARP, IDS, Snort and ARP-guard are detection tools that detect malicious activity. IDS and snort are simple to install on your system to easily detect attacks, but sometimes generate false alarms. And

other tools not on the market are free. The detection tool needed another central host on the network. Installing the software on the host will detect all the systems and easily catch the attack.

You do not have to maintain a central host in port security. Newer devices have new features such as limited binding MAC addresses. There is little performance degradation here because cryptography is not used. The ARP cache access has static entries and does not require a central host. Each host requires a static entry for each ARP request and response. 0% performance loss again.

S-ARP is an encryption technology. In this technique, a private public key pair is generated and used in the authentication certificate to prevent unauthorized access by the user. sarp is a user daemon that uses S-ARP in kernel space and provides backward compatibility. In s-ARP, the key distributor must securely transmit the key to the authenticated user. However, this technology degrades performance and takes up to 49% of the time. T-ARP is based on tickets. Tickets are provided to authenticated hosts to block attackers. Also used in kernel space. It also provides backward compatibility and requires a local ticket agent. This also leads to performance degradation, but is less compared to s-ARP.

4 The Proposed Solution

In this case, there are three or more hosts available on the local network, managing the primary and secondary cache tables, and storing them permanently until the data is removed from Google. The data is stored as text in the secondary cache table. When the data is validated, the default cache is updated with validation. Our main goal is to reduce network overhead and network congestion. At the end of the validation phase, identify the data packets and determine whether the problem is with sending messages to the DHCP server that dynamically allocates IP addresses to the system. We used three systems connected via LAN. The host manages primary and secondary cache tables. The DHCP server uses only the secondary cache table.

A. Monitor by Responding Time

Host A appears to come from Hosts B and C when it receives two similar ARP response packets. Therefore, a malicious host is likely to perform a cloning attack.

MAC	Last Responding Time	The reply times In N timeouts
B	Tb	Nb
C	Tc	Nc

Table 2: Responding packets within N timeouts

Under normal conditions, the response time is subject to normal distribution. The average value is different, so we define response time's average value is Tavg. In the local network, a huge number of ARP request packets have been sent, for example (N = 1000), records the response time (T1,T2, ... Tn). Type the equation here.

Ø2 is the square difference and α = 0.05 is significant level.

$$\delta = T_{avg} = \frac{1}{n}\sum_{i=0}^{999} T_i , \qquad (1)$$

$$\phi^2 = \frac{1}{n}\sum_{i=0}^{999} (T_i^2 - \delta^2). \qquad (2)$$

We received two sample space: Tb (Tb1,Tb2, …, Tbn) and Tc (Tc1, Tc2, …, Tcn). We define assumptions Hb0 and Hb1, Hc0 and Hc1. Hb0 and Hc0 is assumed that assumes a normal distribution of Tb and Tc is the average response time δ and square is Ø2. The test mechanism of Tb and Tc are the same, so we test Tb. Detection steps are as follows:

If Tb is reference to normal distribution, we assume this: δb =δ. We doing hypothesis testing by standard normal distribution function.

$$U = \frac{|\delta_b - \delta|}{\theta/\sqrt{n}} \qquad (3)$$

The significant level α=0.05, P{| U| > Cα} >α , the standard normal distribution Cα =1.96. Using function (1) and (2), we got δb . Then put the values into the function (3), got the value Ub . If Ub >1.96, then we consider that attacker`s MAC is MAC B.

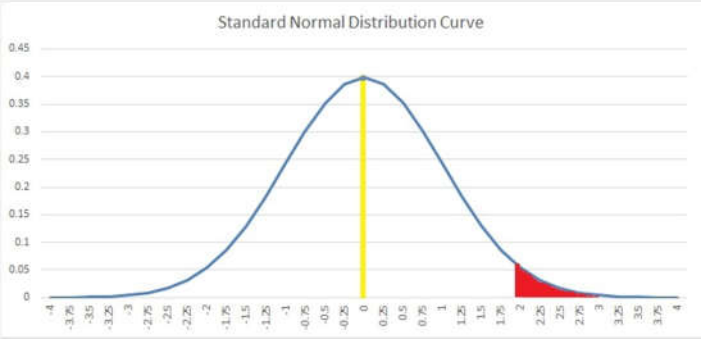

Fig 4: Standard Normal Distribution Curve

B. Proposed Algorithm

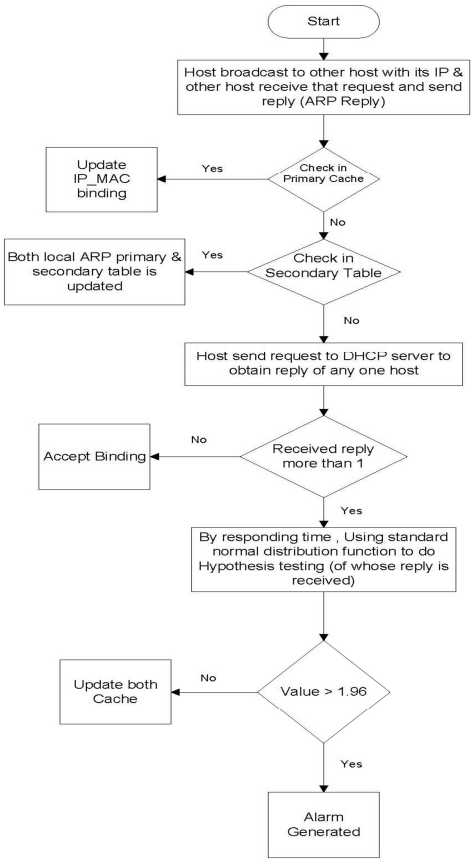

Fig 5: Flowchart for proposed System

5 Experiment And Evalution

A. Prevention Mechanism

We experienced ARP addiction attacks in three systems. We used two simple systems and a LAN-capable gateway. We then used the Linux Ettercap software to perform Arp poisoning attacks on the system. The victim system first tested the connection. After the attacker has changed the MAC address of the victim machine and receives the spoofed Arp, the response packet entry is modified and the attacker's MAC is connected to the IP of the attacker's bridge.

	IP	Mac
Host A	10.1.65.95	f4:4d:30:a8:2d:21
Host B	10.1.64.5	90:6c:ac:76:41:e0
Attacker	10.1.65.152	f0:4d:a2:c3:3f:29

Table 3: Responding packets within N timeouts

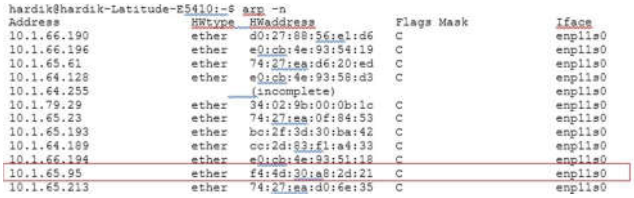

Fig 6: ARP Cache Table Entry-Before Attack

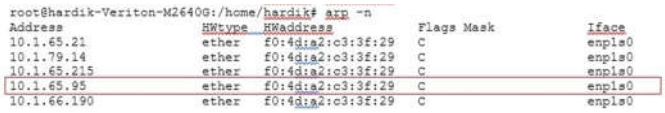

Fig 7: ARP Cache Table Entry-Before Attack

Figure 7 shows that the attacker is attacking the victim's network PC. Now we use the detection control algorithm to compare it with the secondary cache, send an ICMP echo, ask IP, check the correct IP, and what MAC and IP are attacking. If an attacker is identified, a message is sent to the attacker, as shown in Figure 9. The attacker can press the OK button to stop the system.

Fig 8: Notification at Server Side

Fig 9: Notification at Client Side

B. Evaluation

The author ran the application and compares the result of other existing solutions.

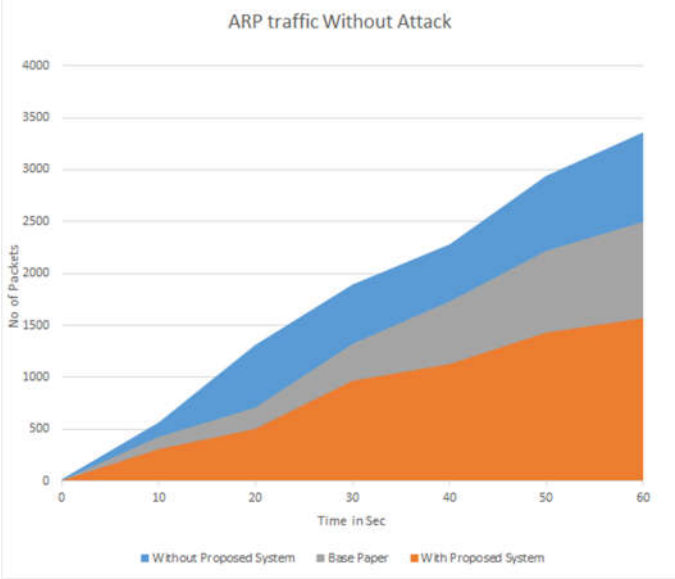

Fig 10: ARP Traffic Without Attack

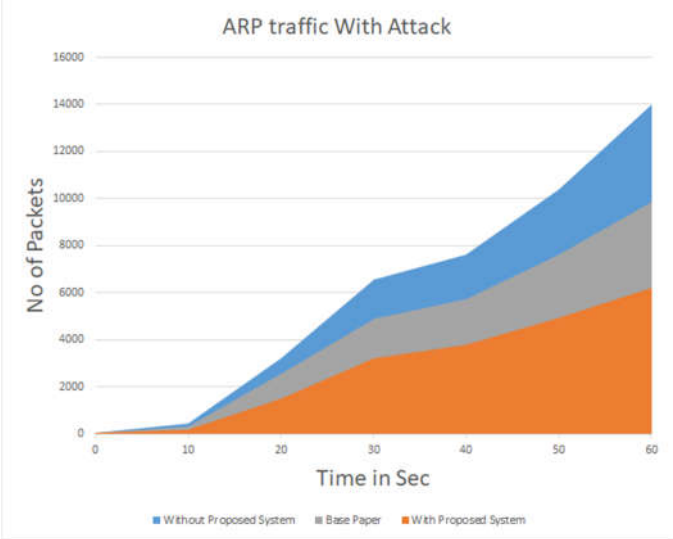

Fig 11: ARP Traffic With Attack

Figure 8 and 9 show ARP traffic comparison in normal situation and attack scenario. While using proposed Application, the author pointed out that network traffic becomes less compared to the normal situation.

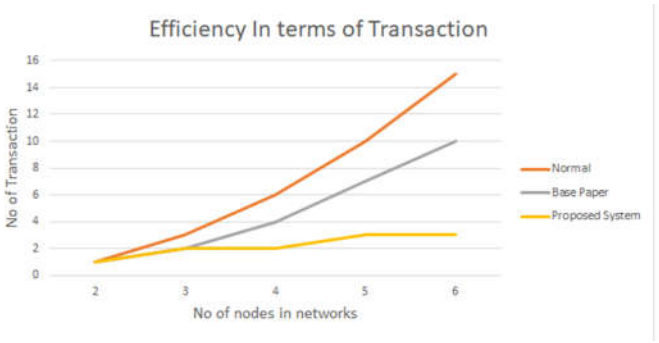

Fig 12: Efficiency In terms of Transaction

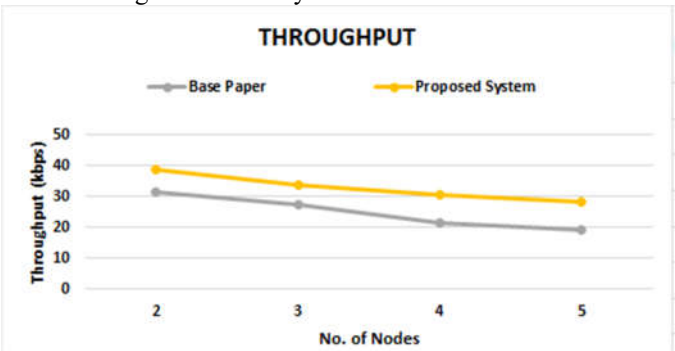

Fig 13: Throughput

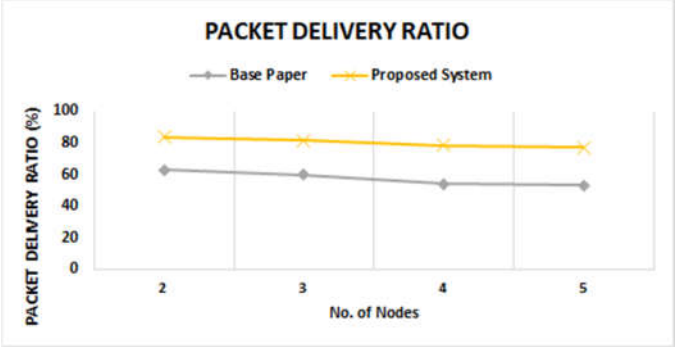

Fig 14: Packet Delivery Ratio

6 Conclusion

ARP poisoning is a dominant security problem in networks that organizations face. This white paper describes deficiencies in existing solutions such as inability to manage, efficiency, efficiency, and backward compatibility. The author also gave an overview of the ARP addiction application to solve this problem which would be helpful in the network area.

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