**Prevention of DDoS TCP Flood Attack using Virtual Network Layer**

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**Abstract**

Because of exponential growth of the users using Internet applications, providing services to them is prominent requirement of internet. The node providing service to them is to be available anytime and anywhere. But the denial-of-service attacker attempts to exhaust the victim’s resources such as bandwidth, processing capacity, storage etc by sending huge unwanted traffic to victim node. By doing so, the attacker makes the victim node to prevent the legitimate nodes from accessing the resources or degrade the services provided by victim node. Hence the network/servers become greater risk. A distributed denial-of-service attack is a large scale attack which launches the many DoS attacks directly or indirectly in the distributed manner. The DDoS attack takes large number of compromised nodes in a network to flood the victim nodes simultaneously from multiple places. This kind of attacks is unpredictable and leads to deadly consequences. Therefore in this paper, we explore the scope of the DDoS TCP Flood attack and the possible ways of prevention of the attacks. We propose a prevention mechanism against the DDoS TCP Flood attack that uses a threshold based attack detection and prevention mechanism. The proposed mechanism is set on a virtual machine of a victim node ie server so that the service requests generated by the attackers are not allowed to the server. The experimental results show that the proposed mechanism performs well as compared with other mechanisms.

**Introduction**

The drastic growth and success of internet changes the life style of human by the way of getting various services such as banking, transportation, medicine, education etc through internet. Therefore the service providers are able to give service to all, anytime and anywhere. It is accomplished by providing adequate resources such bandwidth, processing capacity, storage etc to the service provider. Therefore the providing high degree of availability of such resource to users is very critical in the internet. Besides it, the attacker also attempts to exhaust the service provider’s resource which leads to degrade the availability of resources and services. The attack which exhausts the resources of victims by sending flood of requests/messages, resulting denial of service by the service provider to its legitimate users is called denial-of-service attack (DoS). Syn-flood, teardrop, smurf, ping-of-death, finger bomb, black hole, octopus, snork and ARP cache poisoning are some examples of DoS attack.

On the other hand, Distributed denial-of-service attack (DDoS) uses multiple malicious nodes distributed globally that generate more HTTP traffic to overwhelm victim resources as shown in Fig. 1. It is very difficult to distinguish the attack HTTP traffic from normal traffic [17]. To defend against DDoS attack, traffic control mechanism such as ingress filtering, route-based packet filtering and rate limiter are used. Ingress filtering and packet filtering mechanism detect the packets with spoofed source IP addresses and drop them. But the effectiveness of these mechanisms depends on global deployment of filtering in the internet which is difficult. Rate limiter controls the traffic in the link of victim when it is overwhelmed by the attacker by sending the unwanted traffic. It is suitable for the attacks having high data rate on a link but not suitable for the attacks with low data rate [5]. The rate limiting techniques are very simple and easy to understand also but it is hard to set up proper threshold values for detecting the attacks [15].

In this paper, we propose a threshold based DDoS detection and prevention mechanism which uses a virtual machine set on the victim node. The virtual machine allows only the service requests from the legitimate nodes to the server and other requests are not allowed to the server. Therefore the severity due to the DDoS attack is reduced. When the number of service requests generated by a node exceeds the threshold, then the IP address of the node is assumed as suspicious attacker and marked as blacklist node for a limited period and the service requests from blacklist node are not allowed to the victim.



Fig. 1 overview of the DDos Attack

**Overview of proposed system**

The overview of proposed mechanism is shown in Fig. 2. A virtual network layer is created on a server to prevent the DDoS attack. Any interactions with the server have to pass through virtual network layer. The attack detection mechanism is plugged in the virtual network layer to detect the incoming DDoS attack depending upon the threshold limit allotted to each user. In this paper we consider three different way of spamming the service requests that are

1. Attacker uses its own bots/machines to spam service requests
2. Attacker uses a fake IP addresses generated by multiple bots to spam the service requests.
3. Attacker steals the IP address of a legitimate user to spam the service requests.

Similar to detection mechanism, the prevention mechanism is also integrated with the virtual node. The prevention mechanism cuts the connection between the virtual node and server to prevent any data being stolen or lost or any resource being exhausted. The connection is temporarily terminated and the connection is refreshed after a time period. Even the connection is refreshed after a time period, the IP address is marked in blacklist node

**Request from legitimate users**

**Request from legitimate users**

**Requests from legitimate users**

**A1**

**A2**

**An**

**U1**

**U2**

**Un**

**VIRTUAL NETWORK LAYER**

**SERVER**

**DETECT PREVENT**

**LOG DENY**

**DDoS Attackers**

**Legitimate Users**

**Responses to legitimate users**

Fig. 2 overview of the proposed system.

**RELATED WORK**

In a DDoS flood attack, the victim is flooded the with IP traffic by the attacker [16]. A huge volume of packets sent by the attacker to the victim system slows it down, crashes the system or saturates the network bandwidth which prevents any legitimate users from accessing the victim’s network or system. There are many types of UDP flood attack and TCP flood attack in the Internet as shown in Fig 3. In UDP flood attack, large numbers of UDP packets are sent to victim system which eventually depletes the bandwidth available for legitimate user [10]. In a DDoS UDP Flood attack, the UDP packets are sent to either random or specified ports on the victim system. UDP flood attacks are designed to attack random victim ports. This causes the victim system to process the incoming data to try to determine which applications have requested data. If the victim system is not running any applications on the targeted port, then the victim system will send out an ICMP packet to the sending system indicating a “destination port unreachable” message. There are several other DDos Attacks which shuts down an entire network, such as Smurf Attacks, Fraggle Attacks, Protocol Exploit Attacks, TCP SYN AttacksPUSH + ACK Attacks, Malformed Packet Attacks



Fig. 3 Different types of DDos Attacks.

There are a lot of techniques proposed in the literature for mitigating the effects of DDoS attack as shown in Fig 4. Honeypots are systems that are set up with limited security to be an enticement for an attacker so that the attacker attacks the honeypot and not the actual system. Honeypots typically have values both in deflecting attacks from hitting the systems they are protecting and serving as a means for gaining information about attackers by storing a record of their activity and learning the types of attacks and software tools used by the attacker. A number of current researches discuss the use of honeypots that mimic all aspects of a legitimate network, in order to attract potential DDoS attackers. This prevents a lot of legitimate systems from getting compromised and allows the honeypot owner to track the handler or agent behavior and better understand how to defend against future DDoS installation attacks [8].

Applying a genetic algorithm to find the feature set of each attack, there has been a solution proposed by the SOM for the classification problem. An optimal solution could only be assured with a brute force approach and a significant time commitment (applying soft computing technique to intrusion detection).The distributed nature of DDos attacks make them extremely difficult to combat or trace back, Attackers normally use three methods to spam service requests which are as follows; Spoof ( fake IP ), Bots to generate service requests, Morph a legitimate users IP address to spam service requests. Various classifications of DDos attacks have been proposed in literature over the past decade. In this paper, we mainly focus on DDos flood attacks as one of the most common forms and provide a solution to the existing drawbacks.

Fig. 4 DDos Countermeasures



There are a lot of solutions proposed and partial solutions available for mitigating the effects of a DDoS attack. Many of those solutions assist in preventing only limited aspects of a DDoS attack. However, there is no comprehensive solution to protect against all known forms of DDoS attacks. Also, many derivative DDoS attacks are constantly being developed by attackers to bypass every new countermeasure employed until today. More research is needed to develop more effective and encompassing countermeasures and solutions. Therefore in this paper, we propose a prevention mechanism for mitigating the DDoS TCP Flood attack using virtual network layer.

**PROPOSED SYSTEM**

The architecture of the proposed system is shown in Fig 5. The major process of the proposed system is Detection, Prevention and Recovery phase which prevent the damage caused by the DDos TCP FLOOD attacks. With respect to the different way of DDoS attack mentioned in section 3, we propose the solutions for the design requirements listed below.

1. The victim node doesn’t know which one of the ways is used by the attacker to spam the service request..
2. If the attacker spoofs the IP address of legitimate user, the victim cannot ignore the particulare IP address because it beongs to legitimate user. Instead it can be banned for a limited time. Banning an IP address that belong to a legitimate user for a limited time would not be a noticable issue comparable with damage caused by the attackers.
3. The victim cannot affort the network being attacked.

The following steps are followed in order to implement the detection, prevention and recovery pahse of the proposed system that considers the above mentioned design requirements.

1. Create a virutal network layer : A virtual network layer is created that would eventually act as a decoy to prevent the DDos attacks. Any interactions with the real system will have to pass through the virtual layer, which would give us an instinct when the actual system would come under attack.
2. Integrate a DDos Detection mechanism with the virtual network layer : In this stage, we plug in a Detection mechanism in the virtual network the was created. This part of the network is responsible to detect the incoming attacks depending upon the threshold limit alloted to each user. This would further allow the system to take preventive measures.
3. Taking a preventive measure against the DDos attacks: Once the attack is detected by the virtual network, immediately the preventive measures are toggled by the system. There are more than one way in which this could work since there are 3 different cases that an attacker might spam requests.

The three different cases are explained earlier, however a quick recap on them would be as follows.

1. Attacker uses his own bots/machines to spam service requests
2. The attacker uses a fake IP addresses, generated by multiple bots to spam service requests.
3. Attackre steals a legitimate users addressto spam service requests.

Fig. 5 PROPOSED DETECTION & PREENTION SYSTEM

PACKET SOURCE

BLACKLIST

IP’S

DETECTION SYSTEM

NO

PROCESS YES

CLASSIFIER

LEITIMATE REQUESTS

FORWARD PACKETS TO PREVENTION

TRIGER ALERT

PREVENTION SYSTEM

PROCESS

BLACKLIST LOGS

PACKET TERMINATION

FORWARD PACKETS

PROVIDE SERVICE

SERVER

VIRTUAL NETWORK LAYER

**PROPOSED SYSTEM**

Similar to the detection mechanism, this is also intergrated with the virtual network.Since we would not be able to predict on which one of the above mentioned cases the attacker would initiate, we would block any requests that exceeds a threshold limits.

Considering the possiblity that the attacker uses a legitimate users IP address, it would be impossible to block a address permanently. This leads us to set a ban time on a pirticular set of IP addresses, later sending an notification that such suspecious activity was found from their respective IP addresses.

This would enable the user to tighten their security and possible give a good insight on the attacker of further invistigation was processed.

**STEP 4 :**

On this point, the connection between the virtual network and the Actual netowrk is cut preventing any data being stolen or data loss.

However, this is a case that is highly unlikely to happen and in case this happens the priority of keeping the data safe than that of running the service without an interruption comes first.

Here, we realise that there might be cases that the attack is going out of hands and the prevention mechanish set in the virtual network can no longer with hold the pressure.

Thus the connection between the virtual and the Actual network would eventually be cut until the virtual network is refreshed.

**Advantages :**

1. Prevention of the DDos
2. Usage of a Virtual network
3. Preventing premanent ban on an address
4. Log of data for further invistigation
5. Preventing Data loss or steal.

**Disadvantages :**

1. Short time ban on legitimate user
2. Sometimes, the system have to be taken down offline from the virtual network.

The major disadvantage would be that the legitimate user incase bets a ban time out, will not be able to use the service ustil the ban have been lifted. But considering the priority of any large serviec provider its okay to ben an user if found suspesious and later making up to it justifying the reason for ban.

**Detection phase:**

During the detection phase, the detection sub-system collects the incoming packets within a time frame, for example 60 seconds. The collected packets are subjected to a blacklist check to test whether their sources are blacklisted as attackers of the cloud system. If the packet source is listed in the attacker blacklist, the detection system will send the packets directly to the prevention sub-system without further processing. If the packet source is not blacklisted, the incoming packet will be passed to the classier to decide whether the packets are normal (originating from a client) or abnormal (originating from an attacker). A packet is considered to be an attacking one if the source requests connections to the same destination more frequently than an assumed threshold. The threshold can be manually adjusted by the system administrator to cater for the varying requirements of a particular network. If a packet is considered to be normal, the detection system will send it to its destination (the cloud service provider). Otherwise, the detection sub-system will send the packet to the prevention sub-system.

Algorithm used to detect and remove duplicate requests:

1. Store N records in a temporary file. N is determined based on the number of attacks detected in the previous stage if any.
2. Start Stage 1 at victim server or it can be placed at edge router. Generate Qualifiers Q={Q1,Q2} for each flow identified based on Source IP address and Destination IP address.
3. Use Qualifiers to qualify as suspicious records for those records which satisfy the Qualifier Condition QC where [p (1/H)].
4. Calculate feature components fc1,….., fcn where n=12 of suspicious flows .
5. Generate Feature Vector FV={fc1,fc2,……….fcn} for each suspicious flow.
6. Calculate the similarity measure E using Normalized Absolute Distance between the GAV and FV using Eqn(1):

|  |  |
| --- | --- |
| E=[(GAV)-(FV)]/FV |  |

1. If E > T\_GAV, then it is an Attack. Else it is not an attack
2. If E > T\_GAV, then determine the similarity measure S between FV and different attack signatures A1,…..An stored in DCAP using formula in Eqn (2):

|  |  |
| --- | --- |
| S = [(An)-(FV)]/ FV |  |

1. If Sn of FV matches Threshold T\_S partially or completely, then the attacker is An.
2. Else FV is a new pattern of DDoS attacker from a new attacker.
3. Hence identify FV as An+1 and store it in updated DCAP.
4. Remove the duplicate requests from attackers and drop any other incoming requests from that ip address.
5. Next, use the source IP address from the above generated feature vector After second attempt of DDoS attack from the same source IP address, then block that particular address. It can be used to determine its binder detection used to identify its previous history of attacks, if any.
6. Request for a Virus Scan.
7. Follow step 6 again.

**Prevention phase:**

When the packets reach the prevention system, they are considered to be attacking packets by the detection sub-system. The prevention subsystem alerts the system administrator of the attacks. Then, the prevention sub-system will add the attacking source address to the attacker blacklist used by the detection sub-system, if it is not already on the list. Finally, the attacking packet will be dropped. By the detection sub-system, if it is not already on the list. Finally, the attacking packet will be dropped.

**The following Algorithm is used for further purpose**:

* 1:Load data
* 2: For I=1: n
* 3: P=data (I, 2)
* 4: P2=(I, 1)
* 5: For J=1: n
* 6: N=ﬁnd (data (J, 1)==P2) & (data (J, 2)==P) 7: If N>=K
* 8: New\_data (I, 1)=data (I, 1)
* 9: New\_data (I, 2)=−1
* 10: Else
* 11: New\_data (I, 1)=data (I, 1)
* 12: New\_data (I, 2)=1
* 13: End

**Where:**

**N** is the number of packets

**P** is the destination IP address

**P2** is the source IP address

**N** is the number of packets from the same source to thesame destination within 60 seconds

**K** is the threshold for a packet to be considered an attackingpacket

**1** indicates abnormal packets (blacklist array)

**1** indicates normal packets

**New data ()** is a new entry list with tag ``1'' or `` 1'.

Figure 6 : Prevention Phase

PREVENTION SYSTEM

SUSPISIOUS ACTIVITY / MAX THRESHOLD REACHED

TIME BAN

SAVE ACTIVITY LOGS

REFRESH

BLACK LIST IP ADDRESS

ANALYSE DATA PACKETS AND SERVICE REQUESTS

CHECK LEGITIMATE USER

PROVIDE SERVICE

YES

NO

**Recovery phase:**

The connection between the virtual network and the Actual netowrk is terminated preventing any data being stolen or data loss, which also prevents any damage to the hardware caused by the Attack.However, this is a case that is highly unlikely to happen and in case this happens the priority of keeping the data safe than that of running the service without an interruption comes first.

The termination of connection between the server and the virtual layer occurs only when the attack is going out of hands and the prevention mechanish set in the virtual network can no longer with hold the pressure and protect the system.

Thus the connection between the virtual and the Actual network would eventually be cut until the virtual network is refreshed. This would result in a temperory delay in service but the hardware and data are safe and enough time is bought to counter further incoming attacks.

Figure 7 RECOVERY PHASE

GATEWAY

SERVER

OVER LOAD

PROCESS DATA PACKETS

PREVENTION PHASE

SAVE ACTIVITY LOG

SHUT DOWN VIRTUAL NETWORK LAYER

 RE-INITIATE TASKS

 GENERATE REPORT

DETECTION PHASE

Virtual network layer

**NO**

**YES**

**EXPERIMENTAL SETUP**

Different DDos Attack generating bots are required either virtually programmed or a physical setup i.e. Raspberry pi that could generate a number of service requests from different IP addresses. Then the Virtual network layer have to be configured which acts as a mediator between the actual server and the data packets. This virtual network layer could be setup using a Linux operating system and various networking tools. An network tool have to be assigned to monitor and log the data files.

**Performance analysis**

TO BE ADDED.

**Conclusion**

This paper proposes a mechanism that prevents the DDoS attack and increases the availability of services and resources to the legitimate nodes. Since all the requests generated by the legitimate nodes and the attackers are analyzed by the virtual machine set on the victim node and the only the service requests from the legitimate nodes are allowed to pass to the victim node, the damages caused by DDoS attack is reduced.

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