Brooklyn Dressel
Assignment 4

Abstract

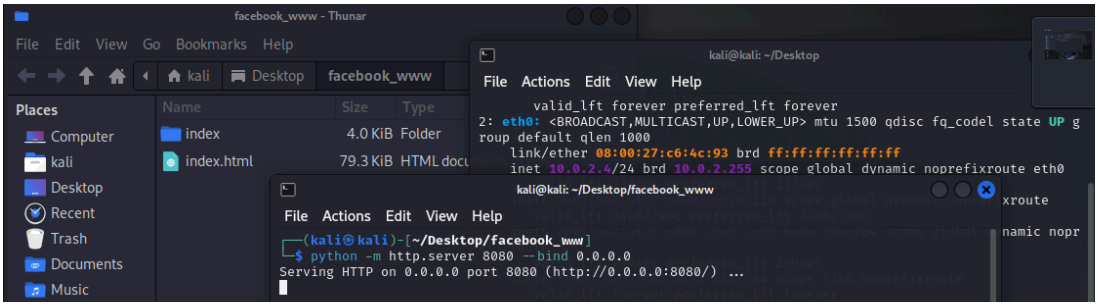
This project explores the use of iptables firewalls to control and manipulate network traffic. Focusing on creating, blocking, and redirecting traffic to and from two virtual machines. Additionally, the limitations of mac address filtering as a security measure are demonstrated and analyzed. Traffic redirection to a local web server is also tested, and used to see the impact of blocking specific devices. It becomes apparent that mac address filtering is not a secure method of access control as mac address spoofing is incredibly easy to perform. However, filtering traffic by IP addresses is proven to be fairly secure and even allows the ability to block all IP addresses under the same subnet mask. Packet analysis using WireShark highlights the availability of communications along SSH servers, HTTP pages, and network traffic with firewall interference. The findings reveal the strengths and limitations of firewalls as it applies to the five main security service categories.

Introduction

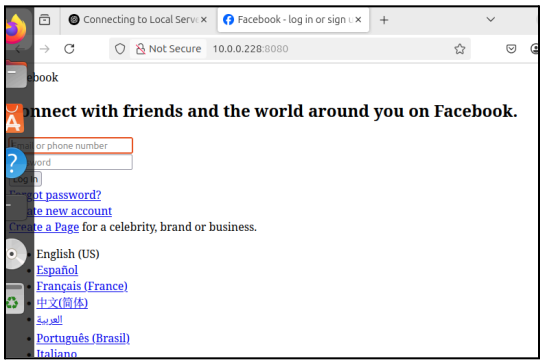
In this project I used a Kali Linux virtual machine to host a local website as well as a SSH server. I used the iptables firewall to block inbound and outbound traffic by blocking port number, ip address, as well as mac address. Additionally, I used an Ubuntu virtual machine to connect to the locally hosted website and the SSH server, the Ubuntu was also used to demonstrate the Kali's firewall capabilities. All traffic packets were captured using WireShark on the Kali system. Both virtual machines were run on a Bridged Network to allow them internet access while also allowing the two virtual machines to communicate with each other. Additionally, all commands used during this project are provided separately.

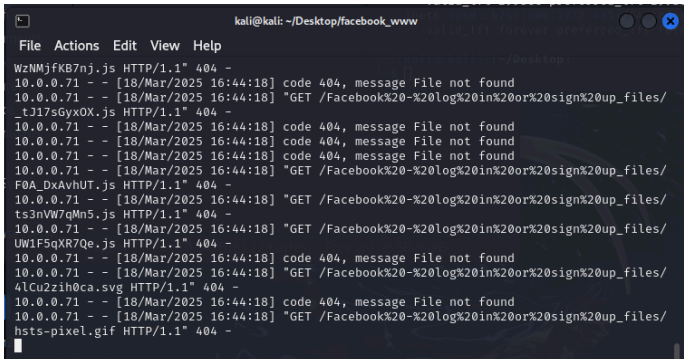
Summary of Results

Upon opening and logging into the Kali Linux virtual machine, I opened Firefox and navigated to the Facebook website. I saved the site by right clicking on the page and created a folder on my desktop for easy access. Inside the folder I renamed the html file index, opened a python terminal inside the folder and ran `command 1` to begin hosting the copy of the facebook website as a locally hosted website. With a response from the terminal, shown below, I knew that the website was successfully hosted.

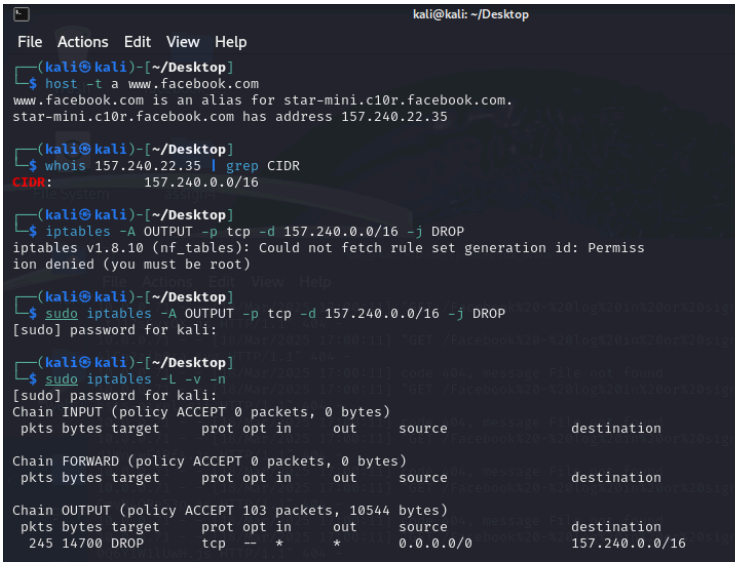


After setting up the webpage on Kali, I used `command 2` in order to get the ip address of my Kali machine, additionally I opened WireShark to prepare to capture the upcoming network traffic. Then I opened the Ubuntu virtual machine and started Firefox, using the url `http://10.0.0.228` I was able to successfully connect to the Kali hosted webpage. It is interesting to note that the url automatically updated to `http://10.0.0.228/8080`, showing that this was in fact a locally hosted website. Since this was an http site, network traffic is not encrypted and plain to see in the packet captures. I was able to confirm this was the Kali hosted webpage as lots of feedback was sent in my Kali terminal, notifying me of the http requests.

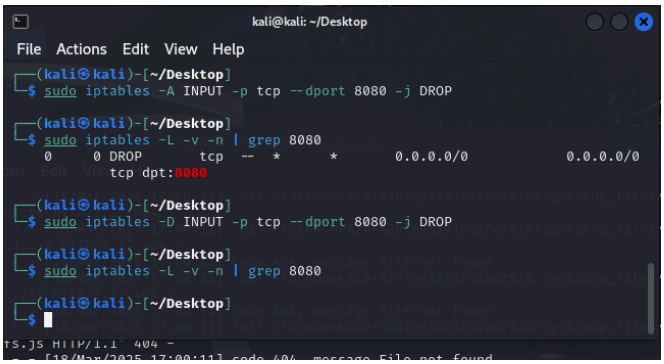


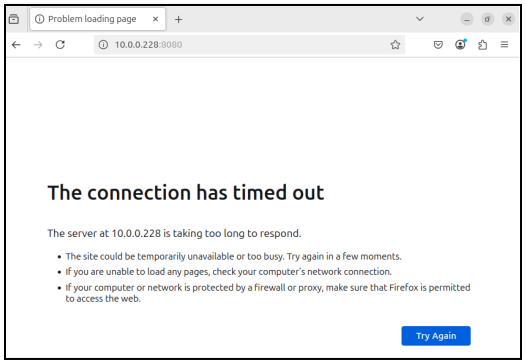


Next, in order to test the limits of Kali's firewall capabilities, I moved to block `www.facebook.com` in its entirety. So, I first used `command 3` to find the host, Facebook, information, specifically Facebook's ip address. Using the ip address, I ran `command 4` in order to find the extent of `www.facebook.com`'s possible ip addresses, from this I found the network address with subnet mask to be `157.240.0.0/16`. Since Facebook could use any of the ip addresses within the range of the subnet mask. Next I ran `command 5` to drop all traffic to that network. I ran `command 6` to confirm that this rule had been created, the result below shows that any outgoing traffic to those ip addresses would be dropped.

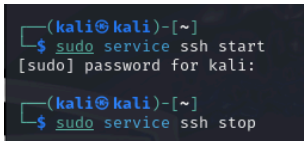


From there, I ran `command 7` to block any inbound traffic headed to port 8080. This blocks all server requests, and I ran `command 8` to ensure that the rule was implemented. This command is similar to `command 6` but it only returns rules that apply to port 8080. Then I attempted to connect to the locally hosted website once more from my Ubuntu machine using the same url before. However, this time the connection timed out and I was unable to connect to the server.



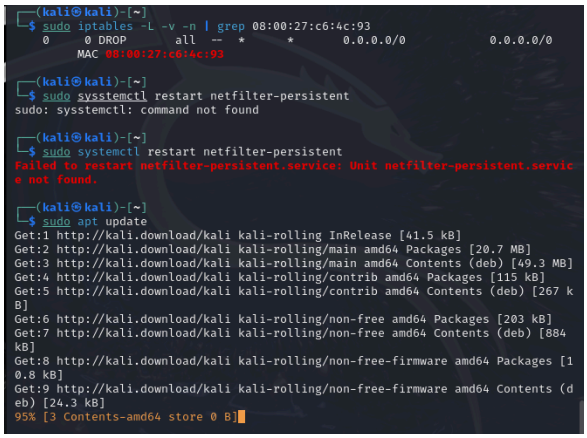


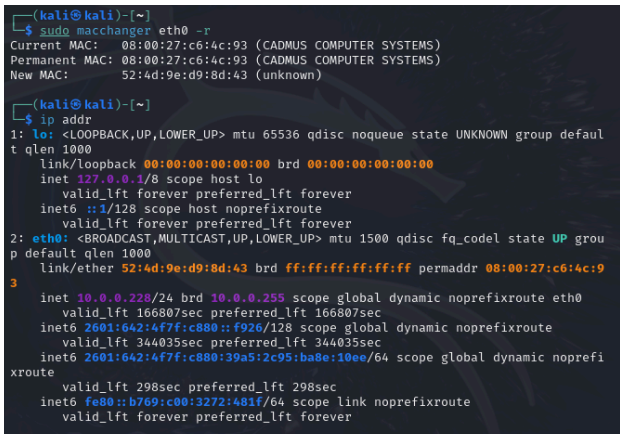
The next step to testing the Kali Linux machine's firewall was to block Ubuntu by it's mac address. Naively, I simply attempted to block all incoming traffic from my Ubuntu's mac address, which I had found using `command 2`, so I ran `command 9` and confirmed the rule was in place using `command 10`. In order to test if this worked I ran `command 11` in order to start hosting an SSH server for my Ubuntu to attempt to connect to.



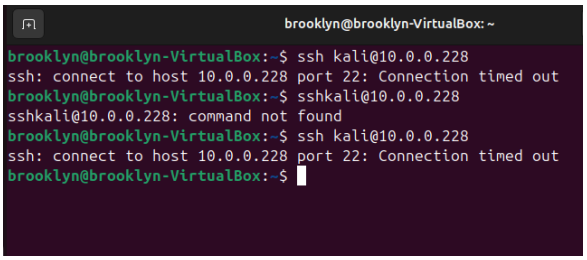
Then I reopened Ubuntu to connect to the SSH, and was able to. So I began looking into what the reason for this was. I double checked the Ubuntu's mac address and ensured the rule was in place again. Finally, I came to the realization that both virtual machines shared the same mac

address, and that this would interfere with the firewall rule. The screenshot below shows my attempts at problem solving this issue before I realized the problem.



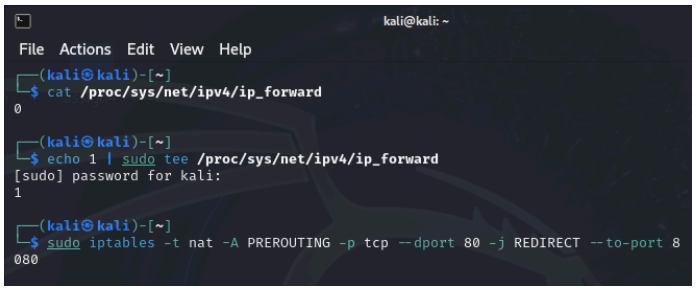


To solve this, I ran `command 12` to change the mac address of my Kali virtual machine, confirmed this by running `command 2`. Now that my virtual machines had distinct mac addresses, I attempted to connect to the Kali SSH server from Ubuntu using `command 13`. The screenshot below shows that this was unsuccessful and the connection timed out. Additionally, Ubuntu was unable to connect to the locally hosted website. Since I had confirmed that this method was successful I ran `command 14` to remove this rule and `command 10` to confirm the change so I could attempt another rule for the Kali firewall.

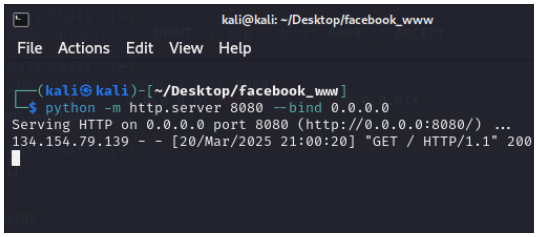


The next attempt at checking the capabilities of the Kali iptables firewall was to block incoming traffic to port 22, which would be to the SSH server specifically. In order to do this I ran `command 15` to create this new iptables rule, confirmed it was enabled using `command 16`. To test the firewall I ran `command 13` in Ubuntu, and once again could not connect to the Kali SSH server. Since this was successful I ran `command 17` to disable this rule and `command 16` to confirm it.

The final test for Kali's firewall was port forwarding. First I ensured that port forwarding, I checked to see if it was by running `command 18`, the output of 0 meant that it was not and I had to enable it using `command 19`. Then I ran `command 20` to forward all incoming traffic headed to port 80 and send it to port 8080 instead.



Now that the rule was set up, I next went back to Ubuntu in order to test it. In order to do this I ran `command 21` from the terminal, the output is shown below, saying I was able to successfully connect. Note that the ip address in this command changed as I forgot to take a screenshot and redid this section of the project in order to properly capture the response in Ubuntu. The Ubuntu screenshot below show the response saying a request was sent to port 80, and the Kali screenshot shows that it served an http request on port 8080.



As extra confirmation I ran `command 21` again to ensure the response was consistent. And as added confirmation I ran `command 22` to see the iptable rules, the screenshot below displays that 2 packets have been redirected from port 80 to port 8080.

Conclusion

Analysis

Review all of the packets captured by Wireshark. Comment on the different types of traffic seen, including SSH and HTTP. What type of encryption does SSH use? Find the key exchange packets.

Filter and save only several relevant packets. Include this filtered capture file.

Conclusion

In addition to your conclusion, add the following:
- What additional steps are required to turn this into an attack?
- How can IPTables be used to improve security?
- What is mac address filtering?
- How does macchanger do? What does this mean about mac address filtering?

- Describe how firewall software does or does not provide:
    - Authentication
    - Access control
    - Data confidentiality
    - Data integrity
    - Non-repudiation

Analysis of the packets reveals that all SSH traffic appears as encrypted TCP packets sent and received on port 22. This is why when we used iptables to block incoming packets on port 22, we were unable to connect to the SSH server from Ubuntu. Additionally, SSH uses a Diffie-Hallman key exchange that is clear to see in the packet captures, after that all packets exchanged are encrypted. For the HTTP traffic, since its non encrypted web traffic (HTTPS is encrypted web traffic), all get requests, responses, and urls are plain to see.

Overall, this project demonstrates the capabilities and variety of techniques you can use to limit traffic to and from your network. There is also the possibility that these limitations can be used maliciously and with a few added steps can be turned into an attack. For instance, if an attacker were to perform a Man-in-the-Middle attack, the first step would be to partition the network. This could be done by using firewalls to stop traffic from heading from one user to another, the attacker could intercept this traffic in the middle by using the firewall or perhaps use the port forwarding technique to have all traffic sent somewhere other than the user's intended destination. If a Man-in-the-Middle attack is used to facilitate the key exchange between two users (Diffie-Hellman key exchange is particularly vulnerable to this style of attack), then the attacker could gain access to all further sent encrypted packets (thus making SSH traffic also susceptible to this style of attack.

The use of iptables can be used to increase and improve security simply by blocking unwanted or possibly malicious traffic from coming onto the network. The catch to this is that the user and network must know some information about the attacker before they are attacked. To solve this issue the user could block all traffic on the network and only allow trusted users and network access, while all others are blocked.

One of the ways that other devices can be blocked using iptables is by mac address filtering. Using this method, all incoming traffic from a particular device (as known by its mac address) can be blocked. However, as we saw during this project using macchanger, it is *incredibly* easy to change your device's mac address and bypass this firewall. However, because of the ease of use of this method, it is oftentimes used to block user's when there are low-security risks, such as at an internet cafe's wifi.

Finally, this project has given insight into how firewall technologies help users in the five service categories. Firstly, we have seen that firewall technologies do not provide authentication outright. There is a level of authentication required for users to bypass firewalls, meaning that authenticated users can access networks, however the firewall itself does not provide the means to authenticate users. Next, access control, yes, this is the primary use of firewalls. They are designed to control access to only specific users while denying access to all other users or simply blocking specific users. Similar to authentication, firewalls do not provide data confidentiality as they do not encrypt anything. However, by limiting the users who have access to data, it does help prevent attackers from getting access and thus seeing the data. Firewalls do not provide data integrity. There is no method in firewalls that can tell if data has been modified or tampered with, thus there are no data integrity checks. However, similar to above, if an attacker does not have access to the data, it helps to ensure that it cannot be altered in the first place. Finally, firewalls can provide non-repudiation to a small degree. The most common way to ensure non-repudiation is with digital signatures, and firewalls do not have the ability to do this. However, since firewalls are capable of logging network activity, there is a certain degree of being able to tell which users have done certain actions. However, this is not fool-proof and not all-encompassing.