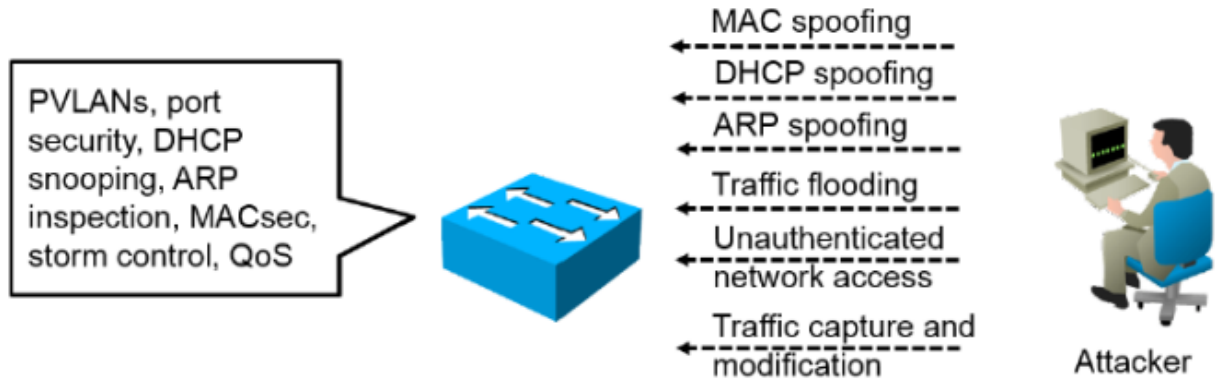
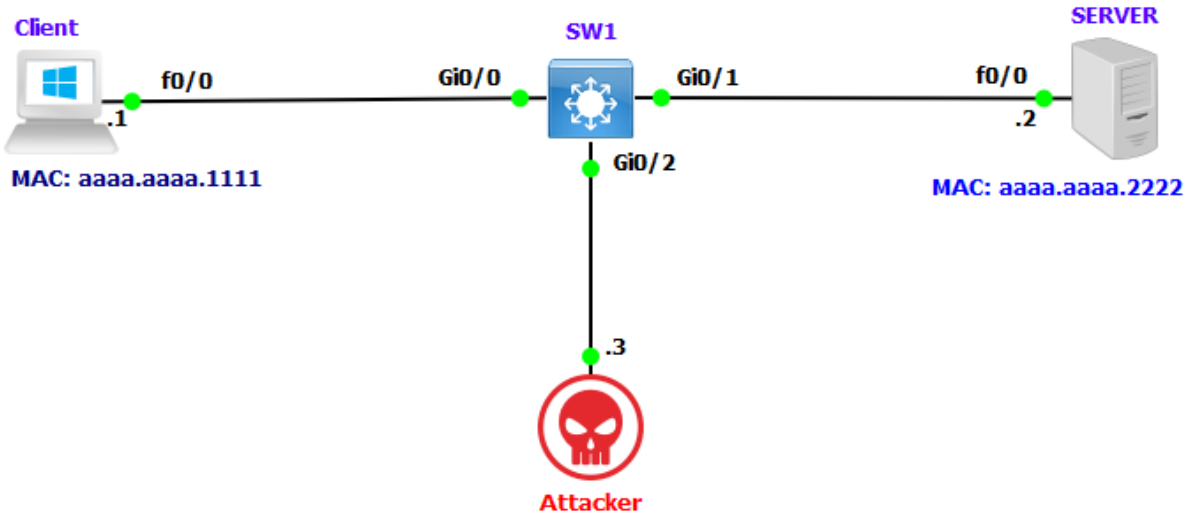
Layer 2 Attacks:

- Most end-user devices connect to the network via Layer 2 access switches.
- End devices such as Computers, Printers, IP Phones, and other hosts etc.
- As a result, the Cisco switches can present a network security risk.
- The Cisco Switches are subject to attack from malicious internal users.
- Switches provide many security features to block internal attacks.
- Security of Layer 2 is aims to mitigate Man in the Middle Attacks (MITM).





DHCP SERVER Configuration
SERVER(config)# interface FastEthernet0/0 SERVER(config-if)# mac-address aaaa.aaaa.2222 SERVER(config-if)# ip address 192.168.1.2 255.255.255.0 SERVER(config-if)# no shutdown
SERVER(config)#ip dhcp excluded-address 192.168.1.1 192.168.1.100 SERVER(config)#ip dhcp pool TEST SERVER(dhcp-config)#network 192.168.1.0 /24 SERVER(dhcp-config)#default-router 192.168.1.2
SERVER# show ip dhcp binding

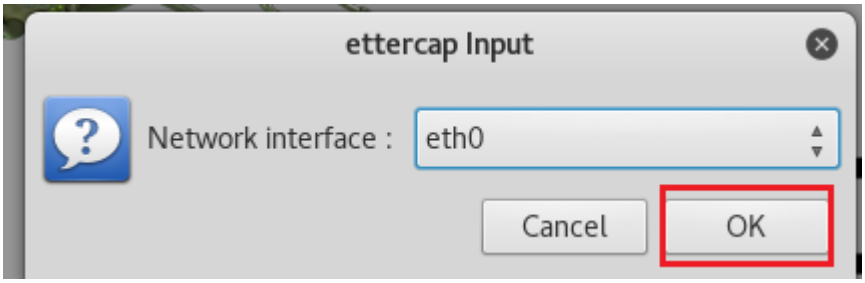
DHCP Client Configuration
Client(config)# interface FastEthernet0/0 Client(config-if)# mac-address aaaa.aaaa.1111 Client(config-if)# ip address 192.168.1.1 255.255.255.0 Client(config-if)# no shutdown
Client(config)# interface FastEthernet0/0 Client(config-if)#no ip address Client(config-if)#ip address dhcp
Client# show ip int br

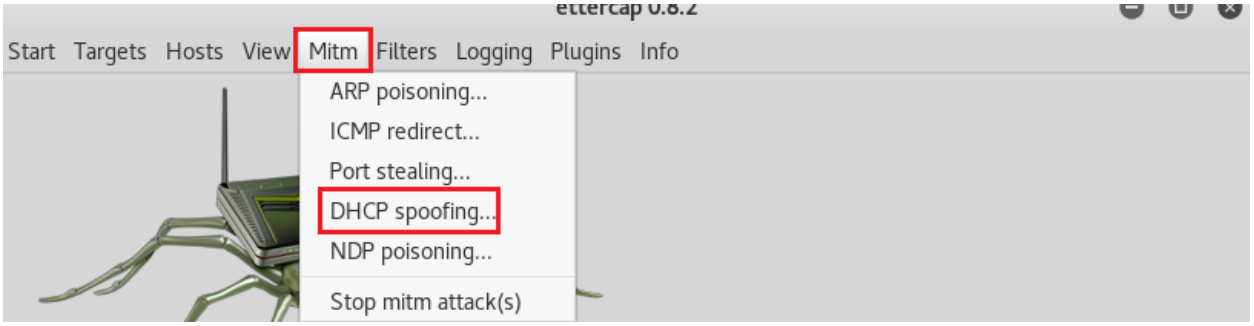
SW1 Configuration
SW1(config)#interface range GigabitEthernet 0/0- 2 SW1(config-if-range)#switchport SW1(config-if-range)#switchport access vlan 1 SW1(config-if-range)#no shutdown
SW1(config)#interface vlan 1 SW1(config-if)#ip address 192.168.1.10 255.255.255.0 SW1(config-if)#shutdown SW1(config-if)#no shutdown

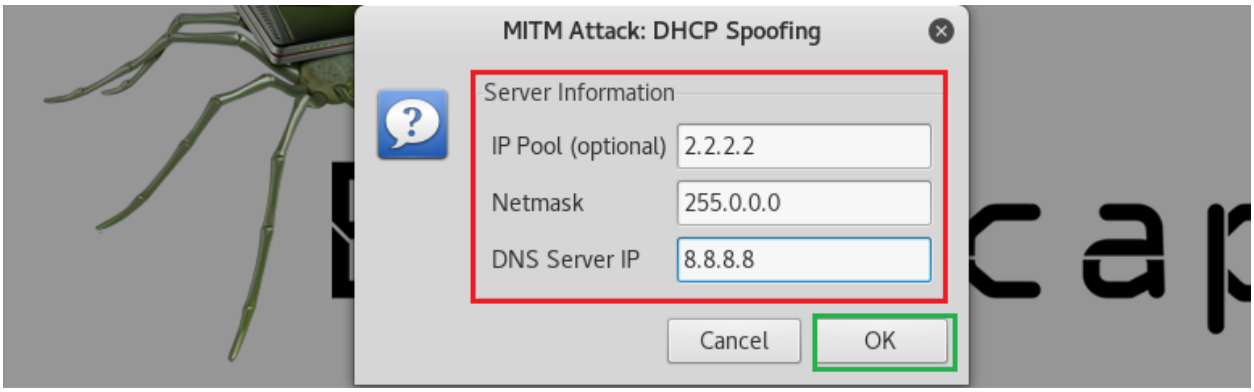
```
Client#show ip int br
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/0        192.168.1.101   YES DHCP   up                    up
FastEthernet1/0        unassigned      YES NVRAM  administratively down down
```

```
SERVER#show ip dhcp binding
Bindings from all pools not associated with VRF:
IP address          Client-ID/                Lease expiration        Type
                    Hardware address/
                    User name
192.168.1.101       0063.6973.636f.2d61.      Mar 02 2002 12:06 AM    Automatic
                    6161.612e.6161.6161.
                    2e31.3131.312d.4661.
                    302f.30
```

Rogue DHCP Server:








```
Client(config-if)#do show ip int br
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/0        2.2.2.2         YES DHCP   up                    up
FastEthernet1/0        unassigned      YES NVRAM  administratively down down
```

DHCP Snooping:

- DHCP snooping is a security feature acts like a firewall between trusted & untrusted.
- DHCP snooping is like a firewall between untrusted hosts & trusted DHCP servers.
- DHCP snooping use trusted source to reply DHCP offer message.
- DHCP snooping will drop DHCP messages from a DHCP server that is not trusted.
- DHCP snooping rate-limits DHCP traffic from trusted and untrusted sources.
- DHCP snooping keep binding database, which is untrusted hosts with leased IPs.
- DHCP snooping binding database validate subsequent requests from untrusted hosts.
- DHCP snooping Can be enable to disabled per VLAN basis.
- DHCP snooping feature is inactive on all VLANs by default,
- DHCP snooping device insert DHCP option No 82 Relay Agent Information Option.
- DHCP Snooping to prevent a man-in-the middle attack on the network.
- DHCP Snooping uses a mechanism of trusted and untrusted sources.
- DHCP Snooping is L 2 security switch feature to blocks unauthorized DHCP servers.
- DHCP snooping feature identifies Switch Ports as "trusted" and "untrusted".
- DHCP Untrusted interfaces where clients are connected cannot source DHCP messages.
- DHCP trusted interfaces where Server are connected source all types of DHCP messages.
- DHCP Snooping provides protection from DHCP starvation & Rogue DHCP Server attacks.

DHCP Snooping Configuration SW1
SW1(config)#ip dhcp snooping
SW1(config)#ip dhcp snooping vlan 1
SW1(config)#interface GigabitEthernet 0/1 SW1(config-if)#ip dhcp snooping trust
SW1(config-if)# no ip dhcp snooping information option
SW1(config)#interface GigabitEthernet 0/1 SW1(config-if)# ip dhcp snooping limit rate 100

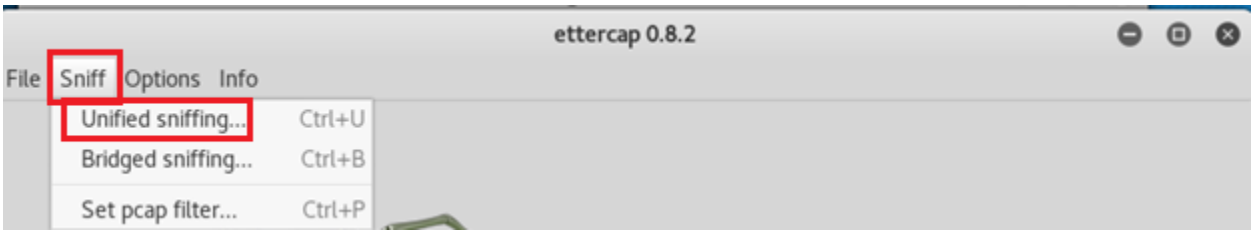
SW1(config)#interface range GigabitEthernet 0/0, GigabitEthernet 0/2
SW1(config-if)# ip dhcp snooping limit rate 20 (20 packets per second)

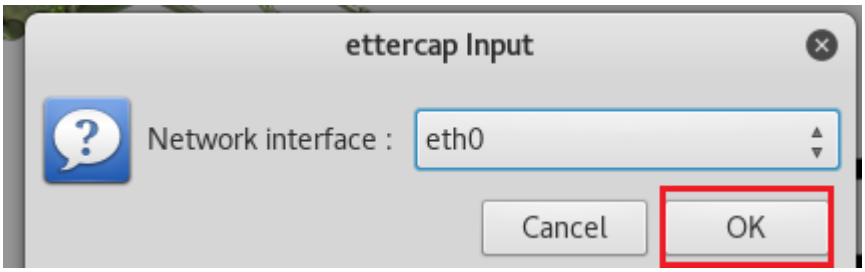
SW1# show ip dhcp snooping binding
SW1# show ip dhcp snooping
SW1# show ip dhcp snooping statistics

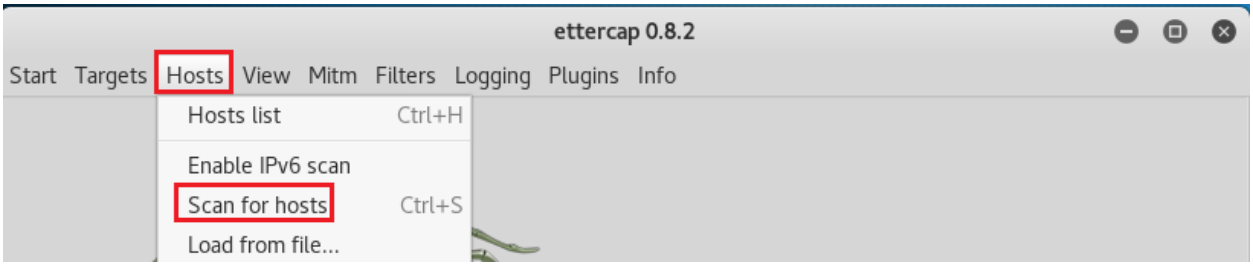
```
SW1#show ip dhcp snooping binding
MacAddress          IpAddress        Lease(sec)  Type           VLAN  Interface
------------------  ---------------  ----------  -------------  ----  --------------------
AA:AA:AA:AA:11:11   192.168.1.102    86382       dhcp-snooping  1     GigabitEthernet0/0
Total number of bindings: 1
```

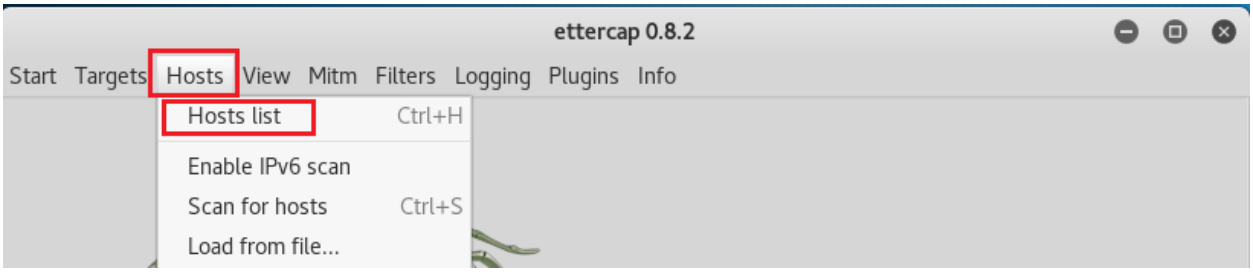
```
SW1#show ip dhcp snooping
Switch DHCP snooping is enabled
Switch DHCP gleaning is disabled
DHCP snooping is configured on following VLANs:
1
DHCP snooping is operational on following VLANs:
1
DHCP snooping is configured on the following L3 Interfaces:

Insertion of option 82 is disabled
   circuit-id default format: vlan-mod-port
   remote-id: 0c05.d1cb.9f00 (MAC)
Option 82 on untrusted port is not allowed
Verification of hwaddr field is enabled
Verification of giaddr field is enabled
DHCP snooping trust/rate is configured on the following Interfaces:

Interface                Trusted    Allow option    Rate limit (pps)
-----------------------  -------    ------------    ----------------
GigabitEthernet0/0       no         no              10
  Custom circuit-ids:
GigabitEthernet0/1       yes        yes             100
  Custom circuit-ids:
GigabitEthernet0/2       no         no              10
Interface                Trusted    Allow option    Rate limit (pps)
-----------------------  -------    ------------    ----------------
```

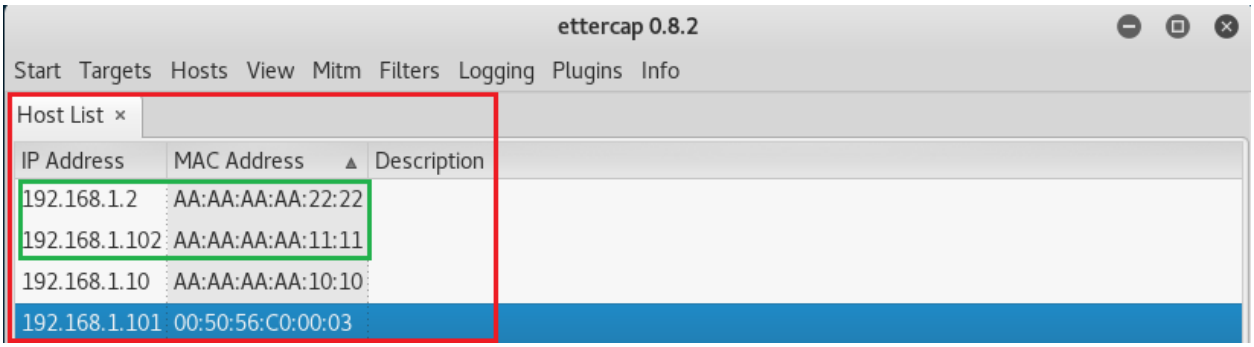
ARP Poisning or Spoofing Attack:

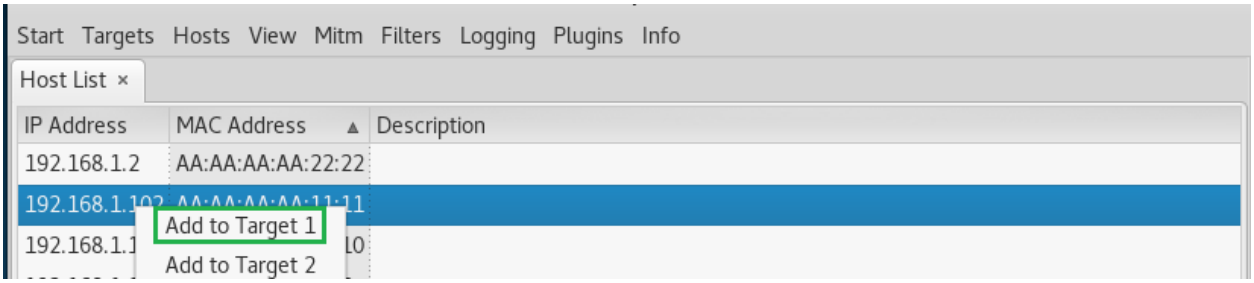


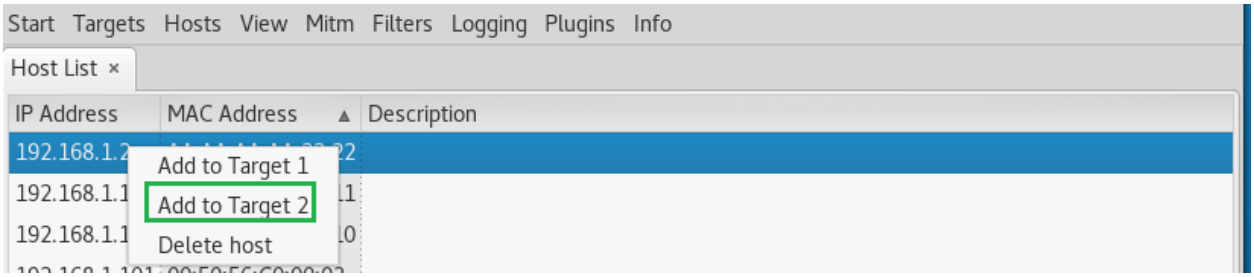


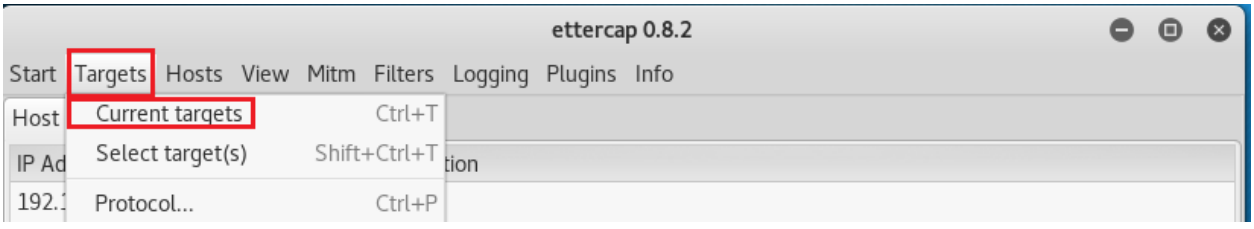


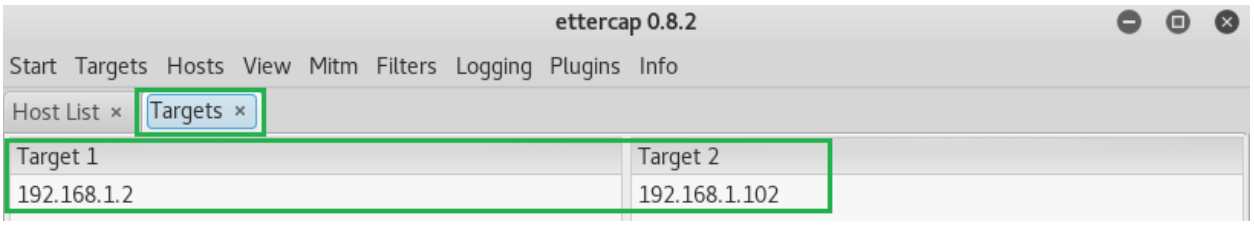

ettercap 0.8.2
Start Targets Hosts View Mitm Filters Logging Plugins Info
Hosts list Ctrl+H
Enable IPv6 scan
Scan for hosts Ctrl+S
Load from file...

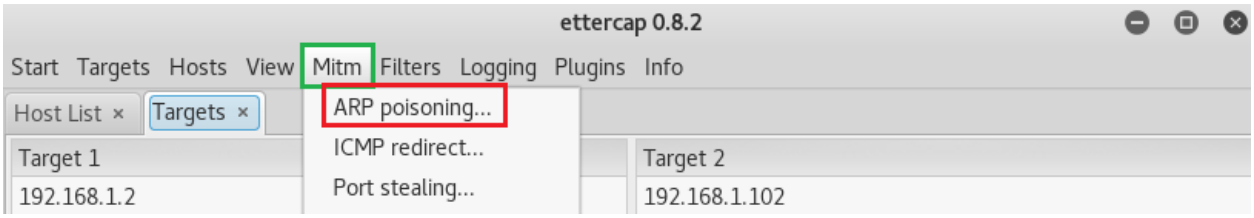

ettercap 0.8.2
Start Targets Hosts View Mitm Filters Logging Plugins Info
Host List ×
IP Address MAC Address Description
192.168.1.2 AA:AA:AA:AA:22:22
192.168.1.102 AA:AA:AA:AA:11:11
192.168.1.10 AA:AA:AA:AA:10:10
192.168.1.101 00:50:56:C0:00:03

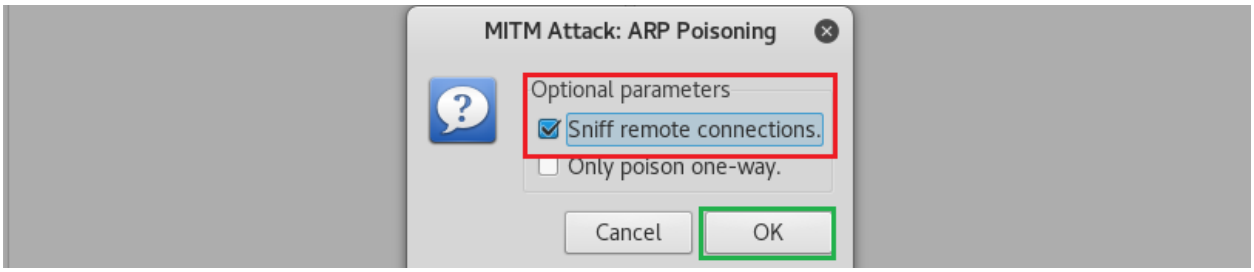

Start Targets Hosts View Mitm Filters Logging Plugins Info
Host List ×
IP Address MAC Address Description
192.168.1.2 AA:AA:AA:AA:22:22
Add to Target 1
Add to Target 2


Start Targets Hosts View Mitm Filters Logging Plugins Info
Host List ×
IP Address MAC Address Description
Add to Target 1
Add to Target 2
Delete host


ettercap 0.8.2
Start Targets Hosts View Mitm Filters Logging Plugins Info
Current targets Ctrl+T
Select target(s) Shift+Ctrl+T
Protocol... Ctrl+P








```
Client#show arp
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  192.168.1.102           -   aaaa.aaaa.1111  ARPA   FastEthernet0/0
Internet  192.168.1.3            10   000c.2968.9f3b  ARPA   FastEthernet0/0
Internet  192.168.1.2             0   000c.2968.9f3b  ARPA   FastEthernet0/0
```

```
SERVER#show arp
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  192.168.1.102           0   000c.2968.9f3b  ARPA   FastEthernet0/0
Internet  192.168.1.3            12   000c.2968.9f3b  ARPA   FastEthernet0/0
Internet  192.168.1.2             -   aaaa.aaaa.2222  ARPA   FastEthernet0/0
```

Dynamic ARP Inspection:

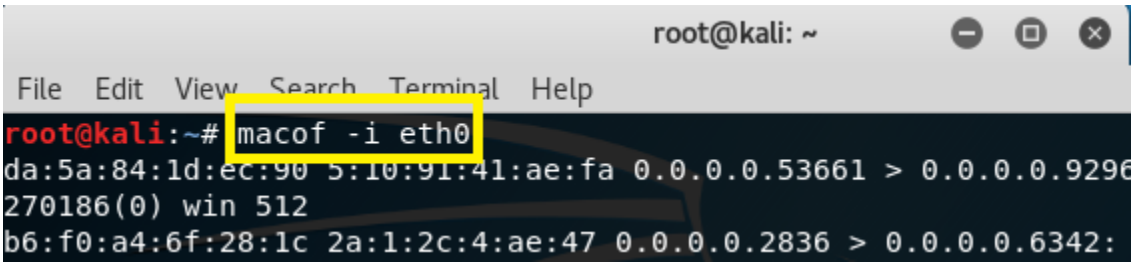
- DAI stands for Dynamic Address Resolution Protocol Inspection.
- DAI is a security feature that rejects invalid and malicious ARP packets.
- DAI feature prevent man-in-the-middle attacks such as ARP poisoning.
- DIA feature prevent man-in-the-middle attack such as ARP Spoofing.
- DAI relies on Dynamic Host Control Protocol snooping.
- DHCP snooping builds bindings' database of valid MAC address, IP & VLAN interface.
- DAI uses the DHCP snooping binding database to validate bindings.
- Dynamic ARP Inspection (DAI) verifies IPv4 address to MAC address bindings.
- If mismatch happened on untrusted port, DAI will discard spoofed ARP packets.
- Dynamic ARP Inspection (DAI) only inspects ARP packets from untrusted ports.
- Dynamic ARP Inspection (DAI) can be enabled globally per VLAN.

Dynamic ARP Inspection Configuration SW1
SW1(config)#ip dhcp snooping SW1(config)#ip dhcp snooping vlan 1 SW1(config)#interface GigabitEthernet 0/1 SW1(config-if)#ip dhcp snooping trust SW1(config-if)# no ip dhcp snooping information option SW1(config)#interface GigabitEthernet 0/1 SW1(config-if)# ip dhcp snooping limit rate 100
SW1(config)#ip arp inspection vlan 1
SW1(config)# interface GigabitEthernet 0/1 SW1(config-if)# ip arp inspection trust
SW1# show ip arp inspection

Change Client IP Address
Client(config)#interface f0/0 Client(config-if)#ip address 192.168.1.103 255.255.255.0
Client# ping 192.168.1.2
Client(config)#interface f0/0 Client(config-if)#ip address dhcp

MAC Flooding Attack:

Now Macof can flood a switch with random MAC addresses. **macof –i eth0**



Port Security:

- Port Security feature protect the switch from MAC flooding attacks.
- Port security feature protect the switch from DHCP starvation attacks.
- Attacker start flooding the switch with very large number of DHCP requests.
- Port Security prevent unauthorized access & limit access, based on MAC address.
- Port Security is disabled by default on every interface of switch.
- If Port Security is enabled by default only one MAC address is, allow per interface.
- If Port Security is enabled by default, violation is shutdown.
- If Port Security is enabled by default, no aging is configured for recovery.
- Port Security can be configure Static, Dynamic and Sticky.
- There are three different types of violation Shutdown, Protect and Restrict.
- Port Security limit (1-8192) MAC address to attach on particular port.

Port Security Violation Types:

- There are three different types of violation Shutdown, Protect and Restrict.

Shutdown:

- Default action after violation.
- Port send to err-disabled mode.
- For re-enable err-disabled recover, shutdown/no shutdown.
- MAC counter keeps history.

Protect:

- Need to configure for violation action.
- Traffic not send to network from violator.
- Interface will be working even after violation.
- No MAC counter keeps history.

Restrict:

- Need to configure for violation action.
- Traffic not send to network from violator.
- Generate log (SNMP/Syslog).
- No MAC counter keeps history.

Violation Action	Description
Protect	Discards the bogus or extra MAC address without notifying the administrator.
Restrict	Discards the bogus or extra MAC address and generates Syslog message or SNMP trap. Alert generation feature of this action makes it preferable over the aforementioned action.
Shutdown	Puts the port in err-disable state and everything is discarded. Syslog/SNMP based alert is also generated. shutdown is default violation action defined in Cisco IOS

Static:

- Static secure MAC addresses are statically configured on each switchport.
- Static secure MAC addresses are stored in the address table.
- Configuration of static secure MAC address is stored in the running configuration.
- Can be made permanent by saving them to the startup configuration.
- SW1(config-if) # switchport port-security mac-address mac-address

Dynamic:

- Dynamic secure MAC addresses are learned from device connected to switchport.
- Dynamic secure MAC addresses are stored in the address table only.
- Dynamic secure MAC addresses lost when the switchport state goes down.
- Dynamic secure MAC addresses also lost when the switch reboots.
- SW1(config-if) # switchport port-security
- By default, MAC addresses are learned on a switchport dynamically.

Sticky:

- A sticky MAC address is a hybrid between a static and dynamic MAC address.
- Dynamically learned, MAC address is automatically entered into the running configuration.
- The address is then kept in the running configuration until a reboot.
- Once the switch is reboot, the MAC address will be lost.
- To keep the MAC address across a reboot a configuration save is required.

Maximum MAC Addresses:

- By default, each secure switchport is configured with a maximum of one MAC address.
- If more than one MAC address is seen on any given port, a violation will occur.
- Maximum MAC address can be modified.

Dynamic Port Security Configuration
SW1(config)#interface g0/0 SW1(config-if)#switchport mode access SW1(config-if)#switchport port-security
SW1#show port-security
SW1#show port-security address
SW1#show port-security interface g0/0

```
SW1#show port-security
Secure Port  MaxSecureAddr  CurrentAddr  SecurityViolation  Security Action
                 (Count)       (Count)          (Count)
---------------------------------------------------------------------------
     Gi0/0              1            1                  0         Shutdown
---------------------------------------------------------------------------
Total Addresses in System (excluding one mac per port)     : 0
Max Addresses limit in System (excluding one mac per port) : 4096
```

```
SW1#show port-security address
              Secure Mac Address Table
-----------------------------------------------------------------------------
Vlan    Mac Address       Type                          Ports   Remaining Age
                                                                    (mins)
----    -----------       ----                          -----   -------------
   1    aaaa.aaaa.1111    SecureDynamic                 Gi0/0       -
-----------------------------------------------------------------------------
Total Addresses in System (excluding one mac per port)     : 0
Max Addresses limit in System (excluding one mac per port) : 4096
```

Static Port Security Configuration
SW1(config)#interface g0/0 SW1(config-if)#switchport mode access SW1(config-if)#switchport port-security SW1(config-if)#switchport port-security mac-address aaaa.aaaa.1111
SW1#show port-security
SW1#show port-security address
SW1#show port-security interface g0/0

```
SW1#show port-security
Secure Port  MaxSecureAddr  CurrentAddr  SecurityViolation  Security Action
                 (Count)       (Count)          (Count)
---------------------------------------------------------------------------
     Gi0/0              1            1                  0         Shutdown
---------------------------------------------------------------------------
Total Addresses in System (excluding one mac per port)     : 0
Max Addresses limit in System (excluding one mac per port) : 4096
```

```
SW1#show port-security address
              Secure Mac Address Table
-----------------------------------------------------------------------------
Vlan    Mac Address       Type                          Ports   Remaining Age
                                                                    (mins)
----    -----------       ----                          -----   -------------
   1    aaaa.aaaa.1111    SecureConfigured              Gi0/0       -
-----------------------------------------------------------------------------
Total Addresses in System (excluding one mac per port)     : 0
Max Addresses limit in System (excluding one mac per port) : 4096
```

Sticky Port Security Configuration
SW1(config)#interface g0/0 SW1(config-if)#switchport mode access SW1(config-if)#switchport port-security SW1(config-if)#switchport port-security mac-address sticky
SW1#show port-security
SW1#show port-security address
SW1#show port-security interface g0/0

```
SW1#show port-security address
            Secure Mac Address Table
------------------------------------------------------------------------------
Vlan    Mac Address       Type                          Ports   Remaining Age
                                                                    (mins)
----    -----------       ----                          -----   -------------
   1    aaaa.aaaa.1111    SecureSticky                  Gi0/0       -
------------------------------------------------------------------------------
Total Addresses in System (excluding one mac per port)     : 0
Max Addresses limit in System (excluding one mac per port) : 4096
```

Client(config)#interface f0/0 Client(config-if)#mac-address aaaa.aaaa.5555
SW1(config)# interface g0/0 SW1(config-if) #shutdown SW1(config-if)# no shutdown
SW1(config)#errdisable recovery cause psecure-violation SW1(config)#errdisable recovery interval 30
SW1# show interfaces status
SW1#show errdisable recovery

```
SW1(config)#
*Apr  5 17:23:19.702: %PM-4-ERR_DISABLE: psecure-violation error detected on Gi0
/0, putting Gi0/0 in err-disable state
*Apr  5 17:23:19.705: %PORT_SECURITY-2-PSECURE_VIOLATION: Security violation occ
urred, caused by MAC address aaaa.aaaa.5555 on port GigabitEthernet0/0.
```

```
SW1#   show interfaces status

Port      Name               Status       Vlan       Duplex  Speed Type
Gi0/0                        err-disabled 1            auto   auto unknown
Gi0/1                        connected    1            auto   auto unknown
Gi0/2                        connected    1            auto   auto unknown
```

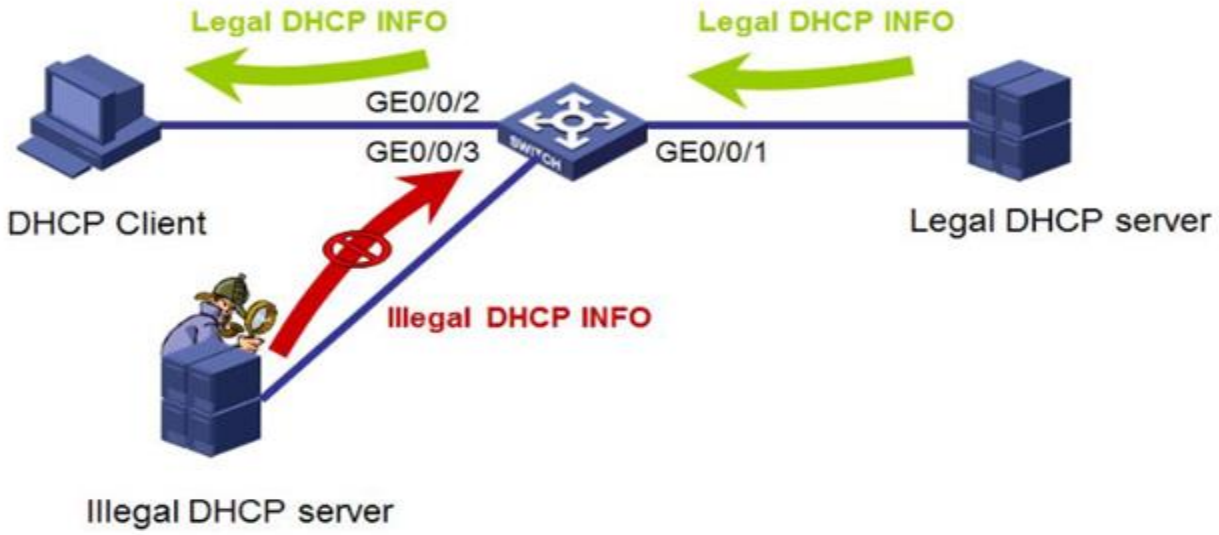
SW1(config)# interface g0/0 SW1(config-if)#switchport port-security violation restrict SW1(config-if)#switchport port-security violation protect
SW1#show port-security address
SW1#show port-security
SW1#show port-security interface g0/0

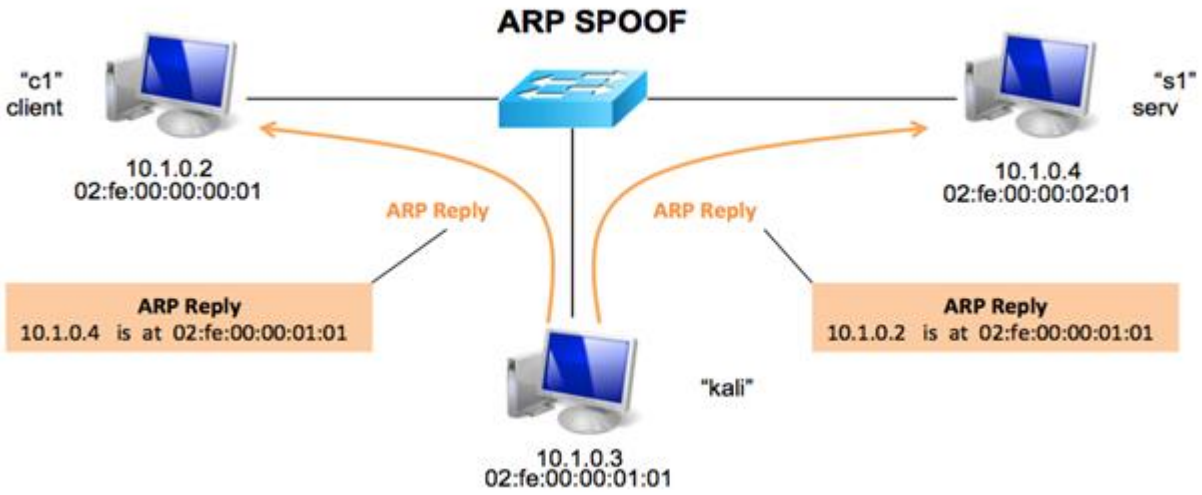
```
SW1#show port-security
Secure Port  MaxSecureAddr  CurrentAddr  SecurityViolation  Security Action
                (Count)       (Count)         (Count)
---------------------------------------------------------------------------
      Gi0/0              1            1                  0         Protect
---------------------------------------------------------------------------
Total Addresses in System (excluding one mac per port)     : 0
Max Addresses limit in System (excluding one mac per port) : 4096
```

```
SW1#show port-security
Secure Port  MaxSecureAddr  CurrentAddr  SecurityViolation  Security Action
                (Count)       (Count)         (Count)
---------------------------------------------------------------------------
      Gi0/0              1            1                  0        Restrict
---------------------------------------------------------------------------
Total Addresses in System (excluding one mac per port)     : 0
Max Addresses limit in System (excluding one mac per port) : 4096
```

Port Security Drawbacks:

- Modern hacking tools can be used to spoof MAC address & bypass this security check.
- Similarly, port security does not work with dynamically configured ports.
- Switch port needs to be in a static access or static trunk mode for port security to work.
- 802.1x is better & secure way of mitigating attacks related to layer two MAC addresses.


Legal DHCP INFO
Legal DHCP INFO
GE0/0/2
GE0/0/3
GE0/0/1
DHCP Client
Legal DHCP server
Illegal DHCP INFO
Illegal DHCP server


ARP SPOOF
"c1"
client
10.1.0.2
02:fe:00:00:00:01
"s1"
serv
10.1.0.4
02:fe:00:00:02:01
ARP Reply
ARP Reply
ARP Reply
10.1.0.4 is at 02:fe:00:00:01:01
ARP Reply
10.1.0.2 is at 02:fe:00:00:01:01
"kali"
10.1.0.3
02:fe:00:00:01:01