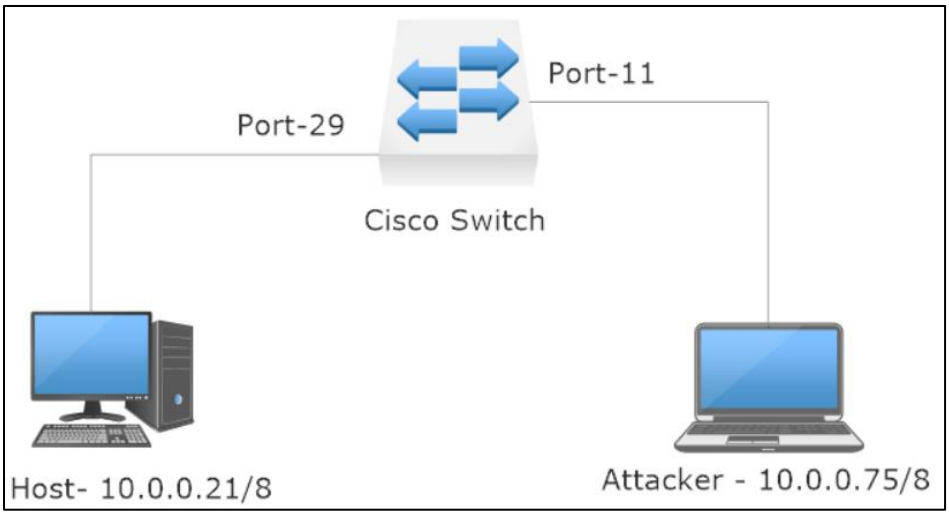
Port Security – Attack & Mitigation

Port Security – a layer 2 attack mitigation for CAM Overflow attack where the attacker, floods switch on a particular port with multiple MAC addresses to store in the CAM table which eventually fills the switch's memory and converting switch to behave like a hub.

To emulate a real-world scenario, a lab setup was created as shown below and implement both attack and its mitigation.



Below are screenshots that show both how the attacker can exploit this particular vulnerability and also how as a network administrator, one can mitigate this by deploying port security in switch.

First, we'll see how attacker can use simple Linux commands to attack and perform CAM overflow attack.

CAM Overflow attack:

```
root@kali:~# ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.0.75  netmask 255.0.0.0  broadcast 10.255.255.255
        inet6 fe80::a00:27ff:fe5b:b1a6  prefixlen 64  scopeid 0x20<link>
        ether 08:00:27:5b:b1:a6  txqueuelen 1000  (Ethernet)
        RX packets 59  bytes 4015 (3.9 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 32  bytes 2404 (2.3 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

IP of Attacker's system

```
C:\Users\Student> ipconfig

Windows IP Configuration


Ethernet adapter Ethernet 4:

   Connection-specific DNS Suffix  . :
   Link-local IPv6 Address . . . . . : fe80::4fb:c7ef:87f2:be3e%15
   IPv4 Address. . . . . . . . . . . : 10.0.0.21
   Subnet Mask . . . . . . . . . . . : 255.0.0.0
   Default Gateway . . . . . . . . . :
```

IP address of host machine

```
root@kali:~# ping 10.0.0.21
PING 10.0.0.21 (10.0.0.21) 56(84) bytes of data.
64 bytes from 10.0.0.21: icmp_seq=1 ttl=128 time=1.11 ms
64 bytes from 10.0.0.21: icmp_seq=2 ttl=128 time=1.71 ms
64 bytes from 10.0.0.21: icmp_seq=3 ttl=128 time=1.33 ms
64 bytes from 10.0.0.21: icmp_seq=4 ttl=128 time=1.62 ms
^Z
[2]+  Stopped                 ping 10.0.0.21
root@kali:~#
```

Ping successful from Attacker to host machine which proves proper switch connection

```
Microsoft Windows [Version 10.0.18363.535]
(c) 2019 Microsoft Corporation. All rights reserved.

C:\Users\Student>ping 10.0.0.75

Pinging 10.0.0.75 with 32 bytes of data:
Reply from 10.0.0.75: bytes=32 time=1ms TTL=64
Reply from 10.0.0.75: bytes=32 time=1ms TTL=64
Reply from 10.0.0.75: bytes=32 time=1ms TTL=64
Reply from 10.0.0.75: bytes=32 time=1ms TTL=64

Ping statistics for 10.0.0.75:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms
```

Same is true from other side i.e. host to attacker's machine

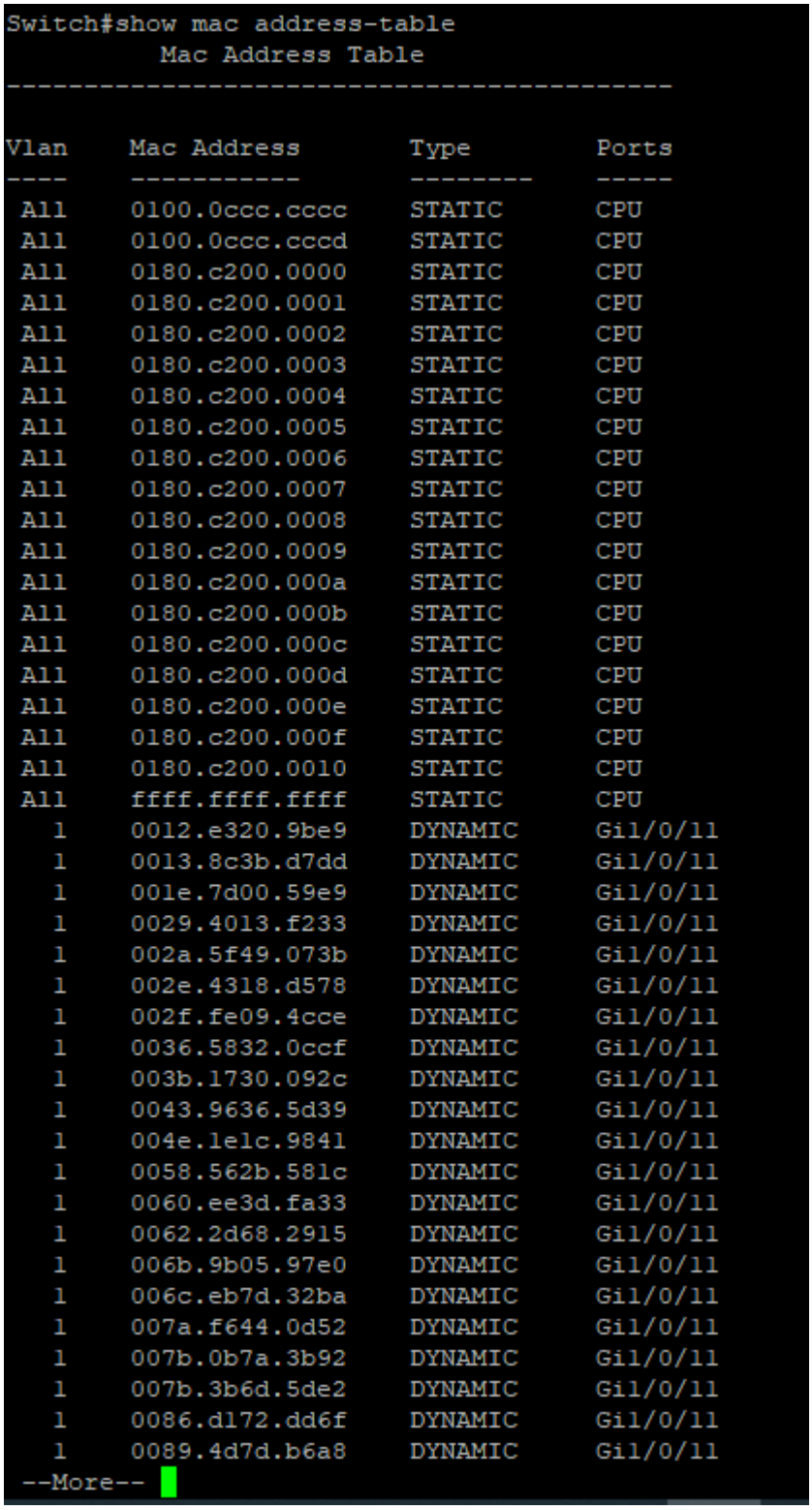
```
Switch#show mac address-table dynamic
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----
   1    0800.275b.bla6    DYNAMIC     Gi1/0/11
   1    7c8a.e10b.b13a    DYNAMIC     Gi1/0/11
   1    ecb1.d740.d7e7    DYNAMIC     Gi1/0/29
Total Mac Addresses for this criterion: 3
Switch#
```

Before attack- Switch CAM table shows 3 MAC addresses (there are 2 MAC addresses on port 11 because attacker used virtual machine)

```
root@kali:~# macof -i eth0
b5:56:67:76:e0:41 82:8e:6:4b:19:22 0.0.0.0.51089 > 0.0.0.0.60701: S 264566966:264
566966(0) win 512
f6:5d:f2:48:96:dc 90:cd:e3:62:d5:dc 0.0.0.0.11003 > 0.0.0.0.6359: S 982171557:982
171557(0) win 512
f4:2f:7e:2a:4f:c5 5f:1a:20:76:26:93 0.0.0.0.24974 > 0.0.0.0.31379: S 1911867676:1
911867676(0) win 512
36:6:43:7b:2d:88 aa:21:33:12:1:db 0.0.0.0.9145 > 0.0.0.0.29143: S 1052687993:1052
687993(0) win 512
de:b6:2e:30:20:24 51:59:79:2f:80:97 0.0.0.0.17350 > 0.0.0.0.11250: S 901803514:90
1803514(0) win 512
7e:25:38:61:2c:fe 9a:21:ab:61:35:97 0.0.0.0.17771 > 0.0.0.0.29410: S 529934310:52
9934310(0) win 512
68:66:77:7e:f5:48 66:c6:42:42:bc:98 0.0.0.0.43222 > 0.0.0.0.51120: S 750712839:75
0712839(0) win 512
d5:3d:f:36:d3:b aa:6d:85:5c:ae:fc 0.0.0.0.34706 > 0.0.0.0.26393: S 1879246613:187
9246613(0) win 512
```

Running the macof command for CAM overflow attack on switch at port 11



Above is the MAC address table after attack. Clearly, the table is being flooded with random MAC addresses on a single port. (port 11)

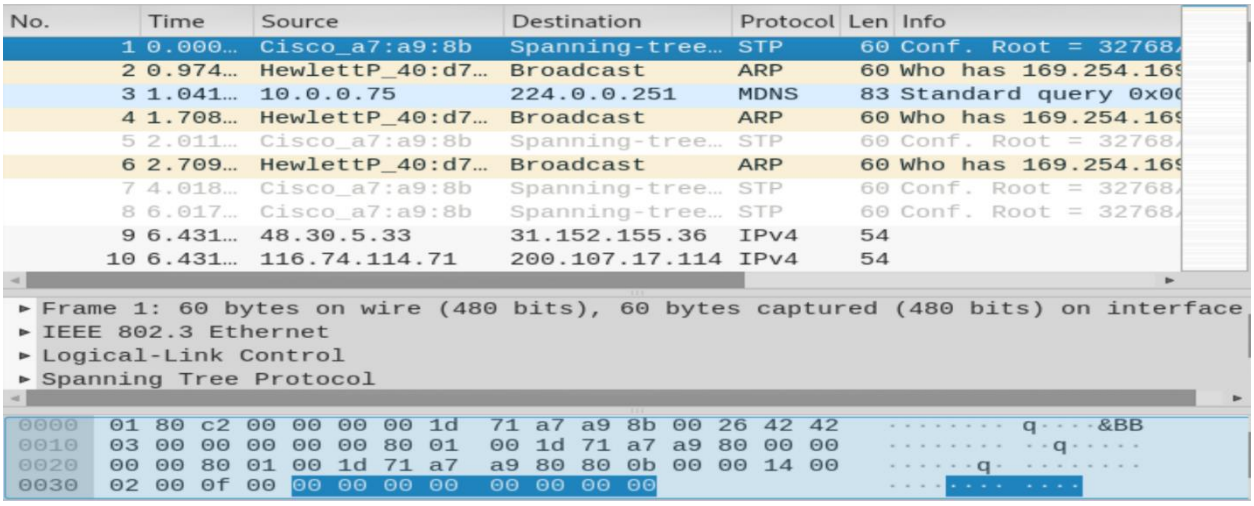
Port Security – Mitigation for CAM Overflow Attack

```
Switch#config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#int gil/0/11
Switch(config-if)#switchport mode access
Switch(config-if)#switchport port-security
Switch(config-if)#switchport port-security maximum 2
Switch(config-if)#switchport port-security mac-address sticky
Switch(config-if)#end
Switch#
*Mar  1 00:37:08.643: %SYS-5-CONFIG_I: Configured from console by console
Switch#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
Switch#
Switch#
Switch#
Switch#enable
Switch#config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#int gil/0/11
Switch(config-if)#switchport mode access
Switch(config-if)#switchport port-security
Switch(config-if)#switchport port-security violation shutdown
```

Above is the snapshot of how port security is being configured on port 11 and setting violation as shutdown. Whenever, port 11 violates port security, that port will be shutdown and the switch will no longer listen on that port.

```
Switch#show port-security
Secure Port  MaxSecureAddr  CurrentAddr  SecurityViolation  Security Action
                (Count)       (Count)          (Count)
------------------------------------------------------------------------------
   Gil/0/11              2            2                  0         Shutdown
------------------------------------------------------------------------------
Total Addresses in System (excluding one mac per port)     : 1
Max Addresses limit in System (excluding one mac per port) : 6144
Switch#
Switch#
Switch#show port-security interface gigabitethernet1/0/11
Port Security              : Enabled
Port Status                : Secure-up
Violation Mode             : Shutdown
Aging Time                 : 0 mins
Aging Type                 : Absolute
SecureStatic Address Aging : Disabled
Maximum MAC Addresses      : 2
Total MAC Addresses        : 2
Configured MAC Addresses   : 0
Sticky MAC Addresses       : 2
Last Source Address:Vlan   : 0800.275b.bla6:1
Security Violation Count   : 0
```

Here, we can see that port security is enabled and no violation has been recorded yet. We can also see what security action is set currently in case of violation. Port-status is currently up and secured. Maximum MAC addresses allowed on that port is 2.




```
1 00:44:53.439: %PM-4-ERR_DISABLE: psecure-violation error detected on Gi1/0/11, puttir
1 00:44:53.447: %PORT_SECURITY-2-PSECURE_VIOLATION: Security violation occurred, caused
1 00:44:54.445: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/11,
1 00:44:55.452: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/11, changed state to down
```

When the attacker's machine executed macof command again, this time attack was successfully mitigated and wireshark captures show that how random mac addresses were flooded onto the switch through a single port.

Above, is the system log message that was generated due to security violation on port 11. The port went under err-disabled state and port 11 status was changed to down.

Below is the capture of port security status after the attack.

```
Switch#show port-security
Secure Port  MaxSecureAddr  CurrentAddr  SecurityViolation  Security Action
                (Count)       (Count)          (Count)
---------------------------------------------------------------------------
   Gi1/0/11              2            2                  1         Shutdown
---------------------------------------------------------------------------
Total Addresses in System (excluding one mac per port)     : 1
Max Addresses limit in System (excluding one mac per port) : 6144
Switch#
Switch#
Switch#
Switch#show port-security interface gigabitethernet1/0/11
Port Security              : Enabled
Port Status                : Secure-shutdown
Violation Mode             : Shutdown
Aging Time                 : 0 mins
Aging Type                 : Absolute
SecureStatic Address Aging : Disabled
Maximum MAC Addresses      : 2
Total MAC Addresses        : 2
Configured MAC Addresses   : 0
Sticky MAC Addresses       : 2
Last Source Address:Vlan   : faf6.974e.e43f:1
Security Violation Count   : 1
```

We can see that security violation count is 1 now and port status is secure-shutdown.

```
Switch#show interfaces status err-disabled

Port      Name               Status       Reason              Err-disabled Vlans
Gi1/0/11                     err-disabled psecure-violation
Switch#
```

We can also see what interfaces ae under err-disabled state, the reason for err-disabled is also listed as psecure-violation.

Conclusion:

The port status can be changed back to normal after running “shut”, “no shut” command from the network administrator. This successfully demonstrates how in real life we can mitigate such CAM overflow attacks. The switch functionality is not hampered and attacker cannot disrupt the flow of traffic.