

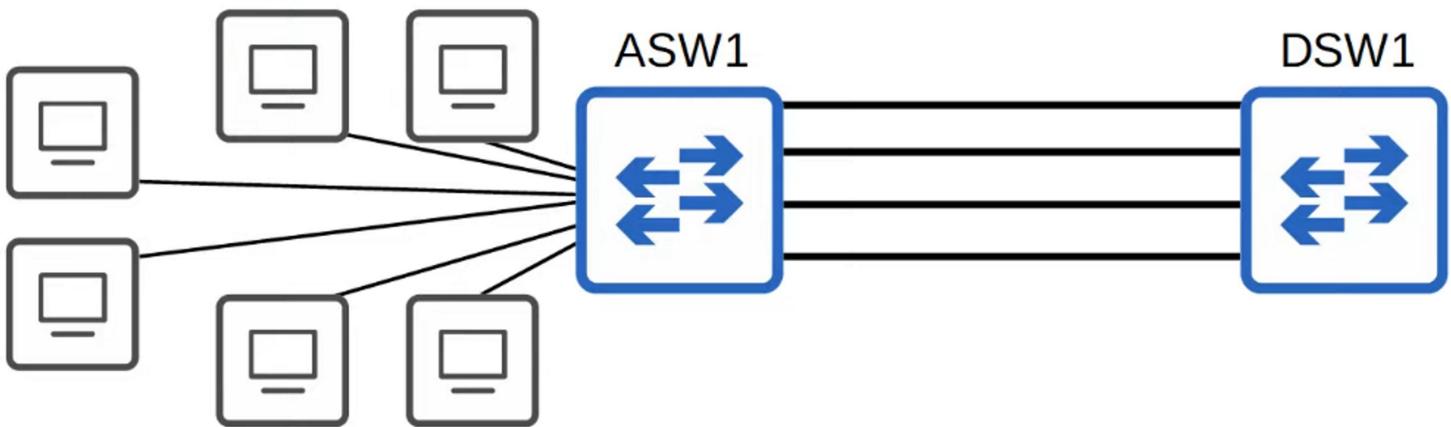
## ETHERCHANNEL

### WHAT IS ETHERCHANNEL?

ETHERCHANNEL allows you to GROUP multiple physical INTERFACES into a group which operates as a SINGLE LOGICAL INTERFACE - so they BEHAVE as if they are a single INTERFACE

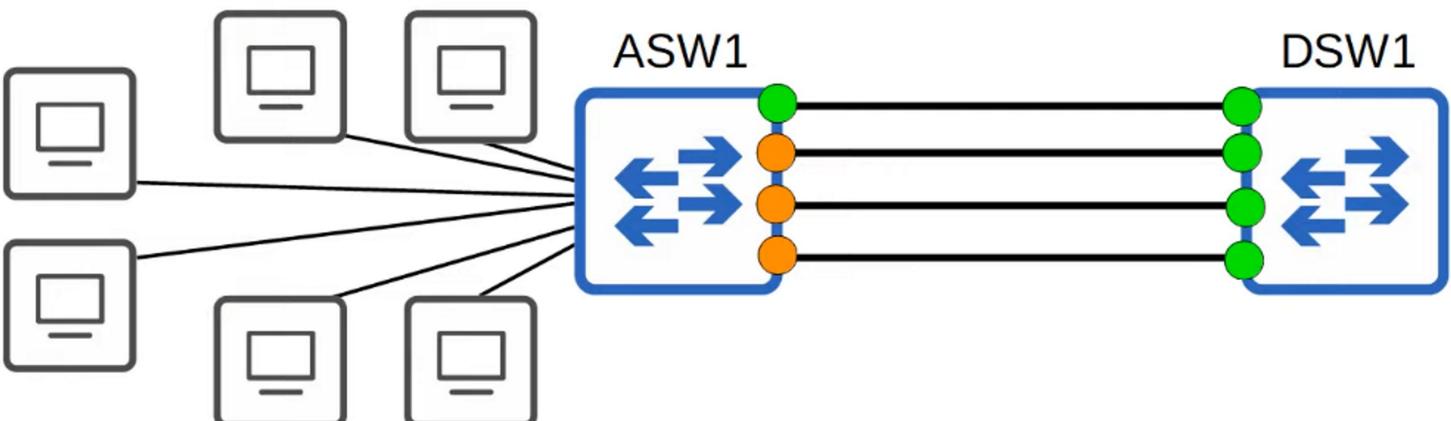
A LAYER 2 ETHERCHANNEL is a group of SWITCH PORTS which operate as a SINGLE INTERFACE

A LAYER 3 ETHERCHANNEL is a group of ROUTED PORTS which operate as a SINGLE INTERFACE which you assign an IP ADDRESS to.



When the bandwidth of the INTERFACES connected to END HOSTS is greater than the bandwidth of the connection to the DISTRIBUTION SWITCH(es), this is called OVERSUBSCRIPTION.

Some OVERSUBSCRIPTION is acceptable, but too much will cause congestion.

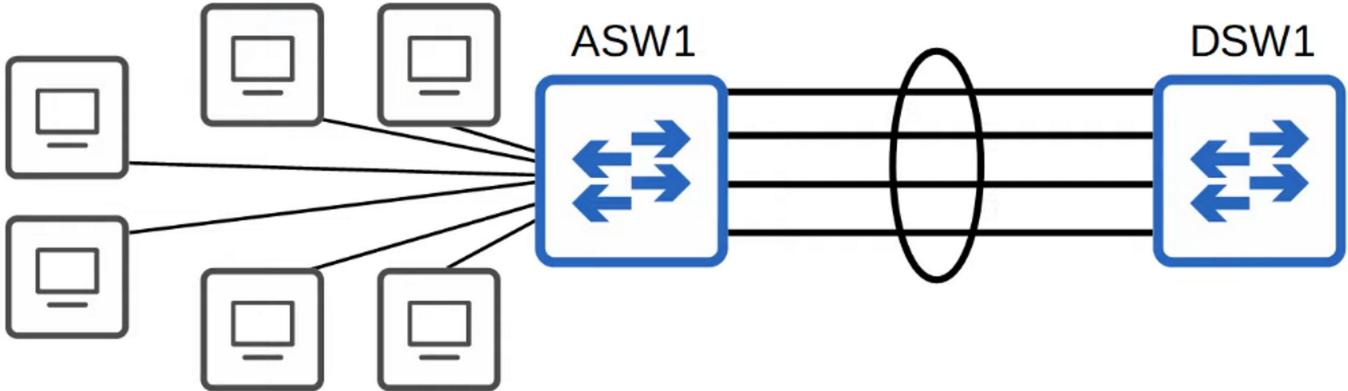


- If you connect TWO SWITCHES together with multiple links, ALL except ONE will be DISABLED by SPANNING TREE PROTOCOL (Green Lights vs. Orange Lights above on ASW1)

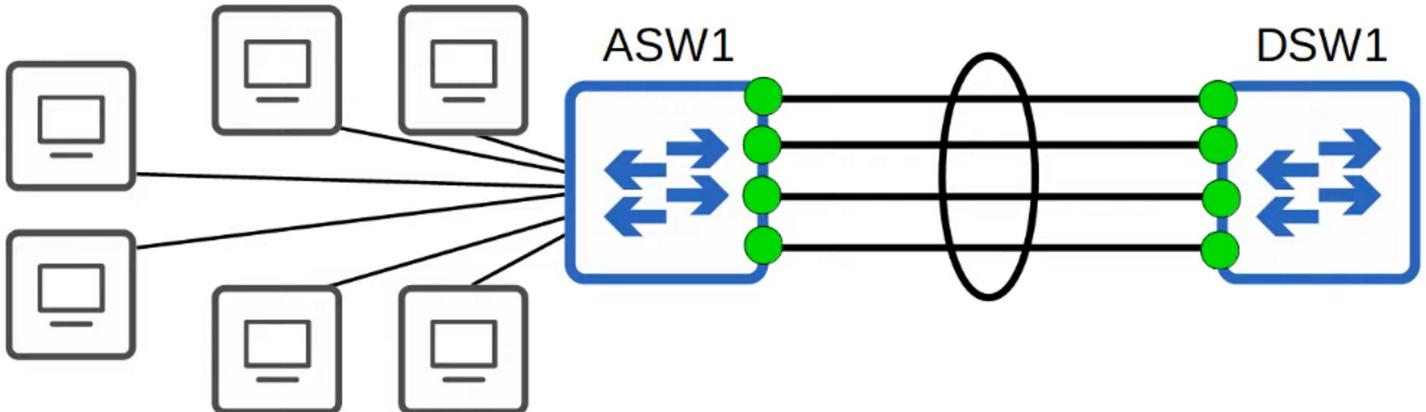
## WHY?

- If ALL of ASW1's INTERFACES were FORWARDING, LAYER 2 LOOPS would form between ASW1 and DSW1, leading to a BROADCAST STORM (Bad!)
- Other links will be unused unless the active link fails. In that case, one of the inactive link will start forwarding.

An ETHERCHANNEL (in network topology diagrams) is represented like THIS (circle around multi-connections)



- ETHERCHANNEL groups multiple channels together to act as a SINGLE INTERFACE
- STP will treat this GROUP as a SINGLE INTERFACE



(All INTERFACES Green!)

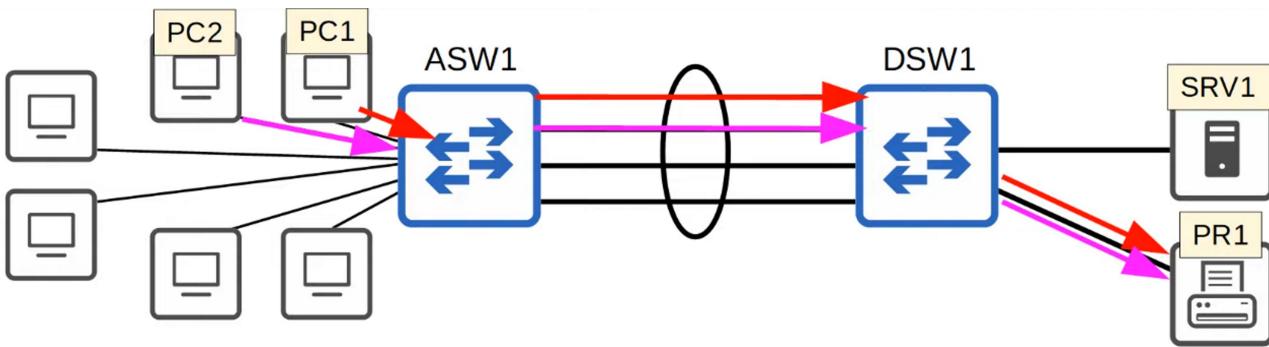
TRAFFIC using ETHERCHANNEL will be load-balanced among the physical INTERFACES in the group.

An algorithm is used to determine WHICH TRAFFIC will use WHICH physical INTERFACE (more details later)

Some other names for an ETHERCHANNEL are:

- PORT CHANNEL
- LAG (Link Aggregation Group)

HOW DOES AN ETHERCHANNEL LOAD-BALANCE?



- ETHERCHANNEL load-balances based on “flows”
- A “flow” is a communication between TWO NODES in the NETWORK
- FRAMES in the same “flow” will be FORWARDED using the SAME physical INTERFACE
- If FRAMES in the same “flow” were FORWARDED using different physical INTERFACES, some FRAMES may arrive at the DESTINATION out of order/sequence, which can cause problems.
- You can CHANGE the INPUTS used in the INTERFACE SELECTION calculation (for “flows”)
  - **INPUTS that can be used:**
    - SOURCE MAC ADDRESS
    - DESTINATION MAC ADDRESS
    - SOURCE and DESTINATION MAC ADDRESS
    - SOURCE IP ADDRESS
    - DESTINATION IP ADDRESS
    - SOURCE and DESTINATION IP ADDRESS

How to see the configuration for LOAD-BALANCING method

```
ASW1#show etherchannel load-balance
EtherChannel Load-Balancing Configuration:
  src-dst-ip

EtherChannel Load-Balancing Addresses Used Per-Protocol:
Non-IP: Source XOR Destination MAC address
  IPv4: Source XOR Destination IP address
  IPv6: Source XOR Destination IP address
```

How to CHANGE the LOAD-BALANCING method

```
ASW1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ASW1(config)#port-channel load-balance src-dst-mac
ASW1(config)#do show etherchannel load-balance
EtherChannel Load-Balancing Configuration:
    src-dst-mac

EtherChannel Load-Balancing Addresses Used Per-Protocol:
Non-IP: Source XOR Destination MAC address
    IPv4: Source XOR Destination MAC address
    IPv6: Source XOR Destination MAC address

ASW1(config)#
```

```
ASW1(config)#port-channel load-balance ?
    dst-ip          Dst IP Addr
    dst-mac         Dst Mac Addr
    src-dst-ip     Src XOR Dst IP Addr
    src-dst-mac   Src XOR Dst Mac Addr
    src-ip          Src IP Addr
    src-mac         Src Mac Addr

ASW1(config)#port-channel load-balance
```

## HOW TO CONFIGURE LAYER 2 / LAYER 3 ETHERCHANNELS

There are THREE methods of ETHERCHANNEL configuration on Cisco SWITCHES

### PAgP (Port Aggregation Protocol)

- Cisco proprietary protocol
- Dynamically negotiates the creation/maintenance of the ETHERCHANNEL (like DTP does for trunks)

### LACP (Link Aggregation Control Protocol)

- Industry standard protocol (IEEE 802.3ad)
- Dynamically negotiates the creation/maintenance of the ETHERCHANNEL (like DTP does for trunks)

### Static EtherChannel

- A protocol isn't used to determine if an EtherChannel should be formed

- Interfaces are statically configured to form an EtherChannel  
Up to 8 INTERFACES can be formed into a single ETHERCHANNEL (LACP allows up to 16 but only 8 will be ACTIVE, the other 8 will be in STANDBY mode, waiting for an active INTERFACE to fail)

## PAgP CONFIGURATION

```
ASW1(config)#interface range g0/0 - 3
ASW1(config-if-range)#channel-group 1 mode ?
  active    Enable LACP unconditionally
  auto      Enable PAgP only if a PAgP device is detected
  desirable  Enable PAgP unconditionally
  on        Enable Etherchannel only
  passive   Enable LACP only if a LACP device is detected

ASW1(config-if-range)#channel-group 1 mode desirable
Creating a port-channel interface Port-channel 1
```

💡 NOTE that “auto” and “desirable” are the ONLY available modes for PAgP

auto + auto = no EtherChannel  
desirable + auto = EtherChannel  
desirable + desirable = EtherChannel

PAgP negotiations to form an ETHERCHANNEL

💡 AWS1(config-if-range)# channel-group 1 mode desirable. Creating a port-channel interface Port-channel1

Shows up in the interface as “Port-channel1”

```

ASW1(config)#do show ip interface brief
Interface          IP-Address      OK? Method Status      Protocol
GigabitEthernet0/0 unassigned      YES unset up        up
GigabitEthernet0/1 unassigned      YES unset up        up
GigabitEthernet0/2 unassigned      YES unset up        up
GigabitEthernet0/3 unassigned      YES unset up        up
GigabitEthernet1/0 unassigned      YES unset up        up
GigabitEthernet1/1 unassigned      YES unset up        up
GigabitEthernet1/2 unassigned      YES unset up        up
GigabitEthernet1/3 unassigned      YES unset up        up
GigabitEthernet2/0 unassigned      YES unset up        up
GigabitEthernet2/1 unassigned      YES unset up        up
GigabitEthernet2/2 unassigned      YES unset up        up
GigabitEthernet2/3 unassigned      YES unset up        up
GigabitEthernet3/0 unassigned      YES unset up        up
GigabitEthernet3/1 unassigned      YES unset up        up
GigabitEthernet3/2 unassigned      YES unset up        up
GigabitEthernet3/3 unassigned      YES unset up        up
Port-channel1      unassigned      YES unset up        up
ASW1(config)#

```

The “channel-group” number has to MATCH for member INTERFACES on the same SWITCH.

It DOESN’T have to MATCH the “channel-group” number on the OTHER SWITCH!

 (channel-group 1 on AWS1 can form an ETHERCHANNEL with channel-group 2 on DSW1)

## LACP CONFIGURATION

```

ASW1(config-if-range)#channel-group 1 mode ?
  active    Enable LACP unconditionally
  auto     Enable PAgP only if a PAgP device is detected
  desirable  Enable PAgP unconditionally
  on       Enable Etherchannel only
  passive   Enable LACP only if a LACP device is detected

```

```

ASW1(config-if-range)#channel-group 1 mode active
Creating a port-channel interface Port-channel 1

```

 NOTE that “active” and “passive” are the ONLY available modes for LACP

**passive + passive = no EtherChannel**  
**active + passive = EtherChannel**  
**active + active = EtherChannel**

LACP negotiations for form an ETHERCHANNEL

The “channel-group” number has to MATCH for member INTERFACES on the same SWITCH.

It DOESN'T have to MATCH the "channel-group" number on the OTHER SWITCH!

💡 (channel-group 1 on AWS1 can form an ETHERCHANNEL with channel-group 2 on DSW1)

## STATIC ETHERCHANNEL CONFIGURATION

```
ASW1(config-if-range)#channel-group 1 mode ?
  active    Enable LACP unconditionally
  auto      Enable PAgP only if a PAgP device is detected
  desirable Enable PAgP unconditionally
  on        Enable Etherchannel only
  passive   Enable LACP only if a LACP device is detected

ASW1(config-if-range)#channel-group 1 mode on
Creating a port-channel interface Port-channel 1
```

💡 NOTE that "on" is the ONLY available mode for STATIC ETHERCHANNEL

ON mode only works with ON Mode

ON + desirable = DOES NOT WORK)

ON + active = DOES NOT WORK

## HOW TO MANUALLY CONFIGURE THE NEGOTIATION PROTOCOL

```
ASW1(config-if-range)#channel-protocol ?
  lacp  Prepare interface for LACP protocol
  pagp Prepare interface for PAgP protocol

ASW1(config-if-range)#channel-protocol lacp
ASW1(config-if-range)#channel-group 1 mode desirable
Command rejected (Channel protocol mismatch for interface Gi0/0 in group 1): the interface can not be added to the channel group

% Range command terminated because it failed on GigabitEthernet0/0
ASW1(config-if-range)#channel-group 1 mode on
Command rejected (Channel protocol mismatch for interface Gi0/0 in group 1): the interface can not be added to the channel group

% Range command terminated because it failed on GigabitEthernet0/0
ASW1(config-if-range)#channel-group 1 mode active
Creating a port-channel interface Port-channel 1

ASW1(config-if-range)#[
```

TWO OPTIONS:

- LACP Protocol
- PAgP Protocol

(Above shows a protocol mismatch error because LACP does not support "desirable" - only PAgP does)

("channel-group 1 mode active" works because LACP supports "active")

## AFTER CONFIGURING THE ETHERCHANNEL MODE

### CONFIGURING THE PORT INTERFACE

```
ASW1(config)#interface port-channel 1
ASW1(config-if)#switchport trunk encapsulation dot1q
ASW1(config-if)#switchport mode trunk
ASW1(config-if)#do show interfaces trunk

Port      Mode          Encapsulation  Status        Native vlan
Po1       on           802.1q        trunking     1

Port      Vlans allowed on trunk
Po1       1-4094

Port      Vlans allowed and active in management domain
Po1       1

Port      Vlans in spanning tree forwarding state and not pruned
Po1       none
```

“show running-config” shows “interface Port-channel1” in the configuration

```
interface Port-channel1
  switchport trunk encapsulation dot1q
  switchport mode trunk
!
interface GigabitEthernet0/0
  switchport trunk encapsulation dot1q
  switchport mode trunk
  media-type rj45
  negotiation auto
  channel-protocol lacp
  channel-group 1 mode active
!
interface GigabitEthernet0/1
  switchport trunk encapsulation dot1q
  switchport mode trunk
  media-type rj45
  negotiation auto
  channel-protocol lacp
  channel-group 1 mode active
!
interface GigabitEthernet0/2
  switchport trunk encapsulation dot1q
  switchport mode trunk
  media-type rj45
  negotiation auto
  channel-protocol lacp
  channel-group 1 mode active
!
interface GigabitEthernet0/3
  switchport trunk encapsulation dot1q
  switchport mode trunk
  media-type rj45
  negotiation auto
  channel-protocol lacp
  channel-group 1 mode active
!
```

 NOTE the PHYSICAL INTERFACES (g0/0-g0/3) were auto-configured by the Port-channel1 configuration!

### IMPORTANT NOTES ABOUT ETHERCHANNEL CONFIGURATION

- Member INTERFACES must have matching CONFIGURATIONS
  - Same DUPLEX (Full / Half)
  - Same SPEED
  - Same SWITCHPORT mode (Access / Trunk)
  - Same allowed VLANs / Native VLAN (for TRUNK interfaces)
- If an INTERFACE's configurations do NOT MATCH the others, it will be EXCLUDED from the ETHERCHANNEL

## VERIFYING STATUS OF ETHERCHANNEL

 “show etherchannel summary”

```
ASW1#show etherchannel summary
Flags: D - down      P - bundled in port-channel
      I - stand-alone S - suspended
      H - Hot-standby (LACP only)
      R - Layer3      S - Layer2
      U - in use       N - not in use, no aggregation
      f - failed to allocate aggregator

      M - not in use, minimum links not met
      m - not in use, port not aggregated due to minimum links not met
      u - unsuitable for bundling
      w - waiting to be aggregated
      d - default port

      A - formed by Auto LAG

Number of channel-groups in use: 1
Number of aggregators: 1

Group  Port-channel  Protocol    Ports
-----+-----+-----+
1      Po1(SU)       LACP        Gi0/0(P)   Gi0/1(P)   Gi0/2(P)
                                Gi0/3(P)
```

NOTE information at bottom. (“SU” means S - Layer2 + U - in use)

Protocol = What protocol the Etherchannel is using (in this case, LACP)

“Ports” = the list of interfaces in the EtherChannel (P = bundled in port-channel)

OTHER FLAGS

```

ASW1(config)#interface po1
ASW1(config-if)#shutdown
ASW1(config-if)#do show etherchannel summary
Flags: D - down P - bundled in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use N - not in use, no aggregation
f - failed to allocate aggregator

M - not in use, minimum links not met
m - not in use, port not aggregated due to minimum links not met
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

A - formed by Auto LAG

Number of channel-groups in use: 1
Number of aggregators: 1

Group Port-channel Protocol Ports
-----+-----+-----+
1     Po1(SD)      LACP    Gi0/0(D)  Gi0/1(D)  Gi0/2(D)
                                         Gi0/3(D)

```

“D” = Down

```

ASW1(config)#interface g0/0
ASW1(config-if)#switchport mode access
ASW1(config-if)#do show etherchannel summary
Flags: D - down P - bundled in port-channel
I - stand-alone S - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use N - not in use, no aggregation
f - failed to allocate aggregator

M - not in use, minimum links not met
m - not in use, port not aggregated due to minimum links not met
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

A - formed by Auto LAG

Number of channel-groups in use: 1
Number of aggregators: 1

Group Port-channel Protocol Ports
-----+-----+-----+
1     Po1(SU)      LACP    Gi0/0(s)  Gi0/1(P)  Gi0/2(P)
                                         Gi0/3(P)

```

Changing one of the Member interfaces using “switchport mode access” has made it different than the other members so it is now appearing as “s” = suspended

Another useful command

 “show etherchannel port-channel”

```

ASW1#show etherchannel port-channel
  Channel-group listing:
  -----
  Group: 1
  -----
    Port-channels in the group:
  -----
  Port-channel: Po1    (Primary Aggregator)
  -----
  Age of the Port-channel = 0d:00h:36m:48s
  Logical slot/port = 16/0      Number of ports = 4
  HotStandBy port = null
  Port state = Port-channel Ag-Inuse
  Protocol = LACP
  Port security = Disabled

  Ports in the Port-channel:
  Index Load Port EC state No of bits
  -----+-----+-----+-----+
  0     00 Gi0/0 Active   0
  0     00 Gi0/1 Active   0
  0     00 Gi0/2 Active   0
  0     00 Gi0/3 Active   0

  Time since last port bundled: 0d:00h:00m:02s Gi0/0
  Time since last port Un-bundled: 0d:00h:08m:42s Gi0/0

```

💡 “show spanning-tree” will show the single EtherChannel port interface

```

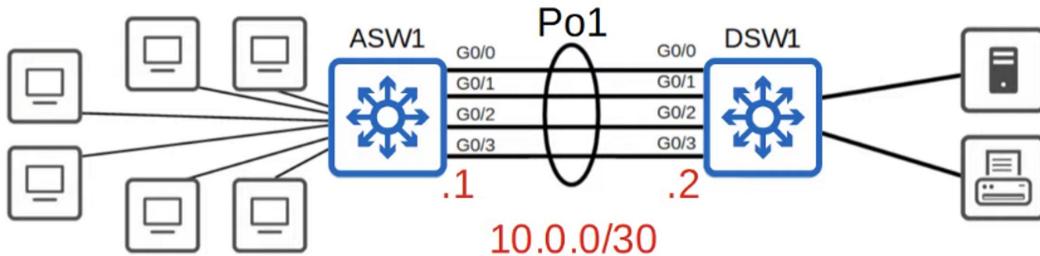
ASW1#show spanning-tree
VLAN0001
  Spanning tree enabled protocol rstp
  Root ID  Priority 32769
            Address 0c04.cf10.ea00
            This bridge is the root
            Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

  Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
            Address 0c04.cf10.ea00
            Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
            Aging Time 300 sec

  Interface Role Sts Cost Prio.Nbr Type
  Po1       Desg FWD 3    128.65 Shr

```

## LAYER 3 ETHERCHANNELS



HOW TO CONFIGURE A LAYER 3 ETHERCHANNEL (from a clean configuration)

```

ASW1(config)#int range g0/0 - 3
ASW1(config-if-range)#no switchport
ASW1(config-if-range)#channel-group 1 mode active
Creating a port-channel interface Port-channel 1

```

💡 “show running-config”

```
interface Port-channel1
  no switchport
  no ip address
!
interface GigabitEthernet0/0
  no switchport
  no ip address
  negotiation auto
  channel-group 1 mode active
!
interface GigabitEthernet0/1
  no switchport
  no ip address
  negotiation auto
  channel-group 1 mode active
!
interface GigabitEthernet0/2
  no switchport
  no ip address
  negotiation auto
  channel-group 1 mode active
!
interface GigabitEthernet0/3
  no switchport
  no ip address
  negotiation auto
  channel-group 1 mode active
!
```

NOTE : No SWITCHPORT and NO IP INTERFACE.

Where do we configure the IP Address? Directly on the PORT INTERFACE !

```
ASW1(config-if-range)#int po1
ASW1(config-if)#ip address 10.0.0.1 255.255.255.252
ASW1(config-if)#[REDACTED]
```

```

ASW1(config-if)#do sh etherch sum
Flags: D - down      P - bundled in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3       S - Layer2
U - in use        N - not in use, no aggregation
f - failed to allocate aggregator

M - not in use, minimum links not met
m - not in use, port not aggregated due to minimum links not met
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

A - formed by Auto LAG

Number of channel-groups in use: 1
Number of aggregators:          1

Group Port-channel Protocol Ports
-----+-----+-----+
1     Po1(RU)      LACP    Gi0/0(P)   Gi0/1(P)   Gi0/2(P)
                                Gi0/3(P)

```

("RU" - "R" = Layer 3, "U" = in use)

```

ASW1#show ip interface brief
Interface          IP-Address      OK? Method Status      Protocol
GigabitEthernet0/0 unassigned      YES manual up       up
GigabitEthernet0/1 unassigned      YES manual up       up
GigabitEthernet0/2 unassigned      YES manual up       up
GigabitEthernet0/3 unassigned      YES manual up       up
GigabitEthernet1/0 unassigned      YES unset  up       up
GigabitEthernet1/1 unassigned      YES unset  up       up
GigabitEthernet1/2 unassigned      YES unset  up       up
GigabitEthernet1/3 unassigned      YES unset  up       up
GigabitEthernet2/0 unassigned      YES unset  up       up
GigabitEthernet2/1 unassigned      YES unset  up       up
GigabitEthernet2/2 unassigned      YES unset  up       up
GigabitEthernet2/3 unassigned      YES unset  up       up
GigabitEthernet3/0 unassigned      YES unset  up       up
GigabitEthernet3/1 unassigned      YES unset  up       up
GigabitEthernet3/2 unassigned      YES unset  up       up
GigabitEthernet3/3 unassigned      YES unset  up       up
Port-channel1      10.0.0.1       YES NVRAM up       up
ASW1#

```

## COMMANDS LEARNED IN THIS CHAPTER

**SW(config) port-channel load-balance \*mode\***

Configures the EtherChannel load-balancing method on a SWITCH

**SW# show etherchannel load-balance**

Displays information about the load-balancing settings

**SW(config-if)# channel-group \*number\* mode {desirable | auto | active | passive | on}**

Configures an interface to be PART of an EtherChannel

**SW# show etherchannel summary**

Displays a summary of EtherChannels on a SWITCH

SW# show etherchannel port-channel

Displays information about the virtual port-channel interfaces on a SWITCH

SwitchA	SwitchB	off	auto	desirable	passive	active	on
off	off	NO	NO	NO	NO	NO	NO
auto	off	NO	NO	PAgP	NO	NO	NO
desirable	off	NO	PAgP	PAgP	NO	NO	NO
passive	off	NO	NO	NO	NO	LACP	NO
active	off	NO	NO	NO	LACP	LACP	NO
on	off	NO	NO	NO	NO	NO	ON