bitDegree.ca

11W NET3011

CCNP SWITCH – Chapter 2

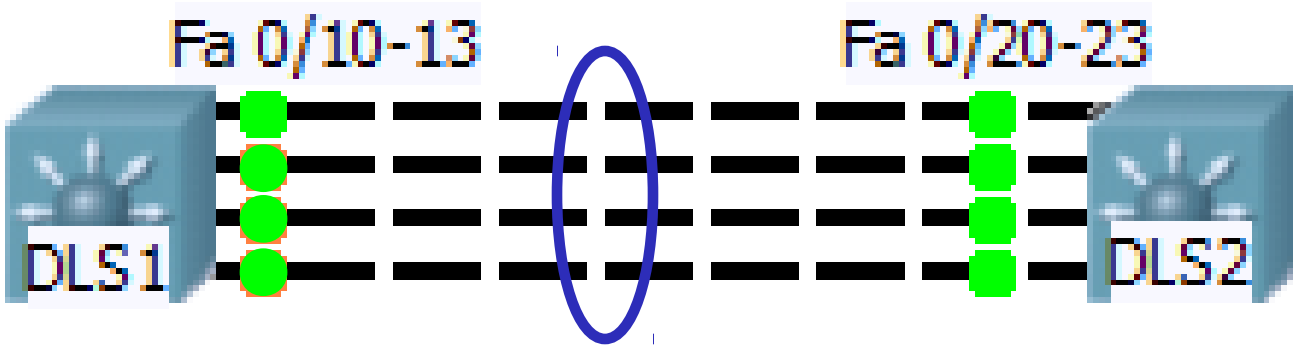
Port Aggregation (EtherChannel)

David Bray

brayd@algonquincollege.com

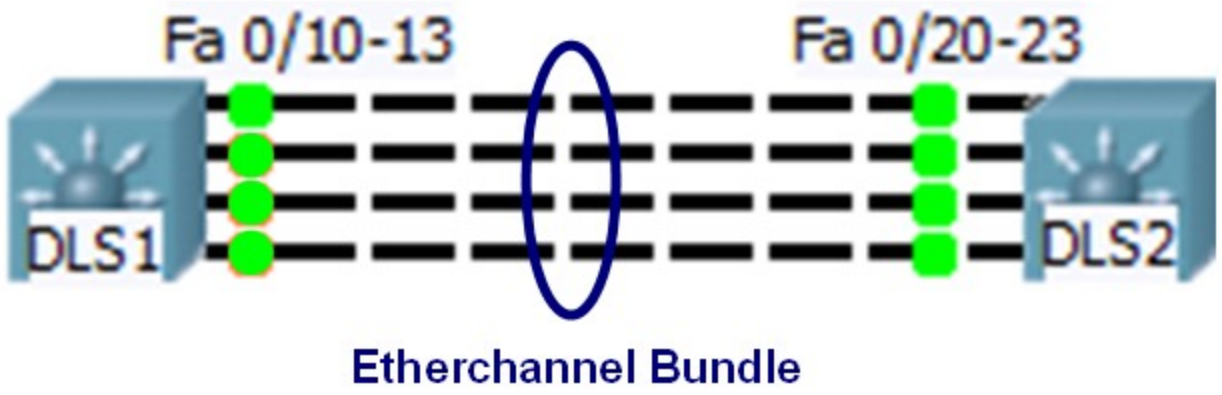
with contributions obtained from Rick Graziani & Cisco

Spanning Tree and EtherChannel



- Spanning Tree only allows a single link between switches to prevent bridging loops – this forces some links to be idle.
- Cisco's **EtherChannel** technology allows for the scaling of link bandwidth by aggregating or *bundling* parallel links.
  - Treated as a single, logical link.
  - A single **fatter** Access or Trunk link.
  - Allows you to expand the link's capacity without having to purchase new hardware (modules, devices).
  - Provides fuller use of existing hardware & links.
- Once configured, this creates a logical interface of type **port-channel**.

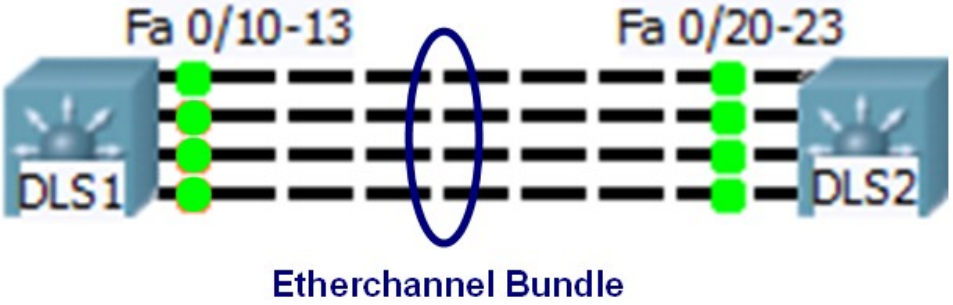
EtherChannel



- EtherChannel allows for two to eight links (*aggregate FDX rating*).
  - Fast Ethernet (FE) → Fast EtherChannel (*Up to 1600 Mbps*)
  - Gigabit Ethernet (GE) → Gigabit EtherChannel (*Up to 16 Gbps*)
  - 10-Gigabit Ethernet (10GE) → 10 Gigabit EtherChannel (*Up to 160 Gbps*)

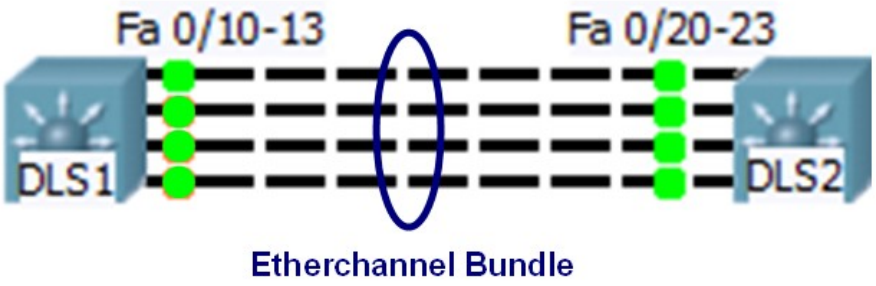
- This does not mean the total bandwidth of the bundle equals the sum of the links.
  - The load is not always distributed evenly (coming).

EtherChannel



- The Cisco Catalyst family of switches supports two types of link aggregation:
  - Port Aggregation Protocol (**PAgP**) - Cisco proprietary
    - Default when the port channel is created (coming)
  - Link Aggregation Control Protocol (**LACP**) - Industry standard protocol based on IEEE 802.3ad.
- EtherChannel provides redundancy.
  - If one link fails, traffic is automatically moved to an active link.
  - Transparent to end user.
  - LACP (coming) also allows for standby links to replace any active link that fails in the bundle (coming).

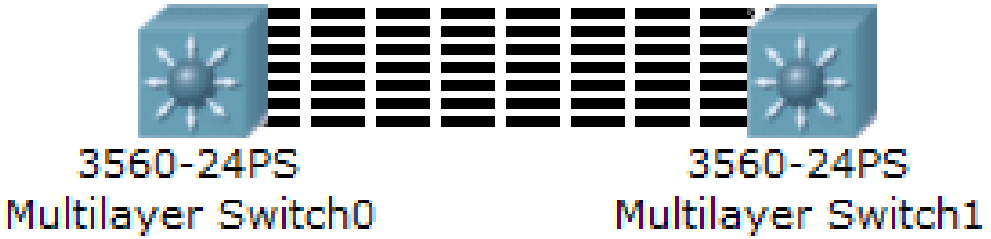
Fast Ethernet
Full duplex
Dot1q auto
Native = VLAN 2
VLANs 1 thru 100



Fast Ethernet
Full duplex
Dot1q auto
Native = VLAN 2
VLANs 1 thru 100

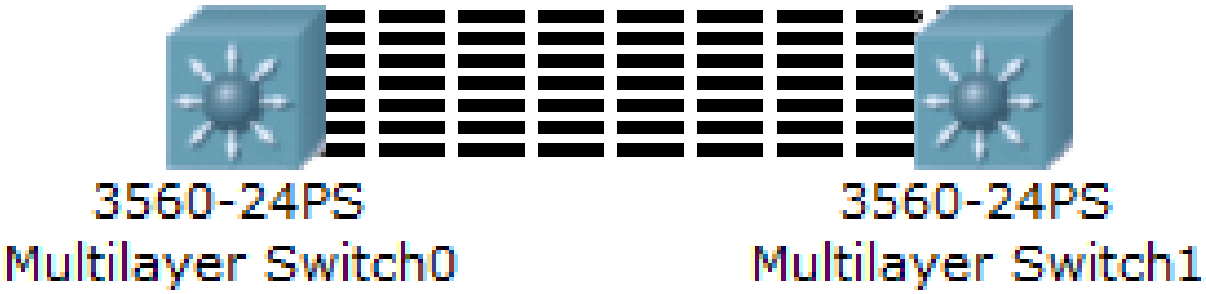
- The key is ***consistency*** for all links in the bundle:
  - Media
    - Same media type and speed
    - Same duplex
  - VLANs – All ports within the bundle must be configured with:
    - for **Access** operation: Same VLAN
    - for **Trunk** operation:
      - Same trunking encapsulation and compatible mode
        - » Port Mode on physical link partners do not have to be identical as long as they're sufficiently compatible to form a trunk.
      - Same Native VLAN
      - Allow the same set of VLANs

Distribution of Traffic and Load Balancing



- Load is not balanced equally across links.
- EtherChannel uses a hashing algorithm – 2 methods.
  - Single input is used (such as Source IP address), the hash will only look at the bits associated with this input. (coming)
  - Two inputs are used (such as Source IP address and Destination IP address), the hash will perform an exclusive OR (XOR) operation on both inputs. (coming!)
- Both methods will compute a binary number that selects a link number in the bundle to carry the frame. (coming!!!)

Load Balancing



- Let's take a brief look at how this works.
- We will focus on the 2, 4 and 8 link possibilities as this is easier to understand and these options provide ideal load balancing.
- A **2 link** EtherChannel bundle uses a **1-bit index** computed via **XOR**.
  - If the index is 0, link 0 is selected
  - If the index is 1, link 1 is selected
- A **4 link** EtherChannel bundle uses a **2-bit index** computed via **XOR**.
  - 4 possible links: 00, 01, 10, 11
- An **8 link** EtherChannel bundle uses a **3-bit index** computed via **XOR**.
  - 8 possible links: 000, 001, 010, 011, 100, 101, 110, 111

Boolean Operations - XOR

Mondays 08:00-10:00, you could be …
← attending my class

XOR *mutually exclusive possibilities*

studying @ home →

- A student can't be in BOTH locations at the same time.
- **XOR (Exclusive OR) operation**
  - where 0 = FALSE and 1 = TRUE
  - If both bits have the same value (both 0, both 1), the XOR will result in a 0.
    - Otherwise, they differ (one is a 0, the other a 1) and the result will be 1.
  - One and ONLY one input value can be TRUE for output to be TRUE.
- *Attend class in-person **XOR** be at home studying/learning the material then, **do well in this course = TRUE!!***

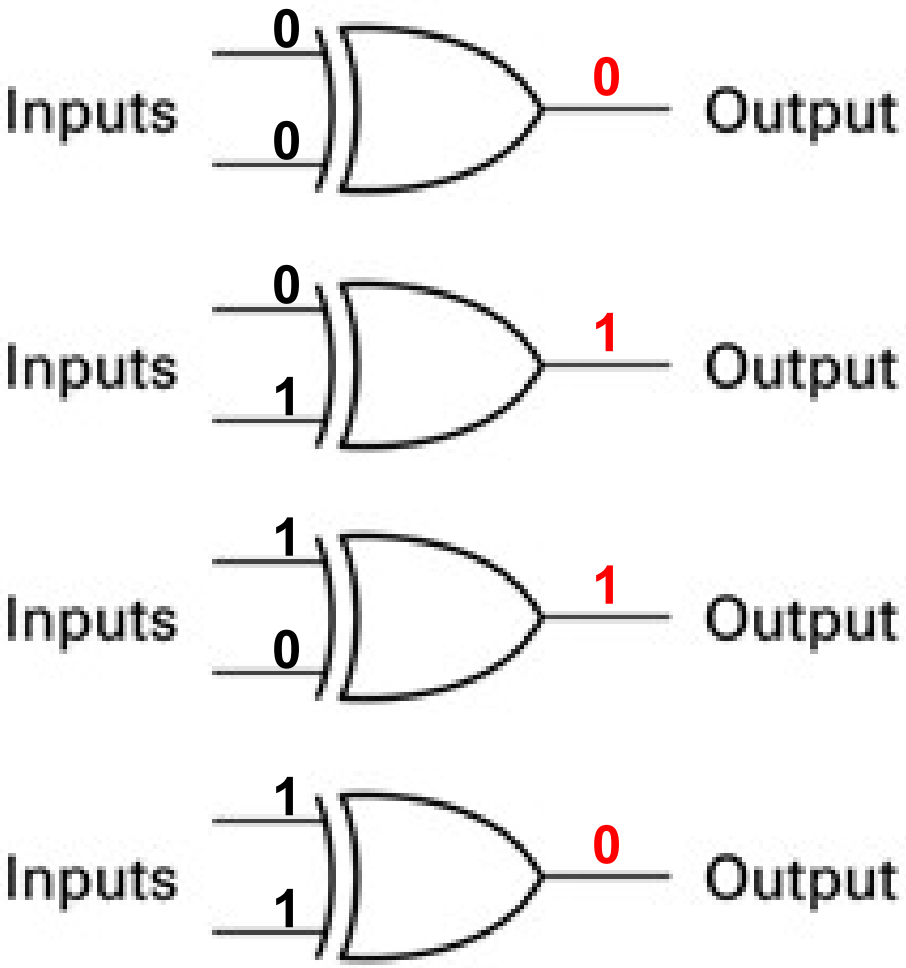
Boolean Operations - XOR

- Of course, you might have had a very tough Sunday night …

- … and might be in no shape to do either …

- … in which case,
- False (NOT attending class) **XOR** False (NOT studying at home) …
- … results in False (don't do so well in this course!)

Boolean Operations – XOR Gate



Truth Table

Inputs		Output
0	0	0
0	1	1
1	0	1
1	1	0

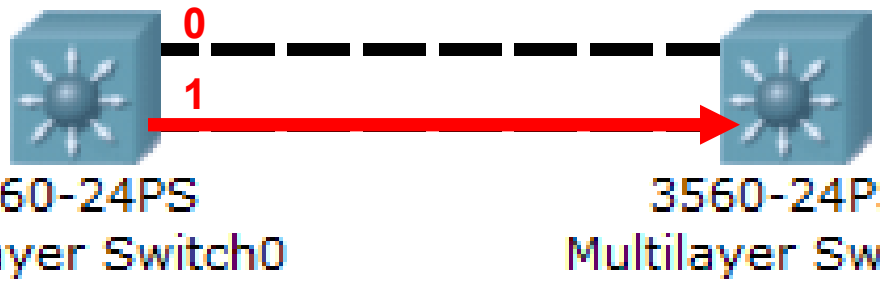
0 = FALSE

1 = TRUE

XOR operation

- When *only* ***one*** input value is TRUE, output is TRUE

Load Balancing

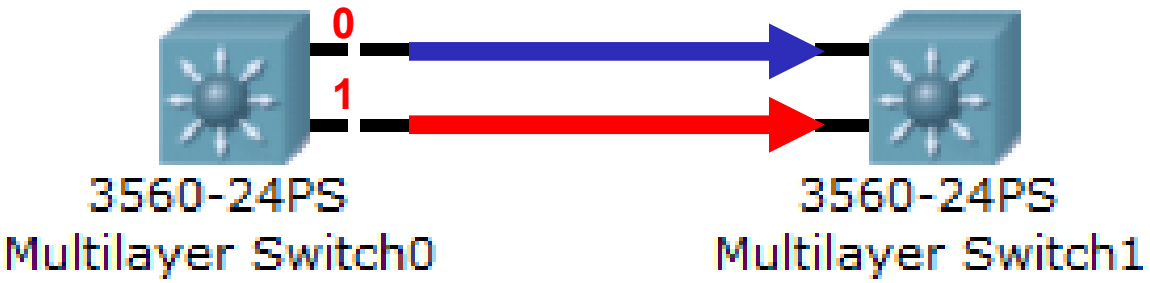


Truth Table

Inputs		Output
0	0	0
0	1	1
1	0	1
1	1	0

- Example: **2 Link** EtherChannel.
  - Packet sent from 172.16.1.1 to 10.10.10.16
  - The **chosen hash** uses **Source IP** and **Destination IP** address
- ***At most*** there can only be 8 links in bundle, so only the **last 3 rightmost bits** (least-significant) of the addresses will ever need to be indexed or examined.
  - 3 bits will give us 8 choices (8 links max in a bundle)
  - 172.16.1.**1** => 00000**0**01 10.10.10.46 => 00101**1**10
- In our example we have **2 links** in the EtherChannel (**1 bit index**):
  - The XOR is performed only on the **rightmost bit 1 XOR 0**
  - **1** XOR **0** = **1**
  - Therefore, Link **1** is used in this case.

Load Balancing

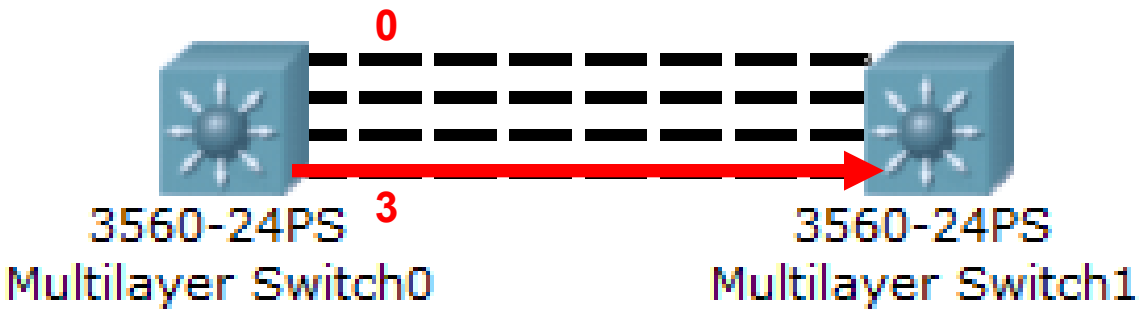


Truth Table

Inputs		Output
0	0	0
0	1	1
1	0	1
1	1	0

- Example: **2 Link** EtherChannel.
  - Our **hash** used the **Source IP** and **Destination IP** address
- The XOR on the rightmost bit of our **Source IP** and **Destination IP** address could result in Link 0 or Link 1 being used.
  - Depends on the last bit of each address!
  - 172.16.1.**1** => 00000001 10.10.10.46 => 00101110
- If XOR of the two bits result in 0, then link 0 is used.
- If XOR of the two bits result in 1, then link 1 is used.

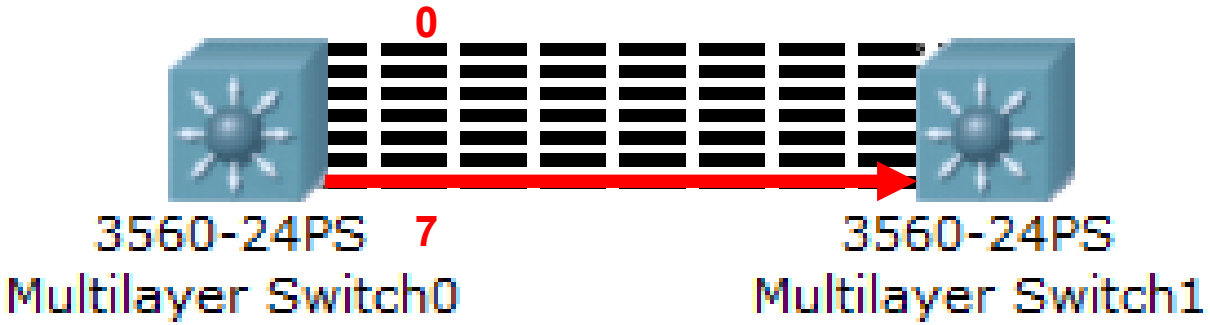
Load Balancing



Truth Table		
Inputs		Output
0	0	0
0	1	1
1	0	1
1	1	0

- Example: 4 Link EtherChannel
  - Packet sent from 172.16.1.1 to 10.10.10.16
  - Our **hash** used the **Source IP** and **Destination IP** address
  - 172.16.1.**1** => 00000**001** 10.10.10.46 => 00101**110**
- If there are **4 links** in the EtherChannel (**2 bit index**):
  - The XOR is performed only on **2 rightmost bits 01 XOR 10**
  - Each bit is computed separately
  - **01** XOR **10** = **11**
    - **1** XOR **0** = **1** (rightmost bits)
    - **0** XOR **1** = **1** (leftmost bits)
  - Link **3** (**11_2**) is used

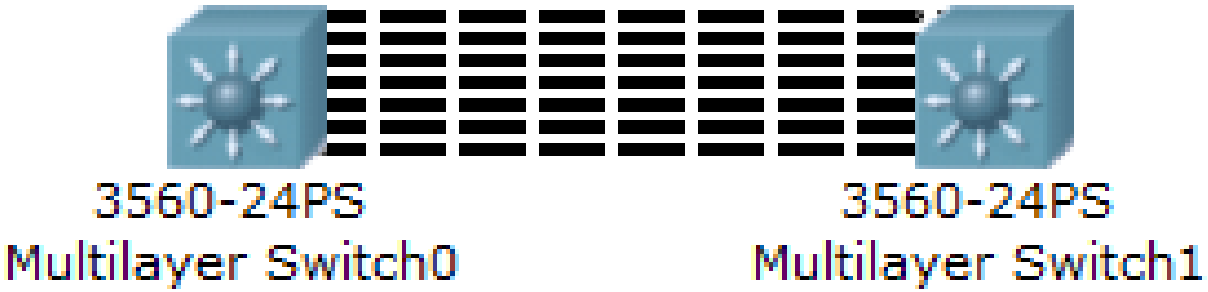
Load Balancing



Truth Table		
Inputs		Output
0	0	0
0	1	1
1	0	1
1	1	0

- Example: 8 Link EtherChannel
  - Packet sent from 172.16.1.1 to 10.10.10.16
  - Our **hash** used the **Source IP** and **Destination IP** address
  - 172.16.1.**1** => 0000**0001** 10.10.10.46 => 0010**110**
- If there are **8 links** in the EtherChannel (**3 bit index**):
  - The XOR is performed only on the **3 rightmost bits 001 XOR 110**
  - Each bit is computed separately
  - **001** XOR **110** = **111**
    - **1** XOR **0** = **1** (rightmost bits)
    - **0** XOR **1** = **1** (middle bits)
    - **0** XOR **1** = **1** (leftmost bits)
  - Link **7** (**111_2**) is used

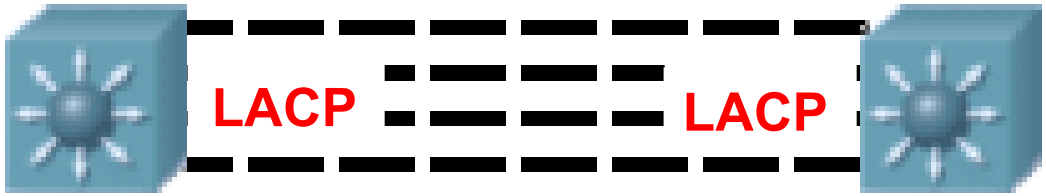
For more information



- For information about load balancing the number of links other than 2, 4 or 8:
  - **Understanding EtherChannel Load Balancing and Redundancy on Catalyst Switches**
  - http://www.cisco.com/en/US/tech/tk389/tk213/technologies_tech_note09186a0080094714.shtml

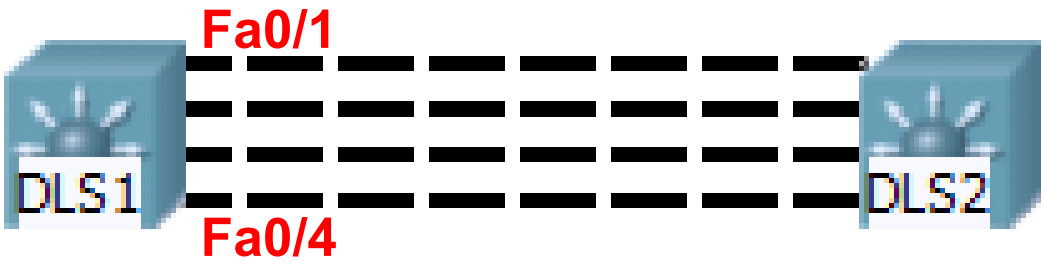
EtherChannel Configuration

EtherChannel Protocols



- The Cisco Catalyst family of switches supports both:
  - Port Aggregation Protocol (**PAgP**) - Cisco proprietary
    - Default when port channel is created (coming)
  - Link Aggregation Control Protocol (**LACP**) - Industry standard protocol based on IEEE 802.3ad.
- Not many differences.
- When a Cisco switch is connected to a non-Cisco switch use **LACP**.
- As with most protocols, the same must be used on both ends!

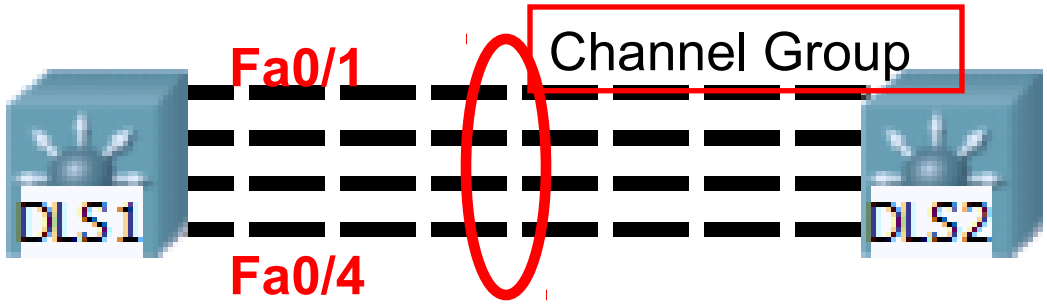
EtherChannel Protocols




```
DLS1(config)# interface range fa 0/1 - 4
DLS1(config-if-range)# channel-protocol ?
  lacp  Prepare interface for LACP protocol
  pagp  Prepare interface for PAgP protocol
DLS1(config-if-range)# channel-protocol pagp
```

- PAgP requires identical static VLANs or trunking encapsulation with same allowed VLANs.
- If the VLAN, speed or duplex on a port in the bundle is changed PAgP automatically reconfigures the rest of the ports in that bundle.

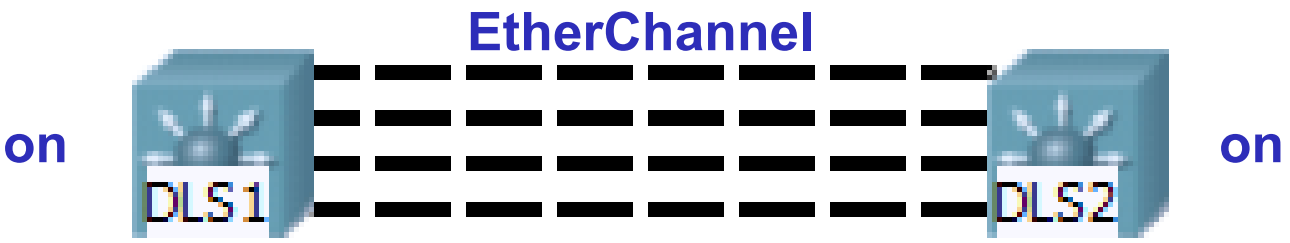
EtherChannel Protocols




```
DLS1(config)# interface range fa 0/1 - 4
DLS1(config-if-range)# channel-protocol ?
  lacp  Prepare interface for LACP protocol
  pagp  Prepare interface for PAgP protocol
DLS1(config-if-range)# channel-group number mode {active | on |
   {auto [non-silent]} | {desirable [non-silent]} | passive}
```

- Channel-group number: 1 – 64
- Assignment to **channel-group X** automatically creates a logical interface **port-channel X**, representing the entire bundle.
- Group number doesn't need to be the same on both switches but doing so can enhance consistency, simplifying network management.

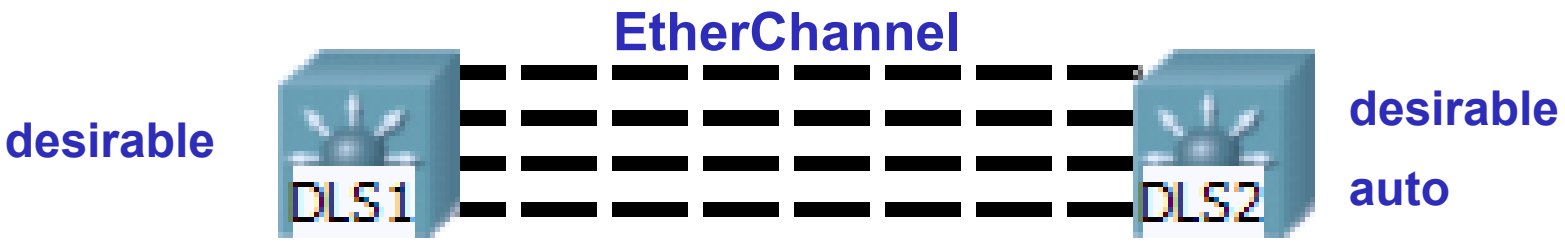
No PAgP or LACP negotiation




```
DLS1(config)# interface range fa 0/1 - 4
DLS1(config-if-range)# channel-protocol pagp
DLS1(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
```

- **on** – Forces port to channel without PAgP negotiation.
  - Both ends must be on.
  - All ports channeling
- You can use **channel-group # mode on** when the connecting device does not support PAgP and you need to set up the channel unconditionally.

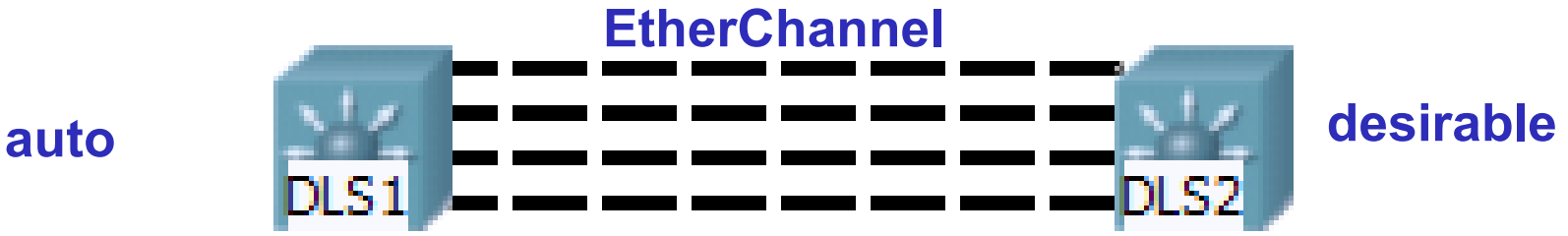
PAgP modes




```
DLS1(config)# interface range fa 0/1 - 4
DLS1(config-if-range)# channel-protocol pagp
DLS1(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
```

- An interface in **desirable** mode can form an EtherChannel with another interface that is in **desirable** or **auto** mode.
  - **Desirable** (Active) - Actively asks to form a channel

PAgP modes




```
DLS1(config)# interface range fa 0/1 - 4
DLS1(config-if-range)# channel-protocol pagp
DLS1(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
```

- An interface in **auto** mode can form an EtherChannel with another interface in **desirable** mode.
  - **Auto** (default, passive) - Waits to be asked to form a channel.
- An interface in **auto** mode **cannot** form an EtherChannel with another interface that is also in **auto** mode because neither interface starts PAgP negotiation.

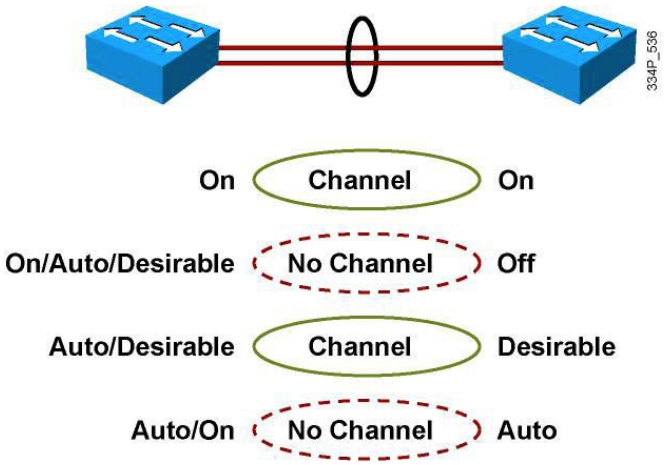
PAgP Silent submode

- channels after a 15 sec timeout if other end does not talk PAgP or transmit a BPDU


```
DLS1(config)# interface range fa 0/1 - 4
DLS1(config-if-range)# channel-protocol pagp
DLS1(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
DLS1(config-if-range)# channel-group 1 mode auto ?
  non-silent  Start negotiation only after data packets received
```

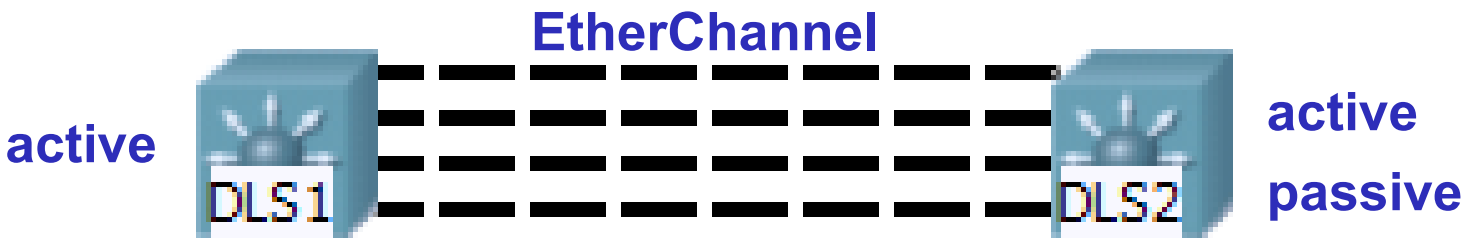
- By **default** PAgP uses the **silent** submode for **desirable** and **auto** – suitable when link partner isn't a switch (i.e. it is a "silent" partner, such as a server or management device)
- If you expect a switch to be on the other end you should use **non-silent**.
  - Either submode will work between switches.
- For more information on when to use silent or non-silent:
  - http://www.cisco.com/en/US/tech/tk389/tk213/technologies_configuration_example09186a0080094953.shtml

Summary of PAgP Modes



Mode	Purpose
Auto	Places an interface in a passive negotiating state in which the interface responds to the PAgP packets that it receives but does not initiate PAgP negotiation (default).
Desirable	Places an interface in an active negotiating state in which the interface initiates negotiations with other interfaces by sending PAgP packets. Interfaces configured in the “on” mode do not exchange PAgP packets.
On	Forces the interface to channel without PAgP.
Non-silent	If a switch is connected to a partner that is PAgP-capable, configure the switch interface for non-silent operation. The non-silent keyword is always used with the auto or desirable mode. If you do not specify non-silent with the auto or desirable mode, silent is assumed. The silent setting is for connections to file servers or packet analyzers; this setting enables PAgP to operate, to attach the interface to a channel group, and to use the interface for transmission.

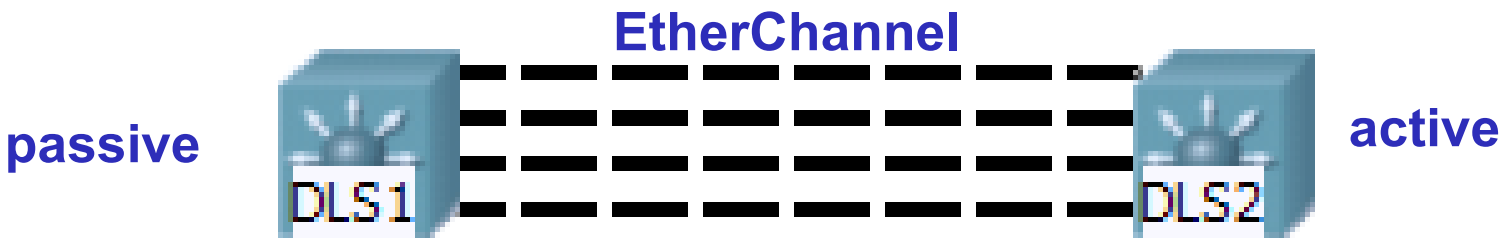
LACP modes




```
DLS1(config)# interface range fa 0/1 - 4
DLS1(config-if-range)# channel-protocol lacp
DLS1(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
```

- An interface in the **active** mode can form an EtherChannel with another interface that is in the **active** or **passive** mode.

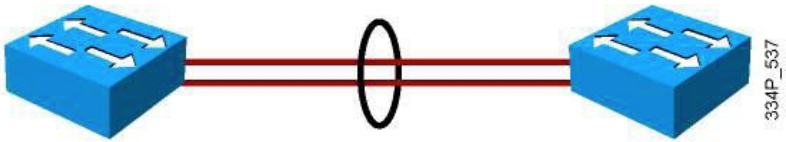
LACP modes

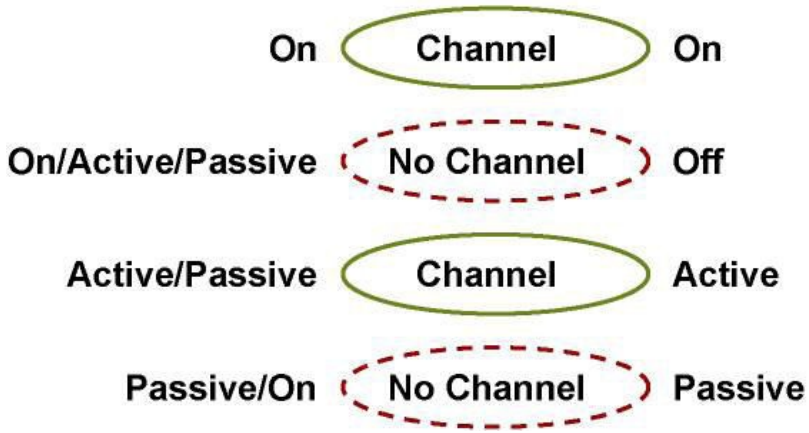



```
DLS1(config)# interface range fa 0/1 - 4
DLS1(config-if-range)# channel-protocol lacp
DLS1(config-if-range)# channel-group 1 mode ?
  active      Enable LACP unconditionally
  auto        Enable PAgP only if a PAgP device is detected
  desirable   Enable PAgP unconditionally
  on          Enable Etherchannel only
  passive     Enable LACP only if a LACP device is detected
```

- An interface in the **passive** mode can form an EtherChannel with another interface that is in the **active** mode.
- An interface in the **passive** mode **cannot** form an EtherChannel with another interface that is also in the **passive** mode because neither interface starts LACP negotiation.

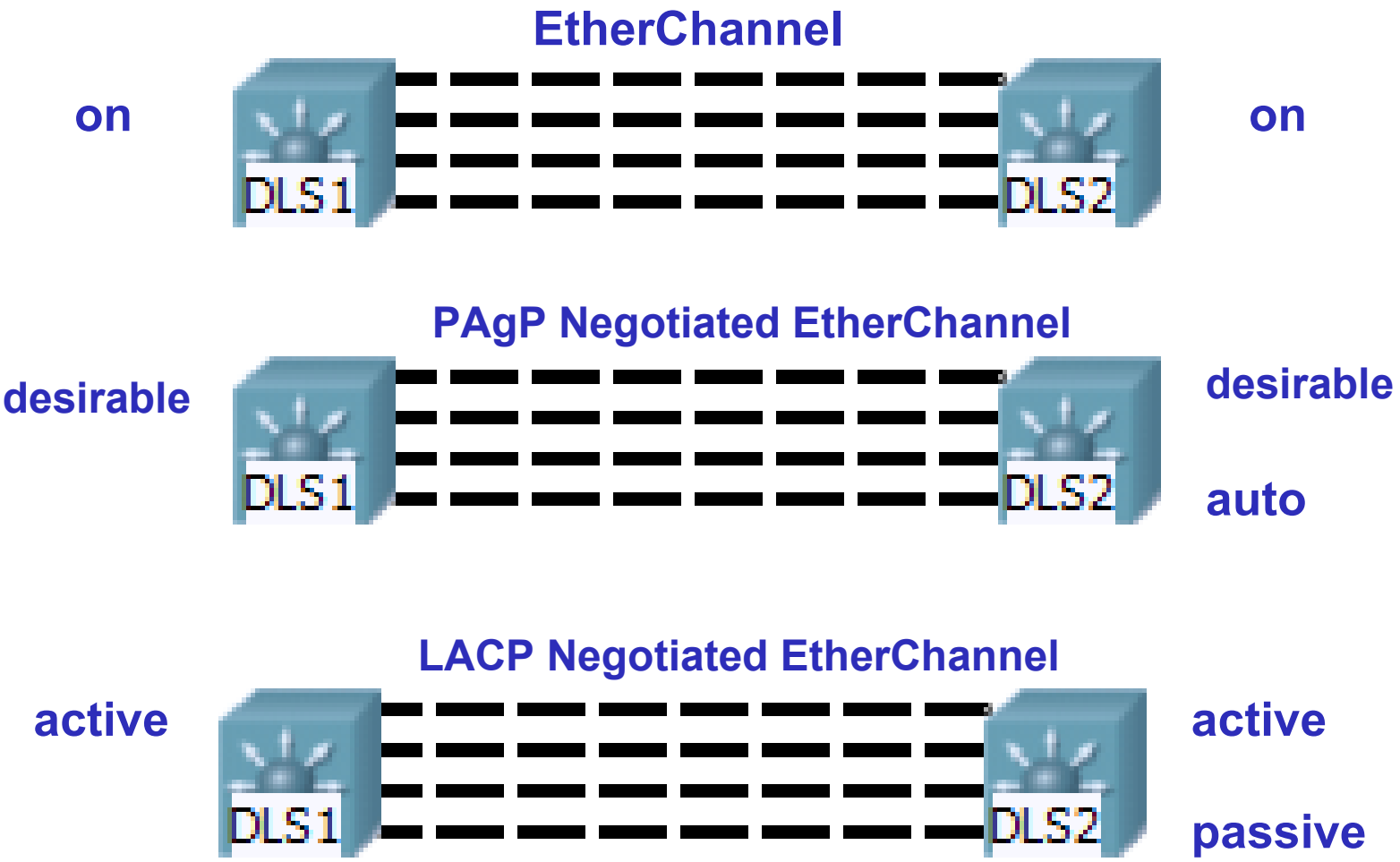
Summary of LACP Modes





Mode	Purpose
Passive	Places a port in a passive negotiating state. In this state, the port responds to the LACP packets that it receives but does not initiate LACP packet negotiation (default).
Active	Places a port in an active negotiating state. In this state, the port initiates negotiations with other ports by sending LACP packets.
On	Forces the interface to the channel without LACP.

Forming EtherChannels



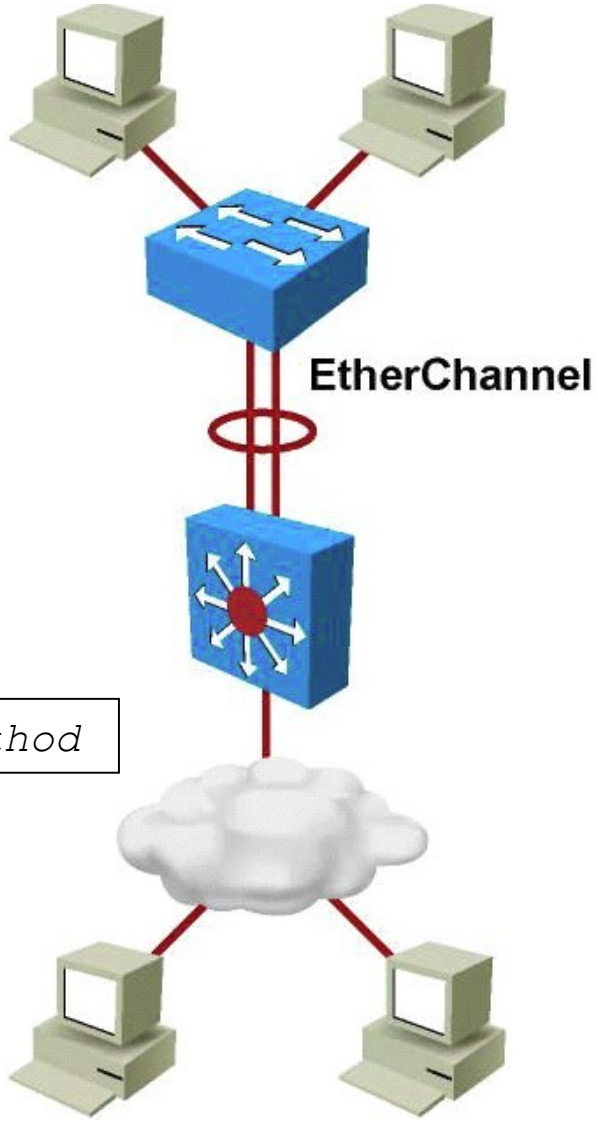
Configuring EtherChannel Load Balancing

- A successful Etherchannel allows multiple links to be used concurrently for forwarding between two devices, but *HOW* does the switch select a physical link on which to transmit?
- The method of load balancing must also be configured and is done in global configuration mode.

```
Switch(config)# port-channel load-balance method
```

- To verify:

```
Switch# show etherchannel load-balance
```



Load Balancing

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

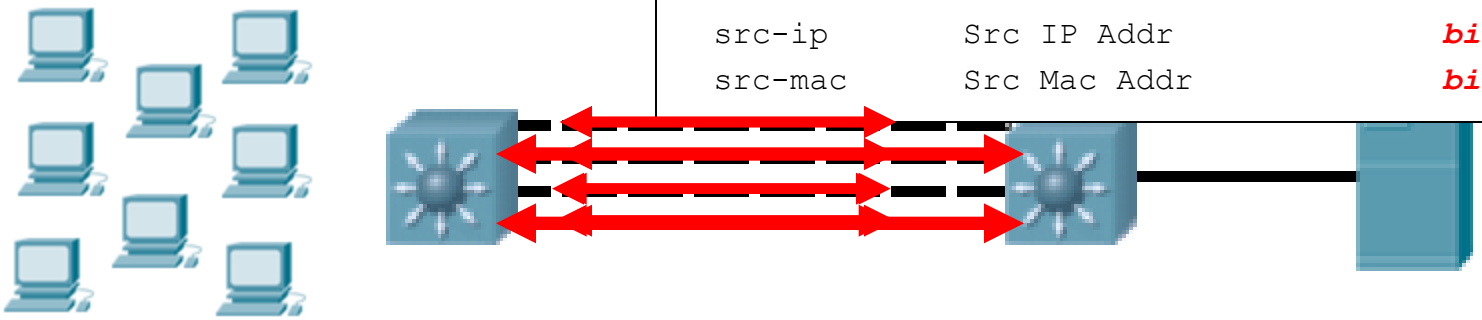
Hash Operation

typical default

- 6500 and 4500 switches also allow hash input to be based on:
  - `dst-port` (destination port)
  - `src-dst-port` (source and destination ports)
- Defaults for 29xx and 35xx (this varies by model so check documentation)
  - Layer 2 switching (switched port) is **`src-mac`** (coming)
  - Layer 3 switching (routed port) is **`src-dst-ip`** (coming)
- Frames for **non-IP traffic** are distributed based on their MAC addresses.
- **Multicasts and broadcasts** sent over one link in the EtherChannel are not sent back over other links in the EtherChannel – behaves as a single link.

Load Balancing

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



```
Switch(config)# port-channel load-balance src-dst-ip
```

- Normally, the default Source IP and Destination IP addresses will result in a fair statistical distribution of frames.
- This is due to the random nature of multiple Source and Destination IP address combinations.
- However, if a **single server's destination IP address** is receiving most of the traffic this may cause half the links to be overused.
  - One link in a two link EtherChannel.
  - Two links in a four link EtherChannel.
  - Four links in an eight link EtherChannel.
- In such a case, use **only Source IP address** *or* **include MAC addresses** to create a more balanced load across the bundle.

Configuring PAgP

```
DLS1(config)# port-channel load-balance dst-ip
DLS1(config)# interface range fa 0/11 - 12
DLS1(config-if-range)# switchport trunk encapsulation dot1q
DLS1(config-if-range)# switchport mode trunk
DLS1(config-if-range)# channel-protocol pagp
DLS1(config-if-range)# channel-group 1 mode desirable
```

```
DLS2(config)# port-channel load-balance src-dst-ip
DLS2(config)# interface range fa 0/11 - 12
DLS2(config-if-range)# switchport trunk encapsulation dot1q
DLS2(config-if-range)# channel-protocol pagp
DLS2(config-if-range)# channel-group 1 mode auto
```

- Notice:
  - Load balancing does not have to match but it usually does.
  - DTP on DLS2 is at its default of dynamic auto. (resulting in successful trunking with DLS1)
  - PAgP is configured on both ends.

Verifying

We will discuss the significance of the Port-channel interface with MLS.

```
DLS1#show run
!
port-channel load-balance dst-ip
!
interface Port-channel1
 switchport trunk encapsulation dot1q
 switchport mode trunk
!
interface FastEthernet0/1
! ...
interface FastEthernet0/11
 switchport trunk encapsulation dot1q
 switchport mode trunk
 channel-group 1 mode desirable
!
interface FastEthernet0/12
 switchport trunk encapsulation dot1q
 switchport mode trunk
 channel-group 1 mode desirable
```

```
DLS2#show run
!
port-channel load-balance src-dst-ip
!
interface Port-channel1
 switchport trunk encapsulation dot1q
!
!
interface FastEthernet0/1
! ...
interface FastEthernet0/11
 switchport trunk encapsulation dot1q
 channel-group 1 mode auto
!
!
interface FastEthernet0/12
 switchport trunk encapsulation dot1q
 channel-group 1 mode auto
```


Verifying

```
DLS1(config)# port-channel load-balance dst-ip
DLS1(config)# interface range fa 0/11 - 12
DLS1(config-if-range)# channel-protocol pagp
DLS1(config-if-range)# channel-group 1 mode desirable
```

```
DLS1# show etherchannel protocol
Group: 1
----------
Protocol:  PAgP

DLS1# show etherchannel load-balance
EtherChannel Load-Balancing Operational State (dst-ip):
Non-IP: Destination MAC address
  IPv4: Destination IP address
  IPv6: Destination IP address
DLS1#
```



```
DLS1# show etherchannel summary
Flags:  D - down        P - in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

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

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-------------------------------

1      Po1(SU)         PAgP      Fa0/11(P)    Fa0/12(P)

DLS1#
```

```
DLS1(config)# port-channel load-balance dst-ip
DLS1(config)# interface range fa 0/11 - 12
DLS1(config-if-range)# channel-protocol pagp
DLS1(config-if-range)# channel-group 1 mode desirable
```



```
DLS1# show etherchannel port

Group: 1
----------

Port: Fa0/11
------------

Port state    = Up Mstr In-Bndl
Channel group = 1           Mode = Desirable-Sl    Gcchange = 0
Port-channel  = Po1         GC   = 0x00010001      Pseudo port-channel = Po1
Port index    = 0           Load = 0x00            Protocol =   PAgP

Flags:  S - Device is sending Slow hello.  C - Device is in Consistent state.
        <output omitted>
Timers: H - Hello timer is running.        Q - Quit timer is running.
        <output omitted>

Local information:
                            Hello    Partner  PAgP     Learning  Group
Port        Flags State   Timers  Interval Count   Priority   Method  Ifindex
Fa0/11      SC

Partner's information:

          Partner               Partner          Partner          Partner Group
Port      Name                  Device ID        Port       Age   Flags   Cap.
Fa0/11    DLS2                  001b.8fc8.0080

Age of the port in the current state: 00d:00h:35m:29s
```

```
DLS1(config)# port-channel load-balance dst-ip
DLS1(config)# interface range fa 0/11 - 12
DLS1(config-if-range)# channel-protocol pagp
DLS1(config-if-range)# channel-group 1 mode desirable
```

Can help determine if the chosen load balancing type is distributing traffic evenly across the links

- **some platforms give similar information via command:**
  show int *interface* **etherchannel**

Configuring LACP

```
DLS1(config)# port-channel load-balance dst-ip
DLS1(config)# lacp system-priority 11111
DLS1(config)# interface range fa 0/11 - 12
DLS1(config-if-range)# switchport trunk encapsulation dot1q
DLS1(config-if-range)# switchport mode trunk
DLS1(config-if-range)# channel-protocol lacp
DLS1(config-if-range)# channel-group 1 mode active
DLS1(config-if-range)# lacp port-priority 99
DLS1(config)# interface range fa 0/13 - 14
DLS1(config-if-range)# switchport trunk encapsulation dot1q
DLS1(config-if-range)# switchport mode trunk
DLS1(config-if-range)# channel-protocol lacp
DLS1(config-if-range)# channel-group 1 mode active
```

Fa0/13-14 has a higher port priority so these will become the standby links should something happen to any of the active links.

Default port-priority = 32,768

- **Port Priority** - (Optional for LACP)
  - LACP uses the port priority to decide which ports should be put in standby mode.
  - Not typically used (because of hardware limitations).
  - Ports with lower priority are active, rest are standby. (Default is 32,768)
- **System Priority** - (Optional for LACP)
  - Valid values are 1 through 65535.
  - Higher numbers have lower priority. (Default is 32768, switch MAC is tiebreaker)
  - Recommended only when some ports are in standby.

Configuring LACP: DLS1 and DLS2

```
DLS1(config)# port-channel load-balance dst-ip
DLS1(config)# lacp system-priority 11111

DLS1(config)# interface range fa 0/11 - 12
DLS1(config-if-range)# switchport trunk encapsulation dot1q
DLS1(config-if-range)# switchport mode trunk
DLS1(config-if-range)# channel-protocol lacp
DLS1(config-if-range)# channel-group 1 mode active
DLS1(config-if-range)# lacp port-priority 99

DLS1(config)# interface range fa 0/13 - 14
DLS1(config-if-range)# switchport trunk encapsulation dot1q
DLS1(config-if-range)# switchport mode trunk
DLS1(config-if-range)# channel-protocol lacp
DLS1(config-if-range)# channel-group 1 mode active
```

```
DLS2(config)# port-channel load-balance src-dst-ip

DLS2(config)# interface range fa 0/11 - 12
DLS2(config-if-range)# switchport trunk encapsulation dot1q
DLS2(config-if-range)# channel-protocol lacp
DLS2(config-if-range)# channel-group 1 mode passive

DLS1(config)# interface range fa 0/13 - 14
DLS2(config-if-range)# switchport trunk encapsulation dot1q
DLS2(config-if-range)# switchport mode trunk
DLS2(config-if-range)# channel-protocol lacp
DLS2(config-if-range)# channel-group 1 mode active
```


Verifying (only showing DLS1)

```
DLS1#show run
!
port-channel load-balance dst-ip
!
interface Port-channel1
 switchport trunk encapsulation dot1q
 switchport mode trunk
!
interface FastEthernet0/11
 switchport trunk encapsulation dot1q
 switchport mode trunk
 lacp port-priority 99
 channel-group 1 mode active
!
interface FastEthernet0/12
 switchport trunk encapsulation dot1q
 switchport mode trunk
 lacp port-priority 99
 channel-group 1 mode active
!
```

```
interface FastEthernet0/13
 switchport trunk encapsulation dot1q
 switchport mode trunk
 channel-group 1 mode active
!
interface FastEthernet0/14
 switchport trunk encapsulation dot1q
 switchport mode trunk
 channel-group 1 mode active
```


Verifying

```
DLS1# show etherchannel protocol

Group: 1
----------
Protocol:  LACP

DLS1# show etherchannel load-balance
EtherChannel Load-Balancing Operational State (dst-ip):
Non-IP: Destination MAC address
  IPv4: Destination IP address
  IPv6: Destination IP address

DLS1#
```

```
DLS1(config)# port-channel load-balance dst-ip
DLS1(config)# interface range fa 0/11 - 12
DLS1(config-if-range)# switchport trunk encapsulation dot1q
DLS1(config-if-range)# switchport mode trunk
DLS1(config-if-range)# channel-protocol lacp
DLS1(config-if-range)# channel-group 1 mode active
DLS1(config-if-range)# lacp port-priority 99
<output imitted>
```


Verifying

```
DLS1# show etherchannel summary
Flags:  D - down        P - in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port


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

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SU)         LACP      Fa0/11(P)   Fa0/12(P)   Fa0/13(H)
                                 Fa0/14(H)

DLS1#
```


Verifying Specific Port Channel

- The **`show etherchannel`** *`number`* **`port-channel`** command can be used to display information about a specific port-channel.
- In the example below:
  - Port-channel 1 consists of two physical ports, Fa0/23 and Fa0/24.
  - It uses LACP in active mode.
  - It is properly connected to another switch with a compatible configuration.This is why the port-channel is said to be in use.
  - Loading across the 2 links are distributed 55% on f0/23 and 45% on f0/24.

```
Switch# show etherchannel 1 port-channel
                              Port-channels in the group:
                              ---------------------------

Port-channel: Po7    (Primary Aggregator)
Age of the Port-channel = 195d:03h:10m:44s
Logical slot/port = 0/1          Number of ports = 2
Port state = Port-channel Ag-Inuse
Protocol = LACP

Ports in the Port-channel:
Index   Load    Port        EC state      No of bits
------+-----+--------+--------------+-----------
0       55      fa0/23      Active                4
1       45      fa0/24      Active                4
```


Odds and Ends (FYI)

- Trunk ports send and receive PAgP and LACP protocol data units (PDUs) on VLAN 1.
- Spanning tree sends packets over the first interface in the EtherChannel (port index 0).
- **For more information on Configuring EtherChannel**
  - http://www.cisco.com/en/US/docs/switches/lan/catalyst3550/software/release/12.1_13_ea1/configuration/guide/swethchl.html