

Link Aggregation Interoperability of the Dell PowerConnect™ M6220 with Cisco IOS or Cisco CatOS Based Switches

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Introduction

This paper describes how to configure the Dell PowerConnect™ 6220M Gigabit Ethernet switch to interoperate and connect with Cisco IOS based switches when using industry standard link aggregation groups (LAGs) that adhere to the IEE 802.3ad standard. This paper discusses both static and dynamic LAGs.

The table below shows some of the terms used to refer to LAGs in Dell and Cisco documentation. This paper will use the term LAG.

Dell PowerConnect	Cisco IOS/CatOS
Link Aggregation Groups (LAGs)	EtherChannel Fast EtherChannel (FEC) Gigabit EtherChannel (GEC)
port-channel	Channeling
channel-group	channel-group

The primary purpose of LAGs is to increase the overall bandwidth between two switches. This is accomplished by effectively aggregating multiple ports together that act as a single, logical connection between the two switches.

The IEEE 802.3ad standard-based link aggregation implemented on the PowerConnect M6220 is interoperable with Cisco Ether Channel using both static and dynamic configuration (dynamic via LACP, not the Cisco proprietary PAgP). Dell is a member of the University of New Hampshire Interoperability Lab, where all PowerConnect products are tested to confirm interoperability with other Consortium members. Included in these tests is link aggregation interoperability with other Consortium members. Additional information regarding UNH's link aggregation testing can be found at:

<ftp://ftp.iol.unh.edu/pub/bfc/testsuites/la.io.test.suite.pdf>

Link aggregation can be configured as either dynamic or static. Dynamic configuration is supported using the IEEE 802.3ad standard, which is known as Link Aggregation Control Protocol (LACP). Static configuration is used when connecting the Dell PowerConnect M6220 Gigabit Ethernet switch to an external Gigabit Ethernet switch that does not support LACP. One advantage of LACP is that the protocol enables the Gigabit Ethernet switch to confirm that the external switch is also configured for link aggregation. When using static configuration, a cabling or configuration mistake involving the Dell PowerConnect M6220 or the external switch could go undetected and thus cause undesirable network behavior. Both static and dynamic

LAGs (via LACP) can detect physical link failures within the LAG and continue forwarding traffic through the other connected links within that same LAG. LACP can also detect switch or port failures that do not result in loss of link. This provides a more resilient LAG. Best practices suggest using dynamic link aggregation instead of static link aggregation.

The configuration examples in this document use the command line interface (CLI) on each switch. For more detailed information about the commands, see the *Dell™ PowerConnect™ M6220 CLI Reference Guide*. The “Port Channel Commands” section contains information about configuring LAGs by using the CLI.

If desired, any of the example configurations can be performed on the Dell PowerConnect M6220 by using the Web Based Interface (WBI) as well. See the *Dell PowerConnect M6220 User's Guide* for a description of the Dell WBI. For information about configuring LAGs by using the WBI, see the “Aggregating Ports” section in the “Configuring Switching Information” chapter.

The *Dell™ PowerConnect™ M6220 CLI Reference Guide* and the *Dell PowerConnect M6220 User's Guide* are located on the Dell support website:

<http://support.dell.com/support/edocs/network/PCM6220/en/index.htm>

Link Aggregation with Gigabit Ethernet Cisco Switches

The examples in this document show minimal configurations necessary to establish a LAG between a Cisco IOS Gigabit Ethernet switch (Catalyst 3750), Cisco CatOS Ethernet switch (Catalyst 6509) and the Dell PowerConnect M6220. These commands work without issue when starting from a default configuration of the switches.

To set the Dell PowerConnect M6220 to the default configuration, use the following commands:

NOTE: This will erase any configuration data previously configured and reboot the switch.

```
M6220# clear config
M6220# reload
```

To set a Cisco IOS based switch to the default configuration, use the following commands:

NOTE: This will erase any configuration data previously configured and reboot the switch.

```
3750# delete flash:/config.text
3750# reload
```

To set a Cisco CatOS based switch (e.g. Catalyst 6509) to default configuration, use the following commands:

NOTE: This will erase any configuration data previously configured and reboot the switch.

```
Cat_6509 (enable) clear config all
```

Please see other sections of this paper for cases when it is impractical to reset the switches to factory defaults.

The Dell PowerConnect M6220 can support up to 18 different LAGs. A port channel can have from zero to eight of the ports as members. Any external or internal port can be a member of a LAG. The examples in this document show different numbers of ports in a LAG.

It is recommended that you physically disconnect the ports to be aggregated on both the Cisco and Dell switches during configuration. This will avoid any network loops being formed before the LAGs are set up.

Configuring the M6220 Ports for Dynamic Link Aggregation

The following example shows the Dell PowerConnect M6220 switch CLI commands for configuring eight ports on the switch for LACP.

```
M6220(config)# interface range ethernet 1/g1-1/g8
M6220(config-if)# channel-group 1 mode auto
```

Command	Description
<pre>interface range ethernet 1/g1-1/g8</pre>	<p>Sets the CLI mode to configure the eight Gigabit Ethernet ports (referred to in the command as 1/g1-1/g8, which stands for Gigabit Ethernet ports 1 through 8 on unit 1).</p> <p>Value ‘1’ in “1/g1 and 1/g8” specifies the unit number, this number depends on the Stack unit number and can be between 1 to 12. When used in a stacked environment, the member ports of the LAG can be chosen from across the stack units.</p> <p>NOTE: All 8 ports do not have to be selected; a LAG can have 0-8 ports depending on the requirements of the network (i.e the more ports in the LAG, the more bandwidth and more redundancy that is available). A LAG can even be configured without any member ports. When ports are added to the LAG, they will be set to the configuration of the LAG.</p>
<pre>channel-group 1 mode auto</pre>	<p>Aggregates the eight ports into a LAG (referred to in the command as channel-group), which will use LACP (referred to in the command as mode auto). The ‘1’ for the channel-group number only has meaning within the switch and is used to differentiate up to eighteen unique channel-groups. For each LAG created, the user will need to choose a number between one and eighteen, for up to the maximum of eighteen groups. Both external and the internal ports can be part of LAG.</p>

Configuring a Cisco IOS Gigabit Ethernet Switch for Dynamic Link Aggregation

The following example shows the Cisco IOS switch CLI commands for configuring six ports for LACP.

```
3750(config)# interface range GigabitEthernet 1/0/1 - 6
3750(config-if)# channel-protocol lacp
3750(config-if)# channel-group 1 mode active
```

Command	Description
interface range GigabitEthernet 1/0/1 - 6	Sets the CLI mode to configure six Gigabit Ethernet ports (referred to in the command as GigabitEthernet 1/0/1 - 6, which stands for Gigabit Ethernet ports 1 through 6).
channel-protocol lacp	Sets ports to use LACP as the LAG protocol (and not PAgP)
channel-group 1 mode active	Aggregates the six ports into a LAG (referred to in the command as channel-group), which will use LACP (referred to in the command as mode active). The '1' for the channel-group number only has meaning within the switch and is used to differentiate unique channel-groups

Configuring a Cisco CatOS Gigabit Ethernet Switch for Dynamic Link Aggregation

The following example shows the Cisco CatOS switch CLI commands for configuring six ports for LACP.

```
Cat_6509(enable) set channelprotocol lacp 2
Cat_6509(enable) set port lacp-channel 2/1-6 mode active
```

Command	Description
set channelprotocol lacp 2	Sets the LAG dynamic protocol to LACP on module 2 (module 2 just happens to be the module that is in the switch used to validate the examples in this paper. Your switch may be configured differently).
set port lacp-channel 2/1-6 mode active	Aggregates six ports on module 2 (referred to in the command as 2/1-6, which stands for ports 1 through 6 on module 2) into a LAG (referred to in the command as lacp-channel), which will use LACP (referred to in the command as mode active).

NOTE: Only the Cisco mode `active` is supported for LACP interoperability with the PowerConnect M6220. The other modes (`passive`, `auto`, `on`, `desirable`) should not be used when using LACP between a Cisco switch and the PowerConnect M6220. Using a mode other than `active` is a common configuration error.

Confirming a Successful Dynamic Link Aggregation Connection with the M6220

The following example shows how the PowerConnect M6220 `show interfaces port-channel 1` command can be used to assure that the M6220 has established a LAG and that the LAG is connected.

```
M6220#show interfaces port-channel 1
Channel  Ports                                     Hashing-mode
-----  -
ch1      Active: 1/g1, 1/g2, 1/g3, 1/g4, 1/g5, 1/g6  3
         Inactive: 1/g7, 1/g8
```

Hash algorithm type

- 1 - Source MAC, VLAN, EtherType, source module and port Id
- 2 - Destination MAC, VLAN, EtherType, source module and port Id
- 3 - Source IP and source TCP/UDP port
- 4 - Destination IP and destination TCP/UDP port
- 5 - Source/Destination MAC, VLAN, EtherType and source MODID/port
- 6 - Source/Destination IP and source/destination TCP/UDP port

The output of the command shows the ports 1/g1-1/g6 are “Active.” This confirms that there is physical link on the ports 1/g1-1/g6 in the LAG and that the M6220 has communicated with the Cisco switch to successfully establish an aggregated link on ports 1/g1-1/g6 with LACP. Ports 1/g7 and 1/g8 are shown as “Inactive” because there is no physical link on 1/g7 and 1/g8 (i.e. these ports are not connected to the Cisco switch).

Confirming a Successful Dynamic Link Aggregation Connection with Cisco IOS

The following example shows how the Cisco IOS `show interfaces port-channel 1 etherchannel` command can be used to assure that the Cisco has established a LAG and that the LAG is connected.

```
3750# show interfaces port-channel 1 etherchannel
Port-channell (Primary aggregator)

Age of the Port-channel = 00d:01h:11m:34s
Logical slot/port = 10/1          Number of ports = 6
HotStandBy port = null
Port state = Port-channel Ag-Inuse
Protocol = LACP
```

Ports in the Port-channel:

Index	Load	Port	EC state	No of bits
0	00	Gi1/0/1	Active	0
0	00	Gi1/0/2	Active	0
0	00	Gi1/0/3	Active	0
0	00	Gi1/0/4	Active	0
0	00	Gi1/0/5	Active	0
0	00	Gi1/0/6	Active	0

The output of the command shows the ports Gi1/0/1 through Gi1/0/6 are “Active.” This confirms that there is physical link on all ports in the LAG and that the Cisco switch has communicated with the PowerConnect M6220 switch to successfully establish an aggregated link on ports 1/0/1 through 1/0/6 with LACP.

Confirming a Successful Dynamic Link Aggregation Connection with Cisco CatOS

The following example shows how the Cisco CatOS `show interfaces lacp-channel info` command can be used to assure that the Cisco switch has established a LAG and that the LAG is connected.

```
Cat_6509> (enable) show lacp-channel info
Chan Port  Status      Channel  Admin Speed Duplex Vlan
id       id
-----
801  2/1  connected  active   395  a-1Gb a-full  1
801  2/2  connected  active   395  a-1Gb a-full  1
801  2/3  connected  active   395  a-1Gb a-full  1
801  2/4  connected  active   395  a-1Gb a-full  1
801  2/5  connected  active   395  a-1Gb a-full  1
801  2/6  connected  active   395  a-1Gb a-full  1
```

...

The output of the command shows the status for ports 2/1 through 2/6 is “connected” and that the channel mode is “active.” This confirms that there is physical link on all ports in the LAG and that the Cisco switch has communicated with the PowerConnect M6220 switch to successfully establish an aggregated link on ports 2/1 through 2/6 with LACP.

Configuring the M6220 Ports for Static Link Aggregation

The following example shows the PowerConnect M6220 Gigabit Ethernet switch CLI commands for configuring three ports of the Gigabit Ethernet switch for static aggregation. Note that a LAG can be configured with 0-6 ports (the example uses 3), and a port may only be part of a single LAG:

```
M6220(config)# interface range ethernet 1/g17-1/g19
M6220(config-if)# channel-group 1 mode on
```

Command	Description
interface range ethernet 1/g17-1/g19	Sets the CLI mode to configure three Gigabit Ethernet ports (1/g17, 1/g18, and 1/g19)
channel-group 1 mode on	Aggregates the three ports into a static LAG. Static LAGs do not use LACP and are defined in the CLI by setting the channel-group mode to mode on. The '1' for the channel-group number only has meaning within the switch and is used to differentiate up to 18 unique channel-groups. For each LAG created, you will need to choose a number from 1-18, for up to the maximum of 18 groups. The internal ports that connect to the servers do not support link aggregation groups

Configuring a Cisco IOS Switch for Static Link Aggregation

The following example shows the Cisco IOS CLI commands for configuring three ports of the Cisco switch for static link aggregation.

```
3750(config)# interface range GigabitEthernet 1/0/9 - 11
3750(config-if)# channel-group 1 mode on
```

Command	Description
interface range GigabitEthernet 1/0/9 - 11	Sets the CLI mode to configure three Gigabit Ethernet ports (1/0/9, 1/0/10, and 1/0/11)
channel-group 1 mode on	Aggregates the three ports into a static LAG. Static LAGs do not use LACP and are defined in the Cisco CLI by setting the channel-group mode to 'on'. The '1' for the channel-group number only has meaning within the switch and is used to differentiate channel-groups. The number of channel-groups supported by Cisco switches depends on the switch model.

Configuring a Cisco CatOS Switch for Static Link Aggregation

The Cisco CatOS CLI allows the configuration of static LAGs via the LACP or the PAgP CLI commands. Both commands are shown below.

The following example shows the Cisco CatOS CLI LACP channelprotocol commands for configuring three ports of the Cisco switch for static link aggregation.

```
Cat_6509(enable) set channelprotocol lacp 2
Cat_6509(enable) set port lacp-channel 2/9-11 mode on
```

Command	Description
set channelprotocol lacp 2	Sets module 2 to use the LACP commands to configure LAGs. Since we are defining a static LAG, the setting for the channelprotocol does not matter (more on this below).
port lacp-channel 2/9-11 mode on	Configures the three Ethernet ports (2/9, 2/10, and 2/11) into a static LAG. Static LAGs do not use LACP and are defined in the Cisco CLI by setting the lacp-channel mode to on.

The following example shows the Cisco CatOS CLI PAgP channelprotocol commands for configuring three ports of the Cisco switch for static link aggregation using the PAgP command.

```
Cat_6509(enable) set channelprotocol pagp 2
Cat_6509(enable) set port channel 2/9-11 mode on
```

Command	Description
set channelprotocol pagp 2	Sets module 2 to use the PaGP commands to configure LAGs. As mentioned previously, in defining a static LAG, the setting for the channelprotocol does not matter.
set port channel 2/9-11 mode on	Configures the three Ethernet ports (2/9, 2/10, and 2/11) into a static LAG. Static LAGs do not use PAgP and are defined in the Cisco CLI by setting the channel mode to on.

NOTE: The number of channel-groups supported by Cisco switches depends on the switch model.

Confirming a Successful Static Link Aggregation Connection

Since LACP is not being used, only careful inspection of the Cisco and PowerConnect M6220 configurations can confirm that a static LAG has been established. The following steps may be helpful:

- Make sure the cabling is attached to the correct ports on both switches
- Check that all LAG ports have link
- On the Dell and Cisco switches, use the `show running-config` command to confirm that the desired ports are in the LAG:
 - M6220# `show running-config`
 - 3750# `show running-config`
 - Cat_6509(enable) `show running-config`

Link Aggregation with Cisco Fast Ethernet Switches

Some customers have an investment in a Cisco Fast Ethernet (100Mbps) network. In this case the customer may not want to incur the expense to replace their Cisco Fast Ethernet switches to match the highest speed of the Dell PowerConnect M6220, but they still want to have the most bandwidth possible. Since the Dell PowerConnect M6220 supports auto-negotiation (on the external ports), there is nothing additional that a customer must do to connect aggregated links to a Cisco Fast Ethernet switch if link aggregation ports on the Cisco switch are also set to auto negotiation.

The ports in a Dell PowerConnect M6220 LAG are set to auto-negotiation by default. If the negotiation setting of the LAG has been changed due to a previous configuration of the switch, use the following command to set the LAG ports back to auto-negotiation:

```
M6220(config)# interface range ethernet 1/g1-1/g8
M6220(config-if)# negotiation
```

To set the ports on a Cisco IOS switch to auto-negotiation, use the following commands:

```
2950(config)# interface range FastEthernet 0/1 - 3
2950(config-if)# speed auto
2950(config-if)# duplex auto
```

To set the ports on a Cisco CatOS switch to auto-negotiation, use the following command:

```
Cat_6509> (enable) set port speed 2/9-11 auto
```

If auto negotiation cannot be used, both the Dell PowerConnect LAG and the Cisco switch ports in the LAG must be set to the same speed and duplex. One switch cannot be left in auto-negotiation mode and the other forced to a certain speed and duplex or intermittent link failures may occur.

On the Dell PowerConnect M6220, each member port of the LAG (or range of Ethernet ports) can be forced to 100 Mbps with the following commands:

```
M6220(config)# interface range ethernet 1/g1-1/g8
M6220(config-if)# no negotiation
M6220(config-if)# speed 100
M6220(config-if)# duplex full
```

The `no negotiation` command means that there is no auto negotiation on the Ethernet port(s). The `speed 100` command sets the port(s) to 100Mbps. Use the `duplex full` command to set the duplex mode to full. The 802.3ad standard requires all ports in a LAG to be full duplex.

Use the following commands to set the ports on the Cisco IOS switch to 100Mbps and full duplex:

```
2950(config)# interface range FastEthernet 0/1 - 3
2950(config-if)# speed 100
2950(config-if)# duplex full
```

Use the following commands to set the ports on the Cisco CatOS switch to 100Mbps and full duplex:

```
Cat_6509> (enable) set port speed 2/9-11 100
Cat_6509> (enable) set port duplex 2/9-11 full
```

Configuration Limitations

Ports to be aggregated must be configured so that they are compatible with the link aggregation feature and with the partner switch to which they connect.

For the Dell PowerConnect M6220, the following limitations apply to aggregated ports. The commands to remove the configuration are shown below each limitation.

- The port cannot belong to another LAG
 - M6220(config)# interface ethernet 1/g1
 - M6220(config-if-1/g1)# no channel-group
- The port cannot be a mirrored port
 - You need to run the following command if the port 1/g1 is already configured as a mirror destination port
 - M6220(config)#no monitor session 1 destination interface
 - You need to run the following command if the port 1/g1 is already configured as a mirror source port
 - M6220(config)#no monitor session 1 source interface 1/g1

To check the configuration of the ports on the Dell PowerConnect M6220, use the `show running-config` command and look at the `interface ethernet 1/gxx` configurations, where the `xx` indicates the port number.

In the following example, the `no monitor session 1 destination interface` command must be issued on port 1/g1 before it can be added to a LAG.

```
M6220 (config-if-1/g1)#exit
M6220 (config)#exit

M6220 (config)#show running-config
!Current Configuration:
!System Description "PowerConnect M6220, 7.31.0.2, VxWorks5.5.1"
!System Software Version 7.31.0.2
!
configure
monitor session 1 destination interface 1/g1
exit
```

Cisco and Dell Port Configuration Differences

On Cisco IOS and CatOS based switches, and also on PowerConnect M6220, ports must be configured identically to be included in a LAG.

Cisco IOS based switches may have the ‘desirable’ and ‘passive’ mode options for the LAG setting. The PowerConnect M6220 does not support this implementation. Do not use the ‘desirable’ or ‘passive’ modes when configuring a LAG with a Dell PowerConnect switch. Only use the ‘active’ (for LACP) or ‘on’ (for static) modes.

On the PowerConnect M6220 switch, when members are added to a LAG they are removed from all existing VLAN memberships. When members are removed from a LAG they are added back to the VLANs that they were previously members of as per the configuration file. Note that a port’s VLAN membership can still be configured when it is a member of a LAG. However, this configuration is only actually applied when the port leaves the LAG. Additionally, the port’s GVRP configuration is overridden by the LAG’s GVRP configuration. Upon leaving the LAG, the port will restore its GVRP configuration. The LAG interface can be a member of a VLAN complying with IEEE 802.1Q.

Cisco and Dell LAG Distribution Configuration

Switches can only control the distribution of outgoing traffic on LAG ports. The PowerConnect M6220 supports six different distribution methods based on source and/or destination MAC or IP addresses, source and/or destination TCP/UDP ports, and source port/module ID to decide which port or LAG a packet will travel. The default distribution is based on the source IP and source TCP/UDP port.

The following list shows the distribution methods available on the PowerConnect M6220:

- 1 - Source MAC, VLAN, EtherType, source module and port ID
- 2 - Destination MAC, VLAN, EtherType, source module and port ID
- 3 - Source IP and source TCP/UDP port
- 4 - Destination IP and destination TCP/UDP port
- 5 - Source/Destination MAC, VLAN, EtherType, source MODID/port
- 6 - Source/Destination IP and source/destination TCP/UDP port

```
M6220#configure
M6220 (config)#interface port-channel 1
M6220 (config-if-ch1)#hashing-mode 1
```

Cisco IOS and CatOS switches provide configuration options for changing the distribution of traffic on LAG ports.

One of the following Cisco IOS commands may be useful if poor performance on the LAG from the Cisco IOS switch is observed. In the order listed, the commands will allow the user to configure the switch to distribute packets to ports in a LAG based on the destination IP address, destination Ethernet address, a combination of source and destination IP addresses, a combination of source and destination Ethernet addresses, source IP address, or source Ethernet address.

```
3750 (config)#port-channel load-balance dst-ip
3750 (config)#port-channel load-balance dst-mac
3750 (config)#port-channel load-balance src-dst-ip
3750 (config)#port-channel load-balance src-dst-mac
3750 (config)#port-channel load-balance src-ip
3750 (config)#port-channel load-balance src-mac
```

One of the following Cisco CatOS commands may be useful if poor performance on the LAG from the Cisco CatOS switch is observed. In the order listed, the commands will allow the user to configure the switch to distribute packets to ports in a LAG based on the destination IP address, destination Ethernet address, a combination of source and destination IP addresses, a combination of source and destination Ethernet addresses, source IP address, or source Ethernet address.

```
Cat_6509> (enable) set port channel all distribution ip destination
Cat_6509> (enable) set port channel all distribution mac destination
Cat_6509> (enable) set port channel all distribution ip both
Cat_6509> (enable) set port channel all distribution mac both
Cat_6509> (enable) set port channel all distribution ip source
Cat_6509> (enable) set port channel all distribution mac source
```