Understanding Stacking Lite

Technology Brief

November 2019

Abstract

With a growing amount of IP-based devices in the Enterprise LAN environment, network managers always want to optimize performance, maximize scalability, and remain flexible. Network managers face the dilemma of choosing an expensive switch with a high port-count or a complex network composed of many low port-count switches.

Stacking Lite technology facilitates and eases the network architecture. Network managers can control hundreds of ports through a single IP and MAC address even when multiple standalone switches are stacked together. Through this technology brief, you will get an overview of Stacking Lite, an example of its use, and how it helps build a flexible IT infrastructure.

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Overview

Stacking Lite improves network manageability for network managers. All switches in the stack are managed as if it were a single switch and controlled using one configuration file with all switches having the same firmware version which simplifies the network topology.

Through stacking cables, multiple standalone switches can be connected together as a stack. The network manager can do the configuration in the designated Primary Master (PM) switch. The PM will trigger the configuration and ask the designated Backup Master (BM) switch to back up the configuration file. The rest of the switches are called Slaves which follows the PM's configuration file to forward packets.

Switches have three different roles in a stack environment, each with a dedicated function.

Primary Master (PM): The primary master is responsible for maintaining the normal operation of a stack.

Backup Master (BM): The backup master becomes the new PM if the original PM becomes inoperative.

Slave (SL): Any other switches other than PM or BM is called a Slave.

Stacking Lite Operation Processes

After enabling the stacking function and rebooting all switches in the stack, Stacking Lite will do the following steps in order to establish the stacking environment. 1. Box ID Assignment 2. Primary Master Election 3. Backup Master Election 4. Firmware Synchronization 5. Configuration File Backup.

Box ID Assignment

The Box ID (BID) is a unique value to identify a switch in the stack for management operations. The BID, which ranges from 1 to 9, identifies each device in the stacking system. By default, the BID starts at 1. When the BID is assigned, the switch model is also recorded by the PM.

When a new switch without an assigned BID joins a stack, this new switch will assign the smallest unused BID to itself.

When a switch with an assigned BID joins a stack and the BID does not conflict with any other switch's BID, this new switch will keep its original BID.

If a new joining switch has a BID which already exists in the stack, this new switch will reassign the smallest unused BID to itself.

Primary Master Election

The Primary Master (PM) election is the most important process when establishing the stacking environment. The PM is decided according to a switch's stacking priority and MAC address comparison between the switches. The switch with the highest priority is chosen as the PM. If there are multiple switches with the same priority setting, then a comparison is done between the switches' MAC addresses. The switch with highest MAC address is chosen as the PM. Once a PM is determined, even if a switch with an equal or higher priority joins the stack, the PM election process will not be triggered.

[**NOTE1**] if a device with the lowest priority achieves PM election prior to other switches, for example by powering on and completing the power on cycle earlier than others, it will be the PM and its role will persist even when a switch with a higher priority joins the stack.

[**NOTE2**] every DGS-3130 model has different time of reaching system ready and this may result in PM determination become unexpected. To avoid the device booting up faster with lower priority being a PM, Stacking-Lite will align the system ready time of every DGS-3130 model under stacking enabled which might need a longer time interval to complete the boot-up process.

Backup Master Election

After the PM is decided, the Backup Master (BM) election is determined by the PM. The BM's election rule is the same as the PM election. The PM will choose the next highest priority as the BM. If there are multiple switches with the same priority, then MAC addresses are compared. The switch with the highest MAC address is chosen as the BM.

Firmware Synchronization

All switches working in a stack must operate with the same active firmware version. When the PM detects that a member's active firmware version is older than the PM's, the firmware synchronization process will start. All stack members' active firmware will be

synchronized and rebooted automatically. If the process fails, the PM will retry the firmware synchronization process. However, if the PM's firmware version is older than the members' version, the PM will do nothing.

Configuration File Backup

In a stable stacking environment, the PM, the BM and the SL should have identical running configuration files. The PM will send the active configuration file to BM and SL once the BM is determined. Every time the configuration file is changed, the PM will then start the synchronization process and send the running configuration file to the BM.

Stacking Lite Details

In this section, more advanced behaviors of Stacking Lite will be introduced.

PM Failure

If the switch designated as the PM fails in the stacking topology, the BM will take over as the PM without resetting any switch's configuration and operation settings. Meanwhile, the new PM will assign a new BM according to BM election rules, resulting in minimal downtime. Furthermore, when a BM becomes a PM, it will inherit the system MAC address and IP address of the original PM. This system MAC address will be the base MAC address to all IP interfaces including the management port and not be saved in any non-volatile memory.

BID Automatic Adjustment

Conflicts between two switches with the same BID number are resolved following the rules below.

1. If one of the switches is the PM, the PM will keep its existing BID. The other switch(es) will be reassigned a new BID.
2. If one of the switches is the BM and the other switch is not the PM, the BM will keep its existing BID. The other switch will be reassigned a new BID.
3. If the conflicting switches are not the PM or the BM, the switch with the higher MAC address will keep its existing BID. The other switch will be reassigned a new BID.
4. If the switches are in a stable state (having been assigned as either the PM, BM, or SL) and the

newly joined switch is not, the switches in stable state can keep their existing BID. The newest switch will be assigned a new BID.

Out of Stacking (OoS)

If the number of stacking switches exceeds the nine (9) switches limitation, out of stacking occurs. The unassigned switch will stay in the initial state and display "E" in the seven-segment LED. The console will show the relevant error messages.

Stacking Cost

The maximum number of switches in a stack is limited by stacking cost or the maximum number of stacking devices. For example, in the DGS-3130 series, the total stacking cost is 12 and the maximum number of stacking devices is 9. DGS-3130-30TS/30S/30PS models each occupy one stacking cost and DGS-3130-54TS/54S/54PS models each occupy two stacking costs in a stack. Therefore, if the stack is constructed of DGS-3130-30TS/30S/30PS series switches, the maximum stacking number is 9 devices per stack. If the stack is constructed of DGS-3130-54TS/54S/54PS switches, the maximum stacking number is 6 devices per stack due to the total stacking cost limitation of 12. If the stack is constructed of DGS-3130-30TS/30S/30PS and DGS-3130-54TS/54S/54PS switches, the stacking number is limited by the total stacking cost and the maximum number of stacking devices.

Seven Segment LED

The seven-segment display (LED) will show "0" continuously during the stacking discovery process. After the stacking topology becomes stable, the LED will display the following information according to the following conditions.

PM: The LED will switch between displaying BID and "H" every 2 seconds.

BM: The LED will switch between displaying BID and "h" every 2 seconds.

SL: The LED will display BID.

Warning State: The LED will switch between displaying BID and "E" every 2 seconds.

Reboot Conditions

Some operations may cause Stacking Lite to reboot switches automatically. Refer to the list of reboot conditions below:

1. Whenever an original PM loses in the new PM election, this will trigger all switches in the original stack to reboot.
2. When a PM is renumbered by the user, this will trigger all switches in the stack to reboot.
3. When performing a factory reset of the PM, this will trigger all switches in the stack to reboot.
4. When BM or Slave (SL) is renumbered by the user, the renumbered BM or SL will be triggered to reboot.
5. When the stacking firmware synchronization is done, the stack will reboot if requested by the PM.

Stacking Priority

Stacking Priority is used to define the precedence of PM/BM election by assigning switches a value ranging from 0 to 15. The higher number the value, the higher the stacking priority of the switch. 0 indicates an unassigned switch. The default setting is unassigned.

Stacking Lite Limitation

1. In a stack system, when the PM upgrades the boot image, only the PM will perform the boot image upgrade. The PM will not synchronize the boot image with other members.
2. In a stack system, the role of PM persists unless another PM with a higher priority or the same priority but with a higher MAC address joins the existing stack system.
3. The configuration file synchronization timing is not manageable.
4. Stacking Lite will not notify users that the configuration file is being written into the device's flash memory.
5. Changing the priority value and setting a new priority value will take effect immediately.
6. In a stack system, the SSH and SSL certificate files can be synchronized when the configuration file is saved as a start-up configuration file or the PM reboots after saving configuration file changes.
7. When two stacking systems are merged together into one, the group (a set of switches) that loses its PM election will be triggered to reboot and then re-join the new stacking system.
8. The PM switch's MAC address is used as the MAC address of the management port. When a BM becomes the new PM, the new PM will inherit the old PM's MAC address. However, this inherited MAC address will not overwrite the new PM's original (burn-in) MAC address. Therefore, the "show version" command in the new PM will display the inherited PM MAC address instead of the native (burn-in) "Device MAC Address".
9. The inherited System MAC address will be purged when the device is rebooted.
10. When the BM is determined, the BM election process will not be triggered even when a switch with a higher priority or MAC address joins the stacking system.
11. A mixed hardware stack is not supported. The switches in the stack must be of the same model series.
12. Chain topology is not stable in Stacking Lite when a single stacking member fails. Ring topology is strongly recommended in a Stacking Lite environment.
13. The amount of stacking connections cannot exceed the maximum Stacking Cost.
14. The execution of configuration-related commands such as "show running-config", "copy running-config", will depend on the total amount of connected interfaces in the stack and the stability of this stacking system. The execution time may take more than 30 seconds.
15. The "show stack" command will not display the bandwidth information of the device that is either in "code-mismatch" or "updating-code" status'. In addition, this command will not display the link partner's BID when the link partner is in the above mentioned two statuses.

Conclusion

Stacking Lite help network managers achieve a flexible and scalable network architecture. The network manager can control hundreds of ports through a single PM's configuration and Stacking Lite will automatically deploy the configuration to all switches in the stack. The BM plays a redundant role in the Stacking Lite environment and by cooperating with the PM, minimizes network downtime.

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Configuration Example

In this section, we will show how to set up Stacking Lite for D-Link switches step by step. Stacking Lite supports four stacking topologies, however the use of Ring topology is strongly recommended.

2-port-10GBaseT	2 10GBase-T switch ports are used as stacking ports
2-port-SFP+	2 SFP+ switch ports are used as stacking ports
4-port-Hybrid	2 10GBase-T and 2 SFP+ switch ports are used as stacking ports
4-port-SFP+	4 SFP+ switch ports are used as stacking ports

Scenario 1: Stacking with 2 10GBASE-T Ports

Physical media type: Ethernet cables
Stacking Bandwidth: 40Gbps
Link type: Single link to stacking neighbor units

Switch Units:
Unit 1: DGS-3130-54PS
Unit 2: DGS-3130-30TS
Unit 3: DGS-3130-30TS
Unit 4: DGS-3130-54TS
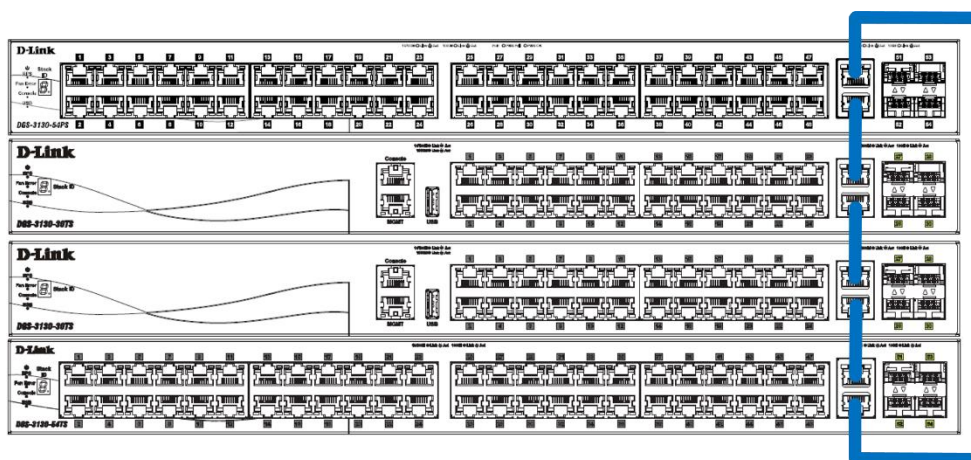
Stacking Ports Connection:
Unit 1 port 50 connects to Unit 2 port 25
Unit 2 port 26 connects to Unit 3 port 25
Unit 3 port 26 connects to Unit 4 port 49
Unit 4 port 50 connects to Unit 1 port 49

Topology

Now we set up all switches by using the following command lines step-by-step.

//enable stacking in each of the switch

Switch> enable
Switch# stack
Switch# stack bandwidth 2-port-10GBaseT
Switch# copy running-config startup-config

//reboot device
Switch# reboot

```
             DGS-3130-54TS Gigabit Ethernet Switch

                      Command Line Interface
                       Firmware: 1.01.B023
           Copyright(C) 2017 D-Link Corporation. All rights reserved.


     Switch>
     Switch>enable

     Switch#stack

      WARNING: The command does not take effect until the next reboot.
     Switch#stack bandwidth 2-port-10GBaseT

      WARNING: The command does not take effect until the next reboot.
     Switch#copy running-config startup-config

     Destination filename startup-config? [y/n]: y

     Saving all configurations to NV-RAM.......... Done
```

//show the stacking information on switch
Switch# show stack

```
     Switch#show stack

     Stacking Mode        : Enabled
     My Box ID            : 1
     Master ID            : 1
     BK Master ID         : 4
     Box Count            : 4

     Box  Module          Priority MAC               PROM/Runtime      H/W  Switch
     ID   Name                                       Version           Ver. Status
     ---  --------------- -------- ----------------- ----------------- ---- -------------
     1    DGS-3130-54PS Unassign 74:DA:DA:33:BB:C4 1.00.003/1.01.B023 A1   OK
     2    DGS-3130-30TS Unassign 74:DA:DA:33:0F:66 1.00.003/1.01.B023 A1   OK
     3    DGS-3130-30TS Unassign 74:DA:DA:33:10:7A 1.00.003/1.01.B023 A1   OK
     4    DGS-3130-54TS Unassign 74:DA:DA:33:2E:50 1.00.003/1.01.B023 A1   OK
     5    --              -        --                --                 -    Not Present
     6    --              -        --                --                 -    Not Present
     7    --              -        --                --                 -    Not Present
     8    --              -        --                --                 -    Not Present
     9    --              -        --                --                 -    Not Present

     Stack Bandwidth:
     Box                  Link         Link          Link Partner
     ID    Interface      Status       Speed (Gb/s)  Box ID
     ----  -------------- ------------ ------------  ------------
     1     0/49           Link Up      10            4
     1     0/50           Link Up      10            3
     2     0/25           Link Up      10            3
     2     0/26           Link Up      10            4
     3     0/25           Link Up      10            1
     3     0/26           Link Up      10            2
     4     0/49           Link Up      10            2
     4     0/50           Link Up      10            1
```

Scenario 2: 2-Port-10GBASE-T with Stacking Priority Assignment

In some application environments, administrators may want to assign one specific unit as the Primary Master. The stacking priority parameter is used to ensure that the specific unit can win the PM election. In this configuration example, one of the DGS-3130-30TS is assigned the highest priority as the Primary Master.

Physical media type: Ethernet cables
Stacking link speed: 40G
Link type: single link to stacking neighbor unit

Switch Units:
Unit 1: DGS-3130-54PS
Unit 2: DGS-3130-30TS
Unit 3: DGS-3130-30TS
Unit 4: DGS-3130-54TS
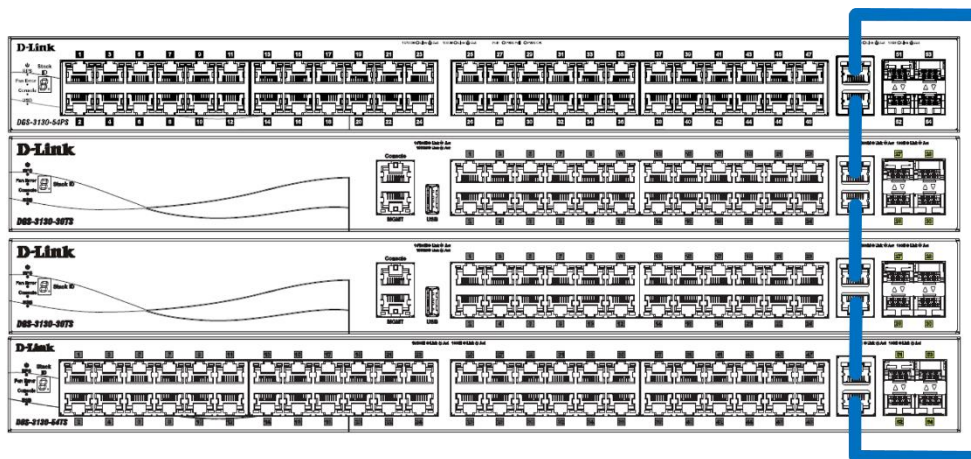
Stacking Ports Connection:
Unit 1 port 50 connects to Unit 2 port 25
Unit 2 port 26 connects to Unit 3 port 25
Unit 3 port 26 connects to Unit 4 port 49
Unit 4 port 50 connects to Unit 1 port 49

Topology

Now we setup all switches by following command lines step-by-step.

//set the highest stacking priority on the specific switch
Switch> enable
Switch# configure terminal
Switch(config)# switch 1 priority 15

```
DGS-3130-30TS Gigabit Ethernet Switch

Command Line Interface
Firmware: 1.01.B023
Copyright(C) 2017 D-Link Corporation. All rights reserved.

Switch>enable

Switch#configure terminal

Switch(config)#switch 1 priority 15
```

//enable stacking on the specific switch and then reboot
Switch# stack
Switch# stack bandwidth 2-port-10GBaseT
Switch# copy running-config startup-config
Switch# reboot

Note: To make sure that this specific switch will be elected as PM, finish the rebooting process of this specific switch before other switches.

//enable stacking in each of the switch and then reboot
Switch> enable
Switch# stack
Switch# stack bandwidth 2-port-10GBaseT
Switch# copy running-config startup-config
Switch# reboot

```
                     DGS-3130-54TS Gigabit Ethernet Switch

                          Command Line Interface
                          Firmware: 1.01.B023
                  Copyright(C) 2017 D-Link Corporation. All rights reserved.

         Switch>
         Switch>enable

         Switch#stack

          WARNING: The command does not take effect until the next reboot.
         Switch#stack bandwidth 2-port-10GBaseT

          WARNING: The command does not take effect until the next reboot.
         Switch#copy running-config startup-config

         Destination filename startup-config? [y/n]: y

         Saving all configurations to NV-RAM.......... Done
```

//show the stacking information on switch
Switch# show stack

The unit with priority 15 wins the PM election and gets assigned as the Primary Master.

```
Switch#show stack

Stacking Mode      : Enabled
My Box ID          : 1
Master ID          : 1
BK Master ID       : 2
Box Count          : 4

Box  Module        Priority MAC               PROM/Runtime         H/W  Switch
ID   Name                                     Version              Ver. Status
---  ------------- -------- ----------------- -------------------- ---- ------------
1    DGS-3130-30TS 15       74:DA:DA:33:10:7A 1.00.003/1.01.B023 A1   OK
2    DGS-3130-54PS Unassign 74:DA:DA:33:BB:C4 1.00.003/1.01.B023 A1   OK
3    DGS-3130-54TS Unassign 74:DA:DA:33:2E:50 1.00.003/1.01.B023 A1   OK
4    DGS-3130-30TS Unassign 74:DA:DA:33:0F:66 1.00.003/1.01.B023 A1   OK
5    --            -        --                --                   -    Not Present
6    --            -        --                --                   -    Not Present
7    --            -        --                --                   -    Not Present
8    --            -        --                --                   -    Not Present
9    --            -        --                --                   -    Not Present

Stack Bandwidth:
Box                    Link           Link           Link Partner
ID      Interface      Status         Speed (Gb/s) Box ID
----    -------------- -------------- ------------ ------------
1       0/25           Link Up        10           2
1       0/26           Link Up        10           4
2       0/49           Link Up        10           3
2       0/50           Link Up        10           1
3       0/49           Link Up        10           4
3       0/50           Link Up        10           2
4       0/25           Link Up        10           1
4       0/26           Link Up        10           3
```

Scenario 3: 4-Port-Hybrid Stacking Bandwidth

Physical media type: Ethernet cables and SFP+ with fiber cables
Stacking link speed: 80G
Link type: pair link to stack neighbor units

Switch Units:
Unit 1: DGS-3130-54PS
Unit 2: DGS-3130-30TS
Unit 3: DGS-3130-30TS
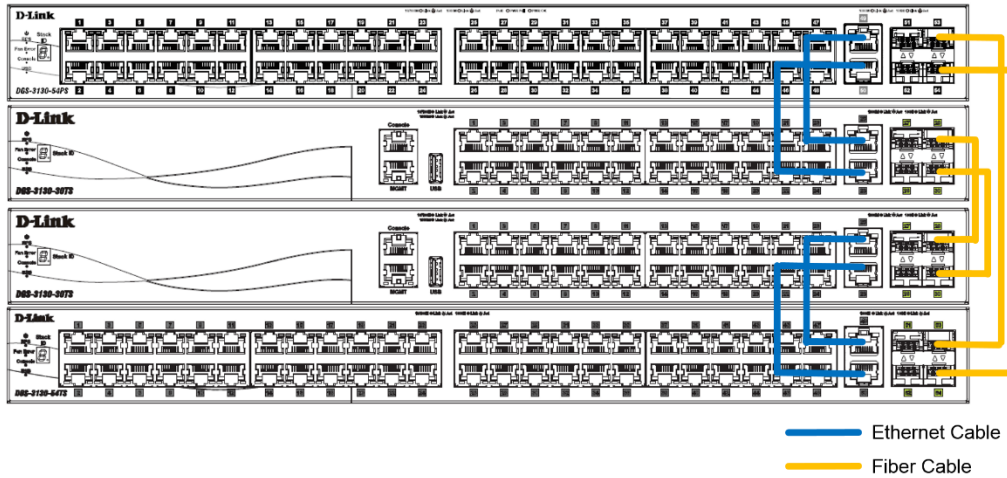Unit 4: DGS-3130-54TS

Stacking Ports Connection:
Unit 1 port 49/50 connects to Unit 2 port 25/26
Unit 2 port 29/30 connects to Unit 3 port 29/30
Unit 3 port 25/26 connects to Unit 4 port 49/50
Unit 4 port 53/54 connects to Unit 1 port 53/54

Topology

Ethernet Cable
Fiber Cable

//enable stacking in each of the switch and then reboot
Switch> enable
Switch# stack
Switch# stack bandwidth 4-port-hybrid
Switch# copy running-config startup-config
Switch# reboot

```
DGS-3130-30TS Gigabit Ethernet Switch

Command Line Interface
Firmware: 1.01.B023
Copyright(C) 2017 D-Link Corporation. All rights reserved.


Switch>
Switch>
Switch>enable

Switch#stack

 WARNING: The command does not take effect until the next reboot.
Switch#stack bandwidth 4-port-hybrid

 WARNING: The command does not take effect until the next reboot.
Switch#copy running-config startup-config

Destination filename startup-config? [y/n]: y

Saving all configurations to NV-RAM......... Done


Switch#reboot

Are you sure you want to reload the stack? (y/n) y
```

//show the stacking information on switch
Switch# show stack

```
Switch#show stack

Stacking Mode       : Enabled
My Box ID           : 1
Master ID           : 1
BK Master ID        : 2
Box Count           : 4

Box  Module        Priority MAC           PROM/Runtime       H/W  Switch
ID   Name                                 Version            Ver. Status
---  -------------  -------- ------------- ------------------ ---- -----------
1    DGS-3130-30TS  Unassign 74:DA:DA:33:10:7A 1.00.003/1.01.B023 A1   OK
2    DGS-3130-54PS  Unassign 74:DA:DA:33:BB:C4 1.00.003/1.01.B023 A1   OK
3    DGS-3130-30TS  Unassign 74:DA:DA:33:0F:66 1.00.003/1.01.B023 A1   OK
4    DGS-3130-54TS  Unassign 74:DA:DA:33:2E:50 1.00.003/1.01.B023 A1   OK
5    --             -        --                --                 -    Not Present
6    --             -        --                --                 -    Not Present
7    --             -        --                --                 -    Not Present
8    --             -        --                --                 -    Not Present
9    --             -        --                --                 -    Not Present

Stack Bandwidth:
Box                 Link         Link          Link Partner
ID   Interface      Status       Speed (Gb/s)  Box ID
---- -------------- ------------ ------------- ------------
1    0/25           Link Up      10            4
1    0/26           Link Up      10            4
1    0/29           Link Up      10            2
1    0/30           Link Up      10            2
2    0/49           Link Up      10            3
2    0/50           Link Up      10            3
2    0/53           Link Up      10            1
2    0/54           Link Up      10            1
3    0/25           Link Up      10            2
3    0/26           Link Up      10            2
3    0/29           Link Up      10            4
3    0/30           Link Up      10            4
4    0/49           Link Up      10            1
4    0/50           Link Up      10            1
4    0/53           Link Up      10            3
4    0/54           Link Up      10            3
```

Appendix – Difference between Stacking Lite and Original D-Link Stacking

The table below shows the difference between Stacking Lite and the original D-Link stacking.

Feature	Stacking Lite	D-Link Stacking
Stacking Cost	Maximum stacking cost is 12	No stacking cost design
Primary Master (PM) Election	Comparing priority first and then MAC address	PM non-preemption first and then comparing priority and MAC address
BID Assignment	If PM assigns a new BID to a member switch, the member switch will reboot.	The member switch will not reboot
PM Non-Preemption	NA	Yes
Stack Bandwidth	Four specific stack bandwidth selections	SIO port configuration
Firmware Synchronization	Automatically synchronize firmware to stacking members	Administrator manually synchronize firmware to stacking members
Configuration Synchronization	1. Synchronize to all stacking members 2. The entire configuration file	1. Synchronize to all stacking members 2. Only the parts of configuration file that has been changed 3. Real-time synchronization

	3. When changes happen in configuration file, a timer will trigger to synchronization processes	
File System Access	PM can access all files in the member's file system	PM can access all files in the member's file system
Stacking Merge (PM Change)	After new PM is decided, all other switches will reboot	After new PM is decided, rebooting is not necessary
System Inheritance	1. When a BM becomes the PM, it inherits the system MAC address and IP address from the original stacking system. This system MAC address will be the base MAC address of all IP interfaces including the management port and not be saved in any non-volatile memory 2. All stacking members inherit the system MAC address and IP address	The stacking member will inherit the PM's system/port/interface MAC address if the PM is missing
Topology	Ring topology is strongly recommended	Chain and ring topology are available
PM and BM Missing	When PM and BM are both missing simultaneously, a new PM will be elected.	When PM and BM are both missing simultaneously, a new PM will be elected.

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