

SummitStack Stacking Technology

Introduction

Extreme Networks® SummitStack™ stacking technology enables the physical connection of up to eight individual Summit® switches together as a single logical unit. This logical unit reduces the management overhead of fixed configuration switches by behaving as a single switch with a single IP address and a single point of authentication. In ExtremeXOS®, Extreme Networks edge-to-core modular operating system, a stack is controlled by a master switch, called the master. The master switch runs the full-featured version of ExtremeXOS and is responsible for maintaining all of the software tables for all the switches in the stack. There can only be one master switch in a stack of switches. All switches in the stack, including the master switch, are called nodes.

A stack of Summit switches can be thought of as a Virtual Chassis™. Each node acts as if it was occupying a slot in a chassis and is controlled by the master. The high-speed stacking links function like the backplane links of a chassis. Stacking offers customers a flexible way to increase switch density and capacity, provides port configuration choices, and controls upfront capital requirements. SummitStack permits mixing and matching Summit switches in a multi-platform stack to provide the port configuration you need, from Ethernet, Fast Ethernet, Gigabit Ethernet to 10 Gigabit Ethernet, in copper, Power over Ethernet (PoE), Power over Ethernet Plus (PoE-plus) and fiber optic interfaces.

The master switch stores any configuration information for the stack in its primary and secondary flash memory. Since the master switch has the knowledge of the state and the

configuration of all the other switches in the stack, it can respond to all external requests for those switches. For example, the master switch can respond to a request for SNMP information from all ports within the stack.

SummitStack is supported through dedicated stacking port functionality with specific stack cables or through the use of existing 10 Gigabit Ethernet ports to stack the switches together. The latter option allows for physical flexibility when stacking needs to be carried over longer distances than is supported in the dedicated stacking cables.

SummitStack is an Extreme Networks solution for fixed configuration switches to provide simplified yet agile operations for scalable converged networks. The mechanism supports many network topology designs and is Ethernet based requiring no new hardware or interfaces.

This technology brief introduces different varieties of stacking and can help clarify areas of potential confusion. Topics covered include: different topologies possible with stacking, aspects of configuring and managing a stack, what happens during stack topology changes, and how to configure a stack for the first time.

SummitStack Varieties

The following table shows the different stacking options available on Extreme Networks stacking products.

Table 1

Stacking Options	Speed per Link (HDX)	Cable Type & Lengths	Summit Switch Series
SummitStack	10 Gbps	0.5m, 1.5m, 3.0m 20G Stacking Cable	Summit X250 Summit X450a Summit X450e Summit X460 Summit X480 Summit X650
SummitStack-V	10 Gbps	0.5m – 100m SFP+, XFP, XENPAK, 10GBaseT	Summit X450a Summit X450e Summit X460 Summit X480 Summit X650
SummitStack-V80	20 Gbps	0.5m – 100m QSFP+ only	Summit X460
SummitStack128	32 Gbps	0.5m, 1.0m, 3.0m	Summit X480 with conversion cable to SummitStack256
SummitStack256	64 Gbps	0.5m, 1.0m, 3.0m	Summit X650
SummitStack512	128 Gbps	0.5m, 1.0m, 3.0m	Summit X650

SummitStack Topologies

Figure 1 presents a graphical representation of a stack and some of the terms that describe stack conditions.

A stack is the collection of all nodes that are cabled together in a stack.

A stack topology is the set of contiguous nodes that are powered up and communicating with each other. Switch 8 is not part of the stack topology in Figure 1 because it is not powered up.

An active topology is the set of contiguous nodes that are active. An active node is powered up, configured for SummitStack operation, and communicating with the other active nodes. Switch 5 in Figure 1 has failed, and stacking is disabled on Switch 6 and Switch 7. Switch 8 has no power, so the active topology includes switches: Switch 1, Switch 2, Switch 3, and Switch 4.

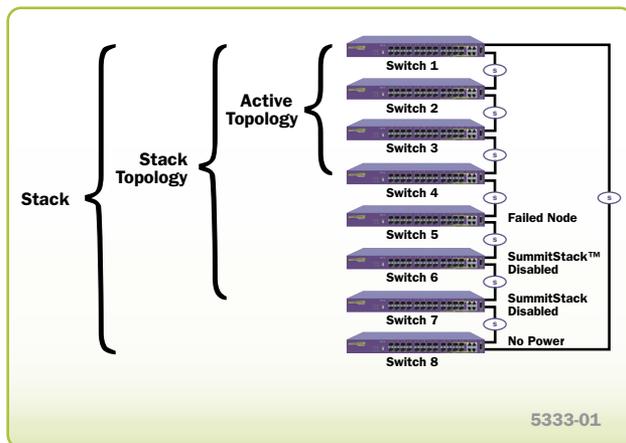


Figure 1: Stack and Topologies

Ring Topology

SummitStack nodes should be connected to each other in a ring topology. In a ring topology, one link is used to connect to a node and the other link is used to connect to another node. The result forms a physical ring connection. This topology is highly recommended for normal operation. Figure 2 shows a maximal ring topology of eight active nodes.

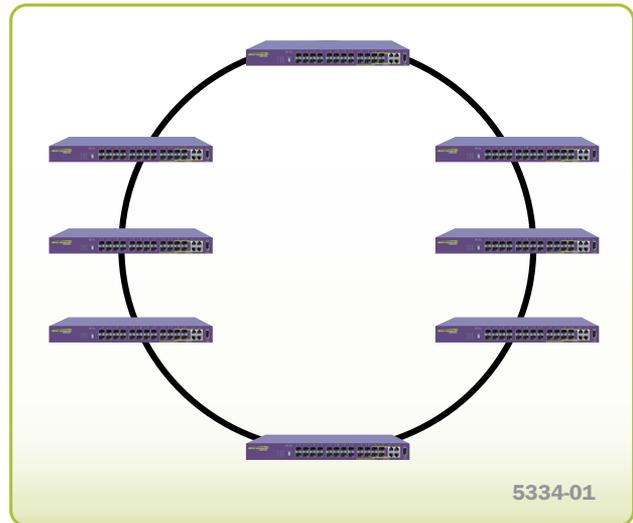


Figure 2: Graphical Representation of Ring Topology

While a physical ring connection may be present, a ring active topology only exists if all nodes in the stack are active nodes. Figure 3 shows eight active Summit X450 series switches in an ring topology.



Figure 3: Summit X450 Series in a Ring Topology

Daisy-Chain Topology

Stackable switches may be connected in a daisy-chain topology. This is a ring topology with one of the links disconnected, inoperative, or disabled. A daisy chain can be created when a link fails or a node reboots in a ring topology, but the daisy-chain topology is not recommended for normal operation. In Figure 4, the nodes delineated as the active topology are operating in a daisy-chain configuration, even though there is physically a ring connection in the stack.



Figure 4: Summit X250e Series in Daisy-Chain Topology

Stack Depth

A maximum of eight nodes are supported in the active topology. The slot number configuration assigns only numbers from one to eight.

The stack tolerates an accidental connection of up to 17 nodes. Because only eight nodes can join an active topology, there should never be an accidental connection of two stacks resulting in more than 16 nodes. If you have more than 17 nodes in a stack topology, all nodes enter an *overflow* state and all stacking links enter a *link overflow* state. While in an overflow state, the active topology does not function. All slots containing active nodes show a *failed state*. The overflow state is maintained until the overflow is cleared by manually disconnecting a sufficient number of nodes. After the overflow is cleared all nodes in the stack topology reboot.

To see all the nodes in a stack topology, use the `show stacking` command.

Understanding SummitStack Configuration Parameters, Configuration Files, and Port Numbering

Stacking configurations are stored in the NVRAM of each node. Some of these configurations take effect only during the next node restart. See Table 2 for stacking configuration items, times of effect and default values.

Stacking parameters, such as mode, slot number, etc., can be configured from a single unit in the stack topology. You can change the stacking-specific configuration even when a node is not in stacking mode but is connected to the stack. The target node for the configuration must be powered on and running a version of ExtremeXOS that supports stacking. Further, the node need not be in stacking mode and can be in any node role.

Most ExtremeXOS configuration parameters are not stored in NVRAM, but are instead stored in a configuration file. Configurations stored in NVRAM are those that are needed when the configuration file is not available. The configuration file chosen for the stack is the one selected on the master node that is first elected after a stack restart.

Table 2: Stacking Configuration Items, Time of Effect and Default Value

Configuration Item	Takes Effect	Default Value
Stacking Mode	At boot time	Disabled
Slot Number	At boot time	1
Master-Capable	At boot time	Yes
License Registration	At boot time	Not configured
Priority	At the next master election	Automatic
Alternate IP Address	Immediately	Not configured
Stack MAC	At boot time	Not configured

The data (non-stacking) port numbers, in the existing configuration files (which were created when not in stacking mode), are simple integer quantities. On a stack, the data port numbers are expressed as slot:port where the slot is an integer representing the slot and port is an integer representing the port, for example: 1:2. The configuration file contains an indication that it was created on a stackable switch in stacking mode. The indication is the stacking platform ID.

Thus when in stacking mode, the ports are referenced in the configuration file with the slot:port notation and when not in stacking mode, the ports are referenced as simple integers.

When the stack restarts, if a switch becomes the master and its selected configuration file was not created in stacking mode, the configuration file is deselected, and the stack completes its restart using a default configuration. In addition, if the previously selected file was named with one of the default names (*primary.cfg* or *secondary.cfg*), the file is renamed to *old_non_stack.cfg*.

Similarly, if a switch is configured not to operate in stacking mode and the selected configuration file was created in stacking mode, the configuration file is deselected, and the switch boots with a default configuration. In addition, if the file was named with one of the default names (*primary.cfg* or *secondary.cfg*), the file is renamed to *old_stack.cfg*.

The renamed file replaces any file that exists with the same name; the existing file is deleted.

Understanding Stacking Link Over Commitment

The stack is formed by each node supplying a pair of full-duplex 10 Gbps stacking ports. Each node can operate on a stack with up to 20 Gbps full duplex throughput.

Even though two links are available, the links might not be fully utilized. For example, suppose there is a ring of eight nodes and the nodes are numbered clockwise from 1 to 8. Suppose node 1 wants to send 10 Gbps of unicast traffic to each of node 2 and node 3. The shortest path topology forces all traffic from node 1 over the link to node 2. Traffic from node 1 to node 3 passes through node 2. Thus, there is only 10 Gbps available. However, if node 1 wanted to send 10 Gbps to node 2 and node 8, there would be 20 Gbps available because both links connected to node 1 would be used.

In a ring of eight nodes, between any two nodes (with one exception), only one link is used. If the devices provide 48 1 Gbps Ethernet ports, the over commitment ratio between two such nodes is approximately 5:1. The exception is if there is an equal distance between the nodes. In this case, if both nodes are 48-port nodes, the nodes are grouped into two groups of 24 ports (by the hardware architecture), and thus it is possible to use both directions around the stack.

About SummitStack-V Stacking Using 10 GbE Ports

In future developments of ExtremeXOS, a stack can be connected using 10 GbE ports. These ports are the optional 10 GbE ports provided on the stackable switches but are repurposed to allow the stacking function to utilize these ports. This technology will provide greater distances for

stacking topologies and will allow for standard interface media such as XENPAK, XFP, SFP+ or 10GBASE-T RJ45 to create stack links. With this technology it is now possible to create stack links that are more than five meters in length, and stacking can now be used between physical locations. It is important to note that once a 10 GbE stacking port is configured into stacking mode, the port cannot be used for any other use, and is unusable for Ethernet traffic.

- Stacking is only supported using 10 GbE ports. (10/100/1000 Mbps ports are not usable for stacking)
- Stacking ports must be directly connected between the two nodes in the stack. (No devices active or passive in between.)

About SummitStack Logging Messages

Each node may generate log messages through the usual logging mechanism.

On backup and standby nodes, a log target and related filter is automatically installed. The log target is the master node. The filter allows all messages that have a log level of warning, error, or critical to be saved in the log file of the master node.

If the master node changes the log target is updated on all the remaining nodes.

You can also log in to any node in the active topology and see the complete log of the node.

About Quality of Service in Stacking

Each SummitStack uses Quality of Service (QoS) on the stacking links to prioritize the following traffic within the stack:

- Stack topology control packets
- ExtremeXOS control packets
- Data packets

For stack performance and reliability, the priority of control packets is elevated over that of data packets. This is done to prevent control packet loss and avoid the timed retries that can lower performance. It is also done to prevent unneeded stack topology changes that can occur if enough stack topology information packets are lost. For these reasons, SummitStack reserves one QoS profile to provide higher priority to control packets.

About Power Management and PoE/PoE-plus

The power management for PoE or PoE-plus is applicable only if there are one or more Summit X460 (PoE-plus), Summit X450e (PoE), or Summit X250e (PoE) switches in a stack.

Each Summit X450e, Summit X460 or Summit X250e switch is equipped with its own independent power supply that provides power for the PoE ports on that switch. Power is not shared with other switches in the stack. PoE configuration and status are maintained on the master node. Configuration information is sent by the master to the hardware on each PoE capable switch to be controlled by the local PoE hardware on that switch. Status is gathered on the master by querying the PoE hardware on each switch. The power supply for each Summit X450e switch is capable of providing a full 15.4 watts per PoE port for all 24 ports or 48 ports, Summit X460 switches are capable of providing full 30 watts PoE-plus power for up to a total of 760 watts budget when two AC PoE PSUs are installed.

About Stacking Node Roles, Redundancy, and Failover

The ExtremeXOS operating system supports control plane redundancy and *hitless failover* for stacks. Hitless failover is supported to the extent that the failing master node and all of its ports are operationally lost, including the loss of supplied power on any PoE ports that the node provided, but all other nodes and their provided ports continue to operate. After the failover, the backup node becomes the master node.

At failover time, a new backup node is selected from the remaining standby nodes that are configured to be master capable. All operational databases are then synchronized from the new master node to the new backup node. Another hitless failover is possible only after the initial synchronization to the new backup node has completed. This can be seen using the `show switch {detail}` command on the master node and noting that the new backup node is *In Sync*.

When a backup node transitions to the master node role, it activates the Management IP interface that is common to the whole stack. If you have correctly configured an alternate management IP address, the IP address remains reachable.

When a standby node is acquired by a master node, the standby node learns the identity of its backup node. The master node synchronizes a minimal subset of its databases with the standby nodes.

When a standby node loses contact with both its acquiring master and backup nodes, it reboots.

A master node that detects the loss of an acquired standby node indicates that the *slot* the standby node occupied is now *empty* and flushes its dynamic databases of all information previously learned about the lost standby node.

A backup node restarts if the backup node has not completed its initial synchronization with the master node before the master node is lost. When a backup node transitions to the master node role and detects that the master node has not already synchronized a minimal subset of its databases with a standby node, the standby node is restarted.

Reboot or Failure of a Non-Master Node

If a backup node fails, a standby node configured as master-capable is elected as the new backup. That new backup node is then synchronized to the databases of the master node.

For all non-master nodes, a node that reboots or is power cycled loses all of its connections to all networks for the duration of the reboot cycle. Any PoE ports that were providing power prior to the event do not supply power.

When a non-master node fails, the master node marks the related slot as *empty*. All other nodes exclude the failed node from the control path and any customer-configured VLANs, trunk group ports, mirroring ports, and so forth.

Configuring a New Stack

Before deploying a new stack, consider the following guidelines:

- Plan to use the stack as if it were a single multi-slot switch. You need to decide the number and type of stackable switches in the stack and how the stack ports will be connected to the network.
- Physically locate the intended master and backup nodes adjacent to each other, and plan to directly connect these nodes to each other so that ExtremeXOS application synchronization traffic is localized to a single stack link.
- Use stacking cables to interconnect the stack nodes into a ring topology (see Figure 3). Only include the nodes that are intended to be active in the stack. To see the recommended procedures for installing and interconnecting a stack, refer to the hardware documentation.

You can physically connect the stack to your networks before the nodes are configured. However, the default configuration on a non-stacking mode switch assumes a default untagged VLAN that contains all switch ports. When first powered on, the switch acts as a Layer 2 switch, possibly resulting in network loops.

- Make sure all nodes support the SummitStack feature and are running the same ExtremeXOS software version. To view the ExtremeXOS software version on a node, restart the node and run the command `show version {detail | process <name> | images {partition <partition>} {slot <slotid>}}`. If any of the nodes do not have the right version, install the correct version on that switch. Extreme Networks recommends that you use the same image partition on all nodes. Once stacking is enabled, an image upgrade on the stack is possible only if the same image is selected on all nodes.
- If you intend to deploy new units that might be part of a stack in the future, you may want to turn on stacking mode during initial deployment to avoid a future restart. The disadvantages of stacking mode are the loss of the two QoS profiles QP6 and QP7 and the reservation of some of the packet buffer space for stacking control traffic.
- You can configure the stack by logging into the master or any of the other nodes.
- If the stackable switches have different purchased license levels, you may need to configure license level restrictions on some nodes before those nodes can join the stack.
- Most stacking specific configurations are effective only after a restart (see Table 2). However, most non-stacking configuration commands take effect immediately and require no restart.
- A basic stack configuration can be achieved by using the procedure described in the “About Easy Setup” section below.

About Easy Setup

Using Easy Setup, you can configure a stack without entering many of the stacking CLI commands. Easy Setup provides you an easy way to configure the required stacking parameters for all nodes.

The Easy Setup procedure creates a stack with a master and a backup. The remaining nodes are configured with the master capability disabled. Extreme Networks recommends

that you configure the stacking license restriction, if needed, before invoking Easy Setup. Otherwise, an additional stack reboot might be needed.

The configuration procedure described in the next section starts Easy Setup. You can also start Easy Setup by entering the `configure stacking easy-setup` command.

Easy Setup performs the functions of the following five commands required to configure and activate the stack:

- `enable stacking`
- `configure stacking slot-number automatic`
- `configure stacking mac-address`
- `configure stacking redundancy`
- `minimal reboot stack-topology`

In a daisy-chain topology (which is not recommended), Easy Setup instead designates the node at the beginning of the chain as the master, and executes the command `configure stacking redundancy none`.

Summary

SummitStack is an Extreme Networks solution for fixed configuration switches to provide simplified yet agile operations for scalable converged networks. The mechanism supports many network topology designs and is Ethernet based requiring no new hardware or interfaces.

Stacking offers customers a flexible way to increase switch density and capacity, provides port configuration choices and controls upfront capital requirements. SummitStack permits mixing and matching Summit switches in a multi-platform stack to provide the port configuration you need, from Ethernet, Fast Ethernet, Gigabit Ethernet to 10 Gigabit Ethernet, with copper, PoE, and fiber interfaces.^{1, 2, 3}

For additional information on SummitStack and ExtremeXOS operating system licensing terms, please refer to the ExtremeXOS Concepts Guide located at <http://www.extremenetworks.com/services/software-userguide.aspx>.

¹ SummitStack (40 Gbps) supports multi-platform stacking among Summit X250e, X450a, X450e, X460, X480 and X650 switches running the same version of ExtremeXOS.

² SummitStack-V80 (80 Gbps) supports Summit X460 switches with planned multi-platform stacking support for Summit X480 and Summit X650 switches running the same version of ExtremeXOS.

³ SummitStack-V (10 Gbps) direct connections are compatible among Summit X450e, X450a, X460, X480 and X650 switches running the same version of ExtremeXOS.

Explanation of SummitStack Terms

Active Node – A node that has joined the control path. The active node can forward the control path messages or can process the control path messages. It can also forward data traffic. Only an active node can appear as a card inserted into a slot when the show slot `{<slot> {detail} | detail }` command is executed on the master node of the stack.

Active Topology – A contiguous set of active nodes in a stack topology plus the set of stacking links that connect them form the active topology. When an active topology consists of more than one node, each node in the active topology is directly and physically connected to at least one other node in the active topology. Thus, the active topology is a set of physically contiguous active nodes within a stack topology. **NOTE** *A node in the stack topology may not necessarily be a member of the active topology.*

Acquired Node – A standby or backup node is normally *acquired* by a master node. This means the master node has used its databases to program the hardware of the standby or backup node. The standby or backup node has acted as a hardware programming *proxy*, accepting the instructions of the master node to do so. An acquired standby node does not maintain the databases needed to reflect why the hardware is programmed as it is; however, a backup node does. An acquired node can only be reacquired (without a reboot) by the backup node when that backup node becomes a master node, and only if both the backup and standby nodes were already acquired by the same master node at the time of its failure.

Backup Node Role – The node that is operating in the backup node role takes over the master node role if the master node fails. The master node keeps the backup node databases in synchronization with its own database in preparation for this event. Upon transfer of role, the backup node becomes the master node and begins operating with the databases it has previously received. This allows all other nodes in the stack to continue operating even after the master node fails.

Candidate Node – A node that is a potential member of an active topology is called a *candidate* node. An active node is also a candidate node. Unlike an active node, a candidate node may not have joined the control path.

Control Path – A data path that is formed over the stacking links that is dedicated to carrying control traffic, such as commands to program hardware or software image data for software upgrade. A node must *join* the control path to fully operate in the stack. A node that is disabled for stacking does not join the control path, but does communicate over the stack path.

Data Ports – This is the set of ports provided by a stackable switch that are available to you for connection to your data networks. Such ports can be members of a user configured VLAN or trunk group, and can be used for Layer 2 and 3 forwarding of user data traffic or for mirroring, or other features you can configure. This term does not refer to stacking ports.

Easy Setup – Easy setup is a procedure that configures the essential stack parameters of every node for initial stack deployment, and automatically reboots the stack to put the parameters into effect. The choice to run easy setup is offered when the `enable stacking {node-address <node-address>}` command is run and the essential stacking parameters are unconfigured or inconsistent. It can also be invoked directly by running the `configure stacking easyssetup` command.

Failover – When a node that is executing the master node role in a stack fails, a failover is initiated. If there is a node that is executing the backup node role, and if the node has completed its initial synchronization with the master node before it failed, the backup node takes on the master node role. The standby nodes continue their operation, and their data ports do not fail.

Hitless Failover – A failover whereby all data ports in the stack, except those of the failing master node, continue normal operation when the master node fails.

Hitless Upgrade – This is an operation where an upgrade of the software image and the commencement of the new image execution are possible without interrupting data traffic or forcing any network reconvergence. This version of SummitStack does not support hitless upgrade.

Master Node Role – A node that is elected as the master (or primary) runs all of the configured control protocols such as OSPF, RIP, Spanning Tree, EAPS, and so forth. The master node controls all data ports on itself, the backup node, and all standby nodes. The master node issues specific programming commands over the control path to the backup or standby nodes to accomplish this purpose.

Node – A node is a stackable switch that runs the ExtremeXOS operating system. The terms *node* and *stackable switch* are interchangeable.

Node Address – Stacking nodes are uniquely identified by their *node address*. This is actually the MAC address that was factory assigned to each node.

Node Role – A node in the active topology plays a role in the stack. There are three node roles: master (or primary), backup, and standby.

Node Role Election – This is the process that determines the role for each node. The election takes place during initial stack startup and elects a master and a backup node. An election also takes place after a master node failover, when a new backup node is elected from the remaining standby nodes.

Node Role Election Priority – For each node, the stack computes a priority to be used in *node role election*. The node with the highest node role election priority during a role election becomes the master node. The node with the second highest node role election priority becomes the backup.

Operational Node – This is a node that has achieved operational state as a *card* in a *slot*. The operational state can be displayed using the `show slot {<slot> {detail} | detail }` command.

Stack – A stack is a set of stackable switches and their connected stacking links made with the intentions that: (1) all switches are reachable through their common connections; (2) a single stackable switch can manage the entire stack; and (3) configurable entities such as VLANs and link trunk groups can have members on multiple stackable switches. A stack consists of all connected nodes regardless of the state of these nodes.

Stack Path – A data path that is formed over the stacking links for the purpose of determining the set of nodes that are present in the stack topology and their locations in the stack. Every node is always present in a stack path whether or not stacking is enabled on the node.

Stack Segment – This is a collection of nodes that form a stack topology. The term is useful when a stack is severed. Each severed portion of the stack is referred to as a stack segment.

Stack State – A state assigned by the stack to a node. This can be displayed using the command `show stacking`.

Stack Topology – A contiguously connected set of nodes in a stack that are currently communicating with one another. All nodes that appear in the show stacking command display are present in the stack topology.

Stackable Switch – A Summit family switch that provides two stacking ports and can participate in a stack.

Stacking Link – A wire that connects a stacking port of one stackable switch to a stacking port of another stackable switch, plus the stacking ports themselves.

Stacking Port – A physical interface of a stackable switch that is used to allow the connection of a stacking link. Stacking ports are point-to-point links that are dedicated for the purpose of forming a stack.

Standby Node Role – A node that is executing the standby node role is prepared to become a backup node in the event that the backup node becomes the master node. When becoming a backup node, the new master node synchronizes all of its databases to the new backup node. As a standby node, most databases are not synchronized, except for those few that directly relate to hardware programming.

System Uptime – This is the amount of time that has passed since a stack first elected a master node after the stack last rebooted. The time can be displayed on a master node by entering the `show switch {detail}` command.



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