Introduction

This document will provide you with the guidelines for creating a high-performance, highly available IP network for use with HP P4000 SANs. As of the writing of this document, this paper applies only to the server based storage nodes, such as the P4500 and P4300. You’ll find important configuration guidelines, best practices, and frequently asked questions that will help you to accelerate a successful deployment.

Implementing HP P4000 SAN solutions along with standard networking and iSCSI technology enables the creation of enterprise-class storage systems at a reasonable price point. Given the options available, HP does recommend specific configurations to promote ease of deployment and functionality.

General recommendations

• Adhere to the recommended switching requirements to reduce performance and configuration concerns (see Specific network recommendations, Recommended switch infrastructure for an HP P4000 SAN, and Table 1).
• Implement adaptive load balancing (ALB) network interface card (NIC) bonding on the storage node for 1 Gigabit and 10 Gigabit Ethernet (GbE) networks.
• To achieve superior performance and redundancy in Microsoft® Windows® Server environments, implement Microsoft Multipath I/O (MPIO) along with the either P4000 device-specific module (DSM) or the Microsoft DSM. For more information on Microsoft MPIO options for P4000, please read the P4000 Windows Solution Pack user guide.
• For NIC fault tolerance and performance with other operating systems, implement NIC bonding in the host software where supported.

Specific network recommendations

• Implement a separate subnet or VLAN for the IP storage network so that you have dedicated bandwidth and storage traffic is contained within your storage network.
• Implement a fault-tolerant switch environment as a separate VLAN through a core switch infrastructure or multiple redundant switches.
• Set Access controls and traffic filtering to ensure that only authorized devices have access to your storage or administrative traffic.
• Set the individual ports connected to the storage nodes and host servers auto negotiate speed, duplex and flow control at the host/node port level.
• Implement switches that have full-duplex, non-blocking mesh backplane.
• Switch buffer mechanism has an impact on the performance of the switch. HP suggests at minimum 512k packet buffer per port.
• Use switches with a low or non-existent oversubscription ratio on a per port, card, or backplane basis. If oversubscription is necessary, cable your storage devices and clients so storage nodes and initiators are balanced across oversubscribed domains.
• Implement flow control on the storage network switch infrastructure. Failure to implement flow control at server, on all storage and network ports connected to the SAN can cause storage performance issues.
• Create separate network segments to isolate your production and storage traffic.
• Ensure that the storage environment has access to network services via direct connections or appropriate routing.
• Optionally, implement jumbo frame support on the switch, storage nodes, and all servers connected to the HP P4000 SAN. If implemented, it must be done on all storage and network ports connected to the SAN.
Recommended switch infrastructure for an HP P4000 SAN

HP does not recommend any particular switch for use with HP P4000 SANs. However, there is a set of minimum switch capabilities that make building a high-performance, high-availability storage network a relatively easy and cost effective task.

The following are three commonly recommended HP switches, but ultimately you will need to follow the recommended switch capabilities in Table 1 below which provides guidance for general switch selection based on your specific needs. As a rule of thumb, any enterprise-class managed switch typically has the capabilities required for most customer installations.

- HP E2910 al Switch Series (10/100/1000Base-T & 4 x optional 10GbE)
- HP A5810-48G Switch (10/100/1000Base-T & 2 x 10GbE)
- HP E6600 Switch Series (10/100/1000Base-T and 10-GbE SFP+)

For common CLI commands for HP and Cisco switches, please download the HP Networking and Cisco CLI Reference Guide, which compares many of the common commands in the HP ProVision, Comware 5, and Cisco operating systems.

Table 1. Minimum recommended switch capabilities for an HP P4000 SAN

<table>
<thead>
<tr>
<th>Switch capability</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gigabit Ethernet support</td>
<td>Each storage node comes with a minimum of two Gigabit Ethernet ports (802.3ab). For proper operation of the SAN environment, Gigabit Ethernet support is required for each device in the SAN infrastructure.</td>
</tr>
<tr>
<td>Non-blocking backplane design</td>
<td>In order to achieve maximum performance on the HP P4000 SAN, it is important to select a switch that has a fully subscribed backplane, which means that the backplane must be capable of supporting all full-duplex communication on all ports simultaneously. For instance, if the switch has 24 10 Gb ports, it will require 480 Gb backplane to support full-duplex Gigabit communications.</td>
</tr>
<tr>
<td>Sufficient per-port buffer cache</td>
<td>For optimal switch performance, HP recommends that the switch have at least 512 KB* of buffer cache per port. Consult your switch manufacturer specifications for the total buffer cache. For example, if the switch has 48*1 Gb ports, the recommendation is to have at least 24 MB of buffer cache dedicated to those ports. If the switch aggregates cache among a group of ports (for example, 1 MB of cache per 8 ports), space your storage nodes and servers appropriately to avoid cache oversubscription. Many switches can be adjusted in regards to the number of buffers per port and memory allocated for each buffer. If possible, tune these parameters to increase the available buffer cache for the storage node ports.</td>
</tr>
<tr>
<td>Flow control support</td>
<td>IP storage networks are unique in the amount of sustained bandwidth that is required to maintain adequate performance levels under heavy workloads. Gigabit Ethernet flow control (802.3x) technology should be enabled on the switch to eliminate, receive, and/or transmit buffer cache pressure. The storage nodes should also be set to have flow control auto-negotiated. Flow control is required when using the MPIO DSM.</td>
</tr>
<tr>
<td>Support for Switch Stacking</td>
<td>For proper management and failover, HP recommends that all switches in your SAN infrastructure be capable of participating in a stacking mechanism for central administration and control. Individual switch manufacturer ISL (Inter-Switch Linking) support is required to link all switches in a SAN infrastructure together. For non-IRF (Intelligent Resilient Framework) switches, the switch should support designating one or more (through Link Aggregation Groups) ports for inter-switch links.</td>
</tr>
<tr>
<td>Individual port speed and duplex setting</td>
<td>HP recommends that all ports on the switch, servers and storage nodes be configured to auto-negotiate duplex and speed settings. Although most switches and NICs will auto-negotiate the optimal performance setting, if a single port on the IP storage network negotiates a sub-optimal (100 Mb/s or less and/or half-duplex) setting, performance of the entire SAN performance can be degraded. Check each switch and NIC port to make sure the auto-negotiation resolves to 1000 or 10,000 Mb/s accordingly with full duplex. P4000 10GbE adapters are configured as 10 Gb, full duplex only, thus the storage network must be 10 Gb.</td>
</tr>
</tbody>
</table>

* This value can be changed on the HP Networking and Cisco switches to reduce the number of buffers but increase the size of each individual buffer cache.
### Switch capability

<table>
<thead>
<tr>
<th>Switch capability</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLAN support</td>
<td>HP recommends implementing a separate subnet or VLAN for the IP storage network. If you are implementing VLAN technology within the switch infrastructure, you will typically need to enable VLAN tagging (802.1q) and/or VLAN trunking (802.1q) or Cisco Inter-Switch Link (ISL). Trunk aggregation (802.3ad or vendor specific) support is required for full bandwidth. Consult your switch manufacturer's configuration guidelines when enabling VLAN support.</td>
</tr>
<tr>
<td>Basic IP routing</td>
<td>The storage nodes require access to external services such as DNS, SMTP, SNMP and Syslog. To support this traffic, you must provide access to these services on your storage network, or provide routing to external services. In addition, if the storage nodes are to be managed from a remote network, an IP route must exist to the storage nodes from the management station. Finally, if remote copy functionality is going to be used, the remote copy traffic must be direct access between the primary and remote sites.</td>
</tr>
<tr>
<td>Spanning Tree/Rapid Spanning Tree</td>
<td>To build a high availability IP storage network, multiple switches are typically connected into a single Layer 2 (OSI Model) broadcast domain using multiple interconnects. In order to avoid Layer 2 loops, the Spanning Tree protocol (802.1D) or Rapid Spanning Tree protocol (802.1w) must be implemented in the switch infrastructure. Failing to do so can cause numerous issues on the IP storage networks, including performance degradation or even traffic storms. If supported by the switch infrastructure, HP recommends implementing Rapid Spanning Tree (R-STP) for faster Spanning Tree convergence. R-STP must be enabled on all ports used for ISLs. All non-ISL ports should be marked as “edge” ports. If configured on the switch, disable Spanning Tree on the storage node and server switch ports so that they do not participate in the Spanning Tree convergence protocol timing.</td>
</tr>
<tr>
<td>Jumbo frame support</td>
<td>Large sequential read and write workloads can benefit approximately 10–15% from a larger Ethernet frame. The storage nodes are capable of frame sizes up to 9 KB. Jumbo frames must be enabled on the switch, storage nodes, and all servers connected to the HP P4000 SAN. Typically, jumbo frames are enabled globally or per-VLAN on the switch, and on a per-port basis on the server. Jumbo frames are enabled individually on each Gigabit NIC in the storage node. Jumbo frame sizes can be different for each brand. Check your switch documentation on enabling jumbo frames to determine the proper values taking into account header sizes and padding. It should be noted that performance could be degraded on certain applications if large frames are enabled.</td>
</tr>
</tbody>
</table>
Storage node connection options

HP P4000 rack mounted storage nodes come equipped with two 1GbE network interfaces standard. When building high-performance, high-availability IP storage networks, HP recommends implementing NIC bonding on every storage node connected to the network. HP SAN/iQ-powered storage nodes support a variety of network interface bonding techniques, and you should choose the appropriate NIC bonding solution for your environment. The HP P4000 allows each storage node to be represented as a single IP address on the network; at this writing, the software does not support storage nodes with multiple IP connections to the same network. Table 2 highlights the HP P4000 software-supported NIC bonding types and provides recommendations for using each of them.

Table 2. HP SAN/iQ software NIC-bonding support

<table>
<thead>
<tr>
<th>NIC bonding support</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adaptive load balancing</strong></td>
<td>ALB is the most flexible NIC bonding technique that can be enabled on the storage nodes. It provides for increased bandwidth and fault tolerance. Typically, no special switch configuration is needed in order to implement ALB. Both NICs in the storage nodes are made active, and they can be connected to different switches for active-active port failover. Any individual client will not exceed bandwidth of an individual link. ALB is supported only for NICs with the same speeds: for example, 2GbE NICs. ALB is not supported between a 10GbE NIC and 1GbE NIC.</td>
</tr>
<tr>
<td>Active/Passive</td>
<td>Active/Passive NIC bonding is the simplest NIC bonding technique that can be enabled on the storage nodes. It provides for high availability only. No special switch configuration is typically required to implement active/passive bonding. Only a single NIC is made active, while the other NIC is made passive. Therefore, an active/passive only a single port is active.</td>
</tr>
<tr>
<td>Link aggregation—802.3ad</td>
<td>Link aggregation (LACP/802.3ad) NIC bonding is the most complex NIC bonding technique that can be enabled on the storage nodes. It provides for link aggregation only. Link aggregation bonds must typically be built on both the storage node and switch as port pairs. Both NICs in the storage nodes are made active; however they can only be connected to a single switch or in a stacked switch configuration where the stack is one logical switch (unless switch vendor provides proprietary extensions to make it multi-switch aware). An individual client will not exceed the bandwidth of an individual link. 802.3ad is supported only for NICs with the same speed and duplex: for example, two Gigabit Ethernet NICs. 802.3ad is not supported between a 10GbE NIC and a 1GbE NIC.</td>
</tr>
</tbody>
</table>

Note these other general recommendations when implementing NIC bonding on the storage nodes:
1. Implement the same NIC bonding type on all storage nodes in the cluster.
2. Implement NIC bonding before joining the storage node to the management group.
Sample configurations

This section illustrates a recommended P4000 configuration.

- **Switch infrastructure**—Dual redundant gigabit switches trunked together for bandwidth and fault tolerance.
- **Storage node connectivity**—ALB NIC bond with one port connected to each switch.
- **Host server connectivity**—Dual NICs connected to the IP storage network with a single port connected to each switch. Multi-NIC configurations in Microsoft Windows require either the Microsoft or P4000 DSM for MPIO to be installed. Network bonding (or teaming) is not supported with the Microsoft iSCSI initiator.

Figure 1: Recommended IP storage network configuration. Dual redundant switches, two NICs on the host server, and ALB configured on the storage nodes.
Sample IP storage network configuration setup

Although the typical configuration blueprint is very similar from one switch manufacturer to the next, you should always consult the switch manufacturer’s configuration reference guides for specific configuration tasks. As a general rule, HP recommends the following configuration tasks to implement your IP storage network:

1. Cable the switches with multiple interconnect cables for redundancy and performance. If the switches do not auto-create the trunk between the switches, configure the trunking protocols. Plan for enough trunk ports to support your expected inter-switch storage traffic.

2. Enable flow control support on the switches. This must be done globally on the switch or flow control will not be negotiated on the network. Verify flow control on the servers and storage nodes.

3. Optionally, enable jumbo frame support on the switches. This must be done globally on the switch or per VLAN, otherwise jumbo frames will not be negotiated on the network and can cause issues.

4. Set up the appropriate VLAN configurations as necessary.


6. For Cisco switches, HP recommends setting the port mode to access. Configure the IP routes necessary to route traffic from the IP storage network into the LAN.

7. Connect all storage nodes and servers to the switches with Cat5e, Cat6, Fibre or SFP+.

8. Set all GbE ports on the switches, servers, and storage nodes to auto-negotiate speed and duplex mode. Verify that all ports are negotiated to full-duplex 1000 or 10,000 Mb/s, accordingly.

9. Optionally, set all ports on the servers and storage nodes to use jumbo frames.

10. Set up ALB NIC bonding on all the storage nodes. Assign static IP addresses to the bond interfaces.

11. Set up the NICs on the host servers. For Windows, set up individual static IP addresses on each NIC. For other operating systems, use the native NIC bonding configuration.

12. For optimum performance, choose NICs that support hardware TCP Offloading and TCP Checksum Offloading. Check to make sure the OS is configured to use these features. At this time, HP does not recommend the use of iSCSI offloading for use with the HP P4000 SAN system without a qualified HBA. HBAs that are qualified at the time of this writing are the QLogic QLE4060c, QLE4062c and QMH4062.

13. Remove all unused protocol bindings from the NICs on your storage network. IPv6 is not supported at this time and can be safely removed from your storage network.

14. Verify that the host servers can communicate with the storage nodes utilizing TCP and UDP traffic. For a list of UDP and TCP ports used by HP P4000 SANs, read the SAN/iQ TCP and UDP Port Usage application note.

15. Proceed with the rest of the SAN configuration.

HP P4000 multi-site SAN networking requirements

Pay special attention to the networking configuration when building a multi-site with the HP P4000 SAN. The two primary factors that contribute to the health of a multi-site cluster are network latency and network bandwidth.

Network latency

High network latency can be the primary cause of slow I/O performance, or worse, iSCSI target disconnects. It is important to keep roundtrip network latency on your storage subnet below two milliseconds. Many factors can contribute to increasing network latency, but two are most common:

• Distance between storage cluster nodes
• Router hops between storage cluster nodes

Configuring a multi-site cluster on a single IP subnet with Layer 2 switching will help to lower the network latency between storage cluster nodes.
Network bandwidth

Network bandwidth required for a P4000 multi-site cluster depends on the server applications, maintenance utilities, and backup and recovery processes. Most I/O-intensive applications, such as Microsoft Exchange and SQL Server, do not consume much network bandwidth, but are more sensitive to network latency issues. Bandwidth becomes much more important when you are performing maintenance operations such as Eseutil.exe for Exchange or backup/recovery. Any sequential read/write stream from the P4000 SAN can consume significant bandwidth.

Note:
Storage data transfer rates are typically measured in bytes (B) while network data transfer rates are measured in bits (b). A 1 Gb/s network connection can transfer a maximum of 120 to 130 MB/s.

Microsoft Windows provides performance monitor counters that can help to determine the data-path bandwidth requirements. Disk bytes/second is the rate at which bytes are transferred to or from the disk during write or read operations. Monitoring this value will provide some insight into the future bandwidth requirements after the data on that disk has been transferred to the P4000 SAN. The bandwidth requirements for every volume on the P4000 SAN must be accounted for in the total bandwidth calculation.

Good rules of thumb for bandwidth minimums are the following:

- **1GbE**: Allocate 50 MB/s bandwidth per storage node pair, and continue to allocate 50 MB/s (that is, 400 Mb/s) to each additional storage node pair as the storage cluster grows.
- **10GbE**: Allocate 200 MB/s bandwidth per storage node pair, and continue to allocate 200 MB/s (that is, 1600 Mb/s) to each additional storage node pair as the storage cluster grows.

Suggested best practices for HP P4000 Multi-Site Configuration

- Use a single IP subnet with Layer 2 switching—Layer 2 switching will help to reduce the network latency introduced by a traditional Layer 3 router.
- Configure redundant network paths—Configure the network topology to eliminate all single points of failure between storage nodes on the P4000 SAN.
- Configure for fast network convergence—Make sure your P4000 SAN network is configured so the network will converge quickly after a component or path failure. Consider Rapid Spanning Tree for Layer 2 switching, with the goal to achieve network convergence in less than 15 seconds.
- Monitor network latency and bandwidth—Monitor network latency and bandwidth consistently on the P4000 SAN network. Make sure to plan properly before adding additional storage capacity or data volumes to the P4000 SAN storage cluster.
- Run data backups against a remote copy of the data—HP SAN/iQ remote copy can be used to create copies of your production data on a storage cluster that is not stretched across the P4000 SAN. You can then perform data backups and data mining from this isolated secondary copy, reducing the impact of these operations on network bandwidth and latency.
- If possible, use automated data failover (recommended)—Configure an equal number of managers on both sides of the P4000 SAN and add a failover manager at a third location. If an event disables any of the three locations, a quorum will still exist with the managers running at the two remaining locations; automatic failover will occur and the volumes will stay online.
- Manual data failover—If a third location is not available to run the failover manager, configure an equal number of managers on both sides of the P4000 SAN and add a virtual manager. If an event disables one side of the P4000 SAN the second site can be brought online quickly by starting the virtual manager.
Remote copy

HP P4000 remote copy provides the capability to take a point-in-time snapshot of a volume and copy that data to a remote location. This section provides an overview of best practices for implementing remote copy in your IP networking environment.

IP networking requirements

You can use HP P4000 remote copy from one cluster to another cluster on a single IP subnet as well as across routed environments. In a routed environment, the two IP subnets must have IP routes to each target network without network address translation (NAT) or port forwarding. You can employ private WAN connections using point-to-point protocols, or you can set up a VPN tunnel between two networks that are separated by the public Internet. The VPN tunnel effectively acts as one hop on a router and will allow the use of private IP space on each end.

Figure 2 shows how two private LANs can connect using VPN devices over the public Internet. Each storage node uses the inside interface of the VPN device as its default gateway. The VPN device encapsulates and encrypts storage node traffic across the public WAN connection, allowing the storage nodes to communicate with remote peers. The Centralized Management Console must be able to communicate with all of the private IP addresses.

Figure 2: Example of an IP network configuration for P4000 remote copy, using VPN gateways to route TCP and UDP traffic between the two private networks.

HP P4000 solutions use both TCP and UDP protocols to communicate between the storage nodes and to the clients initiating volumes. The number of connections to each storage node dictates the quantity of UDP ports used. The UDP protocol uses port ranges and must not be restricted.
**Best practices for IP networking**
- Use a VPN client on a remote host running the management console to manage remote copy tasks. Tasks may also be managed from either Private LAN.
- Use private line point-to-point or VPN connections for your remote copy implementations.
- If using existing VPN solutions, dedicate an interface on each end of the VPN for storage traffic.

**Scheduling bandwidth usage**

The size and frequency of the remote copy snapshots are the two main factors affecting the amount of bandwidth needed for an implementation. You can determine the sizes of your snapshots by using the management console and following these steps:

1. Set up a local snapshot schedule with the frequency you plan to use, and let this run for a couple of days.
2. Highlight the cluster in the management console and click on the Disk Usage tab in the tab pane.
3. Monitor the sizes of the snapshots, and use this size to calculate the amount of bandwidth required.

Once you have characterized the amount of change in your volumes over time, you can determine if the amount of available bandwidth is adequate to keep up with the snapshot frequency.

Figure 3 depicts the creation of a remote volume. Understanding the sizes of the snapshots that are created and transferred is the key to a successful remote copy implementation.

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**Figure 3:** Example of an IP network configuration for P4000 remote copy, using VPN gateways to route TCP and UDP traffic between the two private networks.
**Estimated time to copy**

Link speeds are commonly listed in Mb/s or Kb/s on lower-bandwidth connections. To estimate the time needed for a copy:

1. First convert the size of the volume to bytes: Begin by multiplying the gigabytes by 1024 to get megabytes.
2. Multiply megabytes by 1024 to get to kilobytes.
3. Multiply kilobytes by 1024 to get bytes.
4. Multiply the bytes by 8 to yield the number of bits.
5. Divide the number of bits by 1000 to yield kilobits or again by 1000 to yield megabits.
6. Finally, divide your result by the link speed to get the number of seconds to complete the copy. Convert to the correct order of magnitude, Kb or Mb, before dividing by the corresponding units per second of link speed.

Table 3 illustrates the calculation and provides an example.

**Table 3. Calculating the estimated copy time.**

<table>
<thead>
<tr>
<th>GB to MB</th>
<th>MB to KB</th>
<th>KB to Bytes</th>
<th>Bytes to Bits</th>
<th>Bits to KB</th>
<th>KB to Mb</th>
<th>Mb to seconds to copy</th>
<th>Seconds to minutes to copy</th>
<th>Minutes to hours to copy</th>
</tr>
</thead>
<tbody>
<tr>
<td>GB x 1024 = MB</td>
<td>MB x 1024 = KB</td>
<td>KB x 1024 = bytes</td>
<td>Bytes x 8 = bits</td>
<td>Bits /1000 = Kb</td>
<td>Kb /1000 = Mb</td>
<td>Mb / link speed = seconds (sec) to copy</td>
<td>S to copy /60 = minutes (min) to copy</td>
<td>Min to copy /60 = hours (hrs) to copy</td>
</tr>
<tr>
<td>10 GB x 1024 = 10,240 MB</td>
<td>10,240 MB x 1024 = 10,485,760 KB</td>
<td>10,485,760 KB x 1024 = 10,737,418,240 B</td>
<td>10,737,418,240 B x 8 = 85,899,345,920 b</td>
<td>85,829,345,920 b /1000 = 85,899,345 Kb</td>
<td>85,899,345 Kb /1000 = 85,899 Mb</td>
<td>85,800 Mb /1.05 Mb/s = 81,808 s</td>
<td>81,808 s /60 = 1,363 min</td>
<td>1,363 min /60 = 22.7 hrs</td>
</tr>
</tbody>
</table>

Example: estimating time for copying 10 GB of data over a 1.05 Mb/s link.

After determining the amount of time per each remote copy task, you can develop a schedule. Be sure to verify that the actual times fit your proposed schedules.

**Use bandwidth resources**

You can employ quality of service (QoS) technologies to limit the amount of bandwidth your remote copy tasks have available to them. This will ensure that remote copy does not steal bandwidth from other applications.

Understanding your link utilization is important when planning your implementation. Table 4 shows estimated time for duplicating 10 GB of data to a remote site at various link speeds or bandwidth allocations.

**Table 4. Sample data copy times**

<table>
<thead>
<tr>
<th>Link speed</th>
<th>Remote copy bandwidth</th>
<th>Estimated time to copy 10 GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>384 Kb/s</td>
<td>46 KB/s</td>
<td>62 hours</td>
</tr>
<tr>
<td>768 Kb/s</td>
<td>93 KB/s</td>
<td>31 hours</td>
</tr>
<tr>
<td>1.05 Mb/s</td>
<td>128 KB/s</td>
<td>23 hours</td>
</tr>
<tr>
<td>1.27 Mb/s</td>
<td>155 KB/s</td>
<td>19 hours</td>
</tr>
<tr>
<td>1.54 Mb/s</td>
<td>188 KB/s</td>
<td>15 hours</td>
</tr>
<tr>
<td>2.0 Mb/s</td>
<td>244 KB/s</td>
<td>12 hours</td>
</tr>
<tr>
<td>3.0 Mb/s</td>
<td>366 KB/s</td>
<td>8 hours</td>
</tr>
<tr>
<td>10.0 Mb/s</td>
<td>1220 KB/s</td>
<td>2.5 hours</td>
</tr>
<tr>
<td>25.0 Mb/s</td>
<td>3052 KB/s</td>
<td>1 hour</td>
</tr>
<tr>
<td>500 Mb/s</td>
<td>61035 KB/s</td>
<td>3 minutes</td>
</tr>
<tr>
<td>830 Mb/s</td>
<td>101376 KB/s</td>
<td>2 minutes</td>
</tr>
</tbody>
</table>
Tune bandwidth usage
HP P4000 remote copy is a pull technology and initiates jobs from the remote side of the task. The remote management group should be configured to use only the amount of bandwidth that has been allocated.

As shown in Figure 4, use the management console to edit the remote side by right-clicking on the management group and selecting Edit Management Group. Use the suggested values in Table 4 for specifying the copy bandwidth setting for use with your link speed.

**Figure 4:** Editing remote bandwidth usage.

Best practices for remote copy scheduling and configuration
- Limit scheduling of remote copy to three concurrent tasks.
- Ensure that your remote snapshots can complete the copy prior to the next scheduled snapshot.
- Initiate your first remote copy on a schedule with members of your remote cluster at the primary site prior to installing at the remote location. Differential changes only will be copied once you have readdressed the storage nodes and connected them simultaneously with the management console.
- You can tune remote copy for high-bandwidth, high-latency connections (< 250 ms).
Best practices for 10GbE

Use these tips and best practices to when you set up the 10-Gigabit Ethernet connection.

SFP+ Connections

The P4000 10GbE adapter is an eight lane (x8) PCI Express (PCIe) 10 Gigabit network solution. The adapter has two SFP+ (Small Form-factor Pluggable) cages suitable for connecting to Direct Attach Cable (DAC) or fiber modules supporting SR fiber optic cabling.

For supported cables and connectors, please reference the NC550SFP QuickSpecs at http://h18000.www1.hp.com/products/quickspecs/13555_na/13555_na.html

Switches

Make sure the switches are non-blocking switches that allow 10 Gb/s bi-directionally on every port. If the switch does not offer this level of performance, you may see unexpected performance from your 10-gigabit SAN.

Flow control

Flow control can improve performance dramatically in a 10 Gb environment. This is especially true with a mixed Gigabit Ethernet and 10 Gb environment.

When a network port becomes saturated, excess frames can be dropped because the port cannot physically handle the amount of traffic it is receiving. This causes the packets to be resent, and the overhead of resending the packets can cause a performance decrease. An example of this is a 10GbE link sending data at 10 Gb/s to a single GbE link. Flow control eliminates this problem by controlling the speed at which data is sent to the port. For this reason, best practices dictate that you should always enable flow control.

For flow control to function properly, you must enable it on both the switches and the NICs/iSCSI initiators. If it is not enabled everywhere, the network defaults to the lowest common denominator, which is flow control disabled.

Bonding

The P4500 and P4300 10 Gb SFP+ adapter supports ALB, 802.3ad, and Active Passive bonding between the two 10 Gb ports. In addition, Active Passive bonding is supported between one 10 Gb port and one 1 Gb LOM port. Active Passive bonding provides protection against a single NIC hardware failure.

Bonding of three or four interfaces (such as all the NICs on the NSM) is not allowed. The bonding of bonds (for example, creating two active-passive bonds and then bonding those together with ALB) is also not allowed.

Server-side 10GbE NICs

Follow your server vendor’s recommendations for maximum compatibility and support. HP does not recommend or endorse any particular vendor or 10GbE card for the servers.
HP P4000 multi-site SAN

In a HP P4000 multi-site SAN configuration, each half of the P4000 nodes in a cluster (or each half of a SAN) lives in a different physical space—for example, a separate rack, floor, or building. In order to realize the benefits of 10GbE, the link speed between the two locations must be adequate. Specifically:

- You may need to increase the link speed between the two locations in order to take advantage of the performance benefit of the 10GbE NICs. (If this is a new installation, the link speed should be 200 MB/s per storage node.)
- The latency between the two locations must be two milliseconds or less. If these conditions are not met, the benefits of 10 Gigabit Ethernet will be minimized.

To find out more about the HP P4000 SAN Solutions, visit: www.hp.com/go/p4000