Technical Report

Introduction to NetApp E-Series E5600

Feature Overview with SANtricity 11.30

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Abstract

The NetApp® E-Series E5600 storage system is the tier one SAN storage on which customers rely to support wide-ranging data center and cloud storage requirements. This report provides detailed information about the new system configuration options available on E5600 arrays with SANtricity® 11.30. It also provides detailed information about common features and settings that have been a part of the product for multiple hardware and software generations. This report is a great starting point to introduce system details to sales engineers, partners, service providers, and customers.

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1 E-Series E5600 Storage Systems with SANtricity 11.30

NetApp E-Series E5600-based storage systems provide enterprise-class tier one SAN storage for small and medium-sized businesses and for Fortune 100 companies with branch locations around the world. The combination of ultradense capacity, host interface flexibility, and best-in-class quality makes the E5600 a natural choice for customers who are focused on minimizing their total cost of ownership while maximizing the use of their current footprint.

Note: This document uses the following terms interchangeably with the terms used in NetApp SANtricity Storage Manager and in the technical publications for the product:

- Tray = shelf = enclosure.
- Drive tray = drive shelf.
- Drive = disk.
- Canister = module.
- SANtricity OS = controller firmware.
- SANtricity Storage Manager = storage management software.
- Storage system = storage array.
- Drawer = one of the five drawers in the DE6600 shelf. This term does not apply to other shelf models.
- SANtricity 11.30 = SANtricity Storage Manager 11.30 plus SANtricity OS 8.30.
- SANtricity OS 8.30 = Controller firmware 8.30, the associated NVSRAM software, and matching environmental services module firmware.

1.1 E5600 Primary Use Cases

The E-Series E5600 is an industry-leading storage system that delivers high IOPS and bandwidth with consistently low latency to support the demanding performance and capacity needs of science and technology, simulation modeling, and decision-support environments. In addition, the E5600 is equally capable of supporting primary transactional databases, general mixed workloads, and dedicated workloads such as video analytics in a highly efficient footprint with extreme simplicity, reliability, and scalability.

The E5600 provides the following benefits:

- Support for wide-ranging workloads and performance requirements
- Fully redundant I/O paths, advanced protection features, and proactive support monitoring and services for high levels of availability, integrity, and security
- Increased IOPS performance by up to 35% compared to the previous high-performance generation of E-Series products
- A winning combination of leading IOPS performance at low latencies and throughput density that makes the E5600 a great choice for high-performance workloads
- A level of price-performance, density, and economics that leads in the industry
- Support for private and public cloud workloads behind virtualizers such as FlexArray®, Veeam Cloud Connect, and StorageGRID®

1.2 E5600 Storage Systems

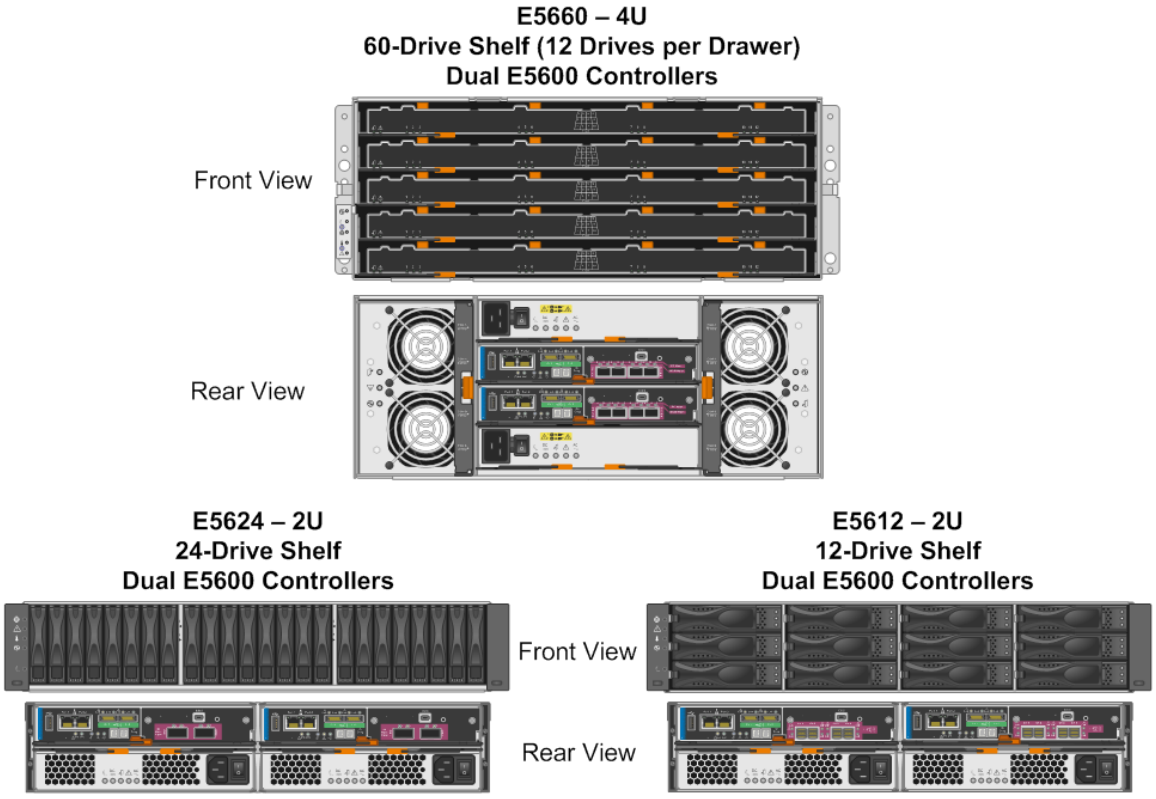
As shown in Table 1, the E5600 is available in three shelf options, which support both hard-disk drives (HDDs) and solid-state drives (SSDs) to meet a wide range of performance requirements for a wide variety of applications.

Table 1) E5600 controller shelf and drive shelf models.

Controller Shelf Model	Drive Shelf Model	Number of Drives	Type of Drives
E5660	DE6600	60	2.5” and 3.5” SAS drives (HDDs and SSDs)
E5624	DE5600	24	2.5” SAS drives (HDDs and SSDs)
E5612	DE1600	12	3.5” SAS drives (HDDs only)

All three shelf options include dual controller modules, dual power supplies, and dual fan units for redundancy (the 12-drive and 24-drive shelves have integrated power and fan modules). The shelves are sized to hold 60 drives, 24 drives, or 12 drives, as shown in Figure 1.

Figure 1) E5600 controller-drive shelf options.



Each E5600 controller shelf includes two controllers, with each controller providing two Ethernet management ports for out-of-band management. The system also supports in-band management access and has two 6Gbps wide-port SAS drive expansion ports for redundant drive expansion paths. The E5600 controllers do not include built-in host ports, but must be ordered with one of the following host interface cards (HICs) installed in each controller:

Note: Both controllers in an E5600 array must be identically configured.

- 4-port 12Gb SAS HIC.
- 2-port 56Gb InfiniBand (IB) HIC. This HIC runs the iSCSI Extensions for RDMA (iSER) protocol as shipped, but it can be converted to SCSI RDMA Protocol (SRP) before initial use by applying a software feature pack in the field at no additional cost.

- 4-port optical HIC, which can be factory-configured as either 16Gb Fibre Channel or 10Gb iSCSI. A software feature pack can be applied in the field to change the host protocol of this HIC:
  - From FC to iSCSI
  - From iSCSI to FC
  - From either FC or iSCSI to FC-iSCSI split mode
  - From FC-iSCSI split mode back to FC or iSCSI

Note: In FC-iSCSI split mode, ports 1 and 2 operate as iSCSI, and ports 3 and 4 operate as FC.

For optical connections, the appropriate SFPs must be ordered for the specific implementation. Consult the Hardware Universe for a full listing of available host interface equipment. Figure 13 provides a close-up view of the E5600 HIC options.

For detailed instructions about changing protocols, go to the Upgrades/Hardware Upgrades section at https://mysupport.netapp.com/eseries.

E5600 controllers are available with two memory options: a standard 12GB DIMM, which can be used with all protocols, and a new 48GB DIMM, which can be used with iSCSI and FC only. Controller memory upgrades from 12GB to 48GB are not available.

2 SANtricity Storage Manager 11.30

E-Series E5000 systems are managed by the SANtricity Storage Manager desktop application. Simple to download and install, SANtricity Storage Manager provides an intuitive, wizard-led GUI as well as full support for a CLI. SANtricity Storage Manager is based on the Oracle Java framework and can be installed on a Microsoft Windows, Solaris, or Linux operating system (OS) platform.

2.1 Application Details

SANtricity Storage Manager supports both out-of-band and in-band system management. NetApp generally recommends using an out-of-band management host that does not participate in the data delivery workload. In-band management is useful for cases in which there is no IP network access to remote storage systems, but it requires in-band traffic connections to the storage system from a SAN-connected host where SANtricity Storage Manager is installed.

SANtricity Storage Manager 11.30 is supported on 64-bit OS platforms and enables storage administrators to perform the following tasks:

- Set up network connections.
- Commission new storage systems.
- Configure NetApp AutoSupport® (ASUP™) settings and preferences.

  Note: For ASUP to function, the event monitor service (also known as SMmonitor or persistent monitor) must be running on the primary SANtricity management server. NetApp does not recommend running the event monitor service on multiple management servers/PCs.
- Provision volumes and map the storage to hosts.
- Set up and manage storage features such as NetApp Snapshot® copies, volume copy, synchronous mirroring, asynchronous mirroring, and SSD read cache.
- Perform hardware and software maintenance activities, including upgrades to manage E-Series storage systems.

When the SANtricity management client is installed on a desktop OS, the following limitations apply:

- Simultaneous user sessions are limited to eight sessions.

- Desktop systems cannot run the host agent for in-band management and, in most cases, cannot send I/O traffic to the E-Series storage system (see the NetApp IMT for exceptions).

SANtricity Storage Manager has two windows that provide management functionality and offer a graphical representation of the storage system:

- **Enterprise management window (EMW).** When SANtricity Storage Manager is initiated, the EMW appears first, as shown in Figure 2. The EMW is used to add the storage systems that are managed and monitored through SANtricity Storage Manager.
- **Array management window (AMW).** From the EMW, the AMW can be launched to access summary views and detailed information about individual storage systems, as shown in Figure 3. The AMW is used to configure, maintain, and manage a storage system and its components.

In addition, the script editor for a storage system can be opened from the EMW, and configuration of the system can be accomplished by using a saved configuration or a custom script. Refer to https://mysupport.netapp.com/eseries for instructions about installing, configuring, and using SANtricity Storage Manager 11.30.

Figure 2) SANtricity Storage Manager 11.30 EMW.

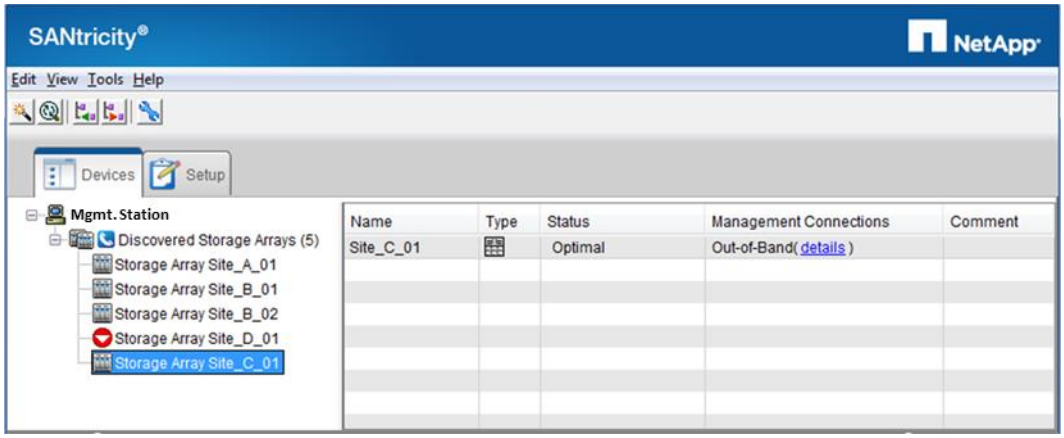
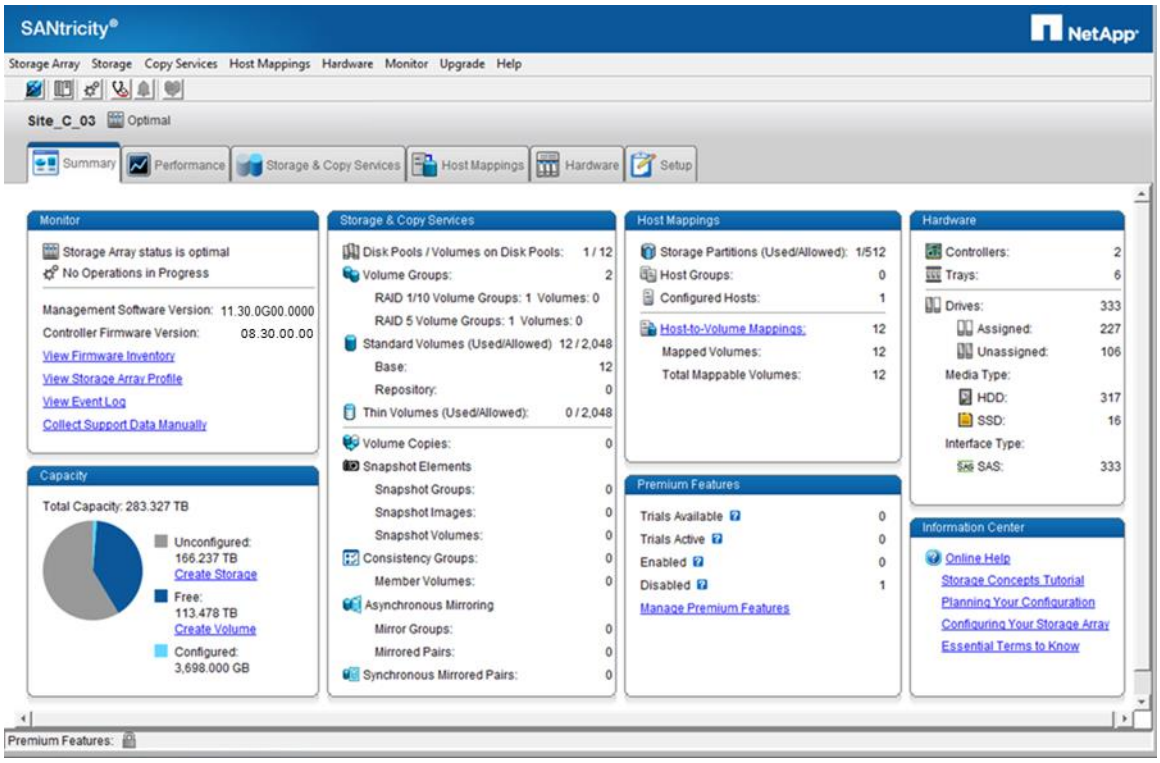


Figure 3) SANtricity Storage Manager 11.30 AMW: Summary tab view of a storage system.



E5600 storage systems are now shipped preloaded with the SANtricity OS 8.30. The SANtricity Storage Manager software version 11.30 must be downloaded from the NetApp Support site and installed/upgraded on any SANtricity management server used to discover storage systems running SANtricity OS 8.30. Previous versions of SANtricity Storage Manager do not manage the E5600 arrays running SANtricity OS 8.30, but the SANtricity Storage Manager version 11.30 manages the new E5600 OS version and all of the previous E-Series array software versions from the last five years.

Note: Creating an account on the NetApp Support site can take 24 hours or more for first-time customers. New customers should register for Support site access well in advance of the initial product installation date.

2.2 SANtricity Management Integration

E-Series storage arrays are easy to install in most physical data center environments, and SANtricity Storage Manager provides an intuitive GUI that makes basic commissioning procedures equally easy to do. This does create a small learning curve, but you do not need to learn the complete management interface if you already use other common storage management interfaces. To expedite the adoption of E-Series storage systems using existing tools and skills, NetApp recommends leveraging the benefits of various SANtricity plug-ins; APIs; providers; and utilities for applications such as Oracle and SQL Server and OSs such as Windows, Linux, and VMware.

Table 2 shows the software packages available to anyone with an active NetApp Support site account and current E-Series product support agreement. Go to http://mysupport.netapp.com/NOW/cgi-bin/software/ and select E-Series/EF-Series SANtricity Management Plug-in**s** for the plug-ins.

Table 2) Available software packages for SANtricity management integration.

Software Package	Use
SANtricity plug-in for VMware vCenter	Configure, manage, monitor, and perform datastore to LUN mapping in vSphere client or web client.
SANtricity storage replication adapter for VMware vCenter Site Recovery Manager	Automate management of replicated datastores and disaster recovery, including testing DR plans.
SANtricity VASA provider (VMware APIs for storage awareness)	Report storage volume capabilities to vSphere for SLO management.
SANtricity management pack for Microsoft System Center Operations Manager	Monitor health status and send storage alerts to Microsoft System Center.

Table 3 shows the SANtricity APIs and toolkits that can be used for scripting and custom integration into other management tools. Go to http://mysupport.netapp.com/NOW/cgi-bin/software/ and select E-Series/EF-Series SANtricity Management Plug-ins for the web services software and documentation. Go to http://mysupport.netapp.com/NOW/download/tools/santricity_powershell_toolkit for the PowerShell toolkit.

Table 3) SANtricity APIs and toolkits.

APIs and Toolkits	Description
SANtricity web services proxy	Web APIs that provide a collection of REST interfaces to configure, manage, and monitor E-Series systems.
SANtricity toolkit for Microsoft Windows PowerShell	More than 100 cmdlets enabling storage administration of E-Series systems.

Table 4 provides a list of third platform plug-ins that leverage E-Series storage systems as storage building blocks in cloud storage environments. The SANtricity web services proxy is available on the NetApp Support site at http://mysupport.netapp.com/NOW/download/software/eseries_webservices/1.3/. In most cases, the plug-ins listed are available on the various provider websites. Contact your NetApp sales representative for more information about third platform integration with E5600 storage systems.

Table 4) Third platform plug-ins that leverage the SANtricity web services proxy.

Software Package	Use
NetApp Cinder driver	Cinder for E-Series leverages SANtricity web services proxy for configuration of E-Series storage.
OpenStack Swift on E-Series storage	E-Series provides high-quality, efficient, block storage that enables large OpenStack environments to operate at a lower overall cost of ownership as compared to similar white box environments.
Custom Puppet module	Puppet agent uses the SANtricity web services proxy for configuration of E-Series storage.
SANtricity plug-in for CHEF	CHEF agent uses the SANtricity web services proxy for configuration of E-Series storage.
SANtricity performance application for Splunk	Display and monitor tool to report on configuration and performance aspects of multiple E-Series systems in one interface.

Software Package	Use
SANtricity plug-in for Nagios	Custom plug-in for monitoring E-Series storage arrays within Nagios framework.

3 SANtricity Features

E-Series systems have a rock-solid reputation for reliability, availability, simplicity, and security. The SANtricity 11.30 release builds on that legacy by adding new reliability, availability, and serviceability (RAS) features and new drive choices.

3.1 New Features with SANtricity 11.30

New functionality available with SANtricity 11.30 adds to an already impressive list of RAS features and capabilities offered with the E-Series portfolio.

Table 5) SANtricity 11.30 new feature list with descriptions.

New Feature Name	Description
Automatic load balancing	The new automatic load-balancing feature provides automated workload balancing that helps to make sure that incoming I/O traffic from the hosts is dynamically managed and balanced across both controllers. The workload of each controller is continually monitored and, with cooperation from the multipath drivers installed on the hosts, can be automatically brought into balance whenever necessary. For more information, search for “what is automatic load balancing?” in the SANtricity Storage Manager online help.
AutoSupport automatic checking	When the EMW launches, it checks whether the Event Monitor is running. If the Event Monitor is running, it sends a test message to the technical support AutoSupport server to see whether communication is successful. This helps you know if AutoSupport is set up correctly. For more information, refer to “Setting the transport protocol for sending AutoSupport messages” in the EMW online help and to “Manage AutoSupport” in the System Manager online help.
Battery learn cycles	In storage arrays with two controllers, the learn cycles for the controllers start simultaneously, but they are not linked together. If the learn cycle for one controller stops for some reason, the learn cycle for the other controller keeps going. In previous versions of the software, if one controller failed its battery during a learn cycle, the alternate controller would stop its learn cycle. For more information, search for “what are battery learn cycles?” in the SANtricity Storage Manager online help.
Maximum volume size for disk pool volumes	The maximum volume size for a standard volume in a disk pool has increased from 64TB to 1PB for E2700 and E2800 storage arrays and to 2PB for E5600 storage arrays. The maximum volume size for a thin volume in a disk pool has increased from 64TB to 256TB. For more information, search for “learn about volumes” in the SANtricity Storage Manager online help.

New Feature Name	Description
SSD cache performance improvements	SSD cache now employs a set of workload analytics-based algorithms to provide adaptive tuning of the cache based on the specific workload. This results in significant improvements in both IOPS and latency for read-intensive workloads. The new adaptive algorithms also mean that administrators no longer need to specify an application type when configuring the cache; the system figures this out automatically. All read-intensive workloads benefit, including relational databases (Oracle and SQL Server), NoSQL databases, and analytics applications. For more information, search for “create SSD cache” in the SANtricity Storage Manager online help.

3.2 SANtricity Standard and Premium Features

E-Series systems ship with significant storage management features that can be simply activated from SANtricity Storage Manager, but there is one premium feature offered with E5600 storage systems:

- Drive security

For premium feature activation, contact your NetApp or partner sales representative to purchase the required license keys.

Table 6 provides a consolidated list of E5600 standard and premium features when running SANtricity 11.30.

Table 6) E5600 standard and premium features using SANtricity OS 11.30.

E5600 Standard and Premium Features with SANtricity OS 11.30
Storage partitions. Individual host without shared LUNs to host groups with shared LUNs or a combination of both.
Thin provisioning. Overcommit storage and add capacity when you actually need it.
SSD read cache. Accelerate 90% or higher random read workloads using a few SSDs. Recommended to accelerate 90% or higher random read workloads.
Secure SSD read cache. The SSD read cache can be secured with a nonsecure base volume or a secure base volume (FDE or FIPS drive). However, when there is a FIPS-secure base volume and the read cache is FDE, the storage management software alerts you that the SSD read cache does not have the same security capabilities as the base volume. **Note:** If drive security is enabled and the SSD is secure-capable, the SSD read cache can be secured only upon creating the SSD read cache.
Data assurance (T10 PI). Make sure of data integrity to the drive, which is especially important with large-capacity drives. This feature automatically detects whether or not the drives and system host protocol can support DA. If the system cannot support DA, the feature is automatically disabled during the volume group or DDP provisioning process. Otherwise, the feature is on by default.
Nondisruptive controller firmware upgrade. Using ALUA host type with multiple paths to hosts combined with a wizard-driven upgrade process that activates one controller at a time, makes sure that upgrades do not affect host-to-LUN access.

E5600 Standard and Premium Features with SANtricity OS 11.30
Online drive firmware upgrade. Upgrades one drive at a time and tracks writes to the affected drives during the upgrade window; should only be used during very low write I/O periods. **Note:** Parallel drive firmware upgrades are supported offline to more quickly upgrade multiple drives during a maintenance window.
Proactive drive monitor and data evacuator. Nonresponsive drives are automatically power-cycled to see if the fault condition can be cleared. If the condition cannot be cleared, the drive is flagged as failed. For predictive failure events, the evacuator feature starts to copy data from the affected drive in an effort to move the data before the drive actually fails. If the drive fails, rebuild picks up where the evacuator was disrupted, thus reducing the rebuild time.
DDP enhanced drawer loss protection. Drawer loss protection for a dynamic disk pool can now be achieved with one 60-drive (five-drawer) drive tray. Drawer loss protection requirements are met when a disk pool includes drives from all five drawers, and the pool includes an equal number of drives from each drawer. A minimum of 15 drives is required in the pool. Drive adds must therefore be in groups of 5 for a single 60-drive enclosure.
Drive security (FDE/FIPS). The full disk encryption (FDE) feature now offers a higher level of assurance with Federal Information Processing Standards (FIPS) 140-2 level 2–validated drives. These FIPS-compliant drives are a type of secure-capable drive, similar to FDE drives, that have an extra level of security, including tamper-resistant seals on the drive casing and other FIPS-approved protocols that are different than standard FDE drives. No external key management is required, and like FDE, FIPS has a minimal performance impact. See TR-4474: SANtricity Full Disk Encryption for full details. **Note:** Drive encryption for data at rest requires the purchase and activation of the drive security premium feature. Contact your NetApp sales representative for purchase details.
Standard AutoSupport and AutoSupport OnDemand. NetApp AutoSupport (ASUP) is an integrated and efficient monitoring and reporting technology that constantly checks the health of NetApp storage systems. It is one of the most important and effective troubleshooting tools for customers and for NetApp Customer Support Delivery (CSD). The AutoSupport OnDemand feature starting in SANtricity 11.25 shifts control of AutoSupport delivery to the NetApp Support back-end servers. Any time an E-Series storage array prepares to deliver an ASUP message, it checks first with the ASUP back end for permission to deliver. OnDemand introduces the ability for an E-Series storage array to check in periodically with the ASUP back end to determine if there are any pending ASUP actions for the storage array. OnDemand also allows NetApp technical support to request retransmission of a particular ASUP message or request that a new ASUP message be collected and sent to NetApp. The storage array is informed of the pending action the next time it checks in with the NetApp back-end servers. For more information about the ASUP feature, go to http://mysupport.netapp.com/eseries and click the Review Storage Concepts link.
Changing host protocol. Supported using new feature pack keys; go to https://mysupport.netapp.com/eseries (Upgrades >Hardware) to obtain the free license keys and detailed instructions for each starting and ending protocol.

E5600 Standard and Premium Features with SANtricity OS 11.30
Split FC-iSCSI protocol support. Split protocol support on a single E5600 storage array increases the flexibility for host connectivity to serve a wide set of use cases, including Fibre Channel, for high-performance workloads and long-distance mirroring through iSCSI for disaster recovery. The quad-port optical HIC supports either 16Gb FC or 10Gb iSCSI, but SANtricity 11.25 and later releases provide the option to use this HIC in a split protocol mode. A feature key can be applied through SANtricity Storage Manager to convert the HIC to FC-iSCSI split mode, in which ports 1 and 2 operate as 10Gb iSCSI and ports 3 and 4 operate as 16Gb FC. A new unified SFP supports both protocols at these speeds. As required, a different feature pack can be applied later to convert the protocol from FC-iSCSI split mode back to all FC or all iSCSI. **Note:** The unified SFPs do not support 1Gbps iSCSI.
Simple Network Time Protocol (SNTP). Simple Network Time Protocol (SNTP) is a time-maintenance feature that is used to keep the clocks in the E-Series storage array synchronized with a central SNTP server instead of the SANtricity management server. When this feature is enabled, the SANtricity OS periodically queries the configured SNTP server and uses it to synchronize the clock in each E-Series controller.

Table 7 provides a comprehensive list of standard copy services features with E5600 storage arrays.

Table 7) SANtricity 11.30 copy services features.

Standard SANtricity Copy Services Features
SANtricity Snapshot copies. Point-in-time Snapshot copies
Synchronous mirroring. Real-time mirroring to a remote site (usually within 10Km)
Asynchronous mirroring. Mirroring to a remote site where RPO = 0 is not a requirement
Volume copy. Used to spin off volumes for test/dev or analytics purposes

See technical report Deploying NetApp E-Series and EF-Series Copy Services with Oracle and SQL Server Databases for additional details and use case information using SANtricity copy services features.

4 Support Tool Enhancements

Improving the customer experience is the central goal of NetApp enablement tools. To continue the legacy of prioritizing enablement tools, several key enhancements have been implemented.

4.1 Config Advisor

Config Advisor is a configuration validation and health check tool for NetApp systems. Config Advisor can be used to check a NetApp system for the correctness of hardware installation and conformance to NetApp recommended settings. It collects data and runs a series of commands on the hardware, then checks for cabling, configuration, availability, and best practice issues.

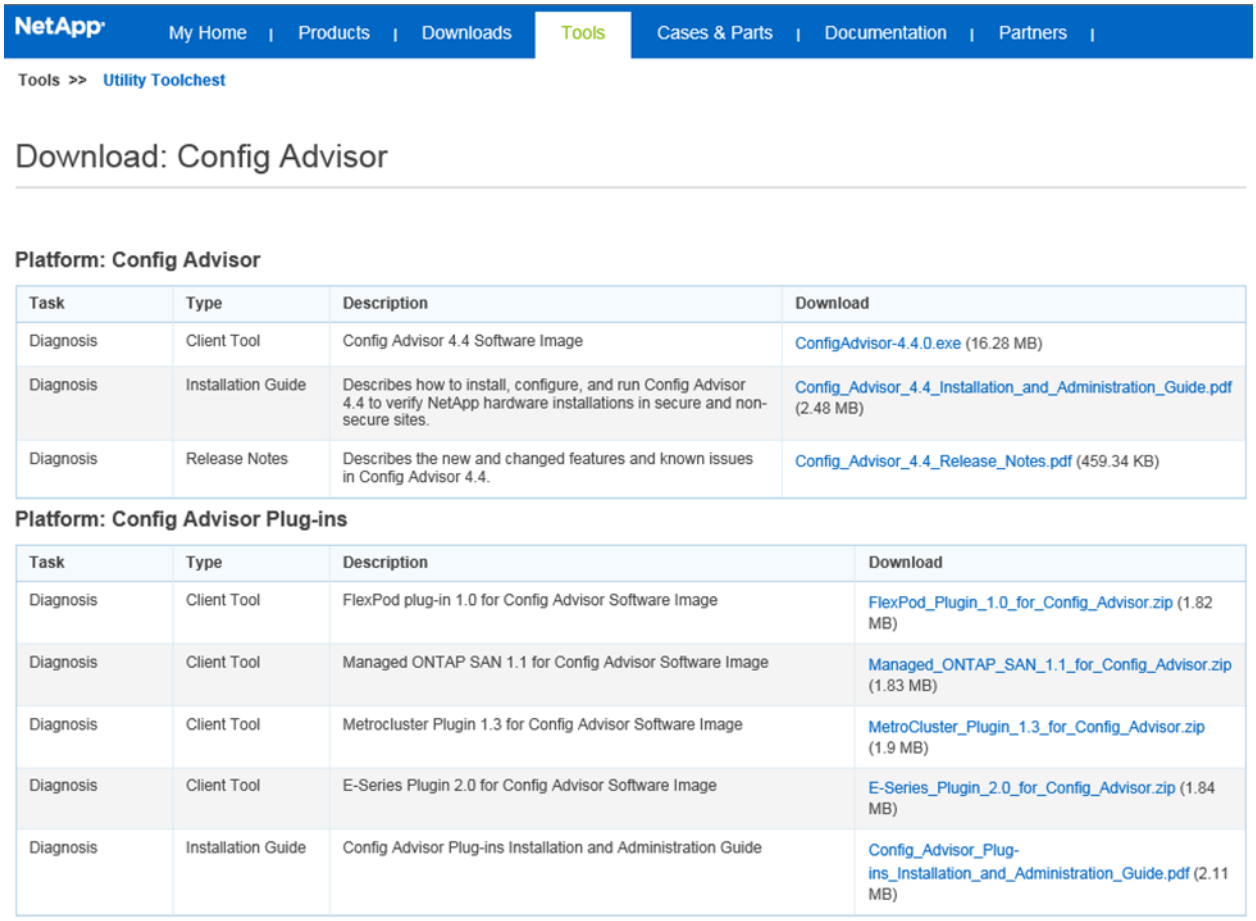
The Config Advisor 4.4 release enables support for E-Series host-side checks and E-Series configuration checks in addition to the standard checks.

Config Advisor creates PDF, Word, and Excel reports on the system configuration summary and health check results. It also sends Config Advisor AutoSupport data back to NetApp over HTTP; this data can be viewed through SmartSolve.

To download the Config Advisor tool, the additional plug-in for E-Series, and associated installation documentation for both software packages (see Figure 4), use the Config Advisor link, acknowledge the

EULA, and select Continue. For general installation instructions, use the Config Advisor 4.4 Installation and Administration Guide; for details about how to install the E Series plug-in, use the Config Advisor Plug-Ins Installation and Administration Guide.

Figure 4) Config Advisor download site landing page.



Config Advisor Workflow and Key Features

Config Advisor has three major components:

- **Data collector.** The data collector supports multiple data input methods, including support for secure site data collection.
- **Analysis engine.** The analysis engine takes the collected data and performs a series of configuration validation and best practices checks. The analysis engine checks for at-risk systems, checks for systems that require firmware updates, and performs network switch checks. It also performs specific checks for clustered Data ONTAP®, Data ONTAP operating in 7 Mode, MetroCluster™, FlexPod®, and E-Series systems.
- **Presentation layer.** The presentation medium is very flexible; users can view the output using Config Advisor's intuitive UI, or they can generate PDF, Excel, or MS Word reports for these contents.

4.2 E-Series Sizer

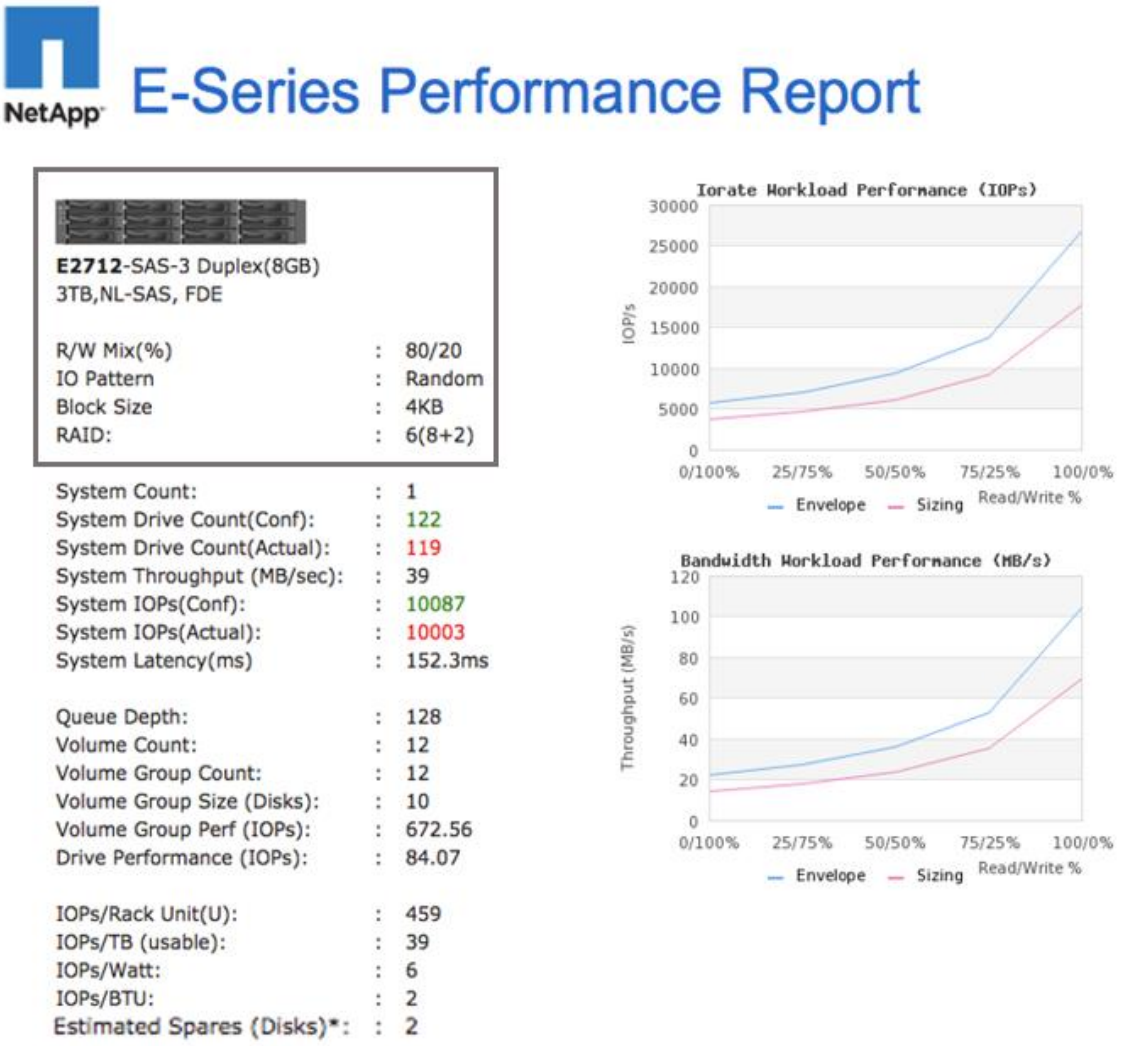
The E-Series Performance Sizing tool allows sales engineers and partners to make sure that specific customer architectures are properly sized to meet customer performance requirements.

The E-Series Sizer tool is available for NetApp employees and is also open for partner access.

Figure 5 shows a performance sizing report, which includes four major sections:

- **Hardware and workload.** The boxed area in Figure 5 shows the hardware and workload section, where users enter the expected hardware and workload.
- **Sizing.** The next section shows the sizing output:
  - The numbers in red show the actual system drive count and the actual system IOPS. These values are used to determine the drive count needed to meet the performance and IOPS targets.
  - The numbers in green show the configured system drive count and the configured system IOPS. These values are used to determine the drive count needed based on RAID group size and IOPS performance.
- **Metrics.** This section shows various metrics such as volume group performance, drive performance, and IOPS/rack unit.
- **Charts.** The charts on the right side of the report present performance as two sets of data points: envelope is the performance curve representing a fully configured system, and sizing is the performance curve representing the sized solution.

Figure 5) Performance sizing report.



4.3 Synergy

NetApp Synergy is a NetApp tool used for accurately designing NetApp configurations. An emphasis is placed on showing realistic capacity yield and environmental details. Advantages of using Synergy over traditional spreadsheets or alternative tools include automatic product updates, best practices enforcement, alignment to the sales workflow, and data sharing with users and tools.

Synergy 6, the latest release, is a full web-accessible experience that is compatible with mainstream browsers such as Microsoft Internet Explorer, Google Chrome, and Mozilla Firefox.

Note: The Synergy User Guide is located here: https://forums.netapp.com/docs/DOC-14888https://forums.netapp.com/docs/DOC-14888.

4.4 Hardware Universe

Hardware Universe (HWU) is a web-based tool that provides a visual presentation of the complete NetApp line of hardware products.

Hardware Universe provides the information needed to make side-by-side comparisons of the various NetApp platforms in terms of capacity, memory size, maximum spindle count, and other features.

HWU has three components:

- **HWU poster** is a one-stop location to find specifications for all NetApp products.
- **HWU application** provides the complete NetApp hardware portfolio in a web application.
- **HWU mobile application** represents the complete NetApp hardware portfolio in a mobile application for iPhone or Android.

Note: The Hardware Universe User Guide is located here: http://hwu.netapp.com/Resources/hwu_ug.pdf.

4.5 Host Utilities

When customers implement E-Series with Windows and Linux operating systems, they can use the settings in the host utilities kits to properly configure each host, according to the latest Interoperability Matrix Tool (IMT) guidance. The kits are on the NetApp Support site at Downloads > Software > Host Utilities—SAN. Currently, the Linux and Windows kits support E-Series and FAS implementations. Other available kits support FAS implementations only.

5 SANtricity Software Specifications for E5600 Hardware

Table 8 lists the SANtricity software specifications for E5600-based storage systems.

Table 8) SANtricity software boundaries for E5600-based storage systems.

Components	Maximum
Storage Hardware Components	
Shelves (system and expansion)	16
Drives	384 (120 SSDs maximum; no more than 25 SSDs per 60-drive shelf)
SSD cache capacity per system	5TB
Logical Components	

Components	Maximum
Partitions	512
Volumes per partition	256
Volumes	2,048
Thin volumes per system	2,048
Disk pools per system	20
Consistency Groups	
Volumes per consistency group	64
Consistency groups per system	32
Snapshot Copies	
Per Snapshot group	32
Per volume	128
Per storage system	2,048
Snapshot Volumes	
Per Snapshot copy	4
Per system	2,048
Snapshot Groups	
Per volume	4
Per system	1,024
Mirrors	
Legacy mirrors per system	128
Mirrors per system	128
Mirrors per volume	1
Mirrors per asynchronous mirror group	64
Asynchronous mirror groups per system	4

6 Hardware Configurations

E5600 storage systems use a modular approach to hardware configurations. This approach can meet most customer SAN storage requirements for flexible host interfaces and versatile drive choices without sacrificing supportability, ease of implementation, and long-term stability.

6.1 Controller-Drive Shelf Configurations

As previously noted, the E-Series E5600 storage system is supported in one of three configurations. For specialized use cases, it can be configured as a mix of shelf types, up to a maximum of 16 shelves total or 384 drives (maximum 120 SSDs; no more than 25 SSDs per 60-drive shelf).

E5660 Controller-Drive Shelf

The E5660 is a four-rack-unit-high (4U) shelf that holds up to sixty 3.5-inch or 2.5-inch drives in five horizontal drawers (12 drives per drawer). It features dual RAID controllers, dual power modules, and dual fan modules with two fans in each module.

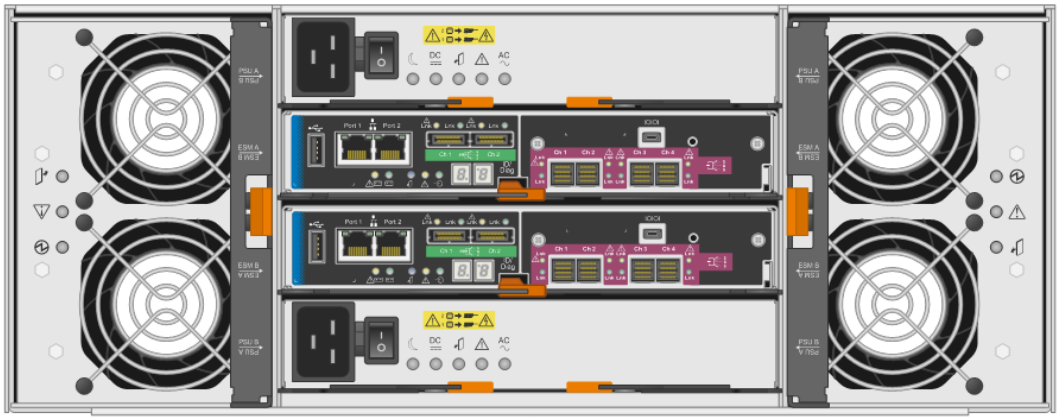
An E5660-based storage system supports a maximum of 360 drives when using only 60-drive shelves or a maximum of 384 drives when using a mix of expansion-drive shelf models. A minimum of 20 drives must be installed in the E5660 controller-drive shelf and in each 60-drive expansion-drive shelf. For purposes of airflow, these drives must be installed in the four front drive slots in each drawer.

Note: Operating the storage system without populating all four front drive slots in each drawer can lead to overheating. In addition, the shelf bezel should be installed during normal operation.

Refer to Table 9 for more details about E5660 technical specifications. Figure 6 and Figure 7 show the front and rear views of the E5660 controller-drive shelf.

Figure 6) E5660 front view without bezel.

Figure 7) E5660 rear view with the four-port 12Gb SAS HIC installed.



E5624 Controller-Drive Shelf

The E5624 is a two-rack-unit-high (2U) shelf that holds up to twenty-four 2.5-inch drives and features dual RAID controllers and dual power supplies with integrated fans. An E5624-based storage system supports a maximum of 384 drives and a mix of expansion-drive shelf models in a single system.

Note: Refer to Table 9 for more details about E5624 technical specifications.

The E5624 has a proven track record of reliability and is well suited for use in remote dedicated environments in which space is limited or in primary data centers.

Figure 8 and Figure 9 show the front and rear views of the E5624 controller-drive shelf.

Figure 8) E5624 front view.

Figure 9) E5624 rear view with the 16Gb FC or 10Gb iSCSI HIC installed.

E5612 Controller-Drive Shelf

The E5612 is a 2U shelf that holds up to twelve 3.5-inch drives and features dual RAID controllers and dual power supplies with integrated fans. An E5612-based storage system supports a maximum of 192 drives when using only 12-drive shelves or 384 drives when using a mix of expansion-drive shelf models.

Note: Refer to Table 9 for more details about E5612 technical specifications.

The E5612 has a proven track record of reliability in remote dedicated environments. Figure 10 and Figure 11 show a front and a rear view of the E5612 controller-drive shelf.

Figure 10) E5612 front view.

Figure 11) E5612 rear view with the 16Gb FC or 10Gb iSCSI HIC installed.

E5600 Hardware Specifications

The E5600 controller has the following base hardware features:

- Dual Ethernet ports for management-related activities
- SAS, FC, iSCSI, or IB ports for host connection
- SAS drive expansion ports to attach expansion-drive shelves

Note: One of the host I/O port options must be ordered when the controller is purchased.

Table 9 lists the physical characteristics of the E5660, E5624, and E5612 controller-drive shelves.

Table 9) E5600 physical characteristics.

Dimensions and Weight	E5660 Controller-Drive Shelf (DE6600 Shelf with 6TB HDD)	E5624 Controller-Drive Shelf (DE5600 Shelf with 1.8TB HDD)	E5624 Controller-Drive Shelf (DE5600 Shelf with 1.6TB SSD)	E5612 Controller-Drive Shelf (DE1600 Shelf with 6TB HDD)
Height	7.0" (17.78cm)	3.47" (8.81cm)	3.47" (8.81cm)	3.4" (8.64cm)
Width	19" (48.26cm)	19" (48.26cm)	19" (48.26cm)	19" (48.26cm)
Depth	32.5" (82.55cm)	19.6" (49.78cm)	19.6" (49.78cm)	21.75" (55.25cm)
Weight (maximum)	240.7lb (109.4kg)	63.0lb (28.6kg)	60.1lb (27.3kg)	65.3lb (29.6kg)

Table 10 lists the technical specifications for the E5600-based storage systems.

Table 10) E5600 technical specifications.

Specification	E5660	E5624	E5612
Maximum raw system capacity	2880TB	691TB	1536TB
Maximum number of drives per system	360	384	192
Shelf form factor	4U, 60 drives	2U, 24 drives	2U, 12 drives
SSD (FDE and FIPS drives available)	3.2TB, 1.6TB, or 800GB 2.5" SSD (25 per shelf maximum, 120 per storage system maximum)	3.2TB, 1.6TB, or 800GB 2.5" SSD (120 per storage system maximum)	Not supported
HDD supported (FIPS and FDE drives available)	1.8TB, 1.2TB, 900GB, or 600GB 2.5" 10K RPM SAS	1.8TB, 1.2TB, 900GB, or 600GB 2.5" 10K RPM SAS	600GB 3.5" 15K RPM SAS (restricted to add-on for existing system only—EOL)
	8TB, 6TB, 4TB, 3TB, or 2TB 3.5" 7.2K RPM SAS	Not supported	8TB, 6TB, 4TB, 3TB, or 2TB 3.5" 7.2K RPM SAS
Memory	24GB (12GB per controller)		
	96GB (48GB per controller), iSCSI and FC only		
Host I/O (controllers must match; a software feature pack can be applied to convert the 4-port FC and iSCSI HICs to FC-iSCSI split mode)	8-port 12Gb SAS (4-port 12Gb SAS [wide-port] per E5600 controller)		
	8-port 16Gb FC (4-port 16Gb FC per E5600 controller)		
	8-port 10Gb iSCSI (4-port 10Gb iSCSI per E5600 controller)		
	4-port 56Gb IB (2-port 56Gb IB per E5600 controller)		
	DE6600 (4U, 60 drives): 5 expansion shelves maximum; supports the same drive types as E5660 controller-drive shelf		

Specification	E5660	E5624	E5612
Drive shelves supported for expansion-drive offerings	DE5600 (2U, 24 drives): 15 expansion shelves maximum; supports the same drive types as E5624 controller-drive shelf		
	DE1600 (2U, 12 drives): 15 expansion shelves maximum; supports the same drive types as E5612 controller-drive shelf		
High-availability (HA) features	Dual active controllers with automated I/O path failover		
	Support for RAID 0, 1 (10 for 4 drives or more), 5, and 6		
	Redundant, hot-swappable storage controllers, disk drives, power supplies, and cooling fans		
	SANtricity proactive drive health monitoring with the drive evacuator feature to identify problem drives and begin removing data before hard failures occur		
	Automatic drive fault detection, failover, and rebuild by using global hot spare drives for standard RAID and spare pool capacity in the case of DDP		
	Mirrored data cache with battery backup and destage to flash		
	Online controller firmware and NVSRAM upgrade		
	Online ESM firmware upgrade (consult CSD for guidance before performing ESM upgrades)		
	Online drive firmware upgrades (consult CSD for guidance before performing drive firmware upgrades)		
	SANtricity Event Monitor and AutoSupport, for making periodic copies of the storage system configuration		

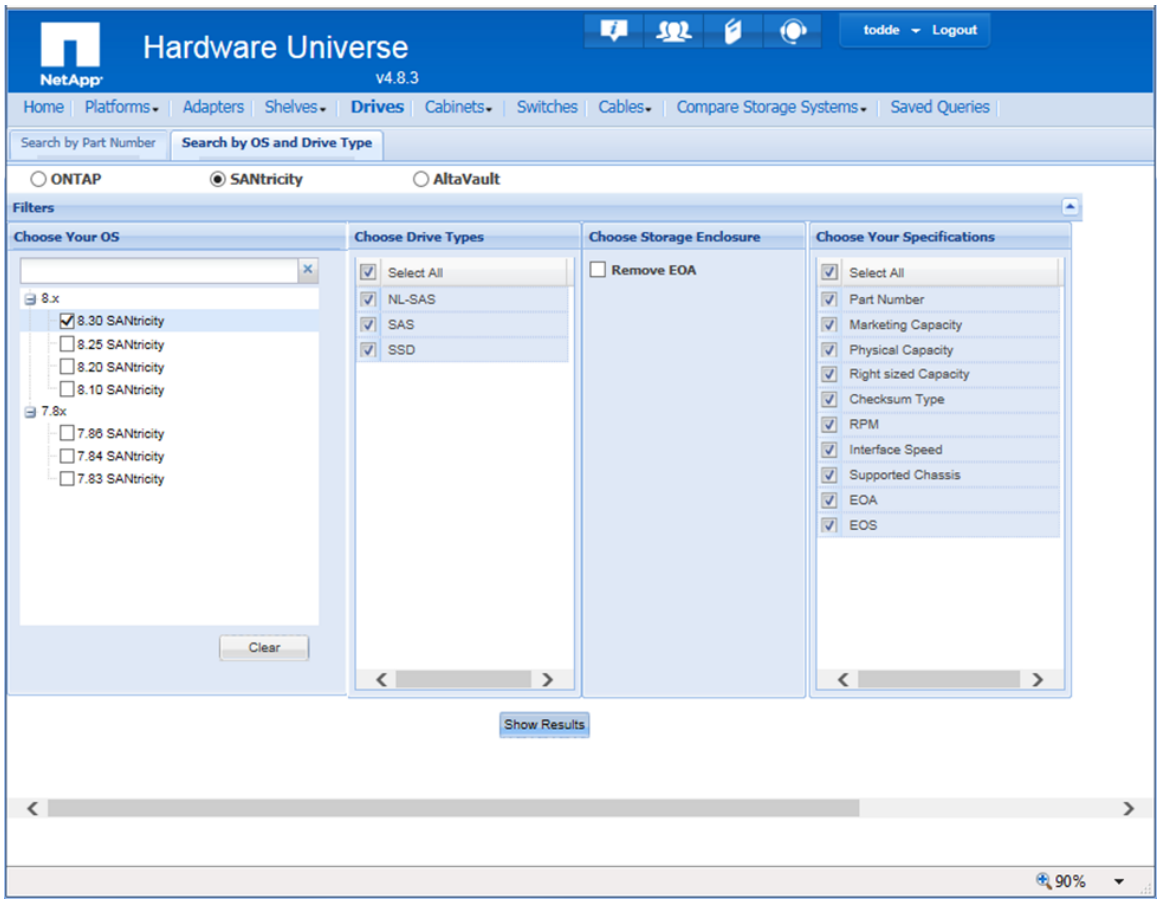
Table 11 provides a reference matrix of supported drive types and associated advanced features, including full disk encryption (FDE) and FIPS. The information is accurate as of March 2016.

Table 11) Drive feature matrix as of March 2016.

Drive Type	Data Assurance (DA): T10 PI	Full Disk Encryption (FDE)	Federal Information Processing Standards (FIPS 140-2 Level 2)
3/4 TB NL-SAS	x		
6TB NL-SAS	x	x	x
8TB NL-SAS	x		
900GB, 1.2TB SAS	x		
1.8TB SAS	x	x	x
800GB SSD	x	x	
1.6TB SSD	x	x	x
3.2TB SSD	x		

Current drive availability information is always available in the Hardware Universe. Figure 12 shows the navigation to select drives by OS and platform compatibility.

Figure 12) Hardware Universe drives by OS and drive type.



For additional information, refer to the NetApp E5600 Datasheet.

6.2 Controller Host Interface Features

By default, the E5600 controller includes two Ethernet management ports that provide out-of-band or in-band system management access and two SAS drive expansion ports that provide redundant drive expansion paths. E5600 controllers do not include built-in host ports, so they must be ordered with one of the following host interface cards (HICs) installed in each controller:

- 4-port 12Gb SAS HIC.
- 2-port 56Gb InfiniBand (IB) HIC. This HIC runs the iSCSI Extensions for RDMA (iSER) protocol as shipped, but it can be converted to SCSI RDMA Protocol (SRP) before initial use by applying a software feature pack in the field at no additional cost.
- 4-port optical HIC, which can be factory-configured as either 16Gb Fibre Channel or 10Gb iSCSI. A software feature pack can be applied in the field to change the host protocol of this HIC:
  - From FC to iSCSI
  - From iSCSI to FC
  - From either FC or iSCSI to FC-iSCSI split mode
  - From FC-iSCSI split mode back to FC or iSCSI

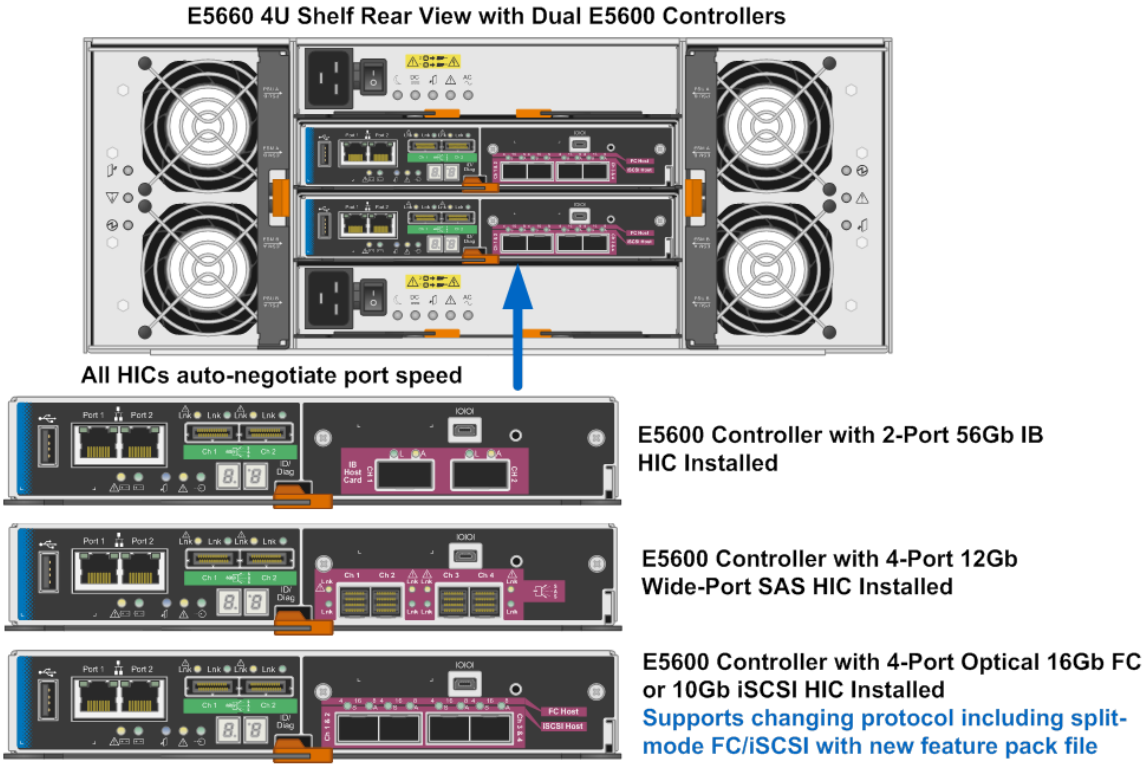
Note: In FC-iSCSI split mode, ports 1 and 2 operate as iSCSI, and ports 3 and 4 operate as FC.

For step-by-step instructions for obtaining and applying software feature packs to change HIC protocol, go to the E-Series Systems Documentation Center (http://mysupport.netapp.com/eseries), click Upgrade/Convert the Host Interface Card, and select one of the PDFs listed for the E5600 model series.

For optical connections, the appropriate SFPs must be ordered for the specific implementation. Consult the Hardware Universe for a full listing of available host interface equipment. Figure 13 provides a close-up view of the E5600 HIC options.

Note: Both controllers in a storage system must be configured identically.

Figure 13) E5600 HIC options.



Note: All HICs support link speed autonegotiation. One exception is the unified SFP used with the 4-port optical HIC. This SFP does support 4/8/16Gb FC and 10Gb iSCSI, but it does not support 1Gb iSCSI. As a result, the unified SFP should not be used with iSCSI remote mirroring because it does not support a 10Gb/1Gb WAN link to the remote site. For this use case, use the 1Gbps iSCSI SFP.

6.3 Hardware LED Definitions

E5600 Controller-Drive Shelf LEDs

The E5600 controller-drive shelf has LED status indicators on the front of the shelf and on the power supply units and fan units installed at the rear of the shelf. The LEDs on the front panel indicate system-wide conditions, and the LEDs on the power supply units and fan units indicate the status of the individual units.

The LEDs on the front panel of the E5600 controller-drive shelf are visible with or without the bezel installed. Figure 14 shows the LEDs on the front panel of the E5660 controller-drive shelf.

Figure 14) LEDs on the front panel of the E5660 controller-drive shelf.

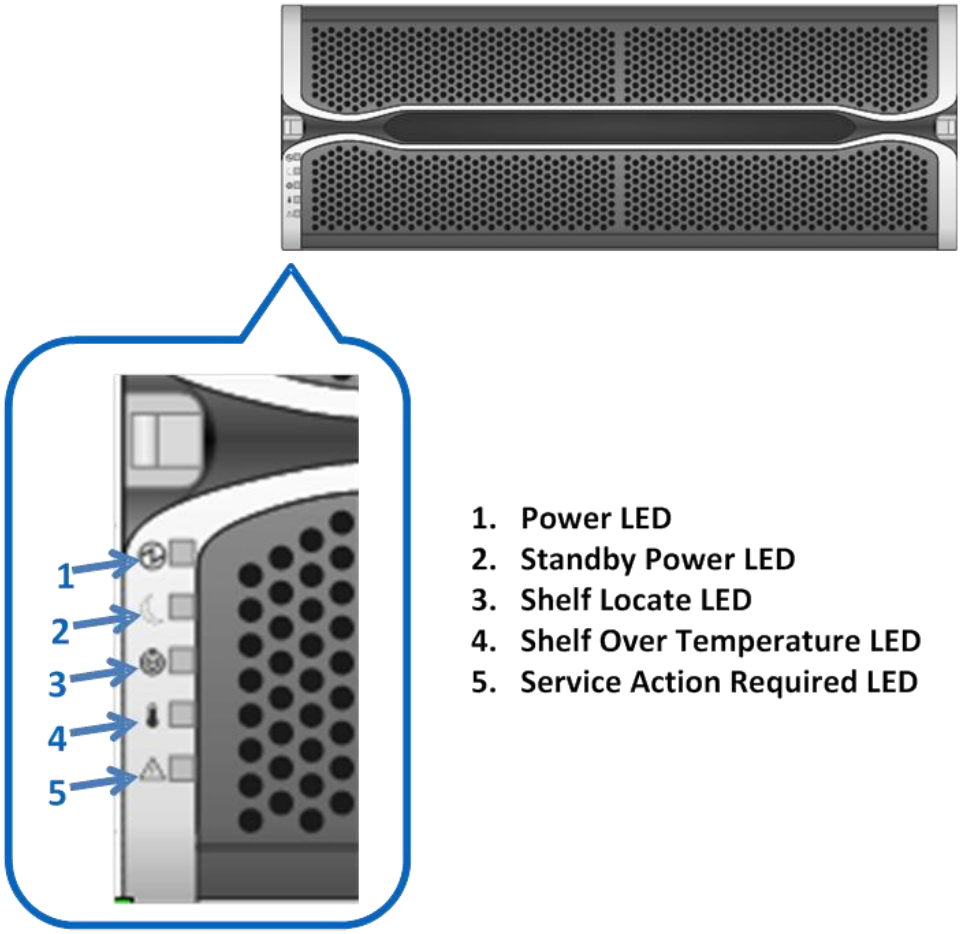
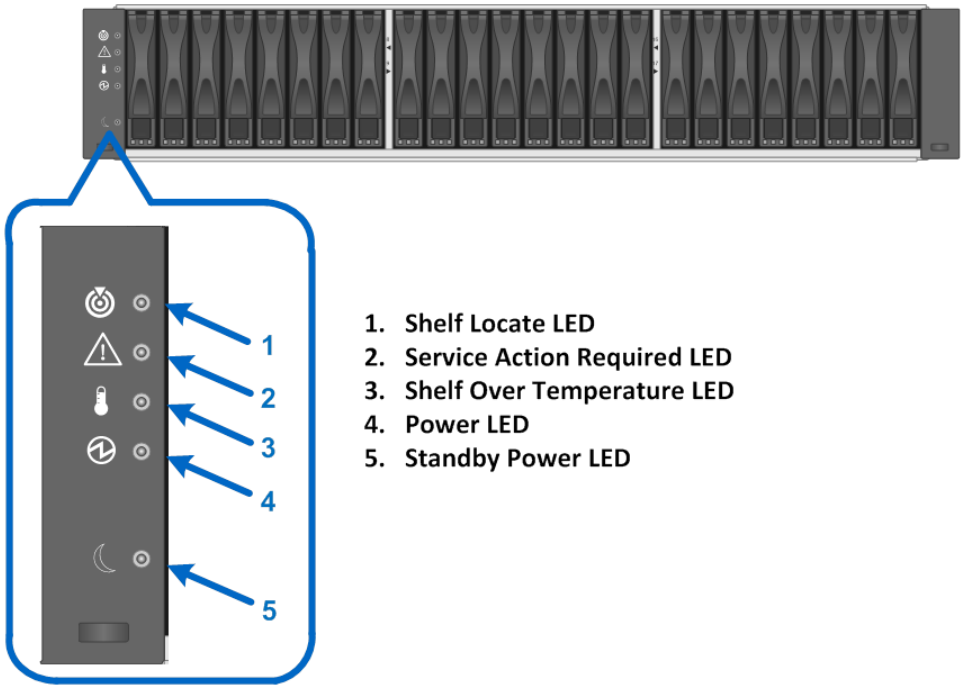


Figure 15 shows the LEDs on the front panel of the E5624 and E5612 controller-drive shelves.

Note: Figure 15 shows the E5624 front panel, but the LEDs are the same for the E5612.

Figure 15) LEDs on the front panel of the E5624 and E5612 controller-drive shelves.



1. Shelf Locate LED
2. Service Action Required LED
3. Shelf Over Temperature LED
4. Power LED
5. Standby Power LED

Note: The LEDs on the front of the E5660 controller-drive shelf are in a different order from those on the front of the E5624 and E5612 shelves.

Table 12 defines the front-panel LEDs on the E5660, E5624, and E5612 controller-drive shelves. The LEDs are listed in the order matching the layout on the E5660 controller-drive shelf.

Table 12) E5600 controller-drive shelf LED definitions (front panel).

LED Name	Color	LED On	LED Off
Power	Green	Power is present.	Power is not present.
Standby	Green	The controller-drive shelf is in standby mode.	The controller-drive shelf is not in standby mode.
Shelf locate	White	The LED lights up to make the controller-drive shelf easy to locate in the equipment rack.	Normal status.
Shelf over temperature	Amber	The temperature of the controller-drive shelf has reached an unsafe level.	Normal status.
Service action required	Amber	A component in the controller-drive shelf requires attention.	Normal status.

Power Supply and Fan Unit LEDs

The E5600 controller-drive shelf supports dual power supplies and fan canisters. Each power supply and fan canister unit is equipped with status LEDs. Figure 16 shows the LEDs on the rear of the E5660 controller-drive shelf.

Figure 16) LEDs on the E5660 power supply and fan units (rear view).

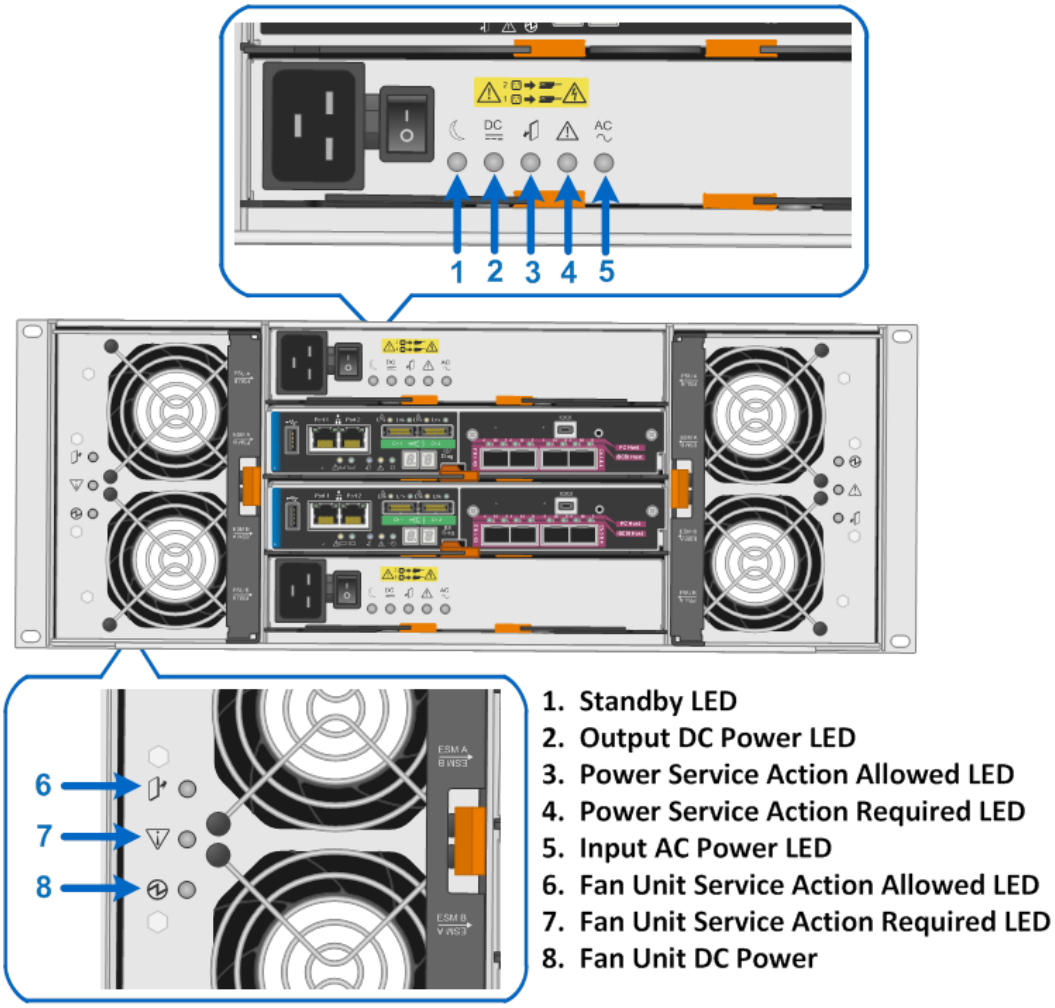


Table 13 defines the integrated power supply and fan unit LEDs on the E5660 controller-drive shelf.

Table 13) E5660 controller-drive shelf power supply and fan unit LED definitions.

LED Name	Color	LED On	LED Off
Standby	Green	The controller-drive shelf is in standby mode.	The controller-drive shelf is not in standby mode.
Output DC power	Green	DC output power is present.	DC output power is not present.
Power service action allowed	Blue	The controller-drive shelf is in service mode.	The controller-drive shelf is not in service mode.
Power service action required	Amber	A power component in the controller-drive shelf requires attention.	Normal status.
Input AC power	Green	AC power is present.	AC power is not present.
Fan unit service action allowed	Blue	The fan unit is in service mode.	The fan unit is not in service mode.

LED Name	Color	LED On	LED Off
Fan unit service action required	Amber	The fan unit requires attention.	Normal status.
Fan unit DC power	Green	Fan AC power is present.	Fan AC power is not present.

The power supply and fan unit for the E5624 and E5612 controller-drive shelf are identical. The power supply LEDs are shown in Figure 17 and defined in Table 14.

Figure 17) LEDs on the E5624 and E5612 integrated power supply and fan units (rear view).

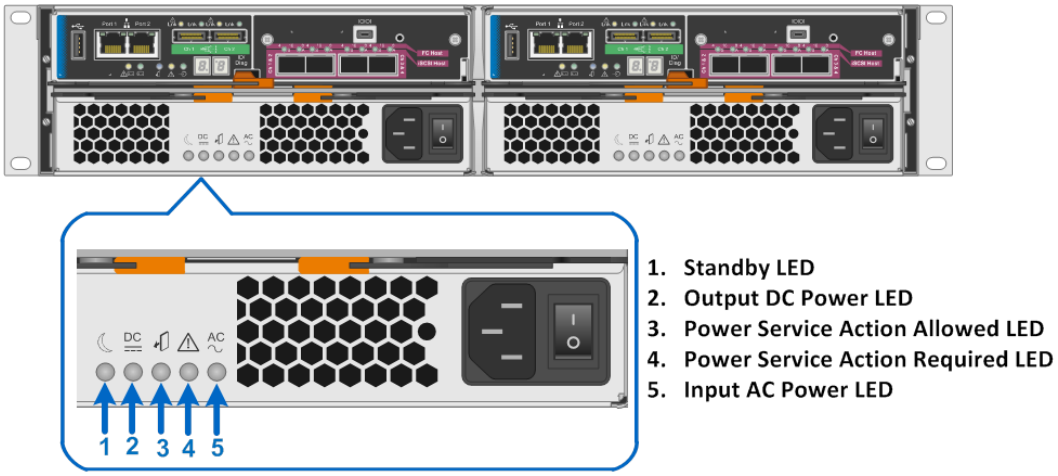


Table 14) E5624 and E5612 controller-drive power supply LED definitions.

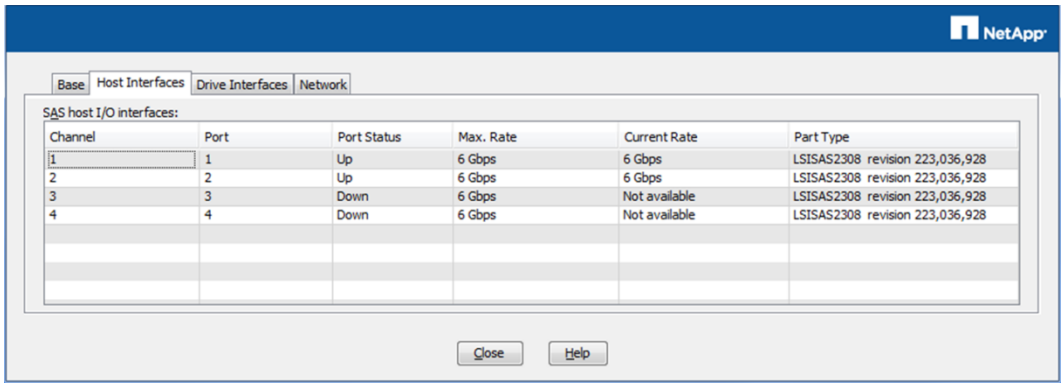
LED Name	Color	LED On	LED Off
Standby	Green	The controller-drive shelf is in standby mode.	The controller-drive shelf is not in standby mode.
Output DC power	Green	DC output power is present.	DC output power is not present.
Power service action allowed	Blue	The controller-drive shelf is in service mode.	The controller-drive shelf is not in service mode.
Power service action required	Amber	A power component in the controller-drive shelf requires attention.	Normal status.
Input AC power	Green	AC power is present.	AC power is not present.

E5600 Controller Canister LEDs

The E5600 controller canister has several LED status indicators. The LEDs on the left side of the canister refer to the onboard ports, including the Ethernet management ports, the SAS drive expansion ports, and the overall controller status. The LEDs on the right side of the canister refer to the status of the host ports.

Host port status can be verified by directly checking the port LEDs or by using the SANtricity Storage Manager GUI. The Host Interfaces tab of the Controller Properties dialog box, shown in Figure 18, details the status of each host I/O interface that is connected to the storage system.

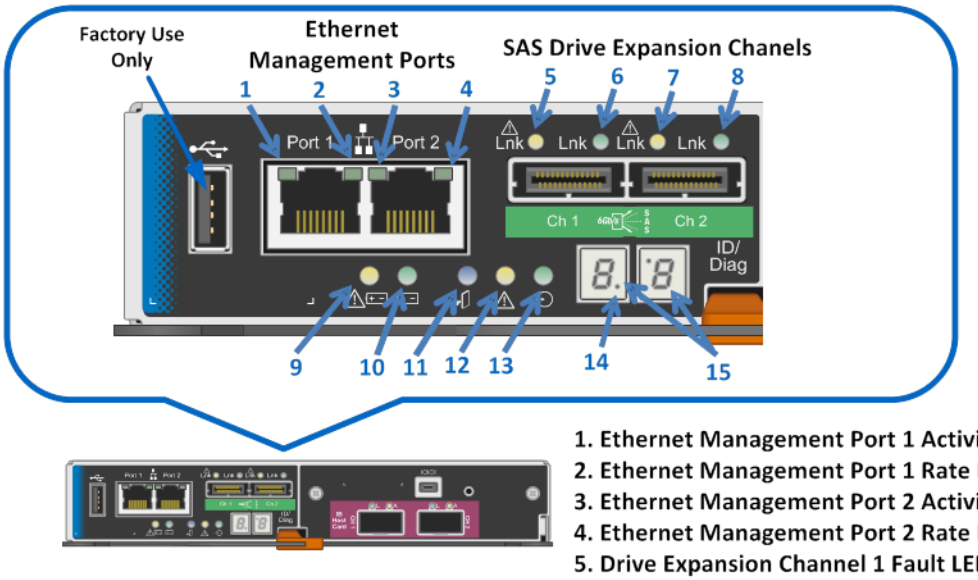
Figure 18) Controller Properties dialog box.



Controller Base Port Status LEDs

Figure 19 shows the onboard LED status indicators on the left rear side of the E5600 controller. Most of the LEDs are lit when a fault condition exists; however, the battery charging LED and the cache active LED are lit when the battery is fully charged and the cache is active. The seven-segment LEDs provide status codes for both normal operation and fault conditions; the dot in the first seven-segment LED is the controller heartbeat indicator, which comes on when an intercontroller communication link has been established.

Figure 19) LEDs on the left side of the E5600 controller canister.



1. Ethernet Management Port 1 Activity LED
2. Ethernet Management Port 1 Rate LED
3. Ethernet Management Port 2 Activity LED
4. Ethernet Management Port 2 Rate LED
5. Drive Expansion Channel 1 Fault LED
6. Drive Expansion Channel 1 Activity LED
7. Drive Expansion Channel 2 Fault LED
8. Drive Expansion Channel 2 Activity LED
9. Battery Service Action Required LED
10. Battery Charging LED
11. Controller Service Action Allowed LED
12. Controller Service Action Required LED
13. Cache Active LED
14. Flashing Dot – Heartbeat Indicator
15. Seven-Segment LED - Hardware Shelf ID

Table 15 defines the Ethernet management port LEDs on the controller (LEDs 1 through 4 in Figure 19).

Table 15) Ethernet management port LED definitions.

LED Name	Color	LED On	LED Off
Ethernet management port activity (top left corner of management port RJ-45 connectors)	Green	• Solid: The link is up without activity. • Blinking: The link is up with activity.	A link error has occurred (link down).
Ethernet management port rate (top right corner of management port RJ-45 connectors)	Green	There is a 1000BASE-T rate.	There is a 10/100BASE-T rate.

Table 16 defines the LEDs for the SAS drive expansion ports used to connect expansion-drive shelves to the E5600 controller-drive shelf (LEDs 5 through 8 in Figure 19).

Table 16) SAS drive expansion port LED definitions.

LED Name	Color	LED On	LED Off
Drive expansion channel fault (channel 1 and channel 2)	Amber	At least one of the four PHYs in the output port is working, but another PHY cannot establish the same link to the expansion output connector.	Normal status.
Drive expansion channel activity (channel 1 and channel 2)	Green	At least one of the four PHYs in the output port is working, and a link exists to the device connected to the expansion output connector.	A link error has occurred.

Table 17 defines the controller or system status LEDs (LEDs 9 through 15 in Figure 19).

Table 17) Controller base feature LED definitions.

LED Name	Color	LED On	LED Off
Battery service action required	Amber	The battery in the controller canister has failed.	Normal status.
Battery charging	Green	• Solid: The battery is fully charged. • Blinking: The battery is charging.	The controller canister is operating without a battery, or the existing battery has failed.
Controller service action allowed	Blue	The controller canister can be removed safely from the controller-drive shelf.	The controller canister cannot be removed safely from the controller-drive shelf.
Controller service action required	Amber	Some fault exists within the controller canister.	Normal status.
Cache active	Green	• Solid: The cache is active. • Blinking: After AC power failure, the cache offload is in process.	The cache is inactive, or the controller canister has been removed from the controller-drive shelf.

LED Name	Color	LED On	LED Off
Dot in lower right corner of first seven-segment LED	Green	A flashing dot indicates that the controller heartbeat is active.	If the dot is not lit, the controller heartbeat is not active (that is, the controller is not in service).
Two seven-segment LEDs	Green	• If the controller status code equals `99`, then the controller is in service. • If the controller status code does not equal `99`, then a fault condition exists. Contact technical support for further assistance.	The controller is not powered on.

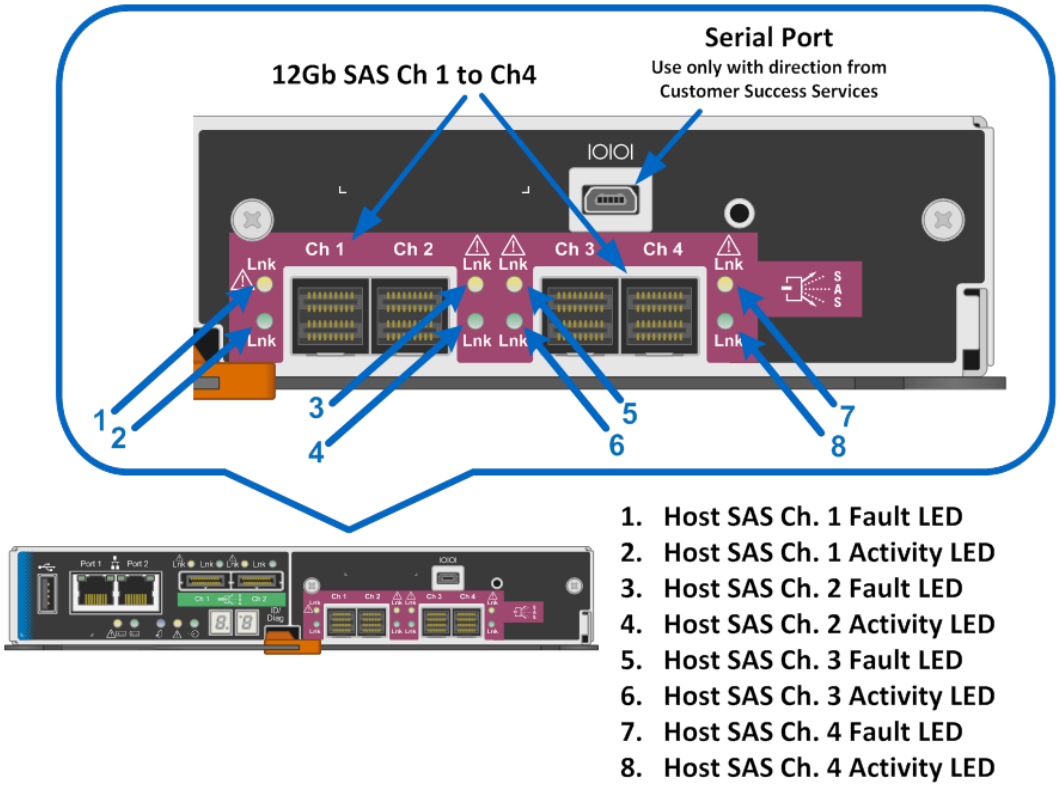
Note: The battery service action required LED indicates that the battery timer has expired or the battery has failed the automatic battery test. This condition can seriously affect the system write performance because the write cache feature is disabled by default when the battery is not functioning normally.

The seven-segment LEDs display the shelf ID, and 99 is the normal ID for controller-drive shelves. Expansion-drive shelves display numbers starting with 00 and increasing as drive shelves are added to the storage system. These shelf IDs can be changed from the default numbering by using the SANtricity management interface. The seven-segment LEDs also display status codes under start-up conditions and some error conditions.

4-Port 12Gb Wide-Port SAS HIC LEDs

The 4-port 12Gb wide-port SAS HIC is shown in Figure 20. The host-side connection ports have status LEDs to indicate the connection status for each link between the storage system and various host-side hardware devices.

Figure 20) LEDs on the 4-port 12Gb wide-port SAS HIC.



Note: The 12Gb SAS3 HIC uses mini-SAS HD (SFF-8643/8644) connectors.

Table 18 defines the 12Gb SAS HIC LEDs.

Table 18) 4-port 12Gb SAS HIC LED definitions.

LED Name	Color	LED On	LED Off
Host SAS channel fault	Amber	At least one of the four PHYs is working, but another PHY cannot establish the same link to the device connected to the host input port connector.	Normal status.
Host SAS channel activity	Green	At least one of the four PHYs in the host input port is working, and a link has been established to the device connected to the input port connector.	A link error has occurred.

4-Port Optical 16Gb FC/10Gb iSCSI HIC LEDs

The E5600 supports a 4-port optical HIC that offers 16Gb FC protocol, 10Gb iSCSI protocol, or a combination of both protocols (FC-iSCSI split mode). When using this HIC and dual controllers, the E5600 storage system provides a maximum of eight 16Gb FC ports, eight 10Gb iSCSI ports, or four 10Gb iSCSI ports and four 16Gb FC ports.

Figure 21 shows the LEDs on the 4-port optical HIC for the E5600 controller.

The optical HIC supports several SFP options, including several 16Gb FC or 10Gb SFP+ options and a unified adapter that supports both 16Gb FC and 10Gb iSCSI. The HIC also supports 10Gb iSCSI copper connectivity by using a special cable with built-in SFP+ adapters on both ends of the cable. These cables are generally available from NetApp and have a 23ft (7m) length limitation.

Note: The unified SFP does not support 1Gb iSCSI. It does support 4/8/16Gb FC and 10Gb iSCSI.

Figure 21) LEDs on the 4-port optical 16Gb FC/10Gb iSCSI HIC.

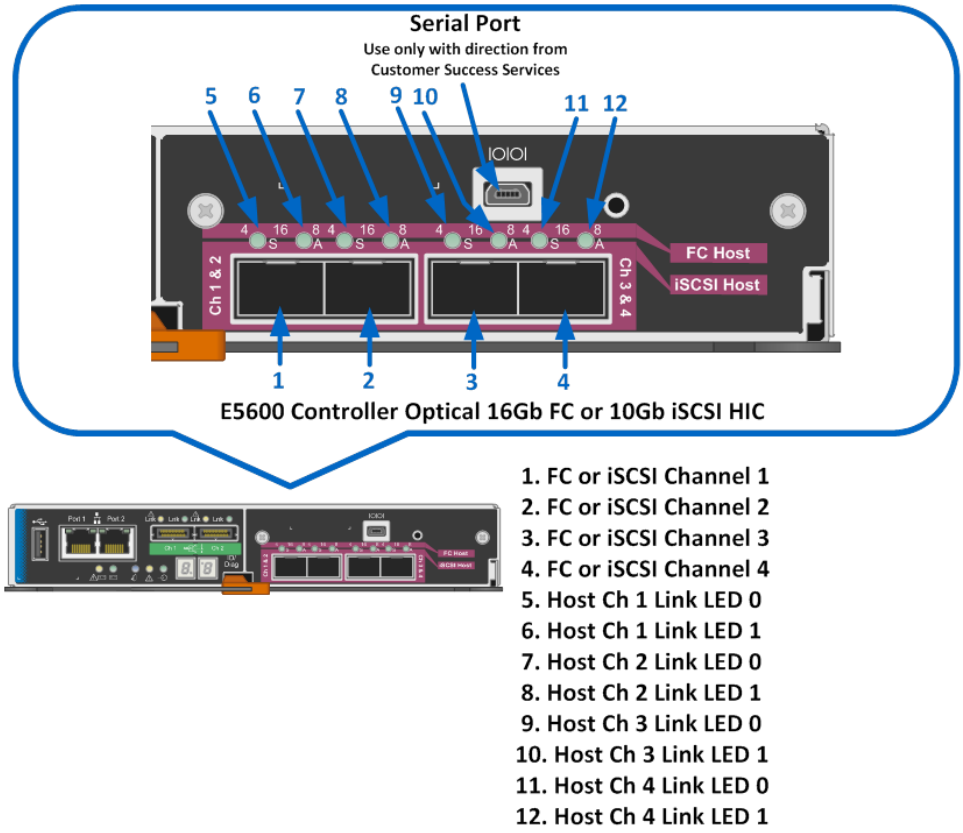


Table 19 defines the LEDs on the 4-port optical HIC when the FC is used.

Table 19) 4-port optical 16Gb FC HIC LED definitions.

LED 0 (Left Side)	LED 1 (Right Side)	Link Rate	Color
Off	Off	Link down	N/A
On	Off	Link operating at 4Gbps	Green
Off	On	Link operating at 8Gbps	Green
On	On	Link operating at 16Gbps	Green

Table 20 provides the 4-port optical HIC LED definitions when the iSCSI protocol is used.

Table 20) 4-port optical 10Gb iSCSI HIC LED definitions.

LED Speed (Left Side)	LED Activity (Right Side)	Link Rate	Color
On	On	Link operating at 10Gbps; no activity	Green
	Blinking	Link operating at 10Gbps with active I/O in progress	Green
Off	On	Link operating at 1Gbps; no activity	Green
	Blinking	Link operating at 1Gbps with active I/O in progress	Green
Off	Off	Link down	N/A

2-Port 56Gb InfiniBand HIC LEDs

The E5600 controller supports a 56Gb IB HIC, but it autonegotiates link speed to accommodate 40Gb IB environments. Figure 22 shows the LEDs on the 2-port 56Gb IB HIC for the E5600 controller.

Figure 22) LEDs on the 2-port 56Gb IB HIC.

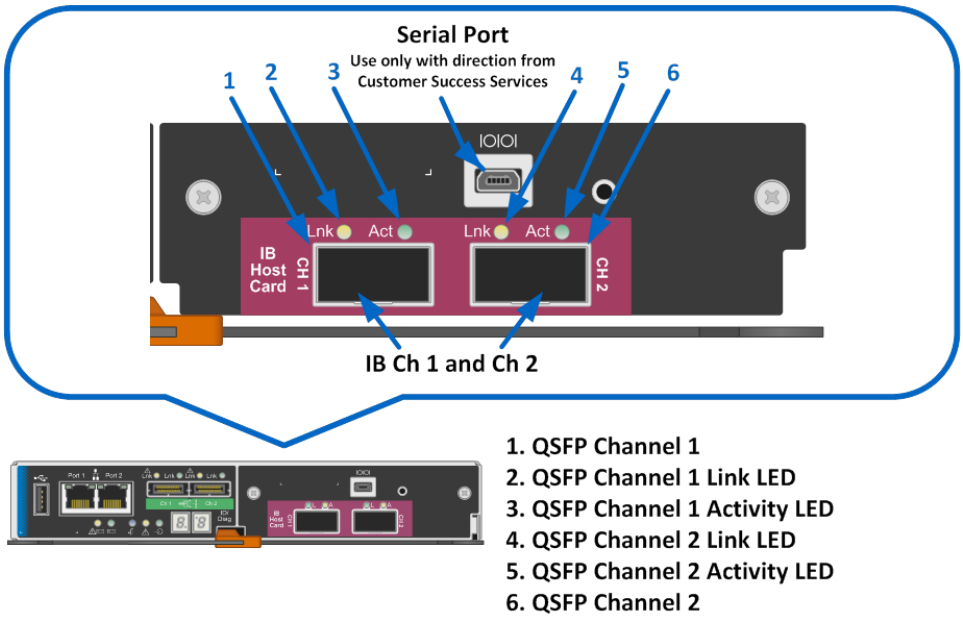


Table 21 defines the LEDs on the 2-port 56Gb IB HIC.

Table 21) 2-port 56Gb IB HIC LED definitions.

LED Name	Color	LED On	LED Off
QSFP link	Amber	The physical link is active.	The physical link is not active.

LED Name	Color	LED On	LED Off
QSFP activity	Green	• Solid: The link is up without activity. • Blinking: The link is up with activity.	The controller has not yet loaded the driver for the ConnectX host channel adapter.

For additional information about the E5600 storage systems and related hardware, refer to the E5600 series documentation at http://mysupport.netapp.com/eseries.

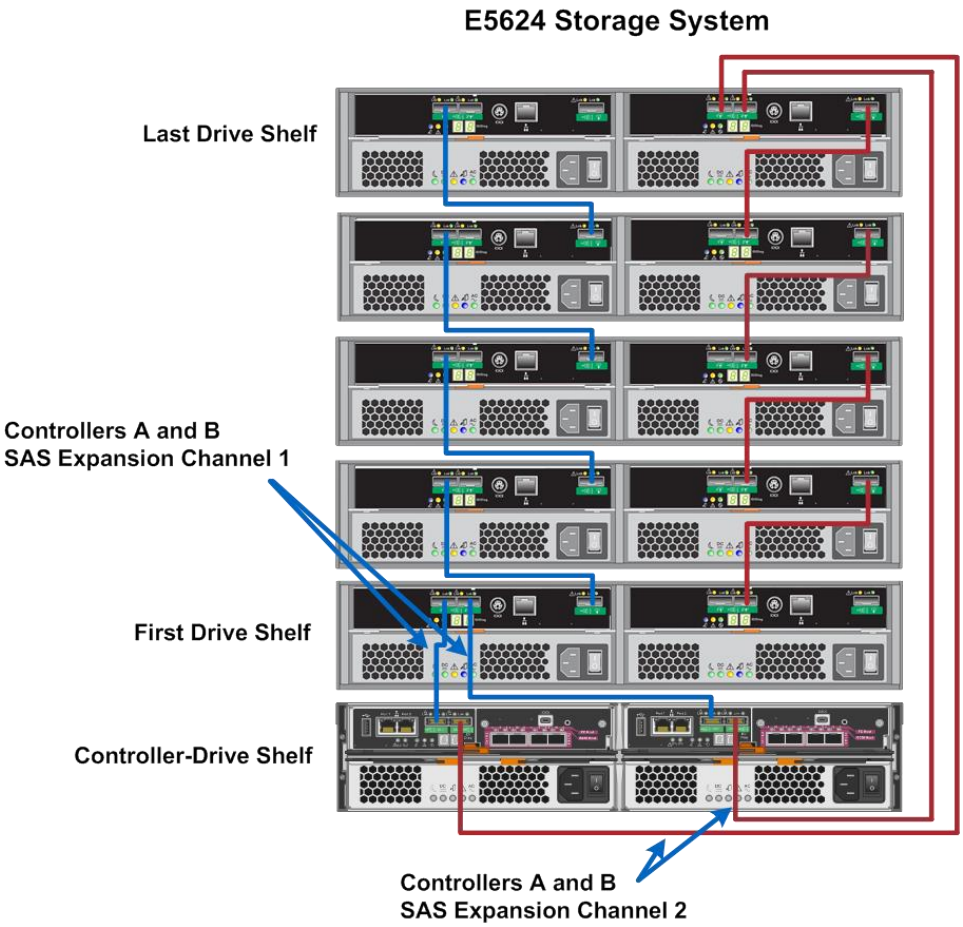
7 Expansion-Drive Shelves

E5600 storage systems support scale-out architectures through the use of expansion-drive shelves that are added on to the controller-drive shelf. This add-on requires a very specific single-stack architecture that is different from the single stack in the E2700 controller.

7.1 New E5600 Array Installations

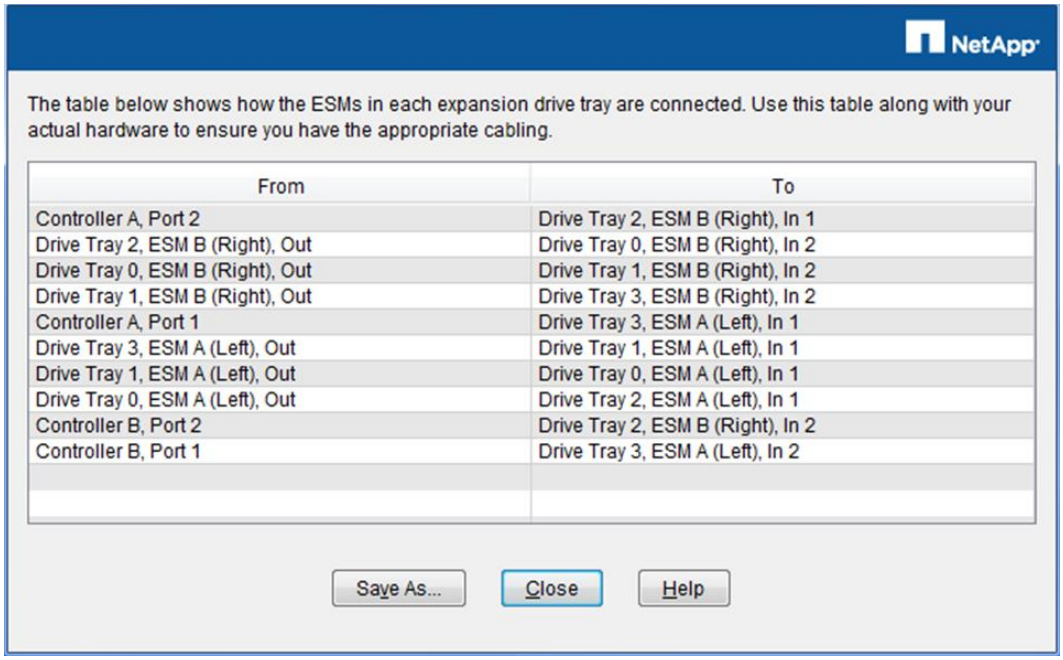
The E5600 single-stack layout is shown in Figure 23. The top-down and bottom-up approach is used to guard against a lost-shelf fault and to enable hot-adding a shelf in the future.

Figure 23) E5624 storage system with five expansion-drive shelves.



The E5600 cabling is innovative because the dual ports on each controller are split across the A and B sides of the attached drive shelves. To confirm the drive shelf cabling is correct, use the cable report in SANtricity Storage Manager, AMW > Monitor > Reports > Cable Connections, to trace each path, as shown in Figure 24.

Figure 24) SANtricity Storage Manager cable connections report.



Failure to cable expansion-drive shelves correctly can lead to a semilockdown state on the storage system. In this state, the system configuration cannot be changed until the cabling issue is resolved.

Best Practice

When initially powering on an E-Series storage system that includes expansion-drive shelves, power on the expansion-drive shelves first and wait one to two minutes per drive shelf before powering on the controller-drive shelf.

Best Practice

To power off an E-Series storage system that includes expansion-drive shelves, confirm that all host I/O operations have stopped. Then, turn off both power switches on the controller-drive shelf and wait for all LEDs on the shelf to go dark. Finally, turn off both power switches on any attached expansion-drive shelves and wait two minutes for the drive activity to stop.

7.2 Expansion-Drive Shelf Hot Add

E-Series storage systems support the addition of expansion-drive shelves and drive capacity to running storage systems. To prevent the loss of data availability to existing drive shelves when new drive shelves are added, the storage system must be cabled according to the cabling best practices that NetApp recommends. Two independent SAS channel paths must be available to the drive shelves so that one path can be interrupted when a drive shelf is added to the storage system while the other path maintains data availability to existing shelves.

The SANtricity cable connections report can be used to verify that the cabling is configured appropriately. After additional drive shelves have been successfully added to a storage system, SANtricity can be used to add capacity to existing volume groups and disk pools or to create new volume groups and disk pools.

When adding an expansion-drive shelf to an existing E-Series storage system, it is critical to follow the specific hot-add installation steps provided in the E-Series Hardware Cabling Guide.

Note: For more information and assistance with adding an expansion-drive shelf to an existing production E-Series system, go to http://mysupport.netapp.com/eseries and click the Cable the Hardware link or contact NetApp Customer Support Delivery.

Figure 25 and Figure 26 show the hot-add connectivity when a storage system is added as the last shelf in the system.

Figure 25) Drive shelf hot-add A-side cabling.

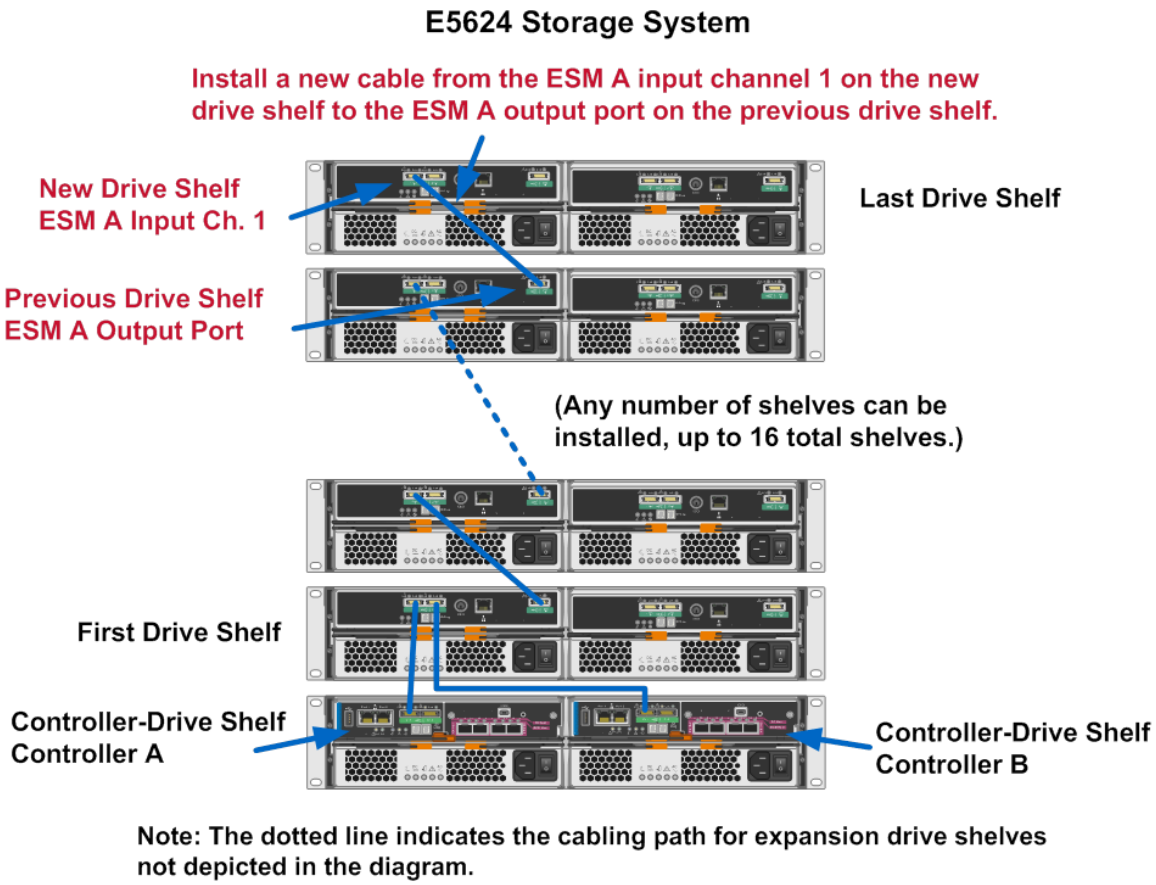
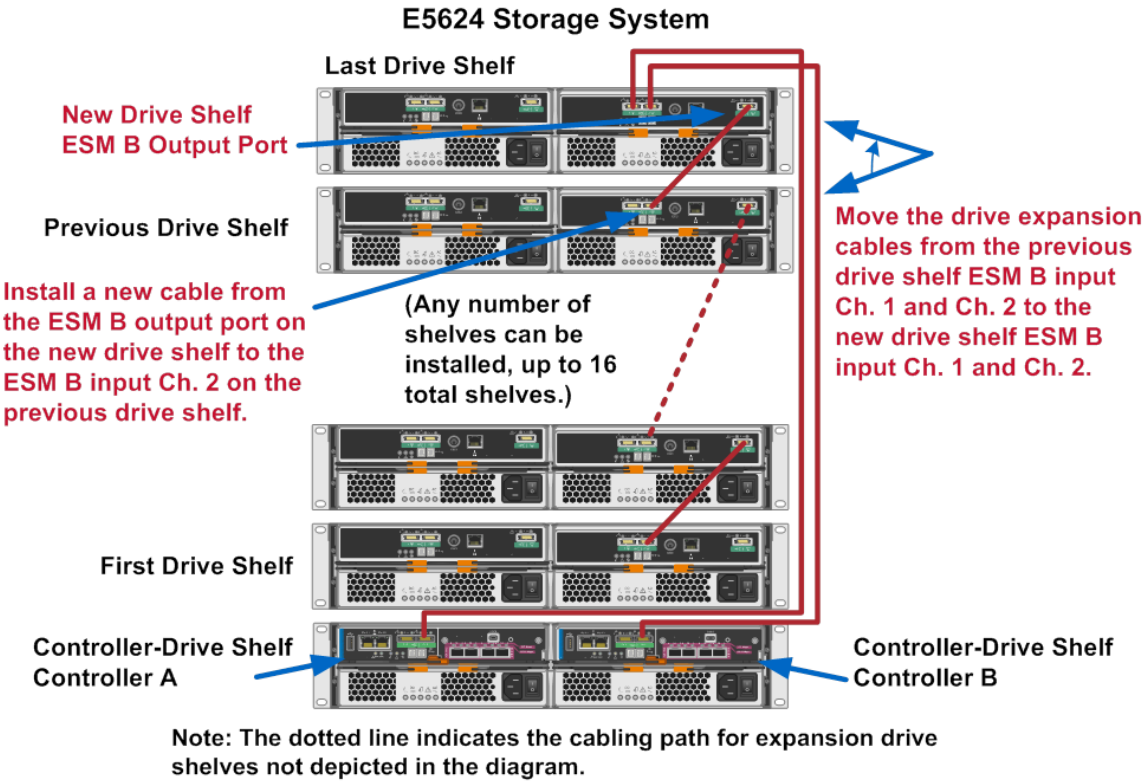


Figure 26) Drive shelf hot-add B-side cabling.



Best Practice

Plan carefully for any drive shelf hot-add activity on production storage systems. Verify that the following conditions are met:

- The existing power infrastructure can support the additional hardware.
- The cabling plan for the new shelf does not simultaneously interrupt the SAS expansion paths for controller A and controller B.

Note: Failure to preserve one active path to existing drive shelves during the procedure can cause host servers to lose access to their LUNs.

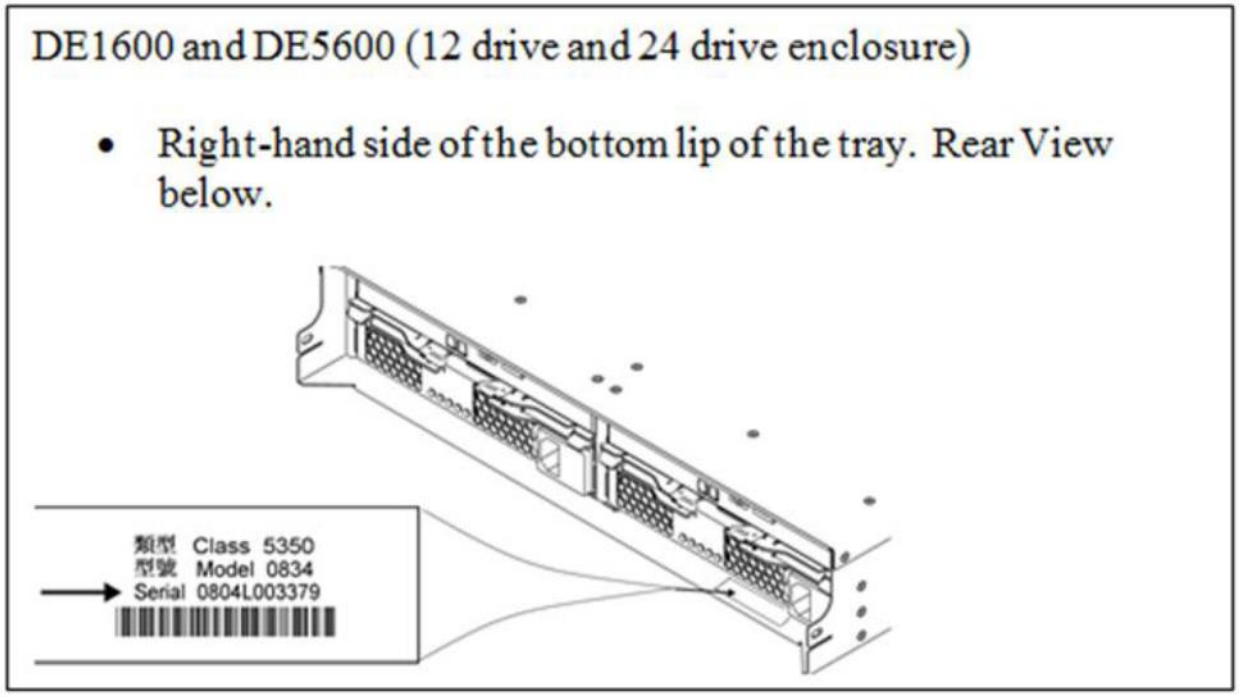
8 E-Series Product Support

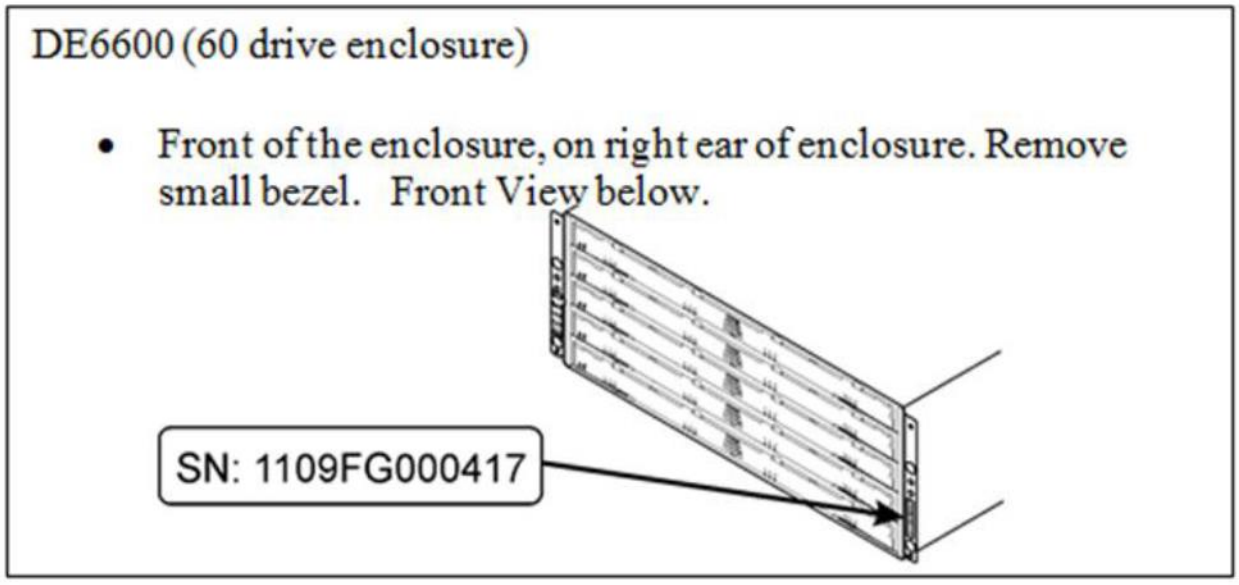
NetApp E-Series storage systems are identified by the serial number (SN) of the E-Series system shelf, not the SNs of the individual controllers within the E-Series system shelf. The correct SN must be registered for an E-Series system because only the SN of the E-Series system shelf can be used to log a support case with NetApp.

8.1 Controller-Drive Shelf Serial Number

E-Series storage systems are shipped preconfigured from the factory (controllers have HICs and batteries installed, and controllers are installed in the controller-drive shelf). The shelf SN is printed on a silver label affixed to the controller-drive shelf, and its location can vary depending on the chassis. The shelf SN is identified by the text “Serial” or “SN,” which is shown in Figure 27 for different system types.

Figure 27) Controller-drive shelf SN.

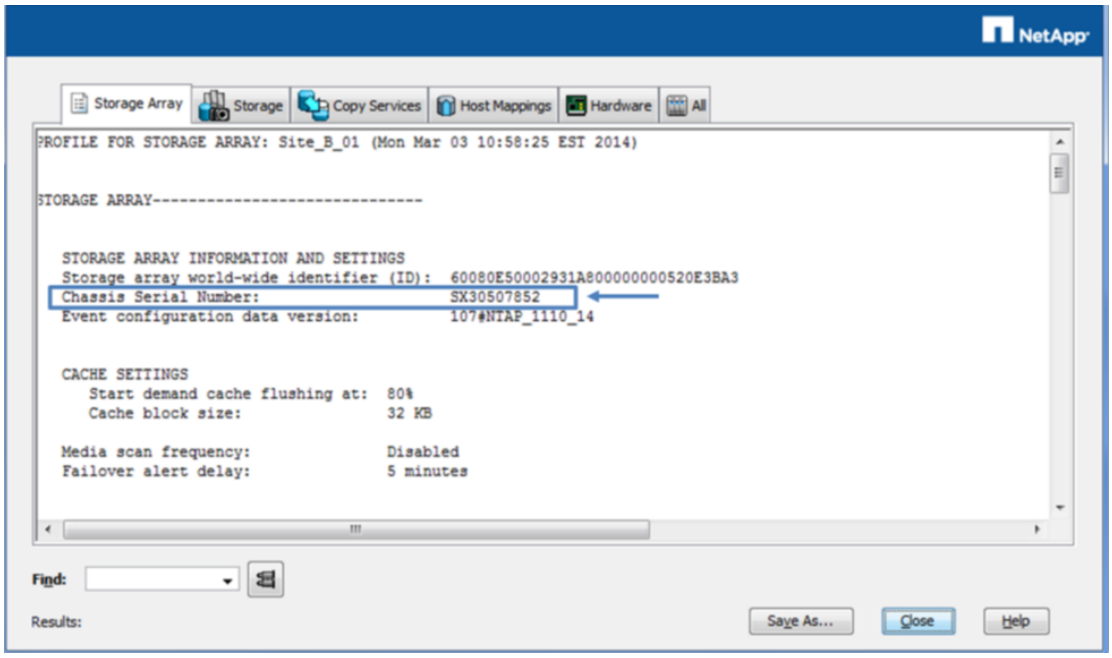




The shelf SN is also included on the shelf UL sticker; however, this sticker is often not visible after the shelves are installed in a rack.

On a running storage system, the SN is also available through SANtricity Storage Manager by viewing the storage array profile shown in Figure 28.

Figure 28) SANtricity Storage Manager AMW storage array profile.



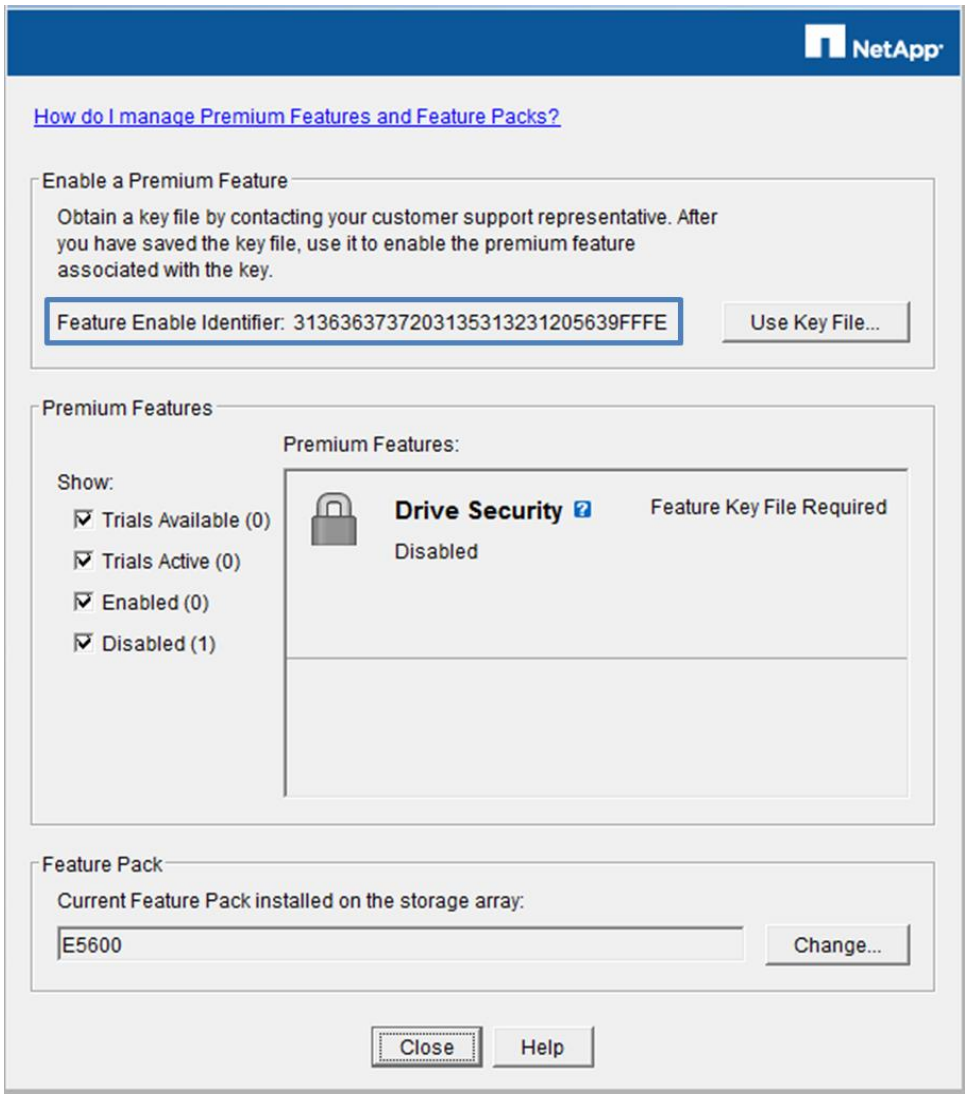
8.2 License Keys

E-Series storage arrays use two types of license keys. One type of key file is for premium features, and the other type of key file is used to change the storage system feature pack (changes the host interface protocol).

Premium Feature Keys

Drive security is the only premium feature in SANtricity 11.30 for E5600 storage systems; it requires a license key file to activate the functionality. License keys for premium features are system specific and can be purchased by sending a request to a sales representative. The request must include the feature-enable identifier that is listed in the Premium Features and Feature Pack Information dialog box (shown in Figure 29) and the storage system serial number (the serial number of the E-Series controller-drive shelf).

Figure 29) SANtricity 11.30 Premium Features and Feature Pack Information dialog box.



When the license key for the drive security feature has been purchased and the order has been processed in the NetApp order system, the key file can be generated by using the NetApp Storage Array Premium Feature Activation tool. The tool requires two types of information to generate license key files: the key activation code and the feature-enable identifier.

The 11-digit key activation code is system generated for purchased licenses and is attained by logging in to NetApp Support and viewing the system details under My Support > Software Licenses. The storage system controller-drive shelf serial number should be used to access the specific system details and key codes.

The feature-enable identifier is a 32-digit code that is unique to a storage system. It can be located by using SANtricity to access the Premium Features and Feature Pack Information dialog box for the storage system.

Customers must have a valid Support site account login and password to access, generate, and download the license key file.

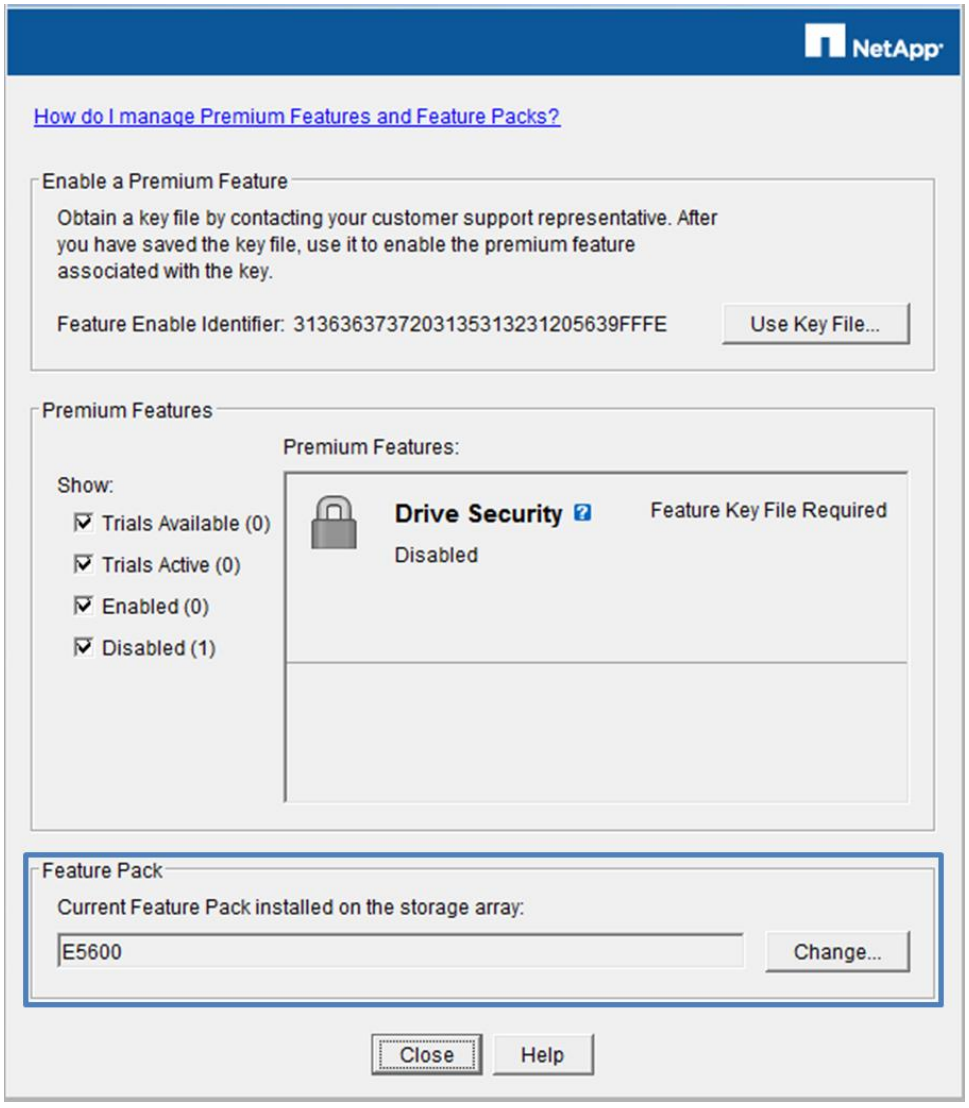
Note: First-time users who apply for a new Support site account have access to their system details and to the license key site delayed for up to five business days while the registration information is

validated and the user account is created. For this reason, NetApp recommends that customers create their Support site accounts as soon as their purchase order has been received by NetApp.

Feature Pack Keys

When E5600 controllers are equipped with the four-port optical FC/iSCSI HIC, feature pack keys are used to change the host interface protocol either from FC to iSCSI, iSCSI to FC, or either of these to split-mode two-port iSCSI/two-port FC. Similarly, a feature pack key is used to change the host interface protocol for the IB HIC from iSER to SPR. The process to generate a new feature pack key for your storage array is the same as the process to generate a premium feature key, except the 11-digit key activation code for each package is available at no additional cost and is listed in the hardware upgrade instructions per controller type available at https://mysupport.netapp.com/eseries.

Figure 30) Premium Features dialog box: feature pack section highlighted.



For issues with accessing license key files, open a support ticket with NetApp Customer Success Services using the serial number of the registered controller-drive shelf for the associated storage system.

9 Summary

The NetApp E5600 storage system leads the industry in meeting demanding high-performance computing requirements and in supporting wide-ranging transactional database workloads as well as tier one storage for data center dedicated workloads, mixed workloads, and even cloud-based workloads on demand. It delivers outstanding performance, footprint density, energy efficiency, and ease of integration to enable successful outcomes for wide-ranging IT operations.

The modular flexibility of the multiple E-Series host interfaces, drive shelf options, and drive offerings enables custom configurations to grow both performance and capacity as needed, providing optimal results while delivering the lowest possible price/performance. Combining E-Series hardware quality with SANtricity management and application integration (plug-ins, management applications, web services, and so on) enables E5600 storage systems to fit into existing data centers without having to reinvent day-to-day operations.

Backed by over 20 years of NetApp storage development experience and nearly 1,000,000 E-Series storage systems in the field, the E5600 provides a field-proven architecture with superior reliability and 99.999% availability. In addition, E-Series offers the NetApp AutoSupport feature to enhance customer service and avoid issues before they happen. The system’s advanced protection features, redundant components, automated path failover, remote administration, and extensive diagnostic capabilities allow E-Series customers to consistently achieve high levels of data integrity and availability.

References

The following references were used in this TR:

- E-Series E5600 Product Datasheet https://fieldportal.netapp.com/Core/DownloadDoc.aspx?documentID=142999&contentID=282657
- E-Series Product Documentation (both online help in SANtricity 11.30 and from the NetApp Product Documentation Library)
- E-Series SANtricity 11.30 Statement of Work (not publicly available)

Version History

Version	Date	Document Version History
Version 1.0	Sept 2016	Initial release concurrent with SANtricity 11.30

Refer to the Interoperability Matrix Tool (IMT) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.