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IBM FlashSystem 900 Model AE3 Product Guide

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Product Guide

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Today's global organizations depend on the ability to unlock business insights from massive volumes of data. Now, with IBM® FlashSystem 900 Model AE3, they can make faster decisions based on real-time insights. Thus, they unleash the power of demanding applications, including these:

- Online transaction processing (OLTP) and analytical databases
- Virtual desktop infrastructures (VDIs)
- Technical computing applications
- Cloud environments

Easy to deploy and manage, IBM FlashSystem® 900 Model AE3 is designed to accelerate the applications that drive your business. Powered by IBM FlashCore® Technology, IBM FlashSystem Model AE3 provides the following characteristics:

- Accelerate business-critical workloads, real-time analytics, and cognitive applications with the consistent microsecond latency and extreme reliability of IBM FlashCore technology
- Improve performance and help lower cost with new inline data compression
- Help reduce capital and operational expenses with IBM enhanced 3D triple-level cell (3D TLC) flash
- Protect critical data assets with patented IBM Variable Stripe RAID™
- Power faster insights with IBM FlashCore including hardware-accelerated nonvolatile memory (NVM) architecture, purpose-engineered IBM MicroLatency® modules and advanced flash management

FlashSystem 900 Model AE3 can be configured in capacity points as low as 14.4 TB to 180 TB usable and up to 360 TB effective capacity after RAID 5 protection and compression. You can couple this product with either 16 Gbps, 8 Gbps Fibre Channel, 16 Gbps NVMe over Fibre Channel, or 40 Gbps InfiniBand connectivity. Thus, the IBM FlashSystem 900 Model AE3 provides extreme performance to existing and next generation infrastructure.

Figure 1 shows IBM FlashSystem 900 Model AE3.

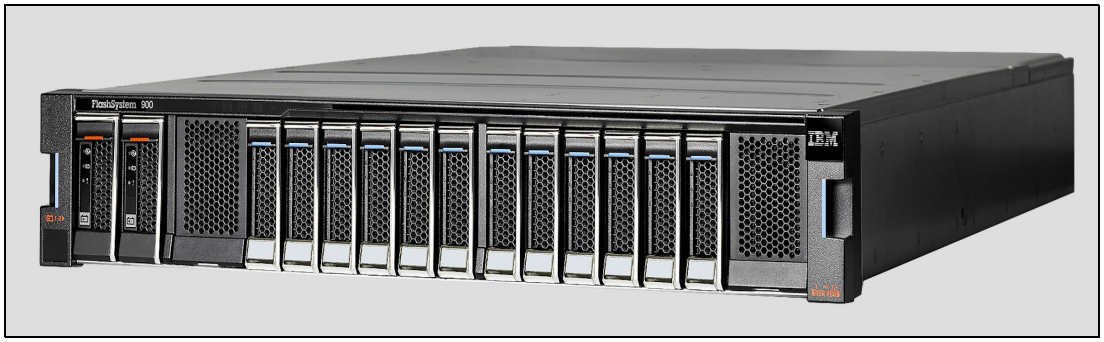

Figure 1 IBM FlashSystem 900 Model AE3

At the heart of FlashSystem 900 is IBM FlashCore Technology, which consists of the following three key elements:

- Hardware-accelerated architecture that is engineered for flash, with hardware-only data paths
- IBM MicroLatency modules that are designed for low latency, density, and reliability
- IBM Advanced Flash Management that improves 3D TLC flash endurance 3.8x over standard implementations, without negatively impacting latency.

Figure 2 shows IBM FlashCore Technology, the DNA of the FlashCore family.

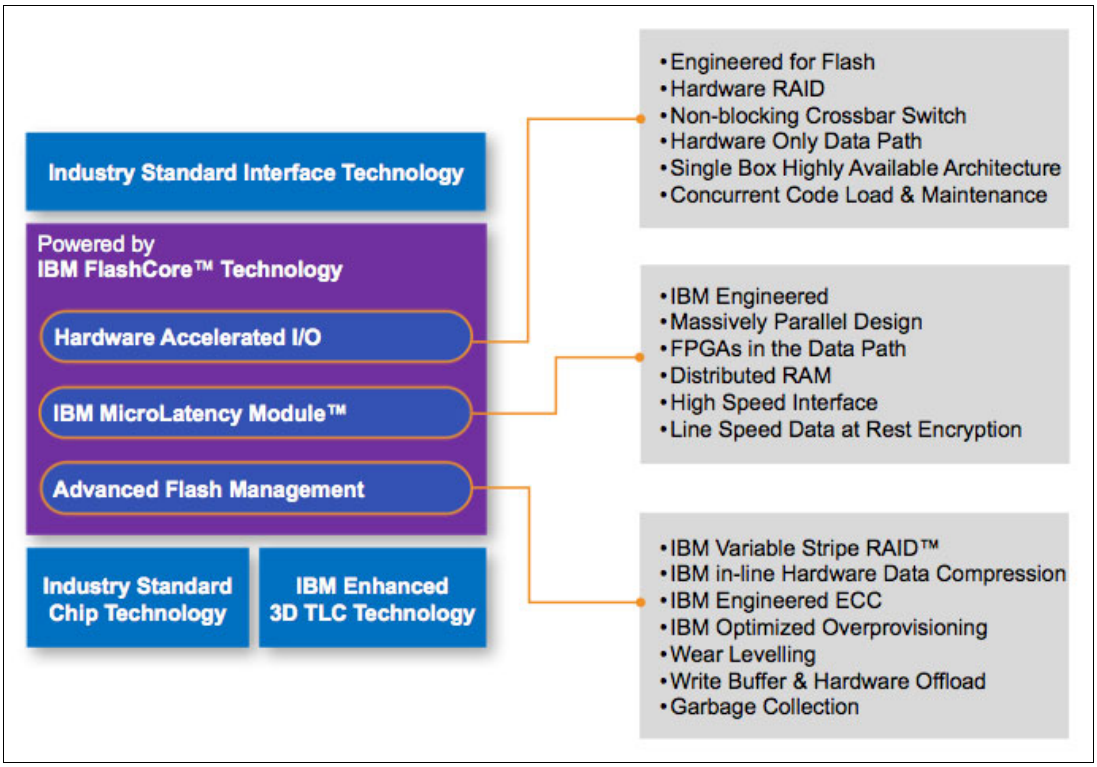

Figure 2 IBM FlashCore Technology

Did you know?

IBM FlashSystem 900 Model AE3 has these characteristics:

- Configurable with 14.4 - 180 TB of usable capacity for scalability and flexibility. This usable capacity equates to 44 - 360 TB of effective capacity with hardware data compression, depending on your configuration.
- Provides flexible interface types including Fibre Channel, NVMe-Fibre Channel and InfiniBand to easily integrate into existing SAN environments.
- Offers both local, hardware-based AES 256 data-at-rest encryption using USB key and IBM centralized key management (SKLM) key server-based encryption, with no performance impact.
- Provides “always on” inline hardware data compression enabled, with no performance effect to clients’ workloads.

Product highlights

IBM FlashSystem 900 Model AE3 provides extreme performance with IBM MicroLatency, macro efficiency, and enterprise reliability.

Scalability and performance

IBM FlashSystem 900 Model AE3 has the following scalability and performance features:

- IBM FlashCore technology for consistently high performance at lower cost:
  - 95 microsecond (µs) read latency and 155 µs write latency
  - Up to 1.1 million random read 4 K IOPS
  - Up to 10 GBps read bandwidth
- IBM-enhanced Micron 3DTLC technology for higher storage density and improved endurance
- Flexible interface types of Fibre Channel and InfiniBand:
  - Up to 16 ports of 8 Gbps or eight ports of 16 Gbps Fibre Channel
  - Up to 16 ports of 16 Gbps NVMe-Fibre Channel (with standard 16 Gbps FC support as well)
  - Up to eight ports of 40 Gbps quad data rate (QDR) InfiniBand, Non-Volatile Memory Express over Fabrics (NVMe-oF) ready
- Slots for up to 12 hot-swappable IBM MicroLatency storage modules in Small (3.6 TB), Medium (8.5 TB), Large (18 TB) and Extra Large (18 TB) capacities
- Configurable between 4.4 - 180 TB of usable capacity for increased flexibility

Enterprise-class reliability features

IBM FlashSystem 900 Model AE3 delivers the following enterprise-class reliability features:

- Concurrent code load enables customer applications to remain online during firmware upgrades to all components, including the IBM MicroLatency modules.
- Hot-swappable IBM MicroLatency modules by way of tool-less front panel access. If a MicroLatency module failure occurs, critical customer applications can remain online while the defective module is replaced.
- All active components are redundant and hot-swappable, including IBM MicroLatency modules, RAID controllers, management modules, interface, batteries, fans, and power supplies.
- Easy access to all components through the front or rear of the enclosure. As a result, IBM FlashSystem 900 Model AE3 does not need to be moved in the rack and no top access panels or cables need to be extended.
- Two-dimensional (2D) Flash RAID, which consists of IBM Variable Stripe RAID and system-wide RAID 5. Variable Stripe RAID technology helps reduce downtime and maintain performance and capacity during partial or full flash chip failures. System-wide RAID 5, with easily accessed hot swappable flash modules, helps prevent data loss and promote availability.
- IBM Advanced Flash Management improves flash endurance 3.8x over standard implementations with IBM engineered ECC, advanced wear leveling, and proprietary garbage collection, relocation, and block picking algorithms.

Energy and space efficiency

IBM FlashSystem 900 Model AE3 has the following energy and space efficiency characteristics:

- Over 3x greater density (usable capacity) than the previous generation
- Reduced power, space, and cooling with only 625 watts typical operating power and 2U form factor

Manageability and security

IBM FlashSystem 900 Model AE3 offers the following manageability and security features:

- Hardware-accelerated AES-XTS 256-bit data at rest encryption including Hot Encryption Activation and Hot Encryption Re-key
- Support for IBM centralized key management (SKLM) key server-based encryption
- Command-line interface (CLI)
- New intuitive graphical user interface (GUI), which is available in any supported browser
  - At the time of this writing, the management GUI supports the following web browsers and versions:
    - Mozilla Firefox 49
    - Mozilla Firefox Extended Support Release (ESR) 45
    - Microsoft Internet Explorer (IE) 11 and Microsoft Edge
    - Google Chrome 54
- Simple Network Management Protocol (SNMP)
- Email alerts
- Syslog redirect to send system log messages to another host
- Remote support assistance allowing IBM support personnel to log in to the FlashSystem, for problem diagnosis and log collection

Product architecture

IBM FlashSystem 900 Model AE3 enclosures include two fully redundant canisters. Each canister contains a RAID controller, two interface cards, and a management controller with an associated 1 Gbps Ethernet port. Each canister also has a USB port and two hot-swappable fan modules.

In addition to the canisters, IBM FlashSystem 900 Model AE3 enclosures include two battery modules and two power supplies, which are all redundant and hot-swappable. All components are easily accessible from the front or rear of the unit, so IBM FlashSystem 900 Model AE3 does not need to be moved in the rack. Any top access panels or cables do not need to be extended.

This configuration makes servicing the unit easy. The front of the enclosure has the two battery modules on the far left of the enclosure, an LED indicator panel next to this, and twelve IBM MicroLatency module slots to the right of the panel and battery modules. See Figure 3.

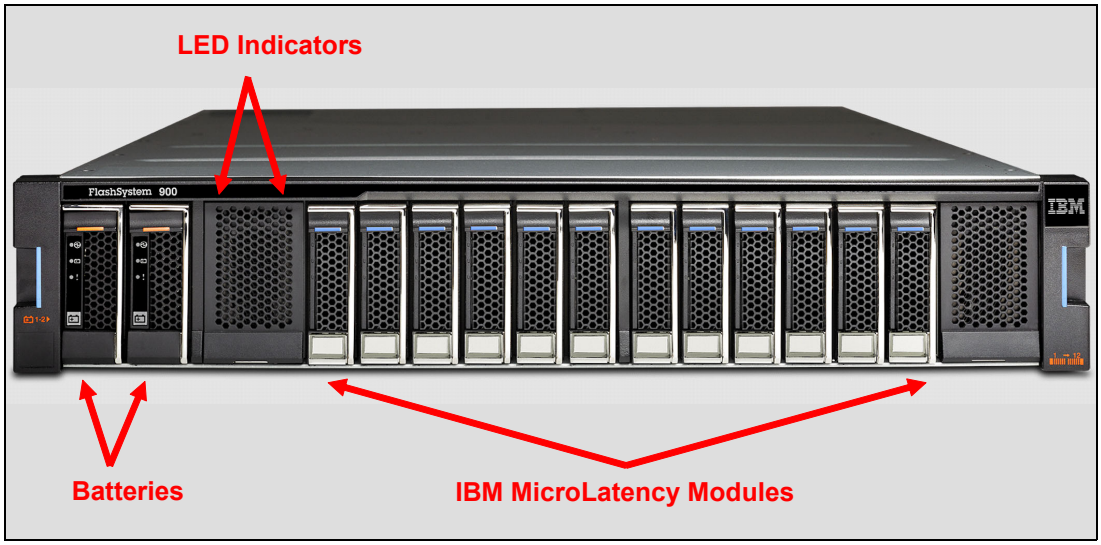

Figure 3 IBM FlashSystem 900 Model AE3 Enclosure Locations

Figure 4 shows the components of IBM FlashSystem 900 Model AE3 from the rear. One of the two canisters is removed, and you see two interface cards and two fan modules. The power supply unit to the right of the fans provides redundant power to the system. All components are concurrently maintainable except for the passive midplane, enclosure LED board, and power interposer board. All external connections are from the rear of the system.

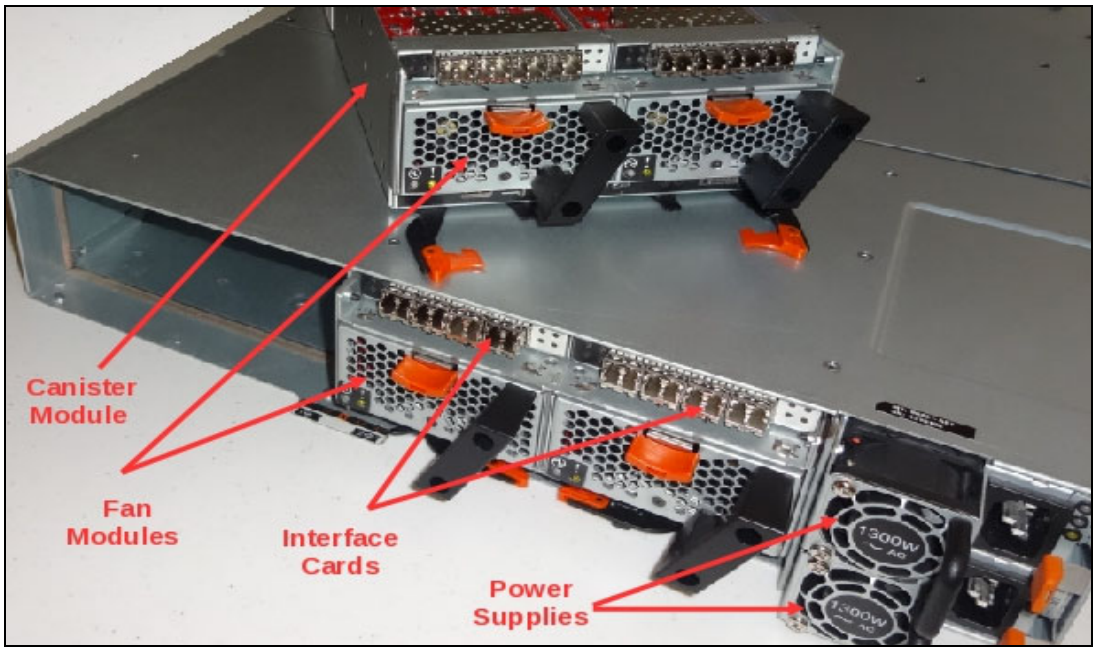

Figure 4 Rear view of IBM FlashSystem 900 Model AE3 with one canister removed

Figure 5 shows a rear view of IBM FlashSystem 900 Model AE3 with Fibre Channel interfaces. The canisters are to the left and the two power supply units, which are stacked on top of one another, are to the right.

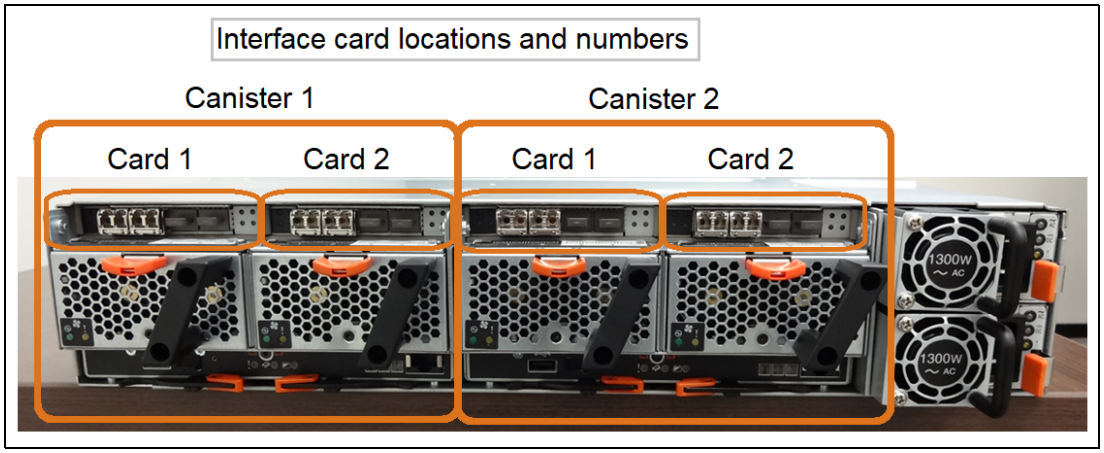

Figure 5 Rear view with 16 Gbps Fibre Channel interface cards and locations

Product specifications

Table 1 lists the specifications for IBM FlashSystem 900 Model AE3.

Table 1 IBM FlashSystem 900 Model AE3 specifications

Specification	Description
Model	9840-AE3 9843-AE3.
Form factor	2U rack-mounted enclosure.
IBM MicroLatency module quantity	Up to 12 IBM MicroLatency modules in increments of 6, 8, 10, or 12 for the Small (3.6 TB) module, and 8, 10, or 12 for the Medium (8.5 TB), Large (18 TB) and XLarge (18 TB) modules. Modules of different sizes cannot be intermixed.
Flash type	IBM-enhanced 3D TLC.
RAID 5 usable capacity (TB/TiB) 3.6 TB Small MicroLatency modules	► 14.40 TB / 13.10 TiB ► 21.60 TB / 19.64 TiB ► 28.80 TB / 26.10 TiB ► 36.10 TB / 32.83 TiB
RAID 5 usable capacity (TB/TiB) 8.5 TB Medium MicroLatency modules	► 51.30 TB / 46.66 TiB ► 68.40 TB / 62.21 TiB ► 85.50 TB / 77.76 TiB
RAID 5 usable capacity (TB/TiB) 18 TB Large MicroLatency modules	► 108 TB / 98.23 TiB ► 144 TB / 130.97 TiB ► 180 TB / 163.71 TiB
RAID 5 usable capacity (TB/TiB) 18 TB XLarge MicroLatency modules	► 108 TB / 98.23 TiB ► 144 TB / 130.97 TiB ► 180 TB / 163.71 TiB

Specification	Description
RAID 5 effective capacity (TB/TiB) 3.6 TB Small MicroLatency modules	► 43.96 TB / 39.99 TiB ► 65.94 TB / 59.97 TiB ► 87.92 TB / 79.96 TiB ► 109.90 TB / 99.95 TiB
RAID 5 effective capacity (TB/TiB) 8.5 TB Medium MicroLatency modules	► 131.94 TB / 120 TiB ► 175.92 TB / 160 TiB ► 219.90 TB / 200 TiB
RAID 5 effective capacity (TB/TiB) 18 TB Large MicroLatency modules	► 131.94 TB / 120 TiB ► 175.92 TB / 160 TiB ► 219.90 TB / 200 TiB
RAID 5 effective capacity (TB/TiB) 18 TB XLarge MicroLatency modules	► 290.14 TB / 263.88 TiB ► 386.85 TB / 351.84 TiB ► 483.56 TB / 439.80 TiB
IBM MicroLatency module protection	ECC error correction, Variable stripe RAID data protection, overprovisioning, and IBM two-dimensional Flash RAID.
RAID support	RAID 5.
Host interfaces	Two RJ45 Ethernet connections for management and host interface connections, which are either up to 16 SFP+ FC or FC-NVMe or 8 QSFP InfiniBand connections, depending on the selected features.
Maximum bandwidth.	10 GBps Read (100%, sequential), 4.5 GBps Write (100%, sequential).
Read IOPS (100% Random)	1,100,000.
Write IOPS (100% Random)	600,000.
Read latency	155 µs.
Write latency	95 µs.
Maximum volume support (LUNs)	2 K (2048).
System management	► IBM FlashSystem 900 Model AE3 GUI is available in any supported browser. ► IBM FlashSystem 900 Model AE3 CLI. ► SNMP. ► Email alerts. ► Syslog redirect.
Cooling	Four hot-swappable fan modules.
Power supply	1300 watts, high-power version to run at maximum performance, during power supply servicing. Two redundant hot-swap 200 - 240 V AC auto-sensing power supplies.
Input power	1300 watts maximum, 625 watts RAID5 typical operation for medium-size flash modules.
Heat dissipation	Approximately 2133 BTU (assuming 625 W). For maximum configurations, it might go as high as 4107 BTU (maximum configuration using RAID 5).
Hot-swap parts	All active components.

Specification	Description
Security features	AES-XTS 256-bit data-at-rest encryption with local key management. Two new functions have been added to the encryption feature and can be accessed by using the FlashSystem 900 GUI: ► Hot Encryption Activation: Adding an encryption license to a previously initialized system. ► Encryption Re-key: Changing the encryption key on a previously initialized system. ► SKLM Encryption Support: up to four key servers can be defined.
Platforms supported	For specific information, see the IBM System Storage Interoperation Center (SSIC).
Warranty	Set of Machine Types in AAS, 24x7 Service level Agreement, 4-hour response time: 9840-AE3 - One year. 9843-AE3 - Three years.
Service and support	Optional warranty service upgrades and post-warranty services are available on site with 24x7 2- to 6-hour response, 24x7, or 9x5 same day, or 9x5 next business day response.
Physical Specifications	
Dimensions	Width: 445 mm (17.5 in.) (19-inch Rack Standard). Depth: 768.12 mm (30.24 in.). Height: 86.2 mm (3.39 in.).
Weight	34 Kg (75 lb.) for fully configured system (12 IBM MicroLatency modules).

Models

The following machine types are supported in AAS:

- IBM FlashSystem 900 Model AE3
- IBM FlashSystem 900 Model UF3

IBM FlashSystem 900 Model AE3

IBM FlashSystem 900 Model AE3 has these warranty options:

- 9840-AE3 - Warranty period 1 year
- 9843-AE3 - Warranty period 3 years

All IBM FlashSystem 900 Model AE3 storage systems include the IBM MicroLatency modules and blanks, power supplies, fans, and canisters preinstalled. The IBM MicroLatency module type and quantity and the host interface I/O cards must be pre-specified. The batteries are packaged separately and must be installed by the person who performs the IBM FlashSystem 900 Model AE3 installation before powering on the system.

The following items are also shipped with IBM FlashSystem 900 Model AE3:

- System chassis
- Rack rail kit

- Warranty documentation
- Printed quick start guide
- Selected power cables
- Selected interface cables (if any)
- IBM FlashSystem DVD
- USB Init Key

IBM FlashSystem 900 Model UF3

IBM FlashSystem 900 Model UF3 has this warranty option:

- 9843-UF3 - Warranty period 3 years

IBM FlashSystem 900 Model UF3 is the Storage Utility Offerings model of the IBM FlashSystem 900 range. It is functionally equivalent to the IBM FlashSystem 900 Model AE3, but comes fully configured with 12 IBM MicroLatency modules in either 3.6 TB or 8.5 TB capacity.

The system must be fully populated with 12 MicroLatency modules, all of the same type/capacity. The total usable capacity that is listed above is user addressable capacity (usable capacity available after RAID and overprovisioning). The IBM FlashSystem 900 Model UF3 delivers always-on, inline data compression and can provide effective capacity up to 110 TB (AF3J) and 220 TB (AF3K). It can be ordered only with the 16 Gbps FC 4-port host optics.

Table 2 shows the available capacity features that can be ordered for the IBM FlashSystem 900 Model UF3.

Table 2 Capacity features available for the IBM FlashSystem Model UF3

Feature	Per Module Capacity	Total usable capacity
AF3J	3.6 TB	36 TB
AF3K	8.5 TB	85 TB

Table 3 shows the mandatory features that must be ordered for IBM FlashSystem 900 Model UF3.

Table 3 Mandatory features for the IBM FlashSystem 900 Model UF3

Included features	Description
AF15	Fibre Channel Host Interface Card
AF19	16 Gb FC 4 Port Host Optics
AF1H	1300 W Power Supply for High Line Voltage

Table 4 shows the optional feature codes for the IBM FlashSystem 900 Model UF3.

Table 4 Optional features codes for the IBM FlashSystem 900 Model UF3

Optional features	Description
AF14	Encryption Enablement Pack
AF1X	Encryption Disablement Code for specified countries

Optional features	Description
Feature code varies	Power cords
Feature code varies	Shipping/Handling

The IBM FlashSystem 900 Model UF3 provides a fixed total capacity, with a base and variable usage subscription of that total capacity.

IBM Storage Insights is used to monitor the system capacity usage. It is used to report on capacity that is used beyond the base subscription capacity, referred to as *variable usage*. The variable capacity usage is billed on a quarterly basis. This feature enables customers to grow or shrink their usage, and pay for configured capacity only.

The base system subscription is required to be facilitated through a three-year lease. The variable usage capacity is billed through the IBM MES system upgrades for the capacity used.

The IBM FlashSystem 900 Model UF3 is shipped with the same shipping group as the IBM FlashSystem 900 Model AE3.

Interface support

IBM FlashSystem 900 Model AE3 supports only one interface type per system. For example, it is not possible to use two Fibre Channel interface cards and two InfiniBand interface cards in the same enclosure.

Interface cards are sold in groups of two feature codes (providing a total of four cards), and supply interfaces of either eight or 16 ports for each system.

IBM FlashSystem 900 Model AE3 supports the following interface protocols and number of connections:

- Fibre Channel - 16 ports of 8 Gbps (these ports also support 4 Gbps)
- **NEW** - Fibre Channel with FC-NVMe - 16 ports of 16 Gbps (these ports also support 8 Gbps and 4 Gbps)
- Fibre Channel - 8 ports of 16 Gbps (these ports also support 8 Gbps and 4 Gbps)
- InfiniBand (eight ports of QDR InfiniBand 40 Gbps)

Note: The new 16 Gbps FC-NVMe adapter card also supports standard FC protocol.

What is NVMe?

This section describes the implementation of the new Non-Volatile Memory Express (NVMe) protocol over the Fibre Channel transport mechanisms. This is abbreviated to NVMe-oF but you might also see NVMe-FC or FC-NVMe. The terms are interchangeable.

NVMe (Non-Volatile Memory Express) is an open logical device interface specification that was created for access non-volatile storage media through a PCI Express (PCIe) bus inside a server chassis.

NVMe has the following characteristics and history:

- Common association is working with flash memory cards and systems

- Reduces stack overhead and can bring about improved performance
- A precursor of NVMe was made public at the Intel Developer Forum in 2007 as NVMHCI (non-volatile memory host controller interface)
- Technical work with NVMe started in 2H'2009 with contributions by more than 90 companies

The IBM FlashSystem 900 AE3 implementation of NVMe-FC is achieved by the addition of a new High-speed 16 Gb Fibre Channel NVMe over Fabrics interface adapter card.

This new card (feature code AF3C), coupled with the NVMe-FC protocol, gives the following characteristic.

- Read latency reduced by 15% to 85 microseconds
- Supports both Fibre Channel and FC-NVMe
  - At the same time, on the same port
- Current IBM FlashSystem 900 AE3 can have an MES added with the new adapter card AF3C
- Firmware 1.6 or higher needed to support the new NVMe adapter card

Fibre Channel support

IBM FlashSystem 900 AE3 supports 16 Gbps Fibre Channel connection speed through the standard Fibre Channel interface card.

There is a new feature code AF3C for FC-NVMe (NVMe for Fibre Channel) which allows a new FC card to support the new NVMe protocol.

The following are the rules for supporting 16 Gbps Fibre Channel and 16 Gbps FC-NVMe (NVMe for Fibre Channel) adapters on IBM FlashSystem 900 Model AE3:

- If you use the 16 Gbps Fibre Channel adapter, these conditions apply:
  - Only two (of the four) ports on the Fibre Channel modules can be used. The two leftmost ports (1 and 2) on each interface card are used for 16 Gbps support. The other two ports are disabled.
  - All four of the Fibre Channel modules are configured for 16 Gbps. This configuration supports a total of eight Fibre Channel ports for the system (2 ports x 4 interface cards).
  - Four Gbps and 8 Gbps Fibre Channel connections are supported on the same system connecting to 16 Gbps devices. However, there are still only a total of eight available active ports (ports 1 and 2 on each interface card). For example, an IBM FlashSystem 900 Model AE3 system can have four Fibre Channel connections at 16 Gbps and four Fibre Channel connections at 8 Gbps.
- If you use the 16 Gbps FC-NVMe (NVMe for Fibre Channel) adapter, all four ports can be used.
- Fibre Channel interfaces support Fibre Channel Protocol (FCP) only, with point-to-point (FC-P2P), arbitrated loop (FC-AL), and switched fabric (FC-SW) topologies. FC interfaces can be configured as N_port or NL_port types. FC-AL is not supported for ports that are connected at 16 Gbps.
- Full active-active multipathing across all interfaces is supported. Host software support for this function might vary.
- Each IBM FlashSystem 900 Model AE3 canister supports two Fibre Channel interface cards for a total of four Fibre Channel interface cards: 8 Gbps Fibre Channel cards support four ports, 16 Gbps cards support two ports.

Note: FC-AL (arbitrary loop) protocol is not supported by four-port 16 Gbps FC-NVMe (NVMe for Fibre Channel) adapters. If this protocol is required, two-port 16 Gbps Fibre Channel adapters must be used.

Table 5 lists the supported Fibre Channel card configurations.

Table 5 IBM FlashSystem 900 Model AE3 Fibre Channel card and optics configurations

Item	Feature code	Ports
8 Gb FC 8 Port Host Optics	AF18	Up to 16 ports of 8 Gbps Fibre Channel
16 Gb FC 4 Port Host Optics	AF19	Up to eight ports of 16 Gbps Fibre Channel
FC Host Interface Card	AF15	Base FC adapter card that requires optics to be added
16 Gb FC-NVMe Interface	AF3C	Base FC-NVMe adapter card that requires optics to be added

Note: If you order 16 Gb FC-NVMe Interface feature code AF3C, you will require quantity 2 of feature code AF19 16 Gb FC 4 Port Host Optics. This item provides 16 Gb SFP modules.

InfiniBand interface card

IBM FlashSystem 900 supports four two-port InfiniBand 40 Gbps cards. A total of eight ports of 40 Gbps InfiniBand connections are supported per IBM FlashSystem 900 Model AE3.

The InfiniBand card ports can connect to QDR, double data rate (DDR), or single data rate (SDR) InfiniBand HCAs by using the SCSI RDMA Protocol (SRP). IBM FlashSystem 900 Model AE3 InfiniBand interfaces support SRP only.

Table 6 lists the supported InfiniBand interface card.

*Table 6 IBM FlashSystem 900 Model AE3 InfiniBand card configuration*s

Item	Feature code	Ports
QDR IB 4 Port Host Interface Card	AF16	Eight ports of 40 Gbps QDR InfiniBand

IBM MicroLatency modules

IBM FlashSystem 900 Model AE3 provides configurable IBM MicroLatency module capacity. All modules are hot-swappable. It is important to configure the amount of storage that is needed correctly, because it is not possible to dynamically add more storage.

Attention: Any capacity upgrades to the system that involve the addition of IBM MicroLatency modules are disruptive. A full backup of the data on the system is required BEFORE the upgrade is started. After the upgrade is complete, the data must be restored to the system.

IBM FlashSystem 900 Model AE3 can be populated with up to 12 x 3.6 TB IBM MicroLatency modules in increments of 6, 8, 10, or 12; or up to 12 x 8.5 TB or 18 TB IBM MicroLatency modules in increments of 8, 10, or 12. These modules of either 3.6 TB, 8.5 TB, or 18 TB cannot be intermixed. Capacity can be upgraded by purchasing the AF3J (3.6 TB), AF3K (8.5 TB), AF3L (18 TB) or AF3M (18XL TB). IBM MicroLatency module feature codes as MES upgrades. Here are the upgrade paths:

- Using AF3J Small (3.6 TB) IBM MicroLatency Module
  - Start with 14.4 TB usable capacity and grow to 21.6 TB, 28.8 TB, or 36.1 TB
- Using AF3K Medium (8.5 TB) IBM MicroLatency Module
  - Start with 51.3 TB usable capacity and grow to 68.4 TB or 85.5 TB
- Using AF3L Large (18.0 TB) IBM MicroLatency Module
  - Start with 108 TB usable capacity and grow to 144 TB or 180 TB
- Using AF3M XLarge (18.0 TB) IBM MicroLatency Module
  - Start with 108 TB usable capacity and grow to 144 TB or 180 TB

Note: IBM FlashSystem 900 Model AE3 MicroLatency modules are NOT interchangeable with previous models of IBM FlashSystem 900.

IBM FlashSystem 900 Model AE3 also provides hardware data compression that is built into the MicroLatency modules, so the effective capacity becomes as follows:

- Using AF3J (3.6 TB)
  - Start with 43.96 TB effective capacity and grow to 65.94 TB, 87.92 TB, or 109.9 TB
- Using AF3K (8.5 TB)
  - Start with 131.954 TB effective capacity and grow to 175.92 TB or 219.9 TB
- Using AF3L (18.0 TB)
  - Start with 131.954 TB effective capacity and grow to 175.92 TB or 219.9 TB
- Using AF3M (18.0 TB)
  - Start with 290.14 TB effective capacity and grow to 386.85 TB or 483.56 TB

Note: The effective capacity of the large modules assumes a maximum data reduction ratio of 1.2:1. On the small and medium modules, it assumes a data reduction ratio of between 2.4 and 3.0:1. If your data is more compressible, you will still get the stated effective capacity.

The large capacity modules AF3L have the same effective capacity as the medium modules. These modules are designed for systems that need additional capacity, but have mixed workloads that might not be able to take full advantage of compression. The larger capacity cards can, in some circumstances, give better performance with these types of workloads.

The extra large modules AF3M now support a compression ratio of at least 2:1.

Table 7 lists the supported IBM MicroLatency modules configurations.

Table 7 IBM FlashSystem 900 Model AE3 MicroLatency modules configuration

Description	Feature code	Maximum Quantity Supported
3.6 TB 3D TLC IBM MicroLatency Module	AF3J	12
8.5 TB 3D TLC IBM MicroLatency Module	AF3K	12
18 TB 3D TLC IBM MicroLatency Module	AF3L	12

Description	Feature code	Maximum Quantity Supported
18 TB 3D TLC IBM MicroLatency Module	AF3M	12

Usability and RAS enhancements

The following enhancements are available:

- IBM Variable Stripe RAID
- IBM Two-dimensional (2D) Flash RAID
- RAID 5
- Enhanced GUI functions, including remote support assistance and the **Open PMR** function
- Automatic battery reconditioning
- Enhanced call home data

IBM Variable Stripe RAID

Variable Stripe RAID data protection is a unique, self-healing data protection that is managed independently by each flash controller on each IBM MicroLatency module. With Variable Stripe RAID, every flash controller creates a striped data layout across its set of chips, similar to an n+1 RAID 5 array with rotating parity. When the Variable Stripe RAID algorithm detects a failure that affects one or more flash chips in a RAID stripe, the following process happens:

1. Data that is stored in the affected regions is reconstructed from the remaining data/parity elements in the stripe.
2. All pages in the affected stripe, including the reconstructed data, are moved to reserved space (overprovisioned area).
3. Subsequent requests for data in the affected stripe are directed to the new locations (now part of the normal storage area in the system).

The original location of the affected stripe is added to the available overprovisioned area as a (n-1) + parity stripe. For example, if the affected stripe was a 9+1 stripe, it becomes an 8+1 stripe.

No system-level rebuild process is necessary to maintain data protection or usable capacity after a failure that is caught by Variable Stripe RAID. The entire Variable Stripe RAID recovery process is automatic and transparent to the user and administrator, and typically takes place in less than a second.

Variable Stripe RAID activities are not normally tracked in system logs. However, the root causes of failures that are typically handled by Variable Stripe RAID-plane failures and block failures are visible as follows:

- As tracked in system counters
- As reflected in the overall IBM MicroLatency module and system health metrics

IBM Two-dimensional (2D) Flash RAID

The combination of IBM Variable Stripe RAID and system-level RAID 5 protection across IBM MicroLatency modules is called two-dimensional (2D) Flash RAID.

Figure 6 shows the 2D RAID and Variable Stripe RAID (VSR) overview.

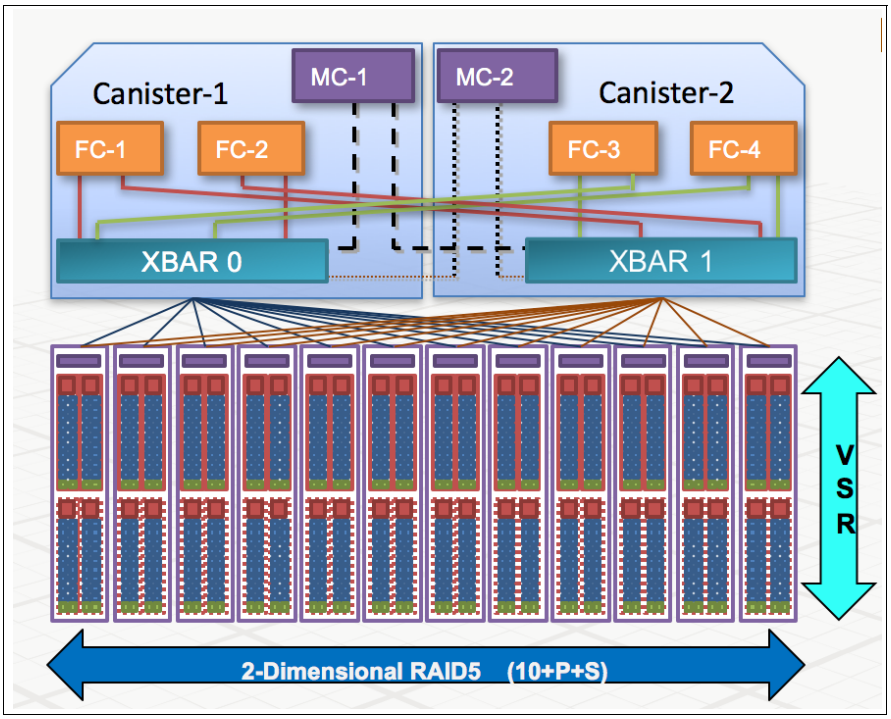

Figure 6 2D RAID and Variable Stripe RAID (VSR) overview

RAID 5

With RAID 5 mode, up to 2048 logical volumes (sometimes referred to as LUNs) can be created in the system, with a minimum size of 1 MB and a maximum size of the full available system capacity. Under the direction of the management module, RAID module Field Programmable Gate Arrays (FPGAs) can coordinate data transfer between modules, for example, to rebuild the system-level RAID 5 data layout.

Note: FlashSystem 900 Model AE3 does not support a RAID 0 configuration.

Enhanced GUI functions

IBM FlashSystem 900 Model AE3 has a new GUI. This GUI provides a new Dashboard view of the system and the more traditional Systems View from previous models of IBM FlashSystem 900. The following are some of the additional features:

- At a glance overview of performance, capacity, and system health
- Enhancements for use with mobile devices, including Event Flag based performance charts
- Performance graphs overlaid with events
- Improvements to “strongly encourage” enabling of Call Home and Remote Access
- An **Open PMR** button
- Capacity over time GUI provides clients more insight on how they are using their capacity over time

Figure 7 shows the main menu page of the new IBM FlashSystem 900 Model AE3 GUI.

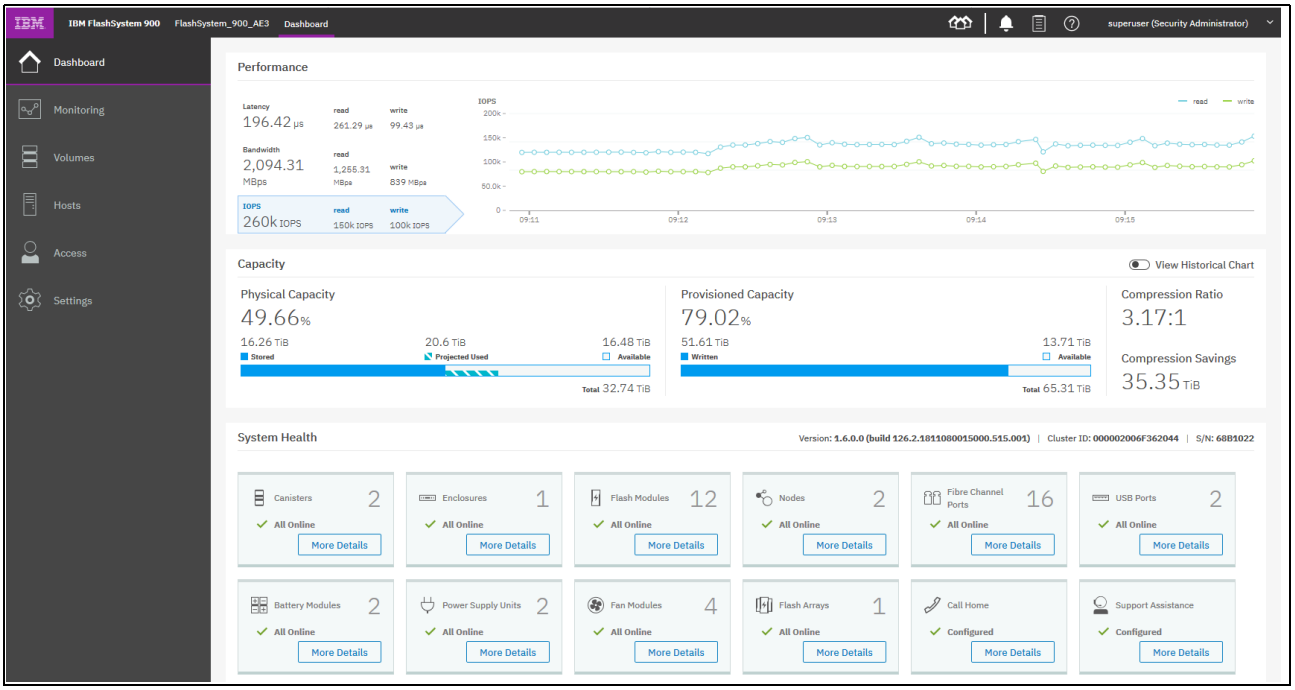

Figure 7 IBM FlashSystem 900 Model AE3 GUI

Remote support assistance

IBM FlashSystem 900 Model AE3 supports remote support assistance. This service allows—subject to customer approval—IBM authorized service personnel remote access to the system. Remote support assistance can be used for numerous support scenarios that do not require handling or replacing hardware. It also eliminates the need for dispatching an IBM service support representative (SSR) on site for manual operations or for guiding customers to conduct special actions on the system.

The following are some example use scenarios:

- IBM Level 1 support center remote collection of SNAP logs
- IBM Level 2 support center personnel logging in and uploading / downloading files to analyze and resolve issues
- IBM FlashSystems developers accessing the system for data recovery

The connection that is initiated by the system can be customer-configurable as one of these types:

- Always (default), or for a limited time
- Automatically upon failure or restart

Access control is restricted through both IBM and customer controls to ensure that no authorized access to the system occurs. Remote sessions and activity are recorded in both IBM FlashSystem Service Center and IBM FlashSystem 900 Model AE3 audit log.

Remote support assistance is a CLI solution only. Currently, remote GUI control is not provided.

Open PMR

The **Open PMR** function, within the **GUI Support** menu, allows the customer to easily open a problem management record (PMR) with IBM support. This facility can be used to report a low-severity issue on the IBM FlashSystem 900 Model AE3 that has not been automatically

reported by the system. Call home function must be set up and enabled for the **Open PMR** function to work.

Automatic battery reconditioning

IBM FlashSystem 900 Model AE3 can allow the user to select either manual or automatic battery reconditioning. The enhancement enables the user to select the battery reconditioning to be run automatically, when needed.

The default is OFF, and there is no change during a code upgrade. All new systems IBM FlashSystem 900 Model AE3 arrays are set to off in the plant. The user must set this option ON, if required, after the system is installed. Automatic battery reconditioning requires the following prerequisites:

- A battery is due for reconditioning. If both batteries are due at the same time, the one that logs it first is reconditioned first.
- The other battery must be online (not failed), charged above 50%, and must not already be reconditioning.
- Both power supply units (PSUs) must be online.
- Concurrent Code Load (CCL) must not be in progress.

The events log shows a warning 72 hours before reconditioning starts.

If reconditioning is auto-started, then canceled, the system waits 24 hours, then attempts to restart it, as long as auto reconditioning is still enabled and the other preconditions are met.

If auto-reconditioning cannot be started because one of the conditions above are not met (for example, if a PSU is offline), the system continues to retry every 24 hours until it succeeds or until you disable auto reconditioning.

Disabling the auto-reconditioning feature does NOT cancel the reconditioning process for a battery that is already being reconditioned. As with any system in which a battery is being reconditioned, a failure of the other battery or a power loss or reboot cancels reconditioning for that battery.

Enhanced call home data

The call home “heartbeats” are enhanced to supply more data, both on the daily heartbeat and the weekly “full” heartbeat. These heartbeats provide vital information about the current health of the IBM FlashSystem 900 Model AE3 array.

The data sent to IBM is then analyzed by the IBM Service Center systems. If any trends or temporary issues that need further analysis are found, the IBM Service Center systems raise a PMR with IBM support.

The following are some of the extra items sent:

- Regular Heartbeat (daily):
  - Fibre Channel and InfiniBand (if applicable) port statistics
  - Flashcard health and status
  - Canister health and status
- Full Heartbeat (weekly):
  - Last 500 lines of the messages related to the config node
  - Configuration data from both canisters
  - Configuration data from the config node

- Status and configuration data of the SAN fabric or InfiniBand network that the IBM FlashSystem 900 Model AE3 is connected to

IBM Storage Insights

IBM Storage Insights is an IBM Cloud™ storage service.

Two versions of IBM Storage Insights are available to help customers manage their storage environment: an entitled version and a subscription-based full version.

The no cost version of Storage Insights (SI) provides a unified dashboard for IBM block storage systems with a diagnostic event feed, a streamlined support experience, and key capacity and performance metrics. In contrast, IBM Storage Insights Pro (SIP) expands the IBM Storage Insights offering to a storage resource management tool, monitoring IBM block, file, object, and EMC storage systems. IBM Storage Insights Pro gives clients more insight into storage performance, configuration, capacity planning, and business impact analysis.

Storage Insights is an integral part of efforts to monitor and ensure continued availability of the IBM FlashSystem 900 AE3.

IBM Storage Insights (SI)

IBM Storage Insights provides a dashboard that gives you a clear view of all your IBM block storage.

Basic performance and capacity metrics are shown. Storage health information enables you to focus on areas that need attention. When IBM support is needed, Storage Insights simplifies log uploads, speeds resolution with online configuration data, and provides an overview of open tickets in one place.

Here are some details of these features:

- A unified view of IBM systems
  - Provides the first pane of glass to display all your systems' characteristics.
  - Displays all of your IBM storage inventory.
  - Provides a live event feed so you know, up to the second what is going on with your storage and enables you to take action quickly.
- Storage Insights provides reports,
  - Telemetry data and call home data.
  - Up-to-the-second system reporting of capacity and performance.
- Overall storage monitoring that looks at,
  - The overall health of the system.
  - Configuration to see whether it continues to adhere to best practices.
  - System resource management: is the system being overly taxed and what proactive steps are recommended for fixing it.
- Storage Insights provides advanced customer service with an event filter to that allows:
  - The ability for you and support to view support tickets, to open and close those tickets, and to track trends.
  - "Auto log collection" capability to collect the logs and send to IBM before support starts looking into the problem. This can save as much as 50% of the time that is required to resolve the case.

Storage Insights (SI) Operation Dashboard

Figure 8 shows a view of the Storage Insights (SI) main dashboard and the systems that it monitors.

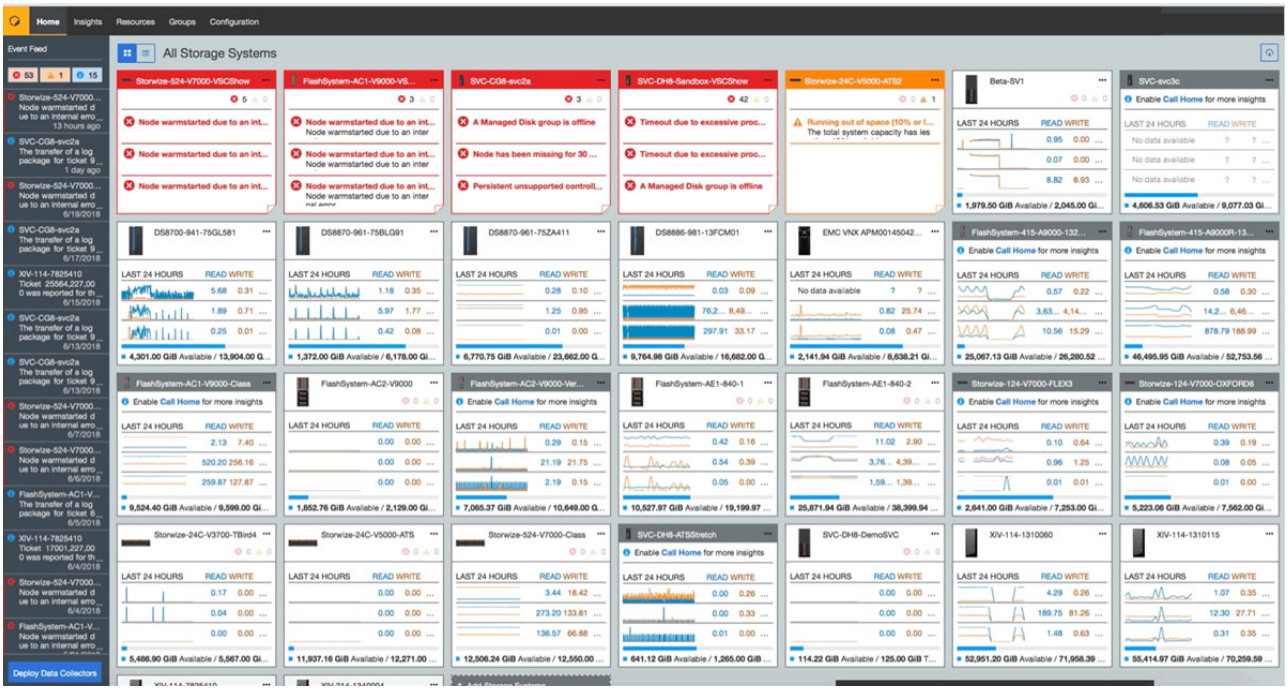

Figure 8 Storage Insights Dashboard.

Storage Insights Pro (SIP)

With IBM Storage Insights Pro advanced performance and capacity monitoring capabilities are provided, along with fully customizable multi-conditional alerting features.

For more details regarding performance monitoring and alerting, see *Viewing and Managing FlashSystem Performance with IBM Spectrum Control*, REDP-5381.

IBM Spectrum™ Control is the On-Premises Storage Resource Management tool. Most functions—especially performance and capacity monitoring functions—are similar between Storage Insights Pro and IBM Spectrum Control™.

Further views and images of dashboard displays and drill downs can be found in the supporting documentation that is listed in the next section.

For the architecture and design overview of Storage Insights, see *Implementing IBM FlashSystem 900 Model AE3*, SG24-8414.

Storage Insights - Information and Registration

The following links provide further information about Storage Insights and about how to sign up and register for the free service.

- Fact Sheet: ibm.biz/insightsfacts
- Demonstration: ibm.biz/insightsdemo
- Security Guide: ibm.biz/insightssecurity
- IBM Knowledge Center: ibm.biz/insightsknowledge

- Registration link: ibm.biz/insightsreg
- Purchase Storage Insights Pro: ibm.biz/BdsUtF

Hardware data compression

With IBM FlashSystem 900 Model AE3, built-in hardware data compression is standard. This data reduction is “always on,” and cannot be turned off.

IBM FlashSystem 900 Model AE3 data compression/decompression algorithm is implemented completely in hardware, with no processor intervention needed.

Compression and decompression are performed on individual logical pages. It is performed as the first step in the inbound data path before any logical-to-physical mapping occurs. Therefore, there is less data to transfer in the back end, which compensates for a small amount of added latency.

Decompression is performed as the last step in the outbound data path immediately before the requested data is returned. There is no store and forward operation. Real time decompression of compressed data is checked against original data before compressed write is committed. If the comparison shows that the data not compressible, it stores the uncompressed original version of the data.

Compression and decompression are completely transparent above the IBM MicroLatency module except for management of space. Performance is not affected and it scales linearly with number of instances.

IBM Compresstimator tool

The IBM FlashSystem 900 Model AE3 is supported in the IBM Compresstimator tool. This host-based application allows the user to estimate the amount of compression on the IBM FlashSystem 900 Model AE3 for given workloads.

The IBM Compresstimator works the same as for previous supported products. For the IBM FlashSystem 900 Model AE3, the following additions have been made:

- New “Storage system type” **-s FLASHSYSTEM**
- New options for storage system type **- FLASHSYSTEM**
- Set the number of flash modules in the simulated system **--flash-modules N**
- Set the size of the flash modules in the simulated system **--flash-module-size [SMALL|MEDIUM|LARGE|XLARGE]**

Scalable configurations

IBM FlashSystem 900 Model AE3 can scale usable capacity from as low as 14.4 TB to as high as 180 TB in its compact 2U enclosure. With IBM FlashSystem 900 Model AE3 many granular capacity points are possible, due to the four choices in IBM MicroLatency module capacity: 3.6 TB, 8.5 TB, 18 TB (Large), and 18 TB (XLarge). IBM MicroLatency modules can be added so that IT personnel can expand capacity to support changing needs for organizations and enterprises of all sizes. However, capacity expansion does require reformatting of the existing RAID 5 array to include the new additional IBM MicroLatency modules.

IBM FlashSystem 900 Model AE3 supports the RAID 5 configurations with the latest capacity points as listed in Figure 9.

Module	Small (3.6TBu)				Medium (8.5TBu)			Large (18TBu)			XLarge (18TBu)		
	Min			Max	Min		Max	Min		Max	Min		Max
Qty	6	8	10	12	8	10	12	8	10	12	8	10	12
Usable	14.4	21.6	28.8	36.1	51.3	68.4	85.5	108	144	180	108	144	180
Expected Effective Cap. (2:1 typical)	28.8	43.3	57.7	72.2	102.6	136.8	171	NA	NA	NA	216	288	360
Max Effective	43.9	65.9	87.9	109.9	131.9	175.9	219.9	131.9	175.9	219.9	263.8	351.8	439.8

Figure 9 IBM FlashSystem 900 Model AE3 supported RAID 5 configurations

RAID 5 configurations provide a high degree of redundancy with Variable Stripe RAID and RAID 5 protection.

RAID5 data protection uses the equivalent capacity of one IBM MicroLatency Module as parity and another module as a dedicated hot spare. Maximum capacity utilization for RAID 5 is provided by using twelve IBM MicroLatency modules.

Depending on your needs, and if capacity expansion is expected over time, consider initial RAID 5 configurations with twelve IBM MicroLatency modules. This configuration provides the least capacity penalty for RAID 5 protection.

Network cables

IBM FlashSystem 900 Model AE3 supports the network cables that are listed in Table 8.

Table 8 IBM FlashSystem 900 Model AE3 supported network cables

Description	Feature code	Maximum Quantity Allowed
Fibre Channel cables (supported on Fibre Channel ports)		
1 m Fiber Cable (LC-LC) OM3	AF1N	16
2 m Fiber Cable (LC-LC)	AF1P	16
3 m OM3 Fiber Cable (LC)	AF1Q	16
25 m Fiber Cable (LC-LC) OM3	AF1R	16
1 m Fiber Cable (LC-LC) SM-LW	AF1S	16
2 m Fiber Cable (LC-LC) SM-LW	AF1T	16
4 m Fiber Cable (LC-LC) SM-LW	AF1U	16
22 m Fiber Cable (LC-LC) SM-LW	AF1V	16
5 m Fiber Cable (LC-LC) OM3	AF1W	16
InfiniBand cables (supported on InfiniBand ports)		
1 m Mlnx QSFP Cop FDR14 IB	A2YG	8

Description	Feature code	Maximum Quantity Allowed
3 m Mlnx QSFP Cop FDR14 IB	A2YH	8
3 m Mlnx QSFP Opt FDR14 IB	A2YL	8
10 m Mlnx QSFP Opt FDR14 IB	A2YN	8

Encryption

IBM FlashSystem 900 Model AE3 storage system supports AES-XTS 256-bit data-at-rest encryption when the Encryption Enablement Pack, feature AF14, is ordered.

IBM FlashSystem 900 Model AE3 storage system also provides for SKLM encryption support. Up to four SKLM key servers can be defined.

Both versions of encryption on the IBM FlashSystem 900 Model AE3 support the following functions:

- Hot Encryption Activation: Adding an encryption license to a previously initialized system
- Encryption Re-key: Changing the encryption key on a previously initialized system

Both of these operations can be done concurrently and do not cause loss of access to data. Both operations do require that you purchase the Feature Code AF14: Encryption Enablement Pack.

For more information, see the IBM FlashSystem 900 Model AE3 Knowledge Center.

IBM Security Key Lifecycle Manager encryption

IBM Security Key Lifecycle Manager centralizes, simplifies, and automates the encryption key management process to help minimize risk and reduce operational costs of encryption key management. It offers secure and robust key storage, key serving, and key lifecycle management for IBM and non-IBM storage solutions by using the OASIS Key Management Interoperability Protocol (KMIP).

SKLM offers the following supported functions:

- USB key encryption still supported
- Up to four IBM SKLM servers are supported
- New internal encryption key structure
- CLI changes, both new CLIs and old ones
- Upgrade from previous models of IBM FlashSystem 900 is supported with committed keys

Note the following additional points about SKLM encryption:

- Either SKLM or USB can be enabled.
- Both SKLM and USB can be enabled.
- Switching between SKLM and USB can be done.
- Disabling both USB and SKLM key servers to an encrypted array results in the data becoming inaccessible. The data must be reloaded to the array, so the operation is disruptive.

You can enable encryption of the FlashSystem array by using USB flash drives to store the keys or by configuring an encryption key server for the system.

You can also have a simultaneous configuration of both key servers and USB flash drives to ensure redundancy of access to encrypted data for these scenarios:

- Either method becomes unavailable
- The keys are permanently lost for one of the methods

Important: To protect against permanent key loss for one of the methods, a simultaneous configuration must be planned in advance. You cannot enable another key method when the keys for an existing method have already been lost.

Figure 10 shows the SKLM encryption setup menu and how to add additional key servers.

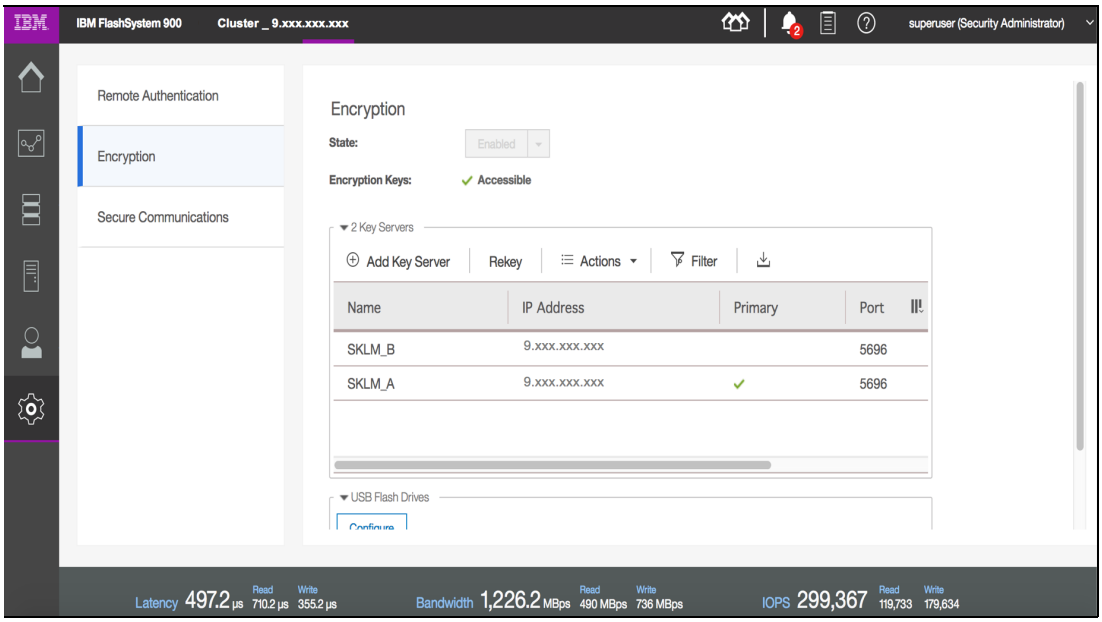

Figure 10 SKLM encryption setup menu

SKLM encryption key server and USB flash drive characteristics

The following list of encryption key server and USB flash drive characteristics might help you to choose the type of encryption enablement that you want to use:

- SKLM key servers can have the following characteristics:
  - Physical access to the system is not required to process a rekeying operation
  - Support for businesses that have security requirements not to use USB ports
  - Key self-replication and automatic backups
  - Implementations follow an open standard that aids in interoperability
  - Audit detail
  - Ability to administer access to data separately from storage devices
- USB flash drives have the following characteristics:
  - Physical access to the system is required to process a rekeying operation
  - No mechanical components to maintain with almost no read operations or write operations to the USB flash drive
  - Inexpensive to maintain and use
  - Convenient and easy to have multiple identical USB flash drives available as backups

Supported platforms

IBM FlashSystem 900 supports a wide range of operating systems including Microsoft Windows Server 2003 and 2008, Linux, IBM AIX®, and IBM i, and various hardware platforms including IBM Power Systems, and Intel x86 based servers. For detailed and up-to-date information, see the IBM System Storage Interoperation Center (SSIC).

Physical specifications

To ensure installability and serviceability in non-IBM industry-standard racks, review the installation planning information for any product-specific installation requirements:

- Width: 445 mm (17.5 in.)
- Depth: 768.12 mm (30.24 in.)
- Height: 87 mm (3.39 in.)
- Weight: 34 kg (75 lb) fully loaded

Operating environment

The operating environment for IBM FlashSystem 900 Model AE3 has these characteristics:

- Temperature:
  - Operating: 10°C - 35°C (50°F - 95°F) at 30.5 m below to 3,000 m above sea level (100 below to 9,840 ft above)
  - Non-operating: -40°C - 50°C (-40°F - 122°F)
- Relative humidity: Operating: 8% - 85% non-condensing
- Electrical power:
  - Voltage range: 100 - 240 V AC
  - Frequency: 50 - 60 Hz
- Acoustical noise emission:
  - Operating: 6.8 bels
  - Idling: 6.8 bels
- Power consumption: 1300 watts maximum, 625 watts RAID5 typical operation, per 2U
- Heat dissipation: 2133 BTU per hour (assuming 625 W)

Warranty information and upgrades

IBM FlashSystem 900 Model AE3 is shipped with a one-year and a three-year warranty. Technical Advisor support will be provided for the first year and only with the three-year warranty products (machine type 9843). This support enhances end-to-end support for the client's complex IT solutions. The Technical Advisor uses an integrated approach for proactive, coordinated cross-team support to enable customers to maximize IT availability.

Technical Advisor support for FlashSystem 900 is delivered remotely and includes these features:

- A documented support plan
- Coordinated problem and crisis management
- Reporting on the client's hardware inventories and software levels
- Consultation about FlashSystem 900 software updates

The Technical Advisor will conduct a Welcome Call with the client and provide a statement of work for this support.

These warranties are available:

- Machine type 9840: One year.
- Machine type 9843: Three years, with TA service for the first 12 months.

Flash media within IBM FlashSystem is covered in full during the warranty and maintenance period. The system is also Energy Star certified.

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- Minimize risk
- Preserve your ability to make flexible equipment decisions throughout the entire technology lifecycle.

Related information

For more information, see these resources:

- IBM Redbooks® Solution Guides and Product Guides for the IBM FlashSystem family
  http://www.redbooks.ibm.com/redbooks.nsf/searchsite?SearchView&query=flashss
- IBM FlashSystem family product page
  http://www.ibm.com/storage/flash
- IBM FlashSystem 900 Model AE3 Knowledge Center Welcome page
  https://www.ibm.com/support/knowledgecenter/STKMQB
- IBM System Storage® Interoperation Center (SSIC)
  http://www.ibm.com/systems/support/storage/ssic/interoperability.wss
- IBM Support Portal
  http://ibm.com/support/entry/portal/

- IBM Offering Information page (announcement letters and sales manuals)
  http://www.ibm.com/common/ssi/index.wss?request_locale=en

  On this page, enter FlashSystem, select the information type, and then click **Search**. On the next page, narrow your search results by geography and language.

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