

A General Introduction

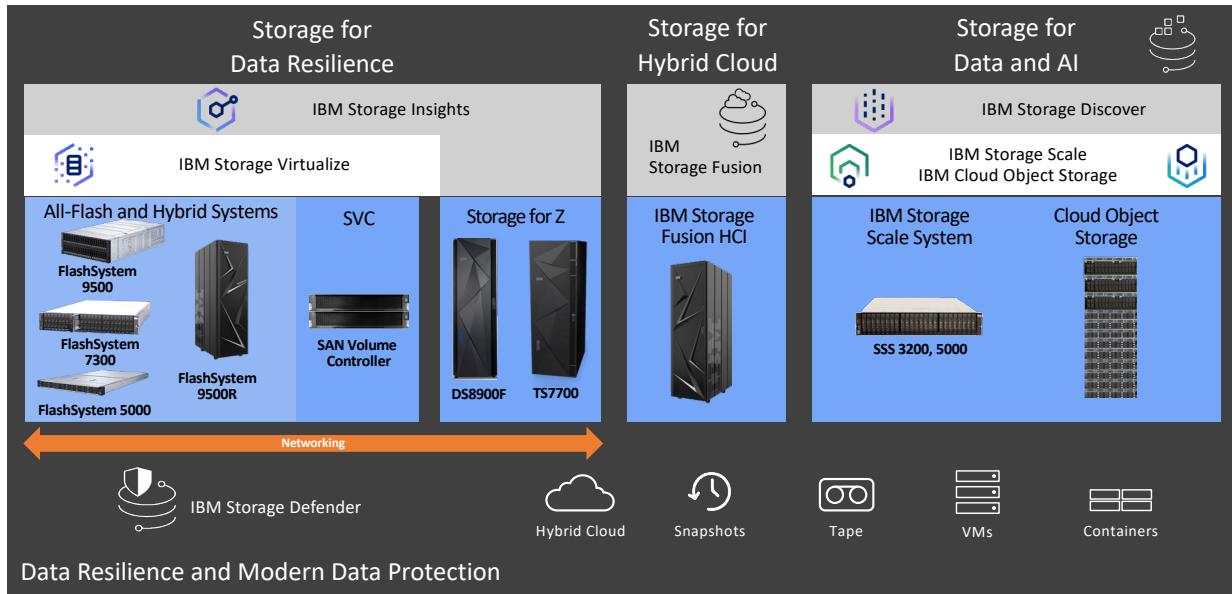
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Welcome to the first module in the FlashSystem Fundamental Concepts course.. In Module 1 we will be looking at IBM Storage FlashSystem arrays and pointing out several things you should always keep in mind when speaking with clients.

IBM Award-Winning Storage Portfolio

Driving Hybrid Cloud and Container Deployments



You can see how IBM's brands and solutions fit into an overall storage framework.
IBM is committed to open platforms and extensible solutions.

When it comes to Storage for Data and AI, IBM provides the highest performance and scaling solutions with IBM Storage Scale and IBM Cloud Object Storage – along with IBM Storage Discover that provides for visibility and extensible metadata across those platforms, as well as NFS platforms from other vendors, such as EMC Isilon, NetApp, and public cloud provider storage.

Storage for Hybrid Cloud is addressed by IBM's Storage Fusion and Storage Fusion Hyper-Converged Infrastructure (HCI) products

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For this presentation the focus will be on IBM's FlashSystem portfolio which is part of IBM's Storage for Data Resilience. Many FlashSystem arrays are enabled with the latest NVMe solutions, and the entire portfolio is powered by common software-defined storage that is also available for public cloud, as well as over 500 storage solutions from IBM and other vendors. IBM provides their unique high-speed recovery feature, Safeguarded Copy in all but one model and they provide their

unique, highly-desirable Inline Data Corruption Detection ability in all models. All of this is managed by Storage Insights or Storage Insights Pro, which provide proactive support and AI driven insights.

New in 2023, IBM Storage Defender is the foundation for IBM's Modern Data Protection. It is a part of our Cyber Resiliency foundation that spans cloud enablement to airgap protection with Tape and leadership in Container enablement and Container backup.

Focus Areas for the IBM FlashSystem –

FlashCore Modules and Software-Defined Storage make a difference



If you remember nothing else, try to hold onto the following 4 items. They will give you the big picture to pass along to your clients.

The IBM FlashSystem portfolio has a very **heavy focus on Hybrid cloud environments, Artificial Intelligence and Containers**. IBM virtualizes storage on-prem to facilitate the movement of data between systems and to the cloud. We also virtualize in the Public Cloud. IBM tightly integrates with VMware to further simplify IT operations. And IBM helps modernize and deliver Container integration, not just for our own storage solutions but for over 500 other storage solutions.

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It is up to all of us to ensure that we help others understand the business benefits behind our technology. FlashCore Modules3 (FCM3) consistently deliver very low latency, which is ideal for transaction-oriented workloads where it helps clients achieve critical service-level agreements (SLAs). Low latency is made even more attractive because each FCM includes hardware-based, wire-speed compression which delivers data reduction with no impact on performance. This enables clients to run additional workloads because their solution isn't required to use valuable overhead to simply achieve data reduction. **IBM's Flash solutions are further differentiated from the competition by enabling the use of multiple different high-performance flash devices in the same enclosure thereby enabling peak performance matched with optimal economics.** Many IBM

FlashSystem solutions can simultaneously support non-volatile memory express (NVMe) solid-state drives (SSDs), FCM3s, and Storage Class Memory (SCM) to handle any combination of workloads while helping you meet critical SLAs. No competitor can match this level of flexibility and economics. Those same systems deliver end-to-end NVMe and fabric leadership.

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IBM's flash solutions are **simple, simple, simple**. It is simple to pick the best system(s) to meet a client's requirements. The systems are incredibly simple to manage. And they are simple to grow, and they make it very easy for clients to move their data to multiple public clouds. These systems make it very simple to meet SLAs. The bottom line is that IBM's flash systems make it simple to do pretty much everything.

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IBM FlashSystem solutions provide AI-empowered storage. IBM is applying AI innovations to keep things simple and efficient. IBM offers Storage Insights, Storage Insights Pro, and Storage Control+Storage Insights to greatly simplify the management of the storage. This enables clients to painlessly obtain best practice insights. They also help quickly troubleshoot tough network issues. IBM also provides an extremely powerful AI capability in the form of Easy Tier, which allows clients to easily gain maximum performance while optimizing the economic efficiencies of their storage. Cumbersome policy-based rules are not required: the AI determines what tiering is essential and then makes it happen.

Note:

- SDS = Software-defined storage (see next slide)

Software-Defined Storage

Delivering flexibility and improved economics

The benefit of software-defined storage is that it provides a bridge to the future for a client's existing hardware. The hardware becomes better, over time, as new features/abilities are added. Software-Defined-Storage helps increase the flexibility and value of the physical storage. For the last several years IBM has been the #1 rated provider of software-defined-storage (SDS)

IBM's Storage Virtualize software stack brings SDS benefits to over 500 different storage systems

Once upon a time IBM's storage systems did not support Deduplication but after a software update those systems immediately gained the ability.

IBM FlashSystem arrays gained Safeguarded Copy after a software update. SDS brought the much sought-after data resiliency to everyone.

IBM FlashSystem gained Inline Data Corruption Detection after a software update. SDS brought the much sought-after data resiliency to everyone.

Everyone has heard about Software-Defined-Storage (SDS) but perhaps not everyone has truly understood what that really means. Let's take one moment and try to ensure that we all have the same understanding of SDS. At IBM we often refer to SDS as a way to provide a Bridge between current and future technologies. The beauty of IBM's SDS is that it brings a wide variety of abilities to various hardware platforms such as FlashSystem and SAN Volume Controller.

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However, the SDS story gets even better because IBM's Storage Virtualize software stack enables SDS to be brought to over 500 different storage systems. So if a client has non-IBM storage there is a good chance it can enjoy much of the same flexibility and improved economics that IBM brings to our own systems.

Let's examine just three instances where SDS has brought significant new abilities to clients who may have owned their systems for quite some time.

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Once upon a

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There was a time

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Finally, there was a time

SDS allows you to separate the hardware and software cycles. Your hardware can continue to obtain new and improved abilities as time goes by thanks to SDS.

Flexibility and economics with HDDs and SSDs

	SAS HDD	SAS SSD	NVMe SSD	FlashCore Module	SCM SSD
Type of Media	Rotating Media	3D NAND Flash	3D NAND Flash	96-layer NAND	Kioxia XL-FLASH
Protocol	SCSI	SCSI	NVMe	NVMe	NVMe
Physical Size	2.5" or 3.5"	2.5" or 3.5"	2.5"	2.5"	2.5"
Capacities	2TB – 20TB	1.92TB – 30TB	800GB – 30TB	4.8TB – 38.4TB 22TBe – 115TBe*	1.6TB
Differentiator	None	None	Limited	Compression, Encryption	Ultra low Latency
Latency	2ms - 9ms (NL)	<1ms	TLC ~50-240µs QLC ~ 250-750µs	QLC ~50-240µs	~15µs

We have seen the different types of storage that clients may chose to deploy in their data centers. We have also discovered that while many of them use the same type of internal flash media they still perform quite differently. Let's take a moment to quickly review the performance characteristics of various media. Please be aware, we are only discussing the storage media itself. We are not talking about the storage media in a storage system, but rather, just the storage devices themselves.

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Serial attached SCSI (SAS) hard disk drives (HDDs) can be used in the control enclosures of the FlashSystem 5015 and 5035. They can also be used in the expansion enclosures on the FlashSystem 5015, 5035, 5200, and 7300. Everyone should be familiar with the relatively lackluster performance of hard drives. They typically deliver latency in the 2-9 millisecond (ms) range depending upon what type of HDD they are, with Near Line HDDs delivering the slowest performance. They do not provide much in the way of differentiation on their own, but when combined with a small percentage of high-performance flash and IBM Easy Tier software they can provide an extremely attractive and economically-sound tier.

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Next up we have SAS solid-state drives (SSDs) which are fast compared to HDDs but not necessarily super fast when compared to other flash options. These drives usually have latencies of less than 1 ms. If we examine a traditional SAS SSD we see that they are comprised of industry-standard NAND Flash. There is nothing particularly unique about them: they are an industry commodity. Any potential differentiation will be due to the storage system software functionality.

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Next comes non-volatile memory express (NVMe) SSDs. Here we observe something that surprises a lot of people. These SSDs also use the same exact NAND Flash as the SAS SSDs, but there is a difference in performance due to the NVMe protocol vs the SAS protocol. Again, there are no outstanding differentiators in these commodity drives. Their latencies they exhibit will vary depending on whether they are based on Triple Layer Cell (TLC) flash or Quad Layer Cell (QLC) flash. TLC will exhibit latencies between 50 to 240 microseconds while QLC will often be around 250 to 750 microseconds (μ s). There is typically very limited differentiation with these drives. Western Digital Nitro drives do offer compression, but they lack the overwhelming majority of features found in IBM's FlashCore Modules.

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Now, we introduce IBM's FlashCore Modules (FCMs). It should come as no surprise to see that they too are based on NAND Flash although they use the latest 96-layer technology and an NVMe interface. However, unlike the commodity drives they have clear differentiators. FCMs have hardware built into them to deliver wire-speed compression and encryption. That means that they obtain the performance benefits of NVMe technology, but also gain compression and encryption without impacting the performance of the storage. FCMs possess a wealth of FlashCore Technology which help to dramatically enhance the endurance of the flash. Technically, since the flash inside a FlashCore Module is the same as the flash in an NVMe SSD you would expect them to have the same performance, but that is not the case. In the development of FCMs, IBM has utilized considerably more dynamic random-access memory (DRAM) as a front-end buffer. DRAM is always used in flash drives as a buffer because it is much faster to write to than flash. IBM's larger DRAM buffers enable larger, longer writes to FCMs compared to commodity SSDs and that makes FCMs faster than NVMe SSDs. FCMs, which are based on QLC flash exhibit latencies between 50 to 240 microseconds which is amazing because that is the range that other vendors TLC flash deliver. IBM has demonstrated to the market that they know how to obtain tremendous performance and longevity from QLC flash. *The second line in the capacity section shows the effective capacity that results due to the native compression.

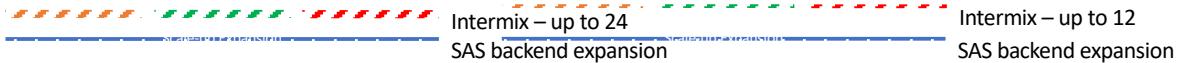
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Finally, let's look at Storage Class Memory (SCM). SCM uses the same NVMe interface as FlashCore Modules and NVMe SSDs, but they employ an entirely different type of flash. These are much faster devices but also more expensive. On top of that, the storage capacities are very small compared with SAS, NVMe, and FCMs. The special differentiating feature with SCM, however, is ultra low latency. This differentiation is capitalized on by the use of IBM's AI-driven Easy Tier software. These devices are extremely fast with approximately 15 μ s latency.

Before we leave this topic, we should make sure that you realize that one of the massive differentiators for IBM's NVMe-based FlashSystem solutions is that IBM can have NVMe SSDs, FCMs, and SCM all in the same control enclosure. This provides clients with tremendous flexibility to meet their ever-changing data environments. Based on feedback from clients, this ability to mix different drive types is a message that resonates with them. While you would think this would be something that everyone could do, it is not. Only IBM delivers this SIMPLICITY!

FlashSystem delivers maximum storage flexibility

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IBM FlashSystems provide clients with tremendous flexibility around storage configurations. FlashSystem solutions, which all run on the Storage Virtualize software stack allow clients to start with a small number of drives and easily grow the number as their needs dictate. On top of that, IBM provides significant flexibility in the drive types that they can use. Additional flexibility is obtained through the use of IBM Storage Insights software which provides an AI-based monitoring and analysis software that comes at no additional cost with your IBM storage. It helps greatly simplify many day-to-day management activities.

IBM FlashSystem 5200, 7300, 9500, and 9500R all support up to 12 Storage Class Memory (SCM) drives in the base enclosure.

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Or, FlashSystem 5200 supports up to 12 of IBM's highly unique FlashCore Modules while FlashSystem 7300 supports up to 24 FCMs in the controller enclosure, and FlashSystem 9500 supports up to 48 FCMs in the controller enclosure.

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Or, FlashSystem 5200 supports up to 12 NVMe-based SSDs while FlashSystem 7300

supports up to 24 NVMe SSDs in the controller, and FlashSystem 9500 supports up to 48 NVMe SSDs in the controller enclosure.

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As good as that sounds, the real flexibility is that all these FlashSystems arrays support the intermixing of SCM, FCMs and NVMe SSDs within the control enclosure.

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The final piece of flexibility is that regardless of the type, or types of drives that are used in the control enclosure, a client can always grow their FlashSystem array with backend SAS expansion.



How the Competitors handle drives



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HPE needed a product to replace their aging Nimble storage portfolio. They introduced Alletra 6000. It replaced SAS drives with NVMe drives but it still suffers from all of the inefficiencies found in the Nimble architecture. Drives must be added 24 at a time. That means clients must use very small capacity drives because of the cost of acquiring 24 drives at one time. There is also another major issue with Alletra 6000 and that is that it is flash-only. HPE clients are faced with a difficult choice if they desire hybrid configuration.

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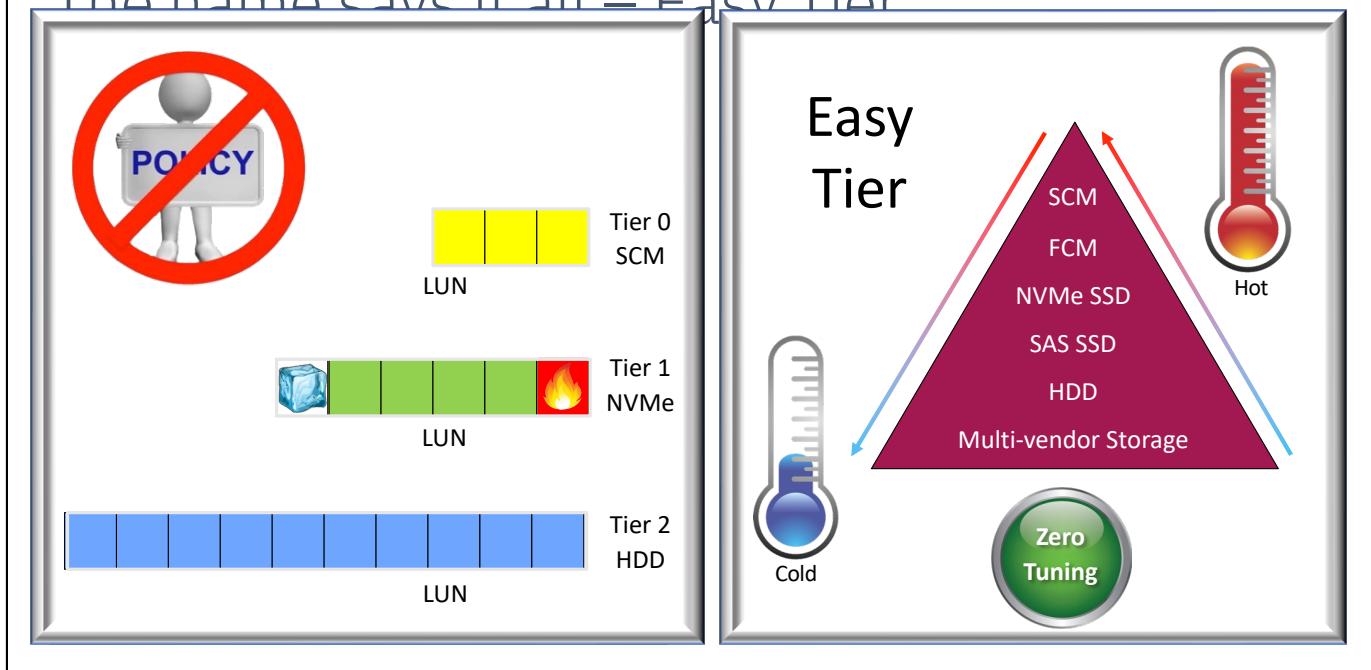
In order to obtain a hybrid configuration, clients must purchase an HPE Nimble system which is clearly based on old technology and appears to have no future. After all, HPE replaced the Nimble line with Alletra 6000. Additionally, clients must still add drives 24 at a time which once again forces them to buy small capacity drives. This is a very inefficient approach. By contrast, IBM's Dynamic DRAID Expansion allows a client to add anything from 1 to 12 drives at a time when additional capacity is

required.

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Pure also employs a strangely restrictive arrangement when it comes to flash media. Pure requires two separate systems to deliver both capacity and performance. While both systems use NVMe drives, the differences are huge. The capacity systems have the performance of hard drives. Pure does not have tiering to easily and automatically facilitate the transfer of data between the systems. Additionally, Pure storage is upgraded with drive packs which typically involve 10 drives. There is a clear lack of flexibility when compared to IBM FlashSystems.

The name says it all – Easy Tier



As we have just seen, IBM FlashSystem solutions support a wide range of storage media. Some of which are phenomenally fast while others are very economical. The plain and simple truth is that no one can afford to buy an entire system based solely on Storage Class Memory and almost no one can tolerate having a primary storage system based on hard disk drives due to their lackluster performance. The ultimate solution lies somewhere between those two configurations. Something that delivers excellent performance and value without bankrupting the client. That is where Easy Tier enters the situation.

IBM's powerful AI-based Easy Tier software is unique. It does not require clients to set policies. Rather, it determines what data is the hottest and what data is the coldest. It then automatically moves the data to the most appropriate tier. What is even better is that it does not need to move an entire logical unit number (LUN). It has the intelligence to only move the hottest portion or the coldest portion. It offers a hands-free approach to tiering. It is part of IBM's **simple yet innovative** design.

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Easy Tier works on a sub-LUN (Logical Unit Number) basis which makes it fast and economical. Without getting complicated this simply means that when you are dealing with a LUN and only part of the LUN is getting heavily used, then only that part of the LUN moves to the faster tier. That makes the approach very efficient.

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Due to the ability of Easy Tier to work on a sub-LUN basis, only the very hottest data will be moved to a higher performing tier. This makes Easy Tier highly efficient and allows significant performance gains to be experienced with a very minimal addition of high-performance flash such as SCM (Storage Class Memory) and/or NVMe (Non-volatile Memory Express).

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In a similar manner, the coldest data is automatically moved to the slowest tier. This enables clients to easily maximize the economics of their systems and do so without even lifting a finger.

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There are many benefits when using Easy Tier. One of the biggest benefits is that Easy Tier removes the guesswork about what data should be moved to another tier. The AI makes that determination and then takes action.

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Another benefit is that Easy Tier helps diminish the work that is associated with tiering and therefore it removes the extra labor a company would need to use. This helps improve the economics of the storage.

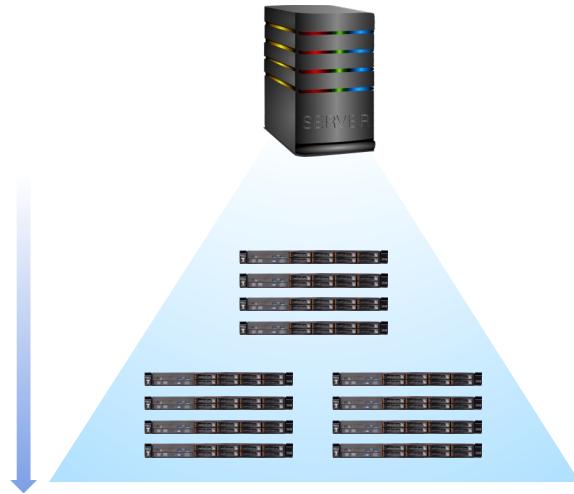
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Easy Tier recognizes the absolute fastest flash available, which is Storage Class Memory (SCM), and gives it its own tier. This is where the sub-LUN capabilities of Easy Tier shine. SCM is expensive but the AI in Easy Tier will only move the hottest data in a LUN to SCM if it is available. Once again this helps improve the overall economics of IBM's solutions.

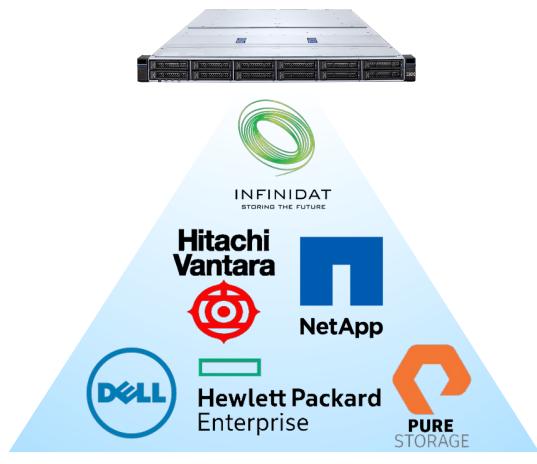
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We have mentioned AI several times, but it is at the heart of the benefits that Easy Tier provides. It helps reduce the workload on already busy IT staff and simply does the work automatically. And, in case you haven't already thought of it, if a client uses their Storage Virtualize storage system to reach out and virtualize other storage systems, then those systems gain the capabilities of Easy Tier and all of its benefits.

Virtualization is a unique powerful strength



VMware turns one physical server into numerous virtual servers which delivers improved flexibility and cost



Storage Virtualize turns many physical storage systems into one virtual system which delivers improved flexibility and cost

Virtualization is an extremely powerful ability. Most people are familiar with server virtualization.

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VMware has brought a huge amount of efficiency to servers, by turning one physical server in numerous virtual servers. This has had a significant impact for a great many years. It has brought levels of efficiency that were previously unknown and, in the process, has helped to significantly lower costs for a number of situations.

So now, let's think about virtualization but apply it to storage rather than servers. Instead of taking one storage system and making it look like many, which IBM can do, let's talk about taking many different storage systems and making them look, and act, like one cohesive system.

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The ability to virtualize storage is part of IBM's Storage Virtualize software which is at the heart of all FlashSystem solutions. External storage virtualization is available with FlashSystem 5200, 7300, 9500 and 9500R. They are able to deliver storage virtualization to over 500 different storage systems. It enables very easy data

migration as well as bringing the wealth of features found in the FlashSystem family to all those other systems.

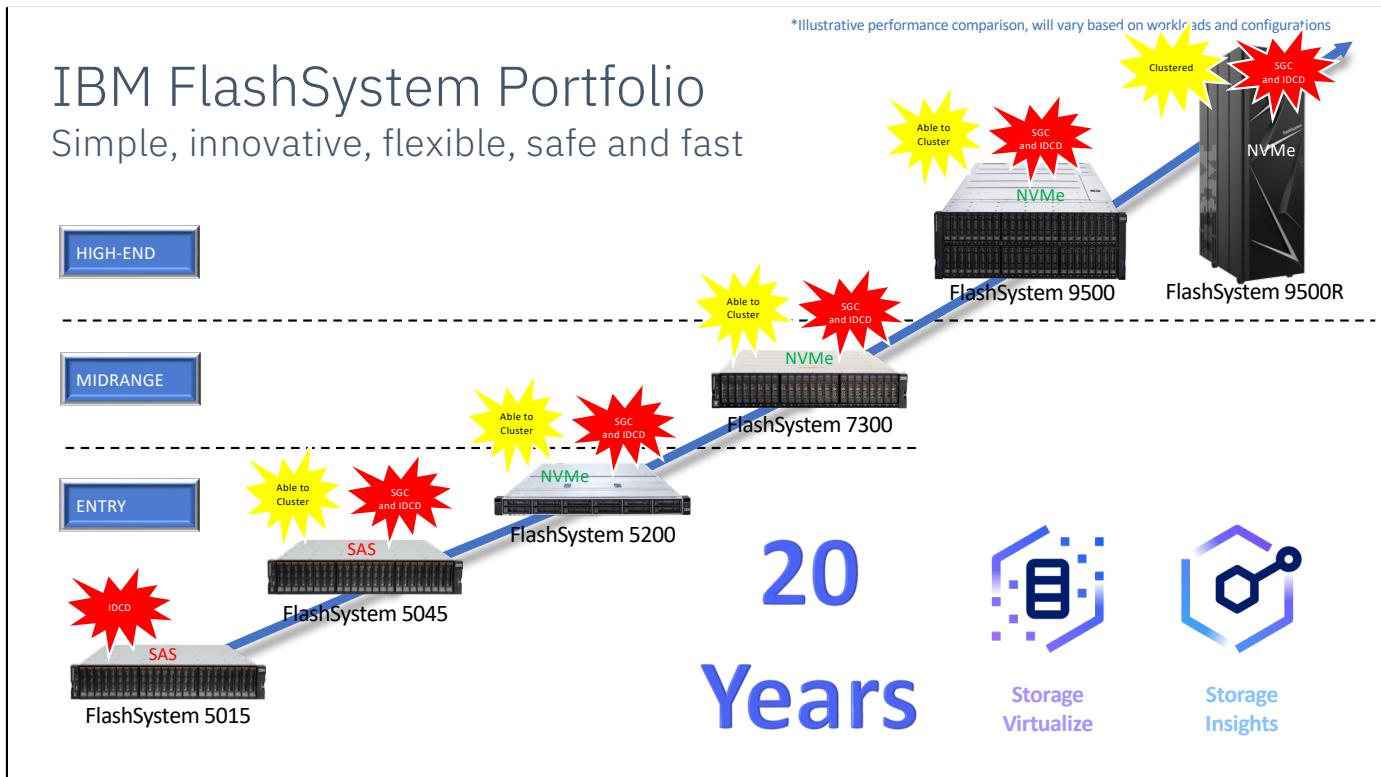
As impressive as that all sounds, there is an even greater benefit that is available, namely, Storage Virtualize provides a consistent on-ramp to the cloud for those 500 storage systems. This is important because, while most vendors have a way of taking their own storage to the cloud, everyone's way is different. That means different APIs and different management approaches. This is problematic because most clients have multiple vendors in their data centers which means multiple approaches to get data into the cloud. Storage Virtualize can eliminate that complexity and enable all of a client's storage.

IBM FlashSystem Portfolio

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Welcome to this module in the FlashSystem Fundamental Concepts course. A brief, but detailed examination of the portfolio is addressed. The prior module was a general introduction to the IBM Storage FlashSystem arrays.



The robust Storage Virtualize software running across IBM FlashSystem and SAN Volume Controller devices was first introduced to the market in 2003. A focus on quality and many years of field hardening has allowed IBM to achieve a measured six 9s availability for the entire FlashSystem portfolio..

The initial entry system in the FlashSystem portfolio is the 5015. It uses serial-attach-SCSI (SAS) drives. In July of 2023, IBM introduced a new mid-entry model, FlashSystem 5045, which utilizes SAS drives throughout. The 5045 is followed by a 1U NVMe entry solution after which there are midrange and high-end NVMe models.

All models of the FlashSystem family deliver six nines (99.9999) of availability. If a customer needs even more availability then up to 100% uptime can be experienced by using Storage Virtualize HyperSwap with a pair of FlashSystem models. If access is lost to one site, for whatever reason, hosts can continue to access data on the other site. When access is restored to the lost site, data will be automatically resynchronised, returning the system to run in a highly available manner. All models from FlashSystem 5045 and up, support HyperSwap.

All models of FlashSystem support IBM's unique, and highly-desirable Inline Data

Corruption Detection (IDCD) and all models from the 5045 and up support the award-winning Safeguarded Copy (SGC).

IBM FlashSystem 5015



Inline Data Corruption Detection

Dual Active-Active Array Controllers with SAS to Flash Media
Dual-ported 2.5" SAS bays (24)

SAS SSDs and HDDs adhering to 2.5" industry standard form factor

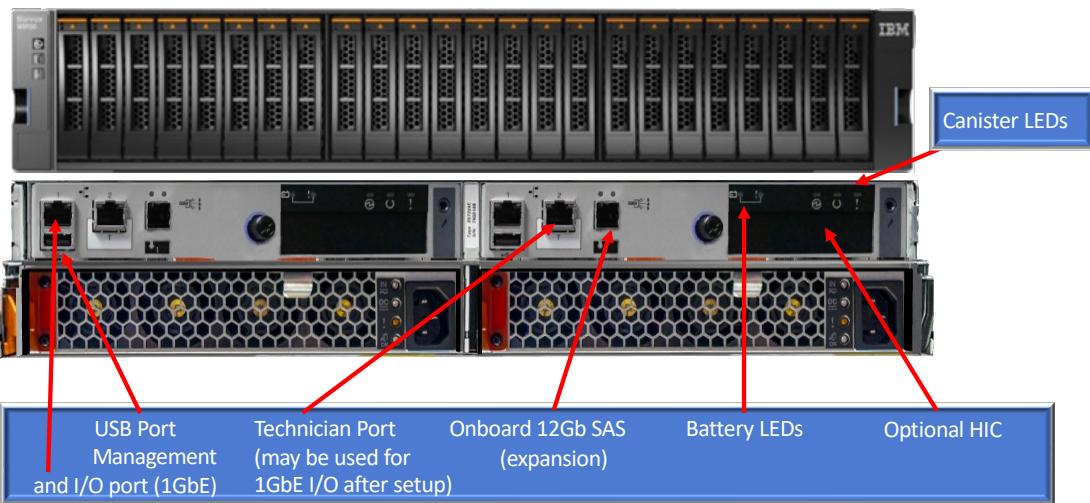
FlashSystem 5015

One 2-core CPU for a total of 4-cores per system

Up to 64GB of cache per system

Up to two host adapter cards per system

Up to 386K IOPS and 7.0GB/s per system



FlashSystem 5015 is the most affordable 2U block storage system in IBM's FlashSystem portfolio. It has dual active Serial-Attach-SCSI (SAS) controllers which easily handle numerous concurrent workloads.

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Each controller has one 2-core CPU. A single 2U system has 4 cores of processing horsepower and up to 64GB of cache. There are numerous configurations of possible host connections. The IBM FlashSystem architecture is fully redundant. The members of the FlashSystem family are rated at 99.9999% of availability and starting with FlashSystem 5045 they have the option to implement HyperSwap for up to 100% uptime.

IBM FlashSystem 5045



Inline Data Corruption Detection

Safeguarded Copy



FlashSystem 5035

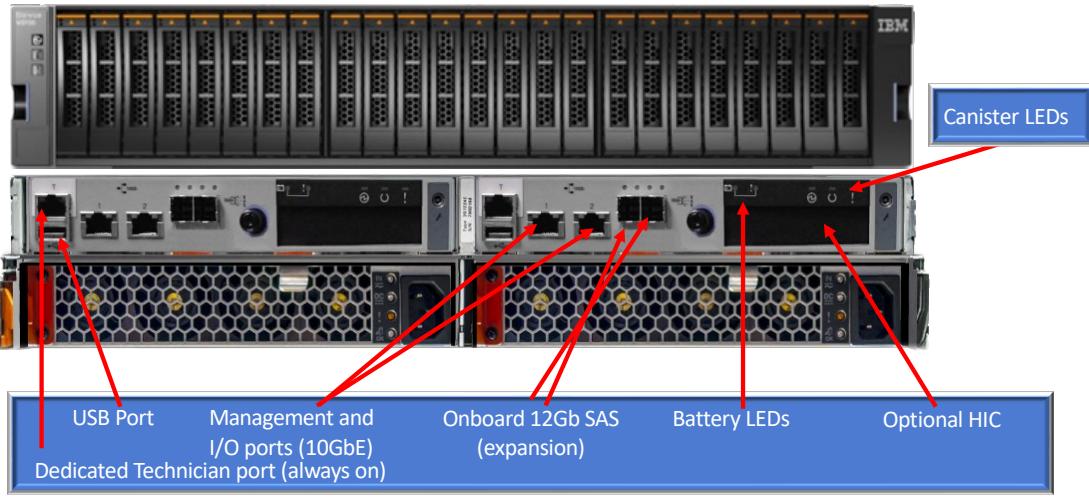
One 6-core CPU for a total of 12-cores per system

Up to 64GB of cache per system

Up to two host adapter cards per system

A single system delivers up to 900K IOPS and 8.2GB/s. Supports 2-way clustering

Dual Active-Active Array Controllers with SAS to Flash Media
Dual-ported 2.5" SAS bays (24)
SAS SSDs and HDDs adhering to 2.5" industry standard form factor



FlashSystem 5045 is the first 2U block storage system in IBM's FlashSystem family that supports clustering. That also means it is the first system in the 5000 family that supports HyperSwap for phenomenal uptime.

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Each controller has a 6-core CPU. A single 2U system has 12 cores of processing horsepower and up to 64GB of cache. There are a number of different configurations of possible host connections. The IBM FlashSystem architecture is fully redundant. The IBM FlashSystem 5035 is rated at 99.9999% of availability with the option to implement HyperSwap for up to 100% uptime.

IBM FlashSystem

5200

FlashSystem 5200

One 8-core CPU for a total of 16-cores per system

Up to 512GB of cache per system

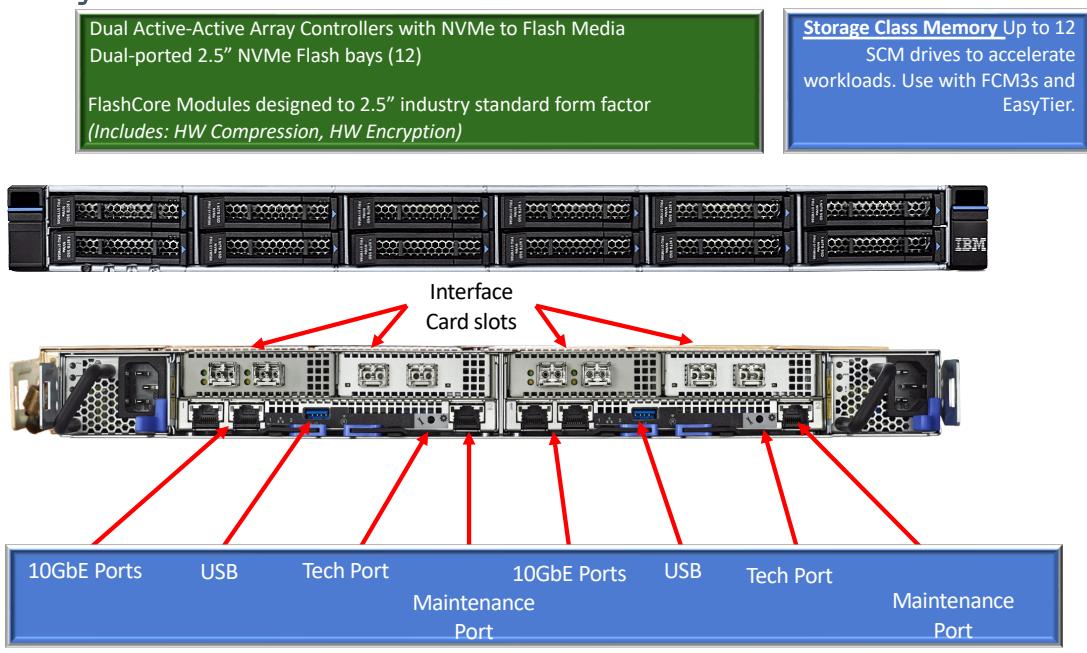
Up to four host adapter cards per system

A single system delivers up to 1.5M IOPS and 21GB/s and supports 4-way clustering



Inline Data Corruption Detection
Safeguarded Copy

Storage Class Memory Up to 12 SCM drives to accelerate workloads. Use with FCM3s and EasyTier.



FlashSystem 5200 is the most affordable, and powerful Non-Volatile Memory express (NVMe)-based 1U block storage system in IBM's portfolio. It has dual active NVMe controllers which easily handle numerous concurrent workloads.

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Each controller has one 8-core CPU. A single 1U system has 16 cores of processing horsepower and up to 512 gigabytes (GB) of cache. There are numerous configurations of possible host connections. FlashSystem architecture is fully redundant. The IBM FlashSystem 5200 is rated at 99.9999% of availability with the option to implement HyperSwap for up to 100% uptime. FlashSystem 5200 can cluster up to 4 systems together.



Inline Data Corruption Detection

Safeguarded Copy

IBM FlashSystem 7300

FlashSystem 7300

Two 10-core CPUs for a total of 40-cores per system

Up to 1.5TB of cache per system

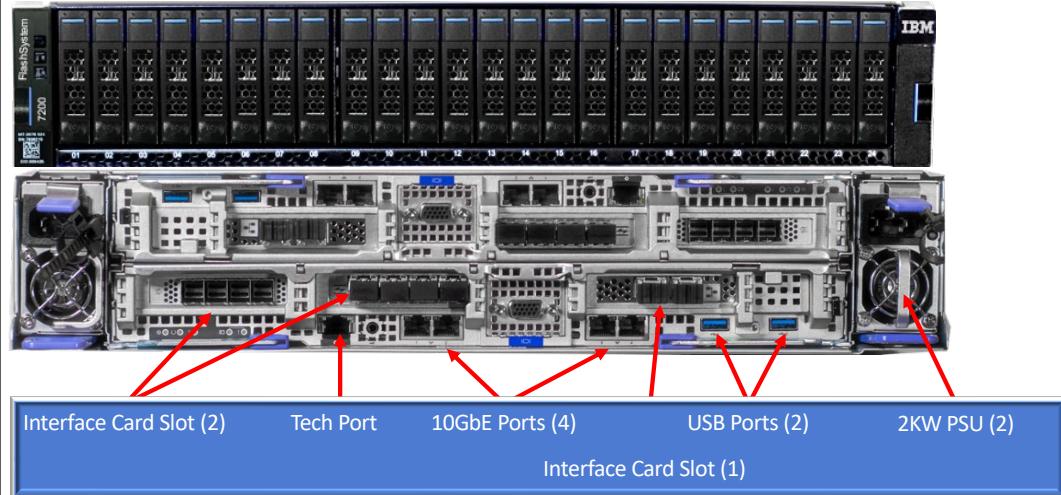
Up to six host adapters cards per system

A single system delivers up to 3.5M IOPS and 45GB/s. Supports up to 4-way clustering

Dual Active-Active Array Controllers with NVMe to Flash Media
Dual-ported 2.5" NVMe Flash bays (24)

FlashCore Modules designed to 2.5" industry standard form factor
(Includes: HW Compression, HW Encryption)

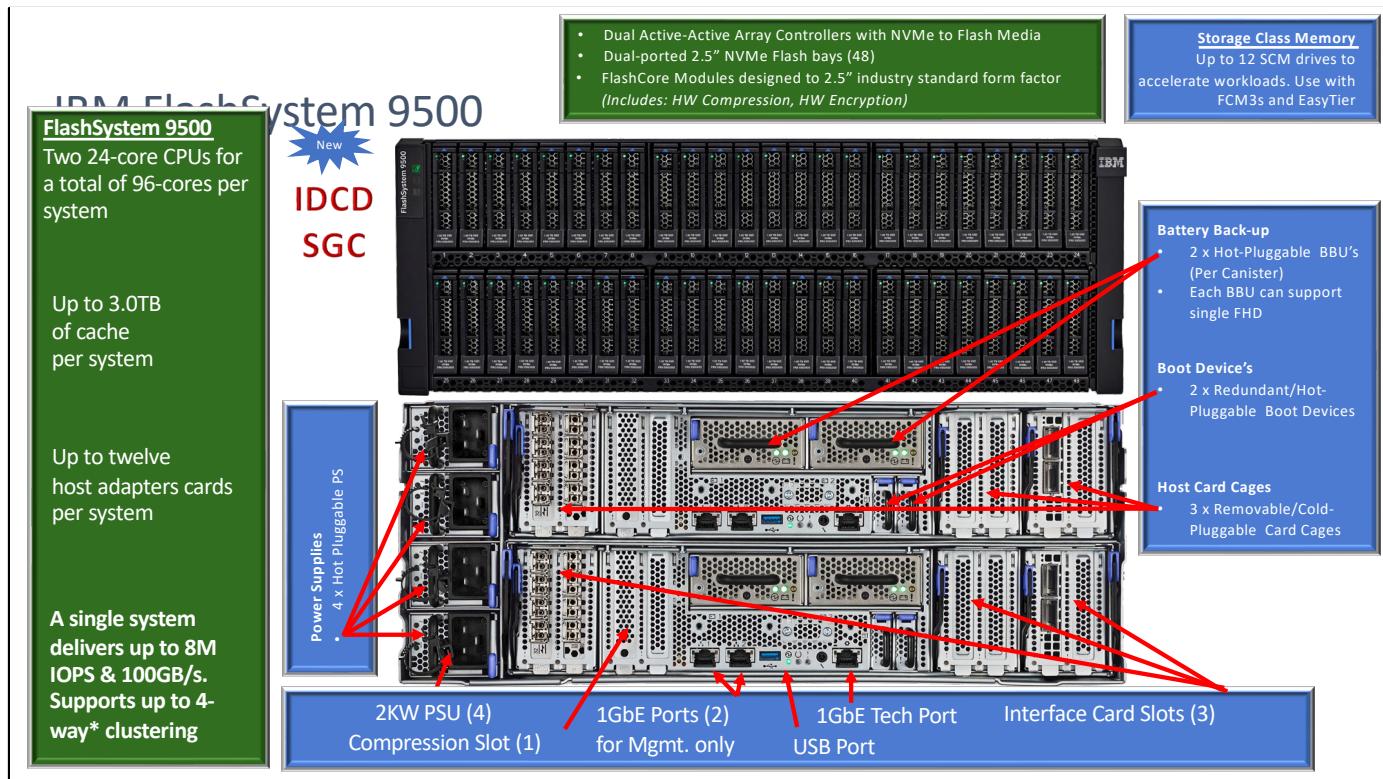
Storage Class Memory Up to 12 SCM drives to accelerate workloads. Use with FCM3s and EasyTier.



FlashSystem 7300 is the most powerful 2U block storage system, and the second most powerful system, in IBM's FlashSystem portfolio. It has dual active Non-Volatile Memory express (NVMe) controllers which easily handle numerous concurrent workloads.

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Each controller has dual 10-core CPUs. A single 2U system has 40 cores of processing horsepower and up to 1.5 terabytes (TB) of cache. There are numerous configurations of possible host connections. The IBM FlashSystem architecture is fully redundant. FlashSystem 7300 is rated at 99.9999% of availability with the option to implement HyperSwap for up to 100% uptime.



FlashSystem 9500 is the most powerful 4U block storage system in IBM's FlashSystem portfolio. It has dual active Non-Volatile Memory express (NVMe) controllers which easily handle a massive number of concurrent workloads. FlashSystem 9500R is comprised of two clustered FlashSystem 9500s in a preconfigured rack.

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Each controller has dual 24-core CPUs. A single 4U system has 96 cores of processing horsepower and up to 3 terabytes (TB) of cache. There are numerous configurations of possible host connections. The IBM FlashSystem architecture is fully redundant. FlashSystem 9500, and FlashSystem 9500R are rated at 99.9999% of availability with the option to implement HyperSwap for up to 100% uptime. FlashSystem 9500 supports 2-way clustering with 4-way available via RPQ.

Expansion Options

2U, 12-slot 3.5" SAS enclosure (12Gb/s)



2U, 24-slot 2.5" SAS enclosure (12Gb/s)



5U, 92-slot 2.5" or 3.5" SAS enclosure (12Gb/s)



Every member of the FlashSystem portfolio supports the ability to scale up capacity through 12Gb/s SAS backend connection.

There is a 2U twelve-slot enclosure for 3.5" SAS drives. There is also a 2U twenty-four-slot enclosure that supports 2.5" SAS drives. Finally, there a 5U ninety-two-slot enclosure that supports 3.5" drives and/or 2.5" drives.

FlashSystem 5015 through 7300 support all-flash configurations or hybrid configurations, while the high-end FlashSystem 9500 and 9500R only support all-flash configurations.

Supported Adapter Cards

Ports per Card	Protocol
4	16G Fibre Channel supports NVMe-oF
2*/4	32Gb Fibre Channel supports NVMe-oF
TBD ¹	64Gb Fibre Channel supports NVMe-oF
2	25Gb RoCE Ethernet supports NVMe RDMA
2	100Gb RoCE Ethernet supports NVMe RDMA
4*/2	12Gb SAS Expansion



* FlashSystem 5200 supports a 2-port x 32Gb FC card and a 4-port 12Gb SAS card

¹ Statement of Direction – For FlashSystem 9500/9500R

Different members of the FlashSystem portfolio support different numbers of Host Bus Adapters (HBAs). It is important to understand the abilities of each model of FlashSystem. For instance, some of them may work with 25GbE cards but they do not support the NVMe RDMA capabilities that those cards possess. Extensive content is available for those who wish to take a deeper dive into the various abilities of the different HBAs and different models of FlashSystem.

The four-port 32Gb Fibre Channel (FC) card doubles the throughput of the 16Gb FC card, but it has greater performance implications. The 32Gb FC card has 10us lower latency for short IO compared to the 16Gb card. It also has about 100us lower latency for large 256k transfers compared to the 16Gb card.

Quick Comparison of FlashSystem Family

	FlashSystem 5015	FlashSystem 5045	FlashSystem 5200	FlashSystem 7300	FlashSystem 9500	FlashSystem 9500R
All-Flash and/or Hybrid	AF ✓ - H ✓	AF ✓ - H ✓	AF ✓ - H ✓	AF ✓ - H ✓	AF ✓ - H X	AF ✓ - H X
Max cache per control enclosure	64GB	64GB	512GB	1.5TB	3.0TB	3.0TB x 2
Host adapter slots per control enc.	2	2	4	6	12	12 x 2
Storage Class Memory support	No	No	Yes	Yes	Yes	Yes
NVMe SSDs and IBM FCMs	No	No	Yes	Yes	Yes	Yes
NVMe-oF support	No	No	Yes	Yes	Yes	Yes
SAS SSDs and SAS HDDs	✓ and ✓	✓ and ✓	✓ and ✓	✓ and ✓	✓ and X	✓ and X
Support for SAS devices	Yes – Control & Exp.	Yes – Control & Exp.	Yes – Expansion	Yes – Expansion	Yes – Expansion	Yes – Expansion
Max physical capacity raw in 1U, 2U or 4U control enclosure	720TB	720TB	460TB	921.6TB	1843.2TB***	1843.2TB*** x 2
Max usable effective with DRAID in 1U, 2U or 4U control enclosure	573TB	Up to 2.8PB*	1PB** Or up to 2.3PB*	2.3PB** Or up to 4.6PB*	2.3PB** / 4.5PB*** Or up to 9.2PB*	2.3PB**/4.5PB*** x 2 Or up to 9.2PB* x 2
Maximum capacity with clustering	NA	32PB (2-way)	32PB (2 tp 4-way)	32PB (2 to 4-way)	32PB (2 to 4-way)	32PB (2-way)
Data Reduction	None	Software DRP	FCM3 (no impact) DRP (Hdw assist)	FCM3 (no impact) DRP (Hdw assist)	FCM3 (no impact) DRP (Hdw assist)	FCM3 (no impact) DRP (Hdw assist)
Installation and support	Customer set-up	Customer set-up	Customer set-up	Customer set-up with Storage Expert Care options	IBM install, w/ storage expert care options	IBM install, w/ storage expert care options
Support for CSI and cloud	Yes	Yes	Yes	Yes	Yes	Yes

* With 5:1 data reduction via DRP
**** Raw capacity, later in 2022

** With 3:1 data reduction via FCM
*** With 3:1 data reduction via FCM later in 2022

← All-Flash and Hybrid

All-Flash Only → 1 Four-way via RPQ

This slide provides you with a side-by-side view of the various members of the IBM FlashSystem family. It is intended to provide you with a quick reference tool.

Pay attention to the maximum effective capacity that can be provided in a single 2U enclosure. There are two numbers shown for FlashSystem 5200 and above. The 921TB/1.8 petabyte (PB) numbers are obtained with twelve/twenty-four 38.4 terabyte (TB) FlashCore Modules (FCMs). With IBM's 2-to-1 data reduction guarantee, those 24 drives will deliver a total of 921TB/1.8PB with no performance penalty. The 2.3PB/4.6PB numbers are obtained with the same 12/24 drives but this time they are used with a Data Reduction Pool (DRP) where zero detection, deduplication and compression may yield up to a 5-to-1 reduction ratio.

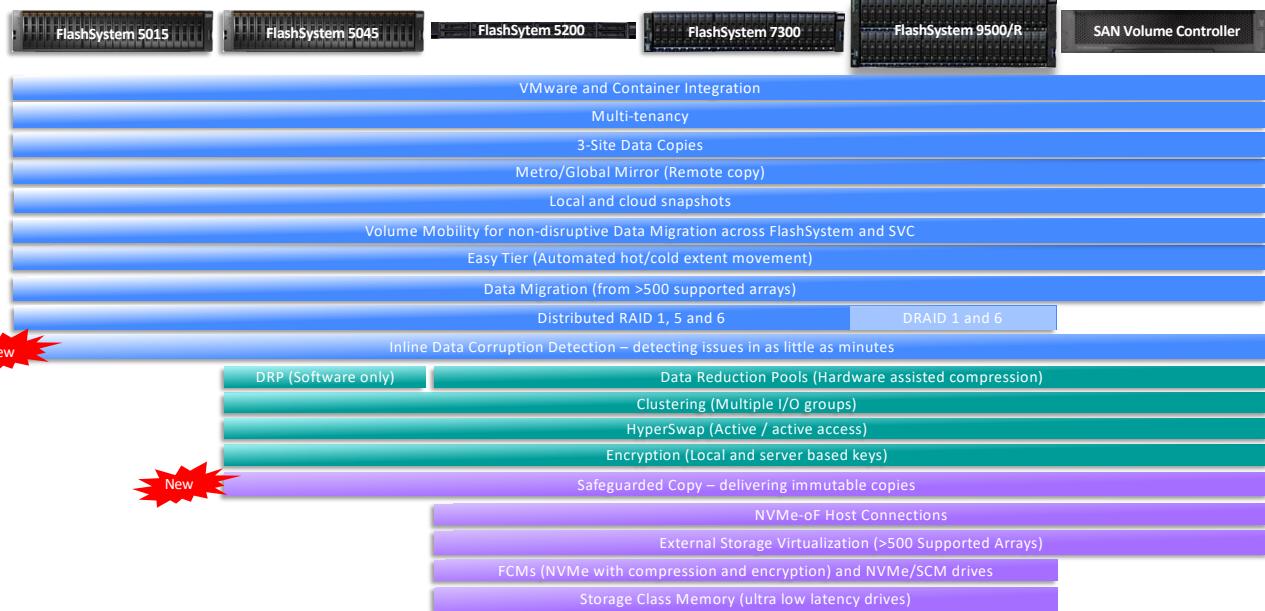
Occasionally, a client may observe that Storage Virtualize solutions have a maximum capacity of 32PB. Some of them then wonder why step up to the high end of the product portfolio when they can get the same capacity in the entry end of the line? First, and foremost, this is possible because the Storage Virtualize family of solutions are all based on the same underlying code. This creates consistency throughout the family. Next, it is important to determine what a client's needs are. If they do not need a large number of features to be simultaneously used, then the lower end of the

product line may be ideal for them. However, as their needs increase, and they require more simultaneous features then so to does their need for additional processing horsepower. They will want to step up a little higher in the family. The last item related to this is that some systems reach the maximum addressable capacity with 2 clustered systems while others can do so with 3 or 4 clustered systems. The more systems that are utilized, the greater the resulting performance.



Storage Virtualize Across The Family

Storage Insights (AI Predictive Analytics and Proactive Monitoring)



Starting at the top, Storage Virtualize adds a common operating environment for all integrated arrays. IBM Storage Insights is included in every block storage solution and provides AI predictive analytics and proactive monitoring.

<CLICK>

Next is a uniform set of features which are common to all arrays from FlashSystem 5015 up to the FlashSystem 9500 and SAN Volume Controller family. IBM provides VMware and container integration. Object based authentication allows you to give access to different users by object, allowing multi-tenancy environments to be created and managed. Additionally, 3-site data copies is supported by synchronous and asynchronous mirroring and allows clients to create HA and DR configurations to protect against site failures. Finally, Distributed RAID, or DRAID, spreads the parity and spare space across multiple physical drives to allow better IO and rebuild performance. This allows the use of very large capacity drives while minimizing the opportunity for loss of redundancy after a physical drive failure. Beginning with Storage Virtualize version 8.6.0, The highly sought-after Inline Data Corruption Detection feature is present in FlashSystem 5015 and above. FlashSystem 5015, 5035 and 5045 will require a Storage Insights Pro Data Collector to use the Inline Data Corruption Detection ability.

<CLICK>

Some capabilities require more system resources to operate efficiently. Clustering, Encryption, HyperSwap, and Data Reduction Pools (DRP) all need more cache and CPU cores in order to provide acceptable performance. These abilities are available starting with FlashSystem 5035. Data reduction via DRP on FlashSystem 5035 is facilitated in software only, while DRP in FlashSystem 5200 and higher

is hardware assisted.

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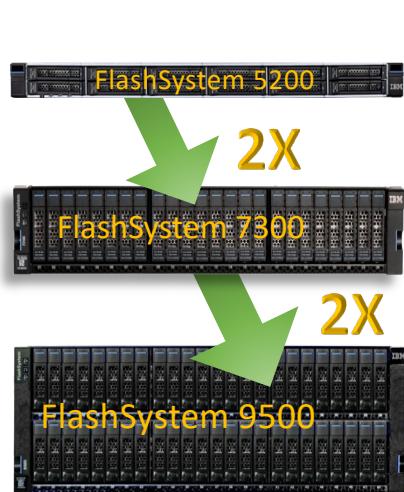
Beginning with Storage Virtualize version 8.6.0, IBM's highly-desirable Safeguarded Copy is available in FlashSystem 5045 and higher. To deliver the highest level of performance along with the ability to provide external storage virtualization, our clients will require Non-Volatile Memory express (NVMe) based solutions. Although these arrays can use industry standard NVMe solid-state drives (SSDs), it is anticipated that most clients will opt for IBM FlashCore modules (FCMs) which possess significant differentiation and competitive advantages. FlashSystem 5200, 7300, 9500 and 9500R are truly future proofed. They support essentially all drive types, including storage class memory (SCM), in order to optimize a client's data economics. Up to 12 SCM drives can be placed in any IBM FlashSystem solution that supports NVMe.

IBM NVMe Enterprise Storage

Choose your **capacity**

Choose your **performance**

Choose your **support**



1U 12 drives, 1PBe
300k** IOPS, 21GB/s
Basic, Advanced

2U 24 drives, 2.2PBe
580k** IOPS, 45GB/s
Expert Care Basic, Advanced or Premium

4U 48 drives, 4.5PBe*
1.6M** IOPS, 100GB/s
Expert Care Advanced or Premium

** IOPS shows are for 16k 70/30/50 workloads and are shown for comparison purposes

Let's take moment to consider what the IBM FlashSystem NVMe family with FlashCore Modules will look like in 2022. The differentiation that's been covered will allow you to independently :

Choose the amount of storage capacity that your data needs. At GA the 9500 will support 24 38TB FCMs for an effective capacity of 2.3PB. With a no-cost software update, a further 24 drives can be added to give 4.5PBe or 18PBe in a 4-way cluster. This can be augmented with SAS expansions for lower tier storage if further cheaper capacity is required.

<CLICK>

Choose the level of performance that your applications need. The performance numbers shown are for 16k 70% read, 30% write with 50% cache hit in order to demonstrate the relative capabilities of each system using a customer relatable benchmark. Your workload requirements should be modelled with the IBM modelling tools that are available to your seller to help you identify the platform that will best meet your needs.

<CLICK>

Choose the level and duration of support that your business needs with IBM Storage Expert Care.

Once you've made your choice, you can get peace-of-mind through the many facets of IBM FlashWatch, and choose how you acquire the storage either through a traditional purchase or lease, or via one of IBM use-base consumption models.

After your storage has been deployed you can then pick and choose from the rich functionality of

Storage Virtualize to utilise your chosen product within your own unique business environment.



Last Updated: July 19, 2023

Welcome to this Module where we will examine the value behind FlashCore Modules. This information will help you effectively sell FlashCore Modules (FCMs). These modules provide IBM with many differentiating abilities. You should know enough about them to ensure that you can demonstrate to prospective clients the value they will bring to their organizations. FCMs are a better option than traditional Non-Volatile Memory express solid-state drives (NVMe SSDs). FCMs can be used in any FlashSystem model that supports NVMe.

FlashCore Module 3

Unprecedented density and performance

Highly Useful
and Unique

Innovative Design

Able to monitor individual flash cells

Extremely low latency

Unprecedented capacity (Compression)

Extended endurance

Business Benefits



Enables significant
flash optimization

Numerous simultaneous workloads

Handles more data with vastly reduced
power, cooling and floor space

Dramatically enhanced longevity with
trouble-free operations

IBM has rolled out the third generation of FlashCore Modules which are often referred to as FCM3s.

<CLICK>

One of the most important things that clients should understand regarding IBM's unique FlashCore Modules is that the numerous unique capabilities we provide are only possible because IBM has the ability to monitor every single flash cell in our devices. This enables IBM to perform custom operations to optimize numerous aspects of the flash. Clients obtain more robust flash which helps them maintain continuous operations.

The innovative design of these custom-designed modules delivers numerous real-world business benefits,

<CLICK>

Extremely low latency

Clients can experience latency as low as 50 microseconds which helps remove bottlenecks in their workloads which in turn enables numerous simultaneous

workloads to be run and to do so without requiring much pre-planning.

The outstanding performance of FCM3s includes data reduction obtained from embedded hardware. Data reduction occurs as fast as data can be written to the modules.

<CLICK>

Capacity takes a huge step forward with IBM's newest FlashCore Module3 devices. The largest capacity is 38.4TB. While that sounds impressive, it doesn't really tell the whole story. Each FCM3 delivers wire-speed compression and with IBM's latest enhancements to metadata management, each module can deliver up to 3:1 data reduction. That means a 38.4TB FCM3 can potentially deliver up to 115TB of effective capacity without an impact to performance.

<CLICK>

A huge, albeit less obvious benefit of the FCMs is greatly enhanced flash endurance. There are many things that help deliver up to 7 times greater flash endurance than an industry-standard, commodity solid-state-drive (SSD). That translates to fewer issues for clients. It means that time doesn't have to be spent dealing with failing SSDs and drive rebuilds.

FlashCore: Hardware Accelerated I/O

Innovative Design

High performance compress/decompress

Compression came from IBM Mainframe

Minimizes data written to flash

ECC is fast, light, and vastly more sophisticated than commodity SSDs

Data reduction is transparent

Business Benefits

Improved economics with no performance impact!

Who Has It?

IBM is the only vendor to deliver these purpose-built next-gen flash modules with inline high-performance compression, encryption and more

IBM has been delivering high-performance, highly-reliable customized flash modules for many years. It started with MicroLatency Modules for the high-performance FlashSystem family. These modules separated the control path and the data path so that nothing would slow down data. They added endurance features and implemented RAID within the modules. Numerous additional technologies and benefits were implemented.

In 2018, IBM took everything it had learned over the years and created FlashCore Modules (FCM1s) which utilize Non-Volatile Memory express (NVMe) and adhere to a standard 2.5" drive form factor. This enabled IBM to start delivering all of the innovative and enormously beneficial storage technologies into a broader range of systems. IBM includes a high-speed compression/decompression engine based on a modified Dynamic GZIP algorithm. IBM has now introduced the next generation of FCMs to bring even greater performance, capacity, and reliability to clients.

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The real business benefit of FCMs are that clients obtain improved economics with no performance penalties. No other storage device can deliver this benefit.

FlashCore Implements Health Binning & Heat Segregation

Highly Useful
and Unique

Innovative Design

FlashCore Technology continuously monitors the health of each block

Health binning → 57% endurance gain

Heat segregation → 45% reduction in write amplification



Business Benefits

Higher endurance in real life workloads due to asymmetrical wear leveling

Asymmetrical wear leveling and sub-chip tiering work in conjunction

Most solid-state drive (SSD) providers wear all flash blocks exactly the same.

Unfortunately, weaker blocks wear out faster, eating into overprovisioning and resulting in earlier replacement.

<CLICK>

The business benefit of how FlashCore Modules (FCMs) handle things is that their asymmetrical wear leveling deliver higher endurance in real life workloads.

FlashCore Implements Variable Voltage Levels

Innovative Design

Dynamic read level shifting

Predictive techniques

IBM Flash developers figured it out

Bottom Line: Keeps old flash productive

Business Benefits

Variable Voltage is the Fountain of Youth,
delivering reliable long life



Who Has It?

IBM is the **only vendor** to
deliver variable voltage to
enhance flash endurance

Dynamic read level shifting over the life of flash blocks in FCMs. This ensures that all flash cells are monitored and automatically have the necessary voltage applied in order to deliver the longest possible lifespan.

redictive techniques to adjust internal flash settings in advance, thereby minimizing the probability of uncorrectable errors.

Using IBM's advanced characterization lab, IBM Flash developers determined the best voltage levels to set for a block as it ages proactively. This is only possible because IBM develops technology rather than depending solely on generic off-the-shelf commodity products from other vendors. This means IBM is able to keep older flash full productive.

FlashCore Implements Variable Stripe RAID (VSR)

Innovative Design

Performs chip-level RAID on modules

If one die fails in a chip stripe, only the failed die is bypassed, and then data is restriped across the remaining chips. No system rebuild is required

VSR reduces maintenance intervals caused by flash failures

Avoids performance robbing system-level intervention the majority of the time

Business Benefits

- Protects data from a chip failure (non-disruptively)
- Dynamically re-stripes data at a sub-chip level to ensure continuous business operations
- Preserves flash life, protection & performance

Who Has It?

IBM is the **only vendor** to deliver Variable Stripe RAID for multiple dimensions of RAID protection while maintaining peak performance

of

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So, who else has Variable Stripe RAID? No one! **IBM is the only vendor** to

A new FlashCore Module 3

Building on IBM's FlashCore technology, the latest FCM 3 drive delivers increased performance and greater storage density



2022: FCM 3

Same SLC/QLC technology

4.8, 9.6, 19.2 and 38.4TB physical capacities

Expanded metadata management delivers up to 3:1 effective to usable ratio improvement with no performance penalty

22, 29, 58, 115TB effective capacities

Significantly increased throughput

FlashSystem 5200, 7300 and 9500

IBM developed FlashCore technology many years ago. They pioneered custom inline compression and encryption in their FlashCore Modules (FCM), which has no impact on performance. The TLC Flash FCMs with their inline compression engine easily supported 2:1 data reduction.

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In 2020, IBM pioneered the use of QLC Flash for high-performance and better economics. They introduced FCM 2 and still delivered 2:1 compression with no impact to performance. IBM introduced a new 38.4TB module which delivered a stunning 76.8TB of effective capacity.

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In 2022, IBM once again shook things up with the introduction of the FCM 3. They are based on IBM's award-winning SLC/QLC design and now support improved metadata management which delivers up to 3:1 data reduction ratio with no performance penalty. IBM is employing state-of-the-art design and development. The 19.2TB and 38.4TB FCM drives will use 7 nanometer (nM) technology and PCIe gen 4 to increase the throughput beyond that of the FCM 2. (*If asked, 4.8 and 9.6TB drives will move to PCIe gen 4 in the future*)

The new FCM 3 drives will be offered on FlashSystem 7300 and FlashSystem 9500, but they will also work on FlashSystem 5200.

Summing up FCMs

Originally the conversations were all about SAS HDDs versus SAS SSDs.

Then the conversations were centered around SAS SSDs versus NVMe SSDs.

Today the conversations are most often about comparing NVMe SSDs with FCMs.



Back in the early days of flash, a lot of people were discussing comparisons of serial-attached SCSI (SAS) hard disk drives (HDDs) and SAS solid-state drives (SSDs). The performance was much better with flash but there were concerns about longevity.

<CLICK>

Several years ago the conversation shifted to comparisons around SAS SSDs and the newer non-volatile memory express (NVMe) SSDs. NVMe SSDs delivered vastly superior performance. And, as far as the reliability and longevity of flash devices, they were both nearly identical.

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More recently the conversation has centered around comparisons of NVMe SSDs and IBM's unique FlashCore Modules (FCM). Both devices employ the NVMe communication protocol, and both are very fast. However, IBM's unique FCMs deliver superior performance, longevity, protection, and capacity. They also typically prove to be significantly less costly on a per-terabyte (TB) basis due to the built-in hardware compression. And remember, that compression comes without a performance penalty.

There are a couple of competitors who can address one or two things that FCMs do, but none of them can provide the long list of technology found in FCMs or the value that technology delivers to clients.

FlashSystem models and where they support NVMe and SAS

	FlashSystem 5015	FlashSystem 5045	FlashSystem 5200	FlashSystem 7300	FlashSystem 9500	FlashSystem 9500R
NVMe in the Control Enclosure	No	No	NVMe SSD FCM3 SCM	NVMe SSD FCM3 SCM	NVMe SSD FCM3 SCM	NVMe SSD FCM3 SCM
SAS in the Control Enclosure	SAS HDD SAS SSD	SAS HDD SAS SSD	No	No	No	No
SAS in the Expansion Enc.	SAS HDD SAS SSD	SAS HDD SAS SSD	SAS HDD SAS SSD	SAS HDD SAS SSD	SAS SSD	SAS SSD

This table is designed to provide you with a single slide detailing which FlashSystem models support NVMe and SAS drives as well where within the system they support those drives.

It is important to note that all FlashSystem solutions support the use of SAS drives in at least one location. However, FlashSystem 9500 and 9500R do not support SAS HDDs, rather, they support SAS SSDs for expansion.

Note:

- NVMe = Non-Volatile Memory express
- FCM = FlashCore Modules
- SCM = Storage Class Memory
- SAS = Serial Attach SCSI
- HDD = Hard Disk Drive
- SSD = Solid-State Drive

A Visual Comparison Between FCMs and Commodity SSDs

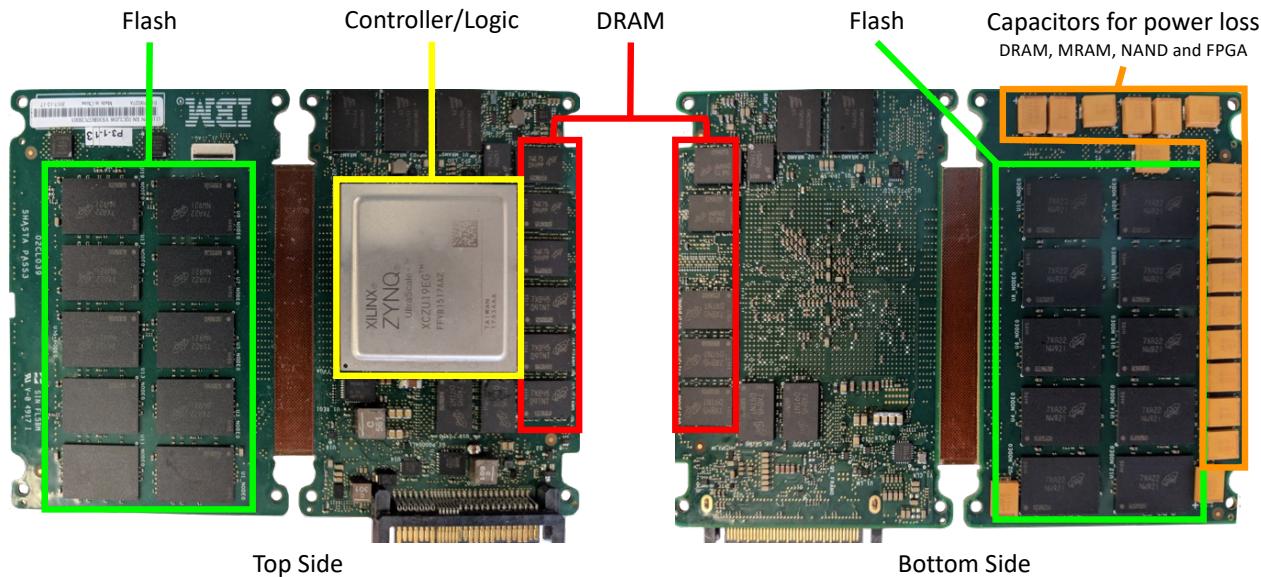
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Last Updated: July 19, 2023

Welcome to this Module in which a visual examination between FlashCore Modules and Commodity SSDs is carried out. This information will help Sellers and Business Partners effectively sell FlashCore Modules (FCMs). These modules provide IBM with many differentiating abilities.

Technically Superior FlashCore Modules

2.5" SFF



This is the interior of an IBM FlashCore Module (FCM). It is custom designed by IBM to meet the needs of a transforming storage market. The design employs IBM's FlashCore Technology to solve problems that nearly all clients encounter.

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FlashCore Modules have a decent amount of extra Flash (overprovisioned) to replace failing flash cells.

<CLICK>

FCMs also contain a fairly large amount of DRAM which is used to handle extensive high-performance Write operations as well as provide a place for compression tables to be handled. Clients will notice latency as low as 50 microseconds. This is a huge area of differentiation for FCMs. They can handle numerous, high-performance Write operations compared to commodity SSDs.

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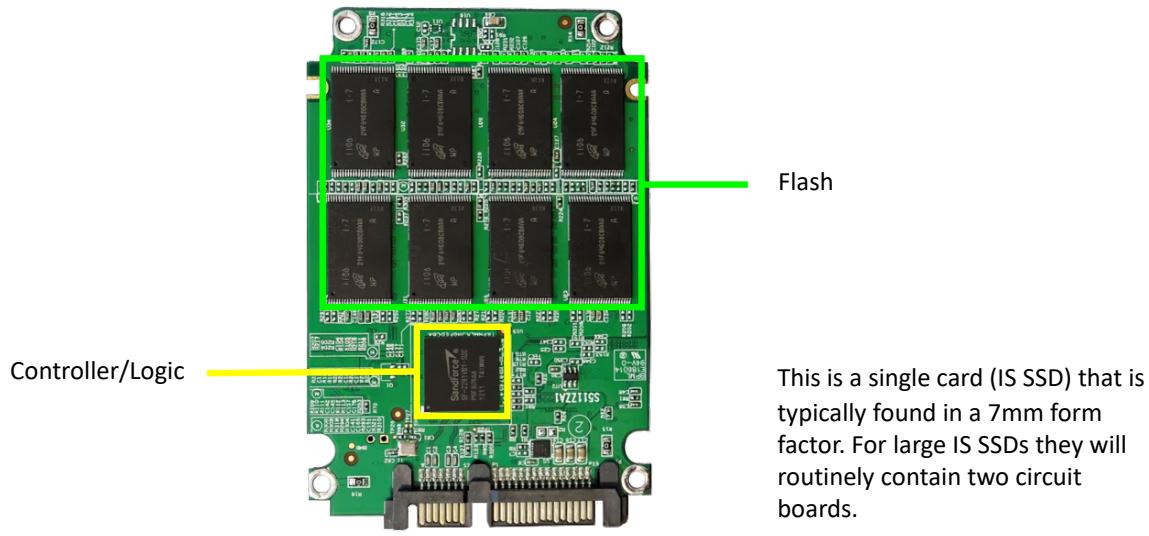
There are a numerous capacitors in the FCM. They are designed to maintain power long enough during a power loss to facilitate the completion of outstanding transactions involving DRAM, MRAM, NAND flash and the FPGA Controller. These are extremely high reliability capacitors with a very long lifespan.

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FlashCore Modules have a large, custom-designed flash controller which serves as the brain of the FCM. This controller has approximately 10x the performance and capabilities of a commodity flash controller. It facilitates the plethora of FlashCore Technology operations which provide FCMs with their uniqueness and clients with business value. We will see more about this on the next slide.

Commodity SSDs represent a compromise

2.5" SFF

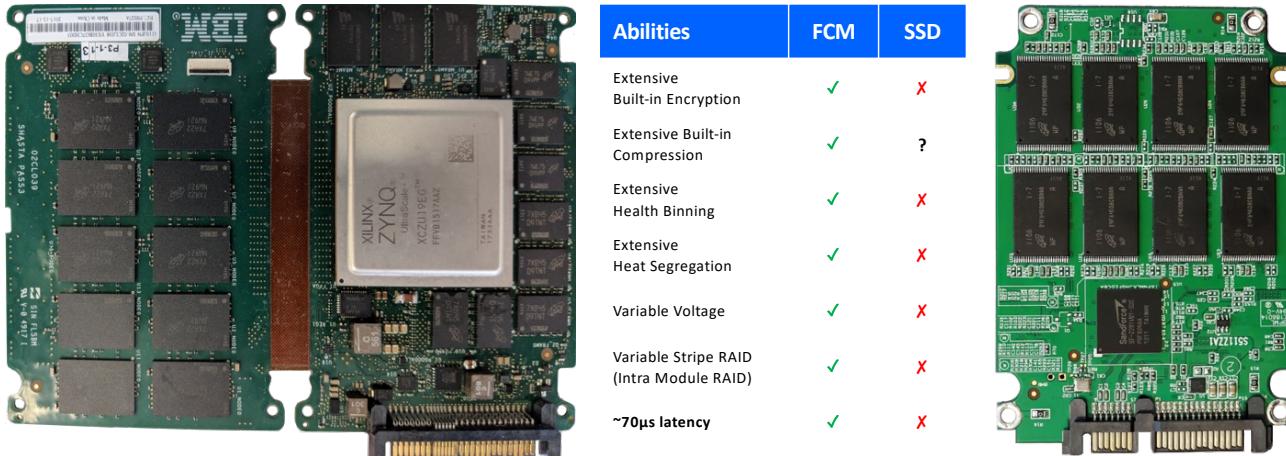


This is the interior of a generic commodity SSD. Regardless of vendor, most commodity SSDs tend to be very similar. It is important to remember that they are designed to appeal to the broadest possible group of people. Therefore, they tend to lack extras that might help them stand out in a crowd. Rather, they are typically built to a "minimum standard".

Commodity SSDs will have a very small amount of extra Flash (overprovisioned) to replace failing cells. They will typically contain a very small DRAM buffer which is used to allow a small amount of faster Writes to the drive. Due to the way flash works, it is not possible to write to it quickly. Vendors will attempt to offset the issue by placing a small DRAM buffer on the drive. Writes can very quickly go into the DRAM buffer at which point they will then be written into flash as quickly as possible. Commodity SSDs will also have a small flash controller which serves as the brain of the SSD. These controllers tend to be small with low performance. Vendors typically can't make them too powerful or they will be too expensive to be able to compete effectively against other commodity SSDs.

Side-by-side comparison of FCM and SSD

2.5" SFF



A quick visual examination of the interiors of an FCM and a commodity SSD, make it very easy to see differences. But don't assume IBM has a better solution simply because it visually looks more impressive. It is critical that we understand the real differences arise from IBM's unique FlashCore Technology. The reason this is being mentioned is because it is inevitable that other Flash vendors will eventually try to incorporate additional technology into their commodity SSD controllers.

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This table lists a number of operations/functions that are provided by IBM's FlashCore Technology. Built-in Encryption, Built-in Compression (more on this shortly), Health Binning, Heat Segregation, Variable Voltage, Variable Stripe RAID, and very low latency. Latency is a major differentiator. IBM delivers better performance because of the highly sophisticated design of FCMs. Larger DRAM buffers coupled with highly sophisticated logic enable FCMs to deliver significantly better performance.

AT the very end of 2019, Seagate introduced a line of SSDs with compression. Before we address this, I would like to make sure people are aware of something. The Seagate line with compression is called Nytro but BE AWARE, not all Nytro SSDs have compression. Only the SATA and NVMe models possess compression while the SAS

models do not have any compression! Now, when we say that another vendor has compression it might cause some people to question whether IBM still has a unique advantage with FlashCore Modules. The answer to that question is, “IBM has definite advantages with FCMs”. The table helps to illustrate the advantages that FCMs possess. The combination of these various functions and abilities are what ultimately deliver business value to clients.

IBM FCM versus Seagate Nytro



	Large Write Buffers	Variable Stripe RAID	Variable Voltage	Extensive Heat Segregation	Extensive Health Binning	Wire Speed Compression	Wire Speed Encryption	Wire Speed Compression	Wire Speed Encryption
Seagate Nytro SATA (1000 series)	✓	✓	✓	✓	✓			✓	
Seagate Nytro NVMe (5000 series)	✓	✓	✓	✓				✓	
IBM NVMe SSDs	✓	✓	✓	✓	✓	✓	✓	✓	✓
IBM FCM (NVMe-based)	✓	✓	✓	✓	✓	✓	✓	✓	✓



Above and beyond what is being offered by Seagate

As previously mentioned, Seagate added wire speed compression to several SSDs in the 4th quarter of 2019. In examples on their web site they do not discuss being able to achieve very large amounts of compression. Clients need to be somewhat careful when dealing with Seagate's Nytro line to make sure they purchase the correct type of SSD. The 1000-series are SATA drives and will likely not see much use in Enterprise environments. Additionally, the 1000 series are only available in small capacities.

The 5000 series are NVMe-based but once again the drives are only available at small capacity points. Neither the 1000, nor 5000 series have good Health Binning, Heat Segregation, Variable Voltage, Variable Stripe RAID, or large DRAM buffers to facilitate high performance writes. This is why FCMs remain the flash of choice for clients seeking great efficiency, capacity, and performance.

Understanding Drive Writes Per Day

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Welcome to this Module where we will examine Drive Writes Per Day (DWPD) and why it no longer a valid way of rating solid-state drives.

What are Drive Writes Per Day?

Drive Writes Per Day (DWPD) is the number of times the total capacity of a drive may be written, per day, within its warranty period.

- Once upon a time, DWPD were perceived to be an indication of drive quality
- Perceptions are often colored by DWPD numbers
- Made sense when SSDs were only a couple hundred gigabytes in size

Example

- You have a 200GB SSD
- It has 5-year warranty period
- It is rated for 1 DWPD



1

Results

- $200\text{GB per day} \times 365 \text{ days/yr} \times 5 \text{ years}$
- Adds up to 365TB of cumulative writes
- By then the SSD may need to be replaced

However...

- If it was rated at 5 DWPD...
- That adds up to 1.8PB of cumulative writes over 5 years

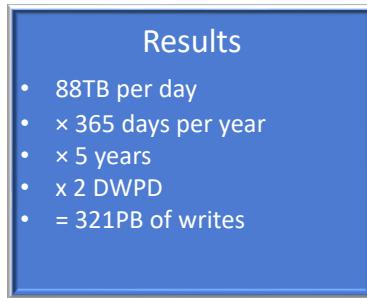
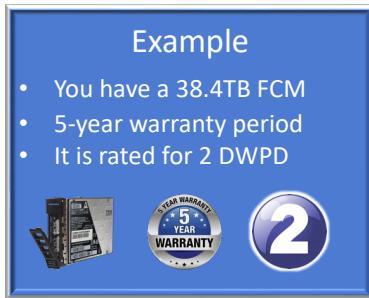
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that

Why DWPD, or TB written, doesn't make sense anymore

- Perceptions are often colored by DWPD numbers
- When you have tens of TBs in a single SSD, most businesses are unable to write that much daily
- FlashCore Modules truly make DWPD a meaningless concept



- DWPD don't matter, as IBM supports the drive regardless of how it is used
 - Write a lot, write a little, it's supported all the same, and completely covered



to

Cumulative writes based on possible DWPD numbers

This is a list of what the total cumulative writes might be based on different drive sizes and different DWPD numbers. The assumption is that all these devices have a 5-year warranty. This is to help visualize DWPD.

Capacity of flash device	1 DWPD	2 DWPD	5 DWPD
400GB SAS SSD	730 TB	1.46 PB	3.65 PB
800GB SAS SSD	1.46 PB	2.92 PB	7.3 PB
960GB SAS SSD	1.75 PB	3.5 PB	8.75 PB
1.92TB SAS or NVMe SSD	3.5 PB	7.0 PB	17.5 PB
3.84TB SAS or NVMe SSD	7.0 PB	14.0 PB	35.0 PB
7.68TB SAS or NVMe SSD	14.0 PB	28.0 PB	70.0 PB
15.36TB SAS or NVMe SSD	28.0 PB	56.0 PB	140.0 PB
4.8TB IBM FCM3	26.3 PB	52.6 PB	131.5 PB
9.6TB IBM FCM3	52.5 PB	105.0 PB	262.5 PB
19.2TB IBM FCM3	105.1 PB	210.2 PB	525.6 PB
38.4TB IBM FCM3	210.2 PB	420.4 PB	1.05 EB

This table is presented in order to provide you with an idea of what total cumulative writes look like over a 5-year period with various DWPD numbers. You can easily see that as drive capacities increase the cumulative writes become extremely large. This helps illustrate why a measurement like DWPD is no longer a useful measuring stick for drive quality.

To help you understand the value behind FlashCore Modules (FCM), let's compare three drives that share similar-sized physical capacities.

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We will start with a 3.84 terabytes (TB) non-volatile memory express (NVMe) solid-state drive (SSD) and a 4.8 TB FCM. Because of the no-penalty compression that is built into the FCM3 it delivers up to 3.75X the cumulative capacity.

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Next, let's examine a 7.68 TB NVMe SSD and a 9.6 TB FCM. Once again, the built-in compression means the FCM3 delivers 3.75X the cumulative capacity.

<CLICK>

Finally, when we look at a 15.36 TB NVMe SSD and a 19.2 TB. With FCM3 we once again achieve about 3.75X the cumulative capacity of NVMe SSDs.

Again, this information is meant to help you visualize why a measurement like DWPD is largely irrelevant when talking about flash devices.

Distributed RAID (DRAID)

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Welcome to this Module where we will examine the value behind Distributed RAID which is also known as DRAID.

Understanding RAID and how it affects configurations

A RAID group (Redundant Array of Inexpensive Drives) contains:

- Some number of Data drives
- 1, or more, Parity drives (they provide the protection)
- And typically a hot Spare drive

1. RAID 6 means you will need 2 parity drives



2. The Spare will require 1 additional drive



3. Divide 23TB by 3.84TB = 6 drives



4. The client will require a total of 9 drives for 23TB under RAID 6 with a spare



You must factor RAID into your capacity calculations

For example, a client tells you they want:

- 23TB of usable capacity
- RAID 6 protection
- 3.84TB SSDs

TRAID versus DRAID



With TRAID the parity drives will be spread across the group, but the spare just sits there and does absolutely nothing.

The spare gathers dust and cobwebs. It costs money yet it does not contribute any value on a daily basis.



With DRAID the Spare is part of the RAID array where it provides additional performance 24-hours per day, 365 days per year.

It delivers value every minute of every day.



Let's take a few minutes to examine Traditional RAID (TRAID) versus the more modern, and beneficial, Distributed RAID (DRAID).

Traditional (TRAID) has a weakness in that it suffers from slow drive rebuilds due to all of the writes needing to queue up in order to be written to a single drive.

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Additionally, the hot spare costs money yet contributes nothing to the array until there is a failure. Many of our competitors continue to use variations of TRAID.

<CLICK>

In order to eliminate this weakness, IBM created Distributed RAID (DRAID). In DRAID, the spare is included within, and distributed throughout, the array.

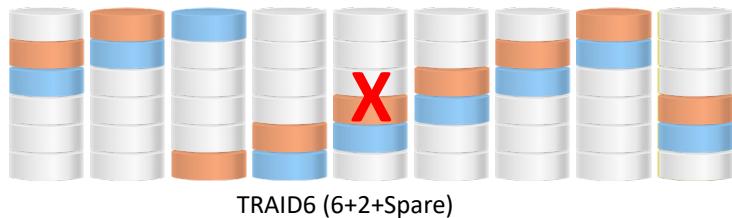
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That means that the spare is an active participant in the array and always contributes to performance. This approach also helps address the rebuild issue that clients experience with TRAID.

Note:

- RAID = Redundant array of inexpensive (or independent) disks

Why TRAID rebuilds are slow



- When a drive fails...
- The Spare steps forward
- It's time to queue up
- Problem is only worsening

Parity 1 Parity 2 Spare



Traditional RAID (TRAID) works very well and has a long history proving its reliability.

<CLICK>

When a drive fails in a TRAID array, a process is initiated which will ultimately help correct the situation.

<CLICK>

more of an

Note:

- RAID = Redundant array of inexpensive (or independent) disks

Why DRAID rebuilds are fast



- When a drive fails...
- The distribution of the spare makes all the difference
- **5x+** faster than with a TRAID array

Parity 1 Parity 2 Spare



One of the greatest benefits of Distributed RAID (DRAID) over Traditional RAID (TRAID) is the speed of drive rebuilds.

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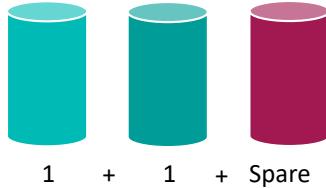
So, when a drive fails in a DRAID array, many things quickly occur.
providing performance rather than
simply sitting to the side and doing nothing as it does with TRAID.

<CLICK>

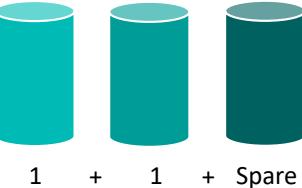
Note:

- RAID = Redundant array of inexpensive (or independent) disks

The benefits, and value of DRAID 1 for FlashSystem 5200/7300/9500



- TRAID1 is just 2 drives + S
- TRAID spare does nothing



- DRAID1 is up to 16 drives
- DRAID spare adds value

- They appear to look the same, but they are not!
- DRAID 1 is ideal for small configurations
- DRAID 1 has approx. 25% faster writes than TRAID 1



IBM brings powerful differences to DRAID 1 over what businesses are used to obtaining with Traditional RAID (TRAID) 1. Most businesses will automatically assume RAID 1 is the same whether it involves Traditional RAID or Distributed RAID. Unfortunately, that is simply not true! It is important we help businesses understand the value of DRAID 1. It is an ideal way of dealing with very small groups of drives. In fact, it is quite likely DRAID 1 will be used with Storage Class Memory (SCM) drives. It may also be used for other high-performance NVMe drives such as FlashCore Modules (FCM). DRAID 1 helps achieve the highest performance while simultaneously helping reduce Write Amplification. We don't have time to go into the details of write amplification here, but other resources are available if you desire a deeper dive.

<CLICK>

Note:

- RAID = Redundant array of inexpensive (or independent) disks

Summing up DRAID vs TRAID

Traditional RAID is effective, but for the majority of the time it derives zero value from the hot spare



Traditional RAID suffers from increasing long rebuild times which leaves a business exposed



Distributed RAID derives value from the hot spare, and it delivers significantly faster rebuilds



It is easy to see the big differences between Traditional RAID (TRAID) and Distributed RAID (DRAID). One of the most frustrating things for clients is that for each TRAID group there must be a hot spare drive that delivers zero value for the business unless a drive failure occurs within that group.

<CLICK>

Because TRAID is architected as it is, it will suffer from long rebuild times and those times are increasing because the drive sizes continue to increase. The problem with long rebuild times is that a business's data is at risk until the rebuild is complete.

<CLICK>

DRAID eliminates the deficiencies found in TRAID. The hot spare is an active part of each group, so it provides value through additional performance on a daily basis. Even better is the fact that rebuilds are more than 5 times faster. That means businesses are exposed for much less time than with TRAID.

DRAID is the clear winner.

Note:

- RAID = Redundant array of inexpensive (or independent) disks

Dynamic DRAID Expansion

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Last Updated: July 19, 2023

Welcome to this Module where we will examine the value behind Dynamic DRAID Expansion. Sellers and Business Partners will learn the benefits behind DRAID Expansion.

What is Dynamic DRAID?

- Dynamic DRAID enables clients to non-disruptively increase the capacity of an existing DRAID array.
- Ability to add one to twelve drives to an existing DRAID array
- A drive can either add extra capacity or extra rebuild areas
- New drives are integrated into array
- Volumes remain accessible throughout process



<CLICK>

The v

Note:

- RAID = Redundant array of inexpensive (or independent) disks

What drives can be added through expansion?

- Use the same drives as the ones in the existing DRAID array
- Additional drives must be same or larger capacity
- New drives must be same or better performance



IBM

The question sometimes arises as to “what drives can be added when doing expansion?”

have the

per
minute (RPM)

Note:

- RAID = Redundant array of inexpensive (or independent) disks

How long does expansion take?

- The goal is to run in the background without impacting host IO performance
- Expansion time depends on the type of drive
- Expansion time is affected by numerous other factors
- Estimated completion time can be obtained using the CLI



The goal for Dynamic Distributed RAID (DRAID) Expansion is to run in the background without impacting host IO performance.

<CLICK>

One of the first questions that people typically ask is “How long does expansion take?” There is not a definitive answer because drive type will affect the results. As a general guideline you can expect that a FlashCore Module (FCM) or non-volatile memory express (NVMe) solid-state drive (SSD) will require many hours to be added into an existing group. NL-Serial-attached SCSI (SAS) drives will require many days to be added into an existing group.

<CLICK>

Expansion times are affected by many other factors. One of those factors is the capacity of the drives in question. Higher capacity drives require more time than smaller capacity drives. Another factor that will affect the time required for expansion is the amount of data in the existing DRAID array. And one other factor that will have a bearing on the amount of time that expansion requires is the Host IO workload and its distribution.

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Note:

- RAID = Redundant array of inexpensive (or independent) disks

Interaction with other processes and failure handling



Array rebuild takes priority over expansion

Expansion takes priority over copy-back process



A e

Benefits of Dynamic DRAID Expansion

Large capacity drives become a client's friend because of DRAID expansion

Example

Client purchases a FlashSystem with eight 19.2TB FCMs for a total of 153TB of raw capacity, which is up to 459TB of effective capacity



12 months later



Option 1

Create an entirely new RAID group



Option 2

Expand the existing RAID group



<CLICK>

Let's look at an example where a client purchases a FlashSystem with eight 19.2 terabytes (TB) FlashCore Module gen 3s (FCMs). That gives them 153 TB of raw capacity. But, because the FCMs have built in compression, the client really can have up to 459TB of effective capacity.

<CLICK>

Over the course of a year or so the client constantly accumulates data and runs their entire enterprise on the highly reliable FlashSystem solution. Unfortunately, they are beginning to run out of capacity. The client has two relatively simple options for dealing with their lack of capacity.

<CLICK>

The first option is for the client to purchase a group of between six to sixteen drives and create a second RAID group in the FlashSystem. This approach would allow the client to potentially choose drives with a different capacity because they would be in their own group. The downside to this approach is just the cost of all of those new

drives.

<CLICK>

The second option is a very easy way to deal with increasing their capacity. The client can simply acquire one or a few 19.2 TB FCMs and dynamically add them to the existing eight FCMs in their FlashSystem. This is a non-disruptive approach and the client will still only have one group to administer. Not only is this easy but it is also a low-cost option.

B

because of the

-

Note:

- RAID = Redundant array of inexpensive (or independent) disks

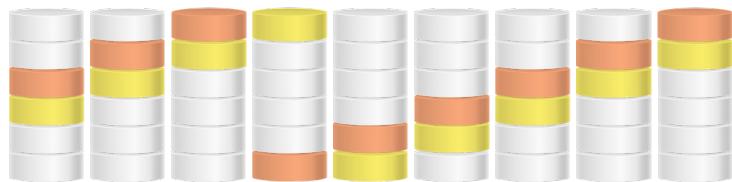
DRAID 6 versus DRAID 5

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Last Updated: July 19, 2023

Welcome to this Module where we will examine the benefits behind DRAID6 versus DRAID5. Both RAID levels are valuable but RAID6 has some very clear advantages.

DRAID 6 versus DRAID 5



DRAID 5 provides good protection



DRAID 6 provides great protection



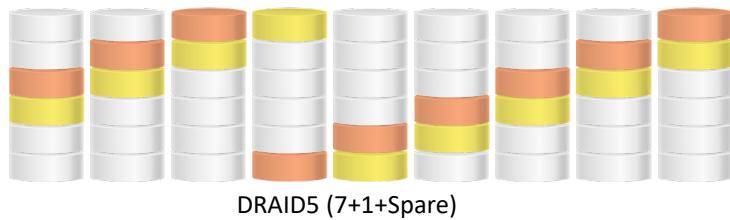
Let's briefly look at DRAID 5 and DRAID 6.

<CLICK>

Note:

- RAID = Redundant array of inexpensive (or independent) disks

What DRAID 5 does, and does not, protect against



- The benefit of DRAID 5
- Drive capacities are an issue
- A second failure is disastrous
- What to be aware of



Parity



Spare



<CLICK>

The benefit of

<CLICK>

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occurs during the rebuild,

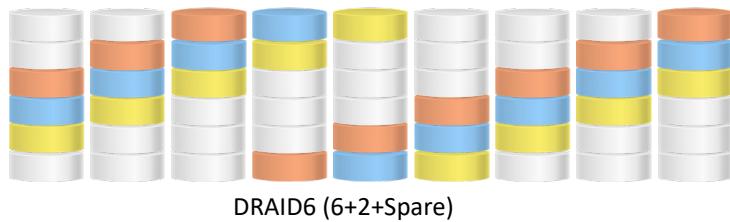
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Note:

- RAID = Redundant array of inexpensive (or independent) disks

What DRAID 6 does protect against



- The benefit of DRAID 6
- Two simultaneous failures
- The real value of DRAID 6
- DRAID 6 is the better choice

Parity 1 Parity 2 Spare



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However, t two

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Note:

- RAID = Redundant array of inexpensive (or independent) disks

Synchronous, Asynchronous 3-site and more

Principal, Learning Content Development, IBM FlashSystem
roger.kasten@us.ibm.com

Last Updated: July 19, 2023

Welcome to this Module where we will examine FlashSystem's ability to support numerous forms of replication as well as 3-site capabilities.

FlashSystem solutions include replication

IBM Storage Virtualize provides **synchronous** replication known as

Metro Mirror

IBM Storage Virtualize provides **asynchronous** replication known as

Global Mirror

IBM Storage Virtualize also has a periodic **asynchronous** replication mode known as

Global Mirror with Change Volumes

Synchronous replication is known as **Metro Mirror (MM)**. It provides data replication between two sites that are located up to several hundred kilometers apart from one another although typically the distance is less than 100 kilometers. It is a process by which two LUNs (volumes) in two disk systems are made to be identical in real-time. Metro Mirror provides a recovery point objective (RPO) which is effectively 0 seconds (immediate). It is used for business continuity and disaster recovery.

<CLICK>

Asynchronous replication is known as **Global Mirror (GM)**. It provides data replication over extended distances between two sites for business continuity and disaster recovery. If adequate bandwidth exists, Global Mirror provides a recovery point objective(RPO) of as low as 3–5 seconds and up to several minutes between the two sites at extended distances with no performance impact on the application at the primary site. It replicates the data asynchronously and also forms a consistency group at a regular interval allowing a clean recovery of the application.

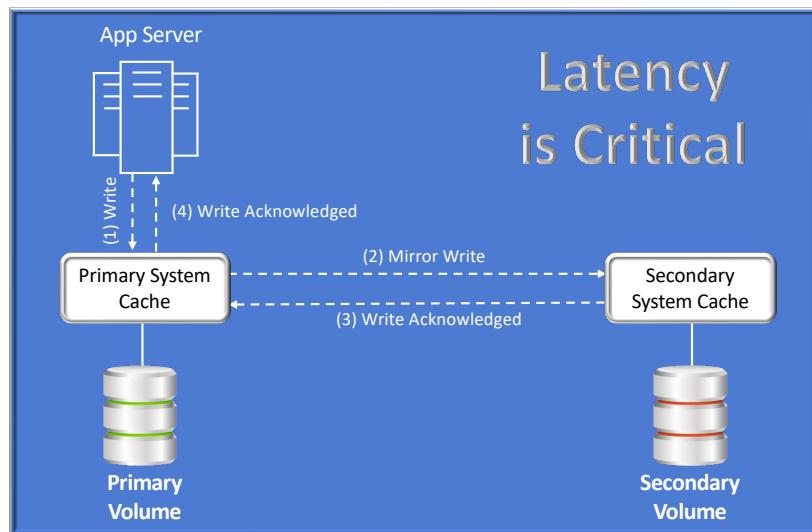
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There is also an implementation of periodic Asynchronous replication known as **Global Mirror with Change Volumes (GMwCV)**. Global Mirror change volumes create periodic point-in-time copies of either the primary volumes or the secondary volumes. The command-line interface is used to create, change, or remove change volumes.

Synchronous replication is part of all FlashSystem solutions

Synchronous replication is known as **Metro Mirror**

Latency is Critical



Synchronous replication is known as **Metro Mirror**. It is an IBM technology that provides data replication between two sites that are located up to several hundred kilometers apart from one another. It is a process by which two LUNs (volumes) in two disk systems are made to be identical in real-time. Metro Mirror provides a recovery point objective (RPO) which is effectively 0 seconds (immediate). It is used for business continuity and disaster recovery. The basis for any Synchronous Disk Replication is something called **the Write Order Sequence**. Allow me to explain.

We will have LUN A at the Primary site and a LUN B at the Secondary site. For each write made by an application the following process will occur:

<CLICK>

A Write is issued from the application to Primary LUN A

<CLICK>

A Write is issued from Primary LUN A to Secondary LUN B

<CLICK>

LUN B acknowledges the receipt of the write back to LUN A

<CLICK>

LUN A now posts a Write Acknowledgement to the Application to let it know that the IO is complete. At this point the application can issue the next write operation.

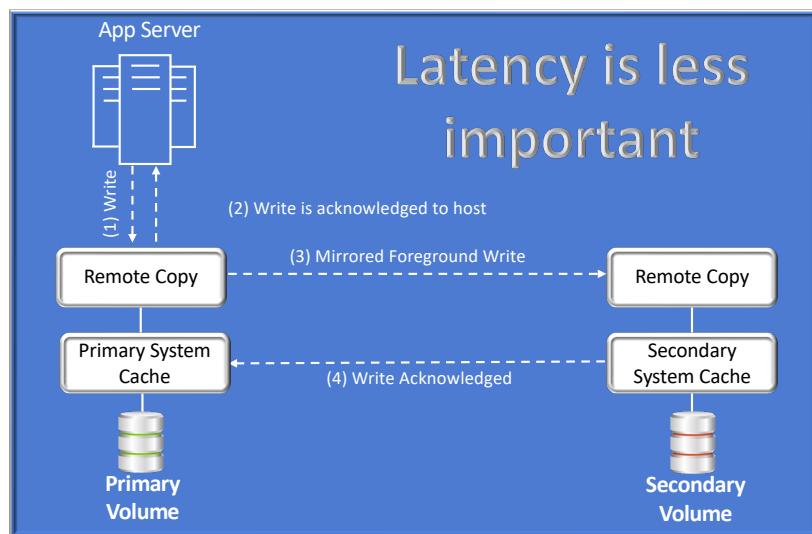
Because this process requires acknowledgement it ensures data remains consistent at both sites. It also requires very low latency which is why there are distance limitations. If the two sites are spread too far apart then another replication solution is called for.

Asynchronous replication is part of all FlashSystem solutions

Synchronous replication is known as Metro Mirror

Asynchronous replication is known as Global Mirror

Latency is less important



Asynchronous replication is known as **Global Mirror**. It is an IBM technology that provides data replication over extended distances between two sites for business continuity and disaster recovery. If adequate bandwidth exists, Global Mirror provides a recovery point objective (RPO) of as low as 3–5 seconds between the two sites at extended distances with no performance impact on the application at the primary site. It replicates the data asynchronously and also forms a consistency group at a regular interval allowing a clean recovery of the application.

<CLICK>

A Write is issued from the application to the Primary LUN A. An Acknowledgement is returned to the Application to let it know it can issue its next Write.

<CLICK>

Next, a Write is issued from the Primary LUN A to the Secondary LUN B at which point LUN B sends an Acknowledgement back to LUN A.

When Global Mirror is employed the latency demands are less important since the

system isn't held at bay while it awaits an acknowledgement to return.

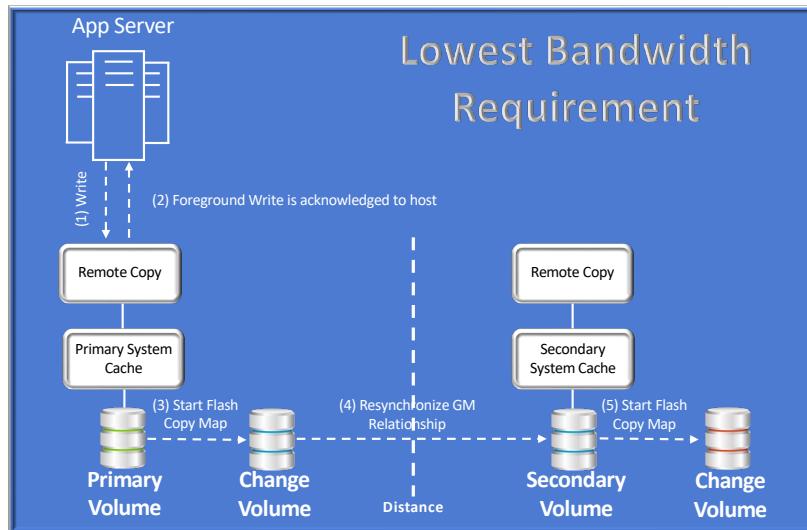
Asynchronous with Change Volumes is part of all FlashSystem solutions

Synchronous replication
is known as Metro Mirror

Asynchronous replication
is known as Global Mirror

There is a periodic Asynchronous
replication known as Global Mirror with
Change Volumes
(aka Cycle-Mode Global Mirror)

Lowest Bandwidth
Requirement



There is also a periodic implementation of asynchronous replication known as **Global Mirror with Change Volumes (GMwCV)**. Global Mirror with Change Volumes creates periodic point-in-time copies of either the primary volumes or the secondary volumes. The command-line interface is used to create, change, or remove change volumes. This is also known as Cycle-Mode Global Mirror.

Change volumes can be used in a number of cases with relationships. There can be active-active relationships with the relationship cycling mode set to Multiple. These must always be configured with change volumes at each site. The real benefit for clients is that this mode works well when bandwidth is relatively low. When a client establishes a Global Mirror with Change Volumes, with the cycling mode set to Multiple, they must create change volumes on both the master (Primary) and auxiliary (Secondary) volumes, that are used in the relationship or consistency group.

<CLICK>

In the same fashion we saw with standard Global Mirror, when a write is sent to the primary storage an acknowledgement is immediately sent back to the application. This tells the app that it is okay to progress with whatever action is next.

For Global Mirror relationships with multiple cycling modes, changes are tracked and copied to intermediate change volumes at the primary site.

<CLICK>

The changes are transmitted to the secondary site continually to lower the bandwidth requirements, requiring only the average throughput not the peak.

Summarizing the differences between approaches

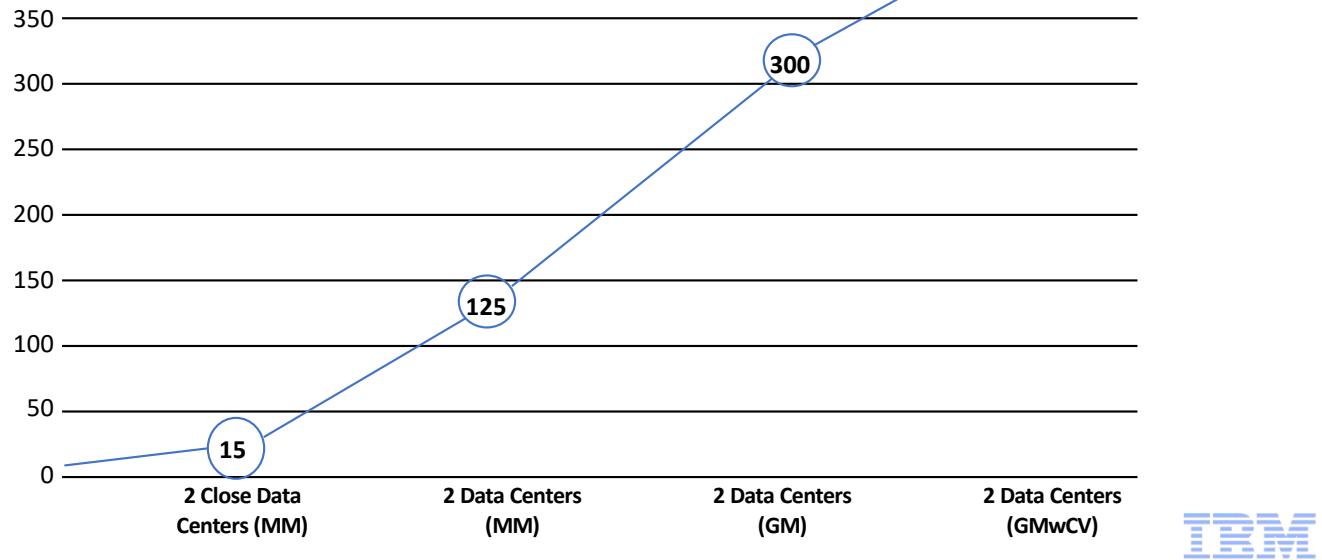
	Metro Mirror (MM)	Global Mirror (GM)	Global Mirror with Change Volumes
Typical RPO	0	< 5 minutes Typically 30 secs	Minutes/Hours
Typical RTO	Minutes	Minutes/Hours	Minutes/Hours
Sensitivity to bandwidth limitations	High	Medium	Low
Distance limit in kilometers	300	25000	25000

Remember, the choice of replication mode is typically more of a business decision than a technical decision.



Let's briefly summarize a few important items that are important to replication.

Distance, bandwidth and appropriate technology

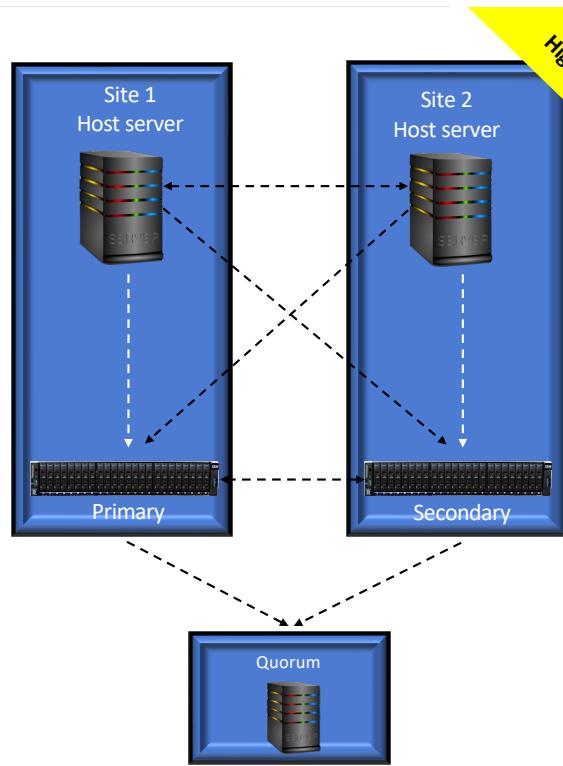


Here is a look at very common replication distances.

<CLICK>

Up to 100% Availability with IBM HyperSwap

- Extreme availability (100%)
- Completely redundant
- Continuous data access
- Moves data without disruption
- Eliminate downtime costs



Unique and
Highly Valuable

The IBM HyperSwap function is a high availability feature that provides dual-site, active-active access to a volume. It is designed to provide up to 100% uptime.

HyperSwap functions are available on systems that can support more than one I/O group (systems that can be clustered). That means all members of the FlashSystem family, except FlashSystem 5010, can be used to deliver the advantages of HyperSwap.

<CLICK>

HyperSwap provides complete redundancy for critical business data. HyperSwap volumes have a copy at one site and a copy at another site. Active-active relationships are made between the copies at each site. Data that is written to the volume is automatically sent to both copies. The main goal with HyperSwap is to enable host I/O to continue, with no need for manual intervention, in the face of failures. This includes things such as the complete failure of the Primary (Master) or Secondary (Subordinate) systems, or the connectivity between them. It is also designed to deal with partial failures such as the exhaustion of physical capacity, failure of multiple software components, and other items of a similar nature.

<CLICK>

Continuous data access is provided with HyperSwap without any performance impact. Host active/active connectivity to the storage systems provides continuous data access when failures occur by delivering automatic failover to the other site. A remote Quorum server is used to assist in critical high availability decisions.

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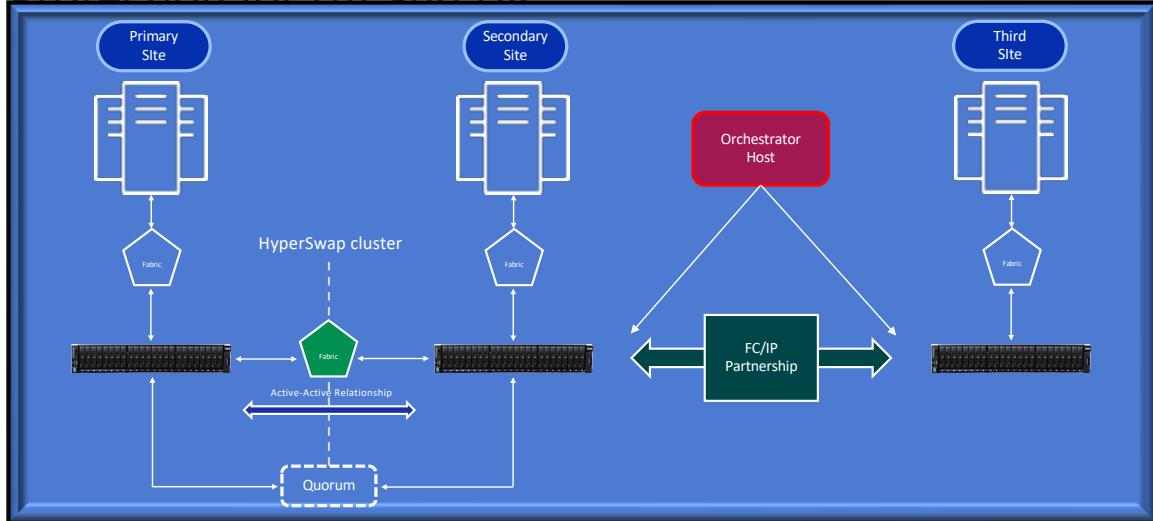
HyperSwap moves data without disruption between sites

<CLICK>

HyperSwap delivers a huge business benefit by eliminating the costs of downtime. What is genuinely amazing is that HyperSwap is available starting with entry-level FlashSystem solutions.

FlashSystem 3-Site Data Protection for HA and DR

Unique and Highly Valuable



Beginning with Storage Virtualize 8.3.1.2, external orchestrator software (installed on a separate server/VM) is used to run commands to configure 3-site. The orchestrator is still required with Storage Virtualize 8.4. With the February 2021 announcements, IBM enables management for 3-site and HyperSwap to be done from the primary GUI.

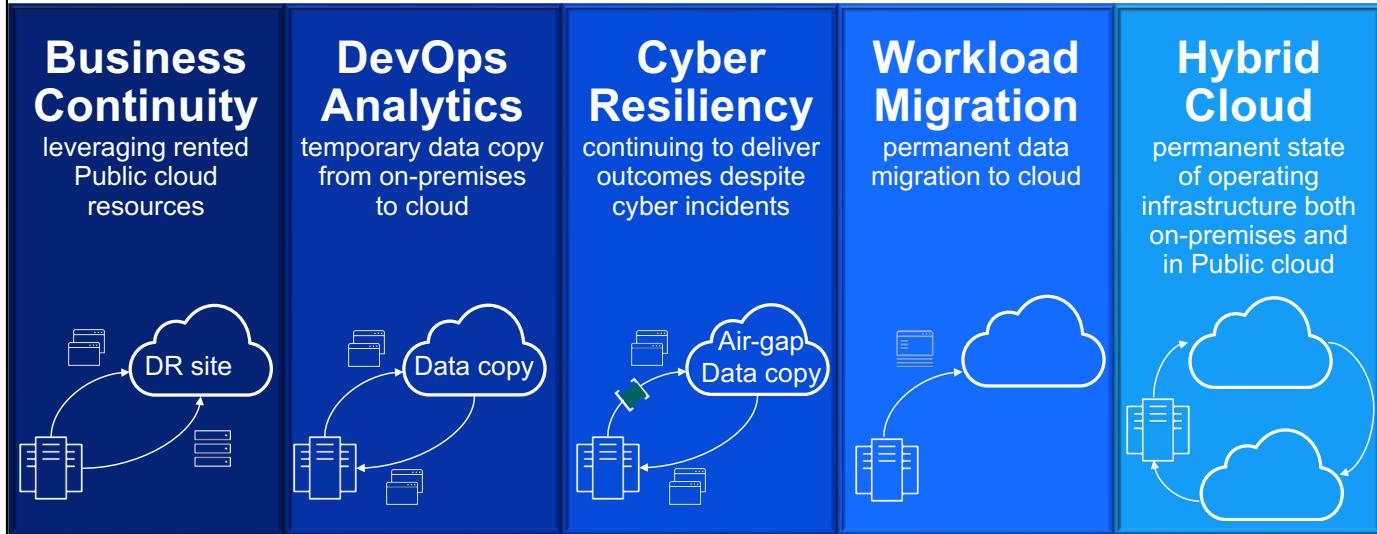
In Q1 of 2020, the FlashSystem 3-site function was enhanced to maintain recovery point objectives (RPO) through any site failure and provides incremental resync after a site outage.

As had been the case, IBM employs a Metro Mirror for high availability (HA) and now a Global Mirror that is active from one site but able to fail over automatically to the other site. This failover is orchestrated by software on a virtual machine, or a set of virtual machines.

As of February 2021, IBM has enabled 3-site and HyperSwap to be managed from within the GUI

Replication fulfills business requirements

Storage Virtualize and Storage Virtualize for Public Cloud



There are numerous reasons why clients may want Storage Virtualize for Public Cloud. Let's briefly explore the types of use opportunities we see on the Hybrid Multicloud journey and how replication plays a role in achieving those opportunities.

<CLICK>

Clients using Storage Virtualize on-prem, find that using Public cloud resources as a disaster recovery (DR) site, setting up replication from their on-premises storage infrastructure to the cloud is highly beneficial.

<CLICK>

Clients are using Public cloud resources to do agile application development and to leverage cloud analytics and AI services for deeper insights. They're transmitting on-premises storage snapshots to the cloud.

<CLICK>

An increasingly important use is for clients to use Public cloud to create air-gap data copies preventing cyber incidences from reaching all of an organization's data and ensuring they can continue delivering their desired

outcomes.

<CLICK>

Some clients following the path of least resistance. They are taking their applications and just “lifting and shifting” to the cloud. Since few, if any modifications are being made to these apps and largely the same IT organization is operating them, they are looking for as much consistency in operations, management, and procedures as possible. What’s more, they are realizing that even though their infrastructure is now being “rented” in the cloud, they are still concerned with tools for controlling efficiency. Storage Virtualize gives them the common environment they are seeking.

<CLICK>

Some clients are maturing to the point they have cloud-native applications built on containers that are portable across, and leveraging the full richness of, the Hybrid Multicloud. With an eye toward delivering the most consistent experience possible – to both developers and the bottom line – IT administrators strive for consistent API’s, efficiency tools, and security. A portable, open storage software foundation. These clients are fully enjoying the benefits of Storage Virtualize and Storage Virtualize for Public Cloud.

Storage Virtualize and Storage Virtualize for Public Cloud



Optimize Public Cloud Block Storage	Extend On Premises to Hybrid Cloud	Business Continuity on Public Cloud	Protection of Data in Public Cloud
<ul style="list-style-type: none"> Lower Cost, Improve Performance of native Public Cloud IaaS Thin-Provisioned Volumes, Space Efficient Snapshots, AI based Auto Tiering Increase Scalability of Public Cloud Storage for Enterprise Apps 	<ul style="list-style-type: none"> Add cloud capabilities to existing Storage on Prem Temporary or permanent data migration to/from Public Clouds, and between Public Cloud providers. Move data to cloud resources, such as containers, VMs. Consistent Management 	<ul style="list-style-type: none"> Create a DR site in the public cloud Synchronize local storage data with sync or async storage replication Protect on prem data for virtualized, containerized, or bare metal applications Integrate an 'air gap' solution to protect against cyber threats 	<ul style="list-style-type: none"> For workloads moved to cloud Use Sync or Async Mirror to protect cloud data center deployments Supported within and between disparate Cloud Provider data centers

Let's drill down a little deeper and examine some specific opportunities and benefits that help clients with their move to Hybrid Multicloud.

<CLICK>

Optimize Public Cloud Block Storage. This is where Storage Virtualize for Public (SV4PC) Cloud shines. It will help clients lower their costs while simultaneously improving the performance of native Public Cloud Infrastructure as a Service (IaaS). SV4PC provides them with Thin Provisioned volumes, space efficient snapshots, and AI-based auto tiering. Additionally, the clients obtain an increased scalability of public Cloud storage for enterprise applications.

<CLICK>

Extend On Premises to Hybrid Multicloud. Storage Virtualize makes it easy to add cloud capabilities to existing storage on-prem, while SV4PC enables temporary or permanent data migration to/from Public Clouds, as well as between Public Cloud providers. IBM's powerful software allows clients to move data to cloud resources, such as containers, and VMs. Storage Virtualize and Storage Virtualize for Public Cloud also deliver consistent management which can help reduce management costs.

<CLICK>

Business Continuity on Public Cloud. The combination of Storage Virtualize and SV4PC enable a client to easily create a disaster recovery (DR) site in the public cloud. The combination also allows a client to synchronize local storage data with synchronous or asynchronous storage replication. Storage Virtualize helps protect on-prem data for virtualized, containerized, or bare metal applications. Using SV4PC, clients can integrate an 'air gap' solution to protect against cyber threats.

<CLICK>

Protection of Data in Public Cloud. Clients want to know that as they move workloads to cloud that those workloads will be safe and protected. The combination of Storage Virtualize and SV4PC enable a client to use synchronous or asynchronous Mirror to protect cloud data center deployments. The real benefit to all this is that this is supported within, and between, disparate Cloud Provider data centers.

FlashSystem models supporting replication

	FlashSystem 5015	FlashSystem 5045	FlashSystem 5200	FlashSystem 7300	FlashSystem 9500	FlashSystem 9500R
Synchronous Mirroring	Yes	Yes	Yes	Yes	Yes	Yes
Asynchronous Mirroring	Yes	Yes	Yes	Yes	Yes	Yes
Asynchronous With Change Volumes	Yes	Yes	Yes	Yes	Yes	Yes
3-Site Replication	Yes	Yes	Yes	Yes	Yes	Yes
HyperSwap	No	Yes	Yes	Yes	Yes	Yes

This table is designed to provide you with a single slide addressing which FlashSystem models support which replication modes. This table helps illustrate the uniformity of abilities across the portfolio.

FlashSystem 5015 is the only model that does not possess the ability to cluster and therefore it is the only model which does not support HyperSwap.

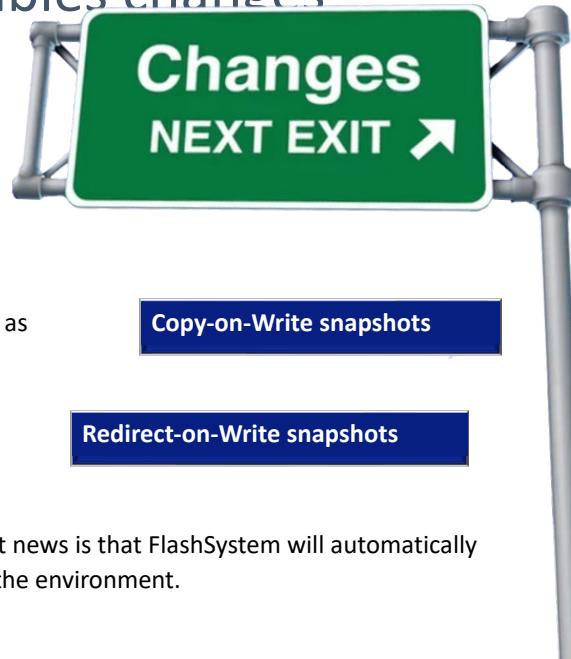
Redirect-on-Write FlashCopy

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Last Updated: July 19, 2023

Welcome to this Module where we will examine the differences between Copy-on-Write and Redirect-on-Write snapshots.

Software-Defined Storage enables changes



Storage Virtualize solutions have historically implemented FlashCopy as

Copy-on-Write snapshots

Storage Virtualize v8.4.x provides the ability to do FlashCopy with

Redirect-on-Write snapshots

Both types of FlashCopy are now part of Storage Virtualize. The great news is that FlashSystem will automatically choose the most appropriate snapshot technology depending upon the environment.

IBM refers to a point-in-time snapshot as a FlashCopy. A point-in-time FlashCopy is a copy of a storage volume, file or database as they appeared at a given point in time and are used as method of data protection. In the event of a failure, users can restore their data from the most recent FlashCopy before the failure.

<CLICK>

Historically, solutions based on IBM Storage Virtualize have implemented FlashCopy with a process known as Copy-on-Write (CoW). This approach has been used by a large percentage of IBM's storage competitors. We will learn more about CoW on the next slide.

<CLICK>

Thanks to the flexibility of Software-Defined Storage (SDS), beginning with Storage Virtualize version 8.4.x, IBM has brought a more efficient process known as Redirect-on-Write (RoW) to FlashCopy. We will see how this process works and its business benefits in a couple of slides.

A visual example of how Copy-on-Write snapshots work

Copy-on-Write



Step 1

Copy-on-Write (CoW) involves **two to three I/Os per write**

This is a visual example to help you quickly grasp the way Copy-on-Write snapshots work. Here we see some storage in a FlashSystem array. In that storage there are several pieces of data. In particular, we will focus on the data that is labeled “A”.

<CLICK>

Let's use the example of new data which we will call A-prime (A'). The A' data is about to be written on top of the existing (original) “A” data. When CoW snapshots are being employed it is a multi-step process. The first step is that the new data (in this example it is A') is sent to the storage system where it will be written. As the data arrives at the array it is effectively told to STOP and momentarily wait.

<CLICK>

The second step is that while the storage system is holding off the new data, it must take the existing data that would be overwritten, which in this case is the “A” data and move it to another location within the storage system.

<CLICK>

The third step takes place as soon as the original “A” data has been written elsewhere. At that point the new A-prime (A') data is allowed to overwrite the

original location of the "A" data. The FlashCopy (snapshot) is complete.

A visual example of how Redirect-on-Write snapshots work

Redirect-on-Write



Redirect-on-Write (RoW) involves **one I/O per write**



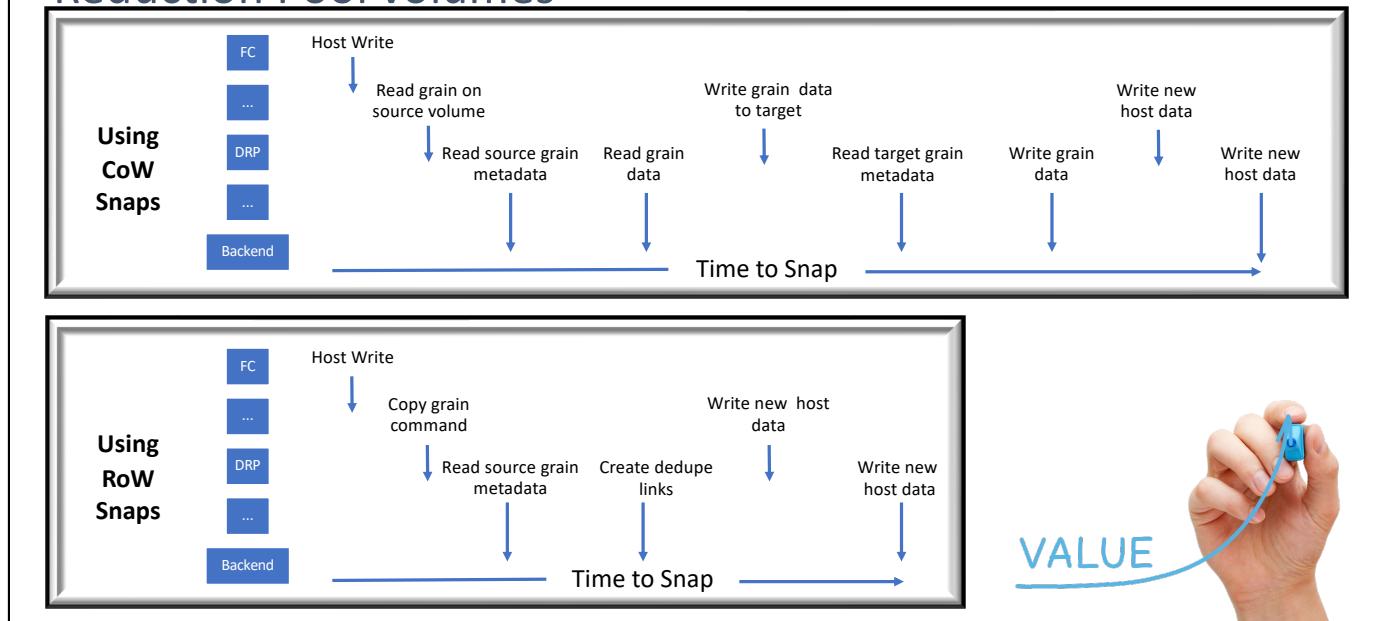
Starting with Storage Virtualize v8.4.x, the FlashCopy procedure changes. Let's use the exact same example that we saw on the previous slide.

<CLICK>

In step 1, which is the only step, the new A-prime (A') data is sent to the storage system where it is simply written to a different location from the original "A" data. That is it. The process is complete. This is the same highly-efficient approach that Storage Accelerate solutions such as XIV, FlashSystem A9000 and A9000R employed. In snapshot-heavy environments it can be noticeably quicker.

We need to be clear that this approach is used when Data Reduction Pools are enabled, and Deduplication is turned on.

Redirect-on-Write enhances Data Reduction Pool volumes



We are going to briefly examine something that is rather technical. Rather than get bogged down in the architecture behind it, let's make focus on the bottom line, which is that IBM's Redirect-on-Write technology helps reduce the time it takes to perform snapshots when using Data Reduction Pools with deduplication.

Technical explanation of CoW process

- Host write to a source vdisk for an unsplit grain for a simple fc map relation between two dedupe supported vdisks
- We need to first read the full grain from the source in FC
 - That involves a metadata read in DRP for the given grain in order to understand the mapping of the virtual space to physical space
 - Data read in DRP for the corresponding chunks of data
- Then FC issues a full write of the read data to the target
 - That involves reading the target vdisk metadata for the given grain in DRP
 - Then drp attempts to deduplicate and match with well known patterns the grain's chunks it can follow by a data write for those it can't. In case the vdisk is compressed we first compress the data in addition to hash calculation.
- FC propagates the host write to DRP for the source.

Technical explanation of RoW process

- We still need to read metadata for the source and target
- However, we can reference the source grain's chunks in DRP instead of writing the data anew. This leads to less IOPs to the backend and better data reduction ratio.
- Read-write flow (COW above) also leads to deduplication savings but since the dedup db lookup is not ideal we are not guaranteed to always find an owner for referencing, for FOS we essentially have an ideal zero cost db lookup as this information is provided from above by FC layer.
- Then we can propagate the write to the source as above.

So we always first need to split the grain pre-write propagation, but while in COW we are essentially creating a new copy of existing data, for ROW we are pointing the target to the existing data and writing the newly written data elsewhere.

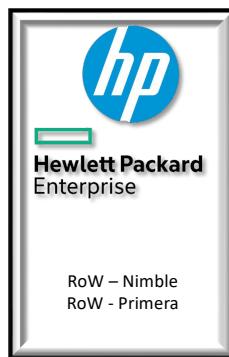
What competitors are using for snapshot technology



RoW - FAS and AFF
CoW - E and EF



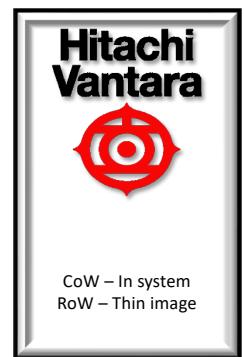
RoW – PowerStore
Both – Unity XT
CoW – SC Series



RoW – Nimble
RoW - Primera



RoW – //X Series
RoW - //C Series



CoW – In system
RoW – Thin image

It is a good idea to understand how your competitors handle their snapshots. That enables you to know whether you have a competitive deficit or advantage. You may discover you both use a similar approach.

<CLICK>

When it comes to NetApp, the choice of snapshot will depend upon which system you are competing against. FAS systems employ RoW while E and EF systems use CoW.

<CLICK>

Dell has numerous systems. Their newest PowerStore systems use RoW snapshots. Dell's Unity XT supports both RoW and CoW snapshots. And Dell's SC Series use CoW snapshots.

<CLICK>

HPE Nimble and Primera both use RoW snapshots.

<CLICK>

Pure Storage //X and //C series both employ RoW snapshots.

<CLICK>

HDS Vantara systems use CoW when performing internal snapshots. If they are snapping to alternate locations they can employ a RoW snapshot.

Virtual Machines vs Containers

roger.kasten@us.ibm.com

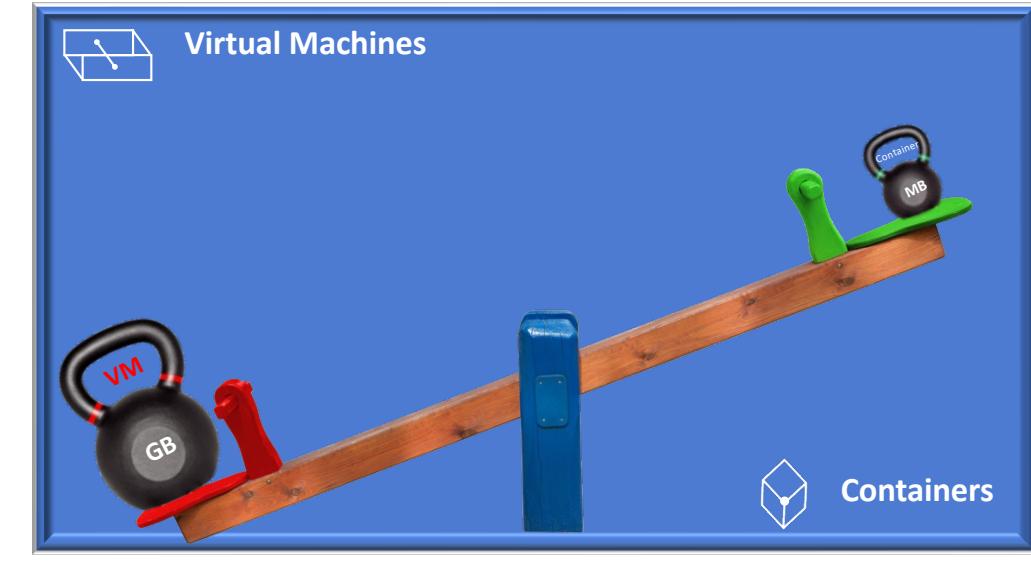
Last Updated: July 19, 2023

This module covers the differences between Virtual Machines and Containers. Many thanks to Nigel Brown who created most of this content which he used for an excellent glass-board presentation.

Link to glass-board presentation: <https://www.youtube.com/watch?v=cjXI-yxqGTI>

Virtual Machines versus Containers

Let's be clear, they both have their place

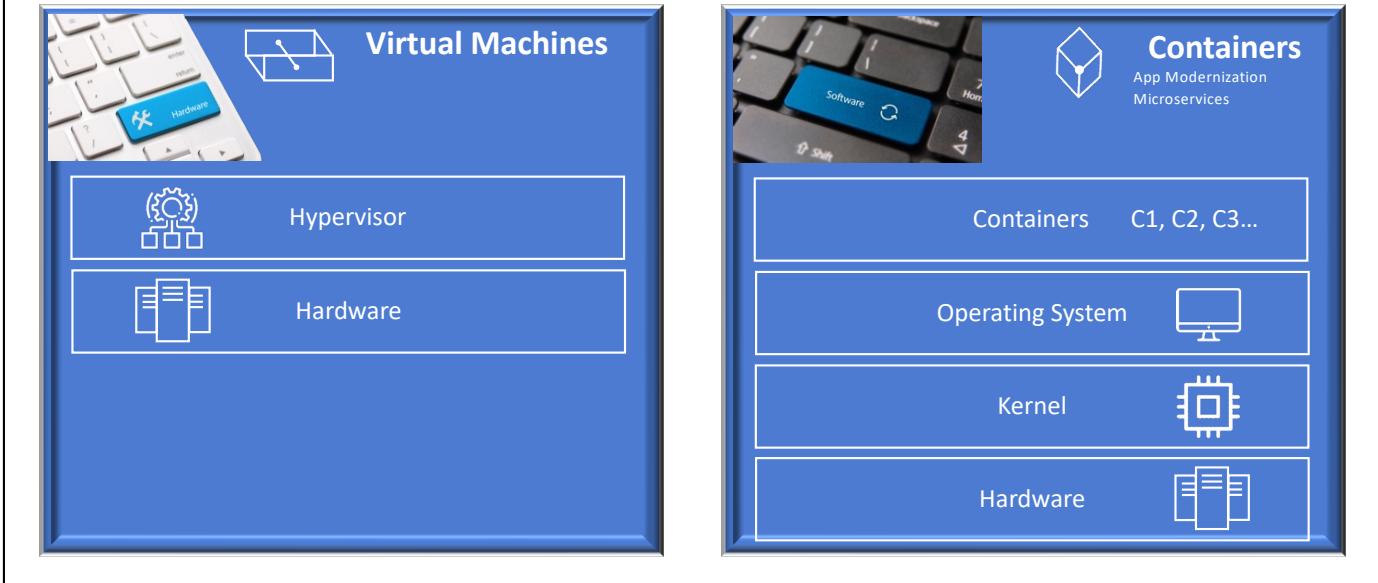


It is not a question of 1 or the other

There is a need for **Both!**

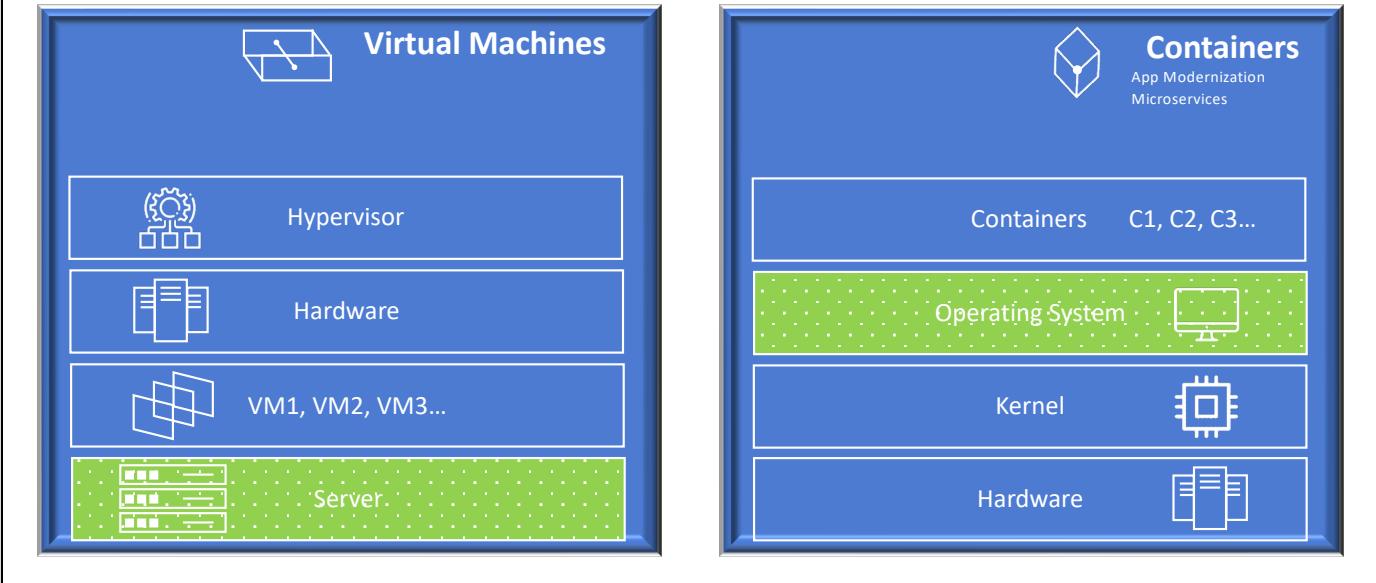
Virtual Machines versus Containers

Step 1: Understanding the differences



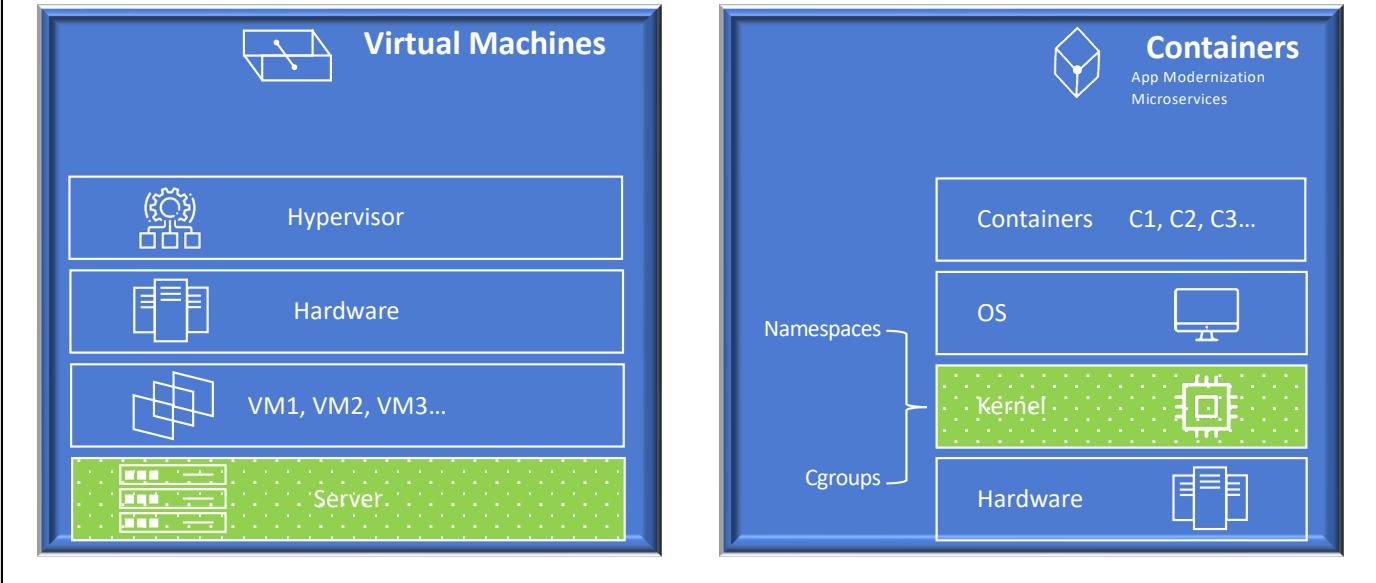
Virtual Machines versus Containers

Step 2: Understanding isolation



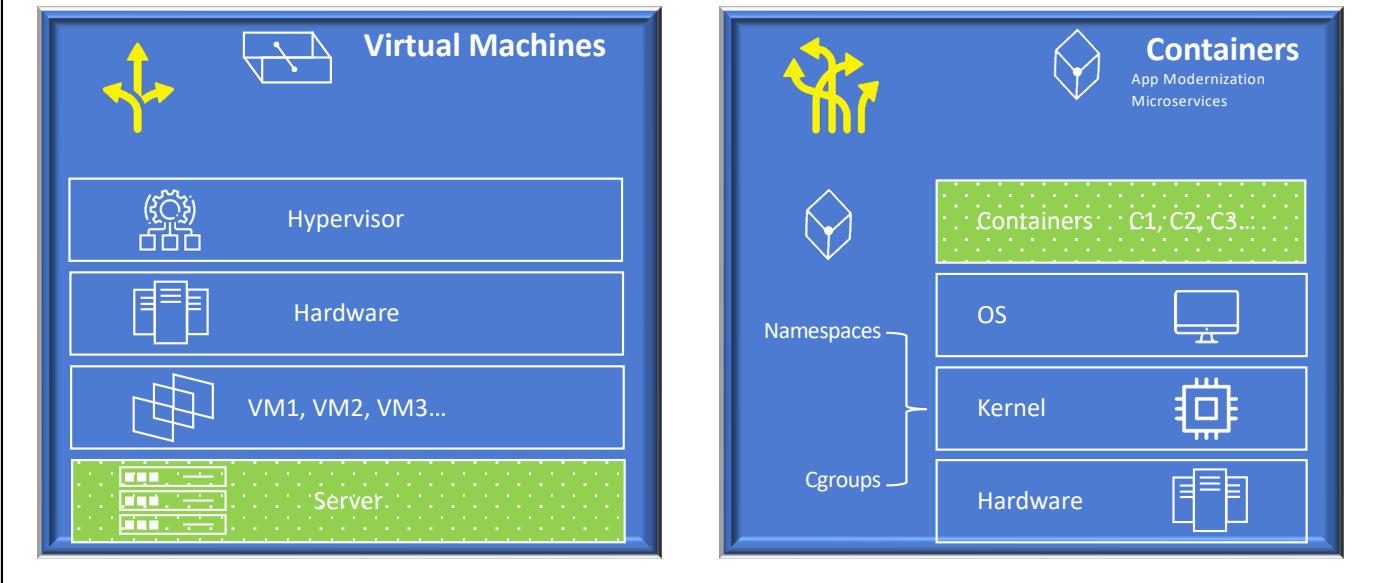
Virtual Machines versus Containers

Step 3: Resources



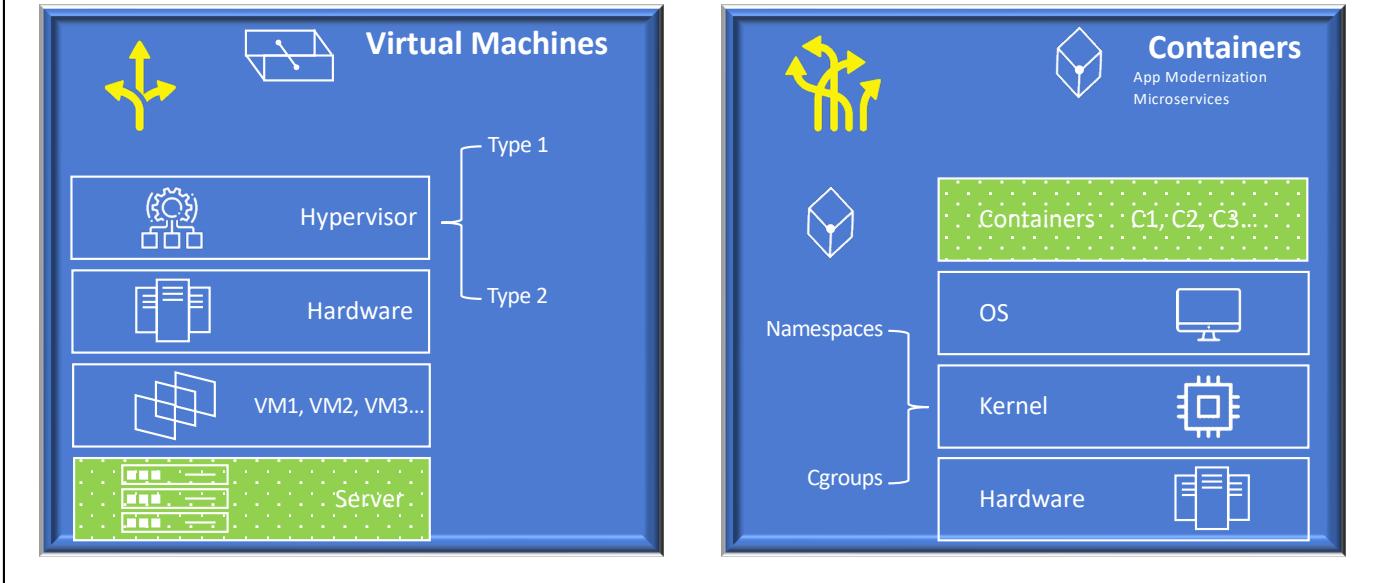
Virtual Machines versus Containers

Step 4: Portability flexibility



Virtual Machines versus Containers

A changing world



The differences between VMs and Containers

Containers are lighter weight and deliver enhanced business benefits:

- Reduced overhead
- Rapid spin up
- Container Isolation and Security
- Portability
- Cost

There are great advantages to use containers in DevOps, Batch computing, Lightweight PaaS and Microservices



Virtual Machines
For data portability



Containers
For data portability

We mentioned on the previous slide that things are changing to VMs and Containers. However, with that said, there are some real differences to remember about the two different technologies. When it comes to portability, containers are lighter weight and provide enhanced business benefits in numerous areas.



<CLICK>

Containers have greatly reduced overhead compared to virtual machines.

Containers can be spun up much more quickly than virtual machines.

Containers can deliver enhanced isolations and security compared to virtual machines.

Containers deliver greater, easier, data portability than virtual machines

Containers are less costly in numerous areas than virtual machines.

<CLICK>

Many businesses are finding containers to provide great advantages in DevOps, Batch computing, lightweight Platform as a Service and Microservices

<CLICK>

When it comes to data portability, VMs are somewhat inefficient, whereas Containers are highly efficient. VMware has been optimized for Servers while Containers are optimized for Storage.

IBM FlashWatch Program

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Last Updated: July 19, 2023

Welcome to this Module where we will examine the value behind IBM's FlashWatch Program and the benefits it provides to clients.

What is IBM FlashWatch?

A comprehensive suite of flash storage guarantee programs that gives you the confidence to purchase, own, and upgrade your IBM Storage

It's the confidence to purchase, own and upgrade your IBM Storage

Acquisition

High Availability Guarantee

Proven 99.9999% availability
Optional 100% commitment when using HyperSwap

Data Reduction Guarantee *

3:1 self-certified
Up to 5:1 with workload profiling

All-inclusive Licensing

All storage function included in licensing cost for internal storage

Operation

IBM Storage Expert Care

Choose the duration and level of support needed, independently of the FlashSystem product purchased

Cloud Analytics

Storage Insights to proactively manage your environment

Flash Endurance Guarantee

Flash media is covered for all workloads whilst under warranty or maintenance

Migration

IBM Flash Momentum

Storage Upgrade Program
Replace your controller and storage every 3 years with full flexibility

Cloud-like Pricing

Optionally available consumption pricing models:
IBM Storage as a Service (StaaS) or Storage Utility Offering (SUO)

No Cost Migration

90 days no-cost data migration from over 500 storage controllers, IBM and non-IBM

Replaces all previous "Controller Upgrade", "Peace of Mind" and "FlashWatch" Programs commencing with purchases made after February 11th 2020
Program applicability varies by product. Check "FlashWatch Product Matrix". * Requires signed contract.

IBM FlashWatch is a series of programs designed to ensure a good customer experience across the ownership cycle of IBM FlashSystem storage.

<CLICK>

Acquisition contains 3 programs that give confidence that the storage being proposed is the right fit for your business.

<CLICK>

Operation contains 3 programs that will assist you in your management of the storage.

<CLICK>

And finally Migration contains 3 programs to help move you to your next IBM FlashSystem storage purchase

<CLICK>

FlashWatch provides the confidence to purchase, own and upgrade your IBM storage. With that said, let's look at each of these programs individually

Acquisition | High availability guarantee

What?

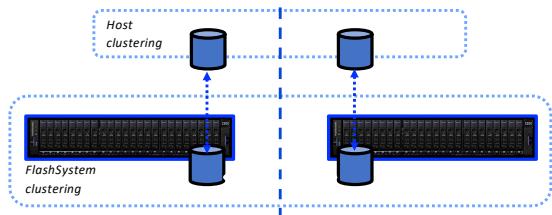
The reassurance that you'll be able to access your data, when you need to

Robust Storage Virtualize software has a measured availability of **99.9999%**. This represents an average of just **30 seconds** per system, per year down time

With the use of a high availability IBM HyperSwap configuration, IBM will commit to **100%** availability to your data - **that's zero interruption to your data access** - for a 3 year period!

IBM Storage/ 17030517USEN / July 20, 2021 / © 2021 IBM Corporation

How?



Using two FlashSystem controllers, HyperSwap presents a synchronised view across two sites

Complimenting host clustering, loss of access to one site no longer means loss of access to your data

The guarantee is underwritten by IBM Lab Services who will set up the environment to adhere to all best practices. If remediation is required at any point in the future, IBM Lab Services will perform the work at no additional cost.

The robust Storage Virtualize software running across IBM FlashSystem and SAN Volume Controller devices was first introduced to the market in 2003. A focus on quality and many years of field hardening has allowed IBM to achieve a measured 6 9s availability.

<CLICK>

If you need even more availability then IBM will guarantee 100% access to your data using Storage Virtualize HyperSwap functionality. IBM Lab Services will set up a pair of FlashSystem controllers in a highly available HyperSwap configuration where data is mirrored across two sites. If access is lost to one site, for whatever reason, hosts can continue to access data on the other site. When access is restored to the lost site, data will be automatically resynchronised, returning the system to run in a highly available manner.

Acquisition |

Data reduction guarantee

What?

You need your storage to deliver the level of data reduction that you expected when you purchased the product

New with the latest generation of FlashCore Modules IBM now offers a **3:1 self-certified** data reduction guarantee to demonstrate the data reduction technology you're relying on is working in your environment

If you want further peace of mind then IBM will work with you to analyse your workloads and will offer a guarantee of up to **5:1**

How?

For the 3:1 data reduction contract the customer will need to self-certify that the data they're writing is able to be reduced (e.g. not encrypted, not already compressed)

IBM also offers a 5:1 data reduction contract where the customer must run Comprestimator and/or DRET tools. IBM will analyze the tooling output and will commit to a data reduction ratio of up to 5:1

In both cases, a signed contract is required prior to the sale (*linked from the FAQ slide*). The remedy is that IBM will provide additional physical capacity up to a committed level. Review the contract for more information.

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Using Data Reduction technology can save money and space by storing more on less physical storage.

IBM thinks you should be able to rely its data reduction technology and will offer a 2:1 data reduction guarantee that doesn't need any up front validation. This reduces the risk of appropriately sizing the storage capacity before purchase. Providing the data you are storing can be compressed – ie data that's not encrypted and not already compressed, then IBM will make up any shortfall by providing additional physical capacity.

<CLICK>

Alternatively, if you're confident that the data you have can be compressed beyond the 2:1 self certified data reduction ratio, then with some up front validation of that data, IBM will guarantee a higher data reduction ratio to suit your environment, with the same remedy of additional physical storage if we don't meet that ratio.

<CLICK>

In both cases, a signed contract is required prior to the sale. The remedy is that IBM

will provide additional physical capacity up to a committed level.

Acquisition | All-inclusive licensing

What?

Spend your storage admin resource on managing your data, not managing your license entitlement

Current FlashSystem products include all-inclusive software feature licensing. This allows you to use all of the richness of Storage Virtualize with all of the capacity purchased with your product

If you want to extend the Storage Virtualize value to externally virtualized storage, then this can be done on a capacity basis

How?

If you're not using external virtualization or encryption, there's nothing more you need to do!

The all-inclusive software feature licenses are included with the purchase of the product.

Encryption is excluded from the all-inclusive license because it's not available worldwide and is a separate orderable feature, limited by geo.

If you're using external virtualization, review the product sales manual for which license to purchase

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IBM want you to use as much of the functionality of the Storage Virtualize product as you need to. To that end we've moved away from individual function licensing for the higher end boxes.

FlashSystem 5015, 5045, 7300 and 9500 come with all-inclusive licensing, meaning you no longer have the headache of ensuring that you've the right licenses for the right functions. Each FlashSystem enclosure comes with a single all-inclusive license charge, allowing you to use any Storage Virtualize function with the storage you're bought.

<CLICK>

There are two exceptions – the first is encryption which is a separately ordered feature code which is limited by geography to ensure compliance with local laws.

<CLICK>

The second is external virtualization which extends all of the goodness of Storage Virtualize to other storage controllers that have been purchased separately.

Operation |

IBM Storage Expert Care FAQ

What's different about Expert Care from other IBM Storage service offerings?

It allows you to independently choose your product, support level and duration to align with your business needs.

What products is IBM Storage Expert Care available with?

FlashSystem 5200 (MT 4662), 7300 (MT 4657), 9500 (MT 4666)

Do I have to purchase Expert Care?

No, but base warranty is limited to just one year. By separating out Expert Care from the base warranty we're allowing you to define the level of support you'll receive as a fixed percentage of the hardware price for the duration you choose.

Are there alternative warranty upgrades or maintenance services?

The only way to extend and improve your warranty is through an Expert Care offering.

Are other service upgrades available with Expert Care?

Yes, complementary services to the Expert Care offerings such as media retention, machine setup support (IBM Installation) and others are available separately.

Can I renew Expert Care at the end of the initial duration?

Yes, you can renew your existing coverage at the end of the contract or choose to renew or upgrade to a higher offering at any point.

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	Warranty	Basic 5015, 5045, 5200, 7300	Advanced 5015, 5045, 5200,7300,9500	Premium 7300, 9500
IBM Storage Virtualize fixes, updates and new releases	1 year	Yes	Yes	Yes
Guidance on installation, usage and configuration		Yes	Yes	Yes
Automated ticket management and alerting		Yes	Yes	Yes
Use of Storage Insights for collaborative problem resolution		Yes	Yes	Yes
Predictive issue alerting			Yes	Yes
Storage Insights Pro entitlement	Standard with 9500	Additional paid service	Additional paid service	Additional paid service for 7300
IBM Installation				Yes
Remote code upgrades (2x year) ***				Yes
Dedicated Technical Account Manager (TAM)				Yes
30 minutes Severity 1/2 response				Yes
Hardware service / parts replacement	9x5 NBD* or 24x7 Same day**	9x5 NBD, IBM on-site	24x7 Same day, IBM on-site	24x7 Same day, IBM on-site

Introduced with the FlashSystem 5200 back in Feb '21, Expert Care became the new way of buying support from IBM.

It allows clients to easily buy the level and duration of support they need at the same time as they purchase their hardware.

Basic level offers support and upgrades, with Storage Insights available to manage your environment and enhance your support experience.

Advanced level adds predictive issue alerting, where IBM support experts with deep technical knowledge analyze your Storage Insights telemetry and proactively bring advice and warnings to your team to help ensure smooth operations every day.

Premium is more inline with the “Enterprise Class Support” you may have been familiar with on the 3-year warranty FlashSystem 9200 and SVC. It adds Storage Insights Pro, remote code loads with an option to upgrade to onsite, a dedicated Technical Account Manager and improved response times.

Operation | Cloud analytics

What?

Let IBM help you monitor your environment and warn you when something needs attention

Storage Insights (SI) provides a single pane of glass for you to monitor your storage estate

IBM Support

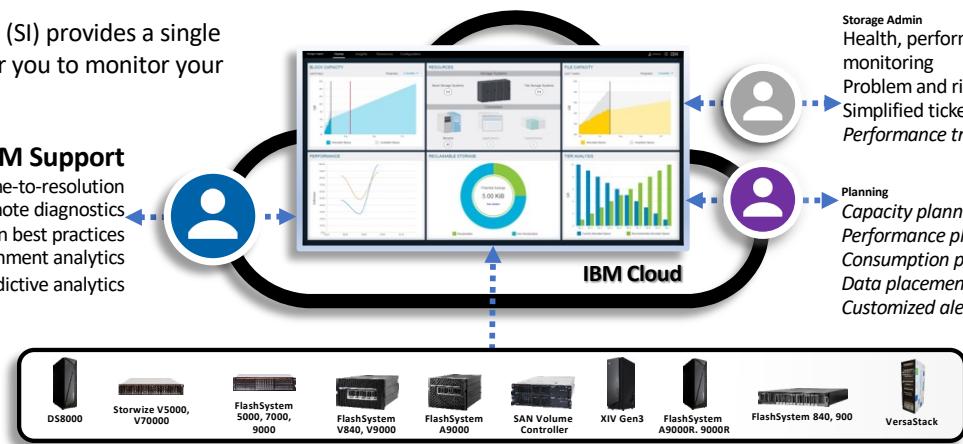
Faster time-to-resolution
Remote diagnostics
Configuration best practices
Environment analytics
Predictive analytics

How?

Sign up for SI! It's available for all Storage Virtualize products with a valid support contract

Storage Admin
Health, performance & capacity monitoring
Problem and risk notification
Simplified ticketing
Performance troubleshooting

Planning
Capacity planning
Performance planning
Consumption planning
Data placement optimization
Customized alerting



Storage Insights Pro features shown in italics. Included with Storage Control license & Expert Care Premium

Storage Insights is available with all IBM FlashSystem and SAN Volume Controller products for no additional charge.

<CLICK>

It provides you with a dashboard to monitor the health of all of your IBM storage, and improves your interaction with IBM support. The dashboard is an amazingly powerful tool for Storage Administrators and enables clients to facilitate a lot of their planning.

<CLICK>

Should you experience any issues, IBM Support, with your permission of course, will be able to see exactly the same data that you can see, and gather logs if needed. All of this leads to a faster time-to-resolution.

Additionally, configuration data sent back to IBM will be proactively analysed against configuration best practises and known issues, helping you avoid issues before they become a problem.

Operation |

Flash endurance guarantee

What?

Remove the worry of wearing out your Flash media

Flash media has a finite lifetime, a finite number of times that you can write to it. Once a Flash module has worn out, it needs replacing

IBM FlashCore Modules use some clever algorithms to prolong Flash memory, along with some fine grain isolation around worn or failed memory. This maximises time-to-failure for each module and reduces likelihood of a RAID rebuild

Regardless, ALL failing Flash media will be replaced while a client is under warranty or HWMA

How?

The FlashSystem 5200, 7300 and 9500 all come with 1 year hardware warranty.

You're also covered with a current Expert Care contract, which includes HWMA.

No doubt as an industry we're getting better with managing the finite lifecycle of Flash storage media.

IBM has invested in its own Flash storage media, the IBM FlashCore modules, which offer hardware inline data compression with no performance penalty, but also do a lot of clever things to extend the life of the Flash memory and isolate around worn or failed memory. All of these things combine to allow IBM to be confident enough to offer a Flash Endurance Guarantee that takes the risk and cost away from wearing out your media.

While we really want you to get the benefit of FlashCore modules, regardless of the Flash media you choose to go with your FlashSystem product, IBM will replace all failing Flash media whilst you're under warranty or hardware maintenance, no questions asked.

Migration | IBM Flash Momentum

Storage Upgrade Program

What?

Maintain control over your environment with a fully flexible offering that refreshes your storage and controller with no lock in

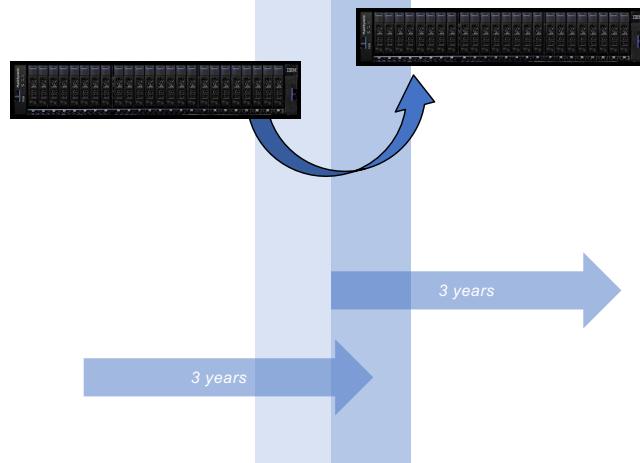
Finance a FlashSystem over a 3-year term

Just before 3 years, you decide whether to **keep** your FlashSystem, **refresh** or simply **walk away**

Refresh your FlashSystem for the **same monthly price or less**, or up/down size your system to meet your needs

3-month period of transition with no dual billing

Also available with cloud-like pricing



IBM understands the pressures on IT budgets and the need to have predictable costs. But IBM also understands the benefits that new refreshed technology brings to your business.

IBM Flash Momentum allows you to use a FlashSystem product over a three year period, and at the end of that period, upgrade to the latest generation controller AND storage for the same monthly price or less. So you continue to pay the same cost for a newer storage, you no longer have to use aging hardware and you don't have to deal with extending service contracts.

There is no lock in or expensive subscription required. And at any time you can upgrade the FlashSystem product you're using by adding extra storage or hardware (for additional cost). If at the end of a term you decide that you need a bigger (or smaller) controller, then we'll give you a new monthly price and promise it across two terms.

IBM will also provide new storage 3 months early so that you have time to migrate the data. This won't change the monthly cost, and you will not incur dual billing during that period.

Migration | IBM Flash Momentum

Storage Upgrade Program

How?

Configure your product and contact IBM Financing to arrange financing and start the first 3-year term

At around 2.5 years, decide if you want to keep the product, replace the controller *and* storage, or simply return the product and walk away

If you replace the product, IBM will provide an 'equivalent' system for which you'll pay the same monthly price or less

- '*Equivalent*' system means a current or next-gen model with CPU, memory, IO cards, storage capacity and expansion enclosures that are either identical or comparable to your current product
- *Subject to a fair market lease from IBM Financing, product availability, client credit approval, changes in any of the following: interest rates, currency, tax rates, market conditions, legislation and IBM policy*
- *This price promise only covers products (MTMs along with any licensed software required for those MTMs) listed in the "FlashWatch Product Matrix". It does not include external virtualization licensing, or other hardware or software products that may have been included in the lease*

If you want a different product or configuration - either bigger or smaller - you'll still get a 3-month migration period, and you can lock in a new monthly price based on the new product across 2 terms

No problems upgrading your storage during a 3-year term (extra storage, cache, etc) – the monthly price just increases for remainder of term. At the end of the term, you can choose a new product and lock in a new monthly price across 2 terms.

The Flash Momentum program is only available through IBM Global Finance.

IBM cannot predict what will happen in the future, but our goal is to offer you an equivalent or like-for-like system for the second term. Any new system will be comparable to your current product.

As mentioned previously, there's up front payment or subscription required, and no lock in. You're free to walk away after the first term, or similarly upgrade or downgrade your storage to suit your business needs.

Migration |

Cloud-like pricing - IBM Storage as a Service

What?

Preserve your cash flow with OPEX billing* and only pay for what you use

Get the confidence and control of on-prem deployment with comprehensive life-cycle management services

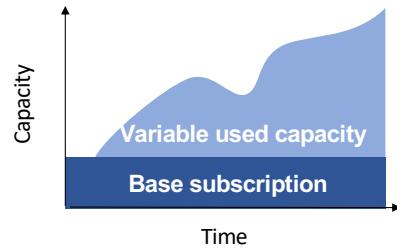
Powered by superior IBM FlashSystem technology

How?

Services contract, order as 9601 (base subscription) and 9602 (variable capacity) and select the model based on your performance and term needs..

Payment consists of base capacity which is billed annually, and flexible option, billed quarterly.

Get the benefit of data reduction technologies



Read the text on this slide to deliver the story

Migration |

Cloud-like pricing – IBM Storage Utility

What?

Don't pay for capacity up front, pay for capacity when you use it.

Entire capacity is installed on day 1, but you're billed based on just what you use monthly.

No disruption when you need to grow, and no overspend on storage you're not using.

How?

Order in econfig as the 4666-UH8, 4657-U7D and 4662-UH6 Storage Utility models.

Payment consists of **fixed costs** (usually 30-40%), and **flexible** portion, billed quarterly.

Use Storage Insights used to monitor environment and measure monthly capacity usage.



For those customers more interested in a pay-as-you-use model, IBM offers “Storage Utility” models.

You agree with IBM on a level of capacity, and pay a fixed cost based on that capacity. A further flexible cost will then be charged based on your monthly usage.

<CLICK>

This has the advantage that you're paying a low price to get access to all of the hardware and all of the performance that comes along with it. There's no disruption if you want to grow the amount of storage available to you, and no overspend on storage if you don't use it. Only as you fill up your storage controller will you start to pay for it.

IBM Storage Insights is further used in this scenario to measure capacity on a monthly basis to determine usage.

Migration |

No cost migration

What?

It shouldn't cost you extra money to migrate your data onto your new storage controller

For a **90** day period, from the date of installation, you can migrate data to your FlashSystem product using an approach of your choice, without having to pay any additional external licensing

- ✓ Migration through **Virtualization** with the virtualization of over 500 different storage controllers from multiple vendors
- ✓ Migration through **Copy Services** or **Volume Mirroring** with another Storage Virtualize product
- ✓ **Host based** migration

How?

Just do it! There's no need to let IBM know

TEMPORARILY uplift the licensing within the GUI to the required amount to allow you to migrate

If you need help with the migration, you can pay IBM Lab Services or a Business Partner to do this

When you've finished, return the licensing to the licensed level

If you're audited during the migration period, quote the FlashWatch No Cost Migration program

To allow you to move to your data to your new IBM FlashSystem storage controller, IBM will allow you to use external virtualization, or indeed any other Storage Virtualize function, for no extra cost. You'll have 90 days to perform the migration, after which you can decommission the old storage.

If you need assistance with the migration, then paid-for services are available from IBM Lab Services or a Business Partner.

IBM FlashWatch Product Matrix						
	SVC	FlashSystem 5000	FlashSystem 5200	FlashSystem 7300	FlashSystem 9500	FlashSystem 9500R
HA Guarantee using HyperSwap	Yes	5035 Only	Yes	Yes	Yes	Yes
Data Reduction Guarantee		Yes	Yes	Yes	Yes	Yes
All-inclusive Licensing (Exc. external virtualisation, encryption)		Yes	Yes	Yes	Yes	Yes
Expert Care	ECS included with 2147-SA2, SV1, SV2; 9x5 NBD warranty	Alternative optional services available; 9x5 NBD warranty	Yes (4662-6H2, UH6, 12G, 24G, 92G)	Yes (4657-924, U7D, 12G, 24G, 92G)	Yes (4666-AH8, UH8, AFF, A9F)	Yes (4666-AH8)
Cloud Analytics with Storage Insights	Yes	Yes, with IBM Storage Expert Care	Yes, with IBM Storage Expert Care	Yes, with IBM Storage Expert Care	Yes, with IBM Storage Expert Care	Yes, with IBM Storage Expert Care
Flash Endurance Guarantee		Yes	Yes	Yes	Yes	Yes
IBM Flash Momentum Storage Upgrade Program	Yes (2072-2N2, 2N4, 3N2, 3N4, 12G, 24G, 92G)	Yes (4662-6H2, UH6, 12G, 24G, 92G)	Yes (4664-924, U7D, 12G, 24G, 92G)	Yes (4666-AH8, UH8, AFF, A9F)	Yes (4666-AH8)	
Cloud-like pricing (Storage Utility)		Yes (4662-UH6)	Yes (4664, 2076-U7D)	Yes (4666, 9848-UH8)		
No Cost Migration	Yes	Yes	Yes	Yes	Yes	Yes

In this IBM FlashWatch FAQ document, this matrix clarifies which of the programs are available against which of the products.

IBM FlashWatch | Storage as a Service matrix

FlashWatch applies to Storage as a Service. This table shows which programs are applicable

- Why no data reduction guarantee?
A: STaaS provides “growth” capacity of ~50% over base needs day 1 with added capacity installed by IBM as the growth capacity is used up. In addition, unlike others who charge on effective (thus keeping the benefit of data reduction and also charging penalty if less than 2:1 data reduction), IBM STaaS charges on usable with no penalty rates.
- Expert Care Note:
STaaS includes all the expert care Premium capabilities as part of full life-cycle management that also included IBM adding capacity as needed and providing a technology refresh and proper recycling of old equipment.
- Technology Refresh Note:
IBM will refresh the technology at no additional cost to the customer. IBM will deploy the new technology with a 90 day overlap to permit customer to migrate their data.

	STaaS Tier 1, 2, 3
HA Guarantee using HyperSwap	Yes
Data Reduction Guarantee	
All-inclusive Licensing (Exc. external virtualisation)	Yes
Expert Care	Full Life-cycle management included
Cloud Analytics with Storage Insights	Storage Insights Pro
Flash Endurance Guarantee	Yes
IBM Flash Momentum Storage Upgrade Program	NA - IBM Refreshes the technology as needed
Cloud-like pricing	Yes
No Cost Migration	Yes

For this slide simply read the text on the screen.

IBM FlashWatch FAQ

Acquisition

How do I get the High Availability Guarantee?

Your IBM rep will need to use contract [Z126-7810 \(IBM only\)](#). They can obtain more information if needed from Jennifer Ho (jkho@us.ibm.com)

Can a customer or Business Partner perform the installation of the HyperSwap environment and still get the High Availability Guarantee?

No, IBM provides and validates the installation and if needed, provides the remedy.

Is there an HA Guarantee for Stretch Cluster?

No, the guarantee is only available for HyperSwap configs.

How do I get a Data Reduction Guarantee?

Your IBM rep will need to complete the 3:1 Self-Certified [Z126-8545 \(IBM only\)](#), or 5:1 Flexible [Z126-7957 \(IBM only\)](#) contract before installation.

Does the Data Reduction Guarantee apply to FlashCore Modules as well as Data Reduction Pools?

Yes, the Data Reduction Guarantee does not specify which data reduction technology you should use, just that the workload be capable of being reduced. It covers, compression with FCMs as well as compression and deduplication with DRP.

Do I have to run the tooling to guarantee more than 3:1 Data Reduction?

Yes, only the 3:1 guarantee is self-certified by the customer.

How long does the Data Reduction Guarantee last?

180 days from the start of the machine warranty

Operation

How do I order IBM Storage Expert Care?

For products with a machine type that has Expert Care enabled, you can order it in econfig at the same time as the FlashSystem product

Can I finance IBM Storage Expert Care

Yes, but it's billed separately to the hardware. The [IBM Storage Virtualize FAQ](#) has some more detail

Where can I find more information out about Storage Insights?

You can see much more information including how to register, what the security considerations are, and how to set up and use Storage Insights [here](#).

Are SAS SSD drives covered by Flash Endurance?

Sure, all drives are covered if you're under warranty or HWMA and will be replaced by IBM.

Migration

How can I use IBM Flash Momentum?

Contact your IBM Financing rep with your desired configuration. If your rep needs help, he can talk to Neil McGovern (neil_mcgovern@uk.ibm.com)

If I use the IBM Flash Momentum, what happens at the end of the second term?

You can get new storage, with a delayed start and take advantage of the program again.

Do I need to commit to the second term up front?

No, you've full flexibility to make that choice as you approach the end of the first term.

Do the IBM Flash Momentum terms and conditions apply to existing leases?

No. You can take advantage of the Momentum when you renew, also requesting a delayed start to avoid dual billing if necessary.

Is the previous Controller Upgrade program available still?

No, that program was only valid for purchases before February 11th 2020

How can I order a system with Cloud-like Pricing?

Purchase a Storage Utility model in econfig. You'll be contacted to agree your specific terms and conditions.

Where can I find out more about Cloud-like Pricing?

[Storage Utility](#)

The same IBM FlashWatch FAQ also contains some common questions and answers about the programs.

Other resources

[IBM FlashSystem & SAN Volume Controller FAQ](#)

Details on the IBM Storage Virtualize products, covering IBM FlashSystem family and SAN Volume Controller

[IBM FlashWatch FAQ](#)

Guidance on the IBM FlashWatch programs

[IBM Redbooks](#)

Detailed information on both IBM FlashSystem products and IBM Storage Virtualize function

[FlashSystem Product Tour](#)

Interactive product tour showing GUI usage and performance

Finally, here are some other resources that you may find useful.

Storage Insights and Storage Insights Pro

roger.kasten@us.ibm.com

Last Updated: Aug 04, 2023

Welcome to this Module where we will examine the value behind Storage Insights and Storage Insights Pro. There are numerous benefits associated with using SI and SI Pro.

Next-Gen Storage Insights and Storage Insights Pro

Numerous benefits for customers



Non-disruptive upgrades

Speed – even faster



SCALABILITY



Scalability – numeric

New generations of Storage Insights and Storage Insights Pro incorporate beneficial enhancements.

Fabric monitoring is part of Storage Insights and Storage Insights Pro



In mid-2021, IBM added Fabric monitoring to Storage Insights (SI) and Storage Insights Pro (SI Pro). We now provide customers the ability to easily monitor their Brocade and Cisco switches from within SI and SI Pro.

Fabric monitoring in Storage Insights and Storage Insights Pro



A screenshot of the IBM Storage Insights Pro web interface. At the top, there's a navigation bar with tabs for Dashboards, Insights, Resources (which is highlighted in yellow), Reports, Configuration, and a promotional message: "Unlock the full potential of IBM Storage Insights Pro". On the far right of the header are icons for notifications, calendar, user profile, and help. Below the header, there's a sidebar titled "Switches" with three status indicators: 0 Normal, 0 Warning, and 0 Error. The main content area shows a table with columns for Name, Condition, Fabric, Ports, Connected Ports, Links, Firmware, Location, and Data Collection. A search bar and a "Filter..." button are at the top of the table. A message at the bottom of the table says "No switches have been found.".

The great news is that customers have very little to learn in order to take advantage of the fabric monitoring. They simply go to the resources tab and select switches. The way we work with Brocade and Cisco switches is the same. What you do for one, you would do for the other. This helps carry forward the simplicity of the Storage Insights.

How fabric data benefits everyone



50%

Over 50% of problems reported as storage
are actually due to other factors



Quicker time to resolution when
troubleshooting storage issues



Provides more data to feed analytics

New Storage Insights Capabilities

Updates of IBM Storage Insights and IBM® Storage Insights Pro

New

[What's new in IBM Storage Insights - IBM Documentation](#)

What's New	IBM Storage Insights	IBM Storage Insights Pro
Support for monitoring VMware hosts and virtual machines added at the end of 2021	✓	✓
Support for monitoring Brocade and Cisco Switches added in mid-2021	✓	✓
Monitoring capacity that is protected by Safeguarded Copy	✓	✓
Monitoring enhancements for IBM Storage Virtualize		✓
More views of your capacity		✓
Inline Data Corruption Detection		✓
The upgrade process for data collectors just got smarter	✓	✓

At the end of 2021, IBM added support for monitoring VMware hosts and virtual machines. In mid-2021, IBM added support for monitoring Brocade and Cisco switches within Storage Insights.

- You can now use IBM Storage Insights to collect and view performance, capacity, configuration, and status metadata about the following VMware ESXi hosts and virtual machines in your environment:
 - ESXi 6.5 or later
 - Virtual machines(VMs) on ESXi hosts

With VMware hosts monitoring you can identify when, and understand why, hosts in your environment encounter problems such as a loss of storage access or high storage latency. It also enables you to more quickly determine if the issues are caused by the host, fabric, or the storage layer. Routing issues to the right people and getting them resolved more efficiently, is now possible with this new monitoring capability. Performance charts for hosts and virtual machines show metrics such as data rate, response time, and I/O rate. Capacity charts show metrics like SAN Capacity, used SAN Capacity, and available drive capacity. For even more details, drill down into the hosts and virtual machines to view the internal and related resources that they depend on, namely datastores, VMDKs, and drives. Other features such as reporting

and alerting are also supported.

If you use the free version of IBM Storage Insights, you'll now be able to do host-centric monitoring. With this new capability, you can connect and monitor your ESXi hosts directly. You can also monitor other hosts that consume your monitored storage but were not directly added to IBM Storage Insights.

- Check out these benefits: View the hosts that are consuming the most storage.
- If you're monitoring fabrics, identify which hosts are connected to multiple fabrics.
- Determine how many switches a host is connected to. For example, if your hosts are attached to two fabrics, and within each fabric they are connected to four servers, you'll be able to determine if each host is connected to four switches.
- Determine how many nodes a host is connected to.

Monitoring capacity that is protected by Safeguarded Copy

The Safeguarded Copy feature is a new type of FlashCopy relationship in IBM Storage Virtualize storage systems. It helps further improve cyber resiliency by frequently creating protected, point-in-time backups of critical data, with minimum impact and effective resource utilization.

- Use IBM Storage insights to monitor the Safeguarded Copy feature across all your monitored IBM Storage Virtualize storage systems. Check out what you can do: Understand how much of the capacity within your storage systems and pools is being consumed by Safeguarded copies.

• Verify that the correct volumes are being protected.

• Generate reports to see how much of your capacity is protected.

Monitoring enhancements for IBM Storage Virtualize

• Monitoring the IP workload of IBM Storage Virtualize Use new performance metrics to monitor and visualize the workload of IP ports at the node level. The types of metrics include transfer size, replication latency, replication data rate, and compressed data rate. You can use these metrics and related charts to complete the following tasks: Quick start your network planning by understanding how much total IP workload is being done between the storage systems in an IP replication relationship

• Troubleshoot IP replication by investigating latency and re-transmissions

• Compare the performance of nodes and quickly spot anomalies when they occur

• To view these metrics, double-click a storage system. On its details page, click IP Ports and go to the IQN (iSCSI qualified name) tasks: Quick the IP addresses of port son IBM Storage Virtualize storage systems, IP ports can be associated with VLANs.

With this enhancement, each node now supports: Up to 64 IP addresses per port

• A total of 256 IP addresses

In IBM Storage Insights, you can track the IP addresses of IP ports to get an overall view of a storage system's connectivity. To check the configured IP addresses, double-click a storage system to views its details. Then, click IP Ports, double-click the port you want to view, and go to the Connectivity supports: Up metrics Existing metrics for nodes and IP ports were reorganized so you can find them more quickly. Key metrics

and data rate metrics were moved from the IP Ports section to the Key Metrics and Data Rates sections under the Node category. The IP Ports section was renamed to IP Workload to contain the new workload metrics for IP ports. More views of your capacity

Tracking your capacity usage and growth just got easier. You can now view capacity charts for managed disks, drives, and RAID arrays on your block storage systems. Use the new charts to visualize usage trends and help enhance your monitoring and capacity planning. To view these charts, open the details page for a block storage system and click a resource, such as Managed Disks. Then, click the Capacity tab.

The upgrade process for data collectors just got smarter

- We always strive to make updates to IBM Storage Insights as smooth as possible, and that includes how your data collectors are upgraded. In this update, the intelligence behind the automatic upgrade process is improved: To help avoid gaps in metadata collection, data collectors are upgraded consecutively rather than all at one time. When one data collector is being upgraded, the other data collectors pick up the slack so you don't miss a beat.
- If the automatic upgrade of a data collector fails and it remains running at the previous level, the upgrade process continues to upgrade your other data collectors.

Helping simplify your operations

Innovation coupled with ease of use



Comes with all IBM FlashSystem solutions

INCLUDED

Optimize storage infrastructures using a cloud-based storage management and support platform that provides predictive analytics and proactive monitoring.

Provides an unparalleled level of visibility for storage environments and helps manage complex storage infrastructures and make cost-saving decisions. SI combines proven IBM data management leadership with proprietary analytics from IBM Research. And, it's **highly secure!**

- ✓ ISO/IEC 27001 ISM certified
- ✓ HIPAA / Blue Diamond compliant
- ✓ GDPR compliant
- ✓ Communication is one way, encrypted and compressed
- ✓ Data at rest is AES 256-bit encrypted
- ✓ Only metadata about your storage is collected

As a cloud-based service, it enables users to deploy quickly and save storage administration time while optimizing their storage. It also helps automate aspects of the support process and enables faster issue resolution. Updates are non-disruptive because they occur in the cloud.

<CLICK>

One of the best things about IBM Storage Insights (SI) is that it is included with every IBM Storage system. Clients do not need to purchase it separately because they are automatically entitled to it.

<CLICK>

The cloud-based SI and the more advanced Storage Insights Pro (SI Pro) simplify storage management and support by using predictive analytics and offers proactive monitoring.

<CLICK>

One of ways that SI and SI Pro simplify storage management is by showing all of a client's IBM Storage systems (and some competitor's systems) on a single pane of glass with an easy-to-use Dashboard which we will examine shortly. SI and SI Pro are highly secure and meet multiple compliance regulations, including the Health Insurance Portability and Accountability Act (HIPAA) and the General Data Protection Regulation (GDPR).

<CLICK>

Storage Insights User Stories that we deliver today

Storage Support Transformation Stories

1. Monitor system health from anywhere
2. Monitor capacity
3. Monitor performance KPIs
4. View open and closed ticket history
5. View call home event history
6. Create tickets that flow into proper support queues
7. Upload diagnostic log packages for support
8. Provide risk assessment and best practice violation analysis on Insights > Advisor panel



Storage Insights provides value around our unique ease-of-use functionality and advanced “AI” “cognitive” functionality.

Through IBM Storage Insights, clients are able to; easily obtain FlashSystem performance – analytics, easily observe resources in the Block Performance Tab, easily see Manual & “Automated” Case creation, easily observe any Cognitive - AI function (ie. Advisor, Capacity projection, Reclamation etc.), easily obtain best practices integration and planning, observe other non-IBM vendor storage, easily establish alerting creation, and easily handle reporting.

As amazing as all that is, the real benefits for clients is that they are able to monitor storage health and performance from anywhere. They receive easy support for their IBM storage. They can visualize storage relationships, which we see in a few moments. Clients are able to share information with the appropriate stakeholders along with metering storage consumption and reclaiming storage capacity. Storage Insights also enables clients to configure to best practices while also gaining access to advanced insights into their storage environment

SI takes the guesswork out of managing your storage

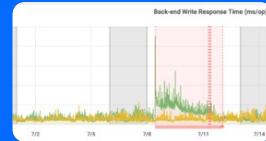


Anomaly detection

Best practices

Failure prediction

AI-based anomaly detection
~23 million telemetry data points collected daily from each system



Analytics offer insights into best practice configuration

Advisor

Keep your infrastructure healthy with these recommendations.

Unacknowledged Recommendations: 181 | 1 Warning | 180 Informational | 777 Acknowledged

Actions Create Report Your role or license does not allow you to perform this action.

Device Name	Event	Recommendation
FlashSystem AFR-9110-1	Node carriers in a control enclosure do not have Fibre Ch...	Consider changing the Fibre Channel zoning so that all node carrie...
FlashSystem AFR-9110-1	Volume protection feature available	Consider enabling volume protection to prevent unintended delete...

Analytics predict component failure avoiding business impact

System contains drives running faulty firmware

Nov 20, 2019, 06:12:43 Device: FlashSystem-AFR-9110-A Reporting Hardware: 785030H-9840-AFR

The system contains one or more drives with known firmware issues that can cause either a loss of access to data or a data integrity issue. The table below shows the set of affected drives. For more information, then please search ibm.com for that document number.

Firmware	Flash Document Number	Impact	Number Of Affected Drives	Product Id
1.2_8	1079945	Undirected Data Loss after po...	18	10140447

Upgrade the drive firmware as soon as possible.

Analytics and AI love a good problem. Give them data to work on and it's sometimes surprising what you can learn.

<CLICK>

Storage Insights (SI) collects telemetry data at the rate of about 23 million points every day from each system. And the AI can detect anomalous patterns in workloads and system behavior that can help identify and resolve complex issues that arise in the storage infrastructure.

<CLICK>

From there, the analytics can offer insights into configuration best practices that will help reduce risk.

<CLICK>

The analytics can also help predict potential component failures to give clients the opportunity to be proactive and avoid an impact to their business.

Storage Insights delivers real business benefits

Improve capacity planning

Increase storage utilization

Enhance performance monitoring

Reduce costs

Simplify reporting

Troubleshoot issues faster

—
insights to move

—
by using analytics-driven

—

Storage Insights makes it simple to get support

The screenshot displays the Storage Insights dashboard. On the left, a callout box contains text about support process automation and a link to a demo video. Below this is a stylized hexagonal icon with internal nodes and connections. On the right, a detailed view of the support workflow is shown. A 'Get Support' button is highlighted with a yellow box. A tooltip window titled 'Get Support for FlashSystem-AF7-9110-1' appears, asking 'What do you need help with?'. It includes options like 'Create Ticket' and 'Report a problem to IBM'. Another window titled 'Create Ticket for FlashSystem-AF7-9110-1' is open, showing 'Collecting information for ticket'. It lists system details: Storage system: FlashSystem-AF7-9110-1, Type: FlashSystem 9100, Serial number: 0000020421E0003CA, Version: 8.3.1.0 (build 150.15.10.0193159200). A note says 'A log package will be automatically added to your ticket'.

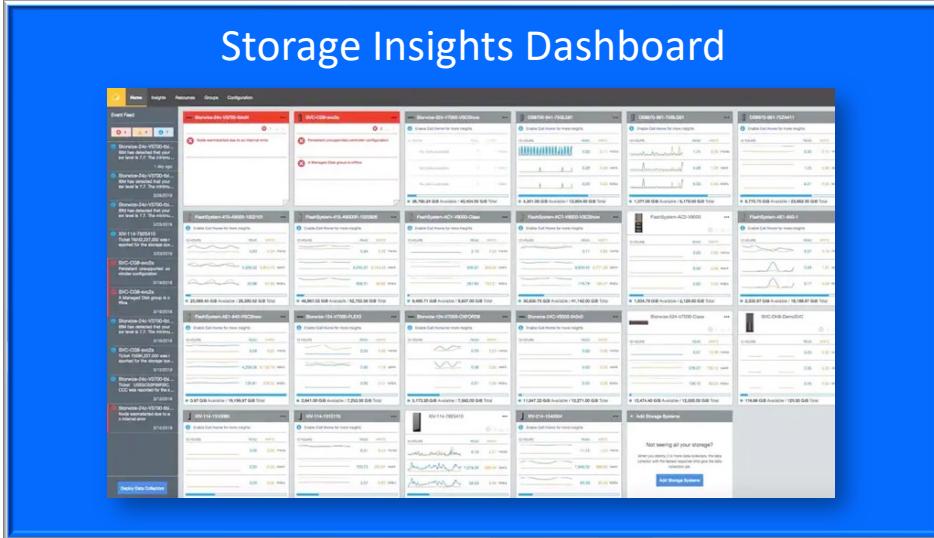
Support process automation to enable faster resolution of issues. Click the button below to watch the 4-minute demo.

Storage Insights is delivered securely from the **IBM Cloud**

Storage Insights (SI) provides an enhanced level of customer service. Event filters eliminate unimportant noise to help get to the root issues quickly. Logs are automatically collected and communicated to IBM Support eliminating the waiting and back-and-forth that, in the past, could slow down time-to-resolution by as much as 50%. And SI gives users direct access to opening, closing, and tracking support tickets and trends. One portal for interactions with IBM Storage Support.

Click the Storage Insights button in the slide to view a 4-minute video on how SI enables faster resolution of issues.

Everything at-a-glance to simplify your management



Information at
your fingertips

Even more
Information at
your fingertips

IBM Storage Insights (SI) is incredibly simple to use. It provides a single pane of glass to provide a Dashboard that displays any issues that may be occurring with any IBM storage system in the environment.

<CLICK>

Critical issues appear in the upper-left corner of the Dashboard, and they are color-coded to reflect the criticality of the issue.

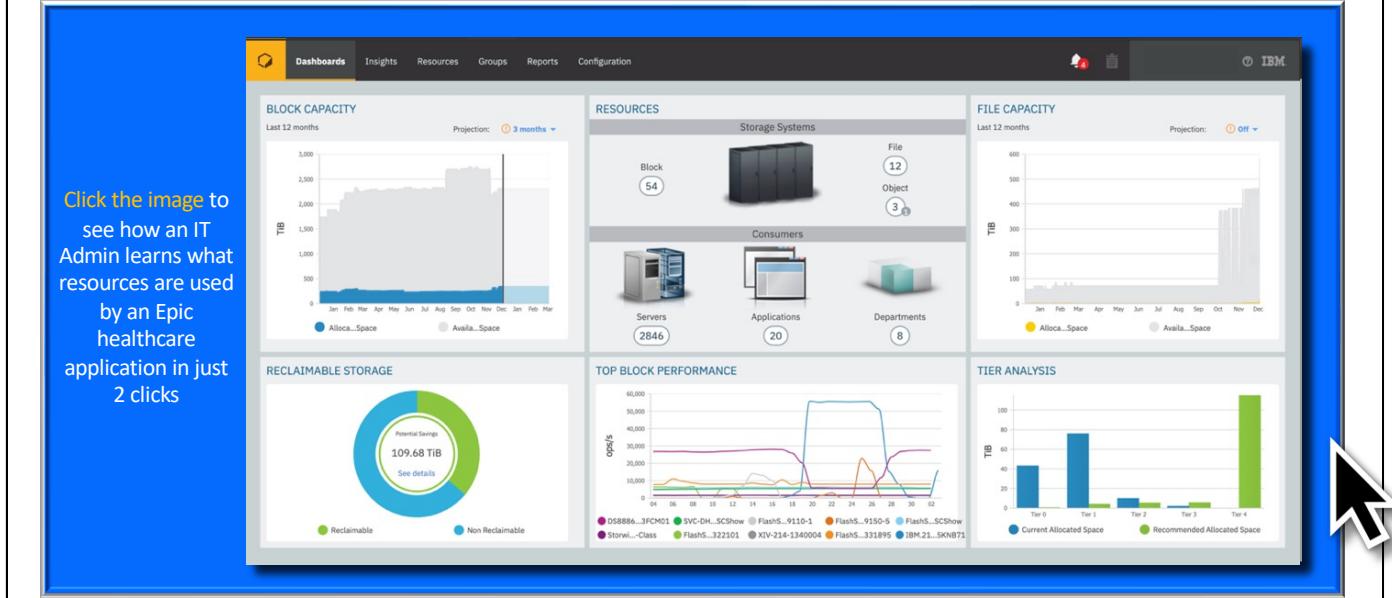
<CLICK>

SI Pro is equally simple to use but it provides clients with additional information. SI Pro also provides the significant benefit of supporting analytics and monitoring of an increasing number of non-IBM storage systems.

<CLICK>

Current issues appear in the top-left corner of the Dashboard, and they are color-coded to reflect the criticality of the issue.

Storage Insights makes it simple to visualize storage relationships



<CLICK>

Storage Insights makes it simple to understand the relationships. Watch the animation as an IT administrator learns what storage resources are used by an Epic healthcare application in just two clicks.

Unlock more capabilities with Storage Insights Pro

- Unlock a full year of data history
- Apply policy-based notifications across many devices
- Schedule reports on performance, capacity, inventory and health
- Troubleshoot application / server performance issues as well as drill down into system performance to isolate risks and avoid outages entirely
- Chargeback reporting by application / server
- Traverse replication and virtualization relationships
- Find space wasters and reclaim unused storage
- Data Tier insights guides you to put data on the optimum storage tier to save infrastructure cost



Instant in app 60 day trial
reveals full data history and
all SI Pro capabilities.

IBM offers Storage Insight Pro (SI Pro) for those customers who are seeking greater capabilities, and flexibility. It is very easy for customers to upgrade from Storage Insights (SI) to SI Pro which is a subscription version of Storage Insights. Let's take a brief look at some of the differences between SI and SI Pro.

<CLICK>

With SI, which is included with all IBM block storage, a customer can view 24 hours of data. However, with the press a button within the application, they can unlock a 60-day trial of the advanced SI Pro features. The included SI software has been collecting and storing historical data. When a customer upgrades to SI Pro, they instantly reveal up to a full year of history. This access to the full data repository is a highly requested capability by customers.

<CLICK>

SI Pro enables customers to apply policy-based notifications; even better is that rather than set threshold notifications for each device, customers can set a policy once and apply it across all their IBM storage systems. This is a huge time-saver for many customers.

<CLICK>

Today, storage administrators manually create inventory, capacity, and chargeback reports by using Excel worksheets. But with SI Pro, they can schedule and send reports to various stakeholders at any frequency.

<CLICK>

Storage Insights Pro adds over 70 additional performance metrics to what customers have in Storage Insights. This helps customers troubleshoot application and server performance issues as well as help customers to quickly drill down into overall system performance to isolate risks and avoid outages entirely.

<CLICK>

The granular details for capacity and performance help admins easily handle chargeback reporting by application and/or server.

<CLICK>

Storage Insights Pro helps storage administrators to more easily observe and understand replication and virtualization relationships.

<CLICK>

A major pain-point solved by of SI Pro is the ability for customers to find space wasters and reclaim unused storage. This improves efficiency and economics by optimize the infrastructure.

<CLICK>

Finally, SI Pro guides the customer and helps them put data on the optimum storage tier which helps them save infrastructure costs.

Storage Insights Pro provides even greater insights

Resource Management	Capabilities	Storage Insights (included)	Storage Insights Pro
Monitoring	Resource management	IBM Block Storage	IBM and non-IBM block, file, and object storage
	Telemetry Data Collection	5 mins	5 mins
	Health	Call home events	Call home events
	Capacity data	4 metrics	25+ metrics
	Performance data	3 metrics	100+ metrics
	Retention data	24 hours	Up to 2 years
	Monitor Brocade and Cisco data fabric	✓	✓
	Monitor numerous competitor's systems		✓
Services	Filter events to quickly isolate trouble spots	✓	✓
	Hassle-free log collection	✓	✓
	Show active PMRs and ticket history	✓	✓
	Best practice violations	✓	✓
	Enhanced reporting		✓
Analytics and Optimization	Full customizable alerting		✓
	Business impact analysis		✓
	Optimize capacity with reclamation		✓
	Handle alerts from IBM's Inline Data Corruption Detection		✓ 

As valuable as the no-cost Storage Insights service is, there is even more that can be unlocked.

Clients can start a free trial of Storage Insights Pro and use all the new abilities it provides with a single mouse-click right from the Storage Insights interface.

Storage Insights Pro deepens the available information on IBM storage and broadens the coverage to include some non-IBM storage.

IMPORTANT NOTE: In June of 2023, IBM introduced their unique Inline Data Corruption Detection feature which is found in all members of the FlashSystem Family. The alerting/reporting system requires Storage Insights Pro.

A quick step required to use Inline Data Corruption Detection on entry IBM FlashSystem storage arrays

Inline Data Corruption Detection requires Storage Insights Pro which requires advanced call home, or in the case of FlashSystem 5015, FlashSystem 5035 and FlashSystem 5045, will require a Data Collector.

The screenshot shows the IBM Storage Insights web interface. On the left, the 'Data Collectors' page is displayed with a table of collectors and a red box highlighting the '+ Deploy Data Collector' button. A red arrow points from this button to a modal window titled 'Select Operating System'. The modal contains six options for different operating systems, each with a 'Select' button and a 'Learn more' link:

- Windows: Windows Server 2012 and later versions
- Red Hat®: Red Hat® Enterprise Linux 7 and later x86-64 only
- AIX®: AIX® versions 7.x and later POWER6® or higher. Restriction: You can't monitor Hitachi devices.
- CentOS: CentOS Linux 7 and later x86-64 only
- POWER Linux: Red Hat® Enterprise Linux 7 and later ppc64le only. Restriction: You can't monitor

To obtain a Data Collector, a client simply goes to a provided Storage Insights URL. They select the Configuration menu and then choose Data Collectors. That will bring up a window where there is a button for Deploy Data Collector.

<CLICK>

When the Deploy Data Collector button is clicked it brings up a new window where the Operating System is chosen. This initiates a download for the appropriate Data Collector which can then be installed at which point Storage Insights Pro is able to work with IBM's new Inline Data Corruption Detection ability and thereby provide a new level of protection that clients have not previously experienced.

Link to Downloading and installing data collectors:

<https://www.ibm.com/docs/en/storage-insights?topic=started-downloading-installing-data-collectors>

Link to Storage Insights secure to the core document: <https://ibm.biz/insightssecurity>

Wrapping it Up

roger.kasten@us.ibm.com

Last Updated: July 19, 2023

Welcome to the final module in the FlashSystem Fundamental Concepts course. In this module we will spend a few minutes and wrap things up.

- Seller guidance and legal disclaimer

IBM and Business Partner
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- All client examples described are presented as illustrations of how those clients have used IBM products and the results they may have achieved. Actual environmental costs and performance characteristics may vary by client.

Include this slide when using content that needs to be shared only with IBM and Business partners.

Businesses benefits from IBM FlashSystem solutions

FlashSystem solutions simplify operations

FlashSystem built around software-defined storage

FlashSystem delivers ultra-high reliability

FlashSystem provides tight integration with VMware

FlashSystem provides tight integration with Containers

FlashSystem provides easy access and consistent management
between on-premises storage and cloud storage



Let's briefly sum up what we have learned.

<CLICK>

<CLICK>

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FlashSystems provides easy access and consistent management between on-premises and cloud storage.

Even more benefits with IBM FlashSystem solutions

FlashSystem provides AI-optimized automatic tiering

FlashSystem supports the most optimal flash configurations

FlashSystem uses DRAID to dramatically reduce exposure

FlashSystem solutions easily cluster to maximize growth, performance, and uptime

FlashSystem brings uniform features and management to over 500 different arrays

FlashSystem arrays are designed to provide enterprise data resiliency



Let's briefly sum up what we have learned.

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FlashSystem storage

<CLICK>

FlashSystem solutions easily cluster which benefits clients by to handle tremendous data growth, increase performance and when implemented with IBM's HyperSwap to obtain 100% uptime.

<CLICK>

FlashSystem solutions

FlashSystems — makes

Note:

- RAID = Redundant array of inexpensive (or independent) disks
- DRAID = Distributed RAID

Why businesses will benefit from FlashCore Modules

FCM3s deliver ground-breaking density/capacity

FCM3s deliver consistently low latency

FCM3s deliver innovation which provides optimal economics

FCM3s deliver unprecedented endurance for worry-free operations

FCM3s deliver consistent performance as they age for easy workload planning

FCM3s can be used with other high-speed flash in the same enclosure



Now let's briefly turn our attention to how businesses benefit from FlashCore Modules (FCM).

<CLICK>

<CLICK>

<CLICK>

<CLICK>

<CLICK>

or independent) disks (

<CLICK>

Why businesses will benefit from Distributed RAID solutions

DRAID delivers faster performance by including the spare within the RAID array

DRAID delivers a faster path to protection

DRAID delivers easy, simple, non-disruptive expansion

Bottom line: DRAID delivers critical value by simplifying growth along with reducing the exposure a business faces while they are undergoing a rebuild



Finally, let's briefly turn our attention to the business benefits derived from Distributed RAID (DRAID).

<CLICK>

<CLICK>

<CLICK>

. DRAID is often the difference between success and failure.

Note:

- RAID = Redundant array of inexpensive (or independent) disks
- DRAID = Distributed RAID

IBM Cyber Resiliency News

Safeguarded Copy & Cyber Vault reported across the globe



[IBM upgrades FlashSystem to tackle ransomware](#)

[IBM flash storage line gets ransomware protection](#)

[IBM announces next-gen FlashSystem Storage offerings](#)

[IBM constructs CyberVault around new FlashSystem family](#)

[New IBM storage product intended to accelerate ransomware recovery](#)

[IBM bolts on Cyber Vault for ransomware recovery](#)

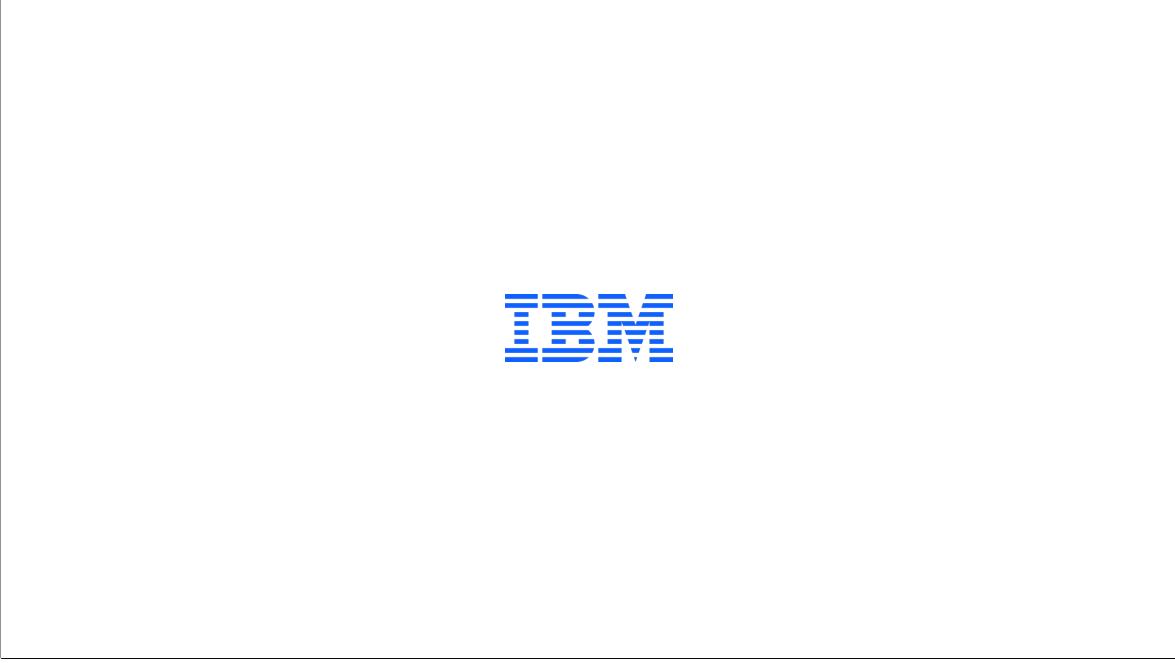
[IBM FlashSystem Cyber Vault Provides Resilience to](#)

[Ransomware](#)

[New IBM Flash Storage Assists in Ransomware, Cyberattack](#)

[Recovery](#)

[IBM Refreshes Storage Portfolio and Brings Enhanced security Features to the FlashSystem Line](#)
[IBM targets ransomware, other cyber attacks with flash storage offerings](#)
[IBM focuses on ransomware and other cyberattacks](#)
[IBM Announces Next-Generation Flash Memory Products](#)
[IBM: Ransomware protection for storage with the "Cyber-Tresor" and two new arrays](#)
[news.mynavi.jp IBM, new ransomware detection and data protection features in IBM Flash System](#)
[IBM unveils next-generation flash memory products, focused on fighting ransomware and other cyberattacks](#)
[IBM updates FlashSystem product line, joins Cyber Vault to fight ransomware](#)
[IBM announces "IBM FlashSystem Cyber Vault" to support detection and recovery of ransomware etc. in flash storage products](#)
[Big company news](#)
[IBM accelerates data recovery after a cyber attack with its new flash storage solution](#)
[IBM targets ransomware, other cyberattacks with next-generation flash storage offerings](#)
[IBM accelerates data recovery after a cyber attack with its new flash storage solution](#)
[IBM strengthens storage security](#)
[IBM announces "IBM FlashSystem Cyber Vault" to support detection and recovery of ransomware etc. in flash storage products](#)
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