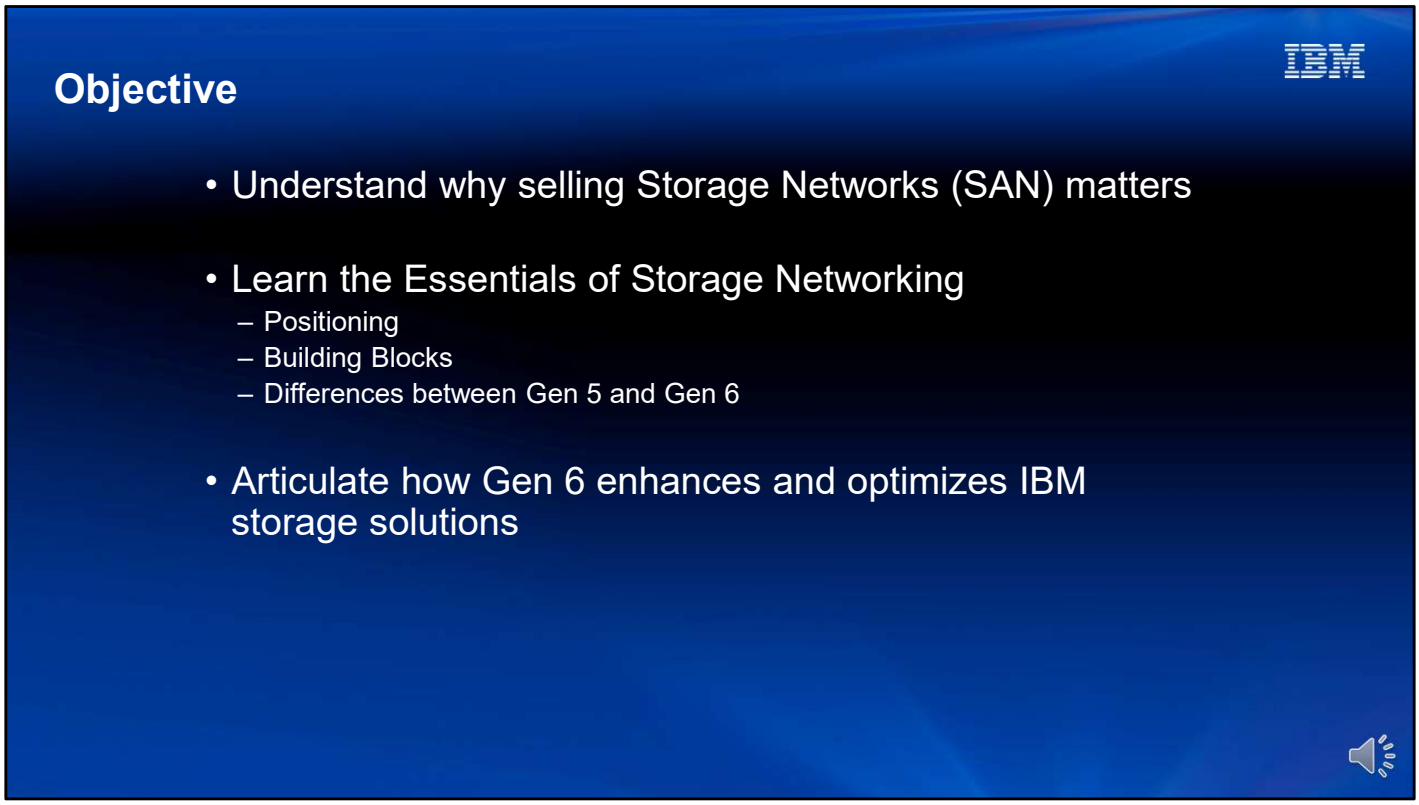

IBM Storage
Pre-Sales Training
Introduction to
IBM b-type Storage Networking

Welcome…..

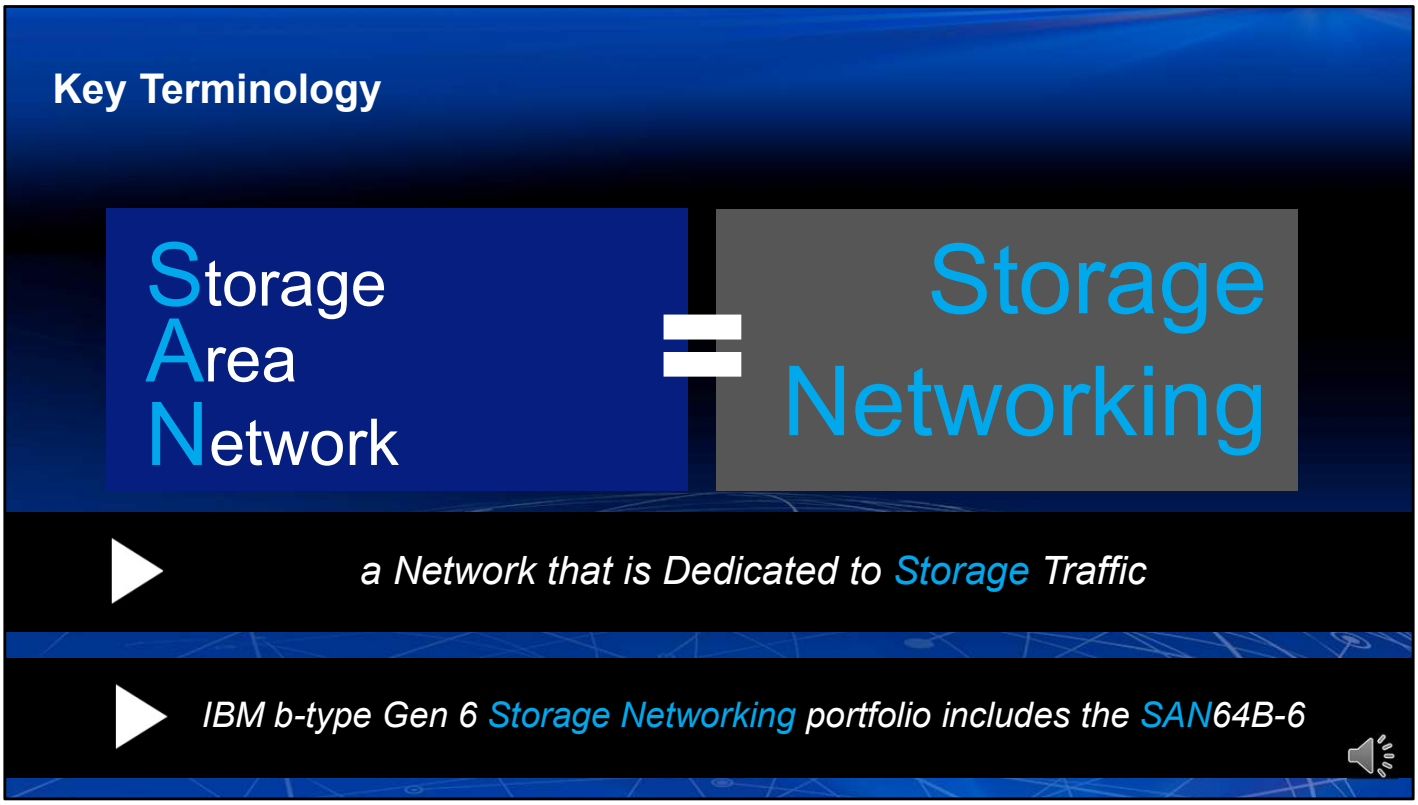


In this course we will start off discussing why selling Fibre Channel SANs matter. In other words, what's in it for you and your customers.

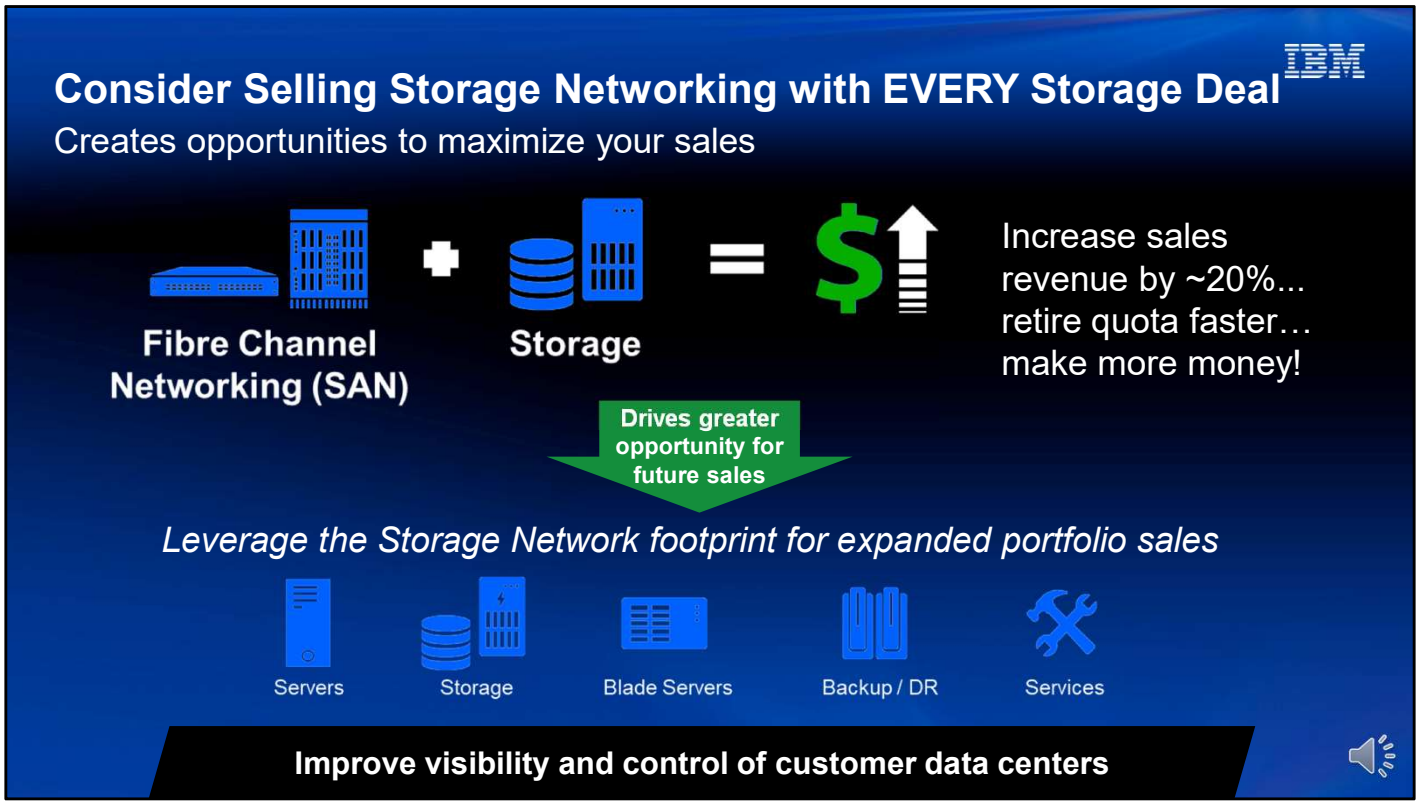
Then we will cover SAN essentials including what a SAN is, why SAN is important from a customer value proposition, where SAN best fits versus other alternatives, when to propose directors versus switches and when to propose extension products.

From a high level view, we will look at how Gen 6 Fibre Channel enhances and optimizes storage solutions.

Last we will provide ways to get additional information on topics covered in this course.



First, lets review fundamental terms to avoid any confusion. Depending on your experience in the storage or networking industry this may be a review.
The terms SAN – "S" "A" "N" – stands for Storage Area Network and was based on the common popular acronym, LAN, for Local Area Network.
While a LAN is typically an ethernet network that carries a variety of very common office type data traffic such as file share, email, management traffic, printers, etc … the SAN is a network that is *dedicated* to storage traffic only. Storage traffic, especially block level storage traffic, is different than typical LAN traffic due to its size and need for high bandwidth, low latency, high availability and other factors.
In this presentation … we will use the terms SAN and "Storage Networking" interchangeably.
The two important terms are built into the IBM names for the products. For example, within the IBM b-type Gen 6 Storage Networking portfolio, there is a product called the "IBM SAN64B-6" switch.



So, consider SAN with EVERY storage deal.
You not only increase revenue per sale by 20% or more….
(Click)
But you can also leverage the SAN footprint for expanded portfolio sales.
Owning the network give you visibility across storage, server, back-up and disaster recovery, and service sales opportunities.
And, since the network touches everything, you are no longer talking about one part of the infrastructure, but rather having a broader conversation with your customers about their entire infrastructure. Selling the network gives you greater account relevance and control.

Now lets look at where SAN fits best versus the other storage alternatives as all storage solutions in the market today have a place.

Storage Connectivity:
What Enterprise Customers Are Looking For

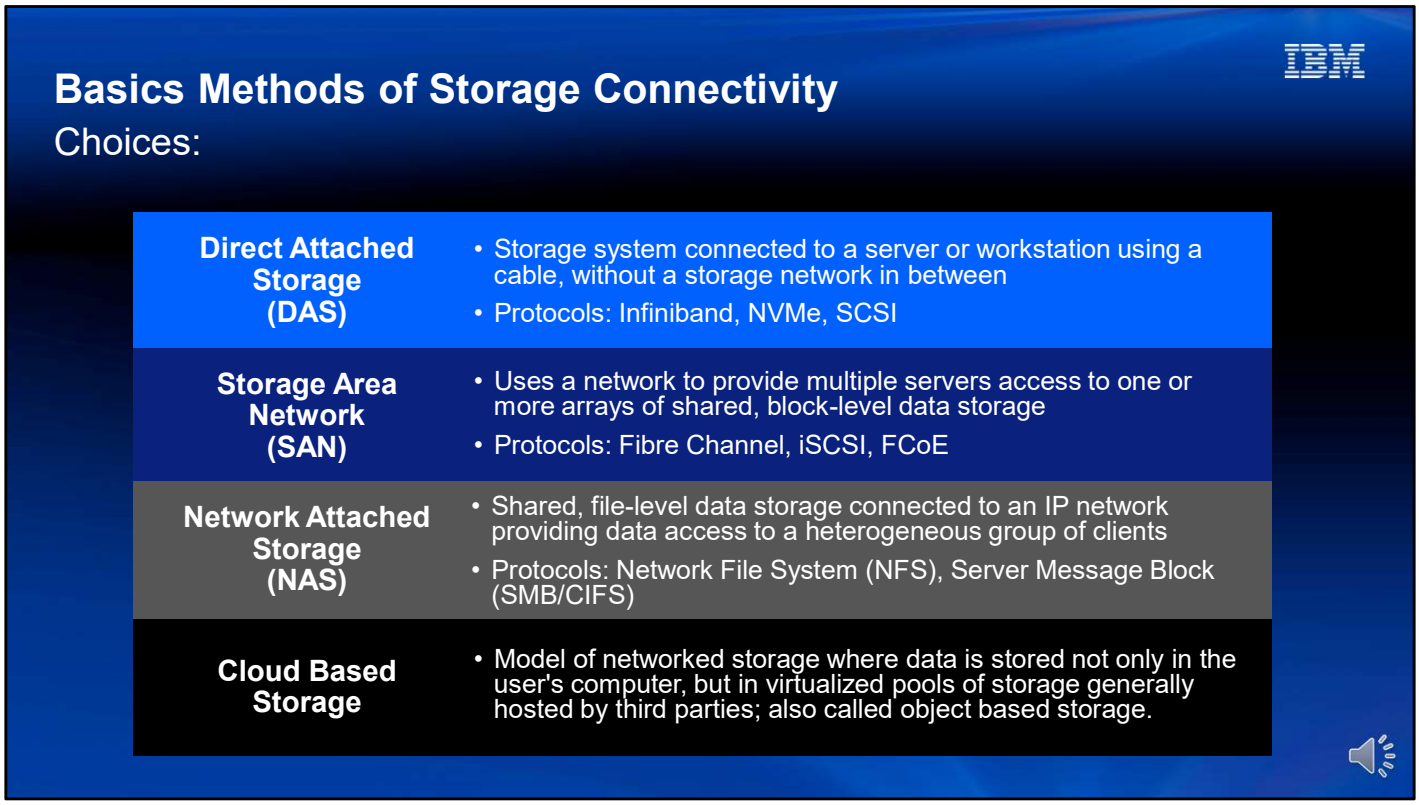
- It must be agile, compatible and reliable
  - Meeting the needs of expanding apps, workloads, protocols
  - While serving existing data and systems
  - Protecting against catastrophic failure
- Automated performance and visibility
  - With supporting tools to optimize infrastructure visibility
- Future-built for tomorrow's business
  - Meeting today's needs – but built to seamlessly expand to new technologies as needed
  - No rip and replace required

What are enterprise customers looking for in storage connectivity?

They need it to be agile, compatible and reliable. It needs to meet the needs of their expanding applications, workloads and protocols while serving existing data and systems while also protecting against failures.

It needs to provide automated performance and visibility with supporting tools to optimize infrastructure visibility.

It has to meet todays needs while also meeting the needs of future technologies without having to rip and replace.



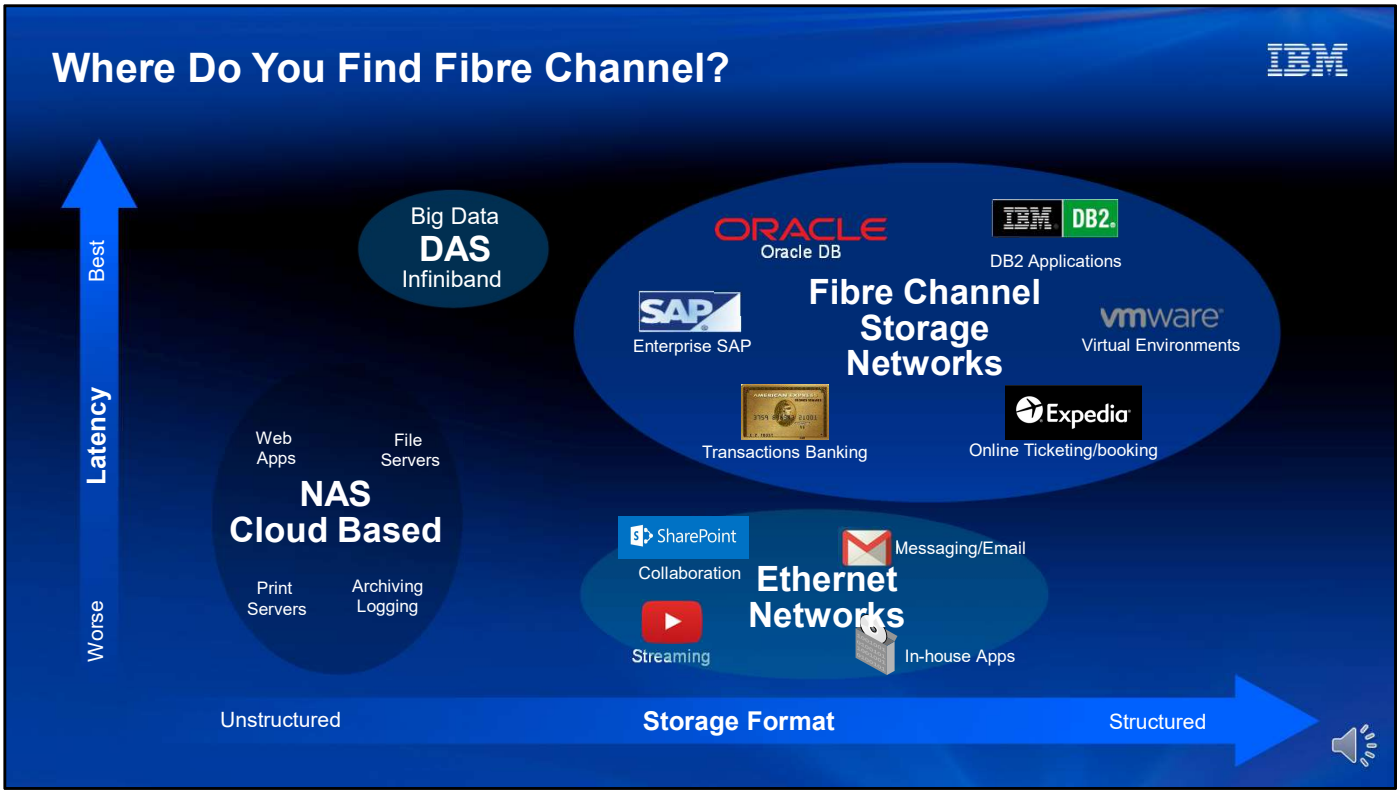
There are four basic methods of storage connectivity. Direct attached storage (DAS), storage area networks (SAN), network attached storage (NAS) and cloud based storage. The key differences are how the storage is connected, whether its directly attached or over a network, and how the storage is presented to the computer operating system (OS). Storage can be presented to a the OS as either block-level, file-level or object based.

DAS storage systems connect directly to servers or workstations using a cable with no network involved and provide block-level data storage using Infiniband, NVMe or SCSI.

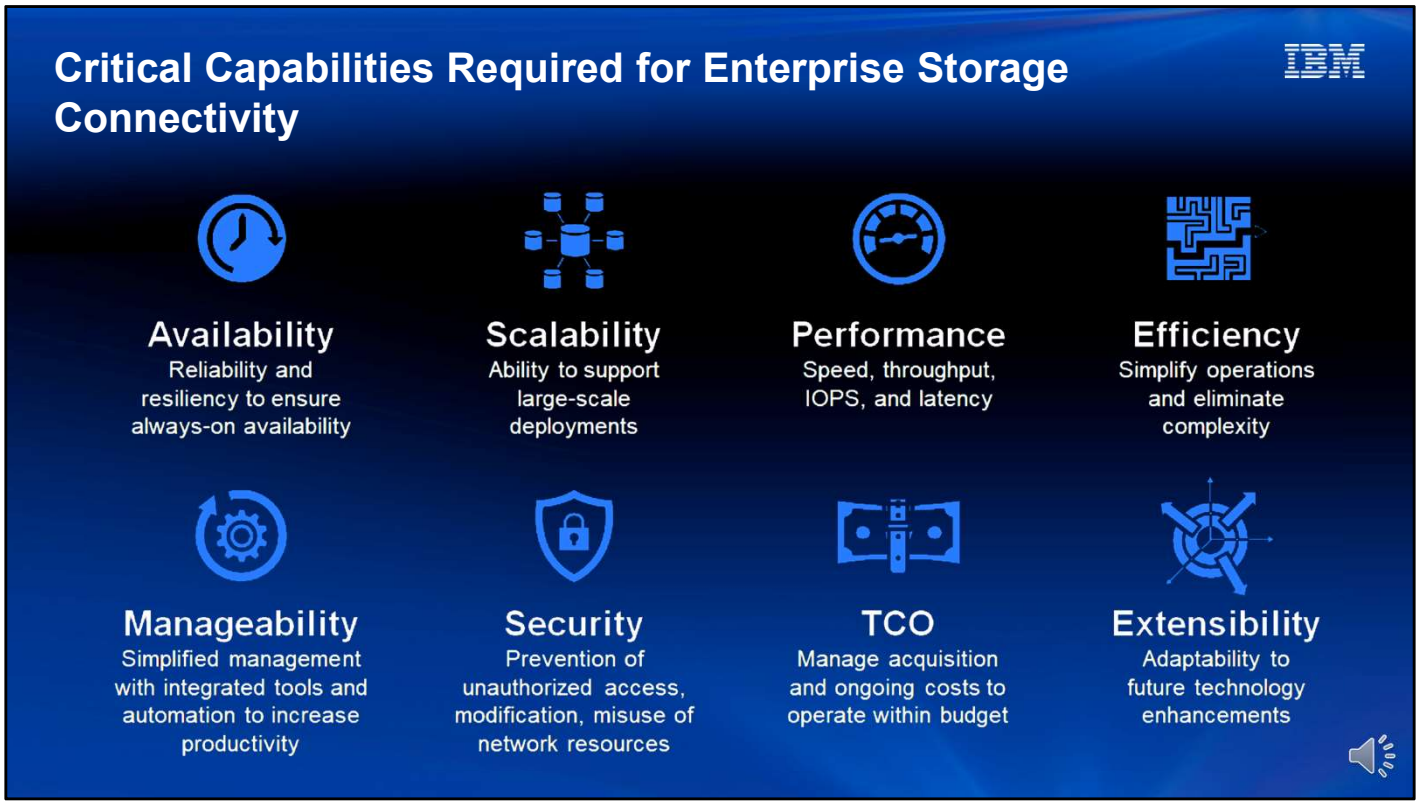
SAN uses a network that provides multiple servers access to one or more shared storage arrays and provide block-level data storage. Fibre Channel SANs use a dedicated purpose built network of Fibre Channel switches, also referred to as a fabric; while iSCSI and FCoE SANs are typically deployed on shared Ethernet networks but may also be deployed over a dedicated Ethernet network.

NAS connects to the shared IP network and provides file-level data storage using common file level protocols such as windows SMB/CIFS and Linux & VMware NFS to a heterogeneous group of clients.

Cloud based storage is a model of networked storage where data is stored not only in a users computer, but in virtualized pools of object-based storage generally hosted by third parties. Object-based storage manages data as objects, rather than file-level storage used by file systems or raw block-level storage.



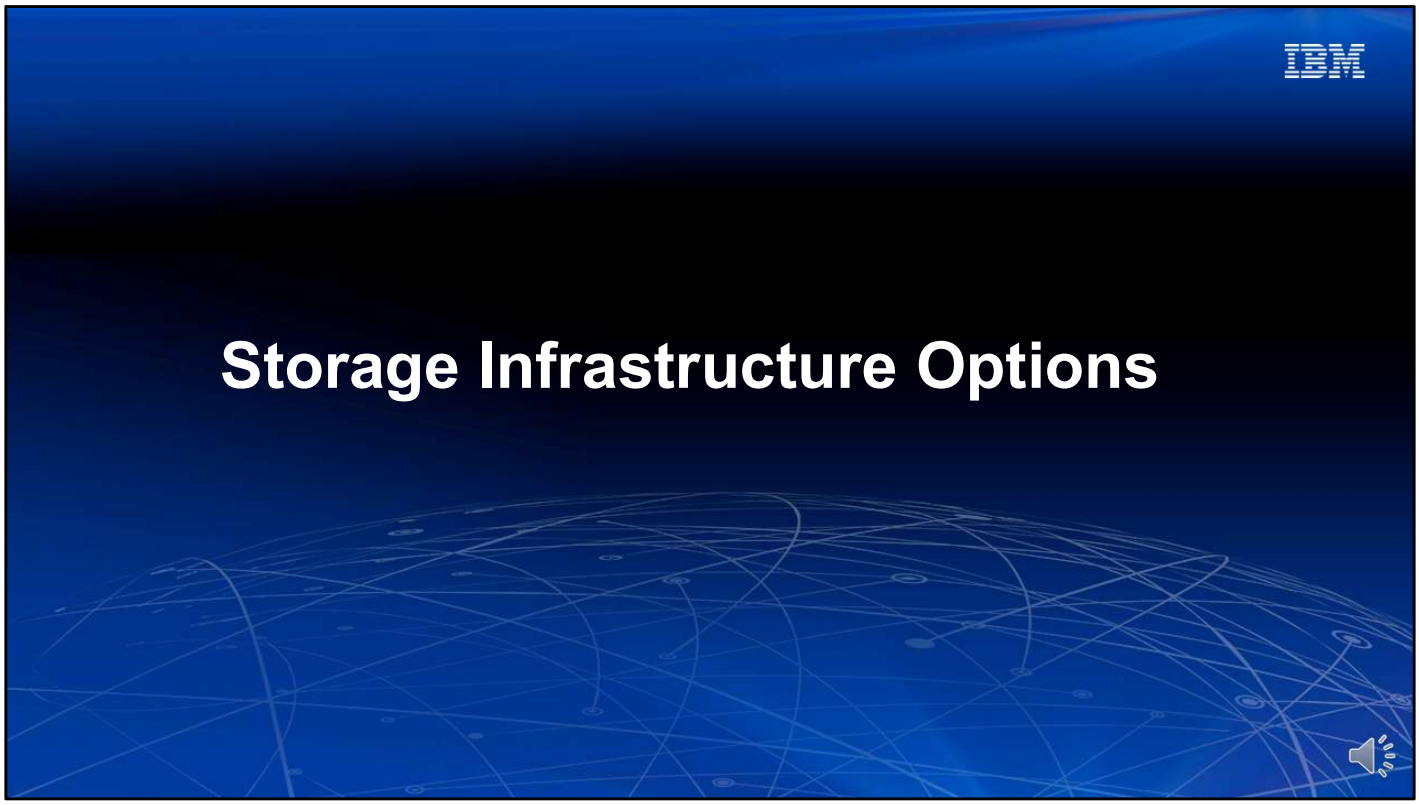
Where will you find Fibre Channel Storage Networks? It's simple: anywhere customers need to support mission critical applications such as databases, Oracle/SAP/DB2, on-line transaction processing or "OLTP" applications, large virtualized environments, and other mission critical applications where data and "always on" matters. Remember, Fibre channel is used where the data matters the most!



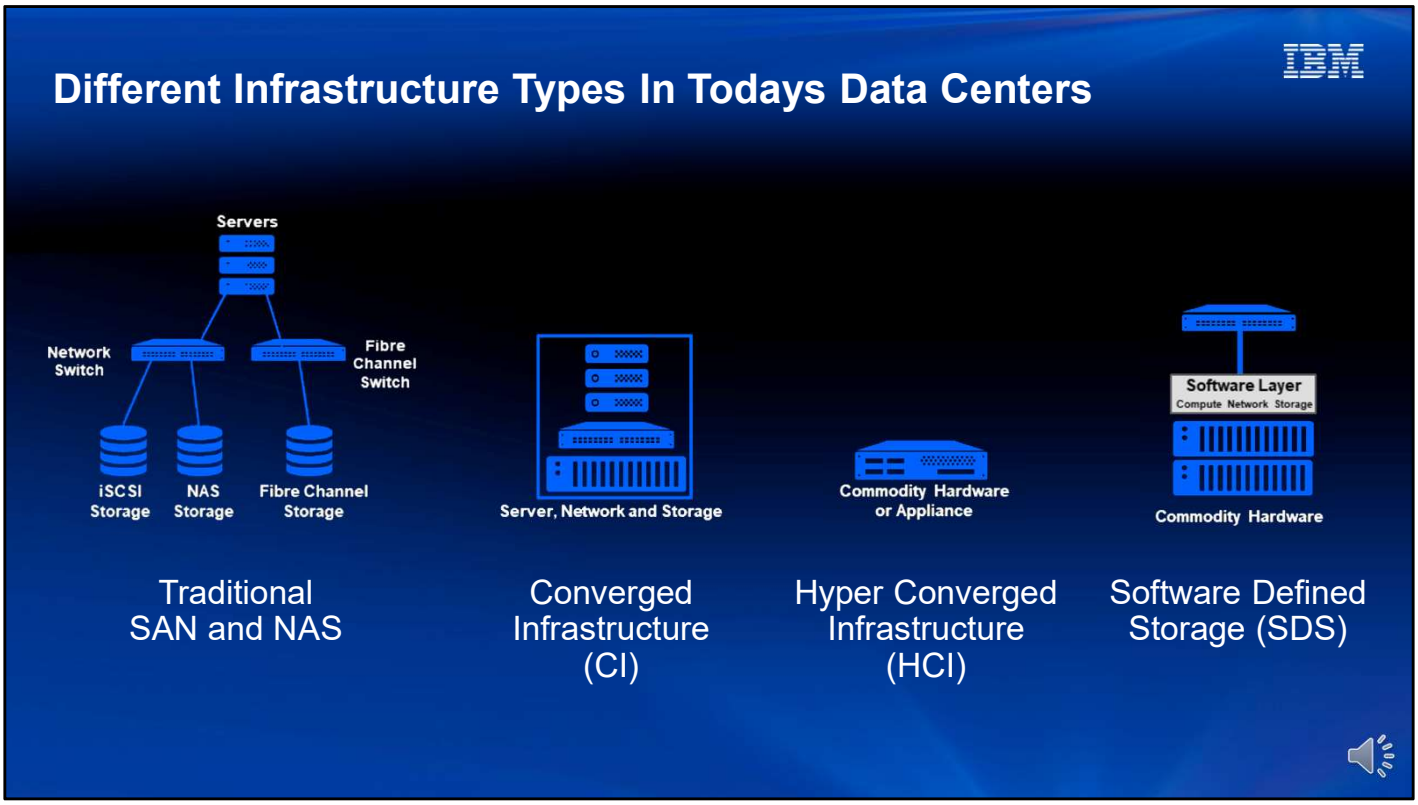
Latency and storage format are just two things to consider when selecting a storage solution. Other things you should consider include:

Availability of the storage solution. Is the solution reliable and is it resilient to ensure always-on availability if a problem does occur?
How scalable is the solution? Does it have the ability to support a larger scale deployment as storage needs grow?
Performance, will the storage solution meet the speed, throughput, IO per second and latency requirements of the applications it will transport?
How efficient is the solution? Does it simplify operations or add additional complexity?
Manageability of the solution, does it offer simplified management, integrated tools and automation to increase productivity or both?
What is the security requirements for the storage solution? Does it provide the appropriate level of unauthorized access, modification or misuse?
What will the total cost of ownership or TCO be? Not just the initial cost to acquire the solution but also implementation and ongoing operational costs?
Lastly, extensibility of the storage solution. Is it adaptable to future technology enhancements?

While all of these are important, each one may not have the same level of importance depending on the customer needs.



Now lets look at where SAN fits best versus the other storage alternatives as all storage solutions in the market today have a place.



Todays data centers utilize a variety of infrastructure types including traditional SAN and NAS deployments as well as newer infrastructure types such as converged infrastructure (CI), hyper converged infrastructure (HCI), and software defined storage (SDS).

We have already talked about the first two which are network based SAN and NAS infrastructures but it's a good idea to highlight some of the details regarding the others, as they all have a place in the data center.

Both CI and HCI take the different components of a storage system (server/compute, network and storage) and bundle them together into a single turnkey solution. The main difference between CI and HCI infrastructure is that CI relies on hardware as its building blocks while HCI is software-defined.

CI is a hardware-focused, building-block approach typically contained within a single rack enclosure. In a converged infrastructure, each of the components in the building block is a discrete component that can be used for its intended purpose within the CI, but if removed from the CI could also be used as stand alone devices.

With HCI, the technology is software defined with the technology typically integrated into a single 1u or 2u rack mountable unit and cannot be broken out into separate components.

Software-defined storage (SDS) is computer data storage software used for policy-based provisioning and management that is independent of the underlying hardware. SDS is the software defined component within the HCI infrastructure solution but a standalone SDS solution can be used with a verity of underlying hardware to provide compute, networking and storage required in all storage solutions.

Gartner's Comparison for the Infrastructures Capabilities

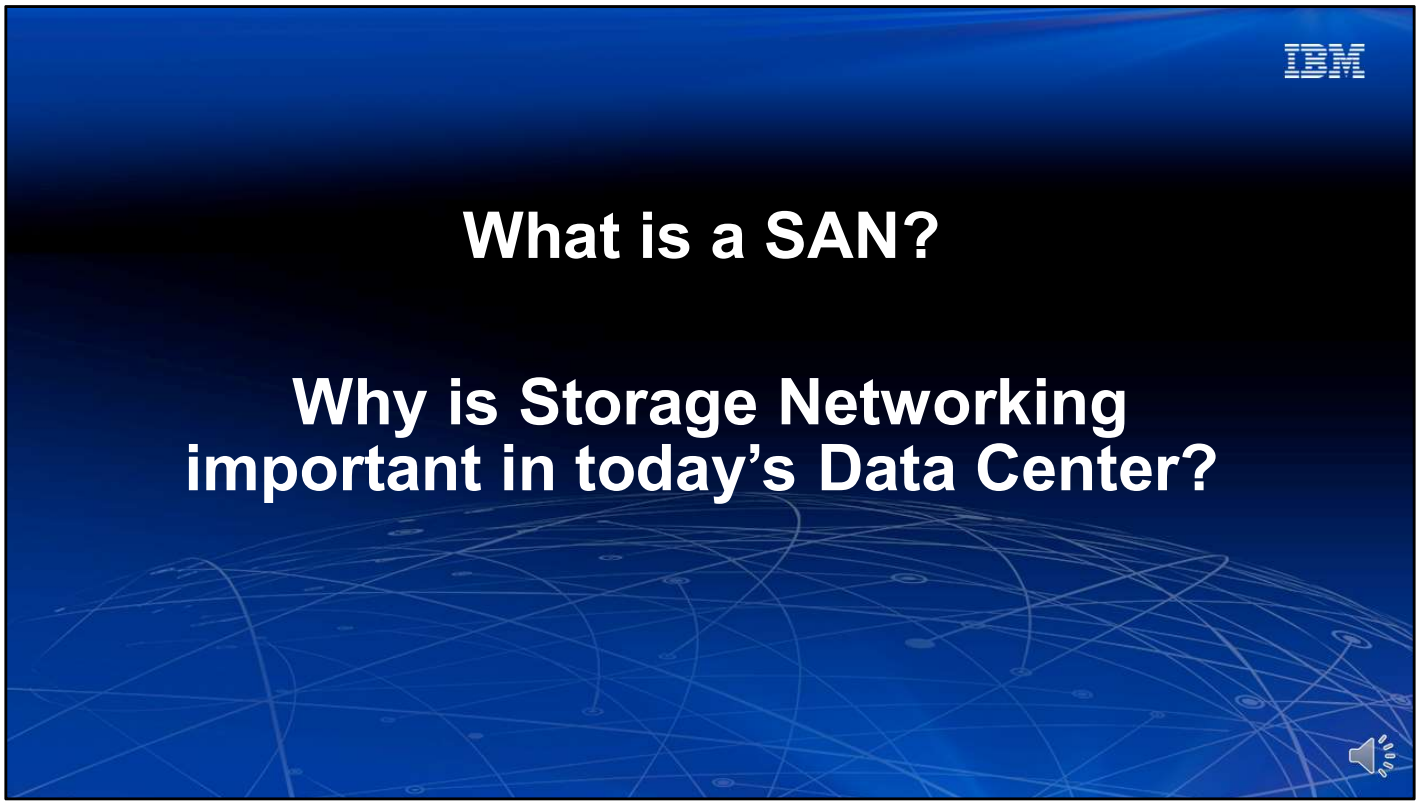
Critical Capability	FC Storage	IP Storage iSCSI/NAS	Converged Infrastructure	Hyper Converged Infrastructure	Software Defined Storage
Availability	★★★★	★★	★★★	★★	★★
Scalability	★★★★	★★★	★★★	★★	★★
Performance	★★★★	★★★	★★★	★★	★★
Agility	★★	★★	★★★	★★★★	★★
Extensibility	★★★★	★★★	★★	★★	★
Manageability	★★★	★★	★★★	★★★★	★
Security	★★★★	★★	★★★	★★	★★
Acquisition and ownership cost	★	★★★	★★	★★	★★★★

Again, each solution has its strengths and purpose in the data center but how do you decide which infrastructure choice to use?

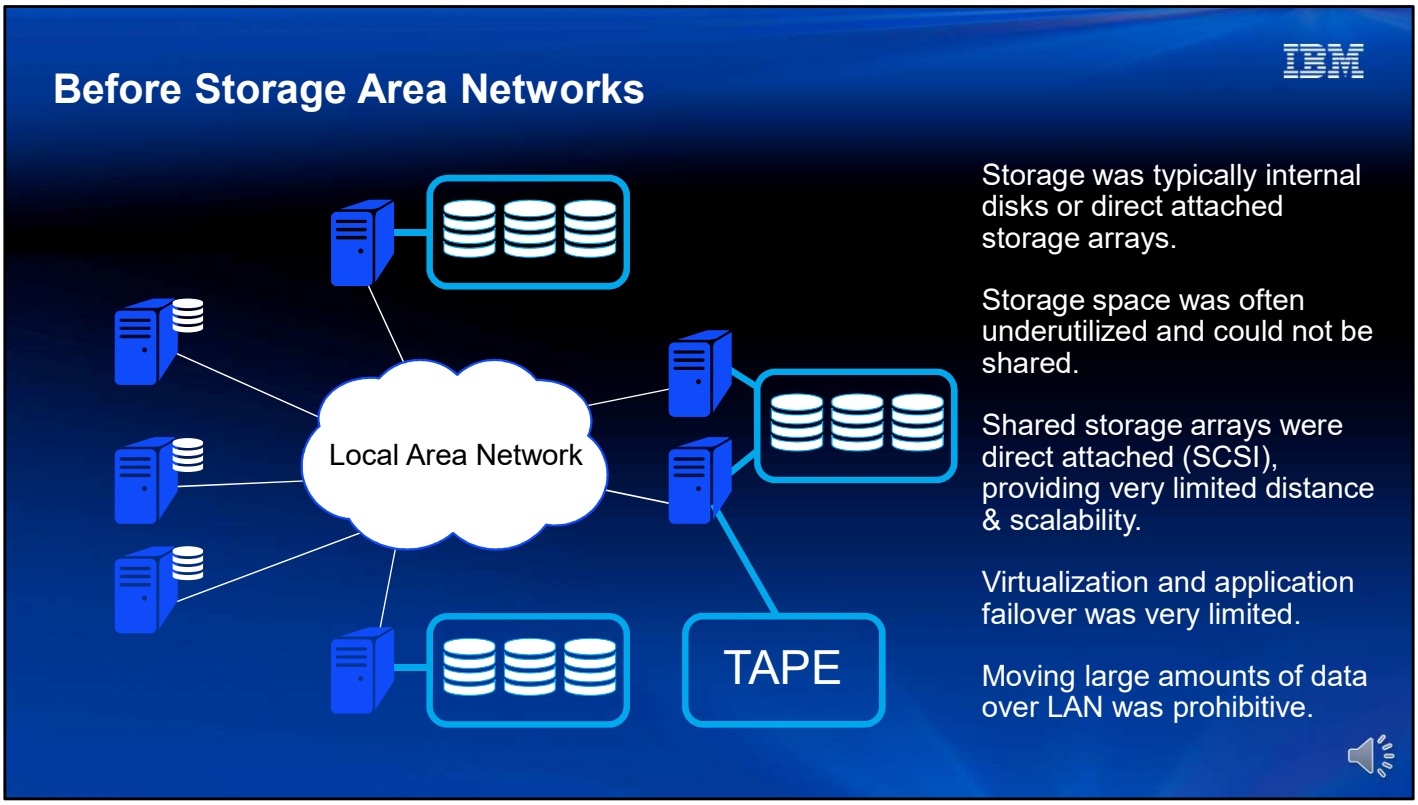
Looking at this chart from Gartner, let's compare the capabilities for some of them.

When the infrastructure requires availability, scalability, performance, extensibility, manageability and security Fibre Channel is the most capable solution. When availability, manageability and security are not a concern IP storage such as iSCSI and NAS may be a good fit. And when agility and manageability are important rather than availability, scalability, performance and security, HCI could be the best option, however, keep in mind that turnkey solutions can lock-in you into a single vendor.

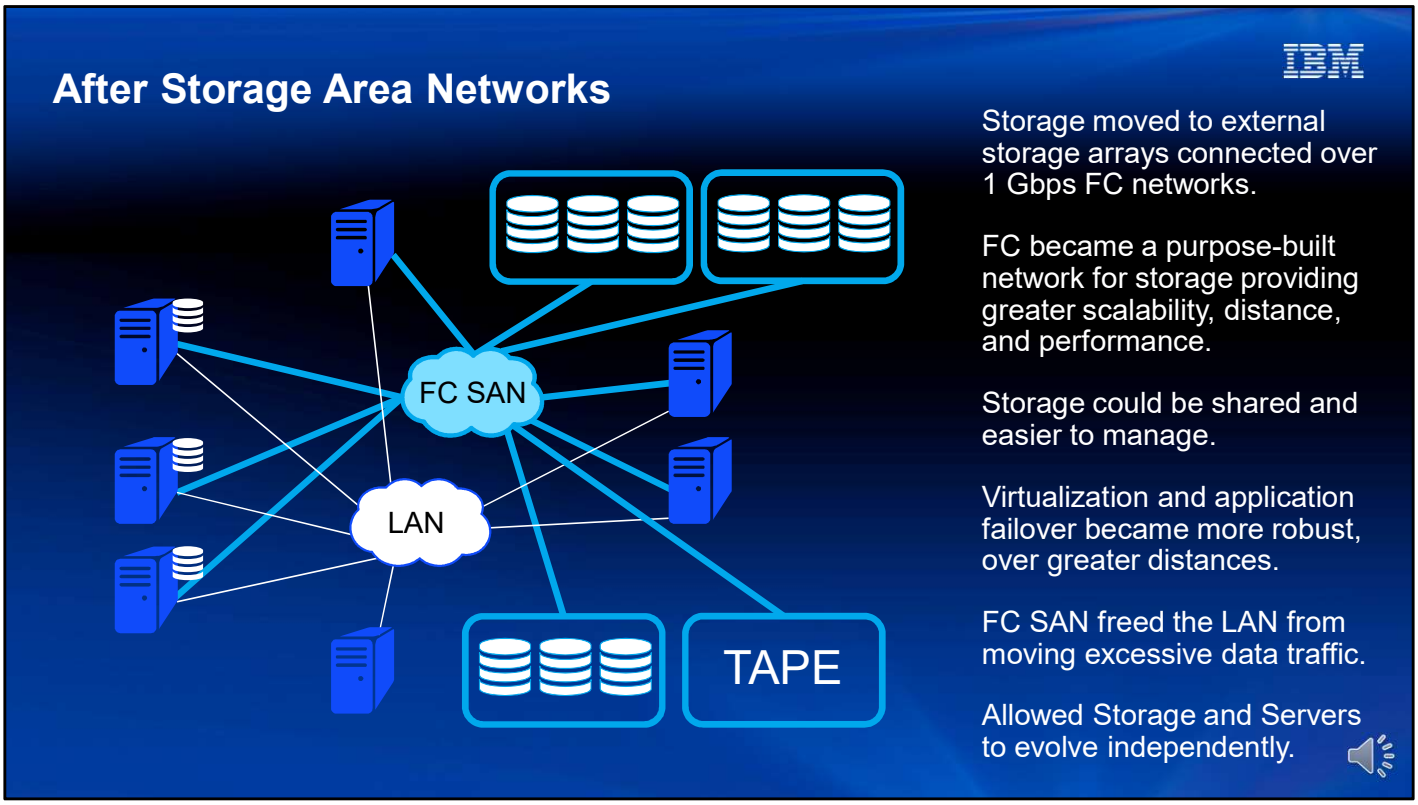
The more bubbles an infrastructure has the better it is in that capability. Take some time to review the chart to familiarize yourself with the strengths of each infrastructure solution before moving on.



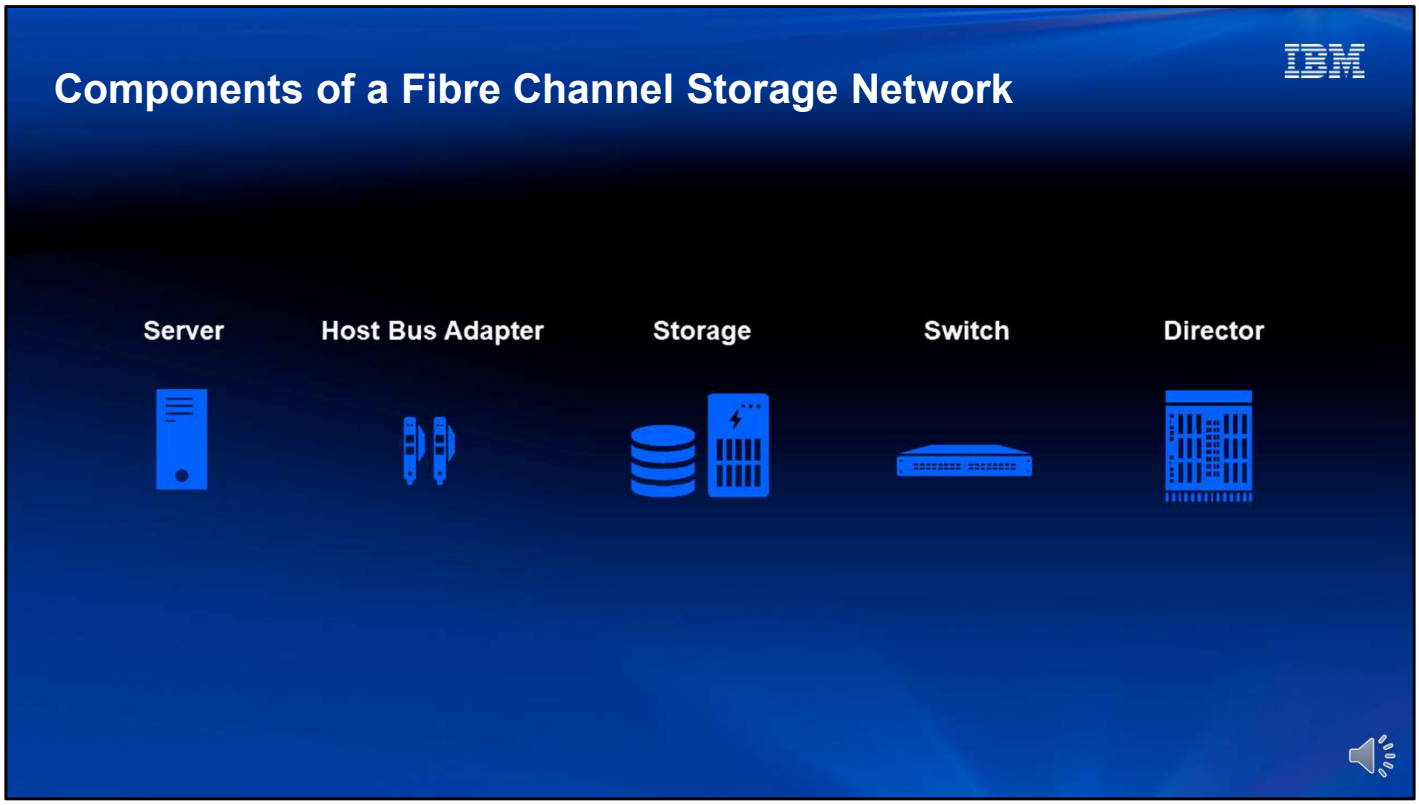
What is a SAN and Why is it Important in Today's Data Center?



Let's start by traveling back in time to the late 1990's and early 2000's, before SANs were fully adopted and everything, for the most part, was connected to the Local Area Networks (LANs). Servers had their own storage often even tape installed. Some servers would have external storage directly attached through thick SCSI cables. This architecture was not optimum for storage because it was common for some servers to underutilize its storage while others ran out of storage – and there was no easy way to share or re-allocate storage between servers. External disk arrays could be added to servers but this was through a thick SCSI cable that had extremely limited distance and scalability support. Everything needed to be in close proximity. Plus these were very difficult to share between servers. Due to this lack of shareability, virtual machines tended to stay on single servers and here were little support for vm failover. Finally, anytime large amounts of data was moved over the LAN between servers and storage or tape, congestion would overwhelm the network and slow all network traffic, This lead to the need for establishing a "backup window" when people and applications were not expected to be on the network.



SANs helped correct many of the problems that organizations were experiencing with the LAN architecture. The 1 Gbps Fibre Channel specification and products were built around the year 2000 as a storage-centric & purpose–built network, a network that provided much greater scalability, distance, and performance. Also, FC storage arrays were built to enhance sharing between a number of servers which also created an environment where virtualization could flourish with failover between servers and between sites. Also, LANs rarely become congestion due to the large data traffic patterns that were now traveling over the SAN. As a matter of fact, “Backup and Restore” solutions were one of the primary “killer apps” for early FC deployments. As more storage moved out of the server and into specialty designed storage arrays, these arrays started evolving on their own, creating a number of new very useful storage features that admins now depend on for daily operation.
As a result of these benefits, SANs became well established in the early 2000’s.



Here are the components that make up a SAN:

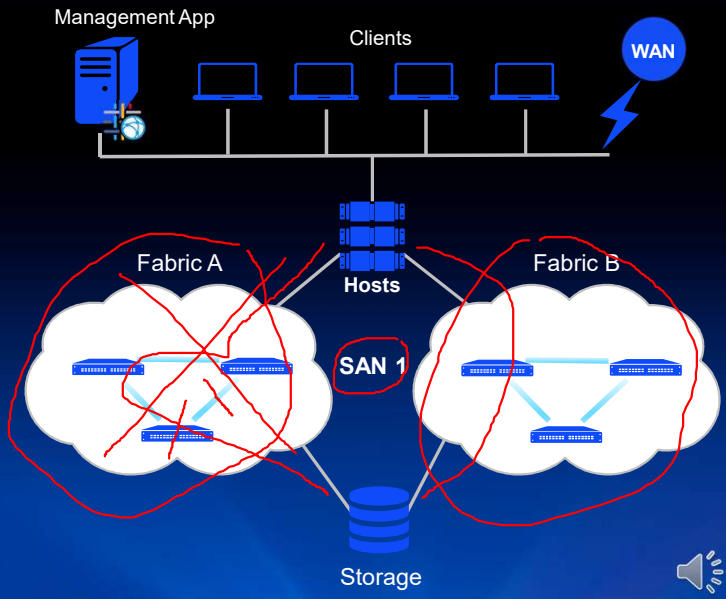
1. Host with a Host Bus Adapter (HBA) - An HBA connects a server, which acts as the host system, to storage devices. In storage area network (SAN) environments, they are typically used to connect hosts to Fibre Channel, FICON and NVMe storage arrays.
2. Storage - A storage array is a data storage system used for block-based storage, file-based storage or object storage. The term is used to describe dedicated storage hardware that contains spinning hard disk drives (HDD) or solid-state drives (SSD). SSD arrays are also know as all-flash arrays (AFA).
3. Switch - A Fibre Channel switch is a fixed form factor network device that provides connectivity between host servers and storage within a SAN).
4. Director - A Fibre Channel director is a modular, chassis-based networking device that provides connectivity between host servers and storage within a SAN.

What is a Storage Area Network (SAN)

Its primary purpose is to connect and share valuable resources

A SAN is one or more purpose built networks used for storage connectivity

- A fabric is a single dedicated storage network within the SAN
- A SAN consist of one or more fabrics
- Hosts attach to both the server/client network and the storage network
- Most SANs are built using Fibre Channel switches and directors
- Management applications are used to monitor and manage the SAN
- Fabrics can also be extended over distance for Disaster Recovery and Business Continuance



As the name implies, a storage area network or SAN is one or more dedicated networks used for storage connectivity between host servers and shared storage. In our example, we see three hosts servers connected to SAN 1. The hosts are accessing a shared storage array, which is also connected to SAN 1.

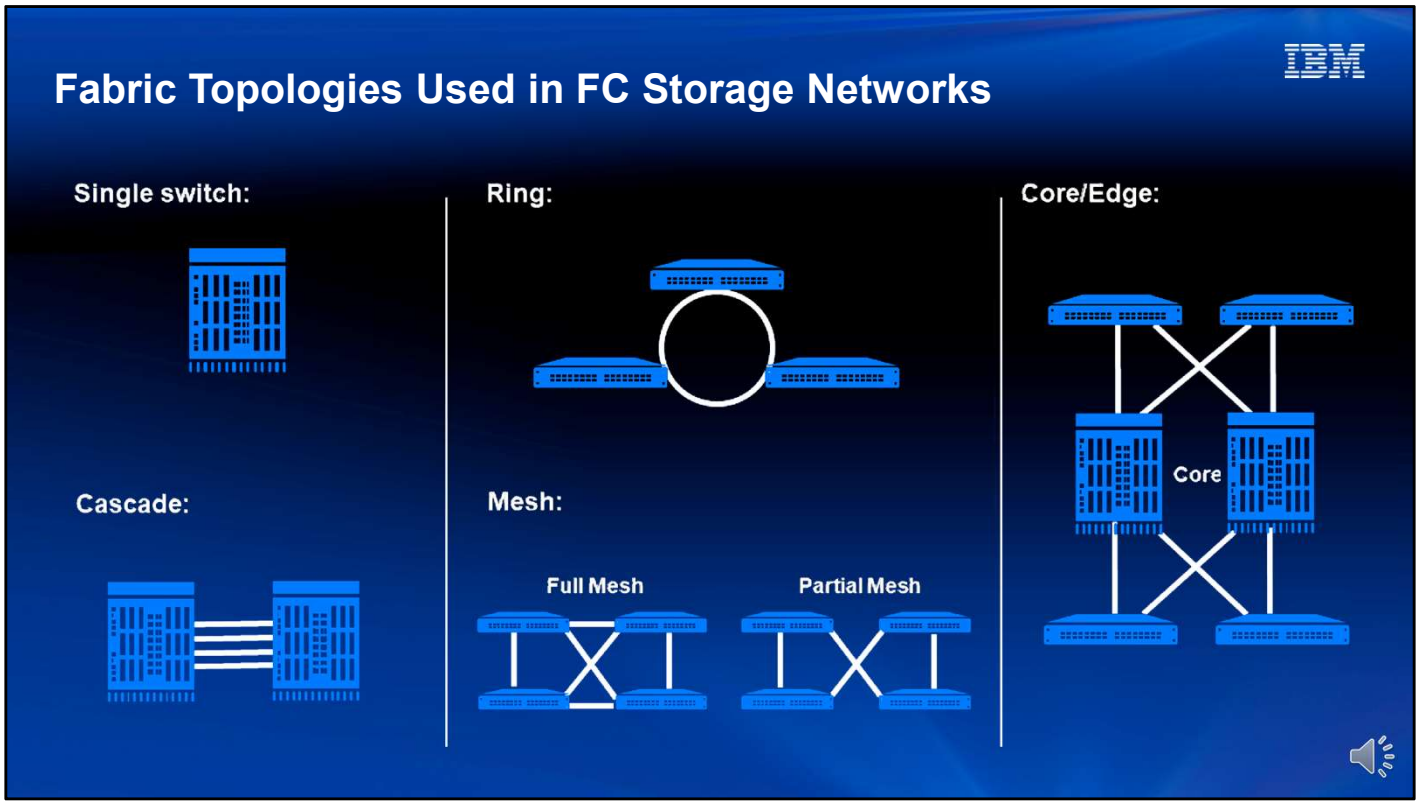
A single storage network is called a fabric and consist of one or more network switches or directors connected to each other.

A SAN can contain one or more fabrics. When referring to a single fabric, the term SAN and fabric are interchangeable but when a SAN contains two or more fabrics, the term SAN refers to all of the fabrics which make up the SAN. In our example, the three hosts are able to access the same shared storage through both Fabric A and Fabric B. This is called a dual fabric. A dual fabric SAN provides redundancy and most SANs are typically designed with two or more redundant fabrics. If a problem occurs within a fabric, the hosts maintain access to the storage through the other fabrics.

Servers connect to both the SAN as well as the traditional Ethernet network used for server client connectivity.

Most SANs are built using Fibre Channel switches and directors. Fibre Channel is a high-speed data transfer protocol commonly running at 1, 2, 4, 8, 16, and 32 gigabit per second rates. It provides in-order, lossless delivery of raw block data and is primarily used to connect data storage to host servers. In addition, A Fibre Channel fabric can be extended over distance for Disaster Recovery and Business Continuance. This can be done using native Fibre Channel links over dark fiber or by tunneling Fibre Channel traffic through an IP WAN.

Management applications such as IBM Network Advisor, IBM Spectrum Control and Brocade's SANnav can be used to monitor and manage the SAN



Lets take a look at the recommended fabric topologies used in Fibre Channel SAN.

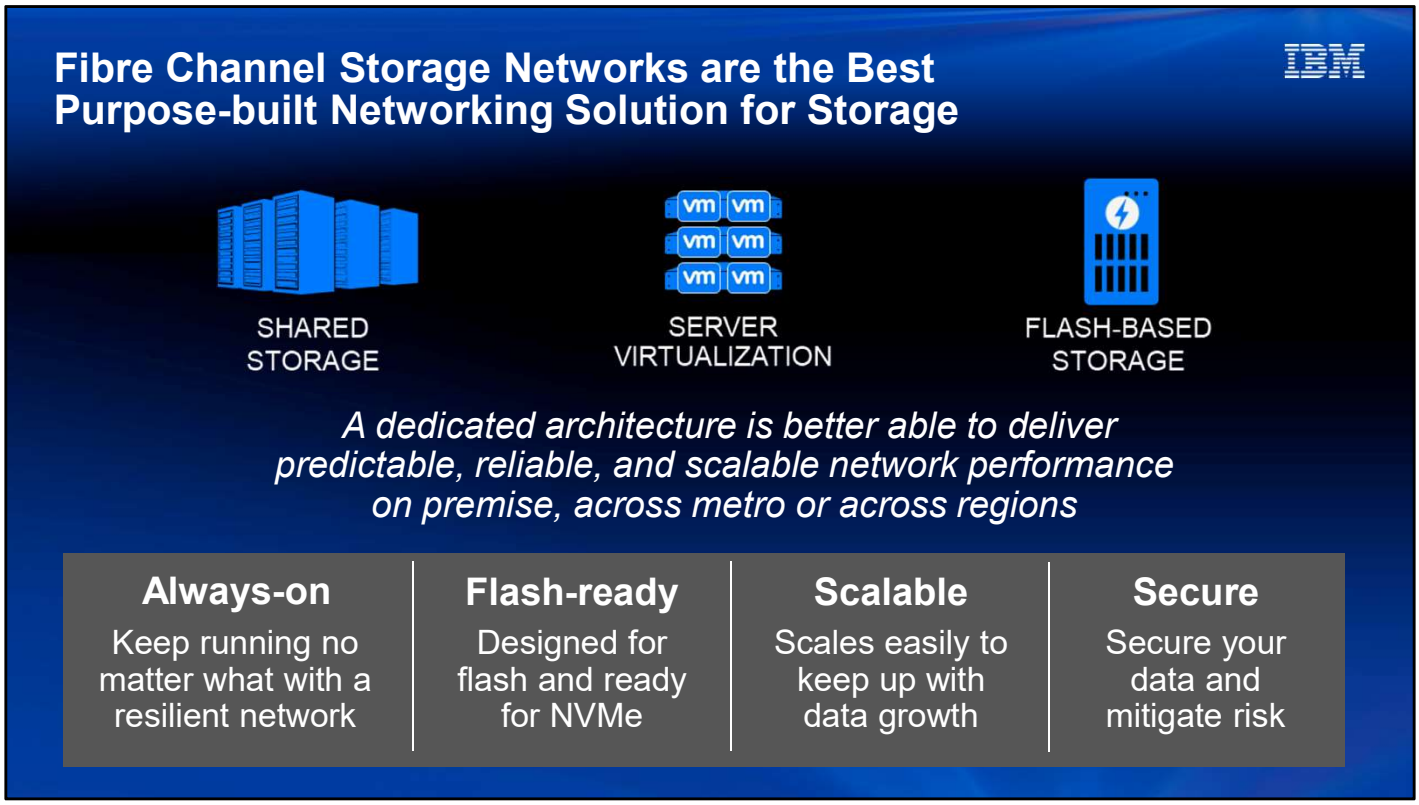
A single switch or director is the simplest SAN solution and recommended for small deployments.

A cascade topology is two or more switches or directors connected in series using inter-switch links (ISL). This topology is best suited when the fabric is limited to two switches or directors.

A ring topology is a variation of the cascade. In this design the last switch/director in the cascade is connected back to the first switch/director forming a ring. It's best suited for fabrics with three to four switches/directors.

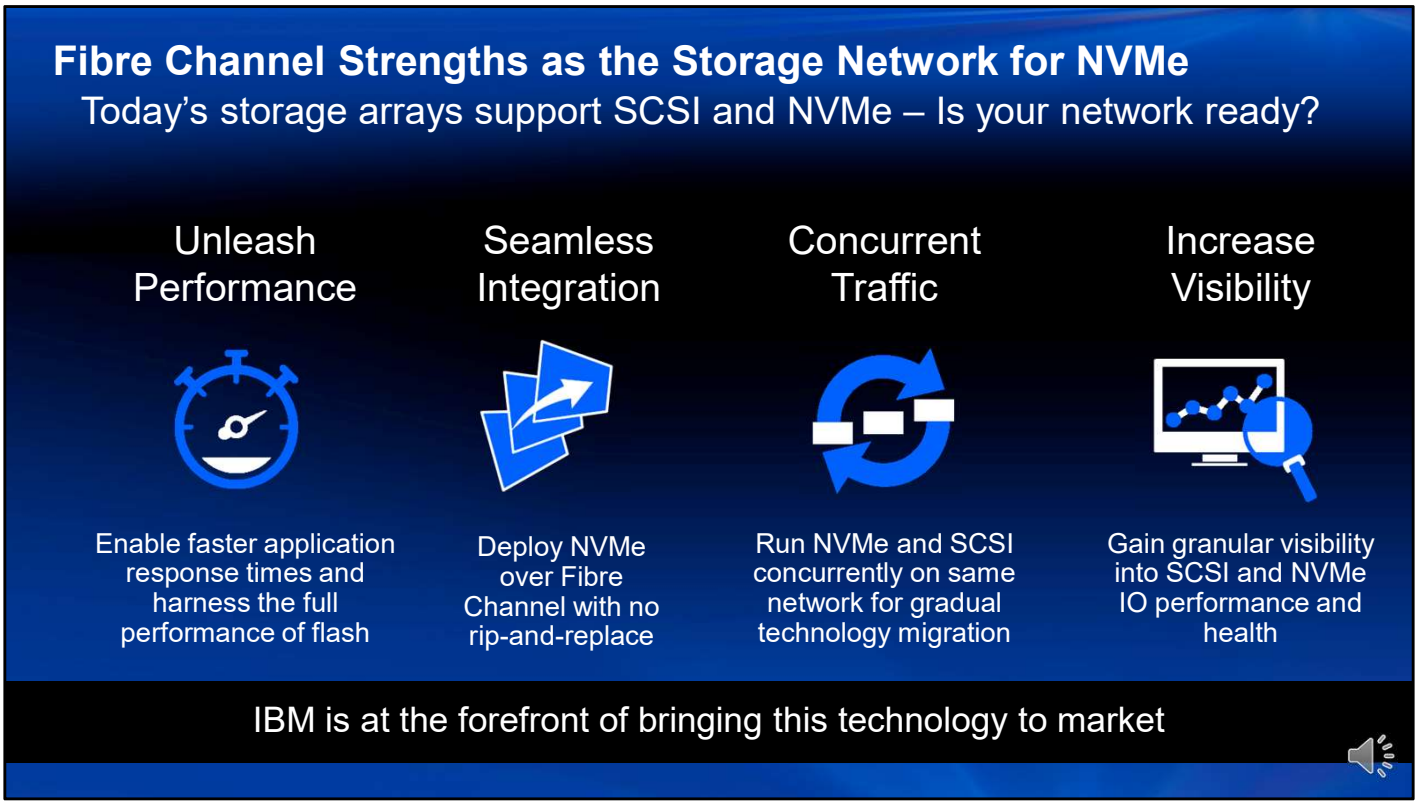
A full mesh topology connects every switch or director to each of the other switches in the fabric. A variation of the mesh topology is the partial mesh. In this design, each switch is connected to most of the other switches but not all of them.

The core/edge topology specializes the role of switches and directors. Hosts servers and storage are typically connected to the edge switches & directors, while core switches are used to connect the core switches to the edge switches. A core/edge design provides excellent scalability, availability, and performance.



And why is Fibre Channel used where data is critical?
Fibre Channel was purpose built for storage. That's also why it's the right network infrastructure to support NVMe storage.
Fibre Channel SAN's are the most trusted and widely deployed purpose-built networks for storage for a couple reasons:
click
They're "always on" networks, and so are used where access to data is critical to a company
click
They're designed specifically to support flash, and are ready today for NVMe
click
They're highly scalable, which is critical as data continues to grow exponentially
click
And they provide a secure network which isolates and encrypts storage traffic from general purpose networks
Fibre Channel has been an integral part of EVERY WAVE of storage advancement in the data center with Shared storage, server virtualization, Flash and now NVMe.
Fibre Channel networks are the connective tissue which connects businesses to their most critical applications and data.

Why partner with IBM? We will now review the strengths of the IBM b-type Storage Networking product line.

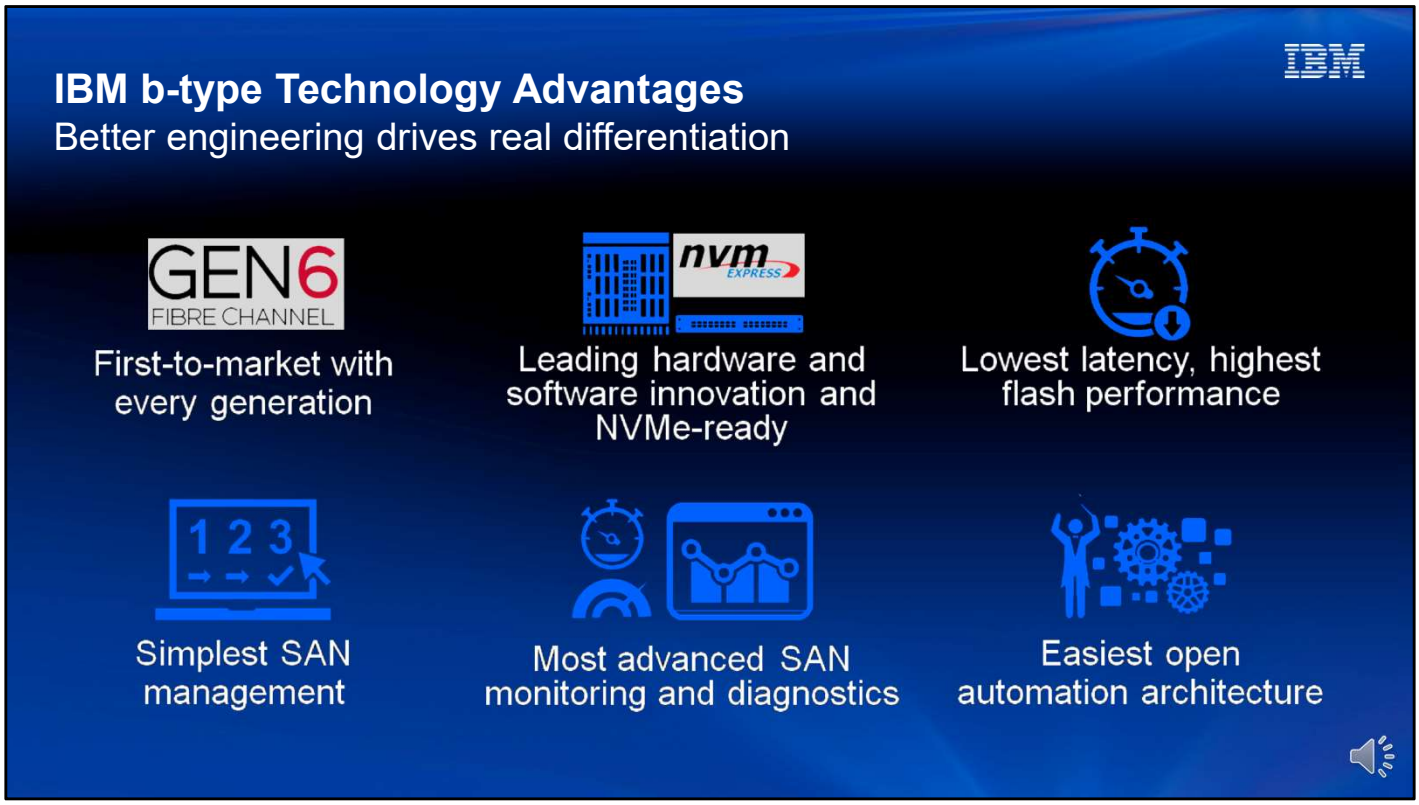


One of the most exciting storage advancements today is NVMe based storage. NVMe-FC is a reality with NVMe over Fibre Channel storage arrays available now from storage vendors.

By integrating the efficiency of NVMe with the high performance and low latency of Fibre Channel, organizations can scale IOPS to deliver the performance, application response time, and scalability needed for next-generation data centers.

And as companies redefine application performance with NVMe technology, NVMe over Fibre Channel will allow them to run both NVMe and SCSI concurrently on the same network for a gradual migration with no disruption.

IBM has been on the forefront of bringing this technology to market. IO Insight is one of the key IBM b-type SAN features that leverages integrated sensors to enable deep visibility into the IO performance of SCSI and NVMe flash storage. It provides unparalleled insight into potential issues and helps maintain service levels. This granular visibility can quickly identify degraded application performance at host and storage tiers, reducing time to resolution. Understanding the IO performance and health of NVMe workloads help organizations to ensure optimal performance in their environment.



IBM is at the forefront of driving Fibre Channel innovation to help customers deliver more value from their applications and infrastructure. Through Fibre Channel leadership, IBM b-type SAN prides themselves in delivering next-generation technology first. While others are preparing to release their next gen products, IBM is already releasing advanced features for their next gen products.

IBM combines innovative hardware and software technology to deliver the lowest latency and highest performance for flash. With the most advanced SAN monitoring and diagnostics technology, organizations can simplify monitoring, increase operational stability, and dramatically reduce costs.

Enterprises today are faced with an unprecedented amount of operational data points and increased infrastructure complexity, that can be overwhelming to manage. In fact, according to ESG's research, 68% of IT decision makers say that IT is more complex than it was just two years ago.

To address this complexity, IBM introduced new SAN management and Automation solutions.

The new SAN management is SANnav Management Portal and SANnav Global View that provide:

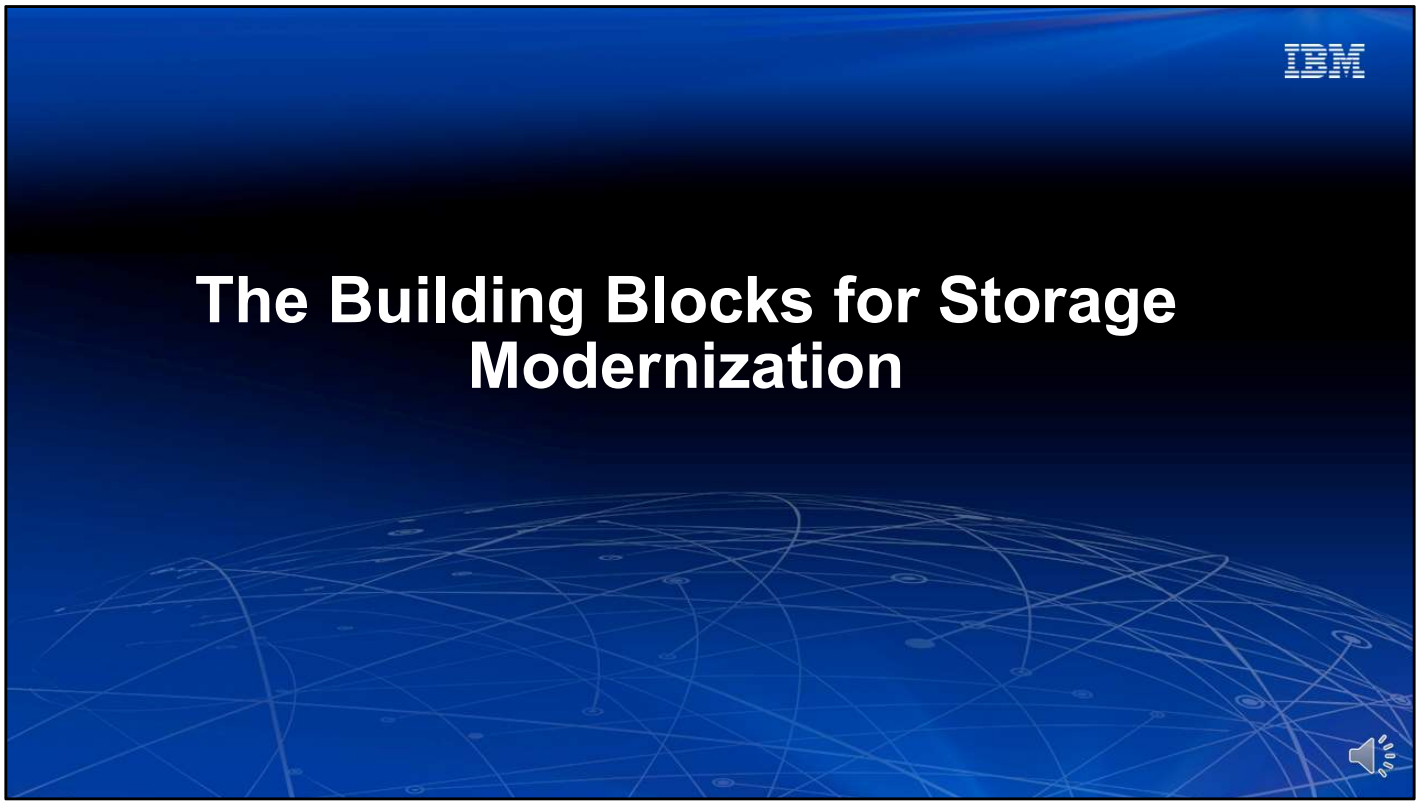
-visibility across multiple SAN fabrics

-transform SAN behavior and performance data into actionable insights

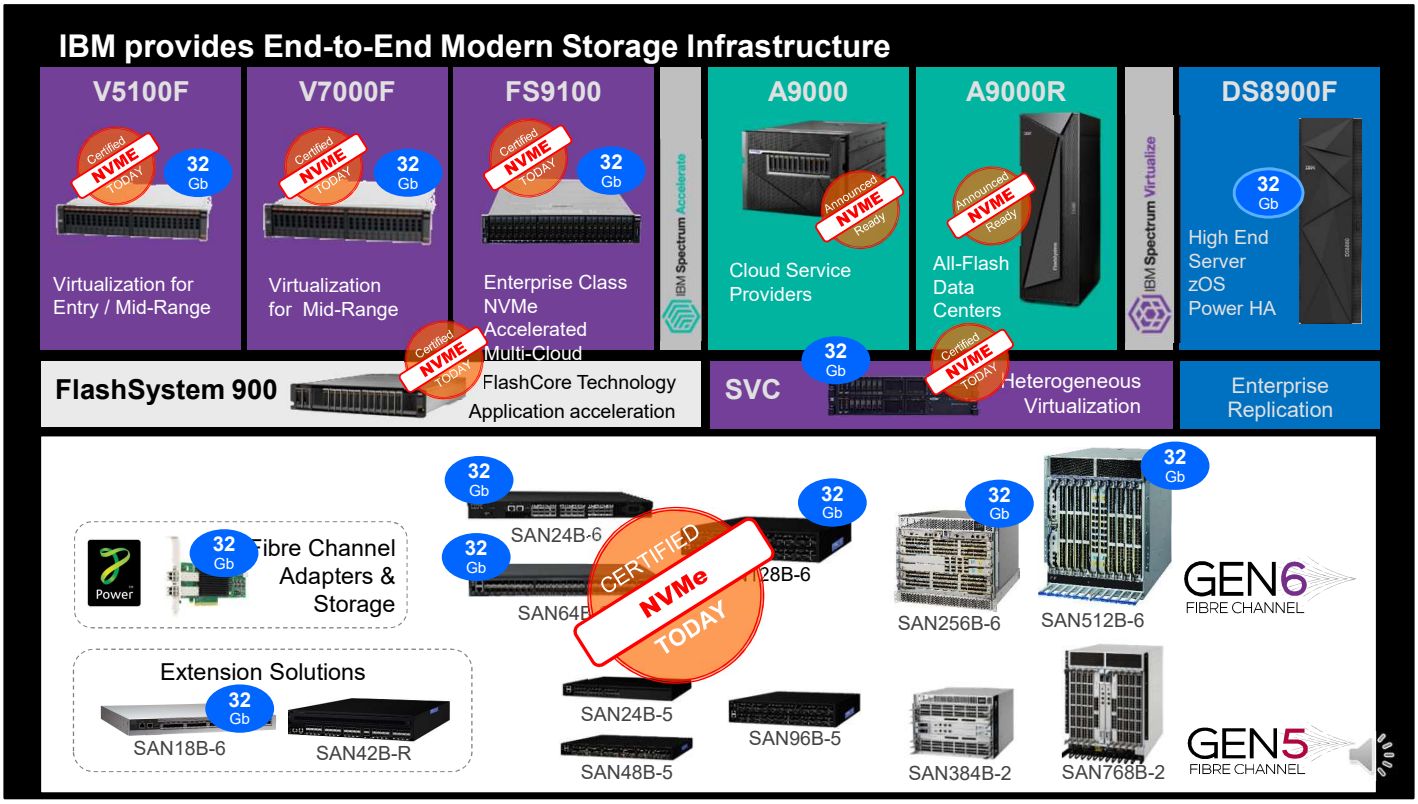
-reduces administrative tasks through automation.

The other solution is IBM automation that leverages open-source technology to automate and orchestrate repetitive tasks, enable IT organizations to significantly improve their efficiency, and decrease the risk of operational mistakes.

These new sophisticated capabilities accelerate administrative tasks by simplifying workflows and automating redundant steps, making it easier for organizations to realize their goals.



Next, lets cover the building blocks need to modernize a data center's storage infrastructure



Here are the current IBM storage array products available. They should be familiar to you, Depending on when you view this training, they have have changed since this snapshot in time. The important aspect to know is that IBM offers clients market leading storage products from entry level to enterprise. Many of them built on core IBM technologies such as FlashCore Modules, SAN Virtualization Clusters (SVC), and Enterprise Replication for providing the absolute best performance, availability and heterogeneous storage support.

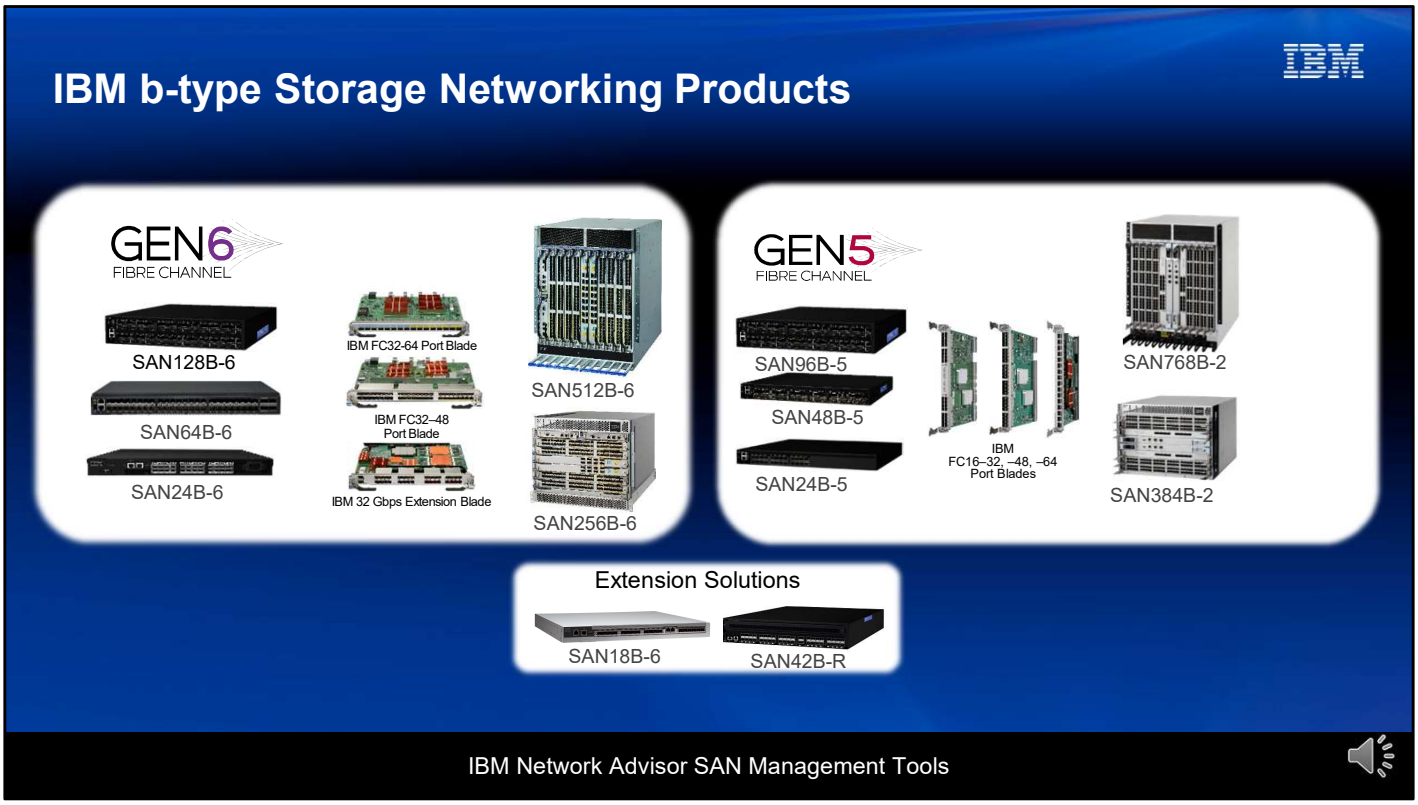
For these products to connect to the applications, storage networking is required. Broadcom partners with IBM, to provide the Fibre Channel server adapters, the Fibre Channel SAN itself, and key technology within the storage arrays, all enabling an end to end solution that meets the needs to today's modern data centers.

All of the IBM b-type Gen 5 and Gen 6 products support the low latency NVMe protocol in addition to traditional SCSI and is a perfect match for all the IBM storage that also supports NVMe.

Additionally, the Gen 6 adapter and SAN products support up to 32 Gbps port speed that perfectly matches the IBM storage arrays supporting 32 Gbps FC.

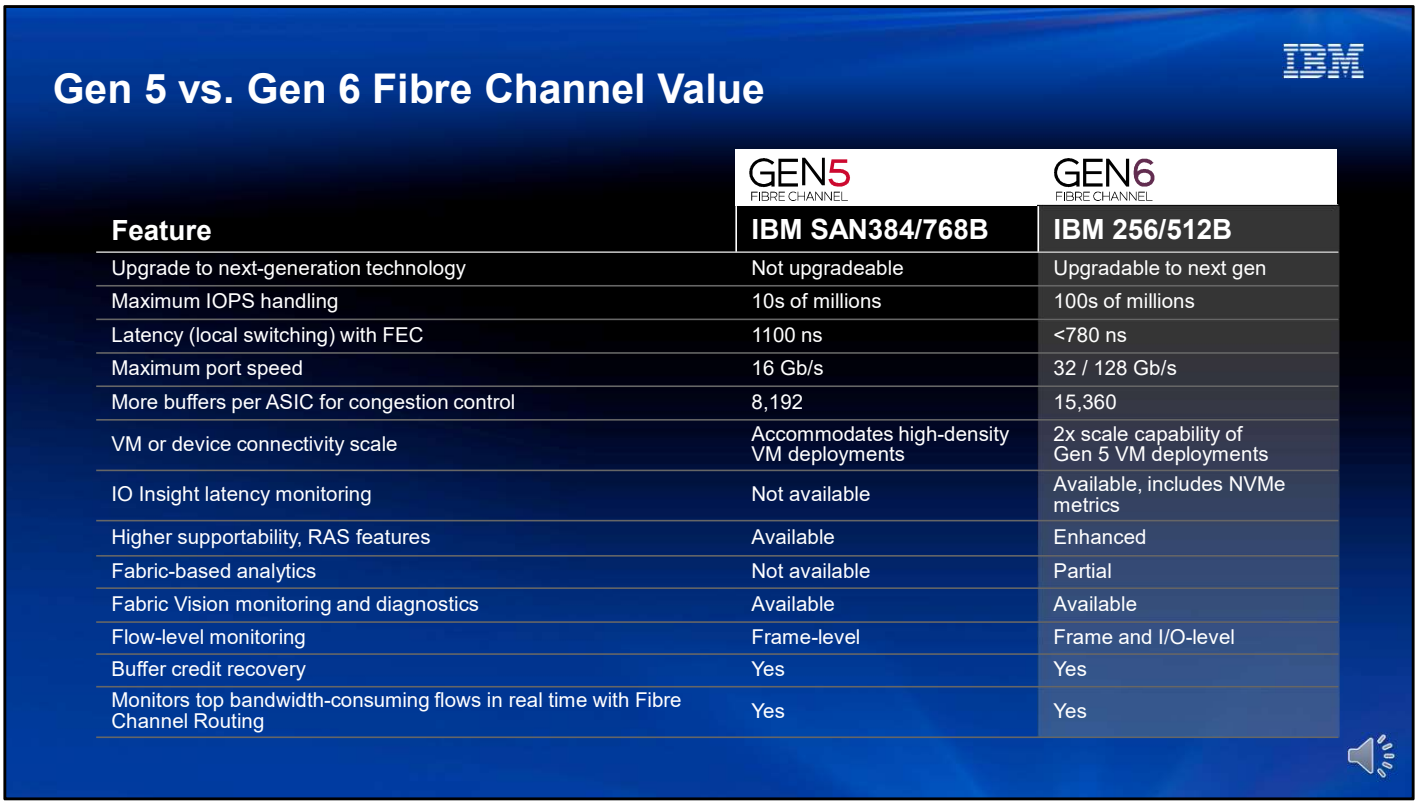
Storage solutions should be viewed as an ecosystem. When you propose storage, you need to check the storage networking to ensure that the maximum performance of the overall solution is not inhibited by a legacy network.

Now let’s look at the b-type products in more detail.

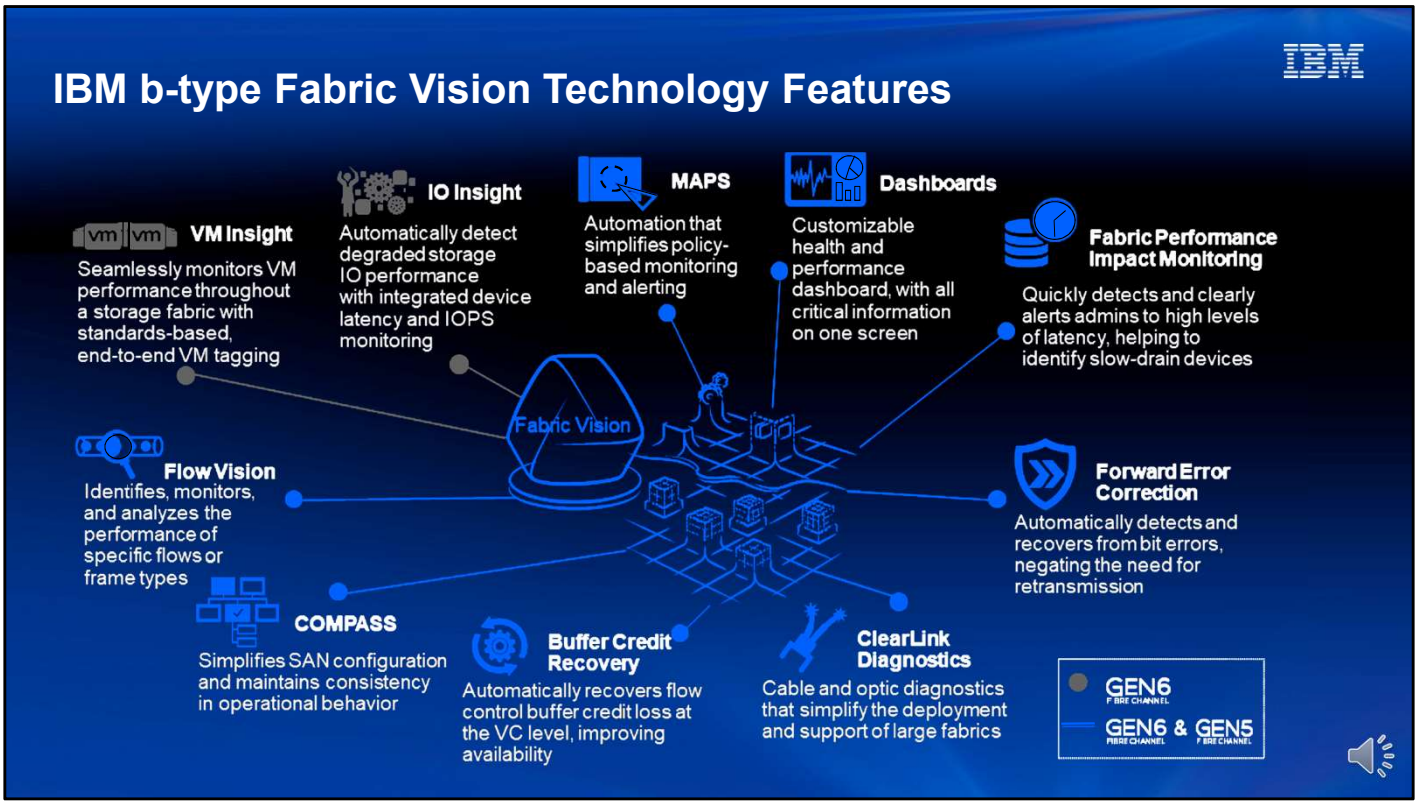


Most SANs are deployed using Gen6 and Gen5 Fibre Channel products.

- Gen6 Fibre Channel products support Fibre Channel port speeds of 32, 16, 10, 8 and 4 Gigabits per second (Gbps). IBM b-type Gen6 products include the SAN512-6 and SAN256-6 directors with blades and the SAN128B-6, SAN64B-6 and SAN24B-6 switches.
- Gen5 Fibre Channel products support Fibre Channel port speeds of 16, 10, 8, 4 and. IBM b-type Gen5 products include the SAN768B and SAN384B directors and blades along with the SAN96B-5, SAN48B-5 and SAN24B-5 switches.
- The SAN 42B-R and SAN 18B-6 extension switches are used to extend SANs over long distance IP links.
- For SAN management, IBM offers the IBM Network Advisor. Stay tune in this area for future management products to come



Beyond port speeds, there are a number of differences between IBM Gen 5 and Gen 6. Gen 6 directors are future proofed and can be upgraded to next gen Fibre Channel. The maximum IOPS jumps from tens of millions to 100s of millions. Local switching latency is also reduced from 1100 nano seconds to less then 780 nano seconds on Gen 6. The number of available buffer credits per ASIC used for congestion control increases from 8,192 on Gen 5 to 15,360 with Gen 6. For virtual machine deployments, Gen 6 is capable of scaling up to two times greater then Gen 5. Gen 6 also supports IBM s IO insight latency monitoring as well as both frame and I/O-level monitoring.



Both IBM b-type Gen 5 and Gen 6 switches and directors support Fabric Vision technology features. They include the Monitoring Alerting Policy Suite (MAPS) for automation that simplifies policy-based monitoring and alerting. There's also customizable health and performance dashboards. Fabric Performance Impact (FPI) is used to quickly detect and alert admins when high latency is detected on both device ports and inter-switch links. Flow Vision is a family of flow based features used to generate, mirror, or monitor traffic flows. They are excellent tools for monitoring and analyzing specific flows or frame types between source and destination devices. Gen 6 platforms also include two additional Flow Vision capabilities. IO Insight can be used to detect degraded storage IO performance with latency IOPS monitoring. While VM Insight monitors performance between virtual machines and storage.

These are just some of the Fabric Vision technology features that differentiate IBM b-type Gen 5 and Gen 6 products.

Gen 6 Fibre Channel Switches

- Fixed form factor – “pizza box” usually 1u or 2u
- Different port counts
  - From 24-port to 128-port
  - Can purchase ports in increments – POD
  - Example: a 24-port SAN24B-6 starts with 8 ports active and you can add up to (2) 8-port PODs to reach 24 ports max
- Use Inter Switch Links (ISL) between switches to scale your SAN
- Runs b-type FOS (Fabric Operating System)
- Fixed single backplane (switch is a FRU)
- Non-disruptive Hot Code Load (firmware upgrade)
- Modular redundant power* and cooling

IBM SAN24B-6

IBM SAN64B-6

IBM SAN128B-6

IBM offers three fixed form factor switches in different port counts from 24-ports to 128-ports. All three provide pay as you grow investment protection through ports on demand (POD) licensing. For example, a 24-port SAN24B-6 starts with 8 active ports and additional ports can be enabled in 8-port increments by purchasing additional POD licenses. The SAN64B-6 is a 64-port switch with 24 active SFP ports in the base configuration. 24 additional SFP ports can be enabled in 12-port increments with POD licenses and the four QSFP ports can be enabled with a single Q-Flex POD license. While the SAN128B-6 is a 128-port switch with 48 active SFP ports in the base configuration. 48 additional SFP ports can be enabled in 24-port increments and the eight QSFP ports can be enabled using a single Q-Flex POD license.

All three have a single processor, run the same Fabric OS and provide non-disruptive Hot Code Load for firmware upgrades. In addition, the SAN64B-6 and SAN128B-6 provide modular field replaceable redundant power.

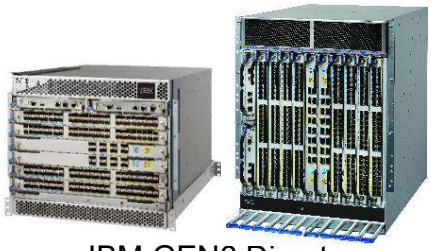
All three support IBM b-type ISL trunking, extended Fabrics, Fabric Vision tools including IO Insight and VM Insight.

The IBM SAN24B- and SAN64B-6 also support Access Gateway mode.

In addition, the SAN64B-6 and SAN128B-6 also support integrated Fibre Channel Routing.

Gen 6 Fibre Channel Directors

- Chassis form factor – 9u to 14u
- Blades determine port counts and function:
  - 4 or 8 slots available dependent on chassis
  - Fibre channel port blades come in 48-port & 64-port
  - Extension Blade
  - Can start with as few as one blade and increase port count by adding additional blades
- Inter Chassis Link connects at backplane to grow SAN up to 10 chassis
- Runs FOS (Fabric Operating System)
- Modular redundant Core Processing and Core Routing Blades
- Non-disruptive Hot Code Load (firmware upgrade)
- Modular redundant power and cooling



IBM GEN6 Directors
SAN256B-6 and SAN512B-6

FC32-48 Blade

FC32-64 Blade

32 Gbps Extension Blade

There are two Gen 6 directors available, the 4-slot 9u SAN 256B-6 and 8-slot 14u SAN 512B-6. Port count and function is determined by which blades are used and how many are installed. There are two port blades available, the 48-port FC32-48 and the 64-port FC32-64. There is also the SX6 extension blade which is used to extend Fibre Channel fabrics over long distances by tunneling Fibre Channel Traffic over IP links, which is referred to as FCIP. It also supports IP extension for native IP SANs.

Both directors include Inter Chassis Link (ICL) ports. The ICL ports are located on the two redundant core routing blades and allow up to 10 chassis to be connected together. In addition to the redundant core routing blades the Directors also have redundant core processing blades.

Both Directors run the same Fabric OS as the Gen 6 switches and provide non-disruptive Hot Code Load for firmware upgrades.

All blades in the chassis, as well as the redundant power and cooling, are hot swappable.

When choosing between deploying switches vs. directors, both use the same generation of ASICs, support the same port speeds and run the same operating system. So it typically becomes a choice of price vs. performance, scale, availability and functionality. While switches come at a lower price, directors offer greater performance, scalability and availability; as well as some additional features such as IO Insight for both target and initiator ports, while switches support target ports only. Directors can scale to larger fabrics, offer a module design allowing customers to use the ports they need now, then simply add a blade later when more ports are needed, and provides greater levels availability with redundant processing & routing blades.

Another aspect that factors into choosing a switch or a director is port count. For small-to-midsize deployments switches can be a great solution but scale and functionality will be restricted. As port count requirements increase the need for directors grow, making them the preferred choice for larger deployments. Looking at the number of available ports on the SAN128B-6 its tempting to consider them for mid-to-large deployments as seven SAN128B-6s with a 2U form factor takes the same amount of rack space as a single 14U SAN 512B-6 director. Seven 128 port SAN128B-6s provides 896 ports while a single SAN 512B-6 fully populated with 64-port blades has 512. This would appear to give the SAN128B-6 an advantage of total available ports for the same amount of rack space used. But this does not factor in the 32 ICL ports which provides the same bandwidth for interconnecting director chassis as 128 user ports. Also, approximately half the available SAN128B-6 ports would have to be used to interconnect the SAN128B-6s together to maintain a similar over-subscription ration.

In the end, switches are a great solution for some implementations but directors should

be your go-to choice.

Beyond Scalability, Directors Deliver Differentiation and Added Value

Director Advantage	Benefit to Customer
Higher Availability with redundant CRs, CPs, Power Supplies and Fans	Highest availability and system uptime
Single management domain	Minimize operational overhead associated with managing multiple switches
Higher port scalability	Ability to quickly adapt to growth demands with industry-leading port density, scales to 512 ports
Flexible storage connectivity and deployment offerings	Adapt to evolving requirements, increase business agility and gain operational efficiency
High performance scale-out architecture with UltraScale ICL connectivity (ICLs)	Consolidate infrastructure for simpler, flatter, low-latency fabrics that maximizes overall port density and frees up device ports for server and storage connectivity
Smaller failure domain	Continuous uptime with non-disruptive, hot-pluggable components and a no-single-point-of-failure design

VS

In review, directors have a several advantages over switches that benefit the customer.

1. They provide higher availability with redundant core routing blades, central processing blades, power supplies and fans providing the highest availability and system uptime for customers.
2. The higher port count of directors means fewer management domains to administer, minimizing operation overhead associated with managing multiple switches.
3. The higher port density also provides greater scalability which allows a customer to quickly adapt to growth demands.
4. Directors provide flexible storage connectivity and deployment offerings allowing customers to adapt to evolving requirements, increase business agility and gain operational efficiency.
5. UltraScale ICL connectivity provides a high performance scale-out architecture. This allows customers to consolidate infrastructure for simpler, flatter, low-latency fabrics that maximizes overall port density and frees up device ports for server and storage connectivity.
6. The no-single-point-of-failure design of directors mean they have a smaller failure domain providing continuous uptime with non-disruptive hot-pluggable components.

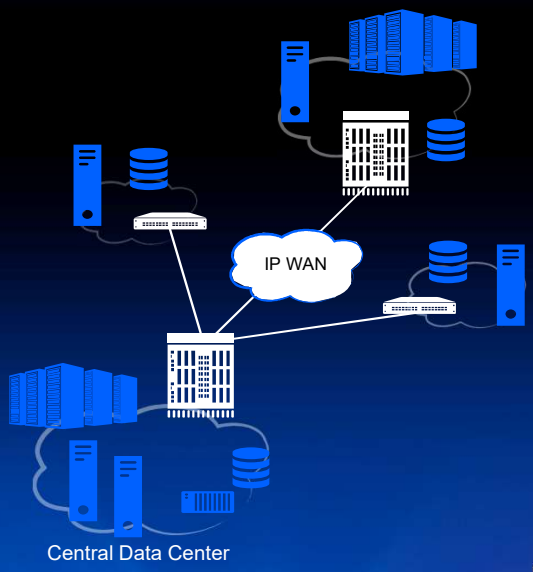
Data Protection with IBM b-type Extension

Move more data over distance faster for FC and IP storage environments

Perfect to Ensure fast and continuous replication of data to anywhere in the world

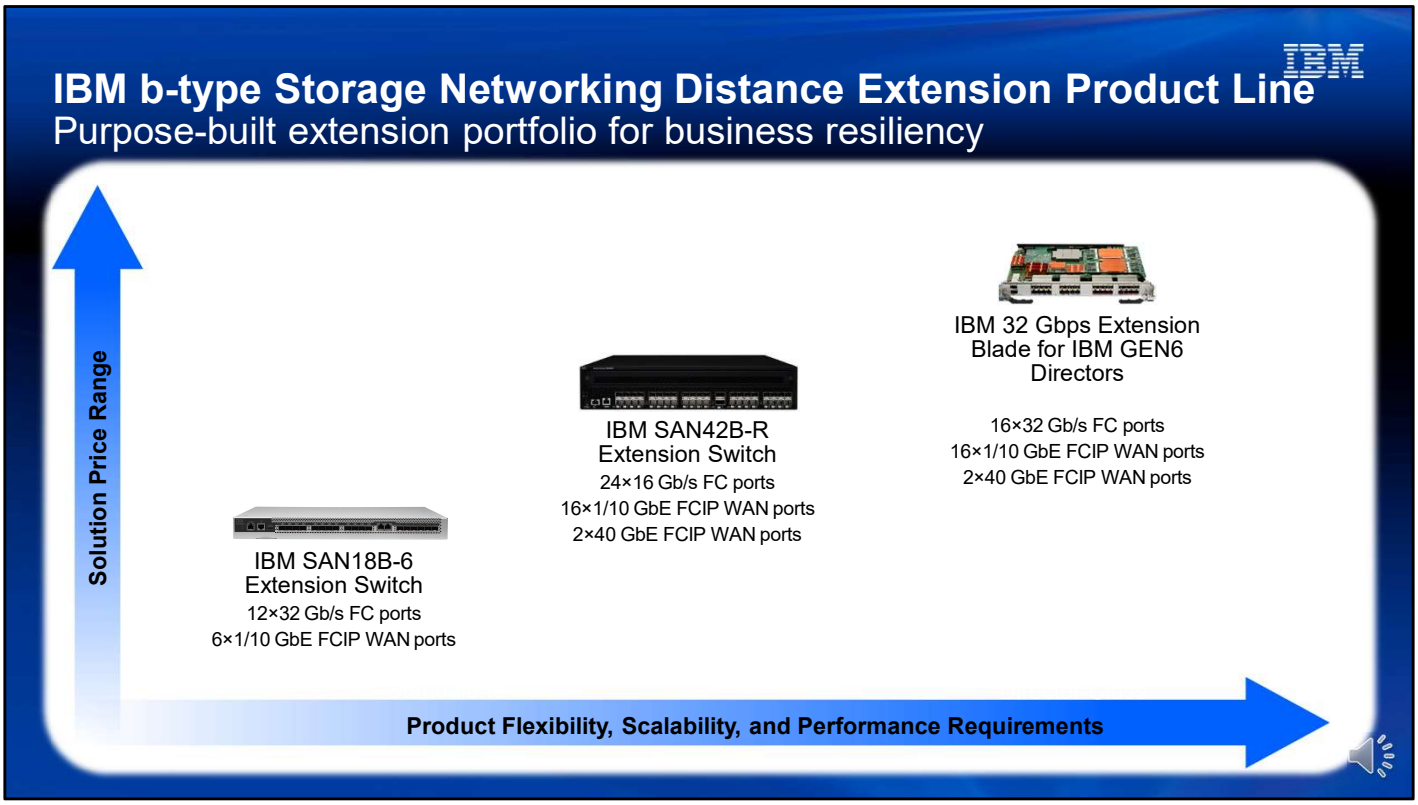
Built to Handle the unrelenting transfer of data between data centers

Optimal for Large-scale, multi-site data center environments implementing block, file, and tape data protection



FCIP is a tunneling protocol that provides transparent interconnection of Fibre Channel fabrics in different geographical locations through an IP-based network. Its used for remote data center replication, mirroring, centralized backup, global data sharing and data migration for environments where IP networking is preferred because of cost or distance limitations of native Fibre Channel over long distance dark fiber links.

- FCIP is perfect to ensure fast and continuous replication of data to anywhere in the world.
- Built to handle the unrelenting transfer of data between data centers
- And optimal for large-scale, multi-site data center environments implementing block, file, and tape data protection



A previously noted, IBM has b-type storage extension products that are used to extend Fibre Channel fabrics over long distances by tunneling Fibre Channel over IP links; referred to as FCIP. The extension products also supports IP extension for native IP SANs.

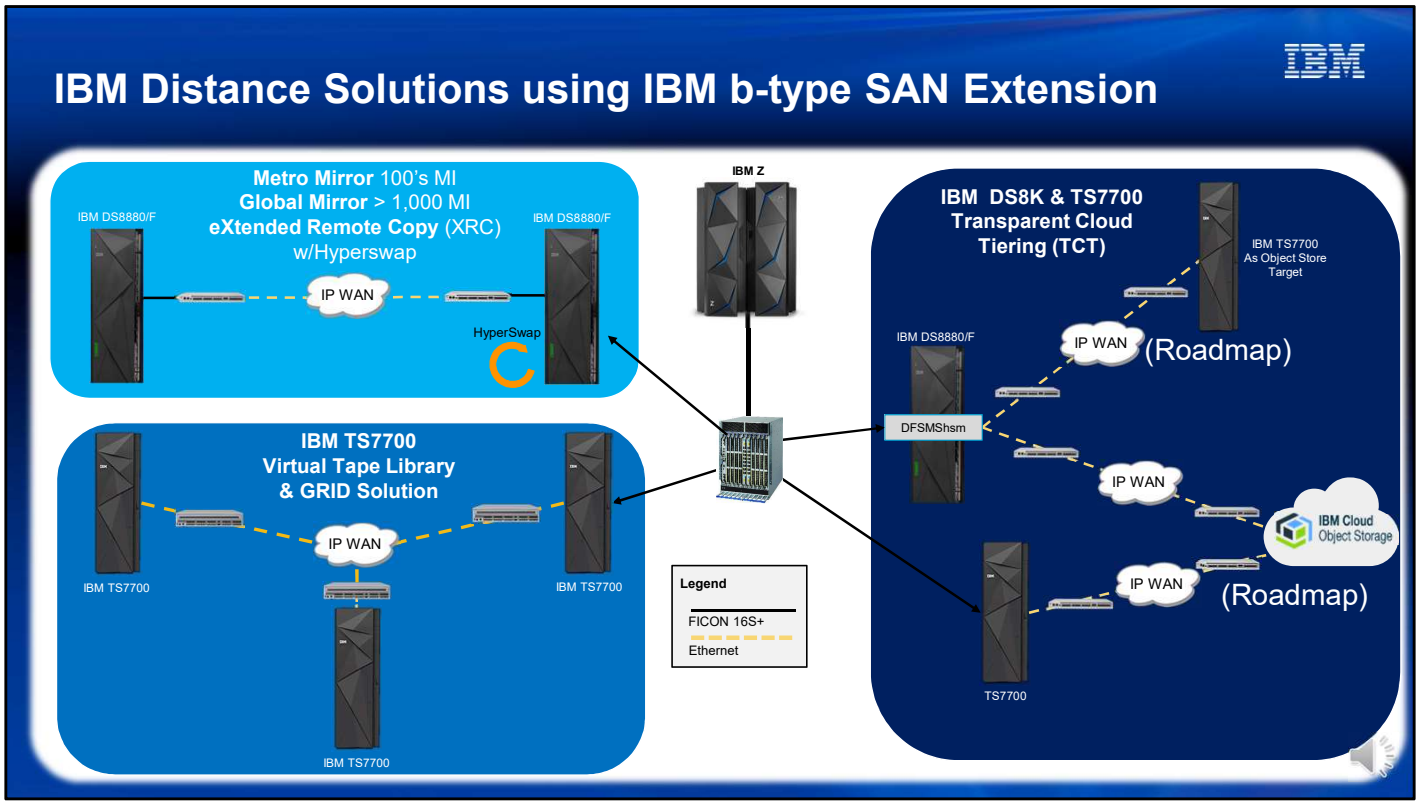
IBM offers three purpose-built extension products. The IBM SAN18B-6 extension switch, the IBM SAN42B-R extensions switch and the 32 Gbps extension blade for the Gen 6 directors. Distance extension requires an extension product at each end and all three are interoperable with each other. All three support compression, IPsec encryption, trunking, adaptive rate limiting (ARL), Fabric Vision, WAN tools and none disruptive Hot Code Load for FCIP and Fibre Channel traffic.

Like directors and switches, which extension product to deploy depends on the customers needs, current topology and typically is driven by price vs. performance, scale, availability and functionality.

For small to medium deployments the SAN18B-6 is a good choice. It offers twelve 32 Gigabit Gen 6 Fibre Channel ports and six 1/10 Gigabit Ethernet ports. Two of the Ethernet ports are designated for FCIP connectivity and four are designated for IP WAN extension. The SAN18B-6 actually has a total of 8 Ethernet ports, 6 SFP and 2 fixed RJ-45 copper ports, but only a total of 6 out of the 8 ports can be active. Ether 6 SFP or 4 SFP and 2 RJ-45.

For large enterprise deployments, the SAN42B-R is a great solution. It offers twenty-four Gen 5 Fibre Channel ports, sixteen 1/10 Gigabit Ethernet ports, and two 40 Gigabit Ethernet ports.

For global 1000/ large enterprise deployments the best solution is the 32 Gbps extension blade. It provides sixteen 32G Gen 6 Fibre Channel ports, sixteen 1/10 Gigabit Ethernet ports, and two 40 Gigabit Ethernet ports. Up to four extension blades are supported in the Gen 6 directors.



Shown on this slide are several very popular enterprise IBM distance solutions that use IBM b-type SAN and extension products.
These solutions include Metro Mirroring for Metropolitan distances in the hundreds of miles, then Global Mirroring for distances over 1000 miles which is also called XRC for eXtended Remote Copy.
IBM also offers the TS7700 Virtual Tape Library Grid Solution where the SAN42B-R and Gen 6 extension blades are used to provide enhanced long distance links with WAN optimization, hardware based encryption and.
A relatively new extension solution is the IBM DS8000 and TS7700 Transparent Cloud Tiering where the data also resides in IBM Cloud Object Storage.
All of these are proven long distance solutions that span the Globe and provide superior Business Continuity and Disaster Recovery.

- Selling SAN with your storage matters. It increases revenue, provides account control,
adds additional opportunities and increases customer satisfaction.
- SAN is a proven, purpose built network for storage traffic that is ideal for enterprises
and a must for mission critical applications.
- IBM b-type Gen 6 products and features modernize storage infrastructure while also
increasing performance, visibility and extensibility. They also provide multi-protocol support with SCSI, NVMe and FICON all supported in the same fabric as the same time.
- And Brocade is here to help with collateral, training and sales support


IBM
Thank You