

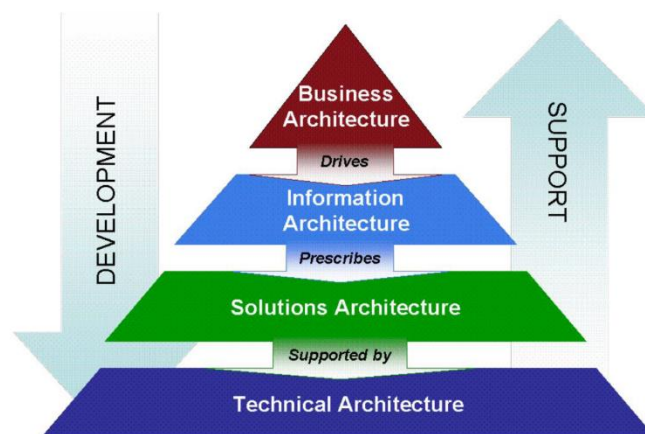


Enterprise Architecture Technical Brief

SAN Booting or DAS Booting

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Enterprise Architecture SAN Booting or DAS Booting

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SAN Boot Recommendation

We recommend eliminating DAS booting in favor of Storage Area Network (SAN) booting. SAN booting can be a valid, high performance, and low maintenance solution in the proper environment. For instance, in large IBM-only environments with stable and supported SANs, booting from SAN can be done with confidence. In small environments with limited support, or third party SANs, or isolated / stand-alone small servers, they should boot DAS. Booting from SAN is not feasible in every case for a variety of reasons. Please use the enterprise architecture exception process when there is a known problem, issue, or concern that makes DAS booting a more common sense approach.

Form is located at this page:

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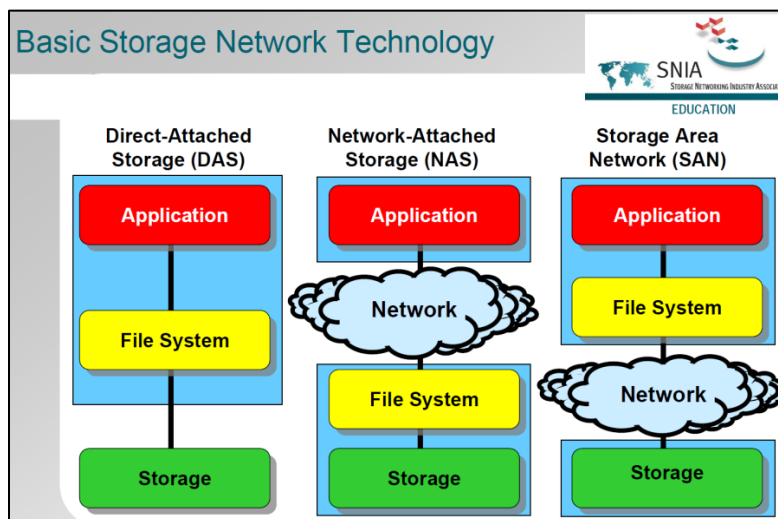


Figure 1: Basic Storage Network Technology. ¹

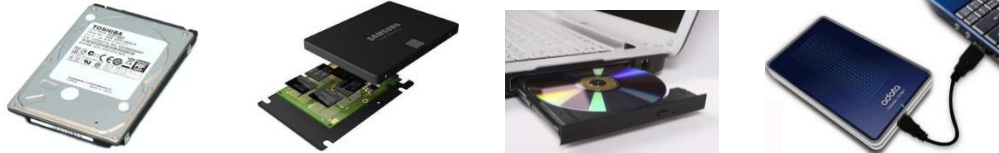
For any comments, questions, and/or concerns with this technical brief, please contact VITA EA: ea@vita.virginia.gov

¹ Network Technologies: Concepts in Internal and External Networked Storage by Howard Goldstein of Storage Networking Industry Association (SNIA). Retrieved from <https://www.slideshare.net/sagaroceanic11/storage-networkingtechnologies> on May 18, 2017.



Direct Attached Storage (DAS) Booting

- Formerly known as DASD for Direct Attached Storage Device.
- DAS.²
 - The name "DAS" is a retronym to contrast with storage area network (SAN) and network-attached storage (NAS).
 - Advances in technology are often responsible for the coinage of retronyms. For example, the term "acoustic guitar" was coined at the advent of electric guitars, and analog watches were thus named to distinguish them from digital watches.³
 - DAS storage is only directly accessible from the host / server to which the DAS is attached.
 - Examples of DAS include hard drives, solid-state drives, optical disc drives, and storage on external drives.



- The storage presented by a DAS to a connected host can of course be shared by that host.
- DAS does not incorporate any network hardware and related operating environment to provide a facility to share storage resources independently.

Direct Attached Storage (DAS)

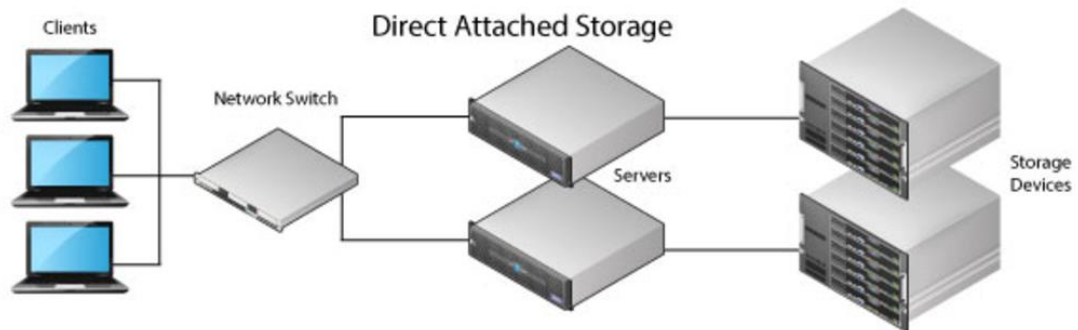


Figure 2: Direct Attached Storage (DAS) View.⁴

- Direct Storage.⁵

² Direct Attached Storage (DAS) by Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Direct-attached_storage on May 18, 2017.

³ Wikipedia – the free encyclopedia. Retrieved from https://en.wikipedia.org/wiki/Retronym_on_May_25, 2017.

⁴ How to Choose the Right Type of Storage Solution for Your Needs by Matt McNulty, Codero Hosting on Demand (article). Retrieved from <http://www.codero.com/blog/how-to-choose-storage-solution/> on May 19, 2017.

⁵ SAN – Storage Area Network by Vangie Beal (article) of Webopedia. Retrieved from <http://www.webopedia.com/TERM/S/SAN.html> on May 19, 2017.



Enterprise Architecture SAN Booting or DAS Booting

- Before the advent of SANs, organizations generally used direct-attached storage (DAS). As the name implies, DAS is directly attached to the server, residing either on the server or in a standalone storage device that is not part of a separate storage networking environment. Many smaller organizations continue to use DAS today because it offers lower upfront costs than deploying a SAN. However, for larger companies, the benefits of a SAN often outweigh the costs.
- Basically DAS refers to anything that attaches directly to a computer (or a server) without any network component (like a network switch) between them.
- DAS is ideal for:⁶
 - Local data provisioning.
 - Quickly deploy for small environments.
 - Being simple to deploy.
 - Reliability.
 - Low capital expense.
 - Low complexity.

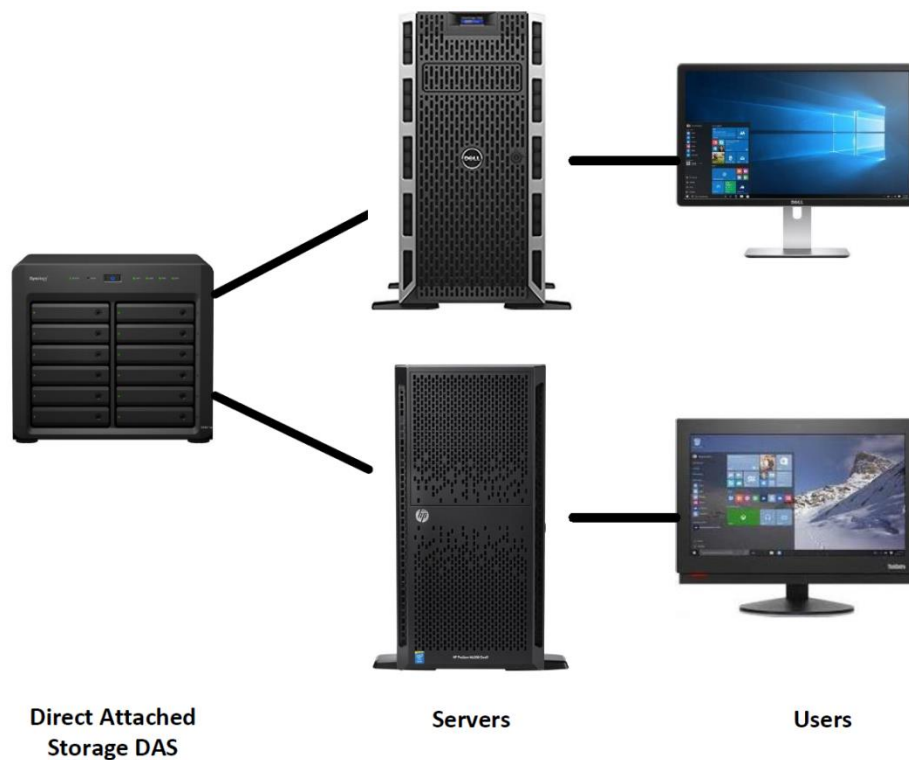


Figure 3: Externally Connected DAS View.

⁶ EMC Presentation (PPT file). Retrieved from the web on May 19, 2017.



Storage Area Network (SAN) Booting

- Storage Configuration Options.⁷
 - SAN is an architecture to attach remote computer storage devices (such as disk arrays and tape libraries) to servers in such a way that **the storage devices appear as locally attached to the servers.**
- Wikipedia on SAN.⁸
 - **SAN has more in common with DAS than many people think**, with the key difference being DAS is a 1:1 relationship between storage and host, whereas SAN is a many to many relationship.
 - DAS is physically connected to a local server by some type of connection cable, while a SAN is directly connected logically to any number of servers.
- What is SAN?⁹
 - SAN storage devices are connected over a high-speed network to servers.
 - Provides block-level storage that can be accessed by the applications running on any networked servers.
 - SAN storage devices can include tape libraries and disk-based devices.
 - **The main functions of a SAN include:**
 - High-speed storage devices on a network.
 - A network connecting storage devices with servers.
 - Applications running on a server that directly access storage devices in a SAN network.
 - Advantages of a SAN include:
 - **Being particularly helpful in backup and disaster recovery.**
 - Data can be transferred from one storage device to another without interacting with a server which speeds up the backup process and **eliminates using server CPU cycles for backup.**
 - Uses networking protocols to span longer distances geographically.
 - SAN can also simplify some management tasks.
 - Offers flexibility, availability, and improved server performance.
 - Because a **SAN** removes storage from the servers and consolidates it in a place where it can be accessed by any application, it **tends to improve storage utilization of the overall environment.**
 - Storage utilization improvements often allow organizations to defer purchases of additional storage hardware, which saves money and requires less physical or floor-space in the data center.

⁷ Exchange 2013 storage configuration options by Microsoft's TechNet last modified on Dec 9, 2016. Retrieved from <https://technet.microsoft.com/en-us/library/ee832792%28v=exchg.150%29.aspx> on May 18, 2017.

⁸ Direct Attached Storage (DAS) by Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Direct-attached_storage on May 18, 2017.

⁹ SAN – Storage Area Network by Vangie Beal (article) of Webopedia. Retrieved from <http://www.webopedia.com/TERM/S/SAN.html> on May 19, 2017.



Enterprise Architecture SAN Booting or DAS Booting

- Thanks to high-speed connections (usually Fibre Channel), **SANs often provide better performance than DAS.**
 - Also, because SANs usually offer multiple connections to and from the data center's servers, they also improve server availability.
 - **Separating storage from servers frees up server computing resources for other non-storage related tasks.**
- Differences between SAN and NAS
 - Sometimes people confuse the term SAN with the term NAS, which stands for "network-attached storage." The key to distinguishing the two lies in the last term of each acronym:
 - **SAN** (storage area network) is **an actual network of storage devices.**
 - **NAS** (network-attached storage) refers to a single **storage device**, typically accessed by users over an IP network.
 - While SANs provide block-level storage for servers, a NAS device provides file-level storage for end users.
 - For example, the mail application on your company servers might utilize a SAN to store all the messages, contacts and other data it requires; by contrast, an end user would use a NAS device to save files, such as word processing documents or spreadsheets.
 - **Operating systems see a SAN as a disk**, while they see a NAS device as a file server.
 - NAS is not recommended, nor used as a boot-from option.

Quick Overview

	DAS	NAS	SAN
Storage Type	sectors	shared files	blocks
Data Transmission	IDE/SCSI	TCP/IP, Ethernet	Fibre Channel
Access Mode	clients or servers	clients or servers	servers
Capacity (bytes)	10^9	$10^9 - 10^{12}$	$> 10^{12}$
Complexity	Easy	Moderate	Difficult
Management Cost (per GB)	High	Moderate	Low

Figure 7: DAS, NAS, and SAN Overview.



Enterprise Architecture SAN Booting or DAS Booting

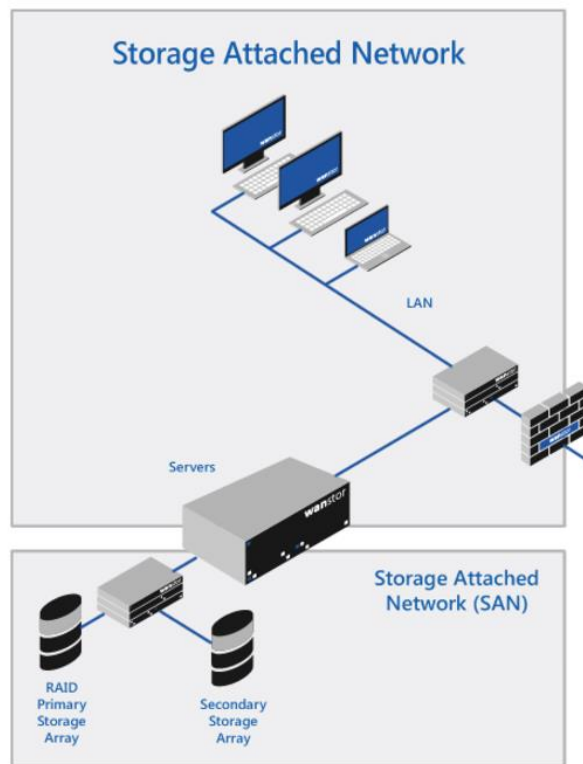


Figure 4: Storage Attached Network (SAN) View.

- How Server Storage Area Networks Fit Into Modern Infrastructure? ¹⁰
 - SAN technology originated in the late 1990's as a way to overcome the inefficiencies of DAS. **By centralizing data between machines, it became easier to move data across clusters – cutting time from hours/days to seconds/minutes**, and making it possible for companies to improve capacity without sacrificing reliability. Rather than keeping data specific to a single device, SANs allow data to be sharable while also enabling multiple devices to pool their capacities.
- TechTarget on SAN Booting Alternatives. ¹¹
 - **Highly virtualized environments already boot the majority of their machines from SAN or NAS because virtual machine (VM) hypervisors require high-bandwidth I/O.**
 - With all server I/O traveling over the network, quick and reliable connections from the host bus adapter (HBA) to the array are critical.

¹⁰ How Server Storage Area Networks Fit Into Modern Infrastructure? By Site24x7 in 2015. Retrieved from <https://www.site24x7.com/blog/server-storage-area-networks> on May 19, 2017.

¹¹ SAN booting alternatives for data storage managers by Stephen Fosgett of TechTarget's SearchStorage (article). Retrieved from <http://searchstorage.techtarget.com/tip/SAN-booting-alternatives-for-data-storage-managers> on May 18, 2017.



Enterprise Architecture SAN Booting or DAS Booting

- Booting from SAN has long been possible, however, it never gained traction from server administrators as they simply felt more comfortable booting from an internal hard disk drive.

Storage Area Network (SAN)

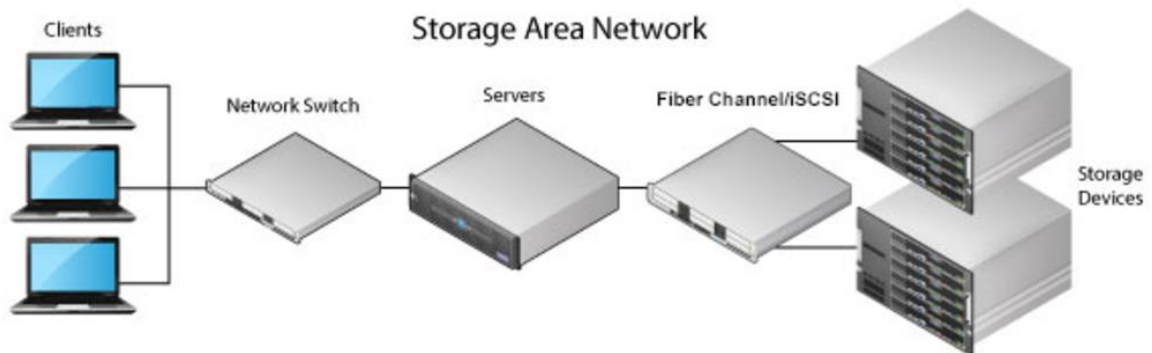


Figure 5: Direct Attached Storage (DAS) View. ¹²

- IBM. ¹³
 - **SAN** boot is so obvious - it is a given default now. **The key is the customer environment.** For instance, in large IBM-only environments with stable and supported SANs, booting from SAN can be done with confidence. In small environments with limited support or third party SANs, they should boot local.
 - The IBM service team confirms that SAN booting your VIOS is business as usual (BAU) saying, "SAN booting VIOS: Completely normal and something being done for quite a long time with customers and they tend to treat it like local storage really (i.e. no difference). **SAN booting should be the default option these days with the exception of isolated / stand-alone small servers which can do local boot.**"
 - Larger environments typically have better standardization, more in-house knowledge and better support tools. For instance, having many AIX systems makes it more likely the platform will be fully supported internally.

¹² How to Choose the Right Type of Storage Solution for Your Needs by Matt McNulty of Codero Hosting on Demand (article). Retrieved from <http://www.codero.com/blog/how-to-choose-storage-solution/> on May 19, 2017.

¹³ POWER8 Enterprise Server E870/E880 and SAN Boot by Nigel Griffiths of IBM via IBM developerWorks' AIXpert Blog on Oct 7, 2015. Retrieved from https://www.ibm.com/developerworks/community/blogs/aixpert/entry/POWER8_Enterprise_Server_E870_E880_and_SAN_boot?lang=en on May 19, 2017.

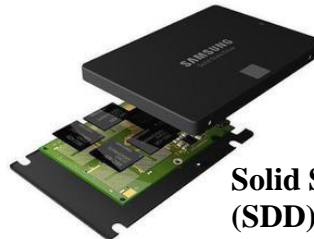


Enterprise Architecture SAN Booting or DAS Booting

- It is the collective experience and support of the customer's own environment that is the enabler for SAN booting. Even a large customer lacking these internal supportability features in their IT organization should not SAN boot due to potential SAN complexities that may be encountered.
- It was not a "toss of the coin" that removed internal disks from the IBM E870/E880. If you look at the E870/E880 there is no room for disk controllers, cables, backplanes, and insertion slots. Each Central Electronics Complex (CEC) would have to be 1U taller to support disks, which comes at a cost. **The trend in large machines is to SAN boot.**
- One reason for having internal disks is so you can boot an OS (VIOS) to investigate the SAN and prove it is the SAN teams' fault, but you can do that with an IBM Power System S812 application server at a fraction of the price."
- With a SAN, the management software just tells you to replace the disk in slot 42 (the one with the orange flashing light) and hit "Return." The SAN then does the rest. With internal DAS such as SSD's, one would still have to manually mirror the VIOS disks and manually recover them on a failure.
- IBM constantly tracks failure rates of all components so they know what fails the most and for Enterprise size systems, **DAS devices like HDDs and SSDs are by far the worst components.** They need to be eliminated.



**Hard Disk Drive
(HDD)**



**Solid State Drive
(SSD)**

- Storage Configurations. ¹⁴
 - The biggest advantage of SAN systems is they offer simplified management, scalability, flexibility, and improved data access, and backup. For this reason **SAN configurations are becoming quite common for large enterprises that take their data storage seriously.**
 - Apart from large networks SAN configurations are not very common. One exception to this is in the video editing industries which require a high capacity storage environment along with a high bandwidth for data access. **A SAN configuration using Fibre Channel is really the best solution for video editing networks and networks in similar industries.**

¹⁴ Storage Configurations by Russell Hitchcock (article) posted by TechGenix on Sep 14, 2010. Retrieved from <http://techgenix.com/storage-configurations/> on May 19, 2017.



Enterprise Architecture SAN Booting or DAS Booting

Storage Area Network (SAN)

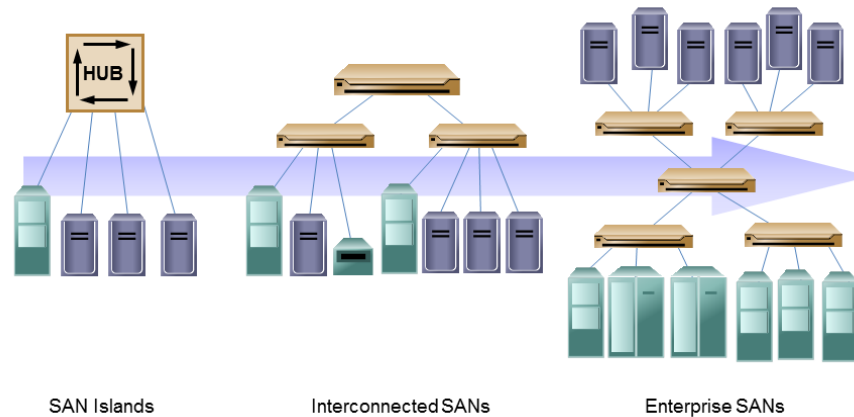


Figure 6: Storage Area Network (SAN) View. ¹⁵

- Microsoft on SAN Booting ¹⁶
 - Microsoft supports booting from a Storage Area Network (SAN) if the SAN vendor supports their particular hardware platform booting a Windows server. The SAN and host bus adapter (HBA) must be configured according to the SAN vendor's guidelines and **the SAN vendor must act as the main point of contact for boot-related issues. This requirement exists because booting from a SAN is extremely complex**, and the vendor needs to support the particular configuration because the SAN vendor provides the SAN boot supportability statement. The SAN vendor must provide specific steps, drivers, firmware revisions and resources about how to make their hardware (storage systems, switches, Host Bus Adapters, and so on) work properly together.

¹⁵ Section-3: Networked Storage by College of Information Sciences and Technology at Pennsylvania State University. Retrieved from <https://www.slideshare.net> on May 19, 2017.

¹⁶ Support for booting from a Storage Area Network (SAN) by Microsoft. Retrieved from <https://support.microsoft.com/en-us/help/305547/support-for-booting-from-a-storage-area-network-san> on May 19, 2017.



Enterprise Architecture SAN Booting or DAS Booting

Analysis

- The difficult challenge of managing the servers for an entire enterprise can be simplified when administrators centrally manage all storage-related tasks, such as operating system (OS) maintenance, at the storage array level rather than at the individual server level.
 - Server boot devices can be located on a storage system that is accessed by servers across a high availability SAN.
 - This strategy enables increased efficiency, and even automation, of many administrative tasks, significantly reducing operating expenses.

Oracle on DAS limitations. ¹⁷

- Traditionally, operating systems were installed on local drives on individual servers, or on direct attached storage (DAS). This DAS approach presents various challenges to IT:
 - Dedicated internal boot devices cannot be shared with other servers and are therefore often underutilized.
 - IT staff must perform management tasks on these systems locally rather than from a central management system, leading to increased administrative costs.
 - For optimal redundancy and performance, additional RAID software or host bus adapters (HBAs) are required to manage these storage devices.
 - Multisite administration and disaster recovery site maintenance.
 - Administrator tasks like the following can involve complex operations requiring specialized software:
 - Creating clones of drive content to offsite hosts.
 - Replicating the operating systems and the data on a server to a disaster recovery site.

Oracle on SAN benefits. ¹⁸

- Booting from a storage area network (SAN) provides solutions to DAS problems while offering additional advantages such as cost savings, enhanced security, ease of management, increased flexibility, and reduced downtime.

Other.

- Virtualization and cloud are mature IT solutions that will only increase opportunities for movement to SAN booting.
- SAN booting is more complex configuring initially, but centralizes administration, which should make it easier to administrate.

¹⁷ Implementing Boot from SAN (Oracle White Paper) on November 2015. Retrieved from <http://www.oracle.com/technetwork/server-storage/san-storage/documentation/implementing-boot-from-san-on-fs-2769859.pdf> on 051817.

¹⁸ *Ibid.*



Enterprise Architecture SAN Booting or DAS Booting

- Issues encountered will be dependent on one’s specific IT environment, and which may cause DAS to be the preferred solution temporarily until time, resources, or cost to migrate to a SAN boot environment are available.
- It may be valid to have a local boot present so the system can stay up during SAN problems such as reconfiguring improper LUN configurations, slow network response times, pagefile latency, and the dreaded problem of all – an outage.
- While there will be issues to contend with moving from a DAS booting to SAN booting environment, there is no known technical stopper to not implement SAN booting.

General Storage Technology

	DAS	NAS	SAN
WHO SHOULD USE?	Small and Predictable Storage	Data Back Up Simple Extra Storage	Bandwidth Intensive Mission Critical Data
THE GOOD	No Network or External Arrays Needed Fast Through-Put	Flat File Storage Simple To Configure And Maintain	Moving Large Blocks Of Data, Scaleable, Reliable, Ease Of Management
THINGS TO CONSIDER	Difficult To Maintain Does Not Balance Loads	Primarily targeted at storing files, not blocks	Price Point
WHERE IS THE BEST FIT	Local Operating System	Flat File, Simple data changes	I/Op Intensive, quick block changes, Databases

Figure 8: General Storage Technology.