Introduction to Storage Area Network

1. **Storage Area Network (SAN)**
2. **Small Computer System Interface (SCSI)**
3. **Fibre Channel (FC):** Fibre Channel Protocol, Fibre Channel topologies, Fiber Channel Layers and Ports, Fibre Channel Infrastructure, Fibre Channel HBA, WWN, Fabric
4. **FC Zoning & LUN Masking:** SAN Zoning, PORT Zoning, WWN Zoning, shared disk file system [Cluster/SAN File System]
5. **Computer Cluster [Definition]**
6. **Definitions & Types of DISK Array, Network attached storage (NAS) array, Modular storage area network (SAN) arrays, Monolithic (enterprise) arrays And Storage virtualization**

By,

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Storage area network

A **storage area network (SAN)** is architecture to attach remote computer storage devices (such as disk arrays, tape libraries and optical jukeboxes) to servers in such a way that, to the operating system, the devices appear as locally attached.

[By contrast to a SAN, Network Attached Storage (NAS) uses file-based protocols such as NFS or SMB/CIFS where it is clear that the storage is remote, and computers request a portion of an abstract file rather than a disk block.]

**Definition of SAN**

A storage area network (SAN) is a high-speed special-purpose network (or sub network) that interconnects different kinds of data storage devices with associated data servers on behalf of a larger network of users. Typically, a storage area network is part of the overall network of computing resources for an enterprise. A storage area network is usually clustered in close proximity to other computing resources such as IBM z990 mainframes but may also extend to remote locations for backup and archival storage, using wide area network carrier technologies such as ATM or SONET.

**Types**

Most storage networks use the SCSI protocol for communication between servers and disk drive devices. However, they do not use SCSI low-level physical interface (e.g. cables), as its bus topology is unsuitable for networking. To form a network, a mapping layer is used to other low-level protocols:

- "iFCP"[^1] or "SANoIP"[^2] mapping SCSI over Fibre Channel Protocol (FCP) over IP.
- iSCSI, mapping SCSI over TCP/IP.
- iSER, mapping iSCSI over InfiniBand (IB).
- HyperSCSI, mapping SCSI over Ethernet.
- FICON mapping over Fibre Channel (used by mainframe computers).
- ATA over Ethernet, mapping ATA over Ethernet.
- Fibre Channel over Ethernet

**SCSI (pronounced skuzzy)**

**Small Computer System Interface** is a set of standards for physically connecting and transferring data between computers and peripheral devices. The SCSI standards define commands, protocols, and electrical and optical interfaces. SCSI is most commonly used for hard disks and tape drives, but it can connect a wide range of other devices, including scanners and CD drives. The SCSI standard defines command sets for specific peripheral device types; the presence of "unknown" as one of these types means that in theory it can be used as an interface to almost any device, but the standard is highly pragmatic and addressed toward commercial requirements.

- SCSI is an intelligent interface: it hides the complexity of physical format. Every device attaches to the SCSI bus in a similar manner.
- SCSI is a peripheral interface: up to 8 or 16 devices can be attached to a single bus. There can be any number of hosts and peripheral devices but there should be at least one host.

- SCSI is a buffered interface: it uses hand shake signals between devices, SCSI-1, SCSI-2 have the option of parity error checking. Starting with SCSI-U160 (part of SCSI-3) all commands and data is error checked by a CRC32 checksum.

- SCSI is a peer to peer interface: the SCSI protocol defines, communication from host to host, host to a peripheral device, peripheral device to a peripheral device. However most peripheral devices are exclusively SCSI targets, incapable of acting as SCSI initiators—unable to initiate SCSI transactions themselves. Therefore peripheral-to-peripheral communications are uncommon, but possible in most SCSI applications. The NCR53C810 chip is an example of a PCI host interface that can act as a SCSI target.

SCSI (Small Computer System Interface) is a set of ANSI standards for connecting devices to computer systems. The vast majority of SCSI devices are data storage devices.

Standard SCSI is a parallel technology, but many serial SCSI variants exist, including FireWire and Fibre Channel.

SCSI is generally considered a higher-end alternative to IDE (Integrated Drive Electronics). A single IDE controller can control two drives. A single SCI controller can control 8 or 16 drives. In addition, SCSI usually offers greater cable length and higher length than IDE.

### SCSI Standards

<table>
<thead>
<tr>
<th>SCSI Standard</th>
<th>Cable Length</th>
<th>Speed (MBps)</th>
<th>Devices Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCSI-1</td>
<td>6</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>SCSI-2</td>
<td>6</td>
<td>5-10</td>
<td>8 or 16</td>
</tr>
<tr>
<td>Fast SCSI-2</td>
<td>3</td>
<td>10-20</td>
<td>8</td>
</tr>
<tr>
<td>Wide SCSI-2</td>
<td>3</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>Fast Wide SCSI-2</td>
<td>3</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>Ultra SCSI-3,8-bit</td>
<td>1.5</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Ultra SCSI-3,16-bit</td>
<td>3.5</td>
<td>40</td>
<td>16</td>
</tr>
<tr>
<td>Ultra-2 SCSI</td>
<td>12</td>
<td>40</td>
<td>8</td>
</tr>
<tr>
<td>Wide Ultra-2 SCSI</td>
<td>12</td>
<td>80</td>
<td>16</td>
</tr>
<tr>
<td>Ultra-3 (Ultra160/m) SCSI</td>
<td>12</td>
<td>160</td>
<td>16</td>
</tr>
</tbody>
</table>

### Fibre Channel

Fibre Channel, or FC, is a gigabit-speed network technology primarily used for storage networking. Fibre Channel is standardized in the T11 Technical Committee of the International Committee for Information Technology Standards (INCITS), an
American National Standards Institute (ANSI)–accredited standards committee. It started use primarily in the supercomputer field, but has become the standard connection type for storage area networks (SAN) in enterprise storage. Despite common connotations of its name, Fibre Channel signaling can run on both twisted pair copper wire and fiber-optic cables; said another way, fiber (ending in "er") always denotes an optical connection, whereas fibre (ending in "re") is always the spelling used in "fibre channel" and denotes a physical connection which may or may not be optical.

**Fibre Channel Protocol (FCP)** is the interface protocol of SCSI on the Fibre Channel.

Fibre Channel started in 1985, with ANSI standard approval in 1994, as a way to simplify the HIPPI system then in use for similar roles. HIPPI used a massive 50-pair cable with bulky connectors, and had limited cable lengths. Fibre Channel was primarily concerned with simplifying the connections and increasing distances, as opposed to increasing speeds. Later, designers added the goals of connecting SCSI disk storage, providing higher speeds and far greater numbers of connected devices.

It also added support for any number of "upper layer" protocols, including SCSI, ATM, and IP, with SCSI being the predominant usage.

### Fibre Channel Variants

<table>
<thead>
<tr>
<th>NAME</th>
<th>Line-Rate (Gbit/s)</th>
<th>Throughput (MB/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1GFC</td>
<td>1.0625</td>
<td>100</td>
</tr>
<tr>
<td>2GFC</td>
<td>2.125</td>
<td>200</td>
</tr>
<tr>
<td>4GFC</td>
<td>4.25</td>
<td>400</td>
</tr>
<tr>
<td>8GFC</td>
<td>8.5</td>
<td>800</td>
</tr>
<tr>
<td>10GFC Serial</td>
<td>10.51875</td>
<td>1000</td>
</tr>
<tr>
<td>20GFC</td>
<td>10.52</td>
<td>2000</td>
</tr>
<tr>
<td>10GFC Parallel</td>
<td>12.75</td>
<td></td>
</tr>
</tbody>
</table>
Fibre Channel topologies

There are three major Fibre Channel topologies, describing how a number of ports are connected together. A port in Fibre Channel terminology is any entity that actively communicates over the network, not necessarily a hardware port. Port is usually implemented in a device such as disk storage, an HBA on a server or a Fibre Channel switch.

- **Point-to-Point (FC-P2P).** Two devices are connected back to back. This is the simplest topology, with limited connectivity.

- **Arbitrated loop (FC-AL).** In this design, all devices are in a loop or ring, similar to token ring networking. Adding or removing a device from the loop causes all activity on the loop to be interrupted. The failure of one device causes a break in the ring. Fibre Channel hubs exist to connect multiple devices together and may bypass failed ports. A loop may also be made by cabling each port to the next in a ring.
  - A minimal loop containing only two ports, while appearing to be similar to FC-P2P, differs considerably in terms of the protocol.
- **Switched fabric (FC-SW).** All devices or loops of devices are connected to Fibre Channel switches, similar conceptually to modern Ethernet implementations. The switches manage the state of the fabric, providing optimized interconnections.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Point-to-Point</th>
<th>Arbitrated loop</th>
<th>Switched fabric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max ports</td>
<td>2</td>
<td>127</td>
<td>~16777216</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(2^24)</td>
</tr>
<tr>
<td>Address size</td>
<td>N/A</td>
<td>8-bit ALPA</td>
<td>24-bit port ID</td>
</tr>
<tr>
<td>Side effect of port failure</td>
<td>N/A</td>
<td>Loop fails (until port bypassed)</td>
<td>N/A</td>
</tr>
<tr>
<td>Mixing different link rates</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Frame delivery</td>
<td>In order</td>
<td>In order</td>
<td>Not guaranteed</td>
</tr>
<tr>
<td>Access to medium</td>
<td>Dedicated</td>
<td>Arbitrated</td>
<td>Dedicated</td>
</tr>
</tbody>
</table>
**Fibre Channel layers**

Fibre Channel is a layered protocol. It consists of 5 layers, namely:

- **FC0** The physical layer, which includes cables, fiber optics, connectors, pinouts etc.
- **FC1** The data link layer, which implements the 8b/10b encoding and decoding of signals.
- **FC2** The network layer, defined by the FC-PI-2 standard, consists of the core of Fibre Channel, and defines the main protocols.
- **FC3** The common services layer, a thin layer that could eventually implement functions like encryption or RAID.
- **FC4** The Protocol Mapping layer. Layer in which other protocols, such as SCSI, are encapsulated into an information unit for delivery to FC2.

FC0, FC1, and FC2 are also known as FC-PH, the physical layers of fibre channel.

Fibre Channel routers operate up to FC4 level (i.e. they are in fact SCSI routers), switches up to FC2, and hubs on FC0 only.

Fibre Channel products are available at 1 Gbit/s, 2 Gbit/s, 4 Gbit/s, 8 Gbit/s, 10 Gbit/s and 20 Gbit/s. Products based on the 1, 2, 4 and 8 Gbit/s standards should be interoperable, and backward compatible. The 10 Gbit/s standard (and 20 Gbit/s derivative), however, is not backward compatible with any of the slower speed devices, as it differs considerably on FC1 level (64b/66b encoding instead of 8b/10b encoding). 10 GB and 20 GB Fibre Channel is primarily deployed as a high-speed "stacking" interconnect to link multiple switches.
**Ports**

The following types of ports are defined by Fibre Channel:

- **node ports**
  - **N_port** is a port on the node (e.g. host or storage device) used with either FC-P2P or FC-SW topologies. Also known as **Node port**.
  - **NL_port** is a port on the node used with an FC-AL topology. Also known as **Node Loop port**.

- **switch/router ports** (used with FC-SW topology only)
  - **F_port** is a port on the switch that connects to a node point-to-point (i.e. connects to an N_port). Also known as **Fabric port**. An F_port is not loop capable.
  - **FL_port** is a port on the switch that connects to a FC-AL loop (i.e. to NL_ports). Also known as **Fabric Loop port**. Note that a switch port may automatically become either an F_port or an FL_port depending on what is connected.
  - **E_port** is the connection between two fibre channel switches. Also known as an **Expansion port**. When E_ports between two switches form a link, that link is referred to as an inter-switch link (ISL).
  - **EX_port** is the connection between a fibre channel router and a fibre channel switch. On the side of the switch it looks like a normal E_port, but on the side of the router it is a EX_port.
  - **TE_port** is a term used for multiple E_ports trunked together to create high bandwidth between switches. Also known as **Trunking Expansion port**.

- **general (catch-all) types**
  - **G_port** or **generic port** on a switch can operate as an E_port or F_port.
  - **L_port** is the loose term used for any arbitrated loop port, NL_port or FL_port. Also known as **Loop port**.
  - **U_port** is the loose term used for any arbitrated port. Also known as **Universal port**.

**LC (left) and SC (right) optic fiber connectors**
**Fibre Channel Infrastructure**

Fibre Channel switches are divided into two classes. These classes are not part of the standard, and the classification of every switch is a marketing decision of the manufacturer.

- **Directors** offer a high port-count in a modular (slot-based) chassis with no single point of failure (high availability).
- **Switches** are typically smaller, fixed-configuration (sometimes semi-modular), less redundant devices.

Brocade, Cisco and QLogic provide both directors and switches.

If multiple switch vendors are used in the same fabric (i.e. fabric is *heterogeneous*), the fabric will default to "interoperability mode", that is to a pure standardized Fibre Channel protocol. Some proprietary, advanced features may be disabled.

**Fibre Channel Host Bus Adapters**

Fibre Channel HBAs are available for all major open systems, computer architectures, and buses, including PCI and SBus (obsolete today). Some are OS dependent. Each HBA has a unique World Wide Name (WWN), which is similar to an Ethernet MAC address in that it uses an Organizationally Unique Identifier (OUI) assigned by the IEEE. However, WWNs are longer (8 bytes). There are two types of WWNs on a HBA; a node WWN (WWNN), which is shared by all ports on a host bus adapter, and a port WWN (WWPN), which is unique to each port. Some Fibre Channel HBA manufacturers are Emulex, LSI, QLogic and ATTO Technology.

Today, the term *host bus adapter* (HBA) is most often used to refer to a Fibre Channel interface card. Fibre Channel HBAs are available for all major open systems, computer architectures, and buses, including PCI and SBus (obsolete today). Each HBA has a unique World Wide Name (WWN), which is similar to an Ethernet MAC address in that it uses an OUI assigned by the IEEE. However, WWNs are longer (8 bytes). There are two types of WWNs on a HBA; a node WWN, which is shared by all ports on a host bus adapter, and a port WWN, which is unique to each port. Major HBA manufacturers are Emulex, QLogic, LSI, and ATTO Technology. There are HBA models from different speed: 2Gbit/s, 4Gbit/s and 8Gbit/s.

[HOST ADAPTER: In computer hardware, a host controller, host adapter, or host bus adapter (HBA) connects a host system (the computer) to other network and storage devices. The terms are primarily used to refer to devices for connecting SCSI, Fibre Channel and eSATA devices, but devices for connecting to IDE, Ethernet, FireWire, USB and other systems may also be called host adapters. Recently, the advent of iSCSI has brought about Ethernet HBAs, which are different from Ethernet NICs in that they include hardware iSCSI-dedicated TCP Offload Engines.]

**World Wide Name**

A **World Wide Name** (WWN) or World Wide Identifier (WWID) is a unique identifier in a Fibre Channel or Serial Attached SCSI storage network. Each WWN is an 8-byte
number derived from an IEEE OUI (for the first 3 bytes) and vendor-supplied information (for the rest).

There are two formats of WWN defined by the IEEE:

- Original format: addresses are assigned to manufacturers by the IEEE standards committee, and are built into the device at build time, similar to Ethernet MAC address. First 2 bytes are either hex 10:00 or 2x:xx (where the x’s are vendor-specified) followed by the 3-byte vendor identifier and 3 bytes for a vendor-specified serial number.
- New addressing schema: first half-byte is either hex 5 or 6 followed by a 3-byte vendor identifier and 4 bytes and a half for a vendor-specified serial number.

**List of a few WWN company identifiers**

- 00:50:76 IBM
- 00:a0:98 NetApp
- 00:60:69 Brocade Communications Systems
- 00:05:1E Brocade Communications Systems, formerly owned by Rhapsody Networks
- 00:60:DF Brocade Communications Systems, formerly CNT Technologies Corporation
- 00:E0:8B QLogic HBAs, original identifier space
- 00:18:32 QLogic HBAs. new identifier space starting to be used in 2007
- 00:C0:DD QLogic FC switches
- 00:90:66 QLogic formerly Troika Networks
- 00:11:75 QLogic formerly PathScale, Inc
- 08:00:88 Brocade Communications Systems, formerly McDATA Corporation. WWIDs begin with 1000.080
- 00:60:B0 Hewlett-Packard - Integrity and HP9000 servers. WWIDs begin with 5006.0b0
- 00:11:0A Hewlett-Packard - ProLiant servers. Formerly Compaq. WWIDs begin with 5001.10a
- 00:01:FE Hewlett-Packard - EVA disk arrays. Formerly Digital Equipment Corporation. WWIDs begin with 5000.1fe1
- 00:17:A4 Hewlett-Packard - MSL tape libraries. Formerly Global Data Services. WWIDs begin with 200x.0017.a4
- 00:60:48 EMC, for Symmetrix
- 00:60:16 EMC, for CLARiiON

**Fibre Channel fabric**

A **Fibre Channel fabric** (or **Fibre Channel switched fabric, FC-SW**) is a switched fabric of Fibre Channel devices enabled by a Fibre Channel switch. Fabrics are normally subdivided by Fibre Channel zoning. Each fabric has a name server and provides other services.

**Fibre Channel zoning**

In storage networking, **Fibre Channel zoning** is the partitioning of a Fibre Channel fabric into smaller subsets to restrict interference, add security, and to simplify
management. If a SAN contains several storage devices, each system connected to the SAN should not be allowed to interact with all of them. Zoning applies only to the switched fabric topology (FC-SW); it does not exist in simpler Fibre Channel topologies.

Zoning is sometimes confused with LUN masking, because it serves the same goals. LUN masking, however, works on Fibre Channel level 4 (i.e. on SCSI level), while zoning works on level 2. This allows zoning to be implemented on switches, whereas LUN masking is performed on endpoint devices - host adapters or disk array controllers.

Zoning is also different from VSANs, in that each port can be a member of multiple zones, but only one VSAN. VSAN (similarly to VLAN) is in fact a separate network (separate sub-fabric), with its own fabric services (including its own separate zoning).

There are two main methods of zoning, hard and soft, that combine with two sets of attributes, name and port.

**Soft zoning** restricts only the fabric name services, to show the device only an allowed subset of devices. Therefore, when a server looks at the content of the fabric, it will only see the devices it is allowed to see. However, any server can still attempt to contact any device on the network by address. In this way, soft zoning is similar to the computing concept of security through obscurity.

In contrast, **hard zoning** restricts actual communication across a fabric. This requires efficient hardware implementation (frame filtering) in the fabric switches, but is much more secure.

Zoning can also be applied to either switch ports or end-station name. **Port zoning** restricts ports from talking to unauthorized ports. Because this is non-standard, it usually requires a homogeneous SAN (all switches from one vendor). Any device plugged in a specific physical switch port is given access to the zone. **Name zoning** restricts access by device's World Wide Name. This is more flexible, but WWNs can be spoofed, reducing security.

Currently, the combination of hard and name zoning is the most popular.

**Example topology of a Fibre Channel switched fabric network**

![Switched Fabric Network Diagram](image)
**What is LUN masking?**

LUN (Logical Unit Number) Masking is an authorization process that makes a LUN available to some hosts and unavailable to other hosts.

LUN Masking is implemented primarily at the HBA (Host Bus Adapter) level. LUN Masking implemented at this level is vulnerable to any attack that compromises the HBA.

Some storage controllers also support LUN Masking.

LUN Masking is important because Windows based servers attempt to write volume labels to all available LUN's. This can render the LUN's unusable by other operating systems and can result in data loss.

**What is SAN zoning?**

SAN zoning is a method of arranging Fibre Channel devices into logical groups over the physical configuration of the fabric.

SAN zoning may be utilized to implement compartmentalization of data for security purposes.

Each device in a SAN may be placed into multiple zones.

**What is port zoning?**

Port zoning utilizes physical ports to define security zones. A user's access to data is determined by what physical port he or she is connected to.

With port zoning, zone information must be updated every time a user changes switch ports. In addition, port zoning does not allow zones to overlap.

Port zoning is normally implemented using hard zoning, but could also be implemented using soft zoning.

**What is WWN zoning?**

WWN zoning uses name servers in the switches to either allow or block access to particular World Wide Names (WWNs) in the fabric.

A major advantage of WWN zoning is the ability to recable the fabric without having to redo the zone information.

WWN zoning is susceptible to unauthorized access, as the zone can be bypassed if an attacker is able to spoof the World Wide Name of an authorized HBA.
Shared disk file system

A shared disk file system, also known as cluster file system or SAN file system, is an enterprise storage file system which can be shared (concurrently accessed for reading and writing) by multiple computers. Such devices are usually clustered servers, which connect to the underlying block device over an external storage device. Such a device is commonly a storage area network (SAN).

Shared disk file systems are necessary because with regular file systems, if multiple instances were to attempt concurrent access to the same physical device, the data would rapidly become corrupt, because there is nothing to prevent two devices from performing a modification of the same part of the file system at the same time.

Computer cluster

A computer cluster is a group of coupled computers that work together closely so that in many respects they can be viewed as though they are a single computer. The components of a cluster are commonly, but not always, connected to each other through fast local area networks. Clusters are usually deployed to improve performance and/or availability over that provided by a single computer, while typically being much more cost-effective than single computers of comparable speed or availability.

Disk array

A disk array is a disk storage system which contains multiple disk drives. It is differentiated from a disk enclosure, in that an array has cache memory and advanced functionality, like RAID and virtualization.

Components of a typical disk array include:

- Disk array controllers
- Cache memories
- Disk enclosures
- Power supplies

Typically a disk array provides increased availability, resiliency and maintainability by using additional, redundant components (controllers, power supplies, fans, etc.), often up to the point when all single points of failure (SPOFs) are eliminated from the design. Additionally those components are often hot-swappable.

Typically, disk arrays are divided into five categories: NAS, Modular SAN arrays, Monolithic SAN arrays, Storage Virtualization and Utility SAN Arrays.

Network attached storage (NAS) arrays

Network attached storage is a hard disk storage system on a network with its own LAN IP address. NAS arrays provide file-level access to storage through such protocols as CIFS and NFS. Examples:

- 3PAR and ONStor UtiliCat Unified Storage
Modular storage area network (SAN) arrays

A SAN is a dedicated network, separate from LANs and WANs, that is generally used to connect numerous storage resources to one or many servers. SAN arrays provide block-level access to storage through SCSI-based protocols such as Fibre Channel and iSCSI. Modular storage system typically consists of separate modules, which afford some level of scalability, and can be mounted, in a standard rack cabinet. Modular storage systems are also sometimes referred as departmental. Examples:

- 3PAR InServ E-Class
- EMC CLARiiON
- Fujitsu ETERNUS 4000/3000 series storage arrays
- HP Storageworks EVA family products
- Hitachi Thunder family products
- IBM DS4000/FAST family of storage servers
- IBM DS6000 series storage servers
- Arena Maxtronic Janus Fibre Channel and iSCSI RAID systems
- Infortrend EonStor/EonRAID family
- NetApp FAS series Unified storage servers
- ONStor Pantera
- Sun StorageTek 6x40
- Xiotech Magnitude 3D

Monolithic (enterprise) arrays

Although this is not a strict definition, the array is considered monolithic when even basic configuration is physically too large to fit into a standard rack cabinet. These arrays are suited for large-scale environments. Often Enterprise storage systems provide ESCON and FICON protocols for mainframes in addition to Fibre Channel and iSCSI for open systems SANs. Examples:

- EMC Symmetrix
- Fujitsu ETERNUS 8000/6000 series storage arrays
- Hitachi Lightning and TagmaStore USP family products
- HP XP
- IBM Enterprise Storage Server (ESS)
- IBM DS8000 series of storage servers
- Infortrend EonStor / EonRAID family
- Sun StorEdge 99xx (9970, 9980, 9985, 9990)

Storage virtualization

Intelligent SAN or Storage Servers (Software that adds disk controller functionality to standard server hardware platforms). Hardware independent software that typically runs as a control program on top of a standard OS platform (Windows, Linux, etc.):
- DataCore Software Corporation SANsymphony and SANmelody Storage Server Virtualization Software
- Falconstor IPStor Software
- IBM SAN Volume Controller
- NetApp V-Series storage virtualization solutions
- RELDATA Unified Storage Gateway Appliance
- EMC InVista

**Utility Storage arrays:**

- 3PAR InServ Storage Servers
- NetApp FAS GX Series
- Pillar Data Systems Axiom

Best Regards,
Amit Sapre.