

SAN Advancement for Central Depository Systems

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DECLARATION

This project is based upon study conducted by ourselves. Use of results obtained by others is appropriately cited. This project has not been previously submitted for any degree.

Signature of
Supervisor

Signature of
Student

DEDICATION

This project is dedicated to my parents, teachers and all my family members who have supported me all the way since the beginning of my studies.

ACKNOWLEDGEMENTS

Special thanks to Dr. Tarem Ahmed, Assistant Professor, BRAC University for helping and supervision me to complete the project.

ABSTRACT

Large data storage has become one of the main problems in the development of network because of rapid increase of data storage. Storage Area Network devices are capable of processing the mass capacity, high I/O transfer speed and ensure high system availability for information access and data sharing services. Emerging enterprise-level applications and business critical data services of public and private limited companies are assigned to facilitate access enterprise level data for thousands of clients from all over the country through Storage Area network. This project shows system upgrade procedure of Central Depository System to remove storage area network constraint due to capital market upsurge. This project also classifies the reason of present infrastructure limitation, new system up gradation and future work of scope.

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I. INTRODUCTION

A. Problem Stated

Central Depository system was incorporated on 20th August 2000 and company started its live operations on 20th October 2003. CDS core services cover the efficient delivery, settlement and transfer of securities through computerized book entry system, recording and maintaining securities accounts and registering transfer of securities, changing the ownership without any physical movement or endorsement of certificates and execution of transfer instruments. Company's operations are carried out in its Main Data Centre which is linked to a remote Disaster Recovery Centre operating as a backup with data update taking place simultaneously. Network connectivity to Depository Participants, Issuers, Banks, Stock Exchanges and Bangladesh Bank Front end interfaces are accessed by WAN link and intranet.

After three and half years, there has been sizable increase in transactions due to capital market rise. The daily settlement trades have increased remarkable which became overload for current system to perform day to day operations and technical faults occurred at production time. Customers are getting late responses to perform their scheduled job.

B. Contributions

To overcome all constraints, company has decided to initiate hardware and software up-gradation with new set of SAN Devices. I contributed to design Storage Area Network

for Data Center and Disaster Recovery Center experiencing professional experiences of HP System standards. Also determine site to site synchronization model of data replication to ensure data accessibility and availability.

C. Outline of Project

The rest of this project is organized as follows. Section II stated the initial SAN infrastructure and limitations of the systems. Section III presents proposed new systems to overcome constraints and introduce new data replication method. Also illustrate the performance improvements of SAN Devices. And lastly in section IV conclude and outline the future solution planning to provide high level of security and maximum system availability.

II. THEORETICAL BACKGROUND

VeDAS (Versatile Engine for Depository Accounting System) **software** application developed on three-tier architecture. Graphical user interface (GUI) is built with Visual Basic at the client side, TUXEDO (Transactions for UNIX, Extended for Distributed Operations) is used as the middleware as the transaction manager and Oracle 8i as the centralized database at Data Center premises. The server platform is HP-Uxix.

Central Depository System (CDS) is engaged in providing depository services for securities held in electronic form which require investors to be able to manage their securities account balances as well as avail other services like transfer of securities, pledging of securities, etc. electronically. In order to facilitate such services, state of the art high-end, high-availability, high storage and redundant computer equipment has been installed and configured in CDS.

The system has been designed not only taking into account the immense processing and storage needs required for handling large volumes of transactions for providing depository services to investors across Bangladesh but also considering all factors for ensuring that the system is online and available at all times. In this regard, redundant equipment have been put into place to eliminate single points of failure at the Main Site as well as in Disaster Recovery Centre (DRC) with identical equipment setup which would come into operation in case of a disaster occurring in the Main Site which will be explained later in this document.

A. Main and DR Site SAN Devices

Both sites of the company equipped with HP HP9000 rp7400 Enterprise Class Application and Database Servers, HP SureStore E Disk Array FC60, HP SureStore E DLT Library 4/40 Deskside for backup and HP Fibre Channel Switches. The rp7400 architecture is a uniquely balanced design providing huge amounts of processor, memory and I/O bus bandwidths. The memory controller is central to the architecture and is supported by up to four memory carriers and from one to 16 pairs of memory DIMMs. Main memory ranges from 1GB to 32GB with 1GB and 2GB DIMMs. The memory controller consists of three VLSI chips and handles all transactions between main memory and system buses. Each system bus connects the memory controller to two runway bus converters and one I/O controller. Each bus converter is a single VLSI chip supporting two PA-8600 or PA-8700 CPUs via their own dedicated runway bus. In rp7400 configured with PA-8600 CPUs (550MHz), system bus runs at 133MHz. Each I/O controller consists of a master I/O controller and six to eight slave I/O controllers. Each PCI Turbo and Twin Turbo slot uses a single slave I/O controller while the core I/O utilizes two slave I/O controllers. Central to the rp7400 system are twin system buses. All processor, memory, and I/O traffic transfers over one of these two buses [1].

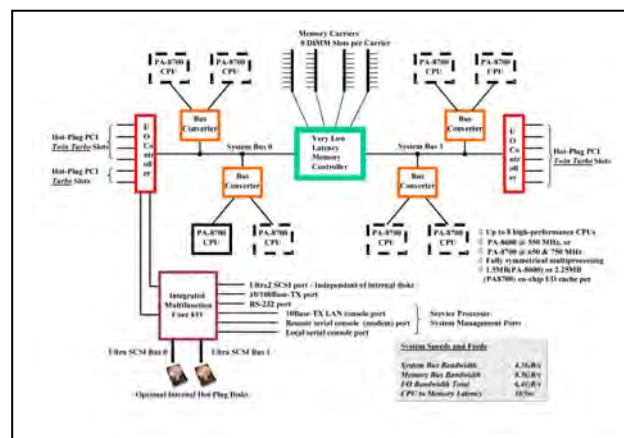


Figure 1. Cell Board Architecture of HP9000 rp7400 servers

HP9000 rp7400 servers are loaded with 64-bit PA-RISC PA 8600 processors, 4 x 550 MHZ processors , Dual Core, 4 GB of RAM and 2 x 18 GB Hot Pluggable internal HDD. HP Server rp7400 delivers more power, control, and confidence which makes the server exceptional platform for today's demanding business applications like e-commerce, advanced Web hosting, messaging, supply chain management (SCM), customer relationship management (CRM), enterprise resource planning (ERP), business intelligence, and high-performance technical computing.

The HP SureStore E Disk Array FC60 is a disk storage system that managed by HP Storage Manager on Windows NT and Windows 2000. The Disk Array FC60 offers High availability with minimal system downtime and Scalable storage capacity which facilitates to add additional disk modules to a disk enclosure and additional disk enclosures to the array. The controller enclosure supports up to six disk enclosures. Each disk enclosure holds up to ten disk modules in capacities of 9.1 Gbyte, 18.2 Gbyte, 36 Gbyte, or 73 Gbyte. This provides a storage capacity range from 36 Gbytes to over 3 Tbytes of usable storage [2]. Disk Array FC60 consists of two primary components, FC60 controller enclosure and HP SureStore E Disk System SC10. The controller enclosure is responsible for providing overall control of the Disk Array by managing the communication between the host and the disk enclosures. FC60 combines the best of fibre channel speed, RAID protection and multi-drive capacity required for meeting the enterprise resource. The storage is prepared with dual controller, 1.16 TB (2 Enclosures x 8 disk modules x 73 gbytes disk capacity) of raw disk storage and two fiber channel interface.



Figure 2. HP9000 rp7400 Server, HP SureStore E Disk Array FC60 and HP Sure Store E DLT Library 4/40

The HP SureStore E DLT 4/40 Deskside has been designed to support and provide automated unmanned online backup facilities by managing tape libraries via robotics technology. It is capable of backing up terabytes of data using multiple tape drives attached to the libraries each containing 10 slots. The tape cartridges are capable of backing up to 80GB of compressed data each. Backup process can be scheduled and the tape library is capable of backing up the data intelligently. The drives can be connected to the host either through SCSI or fibre. Backup system is loaded with SureStore E DLT 8000 four Tape Drives, each drives has 10 slots.

HP Surestore FC 1Gb/2Gb Switch 8B is an eight-port auto-sensing Fibre Channel fabric switch that delivers 1 Gb/s and 2 Gb/s connectivity between servers and storage devices. The FC Switch 8B ports support fabric, fabric-loop, or E_port connectivity and support ISLs and meshed Switched topologies. FC Switch also bundled with Fabric Watch, WEB TOOLS, QuickLoop, Advanced Zoning, SAN management, SAN monitoring and legacy Fibre Channel Arbitrated Loop (FC-AL) support.

B. SAN Design Considerations

A SAN consists of a set of hardware and software components like A Fibre Channel switches create the fabric of the SAN. Routers, bridges, and gateways provide high levels of scalability, dynamic device sharing, and Fibre Channel network fault isolation. Routers, bridges, and gateways extend the SAN over long distances and enable integration of multi-protocol technologies. Storage devices can integrate multiple storage system types such as disk arrays and tape libraries to allocate storage efficiently. HBAs connect the server to the SAN. HBA drivers provide an intelligent interface to the switches and minimize CPU overhead. Fiber optic cables provide the physical connections between SAN components. SAN management applications manage and monitor components and ensure optimal SAN operation [3]. A number of basic SAN design considerations are followed to scale up the SAN Design. SAN design considerations are flexible to extend SAN design by adding more servers and storages as required. Such important considerations are including below:

To start with the layers of SAN Design those are host layer, fabric layer and storage layer. All servers reside in host layer. The servers run the high-performance applications which runs business and those application servers need hard-drive storage space to store their data. Every server in the host layer uses a Host Bus Adapter (HBA) to connect it to the fabric layer. The HBA connects the server with a fiber-optic cable to the FC switches in the fabric layer. Fabric layer is the actual network part of the SAN. This layer is the central connection point between servers in the host layer and the storage devices in the storage layer. The devices in the fabric layer house most of the intelligence that enables

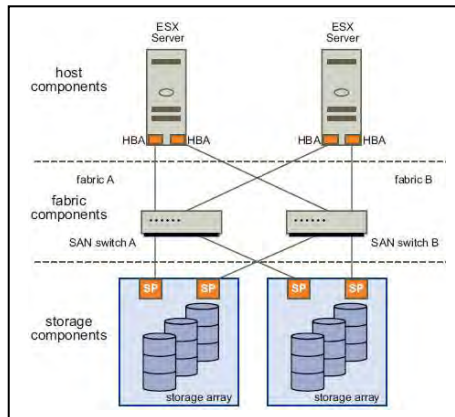


Figure 3. Layers in a SAN

SAN communications to occur so data can flow between the host layer and the storage layer. Storage layer is the layer where all the data storage takes place. It's a hardware combined with disk and tape drives handles storage system for the whole system.

Next consideration is to choose the SAN topology to connect different layer devices together. There are three basic SAN topologies for connecting servers to storages in SAN are Point-to-point, Arbitrated loop and Switched fabric. Point-to-point topology doesn't require hubs or switches. It is the cheapest to implement but also the most limited in its capabilities which network only consists of two devices. Loop topology uses hub and best used in small- to mid-size operations. In a loop only, one device can transmit at a time so all other devices have to wait for their turn. This topology it not recommended for real time mission critical systems which processes online high volume of data of a large scale. Fabric is the most common, most scalable and most expensive topology. This topology is suitable for processing mission critical online data.

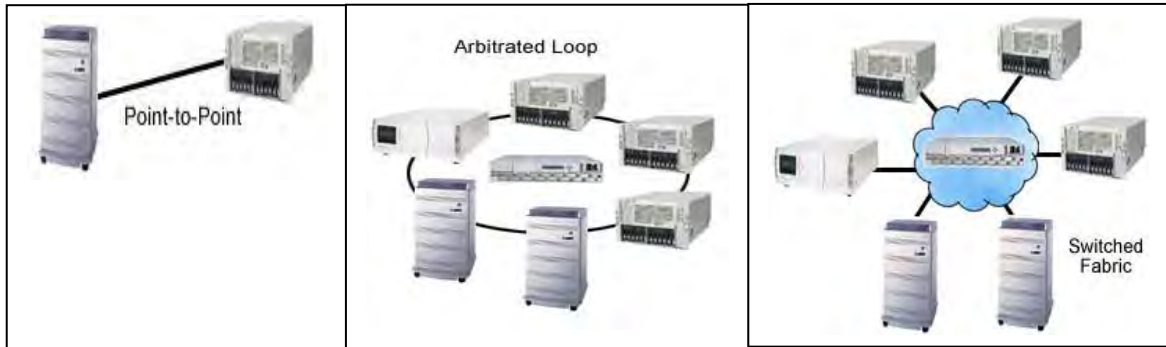


Figure 4. SAN Topologies

A switched fabric can address millions of devices and can communicate with any other device at any time for its no blocking methods which makes systems scalable.

Now it's time to choose the SAN switches based on the amount of switch ports needed to connect SAN devices with redundancy. Two classes of SAN switches are available modular class and director class. The differences between the two classes of switches are the amount of available switch ports, the durability and maintainability of the switches and the speed at which they work. Modular switches are 8, 16, or 32 port variants. The original 1 gigabit switches used older and larger SC type connectors while the newer 2, 4, 8 and 10-gigabit-per-second switches have higher density LC (Lucent connector) ports which allow them to have more ports than the older switches. Director-class switches are expensive and have more ports than modular switches. Port counts usually start between 32 and 64 ports and go up from there. Director-class switches use blades of ports that can be swapped out in case of a failure. Directors also have redundant controller components which are used to run the switch itself. Each individual part can be maintained without bring down the entire switch. If one of the controllers and ports goes down it can be remove and replace the blade simply. FC switch has to be choose based on the number of

FC ports of SAN devices connects the switches and the compatibility of the FC ports speed and bandwidth of the SAN devices with the FC switch ports bandwidth and speed.

Another important factor is to choose the best possible SAN fabric topology for the design to ensure highest level of redundancy with no single point of failure. Here I am going to discuss most reliable and widely used three fabric topologies for enterprise level applications. The best way to implement a small SAN is to start with Dual switch fabric with two 8, 16 or 24-port Switches depending upon the design requirements. In two modular switches, each switch acts as its own fabric. This means that basic building block starts with two SAN fabrics. This model ensures No Single Points of Failure (NSPOF) in fabric layer. Using only two inexpensive 16-port switches for the SAN cell

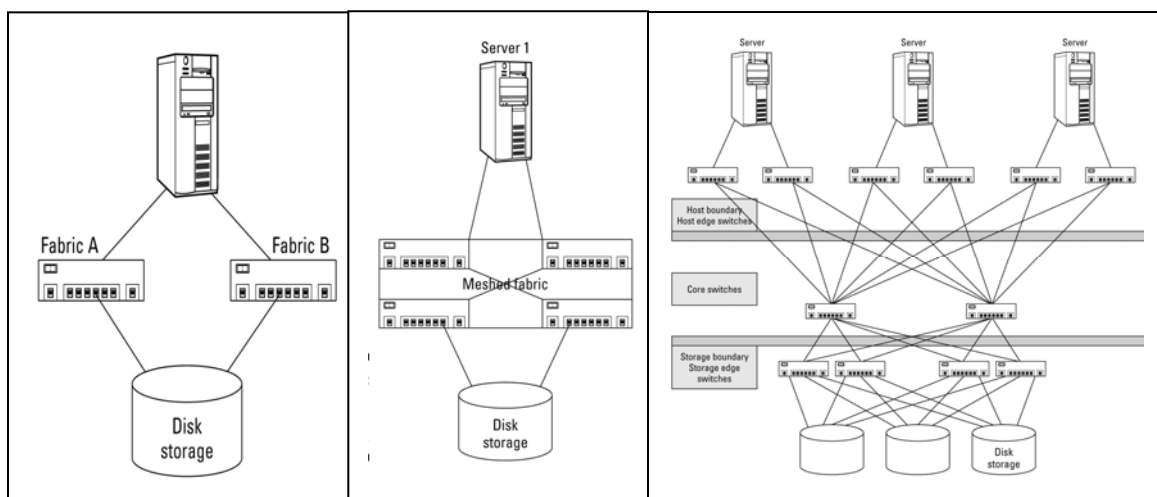


Figure 5. Dual Switch, Meshed and Core-edge Fabric Topologies

gives a total of 32 available ports for servers and storage and all devices in SAN have two paths into the switches. Path-management software makes path fail-over transparent (no human intervention required) in a SAN which runs in servers. A single meshed fabric is resilient because every switch is connected to every other switch. If any path between the

switches fails, data can be rerouted through an alternate path. Meshed fabric requires a minimum of four switches with 16-port switches in a single fabric. An ISL link is the cable used between the switches to connect them. In a single meshed fabric, at least three ports from every switch should be configured as an ISL link. The core-edge topology is the most popular large-scale topology in use today. This design fits into the fabric layer approach separating each layer with its own switches. The two core switches make a difference in the resiliency of the network. Every switch is connected to both core switches which provide redundancy at the core. The two edge layers are the host layer and the storage layer. The core-edge topology is very scalable and provides great reliability. To increase the size of the fabric we can simply add more core switches and more core ports to add edge switches [4].

Designing and creating a workable storage area network (SAN) should be based on tried-and-true basic principles of SAN design with considering the needs. Another consideration should be in mind designing SAN is to flexibility to add more servers and storage if required.

C. SAN Diagram for both sites

In CDS system, SAN devices are connected in two sets of single fabric switch to avail the facility of Dual fabric switch. It ensures easy installation and configuration of servers and storage with maximum fabric performance because all communicating devices connect to the same switch. Also support for local, centralized, and distributed data access needs. Here we use 8 ports auto sensing B-series FC switches for connectivity. Each port can connect SAN devices upto 1GB/s or 2 GB/s. Initial Storage area network is consists of two HP servers (Primary and Secondary), one storage FC 60 disk array and DLT tape library for back. All SAN devices are connected two FC switches with two FC ports from each device to ensure redundancy between SAN devices. Application and database server package holds in primary server and in case of any failure package shifts to secondary server which controlled by HP MC service guard to ensure seamless access to the servers from clients front end application. Heartbeat LAN between two servers sensing the activity of the servers and two other LANs are connected to the CDS Data Communication Network to facilitate the access service for clients. In the DR site, same setup and architecture has been followed like DC site except one server instead of two.

Main Site:

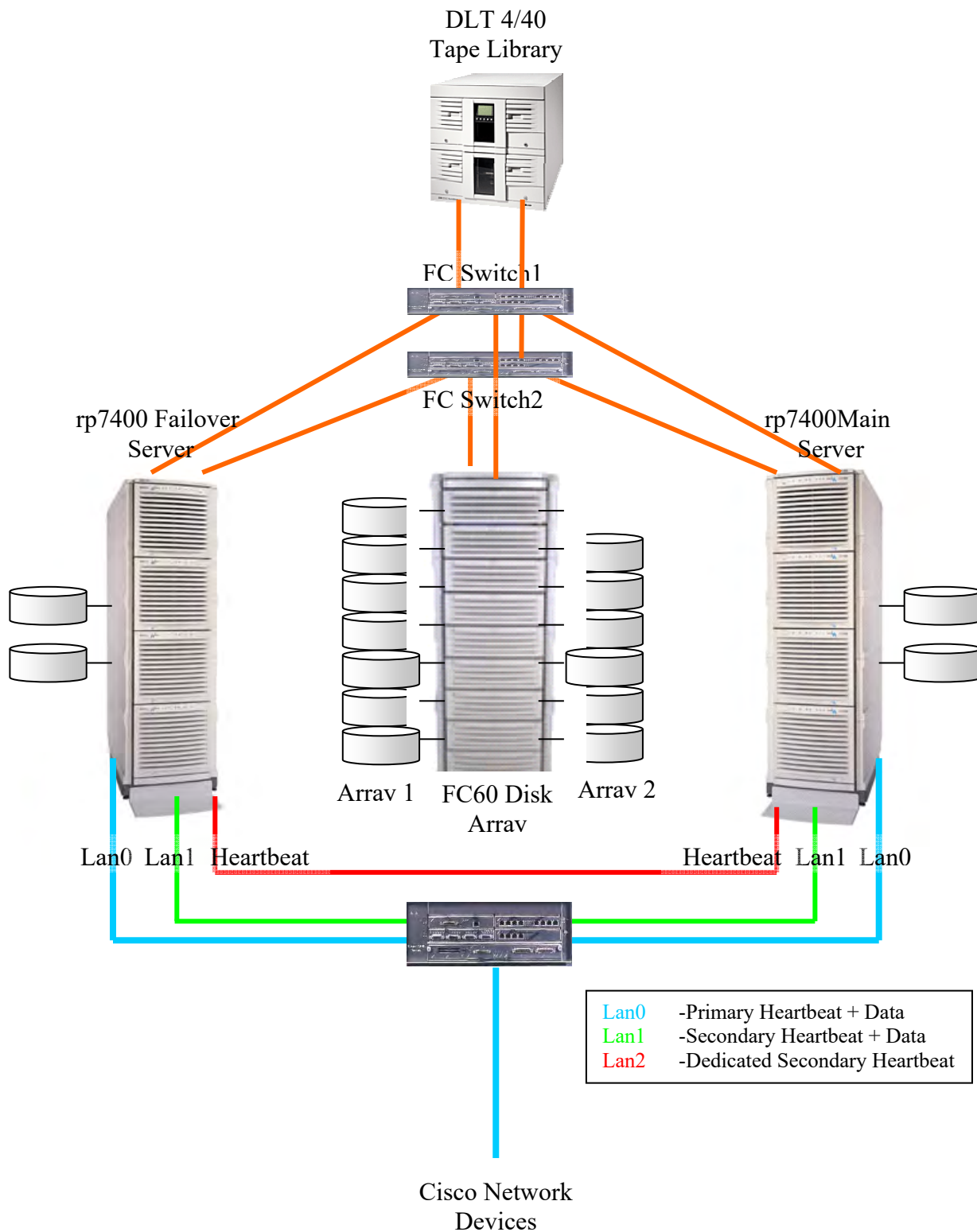


Figure 6. SAN Diagram for Data Center

DR Site:

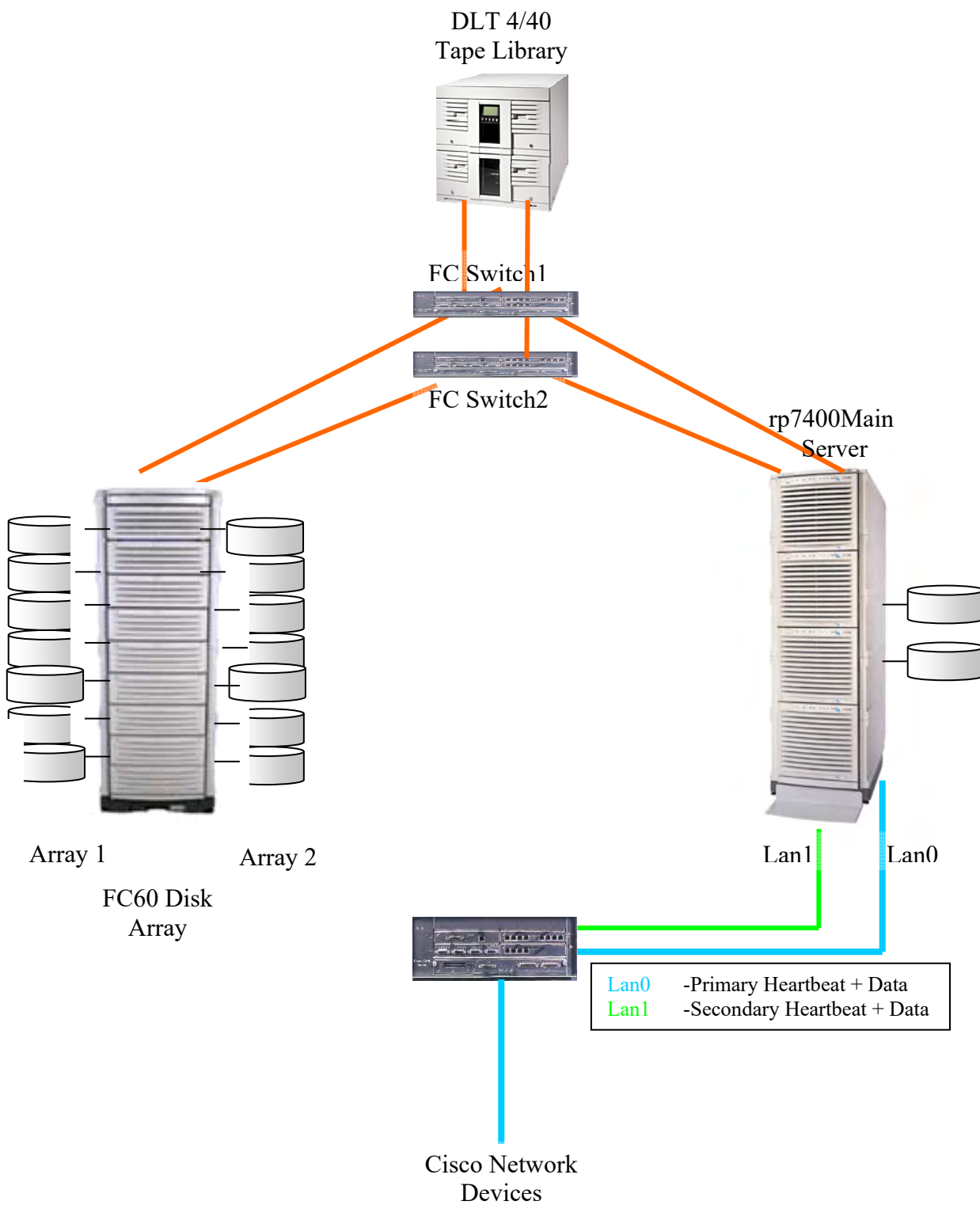


Figure 7. SAN Diagram for DR Center

D. Data Replication between both sites

Oracle Standby database (currently it is called oracle data guard solution) used for oracle database replication to DR. Data is being transfer through point to point wireless connectivity through Aironet 350. SAN to SAN data replication did not exist in 7400 system. So application data replication done by tape backup at Main Site and Data restore at DR site.

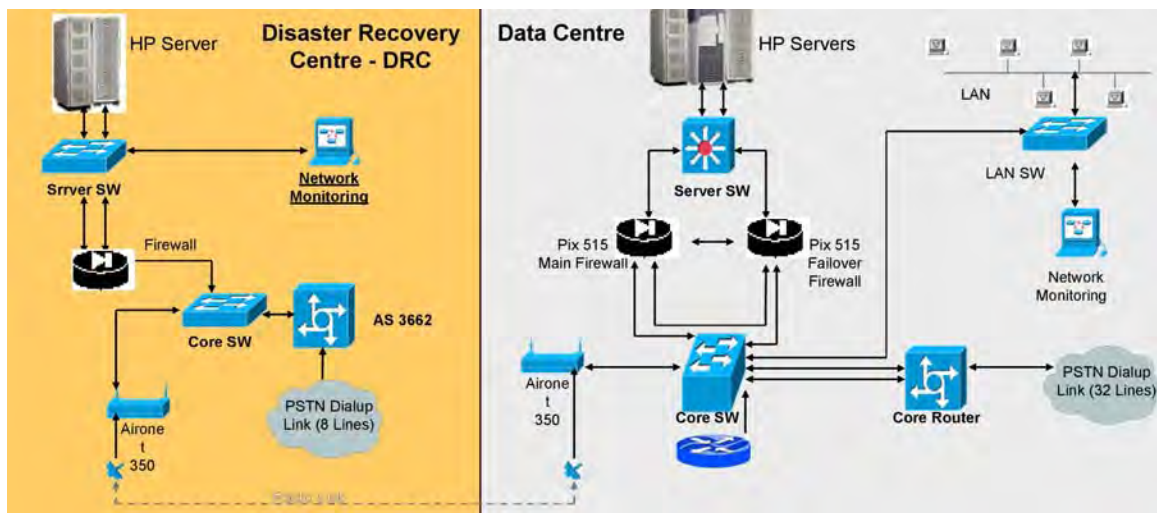


Figure 8. Data Replication through Data Network

E. Limitations of existing system

CDS went live on Nov 2003 with limited capital market services as Treasury Bills and Demat Settlement started. During the time period from 2004 to 2007 there has been sizable increase in daily transactions. The daily settlement trades have increased to around 50,000 and the BO accounts is around 1.2 million. Number of Depository participants and enlisted companies has increased accordingly 95 and 94. Individual

investor's Account growth has increased tremendously in this period by 1.5 million. As investor accounts increase, daily settlement growth has increased by 188% each day which became overload for current system infrastructure.

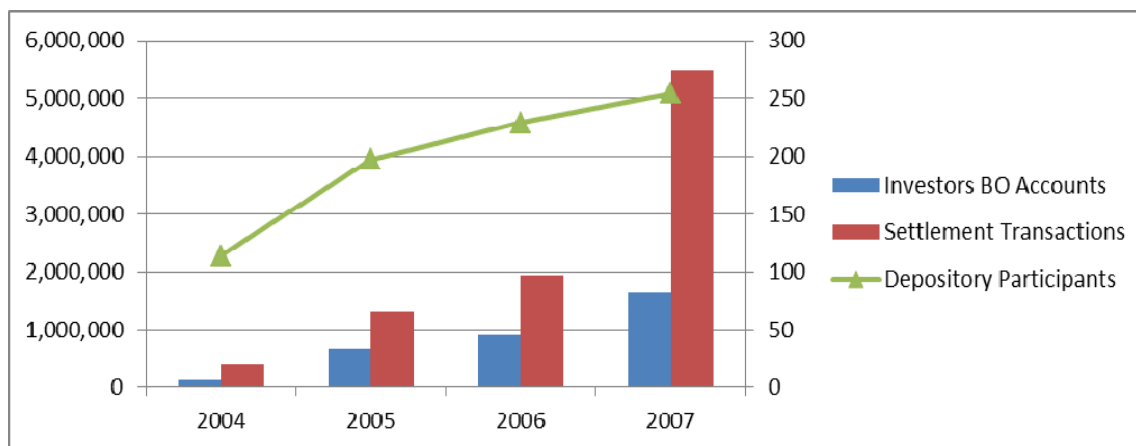


Figure 9. Operational Growth of Depository System for last 4 years

As over saturated operations of capital market leads to system unavailability and some technical faults like processes gone down, cache memory crashed, file system are almost fill-up to 90% etc. occurred at production time during day. Moreover CDS has daytime activities to perform 5 tasks to complete to run the whole process of share enquiry, share transfer to investors account and earmark the traded share quantity of investor's which takes place at Stock Exchanges (DSE & CSE). During this period Depository Participants download daily Reports, inquire BO Balances, open and close BO Accounts, setup and inquire BO Signatures, setup Demat, Remat and Pledge requests, setup Transfer & transmission transactions and setup and upload Freeze and Suspension transactions and Settlement Transactions (Payin and Payout). Processing time increased robustly in 2007 due to huge growth of Capital market of Bangladesh. Start of the day which declares the start of day activities for clients and CDS software takes two and half hours instead of 30 minutes and processing time increased 400%.

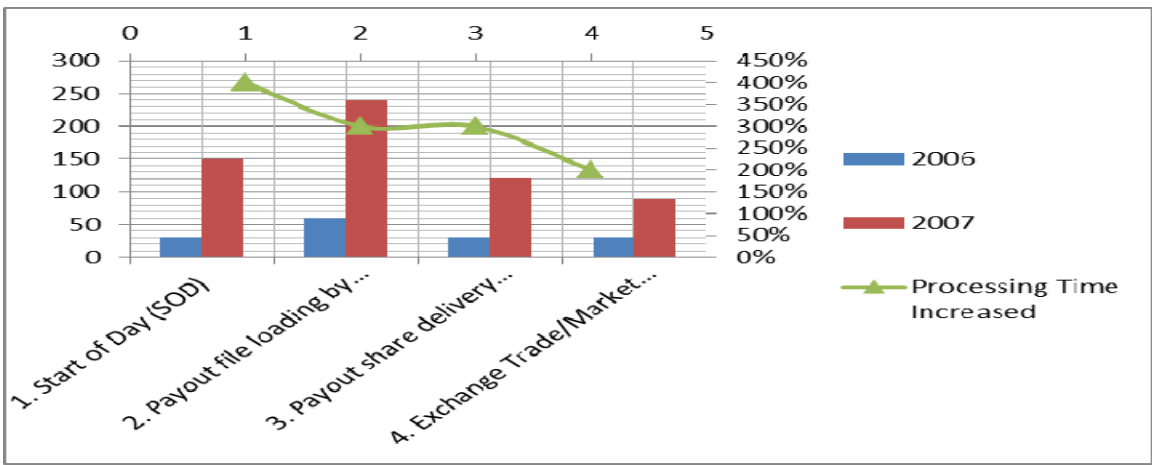


Figure 10. Delay on Day to Day Activities of Depository Systems

It delays rest of the scheduled activities of the day which leads to unavailability of services on time. CDS processes payout file loaded by stock exchanges which indicates the investor's holdings for share selling which processed time increased 200%. And the later part of the CDS perform loading trade file and shortage cover which processing time increased by 300%. Clients are getting late response from their front end software and passing hard time to perform their scheduled job.

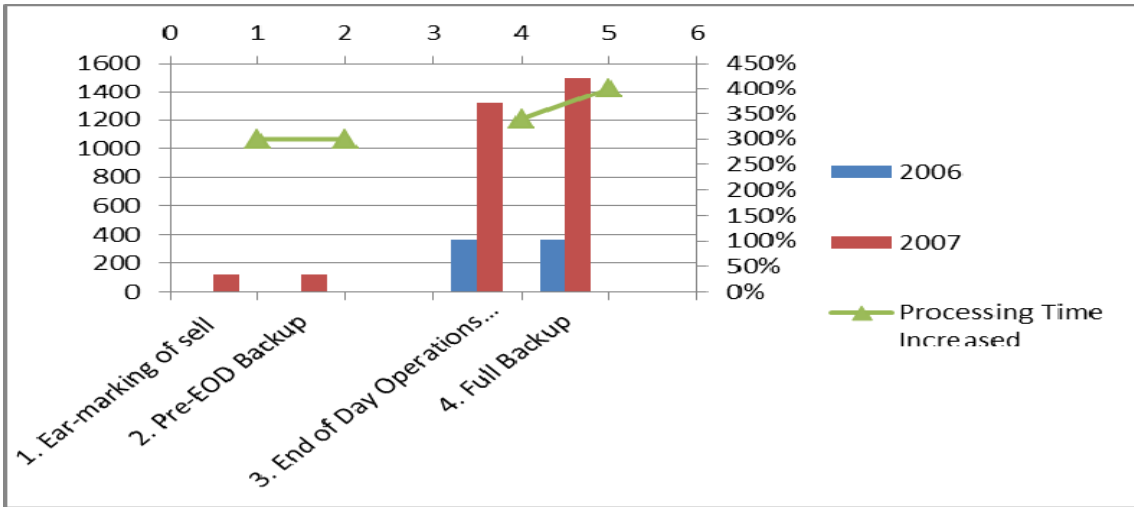


Figure 11. Delay on Overnight Activities of Depository Systems

After Day time activities CDS has to perform in house server end tasks like back of the system before declare end of the Day, complete all tasks regarding EOD and system full backup which also increased processing time by 400%. In some extend in delays to start the next day scheduled task. Corporate Actions (Stock Dividend Cash Dividend Rights Split), IPO Processing and Issuers shareholders request report services have to be scheduled for processing Thursday nights as not enough time is available on weekdays to process these services overnight. End of month billing also had to be shifted to Thursday night on some occasions instead of the scheduled time of the task to avoid delays on day to day activities.

III. PROPOSED SOLUTION

On the other hand Company's Financial grown has also increased by 369% which indicates the availability of currency and considering resolving all technical and operational difficulties, system unavailability and previously proven compatibility of HP-UX platform, Company decided to initiate hardware up-gradation with HP systems.

A. Projected Hardware and Software Up-gradation for both sites

Both sites are prepared with HP9000 rp8440 servers, HP8100 storageworks EVA, HP9000 rp3440 backup server for each rp8440 server, Backup systems like HP StorageWorks MSL 6060 Tape Library and HP StorageWorks 6000 VLS disk to disk system. The HP 9000 rp8440 is built around a modular architecture with components that can be configured to effectively cover a wide range of computing requirements. The cell or cell board is one of the basic building blocks of the rp8440 server. Each cell board is a self-contained unit with a symmetric multiprocessor (SMP) up to four 1.068-GHz dual-processor modules, cell controller and memory mux integrated circuits up to 64 GB of

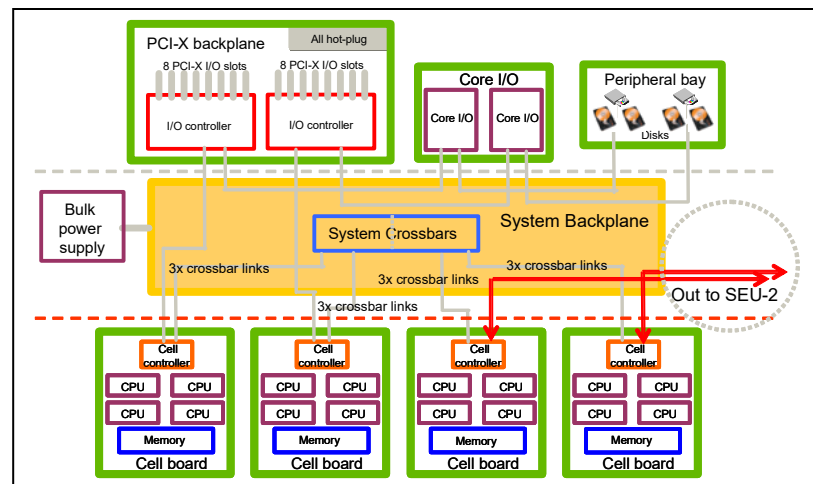


Figure 12. Cell Board Architecture of HP9000 rp8440 servers

DDR-2 memory, data buses, voltage regulator modules, cell management and processor-dependent hardware circuitry. Each rp8440 server holds up to four cell boards [5].

HP9000 rp8440 servers are loaded with 64-bit PA-RISC PA 8900 processors 1.608 GHz, 16 number of processors, 64 GB RAM per cell board, 2x146 GB Hot Pluggable HDD and 8 FC Ports.

The Enterprise Virtual Array (EVA) 8100 family is designed for the data center where there is a critical need for improved storage utilization and scalability. The EVA meets application specific demands for transaction I/O performance for midrange and enterprise customers. It provides easy capacity expansion, instantaneous replication, and simplified storage administration. The Enterprise Virtual Array combined with HP Storage Works Command View EVA software provides a comprehensive solution designed to simplify management and maximize performance. This new storage unit is equipped with two dual controllers and 8 TB of raw disk storage upgradable to 240 GB, four 4GB/s FC ports with replication and local backup software suite [6]. Currently EVA 8100 storage system is running in production system total of 23 TB disk storages in six enclosures due to data growth over the time period which require adding extra disk storages in storage system.

HP 9000 rp3440 Backup Server system was built either to be rack-mounted or standalone servers and to withstand large application tasks. The HP 9000 rp3440 is part of the HP 9000 series. HP Systems Insight Manager provides a single point of administration across all operating systems supported on HP Integrity servers. It also increased system resource utilization while maintaining different service levels. The HP 9000 rp3440 manages automatic resource allocation, simplified management and improved system usage.

Server is loaded with two 1GHz of processors, 4GB of RAM, two 146GB of HDD and two FC ports.

HP StorageWorks MSL6000 Tape Libraries provide a secure, centralized backup in a single automated device freeing valuable IT resources for more strategic work. These libraries are ideal for medium to large IT networks with or without a storage area network (SAN) experiencing uncertain data growth. The MSL6000 Tape Libraries offer a choice of tape technology including HP LTO-4 Ultrium 1840 with embedded hardware encryption support. Encryption key management support is available with HP StorageWorks Data Protector and other ISV backup applications. This portfolio of tape libraries offers a secure, scalable and manageable centralized tape backup solution that can grow with ever-changing backup and recovery needs. Backup system is loaded with Maximum Drive Support 4, 2 x 4Gb FC Interface, No. of Slots 60, Data Transfer Rate 3.4TB/hr and capable of compressed data each drive 96 TB.



Figure 13. HP9000 rp8440 server, HP EVA8100, HP MSL6000 and HP 6000 VLS

The HP 6000 Virtual Library System is deployed managed and operated just like a tape library minimizing disruptions to environment. A single-node solution that offers industry-leading performance and easily scales in performance with capacity to 600

MB/sec and 122 TB of useable storage along with 2:1 hardware compression (VLS6600 only) without impact on performance. Accelerated de-duplication (an optional license) retains up to 50 times more data readily available on disk. Accelerated de-duplication delivers fast backup performance since the de-duplication process does not impact the backup. Self-managed features like auto-configuration, auto-monitoring, self-diagnosis, auto performance-tuning and load-balancing appliance that is easily installed through a simple interface. To ensure real reliability of data protection process, hardware is configured RAID 6. HP's Enterprise Business Solutions (EBS) assures that HP Storage Works 6000 VLS works with leading servers, operating systems and backup applications.

HP StorageWorks 4/16 SAN Switch is sixteen-port auto-sensing Fibre Channel fabric switch that delivers 2 Gb/s and 4 Gb/s connectivity between servers and storage devices. The SAN Switch supports fabric, fabric-loop, E_port connectivity, ISLs and meshed Switched topologies. HP SAN Switch also bundled with Fabric Watch, WEB TOOLS, QuickLoop, advanced Zoning, SAN management, SAN monitoring and legacy Fibre Channel Arbitrated Loop (FC-AL) support.

B. Design of SAN for both sites

In this up gradation, two sets of single fabric switch are placed to avail the facility of Dual fabric switch. Here we followed the same fabric topology like earlier. It ensures easy installation and configuration of servers and storage with maximum fabric performance because all communicating devices connect to the same switch which also support for local, centralized and distributed data access needs. Here in the new design, 16 ports auto sensing B-series SAN switches are setup for connectivity. Each port can connect SAN devices up to 2GB/s or 4 GB/s. Old SAN devices are replaced with new Storage area network devices with HP9000 rp8440 servers, HP8100 storageworks EVA, HP9000 Backup systems like HP StorageWorks MSL 6060 Tape Library and added new dick to disk backup system HP StorageWorks 6000 VLS and rp3440 backup server for each rp8440 server unit. All SAN devices are connected two SAN switches with two FC ports from each device to ensure redundancy between SAN devices. Two individual packages has been introduce for application and database server to facilitate load balancing between two servers instead of keeping one server idle [7]. Servers clustering with packages are controlled by HP service guard to ensure seamless access to the servers from clients front end application. Heartbeat LAN between two severs sensing the activity of the servers and two other LANs are connected to the CDS Data Communication Network to facilitate the access service for clients. In the DR site, same setup and architecture has been followed like DC site except one server instead of two.

Main Site:

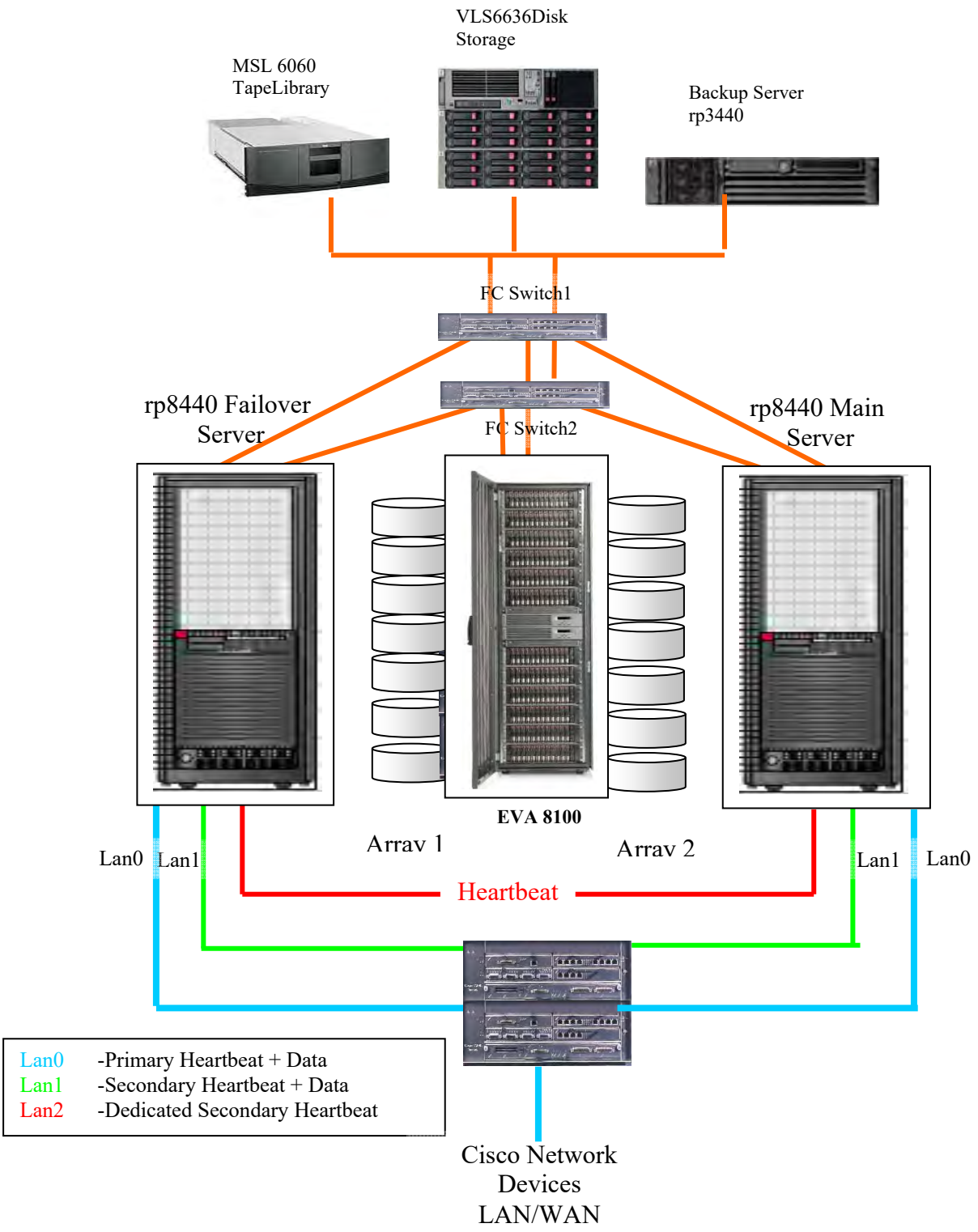


Figure 14. Proposed Design of SAN for Data Center

DR Site:

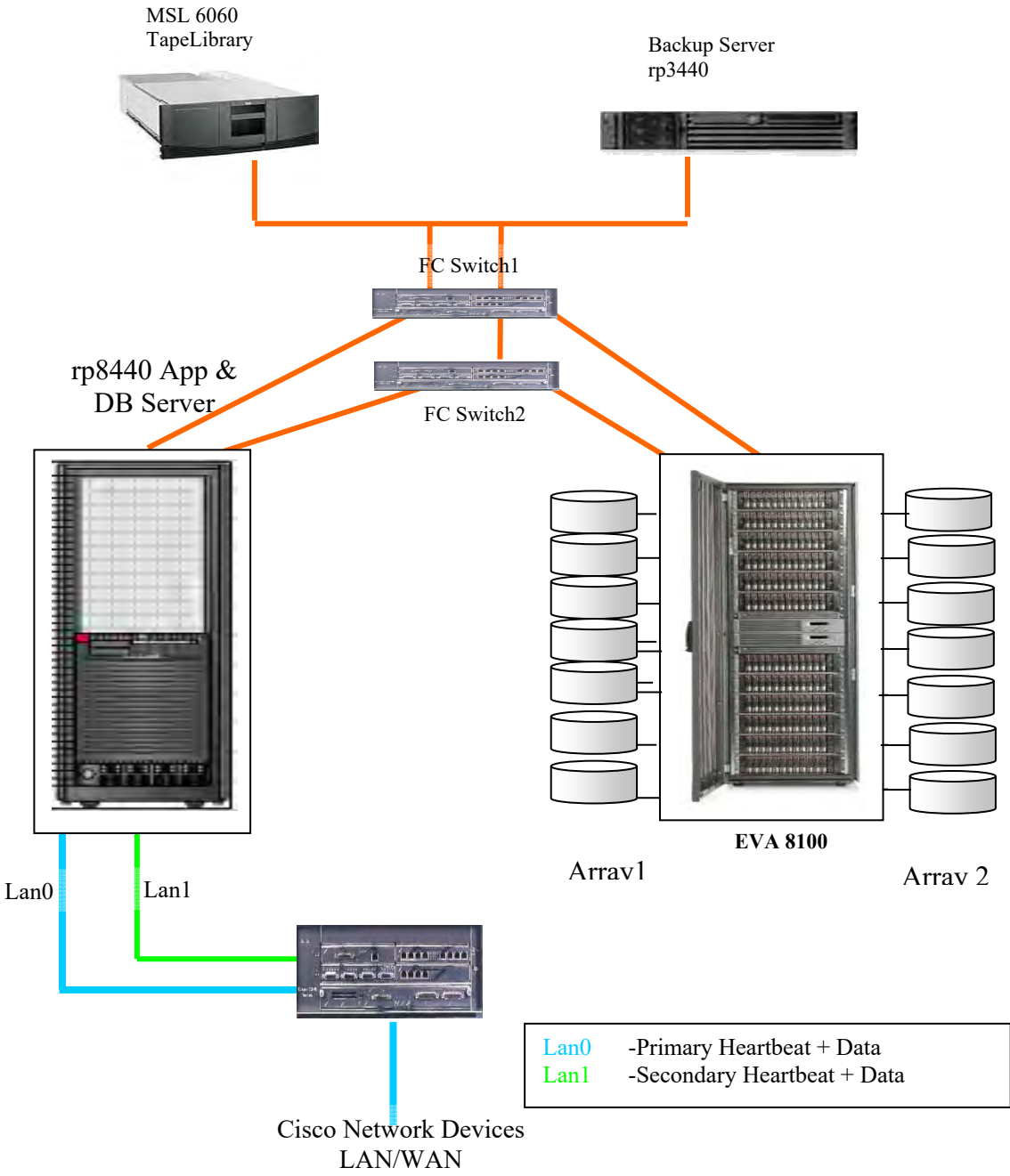


Figure 15. Proposed SAN of Disaster Recovery Center

C. Advanced technology for site to site data replication

Distance between Main and DR site is 6 KM and two sets of HP SAN switches are interconnected with Dedicated Dark Fiber link available installed by independent redundant link from two different data communication service providers to ensure seamless data replication between two storage arrays located in DC and DR site. Long-wave fiber connections between switches methodology has been used to connect both sites SAN fabric into a large fabric [8]. As DR site is within 10 KM, replication SAN switches of both sites are directly connected with 9 μ m Fibre Channel long-wave single-mode lasers cables and long-wave Gigabit Interface Converters (GBIC) ports. Dark fiber

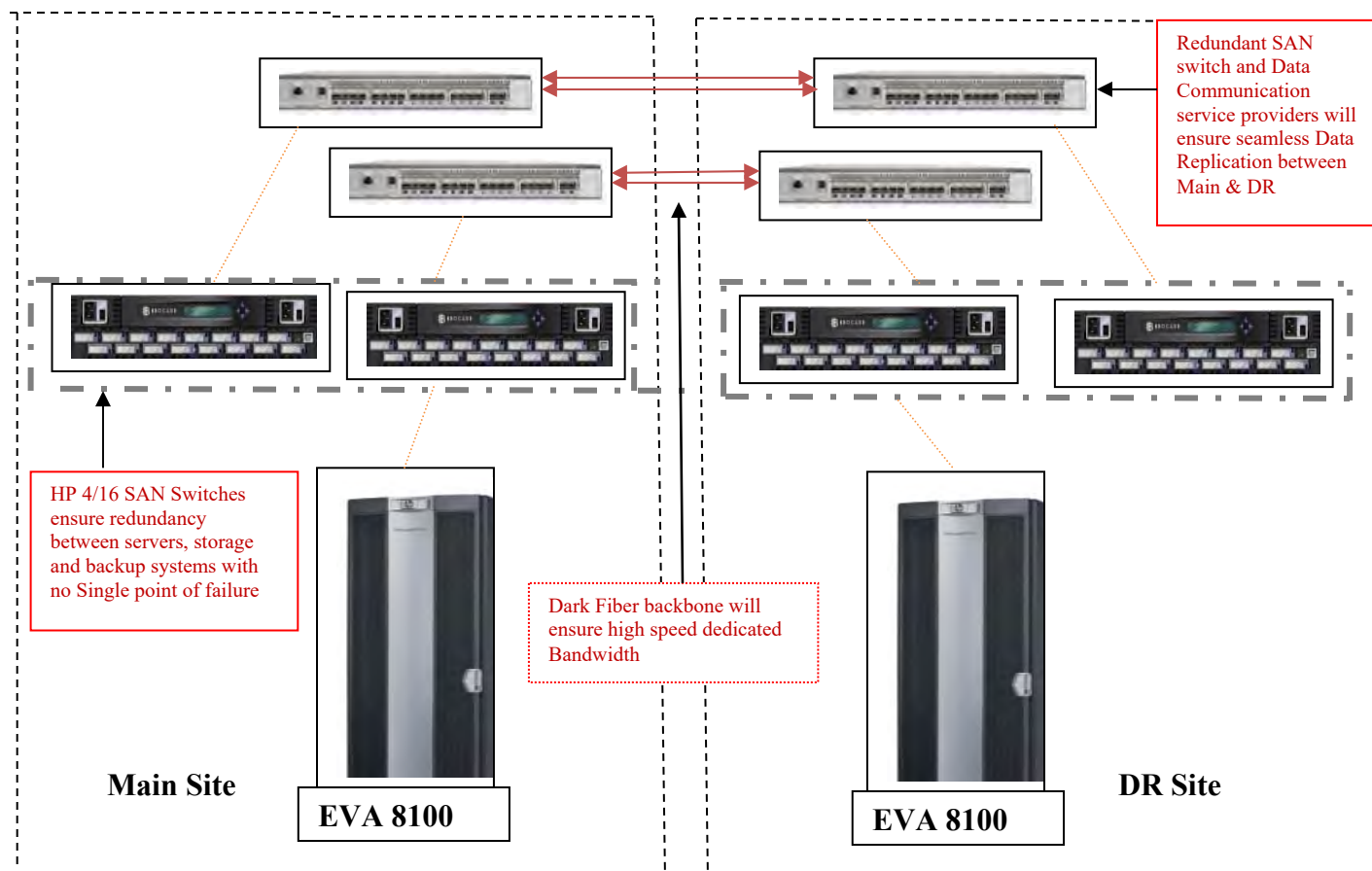


Figure 16. Advanced Data Replication Model

has been used to get the most direct connection and full bandwidth of the dedicated fiber link. I suggested and implemented synchronous replication Data replication mode considering the distance between DC and DR along with to ensure data consistency (zero data loss) between source and destination array. In synchronous replication write I/O commitments at the replication source and destination before a successful write acknowledgement is sent back to the storage host and the requesting application. If the write I/O cannot be committed at the source or destination, the write will not be committed at either location to ensure consistency. Furthermore, a write failure is sent back to the storage host and its application. Application error handling will then determine the next appropriate step for the pending transaction. Synchronous replication required dedicated fiber link network connection between the sites to avoid slow connectivity and required adequate Bandwidth.

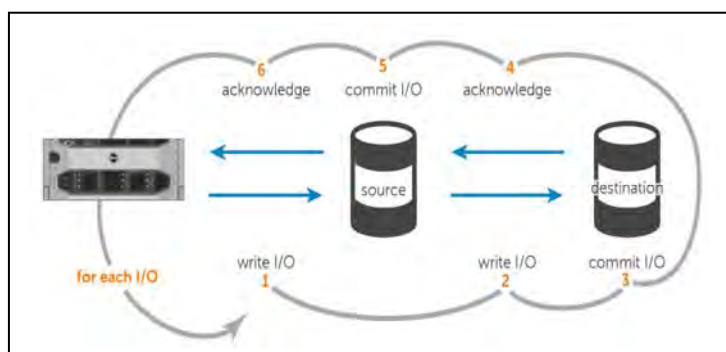


Figure 17. Synchronous Replication write I/O Sequence

The application or server sends a write request to the source volume. The write I/O is mirrored to the destination volume. The mirrored write I/O is committed to the destination volume. The write commit at the destination is acknowledged back to the source. The write I/O is committed to the source volume. Finally, the write acknowledgement is sent to the application or server [9]. With synchronous replication, both arrays process the transaction before an acknowledgement is sent to the host,

meaning the arrays will always be synchronized. The advantage of synchronous replication is to eliminate the risk of accidental data loss. The downside is that it requires low-latency communication because the secondary site ensures error free data packet has been received.

CDS implemented storage-array based replication solution use intelligence in the storage array to replicate data directly to another storage array. This approach requires two servers capable of failover and two storages. Storage array are designed with no single point of failure with dual controllers individual connectivity to replication switches. Thus Storage array replication process provides significantly more reliable replication to local and remote storages. Another major advantage is that servers are not burdened with the load of replication [10].

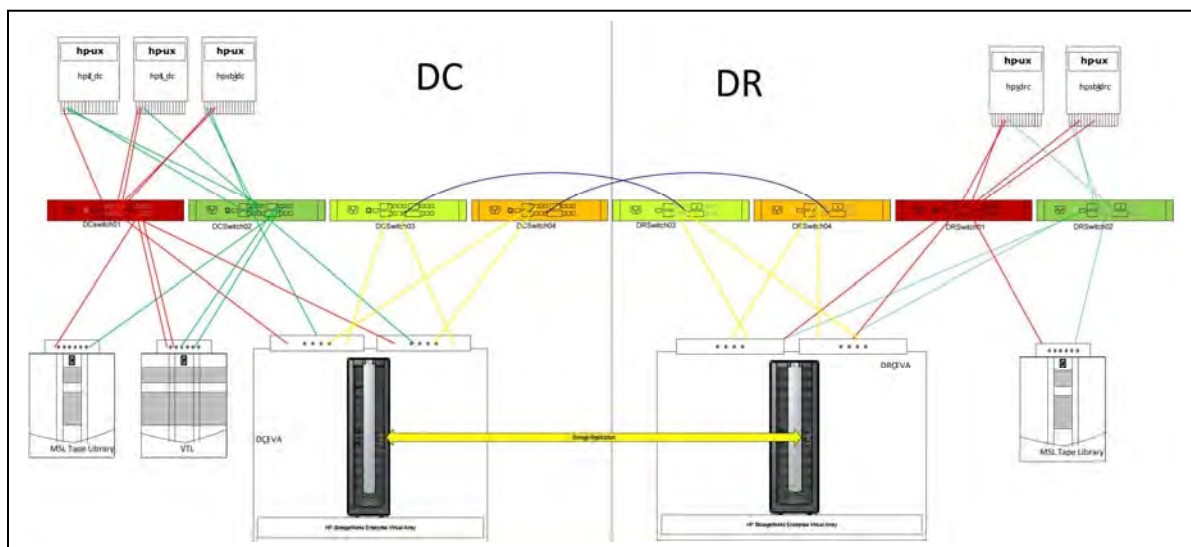


Figure 18. CDS Storage Array-Based Replication

In Array Based Synchronous Replication write is initiated by an application server and received by the source array from host/server. Then write is transmitted by source array to the target array. Target array sends acknowledgement to the source array. Source array

signals write complete to host/server. A dedicated channel (Fibre Channel or Gigabit Ethernet) over a dedicated or shared network infrastructure is required to connect both sites.

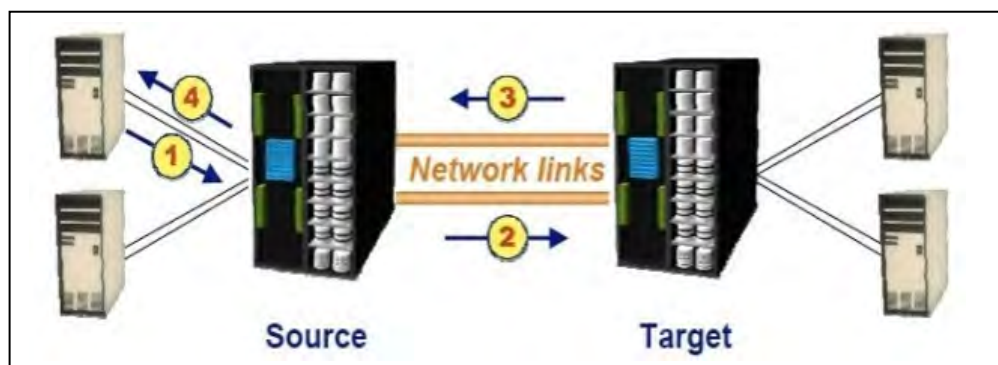


Figure 19. Array Based Replication sequence between source and target

Central Depository System is using a unique integrated replication-management solution HP Replication Solutions Manager which can create and manage remote replication and HP Business Copy handles Vsnap, MirrorClones and Snapclones and for local copy with HP Continuous Access EVA for consolidated backup. It also provides highest level of data protection by ensuring that each write is complete at primary and secondary site before acknowledge write to the host.

D. Performance Enhancement of CDS

New HP 9000 rp8440 server's processor PA8900 is a dual core processor with latest technology and advanced chipset sx2000 than the previous one. A Superdome PA-8900 system can support up to 1 TB of memory with 2 GB DIMMs. The minimum configuration includes four active processors and 2 GB of memory per cell board. The maximum configuration includes eight active processors and 64 GB of memory per cell board using 2 GB DIMMs. Each cell board ships with either four or eight PA-8900

CPUs. The minimum number of active processors on each cell board is 4. On the other hand PA-8600 minimum configuration includes one active CPU and 2 GB memory per cell board. The maximum configuration includes four active CPU and 16 GB memory per cell board. Each cell board ships with four PA-8600 or PA-8700 CPUs.

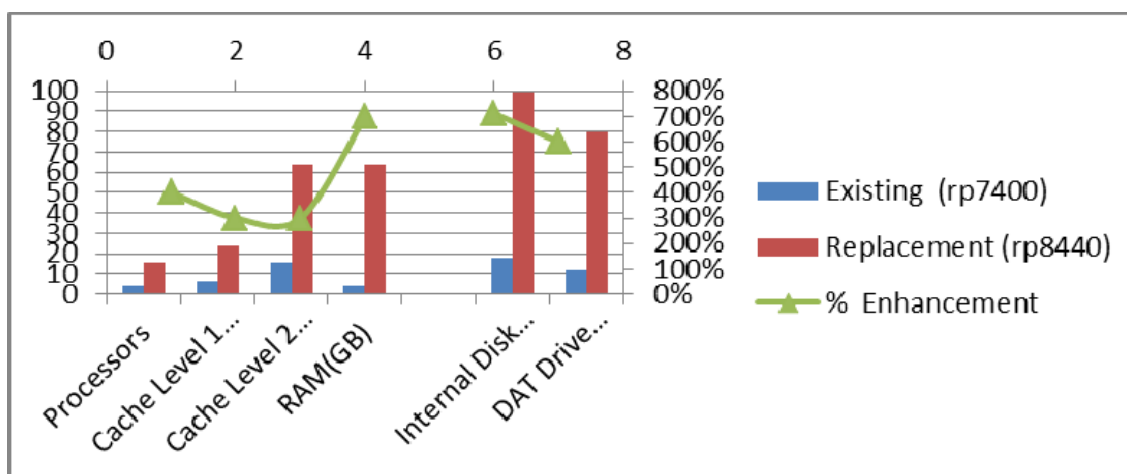


Figure 20. HP servers performane Enhancement

HP9000 rp8440 server's performance is increased enormously with four to six times capacity increased than the previous one considering the higher processor speed with latest chipset, increased number of processor in per cell, 64 GB memory per cell and increased HDD capacity.

HP StorageWorks EVA8100 introduces maximum system availability and easy site to site data replication process by HP StorageWorks Continuous Access EVA which is an array-based application that uses HP StorageWorks Replication Solutions Manager (RSM) which is advanced technology imposed in new system. Continuous Access EVA provides highest level of storage data protection capabilities to meet mission-critical business continuity requirements than HP SureStore FC60 disk Array. EVA8100 also supports HP StorageWorks Business Copy Enterprise Virtual Array Software (Business

Copy EVA) integrated with HP StorageWorks Replication Solutions Manager (RSM) supports Snapclone, MirrorClone and Vsnap for local replication or data backup technologies which is not available in previous FC60 software bundle. Disks also can dynamically be added to the EVA8100 disk array system.

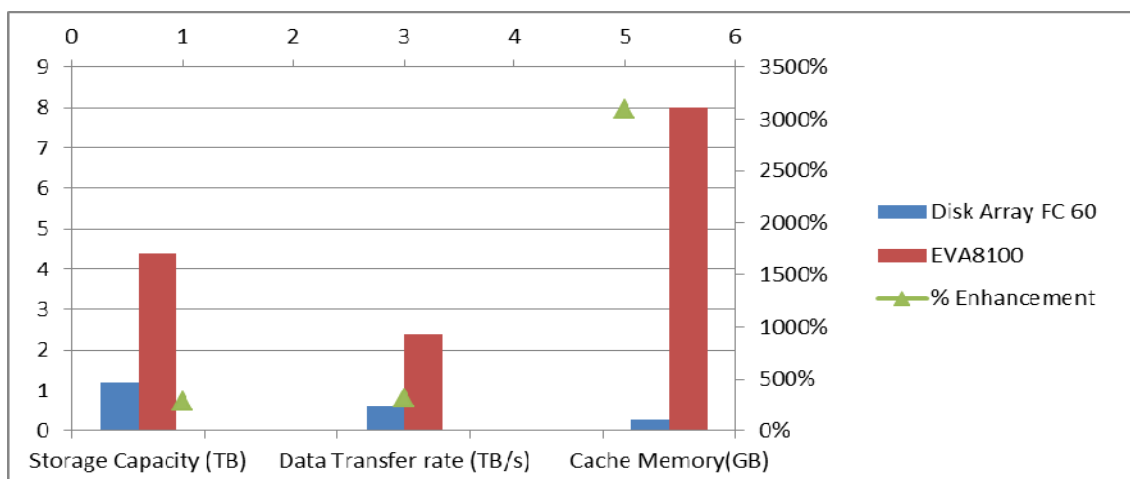


Figure 21. Storage performane Enhancement

EVA8100 provides maximum capacity of 120TB using 500 GB HDD which has tremendous capacity expansion capability than FC60 disk array. In CDS system EVA8100 is equipped with 4 TB disk capacity for production which is 200% performance increased than FC60. New array also supports 4 TB disk capacity for Business ciopy of production data. Cache memory also increased from 256MB to 8GB per controller and I/O requests per second increased from 10k to 225k which rises the performace of the array.

HP StorageWorks MSL6000 Tape Libraries provide a secure, centralized backup in a single automated device. MSL6000 Tape Library is using LTO-4 Ultrium 1840 which is fourth generation of LTO tape technology including HP with embedded hardware encryption support and backup is secure with AES 256-bit hardware encryption embedded on the HP LTO-4 Ultrium 1840 Tape Drives. Encryption key management

support is available with HP StorageWorks Data Protector Application. New tape library is equipped with 60 slots instead of 40 slots in DLT tape library. Compressed data backup capacity is increased by 900% in the new library. Data transfer rate is increased from 1.2TB to 3.4 TB as well.

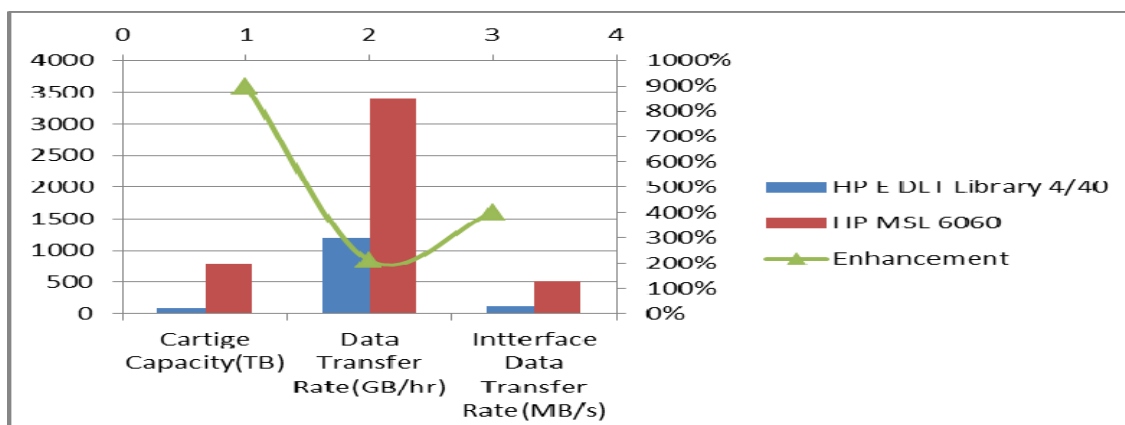


Figure 22. Tape Library performane Enhancement

HP StorageWorks 4/16 SAN B series switch is equipped with 16 ports each capable to transfer data at 2 Gbps to 4 Gbps. Switch is enabled with advanced ISL Trunking.

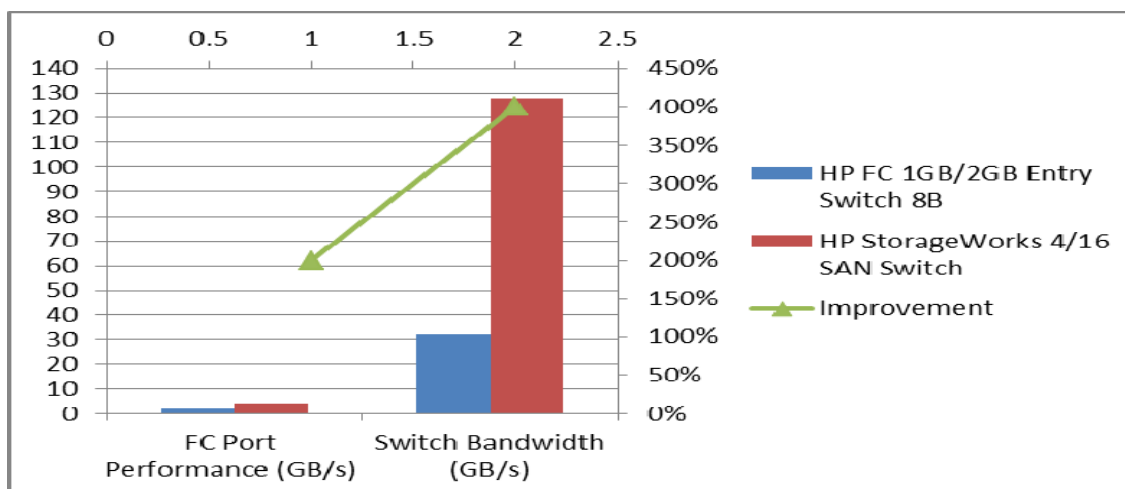


Figure 23. HP FC switch performane Enhancement

Total switch bandwidth and FC port performance has increased doubled comparing the previous entry switch. It also ensure non-blocking architecture with intelligent routing

and faster fabric services to provide a high performance storage network access. Additional Disk Storage System VLS6636 has been introduced in the proposed system for Quick Restoration of data. Data from EVA8100 to VLS6636 will be copied regularly besides Tape Library Backup. Advantages of taking a second backup in VLS6636 storage is to Protect Data, Random Access, Fast Data Restoration. Data can also be restored from Tape Library but it is around 50% slower than Disk Storage Systems. This system is capable of keeping 4.4 TB of data in nine 500GB SATA disks. Hot-swap SATA drives allow recovery from a drive failure without taking down the system. To ensure data reliability hardware can be configured RAID 5 and 6.

HP9000 rp3440 backup server will initiate backup to copy data from EVA8100 and write to MSL6060 Tape drive. The Backup server will track progress of backup and generate report. Backup Server will also copy 1 set of data to VLS6636 Storage. Server is loaded two PA-8900 RISC core processors running at 1.0 GHz and memory of 4 GB. Server also has two hot-plug 146GB disk drives. HP Data Protector Software manages backup and recovery from both disks and tapes delivering maximum data protection while providing continuous 24 x 7 business operations. The software is designed to simplify centralize backup and recovery operations by full backups, on-line backup, open-file backup and instant recovery or zero-downtime backups. After up gradation daytime activities processing time has been radically decreased more than increased processing time before up gradation for all day tasks.

Daytime activities processing time comparison are stated below:

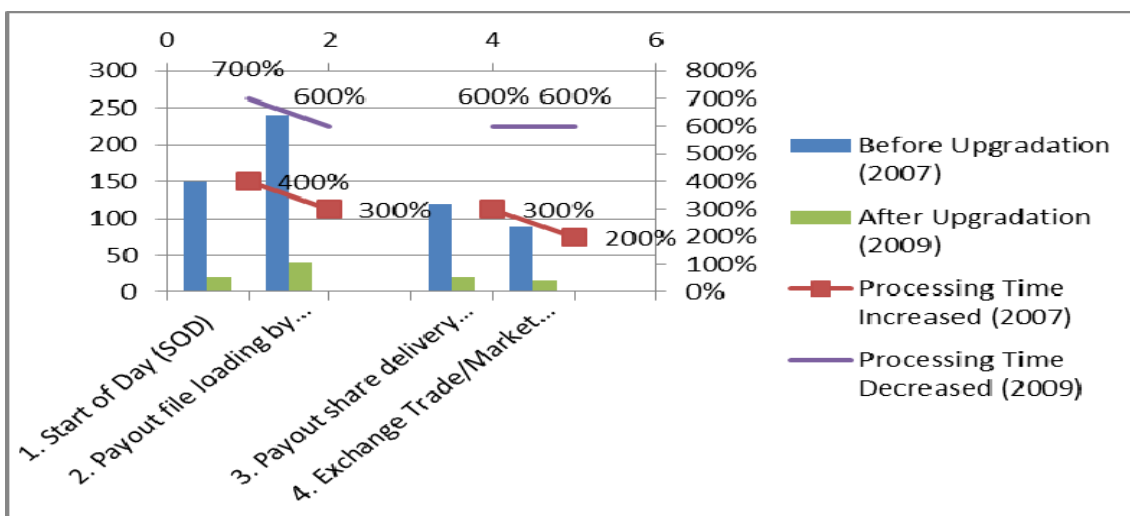


Figure 24. Improved Day activities of Depository Systems

Company's in house server end tasks like shortage clearing, declare end of the Day, complete all tasks regarding End-Of-Day and system full backup processing time decreased outstandingly.

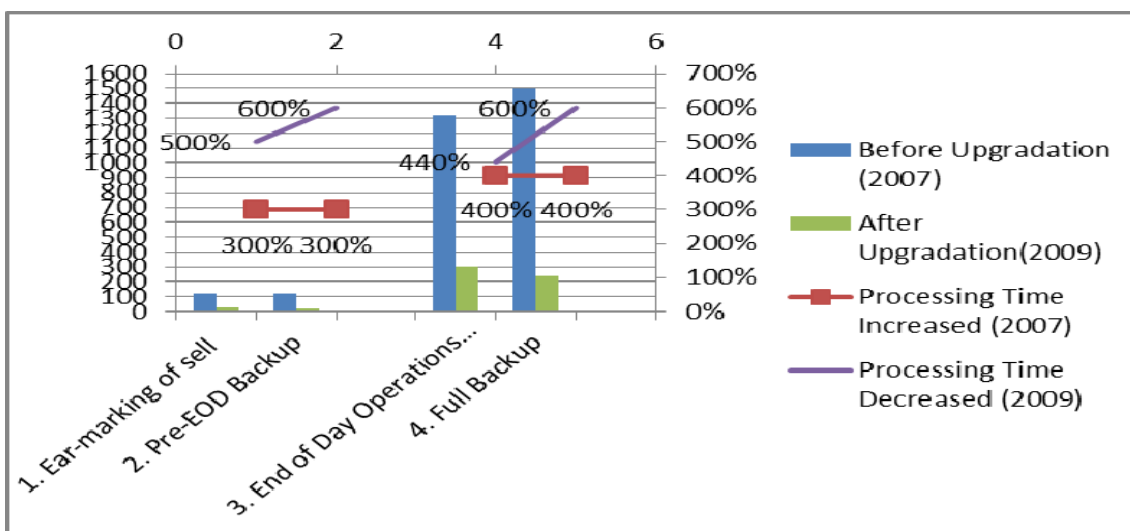


Figure 25. Improved Overnight activities of Depository Systems

IV. CONCLUSION AND FUTURE WORK

The target of this project work is to analyze and develop the existing system design, architecture and SAN equipment. Throughout the work a professional approach of system up gradation has been followed. At first, background of the initial system was analyzed started from existing equipment, Storage area network and database system. The idea is to find out the gaps in the existing system in all aspects and propose an enhanced solution of CDS. In proposed solution an enhanced methodology has been followed comparing to other high performance SAN system. A high performance and strong hardware with enough backup has been proposed to provide high level of security and more than 99% uptime. Future work will focus to implement advanced SAN technology to strengthen the operations of CDS. The core Hardware Systems of the company like HP9000 rp8440 servers, EVA8100 storages and MSL Backup Solutions has been running on live operations for around 7 years at Main & DR Site since 12th October 2008 since last up gradation reached End-of-Life [11]. In view of the expiry of AMC, Company considers to up-grade the existing hardware to the advanced end of technology with latest version of operating systems and layered software. Moreover, there are some more issues which lead to system up gradation mentioned below:

VeDAS software backend codes and data model changes for move from 32 bit HPUX V1 to 64 bit HPUX V3. Oracle 10gR2 up-gradation required to 11g involving VeDAS “source” & “runtime” login and full compilation of all the programs. CDS’s current oracle version 10gR2 will not be compatible with latest HP Operating System HPUX11iV3 requiring up-gradation to 11gR2 or 12c. Transaction Manager TUXEDO

also required up gradation due to oracle version change. CDS's current Micro Focus COBOL version 4.1 will also need to be upgraded to VISUAL COBOL 2.2 to make it compatible with latest version of HP Operating System HPUX11iV3. CDS's Application software VeDAS will be converted to newer .Net & Web based technologies to leverage the benefits of smooth operations of latest .Net Framework which will enable Depository Participants to use the VeDAS Application without any installation on their local client Machine. Offline data entry facility is to be provided the Depository Participants so that user can commit from the offline database to the main database.

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