Oracle’s Storage Augments Mainframe Renaissance

Mainframe Storage Solutions Remain Best in Class

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Delivering Continuing Innovations in Mainframe Storage

The Early Mainframes - 1964

System/360 was announced by IBM in April 1964 and is generally considered the first mainframe computer. More than any other computer development effort, the System/360 family of processors enabled companies to affordably integrate all of their data processing applications into a single management information system. The term “360” was actually chosen to show the versatile nature of the computer, which could cover a “360-degree radius” of business applications. At the time, it defined the mainframe as a system that could perform multiple tasks at the same time on one machine and it was now possible to perform one million instructions per second (1 MIPS). The System/360 was also designed to be compatible through all models so that work performed on any model in the 360 series could be ported to any other model.

The System/360 could process online, batch and databases at the same time in a multi-programming mode so that the system was literally tailored to the specific customer's jobs. Until the introduction of the System/360 architecture, which introduced many of today’s storage management concepts, accessing large amounts of data had been very time consuming. System/360 greatly improved data storage and retrieval capabilities while providing management with real-time decision-making capabilities for the first time.
The mainframe was the predominant computing platform from its introduction in the mid-1960s until the mid 1980s. With the advent of distributed and client-server computing, commonly referred to as open systems, the mainframe began to lose viability as a server platform and seemed relegated to only the largest data centers. Observing this trend, one notable industry analyst wrote in the March 1991 issue of InfoWorld "I predict that the last mainframe will be unplugged on March 15, 1996." That observation was never realized and for the past 45 years, the mainframe has served as the backbone of large-scale enterprise-class computing. Also many of the advanced mainframe storage management functions present on mainframes for the past 25 years such as have yet to establish themselves on non-mainframe systems. The Data Facility Storage Management Subsystem (DFSMS) suite of policy-based functions for data classification, hierarchical storage management, and data placement still has no open systems equivalent. Given this scenario, many businesses are now rethinking their mainframe strategies. The mainframe leads the IT industry in its ability to share data, provide the highest level of security, run all types of mixed workloads, and operate at over 90% utilization at near 100% availability. The resurgence in mainframe technology is under way as its perception is quickly changing from a large, big business computer to a sleek multi-purpose server.

**Mainframes in Transition – 1980s**

By 2008, IBM was the only remaining developer and supplier of mainframe computers. On Feb. 26, 2008 they announced the most advanced and powerful mainframe system yet, the System z10EC (Enterprise Class). This announcement extended the life of mainframe architecture at least a decade. Accompanying the z10EC was the z10BC (Business Class) low-end, low cost mainframe designed to capture new Java or Linux workloads as an x86 consolidation server. Today the z10EC mainframe operates on a new level capable of handling the workload of over 1,000 Intel servers and it can run a variety of operating systems including the mainframe’s operating system z/OS, z/VSE, z/TPF, z/VM and Linux on System Z, while pushing hardware availability towards the six 9s (99.9999%) level in a Parallel Sysplex environment.

The new zIIP (zSeries Integrated Information Processor) specialty engines include the Integrated Facility for Linux, or IFL; the z Application Assist Processor, or zAAP; the System Assist Processors or SAP; and the z Integrated Information Processor, or zIIP and are built to handle Linux, Java and database workloads, respectively. These engines move processor intensive tasks from the mainframe central processors to high-performance processors further adding to performance and parallelism capabilities of the mainframe.

The z10 EC Series provides up to 30 Billion Instructions per Second (BIPS) or 64 processors and up to 1.52 terabytes of memory in 30.44 square feet. The highest-end z10 processors use five quad-core chip packages or 2 cores at 4.4 GHz, 6 MB of Level cache and 4 megabytes of shared Level cache on a single processor. Approximately 25 percent of the System z server capacity is now being delivered for growing Linux workloads. Linux on System z has hit the mainstream. The smaller IBM System z10 BC server provides usable capacity of approximately 23 x86-based servers, while using 83 percent less floor space, and up to 93 percent less energy than the equivalent x86 servers. In terms of physical size, the
largest single mainframes occupied between 2,000 to 10,000 square feet prior to the 1990s and before CMOS technology was introduced, and created “the mainframe is a dinosaur analogy”. Today’s very small mainframe footprint is surprising to many, given the huge footprints of earlier mainframes and by comparison, today’s mainframe can be called a cheetah.

Concurrent I/O performance and throughput levels benefit from up to 336 FICON Express4 (4Gbps) channels and up to 1,024 ESCON channels, far more than any other processor. Not surprisingly, there is a high concentration of mission-critical applications running on mainframes as the System z approaches unprecedented processor availability levels. It is estimated that 8,000 to 9,000 mainframes are installed worldwide and over 50 new mainframe customers have been added since 2000. Key reasons for the mainframe resurgence:

- The lowest outage costs with the highest server reliability, availability and serviceability levels as error detection and recovery is enhanced with error-correcting code (ECC) on L2 and L3 caches and buffers, and extensive parity checking elsewhere with over 20,000 error checkers on a chip.
- Highest resource utilization levels with tape and disk utilization levels capable of exceeding 80% and server utilization attaining near 100% for sustained periods.
- Consolidation capabilities for any workload mix as the Z EC can consolidate over 1,000 x86 servers and the BC can consolidate approximately 230 x86 servers.
- Lowest security breach risks and costs.
- Widest levels of performance with up to 30 BIPS of 64 processors and specialty engines.
- Lowest staffing staff and support costs for enterprise workloads.

**Th System zEnterprise 19 Extends the zSeries Family**

On July 22, 2010 IBM again improved the System z family with the announcement of the zEnterprise 196 (z196) reassuring customers of IBM’s continuing commitment to the keep the mainframe on the cutting edge of technology for many years to come. Compared to the previous generation System z10, the z196 represents a 40-60% increase in overall processor performance and a 60% increase in overall system capacity, at equivalent energy consumption. In multiprocessor configurations, the z196 is capable of delivering over 50 Billion Instructions per Second (BIPS) compared to 30 BIPS on the z10, allowing customers to manage data by the petabyte and share millions of files in a timely manner.

In addition, the z196 boasts a new L4 cache with four times as much shared memory on the Multi-Chip-Module/book (192 MB vs. 48 MB). This means fewer accesses into memory to get needed data, which also improves performance on shared-data, virtualized and other memory-intensive workloads. The z196 uses the latest 5.2 GHz superscalar2 processors, up from 4.4 GHz on the System z10, and has up to 9 quad core chip processors with cores 1 to 80 being configurable for client use. The others are pre-assigned to system functions. Each processor supports over 10 new instructions, which translate to increased overall speed, especially for Java and C++ applications. The processors can be connected to up to 3 TB of RAIM (Redundant Array of Independent Memory), 1.5MB of Level 2 Cache per core, and 24MB of Level 3 Cache per processor chip. The use of water-cooling is optional though IBM states chilled water is considerably more efficient at conducting heat away from servers than air. The z196 offers several new personalities. The z196 platform is designed with performance and capacity for growth and large-
scale consolidation and it will be possible to deploy a truly integrated hardware platform that is able to span and intelligently manage workloads across mainframe and distributed technologies. The z196 has also been referred to as the Unified Resource Manager given its consolidation capabilities.

**Mainframe Innovates Storage Management Capability – HSM and DFSMS Optimize Utilization**

The mainframe has always been asked to support extremely large data storage environments, and every type of application from mission critical to archival applications. In 1976, IBM’s HSM (Hierarchical Storage Manager) software quickly gained appeal for its ease-of-use and automated policy-based capabilities that helped optimize storage management. HSM enabled data set and file backup and archiving in a way that optimized the tiered storage hierarchy (disk and tape devices) without requiring the user to be aware of when or where files are being retrieved from backup or archive storage media. Eventually most businesses ran HSM on a 7x24 basis continually migrating less active data to more cost-effective storage devices freeing higher cost disk space for more important applications.

A major storage management initiative was announced in April, 1988 when IBM announced DFSMS for their mainframe computers. Commonly called “SMS,” this architecture consisted of a set of related software products that easily marked the most comprehensive set of policy driven storage and data management capabilities introduced up to that point of time. There are several components within SMS, but the well-established HSM functionality was the catalyst that enabled businesses to ultimately address the storage capacity dilemma of matching policy based data attributes with the most cost-effective storage technology.

**StorageTek Gives HSM Huge Boost - 1988**

In January 1988, StorageTek, now part of Oracle, announced the first successful robotic tape library, the innovative 4410 Nearline Tape Library. The use of the Nearline 441 soon became widespread within the installed base of mainframe systems. The success of the Nearline 441 was the result of the combination of Nearline’s effective robotic design that eliminated manual tape mounting and the proactive HSM data migration software, which proved to be a highly effective and popular storage management solution, which moved lower activity data to Nearline libraries. Without a reliable automated library, moving this much data to manually mounted tape would have been physically impossible and unaffordable for most businesses. The combination of these two products essentially set the stage for the tiered storage model to become a compelling storage strategy today.

The SMS architecture provided a policy-based storage management solution for large mainframe computer systems and became an integral part of the earlier OS/390 and today’s z/OS mainframe systems. Its primary goal was to provide user-based policies to assist with data classification and to automate the most significant data storage administration tasks. In time, SMS in conjunction with StorageTek’s Nearline library became a highly effective policy engine for managing and optimizing mainframe storage resources enabling businesses to have access to the right data at the right place at the right time.
Mainframes Achieve the Highest Storage Utilization Levels

Today, mainframes consistently have much larger tape environments than Unix, Linux and Windows as the continuous data migration functionality of HSM software migrates less active data to a lower cost level of the tiered storage hierarchy such as Nearline libraries. Though some HSM software products are available for non-mainframe systems, usage is not yet widespread even though the demand is growing. Without HSM-like capabilities driving data to lower cost tape storage, moderate to inactive data tends to accumulate on more expensive disk storage driving hardware and energy costs up for non-mainframe systems.

Mainframes are appealing for attaining high levels of storage utilization for both disk and tape, which reduces infrastructure expenses. Average disk allocation levels for Unix, Linux and Windows systems are low and at best average just 30 to 40 percent of total drive capacity. The combination of SMS, HSM and Integrated Virtual Tape libraries enabled mainframe disk storage to average around 8 percent allocation, significantly improving the cost-effectiveness of the mainframe storage environment.
Oracle/StorageTek Continues to Push Mainframe Storage Innovation and Enhancements

As the mainframe has evolved and repositioned itself as a powerful consolidation and enterprise server, so has mainframe storage. The evolution in storage solutions has been lead by IBM, HDS and EMC who are the primary suppliers of mainframe disk systems and Oracle/StorageTek and IBM who are the only two suppliers for mainframe tape solutions. The tier 3 storage category includes archive, fixed content and compliance data and is the fastest growing segment of the storage hierarchy. Tape is the primary and most cost-effective storage technology used for tier 3 applications in the mainframe market. Tape is not going away and its role is expanding from a pure backup solution to that of a premier long-term storage technology not to mention the role it continues to play in batch processing. Oracle/StorageTek continues to drive much of the innovation in the growing tier 3 market as it has for over 30 years, and it is this segment that derives the most benefit from future tape architectures.

Integrated Virtual Tape Libraries Change the Rules of the Game

There are two types of virtual tape designs in mainframe environments – The Integrated VTL and the VTL. The Integrated VTL (Virtual Tape Libraries – see chart below) was pioneered on the mainframe in the late 1990s by IBM with their VTS (Virtual Tape Server) and StorageTek with their intelligent VSM (Virtual Storage Manager). The Integrated Virtual Tape Library concept delivers significantly improved cartridge utilization levels for tape storage. The Oracle/StorageTek Integrated VTL combines disk array storage that appears as tape drives to an automated tape library and serves as a cache or buffer improving performance for the more active data files in the physical tape library. The movement of data to and from tape is a background task transparent to the system.

Integrated VTLs store multiple virtual tape volumes on a single physical tape cartridge, commonly enabling cartridge utilization levels to reach 8 percent or more. Effective utilization becomes more important as tape cartridge capacities steadily increase. With fewer cartridges, the number of drives and the number of libraries can also be reduced providing significant Capex and Opex reductions. Another virtual tape concept is called the VTL (Virtual tape Library,) VTL, also called tapeless VTL, differs from an Integrated Virtual Tape Library. Using storage virtualization, it is a disk array only that appears to the operating system as a tape library and multiple tape drives. VTLs do not achieve the same utilization rates as Integrated VTLs due to the requirement to over-configure to meet peak processing windows. With an Integrated VTL, physical tape can be used as another tier of storage ensuring adequate capacity is available to meet any peak demand.

Mainframe Integrated VTLs make traditional tape solutions much more cost-effective by:

• Reducing the number of tape cartridges by increasing cartridge utilization with virtual volume stacking
• Reducing the number of tape drives by presenting multiple virtual tape drive images which may be utilized by many backup jobs during the backup window or batch processing
• Improving tape drive and library reliability by satisfying many tape requests from the disk buffer and avoiding access to the tape subsystem thus improving performance
• Using an Integrated VTL results in fewer physical tape mounts, and therefore less wear and tear on tape drives and media, improving reliability of the tape subsystem
• Lowering the overall costs of the tape environment by reducing hardware since fewer tape drives and cartridges are needed by using a hybrid disk and tape solution
• Reducing tape drives and tape cartridges also lowers energy consumption and floor space requirements
• Improving I/O performance, as many requests are satisfied by the disk buffer avoiding a physical tape mount - larger disk buffers mean improved performance and higher availability.

VLE (Virtual Library Extension) Announcement Increases Performance for Integrated Virtual Tape

Virtual tape has proven to increase performance and provide very cost-effective mainframe storage technology. With the 200 announcement of VSM5 (Virtual Storage Manager 5) Oracle/StorageTek increased functionality for both its mainframe Integrated Virtual Tape Library while adding a new VTL (tapeless) product for those businesses that want a disk only solution for their backup and recovery application. In September 2010, Oracle introduced the StorageTek Virtual Library Extension (VLE), a new disk storage architectural enhancement for VSM5. VLE provides businesses with additional disk buffering capability to keep more active data sets resident on disk for longer periods of time before migrating data to a tape library.
VLE Architectural Overview

The VLE attaches to the VSM5 VTSS (Virtual Tape Subsystem) supporting up to 32 connections across 16 physical IP connectors enabling as many as four VLEs to be located locally or remotely. Using 2 TB SAS drives initially, the VLE offers four native capacity options of 55TB, 110TB, 165TB, and 220TB all in a triple parity RAID configuration for higher reliability and availability. The data flowing into the VLE is compressed and assuming VSM5 device-standard 4:1 compression ratio, effective capacities far exceeding raw VLE capacity of 220TB, 440TB, 660TB and 880TB can be achieved. The VLE uses the same highly advanced compression capability used in the VSM5, at compression ratio of 4:1 it’s approximately twice as effective as standard tape compression techniques.

As data becomes less active over time, the probability of re-use diminishes and it will migrate to tape or be deleted. Without the VLE there is more physical tape activity as data is being more frequently migrated and recalled from tape. By reducing tape activity, VLE will reduce wear and tear on tape resources further improving reliability of the VSM5 subsystem. User defined policies enable certain applications to be directed to VLE such as backup where recovery times are critical while archival and tier 3 applications can be directed to the VSM5 and subsequently reside on tape library storage. VLE provides the optimal way to seamlessly integrate backup and archive capabilities.
## Highlights of Oracle’s StorageTek VSM latest capabilities include:

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<th>VSM Capability</th>
<th>Description</th>
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<td>Integrated VTL Performance (Tier 2 and 3)</td>
<td>Integrated VTL buffer expansion from 28TB to 90TB increasing performance and residency time with fewer tape recalls</td>
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| DR Enhancements | o Improved virtual tape DR capabilities with ESCON, FICON and native IP support to interconnect a wide variety of local and remote virtual tape configurations – within tapeplex and between tapeplexes  
o The CDS (Control Data Set) to be shared by all attached hosts improves recovery time and provides more DR options |
| ELS (Enterprise Library Software) Simplification | o Consolidation and integration of multiple library management components  
o Simplification of mainframe software offerings for higher availability  
o Easier to install, test, use, and deploy  
o Continue to drive quality initiative program  
o Changes will be evolutionary - ELS v7.0 is the beginning of roadmap |
| Security | Virtual Tape Data can be placed in read-only mode for security and DR purposes |
| Remote VTL Capability | Improved virtual tape capabilities with ESCON, FICON and native IP to interconnect a variety of local and remote virtual tape configurations |
| Backward Compatibility | VSM1 data can be read on VSM5 offering significant backward compatibility and migration capability |
| Data Replication | VSM supports copies of data on disk and copies of data on tape – local and/or remote |
| VTL (Tier 2) | VTL (tapeless) to complement tape which allows a longer residency time on disk that minimizes recalls for VTVs (Virtual Tape Volumes) |
| VLE (Virtual Library Extended) | Provides increased disk buffering capabilities for VSM to significantly improve performance capability  
o Complements current buffer capabilities of VSM5  
o User defined policy-based interface to select optimal workloads  
o Eliminates Robotic Mount and Drive Load Time  
o Eliminates MVC (Multi-Volume Cartridge) Locate Time for a Recall  
o Eliminates any reclamation for virtual MVCs resident on VLE  
o Offers effective capacities up to 880 TB with 4:1 compression Remote VLE attachment with TCP/IP connection to VSM5 |

Note: The capabilities above include announcements from Oracle.
Summary

The resurgent mainframe market has been given significant boost from Oracle with its recent announcements and statement of direction for virtual tape solutions. These statements are on target given that over 65% of the world’s digital data is optimally suited for tape, which is the most cost-effective choice for tier 3 applications. Tier 3 applications are growing at nearly 60% annually while the value of tier 3 data can change from archival status to critical status based on the circumstances. As the mainframe has repositioned itself for the next decade, Oracle is adding essential storage capabilities for tier 3 applications to do the same. Optimizing all storage assets by improving storage utilization and performance is a primary goal with huge payback for storage administrators, especially in difficult economic times. The mainframe’s much lower TCO, unprecedented levels of security, the ability to do data classification, and the highest availability of any computing platform have again been augmented with Oracle’s new StorageTek Virtual Storage Manager offerings providing proof points that the resurgence will continue for the foreseeable future.