Syncsort MFX for z/OS: EMC Disk Library for Mainframe Performance Test

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Executive summary

Mainframe processing remains critical and MIPS are increasing - Mainframes – despite the annual proclamations “the mainframe is dead” mantra – continue to grow and run mission-critical enterprise applications critical to the business. Mainframe MIPS continue to grow on a yearly basis because it provides support for the core business of many enterprises.

Mainframe users continue to maximize MIPS, reduce storage footprint, and reduce costs thru new investments, new technologies and balancing the expenditure-versus-investment equation

This whitepaper, co-authored by Syncsort and EMC, discusses how both companies are collaborating using Syncsort MFX and EMC Disk Library for mainframe to deliver unique value to meet key customer objectives:

- Improve mainframe ROI
- Meet and exceed Service Level Agreements (SLA’s)

The high number of drives available in the Disk Library for mainframe allows users to allocate more drives to be used in the sorting process. Special sorting techniques in Syncsort MFX provide parallelization and dynamic optimization. Combining these technologies from EMC and Syncsort produce considerable performance and savings. This paper reports on the lab results:

- Up to 56% savings in clock time
- Up to 14% savings in CPU time

Global economic pressures continue to make IT departments face tough decisions about where investments can and should be made. Delicate balances must be weighed between supporting critical infrastructure key to maintaining the business while investing in newer technologies that provide competitive advantage.

Below, please find more detailed information on Syncsort MFX and EMC Disk Library for mainframe and how together these technologies can provide significant ROI and reduced costs for mainframe users.
Syncsort MFX Overview

Syncsort MFX for z/OS is a high-performance sort/merge/join/copy utility designed to exploit the advanced facilities of the z/OS operating system and IBM System z servers, and is the most frequently installed third-party software product on IBM mainframes. MFX is plug-compatible with the IBM system sort.

MFX has a 40-year history of specialized sorting expertise and unique features. MFX exploits significant hardware and operating system advancements for cost saving performance, efficiency and resource management. Additionally, MFX provides a full set of features for data transformation to save programming costs.

MFX provides value with demonstrated benefits in 4 key areas:

- **Performance**
  - Significantly reduced Elapsed time – up to 40%
  - Exploits PAV, MIDAW
  - PARASORT for multiple tape volumes

- **Efficiency**
  - Significantly reduced CPU time – up to 40%
  - zIIP Offload

- **Resource Management**
  - Dynamic Storage Management
  - Incremental DYNALLOC
  - MAXSORT

- **Data Utilities**
  - DB2 Query
  - Data Editing
  - Join Processing
  - Multiple Output
  - SortWriter
Performance and Efficiency

Syncsort MFX utilizes a combination of proprietary sorting algorithms, advanced access methods, and dynamic optimization techniques. MFX’s design sophistication improves sort performance while optimizing overall system efficiency. Reduced CPU time and elapsed time translate directly into improved system throughput and reduced costs.

MFX optimization procedures dynamically monitor and respond to system status, including CPU utilization, DASD contention, controller caching, central storage availability, paging rates, and the specific make and model computer MFX is running on. MFX exploits parallel access volume (PAV) technology to minimize the elapsed time of sort executions.

MFX exploits the MIDAW and System z Integrated Information Processor (zIIP). MFX’s use of the MIDAW facility reduces CPU time and elapsed time. The zIIP facility allows many sorts to have a portion of their processing directed to the zIIP, thereby lowering TCB CPU time cost associated with sorting. The zIIP exploitation also frees conventional CPU cycles for use by other applications that do not exploit the zIIP facility.

PARASORT uses specially designed parallel techniques to reduce the elapsed time of sorts with large multi-volume and/or concatenated tape data set input. This unique technology allows MFX to read data from two, three, or four tape drives simultaneously. PARASORT can improve elapsed time up to 20% when two volumes are processed in parallel and up to 33% when four volumes are processed.

Resource Management

- Dynamic Storage Management (DSM) is an advanced MFX proprietary system that monitors and dynamically controls sort performance and resource use
Monitor
- DSM continually monitors central storage availability and the performance and work load of DASD and DASD I/O channel paths. The information acquired is recorded in a special history database and communicated to other sorts executing concurrently.

Optimization
- DSM analyzes the history database along with current levels of resource use and individual sort job characteristics. DSM then decides how to allocate resources to concurrently running sort jobs based on a balance among their needs, system load, and the needs of other jobs on the system. Guided by DSM, MFX uses the optimum amount of address space and data space and selects available SORTWK devices with the least contention and highest transfer rates.

Overall System Efficiency
- Using a combination of historical tracking and current system monitoring, DSM adjusts resource use for overall system efficiency

- **Incremental DYNALLOC dynamically allocates SORTWK DASD while an MFX job is executing.** It employs a unique incremental allocation technique that minimizes the use of DASD resources for sorting. MFX acquires SORTWK as required during the sort step instead of allocating all anticipated space at sort initiation. In this way, MFX prevents SORTWK ABENDs due to unavailable DASD or inaccurate FILESIZE estimates without over allocating DASD space. Incremental DYNALLOC can save up to 25% of overall SORTWK space and costly reruns due to lack of DASD space.

- **MAXSORT automates sorting of files larger than available SORTWK space** and makes it possible to sort large data sets with minimal DASD space. This capability is useful for shops where DASD workspace is limited or it is unacceptable to monopolize the available DASD for long periods. MAXSORT dynamically segments the input data, sorts the segments, stores them on tape, then merges them – all in a single job step. MAXSORT provides breakpoints for smooth operational control and job scheduling.

Data Utilities
Powerful features retrieve DB2 data, edit records, join records, produce multiple output files, and generate reports.

- **DB2 Query feature** allows MFX SORT or COPY operations to directly retrieve data from a DB2 database based on a query specified by an SQL SELECT statement. The DB2 Query feature improves performance over DB2’s DSNTIAUL program by eliminating the need for setup steps and user-written exits. Most MFX data transformation and report functions can be applied to the records created by the query operation.
• **Data Editing** features allow you to perform a range of data manipulation functions without COBOL programming. MFX control streams take full advantage of MFX performance. MFX can select input and output records (INCLUDE / OMIT) and reformat them (INREC / OUTREC). Reformattting includes extracting fields, adding or deleting characters, performing arithmetic calculations, converting numeric fields to printable format or other formats, and editing with MFX-supplied or user-defined editing masks. MFX can extract fields that are of variable length or position in a record. This is useful for records imported from other platforms. MFX can convert a variable-length input file to a fixed-length output file (CONVERT) or a fixed-length input file to a variable-length output file (FTOV). MFX can consolidate records with equal sort keys, optionally total values in specified fields, or write eliminated records to a separate data set (SUM, XSUM). In addition to these functions MFX can calculate the average, maximum, or minimum values in specified fields (DUPKEYS).

• **Join Processing** joins records from two source files based on keys specified in the JOINKEYS statement. Equally-keyed records from the two files are combined into one or more records. The REFORMAT statement defines the field selection and record layout of the resultant records. MFX supports left, right, inner, and outer joins.

• **Multiple Output** provides the ability to create differently selected and reformatted data groups, which can be assigned to multiple output data sets. The entire process (record selection, editing, multiple output) requires only one sort pass. This effectively combines applications, saving system resources by eliminating multiple passes through the same data.

• **SortWriter** creates high-performance report writing applications without COBOL programming.

**Syncsort MFX Example Use Cases**

• Insurance Corporation of British Columbia (ICBC) needed to process extensive amounts of data for a single view of its customers, but was unable to join DB2 tables quickly. The team tried to extract data from a DB2 database by using DB2 to join several tables. Once this was accomplished, they would use DB2 utilities to reload the data into another DB2 table. The application was taking 27 hours to complete. Utilizing the join feature of MFX, the group reduced the elapsed time on one DB2 application by approximately 89%, cutting the application time to three hours.

• A Federal Credit Union serving millions of members was growing through acquisitions. Membership growth and data expansion were driving the need for frequent mainframe
upgrades. Twice monthly on paydays, there was a huge influx of members accessing funds and putting heavy strains on the processing environment. To meet service level agreements capacity was constantly being added to the mainframe, increasing both hardware and software costs. Syncsort replaced the incumbent sort product reducing CPU time by 41% allowing SLA’s to be met without increasing capacity.

**EMC Disk Library For Mainframe Overview**

EMC Disk Library for mainframe is the industry’s leading tape-on-disk virtual tape solution for mainframe environment. Many customers are moving towards elimination of all tape from their mainframe datacenters. Implementation of EMC’s Disk Library for mainframe tape-on-disk virtual tape brings tremendous benefits:

- Significantly faster performance
- Simplified Disaster Recovery (DR)
- Flexible replication
- High-availability architecture
- Datacenter floor-space reclamations

The Disk Library for mainframe was designed from the onset to support backup, archive, work tapes/batch, and HSM as a single, high-performance tape platform. EMC customers have been able to eliminate physical tape drives, robotic tape libraries, host software, and existing virtual tape library systems due to Disk Library for mainframe’s balanced high-performance design.

**Performance**

Disk Library for mainframe provides outstanding performance for all tape workloads. Customers have reported seeing tape access times reduced from minutes to seconds with Disk Library for mainframe. Even in heavy tape processing periods, customers report seeing their tape access time drop by many orders of magnitude; for example, one customer reported seeing his recall times drop from 6-10 minutes to several seconds with Disk Library for mainframe’s tape-on-disk performance. High performance means greater throughput in less time.

Benefits:
- Consistently fast performance
- Excellent throughput
- Ability to add capacity easily
- Meet SLAs
- Reduce batch windows
**Disaster Recovery**

Disk Library for mainframe uniquely simplifies Disaster Recovery (DR) testing and management. Disk Library for mainframe leverages the inherent intelligence and capabilities of the attached storage. Disk Library for mainframe enables all the tape volumes to participate in DR testing. Disk Library for mainframe eliminates the needs to have to select specific volumes to be eligible for testing.

The DLm6000, for example, leverages the intelligent snapshotting capabilities and ability to put those snapshots into read-only mode or read/write mode for full write-modified tape volumes. Because Disk Library for mainframe enables full writes and reads, all DR tests, including batch or others requiring a “mod on”, can be done for 100% end-to-end DR testing.

Disk Library for mainframe customers have the confidence that should an actual disaster be declared, everything has been tested end-to-end. This is an EMC Disk Library for mainframe-exclusive feature. Moreover, customers typically experience a reduction in their DR test cycle 40-60%.

Benefits:
- 100% end-to-end DR testing
- Verifiable recovery
- Complete read-write capabilities during DR test
- Continuous replication to remote site during DR testing
- Simplified DR testing

**Replication**

Disk Library for mainframe’s approach enables customers to employ flexible replication schemes to copy their data. One-to-one, one-to-many, and cascaded approaches for multiple site replication and recovery options.

Disk Library for mainframe leverages the capabilities of the attached storage platform and its strengths. For example, Data Domain provides Disk Library for mainframe deduplicated storage so the only unique data is replicated resulting in reduced network traffic and cost.

Other Disk Library for mainframe storage platforms provide full synchronous replication to a local site and asynchronous replication to a third site for critical enterprise tape data. This is especially attractive to for customers with demanding Recovery Point Objectives (RPO’s) and Recovery Time Objectives (RTO’s).

Benefits:
- Flexible replication topologies to meet requirements
- Reduced cost using deduplication technologies
- Asynchronous and Synchronous replication options
- Guaranteed Replication (GR)
- Easy implementation, use, and management

**High Availability**
Disk Library for mainframe’s architecture was designed around the requirements of HA. Disk Library for mainframe uses a modular approach to enable continuous availability. Disk Library for mainframe Virtual Tape Emulation (VTE) engines all connect to the storage platform providing redundancy and continuous data availability.

With two or more VTEs in a Disk Library for mainframe, taking a single VTE offline for servicing or maintenance is easily accomplished while still providing access to the data through the remaining VTEs. These are architectural design points to provide high availability and continuous availability without the need for complex grids and multiple node configurations that attempt to provide high availability built into each instance of Disk Library for mainframe.

Benefits:
- High-availability built into every Disk Library for mainframe as a single unit
- RAID-6 protection for data stored
- Multiple data movers for scale and resiliency (VNX)
- Data invulnerability architecture for data integrity (Data Domain)
- Industry-proven availability

**Datacenter Floorspace Reclamation**
Rather than have a tape library or stand alone drives for certain workloads, a virtual tape library for other workloads, and host software performing tape emulation for others, the Disk Library for mainframe has the ability to consolidate all these workloads onto a single platform with consistent high performance for all the workloads.

Customers have reduced floorspace ranging 78-93% and further savings from the reduced power and cooling needed for the old tape infrastructure.

Benefits:
- Floorspace reduction up to 93% compared to existing tape infrastructure
- Reduced power and cooling
- Simplified operations

**Disk Library For Mainframe Example Use Cases**
- One of the world’s largest banks was able to replace 22 aging tape libraries, over 100 tape drives, 100,000 cartridges, and dozen virtual tape systems while reducing their average access time from 6 minutes to 1-2 seconds and reducing their tape footprint more than 90%.
• A leading insurance company improved their HSM ML2 recall time of 2,500 migrated volumes from 90-120 seconds per recall to 1 second apiece with Disk Library for mainframe. They saw further benefits by elimination of CPU cycles used for compression and migration as well as faster recycle times.

• An outsourcer was able to replace 8 automated tape library systems and over 125 tape drives used for backups with a Data Domain attached to the mainframe providing a solution that only consumed 3 floor tiles, while improving reliability, performance, meeting expected SLA’s and the ability to expand their business.

The Syncsort MFX – EMC Disk Library For Mainframe Performance Test

Syncsort and EMC conducted a performance test using Syncsort MAXSORT and PARASORT features with EMC’s DLm6000 tape subsystem. An IBM z10-R05 mainframe with 2,048M of central storage running z/OS v1.12 was used for the test. VMAX DASD and a DLm6000 configured with 2 Virtual Tape Emulation (VTE) engines were configured for use.

Maxsort Disk Library For Mainframe Test

The test consisted of MAXSORT on 200GB of data. 36GB of DASD space was used for the SORTWK and it resulted in 6 intermediate sorts. With each subsequent run of the test, the number of virtual tape drives was increased until a maximum of 7 virtual tape drives used. The number of intermediate merges was decreased from 6 to eventually 1 merge with 7 virtual tape drives. 32KB blocksizes were used for the Disk Library for mainframe tape volumes.

The results of these tests can be summarized in the chart that follows:
Increasing the number of Disk Library for mainframe virtual tape drives from 3 to 7 resulted in a decrease in runtime of 370 minutes (6 hours, 10 minutes) to 243 minutes (4 hours, 3 minutes) or **elapsed time savings of 34%**.

At the same time, the CPU savings going from 3 Disk Library for mainframe virtual drives to 7 drives resulted in CPU time of 49.0 minutes to 42.1 minutes or a **CPU savings of 14%**.

While these tests were conducted on a non-production system, it should be noted that the sorts are representative of real user data.

<table>
<thead>
<tr>
<th># of Tape Drives</th>
<th># of Merges</th>
<th>Elapsed Time (mins)</th>
<th>CPU Time (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>5</td>
<td>370</td>
<td>49.0</td>
</tr>
<tr>
<td>4</td>
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<td>313</td>
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<td>5</td>
<td>2</td>
<td>287</td>
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<tr>
<td>7</td>
<td>1</td>
<td>243</td>
<td>42.1</td>
</tr>
</tbody>
</table>

**PARASORT Disk Library For Mainframe Test**

The other set of tests utilized Syncsort’s PARASORT on 32GB of data. Similarly the first PARASORT test run utilized 1 Disk Library for mainframe virtual tape drive and was increased to a total of 4 Disk Library for mainframe virtual tape drives.
The use of PARASORT with Disk Library for mainframe resulted in a reduction of 34 minutes elapsed time to 15 minutes representing a 56% reduction in elapsed time.

56% elapsed time reduction:

<table>
<thead>
<tr>
<th># of Tape Drives</th>
<th>Elapsed Time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
</tr>
</tbody>
</table>

The combination of MAXSORT and/or PARASORT running with Disk Library for mainframe as a tape storage device results in an environment that provides the following customer benefits:

- Truly scalable solution
- Reduced CPU and Elapsed time for critical jobs
- Improved System throughput
- Reduced costs

This whitepaper underscores the benefits that can be delivered to customers through collaboration, certification, and testing by two industry leaders working together to help reduce customer costs.

**Target Use Cases**
Customer use cases that benefit most from combining these technologies

- Elapsed time critical Sorts with large numbers of tape input volumes that effect SLAs or batch window targets
- Sorts with large data volumes that require more temp DASD storage for more time than is desired (or possible)
- Elapsed time critical MAXSORT jobs that effect SLAs or batch window targets
Tape Assessment Study For Disk Library For Mainframe/MFX PARASORT Opportunities

- Syncsort MFX customers can use the Syncsort sort SMF 208 record to identify all sorts with multiple tape volumes of input. These jobs would be good candidates for leveraging Disk Library for mainframe and PARASORT. Non MFX customers could use SMF type 30 records to identify the same types of jobs.
- After identifying the eligible jobs, make assessments of elapsed time and critical nature of each job toward meeting SLAs or batch window requirements.

Disk Library For Mainframe/MFX MAXSORT Assessment And Opportunities

- Syncsort MFX customers can use the Syncsort sort SMF 208 record to identify all MAXSORT jobs and determine opportunities for elapsed time savings.
- Non Syncsort MFX customers can review SMF data to identify any large volume sorts that utilize large amounts temp DASD storage and match the overall benefits of MAXSORT, namely:
  - To meet sort requirements where available temp DASD storage is limited or it is unacceptable to utilize large amounts of the available DASD for long periods.
  - Provides breakpoints for smooth operational control and job scheduling for sort jobs that require many hours to complete.

Implementation Considerations

- JCL changes are required for the selected elapsed time critical jobs.
- These are usually a small number of these critical jobs.
- PARASORT changes are relatively simple - adding additional DD names to the already specified input DSNs and using esoteric UNIT names to ensure parallelism on the EMC.
Disk Library for mainframe appliance

- MAXSORT changes are relatively simple – straightforward additional DD names specifications and optimizing parameters

**Conclusions**

Each individual product, EMC Disk Library for mainframe and Syncsort MFX, provide mainframe customers great benefits and cost savings.

By combining the technologies of EMC Disk Library for mainframe and Syncsort MFX (unique features MAXSORT, PARASORT) additional and significant performance improvements in specific types of Sort jobs are created. The performance improvement is realized by leveraging best practices and the nature of EMC Disk Library for mainframe’s high-performance tape platform with the parallelism designed into MAXSORT and PARASORT.

The resultant reduced CPU time and elapsed time translates directly into improved system throughput and reduced costs – goals mainframe customers are regularly seeking to improve.