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IBM TS1170 Tape Drive Performance Position Paper

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Introduction

The purpose of this position paper is to examine the performance of the IBM TS1170 Tape Drive in an open systems environment.

TS1170 Tape Drive Overview

The TS1170 tape drive is the seventh generation of the IBM 3592 family of enterprise level tape drives, and the successor to the IBM TS1160 tape drive. As such, it incorporates all the features of the TS1160 tape drive while enhancing performance and including a few new features.

Compared with other IBM tape products, the TS1170 tape drive provides higher levels of performance and cartridge capacity than its 6 predecessors: the TS1160 tape drive (3592 60F), the TS1150 tape drive (3592 E08) and its sibling the TS1155 tape drive (3592 55F), the TS1140 tape drive (3592 E07), the IBM TS1130 tape drive (3592 E06), the TS1120 tape drive (3592 E05), or the IBM 3592 Model J1 A Tape Drive. In addition, the TS1170 tape drive is compatible with existing tape libraries TS4500 and Diamondback, helping customers to protect their investment in tape automation.

There are 2 interfaces available for the TS1170 tape drive:

- 16 Gbps Fibre Channel (FC-16)
- 12 Gbps SAS

The Fibre Channel interface and the SAS interface are available on half height models.

The IBM TS1170 tape drive offers a native data rate of up to 400 MB/s as same data rate as TS1160.

The IBM TS1170 tape drive supports a new generation of data cartridge (JF media) that offers a native capacity of 50TB (125TB with 2.5:1 compression) 2.5x the capacity of the previous JE tape (20TB) cartridge generation.

The IBM TS1170 tape drive will support the Linear Tape File System (LTFS) format in IBM Spectrum Archive™ that presents the tape storage as a file-based storage system.

Performance Overview

The key features of the IBM TS1170 tape drive is designed to improve performance and capabilities, some of the improvements are:

The TS1170 tape drive features hardware encryption of data and two interface options. No native data rate improvement from the previous generation. The tape capacity increases 2.5x from the previous generation TS1160 tape drive.

- Native data rate of up to 400 MB/s
- Native data physical capacity of 50TB
- The data compression keeps the ratio to 2.5:1
- Support for 16Gb FC and 12Gb SAS connectivity
- Cache buffer: 2048MB

This position paper examines the performance benchmarks of the IBM TS1170 tape drive and associated features.

Performance Evaluation

All the performance benchmarks were run on one or more of the following systems:

- Lenovo ThinkSystem SR530 (7X08-CTO) running RHEL 8.5

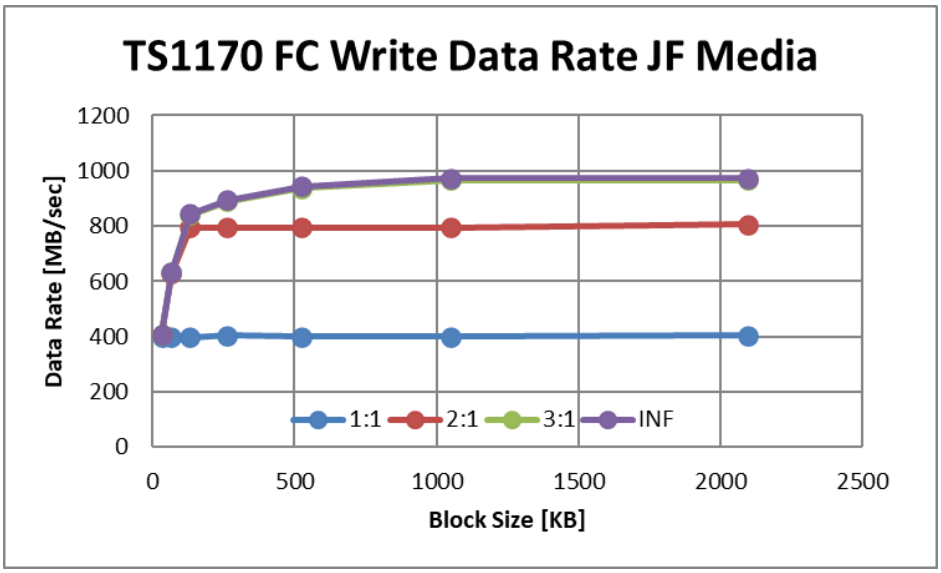
The performance benchmarks used for the tests are a toolbox of in-house C-based performance measurement tools designed to fully exercise the host interface and tape drive with the least amount of overhead. As such, the primary goal of the benchmarks was to provide a picture of the maximum capabilities of the TS1170 tape drive. All data rates/capacity reflect a decimal basis where MB = 1,000,000 bytes and GB=1,000 MB. Actual tape drive data rate and cartridge capacity might vary depending on factors such as data compression, server, and disk performance variables.

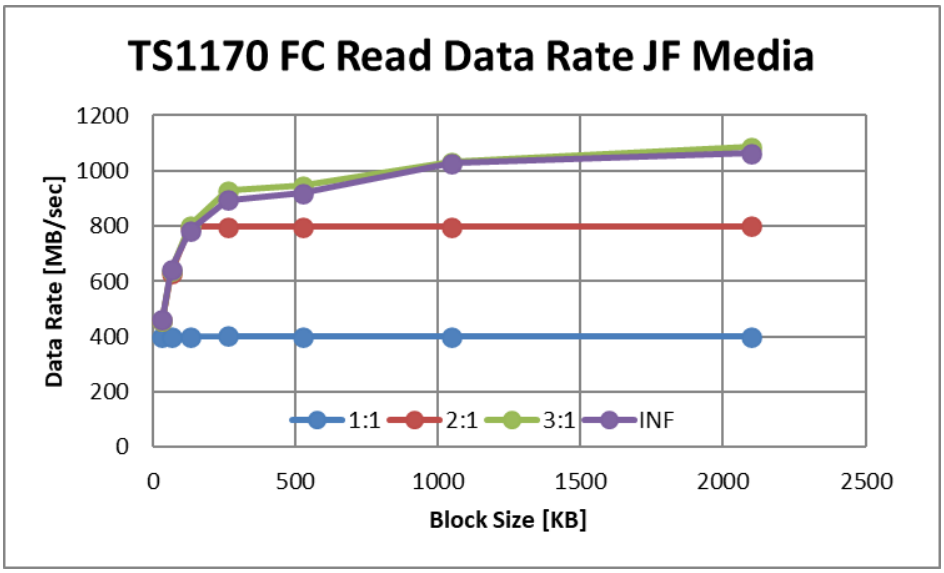
There are several factors that impact performance, especially data rate at high compression ratios and large block sizes. Server hardware performance, server slot and operating system/device driver performance are important factors. Another source of variability in the data rate performance tests could be due to the firmware used for the HBA firmware.

Fibre Channel Data Rate Performance

The data rate performance of the IBM TS1170 Fibre Channel tape drive is described by the following set of charts that show how the drive behaves when writing or reading data that compresses uniformly at ratios 1:1, 2:1, 3:1 and maximum (80:1) using differing block sizes and JF media.

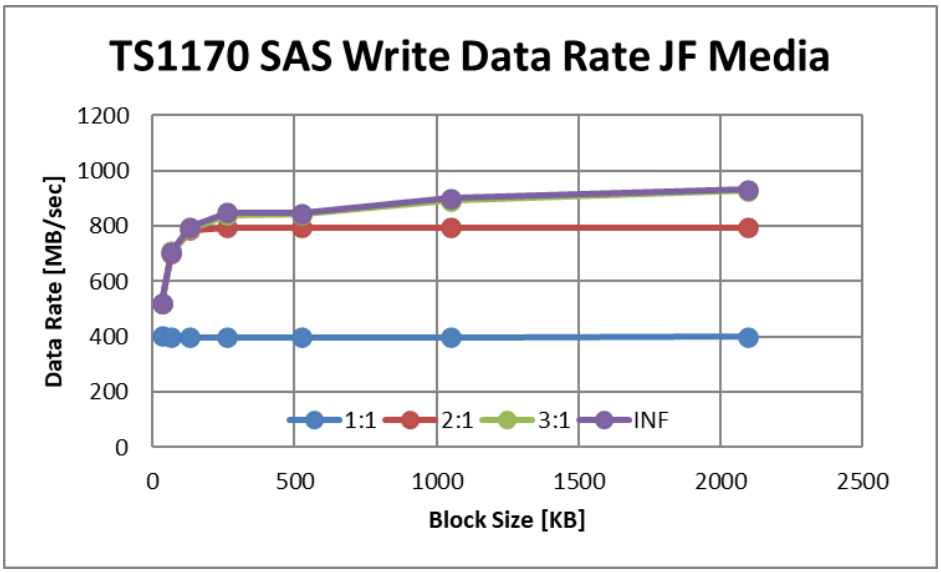
The IBM TS1170 tape drive achieves a native data rate of 400 MB/s with JF media. Higher rates are reached with compressible data. TS1170 uses the same compression engine as TS1160.

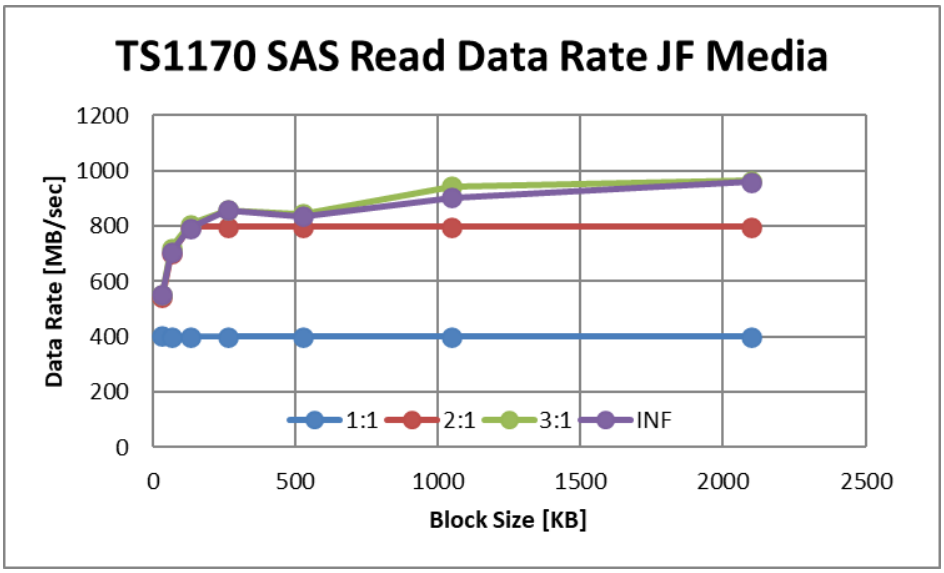




SAS Data Rate Performance

The data rate performance of the IBM TS1170 SAS tape drive is described by the following set of charts that show how the drive behaves when writing or reading data that compresses uniformly at ratios 1:1, 2:1, 3:1 and maximum (80:1) using differing block sizes and JF media.

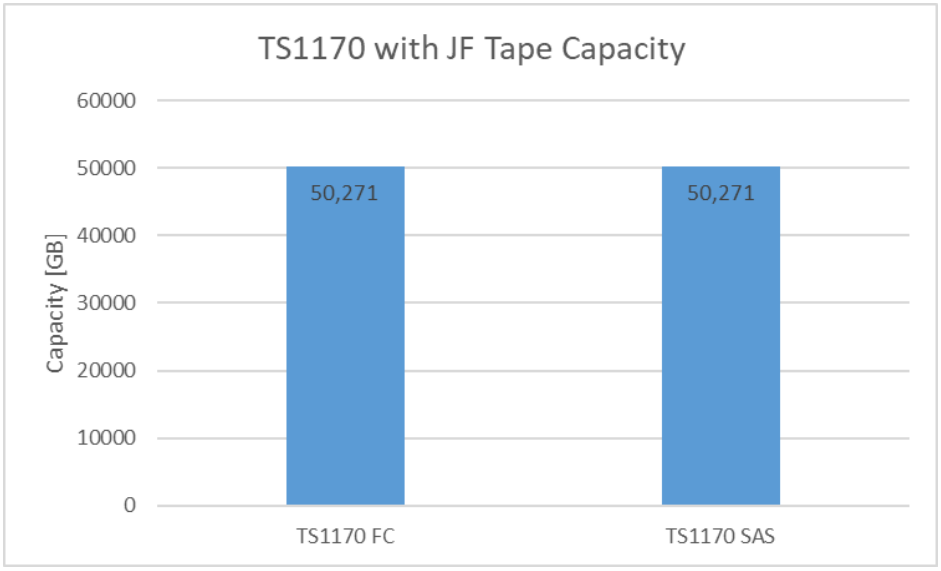




Tape Capacity

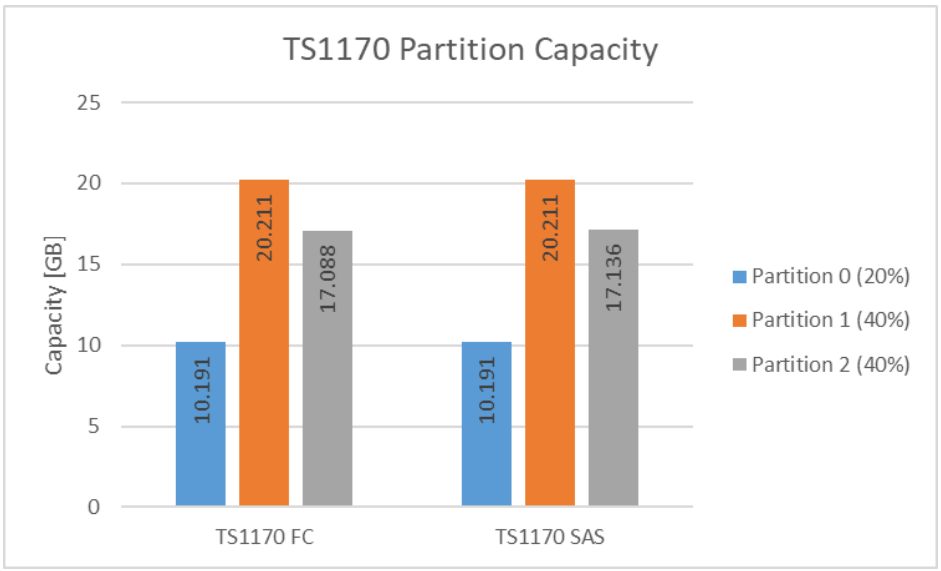
The following chart shows the capacity for JF media measured with the TS1170 tape drive. Tape capacity is obtained by writing 256KB blocks of uncompressible data until an error code is returned when EOT (End of Tape) is reached. The TS1170 tape drive with JF media increases about 250% over TS1160 tape drive with JE tape cartridge capacity offering a native physical capacity of 50TB.

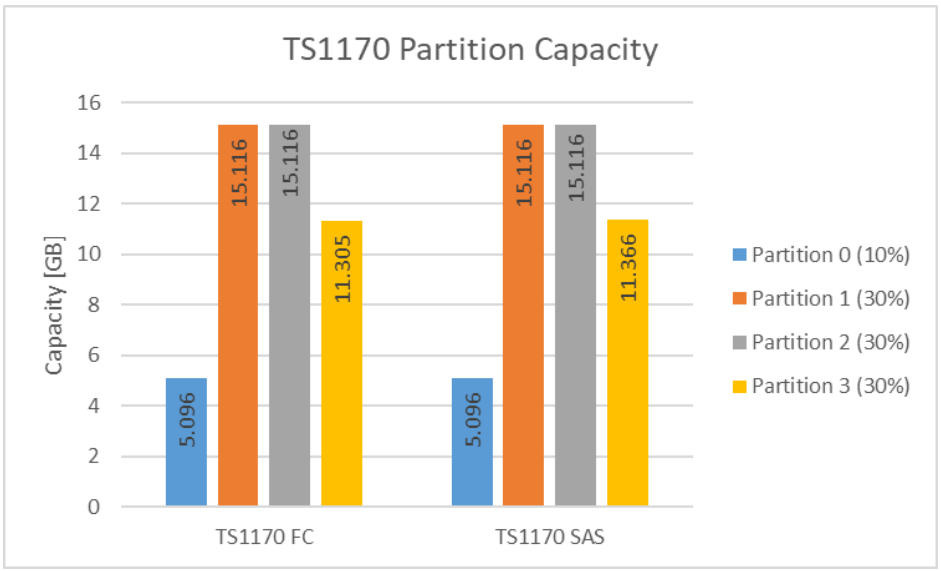
The TS1170 tape drive with JF media offers a significant capacity increase over TS1160 tape drive with JE media.



Tape Capacity when partitioned

The following chart shows the capacity for JF tape medium measured with the TS1170 tape drive when partitioned. The tape is partitioned into 3 partitions at a rate of 20%:40%:40% and 4 partitions at a rate of 10%:30%:30%:30. Tape capacity is obtained by writing 256KB blocks of uncompressible data until an error code is returned when EOT (End of Tape) is reached. The capacity of the last partition is smaller than the others as the size of guard wraps between partitions is consumed.

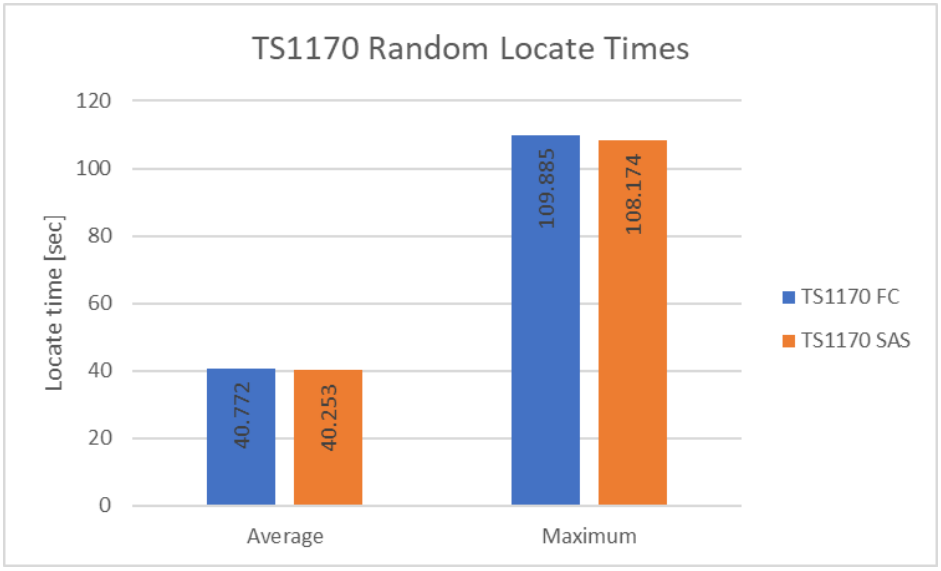




Locate Performance

The following charts shows the average and maximum time for the TS1170 drive to locate a random block on the tape starting at some random location on the tape. To determine average and maximum times, many locate operations were performed on a filled tape.

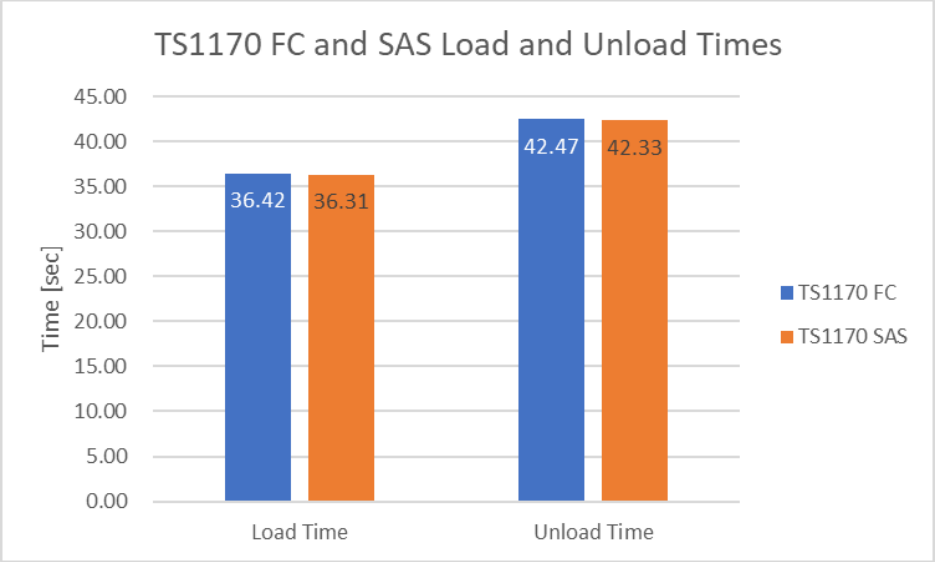
The TS1170 tape drive with JF media offers similar performance for Locate and Rewind.



Cartridge Load and Unload Performance

The following charts show the tape cartridge load and unload times for the TS1170 tape drive with JF.

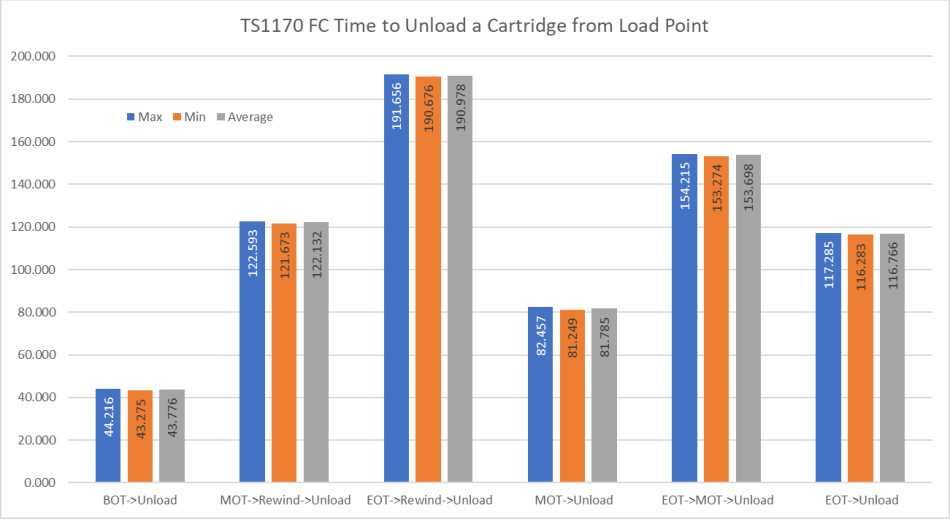
The IBM TS1170 tape drive has good load performance for both interface types.

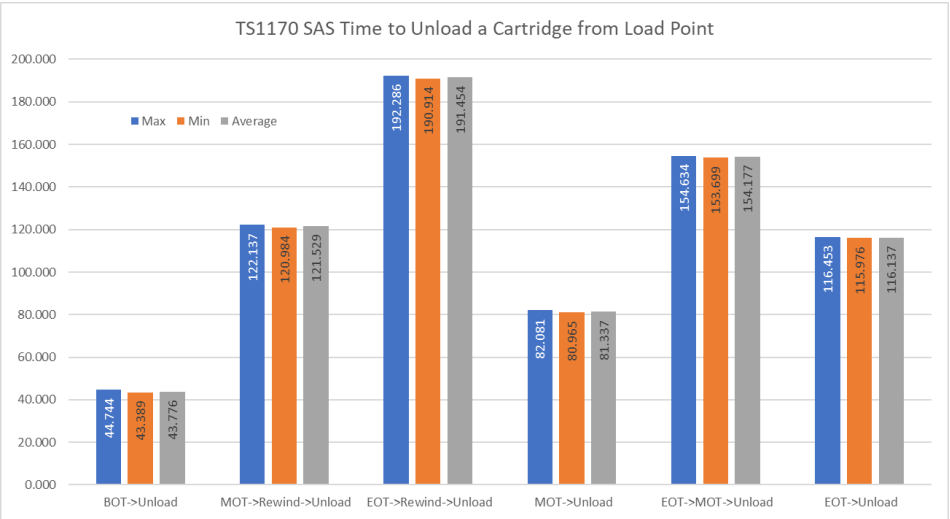


Time to Unload a Cartridge from Load Point

The following charts show the tape cartridge unload times from some load points for the TS1170 tape drive with JF. Tape drive supports Low Tension Rewind feature which moves to last accessed location and unloads the tape with low tension. This reduces the risk of the tape damage and unexpected tape stretch due to winding tape medium into the cartridge with higher tension.

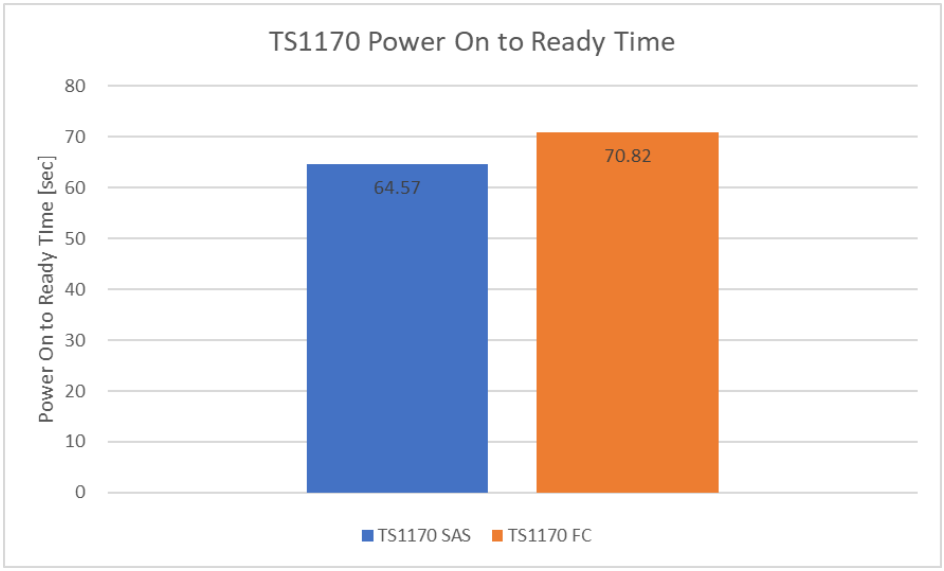
MOT->Rewind->Unload time and EOT->Rewind->Unload time take longer time than MOT->Unload time and EOT-Unload time respectively. This is because the low-tension rewind from BOT to MOT and BOT to EOT increase the time to unload respectively.





Power on to ready time

The following chart shows the time it takes for "drive ready". The time from the power is on until the bezel says “EMPTY” or “@UNLOAD” is measured in seconds.

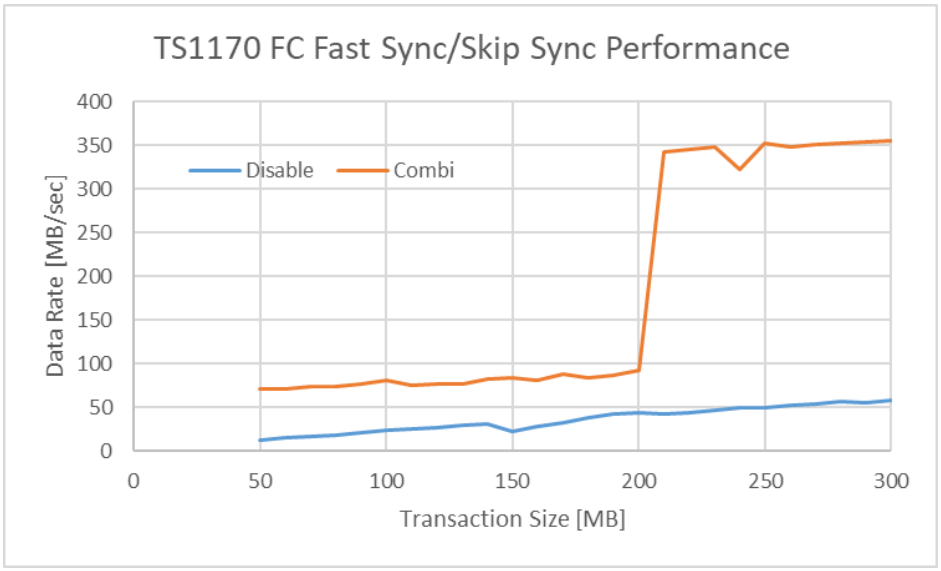


FastSync and SkipSync performance

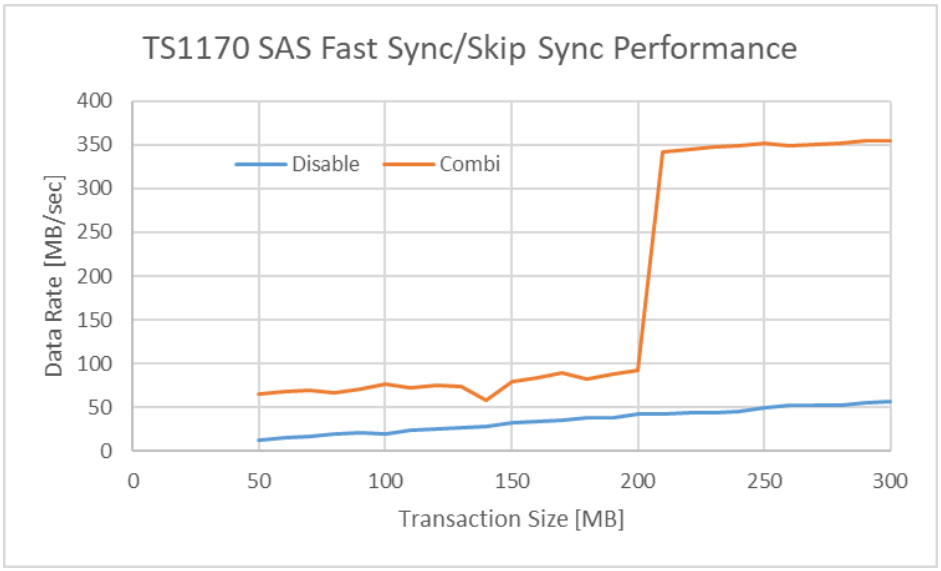
The function known as 'virtual backhitch' improves performance by minimizing the effects of start/stop write processing (tape synchronizing events). Virtual Backhitch, also called FastSync or recursive accumulating backhitchless flush (RABF); can greatly improve write performance through backhitch reduction.

In addition, the chart shows the effect of the function called SkipSync. Briefly explained, SkipSync turns on when FastSync turns off (at or just under 200MB transaction size) and, rather than backhitch after a sync operation, continues the tape forward motion until more data is received from the host, in effect trading a small amount of tape capacity for an increase in data rate performance. The drive does this only when it determines the time to receive data after a sync operation is small enough that it will have a minimal effect on tape capacity not to exceed a 2% capacity penalty. As shown in the chart, the sync data rate performance when SkipSync is invoked can be greater than three times the normal data rate.

The chart below illustrates the usage of the FastSync and SkipSync (Combi) function for TS1170 FC tape drive, displaying the relative data retes when the function is disabled.



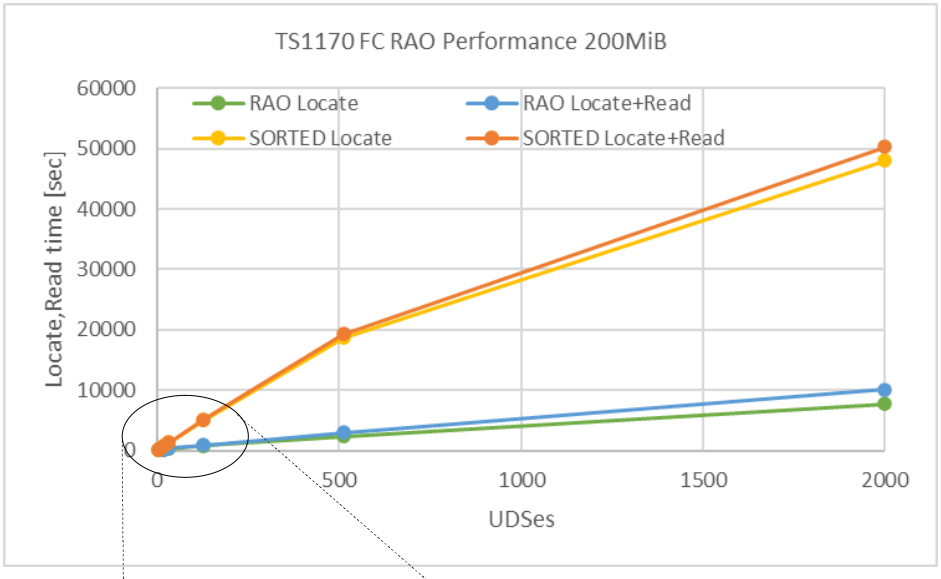
The chart below illustrates the usage of the FastSync and SkipSync (Combi) function for TS1170 SAS tape drive, displaying the relative data retes when the function is disabled.

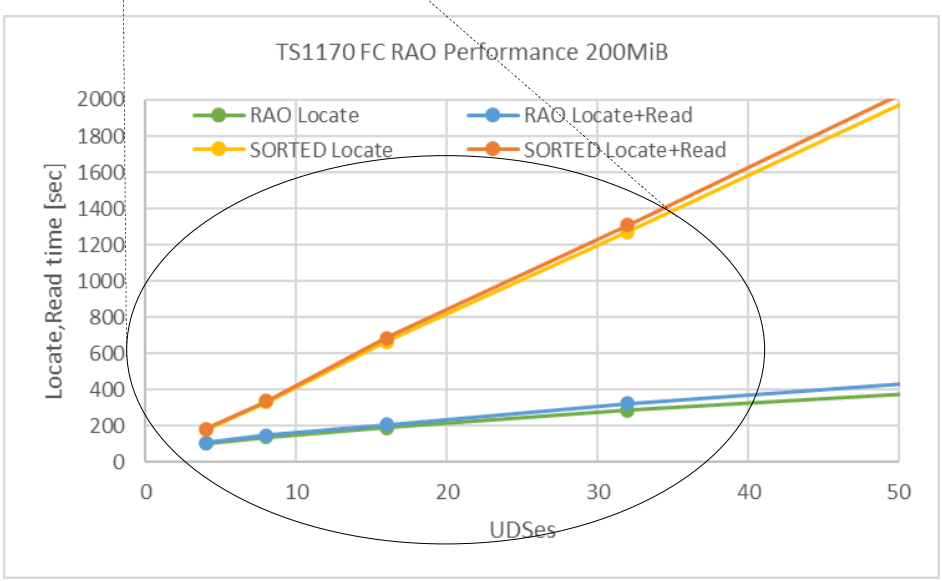


RAO Performance

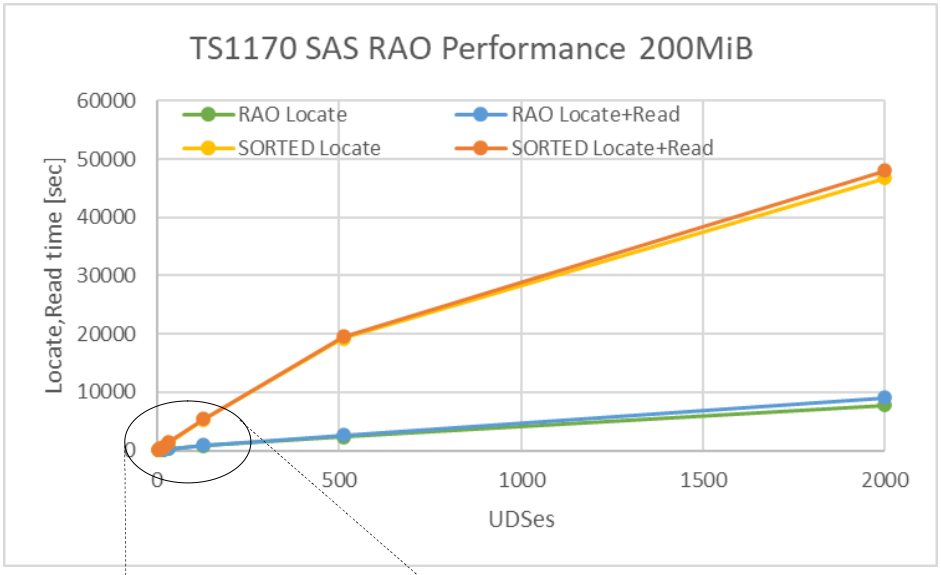
The Locate and Locate+Read performance of the IBM TS1170 FC tape drive is described by the following set of charts that show how the drive behaves when locating or locating+reading data in the access order determined by RAO and Sorted by record number using differing numbers of 200MiB UDSes (4, 8, 16, 32, 128, 512, and 2000).

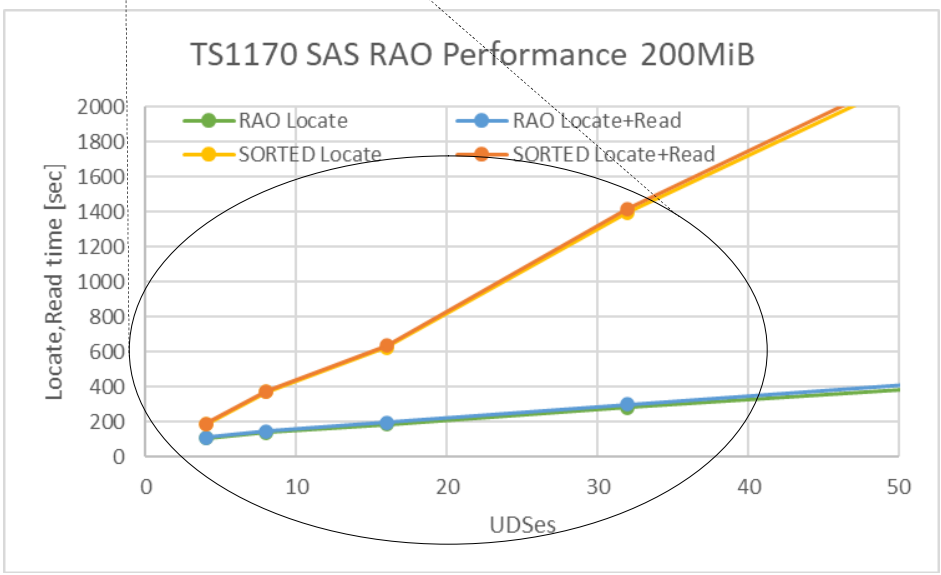
It took less time to locate and locate+read when the order of access was determined by RAO compared to when the order of access was determined by sorting by record number.





The Locate and Locate+Read performance of the IBM TS1170 SAS tape drive is described by the same setting as the charts in previous page.





Conclusions

Since the introduction of the first TS1110 tape drive, every following generation has incorporated new features and performance improvements to respond to storage needs. Now the IBM TS1170 tape drives in conjunction with the new JF media represent an efficient solution for today's growing storage demands.

Native capacity increases from 20 TB (TS1160 tape drive with JE media) to 50 TB (TS1170 tape drive with JF media) and even more with data that is compressible (125 TB with 2.5:1 compression). This capacity increase does not impact locate/rewind performance.

In addition, the IBM TS1170 tape drive continues to support media partitioning, encryption of data, and WORM media.

The IBM TS1170 tape drive is a smart storage solution for businesses requiring backup and archival storage of their data.

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