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IBM LTO 9 Tape Drive Half Height Model Performance Position Paper

Authors:
Tsuyoshi Miyamura (miyamuu@jp.ibm.com)
Osamu Matsumiya (MOSAMU@jp.ibm.com)
Tape systems development
Tokyo, Japan

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Introduction

The purpose of this position paper is to examine the performance of the IBM LTO 9 Tape Drive (LTO 9 tape drive) Half Height Model in an open systems environment.

LTO 9 Tape Drive Overview

The ninth generation IBM LTO 9 tape drive offers a great storage capacity and an excellent performance using technology designed for the mid-range open systems environment that include IBM Power Systems™; selected Oracle and Hewlett Packard servers and Intel servers running supported versions of Microsoft Windows or Linux.

There are 2 interfaces available for the LTO 9 tape drive:

- 8 Gbps Fibre Channel (FC-8)
- 12 Gbps SAS

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

The IBM LTO 9 tape drive half height model offers a native data rate of up to 300 MB/s an increase of 20% over the previous IBM LTO 8 tape drive half height model.

The IBM LTO 9 tape drive supports a new generation of data cartridge (gen9 media) that offers a native capacity of 18000GB (45000GB with 2.5:1 compression) 1.5x the capacity of the previous gen8 tape cartridge generation.

The IBM LTO 9 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. Additionally, the IBM LTO 9 tape drive is able to read and write previous generation 8 media to help customers protect their existing tape investments.

Performance Overview

The key features of the IBM LTO 9 tape drive half height mode are designed to improve performance and capabilities when compared to the IBM LTO 8, IBM LTO 7 and other vendors tape drives, some of the improvements are:

The LTO 9 tape drive features hardware encryption of data and two interface options. The data rate improvement from the previous generation is 20% and the tape capacity also increases 1.5x from the previous generation 8.

- Native data rate of up to 300 MB/s
- Native data physical capacity of 18000GB
- The data compression keeps the ratio to 2.5:1
- Support for 8Gb FC and 12Gb SAS connectivity
- SkipSync Function to provide small file backhitchless flush capability
- Cache buffer: 1024MB

This position paper examines the performance benchmarks of the IBM LTO 9 tape drive half height model and associated features.

Performance Evaluation

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

- IBM System x3550 M5 server running RHEL 7.5 with QLogic ISP8324-based 16Gb Fibre Channel and N2225 12Gb SAS External HBA.

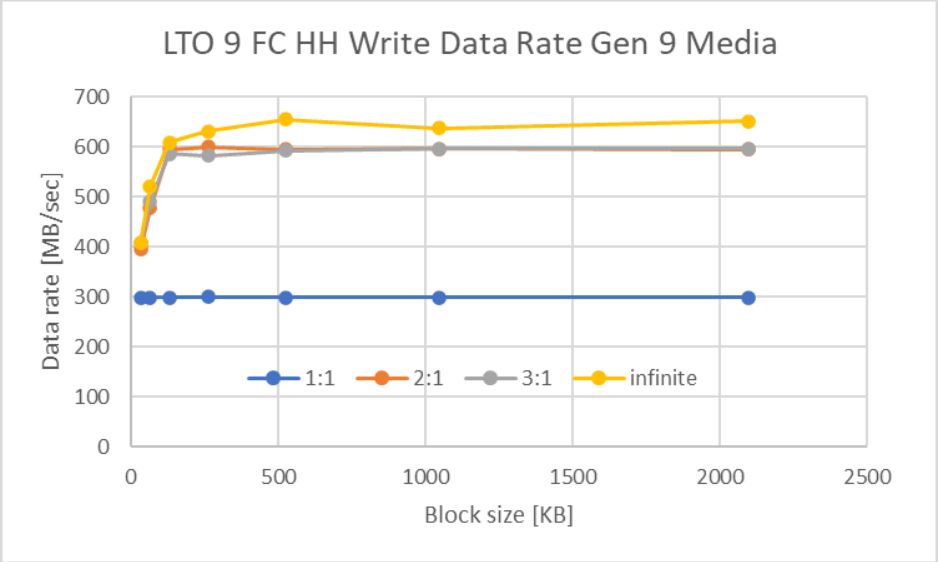
The performance benchmarks used for the tests are a toolbox of in-house C-based performance measurement tools designed to fully exercise the host interface and tape drive with the least amount of overhead. As such, the primary goal of the benchmarks was to provide a picture of the maximum capabilities of the LTO 9 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.

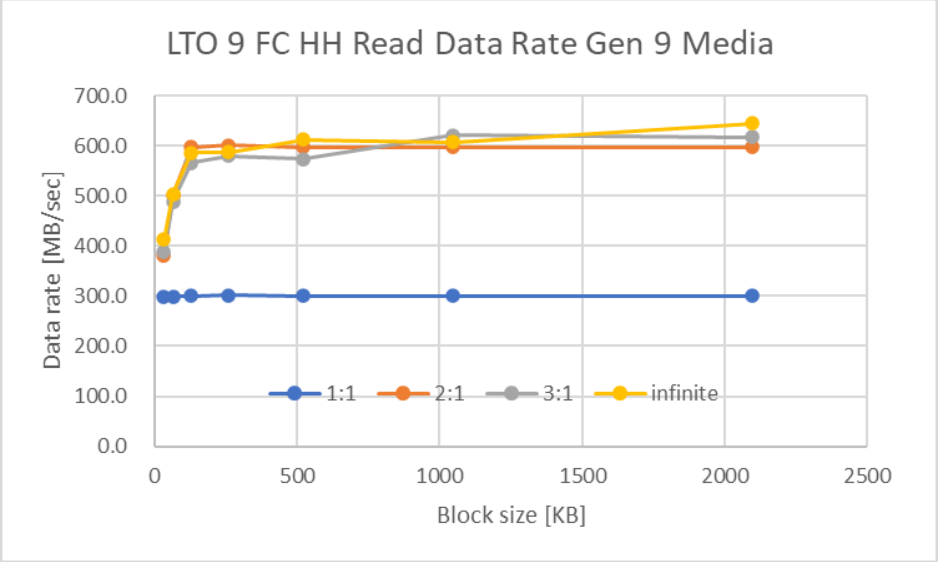
There are a number of factors that impact performance, especially data rate at high compression ratios and large block sizes. Server hardware performance, server slot and operating system/device driver performance are important factors. Another source of variability in the data rate performance tests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

Fibre Channel Data Rate Performance

The data rate performance of the IBM LTO 9 Fibre Channel half height 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 LTO gen9 media.

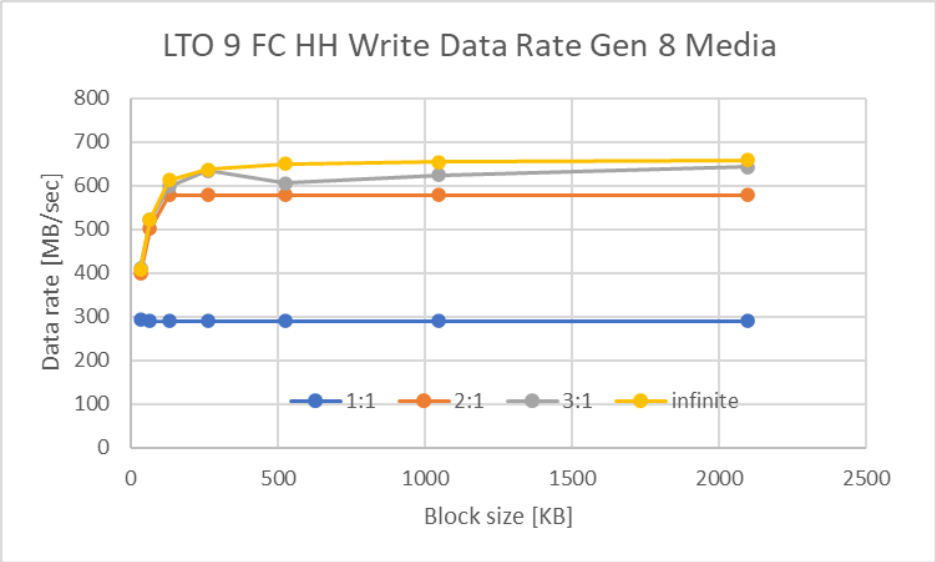
The IBM LTO 9 tape drive achieves a native data rate of 300 MB/s with LTO Gen 9 media. Higher rates are reached with compressible data. LTO 9 uses the same compression engine as LTO 8.

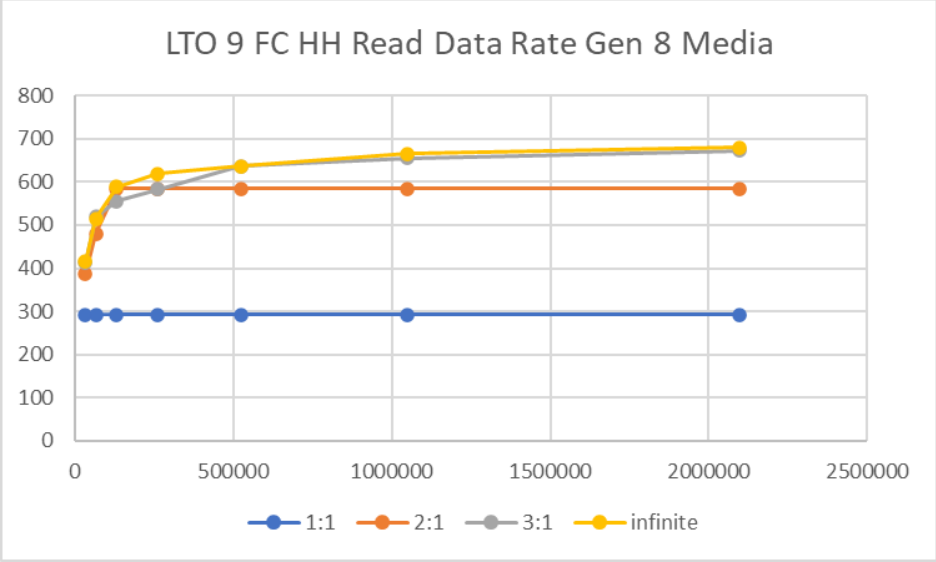




The following charts show the IBM LTO 9 Fibre Channel half height tape drive performance when writing or reading LTO gen8 media with data that compresses uniformly at ratios 1:1, 2:1, 3:1 and maximum (80:1) using differing block sizes.

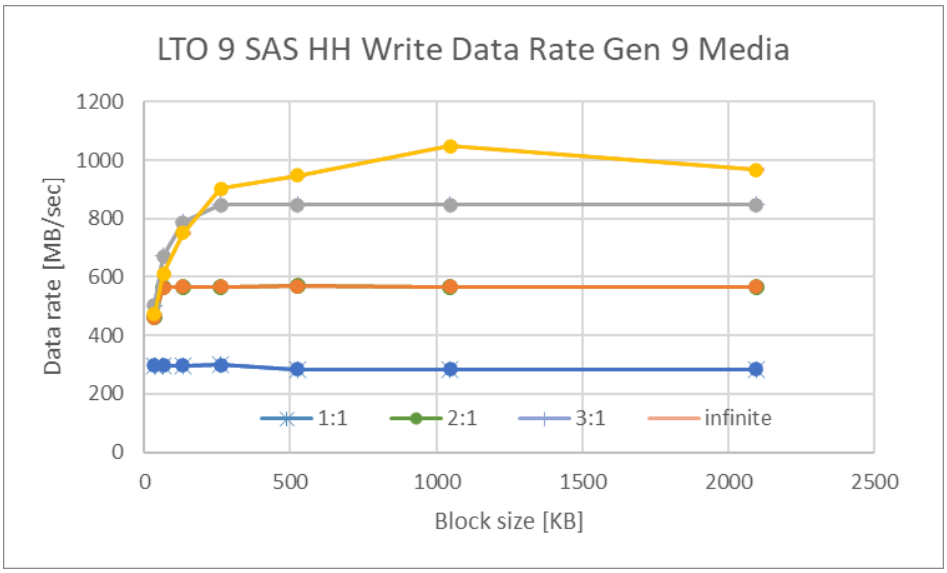
The LTO 9 drive can read and write LTO gen 8 media at the LTO generation 8 operating point. With non-compressible data, a data rate of 300 MB/s is achieved.

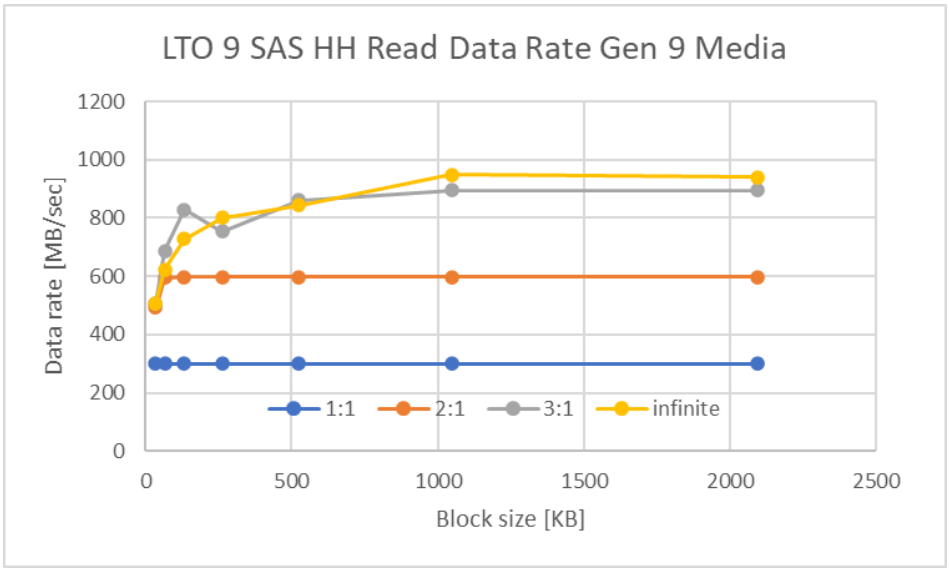




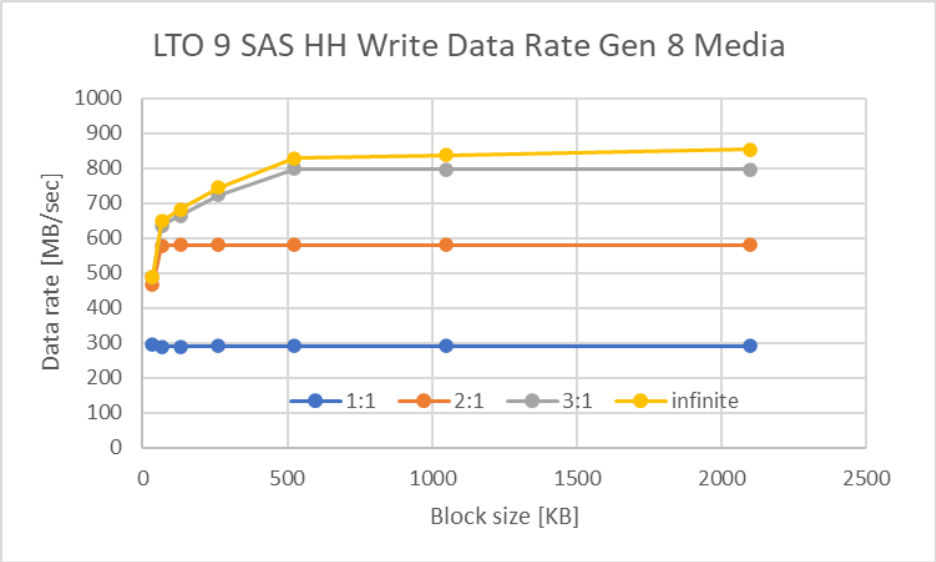
SAS Data Rate Performance

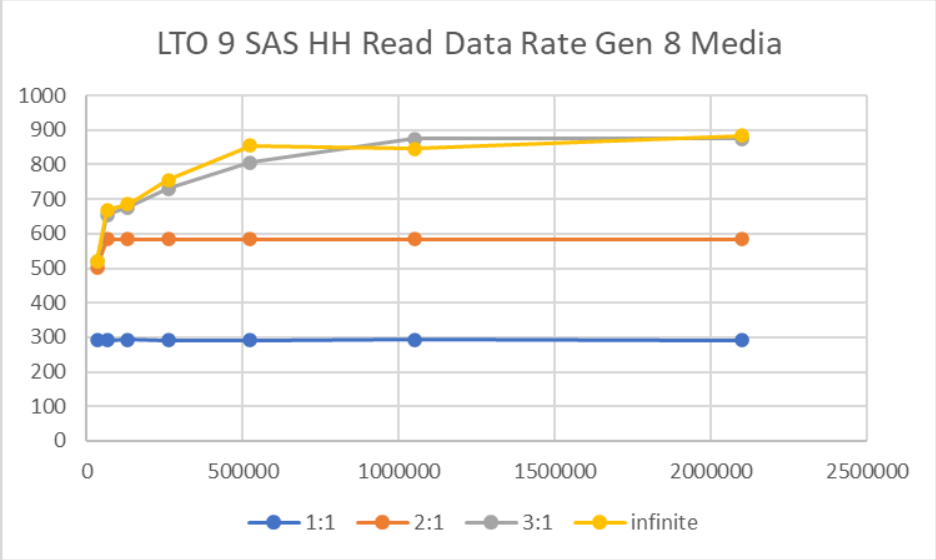
The data rate performance of the IBM LTO 9 SAS half height tape drive is described by the following set of charts that show how the drive behaves when writing or reading data that compresses uniformly at ratios 1:1, 2:1, 3:1 and maximum (80:1) using differing block sizes and LTO gen 9 media.





The following charts show the LTO 9 SAS half height tape drive performance when writing or reading LTO gen8 media with data that compresses uniformly at ratios 1:1, 2:1, 3:1 and maximum (80:1) using differing block sizes.

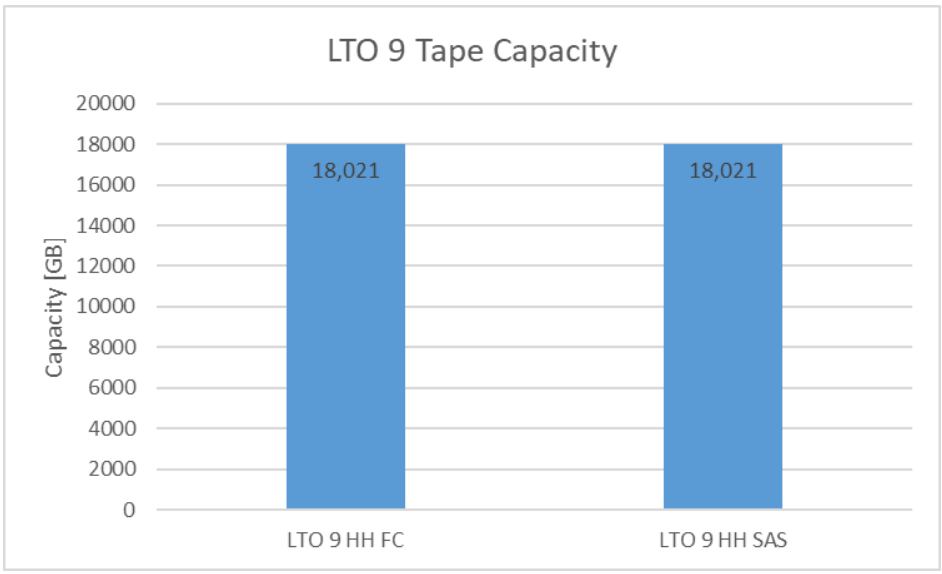




Tape Capacity

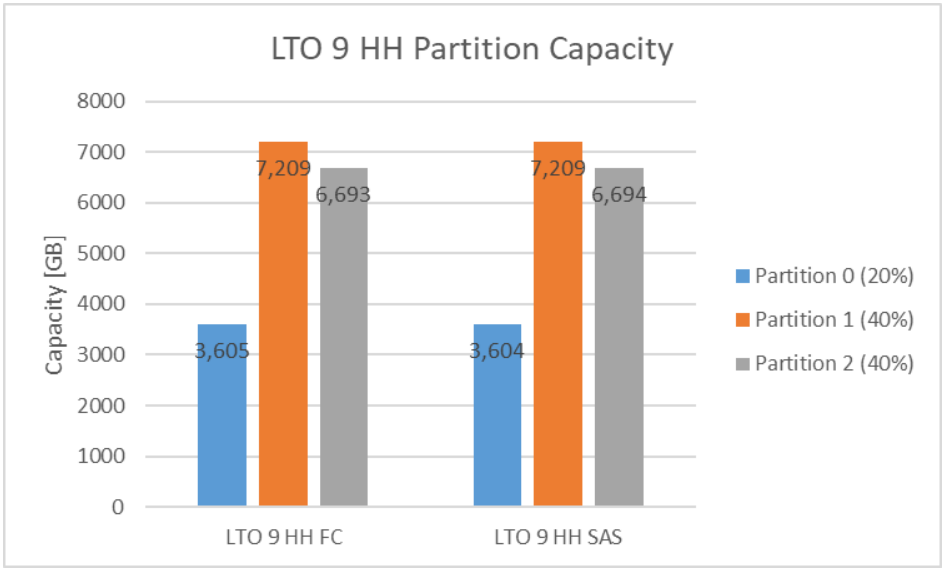
The following chart shows the capacity for LTO gen9 measured with the LTO 9 tape drive. Tape capacity is obtained by writing 256KB blocks of uncompressible data until an error code is returned when EOT (End Of Tape) is reached. The LTO 9 tape drive with gen9 media increases about 50% over gen8 tape cartridge capacity offering a native physical capacity of 18000GB while maintaining the 12000 GB expectation with gen8 media.

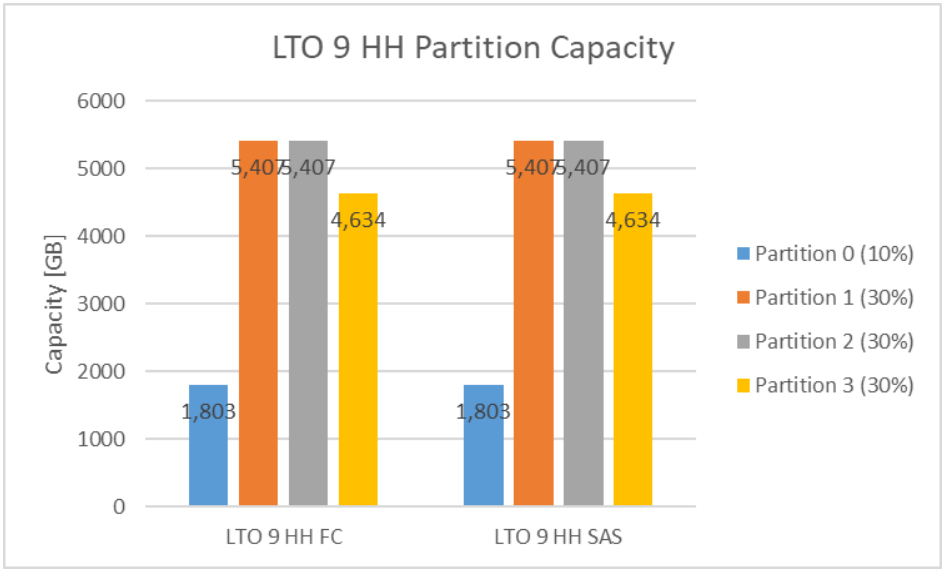
The LTO 9 tape drive with gen 9 media offers a significant capacity increase over gen 8 media.



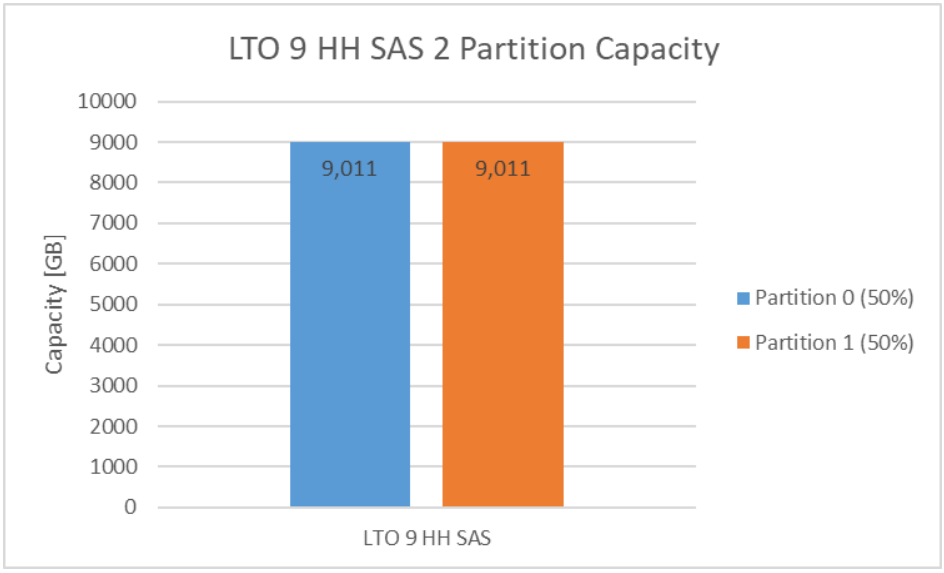
Tape Capacity when partitioned

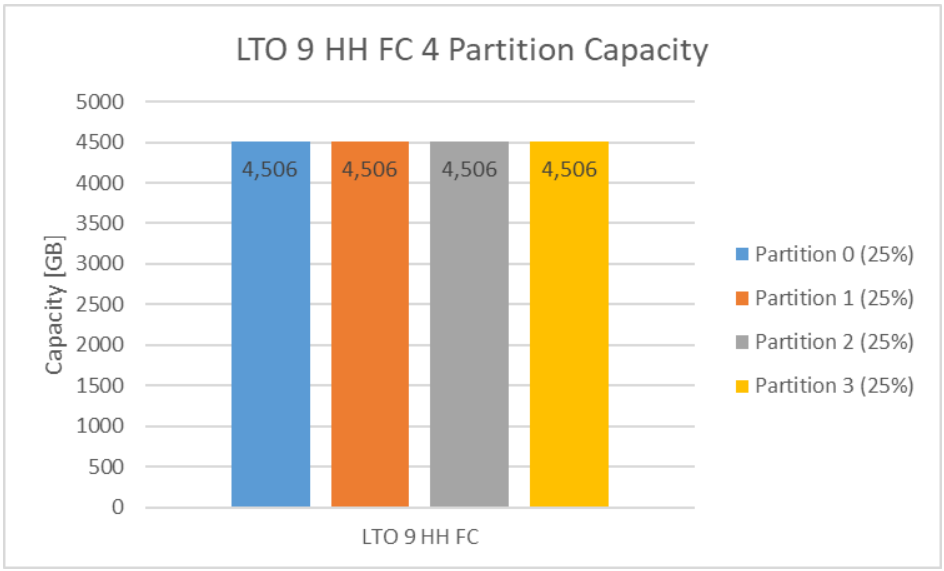
The following chart shows the capacity for LTO gen9 measured with the LTO 9 tape drive when partitioned. The tape is partitioned into 3 partitions at a rate of 20%:40%:40% and 4 partitions at a rate of 10%:30%:30%:30. Tape capacity is obtained by writing 256KB blocks of uncompressible data until an error 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.





The capacity of each partition is lost by the separator between partitions. From LTO 9 Half Height GA and LTO 9 Full Height PGA, new partitioning feature is supported when the tape is partitioned into 2 or 4 partitions at the same capacity. The tape is also partitioned in 2 partitions without capacity loss by partitioning at a rate of 50%:50% and 4 partitions at a rate of 25%:25%:25%:25%.

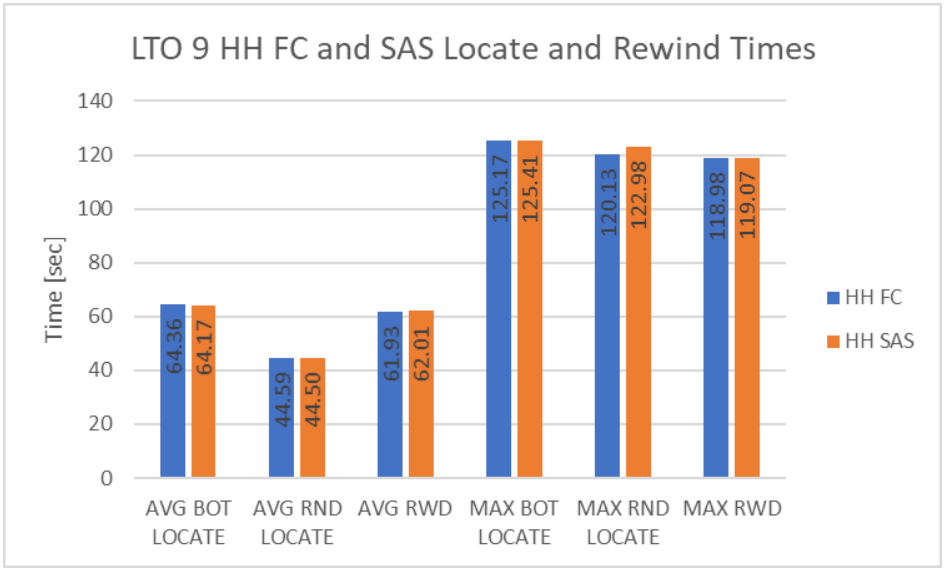




Locate and Rewind Performance

The following charts show the average time for the LTO 9 drive to locate a random block on the tape starting at BOT (Beginning Of Tape), the average time to locate a random block starting at some random location on the tape, the average rewind time as well as maximum times measured for the three operations. To determine average and maximum times, many locate and rewind operations were performed on a completely filled tape.

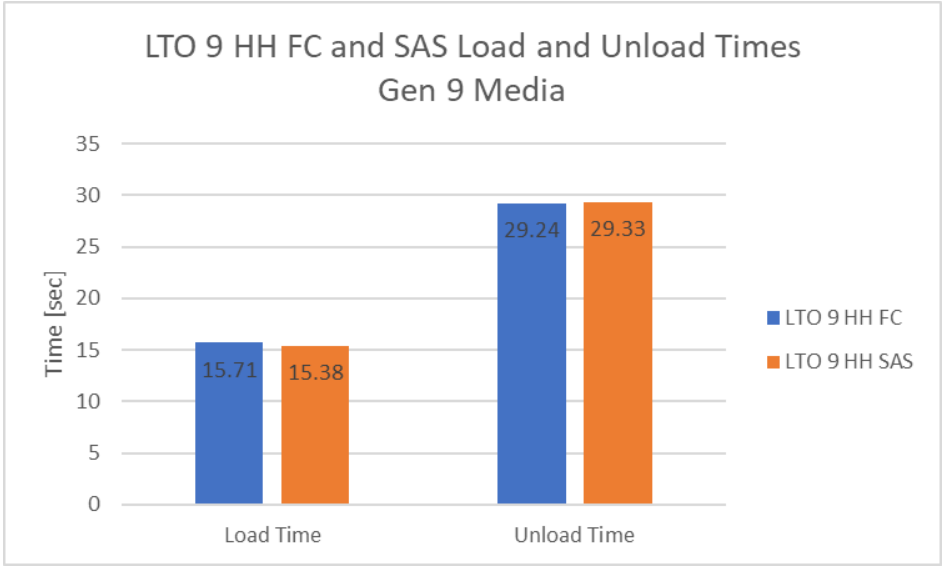
The LTO 9 tape drive with Gen 9 media offers similar performance for Locate and Rewind as compared with Gen 8.



Cartridge Load and Unload Performance

The following charts show the tape cartridge load and unload times for the LTO 9 tape drive with LTO gen 9. There is no significant difference regarding the interface type used.

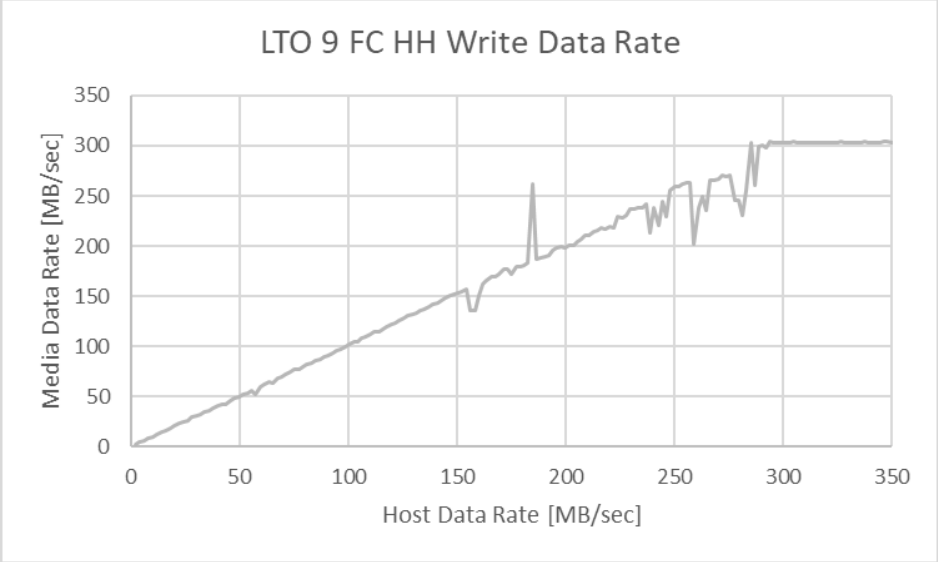
The IBM LTO 9 tape drive has good load performance for both interface types.



Speed Matching Performance

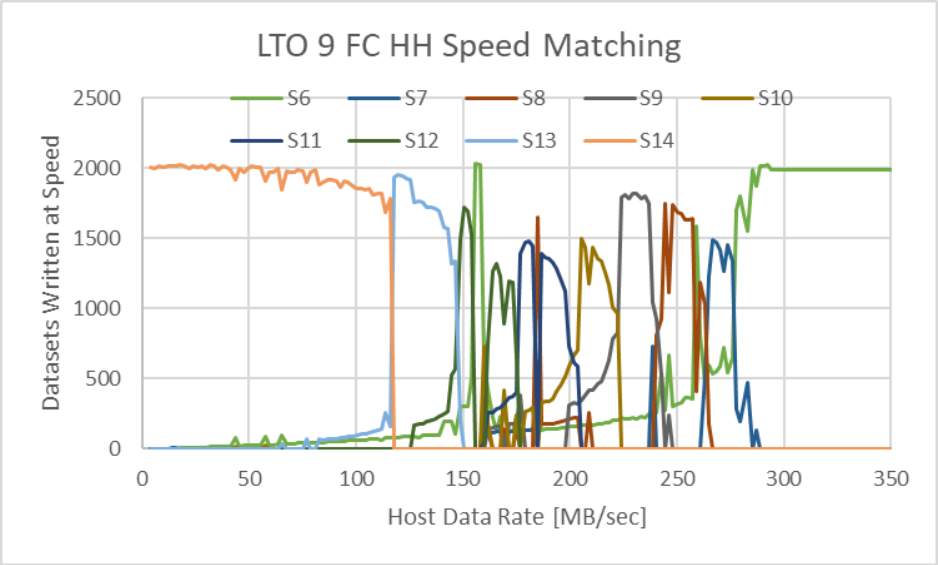
The IBM LTO 9 tape drive half height model uses 9 speeds (from speed 6 to speed 14) to match the host data rate. The implementation of this feature allows the drive to reduce the number of backhitches when the net host data rate is less than the maximum drive native data rate, reducing unnecessary tape motion, and may increase overall performance in certain environments.

To perform this test, non-compressible data is written and host delays are used to vary the speed of the data from the host to the LTO 9 tape drive. At each host data rate the number of datasets handled by each speed is recorded (a dataset is the unit of writing for the drive on the physical tape side and consists of collection of logical blocks, file marks, ECC, and other format attributes). The first chart shows the effective data rate to media (vertical axis) to the host data rate (horizontal axis) on LTO 9 FC HH drive.

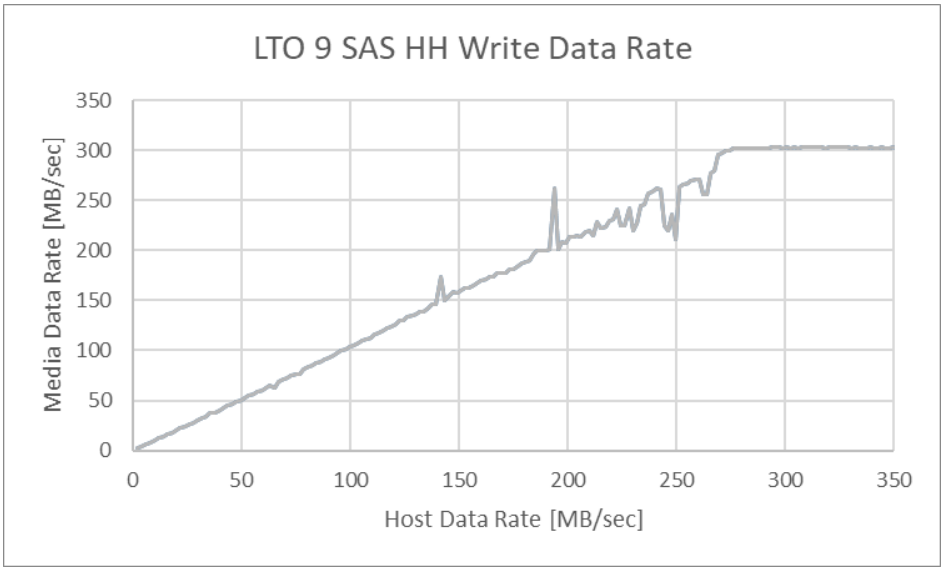


Speed matching helps to improve the overall tape drive data rate at lower host data rates.

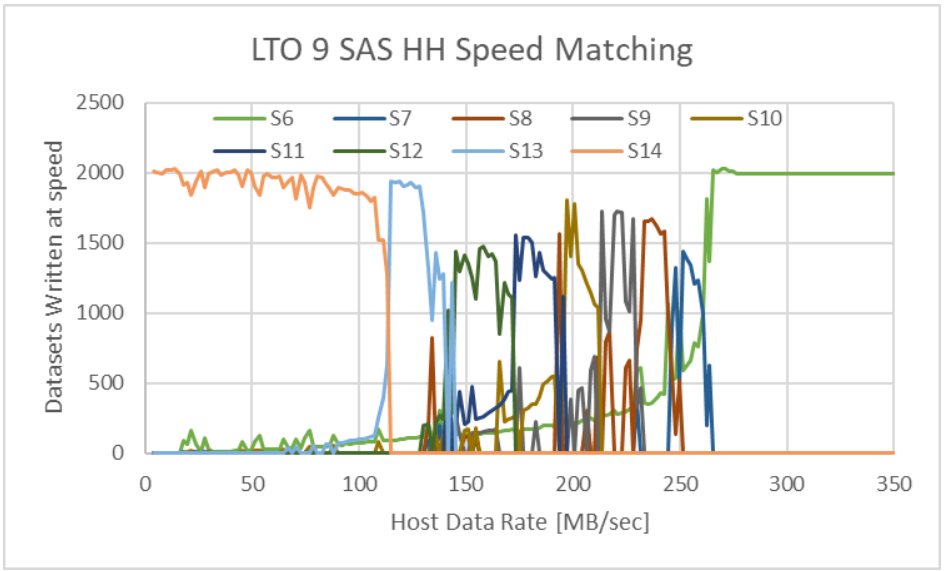
The second chart shows how the drive selects the appropriate speed from the available 9 speeds to match the host data rate and most of the datasets written are handled by the suitable speed on LTO 9 FC HH drive.



The third chart shows the effective data rate to media (vertical axis) to the host data rate (horizontal axis) on LTO 9 SAS HH drive.

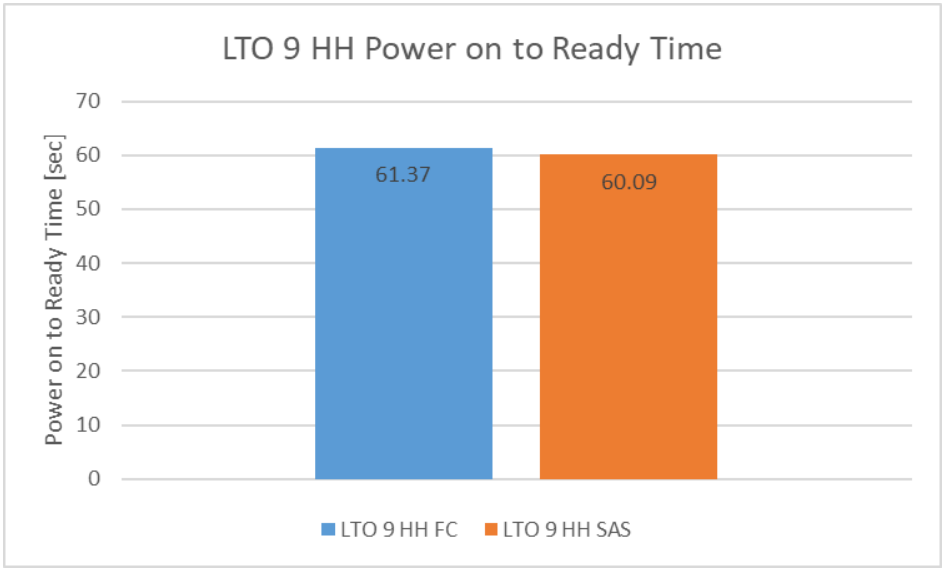


The fourth chart shows how the drive selects the appropriate speed from the available 9 speeds to match the host data rate and most of the datasets written are handled by the suitable speed on LTO 9 SAS HH drive.



Power on to ready time

The following chart shows the time it takes for "drive ready". The time between power on to drive ready when the LED stops flashing is measured in seconds.



Conclusions

Since the introduction of the first LTO tape drive, every following generation has incorporated new features and performance improvements to respond to storage needs. Now the IBM LTO 9 tape drives in conjunction with the new LTO Gen 9 media represent an efficient solution for today's growing storage demands.

Native capacity increases from 12000 GB (gen 8 media) to 18000 GB (gen 9 media) and even more with data that is compressible (45000 GB with 2.5:1 compression). This capacity increase does not impact locate/rewind performance.

In addition, the IBM LTO 9 tape drive continues to support media partitioning, encryption of data, and WORM media.

The IBM LTO 9 tape drive is a smart storage solution for businesses requiring backup and archival storage of their data.

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