IBM® Storage
September, 2015

IBM® LTO® Ultrium® 7 Tape Drive Performance White Paper

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Table of Contents

Introduction

The purpose of this white paper is to examine the performance of the IBM LTO Ultrium 7 Tape Drive (LTO-7 tape drive) in an open systems environment.

LTO-7 Tape Drive Overview

The seventh generation IBM LTO-7 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-7 tape drive:

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

The Fibre Channel interface is available on both models; full and half height. The SAS interface is available on the half height model only..

The IBM LTO-7 tape drive offers a native data rate of up to 300 MB/s an increase of 87% over the previous IBM LTO-6 tape drive.

The IBM LTO-7 tape drive offers a new generation of data cartridge (gen7 media) that offers a native capacity of 6000GB (15000GB with 2.5:1 compression) 2.4x the capacity of the previous gen6 tape cartridge generation.

The IBM LTO-7 tape drive will support the Linear Tape File System (LTFS) format in IBM Spectrum Archive™ which presents the tape storage as a file-based storage system. Additionally the IBM LTO-7 tape drive is able to read and write previous generation 6 media and read only generation 5 media to help customers protect their existing tape investments.

Performance Overview

The key features of the IBM LTO-7 tape drive are designed to improve performance and capabilities when compared to the IBM LTO-6, IBM LTO-5 and other vendors tape drives, some of the improvements are:

The LTO-7 tape drive features hardware encryption of data, two interface options, and two form factors. The data rate improvement from the previous generation is 87% and the tape capacity also increases 2.4x from the previous generation 6.

- Native data rate of up to 300 MB/s
- Native data physical capacity of 6000GB
- The data compression keep the ratio to 2.5:1
- Support for 8Gb FC and 6Gb SAS connectivity
- SkipSync Function to provide small file backhitchless flush capability
- Cache buffer: 1024MB (full and half height models)

This white paper examines the performance benchmarks of the IBM LTO-7 tape drive and associated features. The performance of the different drive host interface types will also be closely examined.

Performance Evaluation

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

- IBM xSeries 3250 server running Linux Suse 11 SP3 with a Qlogic® QLE2562 8Gb FC HBA adapter.
- IBM xSeries 3250 server running Linux Suse 11 SP3 with a LSI® SAS 9212-4i4e 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-7 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.

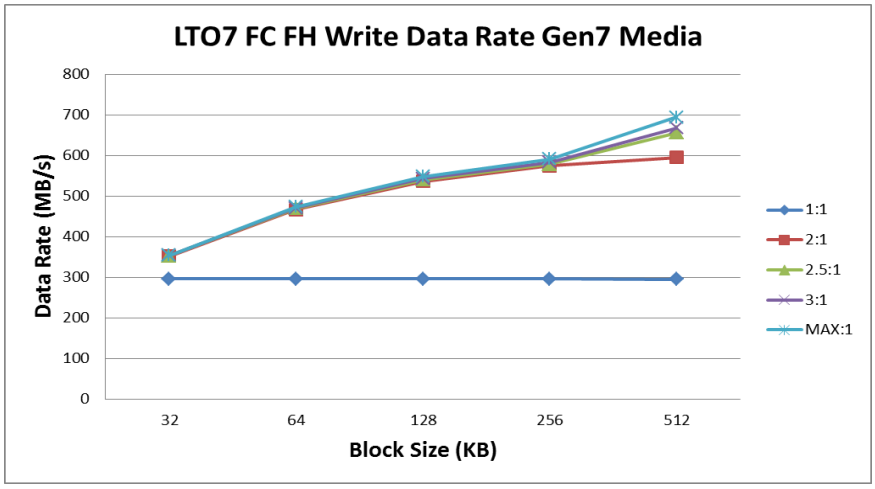
There are a number of factors that impact performance, especially data rate at high compression ratios and large block sizes. Server hardware performance, server slot and operating system/device driver performance are important factors. Another source of variability in the data rate performance tests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

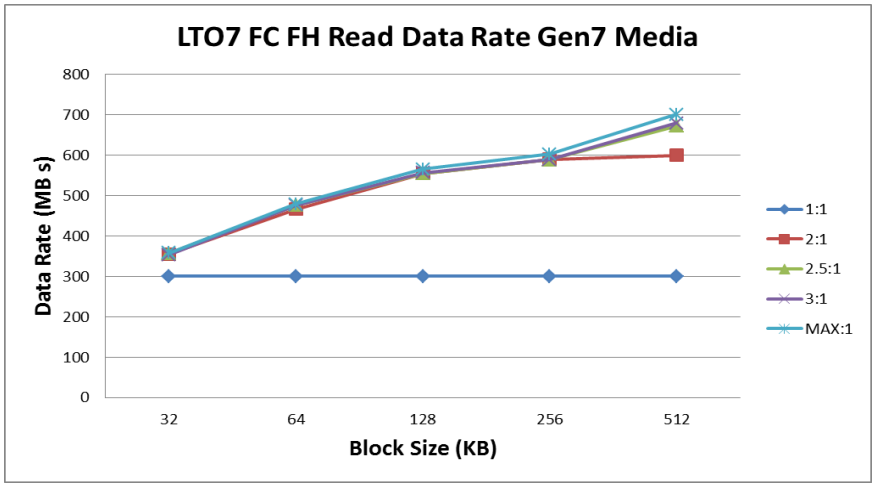
Since this white paper is primarily concerned with looking at LTO-7 tape drive capabilities, it is beyond the scope of this whitepaper to attempt to present a complete picture of the relative performance characteristics of all possible host server/HBA/tape drive combinations. However, when appropriate an attempt will be made to provide some idea of how operating system or HBA selection can affect data rate performance.

Fibre Channel Data Rate Performance

The data rate performance of the IBM LTO-7 Fibre Channel full 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, 2.5:1, 3:1 and maximum (80:1) using differing block sizes and LTO gen7 media.

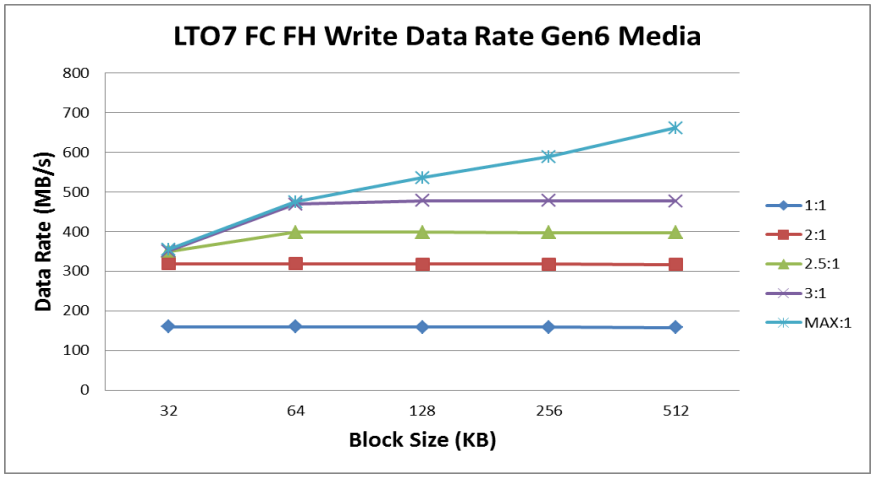
The IBM LTO-7 tape drive achieves a native data rate of 300 MB/s with LTO Gen 7 media. Higher rates are reached with compressible data. LTO 7 uses the same compression engine as LTO 6.

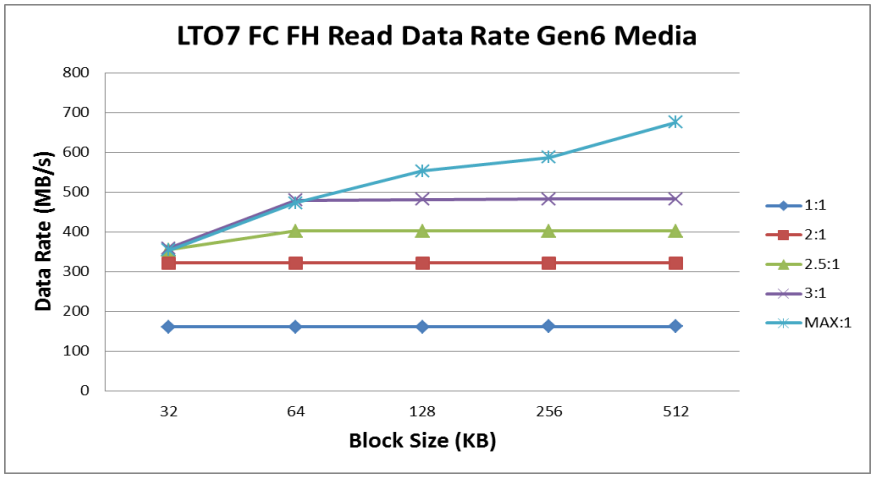




The following charts show the IBM LTO-7 Fibre Channel full height tape drive performance when writing or reading LTO gen6 media with data that compresses uniformly at ratios 1:1, 2:1, 2.5:1, 3:1 and maximum (80:1) using differing block sizes.

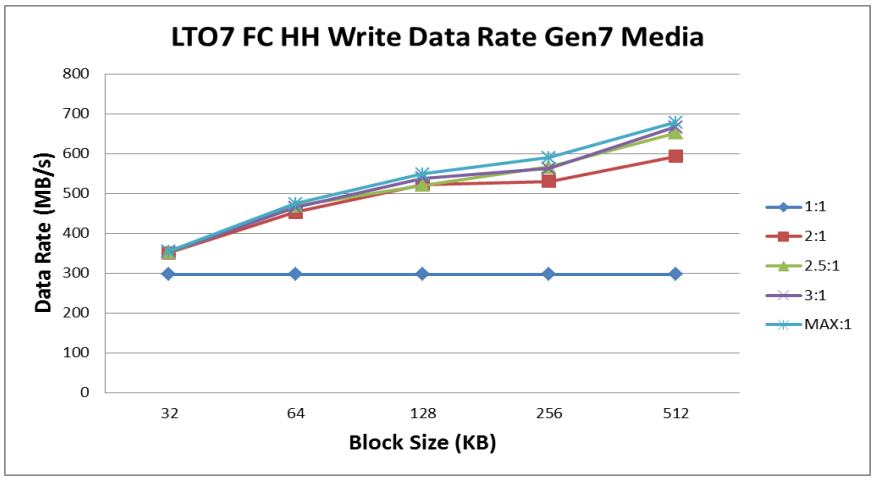
The LTO-7 drive can read and write LTO gen 6 media at the LTO generation 6 operating point. With non-compressible data, a data rate of 160 MB/s is achieved.

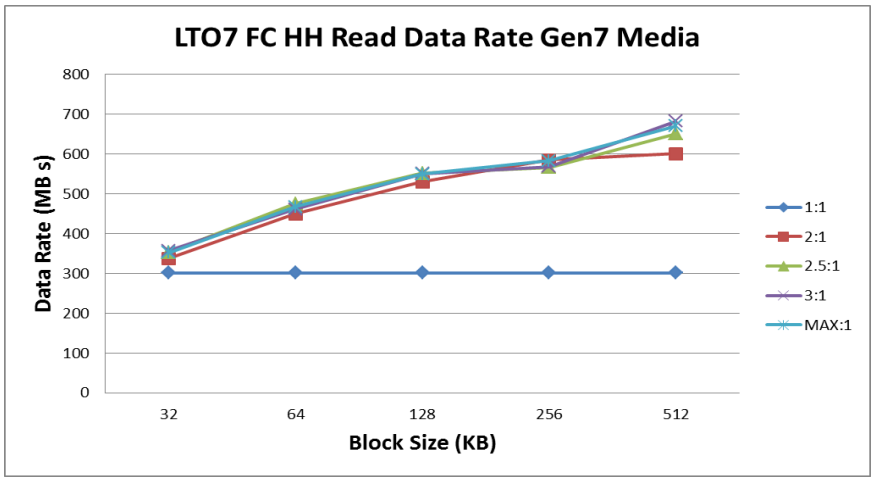




The following set of charts show streaming data rate performance of the IBM LTO-7 Fiber Channel half height tape drive when writing or reading data that compresses uniformly at ratios 1:1, 2:1, 2.5:1, 3:1 and maximum (80:1) using differing block sizes and LTO gen7 media.

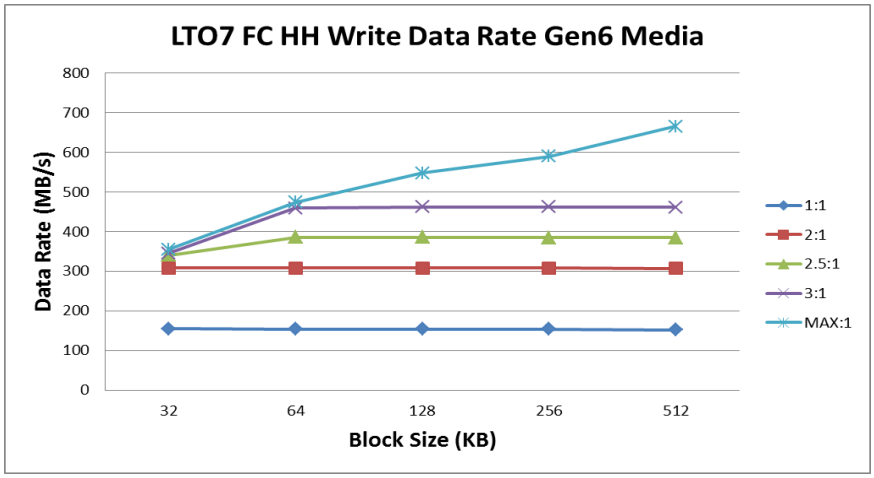
The half-height form factor drive provides similar streaming performance as compared with the full height drive.

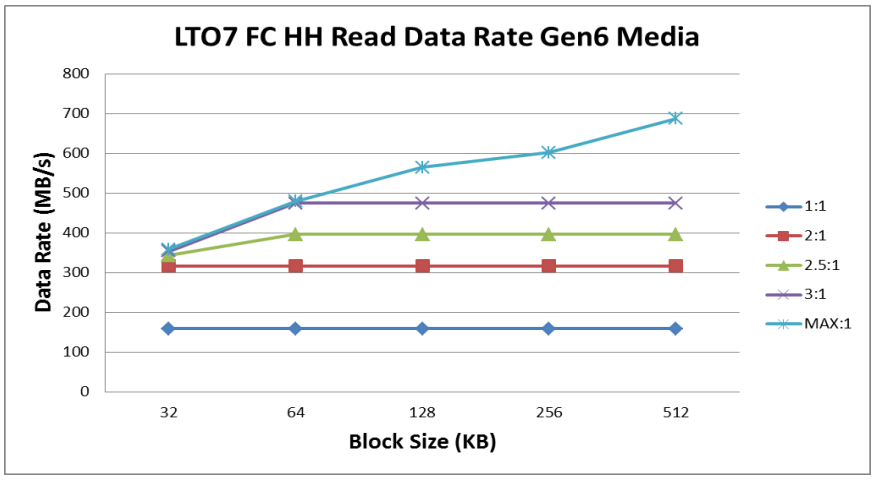




The following set of charts describe the IBM LTO-7 Fibre Channel half height tape drive performance when writing or reading LTO gen6 media with data that compresses uniformly at ratios 1:1, 2:1, 2.5:1, 3:1 and maximum (80:1) using differing block sizes.

The half-height form factor drive can read and write LTO Gen 6 media with similar rates as compared with the full height drive with LTO Gen 6 media.

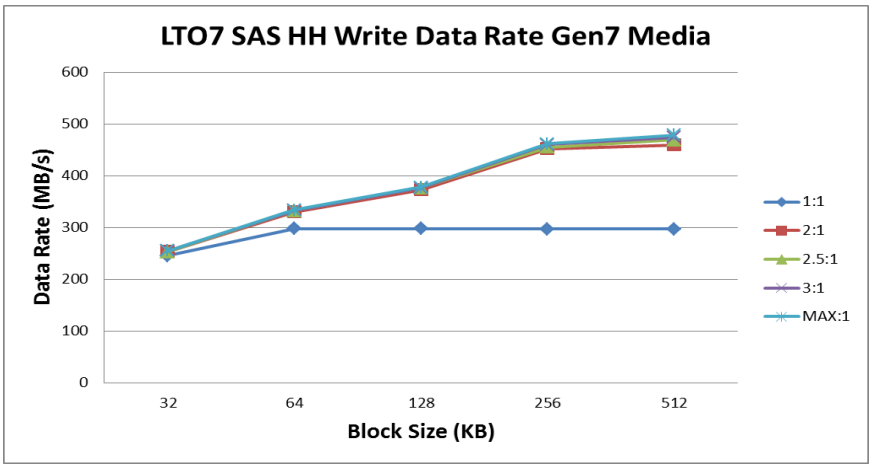


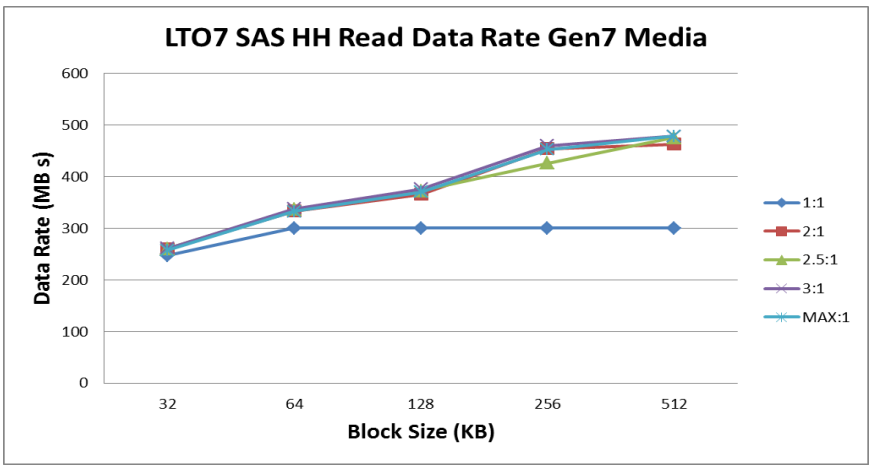


SAS Data Rate Performance

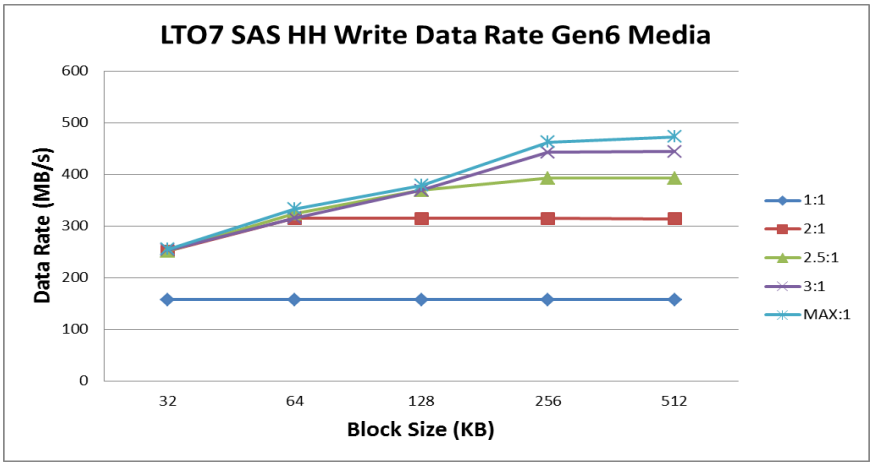
The data rate performance of the IBM LTO-7 SAS half height tape drive is described by the following set of charts that show how the drive behaves when writing or reading data that compresses uniformly at ratios 1:1, 2:1, 2.5:1, 3:1 and maximum (80:1) using differing block sizes and LTO gen 7 media.

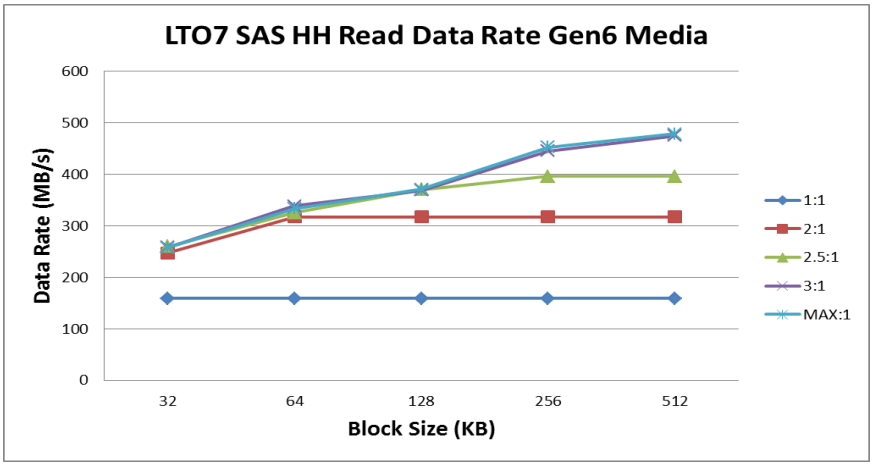
The SAS data rate performance capability of the IBM LTO-7 half height drive meets expectations at all compression ratios.





The following charts show the LTO-7 SAS half height tape drive performance when writing or reading LTO gen6 media with data that compresses uniformly at ratios 1:1, 2:1, 2.5:1, 3:1 and maximum (80:1) using differing block sizes.

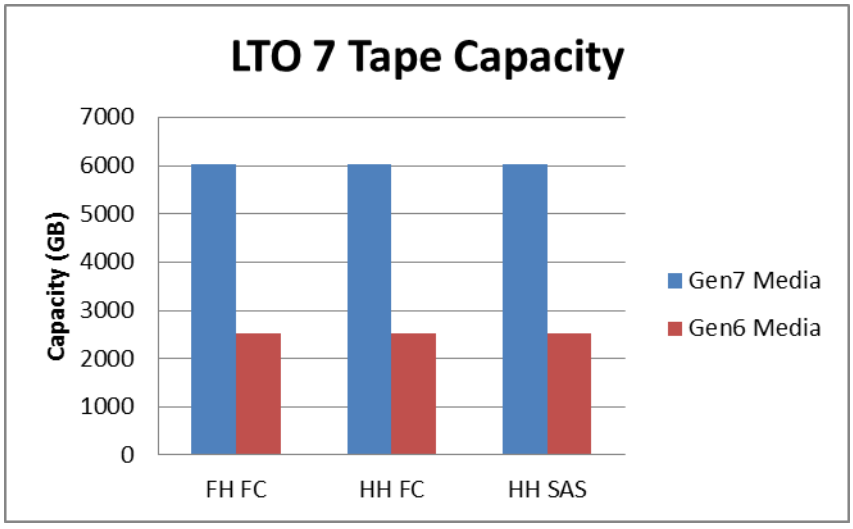




Tape Capacity

The following chart shows the capacity for LTO gen7 and LTO gen6 media measured with the LTO-7 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-7 tape drive with gen7 media increases about 140% over gen6 tape cartridge capacity offering a native physical capacity of 6000GB while maintaining the 2500 GB expectation with gen6 media.

The LTO-7 tape drive with gen 7 media offers a significant capacity increase over gen 6 media.

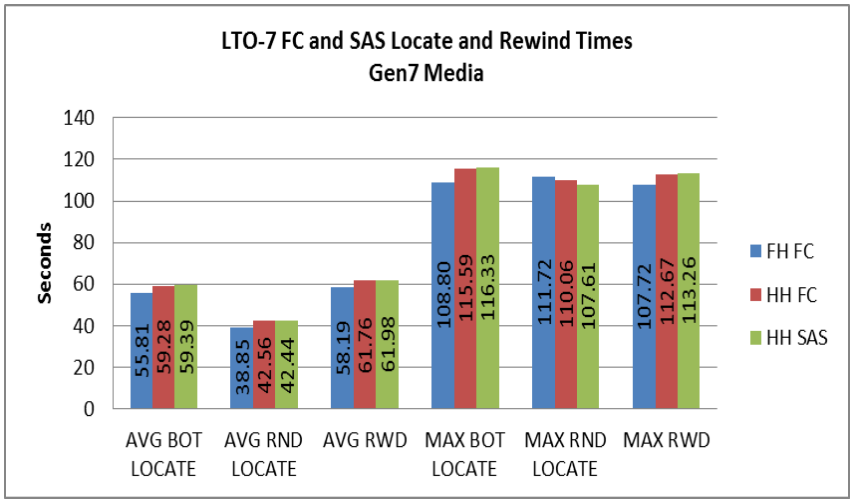


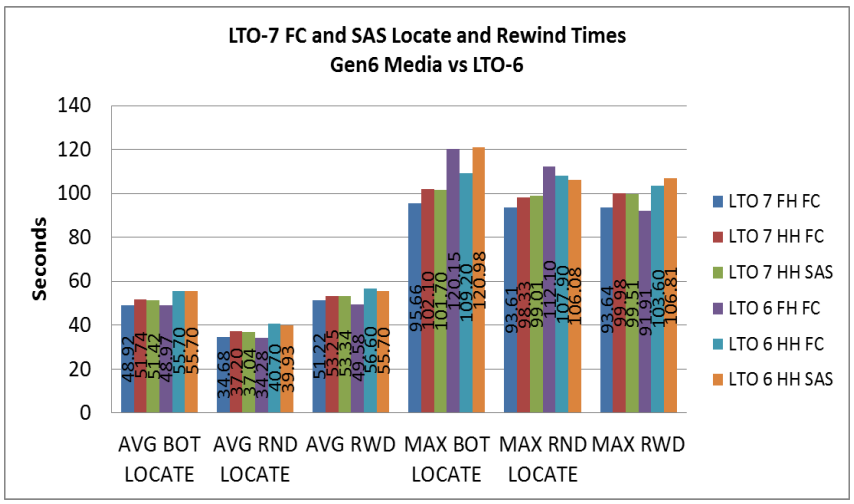
Locate and Rewind Performance

The following charts show the average time for the LTO-7 drive to locate a random block id on the tape starting at BOT (Beginning Of Tape), the average time to locate a random block id 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 full height form factor drives offer a slightly better performance for locate and rewind than the half height form factor drives when using LTO gen 7 media. With LTO gen 6 media, a similar difference is observed.

The LTO-7 tape drive with Gen 7 media offers similar performance for Locate and Rewind as compared with Gen 6.

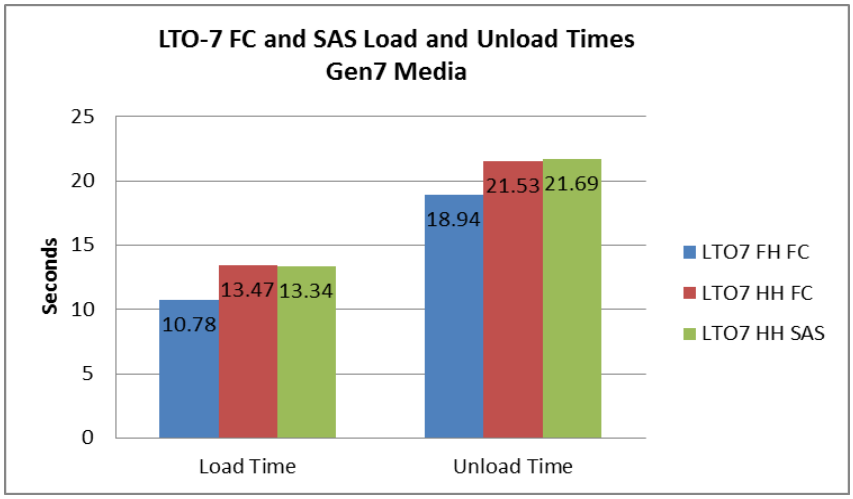


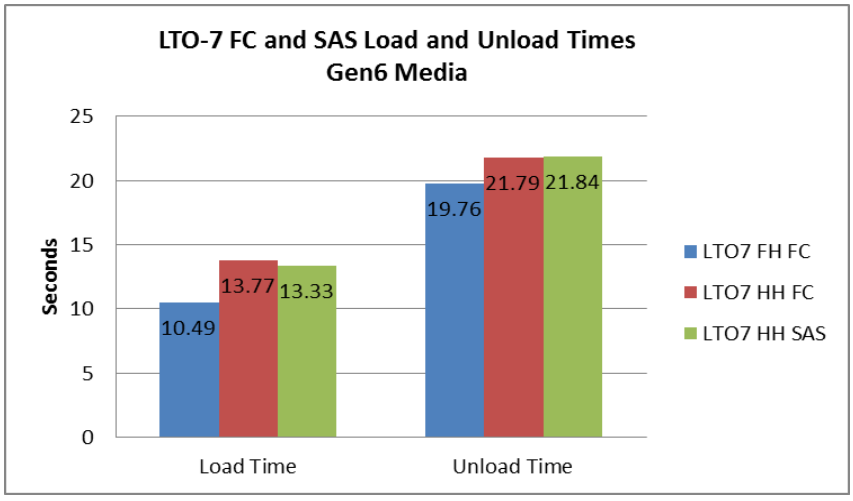


Cartridge Load and Unload Performance

The following charts show the tape cartridge load and unload times for the LTO-7 tape drive with LTO gen 7 and LTO gen 6 media. The performance when loading a cartridge is slightly better for the full height drives. The time to unload a cartridge is faster for the full height drive and there is no significant difference regarding the interface type used.

The IBM LTO-7 tape drive has good load performance for all form factors, generation media and interface types. The time to unload a cartridge is faster for the full height form factor drives for both gen 7 and gen 6 media.



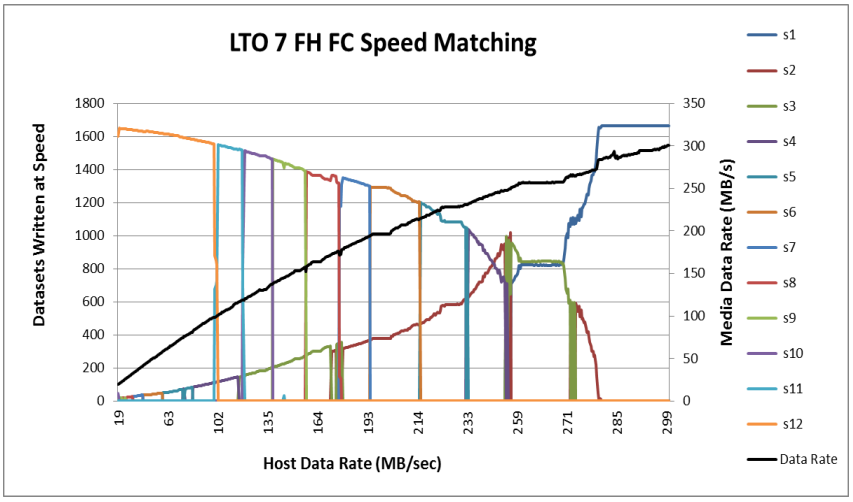


Speed Matching Performance

The IBM LTO-7 tape drive uses 12 speeds 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-7 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 left vertical axis and colored lines show the number of datasets handled by each speed for the host data rate (horizontal axis). The right vertical axis and black line show the effective data rate to media. The chart shows how the drive selects the appropriate speed from the available 12 speeds to match the host data rate and most of the datasets written are handled by the suitable speed.

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



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-7 tape drives in conjunction with the new LTO Gen 7 media represent an efficient solution for today's growing storage demands.

Native capacity increases from 2500 GB (gen 6 media) to 6000 GB (gen 7 media) and even more with data that is compressible (15000 GB with 2.5:1 compression). This capacity increase does not impact locate/rewind performance, and the faster mechanism for the half height form factors improves performance for tape motion operations (locate/rewind times) from previous half height drive generations.

In addition, the IBM LTO-7 tape drive continues to support media partitioning, encryption of data, and WORM media.

The IBM LTO-7 tape drive is a smart storage solution for businesses requiring backup and archival storage of their data.

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5600 Cottle Road,
San Jose, CA 95193

Printed in the United States of America
Sep 2015