



GST Research Report

SLR and your iSeries

SLR Technology and the iSeries



SafeDR™ – Dual SLR Tape Subsystem



AutoDR™ – Workgroup SLR Autoloader



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Abstract

Selection of the correct tape technology to provide the correct data protection strategy has long-ranging effects on the enterprise. Backup and restore strategies, archiving and disaster recovery are all affected by the type of tape technology employed.

IBM chose SLR as the default tape technology for their iSeries server's internal backup drive. This resulted in hundreds of thousands of SLR drives being installed in the over-500,000 iSeries servers now installed worldwide.

This report presents the SLR technology, how it's used by IBM in the iSeries and how GST extends the benefits of this SLR technology through its own tape product line.

A dedicated manufacturer of tape storage solutions, GST, Inc. is providing this GST Research Report as part of its commitment to provide information leading to the better management of data and application protection within the IT industry.



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SLR Technology and the iSeries

This GST Research Report covers Scalable Linear Recording (SLR) technology. It also discusses how IBM and GST have adopted this technology into their own tape backup products for the iSeries, part of IBM's eServer line of servers. IBM selected SLR as the best default tape technology for most iSeries servers, and the drive comes standard as an internal backup tape drive. GST has added SLR technology to its product line to extend the benefits of the original IBM SLR drives for iSeries installations. Between the IBM and GST offerings, SLR provides a highly scalable technology for backup/restore, archival and disaster recovery strategies for iSeries users. The smooth deployment of SLR technology into higher capacity ranges and performance levels deserves attention as an important option for iSeries users as their data volumes and need for faster backup/recovery performance expands.

What follows is a discussion of the value of SLR technology and how it has been adopted for use with the iSeries.

General Information about SLR

1. What is the background of SLR tape technology?

Scalable Linear Recording (SLR) tape technology was first shipped as the SLR1 generation in 1987 by Tandberg Data ASA (www.tandberg.com). Tandberg is a leading global supplier and manufacturer of professional tape storage products based on the SLR™, LTO™ and DLTtape™ linear technology platforms. The company offers secondary storage products based on tape drives, autoloaders, libraries, media, software and hardware components.

SLR tape technology has had an interesting history. It began as Quarter Inch Cartridge (QIC) tape technology, then Single Channel Linear Recording (SLR) technology. This was upgraded to Multi Channel Linear Recording (MLR) and then finally to Scalable Linear Recording (SLR) technology.



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Scalable Linear Recording (SLR) tape technology has evolved through three generations, today represented by SLR7, SLR60 and SLR100. SLR technology provides high capacity and performance, reliability, scalability, and backward and forward compatibility for the use of existing media now and in the future. Data is recorded in parallel on two tracks for SLR7 and on four tracks for SLR60 and SLR100. Data is placed on media in a way that ensures that it can be read during a restore operation even if the media is degraded.

The current generation of SLR technology is characterized by state-of-the-art features like Large Data Buffers, In-Line Compression and an Auto-Sense function that optimizes tape speed.

The remainder of this paper centers on the SLR60 and SLR100 technologies available on the iSeries today. Some basic stats for these drives are below:

Specifications	SLR Technology	
	SLR60	SLR100
Capacity		
Native	30 GB	50 GB
Compressed (2:1)	60 GB	100 GB
Sustained Transfer Rate - MB/s		
Native	4 MB/s	5 MB/s
Compressed (2:1)	8 MB/s	10 MB/s
Sustained Transfer Rate - GB/hr		
Native	15 GB/hr	18 GB/hr
Compressed (2:1)	30 GB/hr	36 GB/hr

2. Who provides SLR tape technology in the U.S.?

Tandberg's subsidiary company in the U.S. is InoStor, Inc. (www.inostor.com). InoStor was created by a merger of Tandberg Data, Inc., a subsidiary of Tandberg Data ASA, and LAND-5 Corporation in March of 2002. InoStor provides Tandberg Data's line of automation solutions, tape drives and media, including SLR to manufacturers like GST. GST works directly with InoStor to obtain SLR technology for GST tape solutions.



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3. Who uses SLR technology?

SLR technology has been incorporated by tape solution manufacturers like GST, Inc. for the development of highly scalable tape subsystems and autoloaders. Beginning with SLR1 through current SLR technologies, SLR has provided inexpensive, entry-level tape solutions that scale up to autoloader and library solutions for the protection and transportation of data. Approximately 3.2 million SLR drives have been shipped, sold and installed since the inception of the technology.

Users requiring low field maintenance rates use SLR, since SLR has the industry's leading reliability rating with a failure rate of approximately 1.5%, lowering the total cost of ownership.

4. Where is SLR technology headed?

With SLR60 and SLR100 available as scalable choices today, and the new SLR140 tape drive shipping in the fourth quarter, 2003, small to medium size businesses have assurance that their investment in SLR technology will expand to meet their future storage requirements. The SLR technology roadmap helps to ensure that assurance.

Technology roadmaps are always subject to change. In fact, they do change over time as the projected generations draw closer to the present. The current roadmap for SLR is summarized below:

Specifications	SLR Technology Roadmap		
	SLR140	SLR200	SLR400
Capacity			
Native	70 GB	100 GB	200 GB
Compressed (2:1)	140 GB	200 GB	400 GB
Sustained Transfer Rate - MB/s			
Native	6 MB/s	16 MB/s	32 MB/s
Compressed (2:1)	12 MB/s	32 MB/s	64 MB/s
Sustained Transfer Rate - GB/hr			
Native	21 GB/hr	56 GB/hr	115 GB/hr
Compressed (2:1)	42 GB/hr	115 GB/hr	230 GB/hr

Backward compatibility is important too. How do you read data once the original tape drive has been replaced and is no longer available? To restore archived tapes, the tape drive must be able to read the older generation tapes. SLR technology is



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backward compatible within families to read earlier SLR generations so that older archived data is still available.

5. Is there an industry-standard tape format for SLR?

Tandberg Data has obtained ISO9001 certification for SLR tape technology. All SLR tape standard formats are determined and specified by Tandberg Data.

6. What is the tape media used?

The SLR cartridge is made by Imation, Inc. (www.imation.com) from high performance Metal Particle (MP+) magnetic media designed for wear-resistance and long life. The shelf life of SLR cartridge-stored data is 20 years when stored properly. SLR's low failure rate of 1.5 percent Field Failure Rate is due in part to the high quality tape media used and the low tape-to-head speeds inherent in the technology. The high quality of SLR tape media and cartridges is augmented by the design of SLR tape drives, where the tape remains completely protected at all times within the cartridge.

SLR head cleaning and media path cleaning is accomplished with SLR cleaning cartridges. The cleaning process consists of simply inserting the cleaning cartridge into the drive. The process is automatic and takes a fraction of the time that wet-type cleaners require.

7. What type of data recording methodology does SLR use?

SLR is based on *linear technology* that is used by most providers of tape technology, including SLR, Travan, NS, DLT, LTO and IBM Magstar. Linear technology writes longitudinally on the tape; when the end of the tape is reached, the read-write head steps down to the next track and the tape reverses its direction. This results in an S-shaped or serpentine path for data on an SLR tape. This process is in contrast with *helical scan* that writes data in vertical tracks across the width of the tape.

"The beauty of SLR tape drives is that the linear format allows for a simple tape path with few mechanical parts, resulting in less wear on the tape and internal drive elements," reports Jack Robinson, Director Strategic OEM Sales and Business Development for Tandberg Data. "Moreover, the large media area on SLR tapes,



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along with fewer mechanical parts and lower head-to-tape speeds, results in very high data integrity for the drives and media cartridges."

Tape media is fully enclosed within the self-contained data cartridge to ensure minimal wear and contamination. 80 percent of the tape mechanism's movable parts are located in the SLR cartridge, so that changing to a new data cartridge is almost like installing a new drive mechanism.

Three key features improve backup rates with SLR7, SLR60 and SLR100 technologies. These are **8MB data buffers** to increase throughput, **in-line compression** to allow compressed data to be stored in the data buffer, and the **Auto-Sense function** that optimizes the tape speed and avoids unwanted start-stop operations.

8. For what applications is SLR suited?

The primary uses of SLR are economical high-quality backup and restore operations, data transfer, as well as the production of tapes needed for archiving data and for disaster recovery. The 20-year shelf life and high reliability characteristics of SLR make it an excellent medium for storing critical data for the long term.

IBM's Utilization of SLR Technology

9. What does IBM offer in SLR tape technology for the iSeries?

"IBM has offered SLR for the iSeries and AS/400 servers for 15 years, since 1988, beginning with the SLR1 120MB tape drive; IBM continues to offer SLR today with SLR7, 60 and 100," reports Tandberg's Robinson.

IBM currently offers two internal SLR drives and two external SLR drive as part of its iSeries tape options:

EXTERNAL: IBM 7207 Model 122 4 GB SLR5 Tape QIC Tape Drive – IBM still provides this entry-level drive for backup, save/restore, archival storage, and data interchange on the AS/400 and iSeries. QIC cartridge capacity is 4GB (compression doubles). The transfer rate is up to 380KB/sec (compression doubles). Backwards



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read/write compatibility exists with QIC 120/150, 525, 1000 and QIC 2GB formats, in addition to the 4GB QIC format. It attaches

INTERNAL: IBM SLR 30 GB ¼-inch Internal Cartridge Tape Unit – This unit is recommended by IBM for save/restore, alternate IPL, program distribution, migration and ¼-inch cartridge tape exchange. The tape capacity is 30GB capacity (compression doubles) with IBM SLR60-30GB Data Cartridges. Other lesser capacities can be stored on IBM MLR3-25GB Data Cartridges, IBM MLR1-16GB Data Cartridges, IBM MLR1-2GB Data Cartridges. Store rate is 4 MB/second (compression doubles).

INTERNAL: IBM SLR 50 GB ¼-inch Internal Cartridge Tape Unit – This unit is also recommended by IBM for save/restore, alternate IPL, program distribution, migration and ¼-inch cartridge tape exchange. The tape capacity is 50GB capacity (compression doubles) using an iSeries specific implementation of SLR100-50GB Data Cartridges (compression doubles). Backward write and read compatibility exists with MLR3 (SLR50) and backward read compatibility exists with MLR2 (DC 5010) tape formats. The store rate is 5 MB/second (compression doubles).

EXTERNAL: IBM 7207 Model 330 External SLR60 Tape Drive – (available Sept. 26, 2003) – a stand-alone streaming tape drive in a single, externally attached enclosure, using SLR60 tape technology. Backward read and write compatible with SLR100, MLR3, and MLR1. Read-only compatible with SLR5 and DC9250 tape formats. Requires OS/400 V5R1 or later and system I/O adapter hardware. Store rate is 4 MB/second (compression doubles).

Ken Cruden, Chief Operating Officer for InoStor, Inc., the North American company for Tandberg Data, reports “At least 80 percent of all AS/400 and iSeries servers have an SLR drive installed.” Today, IBM offers the SLR60 and SLR100 technologies to both AS/400 and iSeries platform users. IBM has offered an SLR Autoloader for the iSeries, but that product was withdrawn from its iSeries tape offerings in 2002.



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"We adopted SLR technology for our tape product line at GST because Tandberg has a longstanding track record supplying the internal drives for the iSeries. The IBM SLR internal drive is probably the most used backup drive on the iSeries, even today. We wanted to reinstate the upgrade path for SLR on the iSeries that existed when IBM offered an SLR Autoloader," reports David Breisacher, CEO and Chairman of GST. "Our advanced functions for Mirrored Backup and Fault-Tolerant operation fit nicely with a dual-drive and an autoloader solution using SLR, and provide a ready upgrade path for users of the IBM SLR internal and external drives on the iSeries."

10. Why did GST select SLR for its tape product line?

Two key design requirements drove the final decision for the highly scalable drive GST wanted for their tape product line:

Strength – *Locate a strong tape drive partner with a solid financial record and secure roadmap showing innovation.* As the original developer of SLR tape technology, Tandberg Data is in a unique position to assist GST's engineers to determine how best to leverage its technology. The company is financially solid and has excellent OEM support engineers to work with GST's development and field technicians.

SLR Technology – *Find a way to augment the current internal tape offering from IBM for the iSeries.* IBM offers both SLR60 and SLR100 internal tape drives for the iSeries. Tandberg OEMs both the SLR60 and SLR100 technologies to provide a fully compatible match with current IBM internal tape offering, allowing GST to provide external tape versions. Also, a clear roadmap exists to SLR140, SLR200 and SLR400 to handle future growth needs.

Footprint – *Find a way to satisfy GST's design objective for a small footprint and modular enclosures.* GST's engineers were able to design modular enclosures (3.5"h, 9.0"w, 11.25"d) for dual SLR drives resulting in small units that weigh 9 pounds and are 10.5 inches tall -- a stack of two Dual SLR Subsystems is less than two feet high. All this combines to save valuable datacenter space.



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Compatibility – *Find a way to extend IBM SLR capability in a compatible and constructive manner.* GST's dual SLR drive configuration, in modular, stackable, external enclosures, enables GST to augment IBM's SLR internal drive that is the de facto backup drive on the iSeries platform. GST's SLR Autoloader provides a compatible extension of IBM's SLR backup capability to eight SLR100 cartridges with a capacity of 400GB (compression doubles).

11. How is scalability handled with SLR?

SLR has evolved through three generations represented by SLR7, SLR60 and SLR100 today. On the iSeries, SLR60 and SLR100 are currently supported by both IBM and GST. These SLR products provide a range of scalable capacities and speeds to accommodate expansion of cartridge capacities of 30GB and 50GB and (compression always doubles this) and expansion of write speeds of 4MB/second (14GB/hour) and 5MB/second (18GB/hour) and again, compression doubles these performance levels.

GST uses SLR60 and SLR100 tape drives in its Dual SLR Tape Subsystem, enabling the addition of 30GB X 2 or 50GB X 2 to augment the capacity of an installed IBM SLR unit. Capacity can be further scaled up with GST's SLR Autoloader that uses SLR100 technology to store 400GB native or 800GB compressed.

One of the primary value-adds of GST's SLR offerings for iSeries users is to provide the scalability needed for installations that are growing in backup volumes beyond the limits of a single SLR cartridge.

12. How is investment protection provided with SLR?

GST's Dual SLR Tape Subsystem is field-upgradeable from SLR60 to SLR100 technology by GST's own technical support organization or by customers themselves, protecting the original investment in all components except the original SLR60 drives.

Also, when adding a GST SLR Autoloader (that only supports SLR100) to an already-installed GST Dual SLR Tape Subsystem, all the tapes on the dual units (whether SLR60 or SLR100) can be read and written on by the SLR Autoloader.



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The SLR100 drive in the Autoloader writes on SLR60 tapes at a slightly degraded speed.

Each SLR generation is backward read-compatible with earlier generations and can be read by future SLR generations, for media investment protection.

13. How does GST handle the repair of a unit?

GST has engineered the concept of Field-Replaceable Unit (FRU) into the design of its tape products as much as possible. Each separate drive and the Commander™ Tape Controller for GST's Dual SLR Tape Subsystem are packaged in separate modules and each is treated as a FRU and can be replaced separately via cross-shipment to the customer, providing the customer a fully-working unit to rely on while the suspect component is being examined at a service location.

For GST's SLR Autoloader, the entire unit is treated as a FRU.

During the normal warranty period (first 3 years), the customer can choose between two plans for handling service calls and repairs. These are described on the GST website under Service (<http://www.gstinc.com/support/serviceplan/index.html>). The **GST Advanced Shipment Program (GASP)** provides for 1-day cross shipping of a replacement unit or FRU. GST also offers 24 hour X 365 day onsite maintenance/repair service.

14. What is the function of the LCD Panel?

The multi-functioned LCD Display Panel is mounted on the front of the GST Commander™ Tape Controller, which is one of the three stackable modules in the GST Dual SLR Tape Subsystem. The LCD Panel continuously displays key drive functions and status of the backup operation. The following key status indicators are displayed:

Presence: whether a tape cartridge is present or absent in the tape drive. This fact is not always visible by simply viewing the drive.

Ready: whether the tape drive is ready for operation or not.

Clean Me: cleaning functions need to be performed on the drive.



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Read: a read operation is taking place in the drive.

Write: a write operation is taking place in the drive.

Load: a tape cartridge is being loaded into the drive.

Unload: a tape cartridge is being unloaded from the drive.

Rewind: the tape cartridge is being rewound.

Position: the tape cartridge is being positioned prior to reading.

Remaining MB: the remaining megabytes of unused capacity on the tape; continuously updated as data is written to the tape. Display shows uncompressed bytes. Used to determine when the capacity of the tape is close to being filled up.

Continuous display of these critical operational factors ensures the operator has full awareness of all key performance and operational measures for the SLR backup unit. This additional information can eliminate operator error due to incomplete information.

15. What is Mirrored Backup?

GST's Dual SLR Tape Subsystem generates identical sets of backup cartridges with no performance penalty on the server, i.e., it takes no additional time to produce the second set of cartridges. One backup set can be safeguarded remotely for immediate access in the event that a disaster recovery procedure needs to be initiated, thus ensuring the rapid deployment of DR activities. The second identical set of backup cartridges can be retained at the server site to be immediately available for expediting the restore process.

16. What other functions are available with GST's Dual SLR Tape Subsystem?

GST's Commander™ Tape Controller enables GST's Dual SLR Tape Subsystem to support Mirrored Backup as described in #15 above. Additional tape functions are also enabled via the GST Commander™ Tape Controller:



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Off-Line Copy: Permits copying one set of cartridges to another set, producing duplicate sets. No server cycles are used (no host penalty).

Off-Line Verify: Identical to Off-Line Copy, except the data on the cartridge in one drive is compared and verified to be identical to the data on the cartridge in the second drive.

Cascade: Permits switching control from one drive to another drive, once the first drive is full during a backup operation. This doubles the unattended backup capacity.

17. What Fault-Tolerant capabilities exist?

The Dual SLR Tape Subsystem has fault-tolerant capability built into the Commander™ Tape Controller. If a failure should occur during a backup or restore procedure on one drive, the second drive continues to operate. This ensures that the backup or restore has been completed no matter what problems might have occurred with the other drive. This fault-tolerant feature can save many hours when it occurs near the end of a restore process, eliminating the need to repeat the entire restore.

18. What are Simplified Weekly Backups?

The GST SLR Autoloader permits simplifying the backup operations for an entire week or longer. The 8-cartridge magazine in the Autoloader provides extended unattended backup capacities using SLR100 technology of 400GB native (800GB compressed). This capacity enables many backup operations to be fully automated for a significant period of time. At the end of the operation, the magazine is removed for safe storage and another magazine pre-loaded with eight cartridges is inserted.

Often, with the GST SLR Autoloader backups can be fully automated for a 7-day or 10-day rotation procedure. This extends unattended backups at a remote server location over the period where an operator is not available.



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19. The effect of high-capacity cartridges on backups.

Increases in cartridge capacity to 100's of Gigabytes of data per cartridge are in contrast to older cartridge capacities of 5 - 10 Gigabytes. These higher capacities result in backup operations that can store entire backups on one or two cartridges. This creates additional exposure during the restore process, since the failure of one cartridge can now take out a much greater portion of the backup data needed in the restore. In the past, if one cartridge of a 10-cartridge backup set was bad, there was a good chance of restoring the other nine cartridges. Today, if a higher-capacity cartridge fails, a much greater share of the backup data is lost.

This situation further underscores the need for redundancy of backup sets. A second backup set generated with Mirrored Backup ensures that if one tape is bad during a restore or disaster recovery operation, a second set is readily available and delays can be avoided. The Mirrored Backup function in GST's Dual SLR Drives ensure there are always two sets of backup tapes available.

20. What kind of connectivity exists with GST's SLR products?

GST SLR tape solutions (dual drives and autoloaders) can backup IBM eServer family members: iSeries, pSeries and xSeries servers. They connect natively with LVD (low voltage differential) and HVD (high voltage differential) SCSI connections. For the Fibre Channel (FC) connection, connectivity is through our BridgeLink™ family of bridges and SanMatrix™ family of routers.

Conclusion

For the past 15 years, SLR has maintained a reputation for quality and reliability in the IBM server world. As IBM's choice for the basic internal drive for the iSeries, SLR technology ensures the reliability of the data protection process that is at the heart of every IT infrastructure.

Increasing demands for larger backup capacities, handled faster and more reliably, are present in many iSeries installations today. For those IT organizations that have chosen to invest in SLR internal backup units, now there are external SLR tape solutions from IBM and GST that can protect that initial investment by building upon it as backup requirements expand. The tape below summarizes the SLR choices for the iSeries marketplace.



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Supplier	Endorsed Technology			Physical Packaging & Solutions			
	SLR5	SLR60	SLR100	Internal	External	Autoloader	Mirrored
GST	No	Yes	Yes	No	Yes	Yes	Yes
IBM	Yes	Yes	Yes	Yes	Yes	No	No

The combination of IBM's ongoing support of SLR tape technology plus GST's patented backup solutions -- including Mirrored Backup, Simplified Weekly Backup, Cascading Backup and Fault-Tolerant Backup -- assures that users can continue to rely on SLR technology to handle capacity and performance demands as they scale up in the future.

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About the author

This GST Research Report was prepared under the leadership of David Breisacher, CEO/Chairman at GST. In addition to founding GST, David has founded several other successful companies including BCC Technologies, a manufacturer of eServer disk, tape and memory storage devices. A visionary for the storage industry since the early 90's, David lends his market insight and predictions for the IBM midrange storage marketplace to the research conducted at GST. His experience in sensing shifts in technology and industry directions has made it possible for David to organize and structure successful companies to rapidly meet the evolving needs of storage users.

Feedback

We value your feedback on this GST Research Report. Please send your comments, suggestions and questions to: research@gstinc.com.

About GST, Inc.

GST Inc. engineers, manufactures, markets and sells a full line of innovative storage backup and restore products to meet today's need for high-performance, fail-safe reliability and cost-effective data storage for a wide variety of servers. GST's advanced tape solutions focus on improved backup/restore processes and enhanced disaster recovery. Products range from single and dual tape subsystems and autoloaders to midrange tape libraries and modular enterprise-wide libraries. Unique modular design enables field upgrades, scalability, investment protection and lower life-cycle costs. Development is guided by expert advisory boards that closely track market needs and ensure use of the latest engineering technology in product design. Complete information about the company, its products and support can be found at: <http://www.gstinc.com>

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