FALCONSTOR®

Modernize your IBM i Environment with FalconStor VTL as a Backup Target

ABSTRACT

For too long, the standard method of backing up IBM i (AS/400) systems has been with a locally attached tape drive or library. The result is reduced performance due to limited backup streams, excessive manual tape handling, and no way to secure data offsite. By introducing the FalconStor® Virtual Tape Library (VTL) solution into an IBM i environment, organizations can non-disruptively replace tape backup in a disk-to-disk (D2D) format to accelerate backup/recovery processes and improve operational efficiency. FalconStor VTL provides significant business and IT advantages for IBM i environments, including integration with native backup tools, IPL bare-metal recovery from virtual or physical tape, and direct physical tape support with encryption to maximize secure operations. This reduces operational and media costs while increasing performance levels to meet stringent application recovery service level agreements (SLAs) and to maximize return on investment (ROI).

INTRODUCTION

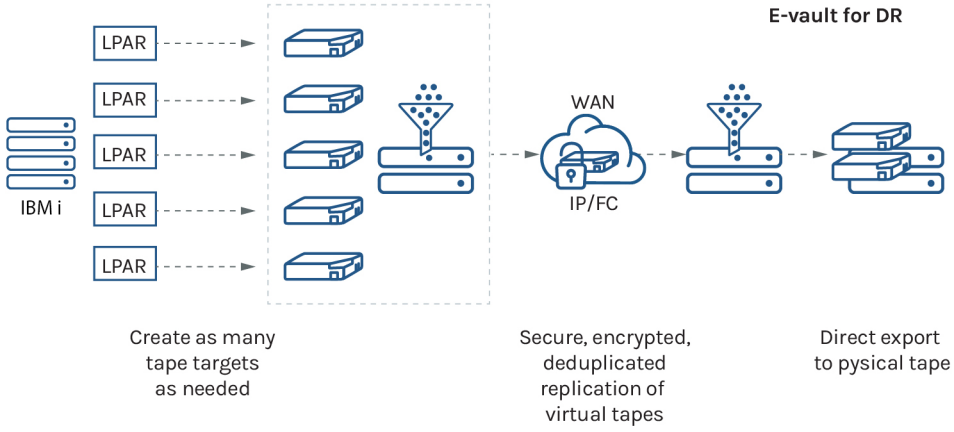
In today's data-driven business environment, customers face increased challenges in protecting their vital data from loss, theft, corruption, and disaster. Traditional backup operations constantly reproduce data for protection and recovery purposes; therefore the amount of data keeps increasing and IT costs keep rising. Even though disk prices are lower each year and tape drive and SAN performance increases, coping with exponential data growth remains a significant challenge for most organizations.

Traditionally, the standard method of backing up IBM i systems has been with a locally attached tape drive or library. However, performance is inhibited due to limited backup streams, excessive manual tape handling, and insufficient offsite data security. In addition, the IBM i backup environment is often an isolated IT island falling outside the rest of the backup operations.

With the introduction of the FalconStor® Virtual Tape Library (VTL) solution, traditional tape backup is replaced by virtual tape in a disk-to-disk (D2D) format. FalconStor VTL is a complete, integrated solution that improves the speed and performance of IBM i backup and recovery, enhances security via encryption to tape, and simplifies data movement. Implementing FalconStor VTL enables high-performance restore, eliminates tape transport, and offers tape encryption at the central site to meet secure offsite vaulting requirements.

Because FalconStor VTL incorporates its own disk resources, it doesn't consume costly IBM i storage, so there is no impact on internal IBM i disk consumption. Emulation of IBM Tape Libraries and Tape drives combined with native support for IBM i backup tools, makes it easy for backup administrators to manage their backup infrastructure. No additional knowledge is required. All operations and process are transparent and continue as normal. The only difference is that backup and restore is faster, and data is stored more reliably and efficiently.

NATIVE IBM i SUPPORT WITH FALCONSTOR VTL



Benefits include:

- Reduce total cost of ownership (TCO)
- Use virtual tape backups to start up IPL to boot IBM i
- Retain more data online with data deduplication
- Replicate data across sites to eliminate tape shipment
- Stream data quickly to physical tape as needed
- Encrypt data onto tape without the need for IBM i software or hardware-based library managed encryption (LME)

ABOUT IBM i

Companies rely on an efficient IT infrastructure to support business-critical applications. They need to know that their systems and business can meet the highest service levels defined by their business units and can be adapted to handle every new business opportunity. IBM i (formerly known as i5/OS) offers a highly scalable and virus-resistant architecture with a proven reputation for business resiliency.

Over the years IBM has transitioned from OS/400 to i5/OS to IBM i. When IBM introduced POWER5, OS/400 was renamed i5/OS. When the POWER6 platform became available in January 2008, IBM announced a major new release named i5/OS V6R1. Later that same year, the name was changed to IBM i to disassociate any presumed dependency on the POWER5 hardware platform. The notations 5.4 and 6.1 were introduced to indicate operating systems release levels V5R4 and V6R1.

The latest release of IBM i is 7.3, which delivers database, virtualization, storage management, web application serving, and other enhancements that allow clients to reduce cost, improve service, and manage risk of their IT infrastructure.

As a turnkey operating system, IBM i runs on a unified server platform, IBM Power Systems, which can house different logical partitions (LPAR). Each LPAR can then run different versions of IBM i. Normally, companies purchase IBM i Standard Edition with the DB2 capability built in, but IBM also offers an IBM i Express Edition option for companies deploying workloads that do not use the DB2 database.

In addition to handling data stored in the DB2 relational database, IBM i has an integrated file system that supports storage management of files in a similar way to Microsoft Windows and UNIX operating systems. The integrated file system provides a hierarchical directory structure and management interface to 11 different file systems (including UNIX, Microsoft Windows, and NFS), each with its own set of logical structures and rules for interacting with information in storage. Compared to systems that focus only on their own native file system technology, the integrated file system gives companies much broader flexibility to integrate with a range of open applications from a wide variety of operating environments.

IBM i TERMINOLOGY

IBM i. IBM operating system. The newest version is 7.3.

Power Systems. IBM hardware supported by IBM i. This hardware is often partitioned to different local partitions so that different operating systems can run concurrently. RAM and disk is considered part of a single storage pool in an IBM i system and is shared among different logical partitions. IBM i can share I/O feature codes such as network and Fibre Channel (FC).

Logical Partition (LPAR). Multiple workloads managed in independent operating system images. Power Systems can be divided into LPARs running different operating systems concurrently. The current operating systems supported in a Power System are IBM i, AIX, and Linux.

Feature code. IBM I/O cards are sometimes known as feature codes. IBM i has FC feature codes dedicated to tape and disk. When connecting to a FalconStor VTL, a tape-based FC feature code is required.

Initial Program Load (IPL). The booting process for IBM i. Normal IPL default is to boot from disk, but IPL can be interrupted to boot from an alternative source including tape devices (virtual or physical). This is known as D-IPL or Alternative IPL. IBM i D-IPL functionality is supported by FalconStor VTL.

Save/Restore. IBM i has a built-in backup and restore program. The native program provides the ability to write to standalone tape drives and tape libraries. GO SAV and option 21 are often used to perform a full system backup. D-IPL can be used to execute a boot from this backup. All functionality in Save/Restore is supported by FalconStor VTL.

Backup Recovery and Media Services (BRMS). Licensed backup software created by IBM that incorporates media management and tape cataloging. Save/Restore does not support media management or tape cataloging. All functionality in BRMS is supported by FalconStor VTL.

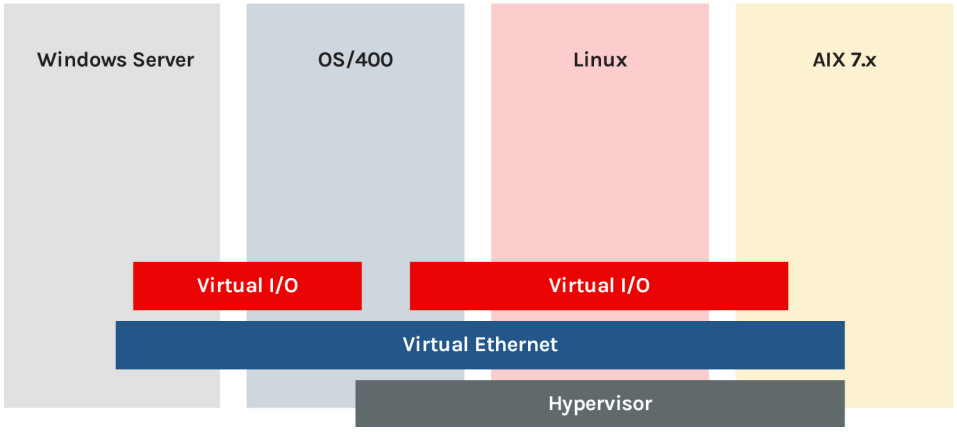
LXI Media Management System (MMS). Licensed backup software created by LXI that provides media management and tape catalog functionality. MMS is fully supported by FalconStor VTL.

IBM i ARCHITECTURE

The IBM i operating environment demonstrates a unique design that delivers innovative technology without complexity. It is a highly integrated, reliable server platform that allows businesses to run multiple operating environments. IBM i dynamically adjusts to the changing requirements of a dynamic business marketplace. IBM i offers an integrated architecture combined with high availability and security levels, simplified management, and mainframe-class technology.

One of the key contributing factors to the efficiency of IBM i is the ability to run multiple business processes and applications reliably and securely. In a study of large enterprises using multiple operating systems, IBM found utilization rates on IBM i-based servers were over 10 times higher than Intel processor-based servers and over twice as high as UNIX and other midrange-based systems (IBM i Data Sheet: IBM i = Efficient, resilient business processing, 2010). The high rate of utilization of Power Systems with IBM i is achieved through the use of a variety of proven virtualization technologies, such as sub-systems (multiple workloads managed in a single operating system image) and IBM PowerVM LPARs.

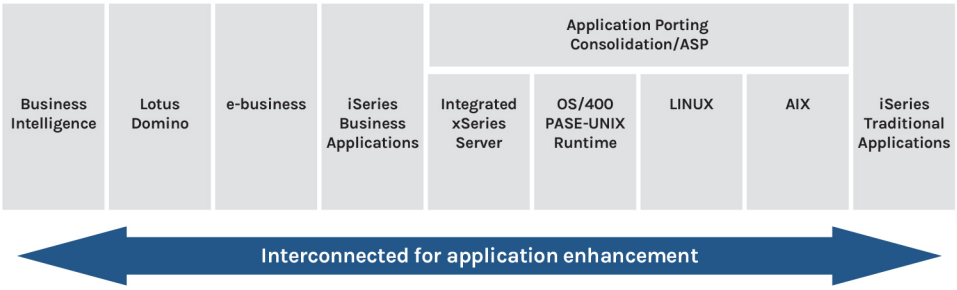
IBM i ARCHITECTURE



With LPAR, companies have both the power and flexibility to address multiple system requirements in a single machine to achieve server consolidation, business unit consolidation, a mix of production and test environments, and integrated clusters. LPARs are ideal for companies that want to run varied workloads in a single IBM i system. Licenses can be managed across partitions.

Each partition's system name is distinct, and the system values can be set independently. Each partition can have a different primary and secondary national language and can be operated using different time zones. This flexibility is ideal for multinational companies that wish to centralize operations in a single location while retaining the national characteristics of each system.

IBM i LPAR



IBM i BACKUP AND RESTORE

Although the IBM i is a reliable system, there are certain risks associated with backup. Data that changes often should be backed up daily. System data and data that only changes periodically should be backed up weekly. Data recovered from a site failure, disk failure, or corrupted data cannot be properly restored if it is not saved on a regular and disciplined basis.

To define a backup strategy, IBM defines the save window as the amount of time that a system is permitted to be unavailable to users while administrators perform save operations. Backup strategies are defined as simple, medium, or complex.

Simple save strategy. The simple save strategy is used by customers with a long save window such as an 8- to 12-hour block of time available daily with no system activity (including batch work). The simplest save strategy is to save everything every night or during off-shift hours. IBM i has a built-in management option 21 (entire system) that can be scheduled to automatically do these backups.

Medium save strategy. A medium save window means that there is a 4- to 6-hour block of time available daily with no system activity. Customers may use this strategy if large batch jobs are run on the system at night or large files exceed the save window.

The following techniques are used in a medium save strategy:

- Saving changed objects.
- Journaling objects and saving the journal receivers.

Save Changed Objects (SAVCHGOBJ) command is used when programs and data files are in the same library. SAVCHGOBJ saves only those files that change.

The save Document Library Object (SAVDLO) command is used to save only the documents and folders that changed. The Save (SAV) command is used to save the objects in directories that have changed since a specific point in time.

If save operations for integrated file system objects and data areas are taking too long, a journal of the objects can be used to make operations more efficient. In files with many records, if a single record changes in a file with many records, the SAVCHGOBJ command saves the entire file.

Journaling database files and saving journal receivers regularly is a better solution, even though recovery is more complex. A similar principle applies to the integrated file system objects and data areas. Journal objects write a copy of every change in the object to a journal receiver, saving only the changed portions of the object rather than the entire object.

Complex save strategy. In instances where there is little or no time to take systems down for interactive or batch work, the complex save strategy must be employed. BRMS are typically implemented in such environments.

BRMS is IBM's strategic backup and recovery product for the IBM i. Its policies provide the necessary interface to manage and execute archive, backup, migration, recovery, and other removable-media-related operations. Backups using BRMS are implemented through Control Groups or native BRMS backup commands. Control Groups are analogous to Control Language Programs without the need for programming expertise. They are easier to create/customize/change without having to compile or recompile. BRMS can save libraries, objects, spool files, document library objects, and objects in directories (IFS) within the same control group. Spool files saved using BRMS can be restored with their attributes and overlays intact.

For additional information, see Backup Recovery and Media Services for IBM i 7.1 (IBM Online Library SC41-5345-07).

COMMON CHALLENGES

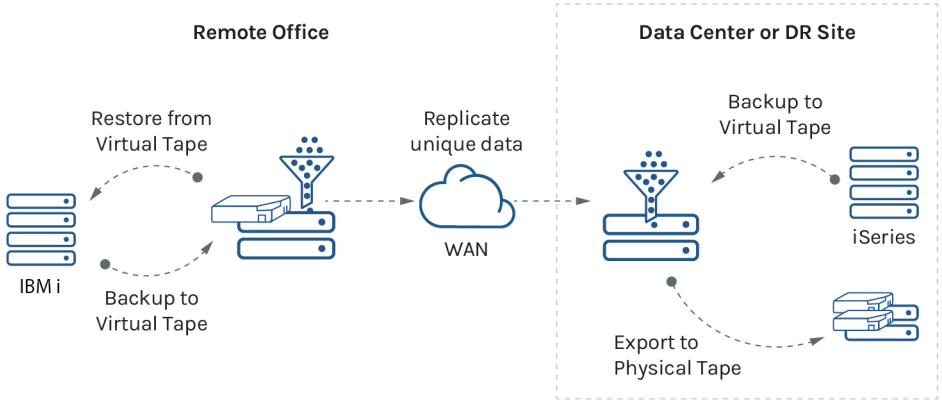
Ensuring data is protected at remote offices is one of the many challenges IT administrators face in an edge-to-core (remote office to data center) enterprise architecture. In an environment of reduced IT budgets and resources, combined with abundant data growth, they can no longer rely on writing to tape at the remote office. In addition, organizations including those running IBM i experience the following backup and data protection challenges:

- Overwhelmed by data growth and unable to meet backup/protection windows
- Struggling to meet defined SLAs for recovery time objective (RTO) and recovery point objective (RPO) requirements
- Trying to cut down or eliminate use of physical tape and the associated storage and transport costs
- Experiencing the need to retain more backup data online without significantly expanding storage footprint
- Aging physical tape infrastructure is too slow and subject to frequent failures
- Consumption, shipment, and management of physical tape is too costly
- Desire to have multi-threaded backup targets (more LTO drives) to reduce backup queue
- Regulatory or compliance requirement to encrypt data written to tape

FALCONSTOR VTL FOR IBM i

FalconStor VTL is designed to increase the speed and reliability of IBM i backup tools and methods by leveraging disk to emulate all IBM i supported tape drive and tape libraries. The FalconStor VTL leverages existing Fibre Channel (FC) or IP SAN to transfer data to and restore data from a disk-based virtual tape at ultra-high speeds.

OPTIMIZED REPLICATION FOR



By using FalconStor VTL with IBM i, smaller offices and remote sites can electronically vault tapes across any distance using standard IP (WAN) networks, centralizing data at the DR site for long-term data protection, retention, and central tape creation. Data over the wire is encrypted (AES 256-bit) and data written from the FalconStor VTL directly to physical tape can also be encrypted (AES 256-bit), ensuring data is safe at all times.

Because FalconStor VTL emulates over 60 popular tape libraries and 50 tape-drive formats in addition to IBM i specific formats, it fits easily and transparently into the existing IBM i backup environment. Extensive certification testing has validated FalconStor VTL operationally with all major backup software packages across multiple operating systems and environments. This allows FalconStor VTL to integrate and interoperate easily with open systems backups as well as IBM i and mainframe systems, allowing consolidation of all backup operations on a single platform.

Because data centers require both disk and tape to meet corporate and regulatory requirements for tiered backup, archive and compliance, FalconStor VTL seamlessly bridges disk and tape through direct write-to-tape and best-of-breed tape management capabilities, removing additional network and operational overhead. Media management capabilities are optimized to reduce complex IT operations, reduce media consumption, and improve security through features that include:

- **Tape caching.** Transparently and directly move data from virtual to physical tape, either concurrently with backup or based on user-defined policies and schedules without the need to transfer data back across networks or through backup or media servers. Physical tape can also be migrated directly and transparently into the FalconStor VTL, natively and without interfering with backup operations.
- **Tape consolidation.** Write multiple virtual tapes to a single physical tape of the same or greater capacity, maximizing physical media utilization.
- **Multi-tape export.** Create multiple copies of physical tapes to meet offsite DR needs, SLAs, and regulatory requirements.

Since data security is only as good as its weakest link, securing data both on backup media and during any replication process is critical to the integrity of corporate information. FalconStor VTL delivers unique features that provide comprehensive data integrity for securing data storage and migration.

- Secure tape export via encryption. To prevent unauthorized access to data on physical tapes, the FalconStor VTL solution can write to tape in an encrypted format based on the Advanced Encryption Standard (AES 256-bit). Because encryption is handled by FalconStor VTL, it does not require any specific backup software or tape drive encryption licensing, nor does it require the BRMS encryption option. It works with any format or any physical tape media, maximizing media investments. The entire tape is encrypted, not just the data, allowing the physical tape to be fully protected in the event the tape is lost or stolen. For mobility, key management is included, and key packages can be exported for use with the remote VTL at the data center or DR site, allowing encrypted tapes to be imported and restored.
- Tape shredding. Tape shredding enables users to "destroy" a virtual tape image so that it cannot be accessed, even when using disk forensics. Shredding performs a three-pass wipe of the selected virtual tapes using an algorithm specified by the U.S. Department of Defense (Standard 5220.22-M).

ENCRYPTION METHODOLOGY COMPARISONS

IBM i Tape Encryption	FalconStor VTL Tape Encryption
Need to deploy additional software with host-CPU impact	No host software required, no impact on CPU
Operational learning curve impacts staff	Minimal learning curve, easily managed
Limited tape drive support: TS1120 and LTO-4 only	Encryption works with any tape drive format supported by FalconStor VTL
Cannot use with existing media investment	Utilize existing media investment: LTO-1, LTO-2, 3580, 3590, etc.

INTEGRATED DEDUPLICATION

Data deduplication dramatically reduces the amount of backup data stored by eliminating redundant data, maximizing storage utilization while allowing IT to retain more nearline backup data for longer periods and faster restores. FalconStor VTL provides integrated policy-based deduplication, offering flexible post-process or inline deduplication methods, configurable for maximum flexibility and performance.

Because IBM i backups write data sequentially to tape, FalconStor VTL is optimized to provide the best results based on backup and tape format awareness. A deduplication parser recognizes each IBM i tape format as well as multi-streamed backup sessions. This allows for proper alignment of the data prior to the start of the deduplication process. The metadata portion of the backup is identified and compressed. The parser is then aligned to the start of the data portion where a hash is calculated based on the best block size, and duplicate blocks are discarded. This patent-pending, tape format-aware deduplication model analyzes tape formats, guarantees that the same files are aligned the same way each time, and achieves the most efficient deduplication ratio. It allows the deduplication parser to align on different size blocks for different IBM i tape formats to ensure maximum detection of duplicate data, improving duplicate data detection by as much as 30% to 40% over generic raw fixed block deduplication analysis.

Equally important is the ability to restore data quickly from the VTL cache, physical tape, or directly from the deduplication repository. FalconStor VTL is optimized for read performance, ensuring a read is nearly as fast as a write by enabling high-performance read-ahead data access, parallel read across a wide disk stripe, and direct block-level access with no file system overhead. This ensures that restore speeds are fast, allowing organizations to bring critical systems back online quickly. When a file read request is initiated, the deduplication index detects the links and reads the blocks directly, in parallel from the deduplication repository, sending data blocks directly to the application for high-speed restore.

THE FALCONSTOR VTL ARCHITECTURE

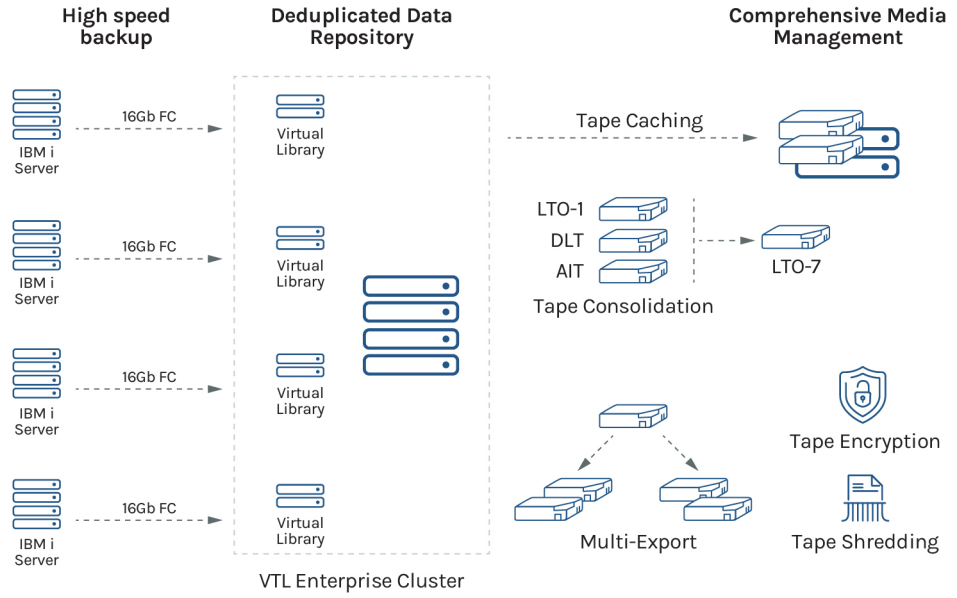
The FalconStor VTL architecture consists of three major components:

- The front-end, which is made up of virtual tape drives within virtual tape libraries using virtual tape cartridges
- A storage appliance, which is made up of an internal disk buffer and VTL and deduplication nodes
- Back-end tape drives within physical libraries using physical tape cartridges

FalconStor VTL runs on RedHat Linux and emulates over 50 tape drives and 60 tape libraries provisioned via FC and/or iSCSI interfaces to the IBM i server. The single-node FalconStor VTL server can fully saturate four 16-Gbps FC interfaces and deliver more than 6400MB/sec throughput, making it the fastest single-node performance of any VTL in the industry.

When equipped with FC HBAs, each FalconStor VTL node has front-end (i.e. target) and back-end (i.e. initiator) FC interfaces.

FALCONSTOR VTL ARCHITECTURE



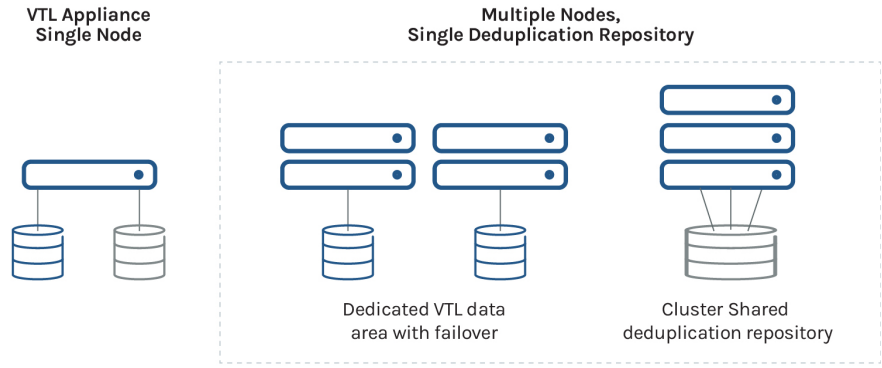
The virtual tape drives are presented to the IBM i servers via the front-end FC interfaces, and the back-end interfaces communicate with the deduplication repository to retain data on high-performance RAID 6 protected disk arrays for fast recovery and restore. The back-end interface can also attach to physical tape drives/libraries for export of VTL tapes for

long-term archival. This “tape out” feature supports all media management functions and has the ability to bridge normal IBM i supported physical tape by writing IBM i virtual tapes to any physical tape drives, even those that are not supported by IBM i.

FalconStor provides multiple deployment options for IBM i environments, including a fully integrated turnkey appliance, FalconStor VTL-S, which includes a preconfigured VTL cache and an integrated deduplication repository. For larger capacity requirements, FalconStor also offers a fully integrated multiple-node cluster solution that includes multiple VTL nodes (up to 8) for high performance and high availability combined with a shared global deduplication repository that can scale up to 4 nodes with as much as 12PB of useable RAID 6 storage deduplication repository.

FalconStor VTL systems support software compression, allowing the VTL to compress and uncompress data at a high speed.

FALCONSTOR VTL HARDWARE CONFIGURATION OPTIONS

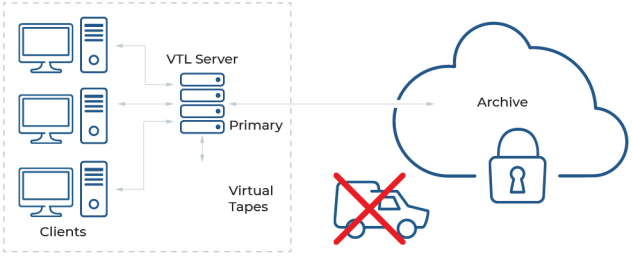


For additional information, please refer to the data sheets listed in the Appendix.

TAPE-TO-CLOUD MIGRATION

Using the FalconStor Virtual Tape Library (VTL) tape-to-object feature, you can export tapes to the cloud and stop physically moving tapes offsite for storage. The IT industry has been increasingly adopting object storage as one of the storage tiers. Virtual tapes can be migrated when they are ejected by backup software. After migration, disk space used by virtual tapes will be freed and virtual tapes will be converted to stub tapes. In this way, you can use the cloud for archiving purposes.

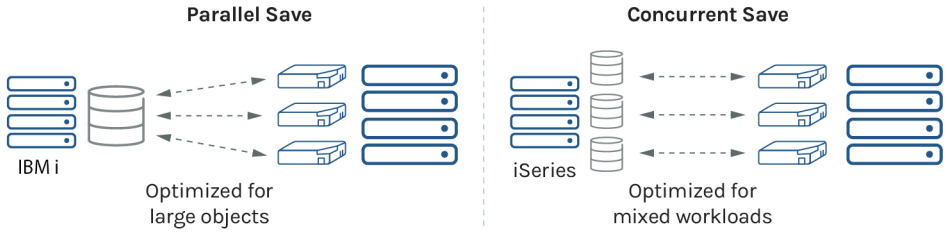
Refer to the FalconStor VTL User Guide for more details



FALCONSTOR VTL: BENEFITS TO IBM i ENVIRONMENTS

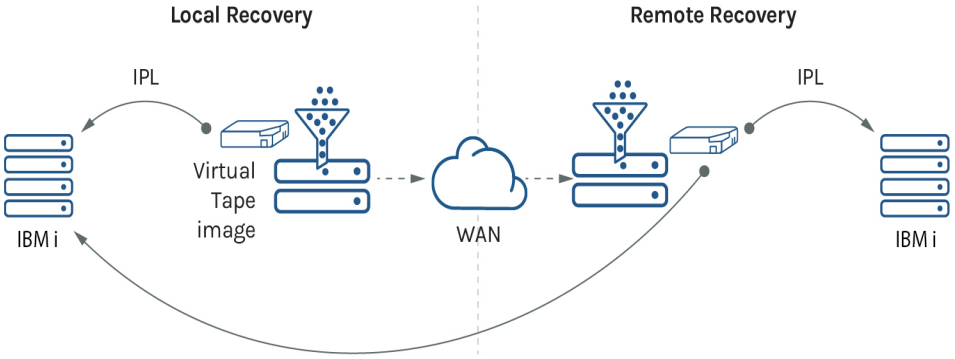
- Non-disruptive operation; IBM i does not see any difference between a physical tape and virtual tape
- Native emulation of all IBM i tape drives and libraries, including IBM 3580, 3590, 3592, TS1120 tape drives; LTO-1 to LTO-7 tape formats, and IBM 3583, 3584, and 3590 libraries
- Supports all IBM i backup tools and methods (BRMS, LXI MMS, SAVLIB, Robot Save, media policies and IPL) without any process change
- Supports mixed open system, IBM i and mainframe system environments
- Ensures business continuity through IPL, bare-metal boot from virtual or physical tape
- Offers the flexibility to create as many tape targets and libraries as needed
- Higher performance (write and restore) with connectivity across 16Gb/sec FC links
- Integrated deduplication to retain backup data on capacity-optimized disk for longer periods
- Eliminates tape shipments with integrated replication and secure data encryption over the WAN
- Only unique blocks of data are transmitted, reducing WAN requirements by as much as 99%
- Direct export of virtual tape to physical tape, simultaneous with backup or based on defined policies and schedules
- FalconStor VTL can cross tape-drive boundaries. Support for tape stacking allows multiple smaller virtual tapes to be consolidated onto larger physical tape media.
- Supports parallel and concurrent save/restore operations for enhanced performance:
  - **Parallel Save.** A single object is saved/restored using multiple virtual tape targets and the same IBM i job
  - **Concurrent Save.** Different objects are saved/restored using multiple virtual tape targets and different IBM i jobs

SAVE/RESTORE OPTIONS



- Business continuity; support for Initial Program Load (IPL) Bare Metal Boot from VTL or physical tape:
  - Virtual or physical tapes function as a data source for system IPL (boot)
  - FalconStor VTL provides fast recovery of systems either local or at remote site (for DR, tests, lab, etc.)

BUSINESS CONTINUITY, IPL SUPPORT



INTEGRATING FALCONSTOR VTL WITH IBM i

FalconStor VTL changes the typical approach to coordinating, managing, and handling backups in an IBM i environment. Its non-disruptive approach resolves many of the issues current IBM i customers have using standard backup architectures. Implementing FalconStor VTL eliminates the contention for physical tape drives, removes media and mechanical failures associated with physical tape drives, and reduces the cost of physical tape transport for vaulting.

Backing up data with IBM i to a FalconStor VTL appliance follows the same rules and procedures as standard backup to tape. The process is completely transparent to IBM i operations, backup proceeds, schedules, and processes.

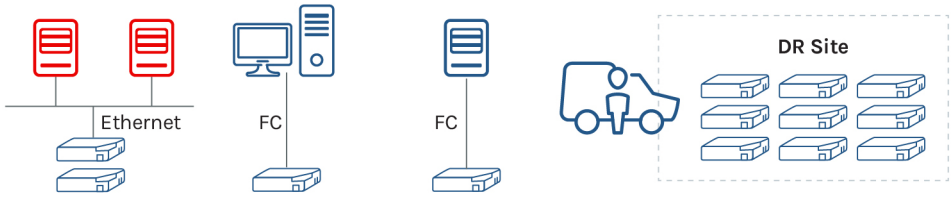
Using a standard FC protocol, FalconStor VTL presents a virtual IBM tape library and IBM tape devices. The virtual library can accept more data streams than a physical library, and can run more jobs simultaneously. With a virtual library, the administrator can create as many tape libraries and drives as needed (up to 128 libraries and 1024 drives per FalconStor VTL node). This means that organizations can deploy multiple backup targets across IBM i systems without time constraints.

The following libraries and tape devices are certified devices to IBM. System i and are supported by FalconStor VTL. Using these common and certified devices makes it transparent for IBM i backup administrators to manage their backup infrastructure:

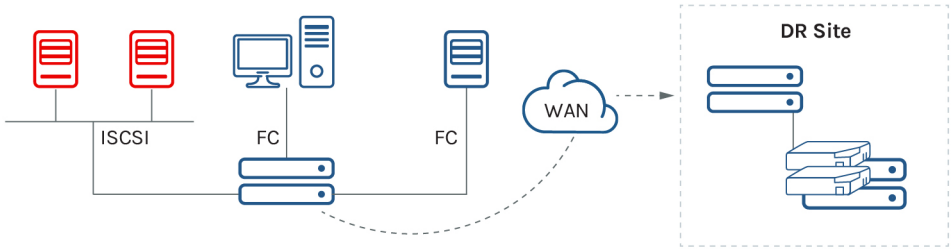
- IBM 3580, 3590, 3592, TS1120 tape drives
- LTO-1, LTO-2, LTO-3, LTO-4, LTO-5, LTO-6
- And LTO-7 tape formats
- IBM 3583, 3584, and 3590 libraries

ENHANCING THE BACKUP MODE

Current Model



VTL Model



One of the bottlenecks of physical tape backup is the fixed number of tape drives. Once all drives are in use, backup streams/jobs begin to queue creating a bottleneck and slowing the overall backup process. The only solution is to add more physical drives or libraries, or to resort to tape-drive sharing, which can be complex to implement, can impact performance, and can require additional licensing fees.

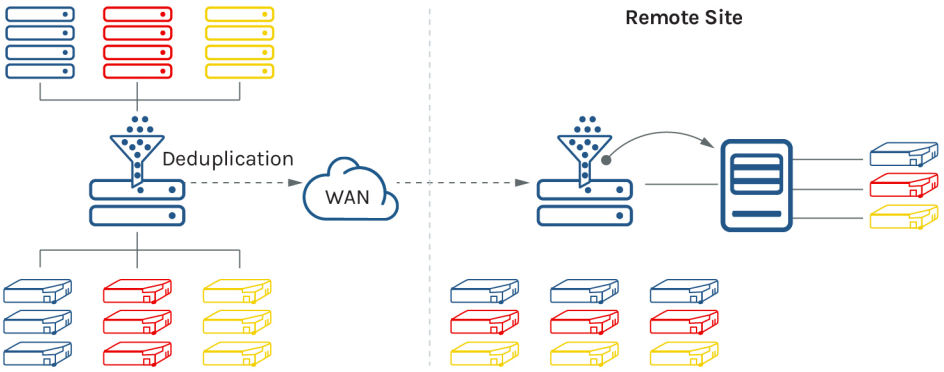
With FalconStor VTL, once the initial number of virtual tape drives is used, the administrator can simply go into the FalconStor VTL console and create new drives, up to the limit of the emulated library. Once a library's maximum drive count is allocated, the administrator can simply create another library on the fly.

Virtual tape replication lets FalconStor VTL electronically vault tapes across any distance over standard IP networks (WAN). Because only deduplicated data is sent over the wire, bandwidth costs are reduced by as much as 90% or more.

As noted, FalconStor VTL supports direct export of virtual tapes to physical tape. Because data is streamed directly from the FalconStor VTL to tape, tape drives can stream at their maximum performance levels, speeding the tape creation process and reducing the number of tape drives needed to produce media. FalconStor VTL technology can also cross tape drive boundaries.

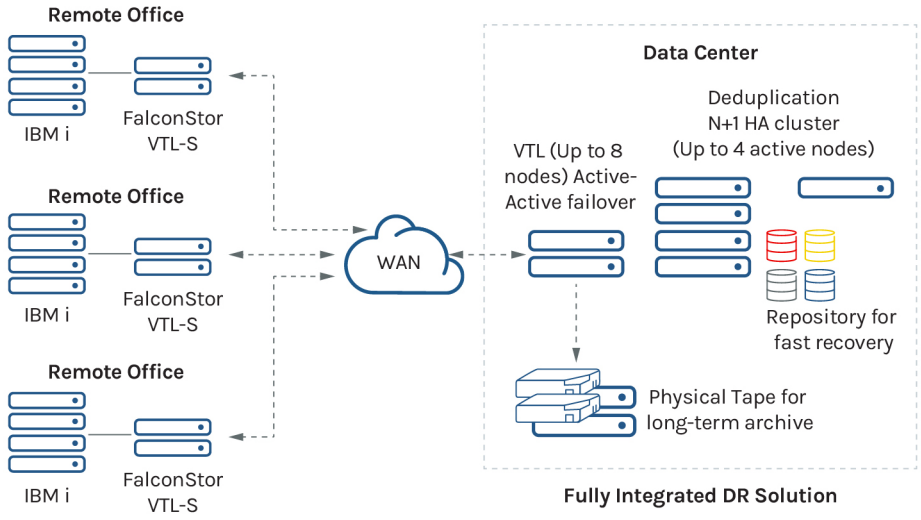
Normally, IBM i recognizes only a few physical tape formats; however, FalconStor VTL can bridge these IBM i virtual tapes to any physical tape, including those not supported by IBM i systems. For example, an LTO-2 virtual tape can be copied to an STK 10000 physical tape. Tape stacking consolidates multiple smaller virtual tapes into a larger physical tape format, maximizing media utilization while reducing tape consumption and cost.

ELECTRONIC VAULTING



Built in replication is used for tape vaulting and DR, eliminating tape transport and providing the opportunity to create secure physical tape at the DR site. Running wizard-based policies, each individual virtual tape or job can be deduplicated, compressed, replicated, and retained at the DR site in the online disk repository for a defined period of time, and then vaulted to physical tape with a unique policy and a defined schedule. Facilitating replication offers additional cost savings by reducing WAN bandwidth requirements, eliminating the need to create tape at the remote or branch office, and the associated tape transport cost while ensuring security. Added benefits include support for IPL (boot); administrators can DIPL from the virtual tape or from physical tape, locally or from the DR site, ensuring fast recovery in the event of a catastrophic failure. Additionally, the FalconStor VTL encryption configuration simplifies the process of selecting tapes to encrypt, and determines where to store the tapes and associated secure encryption keys. The process is transparently managed and controlled by the FalconStor VTL, offloading the computing resource required by IBM i software encryption as well as the need to procure hardware encryption devices to meet security requirements.

FULLY INTEGRATED DR SOLUTION



Fully Integrated DR Solution

CONFIGURATION GUIDELINES

FalconStor VTL is available in several form factors, including an integrated turnkey appliance (VTL-S), a gateway appliance using existing SAN storage, or as a high availability (HA) cluster, which provides the added benefit of higher performance, failover, and higher scalability for longer term data retention. (For more details on architectural differences, please refer to the specific data sheets listed in the Appendix.)

Storage Appliance. The FalconStor VTL storage appliance (VTL-S) is an all-in-one appliance that includes all licenses for virtual tape management, deduplication, replication, physical tape management, and encryption features. The IBM i license is an optional license that must be applied to the FalconStor VTL appliance via the VTL console. The IBM i license allows IBM i SAN Clients via FC Target Mode to be created on the VTL appliance. Virtual and physical resources can easily be defined, allowing the backup administrator to quickly create a virtual tape library to emulate the existing tape library and assign it to the IBM i SAN client. The FalconStor VTL console provides two methods for creating VTLs: a configuration wizard, or the ability to select the Virtual Tape Libraries object and create a new library from a predefined list. Once the administrator creates the emulated tape library and drives, he or she will be prompted to create virtual tapes. At this point the new VTL is assigned to the IBM i SAN client, and all existing backup tools and processes will operate without change. For more details on the easy-to-use process, please reference the latest FalconStor VTL User Guide.

Gateway Appliance. The VTL Gateway operates and is licensed in a similar manner to the FalconStor VTL storage appliance. The FalconStor VTL gateway also includes all VTL licenses for virtual tape management, deduplication, replication, physical tape management, and encryption features, and the IBM i license is an optional license that must be applied via the VTL console. The IBM i license allows IBM i SAN clients to be created on the FalconStor VTL appliance via FC Target Mode. The primary difference is that the FalconStor VTL gateway does not include physical disk. Instead, it attaches to an existing SAN via FC and zones storage resources from that existing SAN.

HA Cluster. The HA cluster configuration is a highly scalable HA configuration that includes independent VTL and deduplication nodes, providing flexibility within each individual environment. Customers can add more VTL nodes for faster backup performance or add more deduplication nodes for higher deduplication performance or for longer data retention. This cluster configuration can scale to 8 VTL nodes, 4+1 deduplication nodes, and up to 12PB of physical RAID 6 usable storage (deduplication repository).

Configuring and administering backup policies to FalconStor VTL is the same as with a physical tape library. Once a virtual IBM tape library and drives are assigned to the IBM i, operations continue as normal.

IBM i backup administrators can start with the IBM i native backup and restore tools to back up data to the FalconStor VTL. As backup needs grow, the administrator can move to more sophisticated IBM backup software, such as BRMS or MMS, and continue to use the FalconStor VTL without change. A single VTL can be partitioned to multiple IBM libraries with multiple drives. Each partition can be dedicated to different LPARs providing, parallel backup streams and reducing backup queues and wait time.

Data recovery is also significantly faster since restores are directly from the FalconStor VTL. With deduplication, the FalconStor VTL can retain 60 or more days of backup data in an optimized format so that restore is directly from disk versus tape. Faster restore performance is the result of advanced read-ahead technology, parallel reads across a large array of disk, direct block-level access, and no file system overhead. When a read operation is performed,

the VTL reads ahead sequentially on the virtual tape and adds the read ahead buffer into a queue. The implementation of this feature dramatically improves read performance as well as deduplication performance. Using this advanced technology; FalconStor has demonstrated that the restore speed from deduplicated data and non-deduplicated data is almost exactly the same across all appliances, including single-node FalconStor VTL-S appliances and cluster solutions

Meanwhile, a copy of the data can be electronically vaulted to the DR site, retained on physical disk in a deduplicated format, or securely exported to a physical tape using the integrated encryption configuration tools. Administrators can restore any required data directly from the DR site on the remote FalconStor VTL or from physical tape.

Encrypt data on virtual and physical tapes

To ensure that the data exported to tape is confidential and secure, FalconStor VTL enables encryption keys to be created that use the Advanced Encryption Standard (AES) 256-bit key algorithm (Secure Tape) published by the National Institute of Standards and Technology. When data is exported to physical tape, an encryption key is chosen to encrypt the data. That same key must be used to import the same data back to virtual tapes or to read the data.

Each key consists of a secret phrase. For additional security, each key is password protected. A single key can be applied to all virtual tapes when exported to physical tape, or a unique key can be created for each tape. Once one or more keys have been created, they can be exported to a separate file called a key package. If encrypted tapes are sent to other locations that run FalconStor VTL, the key package can be sent so tapes can be decrypted remotely.

FalconStor VTL includes a robust key management system, which provides a simple interface for creating, managing, and maintaining keys used to encrypt the data. Once encrypted, the data is not accessible without access to or knowledge of the encryption key. The key management system helps users create high-quality keys that are impossible to crack, but easy to manage and maintain.

The entity that encrypts the data is the owner of the data. It is also the same entity that decrypts the data when needed. Even in the case where another entity needs to decrypt the data, that entity must be authorized with the same level of trust. There is no unknown entity in the trust relationship. Benefits of FalconStor VTL encryption include:

- Key packages can be exported for use on remote VTLs (to allow tapes to be imported/restored).
- The encryption is handled by the VTL and does not require an encryption license on IBM i or backup software.
- Host processing power is not affected by the encryption process.
- The encryption option works with deduplication and replication. This includes the replicated data (unique deduplicated data and metadata) that can also be encrypted.
- The encryption option can work in conjunction with tape stacking (tape consolidation) for long-term tape archival
- Data is encrypted on both virtual tape and physical tape

Sizing

Much has been written about deduplication ratios, and many vendors have a tendency to indiscriminately advertise large deduplication ratios. However, no vendor can guarantee a specific deduplication ratio without first analyzing a customer's specific data and backup methodology. The ratio of data stored (after deduplication and compression) wholly depends on a number of different factors, including:

- Backup methods and policies (full, incremental, daily, weekly, etc.)
- Disk retention policies
- Rate of data change (for example, database data and email data that changes frequently has lower deduplication ratios)
- Type of data (structured, unstructured, images, etc.)

Sizing a FalconStor VTL solution must take these backup methods and policies into account. Since the IBM i is not aware of deduplication, a few general rules need to be followed:

1. Perform an assessment of the backup solution so FalconStor VTL sizing can be done in collaboration with the backup team at the customer site. A discussion of methodologies, long-term intentions, and aforementioned factors should be discussed in detail to understand the customer's environment, retention policies, SLA, and DR environment.

2. Plan for the initial disk design. The size of the FalconStor VTL physical resources are calculated by taking into consideration the size of the total backup source (all data combined) and anticipating a deduplication ratio based on data type, change rate, retention, etc. This will provide a strong phase 1 estimate of the required size.

3. It is critical to understand that the benefits of data deduplication are realized over time. Initial deduplication ratios may be relatively low during the first few weeks of backup. This is normal since larger deduplication ratios are a factor of retaining data for longer time periods, combined with lower rates of changed data. These ratios will improve over time. FalconStor recommends recalculating the FalconStor VTL sizing once a significant subset of production backup data is sent to an IBM i. This will provide a more effective view of long-term deduplication ratios and a better plan for future growth.

By adopting an incremental approach, a backup administrator will be better able to forecast the space needed to sustain data growth. This method requires ongoing measurement that will help the administrator grow the system over time.

SUMMARY

Data is driving our world; information is becoming the new currency. While technology changes, data remains irreplaceable and a corporation's most valuable asset. But protecting that asset presents many challenges. IT budgets are flat or down, and data continues to grow at a rate of 50% to 60% annually.

Most IBM i installations continue to use tape, stockpiling and trucking data to tape silo centers. Furthermore, corporations are saving information for longer periods of time to meet regulatory and compliance requirements, and data is becoming more difficult to find and restore in a timely fashion. IBM i backup administrators face these challenges daily.

Adapting IBM i to the FalconStor VTL infrastructure allows customers to take full advantage of the product's deduplication, replication, and tape media management with encryption, with little or no disruption to backup operations. The FalconStor VTL solution is an ideal backup-to-disk target for IBM i backup environments, allowing organizations and their administrators to:

- Reduce backup storage requirements by as much as 95% through deduplication
- Meet defined SLAs for RTO and RPO requirements by retaining data on disk for longer time periods
- Reduce/eliminate tape expenses by extending disk retention policies
- Eliminate offsite tape management and transportation costs using secure electronic vaulting
- Meet regulatory and compliance requirements through encryption
- Improve resource management through a single platform for open systems, IBM i, and mainframe

For more information, visit www.falconstor.com/products/virtual-tape-library or contact your local FalconStor representative.

Information in this document is provided "AS IS" without warranty of any kind, and is subject to change without notice by FalconStor, which assumes no responsibility for any errors or claims herein. Copyright © 2018 FalconStor Software, Inc. All Rights Reserved. FalconStor Software and FalconStor are registered trademarks of FalconStor Software, Inc. in the U.S. and other countries. All other company and product names contained herein are trademarks of the respective holders. VTLWPIBMi052019

FALCONSTOR

Corporate Headquarters
701 Brazos Street, Suite 400
Austin, TX 78701
Tel: +1.631.777.5188
salesinfo@falconstor.com

Europe Headquarters
Rosa-Bavarese-Strasse 3
80639 München, Germany
Tel: +49 (0) 89.41615321.10
salesemea@falconstor.com

Asia Headquarters
Room 1901, PICC Office Tower
No. 2 Jian Guo Men Wai Avenue
Chaoyang District Beijing 100020 China
Tel: +86.10.6530.9505
salesasia@falconstor.com