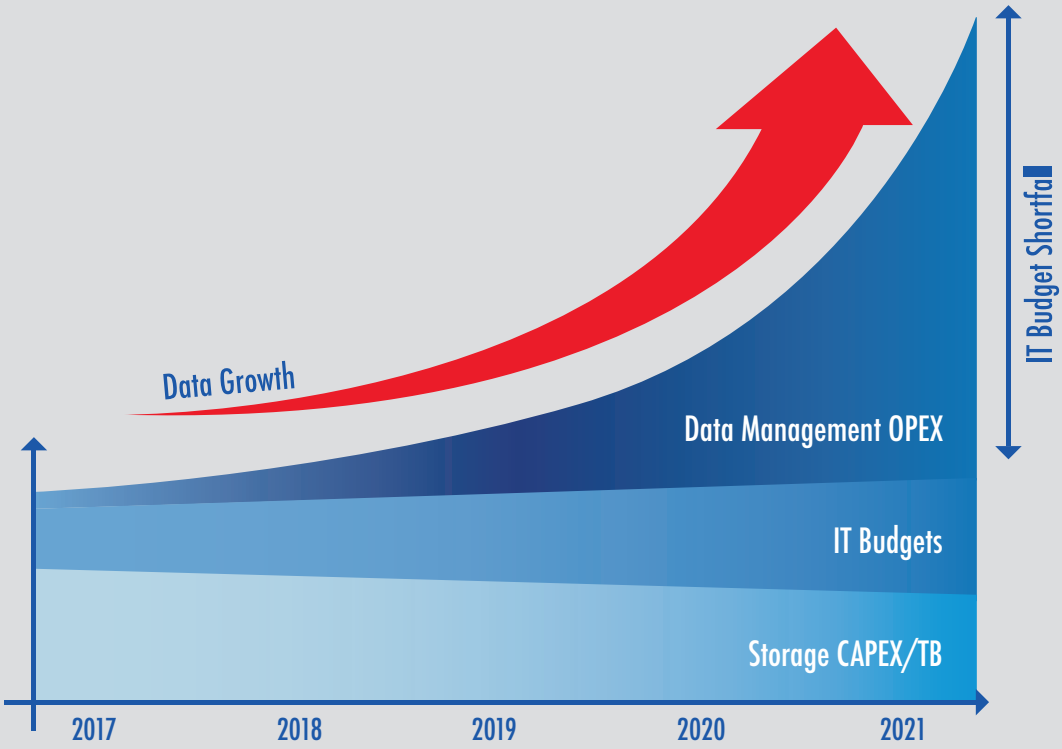
Innovative
Data Storage
Solutions

Active Archive

Drastically Reduce Storage Costs

QSTAR®
TECHNOLOGIES

Unstructured data continues to grow faster than storage budgets.



- E-mail
- E-mail with attached docs
- Faxes
- Graphics
- Instant Messaging
- Logos images
- Correspondence
- Personal Documents
- Business Contracts
- Contracts agreements
- PDF files

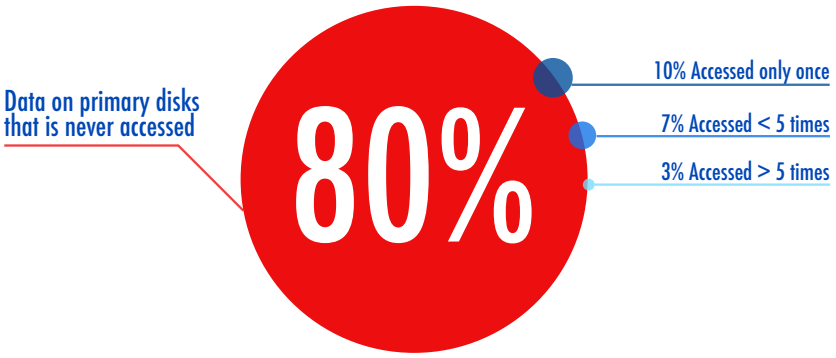
- Photos
- MS Office docs
- Procedures
- Scanned documents
- Social media content
- Multimedia
- Video
- Web data
- White papers
- Word docs
- Sales Documents

Future storage growth will push current storage infrastructures to the limit, making the rate of growth of data the IT Manager's primary concern, closely followed by data backup and disaster recovery.

Enterprise data is growing exponentially for any organization, it doesn't matter the reference market business and size, managing, storing and accessing that data is a constant and costly challenge. This is putting increasing pressure on legacy data center infrastructure that requires constant maintenance, expensive upgrades and continued investment.

At QStar Technologies we believe that managing massive data growth and reducing primary storage requirements, maintenance costs and associated backup requires a fundamentally new approach, using innovative solutions that are simple to implement and administer.

Continuing to add primary storage systems to manage increasing data volumes is not a cost effective long term solution!



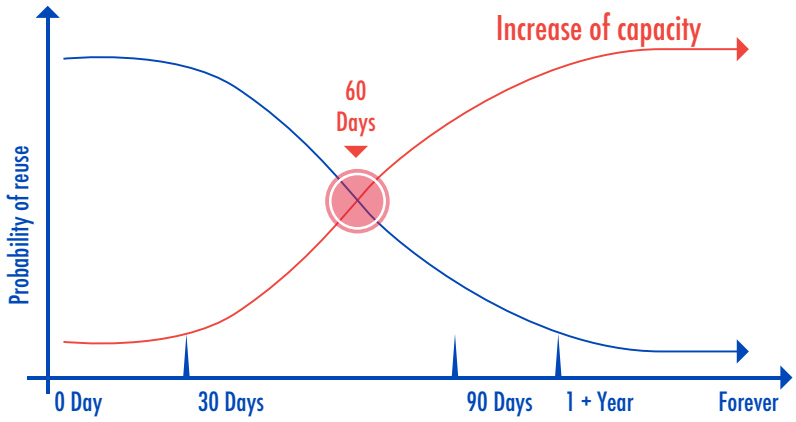
As we know, information quickly loses its worth over time, one year after its creation, more than 80% of data stored on primary disks or flash, is no longer accessed or will be only rarely thereafter.

In addition to these raw storage costs, most backup data – from 80% to 90% – is not changing, and probably will never change again, much of it will never be needed ever again. This data is generally just consuming storage space and slowing up the backup process.

But it is not over yet, these documents / files / data not used and not accessed from a long time, are also migrated over and again within new storage over the years! An aspect too frequently forgotten during cost–benefit analysis of storage consolidation.

This adds up to a huge waste of money and resources, a worrying scenario, especially for those wrestling with limited IT budgets and shrinking staff levels.

QStar can help businesses keep storage costs under control with a wide range of solutions for data management and archiving.



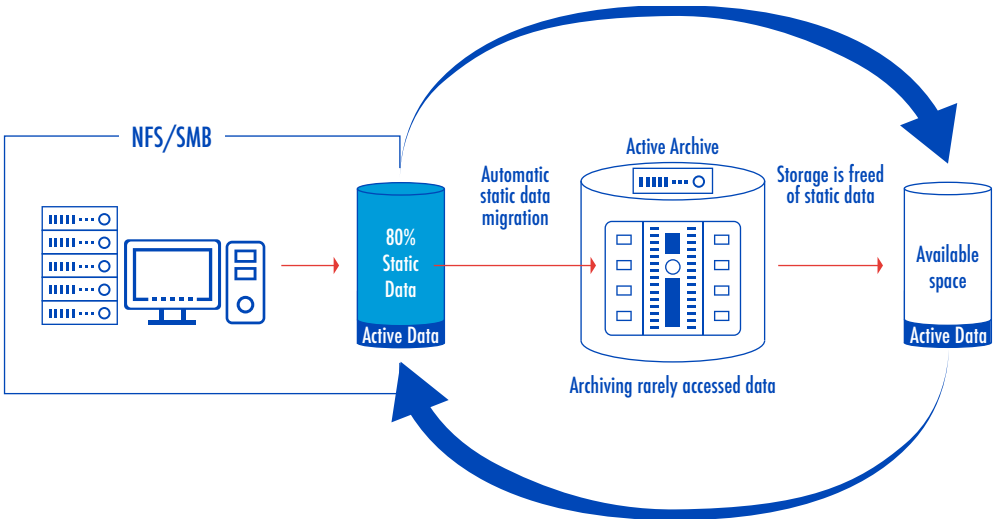
QStar Network Migrator

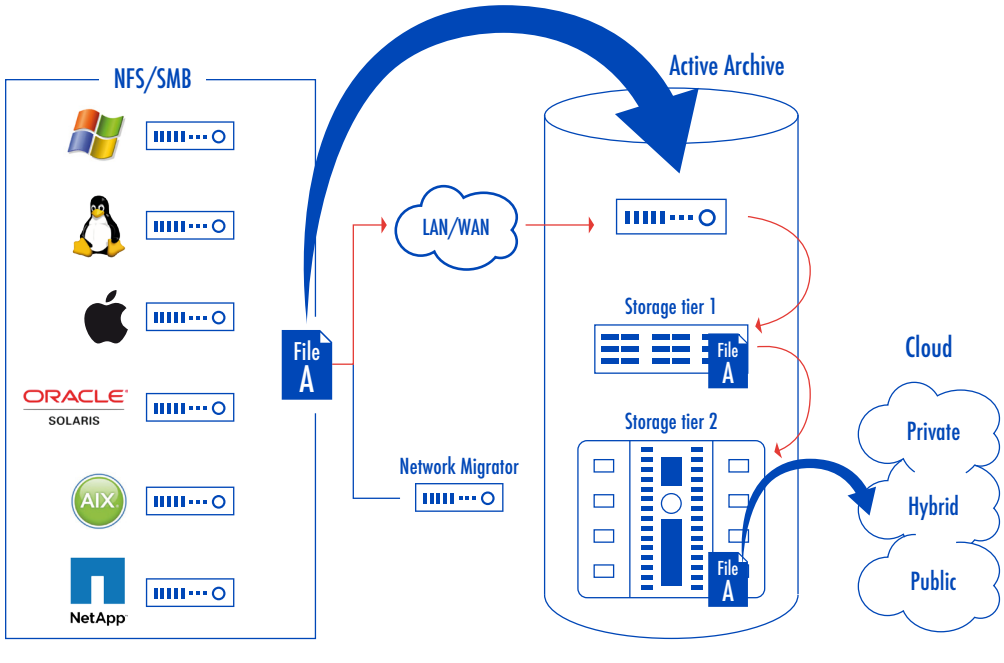
The QStar Network Migrator solution allows automatic migration of static files based on policies created using a combination of their attributes such as date created, modified, accessed, file owner, size and extension.

Establish a data lifecycle management policy – categorize data according to its importance and value, and how frequently it needs to be accessed. A large amount of data loses its importance with time, and is often required for record-keeping or compliance reasons; it will rarely be accessed and can be stored in a long-term archive.

Typically, data that has not been accessed in several months is migrated from existing primary storage infrastructures to lower cost storage such as a long-term archive solution, whilst at the same time it can perform real-time restoration of the data to its original location in a manner which is completely transparent to applications, users and network.

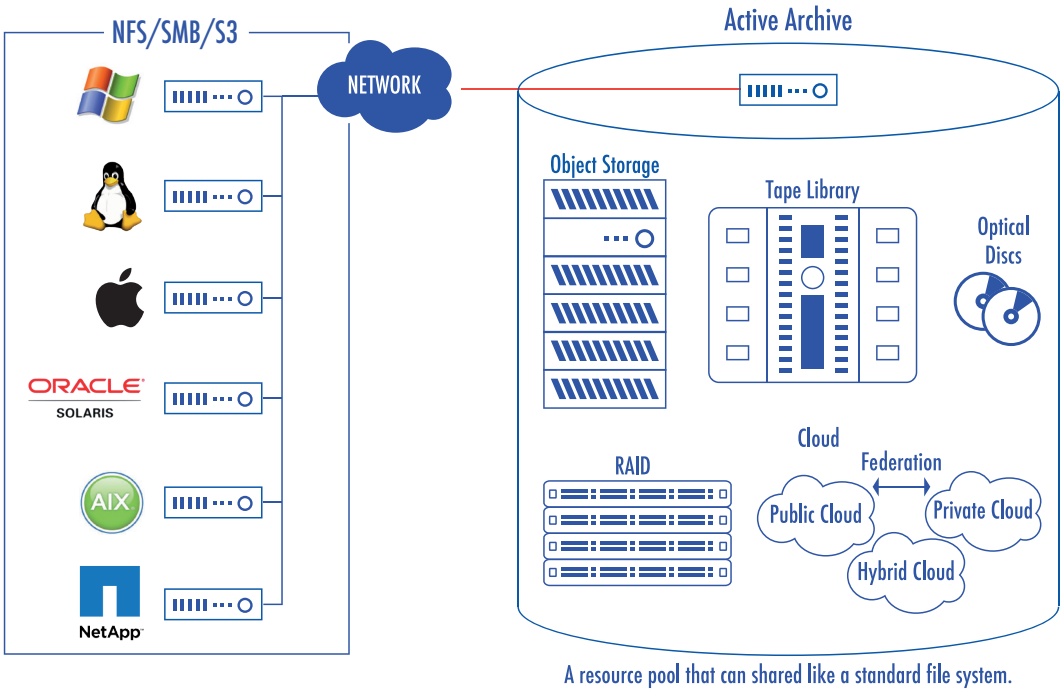
Files that are stored within an Active Archive environment are retrieved in the same manner as the native operating system, even though the data is actually stored in a tape library or other lower cost tier.





QStar Archive Manager

QStar Archive Manager software creates an Active Archive environment as a standard NAS based file system using NFS and SMB protocols or S3 based Cloud APIs. It combines a flash / disk cache with any archive storage technologies such as; Tape Libraries, Object Storage, Cloud Storage (Public, Private or Hybrid) or Optical Libraries.



What is an Active Archive?

An Active Archive is a secure, high-capacity storage environment that does not require separate backup processes.

The purpose of an Active Archive is to make all content available online or near-online (in the case of tape libraries) whilst leveraging low-cost storage.

It is a hybrid architecture that uses different tiers of storage (including cloud) to provide much lower storage costs than standard magnetic-disk or flash-based architectures.

QStar Storage Reporter

IT Managers from all sectors and sizes are charged with effectively managing their organizations data without having a clear picture of what that data is and often how valuable it is to their organization.

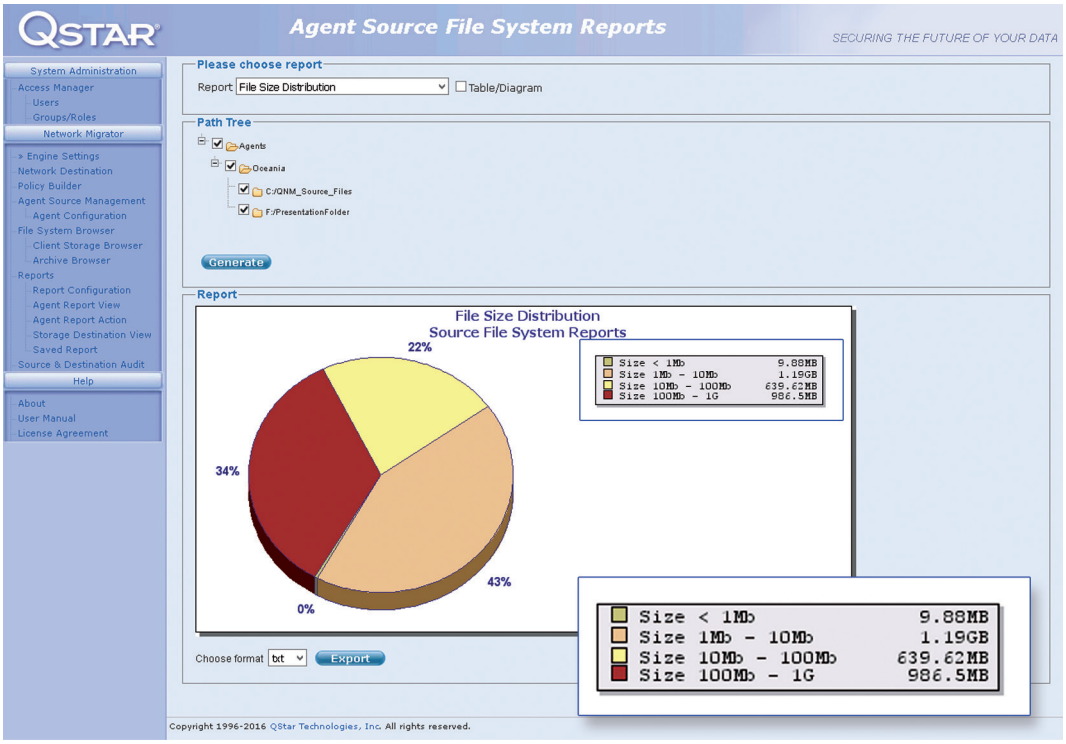
A key first step is to be able to identify rarely or never accessed data to enable key data to be scrutinized effectively. QStar Storage Reporter provides key statistics of existing storage infrastructures without interrupting business operations.

Storage Reporter will take just a few hours to perform an assessment of storage rather than the weeks normally required to carry out such a task.

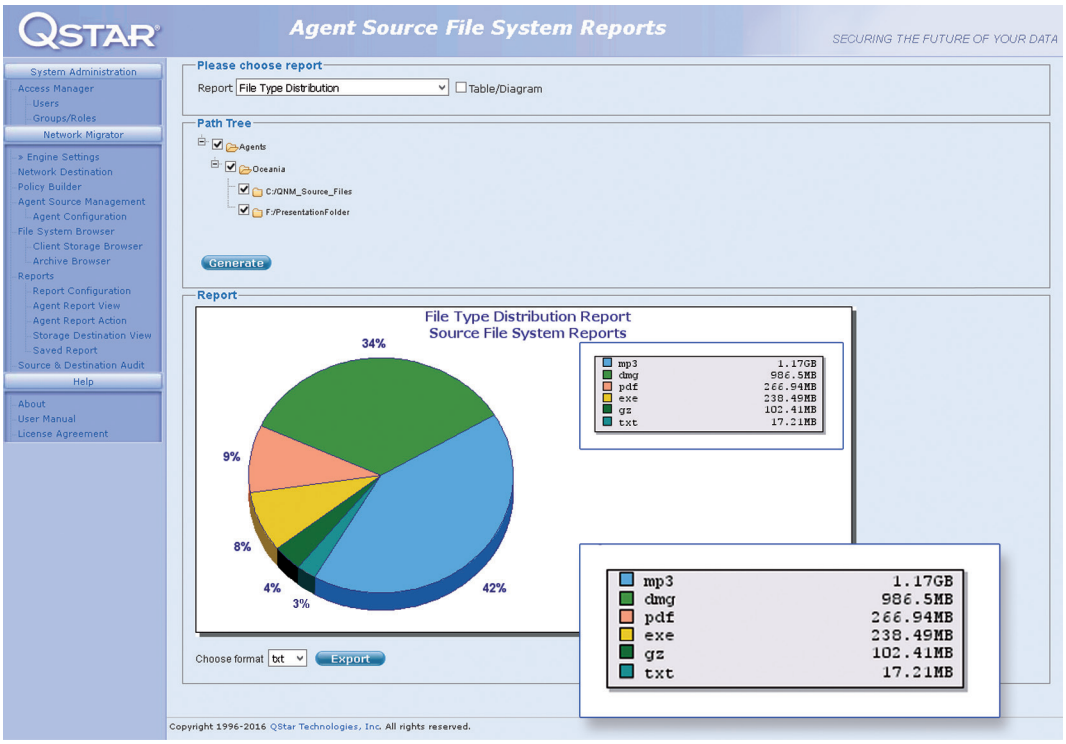
Storage Reporter is simple to install and run. Results of the scan are stored in a database, allowing many reports, like the ones below, to be generated without the need to rescan each time.

QStar Storage Reporter means that storage infrastructure optimization is really just a click away.

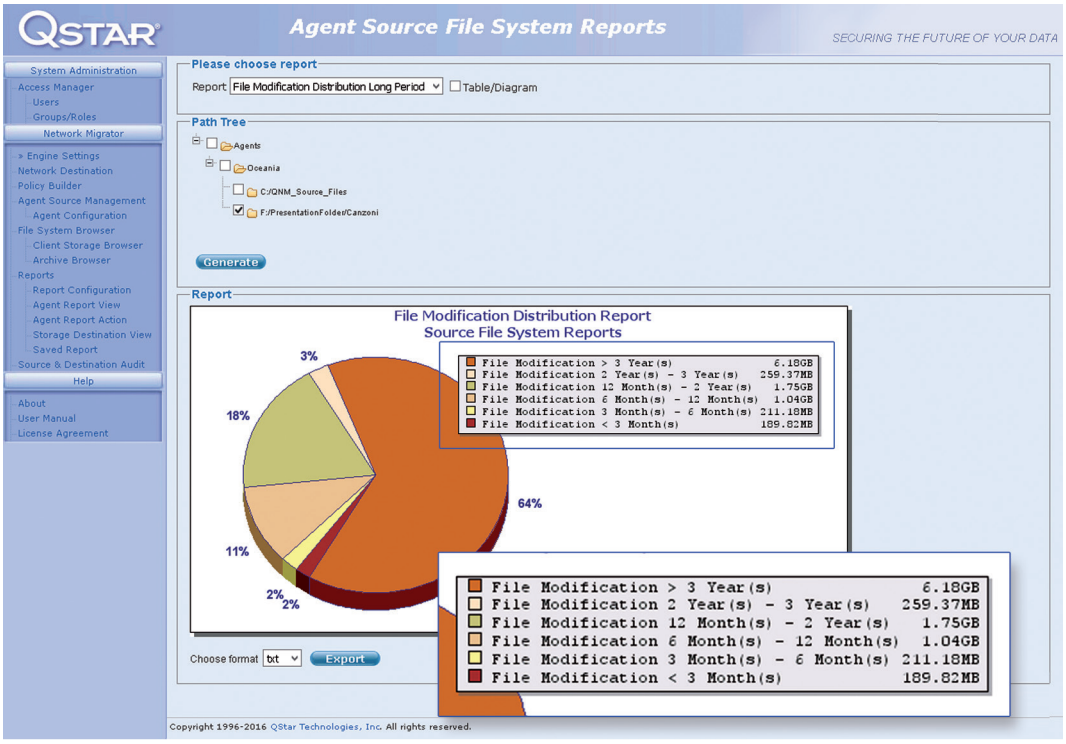
QStar Storage Reporter lets you perform detailed analysis of data composition in the existing storage infrastructure.



Example 1: The graph shows file size distribution, the increments can be varied to fit individual users requirements.



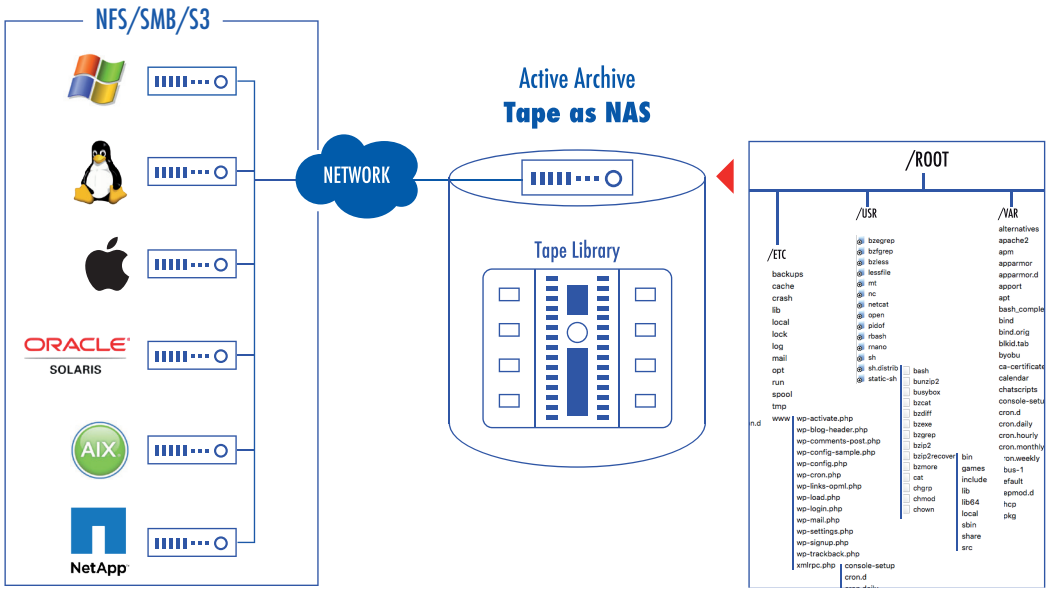
Example 2: The graph shows file type distribution across the primary storage environment.



Example 3: The graph shows how long ago files have been modified. A table can also be produced and downloaded via XML format.

Active Archive Tape as NAS Architecture

QStar's Archive Manager software is the basis for a "Tape as NAS" Active Archive environment. LTO and enterprise-based tape libraries provide the lowest cost form of archive storage. Total cost of ownership for tape is a fraction of that spent with disk-based storage systems.



They can reliably and cost-effectively archive data for years or even decades reducing operating costs dramatically (electricity, cooling, maintenance and capacity upgrades).

COST ANALYSIS: advantages of using a Tape as NAS solution compared to traditional disk-based archiving systems

PROS

- **Cost of Capacity** — 26-30 times lower than a disk array
- **TCO** — 50-290 times lower than a disk array
- **Storage** — 20-30 years for a tape-based archive
- **Error Rate Enterprise Tape** — 100000 times better than a hard disk (SATA)
- **Error Rate LTO** — 1000 times better than a hard disk (SATA)
- **Costs** — 3-5 times less when used to create DR sites

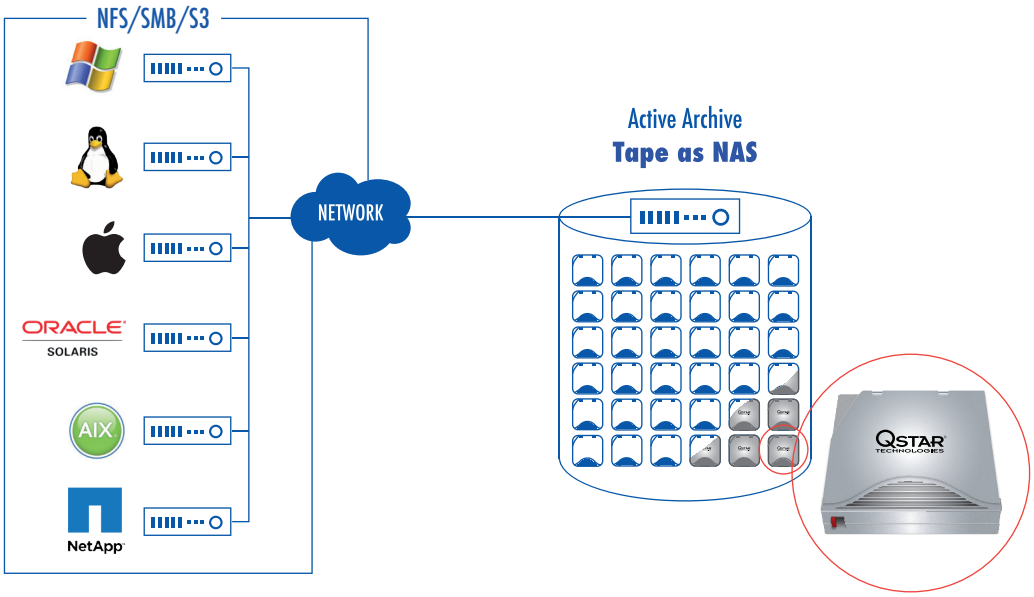
CONS

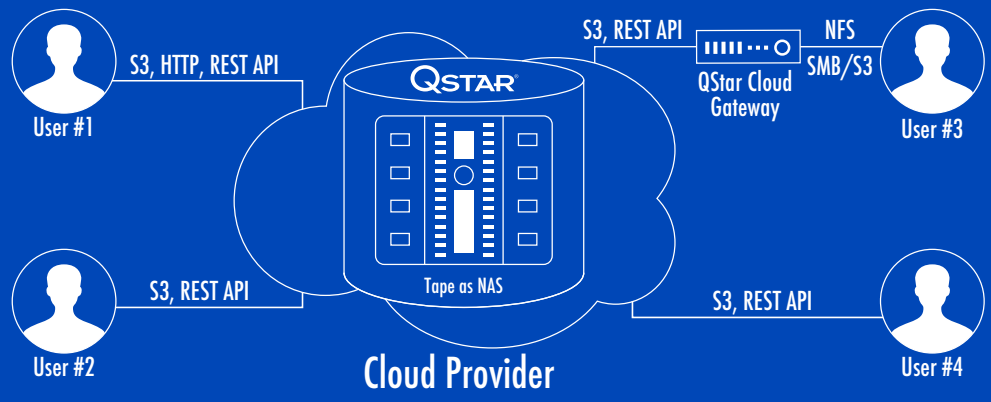
Data recovery

If the archived data is not cached as it hasn't been accessed for a long time, it will be necessary to wait a few seconds / minutes before it appears online.

QStar Archive Manager “Tape as NAS” architecture virtualizes a tape library, effectively converting it into network-attached storage for sharing with multiple users and applications. Users can browse the file system using Explorer type searches while “archive aware” applications, such as MAMs, Video Surveillance, Healthcare PACS, email archive, can archive data directly to a network share or mount and on to the tape library.

The solution supports common networking protocols (SMB and NFS) plus S3 compatible API commands and is integrated on either a Windows or Linux server.





The “Tape as Object Storage” employs the S3, REST API and HTTP protocols to write and read data within the tape library. It uses a hybrid architecture, comprising disks for the front-end and tape library for data archiving (tape as NAS architecture).

This solution was developed to offer a massive storage archive multi-tenant service at very low cost for Cloud Providers.
A ready solution, which does not need complex integration tasks, APIs are available for billing, provisioning, decommissioning, and several more.

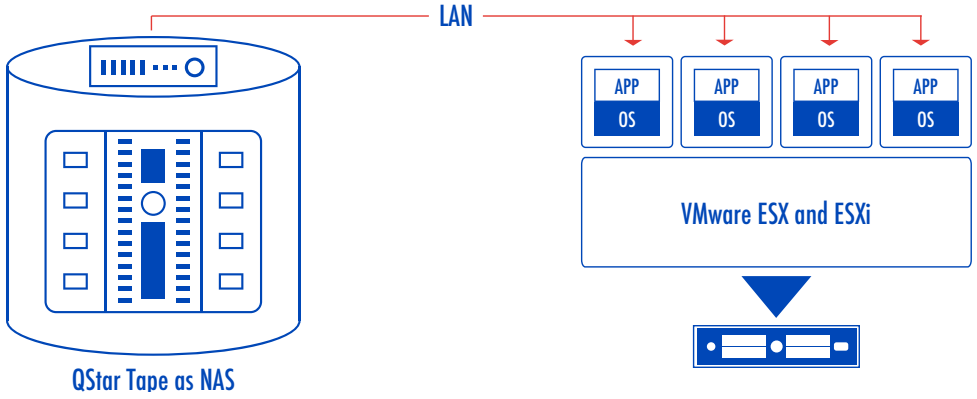
Files that are stored in a Tape as NAS environment are retrieved in the same manner as the native operating system, even though the data is actually stored in a tape library.

Not only do users fail to realise that the volume (file system) they are accessing was created on tape and not on disk, but, through a sophisticated cache architecture, the read/write data activity, is managed so effectively, that performance is comparable to a NAS device.

Transparency is such that the architecture is also supported by virtual machine (VM) environments, even though the VM environment is not designed to support tape drives; existing applications installed in a VM can access the Tape as NAS architecture just like a standard NAS disk. Data can be accessed transparently over the network.

"Access transparency as a standard file system is such that QStar Tape as NAS architecture is also supported by virtual machine (VM) environments such as VMware, Microsoft Hyper-V, Citrix XenServer, Oracle VM and KVM, even though the tapes and tape libraries are not handled natively by the virtualisation systems".

Tape as NAS solution integrated in a VMware environment



Tape as NAS: high data read/write performance

Tape libraries using the latest LTO-8 or enterprise class drives have exceedingly fast transfer rates (LTO-8 supports 350MB/sec native transfers) so stream writing or reading can be as fast as NAS disk solutions.
The tape library's Achilles heel is cartridge insertion/removal, in this case, the time required to access information depends on two main factors:

- whether or not the tape containing the information you want to read is in the drive.
- whether the track containing the information is close to the drive's reading head.

In order to overcome these critical points and make a tape library an exact match to a NAS system, QStar has developed sophisticated architecture that allows data caching even when reading.

The QStar solution offers simultaneous writing of files to both the volume (cache disk) assigned to the cartridge pool and the tapes in the library. Duplicate copies of data are created on the volume (cache disk) and cartridges. How long the data remains cached is determined by specific policies.

This technique allows users and applications to read archived data immediately, understandably the cache disk needs to be of sufficient size to keep online only that data required to stay there for a certain period of time (audits of old invoices, legal contracts requiring examination, project reviews, etc.).

It is possible to set a threshold for the time data remains inside the cache memory and if exceeding such threshold the oldest, most inactive files are removed from the cache (clearly all data is already archived on the tapes regardless of what happens in the cache). The system administrator will set the cache retention period and threshold parameters.
Specified files or elements of files can be retained permanently in disk cache. Index files or parts of a video file that help create proxies (low resolution images of video content) can be retained in cache removing the need to recall data from tape and improving workflow.

The future of archive storage is (still) tape!

In this document we will pay particular attention to Linear Tape Open (LTO) technology and Linear Tape File System (LTFS), open standards for tape drives and media and tape file formats. In addition to the LTO format, QStar Tape as NAS solutions also supports enterprise-class tape drives and libraries, namely, IBM TS11xx and Oracle T10000x. Please see product literature for the relevant technical specifications.

Generally speaking, when choosing an archive technology, besides specific technical features, it is also important to consider its market penetration to avoid being left with an out-of-date or, worse still, discontinued product in the near future.

LTO technology not only guarantees a market approved standard, but also offers a wide choice of manufacturers for media, drives and tape libraries. No other current storage technology can provide such a guarantee for the future. LTO drives are manufactured by IBM, HP and Oracle and media by Fujifilm, HP, IBM, Imation, Maxell, Oracle, Quantum, Sony and TDK.
With tape libraries, a large number of manufacturers offer architecture and capacity designed to meet all operational requirements.

Another important aspect of this technology is the guaranteed compatibility between different generations of products; the LTO standard provides backwards read compatibility with two previous versions, for example an LTO-7 drive can read/write LTO-6 media and read LTO-5 media.

Turning to LTO of the future, the roadmap (see below), has been set out as far as version LTO-10 with an impressive media capacity of 50 TB raw and 125 TB compressed.

LTO Roadmap

	LTO - 3	LTO - 4	LTO - 5	LTO - 6	LTO - 7	LTO - 8	LTO - 9	LTO - 10
Shipment Year	2005	2007	2010	2013	2015	2017	TBD	TBD
Native Capacity	400 GB	800 GB	1.5 TB	2.5 TB	Up to 6 TB	Up to 12 TB	Up to 24 TB	Up to 48 TB
Compressed Capacity	800 GB	1.6 TB	3.0 TB	6.25 TB	Up to 15 TB	Up to 30 TB	Up to 60 TB	Up to 120 TB
Native Transfer Rate	80 MB/s	120 MB/s	140 MB/s	160 MB/s	Up to 300 MB/s	Up to 350 MB/s	TBD	TBD
Compressed Transfer Rate	160 MB/s	240 MB/s	280 MB/s	400 MB/s	Up to 750 MB/s	Up to 875 MB/s	TBD	TBD

Each new generation will guarantee read and write compatibility with the immediate prior generation.

Bit Error Rate (BER) LTO vs Disk

Device	Hard Error Bits Rate	Equivalent in Bytes	Equivalent in PB's
SATA Consumer	10E14	1.25E+13	0.01 Petabyte
SATA/SAS Nearline Enterprise	10E15	1.25E+14	0.11 Petabyte
Enterprise SAS/FC	10E16	1.25E+15	1.11 Petabyte
LTO and some Enterprise SAS SSD/s	10E17	1.25E+16	11.10 Petabyte
Enterprise Tape	10E19	1.25E+18	1110.22 Petabyte

In addition to capacity and performance, LTO technology also provides industry leading data reliability.
On average, Petabyte's of data can be read before encountering an error.

The ideal data-retention solution

From a single drive to tape libraries, LTO technology plays an important part in medium and long-term data retention strategies and Information Lifecycle Management (ILM).

There are many reasons that currently make LTO technology the ideal storage solution; there are the technological aspects of the medium, those regarding the tape library's popularity and those associated with its user-friendliness and cost-effectiveness.

We can also add aspects of no lesser importance such as the future development plans for LTO technology, compatibility with almost all currently-available hardware platforms and operating systems, interoperability, technical support and investment protection.

Linear Tape Open technical specifications

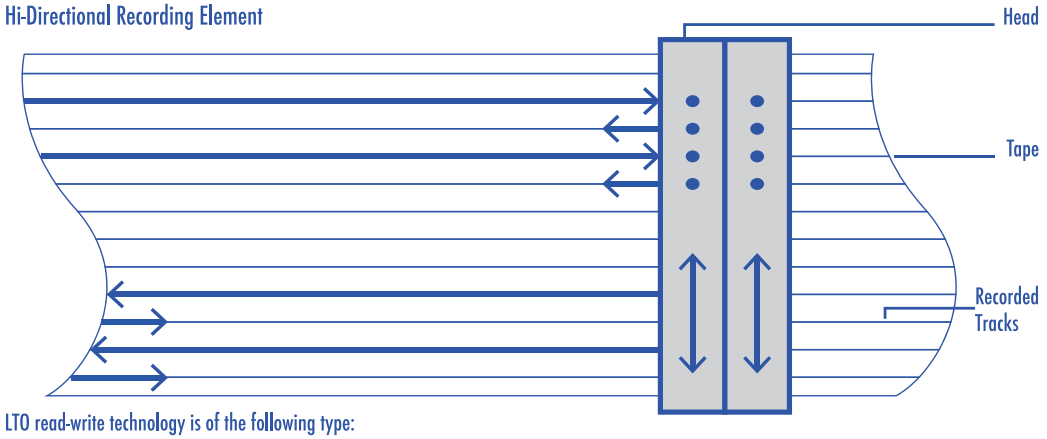
Technology developments continue at a rapid rate in tape and specifically LTO technology. Improvements in the recording mechanisms, increased capacity, higher data integrity, plus mechanical durability and reliability.

An LTO tape is ½ inch wide and passes longitudinally across the tape drive head without touching it, from the beginning of the tape to the end; recording until the tape is fully unwound. Following this media is rewound, writing to an adjacent area on the tape, creating a kind of serpentine pattern.

Attached to each read/write head are two sensors that allow very precise head positioning to the relevant data areas using service tracks on the LTO media.

In order to guarantee a high level of protection, the tape edges (most liable to suffer mechanical damage) are not used for recording. The read/write system utilises multiple magneto-resistive heads that change polarity each time the tape is wound in a different direction.

After recording, data is immediately checked by the reading head for real-time correction of potential errors.



LTO read-write technology is of the following type:

- **Bidirectional**, the tracks are recorded alternately in one direction and then the other;
- **Linear**, data is recorded longitudinally along the entire length of the tape;
- **Serpentine**, at the end of the tape a new parallel track is started in the opposite direction.

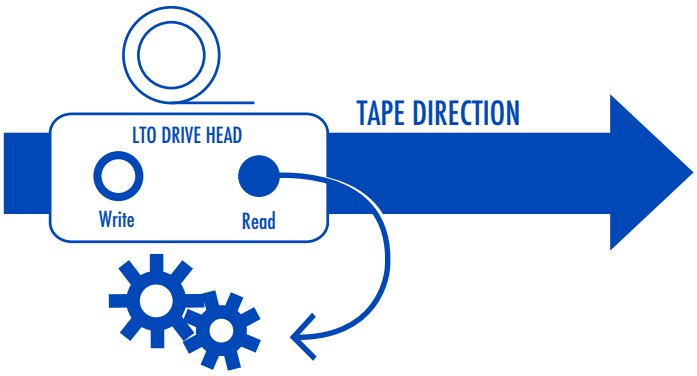
LTO technology, a paragon of reliability

Linear Tape Open (LTO) is a standard introduced in 1998 and jointly developed by IBM, Hewlett-Packard and Seagate with the aim of bringing the concept of open standards and multivendor compatibility to the tape market (as well as providing high reliability, scalability and performance levels).

LTO tapes guarantee an archival life exceeding 30 years, support a million "passes" and 20,000 write cycles per tape and an MTBF (Mean Time Between Failure) of 250,000 hours at 100% duty cycle.

Block-level CRC:

LTO drives perform an on-board data check after every write operation in order to guarantee that every piece of data is correctly written to the tape.



The various types of data integrity verification also include block-level checksum and CRC (cyclic redundancy check) performed directly by the LTO drive.

LTO drives perform on-board data verification of each write operation to physical tape; the LTO drive head is engineered so that each block written to tape is reread in real time by another section of the same head. This makes it certain that data written to the medium (tape) is correct, in addition to this check, each block undergoes a CRC in order to identify a unique numeric value for that particular file block.

During reading operations, these CRC values are also used to detect and correct any errors. If using the QStar proprietary file system (for further details see page 19), an additional checksum is carried out on fixed-size objects within the files. Checksums are calculated for each object and automatically checked upon each reading operation.

Exceptional long-term reliability and integrity for data archived in tape libraries

Besides the media manufacturer's guarantee as to the long-term (30 years) integrity of data recorded on the medium (tape), QStar recommends media copying or replication operations to further protect archived content. It addition we implemented more levels of verification for the integrity of data recorded on tape, thus guaranteeing that archive data can always be read even in the case of damage, wear and potential corruption of the magnetic media, by means of scheduled scanning operations to check integrity by reading specific data inserted when writing the data for each individual file.

Data integrity can be checked by using a hashing functionality, an algorithm that as a function of the writing of data of variable size, it generates a fixed-length "fingerprint" for the data added. This operation is performed for each file archived and the hash determined by the mathematical operation is then stored in the archive along with the file. The use of hash algorithms to check data is available for both the LTFS and TDO proprietary file systems. SHA1, SHA256 and SHA512 hash algorithms can be utilized.

Hashes are recalculated and compared during scheduled scanning to check media integrity. If a hash does not compare during verification, the associated file is marked as "bad" and another copy of the file (security copy) will be retrieved in real time in order to replace the corrupted one. In order to restore the correct number of copies, the second (or third) copy of the retrieved file will be made on a new medium.

LTO-8: superior performance to hard disks

Some vertical markets, such as video or high performance computing, require extremely high sustained transfer rates due to very high capacity data sets, often in multiple Petabytes. LTO-8 offers higher performance levels (350MB/sec Native) than the market's fastest hard disk.

In order to properly compare disk and tape it is important not to be misled by some published specifications (technical specifications are not always complete – for example write speed is often omitted).

There is an appreciable difference between the declared BUS data transfer rate and the effective one, i.e. at which the heads can actually write continuously to the surface of the disk's internal platters before filling the on-board cache of just a few MBs (64-128 MB). A hard disk with 12 Gbit/second SAS interface and speed of 15,000 RPM offers a write data transfer rate of around 148 MB/second.

Two high-performance hard disks are required to obtain the same data transfer rate as a single LTO-8!

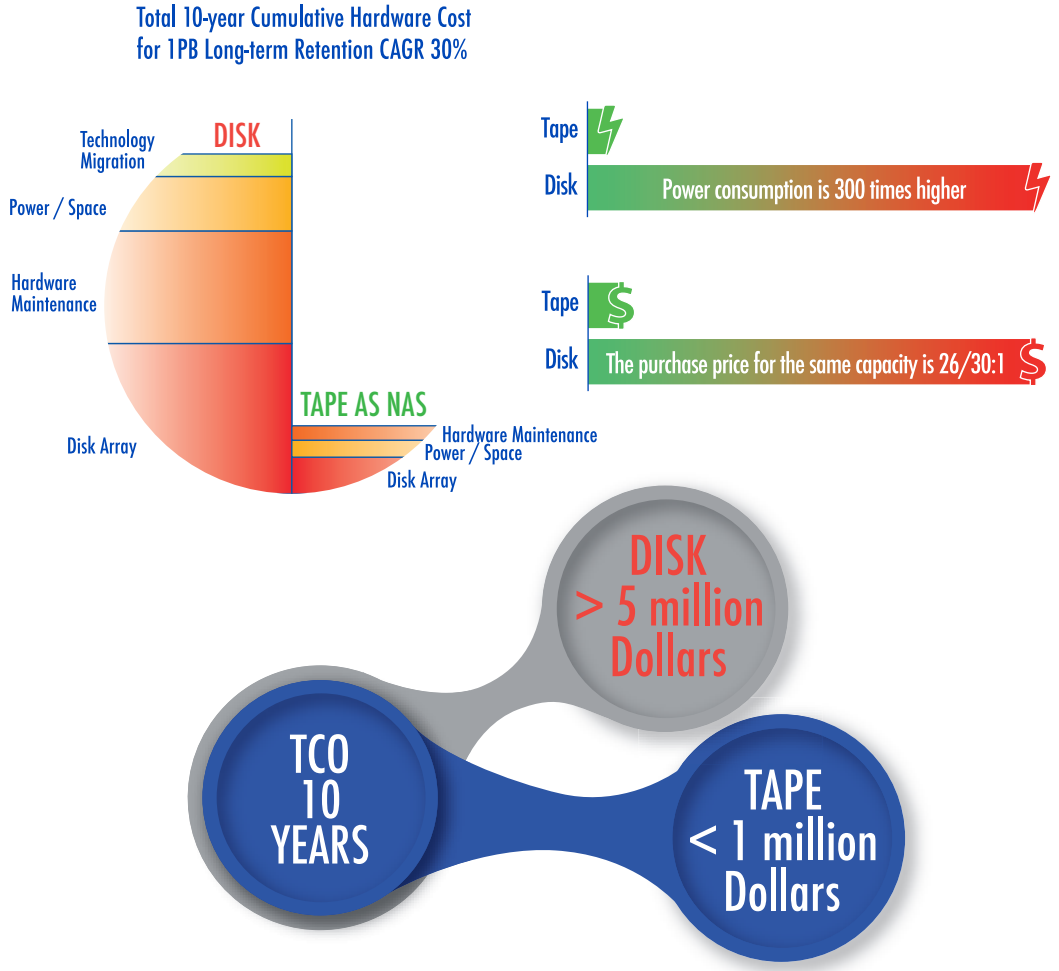
On the other hand, the data transfer rate for LTO drives does not vary between read and write, while for hard disks, as we have seen, write speed is almost halved (approx. –40/45%).

Of course in reality multiple disk drives will be used in an Array and multiple tape drives will be used in a tape library (see page 21). Tape drives can be dedicated to specific read or write operations (unlike disk) allowing for excellent performance tuning for both information retrieval and online archiving operations.

LTO-8 drive specifications

- Capacity: 12 TB, 30 TB compressed 2.5:1
- Data transfer rate: 350 MB/second, 875 MB/second compressed
- Data compression: SLDC (LTO data compression per ECMA-321)
- Available data cartridges: LTO-8 rewritable, LTO-8 WORM
- Backwards Compatibility: read / write LTO-7 media (previous generations could read two generations back)
- Interface: 8 Gb/s Fibre Channel (auto-negotiates to 4 Gb/s or 2 Gb/s); 6 Gb/s SAS (auto-negotiates to 3 Gb/s)
- Encryption: AES256-GCM (256-bit Advanced Encryption Standard)
- Reliability Specifications: Mean time between failures (MTBF): 250,000 hours at 100 percent duty cycle
- Mean swaps between failures (MSBF): 100,000 tape load/unload cycles

Tape libraries: best cost/TB and life cycle the storage market currently has to offer



Today's tape libraries provide the lowest cost form of storage in terms of both initial acquisition cost ($/TB) and running costs: electricity, cooling, operations & maintenance and technology refresh.

Aside from the clear financial benefits, a tape-based data archive offers an exceptionally long data life: data can be securely stored for decades provided that the tape is handled correctly in accordance with the media manufacturer's recommendations, thus guaranteeing an archive life exceeding 30 years, if stored at a temperature of 20 C°.

Suitable areas for tape technology

Tape backup VS deduplication

- Deduplication has no effect for images, log files, compressed files and encrypted files (waste of storage space and CPU cycles), tape is strongly recommended for such files.

Archiving

- Archive large volumes of data easily.
- Retain data for long periods of time at very low cost.
- Avoids to backup data that is not used for month and years.
- LTFS format.

Long-term retention

- Simple policy based data migration.
- Easy data access.
- Extremely long life of the library compared to disks / RAID.
- LTFS format.

Tape as NAS

- Simple file system usage.
- Very low cost for TB.
- Scale - out storage architecture. Retain data for long periods of time.
- LTFS format.

Tiered Storage

- Simple policy based data migration.
- Easy data access.
- Easy migration to the cloud.
- Storage optimization.
- Backup window reduction.
- LTFS format.

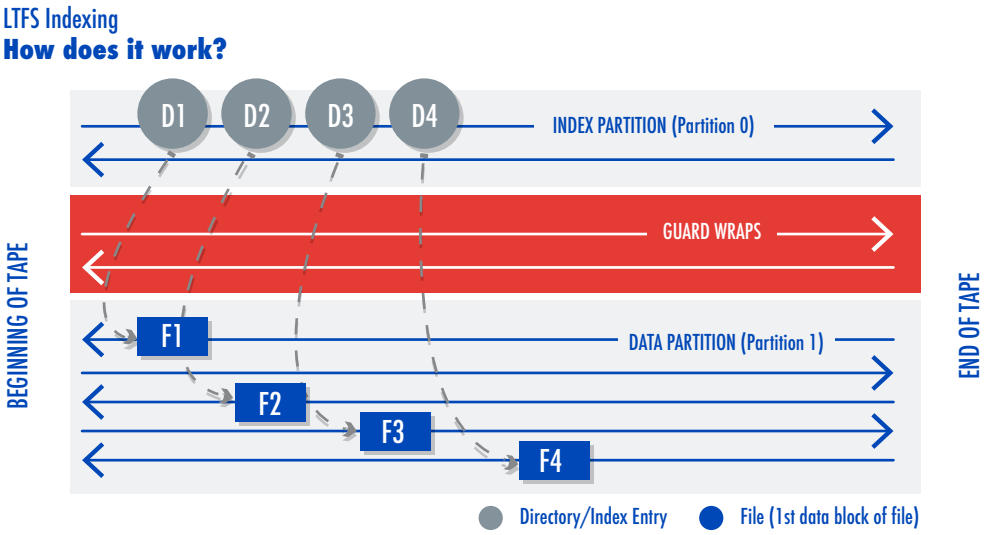
Cloud

- Long term data retention.
- Very low cost for TB.
- Very low TCO.
- LTFS format.

Linear Tape File System – LTFS

The increased popularity of Active Archive tape-based architecture was driven by the introduction of the Linear Tape File System (LTFS) standard initially introduced with LTO-5. **The LTFS format complies with standard ISO/IEC 20919:2016**. The format guarantees media interchange between operating systems and different archive system manufacturers who have adopted it.

LTFS divides the tape into two separate areas known as partitions, one for metadata (file information such as name and size), and the other for storage of the data itself. When an LTFS tape is mounted, the partition containing the metadata is read and the catalogue of contents becomes available to applications.



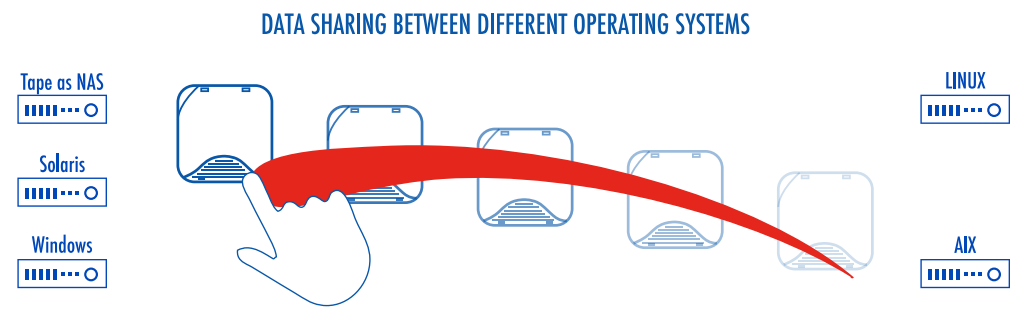
Transferring recorded media between different operating systems

The QStar Tape as NAS solution can import LTFS media created outside of the main archive, e.g. from a remote site or another manufacturer who has adopted this standard. LTFS media can be imported in order to be:

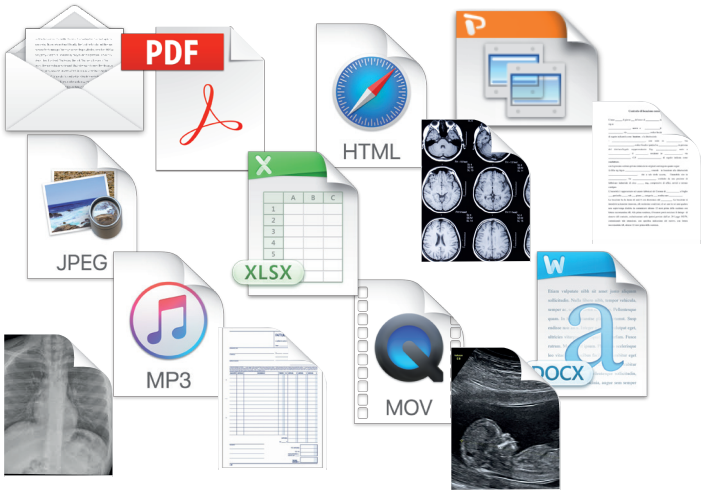
- transferred between different remote sites, the data can be copied to the allocated Active Archive Tape as NAS and then returned to the field for reuse
- stored in the Active Archive Tape as NAS as a separate element of the archive

Likewise, LTFS media created within the environment can be exported and read by other solutions based on the same LTFS standard.

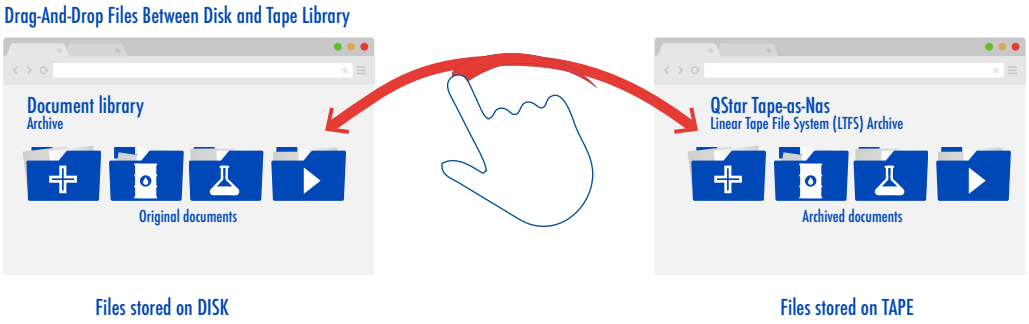
The key advantage of the LTFS standard is the option of transferring recorded media between different operating systems, applications and platforms that employ this format so that the tape can be used just like a removable disk drive, you can even drag and drop files from folders on the server to the tape using a standard Explorer-type operations.



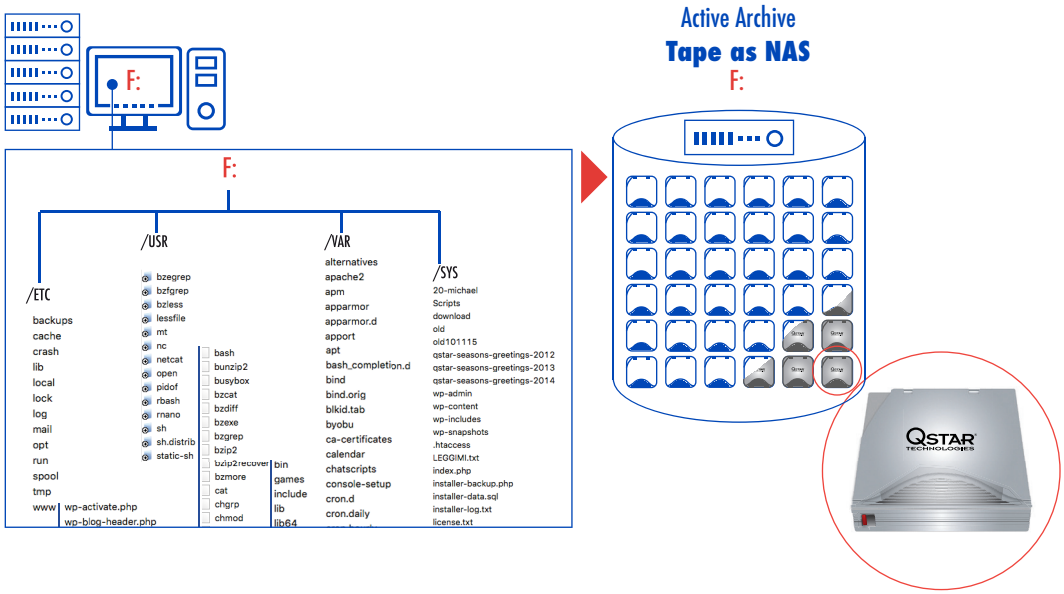
LTFS technology is an ideal archiving solution for production data, files, e-mails, Word documents, legal contracts, invoices, technical documentation, regulations, manuals, projects or works requiring retention, videos, photos, audio files, presentations and web pages, Oil & Gas exploration images, Cloud applications, Media and Entertainment Production, Post-Production, digital video surveillance archives, storage of medical images, X-rays, scans and much more.



LTFS is a tape file system proving read/write interoperability between different operating systems, applications and platforms that implement this format.



Volume-Spanning LTFS



QStar has significantly enhanced LTFS functionality by including the Volume-Spanning option long before its market competitors; this function can combine all media contained within a tape library as one or multiple volumes.

Basically, all media in the tape library can be made to appear as a single (or multiple) share(s) or mount(s) capable of growing in size automatically as new data is archived, a fully automatic and unattended process.

This approach not only removes the complexity of handling hundreds or thousands of volumes assigned to each single medium, but also does away with the manual cartridge selection process.

LTFS offline media management

File location information is stored in an internal database on the cache. All files, even for those no longer in the library following a media export, can be discovered.
Should a user or application request the exported files, the system will automatically notify the storage administrator by email, providing the barcode details of the cartridge containing the required files.

Media within the spanned volume can be removed from the tape library and will continue to appear in the shared / mounted volume, provided that the extended retrieval times in question can be tolerated.

Volume Spanning with QStarTape/Disk Object (TDO) File System

QStar developed a proprietary file system using Volume Spanning to manage tape libraries almost a decade before the current LTFS format was introduced. In some respects, the TDO file system does offer certain advantages over the LTFS format. Unlike the latter, a single file can be spanned across two different media (File Spanning).

Performance is slightly improved as media formatted with TDO does not use multiple partitions. TDO and LTFS file systems can coexist within the same tape library, if required.

Each integral volume database developed by QStar remains on the cache and stores information about all activities for each individual archived file, including all replicated or copied locations.

In order to guarantee data integrity, the database is written periodically to each tape media in the integral volume. Should the cached database or server be destroyed or become corrupted, the entire database can be quickly reconstructed by reading the last cartridge in each media set and rebuilding each integral volume.

	LTFS	TDO QStar format
Open standards (portability)	Yes (governed by ISO/IEC 20916:2016)	No
Files can span multiple tapes	No, files cannot be spanned with standard LTFS 2.2	Yes, QStar fills tapes to capacity before advancing to the next tape in the set.
WORM media support	No	Yes
Limitations on filename length and allowed characters	Yes	No
File size sensivity	Performance favors large files (GBs)	No file size sensivity
Block replication support	No	Yes
File replication support	Yes	Yes

Data redundancy

The Tape as NAS environment requires no external backup, it protects archived data by making multiple media copies for use in the event of disaster. Should, for any reason, a file on primary media (retained in the library) become unreadable, other copies of the damaged file will be automatically requested and used, perhaps sending email requests to the Administrator to retrieve a copy from a local fire safe or offsite store.

Media integrity scans can be used to periodically ensure data on primary media is still accessible and remedial steps taken (see page 14).

Automated media copy

The Media Copy function lets you create one of more identical copies of the media in the tape library and is run when the tape (medium) you want to copy is full. This operation can also be scheduled for off-peak times. As a rule, these copies are then exported from the library and stored in secure locations. (see page 25 - “3-2-1 Best Practice”)

Incremental copy

The Incremental Copy function writes to a second copy to secondary media at scheduled intervals (typically at night).

This allows all available tape drives to be used for standard read/write operations during peak hours. Incremental copying then copies only the data that has been added to the primary copy that day.

Once both primary and secondary media copies are full, it is recommended that the secondary copy be exported and stored in a secure location.

Multiple incremental copy

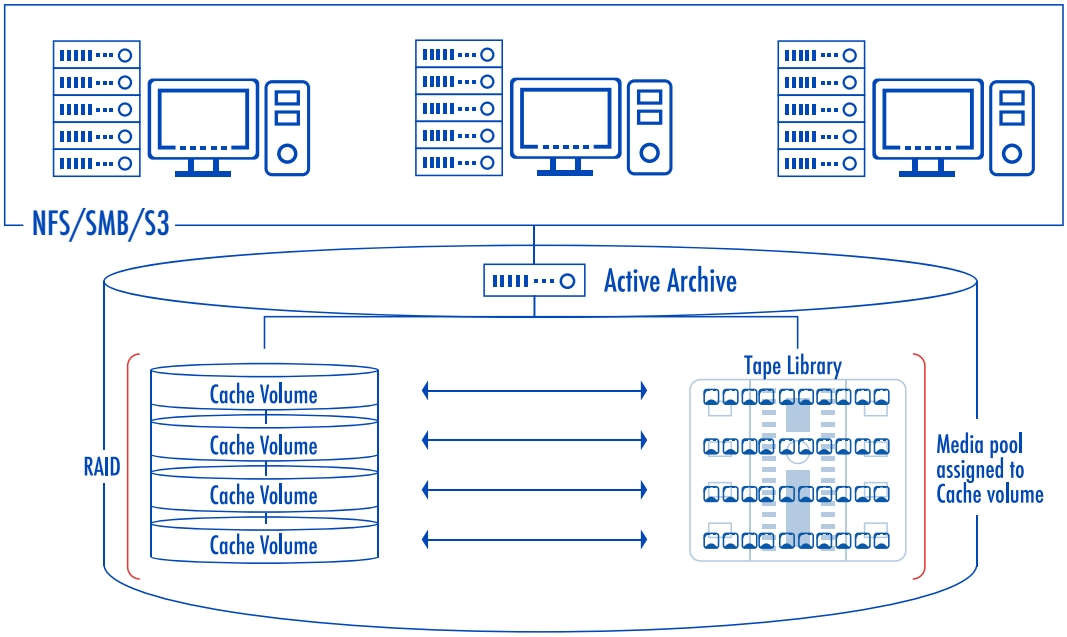
The Multiple Incremental Copy function works just like Incremental Copy, the difference being that it makes several incremental copies that are rotated in and out of the tape library.

This function offers a further level of protection, the copies can be frequently exported, thus restricting the risk in the event of disaster.

Overview of cache memory architecture

The Tape as NAS solution incorporates a sophisticated architecture for data caching during both read and write operations. The cache disk is an important element in the implementation of a high-performance Tape as NAS environment. The architecture's performance is comparable to that of enterprise-level NAS.

The cache disk is assigned to a media pool and recognized by the network as an SMB or NFS share or mount point.



To ensure high performance, the cache disk data transfer rate needs to be double that of the LTO drives installed in the tape library. The cache is performing two operations (a write then a read) for every single write to tape. A 350MB/sec sustained transfer rate for an LTO-8 drive will require at least a 700MB/sec cache. It is important to also consider the speed of the network to which the solution is connected as this should also match that of the architecture.

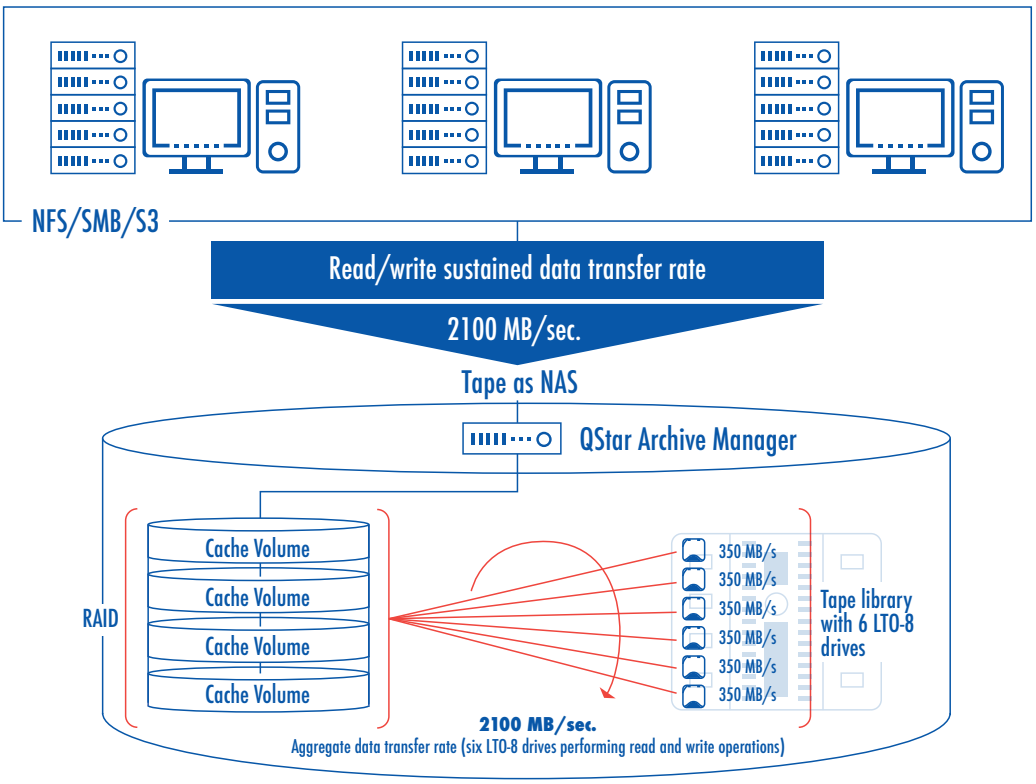
For higher data transfer rates than a single tape drive can handle, it is possible to configure multiple cache volumes assigned to a media set as shown in the figure above. Tape drives will be automatically allocated to either read or write operations.

Before being recorded or read by the tapes, all data passes through the cache memory. For this reason, cache performance has a big effect on general system performance.

The choice of appropriate cache technology should be based on specific operating requirements. QStar solutions can handle cache volumes created using RAID, Disk Array, SSD and Flash systems or a combination of these technologies.
SSD or Flash technology is a valid alternative to disk array for all those applications requiring high performance during data read/write operations.

Regardless of the technology chosen, the cache disk must employ redundant architecture to prevent data loss in the event of failure.

Choosing the tape library's internal LTO drives



The tape library should be equipped with a suitable number of LTO drives capable of supporting high data transfer rates (TB/hour) for both write and read purposes. For higher access environments we recommend the use of multiple LTO drives in order to boost performance during tape read/write operations.

As already noted, the write process used to copy data to tape takes place after it has been written to the cache disk. This operation is controlled by administrator policies.

Data archiving policies can be scheduled to handle heavy or light workloads, for example, you can specify how full the cache is before writing data to tape. This can delay writes to tape when read operations should be prioritized.

Data retention policies

To prevent files in the archive from being accidentally or deliberately deleted or overwritten, the Tape as NAS solution supports Retention Management that can set all files and metadata to read-only status for a predetermined period of time.

A retention time is created for each integral volume at the cache level. Once this time has expired, the cached data and metadata is returned to standard read/write status and can be deleted.

All tape technologies (including LTO) do not allow deletion of individual files. Tape as NAS does not allow direct access to the tape media, content is seen (and therefore protected) at the disk cache level.

In order to handle the sequential nature of tape, the solution offers a retention scheme based on each media set. All files in a specific volume and media set will have the same retention scheme. Data is written sequentially from tape (1) to tape (n) of the set, where the oldest files are on tape (1) and the most recent files are on tape (n).

Expiry of the retention period for these files occurs in the order in which the files were written. Following expiry, all the files on tape (1) (oldest media) are marked as “deleted” and therefore the media can be reused for new Active Archive content.

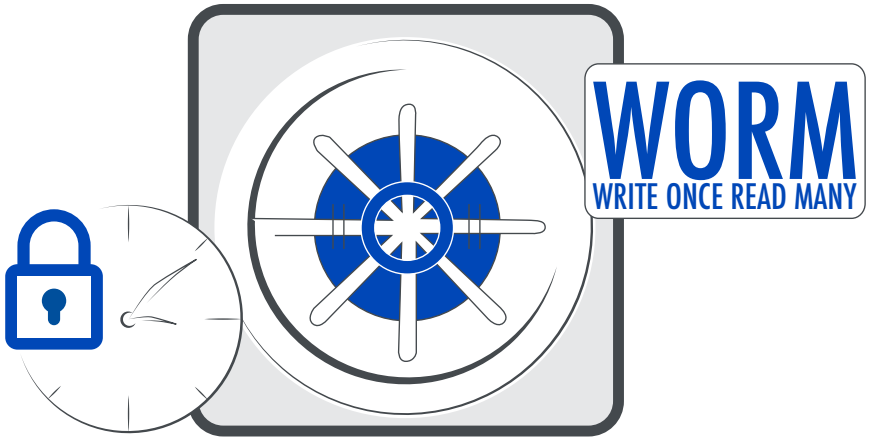
Based on customer archiving requirements, multiple retention periods can be used by creating multiple integral volumes and media sets. For example, volume 1 could have a 7 year data retention scheme and volume 2 a 25 year retention scheme.

The architecture offers an environment specifically designed to ensure the maximum security and integrity for archived data. In this respect, the solution itself can handle migration of archived data from the library to new media, as well as perform continuous archived data integrity checks in order to ensure long-term readability.

WORM technology (Write-Once, Read-Many)

WORM technology can archive data in non-rewritable, non-erasable format; using this method, recorded data can no longer be overwritten, modified and/or manipulated.

It is possible to purchase WORM media for LTO tape or to use QStar’s WORM functionality.



The WORM protection process offered by QStar complies with the strictest national and international regulations covering sensitive data archiving, document management, electronic record storage and log file archiving. The solution guarantees secure, legally-admissible, long-term retention of archived data due to its full compliance with statutory requirements.

This solution allows you to enjoy a sizeable reduction in data archiving costs by also using the existing storage infrastructure. Indeed, the WORM function can be applied to any volume and LUN managed by QStar Archive Manager. The WORM function is completely transparent to applications and users.

A retention period is established for each volume, depending on specific needs, this period can expire after a certain numbers of months or years, or set never to expire - permanent retention.

As soon as a volume is committed to WORM state, files in that volume are automatically locked and they cannot then be modified once written.

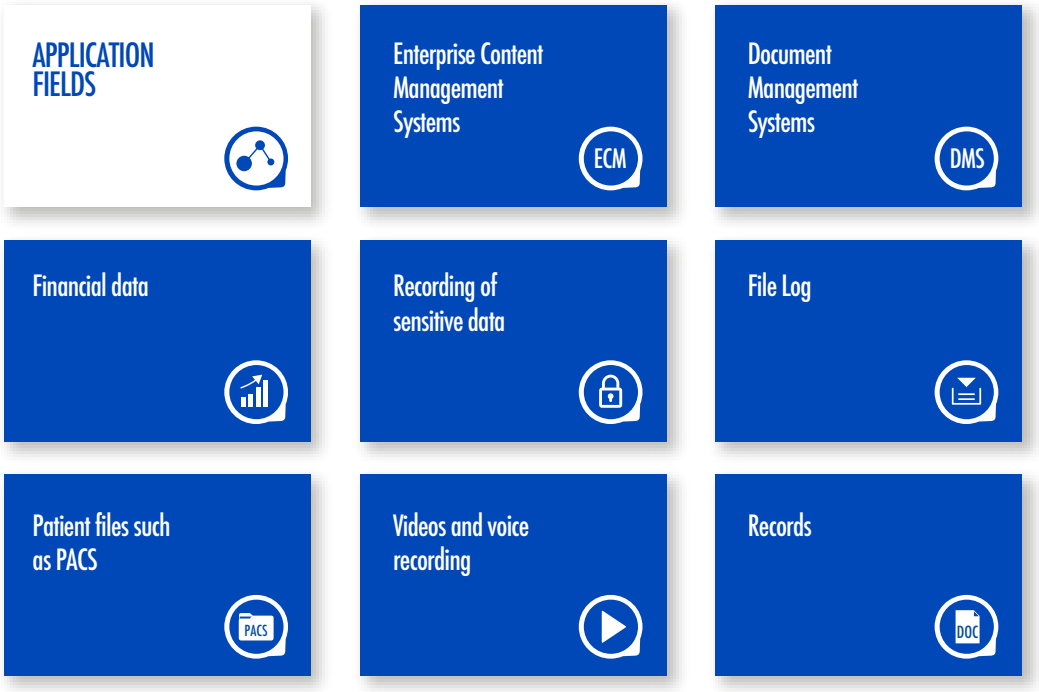
A grace period can be set which is the time before conversion of a file from rewritable mode to non-rewritable (WORM protected).

In addition, when using QStar's TDO tape format, the WORM solution efficiently archives very large numbers of small files (hundreds of millions) without suffering performance loss, an essential requirement when archiving log files created by IT systems.

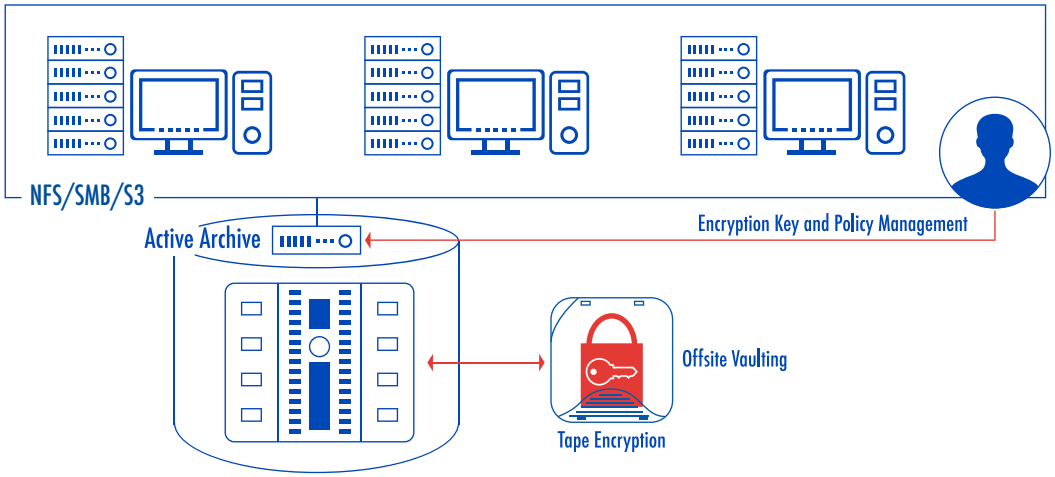
Log files are increasingly important to show traces of incoming and outgoing activities such as in the field of communications. Log files of the network service provider, of the provider hosting the website that the user is browsing, of access to the mailbox, generated by cells allowing a mobile phone location to be tracked, etc.

An examination of log files allows you to trace a person who has performed certain operations using the IT and telecommunications tools at his/her disposal.

Upon expiry of the data retention period, files can be securely deleted.



Inactive data security using “Data at Rest Encryption”



“Data at rest” is a definition used to describe all data in storage; this therefore excludes all data residing in temporary memory (RAM), data to be read and/or updated and that traversing a network. The meaning of data at rest can also include files that have not changed or are modified only rarely.

Data at rest may also refer to data that is regulated but not subject to change. Examples include all important files stored on company disks, the servers of a SAN network or files on service provider servers such as for off-site backup and of course Active Archives.

LTFS tapes used as part of an Active Archive are by definition easily transported and read by multiple solutions on multiple operating systems. Encryption is a key element in preventing unauthorised access to this information. Using this method, cartridges can only be read by those in possession of the correct decryption key.

Active Archive Tape as NAS primarily uses the encryption option provide by tape drives. Encrypt and decrypt operations are automatically undertaken as part of the tape write or read operation. There is no overhead to using tape drive encryption as each tape drive includes a specific encryption chip to undertake these operations. QStar recommends all tape media that contains confidential information be encrypted.

Until recently, all encryption key management systems used their own proprietary procedures. Today tape libraries mainly encrypt data using Key Management Interoperability Protocol (KMIP) Specification that is governed by the Organization for the Advancement of Structured Information Standards (OASIS). Using the KMIP Specification, guarantees a key management procedure conforming to a market-approved standard and offering maximum protection for encrypted data.

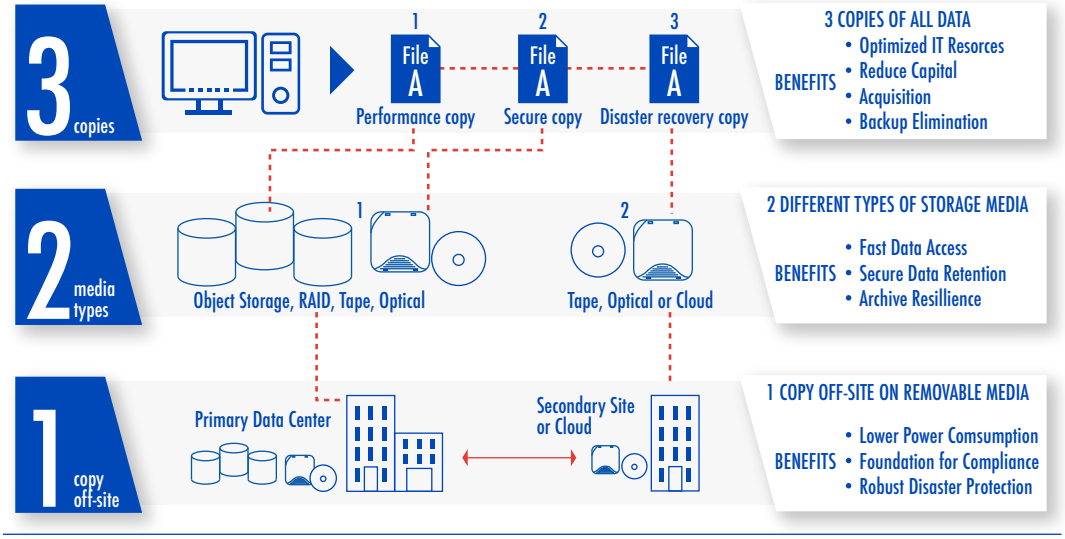
QStar provides an encryption option as well, although this is typically only used for non-tape based archives, such as archiving to Cloud storage.

QStar 3-2-1 Data Protection Best Practice

The 3-2-1 Data Protection Best Practice involves making three copies of the data on two types of media with one of those copies stored offsite.

Designed and developed by QStar Technologies, this technique is internationally acknowledged as one of the top data protection best practices and is used to protect sensitive data by numerous government agencies in the United States.

QStar Active Archive protects data without backup by ensuring all data is available in at least one additional place (preferably two additional places). Archive Manager can create these three copies, using a single archive technology (tape or Cloud only).



To support multiple archive technologies, QStar developed Archive Replicator, an enhancement of Archive Manager that allows replication of data to up to four different types of storage technology (choosing from Tape Library, Object Storage, Cloud, Optical Library or Disk Storage).

The archives may be grouped together at a single site or dispersed to separate geographical locations. Archived data is replicated and written synchronously to each of the stores employed.

Another Archive Manager enhancement is Data Director, which employs physical synchronous block-level mirroring technology using its proprietary TDO media format (normally between two identical archive technologies – such as two tape libraries) and ensures that data is continually written to two storage systems located within a single or geographically-remote site(s).

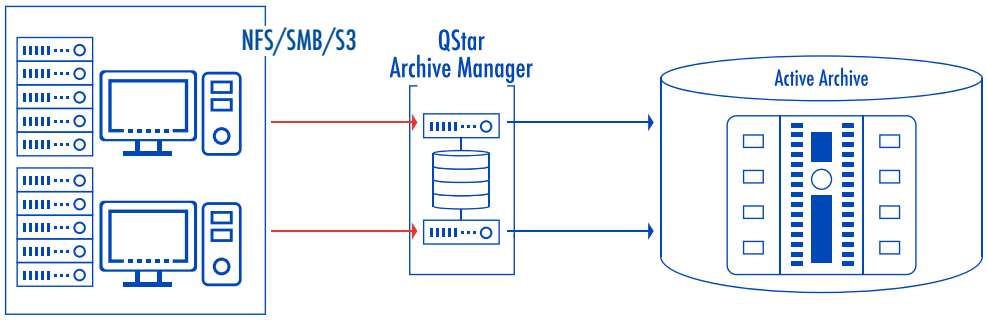
QStar understands that individual organizations have unique requirements for their data. By offering advanced feature options such as data replication, real-time mirroring, file encryption and digital signature, additional levels of security can be added for their archived data protection in order to create an extremely secure, disaster-proof environment.

QStar Archive Replicator offers synchronous file-based data replication to different types of storage technology, local or remote.

QStar Data Director performs synchronous block-level mirroring to a local and remote sites.

High availability architecture

Cluster architecture



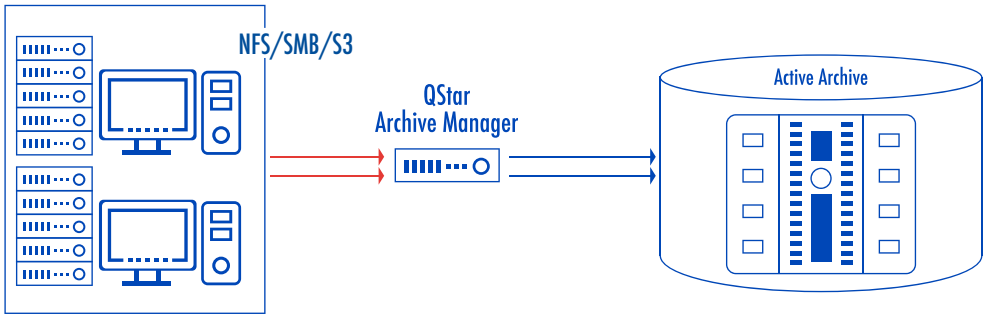
Active Archive Tape as NAS was developed for enterprise environments where access to information has to be guaranteed even in the face of unplanned downtime.

In order to guarantee the service, the system can be configured to control two clustered nodes in order to create a highly resilient environment.

The two nodes can be created using both Linux and Windows clustering. Should the primary server fail, the secondary server assumes its identity and respective IP address.

In this configuration, the cache disk and tape library are shared by the two clustered servers using switches.

Fault Tolerant Architecture with 99.999% uptime for critical business applications



In addition to the above clustering option, whose connection to the services offered will drop for a short time when a fault occurs, while servers reboot, the Fault Tolerant Active Archive Tape as NAS solution guarantees continuity of service with minimal interruptions.

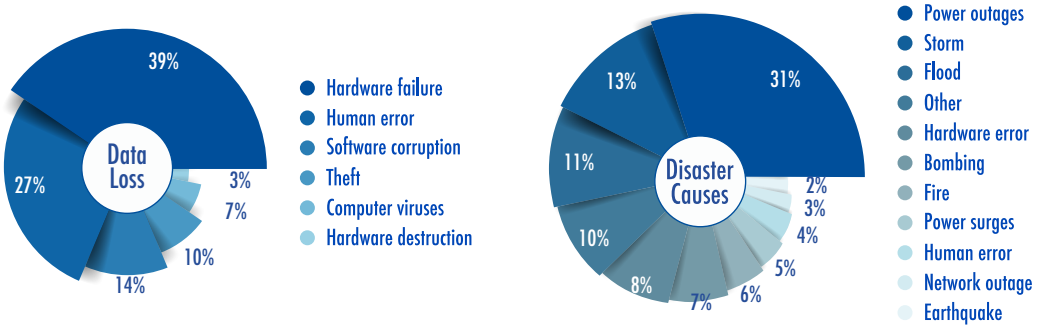
This architecture is designed for all applications that cannot afford a single moment of failure.

The solution is based on architecture designed to guarantee an availability of 99.999%, or, on average, less than 5 minutes of unplanned interruption per year.

Availability rate	Unavailability time on an annual basis
99%	3 days and 15 hours
99,9%	8 hours and 48 minutes
99,99%	53 minutes
99,999%	5 minutes

Disaster Recovery Architecture

Flexible, cost-effective Disaster Recovery Architecture without lock-in



Duplicating data in different geographical locations is the safest way of ensuring business continuity in the event of disaster, even though this is the most cumbersome method.

This requirement, that in some cases has also become a legal obligation, forces businesses to not only acquire and run another expensive infrastructure for the secondary site, but also incur additional running costs for its upkeep (energy, air conditioning, maintenance, upgrades, etc.).

QStar lets you drastically reduce the cost of setting up a disaster recovery site using architecture designed to guarantee data integrity and business continuity at a fraction of the cost of conventional architecture produced for such purposes:

- long-term data integrity (10-30 years)
- highly-competitive acquisition costs as compared to similar solutions built using disk-based systems
- sizeable reduction in running costs (70-80% compared to disks)
- open platform with no lock-in

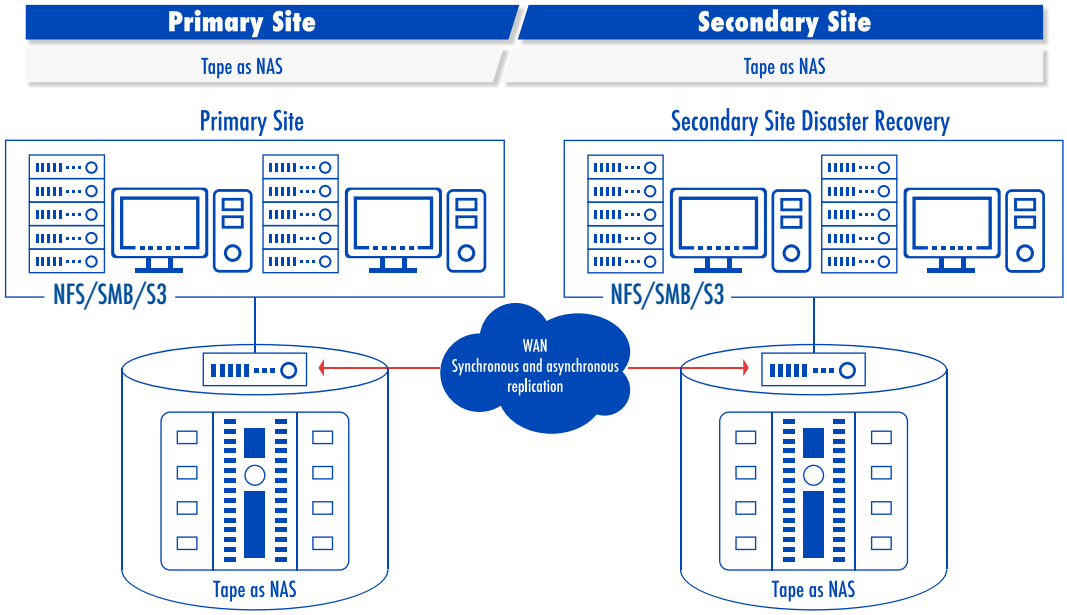
Architecture and configurations available for implementation of the DR site

Method of data replication to DR site

Primary Site	Secondary Site
Tape as NAS	Tape as NAS
RAID	Tape as NAS
Object Storage	Tape as NAS
Active Archive Cloud Gateway	Private or Public Cloud

Both block-level and file-replication data mirroring to the DR site are available. Block-level mirroring is carried out by the QStar Data Director software module using the QStar proprietary file system. Using the LTFS (linear tape file system), file replication is carried out by the QStar Archive Replicator software module. Block-level mirroring enables much faster alignment between remote sites provided of course that the connection is up to such task.

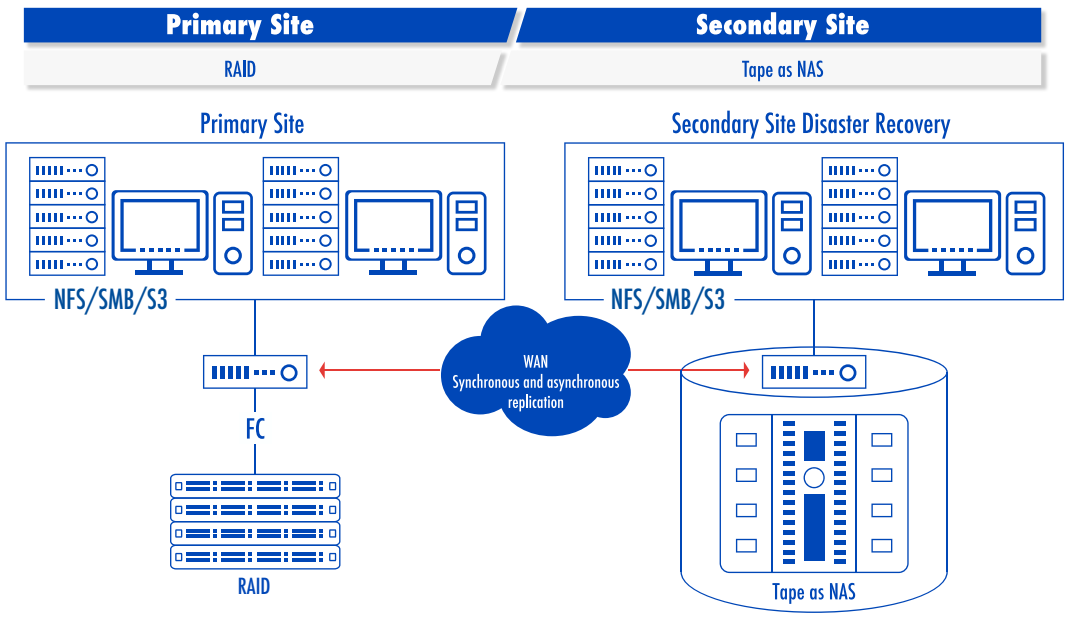
If your connection is too slow, the architecture is designed to incorporate a WAN accelerator capable of boosting data transfer speeds without the additional cost of a bandwidth upgrade. In the long term, this will produce significant savings.



The online capacity of the secondary site's Tape as NAS configuration does not have to match the online capacity of the primary site.

The secondary library may have fewer slots and drives, whilst media may be periodically removed (exported) and stored in a secure, offline place, even though remaining virtually online.

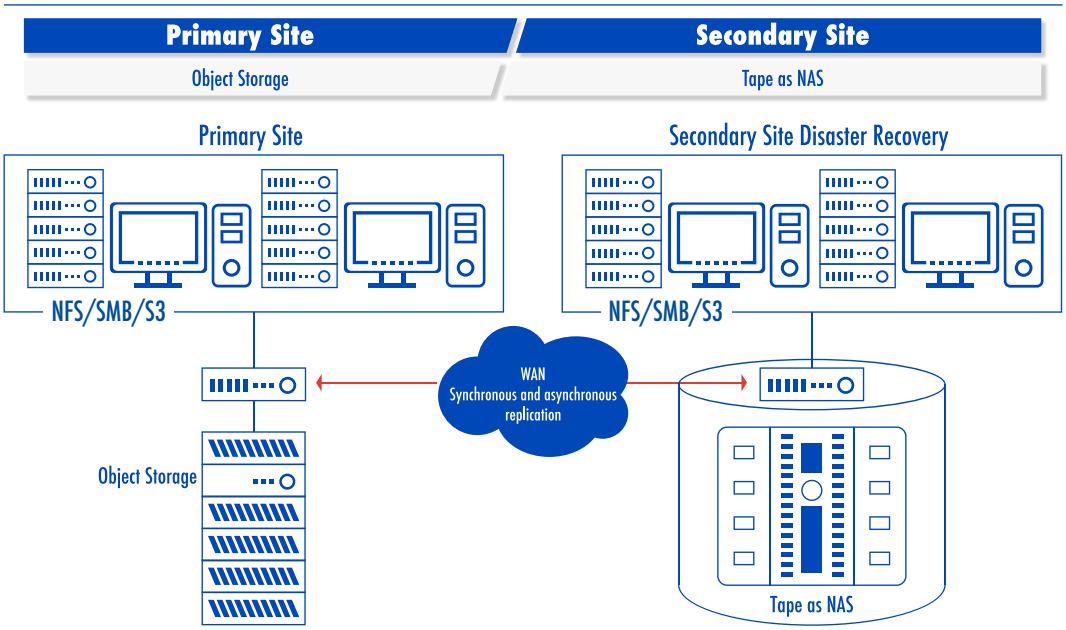
When using Data Director, employing block-level mirroring, the same tape technology, is the only requirement (same drive model). However for Archive Replicator using file replication, the libraries can use different technology, e.g., Oracle T10000X or IBM TS11XX drives on the primary site and LTO drives on the secondary site.



Another option could use part of an existing storage infrastructure at the primary site.
The configuration envisages using the space of a RAID volume by configuring a LUN as virtual tapes.

Each virtual tape should have the same capacity as the DR site's physical medium (e.g.12TB for LTO-8).

The proprietary file system allows synchronous mirroring between the two sites.
For Archive Replicator tape emulation is not required, replicated file based writes can occur to a NAS RAID and LTFS-based tape library.

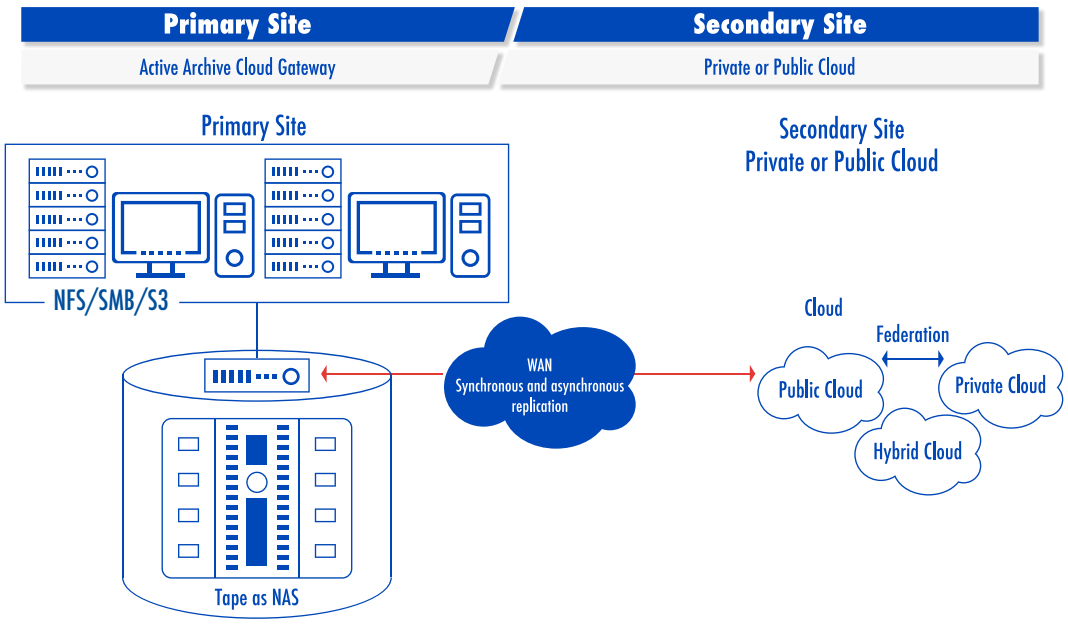


The above option shows the Tape as NAS solution with Object Storage systems.

Object Storage systems are configured to hold a predetermined number of replicated copies. Planning ahead, some organisations require an additional copy on tape due to possible future migration issues and often stipulate use of the LTFS format.

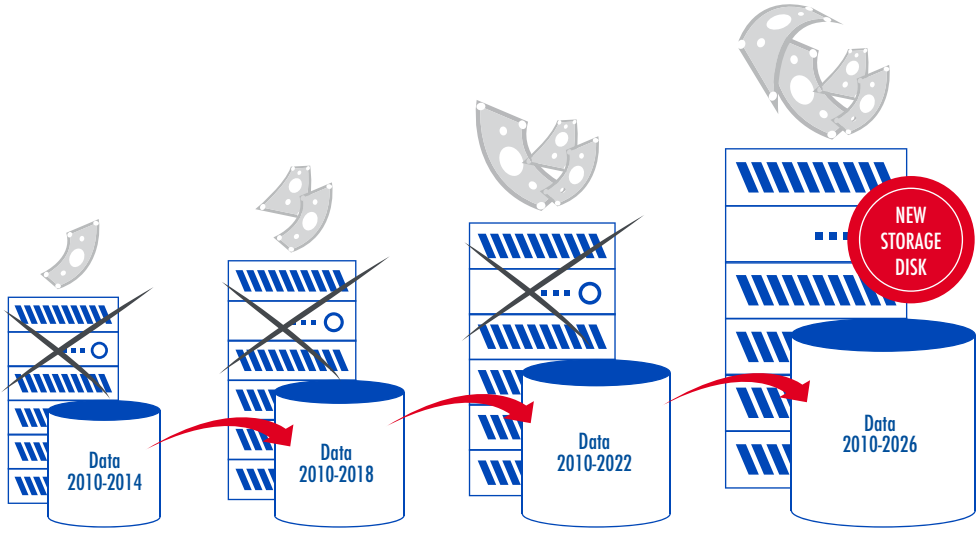
The QStar Archive Replicator module enables data replication from an Object Storage system to a tape library either locally or to a second remote site.

This method is often used in the Media & Entertainment and DNA sequencing industries for the safe copy that is especially important due to the content's intrinsic value and the fact that it cannot be recreated again.



QStar Archive Replicator offers the possibility of using S3-compatible cloud storage for the second copy. This solution is used by many organizations with no second site available for DR. In these cases, it is advisable to enable data encryption as part of the archiving process.

Document management: beware of storage costs!



Legal, accounting and administrative records have a retention period of 10 years, others a much longer period and others still require permanent preservation. At the same time, standard disk-array storage systems have a much shorter life cycle, lasting 4 to 5 years on average before becoming obsolete and no longer supported by the manufacturer.

This means that documents stored on disk are migrated over and over again throughout their life cycle, an aspect all too frequently forgotten during cost–benefit analysis of document management.

Attention is nearly always focused on the document application, forgetting a vital element: where to archive documents over time.

"Hidden" costs can significantly reduce the financial benefits of document management. This often happens because analysis concentrates on the application alone rather than the entire operating environment.

The Tape as NAS solution offers secure data archiving for periods of years or even decades, on expandable memory that can be used to store unlimited amounts of data at a fraction of the cost of any other currently available storage technology.

WORM technology (Write-Once, Read-Many)

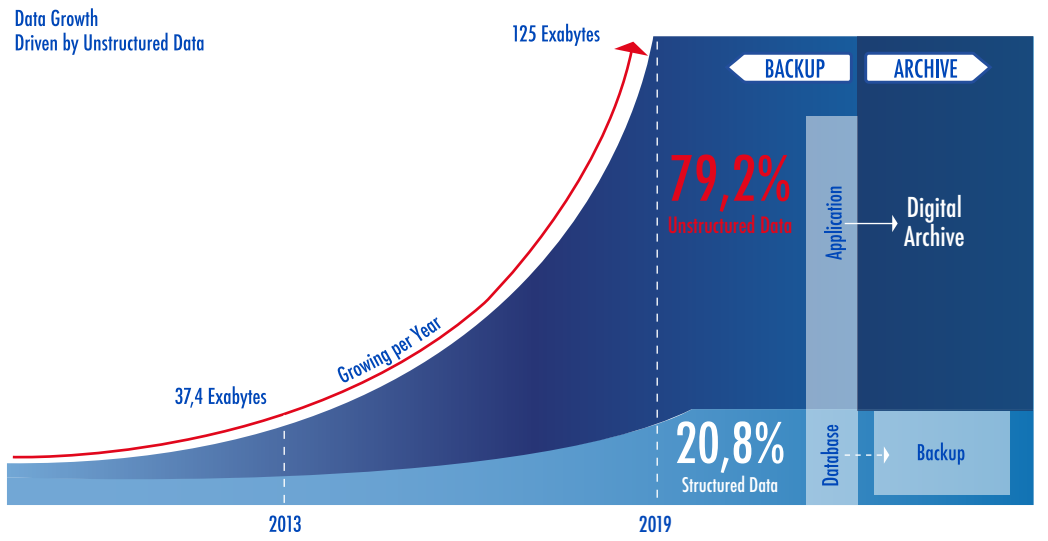
QStar offers WORM technology that can archive data in non-rewritable, non-erasable format; using this method, recorded data cannot be overwritten, modified and/or manipulated.

The WORM protection process offered by QStar complies with the strictest national and international regulations covering sensitive data archiving, document management, electronic record storage and log file archiving.

The solution guarantees secure, legally-admissible, long-term retention of archived data due to its full compliance with statutory requirements.

See page 23 for further details.

Drastic reduction in data backup and recovery times



Most organizations fail to realize that the vast majority of time spent on backup is used (or to be more exact "wasted") on inactive data, files that never change for months or years!

A waste of time and resources that any reasonable person would find hard to justify.
Despite the huge growth in data, this practice has remained virtually unchanged for many years.

Furthermore, the client/server model, designed more than 25 years ago under completely different operating conditions to those of the present day and still employed by the majority of backup products, imposes a further complication and severe constraints in optimizing the todays Data Centers that are overflowing with data.

Data backup deduplication systems have certainly reduced the storage space needed for backup and simplified management, but data save times are still virtually the same; on the other hand, restore times for a few TBs are longer compared to tape because "rehydrataion" of deduplicated data is a laborious, time-consuming process.

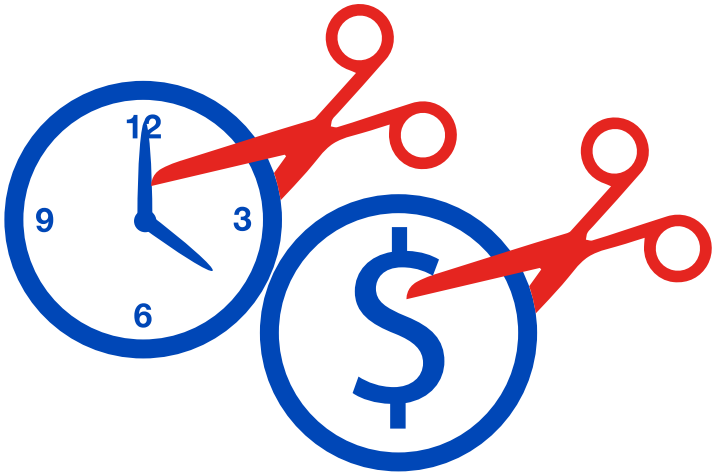
The time for change has come

By archiving first and backing up only those files that remain QStar solutions offer a greatly reduced window for data backup and restore operations.

By automatically finding and migrating files that have remained unchanged for months and years, those files that will no longer be subjected to new and unnecessary backups, but archived to a secure, cost-effective Active Archive for long-term protection.

Only information that is regularly being updated and actively used by the company will undergo backup to protect it.

Regular scans will identify when this data is no longer being actively used and it too will be archived in order to make room for new data.



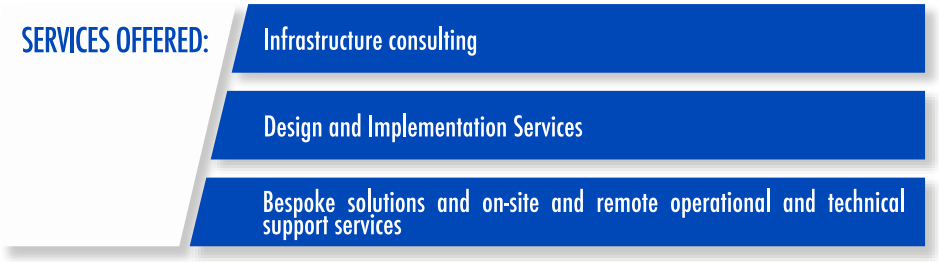
Moving unchanged files from backup to Active Archive means that you can:

- Drastically reduce backup windows.
- Reduce data recovery times.
- Reduce the number of software licences needed for backup.
- Reduce the cost of storage needed for backup operations.
- Reduce the running costs of the entire storage infrastructure.
- Reduce the time that technicians spend on these operations.

Above all, the advice given must be practical

QStar Technologies offers its customers targeted advice using streamlined, functional tools. Advice that drastically reduces analysis times for optimizing infrastructures, cutting costs and improving service levels.

Our method is based on firm deadlines and guaranteed results, we use software tools that are capable of fast, automated analysis of existing infrastructures, specific procedures and skilled consultants with a wealth of in-field experience. A pragmatic approach, capable of directing businesses towards an IT vision in line with current needs, where cost cutting and optimization are essential.
At the end of the process, the data infrastructure will be standardized, streamlined and automated. Our data "state of health" check services also offer regular tuning and optimization in order to meet the increasing demand for security and compliance with regulations covering sensitive data handling and archiving.



An extremely effective consultative model

- Software tools developed in-house in order to automate and drastically speed up the information collection and infrastructure assessment stage (from days to a few hours).
- Effectiveness no longer dependent on expertise in each individual environment or system to be found within the architecture.
- Methods developed for specific business vertical environments and contexts, thus guaranteeing that truly targeted action is taken.
- Consultants boasting great experience in the specific areas of technology and with access to best practices and success stories appropriate to the business environment in question.
- Strategic advice to ensure proper alignment between company business and IT.
- Full assistance with the migration process from the current situation to future scenario.
- Efficiency, compliance and success guaranteed by the use of bespoke methods and tools.
- Analysis and consequent proposition of implementation plans based on customer objectives.
- Measurement of service level with outsourced report generating from individual environment to full system.
- Cost control, bringing CAPEX and OPEX into line, with open and transparent measurement of TCO and ROI to demonstrate the soundness and value of the investment.

Methods

The four implementation steps

First of all, we guarantee fast and efficient analysis because the data collection step is usually the one that takes the longest; a responsibility that the generalist consultant often tends to offload onto the customer.

Bucking this trend, QStar offers expertise in the field of infrastructures and specific software tools for data analysis, migration and archiving. Furthermore, it provides the necessary onsite support to assist the customer in migrating towards new architecture and/or supply of new services.

This step identifies the "critical factors" and a structured, well-considered selection criterion is formulated for the project requirements. There is also a comparison procedure to enable discussion of the alternatives. To assist with this step, requirements are set out and we provide graphic examples of the project, specifications for each option, configuration cost estimates and weighted measurement of selection criteria.

1 DESIGN

The plan highlights potential risks and obstacles, developing a prioritisation matrix and a complete project plan. Implementation roles and required resources are also identified. Finally, project policies and procedures are defined.
During this step a document is supplied that provides an overall vision of the plan, the prioritisation matrix, project schedule, complete list of the products required and a detailed breakdown of proposed costs.

2 PLAN

This is the realization step for which a balanced, suitably-capable team is created and best practices are applied. In addition, a project audit is organized and any changes during execution are dealt with.
In order to gauge and guarantee operating efficiency, weekly progress reports are drafted, complete and accurate documentation produced and standard operating procedures and best practices followed.

3 DEPLOY

This is the moment when responsibilities are handed over to the customer. Change best practices and monitoring processes, to assist with the transfer of know-how to in-house staff. In conclusion, comprehensive documentation is completed and handed over.

4 TRANSITION

QSTAR®
TECHNOLOGIES

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