



Provide a fast data replication solution for your mainframe environment

HP XP7 FlashCopy Mirroring Software

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Introduction

For many years, in the IBM mainframe world, the only way to backup a volume, a database, or an entire data center was to use a full-volume dump. To create the point-in-time copy that the backup required, all related volumes had to be quiesced during the entire backup. In a world where businesses must continue operations around the clock, something better than full-volume dump technology was needed.

With the advent of volume mirroring, customers only had to pause the application for a few seconds (or minutes), just long enough to split the mirrored volumes from the source volumes to create a backup. The disadvantages of this method are the disk space required (doubling of the original capacity), the amount of I/Os, and the amount of time to resynchronize the mirrored volumes after the backup is finished.

Traditional tools like IBM's DFSMSdss and Innovation Data Processing's fast dump restore (FDR) product take a considerable amount of time to backup groups of volumes or a complete data center.

IBM's announcement of "fast data replication" offered a rapid point-in-time copy solution that removed some of the obstacles of the full volume dump methodology. Fast data replication is an IBM term used for FlashCopy technology. FlashCopy first appeared in the IBM ESS family. Prior to the existence of FlashCopy, "fast data replication" was used to refer to a functionality called Snapshot. This paper focuses on FlashCopy and will not address Snapshot.

The advantage of FlashCopy is that volumes need to be quiesced only for a short time, and then the point-in-time copies are available for use by backup technologies. Compared to volume mirroring, FlashCopy can reduce I/O traffic and eliminate resynchronization time.

Now, with Space-Efficient FlashCopy, the requirement for having twice the backed up capacity can be removed in specific cases.

For more information on backup/restore and disaster recovery, see the Introduction to Mainframe Data Backup and Disaster Recovery with HP XP7 Storage white paper:

h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA0-3099ENW&cc=us&lc=en

And the data backup and disaster recovery for mainframe white paper:

h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA0-3228ENW&cc=us&lc=en

Point-in-time copy and data consistency

A point-in-time copy gives the ability to backup, recover, and resume processing from a specific period in time. Thus a point-in-time copy is designed so that all of an application's data (databases, logs, and all other corresponding information) can be stored at exactly the same point in time. When all of the application's data is successfully saved at the same point in time, the data is said to be consistent.

Maintaining data consistency in the secondary volumes is a critical part of providing business continuity. To be sure that all the different volumes of an application are handled correctly, data consistency groups must be created. Using HP XP7 FlashCopy Mirroring Software, HP XP7 Storage provides the ability to create point-in-time copies within consistency groups.

This paper describes the benefits and the general handling of HP XP7 FlashCopy Mirroring Software.

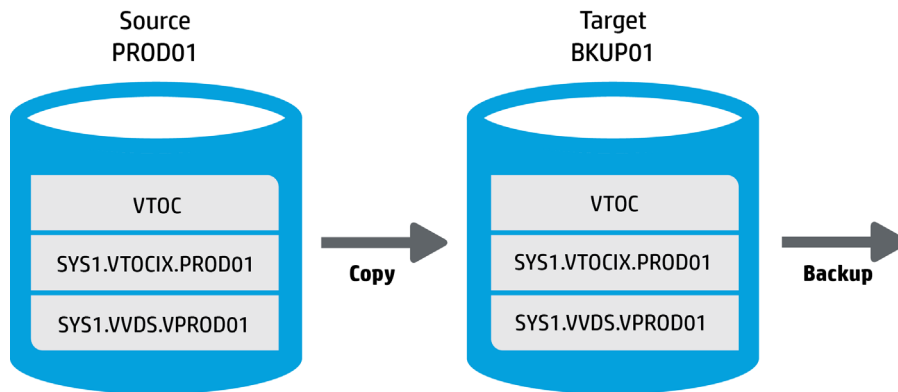
FlashCopy functional overview

FlashCopy is an IBM software tool that works on the IBM ESS and later on direct access storage device (DASD) subsystems. The use of FlashCopy gives the impression of an almost instantaneous copy.

The fast data replication solution is composed of the following phases:

- The initialization phase is completed in a few seconds and creates a bitmap or pointer to the source volume datasets. This is considered to be the logical completion and when this is complete, the source and target are said to have established a relationship. When the relationship is established, the default is for a background copy of the source to the target. The target can be used before the background copy completes. When the data copy completes, the relationship is no longer required. At this point in time, the source and target contents are identical.
- The target data can then be used as input for a backup (for fast recovery) after the background copy completes.
- The last phase consists of copying or dumping the target volume data to tape can be performed while the background copy is occurring, or without the background copy (the "NO background COPY" feature will be discussed later).

Figure 1. A list of different phases involved in the fast data replication solution



Using this technology, it appears to the host that a physical copy was completed in a very short period of time, but in reality no data was actually physically copied.

FlashCopy

FlashCopy, as soon as it reaches logical completion of the source and target relationship creation, allows backup applications to proceed immediately against the target volume. By default, FlashCopy starts a background physical copy that copies the source volume data to the target volume.

If the target volume is only needed for a short period of time (such as for the input of a backup), copying unchanging tracks to the target volume would be a waste of resources compared to using a pointer to the corresponding source volume data. FlashCopy has a “NO background COPY” option. FlashCopy “NO background COPY” is enabled by the FlashCopy keyword FCNOCOPY.

With the “NO background COPY” option, FlashCopy only copies data to the target volume when that data is about to be changed on the primary volume. Assuming that a DFSMSdss DUMP or other backup tool is started on the target volume after the FlashCopy relationship is started, it is likely that only a few source volume tracks will change during the time it takes the backup to complete.

At the completion of the backup, the FlashCopy “NO background COPY” relationship should be terminated to prevent changed data from continually being copied to the target volume.

Space-Efficient FlashCopy

Initially, FlashCopy required that the target capacity be equal to the source capacity being copied. Even when the “NO background COPY” feature was being used, this was a requirement. Now, Space-Efficient FlashCopy provides the capability to use FlashCopy to copy whole volumes using the “NO background COPY” feature to limit the amount of space needed for the target, which is equal to the amount of space that is changed while the relationship is established. Space-Efficient FlashCopy uses a pool to provide space for the data that is changed on the source volume to be maintained similar to the data on the target volume and maintain the point-in-time copy of the target volume.

Limitations

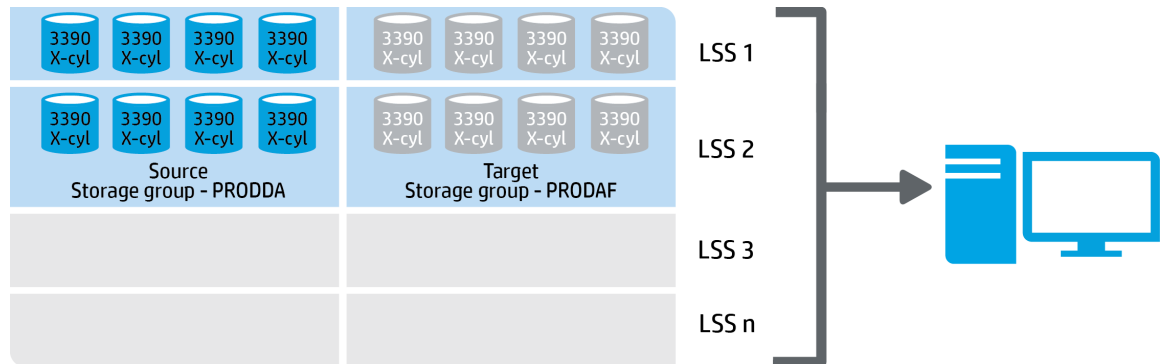
FlashCopy uses individual volumes (or extents) as sources and targets. This becomes a problem when datasets span more than one volume, which is typical for databases. If this is not properly taken into account, portions of the dataset might be missed in the copy process, or datasets might be out of synchronization because volumes are copied at different times. When the volumes containing a dataset are not synchronized, they are said to be inconsistent, and they are not useful for backup.

Care must be taken to identify individual volumes and to maintain the consistency of all the associated data. Specification by volume-only can be a data nightmare. If the datasets that have been spanned are not identified, or if a volume has been left out, the point-in-time copy will not be complete. This could affect batch or online processes, and result in a loss of data consistency.

FlashCopy has established rules about where the source volumes and target volumes need to be located.

For FlashCopy, the pairing rules are: The source volumes and target volumes must be located in the same DASD subsystem and must be of the same device type.

Figure 2. Logical overview of the location of source and target volumes for both FlashCopy and Snapshot



FlashCopy control and usage

This section describes the use of HP XP7 FlashCopy Mirroring software from the HP XP7 Storage point of view. The HP XP7 FlashCopy Mirroring Software product is functionally compatible with the IBM FlashCopy software. On the HP XP7, additional functions can be used to enhance this technology.

Terms and functions

- FlashCopy provides a fast data replication capability behind one or more logical control units (LCUs) in one physical storage unit
- FlashCopy is a hardware solution invoked and controlled by software. FlashCopy creates a relationship between an S-Volume (source) and T-Volume (target)
- FlashCopy allows the creation of a virtual copy (NOCOPY option) or physical copy from a source to a target at the volume level
- After this relation is created, the target can accept host I/O
- When the background copy is complete, the relationship ends
- FlashCopy is compatible with IBM's PPRC commands and the DFSMSdss utility

HP provides 2 versions of FlashCopy for the XP7. They are HP XP7 FlashCopy Mirroring Software and HP XP7 FlashCopy Space-Efficient Software. HP XP7 FlashCopy Mirroring Software is version 2 of FlashCopy (FC2). FC2 includes the functions of the original FlashCopy sometimes referred to as FlashCopy version 1 (FC1). Small changes must be made in the DFSMSdss utility jobs or Rexx procedures when using version 2 if they were developed for FC1.

FlashCopy Mirroring features include:

- Full volume point-in-time copy
- Extent relocation
- Dataset FlashCopy
- Multiple relationships
- Persistent and incremental FlashCopy
- Consistency groups
- Inband FlashCopy
- FlashCopy to PPRC primary volume
- Reverse Restore

FlashCopy Space-Efficient features include:

- Full-volume, point-in-time copy requiring only target space to store updated source data
- Uses same command syntax with one additional parameter that specifies it is okay to use Space-Efficient FlashCopy
- Target volume is a thin provisioned mainframe volume

FlashCopy—what it can do

FC2 enables setup and maintenance of multiple copies of logical volumes within the same XP7 subsystem. It provides an immediate point-in-time copy of a logical volume. An immediate point-in-time copy function provides an instantaneous copy of the original data when the relationship was created. FlashCopy Mirroring operations can be performed in the XP7 subsystem by using TSO and/or DFSMSdss commands from the host.

If FlashCopy Mirroring is used in conjunction with remote replication techniques (for example, HP XP7 Continuous Access Software), multiple copies of critical data can be maintained at the primary and/or secondary sites.

FlashCopy makes it possible to access both the source volumes (S-VOLs) and the target volumes (T-VOLs) before the physical copy process has been completed. By creating an “instant” copy, FlashCopy enables applications or servers that use either the source copy or the target copy to continue operating with minimal interruption.

Additional features in FC2 enhance the basic functionality described above by providing granularity of the relationship at the extent level. This extent level building block provides support for dataset level relationships and multiple relationships between LDEVs. These functions allow copying the source data to a target volume (virtually or physically). Creating pairs using FC2 is called establishing relationships. When a version 2 pair is created, hosts can access data that is copied to the target volume.

When a FlashCopy Mirroring relationship pair is established, a range of data (to be copied) can be specified. When data is copied, according to this range of data, FC2 creates a pair using this specific dataset. The copy range is called the extent. The smallest unit used to measure the extent is the track. When the copy source extent and the copy target extent are located on different volumes, the volume that contains the copy source extent is called an S-VOL, and the volume that contains the copy target extent is called the T-VOL. When an extent data copy is completed, the relationship ends automatically.

Figure 3. An example of FlashCopy version 2 pairs created between extents

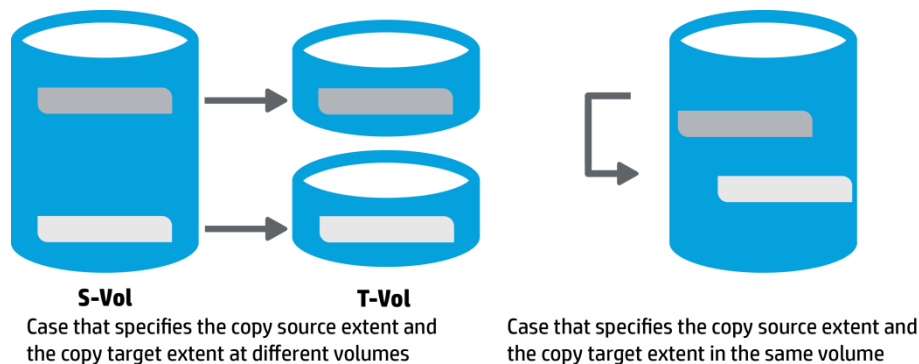


Table 1. Summary of HP XP7 FlashCopy Mirroring Software features

Item	HP XP7 FlashCopy Mirroring Software
Shared memory	Additional shared memory may be necessary.
Requirement on the capacity of the S-VOL and T-VOL for volume copy operation	$S\text{-VOL} \leq T\text{-VOL}$
S-VOL/T-VOL LSS	Can create pairs with volumes in the same LSS or different LSS.
Range of extents	Can create pairs with the entire source and target volumes, or with the copy source and target extents located at the same or different position on the source and target volumes.
Unit used for relationship management	Pairs are managed by the specified extents, or by volume when the entire volume is specified. When multiple datasets are specified on the same volume, each dataset is regarded as a relationship.
Number of relationships created with a source	Maximum of 16 relationships can be created with one source extent (that is multi relationship).
Requirements for creating relationships	You may specify the BC Z volume other than Simplex status for the copy source, but you need to specify the Simplex volume for the copy target. Up to 16 FC2 relationships can be established by specifying the BC Z S VOL that already forms pair with three T VOLs.
Using with other copy solutions	Version 2 can share the volume with the following program products: - Business Copy - Continuous Access Synchronous(R VOLs are also available in some cases) - Continuous Access Journal - Compatible XRC - Concurrent Copy
DFSMSdss command	COPYFULL command is used to create a version 2 relationship with the entire volume. COPYDS command is used to create a version 2 relationship with specified dataset.
When the DFSMSdss command is issued again during background copy operation	If the copy operation is required for the version 2 volume during the copying process, DFSMSdss command will withdraw the relationship, and create the relationship again, and then perform the copy operation.
FCESTABL command	The XTNTLST parameter is supported, so that the extents at different positions can be copied.
FCWITHDR command	The DDSW parameter is supported. When DDSW = YES: Relationships created with the extents on the device specified by SDEVN are withdrawn. When the pairs are created with the source extents in which copy mode is set to COPY, the relationships are withdrawn after the background copy is completed. When the pairs are created with the source extents in which copy mode is set to NOCOPY, the relationships are not withdrawn until the copy mode is switched to COPY and complete the background copy. Relationships established with the copy target extents are withdrawn immediately. When DDSW = NO: The pairs created with the extents on the device specified by TDEVN are withdrawn immediately. The XTNTLST parameter is supported, so that the extents at different positions can be withdrawn.
FCQUERY command	The following information can be displayed: - Number of active relationships - Maximum number of relationships that can be established with the device specified by DEVN
ICKDSF command	Partly supported.

FlashCopy usage

Host command usage

IBM FlashCopy supports both DFSMSdss commands and TSO PPRC commands to enable the execution of FlashCopy operations from the host system. The operating system versions that support FC1 are OS/390 V2R10 and z/OS version 1R0 and higher. FC2 requires z/OS version 1R0 and higher. Since HP XP7 FlashCopy Mirroring Software provides FC2 features, z/OS version 1R0 or higher is required.

This paper does not provide complete instructions for using host commands. For detailed information on using DFSMSdss and TSO PPRC commands, refer to the following IBM user documents:

- z/OS DFSMSdss Storage Administration Reference (SC35-0424) for z/OS V1R7 or lower
- z/OS DFSMS Storage Administration Reference (for DFSMSdss, DFSMSdss, DFSMSshm) (SC26-7402) for z/OS V1R8 and higher
- z/OS DFSMS Advanced Copy Services (SC35-0428)
- z/OS DFSMSdss Advanced Services (SC26-7400)

HP can analyze customer requirements and find the solution to meet and exceed customer expectations.

Appendix A

How does FlashCopy work on HP XP7 Storage?

This section provides an overview of FlashCopy features on HP XP7 Storage. With the implementation of additional products like HP XP7 Business Continuity Manager (BCM) Software, additional functionality can be achieved. The combination of FlashCopy and BCM will make sure that all requirements to make a secure and time-consistent copy of your data are met.

HP will help you implement FlashCopy in your data center.

FlashCopy—the basic copy feature

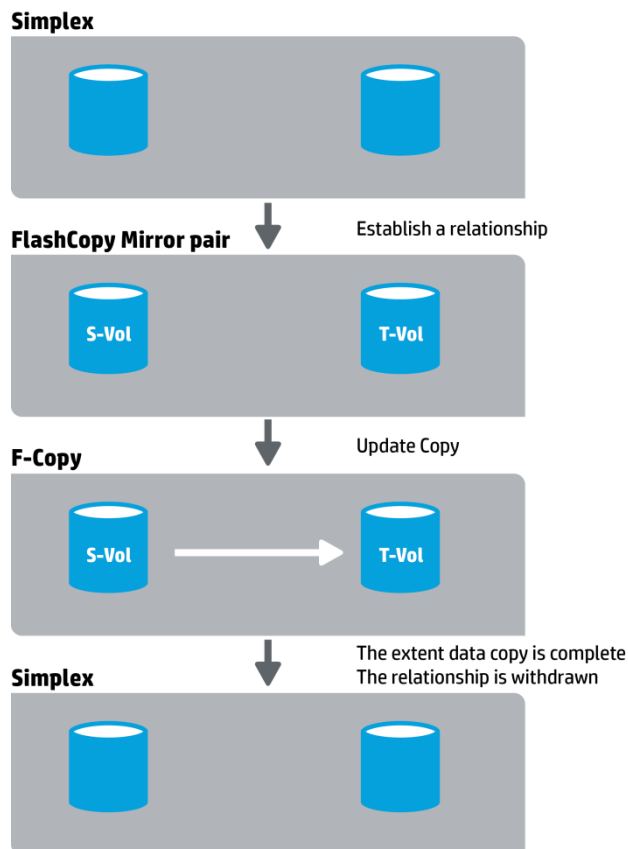
Figure 4 illustrates the pair status transition and the relationship between the pair status and the basic FlashCopy feature operations. The flow of operations is:

- A relationship is established to the simplex volume to create FlashCopy pair.
- During the update copy operation, status of the FlashCopy pair changes to F-Copy.
- When the copy of the specified extent data is complete, the relationship will be automatically withdrawn and the status of the volumes becomes simplex again.

Note

Update copy operations will not be performed when the NOCOPY option is specified.

Figure 4. FlashCopy Mirroring basic pair status transitions for a basic copy



DFSMSdss command support

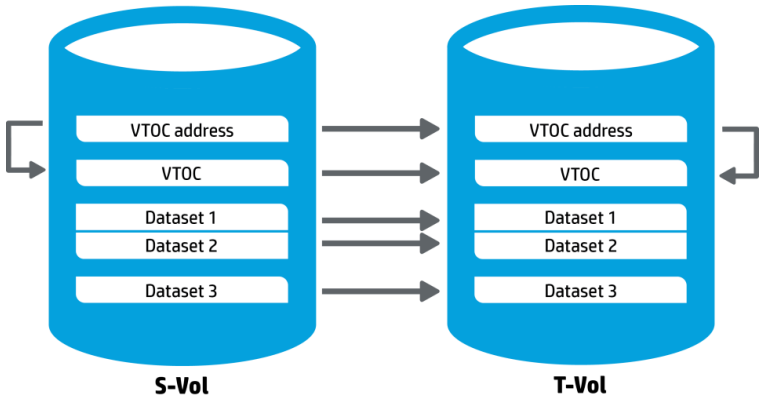
The DFSMSdss COPYFULL command can make use of FlashCopy. When a FlashCopy Mirroring copy is requested, DFSMSdss automatically determines whether it is a FlashCopy Mirroring copy request or an ordinary Business Copy request. The COPYFULL command completes within a few seconds and the FlashCopy Mirroring pair is established immediately. FlashCopy Mirroring data is copied in the background and the completion of the copy is not reported to the user.

DFSMSdss command sample

```
//COPYFULL JOB
/*
//INSTIMG EXEC PGM=ADRDSSU
//SYSPRINT DD SYSOUT=*
//SYSUDUMP DD SYSOUT=V,OUTLIM=3000
//SYSIN DD *
COPY FULL INDYNAM (SORCEV) OUTDYNAM (TRGVOL) COPYVOLID
/*
```

PYVOLID option is necessary for SMS managed volumes.

Figure 5. Copying all datasets using DFSMSdss command



FlashCopy—using extents and multiple relationships

Figure 6 illustrates the relationship between the pair status and the version 2 operations.

Establishing multiple relationships

Creating multiple pairs from one single extent is called multiple relationships. FC2 allows you to create up to 16 copies from one single extent. Figure 6 shows an example of multiple relationships.

Figure 6. Example of FC2 multiple relationships

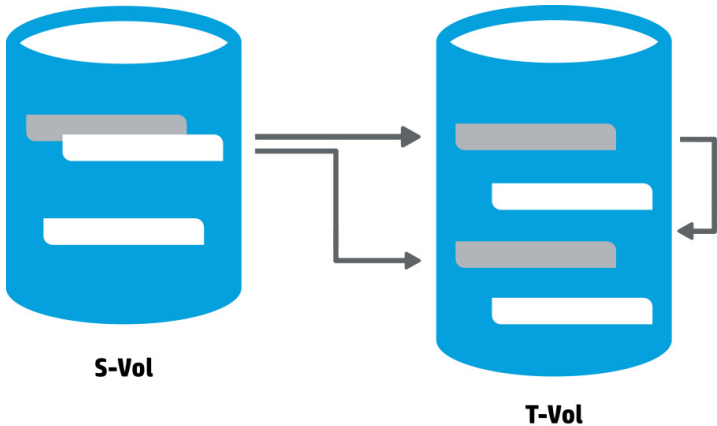
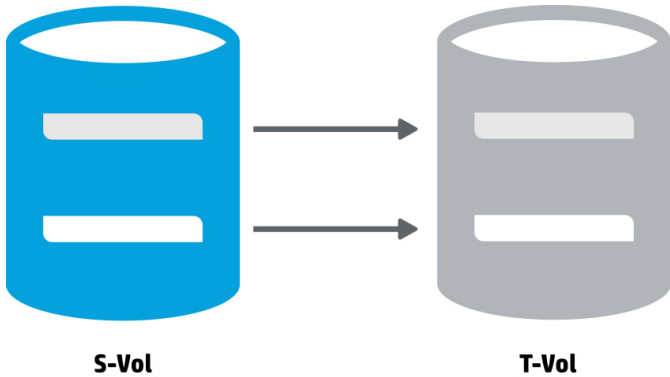


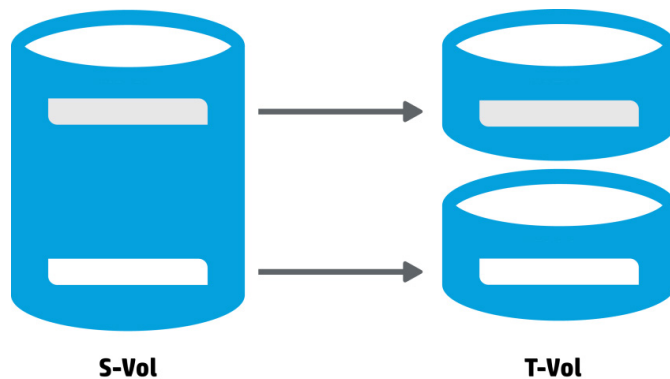
Figure 7. Version 2 copy samples

Copy sample when extents do not overlap

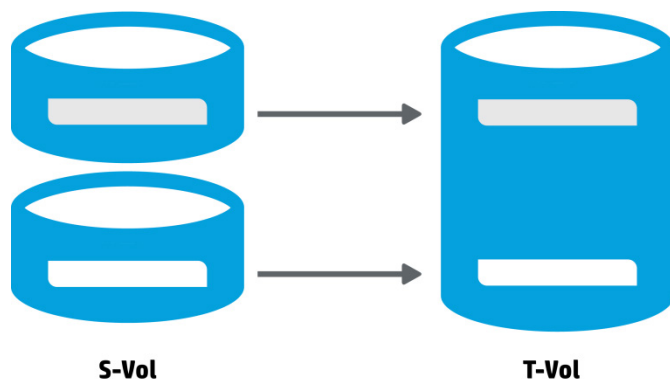


Copying data in two non-overlapping extents (one T-VOL)

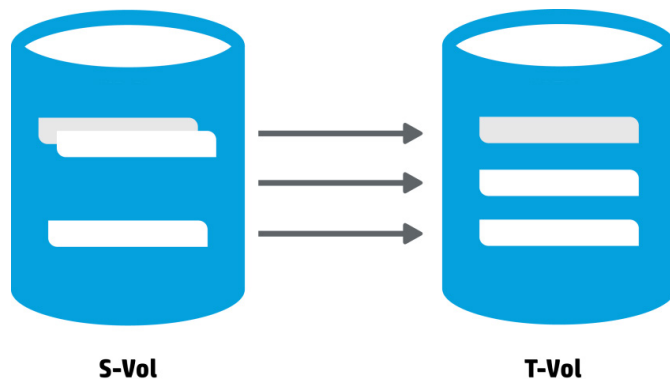
Copying data in two extents that do not overlap (two T-VOLs)



Copying data in two non-overlapping extents (two S-VOLs)

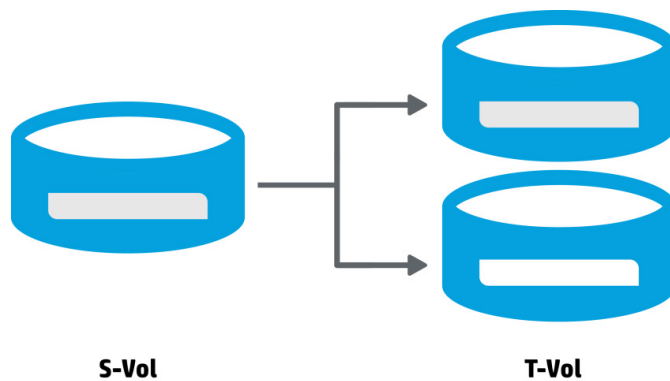


Copy sample when extents overlap

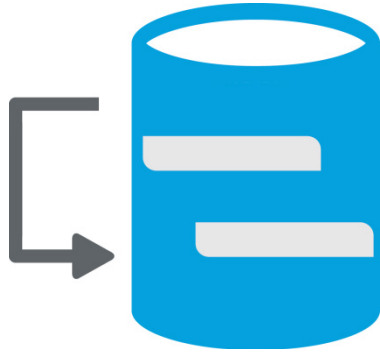


Copying data in three extents that overlap (one T-VOL)

Copying data in two extents that overlap (two T-VOLs)



Copying one extent to another in same volume



An HP Storage Specialist can assist you to calculate your space requirements.

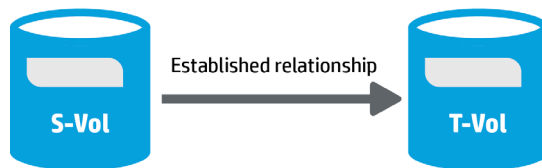
Space-Efficient FlashCopy

Space-Efficient FlashCopy uses thin provisioned mainframe volumes as target volumes in a FlashCopy relationship that has the “NO background COPY” option defined. In such a relationship, the only data copied from the source volume is data that is updated after the relationship is created (copy and write of original data to the target). Modified data is copied to the thin provisioned target volume so the combination of the data on the source volume with the tracks in the target volume define a copy of the volume at the time the relationship was created. The benefit of Space-Efficient FlashCopy compared to regular FlashCopy is that the amount of provisioned data space is less. This reduces the equipment cost as well as the cost of power and cooling of a smaller infrastructure. This makes Space-Efficient FlashCopy ideal for intermediate backup copies that have a short duration. Copies that require a background copy are served by using regular FlashCopy. Space-Efficient FlashCopy relationships must be manually withdrawn when you are done with them.

Figure 8 shows the difference between Space-Efficient FlashCopy (CFCSE) and FlashCopy (CFC).

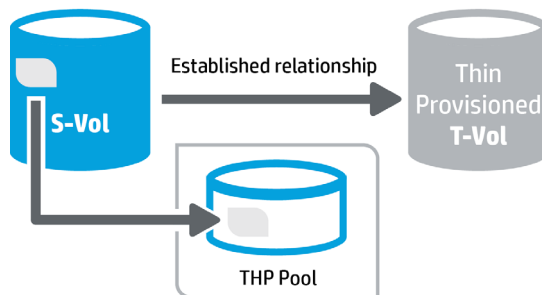
Figure 8. Comparison between CFC and CFCSE

CFC



CFC S-Vol and T-Vol use same amount of space.
Data is copied when updated on S-Vol.

CFCSE



CFCSE T-Vol real disk space is in a thin provisioned (THP) pool and updates of S-Vol are written to the pool which provides space for multiple THP volumes, including space efficient FlashCopy T-Vols. The logical T-Vol is read from the host and actual data is provided from S-Vol or the THP pool as appropriate.

Appendix B

Table 2. Differences between IBM FlashCopy version 2 and HP XP7 FlashCopy Mirroring Software

Compared item	IBM FlashCopy version 2	HP XP7 FlashCopy Mirroring Software
Read access to the area is not specified as the copy range in the copy target in the NOCOPY mode	The data on the track, subject to read operation, is not copied from the copy source to the copy target.	The data on the track, subject to read operation, is copied from the copy source to the copy target.
Status of the pairs when on-demand copy is processed	Pairs are withdrawn automatically when all the copy operations processed by on-demand copy are completed.	Pairs are maintained even when all the copy operations processed by on-demand copy are completed.
Number of multiple relationships	Up to 12 pairs can be created per extent (the smallest unit: track).	Up to 16 pairs can be created per extent (the smallest unit: track).
Maximum number of pairs that can be created per volume	951 pairs (for 3390-3) 2,719 pairs (for 3390-9 when the number of available cylinders are 10,017) 7,615 pairs (for 3390-27 when the number of available cylinders are 28,356) 8,839 pairs (for 3390-27 when the number of available cylinders are 32,760)	65534 pairs (for all volume types)
Establishing relationships by using the TSO command, when you specify a copy target volume of PPRC as a source volume	Supported. The ACTION (FREEZE) option can be used.	Not supported. The command will be rejected.
Reverse Restore	After all the copy operations processed by on demand copy are completed, the Reverse Restore operation can be performed on the relationship created by Incremental FlashCopy function. If differential data does not exist, the Reverse Restore operation can be performed on the relationship after Restore or Reverse Restore is performed with NOCOPY specified.	After all the copy operations processed by on demand copy are completed, the Reverse Restore operation cannot be performed on the relationship created by the Incremental FlashCopy function. Regardless of whether differential data exists, the Reverse Restore operation cannot be performed on the relationship after Restore or Reverse Restore is performed with NOCOPY specified.
Fast Reverse Restore	Regardless of whether or not the option of the Incremental FlashCopy function is specified, if you perform the Fast Reverse Restore, the part of data, which is copied from the S-VOL to the T-VOL will be copied from the T-VOL to the S VOL.	- When you perform the Fast Reverse Restore specifying the option of the Incremental FlashCopy function, only the recently updated part of the S-VOL or the T-VOL will be copied from the T-VOL to the S-VOL. - When you perform the Fast Reverse Restore without specifying the option of the Incremental FlashCopy function, only the copied part of data from the S-VOL to the T-VOL will be copied before the Fast Reverse Restore is executed.
Copying in NOCOPY mode in FlashCopy to PPRC primary volume function	When a FlashCopy pair in NOCOPY mode is created using a PPRC P-VOL, the data is not copied from FlashCopy S-VOL to FlashCopy T VOL, and the FlashCopy S-VOL data is copied to the PPRC S-VOL. When the FlashCopy pair is deleted, the PPRC P-VOL data is copied to the PPRC S-VOL data.	When version 2 pair in NOCOPY mode is created using Cnt Ac-S Z pair M-VOL, the copy operation is executed to version 2 pair T-VOL and Cnt Ac-S Z pair R-VOL. Copy operation is not executed even if version 2 pair is deleted. The value of BCE or BCP displays as F(FALSE) though the value of "#TRACKS YET TO BE COPIED" displayed by the FLASHCPY QUERY RELATIONS command of ICKDSF changes, depending on the number of tracks in which the copy has not been completed.

Compared item	IBM FlashCopy version 2	HP XP7 FlashCopy Mirroring Software
Receiving Failover/Failback command to Cnt Ac-S Z pairs in FlashCopy to PPRC Primary Volume function	Receives Failover/Failback command.	Failover command is received, but after that, the status will be version 2 pair T-VOL and Cnt Ac-S Z R-VOL. Therefore Failback command is rejected.
Execute ICKDSF command for version 2 to TCz pair M VOL in pending status	Ends Normally.	Ends abnormally with CC=12. To avoid abnormal ending, see if ICKDSF Command Ended Abnormally.
Establishing a Cnt Ac-S Z pair in NOCOPY mode whose M-VOL is a version 2 pair T VOL that you establish in NOCOPY mode	Neither FlashCopy data nor PPRC data can be copied.	Data can be copied from the version 2 pair S VOL to T VOL but not to the Cnt Ac-S Z R VOL. In this state if you release the version 2 pair, the data of Cnt Ac-S Z M VOL and R VOL will be different.
FCWITHDR command (DDSW = YES, XTNTLST parameter specified)	The command withdraws the copy targets of relationships existing within the extents specified as the source, provided that: When the copy target of the relationship is only partly included in the specified extent, only the area that is included in the extent is withdrawn. When only the central part of the copy target of the relationship is included in the specified extent, only the area that is included is withdrawn. The remaining area of the relationship is divided up.	The command withdraws the copy targets of relationships existing within the entire extents specified as the source. When the copy target of the relationship is only partly included in the specified extent, the command does not withdraw the relationship. Caution: If one of the following has been performed, the creation of relationships may fail: - A scratch operation - Deletion of datasets - Volume initialization Therefore, if any of these has been performed, do either of the following: - Use the FCWITHDR command to withdraw the relationship. Wait until the background copy operation finishes and the relationship disappears.
FCWITHDR command (DDSW = NO, XTNTLST parameter specified)	The command withdraws the copy targets of pairs existing within the extents specified as the target, provided that: When the copy target of the relationship is only partly included in the extent specified as the target, only the area that is included in the extent is withdrawn. When only the central part of the copy target of the relationship is included in the extent specified as the target, only the area that is included is withdrawn. The remaining area of the relationship is divided up.	The command withdraws the copy targets of relationships existing within the extents specified as the target. When the copy target of the relationship is only partly included in the extent specified as the target, the command does not withdraw the relationship. Caution: If one of the following has been performed, the creation of relationships may fail: - A scratch operation - Deletion of datasets - Volume initialization Therefore, if any of these has been performed, do either of the following: - Use the FCWITHDR command to withdraw the relationship. Wait until the background copy operation finishes and the relationship disappears
REMOVEFCPY (ICKDSF CONTROL command)	The command will finish normally. Relationships will not be deleted.	Not supported. The command will finish abnormally. Relationships will not be deleted.

Compared item	IBM FlashCopy version 2	HP XP7 FlashCopy Mirroring Software
The operation when you establish a dataset relationship by using DFSMSdss command, and specify the source or target volume of a volume relationship as the copy target	Part of the volume relationship will be withdrawn.	- When you specify the source volume of a volume relationship as the copy target, the entire volume relationship will be withdrawn. - When you specify the target volume of a volume relationship as the copy target, the volume relationship will be withdrawn.
		Caution When only a part of the relationship that is the copy target is included in the specified extent as the copy target, the volume relationship will not be withdrawn.

For more information

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