

Oracle replication with Fibre Attached Technology Adapted (FATA) disk drives white paper



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Executive summary

The role of replication and backup operations in data protection and recovery are a critical part of securing online business assets and ensuring operational integrity. HP recognizes the importance of multi-level data recovery and protection for critical database applications and offers flexible low-cost solutions that meet the needs of the simplest to the most complex IT environment. These solutions include the introduction of an entirely new class of disk drive technology—the Fibre Attached Technology Adapted (FATA) drives.

This white paper provides performance reference information for the new FATA disk drive as a replication/backup destination for Oracle®9i databases. It also compares FATA performance with the performance of other Fibre Channel disks and tape drives tested under similar conditions.

The HP FATA drive is a new technology that enhances the HP StorageWorks Enterprise Virtual Array (EVA) family: the HP StorageWorks Enterprise Virtual Array 3000 (EVA3000) and the HP StorageWorks Enterprise Virtual Array 5000 (EVA5000). Designed specifically for the enterprise environment, the FATA drive is a high-capacity, high-speed, low-cost “hybrid” drive that possesses many of the reliability features of the high-performing Fibre Channel (HPFC) disk drives. Its native Fibre Channel interface allows the drive to be plugged directly into the HP StorageWorks EVA, making it easy to integrate into any existing EVA storage infrastructure. As such, these new drives can be used in tiered storage solutions and are ideal for near-line (low duty-cycle) applications such as disk-to-disk (D2D) backup and restore, reference of infrequently accessed data, and archiving.

This white paper presents a potential tiered backup and recovery methodology for business-critical Oracle9i databases and describes the following operations:

- Cloning within a single array to FATA drives using HP StorageWorks Business Copy EVA
- Replication of an Oracle9i database using HP StorageWorks Continuous Access EVA from high-performance fibre drives to remote FATA drives
- Backup to FATA drives with HP OpenView Storage Data Protector 5.1

It includes both local and remote replication operations and describes the performance tests, configuration, and measurement criteria used to arrive at the results presented. All tests measured Oracle database performance as well as backup and restore input/output (I/O) performance.

This white paper also compares FATA drive performance with the HPFC and Linear Tape Open (LTO) disk drives. The HPFC drives are the standard disks for the HP StorageWorks EVA disk arrays. The comparison testing used several different backup/replication methods that provided information about the relative benefits of these disk drive technologies.

In general, the test results show that utilization of low-cost disk drives and backup and recovery sources meet the requirements for backup and recovery of a high-performance database environment. Although there is a difference in transfer rates between HPFC drive and FATA drive technologies, the methodology presented showed an improvement in the Oracle database Transactions Per Second (TPS) and the Response Time (RT) performance.

In comparison, the LTO drive in the tape library did not perform as well. This low performance was due mainly to media management activities (loading, positioning, rewinding, and unloading media) and the relatively small size of the test database. A much larger test configuration could have perhaps improved the tape library performance results.

Introduction

Different replication and backup strategies protect against different types of problems—hardware failures, user errors, viruses, or system disasters. Snaps, clones, and mirrors are the most common disk-based technologies utilized in data protection today. Point-in-time replication technologies, such as Business Copy EVA snapshots or Snapclones and Storage Data Protector backups offer the best protection against user errors and viruses. Mirroring replication technologies, such as Continuous Access EVA, however, offer the best protection against hardware failures and disasters. These, combined with high-availability arrays, such as the HP StorageWorks EVA, provide a backup and replication strategy that gives reliability and flexibility with no interruption of the application.

Corporate IT environments need a combination of these replication technologies for maximum protection. To this end, the configuration for the Oracle database replication tests utilized an HP StorageWorks EVA with Business Copy EVA to create clones on FATA and HPFC disks, and Storage Data Protector 5.1 (with and without Snapclone) for D2D and disk-to-tape (D2T) backups and restores. Remote replication tests used Continuous Access EVA for D2D operations. To simulate a remote recovery from a disaster, the tests used Business Copy EVA to create a Snapclone from a remote FATA disk to a remote HPFC disk and to recover the Oracle9i database on the remote site. The use of FATA disk drive technology in these tests demonstrated how customers can attain a low-cost and flexible solution for all their backup and replication needs and preserve infrastructure investments without sacrificing performance.

To run these tests, the HP testing team assembled and configured the system illustrated in Figure 1. The tests were designed to demonstrate the efficiency of low-cost high performance FATA disk drives when replicating data with HPFC drives in both local and remote scenarios. They included two basic scenarios:

- Local scenario—Replication of data using Snapclones from HPFC to HPFC copies, from HPFC to FATA copies, copies using Business Copy EVA, and copies using Storage Data Protector software.
- Remote scenario—Replication of a production site running EVA5000 with HPFC drives to a remote EVA5000 with FATA disks over a 10-km distance using Continuous Access EVA.

For a list of test scenarios, refer to Table 1.

Table 1. Replication, backup, and restore test scenarios

Local replication performance tests	
Replication and restore using Business Copy EVA to create Snapclones	
	<ul style="list-style-type: none"> • Clone-based replication to create Snapclones to FATA and HPFC disks
	<ul style="list-style-type: none"> • File-level restore from FATA and HPFC Snapclones
	<ul style="list-style-type: none"> • Full restore using Snapclones from FATA and HPFC disks
Backup using Storage Data Protector 5.1 with and without Snapclones	
	<ul style="list-style-type: none"> • From HPFC disk to FATA disk
	<ul style="list-style-type: none"> • From HPFC disk to HPFC disk
	<ul style="list-style-type: none"> • From HPFC disk to LTO tape
Restore using Storage Data Protector 5.1	
	<ul style="list-style-type: none"> • From FATA disk to HPFC disk
	<ul style="list-style-type: none"> • From HPFC disk to HPFC disk
	<ul style="list-style-type: none"> • From LTO tape to HPFC disk
Remote replication performance tests	
Replication of remote Oracle9i database using Continuous Access EVA	
	<ul style="list-style-type: none"> • From HPFC disks to FATA disks
	<ul style="list-style-type: none"> • From HPFC disks to HPFC disks
Disaster recovery simulation using Business Copy EVA to create a Snapclone from remote FATA to remote HPFC disk and recover Oracle database on remote site.	

Test configuration

The hardware and software test configuration used for the performance tests is illustrated in Figure 1. It includes:

- (2) HP L3000 servers running HP 11.11 (Oracle 9i servers)
- (1) HP L3000 server running HP 11.11 (Storage Data Protector Backup Server)
- (1) HP LPr6000 running Benchmark Factory (Oracle load generator)
- (2) HP OpenView Storage Management Appliance III with Microsoft Windows 2000
- (2) EVA5000 disk array storage
- (2) HP StorageWorks MSL5060 Ultrium-2 tape library with four drives
- (4) HP StorageWorks 2/8 2-GB Fibre Channel switches
- HP StorageWorks Command View EVA
- Continuous Access EVA
- Business Copy EVA
- Storage Data Protector 5.1
- HP StorageWorks Storage System Scripting Utility
- Oracle 9i (with RMAN)

For test equipment specifications, refer to the Appendix.

Figure 1. Logical configuration diagram

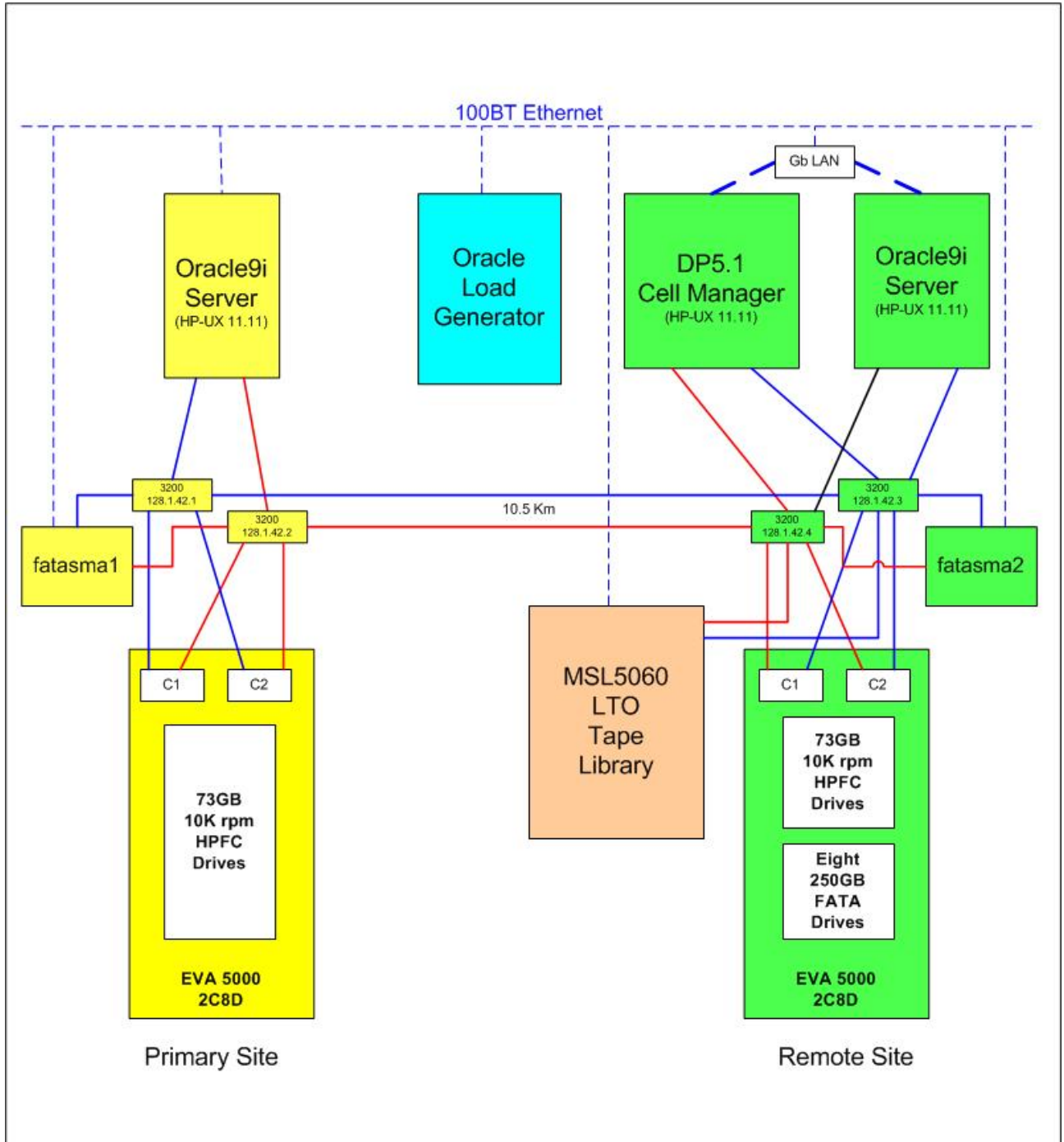


Table 2. Disk groups and virtual disks

Disk groups	
Oracle_DB	8 HP Fibre Channel drives with single disk failure protection (73 GB 10K rpm)
Oracle_RL	8 HP Fibre Channel drives with single disk failure protection (73 GB 10K rpm)
Oracle_AL	8 HP Fibre Channel drives with single disk failure protection (73 GB 10K rpm)
FATA_BU	8 FATA drives with no disk failure protection (250 GB)—Remote site
HPFC_BU	8 HPFC drives with no disk failure protection (73 GB 10K rpm)—Remote site
Virtual disks	
Oracle_DB	20-GB VRAID1 using the Oracle_DB Disk Group (for DB files)
Oracle_RL	10-GB VRAID1 using the Oracle_RL Disk Group (for DB Redo Logs)
Oracle_AL	100-GB VRAID5 using the Oracle_AL Disk Group (for DB Arch Redo Logs)
FATA_BU	50-GB VRAID0 using the FATA_BU Disk Group (for DP5.1 Backups)—Remote site
HPFC_BU	50-GB VRAID0 using the HPFC_BU Disk Group (for DP5.1 Backups)—Remote site
Oracle_DB_CA_FATA	20-GB VRAID1 using the FATA_BU Disk Group (CA destination for DB files)—Remote site
Oracle_RL_CA_FATA	10-GB VRAID1 using the FATA_BU Disk Group (CA destination for Redo Logs)—Remote site
Oracle_AL_CA_FATA	100-GB VRAID5 using the FATA_BU Disk Group (CA destination for Arch Redo Logs)—Remote site
CA_FATA_DB_SNAP	20-GB VRAID1 using the Oracle_DB Disk Group (Snapclone from Oracle_DB_CA_FATA)—Remote site
CA_FATA_RL_SNAP	10-GB VRAID1 using the Oracle_RL_Disk Group (Snapclone from Oracle_RL_CA_FATA)—Remote site
CA_FATA_AL_SNAP	100-GB VRAID5 using the Oracle_AL_Disk Group (Snapclone from Oracle_AL_CA_FATA)—Remote site

Oracle load generation

The Benchmark Factory load generator by Quest Software was used to simulate a generic Oracle user load. All testing used a load profile based on the TPC-C specification (www.tpc.org). An initial load profile provided data that showed how the configuration performed as the number of users changed. Based on this data, all subsequent data used a user load of 300 users. At this load level, the server CPUs were approximately 70% busy on average with 28% of the time spent waiting for I/O. The disks were at 90% utilization with a 6-ms response time.

Local replication test results

Local replication tests used Business Copy EVA firmware to create Snapclones for backup and restore. A Snapclone is a copy of a source disk created within one EVA disk array. This technology first creates a point-in-time image of the source disk that is available for use while the data is copied from the source disk to the destination disk in the background. When the copy operation completes, the destination disk contains an independent copy of the data.

For detailed performance results, refer to the tables in this section. They present the performance of the FATA disk drives and LTO tape drives (as applicable) and compare results to the performance of the HPFC disk drives. Absolute numbers are provided in certain cases for clarity.

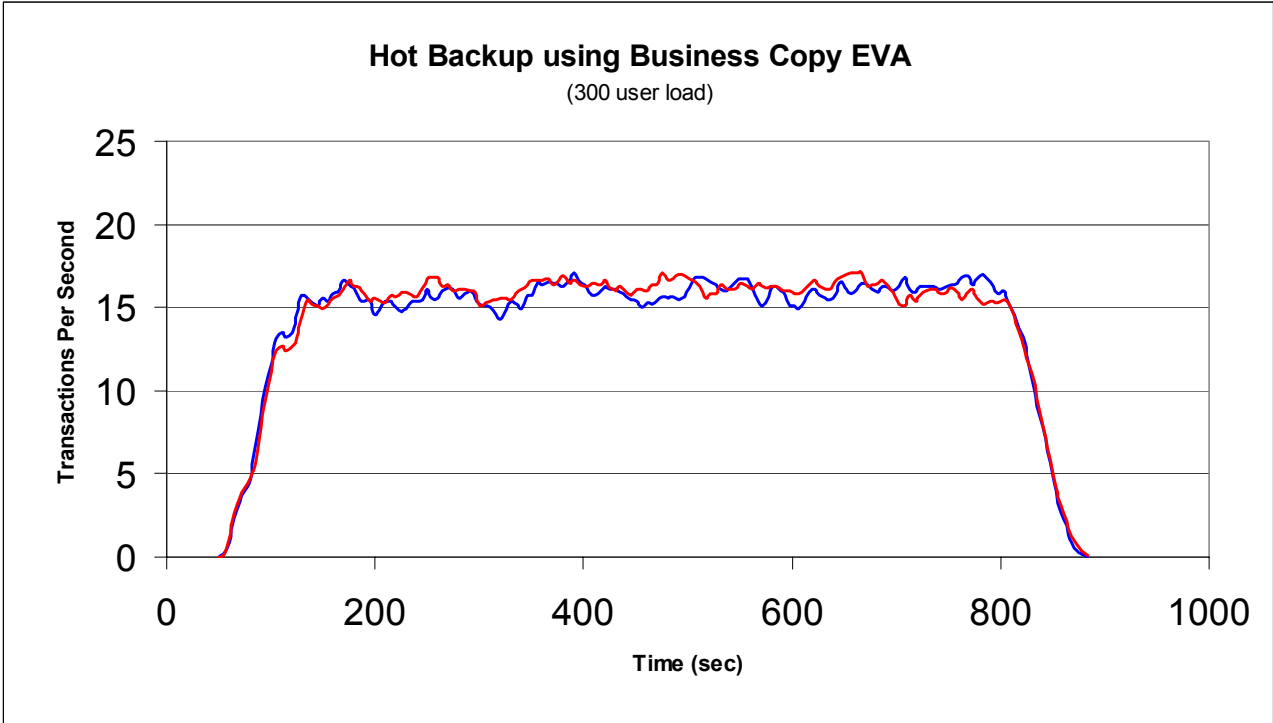
Local replication and restore using Business Copy EVA

This test included three separate scenarios:

- Replication using Business Copy EVA to create a Snapclone to FATA and HPFC disks
- File-level restore from FATA and HPFC Snapclones
- Full restore using Snapclones from FATA and HPFC disks

The test results are provided in Table 3. In these test scenarios, scripts were used to place the Oracle9i database in backup mode, create a Snapclone to the FATA or HPFC disk drives, take the database out of backup mode, and monitor the Snapclone copy process until completion. Figure 2 shows Oracle TPS performance before, during, and after running the backup script. The data in Table 3 provides detail on backup performance as well as Oracle TPS and RT performance.

Figure 2. Oracle TPS performance with backups using Snapclones



- Backup to HP Fibre Channel disk drives
- Backup to FATA disk drives

The backup process had no noticeable effect on Oracle TPS performance for both the FATA and HPFC disk drives.

In Table 3, the total backup time is the time taken to complete the entire backup process. The data backup was a Snapclone of the 20-GB LUN containing the database files. The EVA handled the Snapclone copy process internally. The copy took an extra 2 minutes when using FATA drives as the Snapclone or backup destination. This corresponded to a 27% difference in transfer rate.

Table 3. Backup test results for replication using Business Copy EVA with Snapclone

Performance tests	Technology		
	HPFC	FATA	LTO
Business Copy EVA Snapclone backup	Reference (100%)		N/A
Total backup time		145%	
Time until Snapclone available		100%	
Snapclone copy performance		73%	
Impact on Oracle performance (TPS)		102%	
Impact on Oracle performance (RT)		88%	
Single-file restore from Snapclone			N/A
Total database downtime		101%	
Database recovery time		101%	
File copy performance		100%	
Full restore from Snapclone			N/A
Total database downtime		101%	
Database recovery time		101%	
Snapclone copy performance		99%	

Because the FATA drives demand less bandwidth than HPFC drives, Oracle RT performance improved 12%. Although the time required to complete the Snapclone copy process increased by 2 minutes, or about 38%, the time it took to for the Snapclone to become available was identical (52 seconds).

This is significant because as soon as the Snapclone image is available, it can be used as a valid recovery source. If a file on the source disk is lost or corrupted, it can be recovered from the Snapclone even if the copy process is not complete. In this sense, there is no difference in backup time between FATA and HPFC disks. In all the restore tests, FATA drives performed as well as HPFC disks.

HP OpenView Storage Data Protector 5.1 backup/restore test results

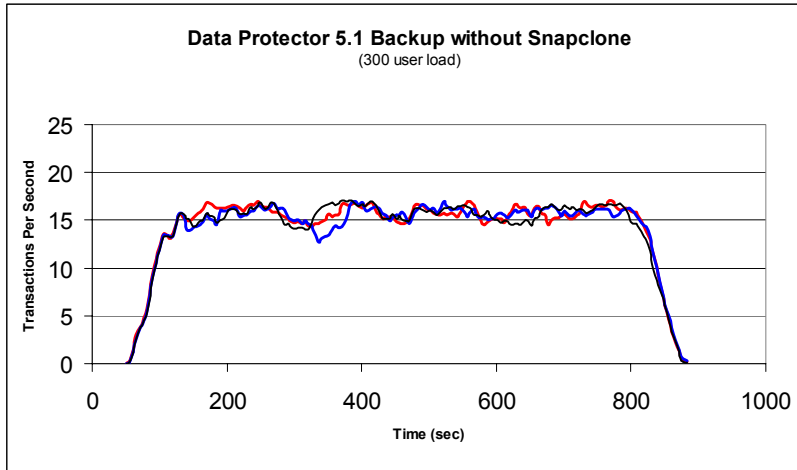
The Storage Data Protector 5.1 backup performance tests included the following scenarios:

- Backup from HPFC disk to FATA disk (with and without Snapclone)
- Backup from HPFC disk to HPFC disk (with and without Snapclone)
- Backup from HPFC disk to LTO2 tape (with and without Snapclone)
- Restore from FATA disk to HPFC disk
- Restore from HPFC disk to HPFC disk
- Restore from LTO2 tape to HPFC disk

This set of tests used Storage Data Protector 5.1 to perform backup operations from HPFC disks to FATA and HPFC disks, or to an LTO2 tape drive. The LTO2 drives used for this test were in an MSL5060 tape library. For each backup destination, the backup operation was performed with and without a Snapclone.

From an Oracle perspective, the only differences in TPS performance occurred when using FATA Snapclones while backing up to the LTO2 tape. This difference however was not significant. The test recorded only a 0.3 second difference in Oracle RT and essentially no difference in the average Oracle TPS performance numbers. For a comparison of test results, refer to Figure 3, which contains several graphs showing Oracle TPS performance for the preceding test scenarios.

Figure 3. Oracle TPS performance with Storage Data Protector backups



- Backup to HPFC disk drives
- Backup to FATA disk drives
- Backup to LTO tape drives

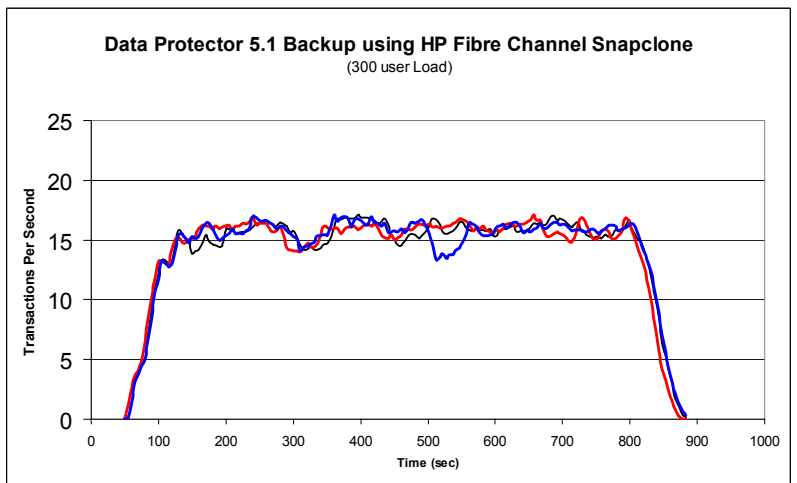
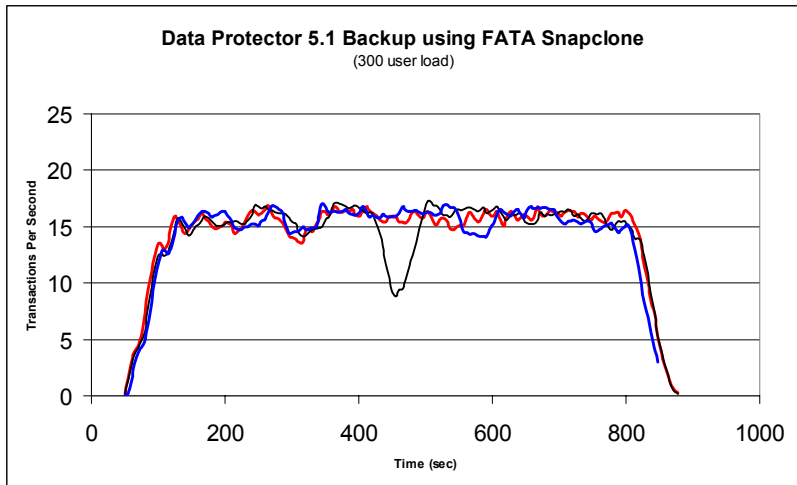


Table 4 compares the performance of FATA and LTO2 drives to HPFC drives when they are used as a Storage Data Protector 5.1 backup destination device.

Using Storage Data Protector 5.1 to back up to FATA drives without using Snapclone technology yielded less than a 3% difference in performance compared to backup results to HPFC drives. In addition, Oracle RT improved by 11%.

Tests using Storage Data Protector 5.1 to back up to FATA drives with either a FATA or HPFC Snapclone yielded a 14% to 20% increase in backup time and 13% to 17% reduction in backup performance. The increase in backup time was from 30 to 60 seconds. Oracle performance was relatively unaffected. Restore operations from FATA drives showed no more than a 6% difference compared to restores from HPFC drives.

In most of the tests, backup to the LTO tape library took twice as long as backup operations to the FATA drives. Restore from the tape drive took from 3 to 7 times longer compared with FATA drives.

The test database consisted of 10 data files. Most of the files were very small except for one that was approximately 5 GB. During the tests, although four LTO2 drives were available for the backup, only one drive was busy for any significant length of time. In addition, since the amount of data backed up was relatively small, the media management time (for loading, positioning, rewinding, and unloading) created a significant impact on the overall performance measurements. When the media management time is backed out of the results, test results show that the one LTO tape drive achieved approximately 74% of the transfer rate of an HPFC disk group consisting of eight disk drives. In larger applications where the database contains large numbers of files and the amount of data transferred is higher (not contained in one file), the metrics for the LTO tape library would have been much better.

The tests demonstrated the performance reliability and flexibility of the FATA disk drive as a backup and replication device for configurations similar to those tested. With a minimum disk group consisting of eight 250-GB disks providing up to 2 TB of backup space, FATA should perform well against HPFC and LTO tape drives in large configurations as well.

Table 4. Performance test results for Storage Data Protector backups

Performance tests	Technology		
	HPFC	FATA	LTO
Storage Data Protector 5.1 backup without Snapclone			
Total backup time		97%	241%
Effective backup performance		103%	42%
Real LTO data transfer rate		N/A	60%
Impact on Oracle performance (TPS)		101%	102%
Impact on Oracle performance (RT)		89%	87%
Storage Data Protector 5.1 backup with FATA Snapclone			
Total backup time		120%	210%
Effective backup performance		83%	48%
Real LTO data transfer rate		N/A	72%
Impact on Oracle performance (TPS)		99%	98%
Impact on Oracle performance (RT)		106%	127%
Storage Data Protector 5.1 backup with HPFC Snapclone			
Total backup time		114%	208%
Effective backup performance		87%	48%
Real LTO data transfer rate		N/A	74%
Impact on Oracle performance (TPS)		100%	101%
Impact on Oracle performance (RT)		98%	92%
Storage Data Protector 5.1 restore without Snapclone			
Restore time		106%	351%
Recovery time		104%	46% ¹
Effective restore performance		94%	29%
Storage Data Protector 5.1 restore with FATA Snapclone			
Restore time		105%	598%
Recovery time		100%	68% ¹
Effective restore performance		95%	17%
Storage Data Protector 5.1 restore with HPFC Snapclone			
Restore time		100%	679%
Recovery time		98%	70% ¹
Effective restore performance		100%	15%

Reference (100%)

¹ Recovery time is the time taken by Oracle to apply Redo logs to the restored file. This time is dependent on the amount of changes made to the database since the last backup. Because tape operations caused the database files to be backed up later in the test cycle, fewer changes were made to the database resulting in a shorter recovery time.

Remote replication test results

Replication of remote Oracle9i database using Continuous Access EVA

Remote replication tests used Continuous Access EVA array-based replication software to create a remote, mirrored copy of a source disk. This is a data mirror between two EVA disk arrays. As opposed to a Snapclone or a point-in-time image, this copy of the data is continuously updated as the source data changes. Replication performance tests were run from a production site using HPFC disk drives to a remote site using low-cost FATA drives running Oracle 9i. There were two test scenarios used:

- Remote replication from HPFC disks to FATA disks
- Remote replication from HPFC disks to HPFC disks

The tests utilized a synchronous link between two EVA5000 storage arrays over a 10-km distance. All writes to database datafiles, online redo logs, and archived redo logs were mirrored. Performance measurements were taken before the link was created, while the remote disaster recovery LUNs were synchronizing, and after synchronization was complete. These measurements were performed with FATA drives as the destination device and again with HPFC drives as the destination device. After measurements were taken, the data from the primary site was moved to the remote site using Business Copy EVA to create a Snapclone from the remote FATA destination drives to remote HPFC drives. The remote Snapclone was then mounted on the remote server, and the database was presented to the standby Oracle server on the remote site.

This process took only a few minutes because there was no need to wait until the remote Snapclone copy was complete. As soon as the remote Snapclone was available, it was used to start the database. For more details about specific performance results achieved during this test, refer to Figure 4 and Table 5.

Figure 4. Oracle TPS performance with Continuous Access EVA

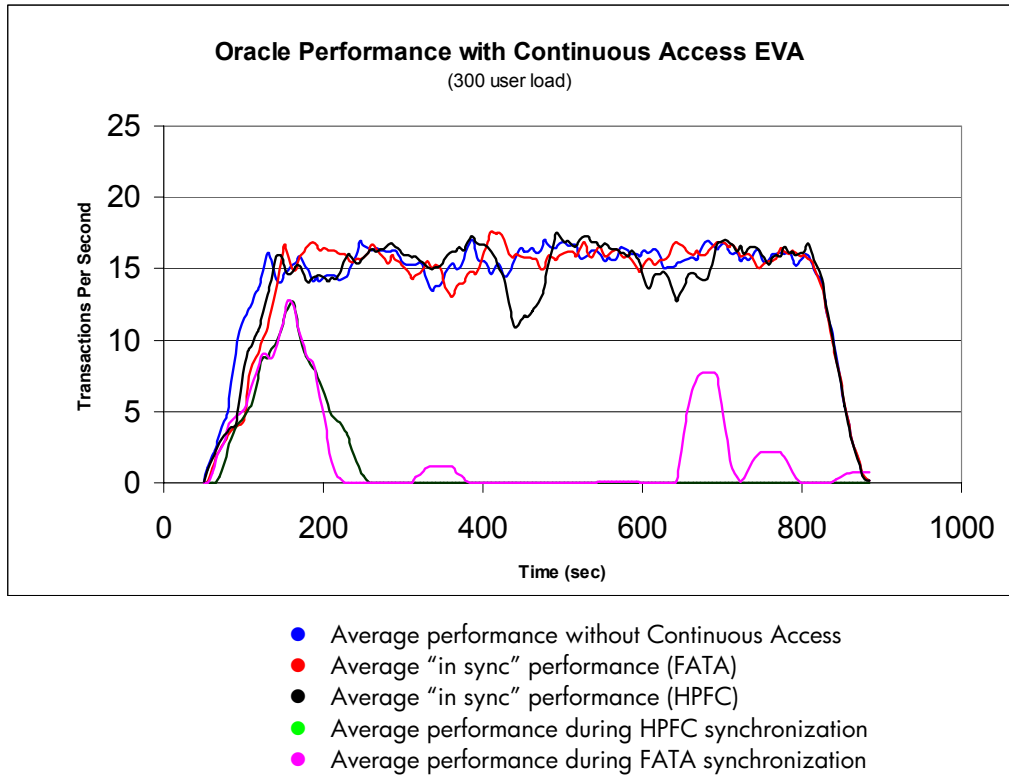


Table 5. Performance test results for remote replication with Continuous Access EVA

Performance tests	Technology		
	HPFC	FATA	LTO
Remote replication with Continuous Access EVA	Reference (100%)		N/A
Initial Continuous Access link creation time		104%	
Initial Continuous Access link creation performance (MB/s)		96%	
Oracle performance during link creation (TPS)		See following text.	
Oracle performance during link creation (RT)		See following text.	
Oracle performance after link creation (TPS)		102%	
Oracle performance after link creation (RT)		65%	

Using FATA drives as a destination device for a Continuous Access EVA yielded slightly better results than using HPFC drives. While it took a little longer time to initially synchronize the remote disaster recovery LUNs with FATA drives, Oracle TPS performance increased 2% and Oracle RT decreased 35% after the LUNs were synchronized.

As shown in Figure 4, Oracle was effectively shut down during the initial Continuous Access synchronization process. This occurred with FATA and HPFC drives as the destination device. Test results suggest that without a Continuous Access EVA link throttling mechanism, Oracle should be shut down until the two sites are fully synchronized.

It took approximately 1 hour to synchronize 130 GB of data. After Continuous Access link creation, Oracle performance remained relatively unaffected compared to Oracle performance without Continuous Access for the I/O load applied.

Conclusions

This report describes the application of the FATA disk drive as a cost-effective high-performance storage option for handling replication of data in both local and remote IT environments. In test results, the FATA drive demonstrated performance characteristics that were similar to HPFC drives when used as the destination device for replication, backup, and restore operations.

In general, these tests also showed that the impact of backup operations on Oracle9i database performance was negligible. For this test case, using FATA drives as the backup or replication destination device caused less of an impact on Oracle performance than using HPFC drives. This suggests that backups can be performed more frequently improving Oracle recovery time.

The performance impact of maintaining a 10-km synchronous Continuous Access EVA link also was negligible. Like the backup tests, there was a slight improvement in Oracle performance when FATA drives were used as the replication destination device. Link creation on the other hand is a very disruptive activity, and test results suggest that Oracle should be shut down or very lightly loaded until the link is in sync. With an active synchronous Continuous Access link, the “disaster recovery” procedure took only a few minutes.

The LTO tape library in comparison did not perform as well as the FATA drives in the configured test environment because of the relatively small backup set size. It is clear that FATA drives perform well in small configurations, and have the ability to handle replicated data requirements in much larger configurations as well. The tests suggest that as the backup set size increases, the performance gap between the LTO and FATA drives will become narrow.

The FATA disk drive technology offers a flexible low-cost storage solution for handling and protecting less frequently accessed data as a destination device for replication and backups. This report shows that it delivers the same high levels of performance and reliability as traditional Fibre Channel disk drives. While the final decision on which technology to use depends on the specific data requirements of your business, the performance of the new FATA disk drive makes it a competitive storage solution for both small and large Oracle database configurations.

Appendix

The following table lists the equipment used to run the performance tests described in this white paper.

Table 6. Test equipment specifications

Host name	Model/operating system	HBAs	Driver	CPUs/RAM	Bios	Comments
H07HPL30	L3000-5x / HPUX B.11.11	A6795A	PHKL_28984 PHSS_26799	PA8600/550 X 4 / 4GB	43.22 PDC	Oracle Server
H05HPL30	L3000-5x / HPUX B.11.11	A6795A	PHKL_28984 PHSS_26799	PA8600/550X4 / 2GB	43.22 PDC	Cell Server
H06HPL30	L3000-5x / HPUX B.11.11	A6795A	PHKL_28984 PHSS_26799	PA8600/550X4 / 4GB	43.22 PDC	Oracle Server

Name	Model	Firmware	Topology	Port speed	Zoning	Hop Count
128.1.42.1	Brocade 3200	V3.1.1c	Fabric	AN, 2GB	Yes	0 Host-Storage 1 Continuous Access Link
128.1.42.2	Brocade 3200	V3.1.1c	Fabric	AN, 2GB	Yes	0 Host-Storage 1 Continuous Access Link
128.1.42.3	Brocade 3200	V3.1.1c	Fabric	AN, 2GB	Yes	0 Host-Storage 1 Continuous Access Link
128.1.42.4	Brocade 3200	V3.1.1c	Fabric	AN, 2GB	Yes	0 Host-Storage 1 Continuous Access Link

Array	Firmware	Topology	Port speed	Number of LUNs	RAID configuration	LUN security
Scorpion EVA1 EVA5000 2C8D	VCS 3020	Fabric	2 Gb	6	RAID 0/1	Yes
Scorpion EVA2 EVA5000 2C8D	VCS 3020	Fabric	2 Gb	6	RAID 0/1	Yes

SAN appliance	Operating system	SMA software	CmdView
Scorpion EVA2 EVA5000 2C8D	WIN2K ADVSERVER	V2.1	3.2

Tape library	Library firmware	Library boot code	HW rev	Drive type	Drive FW	Number of drives	Comments
MSL5060	4.21	3	1	LTO 1st Gen	7.047	4	Lib IP 15.43.208.201

Software	Operating system	Version	Comments
Oracle 9i	HPUX	9.2	
HP StorageWorks Secure Path	HPUX 11.11	V3.0D	
SSSU*	HP-UX 11.11	V3.1	

*SSSU allows scripts to control Business Copy EVA and Continuous Access EVA functions as well as other array management functions, for example, creating and presenting LUNs.

For more information

HP storage

For the latest information on this solution, visit: <http://www.hp.com/country/us/eng/prodserv/storage.html>
From this website, select the appropriate product or solution.

The following links provide information about this solution and its components:

- HP StorageWorks Business Copy EVA
<http://h18006.www1.hp.com/products/storage/software/bizcopyeva/index.html>
- HP StorageWorks Continuous Access EVA
<http://h18006.www1.hp.com/products/storage/software/conaccesseva/index.html>
- FATA disk drive information
<http://h18006.www1.hp.com/storage/highlights/07122004.html>
- HP StorageWorks Enterprise Virtual Array 5000
<http://h18006.www1.hp.com/products/storageworks/enterprise/index.html>

HP technical support

Telephone numbers for worldwide technical support are listed at <http://www.hp.com/support/>. From this website, select the country of origin.

Note: For continuous quality improvement, calls may be recorded or monitored.

Be sure to have the following information available before calling:

- Technical support registration number (if applicable)
- Product serial numbers
- Product model names and numbers
- Applicable error messages
- Operating system type and revision level
- Detailed, specific questions

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