FalconStor®
Software

Optimizing
Business Continuity
And
Disaster Recovery Capabilities
for Oracle®

A WHITE PAPER

Abstract: FalconStor Software's Solution for Oracle delivers rapid, reliable, quality backup, restore, and recovery associated with routine and unplanned events, minimizing downtime, maximizing availability, streamlining storage administration, and reducing associated costs. The result is improved performance, availability, resource utilization, and management in an enterprise Oracle environment.

December 2004

Optimizing Business Continuity and Disaster Recovery Capabilities for Oracle with a FalconStor® Software Solution

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Optimizing Business Continuity and Disaster Recovery Capabilities in an Oracle Environment with a FalconStor Software Solution

Introduction

This paper is intended to highlight the common challenges associated with data protection in an Oracle environment as well as illustrate how the FalconStor Software Solution for Oracle can improve both business continuity and disaster recovery capabilities in a mission-critical Oracle environment. This paper is meant to accompany the FalconStor Software Solution for Oracle User Guide, a more technical installation and administration document.

This paper, as well as the FalconStor Solution for Oracle, focus on the challenges and capabilities associated with Oracle8i, Oracle9i, and Oracle10g standard edition, enterprise edition, or in clusters, on Windows, Linux, Solaris, or UNIX systems. The FalconStor Solution for Oracle currently supports Oracle 32- and 64-bit systems.

FalconStor products referenced herein—including IPStor®, TimeMark®, TimeView®, FileSafe™, and DiskSafe™, Storage Service Enabler, Snapshot Agent for Oracle, Backup and BareMetal Recovery, Remote Replication Software, and Active-Active Failover—are part of a comprehensive array of integrated, scalable software options available in the FalconStor Solution for Oracle. Functionality is the focus of this paper. FalconStor product datasheets and brochures are available for additional detail via the company's website at www.falconstor.com.

Data Protection Challenges in an Oracle Environment

Enterprise success today hinges on critical application and data availability. Information gathering and collection applications—databases—are the business-application pinnacle. At the forefront of database reliability and performance, Oracle databases have become an industry-standard. Tens, hundreds, thousands, and even tens of thousands of users within a single organization expect and require Oracle databases to be intact, up-to-date, and accessible at all times and under all conditions. Application and data unavailability resulting from downtime of any sort, for any reason, even in the event of a disaster, is unacceptable. Business continuity is paramount. Consequently, data protection schemes must provide for rapid, seamless, non-disruptive backup, restoration, and recovery.

Due to the explosive growth in the popularity and use of Oracle, coupled with the equally explosive growth in associated data volume, companies relying on Oracle often find themselves with a proliferation of servers, storage, and data—at both local and remote sites—that can be difficult to administer, manage, and protect and can promote ongoing and broad resource inefficiency, affecting enterprise performance, productivity, and bottom lines. The typical Oracle-dependent enterprise hosts numerous databases, multiple servers, and increasing terabytes of associated data storage capacity. Because enterprises typically grow piecemeal, a disconnected, often redundant infrastructure, with unnecessarily complex processes, higher overhead, wasted assets, and hindered application availability most often are the de-facto result in an otherwise-promising Oracle scenario.

While Oracle applications feature built-in data protection capabilities and also offer additional data protection solutions,[1] total enterprise data protection—comprehensive and efficient backup and recovery and disaster recovery—in such a critically important environment can be overwhelming, let alone ineffective. Moreover, enterprises seek to design and implement highly available Oracle environments. Yet, in the most common scenario, Oracle availability is restricted not by application server performance or capability, but by backup, restore, and recovery windows, driven by process- and task-time. As a result, the key to the most effective and highly performing enterprise Oracle system is optimization of data protection capabilities.

In any Oracle environment, the burgeoning availability requirements, user traffic, and data growth—command constant attention from any database and IT administrator.

Frequent data protection challenges and concerns include:

- Shrinking backup windows but larger backup requirements - making traditional methods of backup less realistic
- Hard-to-achieve recovery point and recovery time objectives - putting enterprise data and business continuity at risk in the event of unplanned downtime due to a disaster
- A constant need for reconfiguration of disk resources and additional storage capacity - a result of growth in data volumes and application servers, producing an inability to dynamically manage storage and capacity growth across multiple servers

Slow and Inadequate Backup, Restore, and Recovery

Most data protection initiatives provide for data copying. Oracle itself permits automatic backup of control files as well as automatic backup of database log archives, individually or in groups. However, the speed and quality of data copying varies by implementation, and is largely dependent on by the underlying storage solution. While this may have sufficed in the past, for many enterprises, they are no longer adequate in the current environment.

Depending upon the particular enterprise and the level of database transactions over a given period, the rate at which data changes—and, therefore, must be protected—varies immensely. Many storage and data protection solutions simply force Oracle administrators to duplicate entire databases and data volumes every time, pushing the boundaries of storage capacity and management by precluding rapid, efficient, incremental data protection.

Most traditional solutions also mandate either online ("hot") or offline ("cold") backup, but rarely are flexible enough to permit both methods. If a solution mandates online backup techniques, it likely reduces primary server and/or production environment availability by precluding effective offline data copying. If a solution mandates offline backup techniques, it likely reduces primary and production availability by precluding effective online data access. Either way, an enterprise customer depending on a traditional Oracle data protection scheme is left with little choice. The same can be said for local and remote backup capabilities. Without an advanced solution, the ability to centrally replicate all enterprise Oracle data is difficult.

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[1] For example, Oracle DataGuard, Oracle Enterprise Backup Utility, Oracle Managed Files, Oracle Automatic Storage Manager (www.oracle.com/technology/oramag/webcolumns/2003/techarticles/murphy_asm.html), or Oracle Recovery Manager (www.oracle.com/oramag/oracle/02-mar/o22recovery.html).

The process used to backup Oracle data can have a substantial impact on the application's availability because most data protection schemes and storage infrastructures were not conceived or configured to address the particular replication needs of today's typical enterprise 24x7xForever environment. In this context, increased Oracle data protection will lead to maximum Oracle application availability.

Data restore and recovery in an Oracle environment can be equally challenging. Oracle offers built-in and add-on recovery enhancements, including block-level recovery capabilities. However, it can be difficult to quickly resume operations after a version upgrade or repair and recovery of a corrupt database with assured data integrity and limited downtime.

Traditional data protection and storage solutions permit slow and unreliable data recovery, at best, leaving IT staff to sort through a maze of data volumes, while users experience critical application downtime. In a high-growth Oracle environment, these challenges merely are exacerbated. In addition, when it comes time to attempt data recovery, those organizations still relying on tape-only backup schemes experience even higher degrees of data loss and unavailability due to infrequent, unreliable, or inefficient tape backups.

In short, in an enterprise Oracle environment, administrators often spend too much time trying to meet backup needs, addressing database problems, and performing archive retrievals, emergency restores, or system recoveries. In the end, despite Oracle's capabilities, users do not achieve the application uptime that is needed because administrators cannot achieve the system performance required. Once again, backup, restore, and recovery optimization in an Oracle environment is the key.

Complex and Unreliable Disaster Recovery

While many firms dedicate countless hours to disaster recovery strategies and plans, not many are truly assured of a fully operational recovery—with current data and its integrity intact—following a disaster. In an enterprise Oracle environment, lost or inaccessible data due to an unplanned event can be catastrophic. Existing data storage infrastructure at some companies means the best-case scenario is resumption of business—often days later—under a dated or incomplete Oracle database. Sometimes, the next-best scenario is resumption of business with a corrupt database from a sudden or rolling outage.

In addition, many enterprises set up duplicate hardware and software "hot-spare" combinations in an effort to protect them from a site failure. Oftentimes, however, if the hot-spare disaster recovery combination is not an exact match—in product type, configuration, and currency—of the primary, production server or combination of servers, the ability to effectively resume Oracle operations during or post a disaster remains elusive.

The bottom line here is that many of today's enterprise Oracle environments are not prepared to handle or recover from a disaster. Even with adherence to Oracle disaster recovery guidelines, including remote mirroring,[2] many of these environments certainly are not set up to do so with any sense of simplicity, speed, or reliability. At a minimum, the consequence for most organizations is an increasing dependence on an enterprise Oracle environment that has a heightened level of data vulnerability, while continuing to function in an operating environment that has a heightened level of business risk.

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[2] See, for example, "Guidelines for Using Remote Mirroring Storage Systems for Oracle Databases," Oracle Corporation, November 1999.

Such a result cheats Oracle application aptitude. With the proper data protection and storage solution, disaster recovery capabilities in an enterprise Oracle environment can be optimized to reduce data vulnerability and business risk—as well as improve operating efficiencies and overall performance.

Difficult to Manage Infrastructure and Processes

As already noted, in the typical enterprise Oracle environment, the variety and placement of infrastructure alone can make storage management difficult. Enterprise-wide, Oracle systems can be dependent on a combination of storage types (DAS, NAS, SAN) and operating systems (Windows, Linux, etc.), introducing added complexity and duplicity into any administrator's list of data protection tasks, to say nothing of overall system management. According to Oracle research, due not to the nature of Oracle, but, rather to the complexity of the typical enterprise environment, on average, database administrators spend more than half of their time carrying out ongoing management tasks that include provisioning, configuring, and mapping for the purposes of performance tuning, space management, and system resource tuning.

For example, for each database, administrators must manage the database file system and volume manager as well as an endless number of associated files. In addition, the ability to scale Oracle-associated storage without downtime (and, therefore, without disrupting database availability) is not a common capability of most solutions. However, database data volumes can grow 20% or more annually, mandating ongoing, additional storage capacity. And, most database archival schemes also were not devised for quick access, at a granular level, to archived data. The inability to rapidly recover a storage group or database in minutes means not just additional user productivity downtime but also the absorption of additional wasted administrative labor hours.

These and other similar difficulties compound the challenges facing today's database and storage administrators. Some of these tasks can require dozens of manual activities and take days or weeks under a traditional storage scenario. FalconStor Software understands the nature of critical Oracle application needs, especially in an enterprise environment. FalconStor understands data storage, especially in an enterprise environment. FalconStor enables optimized data protection functionality—both for backup and recovery and disaster recovery—in an Oracle enterprise environment with the FalconStor Solution for Oracle.

The FalconStor Solution for Oracle

By combining a standard open architecture, advanced storage virtualization features, and intelligent storage management and services capabilities with advanced, application-specific tools, FalconStor ensures that enterprise Oracle environments are reliably protected, highly available, and easily managed. The consistent results of the FalconStor Solution for Oracle are:

- Optimized data protection and availability
- Efficient storage provisioning
- Maximized storage utilization
- Lower management costs
- Reduced downtime
- Lower total cost of ownership
- Increased return on investment.

The FalconStor Solution for Oracle enables the utmost in business continuity and disaster recovery by moving storage functionality and management—specific to the application—to the layer between the host and the storage, into the storage network. The center of the FalconStor Solution—FalconStor IPStor Enterprise—delivers an intelligent storage infrastructure across heterogeneous environments.

The software architecture is easy to understand, deploy, and manage. It is simple to integrate into an existing environment since the associated appliance (an IPStor appliance, a standard, off-the-shelf, Linux- or Solaris-based server running IPStor software) sits between the servers and storage and supports any-to-any connectivity. IPStor places no limitations on hardware, software, or storage choices—an important point in today's varied Oracle environments. It works with any vendor/type storage pairing that is Fibre Channel (FC)-attached, iSCSI-attached, direct-attached, or any combination thereof.

Implementing an IPStor-based storage solution in any environment, including in an existing enterprise Oracle environment, is easy and the associated services are readily available via the FalconStor intelligent wizard functionality. One or more IPStor appliances are simply positioned between the relevant application servers and the currently associated server storage. IPStor immediately is able to see and access the storage devices the servers originally were using. The original Oracle data is neither moved nor modified (unless desired).

So, with the FalconStor Solution for Oracle, improved data protection functionality is gained without changing the existing storage paradigm (unless desired). The storage devices appear to their respective servers as the same devices they were using before solution implementation. Once the solution has been placed in the "data path," between the host (the Oracle application server) and the storage, advanced data protection for backup recovery and disaster recovery in an enterprise Oracle environment can be achieved immediately.

The FalconStor Solution for Oracle enables rapid, simple, and comprehensive backup and recovery and disaster recovery capabilities, including:

- Point-and-click creation of transaction-consistent images of Oracle databases
- Automatic, alternate-location, including off-site, creation of Oracle database replica
- Instantly accessible, full-integrity Oracle database backups (which can be achieved online or offline, local or remote) for disaster recovery purposes (such as in the event of a site loss and/or sudden or rolling disaster)
- Complete recovery from logical database corruption (such as in the event of the loss of a single mission-critical Oracle database)
- Administrator-initiated restores.

The FalconStor Solution for Oracle also delivers the improved infrastructure and management efficiencies that come with any FalconStor IPStor-centered solution. Illustrations of how the FalconStor Solution optimizes Oracle performance and availability in backup, recovery, and disaster recovery scenarios as well as how the FalconStor Solution elevates overall IT asset performance and availability appear in the sections that follow.

Improved Business Continuity Capabilities

The FalconStor Solution for Oracle offers end-to-end data protection, immediate recovery from hardware, software, and network failures, pro-active work without downtime, and non-stop data availability.

Whether associated with "what-if" scenario requirements, administrative error, user error, or just plain data degradation due to outside events, the FalconStor Solution ensures highly available, highly dependable enterprise Oracle environments.

With the FalconStor Solution (via the IPStor TimeMark option), administrators gain a continuous point-in-time (PiT) capability and an instant, granular, rollback capability (via disk-based journaling) to protect data from soft errors such as accidental deletions, corruptions, and viruses. At any given point in time, an administrator can elect to rollback to a database status of minutes, hours, days, weeks, or months prior. Even individual database files or table spaces, deleted outside of Oracle supplemental data protection features, can be retrieved, quickly and fully intact.

The FalconStor Solution for Oracle permits creation of continual, consistent, PiT images of any managed volume (including both data and logs) by using copy-on-first-write technology. TimeMark PiT snapshots behave much like physical copies, but, unlike a physical mirror, do not require a significant amount of time or storage capacity. Snapshots require mere moments and only a fraction of the disk storage space demanded by the original application. Consequently, a greater volume of Oracle data can be protected using snapshot technology and backup and restores can be accomplished without negatively impacting data integrity or availability.[3] The FalconStor Solution can be used for both hot and cold backups (as well as for remote replication and PiT disaster recovery, both of which are addressed in an ensuing section of this paper).

For example, when a snapshot request comes in, the Oracle database is put into online backup mode (e.g., a hot backup in archive-log mode, where the table spaces are altered to begin the backup). Normal database operations then are resumed (when the table spaces are altered again to end the backup). However, because the process does not necessitate reading the data from beginning to end, but, rather, simply capturing an image of the data on the disk, backup speed is rapidly increased and the backup window is dramatically reduced. Both process time improvements translate to greater database application availability.

With the FalconStor Solution for Oracle, one can create up to 256 TimeMark "copies" per Oracle data volume and still use only a small amount of storage—20% of the original capacity, on average. One can schedule snapshots to occur by the minute, hour, day, etc., using varying changed-data parameters. In other words, with the FalconStor Solution for Oracle, customized data protection policies can be set for different Oracle data volumes, further extending Oracle data protection optimization.

Because only changed data is saved using disk-based delta snapshots, less storage is required. What results is an ability to store incremental Oracle backups online, making all backed up data, from any of the 256 PiTs, immediately and easily retrievable. With this capability, restores require only the time it takes to make a few mouse clicks, not the time it takes to retrieve, load, and scan an actual linear storage medium like tape.

The FalconStor Solution for Oracle also permits wide flexibility in backup methodology. A FalconStor customer, for example, can opt to perform hot online backups, as described above, or to perform traditional cold, offline backups as well as both hot and cold backups using "export" scenarios.

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[3] For more details, see, for example, "Guidelines for Using Snapshot Storage Systems for Oracle Databases," Oracle Corporation, October 2001.

In a cold offline scenario, Oracle databases are shut down entirely (i.e., during non-business hours) and all data, log, and control files can be backed up rapidly and efficiently via the IPStor and snapshot capabilities. Upon the restart of the database, normal operations are resumed.

In an export scenario, data table information can also be exported to a separate temporary file, outside of the production environment, and the FalconStor Solution can capture an image of the "logical" definitions and data (as opposed to the "physical" data) in the temporary file or place a copy of the entire file on a backup server.[4] Either way, backup window time is taken offline. Basically, in a cold export, the local database is shut down (either normally or immediately), all changes are propagated to a secondary site (with async mode), a snapshot is set, the primary database is restarted and normal operations are resumed, and the remote secondary database can be used to take the backup at any time. In a hot export, the process is the same except that the table spaces are simply altered to begin and end the backup, but the database is not shut down.

The FalconStor Solution for Oracle also permits an administrator to assign and mount any TimeMark snapshot as a virtual disk—or "TimeView"—to any server connected to the IPStor-managed storage network. Not only does the server then have full read-write access to the new disk, TimeView copies subsequently can be backed up or mounted for other operational uses (including for pro-active purposes), while the original data set is in use and unaffected. TimeViews also can be taken from replicated data copies, allowing operations (e.g., for backup, reporting, consistency checking, or retrieval of a lost record) on a stable image in a remote location, for example. The same functionality can be used for recovery when system reset is undesired. And, FalconStor snapshot capabilities enable database modeling without affecting the production database.

FalconStor Solutions excel in high-growth and high-volume database environments requiring strict and dependable backup regimes. This is the case especially for critical data gathering and serving applications like Oracle because FalconStor Solutions are conceived, designed, and fully integrated to be application-specific.

Meeting Recovery Time Objectives with Snapshot Agents for Oracle

Advanced Backup & Recovery for Oracle:

- Snapshot Agent for Oracle and TimeMark features increase backup frequency with 100% guaranteed data integrity
- TimeView feature delivers accelerated, space-efficient recovery process designed to exceed Recovery Time Objectives (RTOs)
- Backup & BareMetal Recovery feature provides ability to guard against boot disk failure

FalconStor Solutions integrate tightly with Oracle for rapid and reliable backup and recovery because FalconStor has combined IPStor features (such as TimeMark and TimeView) with an application-aware, client-based snapshot agent (the Snapshot Agent for Oracle). This unique combination minimizes downtime for quick time-to-restore and ensures that active databases are backed up with full transactional integrity and PiT consistency, even if the data is spread across multiple drives and locations.

Although multiple Oracle databases can reside on the same device, Oracle suggests each database—particularly mission-critical databases and including both logs and database files—preferably are placed on separate disks in order to address both fault tolerance and performance issues (for example, in a single

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[4] Note: Should a user need to replace a damaged file or provide a duplicate database copy; a user cannot "roll forward" from a restored export file—regardless of the solution.

enterprise, three Oracle databases on three disks reduces data risk and availability impact). With many solutions, however, this imposes this same requirement on the snapshot agent. The FalconStor Solution for Oracle delivers more options. With the FalconStor Solution, an administrator has the ability to put each database in backup mode individually, one database at a time, or together.

Building on the snapshot agent technology, IPStor's Snapshot Group feature allows disks to be grouped for snapshot synchronization purposes. Snapshots for all resources in a group are taken at the same time, whenever a snapshot is triggered. This feature, working in conjunction with the IPStor Snapshot Agent for Oracle, ensures transactional integrity for transaction logs and database files that reside on multiple disks.

Whether capturing individual Oracle databases or groups, the snapshot agents make certain that each TimeMark is valid and mountable by the Oracle server. Where many solutions falter, in the time for recovery (i.e., in their ability to meet Recovery Time Objectives) and quality of recovery, the FalconStor Solution for Oracle excels by permitting rapid and complete data recovery. The FalconStor Solution makes it unnecessary to perform time-consuming data validity checks (e.g., using the "chkdsk" command) and database recovery procedures in order to successfully mount the database. Many other Oracle data protection solutions (and, therefore administrators) do not check backup media to ensure that database has been successfully written to the backup tape or disk. In many cases, an empty or incomplete backup is written, leaving the enterprise stranded in time of need.

With the FalconStor Solution, when the TimeMark process is activated (either manually or automatically via scheduled policies), the Oracle snapshot agent communicates with the appropriate Oracle database to let it know that a snapshot is about to be taken. The Oracle snapshot agent makes calls to the Oracle APIs to put the database in hot backup mode, momentarily quiescing the database. All transactions are flushed to disk (simultaneously for both the database and transaction log disks) to ensure database transactional integrity. Once the snapshot is taken, the database resumes normal operations. What results is a snapshot that contains a transactionally consistent picture of the database and associated logs. Again, FalconStor IPStor snapshot agents are specifically written and tested for each database application product, including Oracle, to ensure that the application is correctly quiesced resulting in a PiT TimeMark that has guaranteed integrity.

Oracle Continuity Challenge: Non-Disaster Hardware Failure

The FalconStor Solution for Oracle protects against "soft" errors (e.g., when hardware operations are maintained, but a non-hardware-associated error affects continuity) as well as against "hard" errors (e.g., when software operations are maintained, but a hardware-associated failure affects continuity). The FalconStor Solution for Oracle limits downtime and optimizes application and data availability in the event of either scenario.

For example, many competing backup and recovery solutions for Oracle provide protection from data loss but exclude protection from boot-disk failure, making recovered data unusable or forcing unnecessary downtime for hardware replacement or repair in order to restore the Oracle server to working order. If an Oracle server cannot be rebooted, even the most fault-tolerant data protection scheme is useless.

The FalconStor Solution for Oracle (with the DiskSafe software option) permits expedited data recovery even after boot-disk failure of the Oracle server by capturing a system's boot disk image and saving it to a separate, online disk. (DiskSafe is an online mirroring process that clones the direct-attached Oracle boot/system disk.) Return-to-service time is reduced to minutes rather than hours or days because the targeted system can be rapidly reset over standard protocols (iSCSI or FC). Once the system is rebooted, the local boot disk can be replaced and the boot information and data can be restored to the newly replaced

local disk all via simple point-and-click functionality. The FalconStor Solution makes certain that both the Oracle server and the associated Oracle data are protected and highly available.

Improved Disaster Recovery Capabilities

The ultimate business continuity challenge is a disaster recovery challenge. End-to-end, enterprise business continuity—especially for mission-critical database applications—is mandatory, even in the event of a disaster. There are many solutions available to maintain Oracle high availability.[5] However, the FalconStor Solution for Oracle ensures enterprise Oracle business continuity in the event of all kinds of disasters—including sudden outages, rolling outages, and site elimination—as well as for all kinds of facilities—including headquarters and remote data centers and offices.
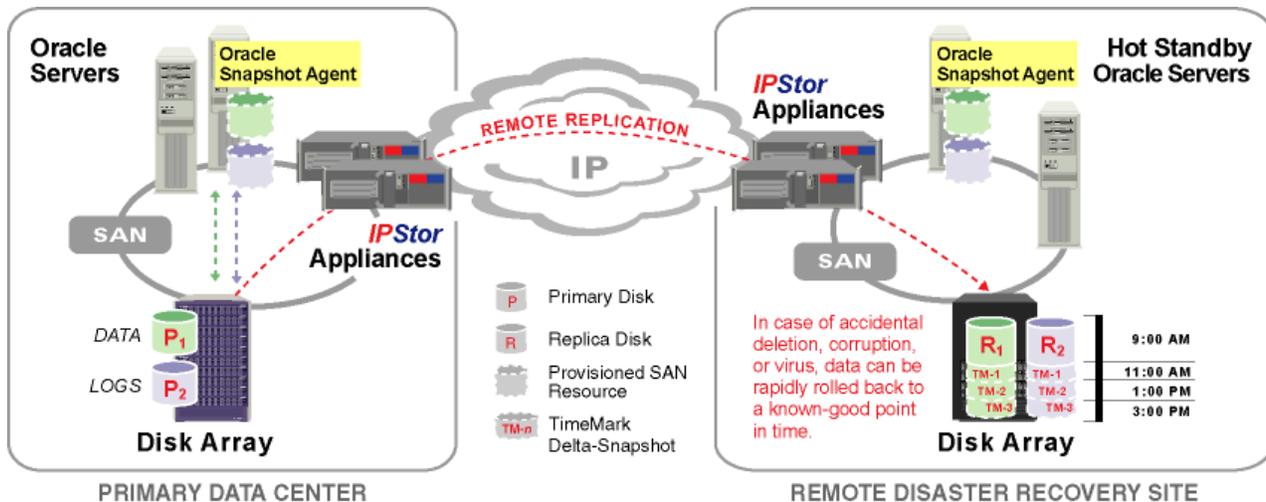
No matter what the cause, the FalconStor Solution for Oracle secures business continuity before, during, and after a disaster strikes and without the expense or effort to integrate new, expensive, specialized storage arrays. With the FalconStor Solution, disaster recovery-associated Oracle data protection can be assumed the minute FalconStor software is installed. In the event of any kind of disaster, Oracle operations can be resumed rapidly with minimal data or production time loss.

Utility power failures, local or widespread fires or floods, high-level hacker attacks, and national emergencies all can cause unplanned outages that leave a company's IT systems vulnerable and, quite often, inoperable. In a mission-critical enterprise Oracle environment, IT administrators must devise a strategy—as well as build an infrastructure—that permits quick and effective disaster recovery. The FalconStor Solution for Oracle does just that.

Optimized Delta-Based Replication

The FalconStor Solution for Oracle epitomizes the optimal enterprise Oracle disaster recovery architecture both in terms of speed and flexibility. The FalconStor Solution (via IPStor functionality) facilitates simple yet comprehensive protection of mission-critical Oracle data between data centers, or between remote offices and data centers, via innovative remote replication over IP (using a foundation process much like that described in a hot export backup to create a second instance of an Oracle database).

Replication over IP is reliable, secure, and efficient:

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[5] See, for example, Oracle Fail Safe, Oracle Parallel Server, Oracle HA Server, etc.

- Reliability is achieved through automatic retry and resume in the case of disrupted replication sessions
- Encryption ensures the security of the data in transit
- Data compression combined with a high-resolution microscan (identifying sector-level changes) enables optimal use of WAN links.

Using delta-based replication over IP, the FalconStor application-aware, transaction-based, remote replication capability (via IPStor Remote Replication Software) enables sites to replicate delta changes in Oracle data across any distance via IP to same or dissimilar hardware for continuous Oracle application operation in case of a disaster. The remote replication capability integrates seamlessly with the IPStor snapshot agent for Oracle maintaining consistent PiT copies of Oracle data replicas for quick data recovery. And, with FalconStor, it is possible to never affect a performance impact on Oracle production servers at the primary site.

Using quick, initial synchronization, the FalconStor Solution easily protects even very large primary disk stores associated with Oracle. FalconStor software allows bulk transfer of the replica via either mirror-and-ship or by image backup/restore via tape, so that the Oracle replica is always in sync, outside of changes that occurred during the shipping or backup process time. The FalconStor Solution is then able to scan the replica for departures from the initial map and sync up any differences (only changed blocks are applied). The primary and replicated data are identical and concurrent. Data compression and encryption are used to maximize network bandwidth and protect data security.

Using the FalconStor Solution, Oracle data protection and availability is optimized. Traditional methods demand more and more data volume duplication, driving up storage capacity and administrator task-time requirements.

Oracle Disaster Challenge: Site Loss

Specifically designed to guard against site loss, the FalconStor Solution for Oracle provides automated, off-site, data protection capabilities. The FalconStor Solution allows a replica disk to be pre-assigned to hot standby servers at the disaster recovery site. In the event of a disaster, the replica is promoted to primary status and the LUN assignment operates automatically. LUN pre-assignment prevents the confusion that typically occurs in the midst of a disaster. Oracle and IT administrators have one less process to manage during their crisis.
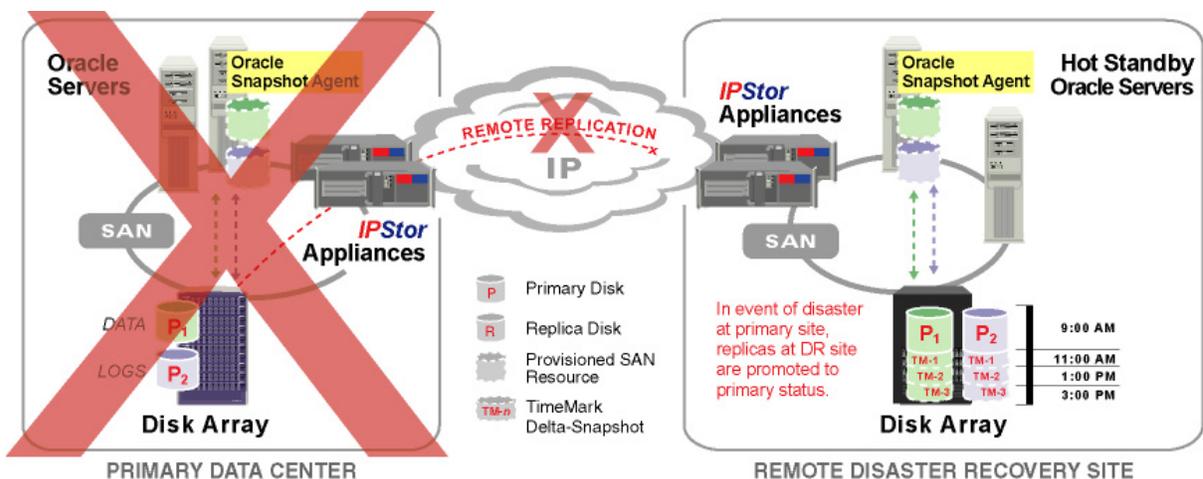
After promotion and assignment, each standby Oracle server is ready to be powered up. With the FalconStor Solution, when the TimeMark option is enabled at the replica, each individual change is recorded. In the event of a disaster that causes Oracle data corruption, for example, any of the previous 256 snapshots can be used in a rollback (both current and previous versions can be mounted for read/write access over IP). And, because replica changes are stored in a separate area and not written to the stored replica until the full data set is confirmed received and intact, the FalconStor Solution for Oracle guards against replica corruption and interruption, even due to a disaster.

Advanced Business Continuity and Disaster Recovery for Oracle:

- Pre-disaster
  - Remote replication of Oracle LUNs via multiple TimeMarks and transactional integrity via snapshot agents
  - Pre-assignment of replica LUNs to standby Oracle servers
- During disaster
  - Sudden disaster—RTO achieved through rapid promotion of replicas to the disaster recovery site
  - Rolling disaster—Immediate roll reversal, leveraging TimeMarks, of primary and disaster recovery sites for business continuity
- Post-disaster
  - Reverse synchronization, by scanning only for data that has changed, minimizes the time and capacity needed to re-establish the primary site

Finally, unlike other solutions, in a disaster recovery circumstance, the FalconStor Solution for Oracle guarantees that both the data and the boot disk are safe. Using the same functionality in the case of any type of unplanned downtime, the FalconStor Solution provides expedited recovery of Oracle data and databases—even after boot-disk failure—and does not require server takedown. Rapid disaster recovery is achieved with a remote boot, especially in the case of a site loss, because the boot can be conducted off anywhere (with equivalent hardware), without productivity loss.

Oracle Disaster Challenge: Post-Disaster Restoration

After the disaster recovery site has been promoted to production status, the enterprise will be fully operational at the remote disaster recovery location. The Oracle servers will be providing services to the entire enterprise. However, most disaster recovery solutions do not address the methodology to then quickly re-recover the primary site. The FalconStor Solution for Oracle has been designed specifically to provide rapid, post-disaster restoration.
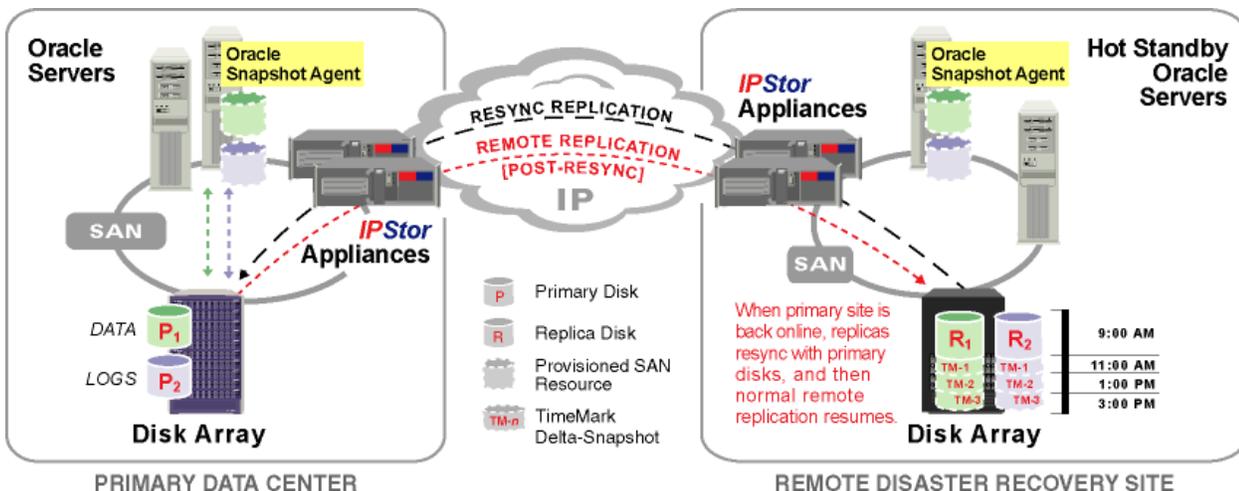
Following a disaster, to revive or restart the primary site after the problem or failure is rectified; reverse synchronization can be achieved simply by moving the "newer" Oracle data from the disaster recovery site back to the primary site. The FalconStor Solution for Oracle facilitates this near transparent "role reversal" by scanning for differences, minimizing the time and capacity necessary to re-establish the primary site.

Architecture for a Complete BC/DR Solution for Oracle

FalconStor facilitates high availability for Oracle environments. To accomplish this, the FalconStor Solution for Oracle (via the IPStor Active-Active Failover option) empowers one IPStor appliance to take over the processing tasks of a second IPStor appliance in the event of a system failure, protecting the enterprise Oracle environment from any single point of failure.

In the FalconStor high availability scheme, the primary and secondary servers are independent IPStor appliances. Each may have assigned clients that are being serviced (active-active mode) or one may not be serving any clients while it awaits a failover (active-passive mode).

The FalconStor Solution for Oracle also can make use of multi-pathing software to heighten business continuity. The solution leverages multi-pathing software at the application server to create parallel active storage paths that transparently re-route traffic to a redundant storage path without interruption.

For continuous operation during a planned or unplanned outage, the FalconStor Solution for Oracle delivers a highly redundant storage solution offering 24x7xForever availability. Whether the outage is due to unplanned hardware failure or planned maintenance/upgrades, the FalconStor Solution for Oracle ensures non-stop data availability.

Improved Overall Storage and Management Capabilities

The FalconStor Solution for Oracle unifies an overall storage infrastructure and streamlines processes, improving data protection as well as data storage and management capabilities. In an enterprise Oracle environment, this translates to the highest in availability and best possible performance.

Management Benefits for Oracle:

- Maximum resource utilization of storage, tools, and personnel
- Enhanced performance of storage, tools, and personnel
- Greater availability of applications, data, storage, infrastructure, and personnel
- Efficient management of applications, storage, tools, and overall infrastructure

First, the FalconStor Solution is very flexible. It integrates into and out of existing enterprise Oracle, storage, and data protection environments without changes to the existing hardware infrastructure or paradigm. Using IPStor and other available FalconStor software options, storage can be immediately virtualized and storage services can be instantly enabled. Simple wizards direct all management functionality. Oracle performance and availability are optimized via advanced data protection capabilities. Like all FalconStor Solutions, the FalconStor Solution for Oracle fits a customer's preferred method of doing business. FalconStor customers do not have to change to fit FalconStor's way of doing business.

Second, FalconStor facilitates heterogeneous storage consolidation. IPStor maximizes capacity utilization through consolidation of application servers and disk resources across OS, cabinet, vendor, and connectivity and interface types. Storage managed by IPStor can be of any type (DAS, SAN, NAS, disk-array, RAID, SSD), supporting any OS (Windows, Linux, AIX, Solaris, HP-UX, NetWare, etc.), and at any location (local, remote). With FalconStor Solutions, separate, disparate SAN islands can be unified over IP.

Existing storage resource combinations can be combined with new resources to create both SAN (block level) and NAS (file level) resources. As a result, in an enterprise Oracle environment, IPStor capabilities can be extended across architectural and location boundaries to provide the utmost in data protection, while still maintaining infrastructure performance, reliability, and integrity.

Third, for companies that need to improve operations, performance, and availability while leveraging existing storage investments, the FalconStor Solution allows for complete use of legacy tools, including tape libraries and other backup tools. In fact, for even greater protection and critical archival purposes, via TimeView, backup to tape can be completed from a replica with no impact on the production environment, application, or data availability. In addition, the FalconStor Solution for Oracle leverages the functionality of existing third-party backup software. FalconStor software solutions (for example, HyperTrac Backup Accelerator and ZeroImpact Backup) accelerate third-party backups and yet the backup process still can be offloaded from the production server, centralizing management, improving overall Oracle application availability, and further strengthening business continuity.

Fourth, FalconStor delivers centralized, simplified storage management. In an enterprise Oracle environment, this translates into improved management of both single and multiple groups. IPStor software merges storage and storage services management at the IPStor console, a single, unified, easy-to-use, go-anywhere, Java-based interface. Fast and easy point-and-click and wizard functionality can be used for storage provisioning, management, and administration tasks. Oracle-associated data management is simplified and costs lowered by consolidating storage into the network on the IPStor appliances and off the servers as well as simplifying ongoing management via the unified console.

Fifth, downtime and performance impact due to routine and non-routine tasks are significantly reduced with the FalconStor Solution for Oracle, freeing up IT staff for more pro-active and strategic assignments. Downtime and task-time is eliminated during disk upgrade or replacement, data migration from old to new storage, and data replication. Downtime and task-time associated with recovery is slashed to minutes.

Finally, with the FalconStor Solution for Oracle, for those Oracle enterprises using file system storage solutions (e.g., NAS), administrators gain the ability to add associated storage capacity (via the Capacity-on-Demand function) without downtime and, therefore, without disrupting database application functionality. The Capacity-on-Demand capability permits policy settings for automatic storage capacity expansion of specified volumes at specified thresholds. This capability is critical in enterprise Oracle environments, where data volumes grow exponentially each year. Projecting disk capacity requirements or disk space allocations 12 or 18 months out can be very difficult. With FalconStor's Capacity-on-Demand feature, the worry, uncertainty, and cost inefficiencies associated with capacity planning are eliminated. A FalconStor Solution for Oracle guarantees storage capacity always will be available. Plus, IPStor can be used to serve other storage, further extending the Capacity-on-Demand line of benefits into the enterprise.

Conclusion

It is clear that successful business operations hinge on a company's ability to maintain a high level of enterprise data availability. Critical applications, such as Oracle, demand advanced data storage management. In an enterprise Oracle environment, the FalconStor Solution optimizes application and data availability as well as storage management capabilities, delivering an enhanced backup, restore, and recovery regime that protects against soft and hard errors.

The result is not just greater business continuity, but also improved physical and human resource utilization, improved application and infrastructure performance, and easier and more efficient application and storage management. Most organizations cannot afford to lose precious operational uptime or valuable enterprise data. Most enterprises using Oracle cannot function without Oracle. Simple and dependable, the FalconStor Solution for Oracle optimizes Oracle data protection functionality.

In summary, the key benefits of the FalconStor Solution for Oracle include:

- Creating transaction-consistent images of databases
- Improving replica frequency and integrity while minimizing storage capacity requirements
- Conducting automatic, alternate-location (including off-site), instantly accessible, full-integrity data replication
- Rapid recovery from a disaster, including a complete site loss and/or sudden or rolling disaster due to Oracle-associated hardware or other infrastructure failure
- Rapid recovery from logical corruption, including the loss of a group in a mission-critical database
- Guarding against boot disk failure
- Improving resource utilization, availability, and performance
- Better management of data storage and data protection

About FalconStor Software

FalconStor Software, Inc. (Nasdaq: FALC) is a leading developer of network storage software designed to optimize the storage, protection and availability of enterprise data. FalconStor's flagship product, IPStor, enables corporate IT to deploy a hardware-agnostic, network-centric foundation to maximize operating efficiency and business continuity, and to meet the availability requirements of mission-critical applications. IPStor-powered network storage solutions are available and supported by major OEMs, as well as system integrators and resellers worldwide.

Founded in 2000, FalconStor is headquartered in Melville, NY, with offices throughout Europe and the Asia Pacific regions including Paris, Tokyo and Taiwan. FalconStor is an active member of the Technical Support Alliance Network (TSANet), Storage Networking Industry Association (SNIA) and Fibre Channel Industry Association (FCIA). For more information, visit www.falconstor.com or call 1-631-777-5188.

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