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Architecture Principles and Implementation Practices for Remote Replication Using Oracle ZFS Storage Appliance
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Introduction

An increase in storage demand increases the complexity of protecting data. The storage-based remote replication feature of Oracle ZFS Storage Appliance products offers a simple and effective automated solution for businesses that require off-site copies of production data in addition to local backups. By maintaining a replica of the primary data at a remote site, disaster recovery time is dramatically reduced compared to traditional offline backup architectures.

To help system planners seeking to protect local copies of data by replicating them to a remote site, this paper addresses considerations in planning and implementing remote replication with the Oracle ZFS Storage Appliance. The information particularly addresses system planners seeking to simplify off-site data protection.

This paper presents the following topics:

- Overview of the remote replication feature of the Oracle ZFS Storage Appliance
- Implementation guidelines for deploying remote replication
- Application-specific implementation guidelines
- Example architecture
- Remote replication benefits
- Remote replication considerations

Note that some of the functions and features described in this white paper are introduced in the 2013 release of the Oracle ZFS Storage Appliance and are not available in earlier releases.
NOTE: References to Sun ZFS Storage Appliance, Sun ZFS Storage 7000, and ZFS Storage Appliance all refer to the same family of Oracle ZFS Storage Appliance products. Some cited documentation or screen code may still carry these legacy naming conventions.
Overview of Oracle ZFS Storage Appliance Replication

The Oracle ZFS Storage Appliance products support snapshot-based replication of projects and shares from a source appliance to any number of target appliances or to a different pool in the same appliance. Replication can be executed manually, on a schedule, or continuously for the following use cases:

- **Disaster recovery.** Replication can be used to mirror an Oracle ZFS Storage Appliance for disaster recovery. In the event of a disaster that impacts service of the primary appliance (or even an entire data center), administrators activate service at the disaster recovery site, which takes over using the most recently replicated data. When the primary site has been restored, data changed while the disaster recovery site was in service can be migrated back to the primary site and normal service restored. Such scenarios are fully testable before such a disaster occurs.

- **Data distribution.** Replication can be used to distribute data (such as virtual machine images or media) to remote systems across the world in situations where clients of the target appliance would not ordinarily be able to reach the source appliance directly, or such a setup would have prohibitively high latency. One example uses this scheme for local caching to improve latency of read-only data (such as documents).

- **Disk-to-disk backup.** Replication can be used as a backup solution for environments in which tape backups are not feasible. Tape backup might not be feasible, for example, because the available bandwidth is insufficient or because the latency for recovery is too high.

- **Data migration.** Replication can be used to migrate data and configuration between Oracle ZFS Storage Appliances or moving data to a different pool within the same Oracle ZFS Storage Appliance for reasons of upgrading hardware or rebalancing storage. Shadow migration can also be used for this purpose.

The replication feature has several important properties:

- **Snapshot-based.** The replication subsystem takes a snapshot as part of each update operation and sends the entire project contents up to the snapshot, in the case of a full update. In the case of an incremental update, only the changes since the last replication snapshot for the same action are sent.

- **Block-level.** Each update operation traverses the filesystem at the block level and sends the appropriate filesystem data and metadata to the target.

- **Asynchronous.** Because replication takes snapshots and then sends them, data is necessarily committed to stable storage before replication even begins sending it.
Continuous replication effectively sends continuous streams of filesystem changes, but it is still asynchronous with respect to NAS and SAN clients.

- **Includes metadata.** The underlying replication stream serializes both user data and Oracle Solaris Zettabyte File System (ZFS) metadata, including most properties configured on the Shares screen. These properties can be modified on the target after the first replication update completes, though not all take effect until the replication connection is severed, for example, to allow sharing over NFS to a different set of hosts than on the source. See the replication documentation in the “Remote Replication” section of the “Service” chapter in the administration guide at http://www.oracle.com/technetwork/documentation/oracle-unified-ss-193371.html for details.

- **Secure.** The replication control protocol used among Oracle ZFS Storage Appliance products is secured with secure socket layer (SSL). Data can optionally be protected with SSL as well. An Oracle ZFS Storage Appliance can only replicate to/from another Oracle ZFS Storage Appliance after an initial manual authentication process; see the administration guide for more details.

- **Protocol Independent.** The Oracle ZFS Storage Appliance supports both file (CIFS and NFS) and block based (FC and iSCSI LUN’s) storage volumes. The replication mechanism is protocol independent.

The site that hosts the project to be replicated is called the **source** and the receiving side is called the **target**. Administrators must define replication actions on the source appliance. Actions are the primary administrative control point for replication. The replicated data at the target is referred to as a **package**.

Replication can be configured either 1:1, 1:many, or many:1 between Oracle ZFS Storage Appliance systems. Likewise, more than one action can be added to a project. In this context, many projects can be replicated to many targets simultaneously. Replication is supported between any Oracle ZFS Storage platform. It is also possible to replicate between different storage profiles.

One Oracle ZFS Storage node can act as both source and target for projects to be replicated.

For example, node 1 contains three projects: project1, project2 and project3. Node two contains two projects: project1 and project2. Node one replicates project1 to node 2 and node 2 replicates project2 to node 1. In this scenario, each node keeps a copy of the project of the other node. Additionally, node 1 can replicate project3 to itself. You could use this setup to migrate a project to a different pool or to copy data from a deduped pool to a non-deduped pool.

Consult the administration guide for more details on these replication procedures.

In this paper, the term **replication update** refers to a cycle of operations starting with an implicit snapshot followed by streaming of the data to the target to completion.
Replication Modes

Oracle ZFS Storage Appliance remote replication supports three different replication modes to give administrators flexibility when supporting new deployments and complex legacy applications:

- **On-demand**: Replication is triggered manually by the user at any time.
- **Scheduled**: Replication is automatically executed according to a predetermined schedule. Schedules can be defined at the granularity of half-hourly, hourly, daily, weekly, and monthly.
- **Continuous**: The replication process is automatically executed continuously. As soon as one replication update is complete, a subsequent update is started. This way, the changes are transmitted as soon as possible.

The replication process is the same for each mode except that the time interval between the replications is different. The replication modes can be changed from one to another at any time to support different and changing business requirements.

The following diagram provides a high-level overview of the replication concept. Oracle ZFS Storage Appliance systems are used as both source and target. A project with three types of shares (NFS, CIFS, and a block-based volume (LUN) are replicated. At time t1, a full replication happens and subsequently at time t2, only the changes between the time t1 and t2 are replicated.
Using the Replica at the Target Site

The replicated package can be used for failover, test, backup, and reporting purposes after at least one successful transmission to the target site.

The Oracle ZFS Storage Appliance products provide several ways to use the replica target:

- **Read-only access**: Enable shares to be mounted from the client for read-only purposes using the Export option.
- **Clone/export replica**: Create a new writable project from the replica for alternate business processing at the target.
- **Sever link**: Convert a replication package into a writable local project by severing the replication connection.
• **Role reversal (reverse replication):** Sever the link (see preceding) and establish replication back to the original source; this operation reverses the roles of the source and target sites.

The replica at the target site can be promoted into production operation in the event of a disaster in which the source site is completely lost. Furthermore, snapshots can be taken of the exported clone of the replica to allow for save points to protect system administrators from mistakes that can be made when acting quickly during unfamiliar circumstances.

**Monitoring Replication**

Once a replication action has been created and the associated replication has been scheduled, the replication progress can be monitored. Its progress is shown under the replication rule and it shows percentage of the data replicated, the replication throughput and the estimated remaining time to completion. The same information can also be determined on the Oracle ZFS Storage CLI.

![Replication Progress Monitoring](image)

**Figure 2. Replication Progress Monitoring**

Replication performance can be investigated in further details using specific replication analytics statistics available under actions in the analytics worksheet window.

![Data Movement](image)

**Figure 3. Replication Analytics worksheet actions**

Each action can be broken down into by direction, by type of operation, by peer, by pool name, by project or by dataset.
Replication Auditing

Replication actions are logged in the auditing log, so all actions and changes to actions can be tracked.

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**Figure 4. Replication Analytics worksheet example**

**Figure 5. Replication audit log messages**
Performing the Initial Seeding of a Remote Node

When setting up a remote replication configuration, the initial replication of the data set can take a long time when the available bandwidth between two locations is limited. To overcome this problem, the initial replication synchronization can be done by locating source and destination Oracle ZFS Storage Appliance products next to each other. Once data has been synchronized, you can ship the system intended for the remote site to its location. Once this Oracle ZFS Storage Appliance is connected to the network, you can change its new target IP address in the source Oracle ZFS Storage Appliance.

General Implementation Guidelines

The following are general guidelines and considerations for administrators who are applying remote replication features in the Oracle ZFS Storage environment.

Configuring a Replication Mode

An administrator of Oracle ZFS Storage systems can configure or change the replication mode among continuous, scheduled, and on-demand at any time. The administrator can also configure different replication modes for the same target when using multiple replication actions.

Choosing the optimal configuration depends on the technical and operational requirements of the specific implementation. With regard to the replication mode, the administrator should consider the following details.

- Recovery point objective (RPO)
- Recovery time objective (RTO)
- Available bandwidth between the source and target sites

Continuous replication of the project is an appropriate choice for technical and operational requirements that require near-real-time protection of data at the remote site, such as RPO and RTO of less than a few minutes. Updates to the source data set will be sent to the target site as fast as the network permits in this case.

Oracle ZFS Storage Appliance products use asynchronous communication between the source and the target to ensure that network latency does not slow production operations. This technology cannot guarantee that updates to the source will be present at the target site after a loss of the source site; however, the image of the project at the target site is guaranteed to be write-order consistent as of the time of the most recently completed data transfer.

Scheduled replication provides a good alternative to make the best use of available resources when available replication network bandwidth is insufficient for continuous replication, or when technical and operational requirements allow for longer RPO and RTO. With scheduled
replication, Oracle ZFS Storage Appliance periodically replicates a point-in-time image (snapshot) of the source project to the remote site. This reduces network traffic while preserving consistent and timely copies of the primary data set.

On-demand replication is designed for applications that need to put data into a specific state before the replication can occur. For example, a replica of a cold or suspended database can be produced every time the database is shut down by integrating a call to trigger an on-demand replication update in the database shutdown or suspend scripts. On-demand replication updates can be triggered from arbitrary locations in the application-processing stack through the automated scripting language of the Oracle ZFS Storage Appliance command-line interface (CLI).

Use at the Target (Remote) Site

The replica at the target site contains all the information present at the source site as of the most recently completed replication transaction. The replica can be used as a direct substitute for the original source in the event that the source is lost, or clones of the replica can be used for additional business processing, such as backup, test, or analysis.

Accessing Read-Only Copy

The replicated package can be mounted and could be used as a read-only source from the client. Setting the Export option for the replicated project makes the project and its shares mountable from the client. While this mode is not suitable for database access, the data can be used for backup and other read-only purposes.

Role Reversal (for Production Failover)

The client application can be failed over to the target site in the event of a primary site disaster, or during a maintenance operation at the primary site. The target becomes the “production” site in this mode. Only the data that is changed after the failover is replicated back when the primary site is back up again. If the original primary site is set to become the production site again, the role-reversal operation is performed at the new target. It is strongly recommended to suspend or stop the replication before initiating this operation. This is the most preferred operation during failover and failback operations for the databases.

Test, Backup, and Reporting

To access the replicated package for read/write purposes, a package is cloned. This operation essentially clones the project that is received. Clones of the replication target can be used for test, reporting, and any other type of business processing.

Cloning the replication target efficiently uses storage resources because space allocation for clones is performed only when updates to the primary or cloned data set are performed. Clones
can be cloned and deployed to these different applications in cases where multiple applications need access to copies of the same data set.

Alternatively, many clones from the same replica can be created. Space utilization is further enhanced in this case because the read-optimized flash devices in the L2ARC store a copy of the on-disk image, which is only the original data set plus the updates to the data set.

Multiple test applications can take advantage of the performance of read-optimized flash devices without requiring large amounts of read-optimized flash storage in cases where few updates are performed on the data set. This provides a high-performance and cost-effective solution for using replication resources to perform value-added business functions.

**Multiclone Setup**

The target site allows multiple clones from the package at different points in time. A clone project, clone-t1, is created at time t1, which has the point-in-time data as of the last received replica. The replica is refreshed by a replication update after t1. At time t2, another clone project, clone-t2, is created from the same replica.

Likewise, any number of clones can be created at the target. If the clone projects are not used for updates, the additional space occupied in this setup at the target is only a minimal amount used for metadata. This multiclone setup is useful when the requirements are to maintain few point-in-time images at the target site for various purposes.

**Managing Backups**

The replication target offers an alternative solution when the resources of the primary site are insufficient or unavailable to perform backups. Network Data Management Protocol (NDMP) backups can be used to back up NFS and CIFS shares using the read-only mount, and arbitrary backup applications can be used to back up data over any protocol supported by Oracle ZFS Storage Appliance systems.

**Backup Using NDMP**

Local, remote, and three-way NDMP backups can be performed by Oracle ZFS Storage Appliance systems on CIFS and NFS shares. In either case, the backup is performed by exporting the project as read-only.

Local full backups can be performed by attaching tape storage devices to an Oracle ZFS Storage Appliance system, and remote backups are performed over the network when the tape devices are not attached to an Oracle ZFS Storage Appliance system but instead are connected to a media server. The data to be backed up is transferred over the network to the media server.

A three-way backup is performed by executing a remote backup to an alternate Oracle ZFS Storage Appliance system with access to tape devices.
The local NDMP backup is the most efficient mode for the backup because it does not incur any data transfer over the network. The other modes require the data to be transferred over the network, so the architecture design should take into consideration the bandwidth requirements. Using the read-only mount, both full and incremental backups can be performed for replicated shares.

Application-Specific Implementation Guidelines

This section augments the general guidelines presented in the previous section. The principles described in this section can be applied to other applications when the behavior of the application is similar to that of the applications described.

Databases

Database replication is accomplished in one of three architectures:

- Full database replication
- Partial database replication
- Logs-only replication

In full database replication, all the files associated with the database are placed in the same project and the project is replicated. This method provides a write-order consistent image of the database as of the last successful replication. Full database replication generally provides the shortest recovery time and simplest process after a failure.

Partial database replication can be set up when not all components of a database are required for disaster recovery (DR) operations. In partial database replication, the database is split into two or more projects: the first project contains all the database files required for DR operations, and the additional projects contain files that are not required for DR operations. For example, temporary data or read-only can be reconstructed after a failure, so replicating that data is not required.

Logs-only replication is accomplished by replicating only the database's log stream and applying the log stream to a previously shipped copy of the database. This technique makes the most prudent use of network resources; however, it typically leads to longer recovery time and a more complex recovery process.

Full Database Replication

The simplest implementation method for database replication is full database replication. All files for the database are stored in the same project, and the entire project is replicated from the source to the target in this method. Recovery at the remote site is accomplished through traditional crash recovery methods that are used after a power-fault of the database server, because write-order is preserved throughout the project. The database will start up as though the
crash occurred slightly earlier in time in cases where the replication data has not made it to the remote site.

With full database replication, database files can be distributed over multiple shares within a project for optimal deployments. A practical database deployment can include the following shares:

- **redologs**: A 128-kilobyte record size share for storing online redo logs and control files
- **datafiles**: A share configured with a record size that matches the database block size for storing database data files
- **indexes**: A share configured with a record size that matches the index block size for storing database index files
- **temp**: A share configured with a record size to match the database sort area page size
- **recovery**: A share configured with a 128-kilobyte record size and compression to store copies of the redo logs, backup sets of the database, and any other recovery information
- **unstructured**: A dynamic record size share to store unstructured data associated with the database

Any replication mode (continuous, scheduled, or on-demand) can be used with full database replication. If the replication target will be integrated into a backup system, then on-demand replication is required if the database needs to be in a backup state (for example, Oracle hot backup mode) to take a valid copy using a storage-based copy technology.

**Partial Database Replication**

The administrator can segregate the database into two or more projects to optimize network traffic. The first project would contain files that must be replicated, such as the redo stream and production data files, and subsequent projects contain temporary files or read-only files.

Temporary files will need to be recreated, and read-only data will need to be referenced from an alternate location during recovery operations at the remote site. A sample partial database deployment could have two projects: replicated and non-replicated.

The replicated project could be configured as follows:

- **redologs**: A 128-kilobyte record size share for storing online redo logs and control files
- **datafiles**: A share configured with a record size that matches the database block size for storing database data files
- **indexes**: A share configured with a record size that matches the index block size for storing database index files

The non-replicated project could be configured as follows:
• **temp**: A share configured with a record size to match the database sort area page size

• **recovery**: A share configured with a 128-kilobyte record size and compression to store copies of the redo logs, backup sets of the database, and any other recovery information

• **read-only**: A share configured to match the block size of the read-only database

Similar to full database replication, any replication mode (continuous, scheduled, or on-demand) can be used. If the replication target is to be integrated into a backup system, on-demand replication is required if the database needs to be in a backup state (for example, Oracle hot backup mode) to take a valid copy using a storage-based copy technology.

**Logs-Only Replication**

Logs-only replication is useful when network bandwidth must be conserved. In this architecture, the log files are shipped using replication and then applied to the database following an outage at the primary site. Logs-only replication can be accomplished for an Oracle database by replicating only the shares that store online redo logs.

The redo log share contains a copy of the online redo log and control file and is maintained with continuous replication. The archived-redo share contains a copy of the online redo log and is maintained with on-demand replication, so the archived log stream can be periodically applied to the database at the remote site. Finally, the data files share contains all the data files associated with the database, and this project is not replicated, because the changes to bring the remote copy forward in time can be accomplished by applying the replicated copies of the online and archived redo log stream.

**Business Applications and Middleware**

Metadata and configuration details, as well as unstructured business application data, can be protected by storing the information on an Oracle ZFS Storage Appliance system and replicating the content to a target system. Different applications’ data can be stored on different shares in the same project in cases where the data must be kept consistent with the data of a disparate application. A consistent image of a federated system can be maintained at the remote site in this model. Continuous, scheduled, or on-demand replication can be used, depending on the specific requirements of the implementation.

**Consolidating Virtualized Environments**

Protecting the virtualized environment infrastructure is very critical. The virtual disk images (VMDK) files form the crux of the virtualized environment. The disk images are stored on either iSCSI LUNs or over NFS files. It is recommended to place the related disk images on a single project for replication. Then, a number of projects can be created and replicated.
A VMFS3 file system can be created on the iSCSI LUN to host VMDKs, or the iSCSI LUN can be attached directly to a virtual machine using Raw Device Mapping (RDM).

Configure differing replication schedules for different types of virtual machines or for subsets of virtual disk types; for example, OS/boot versus production data. For the replication, configure multiple projects, each to replicate on their own schedule.

Either continuous or scheduled mode of replication can be configured. If the images need to be in a quiesced state, a manual mode using scripting at the virtual machine server that quiesces the image and then initiates the replication is preferred.

Protecting Mail Servers
Mail servers are a critical piece of the business component that needs to be protected either by backup or by replicating to a remote site. In the event of a primary site problem, the mail server can then fail over to the target site to avoid downtime. Microsoft Exchange Server uses database and log components. Also, only iSCSI LUNs are supported to host these files.

In order to perform full replication, the logs and the database files are stored in the same project and replicated using any of the modes. Note that Microsoft recommends that logs and database files be separated on different physical drives for better protection. However, having a mirrored storage pool in a Oracle ZFS Storage Appliance system alleviates the problem and also provides better performance.

Providing a Disaster Recovery Solution — An Example Architecture
The following figure shows an example scenario for an enterprise's disaster recovery setup.
Source Site Configuration

In the example architecture, distributed Oracle ZFS Storage Appliance systems which are serving various application needs are deployed across the enterprise. These individual storage systems host a number of projects with varied types of application usage. All the critical data from all these sites are replicated to the high-end Oracle ZFS Storage Appliance system. Each site's Oracle ZFS Storage Appliance may differ in the mode of replication, size, and I/O access pattern.

A midrange Oracle ZFS Storage Appliance system is used as storage for Microsoft Exchange Mail Server over iSCSI, and VMware ESX disks over NFS and iSCSI. Scheduled replication is set up for Microsoft Exchange Mail Server to replicate every night for backup purposes. A virtualized storage project is scheduled for replication every four hours.

A low-end Oracle ZFS Storage Appliance system is used as a repository for the application layer of the infrastructure. It does not demand too much of the storage. A manual replication is set up and will be triggered whenever any of the components are changed.

A high-end Oracle ZFS Storage Appliance system is used as storage for a few databases. A critical production online transaction processing (OLTP) system is set up for full database
replication in continuous mode while the other back-office databases are set up for scheduled replication. The target site is set up as a DR site for all the database failover.

All these systems have a dedicated gigabit Ethernet infrastructure to the target site.

**Target Site Configuration**

In this example, the target site is used for several purposes:

- As a DR site for all the applications
- To serve as test/development/report
- For backups

A high-end Oracle ZFS Storage Appliance system is configured to handle the workload and to provide high-availability capability. One head of the cluster node is configured to receive the database and the application components from Oracle ZFS Storage Appliance midrange and low-end systems. The second head is the target for the mail server and VMware components from the Oracle ZFS Storage Appliance midrange system. The cluster heads are also used as the DR destination for all the applications.

**Target Backup**

Two backup servers are used at the target. One is to perform the NDMP backup of back-office databases using “local” mode.

The other backup server is used for incremental backups and doing some non-NDMP backup. The tape library is attached to the backup media server. The replicas of Microsoft Exchange, VMware disks, and the OLTP database production system are cloned. The iSCSI replica from the mail server is backup as a full backup. Then a combination of full and incremental backup is initiated from all these clones. The OLTP database replica is started, which performs the crash recovery. Then, using Oracle Recovery Manager (RMAN), the backup is performed.

In all the backup setups, the replica is never destroyed.

**Testing and Reporting at the Target Site**

The site is also used for testing and reporting purposes. For the database replicas, the database is cloned and opened for doing reporting and for backup purposes. Any application development or QA testing can be done on the replica of the database. A snapshot is taken from the cloned replica to revert quickly to the previous state while doing the testing.

**Failover to the Target**
All the applications can be failed over to the target site. Production failover or a role reversal can be performed, depending on the type of application and the type of failure that occurs at the source site.

**Target Considerations**

When considering a target site for testing, reporting, QA, backup, and failover, some of the items that need to be identified and planned include the following:

- Capacity requirement to hold all the data
- Storage tiering and archiving requirement
- Storage profile (mirror or RAIDZ-DP preferred)
- SLAs for failover applications
- Network bandwidth to handle all the concurrent replication updates

**Features and Benefits of Remote Replication**

The remote replication capability of the Oracle ZFS Storage Appliance provides the following features:

- Replication is supported across Oracle ZFS Storage platforms and across storage profiles.
- Replication can be performed either at the project level or at the share level.
- No dedicated link is necessary; any network can be used for replication.
- Encryption is an optional feature for data protection, and it can be disabled when performance is more important.
- The same project from the source can be replicated to one or more targets with different schedules.
- For faster and efficient target site catch-up, only changes are replicated (except during the initial replication).
- Administrators have the flexibility to change the mode of replication from one mode to another.
- The target site replica can be used for many purposes, alleviating the performance pressure from the source site.
• The clone from the replica is treated as any other project, including taking snapshots of the shares, which provides more flexibility for QA and test purposes.

• Efficient single-click reverse replication is provided to reverse the role of the source and target for a project, enabling faster DR.

Considerations for Remote Replication Use

• Synchronous mode is not supported, so a zero data loss requirement cannot be met. However, the continuous replication mode can provide an alternate with minimal data loss in the event of a disaster.

• The write ordering and write consistency is maintained at the granularity of the replicated component. The write ordering is preserved within the share if the replication is set at the share level. However, the write ordering is not preserved across the shares if more than one share is replicated. The write ordering at the target for all the shares in the project is preserved if the replication happens at the project level. The write ordering is not preserved across the projects. Refer to the particular model's Oracle ZFS Storage Appliance administration guide at http://www.oracle.com/technetwork/documentation/oracle-unified-ss-193371.html for details.

• Business processes, such as RTO, RPO, and SLA, should be considered in deciding the mode of replication. The rate of change, latency, bandwidth, and number of projects to replicate all influence the decisionmaking process.

• The target site is not verified for the space requirement when the replication is established. Before initiating the replication, you must verify that the target site has enough storage space to receive the replica.

Conclusion

This paper explained considerations for planning and implementing remote replication with Oracle ZFS Storage Appliance systems. An example architecture and various options were described to enable system planners to simplify off-site data protection. Administrators can use these guidelines in tailoring their application of remote replication to their particular storage environments.
References

Oracle ZFS Storage Appliance resources:

- [Product information](#)
- [Product documentation](#)

Data replication information:

- [Oracle Database 11g Data Replication](#)

Additional resources:

- Download [Oracle Solaris 11](#)
- Learn more with: [Oracle training and support](#)
- Check out [Oracle Blogs](#) for Oracle ZFS Storage Appliance tips and tricks