

ESG Lab Validation

Zero Data Loss Recovery Appliance from Oracle

A Game Changer for Oracle Database Environments

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ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about data center technology products for companies of all types and sizes. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab's expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments.

Introduction

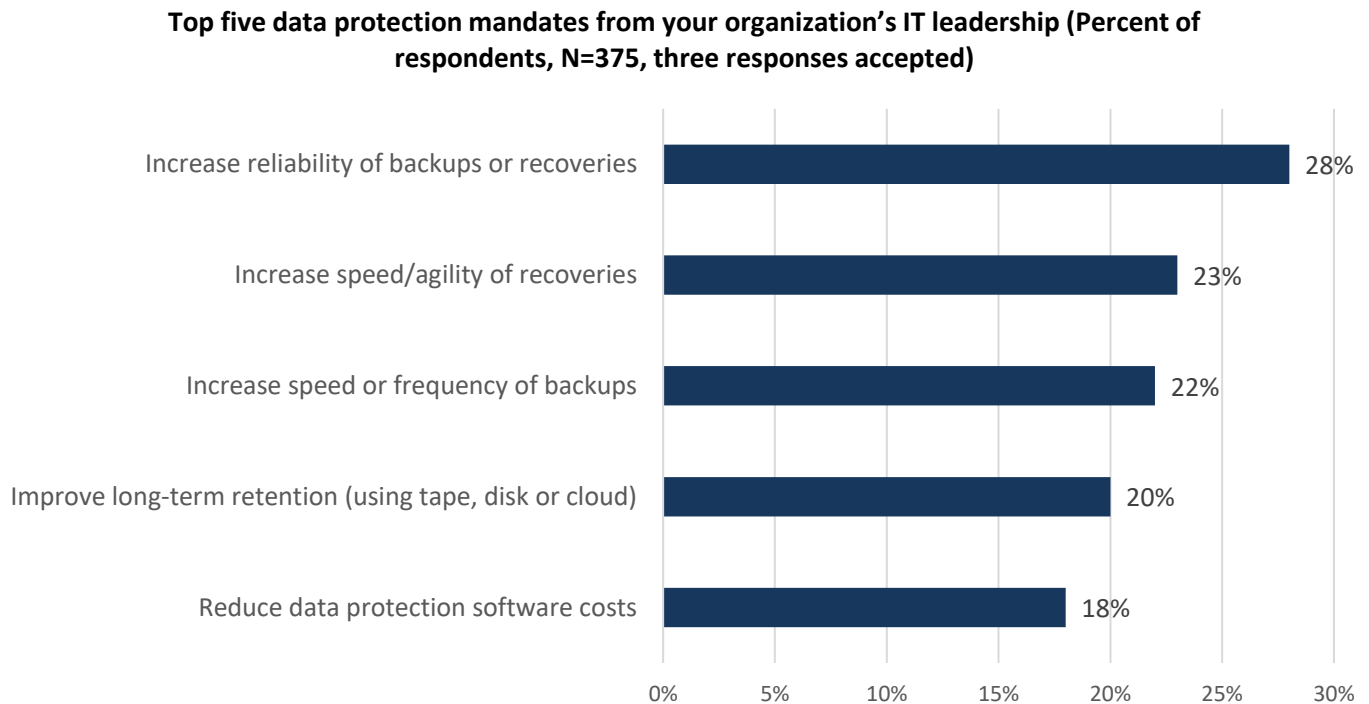
ESG Lab evaluated the Zero Data Loss Recovery Appliance from Oracle with a focus on its ability to deliver reliable data protection by recovering Oracle databases to any point in time with sub-second RPO in a highly scalable scale-out solution that is easy to use and manage.

Background

Year after year, ESG respondents consistently cite improving data backup and recovery among the top IT priorities in our annual spending intentions survey (including 2016’s iteration).¹ Why? Because when unforeseen infrastructure failures or data corruptions occur, the ability to restore not only business-critical information but also application and end-user access to that information become paramount. Lost or prolonged inaccessibility to business-critical data and applications most often means lost revenue and productivity to the business, and possibly the inability to meet regulatory requirements.

ESG research also indicates that IT leadership is increasingly focused on improved recoverability.² As shown in Figure 1, the first three of the top five IT leadership data protection mandates include increased reliability of backups or recoveries, increased speed and agility of recoveries, and increased speed or frequency of backups. Rounding out the top five are improving long-term data retention and reducing data protection software costs.

Figure 1. Top Five Data Protection Mandates



Source: Enterprise Strategy Group, 2016

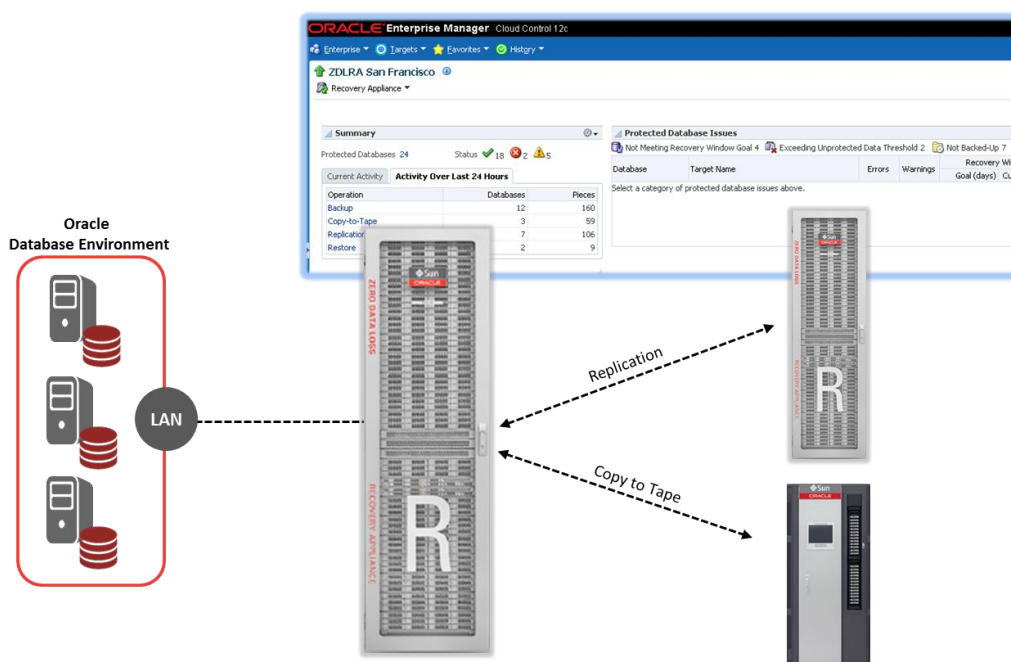
¹ Source: ESG Research Report, [2016 IT Spending Intention Survey](#), February 2016

² Source: ESG Research Report, [2015 Trends in Data Protection Modernization](#), September 2015

Zero Data Loss Recovery Appliance Overview

Zero Data Loss Recovery Appliance (Recovery Appliance) from Oracle is a purpose-built, turn-key appliance designed for Oracle Database protection. The solution is based on the Oracle Exadata platform and is tightly integrated with the Oracle Database and Recovery Manager (RMAN). As shown in Figure 2, Oracle Enterprise Manager provides an intuitive management interface to effectively manage the full data protection lifecycle with policy-based management as well as extensive monitoring and alerting to ensure recovery service level agreements (SLAs) are met. With the Recovery Appliance, Oracle Database backups are efficiently stored on disk and may be copied to tape, and/or replicated offsite to another Recovery Appliance. It uses a Recovery Manager (RMAN) incremental forever backup strategy (after initial full) with virtual full restore capability and Real-time Redo Transport on the database host to efficiently send only changed data to the appliance.

Figure 2. Recovery Appliance Solution Overview



Source: Enterprise Strategy Group, 2016

Key Recovery Appliance features that improve Oracle Database protection include:

- Improving reliability:** Recovery Appliance uses policy-based management to easily manage tiers of databases as a group and to provide consistency across the Oracle Database backup domain, thereby reducing backup and recovery complexities. The Recovery Appliance administrator(s) creates a Protection Policy for each database tier with the same recovery requirements and then simply adds databases to the Recovery Appliance environment, associating them with the appropriate protection policy. A protection policy is a defined class of service for recovery windows from disk and tape, data loss exposure threshold for alerting purposes, backup copy requirement, and more. The solution validates backup data at every touch point and periodically for data at rest to ensure data integrity end-to-end. If a bad block(s) is discovered, it is automatically repaired from a mirrored copy. As the Recovery Appliance knows what System Change Numbers (SCNs) are needed for point-in-time recovery, it provides real-time recovery status for all databases under management—both the current recovery window and data loss exposure. This level of reliability is important as Recovery Appliance customers will know recovery status beforehand, eliminating the unfortunate surprise during restoration that a backup is corrupt.

- **Eliminating data loss exposure:** Several Recovery Appliance features reduce data loss exposure and deliver any-point-in-time recoverability. If real-time redo transport is enabled for continuous data protection, the Recovery Point Objective is reduced from the time since last backup to the sub-second level. Oracle-aware validation, as previously discussed, provides recovery assurance and even the underlying storage is dynamically allocated to meet the databases' Recovery Window Goals versus setting arbitrary storage quotas. The Recovery Appliance is designed around recovery versus just backups and alerts are generated if a database exceeds its user-defined data loss exposure threshold—effectively eliminating the need to babysit backups. The Recovery Appliance's replication helps protect against site failure, and tape copy functionality can be used to extend retention and supplement offsite capabilities. Backups on replica or tape are automatically restored without user-intervention if the backup is not available on the source Recovery Appliance.
- **Minimizing the impact to production:** The Recovery Appliance's "Delta Push" technology sends only changed blocks from the database server to the appliance and has two components: RMAN incremental forever backup (after initial full) with virtual full restore and continuous data protection when real-time redo transport is enabled. Customers benefit from Delta Push as the need for periodic full backups is eliminated. This translates to much less overhead on database servers performing incremental versus full backups and periodic archived log backups are no longer needed. In addition, other processes are offloaded to the Recovery Appliance, such as backup validation, compression, incremental apply/merge during restoration, and copy to tape. Backups received by the Recovery Appliances (or those replicated to another Recovery Appliance) are validated, compressed, and indexed during the ingest process. Copy to tape operations are offloaded from database servers and centralized on the Recovery Appliance. Backup copies may be written to tape using a full, incremental, or periodic archived log backup strategy. For example, if weekly full backups to tape are scheduled, the Recovery Appliance creates a virtual full restore to the point of the most recent incremental backup, which is then written to tape in traditional RMAN format. This means copy to tape operations can run 24x7 better, utilizing tape drives without any overhead on the database servers.
- **Providing a scalable solution:** The Recovery Appliance's base configuration includes two compute servers and three storage servers internally connected using high speed InfiniBand with 94 TB of usable capacity for incoming backups and replicated backups. The base rack can be upgraded incrementally by adding storage servers, up to a maximum of 18 in a full rack with each storage server adding 32 TB of usable capacity for total usable capacity of 580 TB (e.g., 5.8 petabytes of Virtual Full Backups). If additional capacity is required, up to 18 fully configured racks can be added, interconnected via high-speed InfiniBand, in a single appliance, providing more than 10 PB of usable capacity (e.g., over 100 Petabytes of Virtual Full Backups).

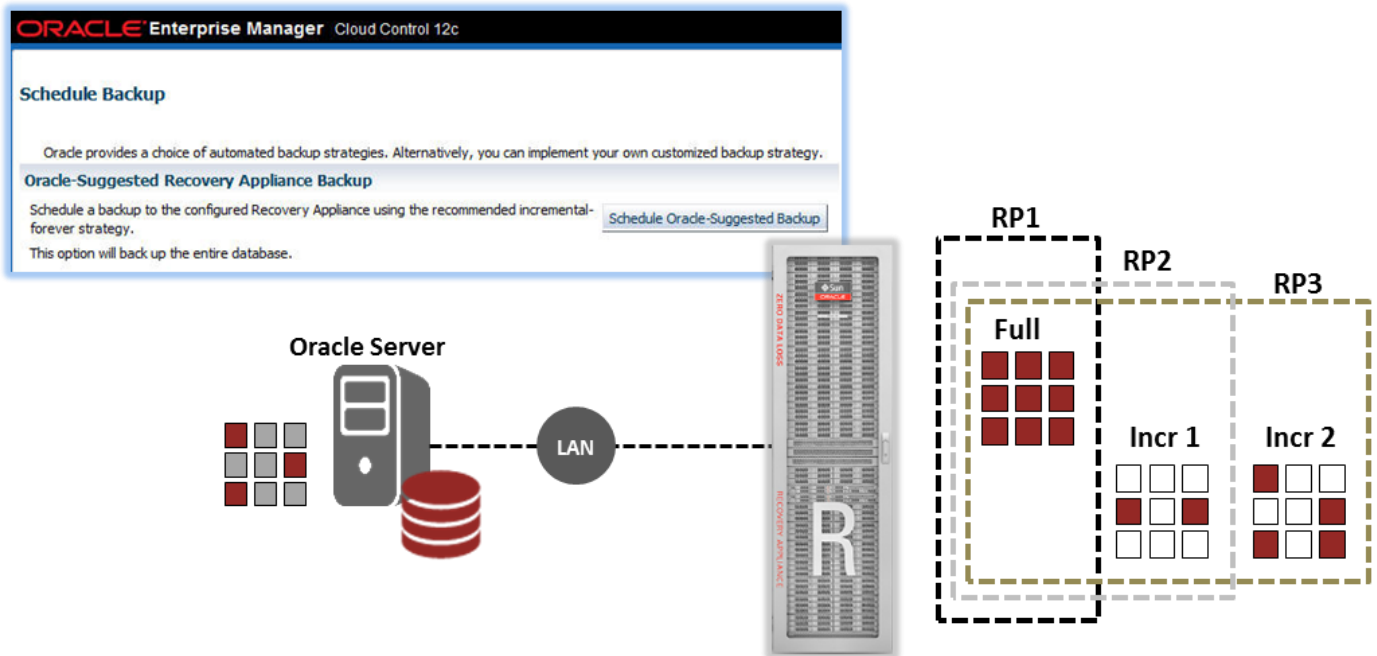
Protection Workflow

Oracle’s Zero Data Loss Recovery Appliance is designed for recovery and has the added benefit of offloading most backup processing from the database servers. As discussed earlier, Delta Push only sends changed blocks to the appliance. Then a virtual full backup is created to the point of each incremental so that during restore, a virtual full to the point of the most appropriate incremental, along with necessary archived log backups needed to recover to the desired point-in-time, are sent to the database server. This eliminates considerable network traffic and the need for incremental backups to be applied on the database server. Only archived logs since last incremental are applied on the database server during recovery.

After the Recovery Appliance administrator adds the database to the appliance, the DBA then directs RMAN to back it up to the appliance and schedules backups using the Oracle-Suggested Recovery Appliance Backup, which performs an initial full and then incremental forever thereafter. *It’s that simple.*

As shown on the left side of Figure 3, RMAN incremental backups are sent over the LAN to the Recovery Appliance. Incremental backups are immediately ingested on the appliance, which consists of validating, compressing, and indexing blocks. No backup agent is needed on the Oracle server, only the RMAN tool. The right side of the figure shows how Delta Store ingests the data and stores it as virtual full recovery points represented by RP1, RP2, and RP3. The virtual full backup is immediately listed in the Recovery Appliance’s catalog with the backup name beginning with VB\$. The Recovery Appliance’s catalog is automatically managed by the appliance and eliminates the need to maintain an RMAN catalog.

Figure 3. Recovery Appliance Data Protection Workflow



Source: Enterprise Strategy Group, 2016

ESG Lab Validation Testing

ESG Lab performed hands-on evaluation and testing of the Recovery Appliance at an Oracle facility in Nashua, New Hampshire. Testing was designed to demonstrate the reliability, zero data loss recoverability to any point in time, and ease of management the Recovery Appliance delivers for Oracle Database protection.

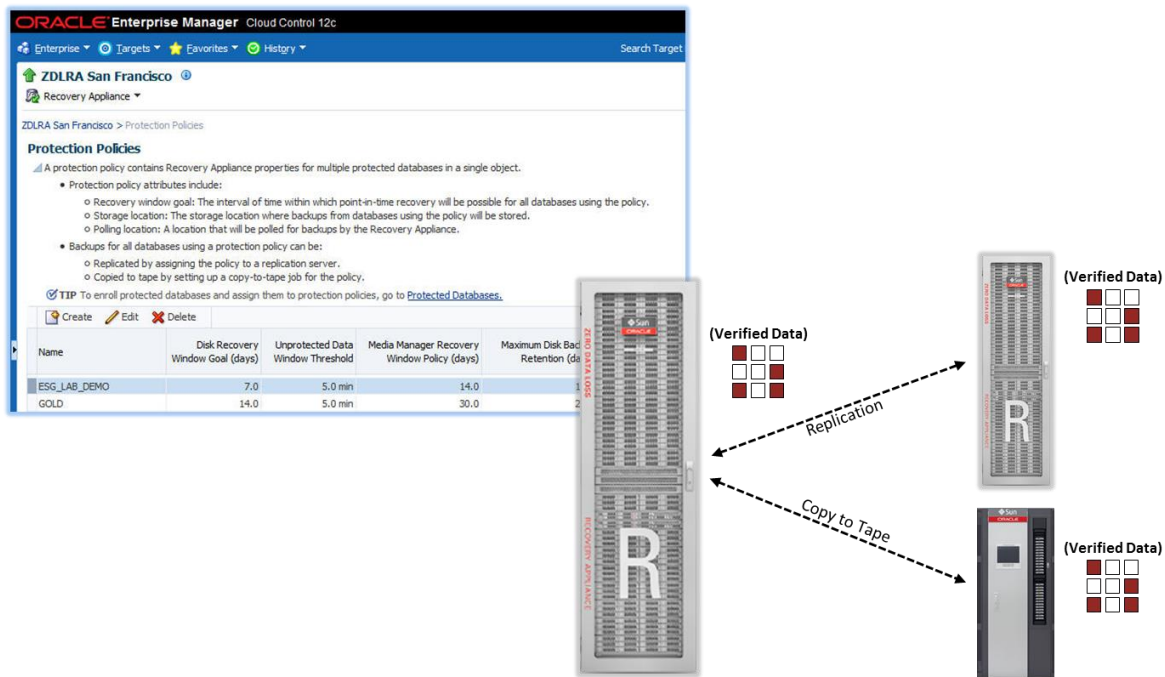
Reliability

ESG Lab started the Recovery Appliance testing with a focus on how each component contributes to its reliability. The key features that deliver reliability include:

- The underlying Exadata platform that delivers unparalleled scalability and a no single point of failure architecture.
- Integrated replication and/or copy to tape.
- End-to-end Oracle-aware data validation at ingest and periodically while data is at rest.
- Real-time recovery status displayed within Oracle Enterprise Manager and in out-of-the-box reports.

Figure 4 illustrates the test bed and protection policy used by ESG Lab for this validation report. Recovery Appliance management is tightly integrated with Oracle Enterprise Manager. The left side of Figure 4 shows the Recovery Appliance protection policy view from within Enterprise Manager. Protection policies define how a database or group of databases will be protected. Parameters include disk and tape recovery windows, maximum retention on disk, and more. The intent is that policies will be designed and implemented to match recovery objectives. Once a policy is created, databases with those recovery requirements can be simply added to the appropriate policy.

Figure 4. Recovery Appliance Protection Policy



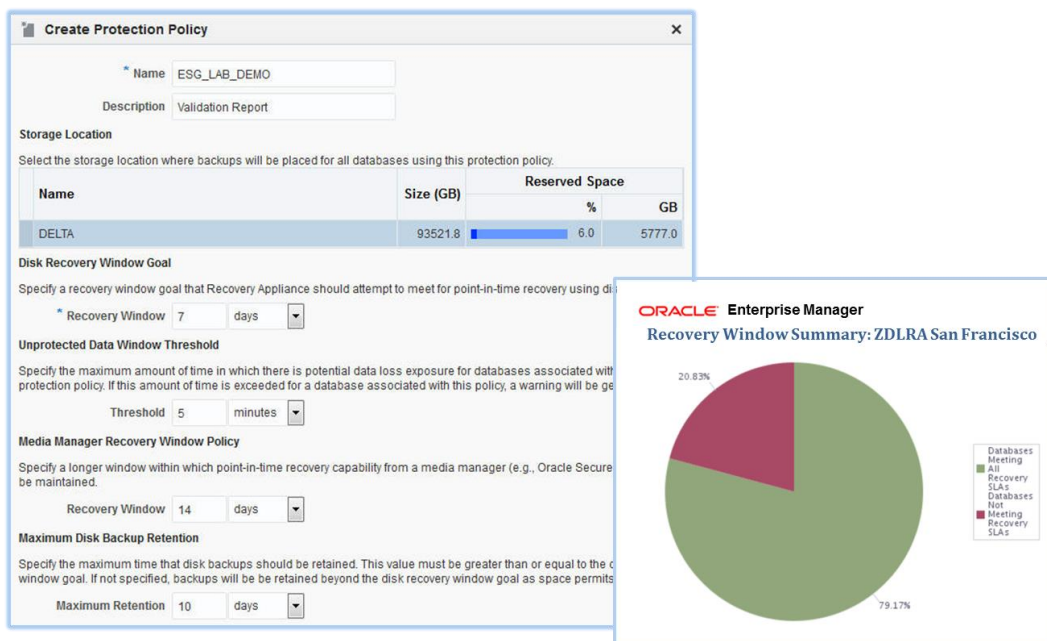
Source: Enterprise Strategy Group, 2016

The right side of Figure 4 shows a high-level view of the Recovery Appliance’s deployment options and the data verification process. Recovery Appliance customers can start with a highly available base configuration that enables efficient disk-based Oracle Database backups.

A single Recovery Appliance environment can be scaled up to 18 fully populated racks that can be deployed in a geographically distributed configuration with directional or bi-directional replication. The solution also supports Fibre Channel-attached tape libraries and drives when using the bundled Oracle Secure Backup media manager or customers can use a non-Oracle media manager for copy to tape over the LAN to a tape device attached to that product’s media server. Also, as shown on the right side of Figure 4, any time data is moved within the Recovery Appliance environment backups are validated.

Next, as shown in Figure 5, we configured a protection policy. We used the Recovery Appliance’s Enterprise Manager interface to create the **ESG_LAB_DEMO** protection policy for validation testing. The left side of the figure shows a subset of the policy setting that defines protection objectives including recovery goals, recovery alert threshold, retention on disk periods, and storage location. The bottom right side of Figure 5 shows a portion of a **Recovery Window Summary** report. Recovery Appliance monitoring and reporting make it easy to identify issues within the environment that might impact recoverability. The pie chart shows a high-level view of the percentage of databases that are meeting their recovery goals. Much more detail is included in the full report to assist with issue remediation.

Figure 5. Protection Policy Settings and Recovery Report



Source: Enterprise Strategy Group, 2016



Why This Matters

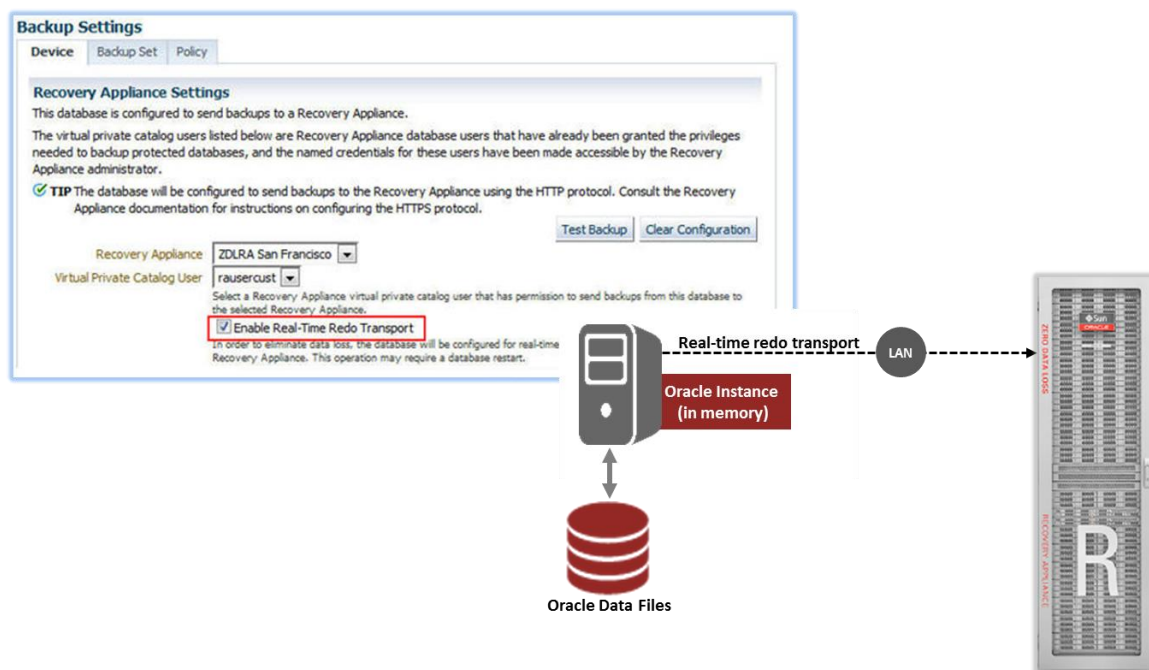
Choosing the right backup and recovery solution is essential, especially the one that protects your organization’s mission- and business-critical data. When the time comes that you have to perform a recovery, you need to be confident that the backups are available and the data is good.

ESG Lab confirmed that when customers choose the Zero Data Loss Recovery Appliance from Oracle, they get the peace of mind that comes from knowing their up-to-date backups are ready to go. Why? Because the solution is tightly integrated with the Oracle Database and the data it is intended to protect, offers local and offsite protection options, and the data is validated at all critical points throughout the protection process and is recoverable to any point in time to the sub-second level.

Zero Data Loss Recovery

To demonstrate the recovery capabilities of the Recovery Appliance, ESG Lab explored the benefits of using the Real-time Redo Transport technology and also conducted a point-in-time recovery of an Oracle Database. Real-time Transport technology enables Oracle databases to continuously send redo data directly to the Recovery Appliance. Redo Transport was first introduced in Oracle Data Guard and has been integrated into the Recovery Appliance, where it provides similar levels of data protection by reducing the Recovery Point Objective (RPO) to less than a second. It supports Oracle Database 11g Release 2 or higher. As shown in Figure 6, Real-time Redo Transport is enabled in Enterprise Manager at the database level. Once enabled, it allows the Recovery Appliance to act as a secondary location for redo log data. Because it sends redo data directly from the database shared memory to the appliance, there is very little overhead on the production database server.

Figure 6. Real-time Redo Transport



Source: Enterprise Strategy Group, 2016

Real-time Redo Transport provides continuous data protection and eliminates the need to periodically back up archived logs. It is easily monitored from Enterprise Manager as the **Unprotected Data Window** (data loss exposure window) which is displayed in real time along with the databases' current recovery window so customers have up-to-date information regarding point-in-time recovery (e.g., time period 5.3 days). After an initial backup of a test database, we used the Swingbench utility to generate a workload. We observed our unprotected data window shrinking to less than one second as redo data was sent in real time.

Next, ESG Lab conducted a point-in-time recovery of a test database. The test was designed to demonstrate the ability to recover from a virtual full backup and ease of recovery. To ensure the creation of a virtual full backup, we conducted an initial full and several incremental backups using RMAN on the target database.

To simplify the fault injection and recovery process, we created a restore point named **BEFORE_DELETE** to easily identify the SCN, a system change number or stamp that defines a committed version of a database at a point in time before we deleted a tablespace. SCNs occur naturally in a database when transactions are committed.

Next, we injected a fault into our test database by deleting a table space. We used Enterprise Manager to confirm deletion and as shown in Figure 7, navigated to the **Perform Recovery** page to conduct our restore. The process consisted of five guided steps that included selecting the database, the recovery point, the recovery scope and type, and entering the required credentials. Since this process is familiar to DBAs, there is no learning curve. We clicked submit and monitored the job status in Enterprise Manager. Once it completed, we checked the database and ensured that the deleted table had been restored. We were able to restore and recover to the last transaction. Even though it wasn't included in our last backup, the transaction was available for recovery as it had been sent to the Recovery Appliance via Real-time Redo Transport.

Figure 7. Guided Database Recovery



Source: Enterprise Strategy Group, 2016



Why This Matters

According to ESG research, improving backup and recovery remains a top priority for IT organizations. However, improving reliability is not the sole concern—improving speed and frequency are also essential, because a daily or weekly backup is often not enough to meet today's recovery requirements.

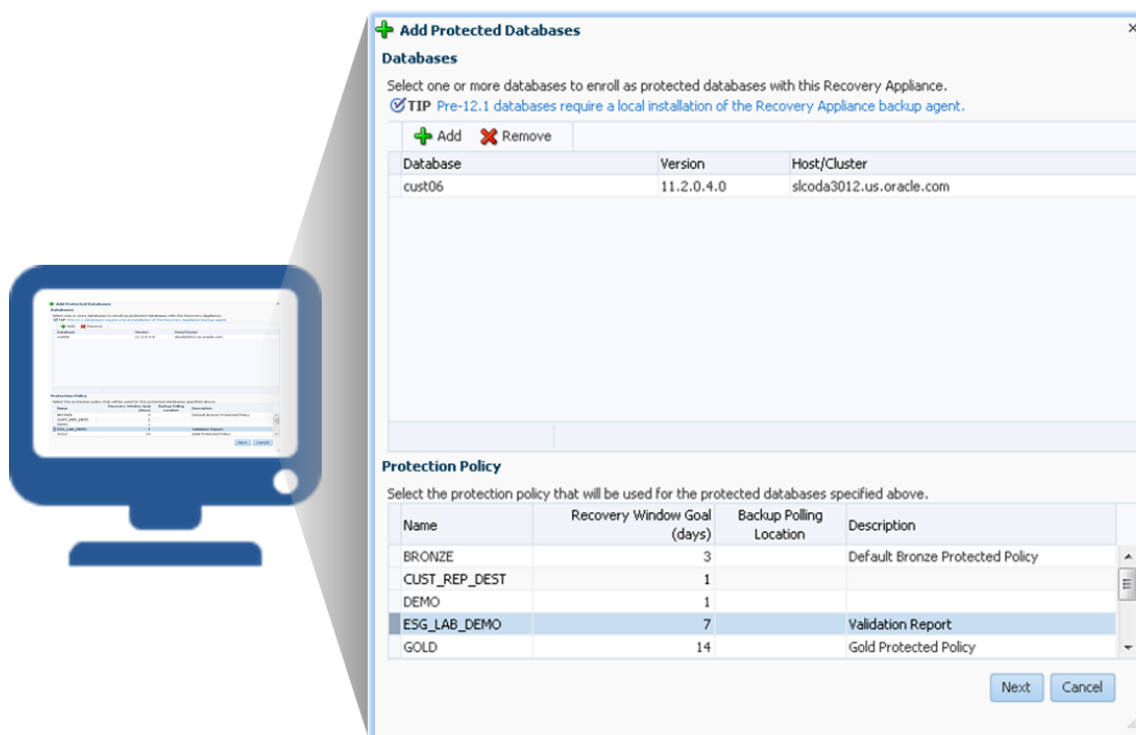
ESG Lab validated that the Recovery Appliance can help customers meet their recovery point objectives and reduce the complexity of Oracle Database data protection. The Recovery Appliance's Delta Push technology significantly reduces backup windows by eliminating periodic full backups and reduces Recovery Point Objective (RPO) to <1 second for continuous data protection when Real-time Redo Transport is enabled.

Easy to Use

Ease of use is an important element in the overall success and adoption of a new technology solution. It is particularly important in data protection solutions where tasks run on a schedule and administrators may not visit the user interface on a regular basis. When it comes to protection of mission- and business-critical data, success depends heavily on the ability to intuitively execute user-defined tasks.

ESG Lab validated the Recovery Appliance’s usability by navigating the user interface and executing a number of common data protection operations. We started by logging into Oracle Enterprise Manager and exploring the Recovery Appliance’s home page, which provides a dashboard style view of system metrics including performance, health, and capacity information. Next, we created a protection policy that defined our data protection class-of-service. As shown in Figure 8, we used Enterprise Manager to add the *cust06* database to our protection policy. The **Add Protected Databases** pages guided us easily through the process with instructions and predefined drop-down options. We simply selected our database from a list, chose a protection policy, assigned it an initial reserved space (accepted the default), and selected our Recovery Appliance credentials. Databases can be added by selecting them individually, in multiples, or by selecting a preconfigured Enterprise Manager group.

Figure 8. Add Protected Database



Source: Enterprise Strategy Group, 2016

Next, ESG Lab reviewed the Recovery Appliance’s media management capabilities. A Media Manager is integrated with RMAN for tape backups. Oracle Secure Backup is bundled and pre-configured on the appliance (if tape backup is desired) and tape devices may be Fibre Channel attached to the appliance. This eliminates the need for third-party media management products to be installed and licensed on each database server for RMAN integrated backups to tape. As shown in Figure 9, our test environment Recovery Appliance had one library (a StorageTek SL150 tape library with 30 cartridge slots) and two tape drives. It should be noted that the Recovery Appliance can use a partition from an existing library that is shared with other applications as long as the library supports partitioning. It does not require dedicated library resources.

With the library and drives configured automatically during Recovery Appliance installation, ESG Lab set up a tape copy job for our protection policy. Copy to tape jobs may be scheduled by protection policy or for individual databases. We simply clicked the **Copy-To-Tape Jobs** link on the the Media Manager's page, which brought us to the **Copy-to-Tape Job Templates** page. We clicked the **Create** tab to configure tape copy parameters including library and drive selection, policy selection, backup type (full, incremental, archived log, or all), and schedule. It should be noted that the Recovery Appliance provides a similar ease of configuration for replication. Replication is configured by protection policy and all database backups associated with that protection policy are automatically replicated without the need to schedule individual replication operations. We set up replication for our protection policy and monitored both replication and copy to tape status via Enterprise Manager.

Figure 9. Recovery Appliance Media Manager

Media Manager

The screenshot shows the Oracle Enterprise Manager interface for the 'ZDLRA San Francisco' instance. The 'Media Managers' section includes a list of libraries and a table of 'Media Manager Libraries'. The 'Copy-To-Tape Jobs' link is highlighted in red. An inset window shows the 'Create Copy-to-Tape Job Template' dialog box with the following configuration:

- Name: ESG_Copy_Backup_To_Tape
- Media Manager Library: ROBOT0
- Attribute Set: ROBOT0_DRIVE_COUNT_2
- Scope: Protection Policy: ESG_LAB_DEMO
- Backup Type: Full
- Priority: Medium
- Copies: 1
- Runtime Window: Hours
- Schedule: Start: Immediately, Repeat: Do not repeat

Source: Enterprise Strategy Group, 2016



Why This Matters

Organizations are constantly looking for ways to simplify data protection management. They report that administrators tasked with supporting specific workloads and platforms are also involved—at least to some extent—with the technologies and processes for protecting these resources. In fact, in database environments, DBAs are known to be active in almost every aspect of data protection. This means that, when designing ease of use into a solution, developers should consider the interaction of both the specialized IT professional and the workload-specific administrator.

ESG Lab validated that Enterprise Manager makes the Zero Data Loss Recovery Appliance extremely easy to use. Oracle smartly integrated the Recovery Appliance into the existing Oracle Enterprise Manager interface, a tool with which many DBAs are already familiar. Even as new users, we found Enterprise Manager very easy to use during our validation.

ESG Lab Validation Highlights

- ☑ ESG Lab validated that by delivering backup and recovery in a purpose-built, turnkey solution with performance and scalability designed in at every level, the Recovery Appliance provides its users peace of mind for Oracle Database protection.
- ☑ ESG Lab confirmed that with Real-time Redo Transport enabled, the Recovery Appliance provides continuous data protection with sub-second RPO. We were pleased to see the Recovery Appliance integrated into Oracle Enterprise Manager, a user interface already familiar to the Oracle Database community and one we found very easy to use.
- ☑ We also found that the Recovery Appliance made Oracle Database recovery extremely easy. We confirmed that with the Recovery Appliance, recovery operations are extremely straightforward, recovery status is known and reported in real time, and one doesn't need DBA expertise to manage the appliance itself. This level of integration and protection of the Oracle Database should not have come as a surprise since the Recovery Appliance was developed by the same engineering team that developed the Oracle Database.

Issues to Consider

- ☑ The Recovery Appliance is a solution specifically designed for Oracle Database protection. Organizations will still need a backup solution for other applications (e.g., file servers, VMs, messaging, etc.). However, you can easily share an existing tape library with the appliance as long as it supports partitioning. It also provides protection status visibility via monitoring and reporting capabilities that can be easily shared with anyone in your organization. In addition, Oracle offers the ZFS Backup Appliance for high-speed backup and restore of any database, any application, any file type, and any VM.
- ☑ The Recovery Appliance is a feature-rich data recovery solution built on the enterprise-class Exadata platform. ESG Lab believes that Oracle customers would welcome the on-premises Recovery Appliance and a complementary service model offering in the Oracle Public Cloud.

The Bigger Truth

Since the first release of its relational database in the late 1970s, Oracle Corporation has been making enhancements and improvements to both its Oracle Database and the tools required to manage and protect it. This includes RMAN, first introduced in version eight of the database, and designed to provide backup and recovery capabilities, and Oracle Data Guard for high availability with an integrated database standby for failover and offload of queries (Active Data Guard). It also includes Oracle Enterprise Manager, a set of web-based tools designed to manage software and hardware produced by Oracle Corporation and some third-party vendors.

Both Oracle DBAs and backup software vendors have long relied on the RMAN utility for data protection. For the DBA, it's the tool used to send backups to disk and tape storage resources provisioned by their IT organizations. For backup software vendors, it is at the core of their Oracle Database protection agents. However, RMAN alone does not guarantee a highly integrated end-to-end solution for Oracle Database protection. In fact, if not properly or thoroughly integrated, a multi-step/vendor configuration could lead to disconnected backup schemas, redundant backup processing, redundant storage resource provisioning, and gaps in recoverability.

That's why Oracle developed the Zero Data Loss Recovery Appliance, a turn-key, purpose-built backup and recovery appliance specifically designed to protect Oracle databases. The Recovery Appliance integrates the latest Oracle hardware and software, as only Oracle can, to deliver the complete lifecycle of Oracle Database protection with capabilities not available with other products. During testing, ESG Lab validated several Recovery Appliance features, reviewed design concepts, and audited POC performance results. We found the following:

- Real-time Redo Transport enables sub-second recovery from continuous data protection of Oracle databases version 11g Release 2 or later.
- With policy-based management, and Oracle Enterprise Manager integration, the Recovery Appliance makes it easy to deliver Oracle Database Protection-as-a-service (DPaaS) across the enterprise.
- Delta Store enables the Recovery Appliance to store up to 100 Petabytes of virtual full backups.
- The combination of high-throughput compute, network, and storage features delivers up to 216 TB/hour of delta ingest and restore. We found it reassuring to see a solution focused on achieving the high performance for both backup and restore. Many vendors focus on backup performance alone.
- The Recovery Appliance uniquely improves performance on production database servers because it does not take away resources such as CPU and memory the way traditional backup processes do and its architecture offloads most of the data protection overhead from the production environment.
- The Recovery Appliance uses unique Oracle-aware virtual full backups. This innovation saves money on WAN transfers, capacity requirements, power, space, cooling, racks, cables, and of course weekly backup times.

If your organization stores data in Oracle databases and you want a solution that connects all the data protection dots, who better to look to than Oracle itself? The company has been helping its customers successfully protect their Oracle environments for a long time. The Zero Data Loss Recovery Appliance continues that trend, with its turn-key appliance approach that easily scales as your production environment grows, takes the guesswork out of recoverability, validates data end-to-end, and enables recovery to any point in time with sub-second RPO. And, because it's from Oracle, no other backup vendor can offer the same level of Oracle Database protection integration. Companies can back up all day and all night long, but if they can't recover quickly and get back in business, the IT practitioners in charge will be spending inordinate amounts of time restoring not just data but their reputations as well.

Appendix

TABLE 1. ESG Lab Test Bed

Oracle Databases	
Oracle RAC	Version 12c
Oracle Databases	Version 11.2.0.4.0
Oracle Enterprise Manager	Version 12c
Zero Data Loss Recovery Appliance (San Francisco)	
2 x Compute Servers	CPU: 2x 22-core Xeon E5-2669 v4 processor Memory: 256GB InfiniBand Ports: 2x QDR (40Gb/s)
3 x Storage Server	CPU: 2x 10-core Xeon E5-2630 v4 processors Disk Drives: 12 x 8TB 7200 RPM Memory 24GB InfiniBand Ports: 2 x QDR (40Gb/s)
Zero Data Loss Recovery Appliance (New York)	
2 x Compute Servers	CPU: 2x 22-core Xeon E5-2669 v4 processor Memory: 256GB InfiniBand Ports: 2 x QDR (40Gb/s)
3 x Storage Server	CPU: 2x 10-core Xeon E5-2630 v4 processors Disk Drives: 12 x 8TB 7200 RPM Memory 24GB InfiniBand Ports: 2 x QDR (40Gb/s)
Tape Library	
Oracle StorageTek	Model SL150 Tape Drives: 2 x LTO-7 Cartridge Slots: 30 LTO cartridge slots

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