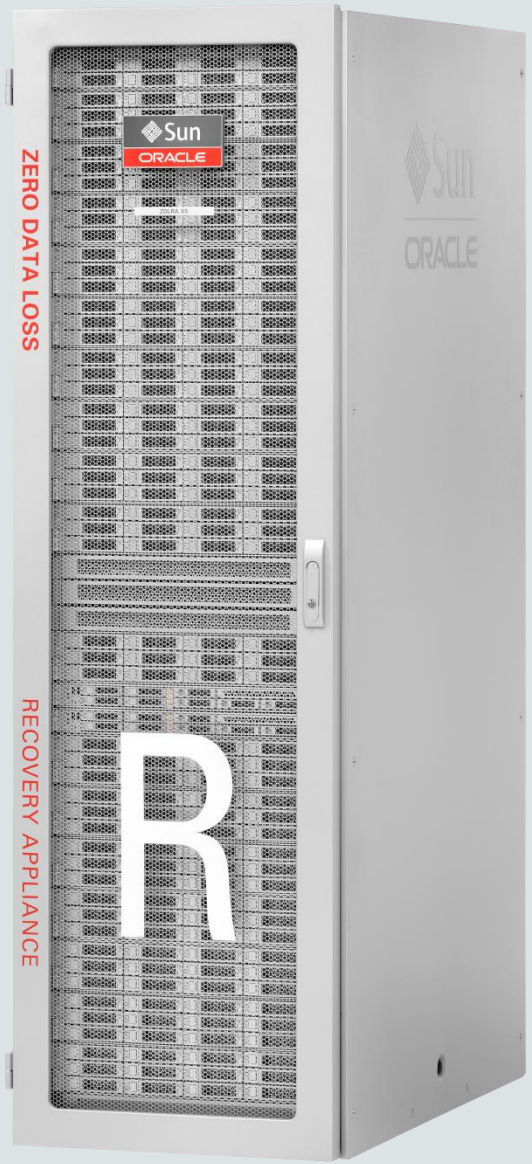

ORACLE®

Zero Data Loss Recovery Appliance

Technical Overview

Name

Title
Organization / Responsibility



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Safe Harbor Statement

The following is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle's products remains at the sole discretion of Oracle.

Program Agenda

1. Today's Data Protection Goals & Challenges
2. Recovery Appliance: A Fundamentally Different Approach
3. Centralized Data Protection Management
4. Discussion Prior to each Exercise:
    - Database Protection as A Service
    - Point-in-Time Recovery
    - Copy to Tape
    - Monitoring, Alerting and Reporting

Inadequate Data Protection = Downtime

European Cloud Infrastructure Provider

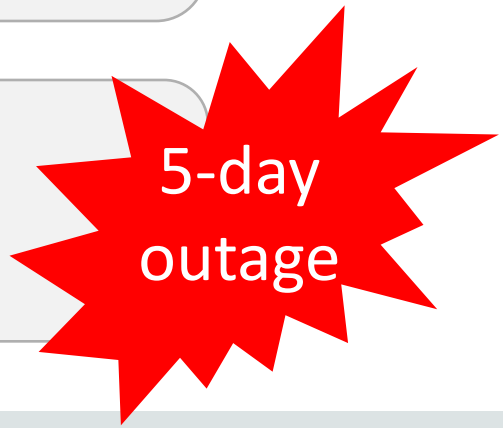
- Storage array failed, unable to read tape backups used for DR

Global Specialty Retailer

- Disk failure, followed by mirrored disk failure. Restore from local backup failed. Restore using copy at DR site also failed.

U.S. State Government

- SAN memory failure, problem mirrored to standby SAN.



Data Protection is Not Easy

"**88%** of CIOs experience capability-related challenges with backup and recovery,

87% with cost and
84% with complexity

showing that data protection is still not a simple task"

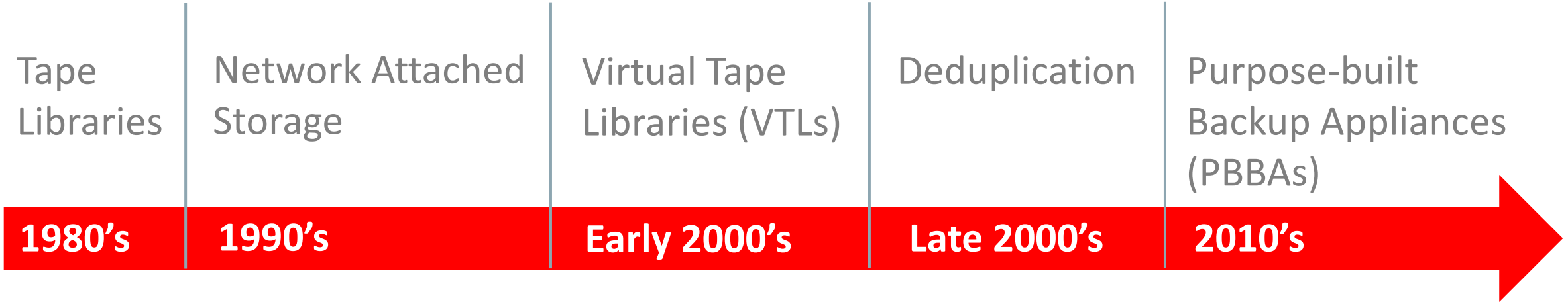
– Veeam Annual Data Protection Report 2013

#1 Top IT Priority

"Improve data backup and recovery"

– Source: ESG Research Report, 2012 IT Spending Intentions Survey

Backup Technology Evolution



Industry focus on Optimization of Storage Capacity, not on Application Availability

Backup Appliances Are Not Designed for Database

Treat Databases as Just Files to Periodically Copy

Data Loss Exposure

Lose all data since last backup

Daily Backup Window

Large performance impact on production

Poor Database Recoverability

Many files are copied but protection state of database is unknown

Many Systems to Manage

Scale by deploying more backup appliances

Need a Fundamentally Different Approach to Protect Business Critical Database Data

Zero Data Loss Recovery Appliance

Recovery Appliance Unique Benefits for Business and I.T.

Eliminate Data Loss

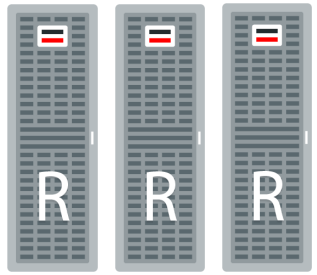
Real-time redo transport provides instant protection of ongoing transactions

Minimal Impact Backups

Production databases only send changes. All backup and tape processing offloaded

Database Level Recoverability

End-to-end reliability, visibility, and control of databases - not disjoint files

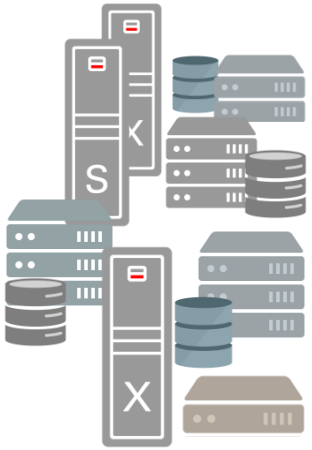


Cloud-Scale Protection

Easily protect all databases in the data center using massively scalable service

Zero Data Loss Recovery Appliance Overview

Protected Databases

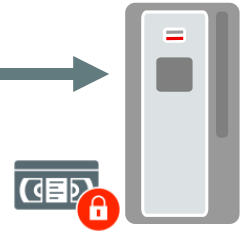


Delta Push

- DBs access and send only changes
  - Minimal impact on production
- Real-time redo transport instantly protects ongoing transactions

Recovery Appliance

Offloads Tape Backup



Protects all DBs in Data Center

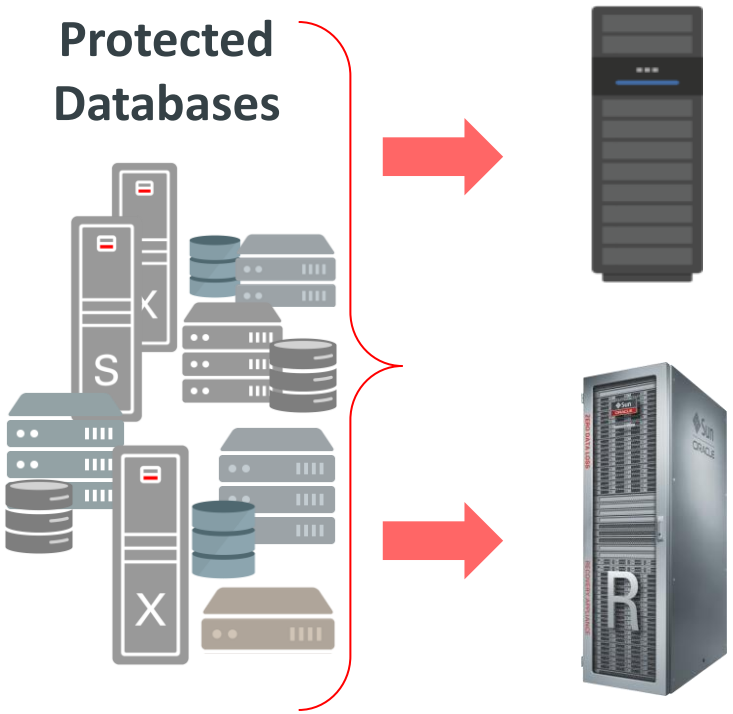
- Petabytes of data
- Oracle 10.2-12c, any platform
- No expensive DB backup agents

Delta Store

- Stores validated, compressed DB changes on disk
- Fast restores to any point-in-time using deltas
- Built on Exadata scaling and resilience
- Enterprise Manager end-to-end control

Replicates to Remote Recovery Appliance

Data Guard Like Protection for all Databases



Generic Bit-Copy Backup Appliance

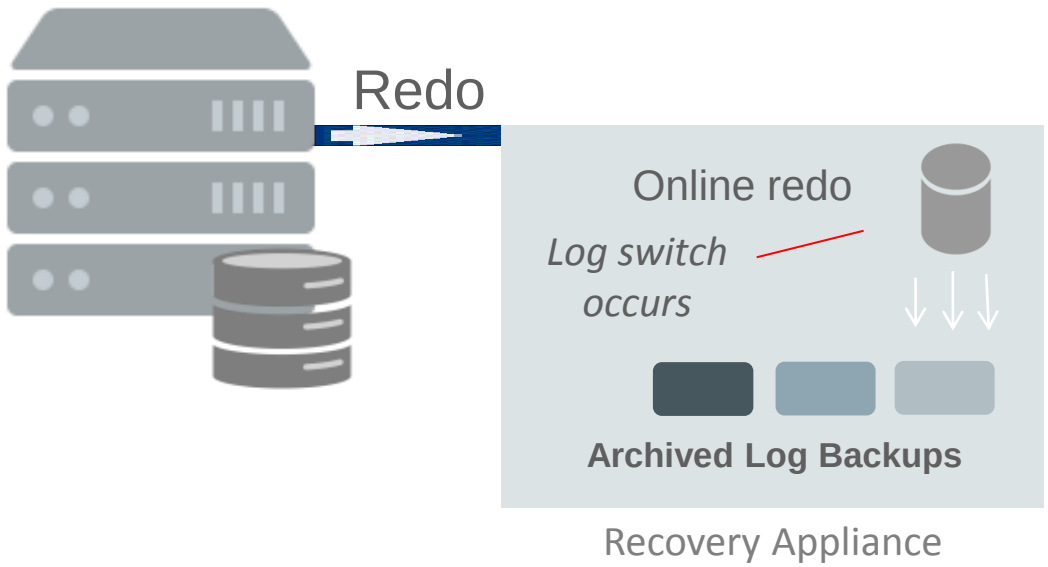
- Backup taken once a day
- Data loss exposure: all transactions since last backup

Zero Data Loss Recovery Appliance

- Uses Data Guard continuous real-time redo transport from in-memory buffers to immediately protect ongoing transactions

Data loss is inherently bad.
Even worse..it creates *massive consistency issues across databases*

Real-Time Redo Transport



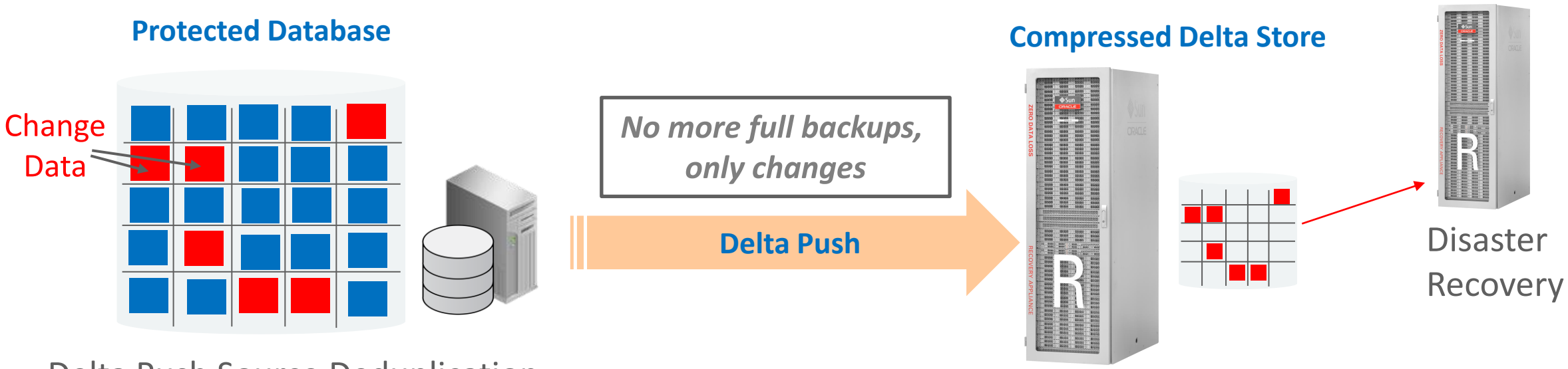
- How use of redo differs:
  - Recovery Appliance backs up the archived logs
  - Data Guard applies the redo to a standby database

- Two distinct benefits of how Recovery Appliance leverages real-time redo:
  - Reduces data loss exposure to a sub-second level
  - Offloads backup of archived logs from production database server
- Recovery Appliance is configured as an additional redo destination for protected databases
  - Oracle Database 11.1.0.7 forward*

*Platform and advanced capabilities may vary by database version

Delta-Only Architecture

No More Full Backups: Database Optimized Incremental-Forever



Delta Push Source Deduplication

- Fast Incremental Backup
  - Never reads duplicate blocks
  - Never sends duplicate blocks
- Eliminates Undo Blocks for committed transactions
- Eliminates Unused Blocks

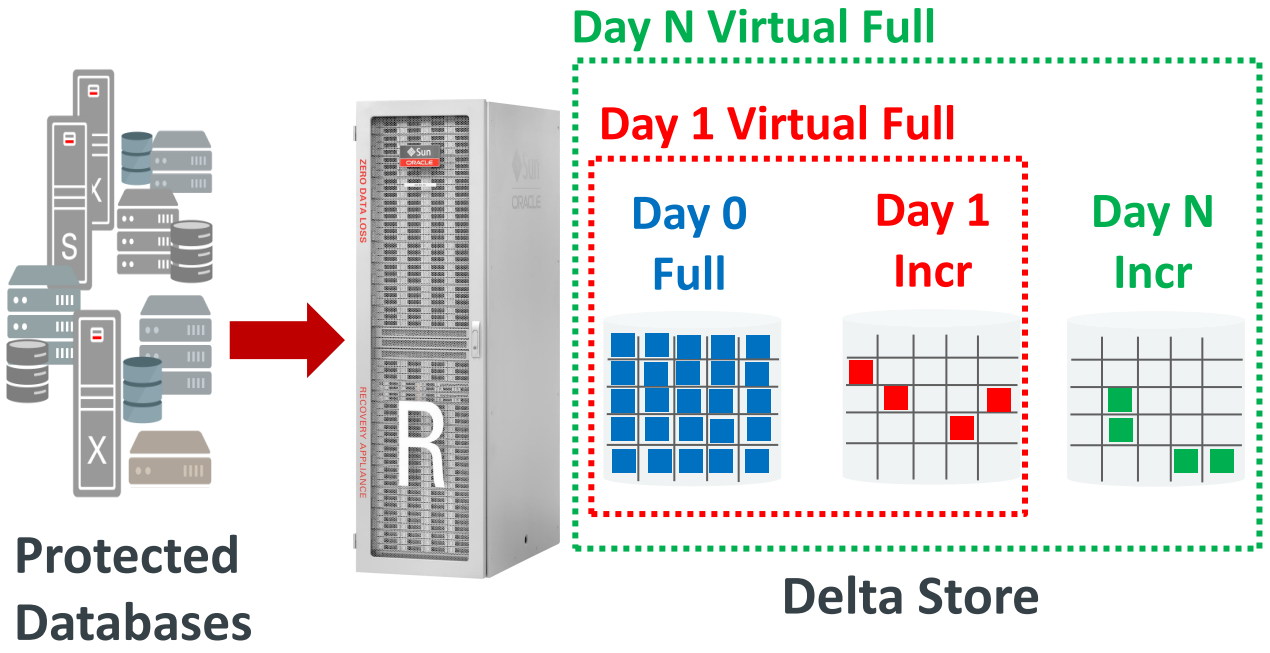
Delta Store Backup Management

- Stores only change data
- Compresses at block-level
- Ships only Deltas to Replica

Dramatic Database I/O & Network Savings

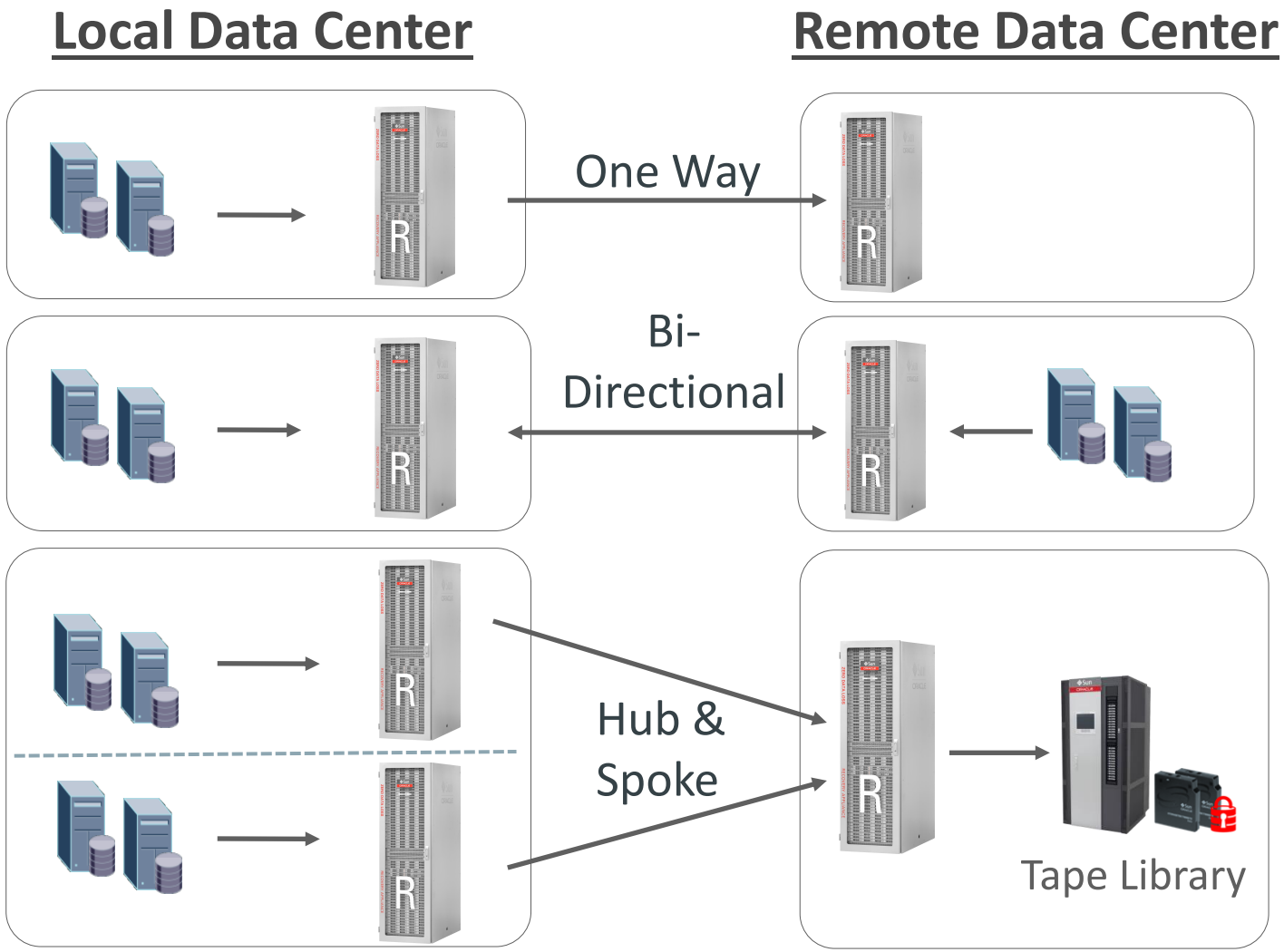
Space-Efficient “Virtual” Full Backups

No More Full Backups: Incrementals Forever Architecture



- After one-time full backup, incrementals used to create ***virtual*** full database backups on a daily basis
  - Pointer-based representation of physical full backup as of incremental backup time
  - Virtual backups typically 10x space efficient
  - Enables long backup history to be kept with the smallest possible space consumption
    - **“Time Machine” for database**

Data Loss Protection from Site Disasters



- Replication to Remote Appliance protects data from disasters or site failures
- Automated restore from Local Appliance or directly from Remote Appliance

Data Loss Protection from Users or Errors

Autonomous Tape Archival

16Gb FC

Supports Most Major Tape Libraries

- Optional low-cost Tape Archival provides unalterable protection from:
  - Intentional attacks by hackers, employees, and viruses
  - Accidental data deletion using tape as long-term archive
  - Malfunction of primary data protection system
- Autonomous Tape Archival is built-in: just connect tape drives
  - Offloads tape backup activity from production servers
  - No expensive media manager backup agents on production systems
  - Tape drives run all day without slowing production systems
  - Oracle Secure Backup included, or use your own tape software

Data Loss Protection from Corruptions

Recovery Appliance Understands and Validates Database Formats End-to-end

- Data validated on receive
- Data periodically revalidated
- Data validated on restore

Production Appliance

Tape Archive

- Data validated when copied to and restored from tape

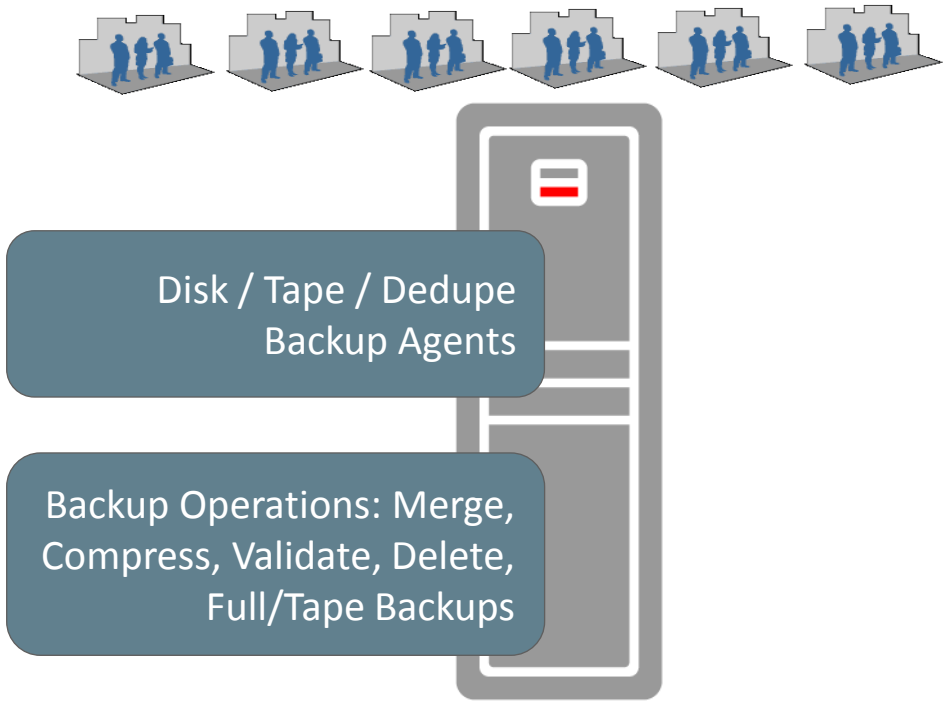
Remote Replica

- Data validated on receive, restore, and periodically on-disk

Minimal Impact Backups: Boost Production Server Performance

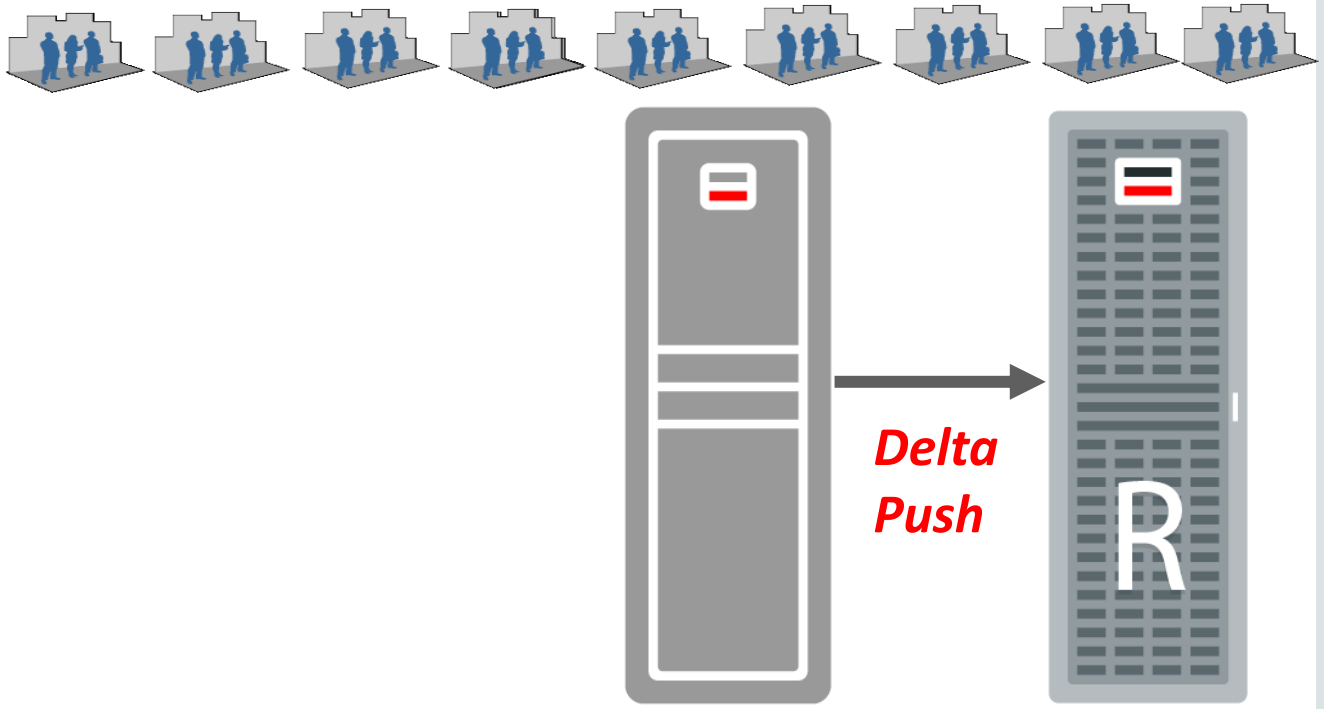
Offload Backup Processing, Eliminate Expensive Backup Agents, Reduce Network Load

Performance degrades with backups



Database Server Today

Performance improves with backup offload

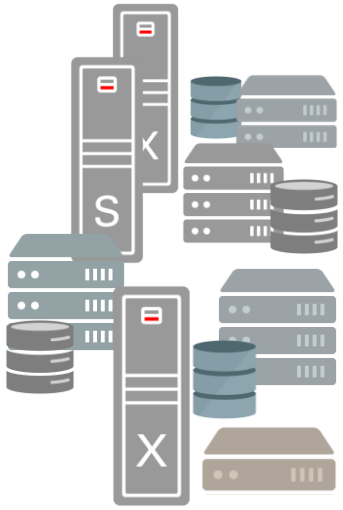


Database Server with Recovery Appliance

Modern Cloud-Scale Database Protection

No Bottlenecks, No Single Point of Failure

Protected Databases



Oracle Database
10.2, 11g, 12c

Connectivity scales with capacity

10 GigE or InfiniBand

Fibre Channel connectivity scales with capacity

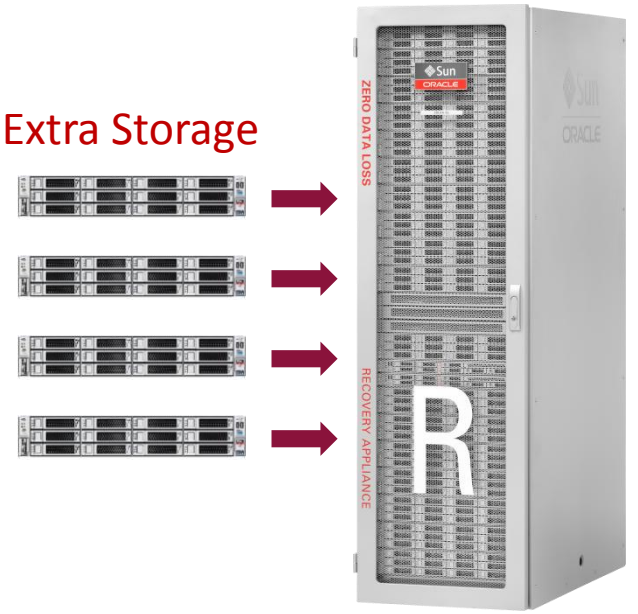
- Scale-out compute servers for data processing
- Scale-out storage servers for persistence and deduplication
- Scalable InfiniBand internal fabric

Single System Scales to Protect an Entire Data Center

Start with Base Rack Configuration and Scale

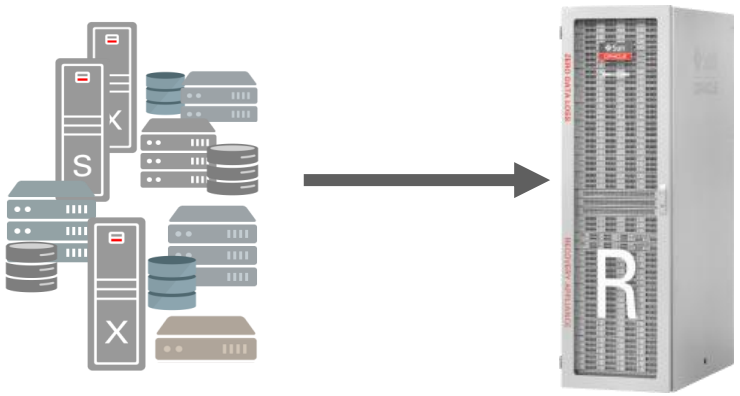
- Base Rack
  - 2x Compute Servers with high speed connectivity
    - Eight 10 Gb Ethernet ports per rack
    - Twelve 40 Gb InfiniBand ports per rack
    - Optional Four 16Gb Fibre Channel ports for tape connectivity
  - 3x Storage Servers
    - Each storage server has 12 high capacity disks
    - 50.5 TB usable backup capacity
- Each Storage Server adds 19.3 TB of usable backup capacity
- Full Rack: 2x Compute Servers, 18x Storage Servers
  - 340 TB usable backup capacity

Recovery Appliance Base Rack



Fully Redundant

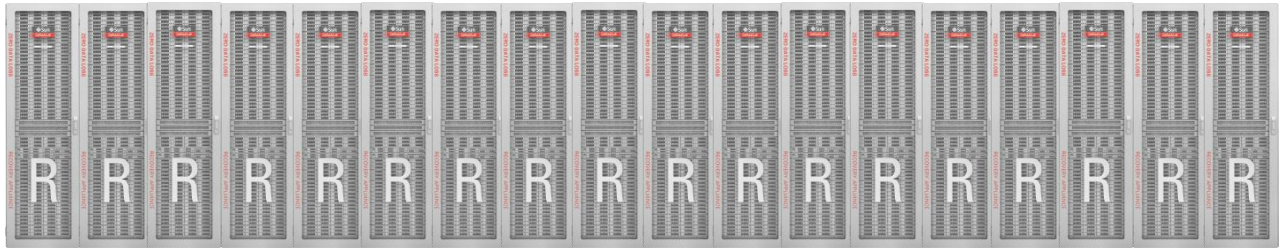
Recovery Appliance X5 Scaling



Performance per Full Rack

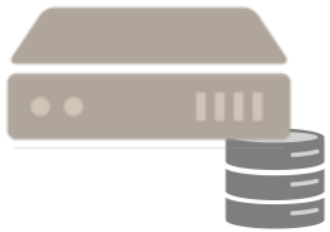
- Up to 120 TB/hour Virtual Backup Rate
- Up to 12 TB/hour Sustained Delta Ingest
- Up to 12 TB/hour Restore Rate

- Add InfiniBand connected racks to scale
- Can expand with new generation hardware
- Scale to 18 Racks
  - Up to 216 TB/hour Delta Ingest and Restore

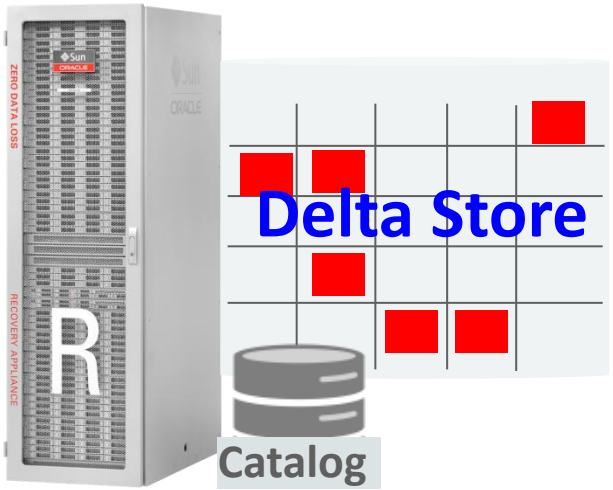


Centralized Data Protection Management

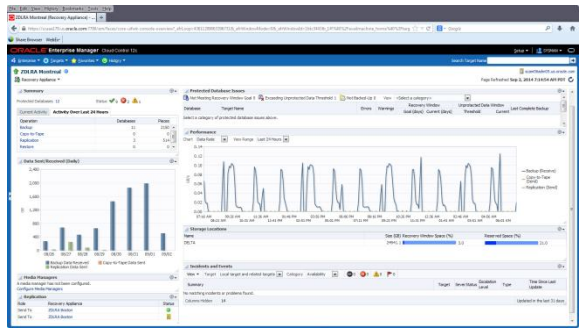
Standard Configuration – Single Vendor Technical Support



- Recovery Appliance Backup Module on client databases

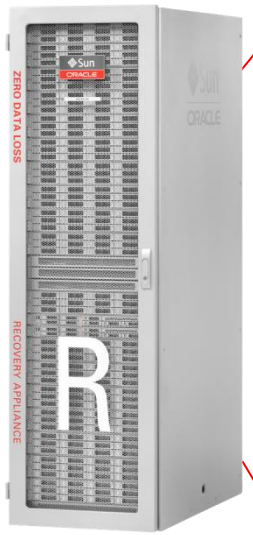


EM Cloud Control 12c



- Recovery Appliance software stack
  - Embedded and optimized in Oracle 12c Database
  - Oracle database houses Recovery Appliance metadata and RMAN catalog
  - Oracle Secure Backup bundled for tape media management
  - Exadata software optimized for Recovery Manager
- Scalable Exadata platform
  - 80Gbits InfiniBand internal network bandwidth (Per Compute server)
  - 16Gb Fibre Channel cards for tape connectivity (optional) (Per Compute server)
  - Exadata Smart Flash Optimized for Backups
- Exadata HA Platform

Pre-Defined Storage Configuration



Storage Location(s)

- Logical storage container:
  - Database backups
  - Archived log backups
- Space dynamically shared based on user-defined recovery settings
- Shared by all / many databases

Fast Recovery Area

- Incoming redo from protected databases

Recovery Appliance Catalog

- All protected databases leverage the Recovery Appliance catalog
- Two pre-defined disk groups:
  - Catalog - High redundancy
  - Delta - Normal redundancy
- On Storage Location (Delta) is pre-configured and leverages all usable space on the appliance
  - The storage location may be easily expanded as additional capacity is needed

Eliminate Storage Over-Provisioning

Dynamic Storage Allocation to Meet Recovery Window Goals

Protected Database Requirements

Business Requirement
- Recovery Window Goal

Disk Storage Projected to Meet Recovery Goal
*-Recovery Appliance " **Reserved Space**"*
- Guaranteed storage amount provided ***IF*** needed to meet Recovery Window Goal

Oracle ZDLRA Storage Location

All Recovery Window Goals

Storage is dynamically shared across all databases within the location to meet recovery window goals.

Balances individual database and aggregate of all database recovery goals.

Database Protection as A Service

- Defined Class of Service

Protection Policies – Defined Class of Service

Foundation of Database Protection as A Service

Business SLAs categorized:
- One policy per database tier

Protection Policy

- Recovery requirements
  - Disk
  - Tape
- Maximum on disk retention
- Prioritization of backups
- Polling local backups
- Unprotected data window threshold

- Defined Class of Service

- Databases are managed as a group (by policy) to define:
  - Replication
  - Scheduling copy of backup to tape or cloud
- Same or different policy on remote Oracle DBLRA
- Reporting by policy and database

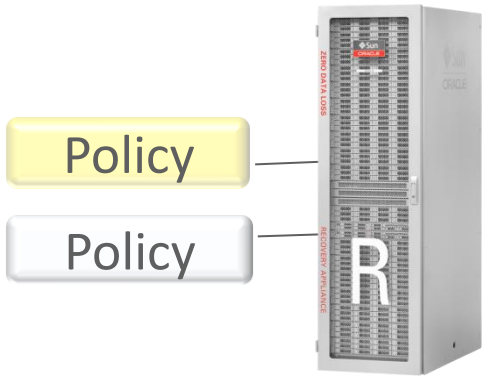
Standardization Across the Enterprise

Autonomous Management of all Backup Assets

Protection Policy

- Recovery Window = 7 days on disk, 90 days on cloud or tape
- Maximum disk retention = 8 days
- Copy of backup required on alternate media
- Unprotected Data Window Threshold = 2 minutes

(Example)



Replicate

Gold Policy
(Mission-Critical)
→ Weekly full / daily incremental

Silver Policy
(Business-Critical)
→ Weekly full

Bronze Policy
(Test / Dev)
→ Weekly full

Protect Policies – Defines Class of Service

Foundation of Database Protection as A Service

- One protection policy associated with many databases
  - Define one protection policy for each Class of Service:
    - Disk recovery window goal and Guaranteed Copy Policy
    - *Optionally* - tape recovery window, unprotected data window threshold, maximum disk retention or backup polling settings
- If unprotected data window threshold defined:
  - Ensure all databases associated with the policy have real-time shipping enabled or backup on the same frequency
- Replication is configured by protection policy so all databases associated with a protection policy should have the same replication requirement

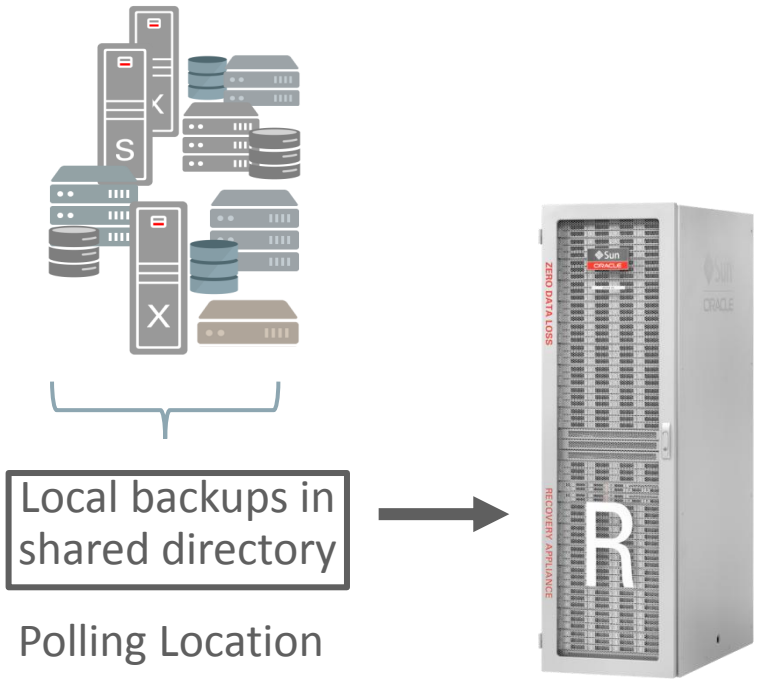
Prioritization of Incoming Backups or Recovery Window

Applicable ONLY if NO Space Available for Incoming Backups

- Only applicable IF extreme space pressures which it NEVER should!
  - Could only happen if the Recovery Appliance administrator IGNORES the numerous alerts and warning
- Guaranteed Copy Policy setting in the Protection Policy dictates behavior IF extreme space pressure occurs (means no space for incoming backups):
  - *Disabled:* Always accept new, incoming backups (default)
    - Oldest backup within the recovery window could be purged to make room for incoming backups
  - *Enabled:* Refuses new, incoming backups if not enough space AND a copy of the backup doesn't exist on tape or replica
    - Backups within recovery window could only be purged on disk thereby making room for the incoming backup, if they'd been copied to tape or replicated
    - If this policy is enabled, a database's backups on the Recovery Appliance will never consume more storage than its reserved space setting

Automated Backup Polling

Copy or Migrate Local Backups to the Recovery Appliance



- Recovery Appliance can copy or migrate local RMAN backupset backups
  - Backup polling directory and frequency (schedule) is defined in a Protection Policy and applicable to all databases associated with the policy
- Backup polling can be effectively used to migrate existing RMAN backupset backups into the Appliance
  - Extends point-to-time recovery capability from the Appliance to that of the oldest backup copied
    - Avoids having to perform the initial full backup to seed the Appliance
- Mount the Network File System (NFS) directory that stores backups

End-to-End Visibility and Management

Multi-Tiered Environment: Copy to Tape and/or Replica

- Managing databases as a group increases consistency and manageability:
  - Replication is defined by Protection Policy
    - Incoming backups of databases associated with the protection policy are immediately replicated – No scheduling required
    - If replication activity is paused by the user, upon resuming replication all backups since the pause would be automatically replicated
  - Copy to tape jobs may be scheduled by database or protection policy
- When initially configuring replication or a copy to tape job, the most recent virtual full backup will be copied (e.g. point of last incremental)

Point-in-time Recovery

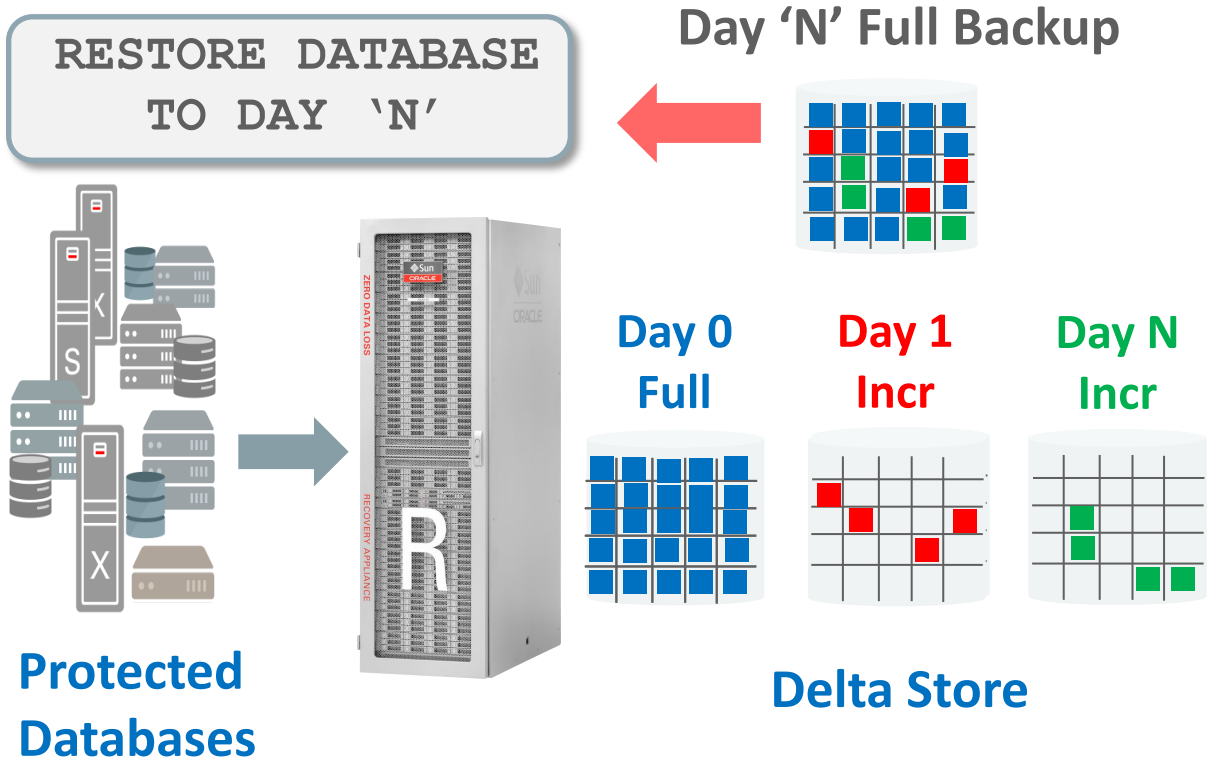
Same RMAN Recovery Process

Recovery Appliance

- RMAN restore and recovery commands identical between traditional recovery and modern Recovery Appliance environments
  - RMAN backup strategy changes to use incremental forever strategy – Same level 1 backup commands
  - Granularity of recovery from block media to full virtual restore
- Oracle Data Recovery Advisor (DRA)
  - Enables database recovery by using automatic repair actions
- User Directed Recovery
  - Manual recovery based on specified criteria

Fast Restore to Any Point-in-Time

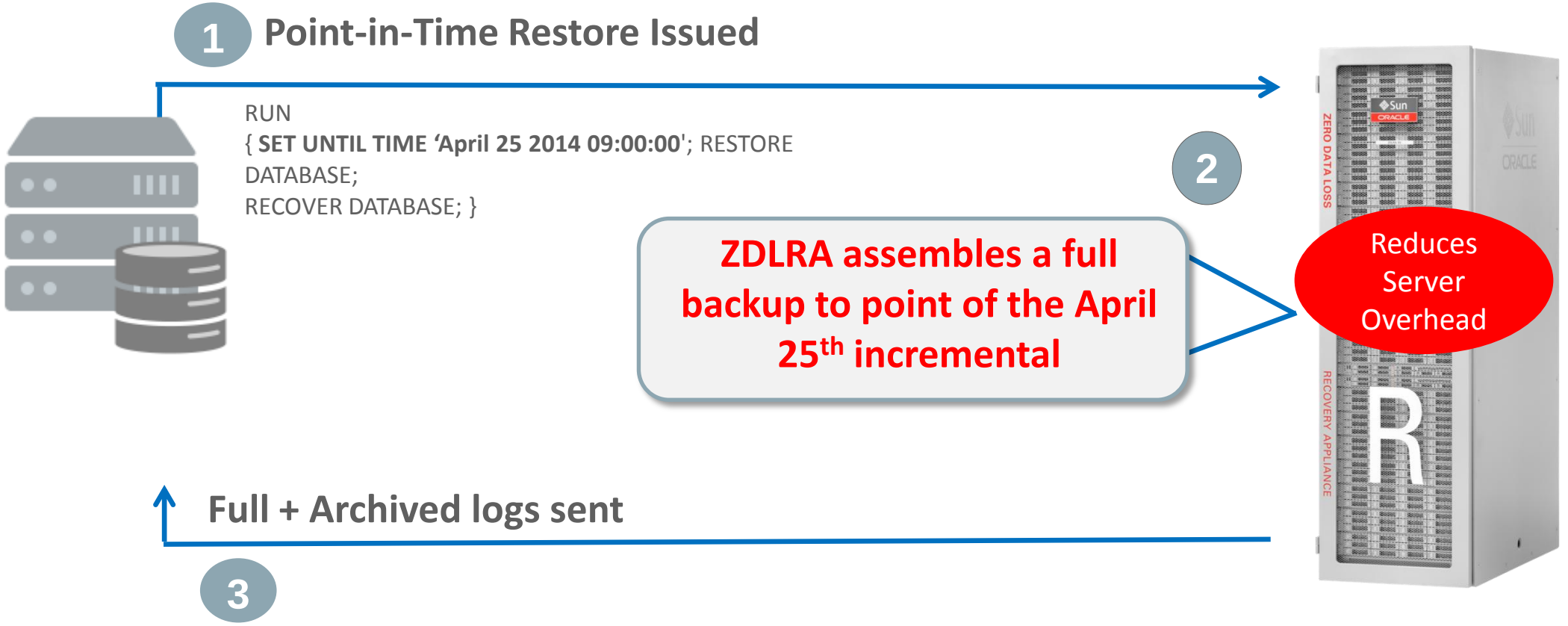
No Load On Production Servers to Merge Old Backups



- Directly restore any virtual full backup
  - All blocks referenced from virtual full are efficiently retrieved
  - Eliminates production server overhead of traditional restore and merge of incrementals
- Supported by the scalability and performance of the underlying Exadata hardware architecture

Virtual Full Restore Sent to Database Server

Synthesized from Low-Impact Incremental Backups



Centralized Copy to Tape

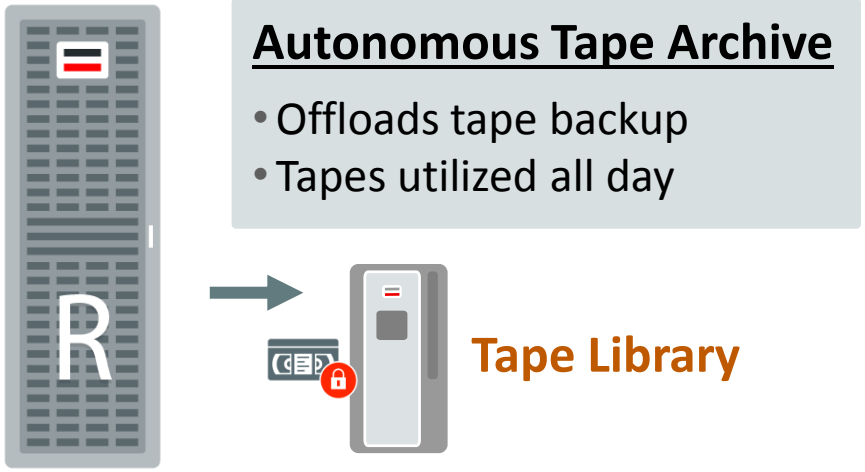
Centralized Copy to Tape

- Tape backup processing is offloaded from the database servers
- Media manager is installed not on production servers but only on ZDLRA
  - Simplifies management as tape backup scheduling and tuning is performed on ZDLRA instead of every database server
  - Eliminates need for media management database agents / modules on production servers

Better tape device utilization:

- Leverage 24 x 7 w/o impacting production servers or network!

Out-of-the-Box with Oracle Secure Backup



- Oracle Secure Backup (OSB) pre-configured with default settings:
  - Recovery Appliance compute servers are OSB media servers for direct attached tape devices
  - Tape pools (OSB media families)
  - Automated OSB catalog backup
  - Automated discovery and configuration of attached tape devices
- Easily customize for advanced tape management (e.g. tape duplication and vaulting etc)

Managing Copy to Tape Operations

Recovery Appliance Protection Policy

- Defines the recovery window on tape

Attribute Set (s)

- Associated with a Media Manager Library
- Define number of streams to use for the backup operation
- Media management parameters (optional)
  - These will override any defined in the Media Manager Library setting or via the media manager

Copy to Tape Job Templates

Defines:

- Specific database or all databases in a protection policy
- Type of backup - Full, Incremental and / or Archived logs
- Job priority, # of copies and runtime window
- Media Management Library and Attribute Set
- Copy to tape schedule – one time or recurring

Media Manager Library

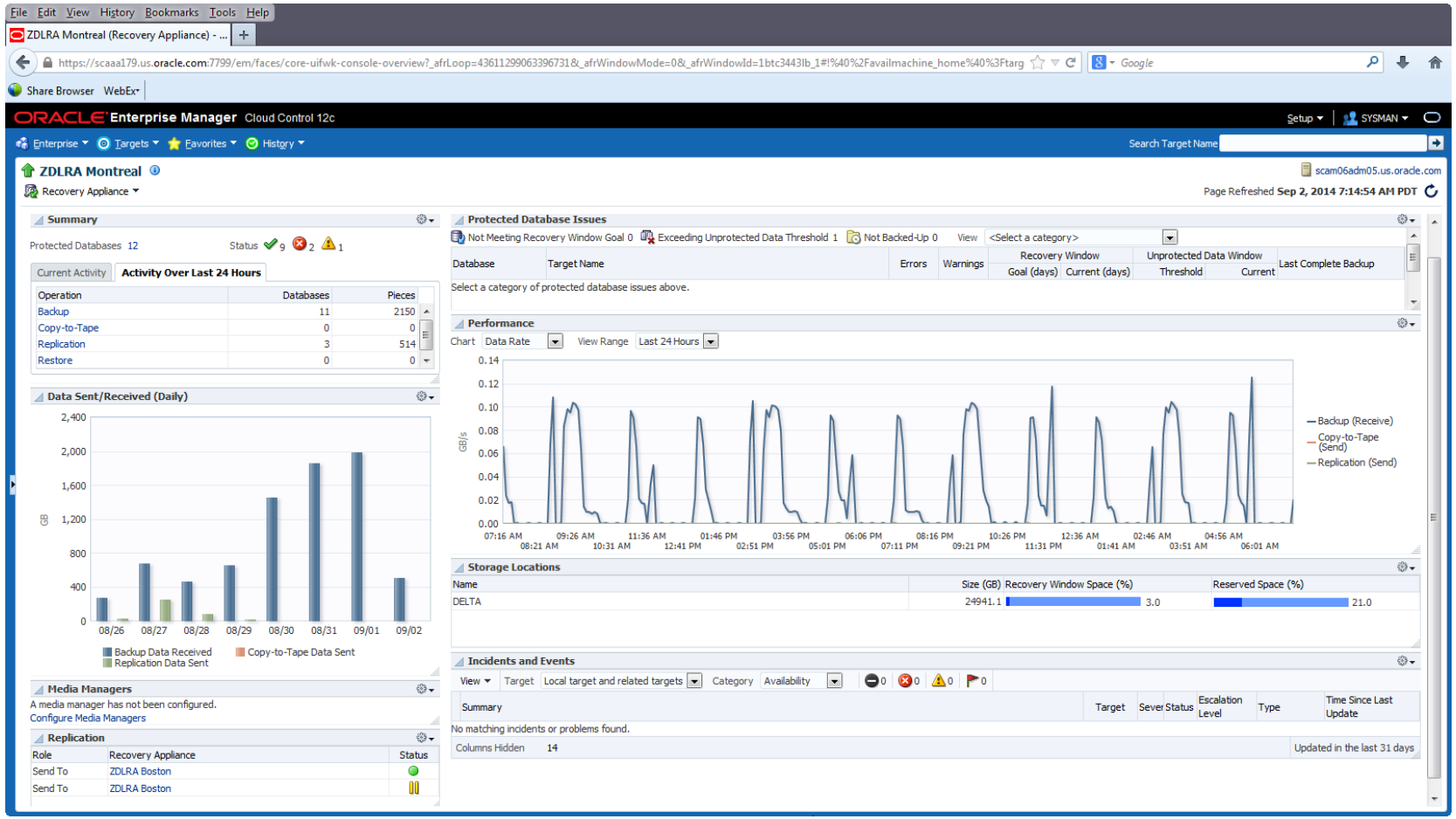
- Associated with installed media manager specific SBT library (OSB by default)
- Sets maximum number of RMAN channels which can be used concurrently (based on # of available tape drives)
- Define RMAN media parameters to be used

Monitoring, Alerting and Reporting

Recovery Appliance Home Page

Dashboard for Current Status of the Backup Domain

- Sections include:
  - Summary of current and recent activity
  - Protected database backup/recovery issues
  - Daily data sent / received
  - Performance
  - Media Manager status
  - Replication status to / from
  - Storage Location status
  - Incidents and Events



Advanced Monitoring and Alerting

Leverages Enterprise Manager Monitoring Framework

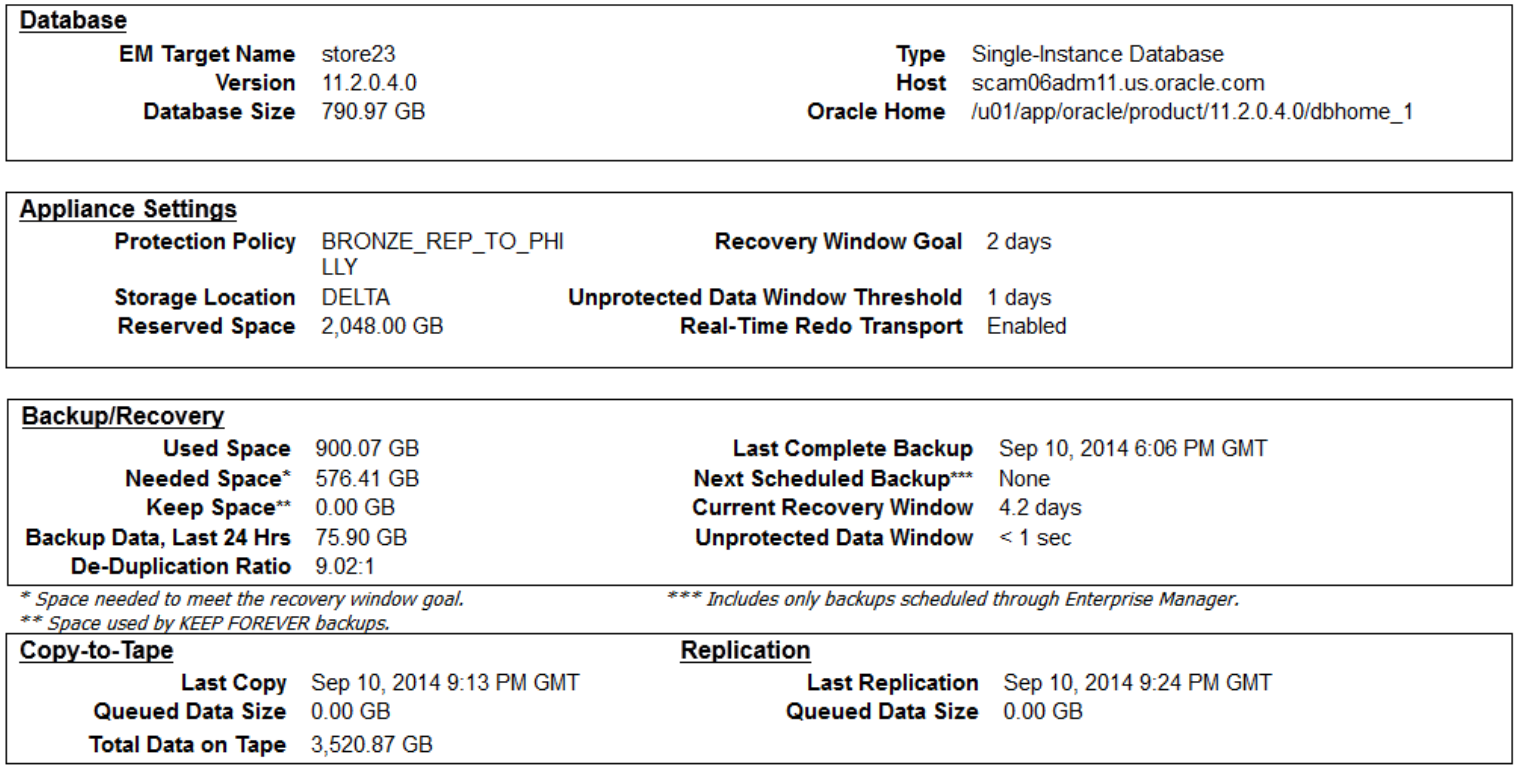
- The Recovery Appliance home page provides a dashboard of current status
  - Warnings and alerts are prominently displayed which may need user attention
- Effectively manage any issues, assign ownership and track problems through to resolution
  - Leverages the EM incident and event notification system
- Default and user-defined metrics trigger warnings or error messages based on thresholds
  - EM collects metrics on key information providing out-of-the box monitoring and alerting

Out-of-the-Box Reports

Leverages Enterprise Manager BI Publisher

- Protected Database Details →
- Recovery Window Summary
  - Recovery status by protection policy
- Top 10 Protected Databases by Data Transfer
- Capacity Planning Reports:
  - Summary
  - Details

Protected Database Details Report (Partial screenshot):



Database

EM Target Name	store23	**Type**	Single-Instance Database
Version	11.2.0.4.0	**Host**	scam06adm11.us.oracle.com
Database Size	790.97 GB	**Oracle Home**	/u01/app/oracle/product/11.2.0.4.0/dbhome_1

Appliance Settings

Protection Policy	BRONZE_REP_TO_PHILLY	**Recovery Window Goal**	2 days
Storage Location	DELTA	**Unprotected Data Window Threshold**	1 days
Reserved Space	2,048.00 GB	**Real-Time Redo Transport**	Enabled

Backup/Recovery

Used Space	900.07 GB	**Last Complete Backup**	Sep 10, 2014 6:06 PM GMT
Needed Space*	576.41 GB	**Next Scheduled Backup*****	None
Keep Space**	0.00 GB	**Current Recovery Window**	4.2 days
Backup Data, Last 24 Hrs	75.90 GB	**Unprotected Data Window**	< 1 sec
De-Duplication Ratio	9.02:1		

** Space needed to meet the recovery window goal.*
*** Space used by KEEP FOREVER backups.*
**** Includes only backups scheduled through Enterprise Manager.*

Copy-to-Tape

Last Copy	Sep 10, 2014 9:13 PM GMT
Queued Data Size	0.00 GB
Total Data on Tape	3,520.87 GB

Replication

Last Replication	Sep 10, 2014 9:24 PM GMT
Queued Data Size	0.00 GB

Recovery Window Summary Report

Status by Protection Policy on Degree to Which Recovery SLAs are Being Met

- Report provides a summary of the number of databases by protection policy meeting or not meeting Recovery SLAs

Category	Description
Databases meeting all Recovery SLAs	Meeting Recovery Window Goal and Within Unprotected Data Window Threshold
Databases not meeting one or more Recovery SLAs	• Exceeding Unprotected Data Window Threshold and Not Meeting Recovery Window Goal • Exceeding Unprotected Data Window Threshold but Meeting Recovery Window Goal • Not meeting Recovery Window Goal but Within Unprotected Data Window Threshold

Top 10 Protected Databases by Data Transfer Report

- The report provides information on which databases are sending the most data categorized in three ways:
  - By Backup Data
  - By Replication Data
  - By Copy to Tape Data
- The report includes two graphs for each database with the category showing data throughput aggregated by database by hour for the last 24 hours and an aggregated by day for the last 7 days.

Capacity Planning Reports

Pro-active Monitoring of Capacity Based on Backup Data Growth Rate

Capacity Planning Summary Report	Capacity Planning Detail Report
Storage utilization table and charts for 7, 31 and 365 days - Storage location size, recovery window space and number of protected databases	Storage, network, CPU, Memory and IOPS capacity planning information
- Network throughput for last 24 hours - Average and maximum receive and transmit rates for 7, 31 and 365 days	Report is divided into two main sections: - Charts and Daily Data
- Schedule the report to be generated weekly	- Leverage the report as needed to review issues

Storage Capacity Planning Summary

	Last 7 Days	Last 31 Days	Last Year
Storage Growth Rate (GB/day, average)	886.38	No Data Available	No Data Available
Days Until Capacity is Exceeded*	121.23	No Data Available	No Data Available

*The appropriate number of days in which the needed aggregate recovery window space will exceed the available storage location space, calculated at the weekly, monthly and yearly average growth.

Standardized Oracle Database Protection

- Database Protection as A Service
  - Defined class of service whereas databases may be managed as a group for multi-tiered protection strategy
  - Reports by database, appliance and protection policies
- Incremental forever backup strategy for all Oracle databases in the data center
- Shifts focus from retention to database recoverability
- Pro-active capacity monitoring to meet current and future requirements

Hardware and Software
Engineered to Work Together


ORACLE®

Recovery Appliance & Oracle Maximum Availability Architecture

Production Site

RAC
– *Scalability*
– *Server HA*

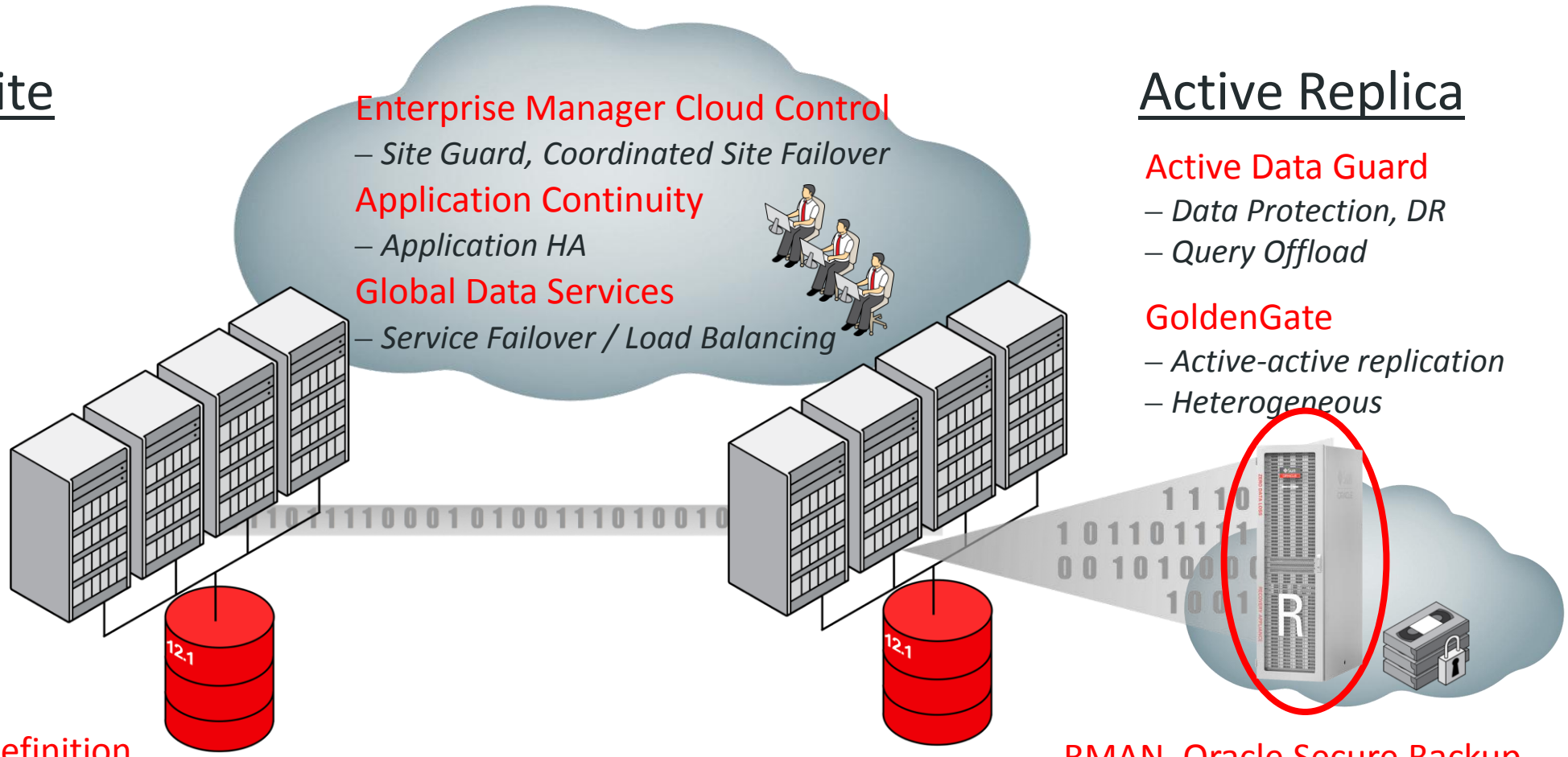
ASM
– *Local storage protection*

Flashback
– *Human error correction*

Enterprise Manager Cloud Control
– *Site Guard, Coordinated Site Failover*

Application Continuity
– *Application HA*

Global Data Services
– *Service Failover / Load Balancing*



Active Replica

Active Data Guard
– *Data Protection, DR*
– *Query Offload*

GoldenGate
– *Active-active replication*
– *Heterogeneous*

Edition-based Redefinition, Online Redefinition, Data Guard, GoldenGate
– *Minimal downtime maintenance, upgrades, migrations*

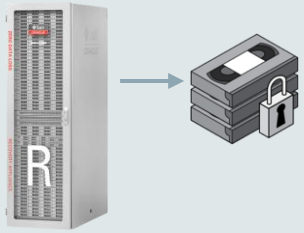
RMAN, Oracle Secure Backup, Zero Data Loss Recovery Appliance
– *Backup to disk, tape or cloud*

Recovery Appliance & Oracle High Availability Technologies

Fast & Low-Cost
Backup Store

ZS3 Backup Appliance

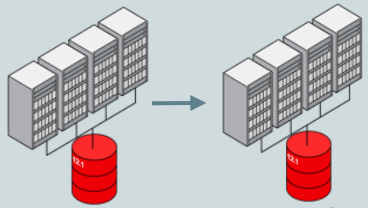
- Fast low-cost storage for backup
- RAID-Z and compression for high storage efficiency
- Built-in snapshots and cloning for dev/test



Enterprise
Data Protection

Zero Data Loss Recovery Appliance

- Real-time redo transport, store online history for weeks or months
- Offload disk and tape backup activity from production servers
- Scalable database protection as a service for the enterprise



Dedicated System for
Failover + Data Protection

Active Data Guard

- Fast **failover** for for one database, highest application availability (RTO ~=0)
- Real-time redo transport (RPO = 0)
- Optimize performance and availability by offloading queries