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Oracle Database 11*g*: Next Generation High Availability

Ashish Ray
Director of Product Management, Oracle Database High Availability

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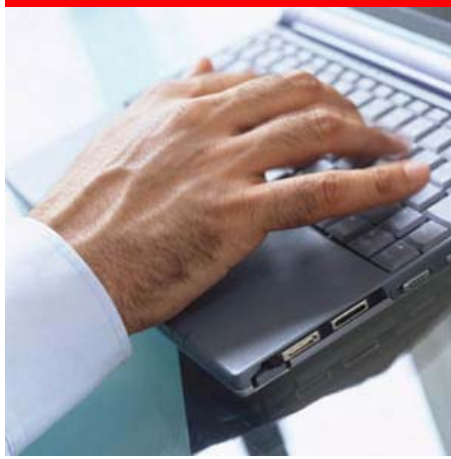
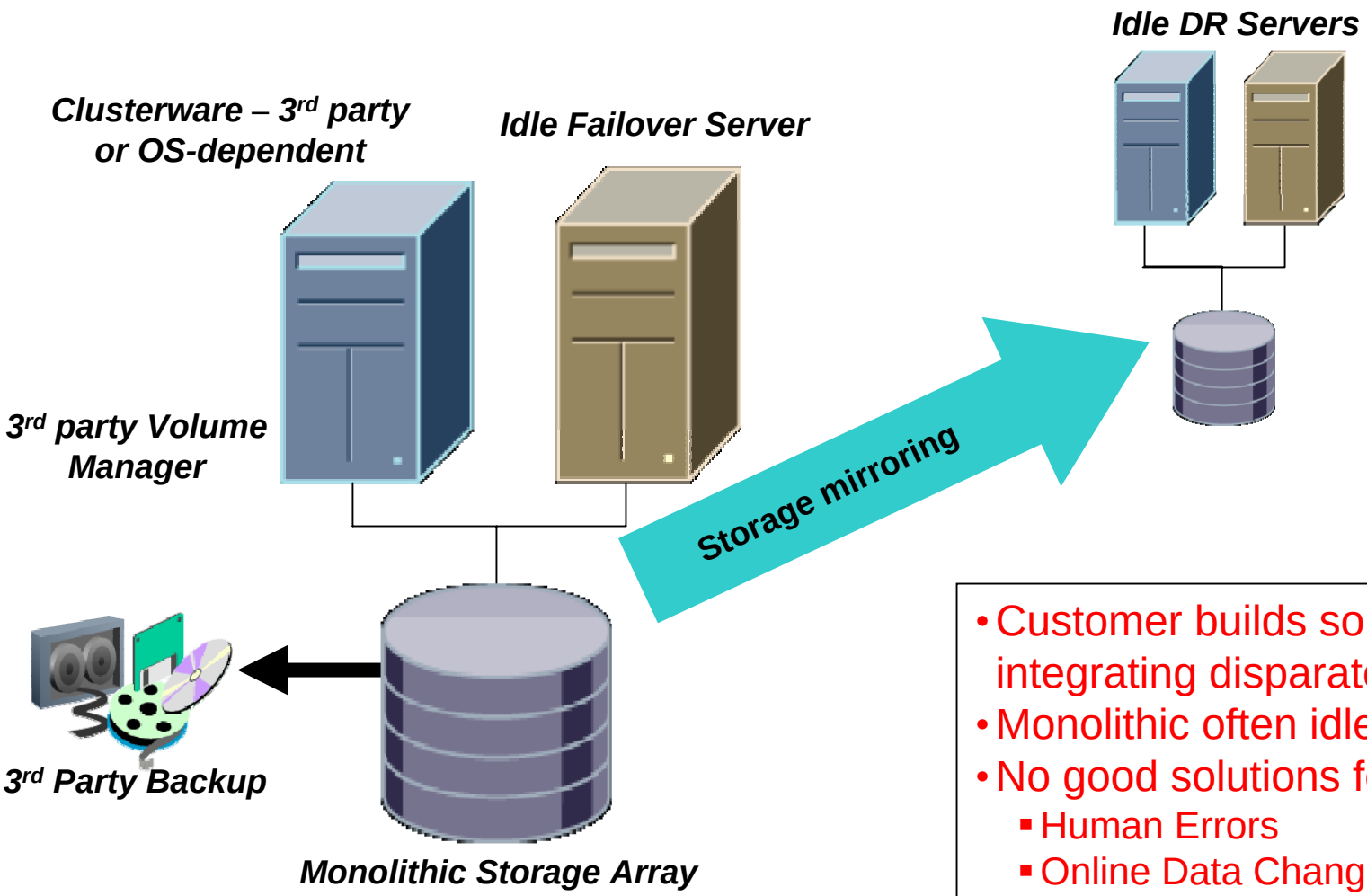
Agenda



- Introduction: Oracle Database High Availability (HA)
- Description: Oracle Database HA Components
- Maximum Availability Architecture (MAA)

Traditional Database High Availability



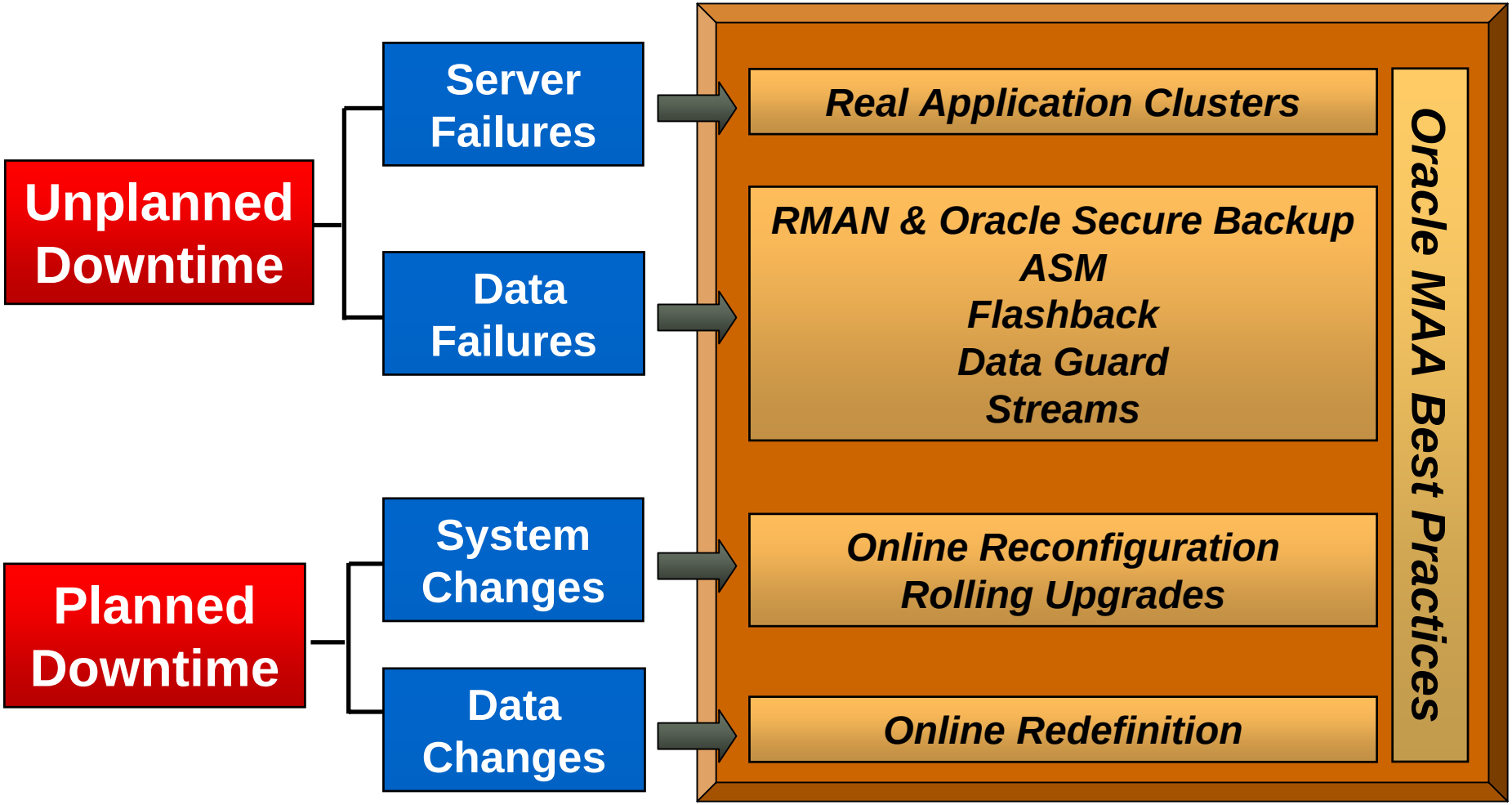
- Customer builds solution by integrating disparate components
- Monolithic often idle hardware
- No good solutions for:
  - Human Errors
  - Online Data Changes
  - Software Upgrades

Oracle Database High Availability

- Next-generation architecture
  - Based on industry-standard low-cost modular components
  - Uses all components productively
  - Scales easily to meet business growth
- Maintains continuous uptime
  - Tolerates many outages transparently
  - Recovers from outages very fast
  - Protects data from both physical and logical failures
- Easy to implement and administer
  - Fully integrated for the Oracle stack
  - Application and Storage transparent
  - Unified management through Oracle Grid Control

Oracle's HA Solution Set

Integrated with Database – Unparalleled in the Industry!

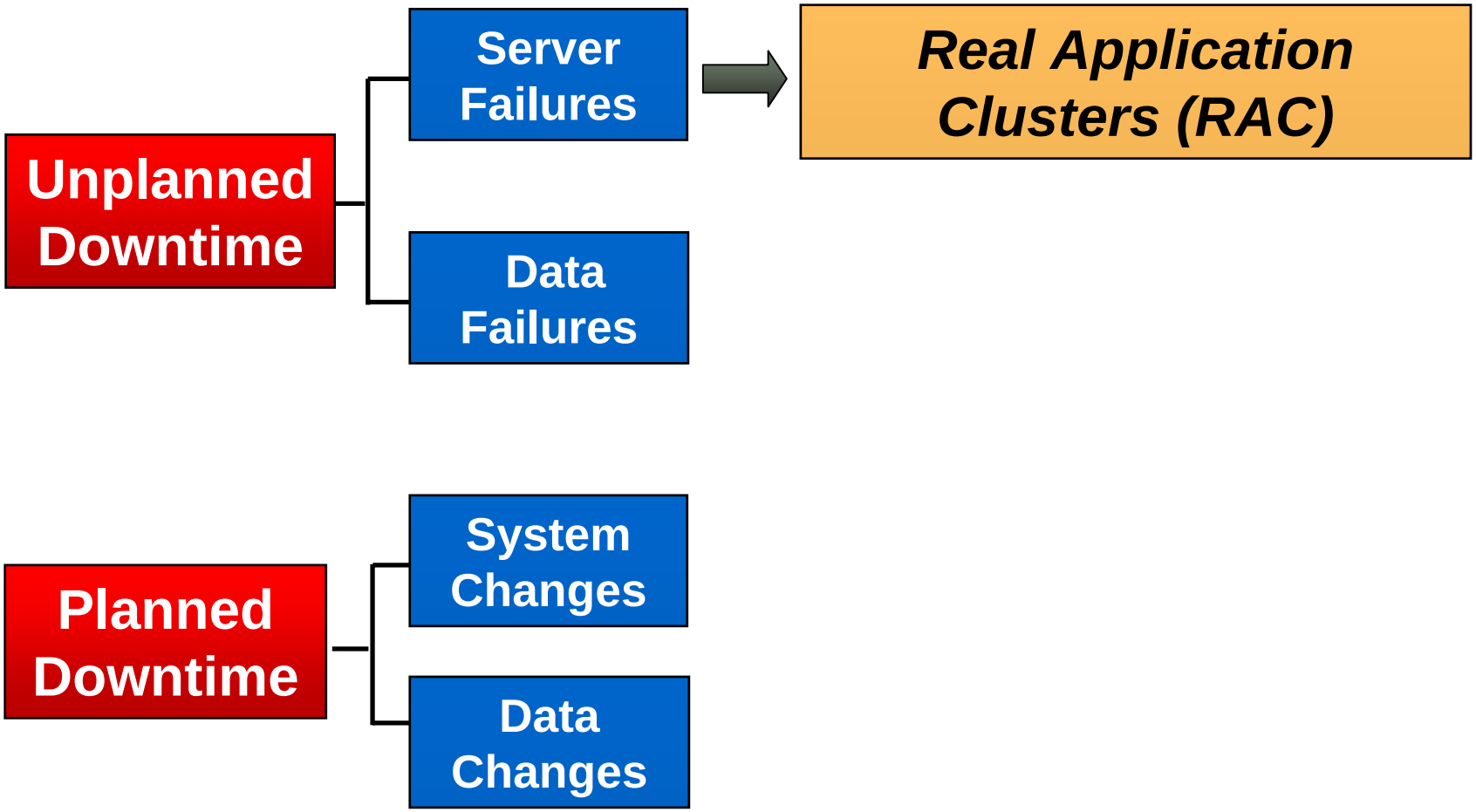


Agenda

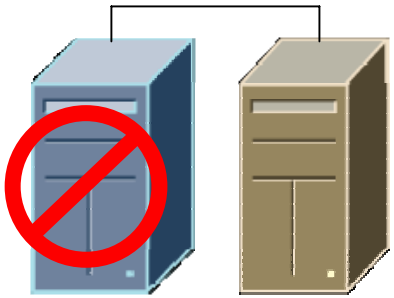
- Introduction: Oracle Database High Availability (HA)
- Description: Oracle Database HA Components
- Maximum Availability Architecture (MAA)

Best-of-Breed Server Protection

At Lowest Cost



Server HA & Scale-Out with RAC



- RAC pools standard low cost servers
- Great Scalability & Availability
  - No Idle Resources
- No application changes required
- Thousands of customers

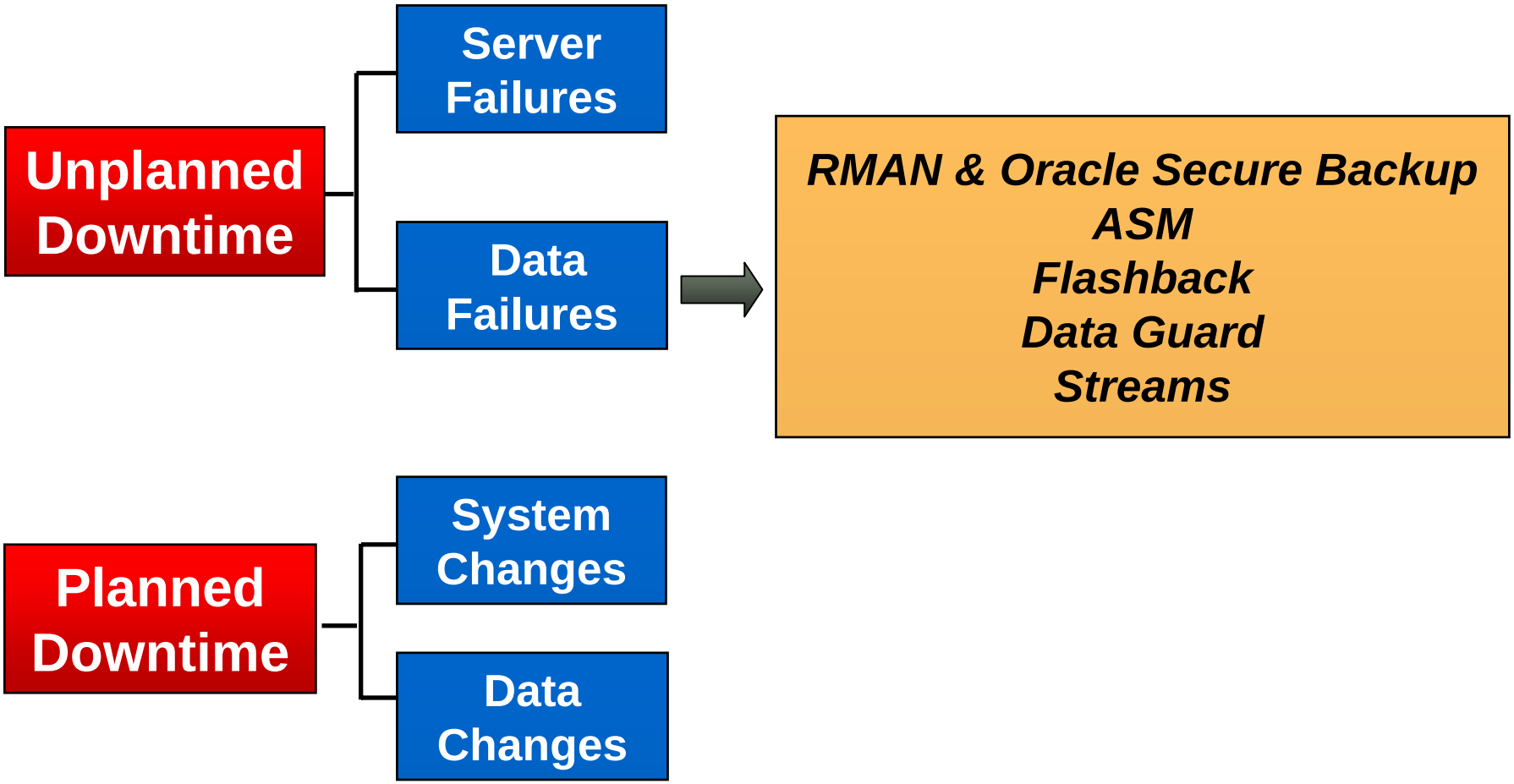
ORACLE DATABASE 11g

- Fine-tuned performance, scaling, failover, management, integration

Designed to Tolerate Server Failures

Best-of-Breed Data Failure Protection

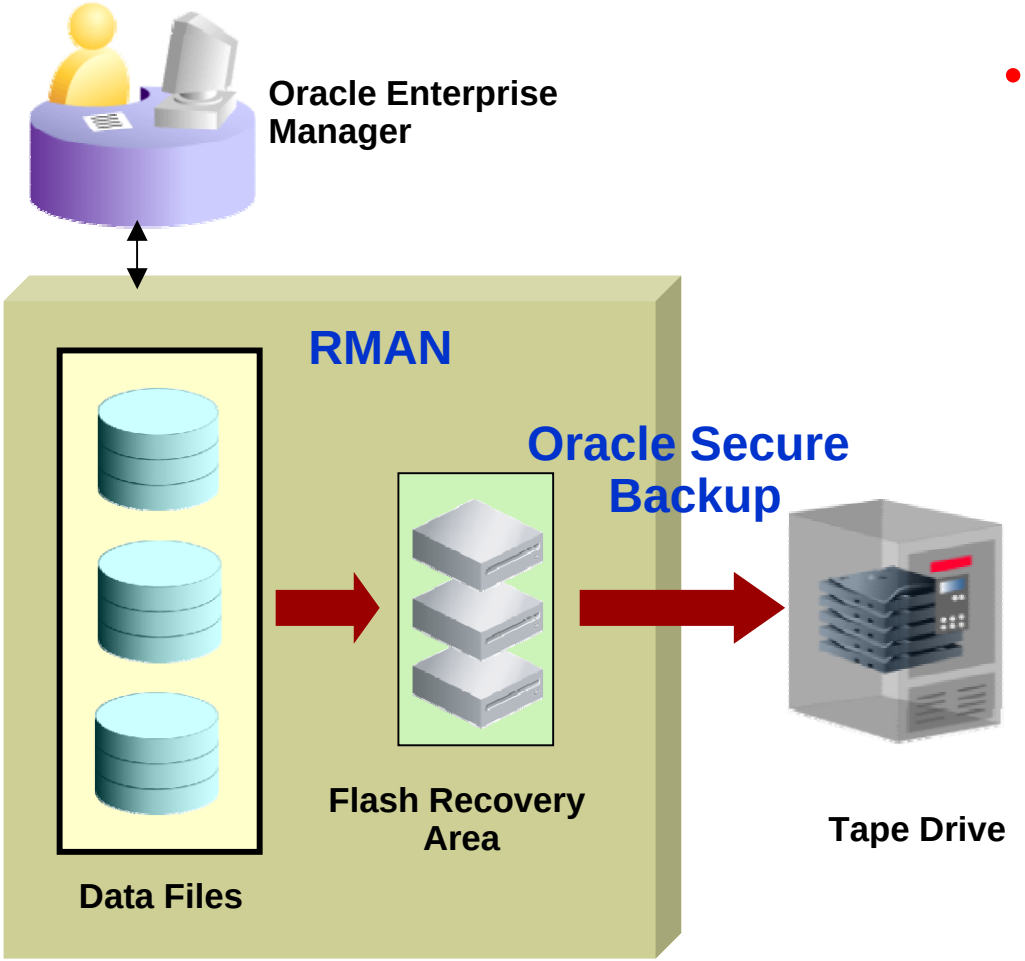
At Lowest Cost



Oracle Backup & Recovery

- Purpose:
  - Protection from data failures by reconstructing database after failure
    - Media failures – physical disk errors
    - Data loss – user errors (incorrect updates / deletions)
    - Data corruptions – hardware problems, software bugs
  - Also used for:
    - Data archiving (off-site storage, compliance)
    - Cloning for Dev/QA
- Components:
  - RMAN
  - Flash Recovery Area
  - Oracle Secure Backup

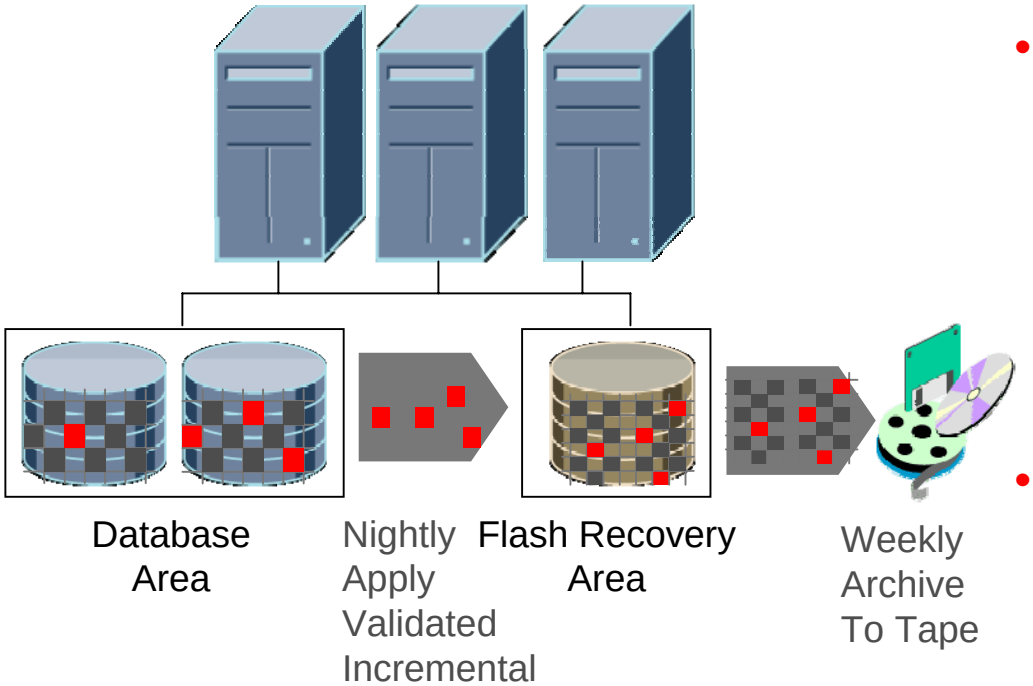
Oracle Recovery Manager (RMAN)



- Oracle's Integrated Backup & Recovery solution
  - Intrinsic knowledge of database file formats and recovery procedures
    - Block validation during backup and restore
    - Space-efficient via unused block compression
    - Online, multi-streamed backup
    - Online, block-level media recovery
  - Safeguard backups with native encryption
  - Easy administration via EM or CLI
  - Integrated with Oracle disk-backup (Flash Recovery Area) as well as Oracle tape-backup (Oracle Secure Backup)

Oracle Flash Recovery Area

Automatic Disk-to-Disk (D2D) Backup & Recovery



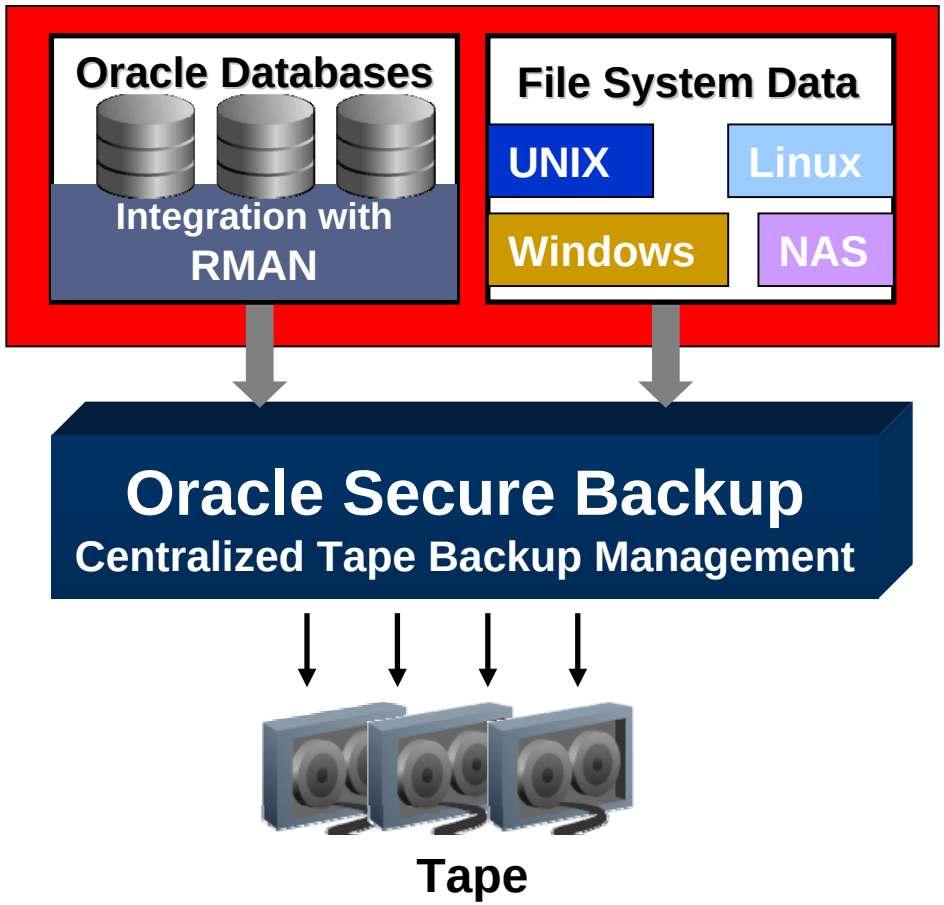
Integrated storage tiering

- Flash Recovery Area – Integrated D2D backup and recovery
  - Favorable disk economics – low-cost SATA disks used for recovery area
  - Oracle makes it even better with instantaneous restore:
    - `RMAN> switch datafile 4 to copy;`
    - `RMAN> recover datafile 4;`
- Fast incremental backups
  - Backs up only changed blocks
  - Changed blocks are tracked using a very efficient algorithm – 20x faster
- Nightly incremental backup rolls forward recovery area backup
  - No need to do full backups

Oracle Secure Backup

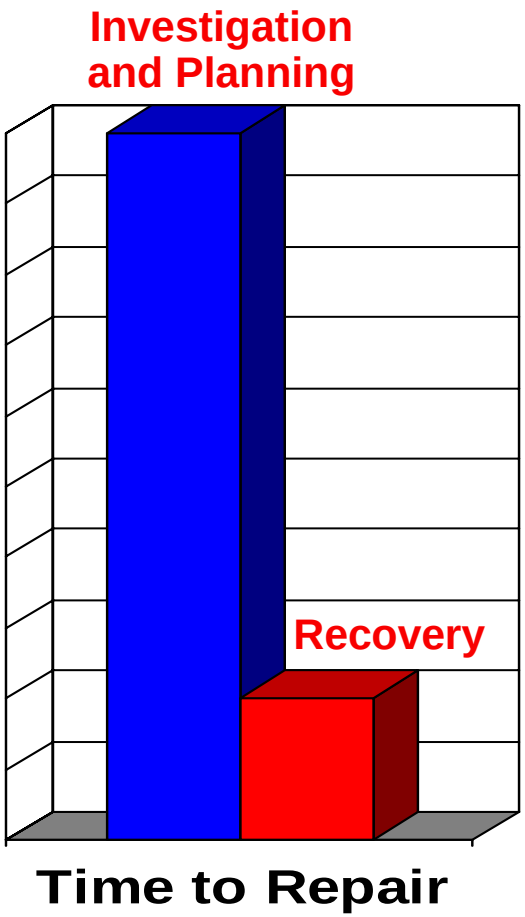
Integrated Tape-based Backup & Recovery

ORACLE SECURE BACKUP



- Protects entire environment
  - Oracle Database 11*g*, Oracle Database 10*g*, Oracle9*i*
  - Application files
- Built-in Oracle integration
  - Single-vendor advantage
- Fastest backup for Oracle
  - 25-40% faster than competition
- Lowest cost
  - $3,000 per tape drive
  - Free Express version bundled with Oracle Database
- Product availability:
  - OSB 10.1, OSB 10.2

Data Recovery Advisor



- In an outage, uncertainty and confusion greatly increase downtime
- Data Recovery Advisor
  - Automates problem investigation
  - Intelligently determines plan for recovery
  - Can automatically apply recovery plan

Reduces Downtime by Eliminating Confusion

Solutions Beyond Backup & Recovery

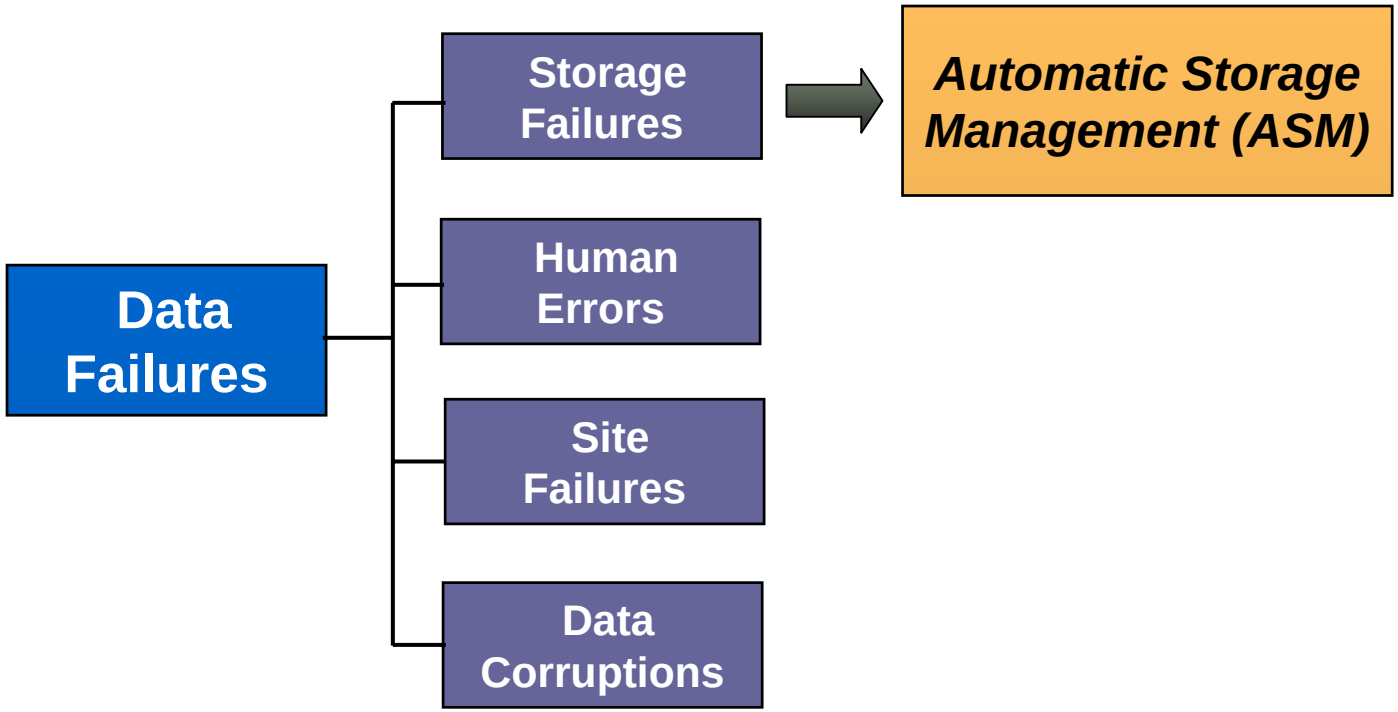
- For certain data failures, Oracle HA solutions such as
  - ASM
  - Flashback
  - Data Guard
  - Streams

provide much better recovery characteristics than backup & recovery:

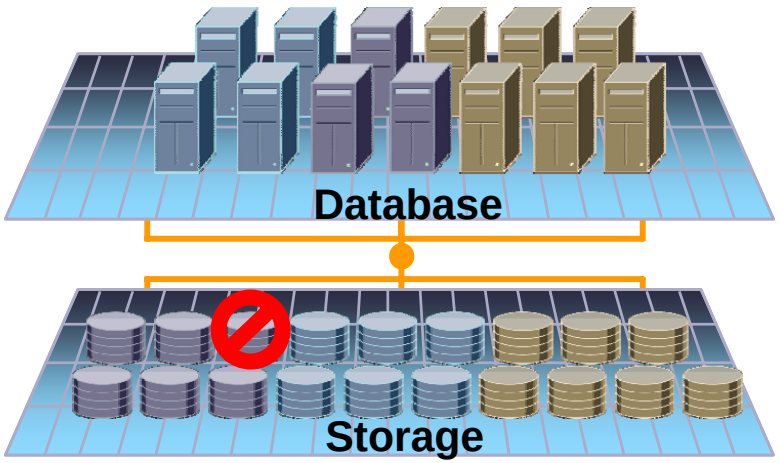
- RTO (Recovery Time Objective) – maximum time the business can tolerate to recover from outages
- RPO (Recovery Point Objective) – maximum data loss the business can sustain in the event of outages

Best-of-Breed Storage Protection

At Lowest Cost



Data Mirroring with ASM



- ASM mirrors data across low cost modular storage arrays
  - Protection from disk / array failures
  - Automatically remirrors when disk or array fails

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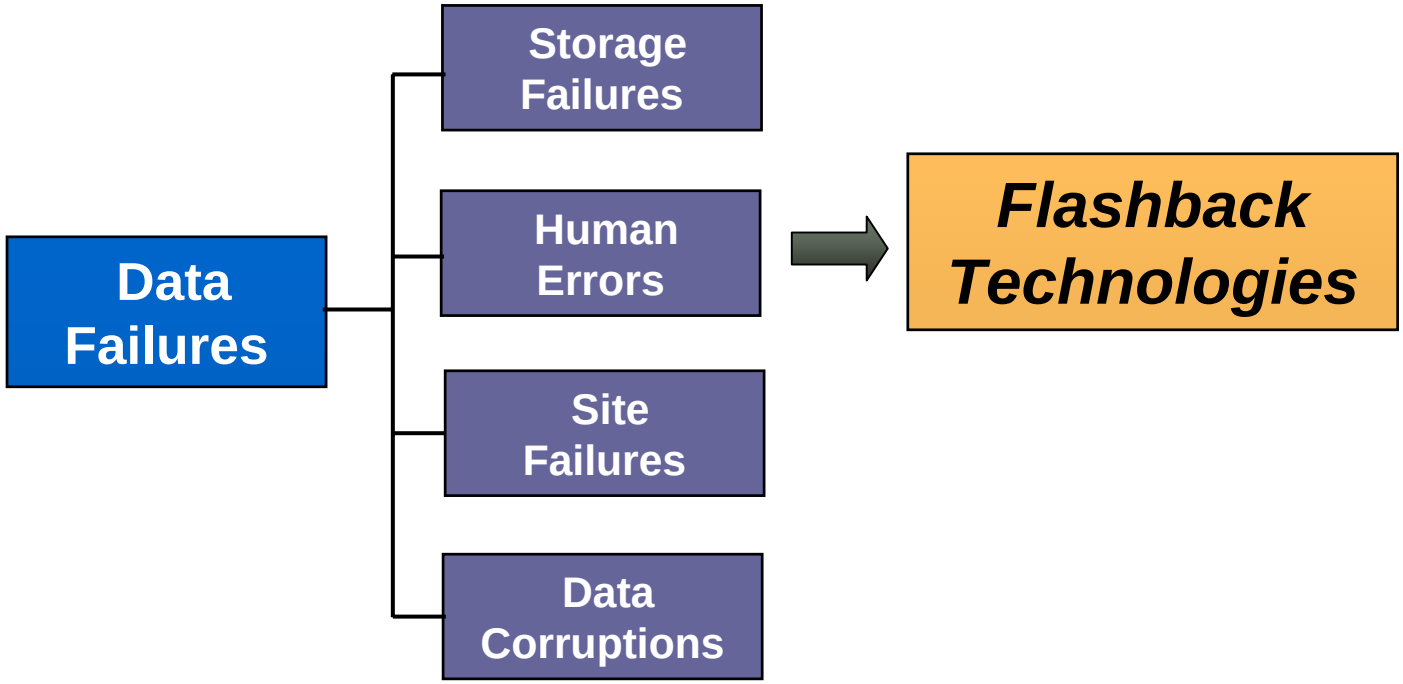
- ASM streamlines recovery by automatic repair of corrupted blocks from mirrored copy, fast recovery from transient disk failures

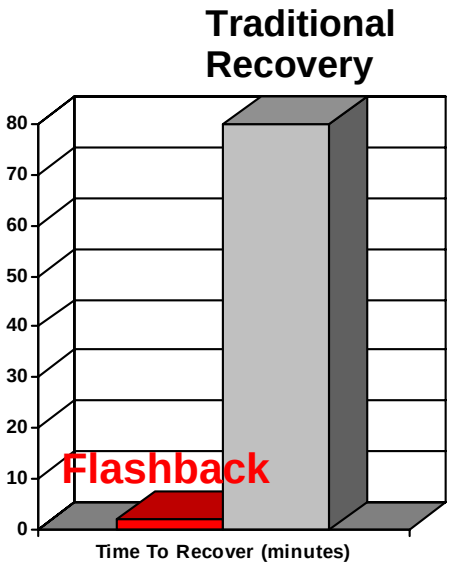
Designed to Tolerate Storage Failures

Best-of-Breed Human Error Protection

At Lowest Cost



Revolution in Recovery



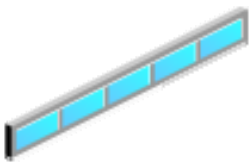
- Flashback Revolutionizes Error Recovery
  - Operates on just changed data
  - Time to correct error equals time to make error
    - Minutes instead of hours

Correction Time = Error Time + ~~f(DB_SIZE)~~

- Flashback is Easy
  - Single command instead of complex procedure
  - Flashback Database impact for OLTP workload observed to be less than 2%
- Great for testing also!

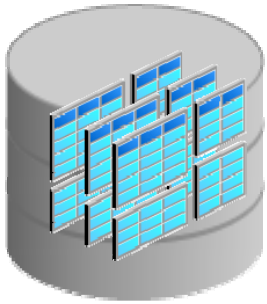
Flashback is Flexible

Choose desired level of granularity



Flashback Query

Flashback Table



Flashback Transaction

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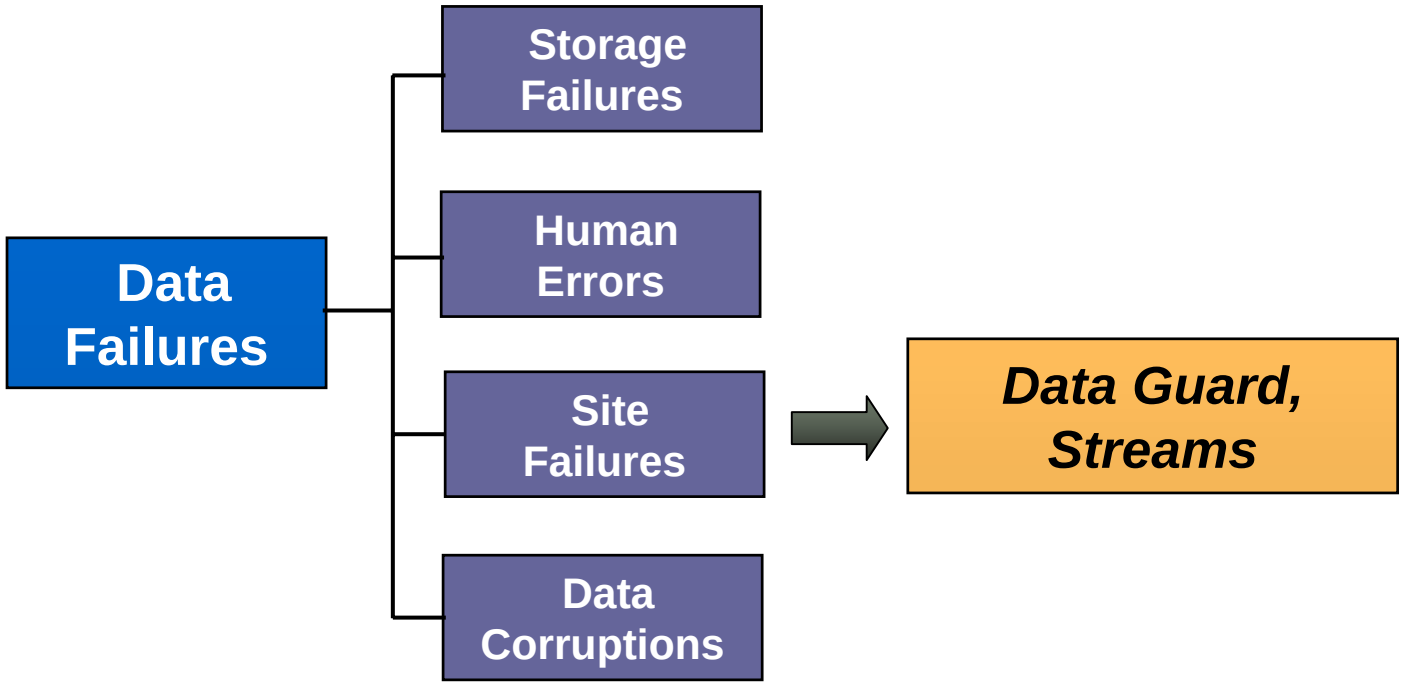
Flashback Database

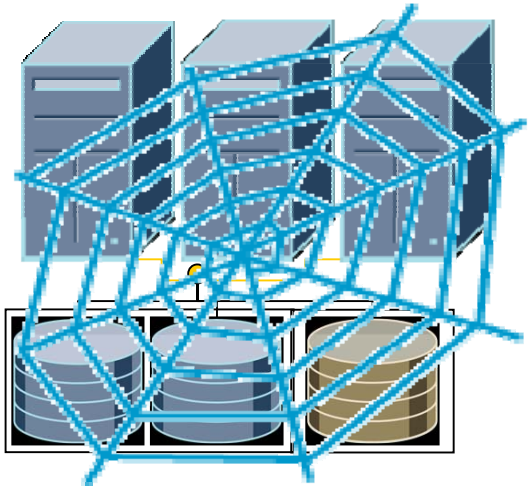
Continuous Data Protection (CDP) Built Within the Database

Best-of-Breed Site Failure Protection

At Lowest Cost



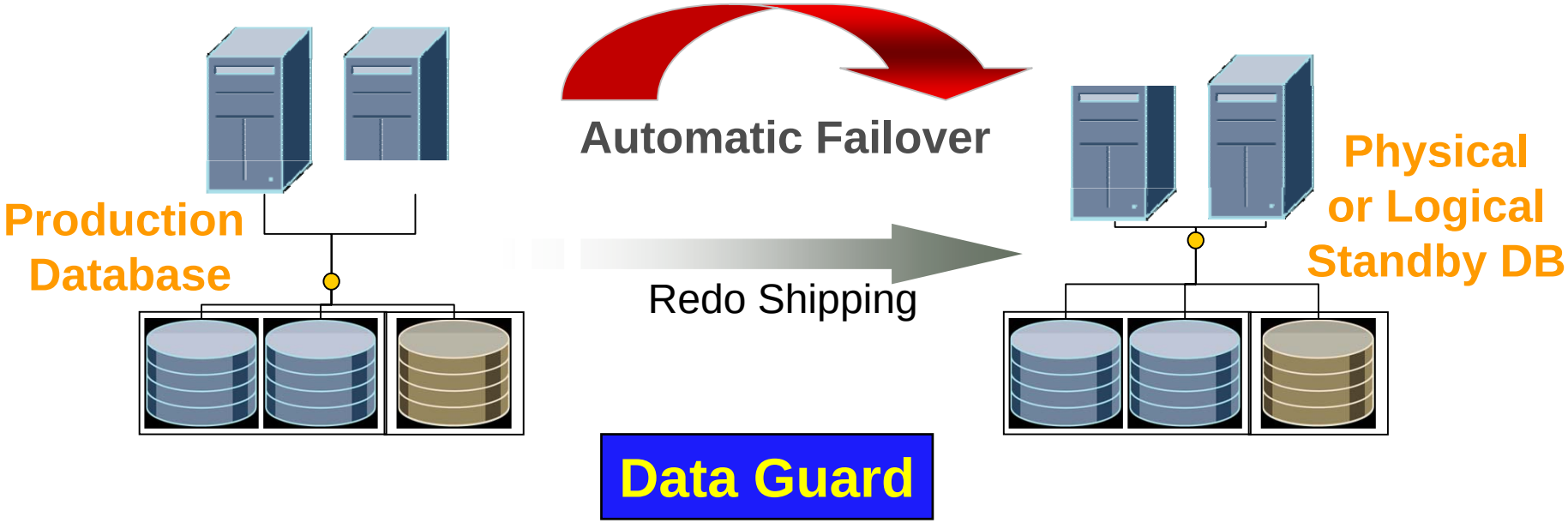
Site Failures: Disaster Recovery (DR) Realities



- Majority of customers never benefit from DR investment
  - Expensive – choose no DR, or under-configure DR
  - Loses data – causes problems with interconnected systems
  - Slow – prefer to try to fix problems instead of using DR
  - Limited – protection from site failures only
- Users are afraid to use DR because it may not work

DR Systems Gather Dust

Data Guard: Best Failure Protection at Lowest Cost

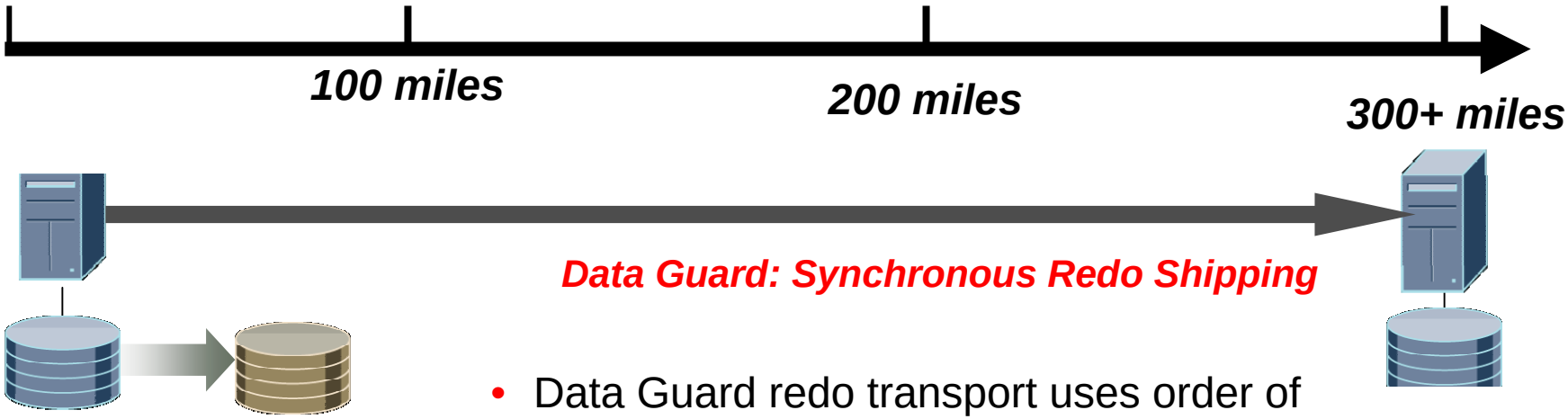


- Comprehensive data protection – e.g. data corruptions don't propagate
- Failover in seconds – standby is already synchronized

Data Guard: Zero Data Loss Over Long Distance

Data Guard DR Sweet Spot

- Far enough to avoid regional disaster
- Close enough for zero data loss

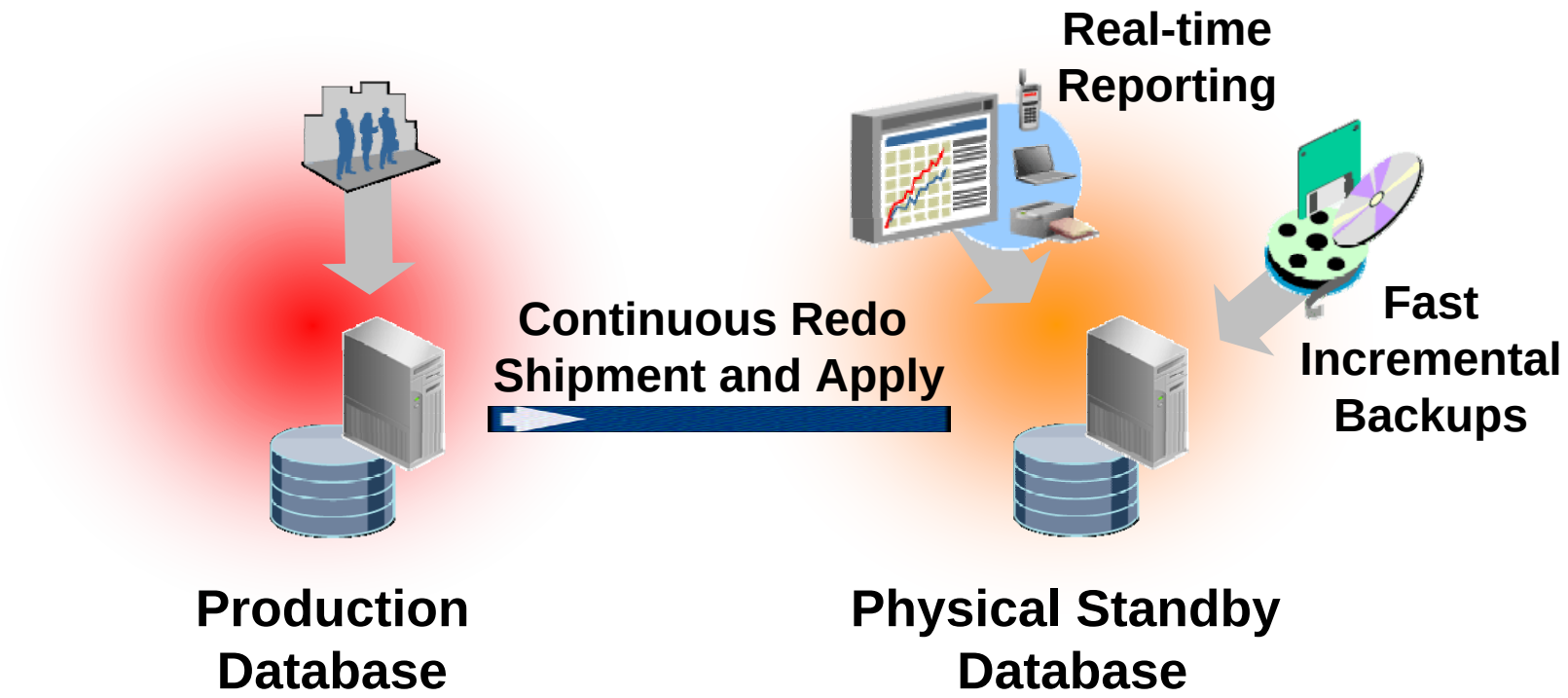


Synchronous Disk Mirroring

- Data Guard redo transport uses order of magnitude less network messaging than disk-based remote mirroring solutions
  - Enables zero data loss at hundreds of miles

Active Data Guard

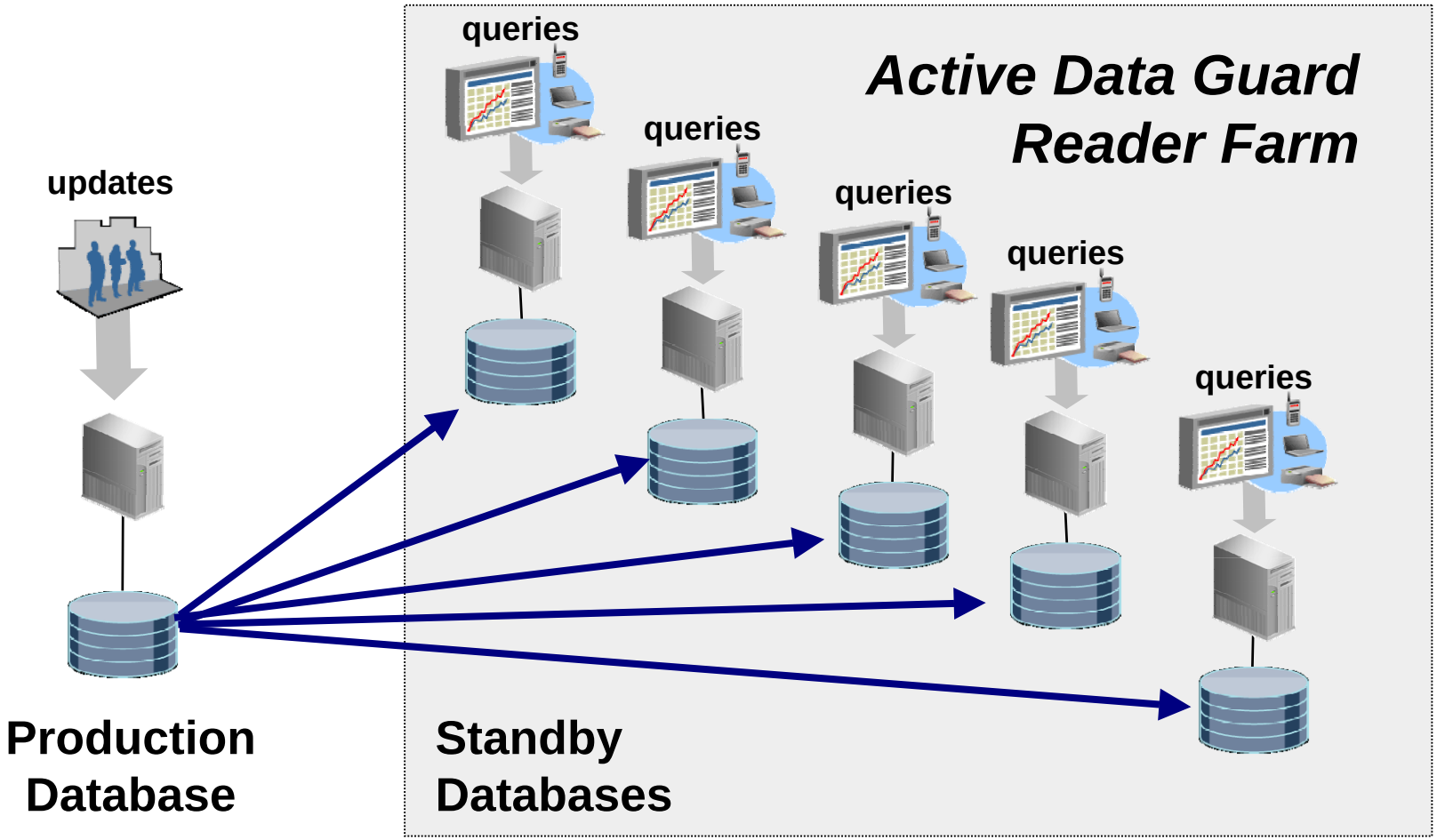
Offload Processing to Standby – Improve Primary Performance!



- Offload read-only queries to an up-to-date physical standby
- Perform fast incremental backups on a physical standby

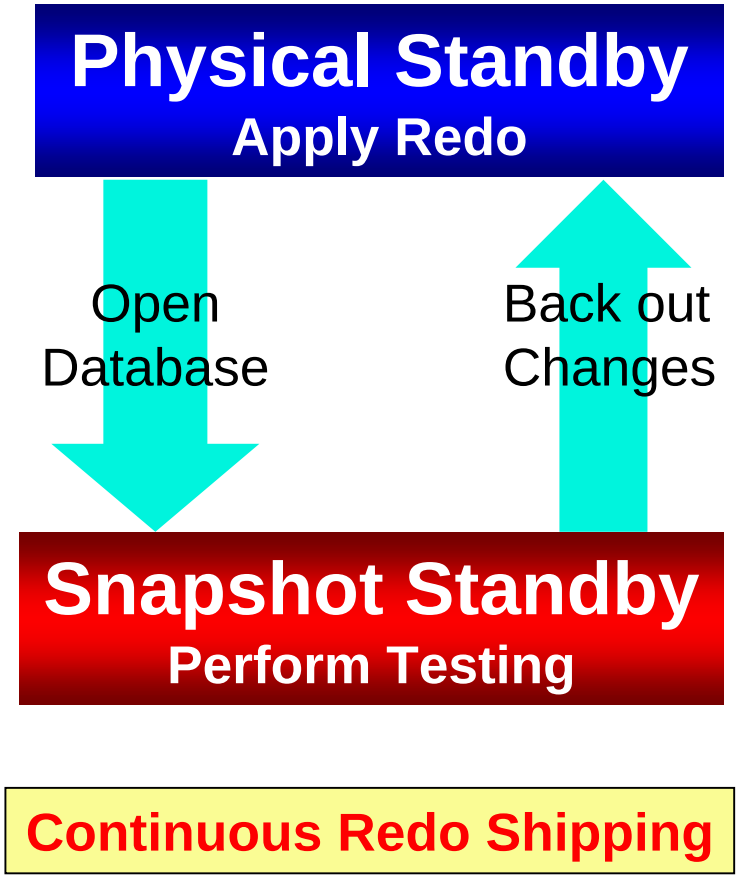
Active Data Guard Deployment Example

*Scale-out Query Performance to Web-Scale**



DR included *

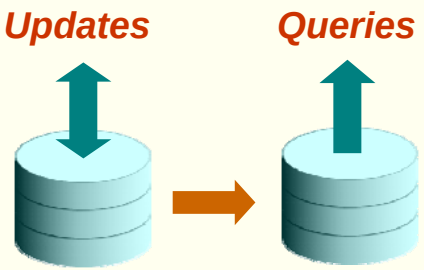
Snapshot Standby



- Use Standby Database for Test & Dev
  - Eliminates cost of DR
  - Combine full scale test and DR environment
- Preserves zero data loss
  - But no real time query or fast failover
- Similar to storage snapshots, but:
  - Provides DR at the same time
  - Uses single copy of storage

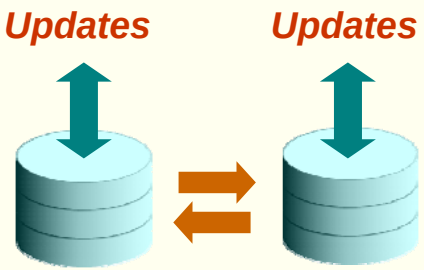
Supporting Fully Active-Active Sites

While Protecting From Site Failures



Data Guard

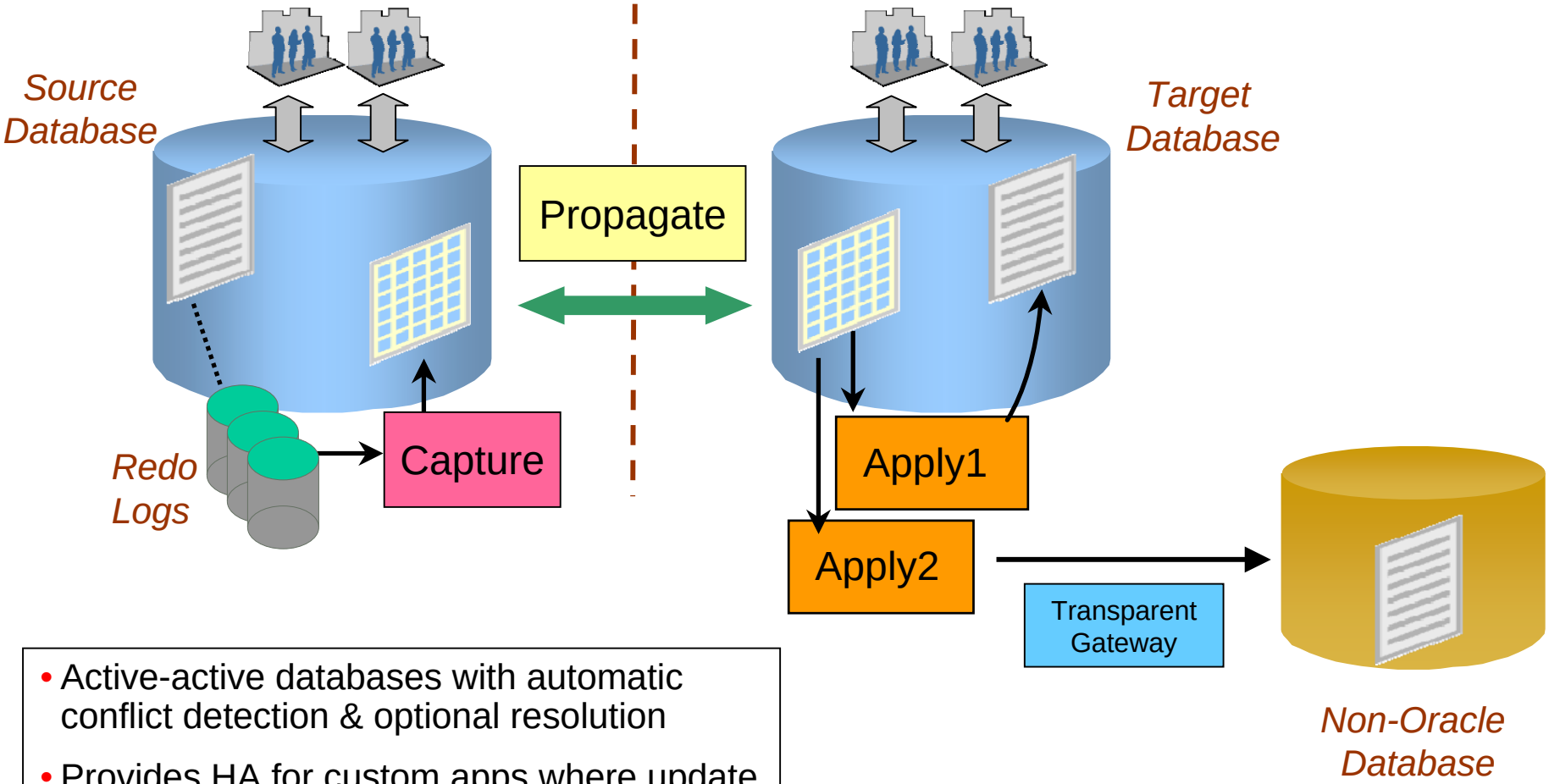
- Simplest solution for disaster recovery
- Replica active for read-only access
- Protection of the whole database
- Supports all datatypes (physical standby)
- Data can't be transformed while replicated
- Generally requires similar platforms between primary and standby



Streams

- Flexible solution for information sharing
- Both sites fully active
- Can be used to protect data subsets
- Some datatypes not supported
- Supports transformation of replicated data
- Supports different platforms between source and target

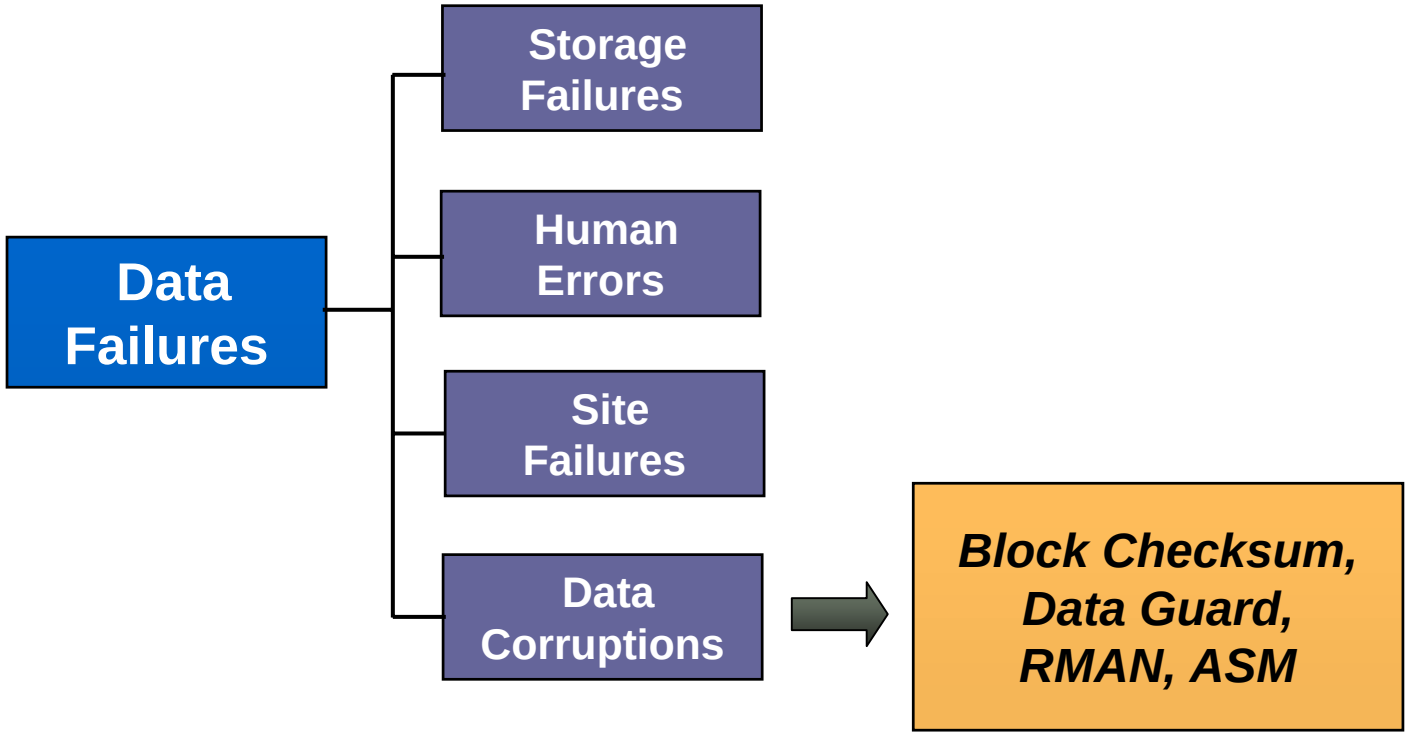
Oracle Streams Replication



- Active-active databases with automatic conflict detection & optional resolution
- Provides HA for custom apps where update conflicts can be avoided or managed

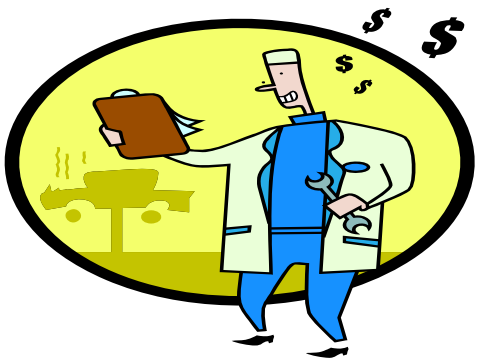
Best-of-Breed Data Corruption Protection

At Lowest Cost



Data Corruptions

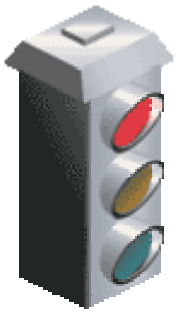
- Any component in the systems stack can fail and cause corruptions
  - Software – applications, middleware, database, …
  - Hardware – disk drives, disk controllers, HBAs, memory, …
  - Network – routers, switches, cables, …
  - Operational – human errors, bad installs & upgrades, …
- Data corruption results can be disastrous
- Very hard to debug and diagnose



Data Corruptions & Real-life "Disaster"

Financial Services Company

- Examples of the errors observed in the alert.log of the production database:
  - `Errors in file /opt/app/oracle/admin/dg/bdump/dg1.trc:`
  - `ORA-01186 : file 93 failed verification tests`
  - `ORA-01122 : database file 93 failed verification check`
  - `ORA-01110 : data file 93: '/dbmnt/db01/oradata/dg/arch05.dg'`
  - `ORA-01251 : Unknown File Header Version read for file number 93`



- `ORA-01251 - Corrupted file header. This could be caused due to missed read or write or hardware problem or process external to oracle overwriting the information in file header.`

- Affected database: one of the most critical databases supporting its retail businesses
  - Supports the firm's primary customer facing applications for trade transaction confirmation, new accounts, and customer account information

Configuring Data Corruption Protection

- For Oracle Database 11*g*:
  - Set **DB_ULTRA_SAFE**, this enables:
    - **DB_BLOCK_CHECKSUM**
      - Detects corruptions in data and redo blocks using checksum validation, prevents propagation to standby databases
    - **DB_BLOCK_CHECKING**
      - Detects data block corruptions using semantic checks
    - **DB_LOST_WRITE_PROTECT**
      - Using a standby database, detects writes lost by the I/O subsystem
  - Can be configured for data blocks / data + index blocks

- For Oracle Database 10*g*, set
  - **DB_BLOCK_CHECKING** and **DB_BLOCK_CHECKSUM**

Data Guard – Highly Effective Solution for Corruption Protection

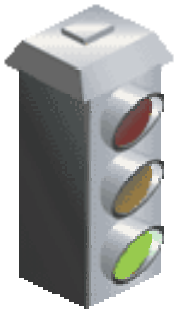
- Principle: Fault-isolation between primary and standby databases
- Data Guard: a loosely coupled architecture
  - ✓ Standby databases synchronized through redo blocks, completely detached from possible datafile corruptions on primary
  - ✓ Redo shipped from primary SGA, detached from primary's I/O corruptions
  - ✓ Software code-path executed on standby different from that of primary – effective seclusion from software errors
- Corruption-detection checks at key interfaces
  - ✓ Primary: during Redo Transport
  - ✓ Standby: during Redo Apply

- If redo corruption detected on standby, Data Guard tries to re-fetch valid logs as part of archivelog gap handling

Remember – Real-life "Disaster"?

What Did They Do?

- Thankfully, they already had Data Guard implemented
  - Data Guard architecture prevented corruption from affecting their standby databases
- Failed over to the standby database
  - New production database up in minutes, no loss of data
- Independently investigated problems at original production server
  - Problem traced to faulty storage array component
  - Took a few days to investigate and fix the problem



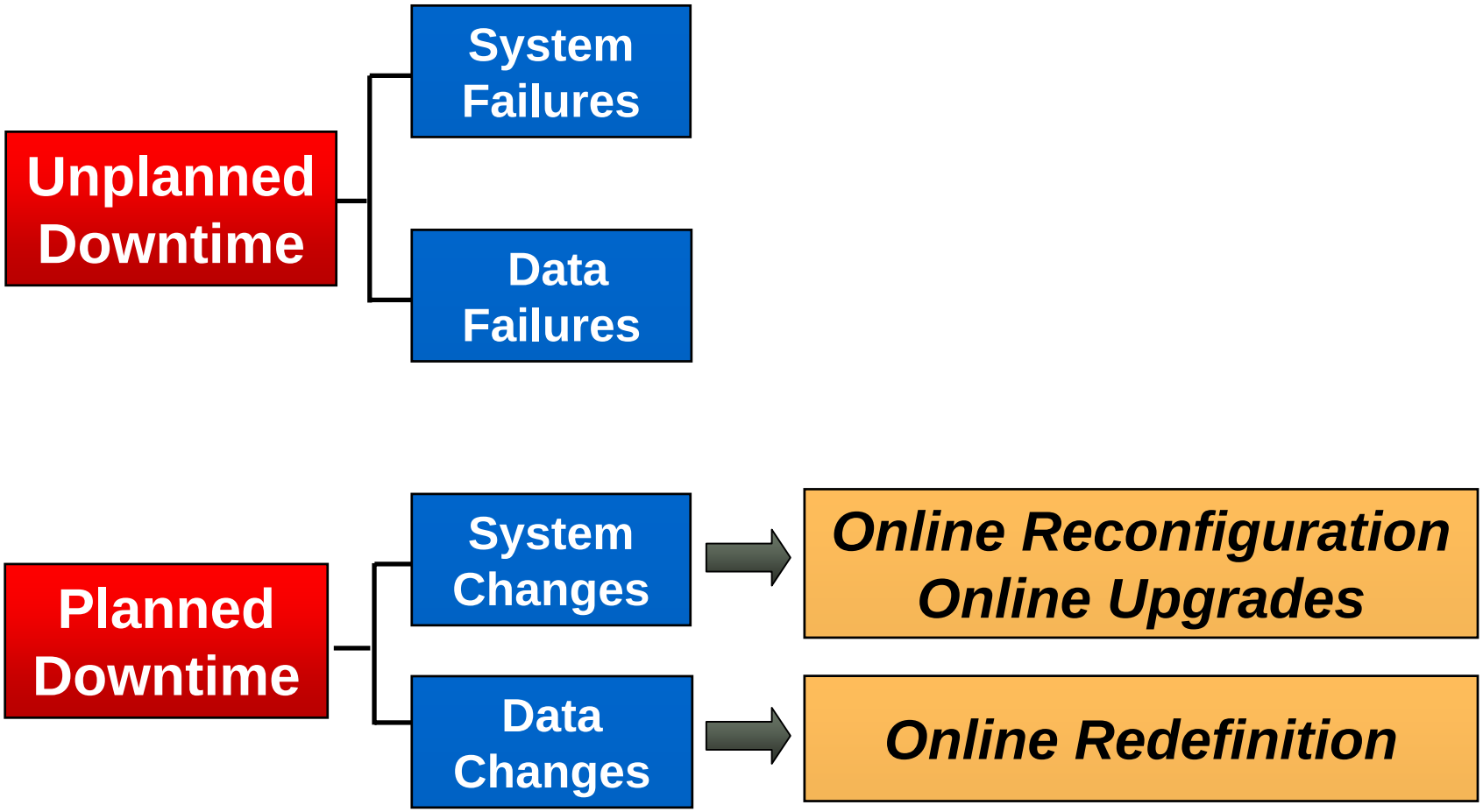
Data Corruption Protection – RMAN, ASM

- Recovery Manager (RMAN) – ensures valid backup & restore
  - Always verifies block checksums on backup & restore
  - Provides optional logical block validation (e.g. missing row piece)
  - Checks on-demand for backup / restore corruptions without creating backups / restores (**`BACKUP VALIDATE`** / **`RESTORE VALIDATE`**)
  - Provides online recovery of individual block corruptions or all identified corruptions with Block Media Recovery (**`RECOVER BLOCK`**)

- ASM – ensures automatic corruption detection & repair
  - Automatically repairs corrupt blocks from valid mirror copy
  - Automatic protection for data files, control file, redo logs …

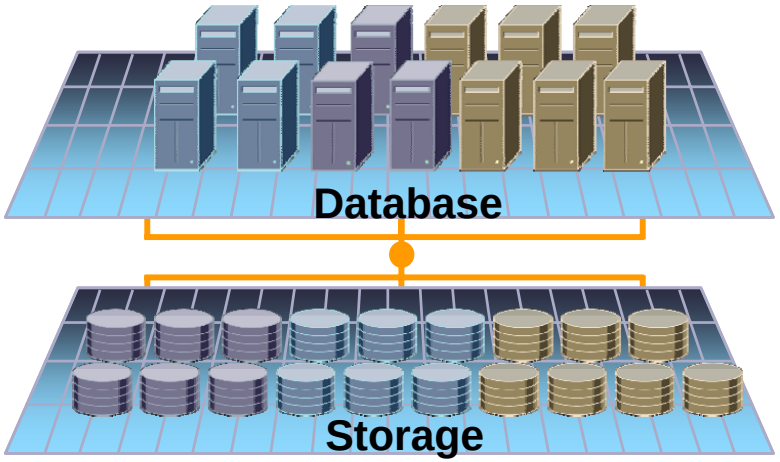
Best Online System & Data Changes

At Lowest Cost



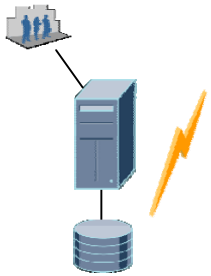
Online Reconfiguration

Scaling on Demand



- Servers
  - Add/Remove RAC nodes online
  - No data movement needed
- Storage
  - Add/Remove ASM disks or arrays online
  - Automatically rebalance after storage change
- Clusterware, ASM
  - Upgrade Oracle Clusterware and ASM (11g) in an online manner

Online Patching and Upgrades



- Simple one-off patches can be applied to a running Oracle instance
  - Initially on Linux x86 (32 and 64-bit)
  - Others platforms to follow

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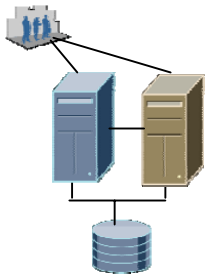
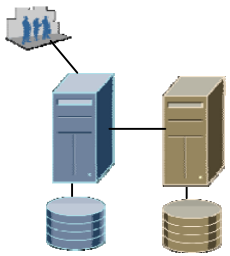


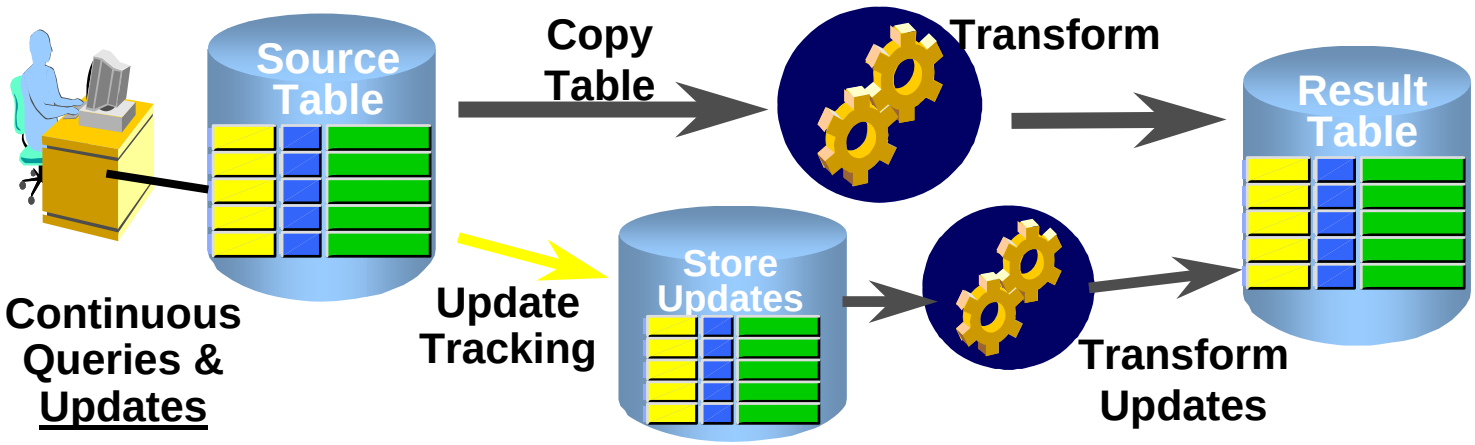
- More complex one-off patches can be deployed online using RAC rolling patches (available 10g onwards)



- Database release/patchset upgrades, operating system upgrades, platform migrations can be applied in rolling fashion using Data Guard / Streams

Online Table & Index Redefinition

- All index changes can be done online
- Tables can be Reorganized & Redefined online
  - Allows changing location, table type, partitioning, columns, column types
  - Contents can be transformed as they are copied



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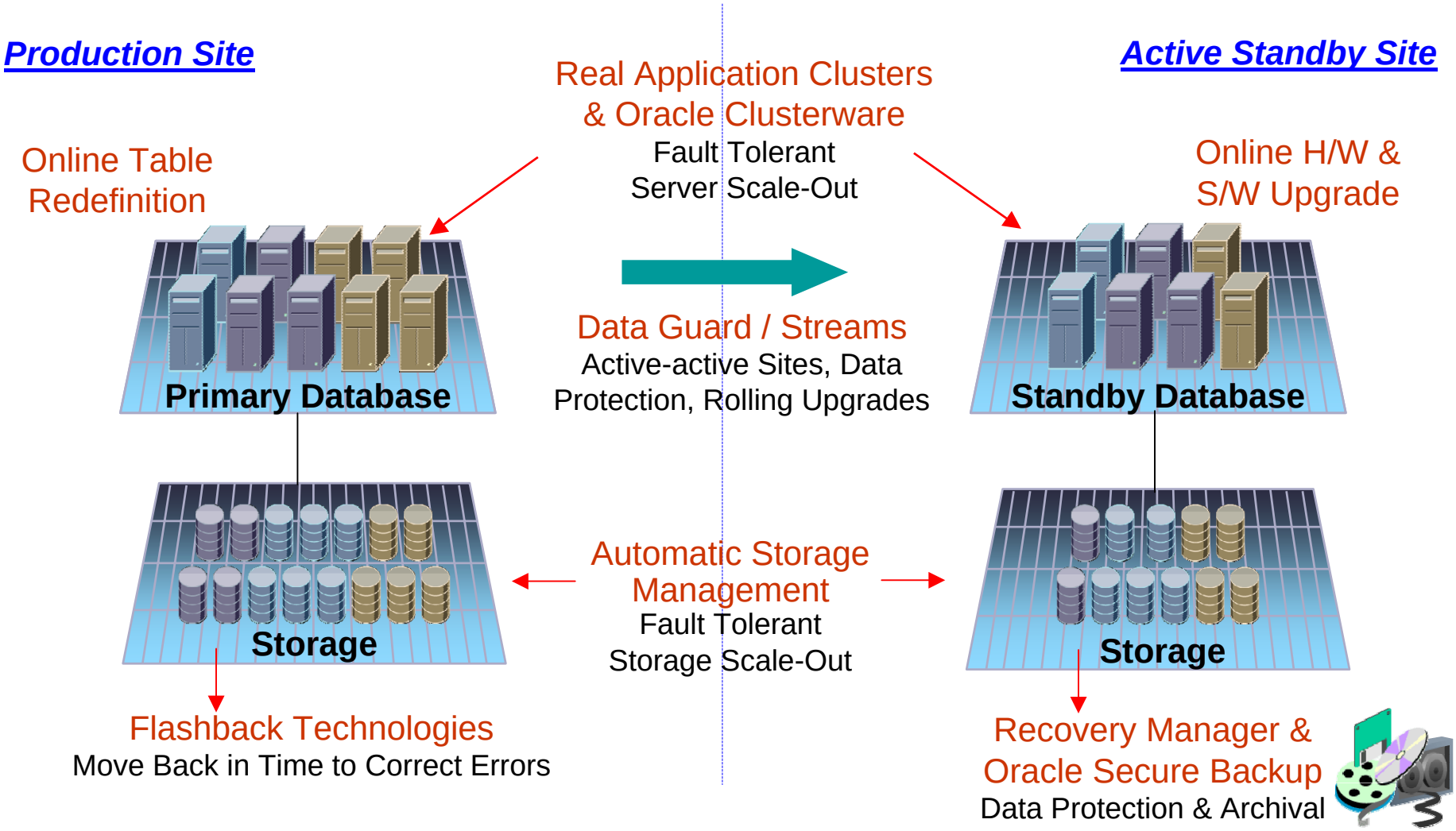
Oracle Maximum Availability Architecture

Integrated Deployment of Oracle HA Technologies



Oracle Maximum Availability Architecture

Integrated set of Oracle HA Best Practices

- Technology alone is not enough
- MAA is also a blueprint for achieving HA
  - Brings together all that has been discussed
  - Operational best practices
  - Prevent, tolerate, and recover from outages
- Tested, validated, and documented
  - Database, Middleware, Apps
  - Storage, Cluster, Network

otn.oracle.com/deploy/availability

Maximum Availability = Unbreakable Architecture + Best Practices

Oracle MAA: Customer Success Stories

- ADT Security Services - Using Data Guard SQL Apply Across a Wide Area Network
- Amadeus - Using Data Guard for Disaster Recovery & Rolling Database Upgrades
- Amazon.com - Automatic Failover using Data Guard Fast-Start Failover
- Banknorth Group, Inc. - Using the Snapshot Capabilities of Flashback Technologies
- CGI - Helps Major North American Oil & Gas Company Save $500K with RMAN
- ChevronTexaco - RMAN DUPLICATE – DBA Time Saver to the Rescue
- Chicago Stock Exchange - Expects 171% ROI in Five Years from Oracle Enterprise Grid Computing
- Colgate-Palmolive - Increased Performance with RMAN
- CSX - Online RMAN Backups Protect over 16TB of Data
- Dell - Dell Consolidates European Support System with Oracle Enterprise Grid on Dell
- E-Rewards Market Research - Isolating Data Warehouse Operations from OLTP – using Data Guard SQL Apply
- Fannie Mae - Supporting 835 transactions per second & Zero Data Loss Protection in Oracle Database 10g
- First American Real Estate - Using Data Guard
- The Hartford - Incrementally Updating Transportable Tablespaces using RMAN
- Kemira GrowHow Ltd, UK - Replacing Outsourced Disaster Recovery Services with Oracle Data Guard
- KLM - KLM Royal Dutch Airlines Eliminates Costly Downtime with Grid Solution
- NeuStar - Synchronous Zero Data Loss Protection with Production and Standby Databases Separated by 300 Miles
- Amtrust Bank - Oracle Database 10g - Maximum Availability Architecture & Zero Data Loss
- Oracle Global IT - Oracle E-Business Suite with Data Guard over a WAN
- Purdue Pharma L.P. - Surviving Media Disaster with RMAN
- ReserveAmerica - Capitalizing on Oracle 10g Flashback Technologies
- Starwood Hotels - RMAN in Oracle Database 10g Best Practices for Maximum Benefit
- TALX Corporation - Increased Performance with RMAN and Oracle Database 10g
- USA Today – Data Protection and Availability for Mission Critical Publishing System
- Trilegiant - Online RMAN Backups Protect over 8TB of Data
- Volkswagen Group – Streams Hub & Spoke Architecture with Data Guard Standby Database

and many more* …

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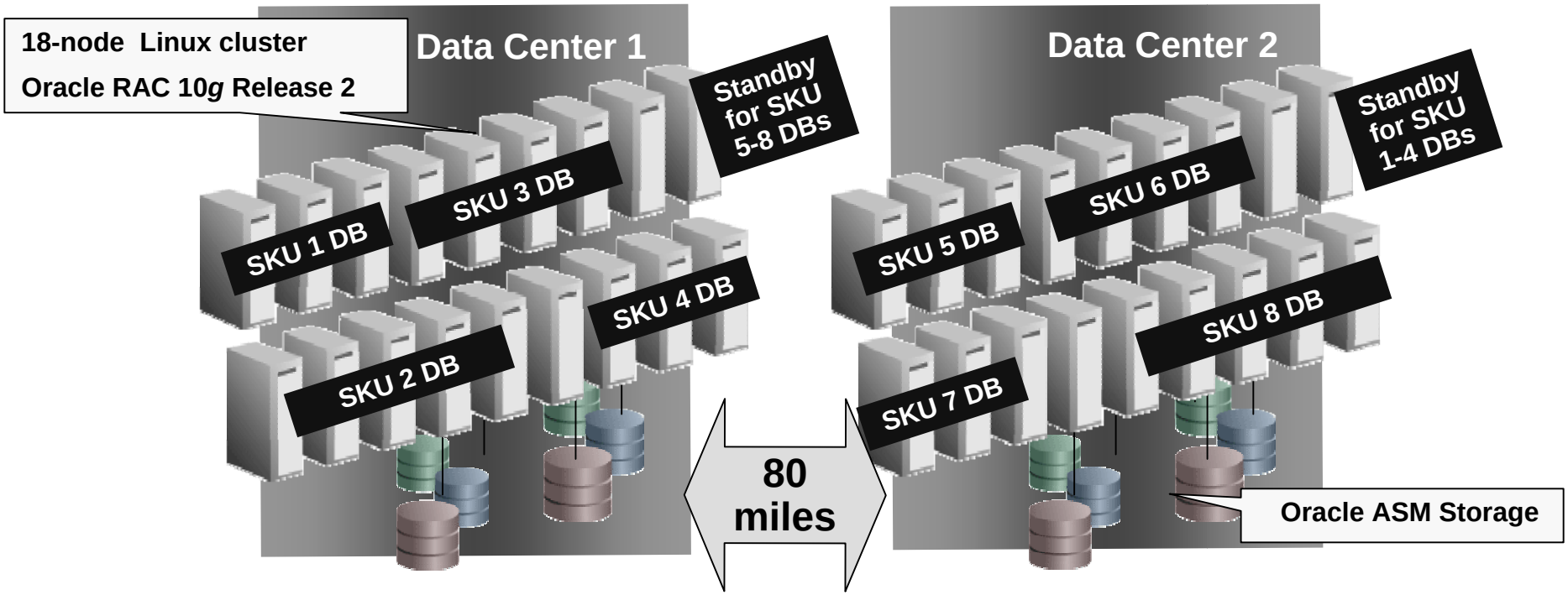
** http://www.oracle.com/technology/deploy/availability/htdocs/HA_CaseStudies.html*

Burlington Coat Factory

Benefits Achieved

- Scalability - Easily Expanded Original 10 Node Cluster to 18 Nodes
- Improved Availability
- Disaster Tolerance with Data Guard
- Better Performance - Large Queries – 50% Faster
- Easier, Less Disruptive Storage Changes with ASM
- Significant Cost Savings, Better IT Productivity



Thomson Legal

Using Oracle HA for Rolling Upgrade & Technology Refresh

Primary Site

Secondary Site

6 *Decommission old platforms A & B*

10.1.0.3, old platform

Old Primary **A**

Data Guard

10.1.0.3, old platform

Old Logical Standby **B**

Data Guard

1 *Create logical standby, C*

New Primary **C**

Data Guard

3 *Create physical standby, D*

New Logical Standby **D**

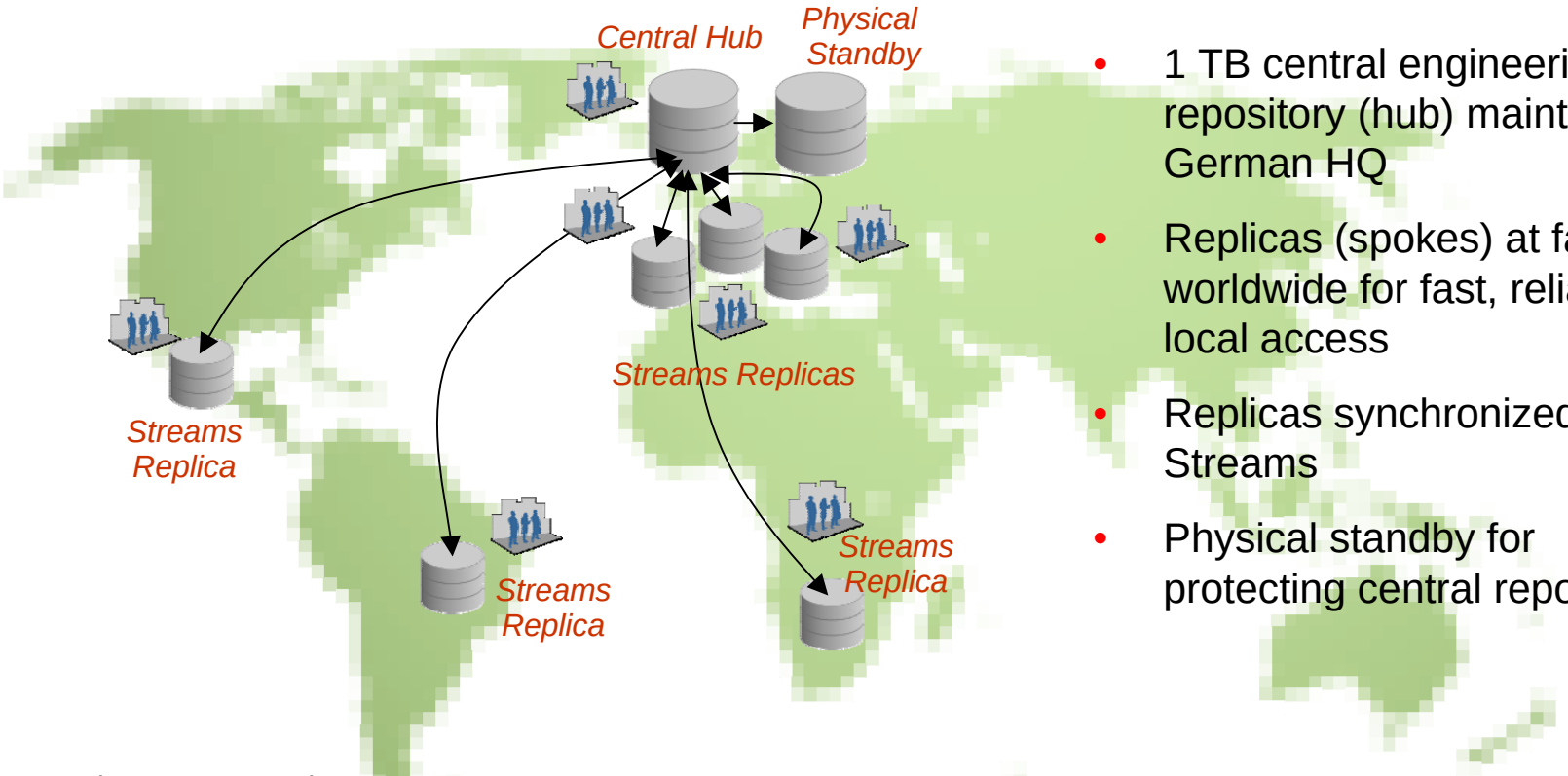
2 *Upgrade logical standby: 10.1.0.3 to 10.1.0.4, implement db changes*

4 *Switchover to this logical standby, C becomes new primary*

5 *Convert this physical to logical*

Volkswagen AG

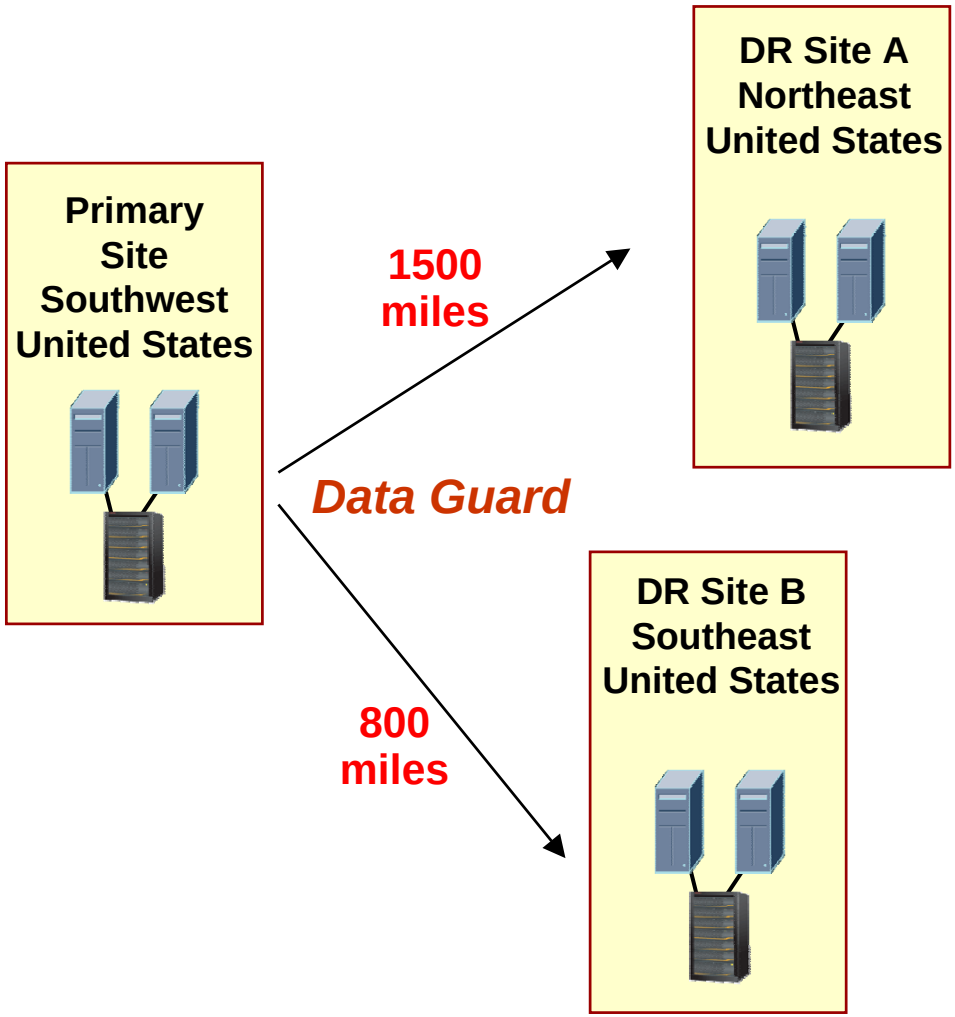
Oracle Streams Hub and Spoke Configuration



- 1 TB central engineering repository (hub) maintained at German HQ
- Replicas (spokes) at factories worldwide for fast, reliable, local access
- Replicas synchronized with Streams
- Physical standby for protecting central repository

- $100,000 - $200,000/hr per site savings in downtime costs
- Fully bi-directional, automatic conflict detection and resolution
- Minimum subset of data replicated across WAN (about 1/3 out of 200 tables)

Federal Government Customer



- Financial applications
- Oracle Database 10*g*
  - 3rd party cold failover cluster
  - Migrating to Oracle RAC
- Multi-standby configuration
  - Two physical standby databases
  - Deployed on WAN – over 1,000 miles apart
  - ASYNC transport
- Continuous DR protection against multi-site threats
  - At failover, the remaining standby automatically protects the new primary database

Resources

- **Oracle.com:**
  http://www.oracle.com/ha
- **Oracle HA Technology Portal on OTN:**
  http://www.oracle.com/technology/deploy/availability/
- **Oracle HA Customer Success Stories on OTN:**
  http://www.oracle.com/technology/deploy/availability/htdocs/HA_CaseStudies.html
- **Maximum Availability Architecture white papers:**
  http://www.oracle.com/technology/deploy/availability/htdocs/maa.htm
- **Article: "*Application-aware data protection: Databases*", InfoStor, Nov 2007:**
  http://www.infostor.com/display_article/311336/23/ARTCL/none/none/1/Application-aware-data-protection:-Databases/

QUESTIONS ANSWERS

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