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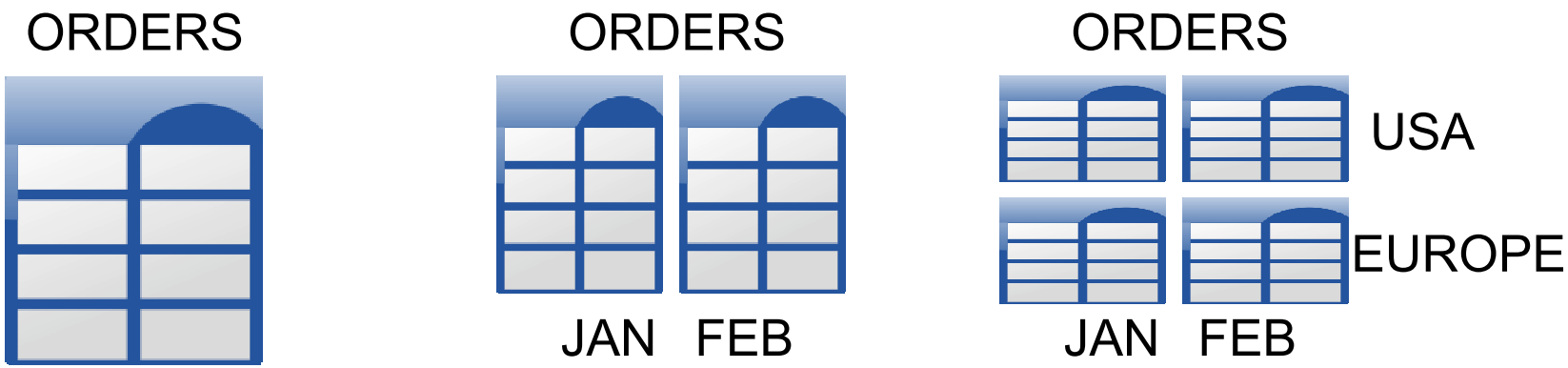
SGSS Tech Day
Database Options – Partitioning, Advanced Security, Compression

Partitioning

The Concept of Partitioning

Simple Yet Powerful



Large Table

Difficult to Manage

Partition

Divide and Conquer

Easier to Manage

Improve Performance

Composite Partition

Better Performance

More flexibility to match business needs

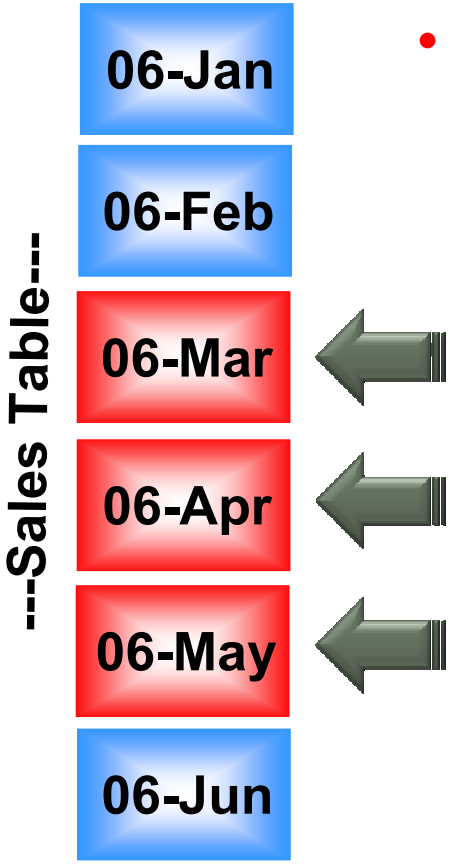
Transparent to applications

Partitioning Benefits

Partitioning is

- Faster
  - By touching and maintaining only the relevant data
- Cheaper
  - By storing the data appropriately and most cost-effective
- Flexible
  - By managing partitions autonomously

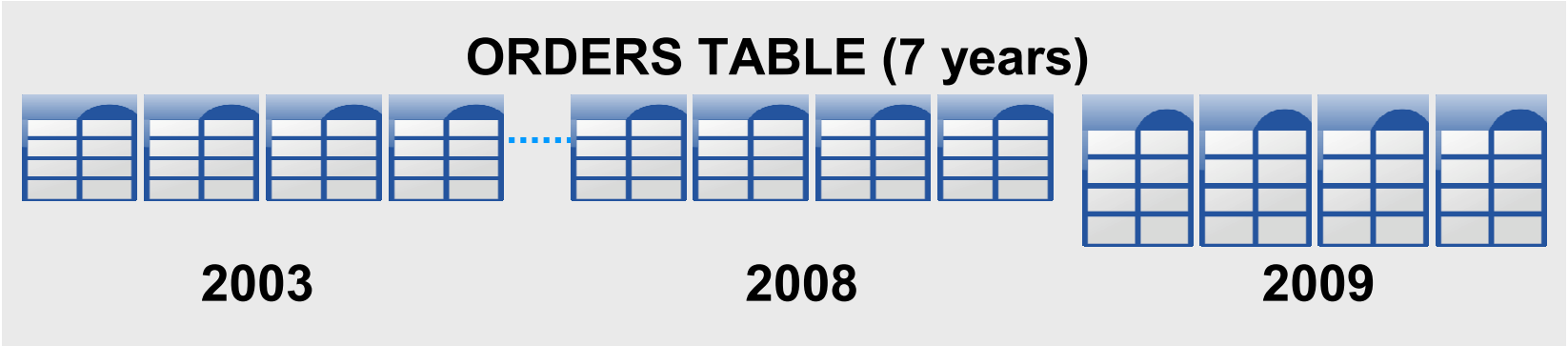
Partition for Performance



- Only relevant partitions will be accessed
  - Static pruning with known values in advance
  - Dynamic pruning uses internal recursive SQL to find the relevant partitions
- Minimizes I/O operations
  - Provides massive performance gains

```
SELECT sum(sales_amount)
FROM   sales
WHERE sales_date
BETWEEN '01-MAR-2006' AND '31-MAY-2006';
```

Partition for Tiered Storage



Low End Storage Tier

2-3x less per terabyte

High End Storage Tier

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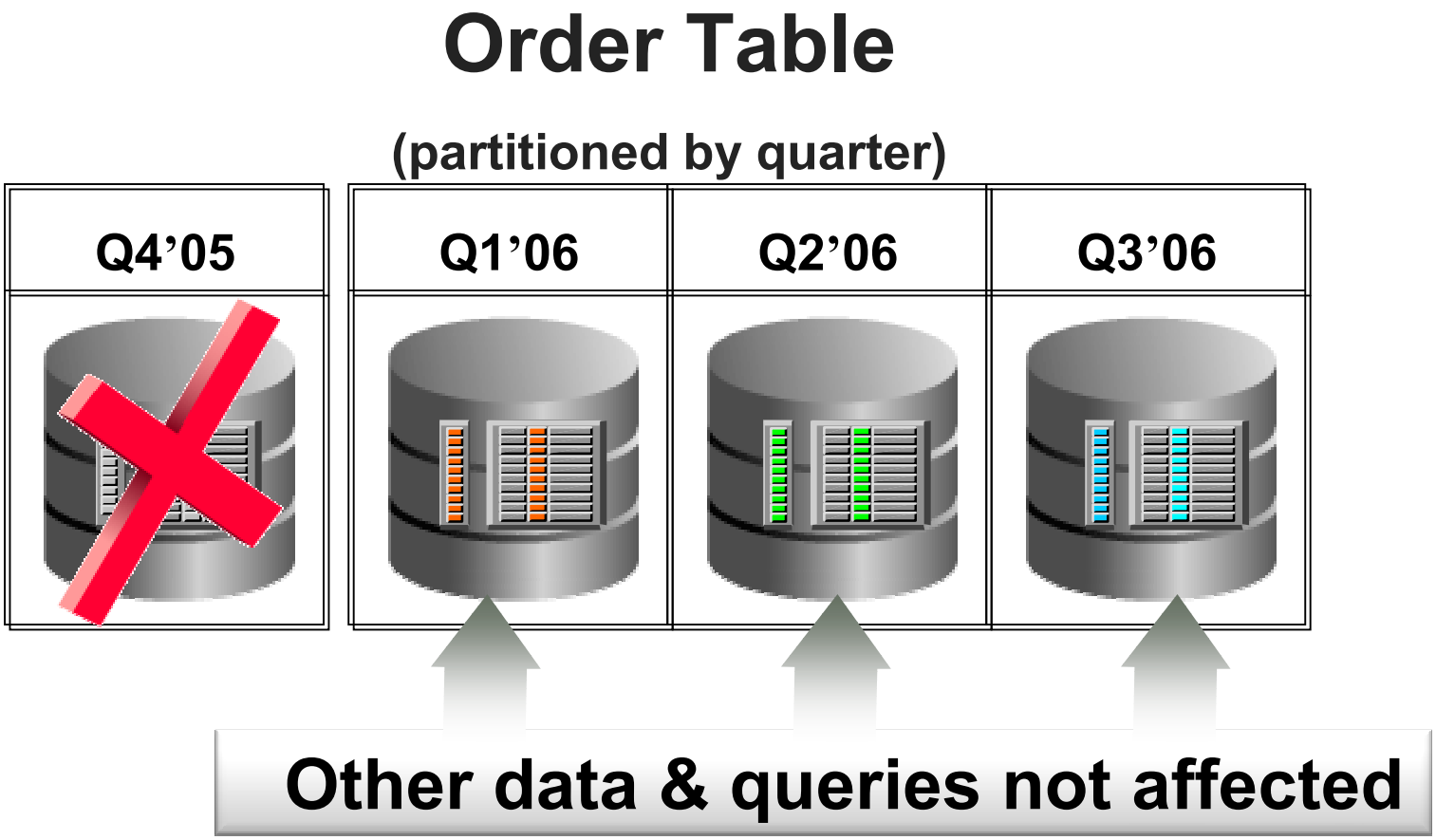
Flexible

Partition for Manageability/Availability



Oracle Partitioning

Over a decade of development

	Core functionality	Performance	Manageability
Oracle 8.0	**Range partitioning** **Global Range indexes**	**Static partition pruning**	**Basic maintenance: ADD, DROP, EXCHANGE**
Oracle 8*i*	**Hash partitioning** **Range-Hash partitioning**	**Partition-wise joins** **Dynamic partition pruning**	**Expanded maintenance: MERGE**
Oracle 9*i*	**List partitioning**		**Global index maintenance**
Oracle 9*i* R2	**Range-List partitioning**	**Fast partition SPLIT**	
Oracle 10*g*	**Global Hash indexes**		**Local Index maintenance**
Oracle 10*g* R2	**1M partitions per table**	**Multi-dimensional pruning**	**Fast DROP TABLE**
Oracle 11g	**Virtual column based partitioning** **More composite choices** **REF partitioning**		**Interval partitioning** **Partition Advisor** **Incremental stats mgmt**
Oracle 11g R2	**Hash-Hash partitioning**	**"AND" pruning**	**Multi-branch execution** **Segment creation on demand***

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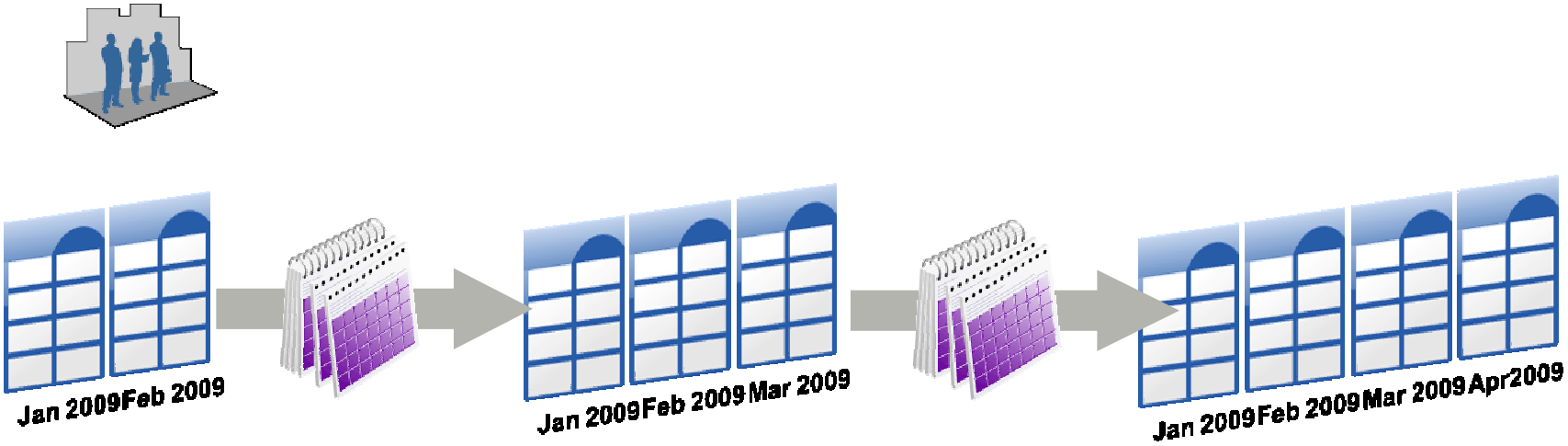
* available with 11.2.0.2

Interval Partitioning

- Partitions are created automatically as data arrives

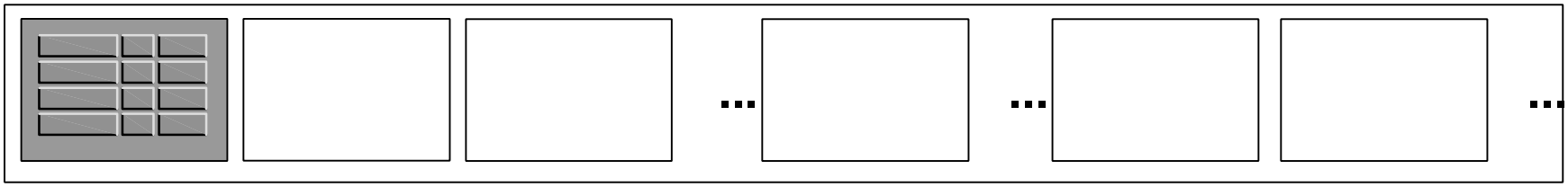


Interval Partitioning

- As easy as One, Two, Three ..

```
CREATE TABLE sales (order_date DATE, ...)
PARTITON BY RANGE (order_date)
INTERVAL(NUMTOYMINTERVAL(1,'month')
(PARTITION p_first VALUES LESS THAN ('01-JAN-2006');
```

Table SALES

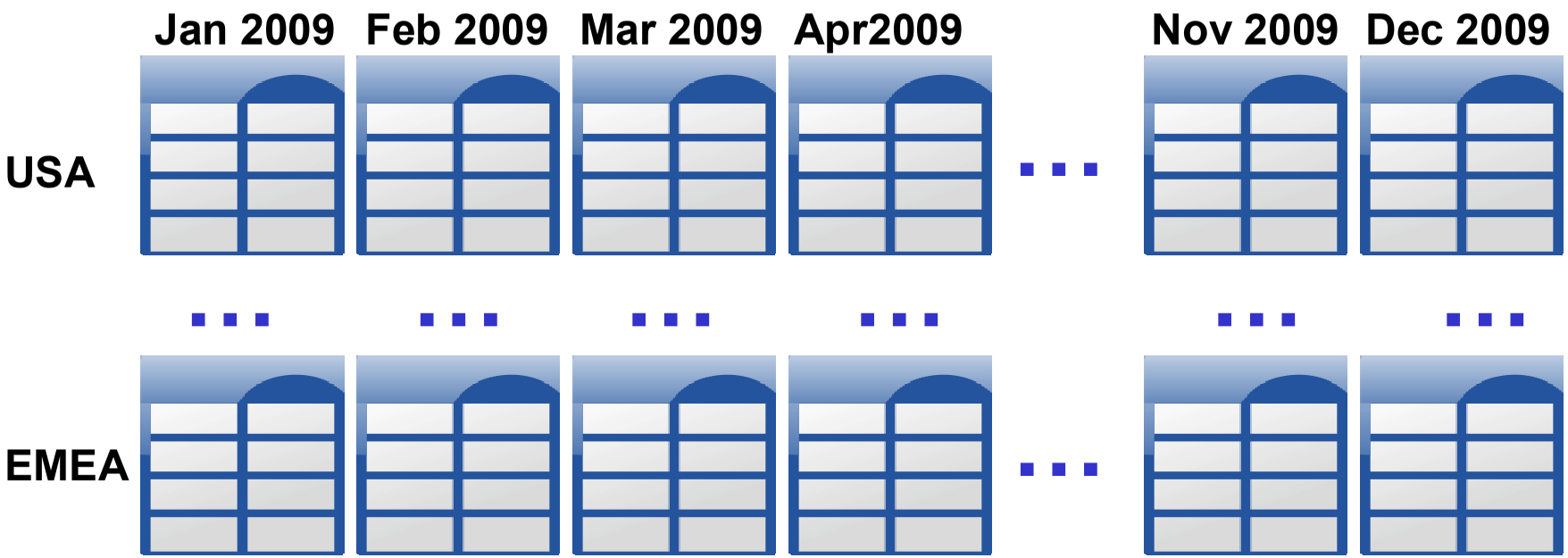


Jan 2006 Feb 2006 Mar 2006 Jan 2007 Oct 2009 Nov 2009

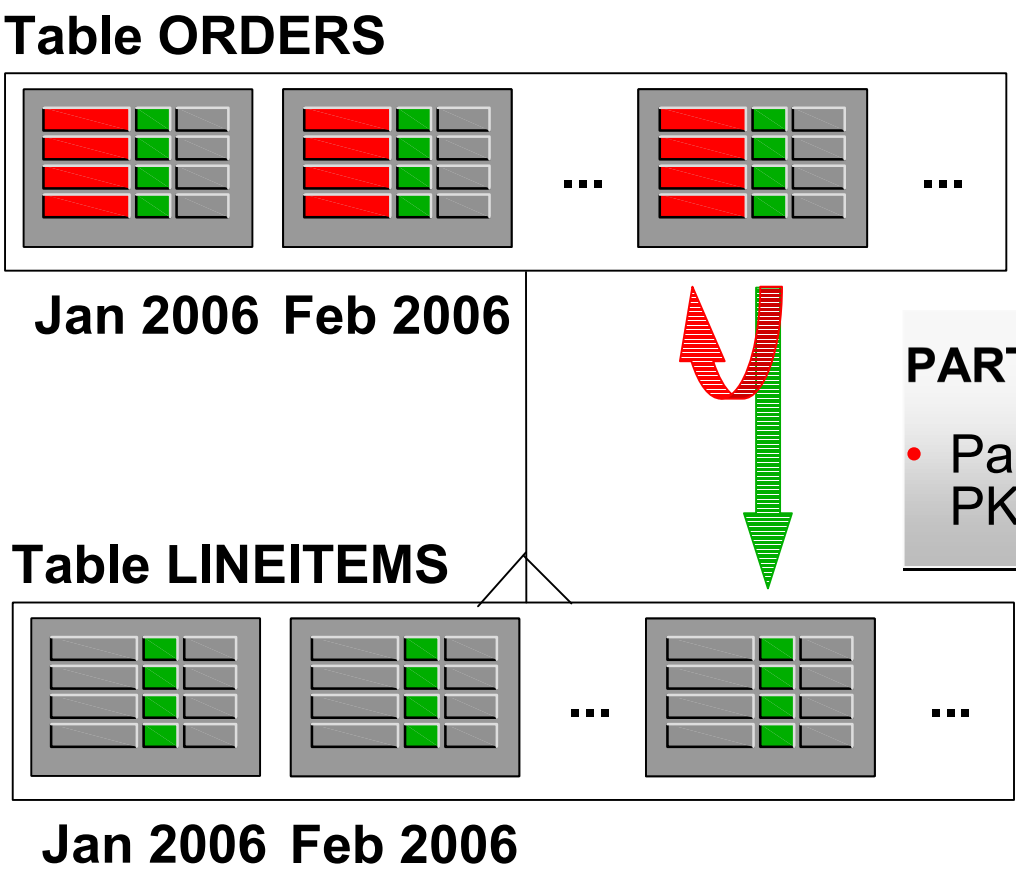
- First segment is created
  - Mandatory to have a defined lower bound
- Other segments only meta-data
  - Will be allocated when data is inserted

Composite Partitioning

- Data is organized in along two dimensions
  - Record placement is deterministically identified by dimensions
    - Example RANGE-LIST



With REF Partitioning



- RANGE(order_date)
- Primary key order_id

PARTITION BY REFERENCE

- Partitioning key inherited through PK-FK relationship

- RANGE(order_date)
- Foreign key order_id

Virtual Columns

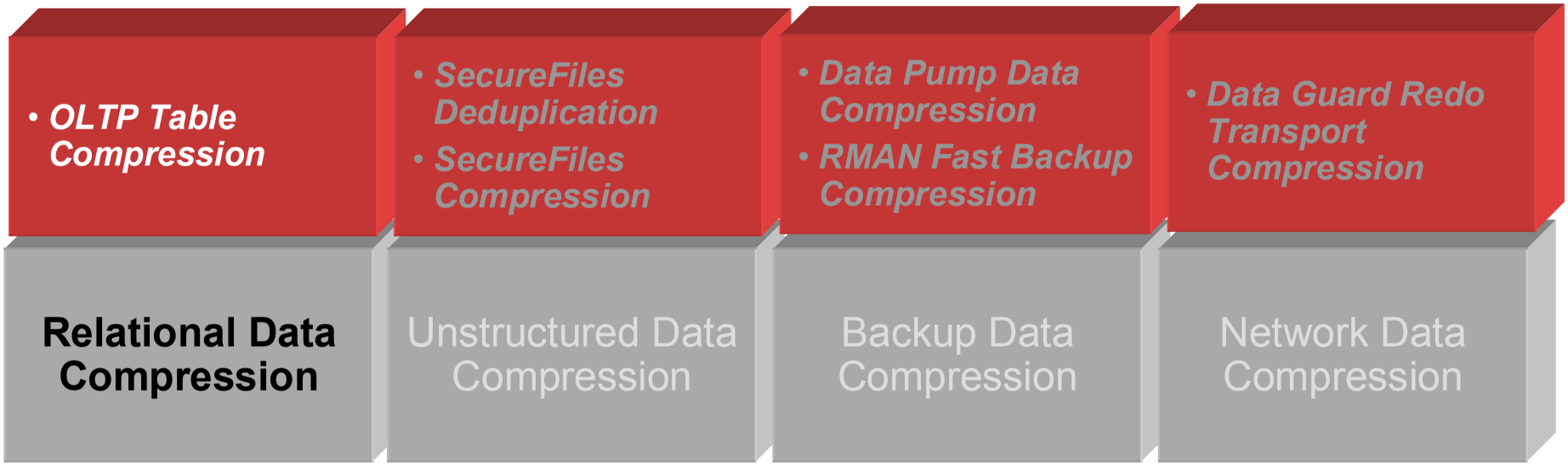
- Base table with all attributes
  - Virtual (derived) column based on values of other columns
  - No cross-table references possible

```
CREATE TABLE accounts
(acc_no      number(10)    not null,
 acc_name    varchar2(50)  not null, ...
 acc_branch  number(2)     generated always as
                           (to_number(substr(to_char(acc_no),1,2)))
```

12500	Adams	12
12507	Blake	12
12666	King	12
12875	Smith	12

Compression

Oracle Advanced Compression Option



- Reduces resource requirements and costs
  - Storage System
  - Network Bandwidth
  - Memory Usage

ORACLE DATABASE 11g

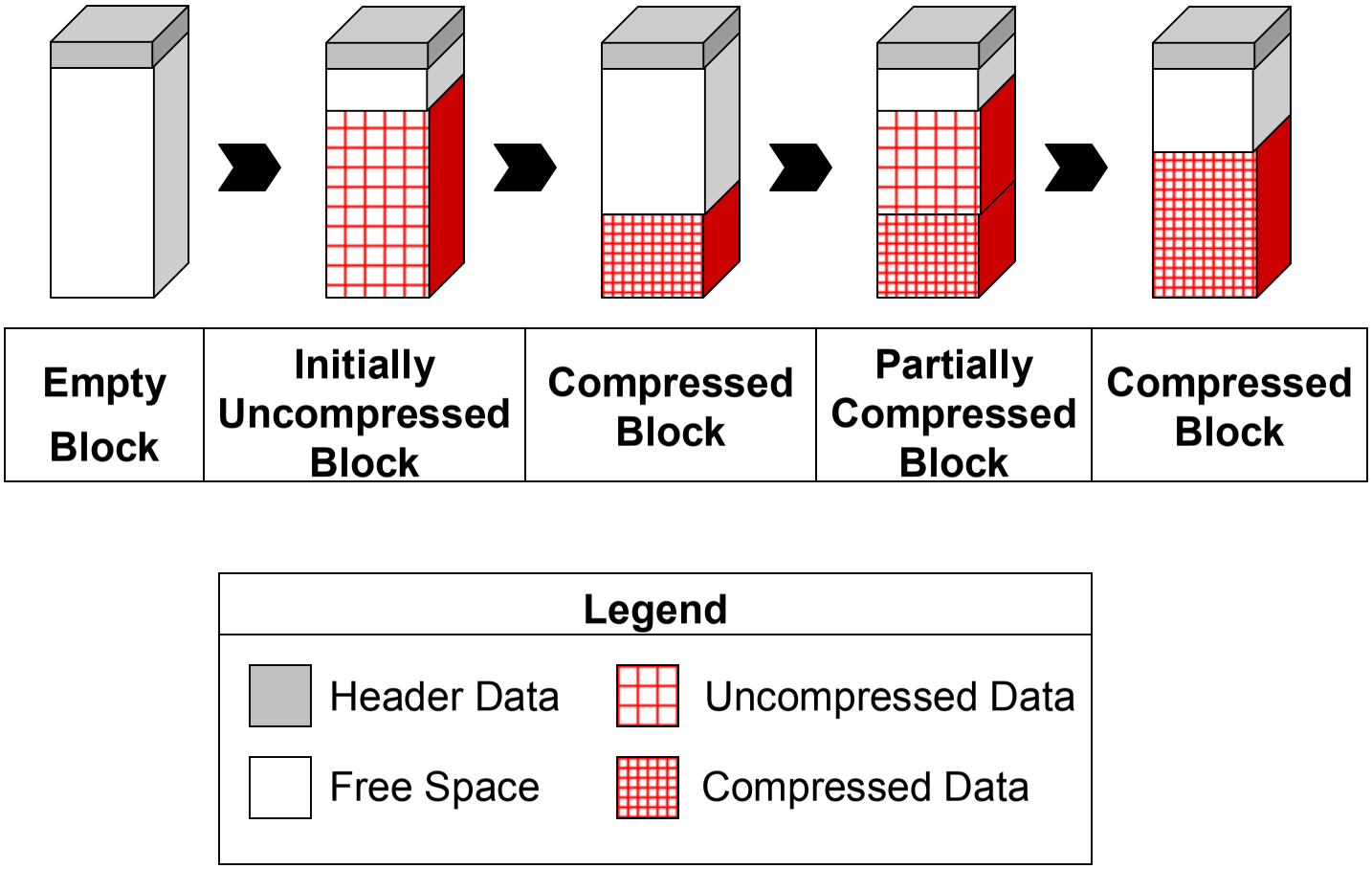
Table Compression

- Introduced in Oracle Database 9*i* Release 2
  - Compression during bulk load operations (Direct Load, CTAS)
  - Data modified using conventional DML not compressed
- Optimized compression algorithm for relational data
- Improved performance for queries accessing large amounts of data
  - Fewer I/Os
  - Buffer Cache efficiency
- Data is compressed at the database block level
- Compression enabled at either the table or partition level
- Completely transparent to applications

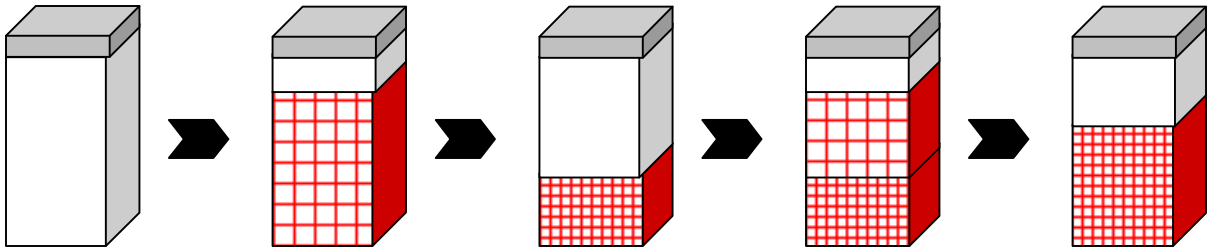
OLTP Table Compression

- Oracle Database 11*g* extends table compression for OLTP data
  - Support for conventional DML Operations (INSERT, UPDATE)
- New algorithm significantly reduces write overhead
  - Batched compression minimizes impact for OLTP transactions
- No impact on reads
  - Reads may actually see improved performance due to fewer I/Os and enhanced memory efficiency

OLTP Table Compression Process



Block-Level *Batch* Compression



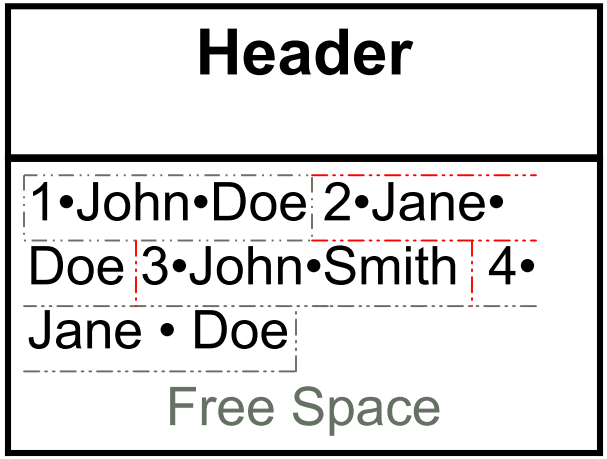
- Patent pending algorithm minimizes performance overhead and maximizes compression
- Individual INSERTs and UPDATEs do not cause recompression
- Compression cost is amortized over several DML operations
- Block-level (Local) compression keeps up with frequent data changes in OLTP environments
  - Competitors use static, fixed size dictionary table thereby compromising compression benefits

OLTP Table Compression

Employee Table

ID	FIRST_NAME	LAST_NAME
1	John	Doe
2	Jane	Doe
3	John	Smith
4	Jane	Doe

Initially Uncompressed Block




```
INSERT INTO EMPLOYEE
    VALUES (5, 'Jack', 'Smith');
COMMIT;
```

OLTP Table Compression

Employee Table

ID	FIRST_NAME	LAST_NAME
1	John	Doe
2	Jane	Doe
3	John	Smith
4	Jane	Doe
5	Jack	S

Compressed Block

Header

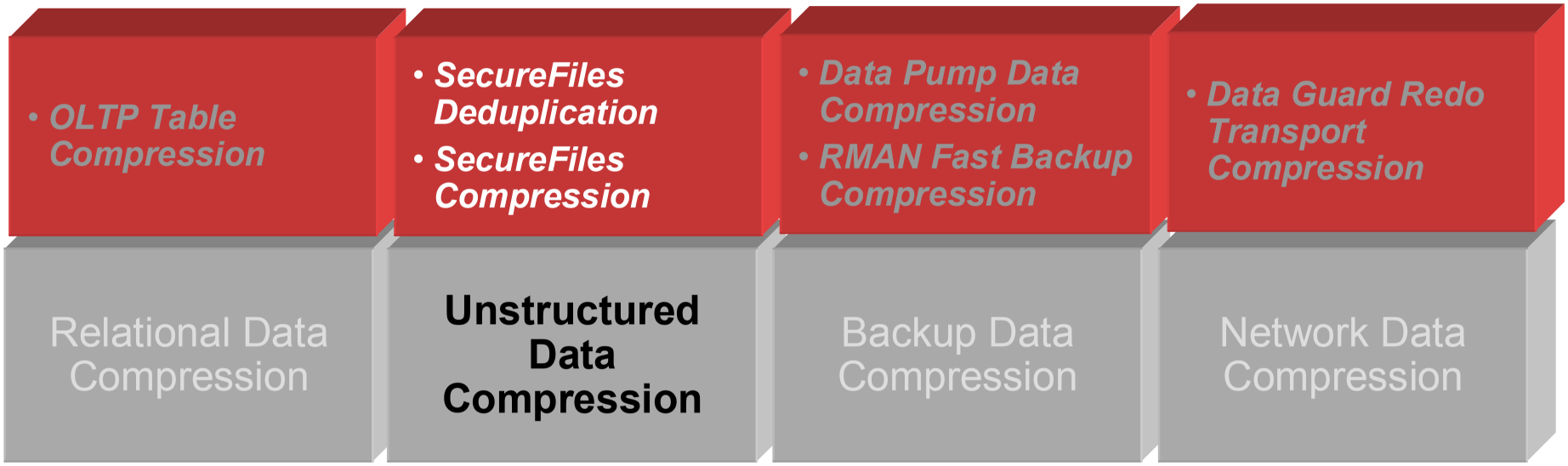
John=❍|Doe=❶|Jane=❷|Smith=❸

1•❍•❶ 2•❷•❶ 3•❍•❸ 4 • ❷ • ❶ 5•Jack•❸

Free Space

Local Symbol Table

Oracle Advanced Compression Option



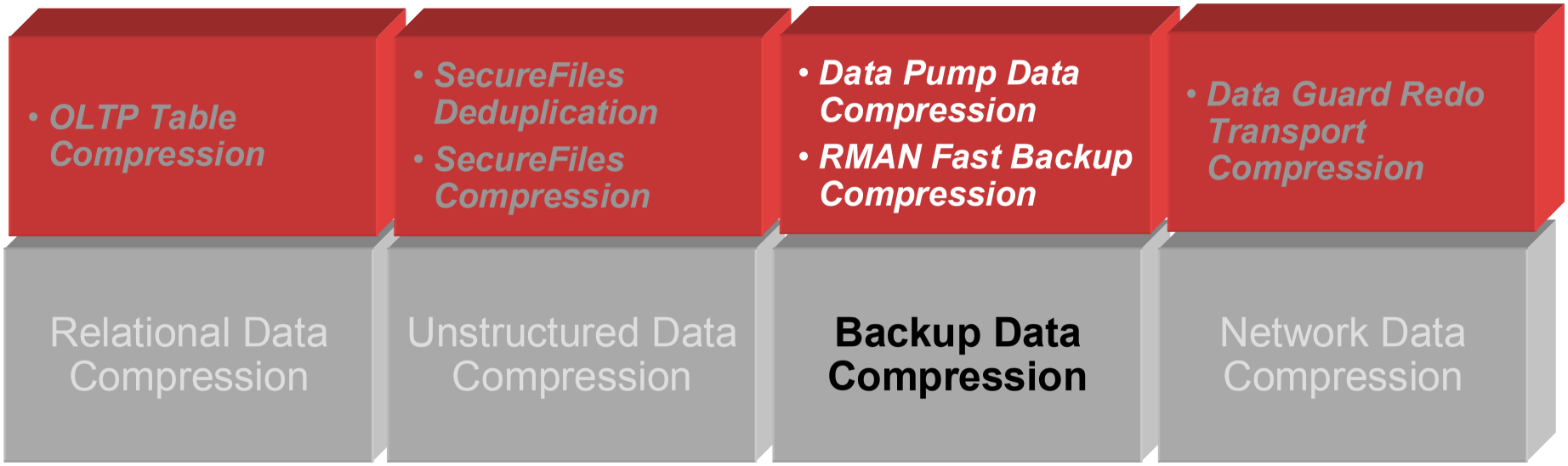
- Reduces resource requirements and costs
  - Storage System
  - Network Bandwidth
  - Memory Usage

ORACLE DATABASE 11g

SecureFiles Deduplication/Compression

- Enables storage of a single physical image for duplicate data
  - Significantly reduces space consumption
  - Dramatically improves writes and copy operations
- No adverse impact on read operations
  - May actually improve read performance for cache data
- Duplicate detection happens within a table, partition or sub-partition
- With SecureFiles compression, typical files such as documents or XML files, experience a reduction of 2 to 3 times in size
  - Automatically avoids compressing data that would not benefit from compression
- Specially useful for content management, email applications and data archival applications

Oracle Advanced Compression Option



- Reduces resource requirements and costs
  - Storage System
  - Network Bandwidth
  - Memory Usage

ORACLE DATABASE 11g

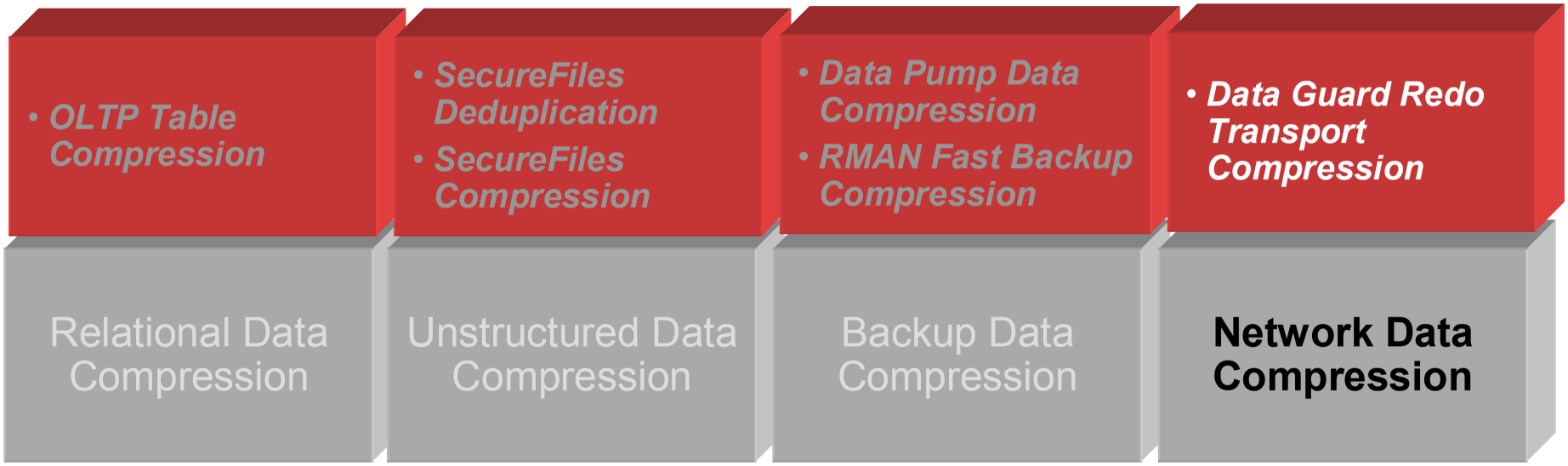
Data Pump Compression

- Metadata compression available since Oracle Database 10*g*
- Oracle Database 11*g* extends compression to table data during exports
  - No need to decompress before import
- Single step compression of both data and metadata
  - Compressed data directly hits disk resulting in reduced disk space requirements
  - Internal tests reduced dump file size up to 75%
- Application transparent
  - Complete Data Pump functionality available on compressed files

RMAN Backup Compression

- RMAN compression can dramatically reduce the storage requirements for backup data.
- Backup data is compressed before it is written to disk or tape and doesn't need to be uncompressed before recovery
- Three levels of RMAN Compression: LOW, MEDIUM, and HIGH.
  - Compression Level LOW (New in 11.2)
    - Fastest compression algorithm
    - *Best suited when backup is constrained by CPU*
  - Compression Level MEDIUM (New in 11.1)
    - Balance between CPU usage and compression ratio
  - Compression LEVEL HIGH (New in 11.2)
    - Best compression ratio and highest CPU utilization
    - *Best suited when backup is constrained by network or I/O*

Oracle Advanced Compression Option



- Reduces resource requirements and costs
  - Storage System
  - Network Bandwidth
  - Memory Usage

ORACLE DATABASE 11g

Network Compression

Data Guard Redo Transport Services

- Compress network traffic between primary and standby databases
- Lower bandwidth networks (<100Mbps)
  - 15-35% less time required to transmit 1 GB of data
  - Bandwidth consumption reduced up to 35%
- High bandwidth networks (>100 Mbps)
  - Compression will not reduce transmission time
  - But will reduce bandwidth consumption up to 35%

Advanced Security Option

Database Defense-in-Depth

Monitoring

- Configuration Management
- Audit Vault
- Total Recall

Access Control

- Oracle Database Vault
- Oracle Label Security

Encryption & Masking

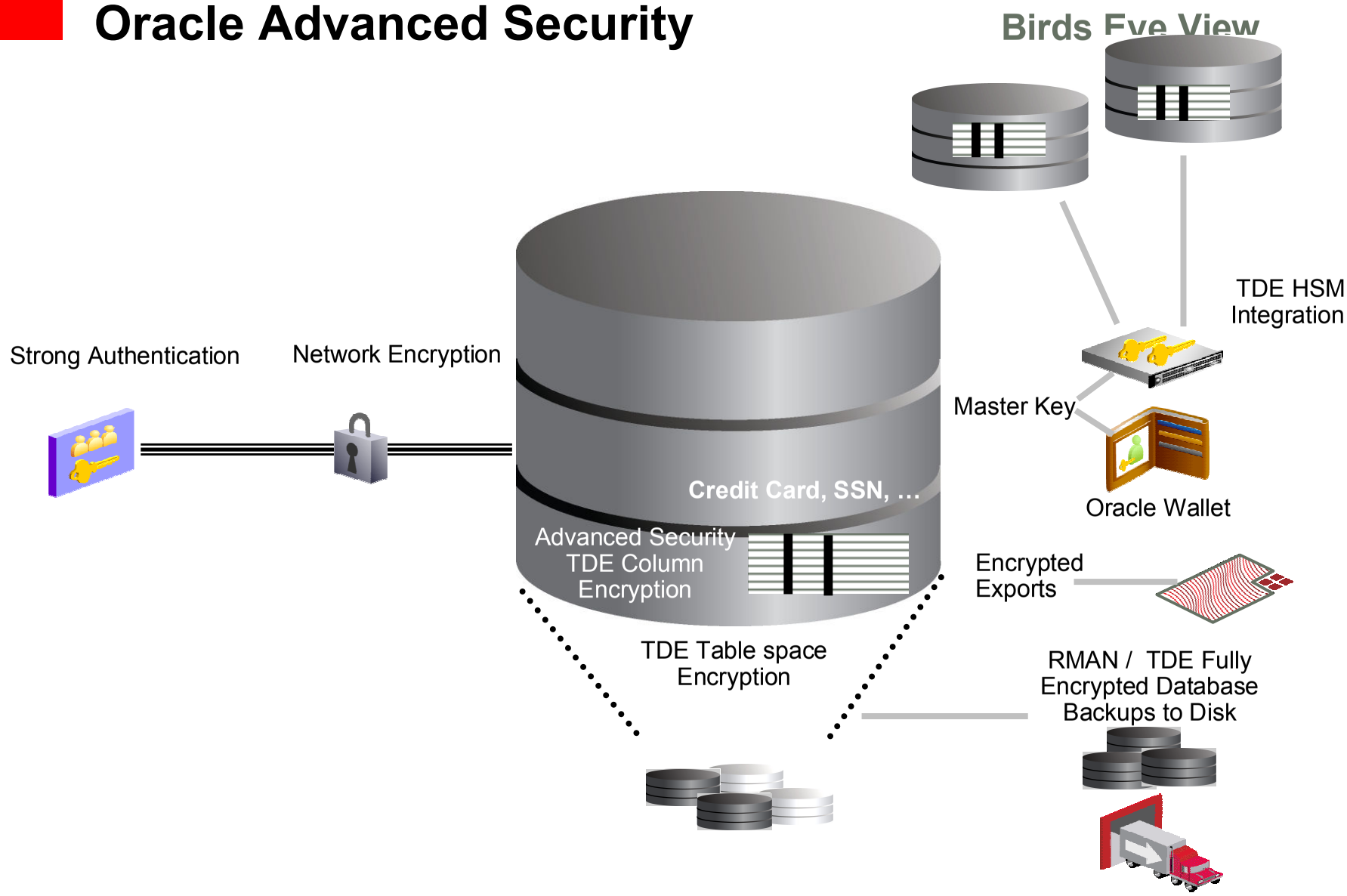
- Oracle Advanced Security
- Oracle Secure Backup
- Data Masking Pack

Oracle Advanced Security

Key Features

- Transparent Data Encryption
  - Column encryption
  - Tablespace encryption
  - Bulit-in Key management
  - Encryption of backups to disk
  - Encryption of SecureFiles (LOBS)
  - Encryption of DataPump exports
- Network Encryption
  - Native (no certifications required)
  - SSL / TLS
- Strong Authentication
  - Kerberos, PKI, RADIUS

Oracle Advanced Security



Oracle Advanced Security

By Release

Key Features

Feature \ DB Vers	9i R2	10gR2	11gR1	11gR2
Strong auth	✓	✓	✓	✓
Network Encryption	✓	✓	✓	✓
TDE column encryption		✓	✓	✓
TDE column with HSM Key Management			✓	✓
TDE with secure files (LOBS)			✓	✓
TDE table space encryption			✓	✓
TDE tablespace with HSM Key Management				✓
TDE with Exadata				✓

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Oracle Advanced Security

Easy Deployment – Encrypted Tablespaces

Database Instance: ora11201.us.oracle.com > Tablespaces >

Create Tablespace

General | Storage

* Name PS_ORDERS_ENC

Extent Management

- (•) Locally Managed
- ( ) Dictionary Managed

Type

- (•) Permanent
  - [ ] Set as default permanent tablespace
  - [x] Encryption [Encryption Options]
- ( ) Temporary
  - [ ] Set as default temporary tablespace
- ( ) Undo
  - Undo Retention Guarantee ( ) Yes (•) No

Oracle Advanced Security

Easy Deployment – Encrypted Columns

Database Instance: ora11201.us.oracle.com > Tables >

Encryption Options for Table : EMPLOYEES

Specify the encryption algorithm and the key seed to be used for

Encryption Algorithm AES256

AES192
3DES168
AES128
AES256

Key Generation

Key value is used to ...m number generator that

Database Instance: ora11201.us.oracle.com > Tables >

Edit Table: HR.EMPLOYEES

General | Constraints | Segments | Storage | Options | Statistics | Indexes

Name EMPLOYEES

Schema HR

Tablespace EXAMPLE

Organization **Standard (Heap Organized)**

Columns

Set Default LOB Attributes | Encryption Options

Advanced Attributes | Delete | Insert Column: Abstract Data Type | Insert

Previous 1-10 of 15 Next 5

Select		Name	Data Type	Size	Scale	Not NULL	Default Value	Encrypted
◉		EMPLOYEE_ID	NUMBER	6		☑		☐
○		FIRST_NAME	VARCHAR2	20		☐		☐
○		LAST_NAME	VARCHAR2	25		☑		☑
○		CREDIT_CARD_NO	VARCHAR2	19		☑		☑

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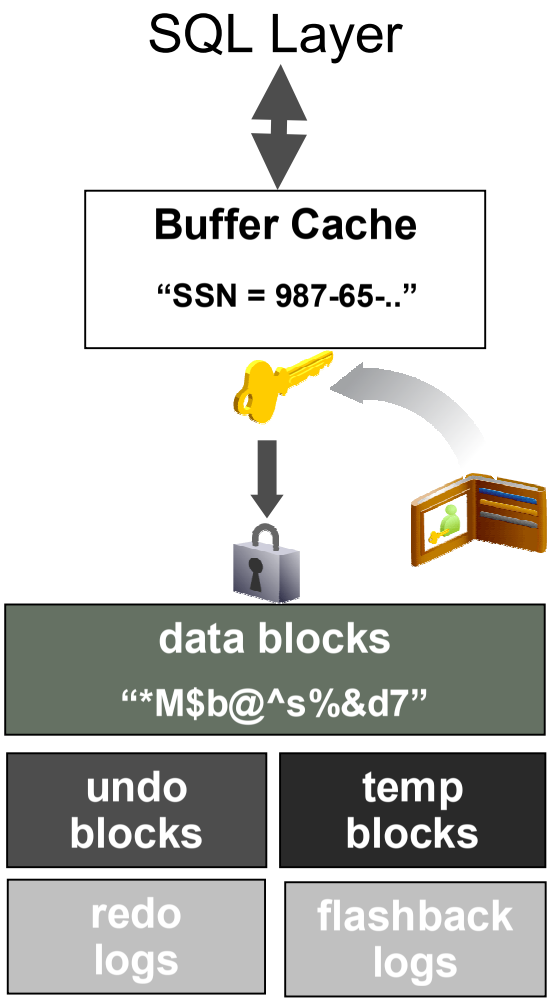
Oracle Advanced Security

TDE tablespace encryption

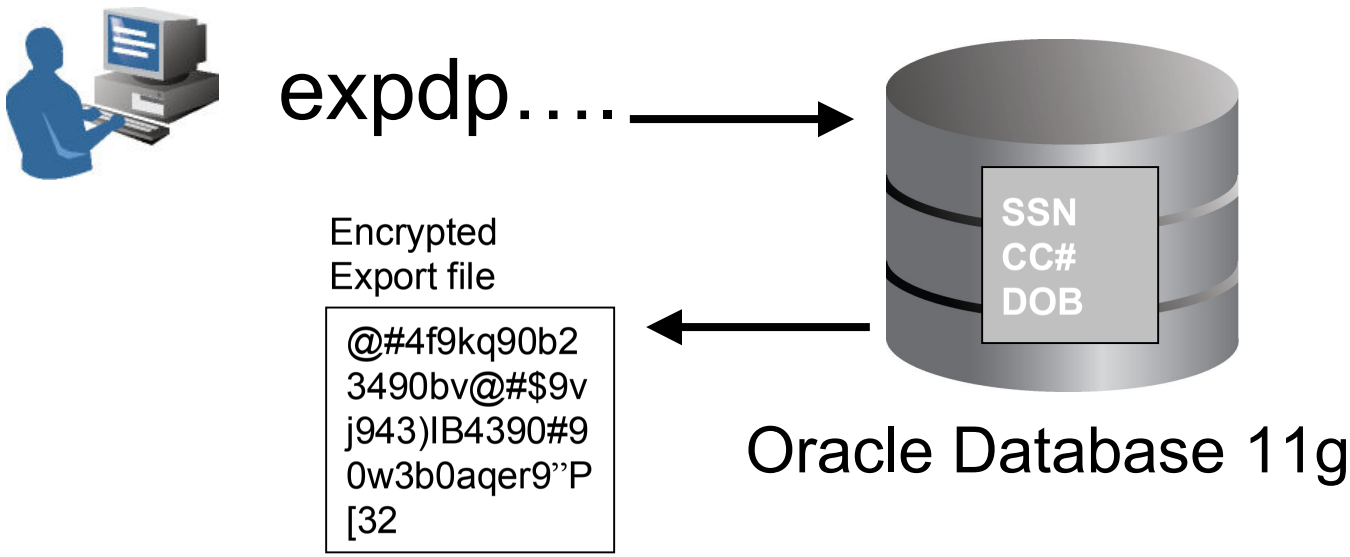
- Encrypt all application data
  - Encrypt entire tablespaces
  - No need to worry about encrypting individual columns
- Highly efficient
  - High performance
  - Certified with Oracle Advanced Compression
- No application changes
  - All data types supported
  - Index range scans supported
  - Foreign key constraints supported



Oracle Advanced Security

TDE for Data Pump

- Oracle Data Pump used for bulk export/import to Operating system flat files



Oracle Advanced Security

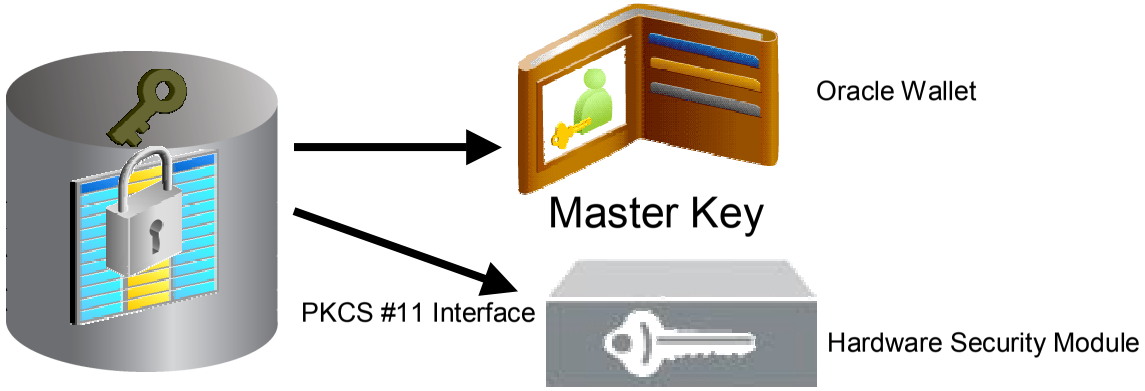
TDE for Unstructured Data

- Protection for unstructured data in the database
  - X-ray images (DICOM)
  - Scanned financial contracts
- Encrypt using TDE **column** encryption
  - Oracle SecureFiles were introduced in Oracle Database 11g
- Encrypt using TDE **tablespace** encryption
  - Encrypt the entire tablespace containing data in Oracle SecureFile

Oracle Advanced Security

TDE Built-in key management

- Generate, store, and rotate encryption keys
- Two tier key architecture
  - Master key protects table column and tablespace keys
  - Master key
    - External Security Module (Wallet or HSM)
    - Certified: HSMs from Thales/nCipher, Safenet, RSA, Utimaco



Oracle Advanced Security

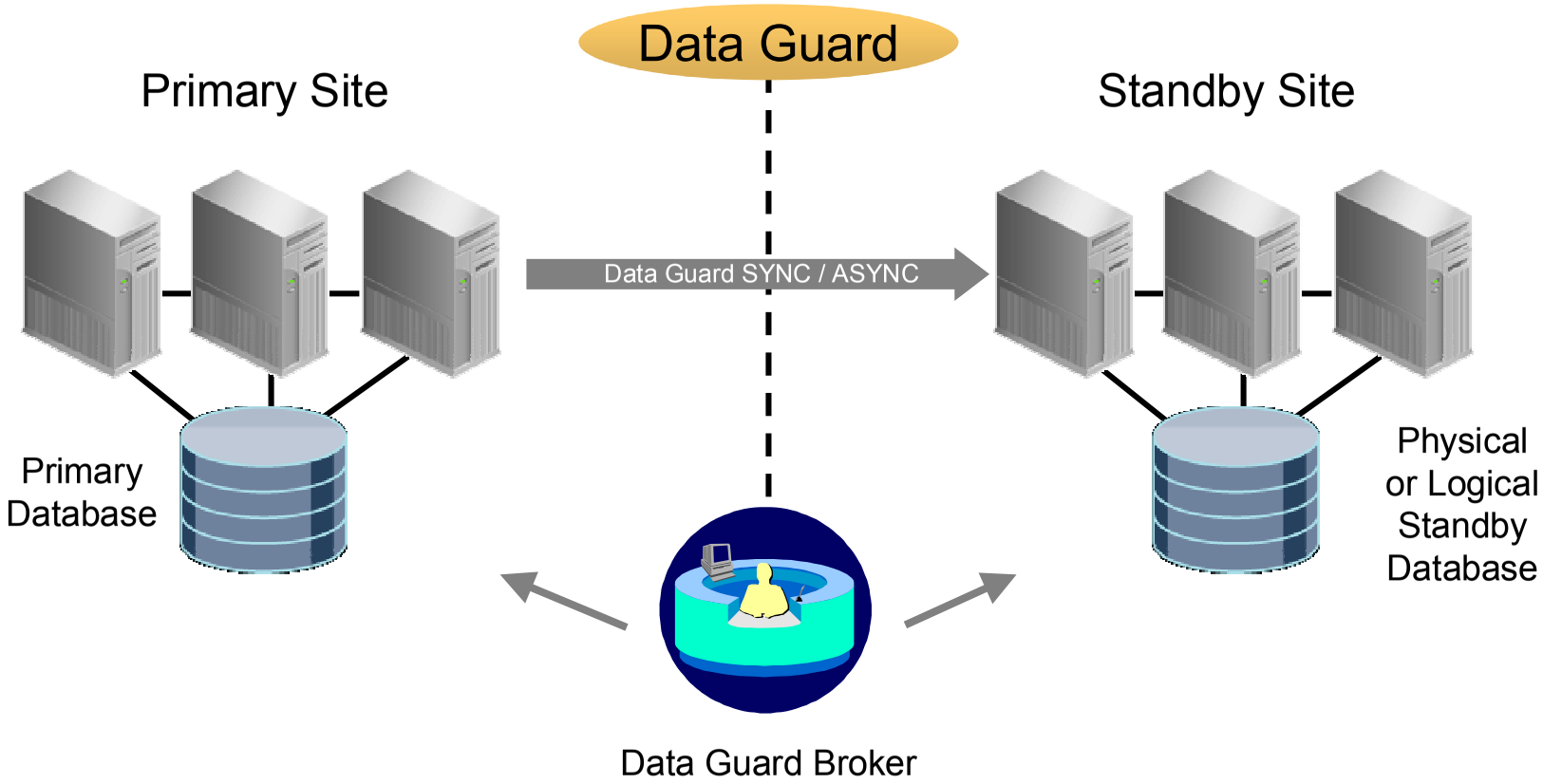
Network Encryption and Strong Authentication

- Encrypts all communication with the database
  - AES (128, 192, 256 bit keys)
  - RSA RC4 (128, 256-bit keys)
  - 3DES (2 and 3 key)
  - Diffie-Hellman key exchange
- Data integrity with checksums
  - SHA-1
  - Automatically detects modifications, replays, missing packets
- Strong Authentication
  - Kerberos, PKI
  - RADIUS

DataGuard/Active DataGuard

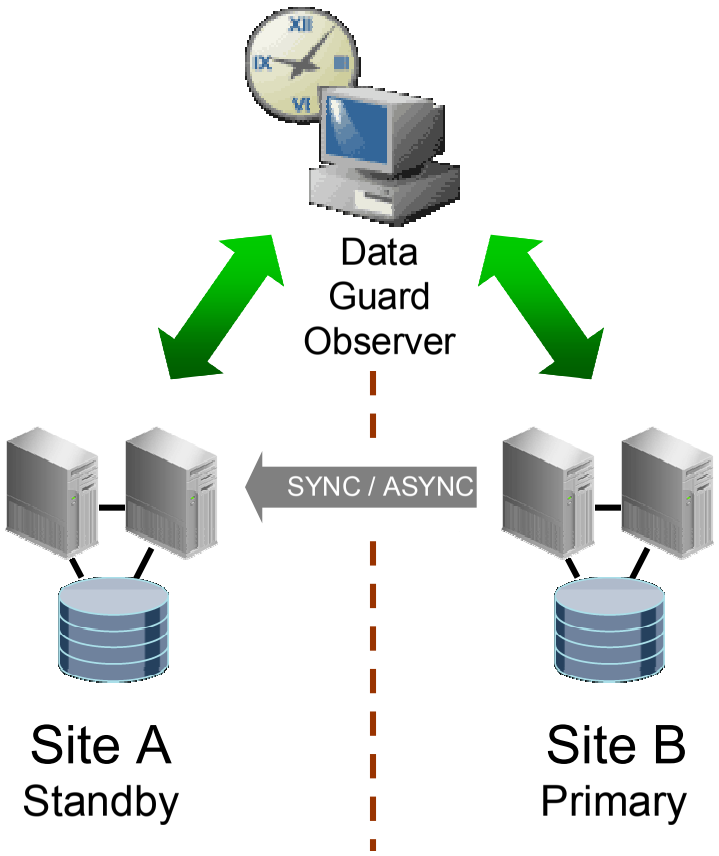
Oracle Data Guard

Feature of the Oracle Database



Reduce Unplanned Downtime

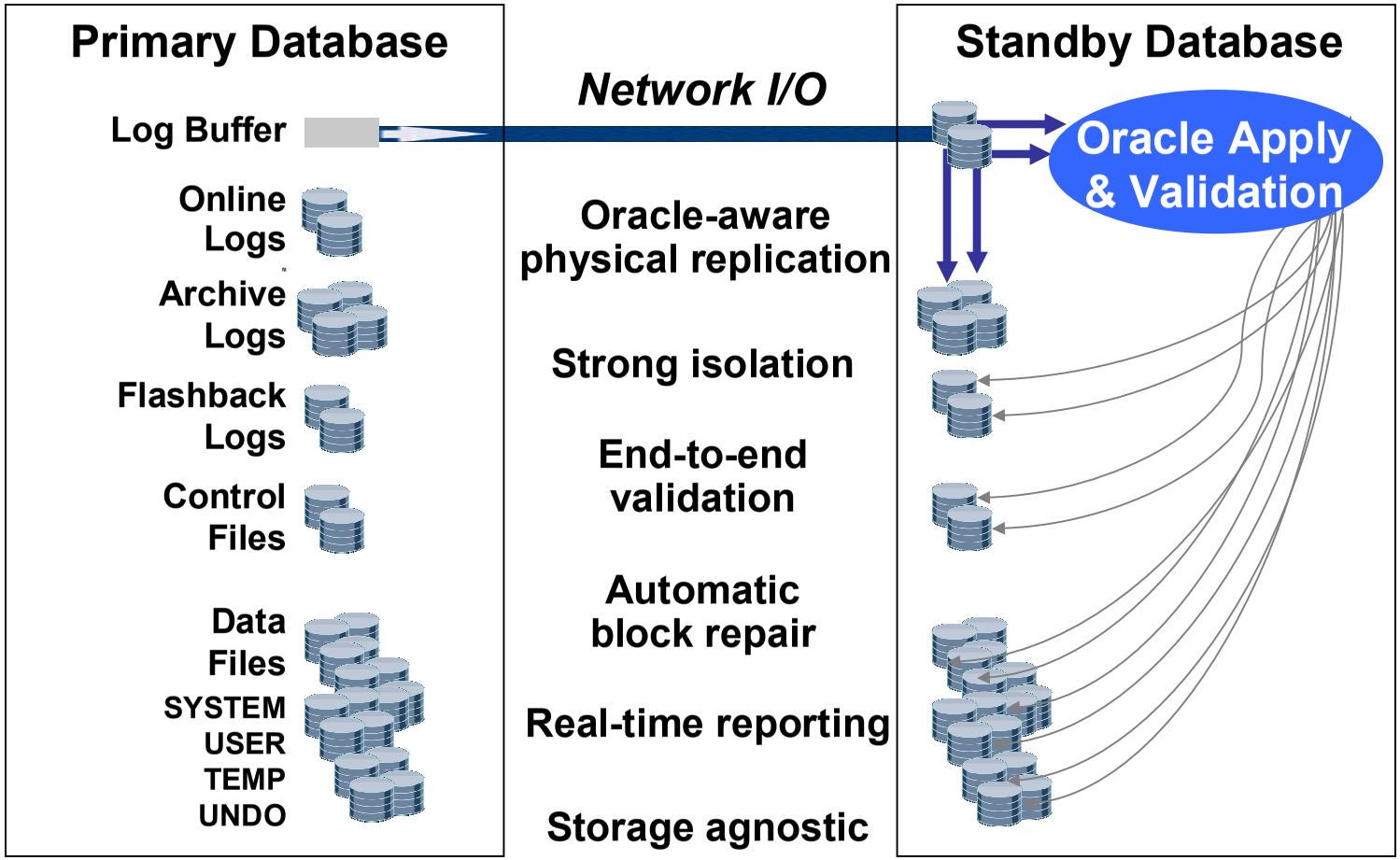
Data Guard 11g Fast-Start Failover



- Automatic database failover
  - Database down
  - Designated health-check conditions
  - Or at request of an application
- Maximum Availability (10.2)
- Maximum Performance (11.1)
- Integrated role-based services (11.2)
  - Automatically start services
  - Automatic notification and redirection of client connections to new primary

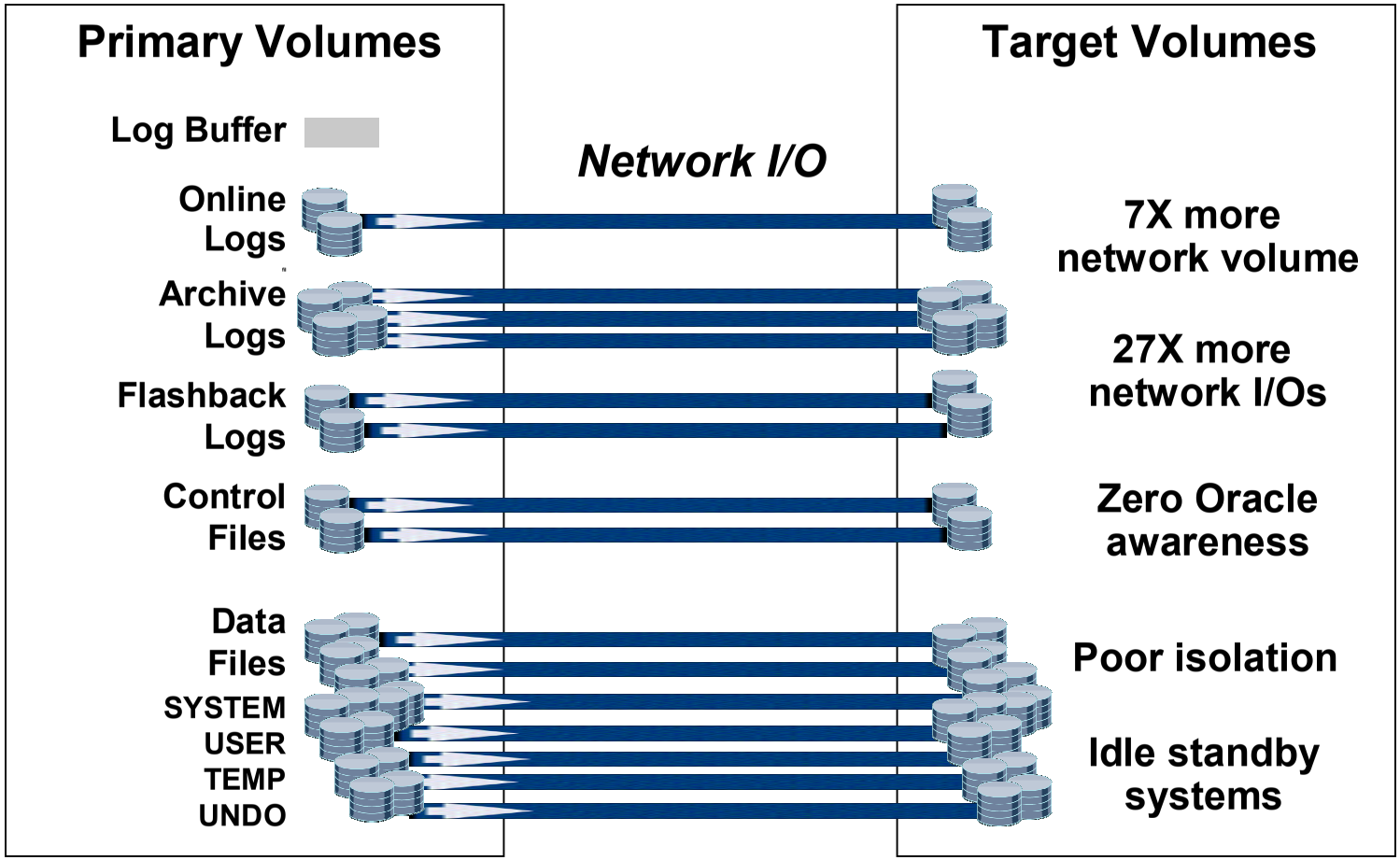
Data Guard

Database-Aware Physical Replication



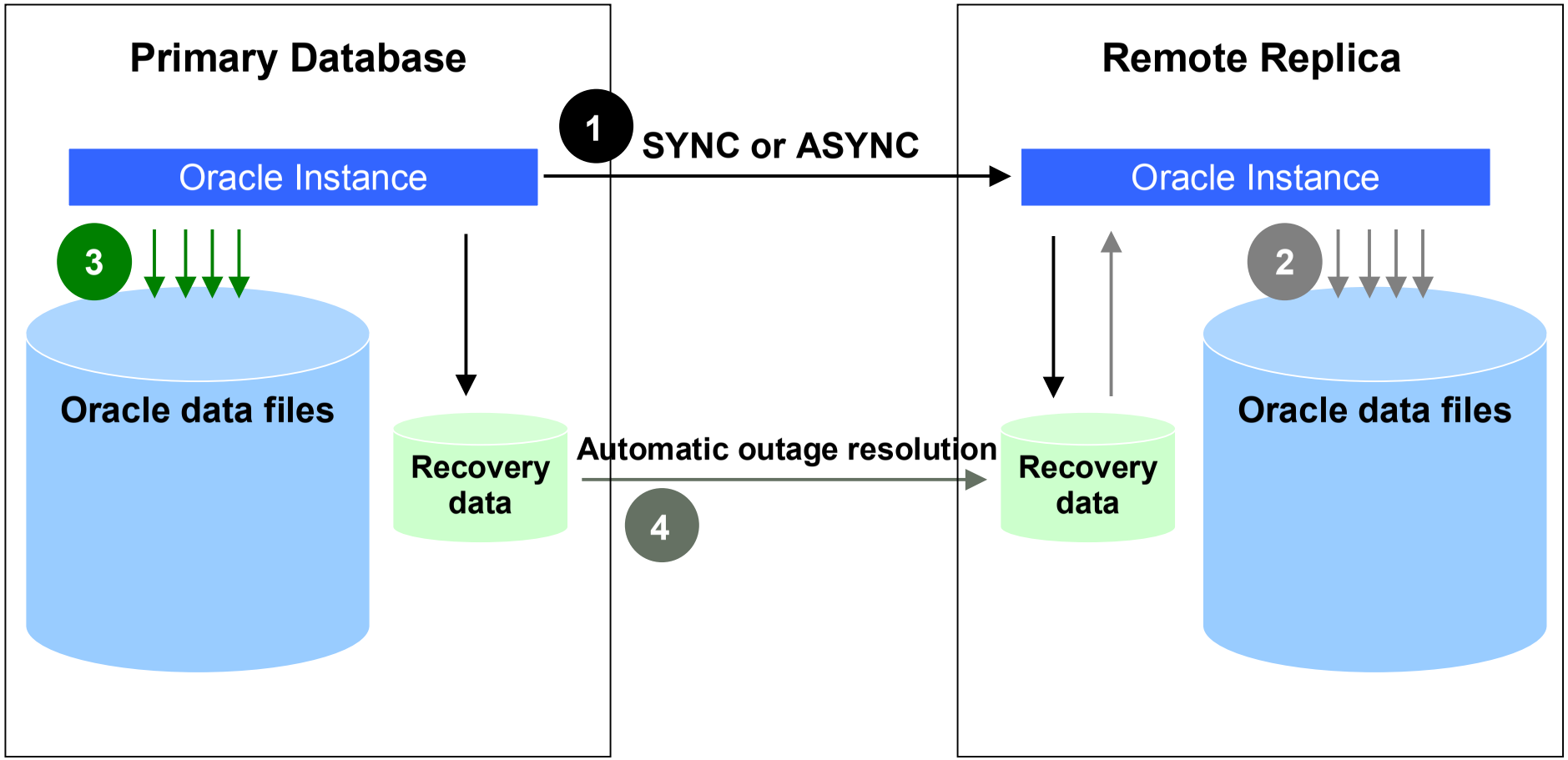
Storage Remote Mirroring

Weaknesses



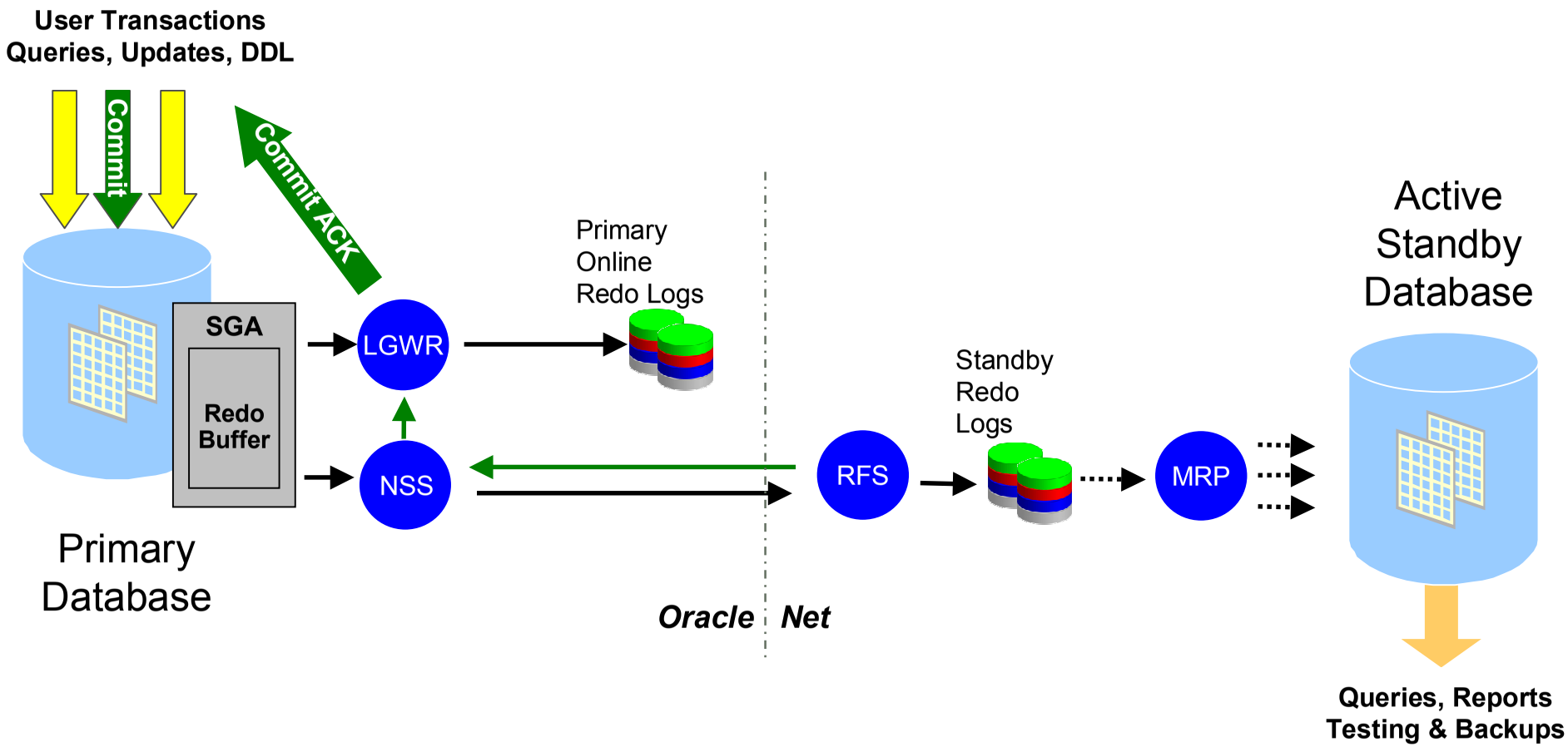
Data Guard Architecture

How it works



Data Guard SYNC Transport – Maximum Availability

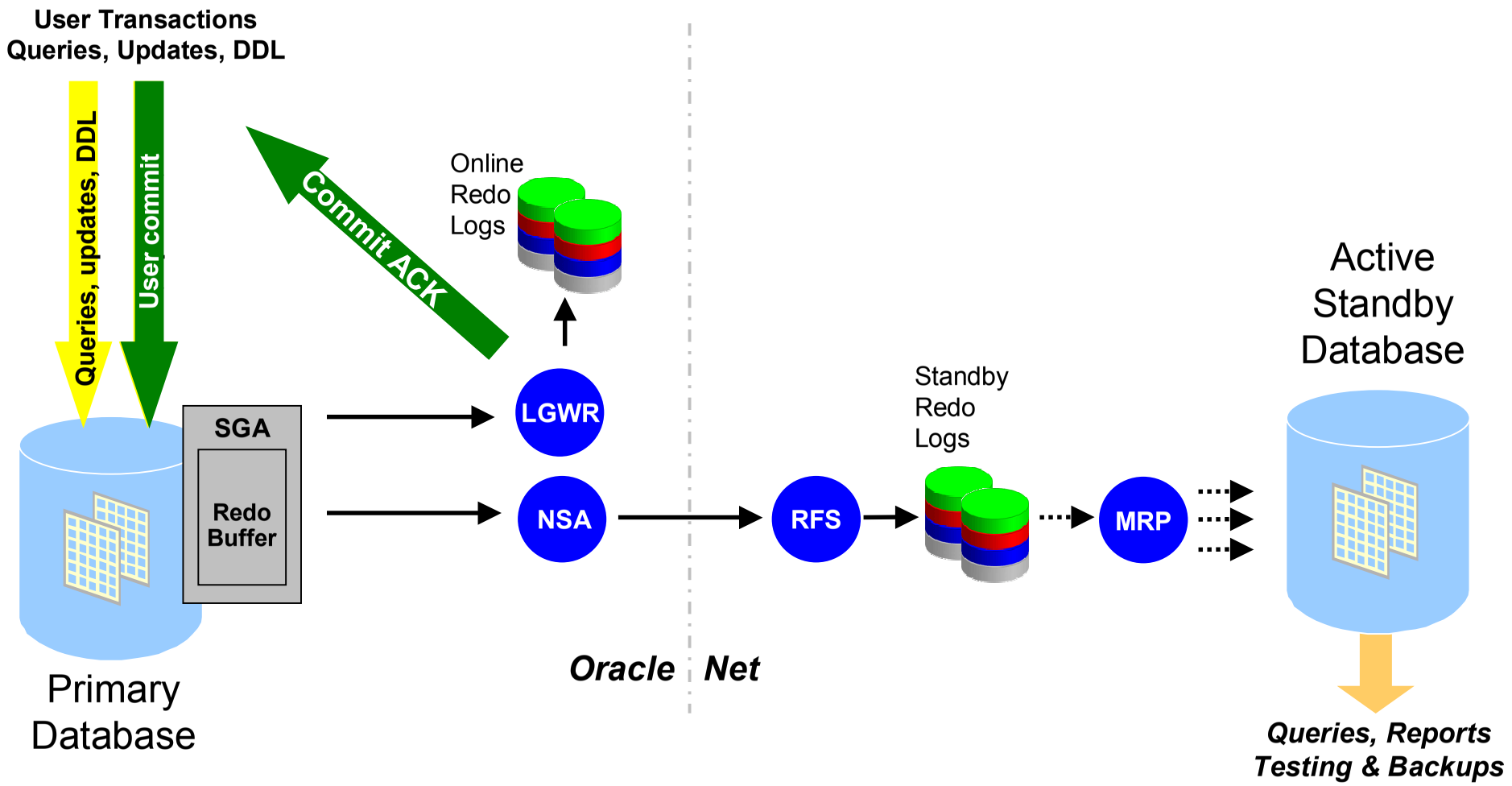
Remote Transport and Local Log File Write Occur in Parallel



Primary waits no longer than `NET_TIMEOUT` parameter of `LOG_ARCHIVE_DEST_n` to receive acknowledgement from standby database

Data Guard ASYNC Transport – Maximum Performance

Direct Transmission from Log Buffer and New Streaming Protocol



Lost Write Protection in Data Guard 11g

Capability Unique to Oracle Database

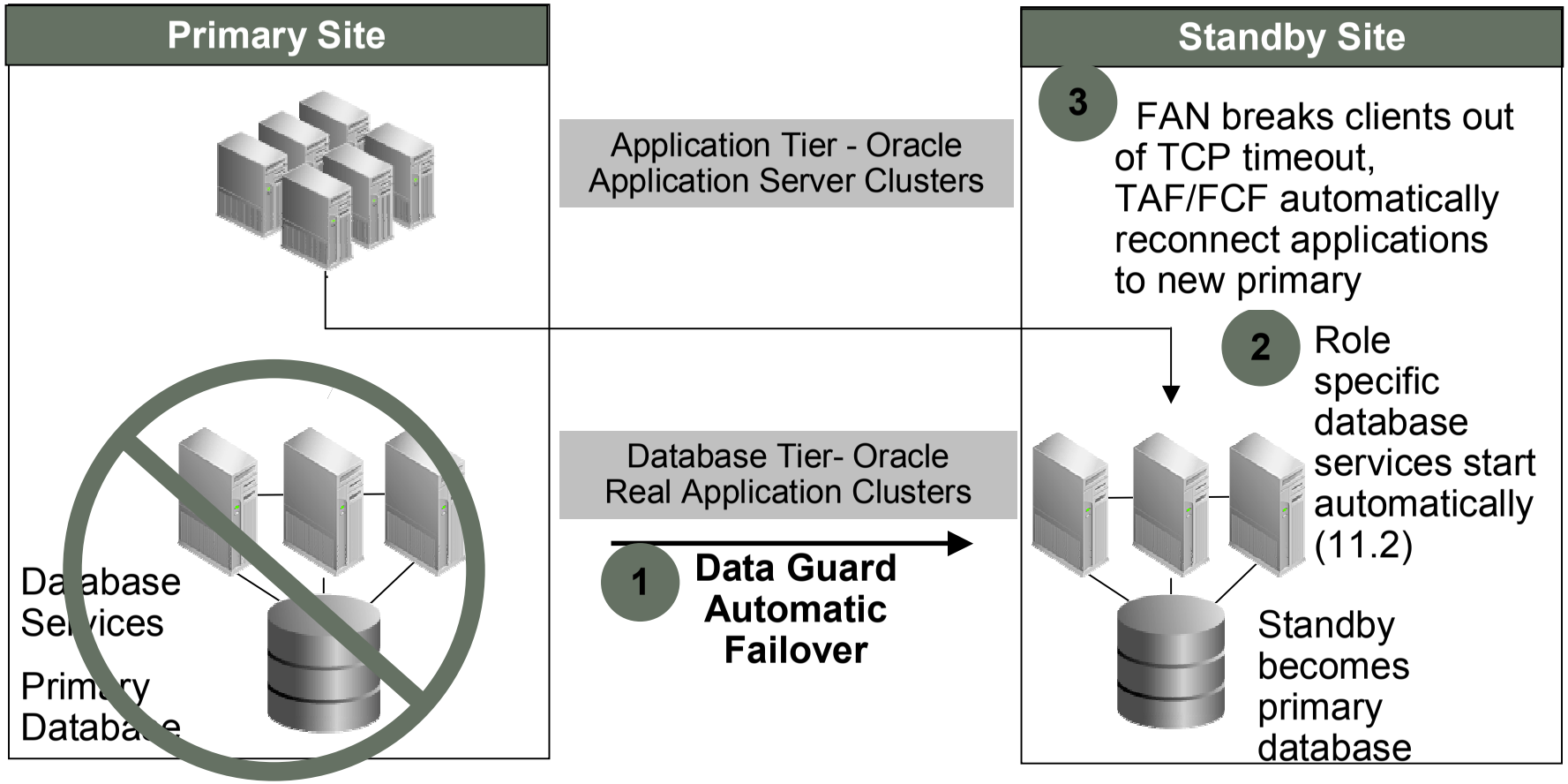
- Detect lost writes using new initialization parameter

```
db_lost_write_protect
```

- Apply compares standby version of block to incoming redo
  - ORA-752 if block SCN from primary is lower than standby
    - 100% certain of a lost write on the primary database
    - Resolve via failover to standby to restore data consistency
  - ORA-600 [3020] if block SCN from primary is higher than standby
    - Possibility of a lost write on the standby database
    - Resolve by re-creating the standby database or affected files

Application Failover

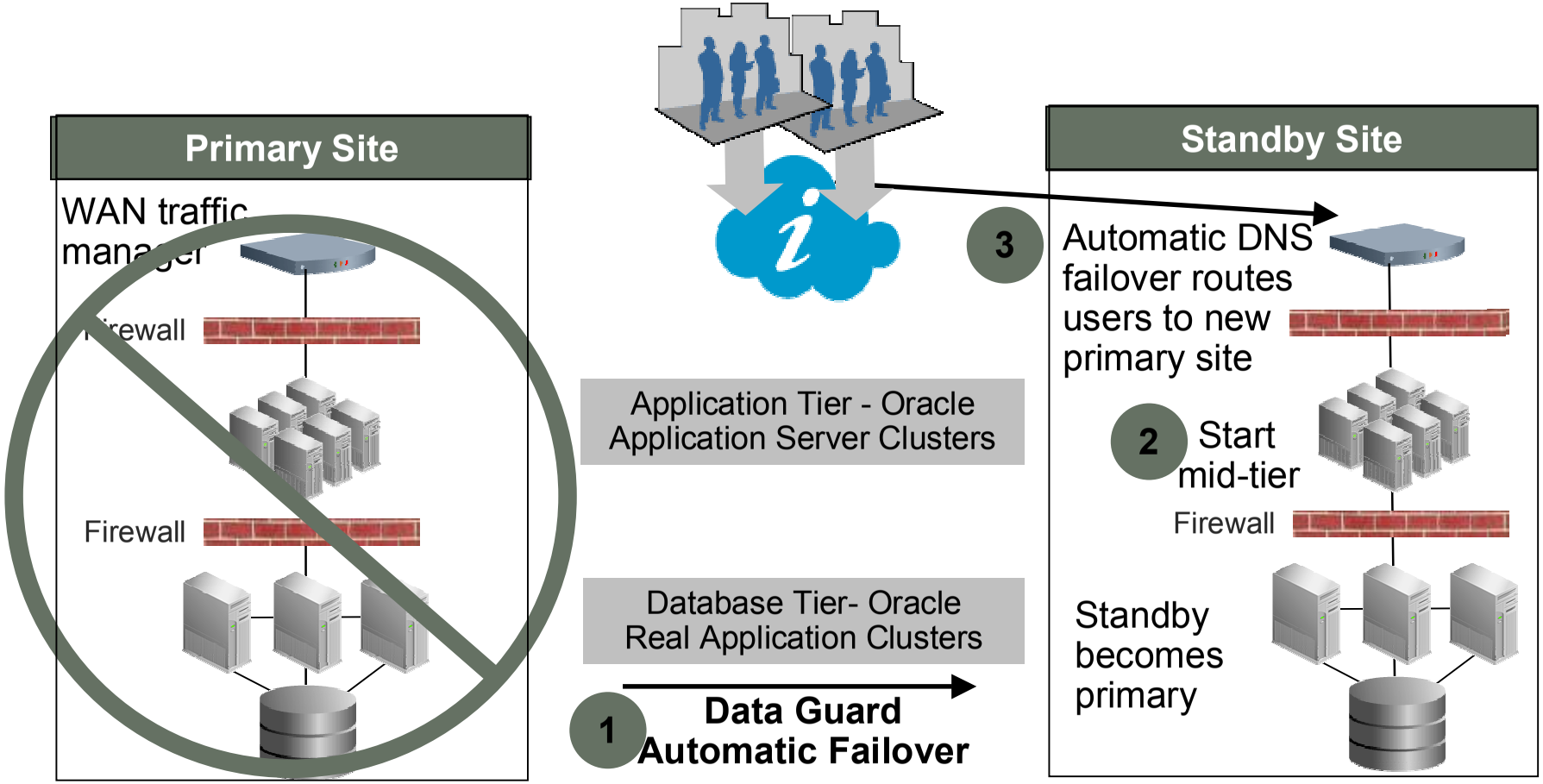
Application Tier is Still Viable



MAA Best Practices for Client Failover in a Data Guard Configuration

Demonstrations – Automatic Database, Application & Complete Site Failover

Complete Site Failover



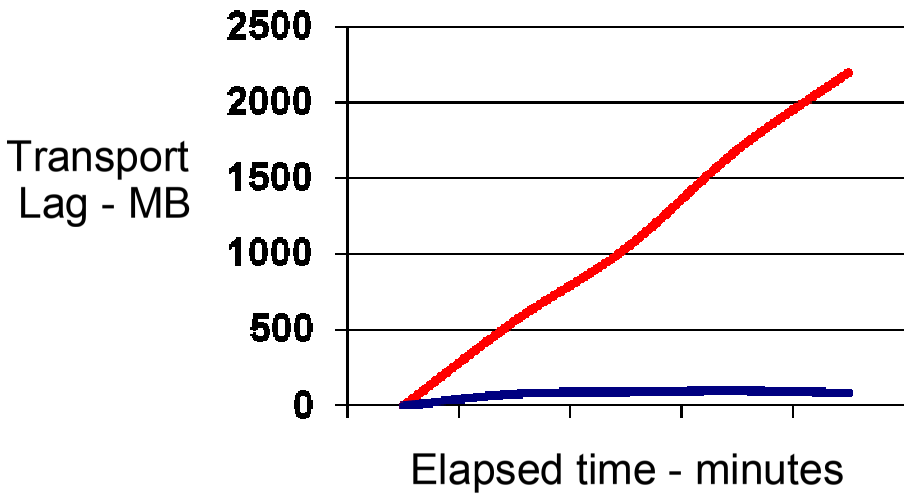
Chapter 4.2.1 of HA Best Practices – complete site failover

Demonstrations – Automating Site Failover, E-Biz Suite and Siebel Apps

Oracle 11g Transport Compression

Oracle Advanced Compression Option

- Reduce RPO, reduce bandwidth utilization



Bandwidth Consumption

Uncompressed 22 MB/sec
Compressed 12 MB/sec

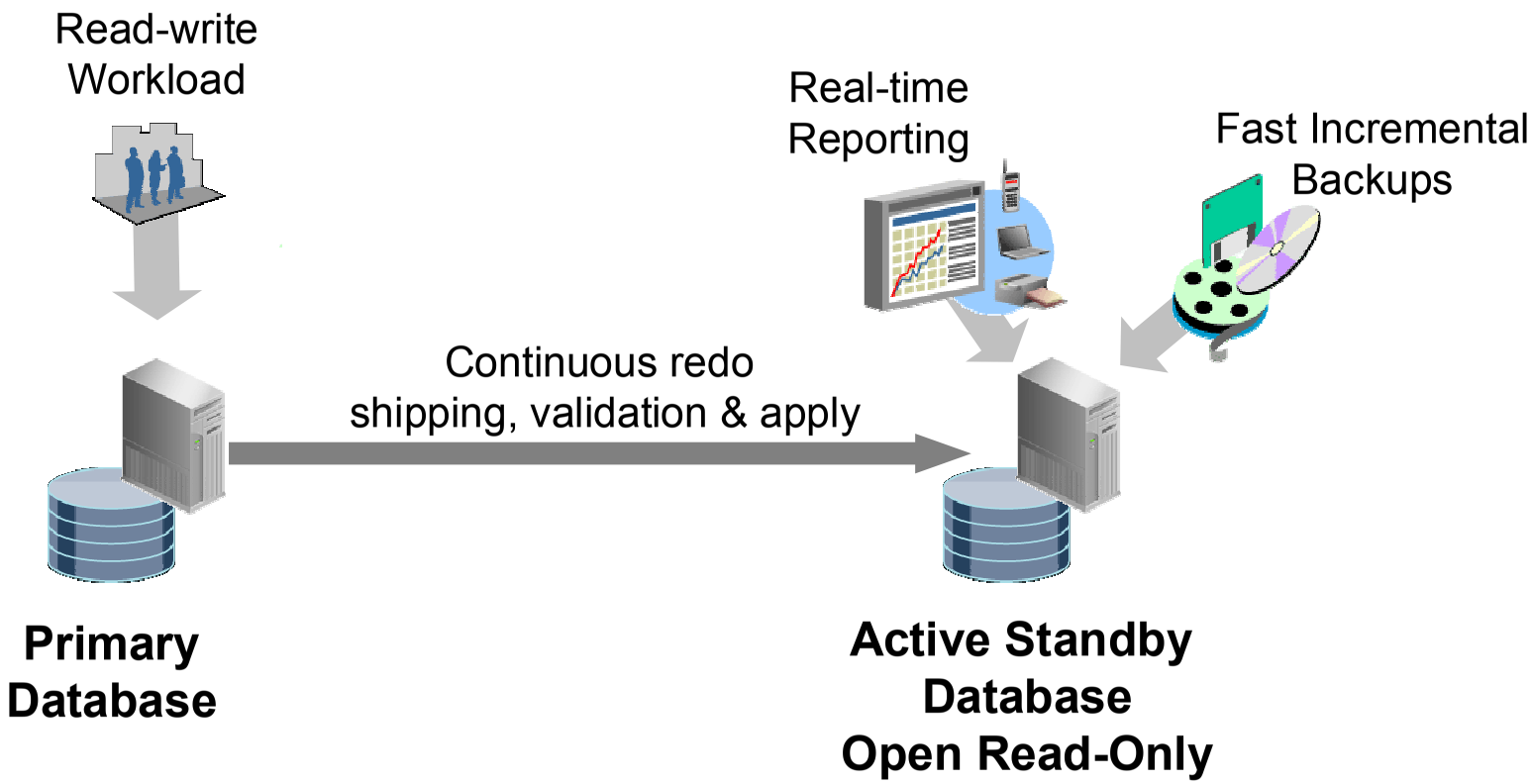
Test Details
- Asynchronous
- 12.5MB/sec bandwidth
- 22MB/sec redo rate

- What DBA's need to know:
  - Hidden parameter enables redo transport compression for Maximum Performance in Oracle 11g Release 1, MOS Note 729551.1
  - Compression for all protection modes from Oracle Database 11.2 onward

[9]MOS Note 729551.1, Redo Transport Compression in a Data Guard Environment

ROI - Active Data Guard 11g

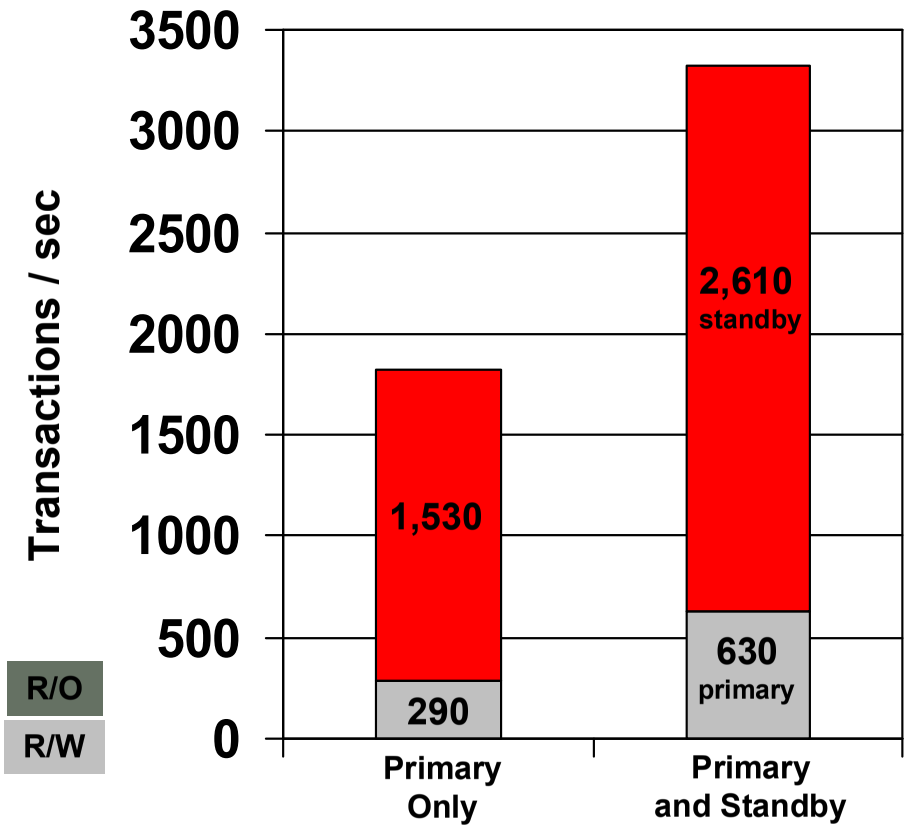
Utilize Physical Standby Database to Offload Primary



Always active – use standby for queries, reports, backups

ROI - Improve Performance

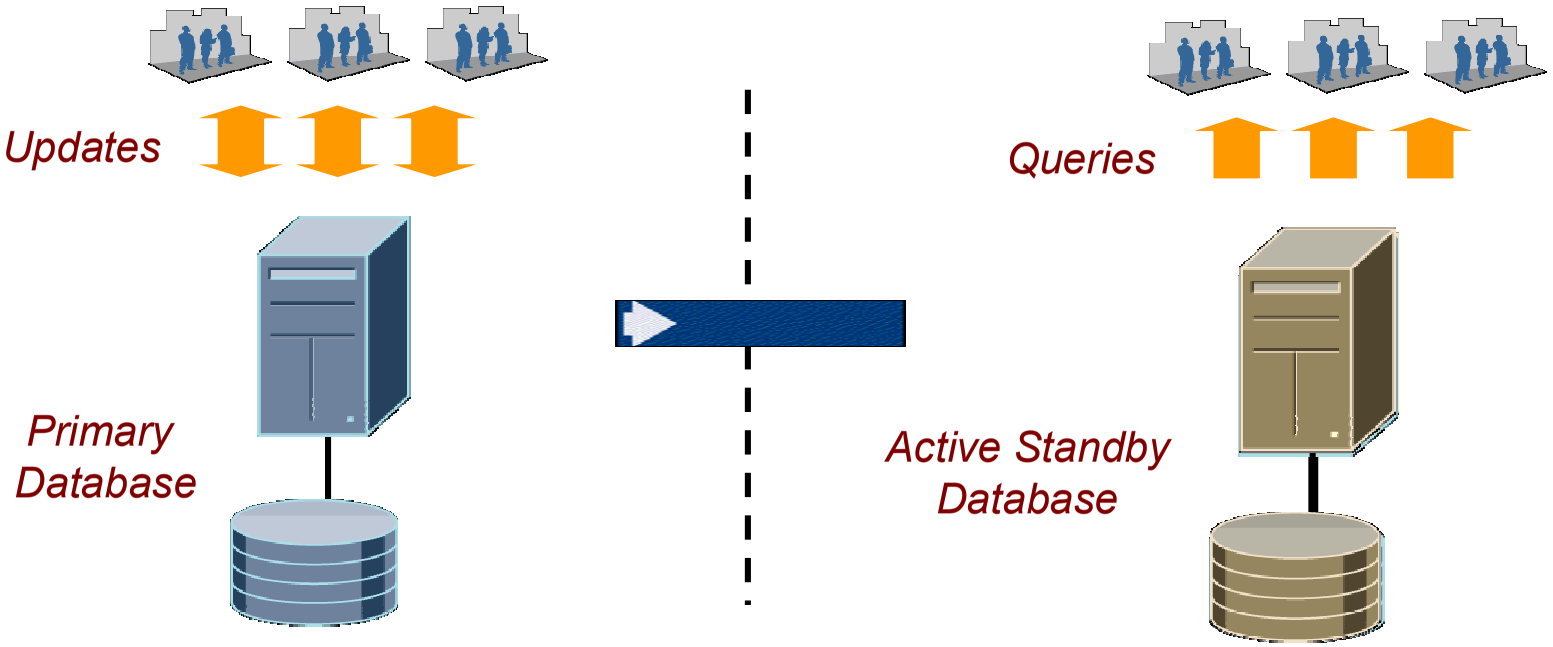
For all Workload



- Double read-write throughput
- Increase read-only throughput by 70%
- Eliminate contention between read-write and read-only workload
- Simplify performance tuning

Data Guard Snapshot Standby

Implement Changes with Confidence – Use as Test System

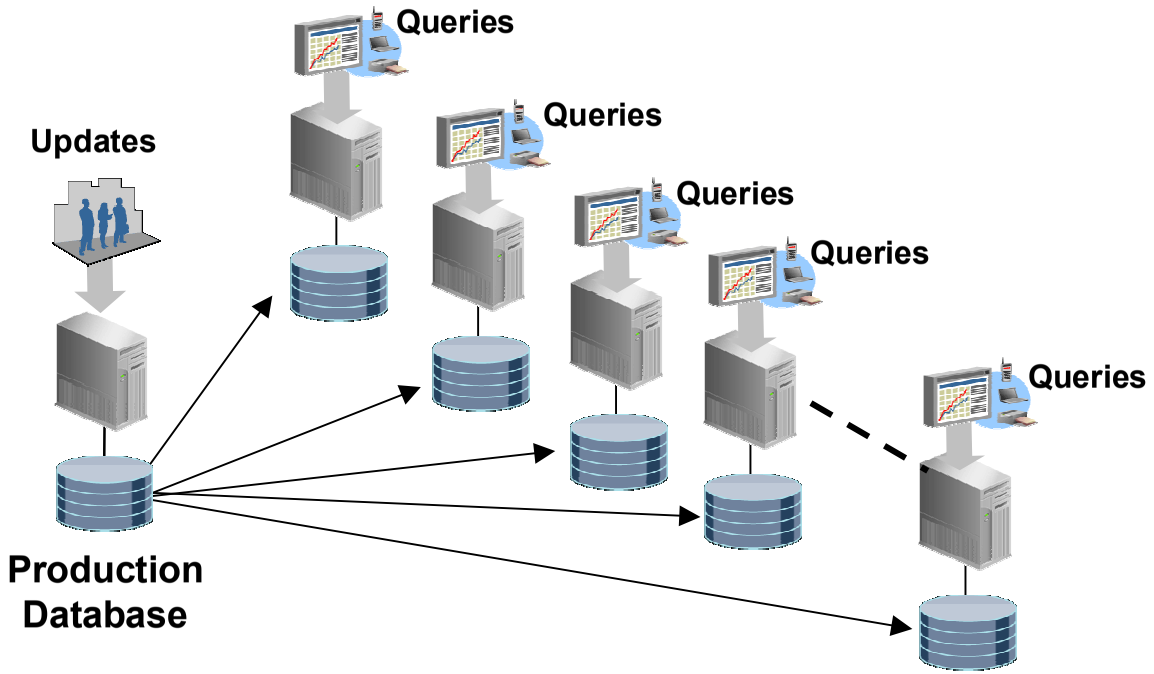



```
DGMGRL> convert database <name> to snapshot standby;
DGMGRL> convert database <name> to physical standby;
```

Active Data Guard 11g Release 2

Scale Read Performance

- Support for up to 30 active standby databases



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