

# Deploying Oracle Database 11gR2 with ASM and Hitachi Dynamic Provisioning Software on the Hitachi Virtual Storage Platform

Best Practices Guide

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*October 2010*

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# Deploying Oracle Database 11gR2 with ASM and Hitachi Dynamic Provisioning Software on the Hitachi Virtual Storage Platform

## Best Practices Guide

Storage capacity planning and database utilization management are complex tasks that are made even more difficult by the rapid increase in data storage demands and ever-increasing database sizes. Data center managers must control storage budgets and help storage and database administrators efficiently plan for storage demands and minimize administration complexity.

The Hitachi Virtual Storage Platform can help you leverage your information, which is the new currency in today's data-driven economy. Information, which exists in many forms, must be protected and readily accessible to ensure business survival and success. The Virtual Storage Platform maximizes cost efficiency and return on investment by creating an agile storage infrastructure that reduces costs and increases performance, availability, scalability and reliability.

The Hitachi Virtual Storage Platform is the industry's only 3D scaling storage platform. With the unique ability to concurrently scale up, scale out and scale deep in a single storage system, the Virtual Storage Platform flexibly adapts for performance, capacity, connectivity and virtualization. No other enterprise storage platform can dynamically scale in three dimensions. Scaling up allows you to increase virtual server consolidation, improve utilization of resources, and reduce costs. Scaling out is required when you add new physical or virtual servers to your environment to meet business demands. Scaling deep extends the advanced functions of the Virtual Storage Platform to external multivendor storage.

Deploying a Hitachi Virtual Storage Platform with Hitachi Dynamic Provisioning software for the Oracle ASM data volumes can simplify those tasks. This solution brings significant benefits by reducing initial cost of storage ownership, improving capacity design and lowering management costs. Hitachi Dynamic Provisioning software helps satisfy storage needs as they arise but also allows provisioning for future needs, avoiding the need to procure the entire forecasted storage requirements in advance.

With the release of Oracle Database 11gR2, the Automatic Storage Management (ASM) functionality is enhanced to manage data such as Oracle database files, clusterware files and non-structured general purpose data such as binaries, external files and text files. ASM increases storage utilization, performance, and availability.

This white paper provides best practice guidelines for using Hitachi Dynamic Provisioning for Oracle 11gR2 ASM database deployments. It is intended for Storage and Oracle database administrators. It assumes familiarity with general storage concepts and Oracle Database and Oracle Automatic Storage Management features.

## Solution Components

This section describes the hardware and software components mentioned in this best practices guide.

### Hitachi Virtual Storage Platform

The Hitachi Virtual Storage Platform is the industry's only 3D scaling storage platform. With the unique ability to concurrently scale up, scale out and scale deep in a single storage system, the new Virtual Storage Platform flexibly adapts for performance, capacity, connectivity and virtualization. No other enterprise storage platform can dynamically scale in three dimensions. The Virtual Storage Platform provides virtual storage that meets the growing demands of server virtualization.

The trend in server virtualization is to consolidate the I/O workload of many servers onto a single storage system. As more virtual machines are consolidated onto a physical host, storage systems must be able to dynamically add more storage resources to keep up with I/O demand. The 3D scaling capability of the Virtual Storage Platform meets that requirement.

Scaling up allows you to increase virtual server consolidation, improve utilization of resources, and reduce costs. With the Hitachi Virtual Storage Platform, you can increase performance, capacity and connectivity by adding cache, processors, connections and disks to the base system. A virtual server that accesses the storage system can use all these resources, which act as one system managed as a common pool of resources.

Scaling out allows you to meet increasing demands by combining multiple chassis into a single logical system with shared resources. By scaling out you can support increased resource needs in virtualized server environments.

Scaling deep extends the advanced functions of the Virtual Storage Platform to external multivendor storage. By dynamically virtualizing new and existing storage systems, those systems become part of the Virtual Storage Platform's pool of storage resources. Once virtualized, external data can then be migrated, tiered, replicated and managed by the Virtual Storage Platform. In this manner, older data storage systems can gain a longer useful life. You can extend distance replication for business continuity to lower-cost, lower-function storage systems by virtualizing them behind a Virtual Storage Platform.

The switch matrix architecture of the Virtual Storage Platform makes all of this possible. It connects the basic components, front-end directors, back-end directors, global cache modules and virtual storage directors. You can add redundant pairs of directors and cache modules as required without disruption to connected host servers. All these resources are tightly coupled through a global cache that creates a common pool of storage resources. These resources can include external storage that is connected through front-end director initiator ports.

## *Virtual Storage Platform Architecture*

The Virtual Storage Platform offers an entirely new level of scalable enterprise storage, capable of handling the most demanding workloads while maintaining great flexibility. The Virtual Storage Platform offers much higher performance, higher performance scalability, higher reliability and greater flexibility than any storage system on the market today.

The Virtual Storage Platform offers these features:

- The HiStar-E PCI Express Switched Grid acts as the interconnection among front-end directors, back-end directors, data cache adapter boards and virtual storage director boards.
- Data accelerator processors on the front-end directors and back-end directors work with central processor boards called virtual storage directors that manage all I/O by sets of assigned logical devices (LDEVs).
- Dual SAS controllers on back-end director boards contain eight 6Gbps SAS links per board.
- The control memory function resides in global cache and each VSD board contains a local copy with information for its LDEVs. Most control memory accesses are lookups to the local copy.
- Global cache is backed up to solid state drives (SSDs) on the cache boards.
- Each virtual storage director board controls all I/O operations for a discrete group of LDEVs. LDEVs are assigned round-robin across the installed virtual storage directors boards as they are created. If necessary, you can manually reassign LDEV ownership to a different virtual storage director.
- Each virtual storage director board executes the code for initiator mode (hosts), external mode (virtualization), back-end director mode, or the copy products send and receive modes. Code execution is done on a per-job basis.
- A Virtual Storage Platform can be scaled from a single-chassis system to a dual-chassis system. Each chassis has a control rack and a logic box.
- Up to 1,280 3.5-inch large form factor (LFF) drives or 2,048 2.5-inch small form factor (SFF) drives can be installed in a dual-chassis system. If you install both LFF and SFF disk containers and drives in a storage system, the limits change based on the configuration you choose.

The Virtual Storage Platform is built as a single-chassis or dual-chassis storage system. Each chassis has one control rack and up to two disk expansion racks. The control rack has the logic box that holds all of the control boards for a chassis and one or two disk containers. The disk expansion racks can hold three disk containers each. Disk containers come in two types: small form factor (up to 128 2.5-inch drives) and large form factor (up to 80 3.5-inch drives). When using two chassis as a single integrated storage system, the two units are cross connected at the grid switch level. The storage system behaves as a single unit, not as a pair of units operating as a cluster.

Figure 1 shows the two types of racks available for a Virtual Storage Platform.

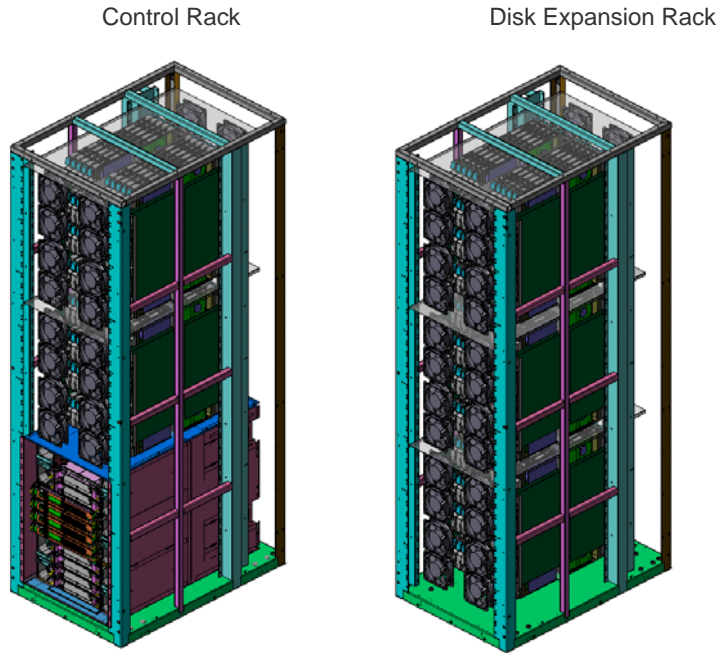


Figure 1

Figure 2 shows the logic boards in a fully populated single-chassis Virtual Storage Platform.

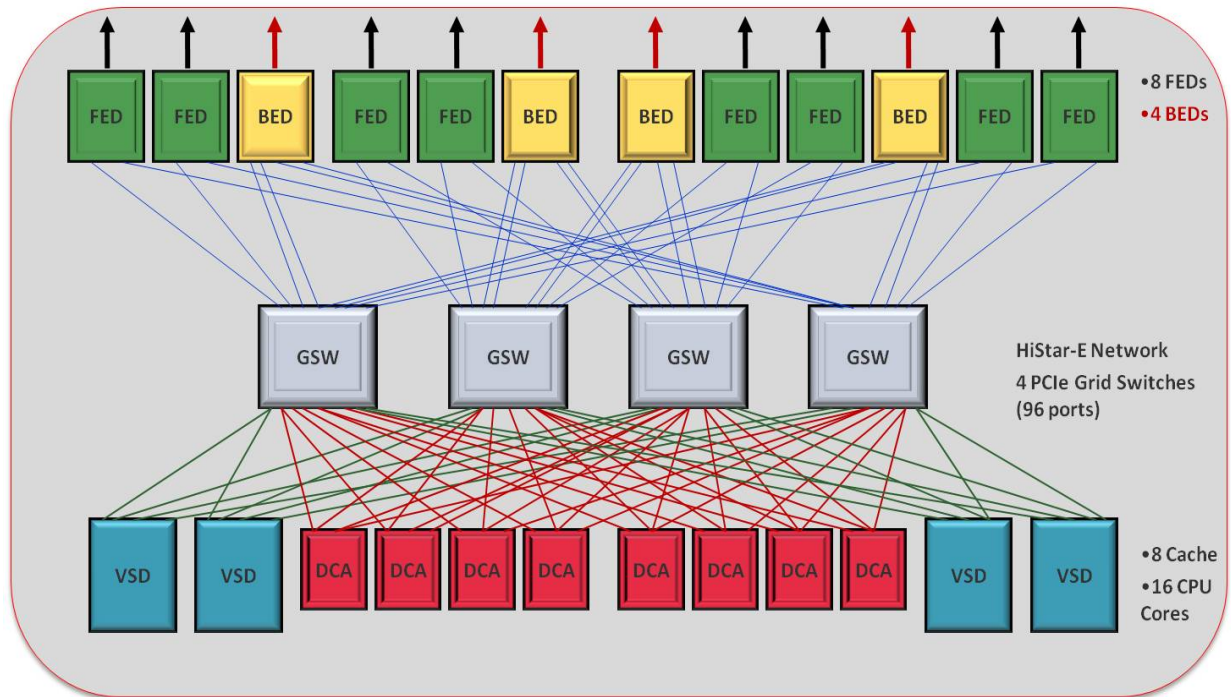


Figure 2

Figure 2 shows the following chassis components (note that a feature is a pair of boards on two separate power domains):

- **GSW** — Grid Switch PCI Express Switch. One or two features (two or four boards) per control unit with 24 2GB/sec HiStar-E ports each can be installed
- **DCA** — Data cache adapter cache memory. One to four features (two, four, six or eight boards) per control unit with up to 32GB of RAM each can be installed
- **VSD** — Virtual storage director processor module. One or two features (two or four boards) per control unit can be installed.
- **FED** — Front-end director host port module. One to four features (two, four, six or eight boards) per control unit of four or eight 8Gbps Fibre Channel ports can be installed.
- **BED** — Back-end director disk controller module. One or two features (two or four boards) per control unit with eight 6Gbps SAS links per board can be installed. If the back-end director options are not installed (available for the single-chassis configuration only), two additional front-end director options can be used in those chassis slots.

### *3D Scaling Architecture*

The Hitachi Virtual Storage Platform allows for optimal infrastructure growth in all dimensions by scaling up, scaling out and scaling deep.

#### *Scale Up*

Scale up to meet increasing demands by dynamically adding processors, connectivity and capacity in a single unit, providing the highest performance for both open and mainframe environments.

In the basic single chassis configuration, the number of logic boards, disk containers, and drives is highly scalable. You can start with the minimum set of logic boards, 10, and one disk container, then add more boards (up to a total of 28 boards in a single chassis) and disk containers (up to a total of eight disk containers in a single chassis). Disk container types may be intermixed within a chassis.

#### *Scale Out*

Scale out to meet multiple demands by dynamically combining multiple units into a single logical system with shared resources, support increased demand in virtualized server environments, and ensure safe multitenancy — that is, the ability to run multiple servers simultaneously without the risk of corruption or modification of data from one server to another — and quality of service through partitioning of cache and ports.

You can double the scalability of the Virtual Storage Platform with a dual-chassis system with up to six racks. The logic box in each chassis is the same, using the same types and numbers of logic boards. Any front-end port can access any back-end RAID group; no division within the storage system exists between the chassis.

A dual-chassis Virtual Storage Platform can manage up to 247PB of total storage capacity.

Table 1 lists the capacity differences between a single-chassis and a dual-chassis Virtual Storage Platform storage system.

**Table 1. Virtual Storage Platform Chassis Capacity Comparison**

<i>Maximum Capacity</i>	<i>Single Chassis</i>	<i>Dual Chassis</i>
Data cache	256GB	512GB
Raw cache bandwidth	64GB/s	128GB/s
Solid state drives	128	256
2.5" SFF drives	1,024	2,048
3.5" LFF drives	640	1,280
Logical volumes (LDEVs)	65,280	130,560

### *Scale Deep*

Scale deep to extend storage value by dynamically virtualizing new, existing external storage systems, extend Hitachi Virtual Storage Platform advanced functions to multivendor storage and offload less demanding data to external tiers to optimize the availability of your tier one resources.

The Virtual Storage Platform provides the virtualization mechanisms that allow other storage systems to be attached to some of its front-end director Fibre Channel ports and accessed and managed via hosts that are attached to the host ports on the Virtual Storage Platform. As far as any host is concerned, all virtualized logical units passed through the Virtual storage Platform to the hosts appear to be internal logical units from the Virtual Storage Platform. The front-end ports on the Virtual Storage Platform that attach to the external storage system's front-end ports are operated in external or SCSI initiator mode (attached to servers), rather than the usual SCSI target mode (attached to hosts).

For more information about the Hitachi Virtual Storage Platform, see the Hitachi Data Systems [web site](#).

## Hitachi Dynamic Provisioning Software

On the Virtual Storage Platform, Hitachi Dynamic Provisioning software provides wide striping and thin provisioning functionalities. In the most basic sense, Hitachi Dynamic Provisioning software is similar to the use of a host-based logical volume manager (LVM), but with several additional features available within the Hitachi Virtual Storage Platform and without the need to install software on the host or incur host processing overhead. Hitachi Dynamic Provisioning software provides for one or more pools of wide striping across many RAID groups within a Virtual Storage Platform. One or more Dynamic Provisioning virtual volumes (DP-VOLs) of a user-specified logical size of up to 60TB (with no initial physical space allocated) are created against each pool.

Primarily, you deploy Hitachi Dynamic Provisioning software to avoid the routine issue of hot spots that occur on logical devices (LDEVs) from individual RAID groups when the host workload exceeds the IOPS or throughput capacity of that RAID group. By using many RAID groups as members of a striped Dynamic Provisioning pool underneath the virtual or logical volumes seen by the hosts, a host workload is distributed across many RAID groups, which provides a smoothing effect that dramatically reduces hot spots.

Hitachi Dynamic Provisioning software also carries the side benefit of thin provisioning, where physical space is only assigned from the pool to the DP-VOL as needed using 42MB pages, up to the logical size specified for each DP-VOL. A pool can also be dynamically expanded by adding more capacity or reduced by withdrawing pool capacity. Either operation is performed without disruption or requiring downtime. Upon expansion, a pool can be rebalanced so that the data and workload are wide striped evenly across the current and newly added RAID groups that make up the pool.

Hitachi Dynamic Provisioning software's thin provisioning and wide striping functionalities provide virtual storage capacity to eliminate application service interruptions, reduce costs and simplify administration, as follows:

- Optimizes or “right-sizes” storage performance and capacity based on business or application requirements.
- Supports deferring storage capacity upgrades to align with actual business usage.
- Simplifies the storage administration process.
- Provides performance improvements through automatic optimized wide striping of data across all available disks in a storage pool.
- Eliminates hot spots across the different RAID groups by smoothing the combined workload.
- Significantly improves capacity utilization.

For more information, see the Hitachi Dynamic Provisioning software datasheet.

## Oracle Database 11gR2 Automatic Storage Management

Oracle Database's Automatic Storage Management (ASM) system combines the features of a volume manager and an application-optimized general purpose file system. It is optimized for use with Oracle products. Oracle ASM makes it possible to stripe and mirror data automatically and to add and delete disks online; because data is reallocated automatically, ASM makes physical file management easy.

ASM Cluster File System (ACFS), which was introduced in Oracle 11gR2, is a general-purpose, single node and cluster-wide file system for non-Oracle database files. An ACFS file system is created on top of an ASM dynamic volume. Dynamic volumes are simply ASM files with an ASM volume type. They inherit -- and benefit from -- all ASM functionality as an integrated solution. The file system can store Oracle binaries, application executables, trace files, alert logs, image files and any general purpose files.

## Storage Configuration Best Practices

The following sections provide best practices for configuring storage for use with Oracle Database 11gR2 with ASM.

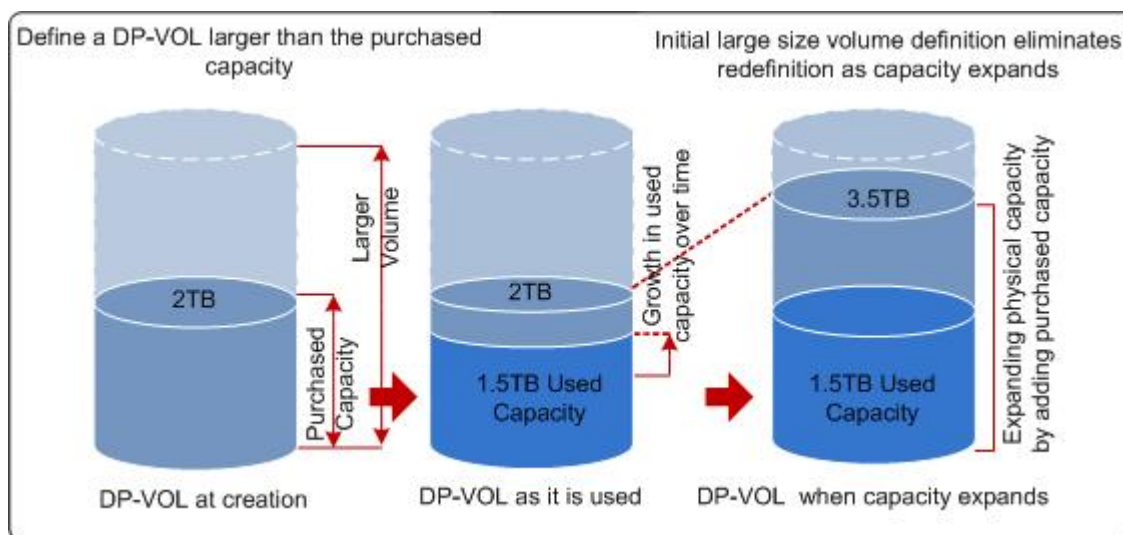
### Hitachi Dynamic Provisioning Software

Hitachi Data Systems recommends using Hitachi Dynamic Provisioning software in environments where its thin provisioning and wide striping features can improve performance and capacity utilization. The effectiveness of thin provisioning is dependent on how your operating system formats volumes and how applications allocate space. ASM is a thin-friendly application if you follow the best practices for managing Oracle data included in this white paper.

With Hitachi Dynamic Provisioning software, storage allocation decisions need not be made at an early stage. They can be delayed until capacity is actually required, while the application grows over time. This gives greater management flexibility and efficiency in the following ways:

- Newly purchased storage is not directly allocated to specific servers but instead is allocated to one of the configured storage pools.
- As application space is used, it is allocated directly from the pool only when needed.

Figure 3 shows how Dynamic Provisioning software allows for efficient capacity planning and eases storage administration.



**Figure 3**

Deploying Oracle ASM disks using DP-VOLs from Dynamic Provisioning pools on the Virtual Storage Platform brings the following benefits:

- Provides larger I/O buffer for peak usage times or intense maintenance activities like content indexing or database integrity checks
- Reduces the occurrence of hot spots across the different RAID groups, resulting in reduce data migration moves related to performance or capacity constraints
- Reduces management of the placement of heavy load databases
- Allows you to reclaim free space in ASM disks after deleting a large tablespace

Using Hitachi Dynamic Provisioning software does not mean you have to stop using static provisioning methods. Both are available simultaneously and most sites use both technologies. With static provisioning, physical location, reliability, performance and cost are fixed at the time the storage is made available to the server. This white paper shows two different Dynamic Provisioning pool and DP-VOL layouts. Your design will vary based on which requirements, such as reliability, scalability and performance, are your highest priorities.

## Storage Space Reclamation

Files space reclamation is important because pages of storage space can be made available for reuse. For this purpose, Hitachi Dynamic Provisioning software provides a function called Reclaim Zero Pages. It is available in the virtual volumes management function in Hitachi Storage Navigator software. It returns all zeroed pages to available space for reuse. After releasing space for a DP-VOL, the Reclaim Zero Pages function performs a rebalance operation. Free space is not released to the Dynamic Provisioning pool after operations like database deletion, tablespace deletion or triggering an ASM rebalance operation. Before free space can be reclaimed by Hitachi Dynamic Provisioning software, unused data blocks must be filled with zeroes. After any of these operations, you must use the ASRU utility provided by Oracle Database to identify and write zeros to unused data blocks. At this point, you can use the Reclaim Zero Pages reclaim function to detect and release page space. Schedule the Reclaim Zero Page operation during maintenance hours or low I/O activity periods.

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**Key Best Practice** — Hitachi Data Systems recommends running Hitachi Dynamic Provisioning software's Reclaim Zero Pages function after using the ASRU utility.

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## Performance Planning

The Dynamic Provisioning pool performance requirement, or the number of IOPS, is the aggregate of all applications using the same pool. Dynamic Provisioning pool design and use depends on the application performance requirements. You might need to evaluate more than one workload at the same time. This analysis provides data to inform your decisions about RAID level, minimum number of spindles necessary for performance and number of spindles required for anticipated capacity.

It is important to choose appropriate RAID levels in an ASM environment. Choose RAID levels based on your I/O performance and data availability requirements. When servicing a database workload, the difference between RAID-1+0 and RAID-5 for random writes is not pronounced when I/O is large or sequential. For example, for OLTP workloads with 30 percent random writes of 4K-32K, consider using RAID-1+0. However, if your workload consists of large writes (greater than 32K) or your database access is sequential in nature, for example, in a data warehouse, consider using RAID-5.

When servicing large streaming sequential I/Os, an entire stripe set can be rewritten in one operation. However, in online transaction processing (OLTP) database applications, this happens comparatively infrequently due to the relatively large stripe width.

An OLTP application might only require the storage capacity of one RAID group, but might have a peak IOPS load that requires four RAID groups in a RAID-1+0 (2D+2D) configuration.

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**Key Best Practice** — Base your storage configuration decisions on performance requirements first, then capacity requirements.

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For multiple, large or performance-intensive databases, your performance requirements might justify creating a separate pool or pools for each database.

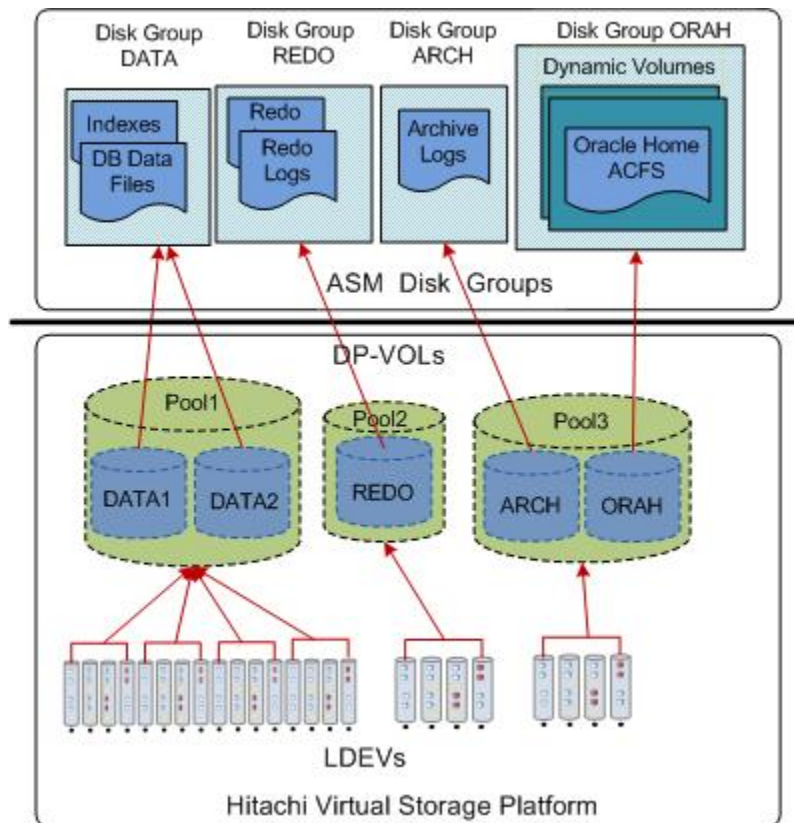
Hitachi Dynamic Link Manager software provides active-active dynamic multipaths from the Virtual Storage Platform system's storage ports to the HBA ports. You can improve I/O performance with the load balancing feature of Hitachi Dynamic Link Manager software. If you use Hitachi Dynamic Link Manager software for multipathing with ASM, you must change the value of ORACLEASM\_SCANORDER parameter to ORACLEASM\_SCANORDER="sddl m" in the /etc/sysconfi g/oracl easm file.

## ASM Configuration Best Practices

It is critical to understand how Hitachi Dynamic Provisioning software interacts with ASM and Oracle storage objects.

### Oracle ASM

An ASM disk group is created from one or more disk devices to form one logical storage container. When it is deployed with Hitachi Dynamic Provisioning software, an ASM disk group acquires and stamps ASM labels on DP-VOLs presented by the operating systems as disk devices. Various database files like the control files, data files, temporary files, redo files and archive logs, Oracle binaries, trace logs, and so on are created in the disk group and distributed or striped through it. Figure 4 shows how ASM disk groups and an ACFS file system map to DP-VOLs.



**Figure 4**

Because the space required by metadata can grow quickly, you must carefully evaluate metadata space allocation and management to make efficient use of Dynamic Provisioning pool space. This is a function of the volume and file system management software you use. ASM allocates only a few pages of initial metadata and remains efficient.

Hitachi Data Systems testing shows that the ASM metadata allocation process works efficiently with Hitachi Dynamic Provisioning software. Table 2 lists the amount of space allocated in a Dynamic Provisioning pool after various ASM operations during the creation of a tablespace on a new disk.

**Table 2. Metadata Space Allocation with ASM and Hitachi Dynamic Provisioning Software**

<i>Action</i>	<i>Pool Allocated for Metadata (cumulative total in MB)</i>
Label and partition disk	42
ASM create disk	84
ASM create disk group	126
Create 42MB tablespace	168

At this point, a tablespace with capacity for 42MB of data blocks is initialized. You can expand this tablespace manually or with AUTOEXTEND when you need more capacity. The diskgroup also has free space for other data objects. Less than 126MB is used for metadata, this compares well with other volume managers. Also, the metadata remains fixed, no matter how large the disk or Oracle objects become; general purpose systems often allocate increasing quantities of metadata as the objects become larger.

## Data Storage Objects

Oracle Database stores data in physical and logical data structures. These data storage objects are grouped in several ways by Oracle Database depending on the type of data usage. Table 3 lists the data storage objects.

**Table 3. ASM and Oracle Database Data Storage Objects**

<i>Object</i>	<i>Description</i>
<b>ASM Disk Objects</b>	
DISK	The storage LUN presented to the OS as a physical device. ASM controls disk objects by writing a disk label.
DISKGROUP	A number of disks grouped together logically. Data is automatically striped across all disks in the disk group.
DYNAMIC VOLUME	A logical disk created from the disk group. The volume is an ASM file of type asmvol .
FILE SYSTEM	An ACFS file system built on an ASM dynamic volume. It can be the database home file system or a general purpose file system.
<b>ORACLE Data Objects</b>	
DATAFILE	An ASM file stored in an ASM disk group.
TABLESPACE	Data, such as tables, indexes and other user data, are stored in tablespaces. In ASM configuration, a table space is a collection of one or more ASM files. Table spaces contain one or more segments.
SEGMENT	A group of one or more extents within a tablespace used to store one logical object. Specialized segment types also exist for rol I back, undo and temp.
EXTENT	A contiguous set of data blocks within a single data file. The fact that these are contiguous is very important to how Hitachi Dynamic Provisioning software operates.
BLOCK	The basic unit of storage. Block size can vary between tablespaces.

Figure 5 shows how ASM and Oracle Database data storage objects are structured in a typical database.

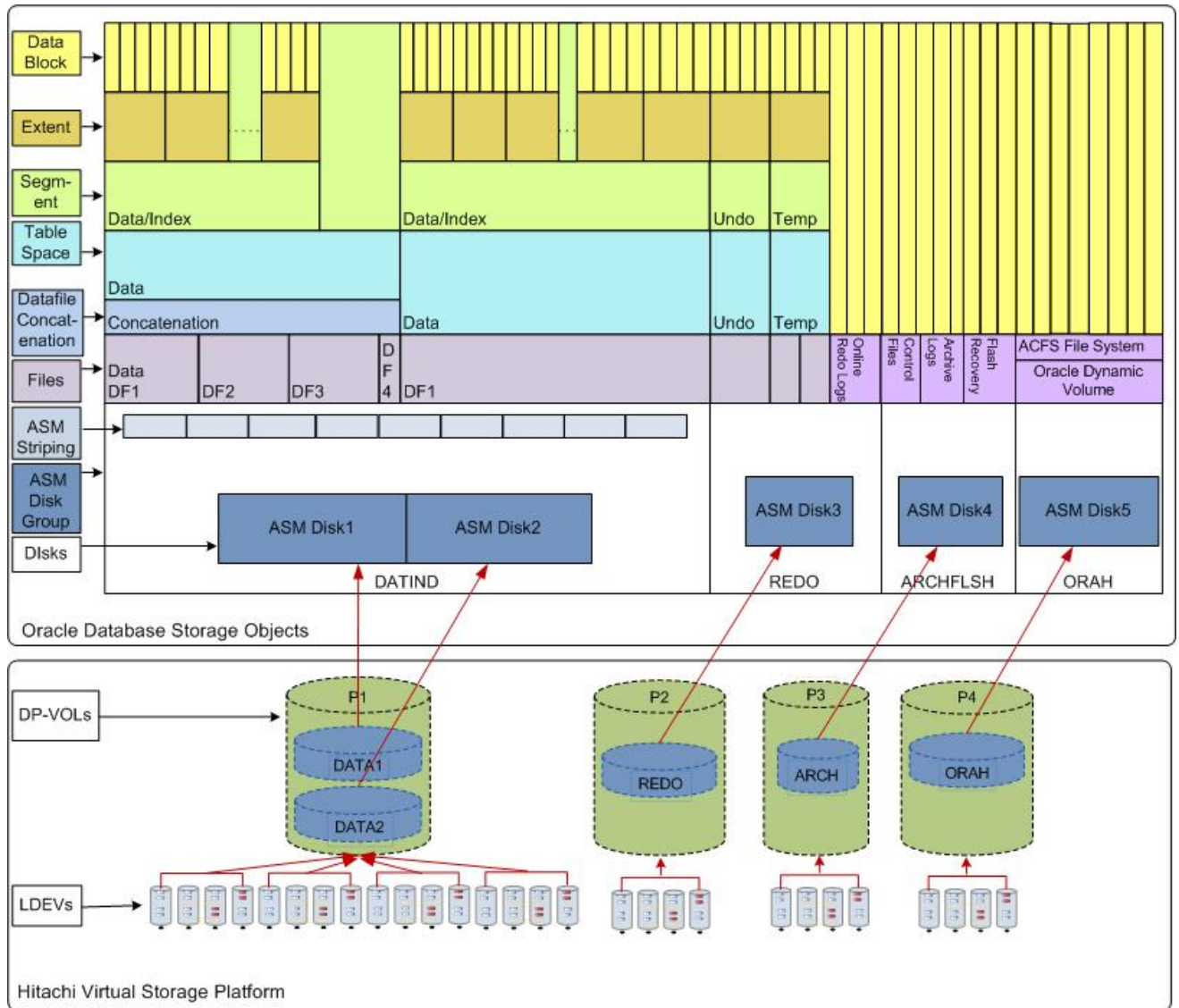


Figure 5

Figure 5 also shows the ASM disk layout mapping to DP-VOLs, including details of data files and redo files. It is important to note that the data blocks in each extent are contiguous and pre-reserved. This means that if the extent size is too large, space can be wasted. With 11gR2, you can assign a block size to online redo logs. The ACFS file system block size is fixed at 4K.

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**Key Best Practice** — Manage extent size and block size to avoid wasting storage capacity.

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## ASM Disk Group Configuration

An Oracle database can be stored in a single disk group or across many disk groups. When used with Dynamic Provisioning software, any disk group layout is acceptable. Hitachi Data Systems recommends spreading data across multiple disk groups when using Hitachi Dynamic Provisioning software.

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**Key Best Practice** — To achieve additional flexibility and performance, place data into different disk groups based on the Oracle Database file type.

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While using ASM with Dynamic Provisioning software, you can back up Oracle Database using Hitachi software, which enables disk mirroring of the Hitachi Virtual Storage Platform. For backup and mirroring, Hitachi Data Systems recommends creating at least three ASM disk groups. Create a separate disk group for the ACFS `oracl e home` file system.

Dividing the data this way permits implementation of a replication backup solution using products such as Hitachi TrueCopy<sup>®</sup> Synchronous software, Hitachi TrueCopy Asynchronous software, Hitachi Universal Replicator software, Hitachi ShadowImage<sup>®</sup> Heterogeneous Replication software or Hitachi Copy-on-Write Snapshot software. For more information about these products, see the Hitachi Data Systems [Storage Software web site](#).

Table 4 lists a suggested disk group layout for a database.

**Table 4. Sample Oracle Database Disk Group Layout**

<i>Disk Group</i>	<i>Use</i>	<i>Notes</i>
DATIND	One or more tablespaces, indexes, UNDO segments	N/A
REDO	Online redo log files, control files	Separating redo from data and indexes makes it easier for tablespaces to be backed up independently from online redo logs. Oracle requires that you never back up online redo logs as its restore might corrupt the database. If separated, it is possible to place this I/O onto different storage and improve performance. Although redo logs are never backed up; however, in disaster recovery scenarios, redo logs can be replicated because replication minimizes recovery time.
TEMP	Temporary tablespaces	It is not critical to separate this data. However, if you replicate the database to another site, separation is beneficial, as temporary tablespaces do not need to be replicated. In some scenarios, temporary tablespaces receive large amounts of I/O, and removing this can save valuable inter-site bandwidth. TEMP I/O is also subject to traffic patterns in bursts; in asynchronous environments replicating this might affect the RPO. Scenarios with high TEMP I/O, for example, decision support environments, involve large complex queries.
ARCHFLSH	Control files, archive REDO log files, RMAN backup files, flash recovery files	Like REDO, you can restore this independently from the DATA tablespaces. In addition, archive files have a lower and much less critical data rate than DATA. You might consider placing this on lower-cost storage, but it can only be considered if on a different disk group. Backup can be replicated between sites if all resources necessary to perform restore and recovery are also replicated.
ORAH	Oracle Database binaries, log and diagnostics files.	This is the Oracle ACFS; it is built on an Oracle dynamic volume. Hitachi Data Systems recommends using a separate disk group because it holds the Oracle binaries and any other diagnostics files. It is helpful for backup, restore and replication purposes.

These recommendations are designed to deliver flexibility and choice, but are not hard rules. For example, although placing REDO, ARCHFLSH and DATAIND on different disk groups and different pools might be ideal, other factors might require a different design. For example, in a demanding OLTP environment with limited disk capacity, the LDEVs for the data and index area might not result in enough disk spindles to meet the IOPS requirement. In this case, Hitachi Data Systems still recommends using separate disk groups with separate DP-VOLs, but these can all share a single Dynamic Provisioning pool.

More than one database can be stored in an ASM disk group or disk group set. For example, if you have a limited number of spindles, you might choose to store more than one database in an ASM disk group. However, having only one database in a disk group or disk groups minimizes disruption during database maintenance tasks like resizing disks. For example, if a disk group has more than one database, and one of its databases needs a disk resize, that operation might involve disk group downtime and create disruption for all databases in that disk group. You can avoid this problem by having a single database in a disk group.

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**Key Best Practice** — For ease of management, Hitachi Data Systems recommends ensuring that ASM disk groups contain data belonging to only one database.

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## Configuring Tablespace Space Management

In Oracle Database, three keywords control most disk space use: INITIAL SIZE, NEXT SIZE and MAXIMUM SIZE. These control how disk space is allocated initially and as the database grows. This allocation directly controls how much Dynamic Provisioning pool space is used.

When a tablespace is created or when a table is created inside a tablespace, it is created with an initial size that is controlled by the INITIAL SIZE keyword. This initial allocation is guaranteed to be contiguous. Oracle Database initializes this space. This initialization causes an equivalent amount of Dynamic Provisioning pool space to be allocated.

The NEXT SIZE keyword defines how much a table or tablespace grows if the currently allocated space is exhausted. Many alternatives exist. Growth by fixed sizes is supported. You can also have Oracle Database tune each allocation automatically, depending on how much data is inserted.

Use the MAXIMUM SIZE keyword to limit the size to which an object can grow. This can be especially valuable in an environment that uses Hitachi Dynamic Provisioning software to avoid running out of space in a Dynamic Provisioning pool when it is overprovisioned.

Hitachi Data Systems recommends using the smallest increment that allows you to balance locality of reference against the amount of unused capacity. With Hitachi Dynamic Provisioning software, use an increment of at least 42MB because of the way it allocates space. The tablespace is automatically extended as the application's space requirements grow. This initial allocation and each extension results in equivalent pool space being allocated.

## Data Files and BIGFILE Tablespaces

ASM restripes existing data across all new disks. Adding disks to an ASM disk group can improve performance of that diskgroup, depending on your workload. Because of this it is now more common to use a single data file for each tablespace. The BIGFILE tablespace type only supports one data file. Designed for implementing very large databases (VLDB), a BIGFILE tablespace can store up to 32TB for a tablespace with 8K blocks. Hitachi Dynamic Provisioning software works well with all tablespace types. When a Dynamic Provisioning pool has sufficient spindles, Hitachi Dynamic Provisioning software's wide striping feature provides the performance benefit. Having few overprovisioned DP-VOLS reduces storage system workload for needed for rebalancing. Hitachi Data Systems recommends using the BIGFILE tablespace type with few overprovisioned DP-VOLS in environments with very large tablespaces.

## ASM Striping and Mirroring

ASM distributes data on all the disks in the disk group. Striping options are COARSE and FINE. COARSE striping is laid out in allocation units (AU) of 1MB and FINE striping is laid out in finer units of 128KB. ASM mirrors at the file level, files are partitioned in allocation units (AU) of 1MB, and are laid out on different disks to implement mirroring. ASM provides two levels of mirroring through NORMAL and HIGH redundancy options. In NORMAL REDUNDANCY, data is duplicated. In HIGH REDUNDANCY, data is in triplicate. ASM also provides the ability to create disk groups without mirroring, using EXTERNAL REDUNDANCY. This feature allows you to leverage the storage's RAID implementation.

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**Key Best Practice** — Hitachi Data Systems recommends using the EXTERNAL REDUNDANCY option, whether or not you use Hitachi Dynamic Provisioning software.

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If you use the HIGH or NORMAL REDUNDANCY options instead of the EXTERNAL REDUNDANCY option, the disk drive mirrors are likely to become fully allocated in the Dynamic Provisioning pool. This can lead to inefficient use of Fibre Channel bandwidth, host processing cycles and storage space due to redundant mirror data.

## Adding Disks and ASM Rebalance Operations

The rebalance operation cannot occur if the ASM disk group consists of only one disk. However, adding disks to an ASM disk group can lead to some degree of unwanted pre-allocation. For example, consider a disk group with three ASM disks, each with a 100GB capacity and each 80 percent full. 240GB [3 x (0.80 x 100)] of Dynamic Provisioning pool space is allocated. Adding a disk to the disk group causes ASM to rebalance the data across the existing disks and the new one. This puts 60GB of data onto each disk, including the new one. But the three original disks remain at 80 percent allocated. 300GB (240+60) of Dynamic Provisioning pool space is allocated and only 240GB of data is stored. This is only a temporary situation. After the data grows to 300GB, the disks return to an efficient state. To avoid this effect, Hitachi Data Systems recommends using larger, overprovisioned DP-VOLs for the disks you add to an ASM disk group. This ensures that the addition of disks is rarely needed. Rather than adding disks to ASM disk groups to gain more capacity, consider alternatives such as expanding ASM disk objects into free space on the DP-VOL or dynamically resizing the underlying DP-VOLs and expanding the ASM disk objects. Be sure to consider your operating system's requirements when evaluating these options. This approach aligns with ASM's stripe and mirror everything (SAME) recommendation because a DP-VOL on RAID-1+0 groups is mirrored and wide striped over all available RAID groups allocated to the DP-VOL. Using wide striping techniques, Hitachi Dynamic Provisioning software automatically spreads the I/O load of all applications accessing the common Dynamic Provisioning pool across the available spindles. This process reduces the chance of hot spots and optimizes I/O response times. Using Hitachi Dynamic Provisioning software's rebalance feature instead of Oracle's native rebalance utility also reduces management effort and reduces the load on the Oracle Database server.

## Monitoring Best Practices

Monitoring your environment is an important part of ensuring that it remains available and reliable.

To avoid running out of capacity on a Dynamic Provisioning pool, Hitachi Data Systems recommends monitoring pool volume capacity usage when using Oracle Database ASM with Dynamic Provisioning software. Within Hitachi Dynamic Provisioning software, you can manage threshold values for free pool volume capacity for the pool. When a set threshold is exceeded, an alert is triggered. Regularly audit space used against space allocated. Reclaim space where appropriate.

Hitachi Tuning Manager software provides advanced storage resource management reporting and analysis to enable comprehensive performance monitoring, troubleshooting and capacity forecasting for Hitachi storage environments. Use Hitachi Tuning Manager software for reporting the trends of pool and LDEV usage. Configure Tuning Manager software to generate alerts when usage exceeds pre-defined thresholds. For more information, see the [Hitachi Tuning Manager web site](#).

Use Hitachi Command Control Interface commands to generate DP-VOL and pool level space usage reports. For more information, see the *Hitachi Command Control Interface (CCI) User and Reference Guide* that accompanies the software.

## Conclusion

This white paper provides best practices for deploying Oracle Database 11gR2 with ASM and Hitachi Dynamic Provisioning software on the Hitachi Virtual Storage Platform. Following these best practices helps to ensure that your infrastructure is well designed and scalable and offers ease of management, better resource utilization and increased uptime.

Table 5 lists the best practices provided in this white paper.

**Table 5. ASM Configuration Best Practices**

<i>Description</i>	<i>Best Practice</i>
Performance and capacity utilization	Use Hitachi Dynamic Provisioning software in environments where its thin provisioning and wide striping features are beneficial.
Storage space reclamation	Schedule the Reclaim Zero Page operation during maintenance hours or low I/O activity periods.
	Run Hitachi Dynamic Provisioning software's Reclaim Zero Pages function after using the ASRU utility.
Performance planning	Base storage configuration decisions on performance requirements first, then capacity requirements.
Data storage objects	Manage extent size and block size to avoid wasting storage capacity.
Disk group configuration	Spread data across multiple disk groups when using Hitachi Dynamic Provisioning software.
	Place data into different disk groups based on the Oracle Database file type.
	Create at least three ASM disk groups for backup and mirroring.
	Create a separate disk group for the ACFS Oracle home file system.
	Ensure that ASM disk groups contain data belonging to only one database.
Tablespace space management	Use the smallest increment that allows you to balance locality of reference against the amount of unused capacity. With Hitachi Dynamic Provisioning software, use an increment of at least 42MB because of the way it allocates space.
BIGFILE tablespaces	Use the BIGFILE tablespace type with few overprovisioned DP-VOLS in environments with very large tablespaces.
ASM rebalance operations	Use larger, overprovisioned DP-VOLs for the disks you add to an ASM disk group.
ASM striping and mirroring	Use the EXTERNAL REDUNDANCY option.
Monitoring	Monitor pool volume capacity usage when using Oracle Database ASM with Dynamic Provisioning software.
	Configure Tuning Manager software to generate alerts when usage exceeds pre-defined thresholds.

Hitachi Data Systems Global Services offers experienced storage consultants, proven methodologies and a comprehensive services portfolio to assist you in implementing Hitachi products and solutions in your environment. For more information, see the Hitachi Data Systems Global Services [web site](#).

Live and recorded product demonstrations are available for many Hitachi products. To schedule a live demonstration, contact a sales representative. To view a recorded demonstration, see the Hitachi Data Systems Corporate Resources [web site](#). Click the **Product Demos** tab for a list of available recorded demonstrations.

For more information about the Hitachi Virtual Storage Platform and other Hitachi products mentioned in this best practices guide, see the [Hitachi Data Systems](#) web site, your sales representative or a channel partner.

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