

# HP StorageWorks

## Using Oracle<sup>®</sup> on Enterprise File Services Clustered Gateway

### user guide

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Using Oracle on HP EFS Clustered Gateway user guide

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# About this guide

This guide provides information about:

- Using Oracle® on the HP StorageWorks Enterprise File Services Clusterd Gateway.

## Intended audience

- The intended audience for this guide is Oracle Database Administrators.

## Prerequisites

Prerequisites for using this product include:

- Knowledge of Network Attached Storage (NAS) with the Network File Systems (NFS) protocol
- Knowledge of the HP StorageWorks Enterprise File Services Clusterd Gateway
- Knowledge of deploying Oracle databases

## Related documentation

In addition to this guide, please refer to other documents for this product on the HP NAS storage web site:


<http://www.hp.com/go/efs>.

# Document conventions and symbols

**Table 1** Document conventions

Convention	Element
Medium blue text: <a href="#">Figure 1</a>	Cross-reference links and e-mail addresses
Medium blue, underlined text ( <a href="http://www.hp.com">http://www.hp.com</a> )	Web site addresses
<b>Bold font</b>	<ul style="list-style-type: none"><li>• Key names</li><li>• Text typed into a GUI element, such as into a box</li><li>• GUI elements that are clicked or selected, such as menu and list items, buttons, and check boxes</li></ul>
<i>Italics font</i>	Text emphasis
Monospace font	<ul style="list-style-type: none"><li>• File and directory names</li><li>• System output</li><li>• Code</li><li>• Text typed at the command-line</li></ul>
<i>Monospace, italic font</i>	<ul style="list-style-type: none"><li>• Code variables</li><li>• Command-line variables</li></ul>
<b>Monospace, bold font</b>	Emphasis of file and directory names, system output, code, and text typed at the command line

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 **WARNING!** Indicates that failure to follow directions could result in bodily harm or death.


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 **CAUTION:** Indicates that failure to follow directions could result in damage to equipment or data.


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 **IMPORTANT:** Provides clarifying information or specific instructions.

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 **NOTE:** Provides additional information.

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 **TIP:** Provides helpful hints and shortcuts.

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## HP technical support

Telephone numbers for worldwide technical support are listed on the HP support web site: <http://www.hp.com/support/>.

Collect the following information before calling:

- Technical support registration number (if applicable)
- Product serial numbers
- Product model names and numbers
- Applicable error messages

- Operating system type and revision level
- Detailed, specific questions

For continuous quality improvement, calls may be recorded or monitored.

HP strongly recommends that customers sign up online using the Subscriber's choice web site at <http://www.hp.com/go/e-updates>.

- Subscribing to this service provides you with e-mail updates on the latest product enhancements, newest versions of drivers, and firmware documentation updates as well as instant access to numerous other product resources.
- After signing up, you can quickly locate your products by selecting **Business support** and then **Storage** under Product Category.

## HP-authorized reseller

For the name of your nearest HP-authorized reseller:

- In the United States, call 1-800-345-1518.
- Elsewhere, visit the HP web site: <http://www.hp.com>. Then click **Contact HP** to find locations and telephone numbers.

## Helpful web sites

For third-party product information, see the following HP web sites:

- <http://www.hp.com>
- <http://www.hp.com/go/storage>
- <http://www.hp.com/support/>
- <http://www.docs.hp.com>



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# 1 Introduction

Network Attached Storage (NAS) with the Network File Systems (NFS) protocol has evolved into a practical deployment option for Oracle databases. Oracle Corporation maintains a program called Oracle Storage Certification Program to validate NAS technology for use with Oracle Databases. Only NAS devices certified through this program may be used for deploying Oracle databases.

The HP StorageWorks Enterprise File Services Clustered Gateway (EFS Clustered Gateway) is a scalable, fault-tolerant NAS device that has been certified for use with Oracle databases through the Oracle Storage Certification Program.

This guide discusses the EFS Clustered Gateway configuration and best-practices information for deploying Oracle. Further specific documentation about the EFS Clustered Gateway can be found in the *HP StorageWorks Clustered File System administration guide*, *HP StorageWorks Clustered File System setup guide*, *HP StorageWorks Clustered File System Command Line reference guide*, *HP StorageWorks Clustered File System for Linux: NFS Configuration installation and administration guide*, and in the *release notes*.



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## 2 Overview

The HP StorageWorks Enterprise File Services Clustered Gateway, or EFS Clustered Gateway, is new and radically different NAS technology. The key differences between the EFS Clustered Gateway and other NAS offerings in the industry are:

- **Availability**—The EFS Clustered Gateway includes a specialized, proprietary NFS Server implementation that combines with Virtual Host functionality to support completely transparent NFS client failover if a NAS head failure occurs or maintenance needs to be performed.
- **Modularity**—The EFS Clustered Gateway supports from 2 to 16 NAS heads
- **Scalability**—The EFS Clustered Gateway supports truly scalable NAS. Because of the built-in, fully symmetric, distributed cluster filesystem, all NAS heads can present any or all filesystems with fully coherent direct read/write access. Additionally, each NAS head can present filesystems over as many as three network interfaces for a system total of 48 Gigabit Ethernet interfaces for NFS traffic!
- **Standards**—The NAS heads that comprise the EFS Clustered Gateway are Intel-compatible Linux servers. No proprietary hardware. Moreover, the NAS heads run Linux and, although there are proprietary kernel enhancements, administering the NAS heads is no different than any other Linux system.



## 3 Configuring Oracle on the EFS Clustered Gateway

There are 4 important concepts to consider when deploying Oracle on the EFS Clustered Gateway.

- EFS Clustered Gateway Filesystem Mount Options
- EFS Clustered Gateway Virtual NFS Service Export Options
- Hosting Virtual NFS Services for High Performance
- Configuring NLM

### EFS Clustered Gateway filesystem mount options

The EFS Clustered Gateway supports both a Volume Manager and internal filesystem the require some consideration to optimally support Oracle. These considerations are covered in the following sections.

#### EFS Clustered Gateway Volume Manager

The EFS Clustered Gateway includes an integrated Volume Manager. LUNs are presented to the EFS Clustered Gateway by the SAN administrator and imported into the EFS Clustered Gateway. Internal to the EFS Clustered Gateway, these LUNs are then made into a striped (RAID 0) volume of user-defined stripe width. For more information on importing disks into the EFS Clustered Gateway, please refer to “Import SAN Disks” section in the *HP StorageWorks Clustered File System administration guide* or the “Import a disk into the cluster” section in the *HP StorageWorks Clustered File System Command Line reference guide*. The LUNs are redundant (e.g., RAID 1) at the SAN storage array level. Since the EFS Clustered Gateway can scale to 16 symmetrical NAS heads, it can support single volumes of up to 16TB of redundant, high-performance (RAID 1+0) storage. The size of volumes can be dynamically increased and the EFS Clustered Gateway supports large numbers of filesystems-up to a maximum theoretical limit of 512.

For Oracle, it is recommended that the filesystems used for databases be striped volumes with a stripe width larger than the largest Oracle single block transfer. On most Oracle ports that is 1MB, on a few ports even larger transfers are supported. In general, a 4MB EFS Clustered Gateway volume stripe width is a good choice. Since the LUNS are mirrored in the array, striping with the Volume Manager achieves the optimal S.A.M.E. (Stripe And Mirror Everything) data placement methodology recommended by Oracle Corporation. For more information regarding the EFS Clustered Gateway Volume Manager, please refer to the “Configure Dynamic Volumes” section in the *HP StorageWorks Clustered File System administration guide* or the “mx dynvolume - dynamic volume commands” section in the *HP StorageWorks Clustered File System Command Line reference guide*.

#### EFS Clustered Gateway filesystem

All NAS devices present an internal filesystem via NFS. In the case of the EFS Clustered Gateway, the filesystem is called psfs, which is fully symmetric and distributed. This means that all NAS heads have equal, direct read/write access to all filesystems. Combining the filesystem with the volume manager makes the foundation for the tremendous scalability this architecture offers.

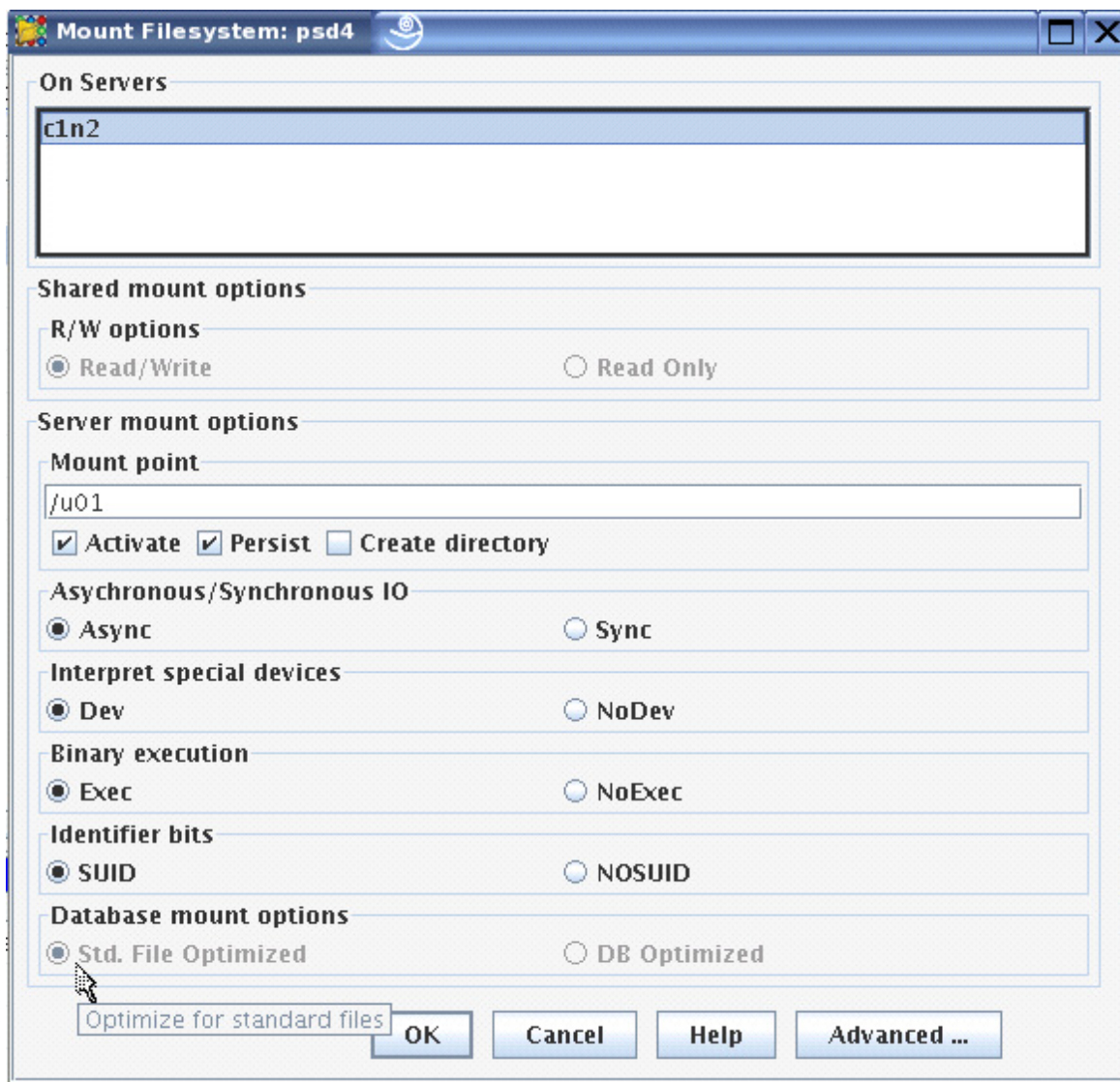
Before filesystems can be exported from the EFS Clustered Gateway, the Database Administrator will need to establish the purpose of the filesystem so the Storage Administrator can use the appropriate EFS Clustered Gateway mount options. There are two EFS Clustered Gateway mount options to consider. These are not to be confused with NFS client mount options which will be discussed in a later section of this paper. The two EFS Clustered Gateway mount options are:

- Standard File Optimized
- DB Optimized

## Standard file optimized mount option

Filesystems in the EFS Clustered Gateway can be mounted for general purpose use or for optimal database use. If the Database Administrator wishes to install Oracle executables into the EFS Clustered Gateway in separate or a shared Oracle Home, the Storage Administrator will need to mount the filesystem with regular mount options. On the other hand, any Oracle database object (e.g., control files, redo logs, datafiles) should reside in an EFS Clustered Gateway filesystem mounted with the DB Optimized mount option. For Real Application Clusters databases and Clusterware files (e.g., 10gR1 CRS, 10gR2 Clusterware), the DB Optimized mount option is a requirement.

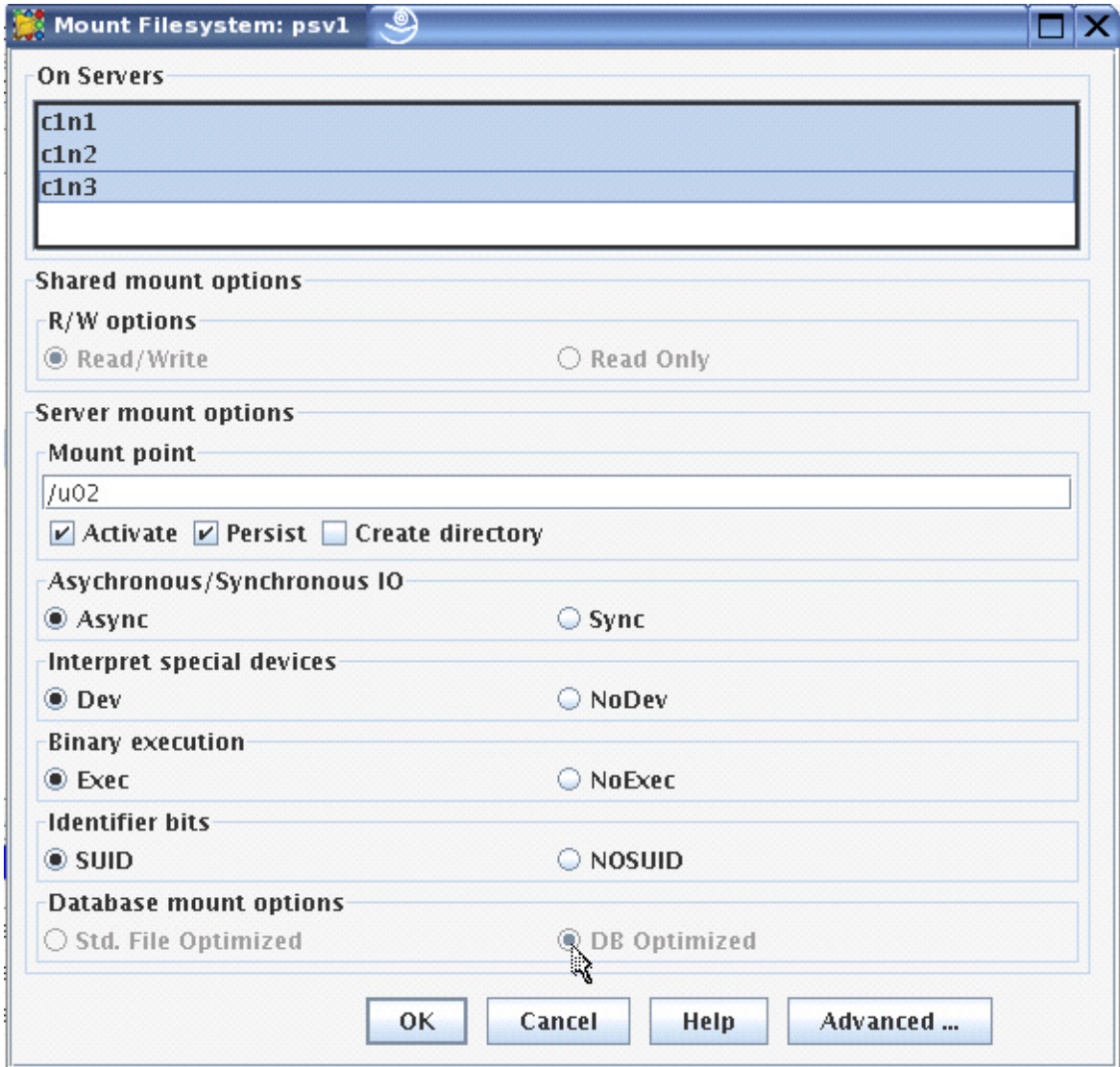
Figure 1 shows the EFS Clustered Gateway Management Console Graphical User Interface where the filesystem called /u01 is being mounted on the EFS Clustered Gateway NAS head called c1n2. Since this filesystem is intended for a shared Oracle Home installation with the standard Optimal Flexible Architecture (OFA), the Std. File Optimized button has been clicked.



**Figure 1** EFS Clustered Gateway Management Console filesystem mount dialogue

## DB optimized mount option

Figure 2 shows another EFS Clustered Gateway Management Console screenshot where a filesystem called /u02 is being mounted with the DB Optimized mount option. This filesystem mount option is intended for storage of Oracle databases and Clusterware files.



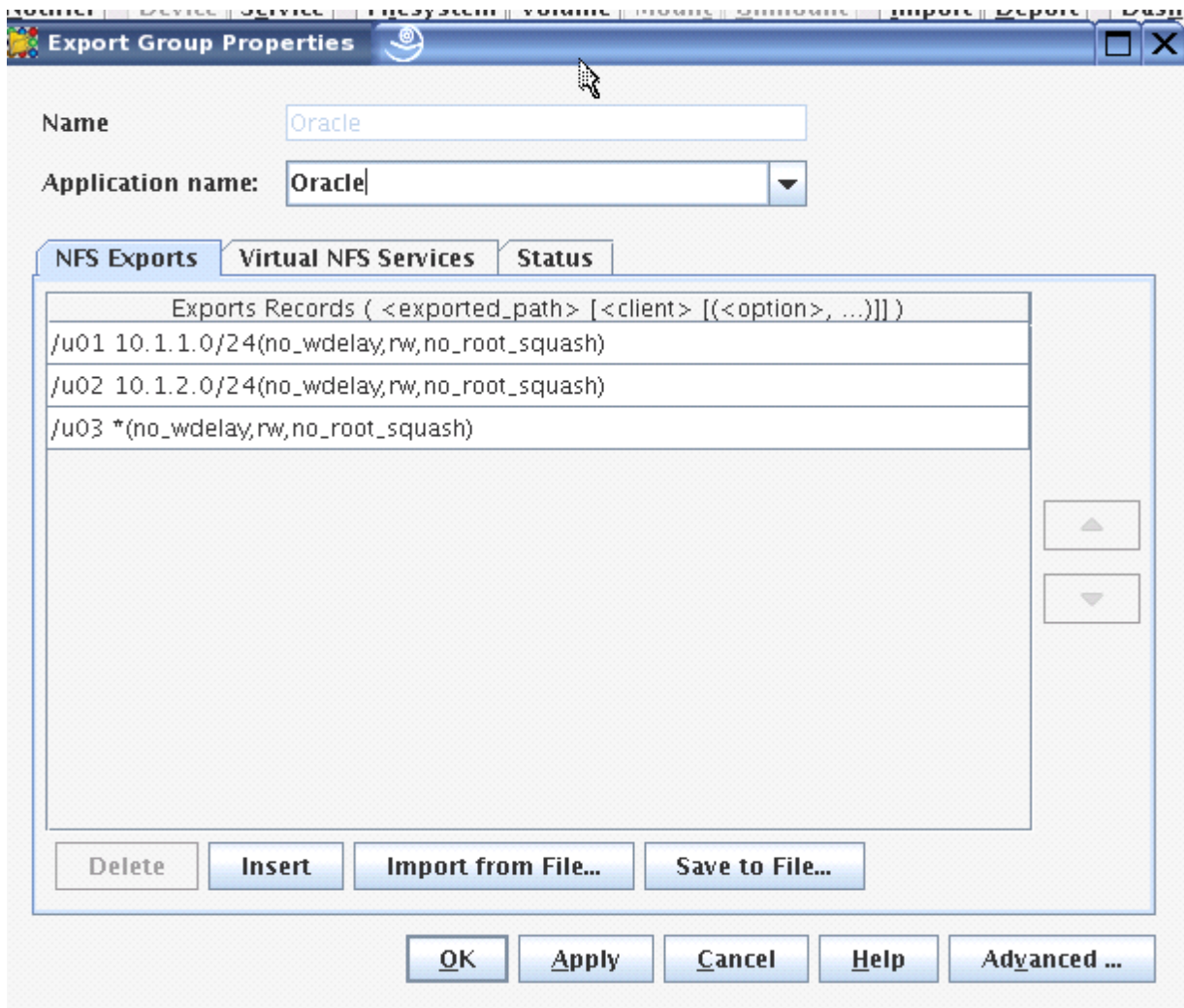
**Figure 2** EFS Clustered Gateway Management Console for DB optimized filesystem mount operation

## EFS Clustered Gateway Virtual NFS Service export options

The EFS Clustered Gateway requires the same NFS export options as most other OSCP-certified NAS offerings. The three required export options are:

- no\_wdelay
- rw
- no\_root\_squash

Figure 3 shows an EFS Clustered Gateway Management GUI screenshot with 3 filesystems configured in a single Export Group, all with the required export options. For more information on Export Groups, please refer to the "Configure Export Groups" section in the *HP StorageWorks Clustered File System for Linux NFS Configuration installation and administration guide* or the "mx exportgroup - Export Group commands" section in the *HP StorageWorks Clustered File System Command Line reference guide*.



**Figure 3** EFS Clustered Gateway Management Console NFS export group options

## Hosting Virtual NFS Services

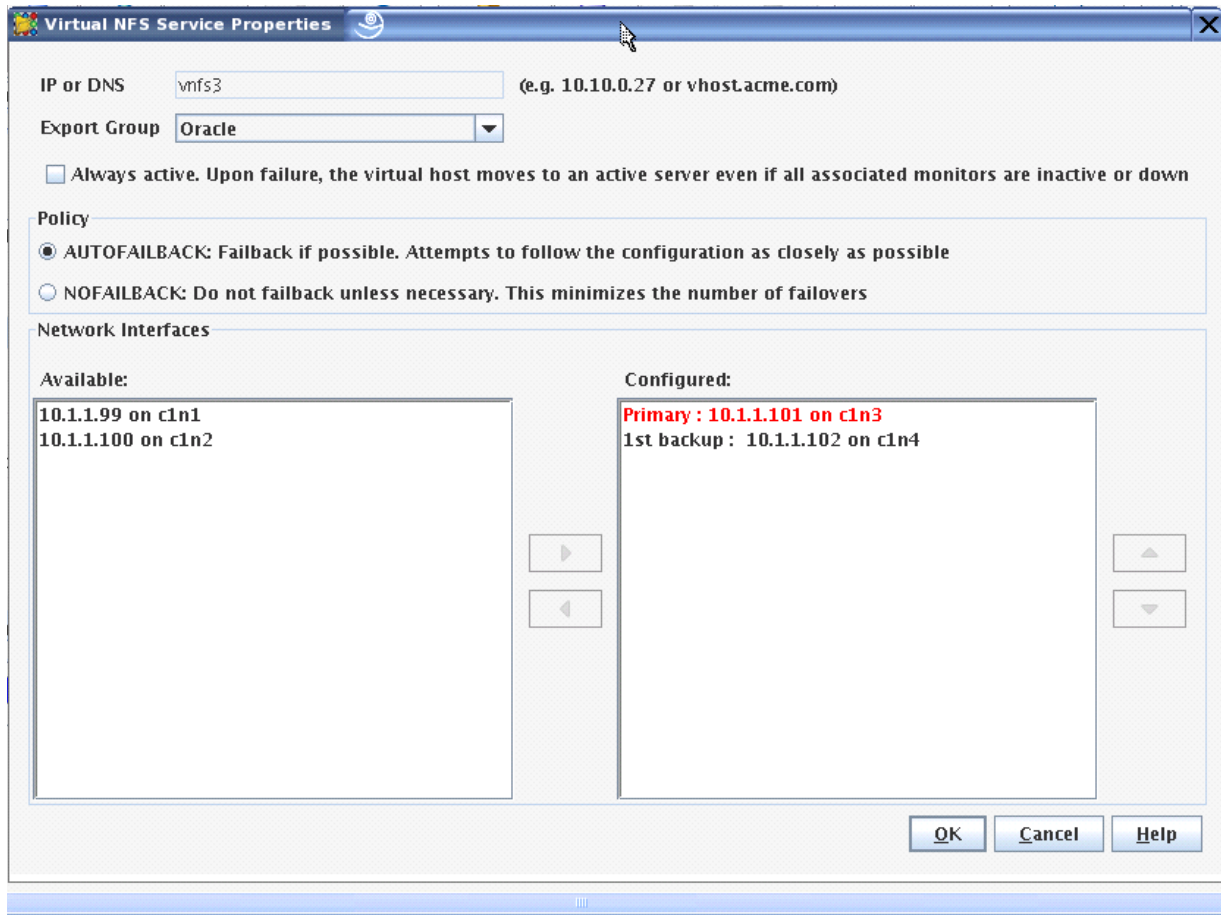
The EFS Clustered Gateway provides a truly revolutionary NFS server implementation with special support for highly available NFS. All NFS export groups are presented to NFS clients via a Virtual NFS Service, or VNFS for short. Virtual NFS technology is very important for two reasons:

- **Failover**—If a NAS head in the EFS Clustered Gateway fails, the Virtual NFS Services running on the failed nodes will be transparently failed over to a backup NAS head. The NFS clients and the processes with open file handles on the filesystems involved will not be affected in any way.
- **Re-hosting**—Using the EFS Clustered Gateway Management GUI or CLI, the administrator can move an active NFS service from one NAS head to the other for such reasons as load balancing or maintenance. This operation is also fully transparent at the NFS client level and there is no need to stop applications. Just a simple GUI drag and drop.

A VNFS is a combination of Virtual Host IP and a proprietary enhancement to the NFS Server stack to support completely transparent NFS client failover. The filesystems remain accessible without re-mounting and, most importantly, processes with active file handles accessing files in the NFS filesystems are not impacted. For in depth information regarding Virtual NFS Services in the EFS Clustered Gateway, please refer to “Configure Virtual NFS Services” section in the *HP StorageWorks Clustered File System for Linux NFS Configuration installation and administration guide* or the “mx vnfs - Virtual NFS Service commands” section in the *HP StorageWorks Clustered File System Command Line reference guide*.

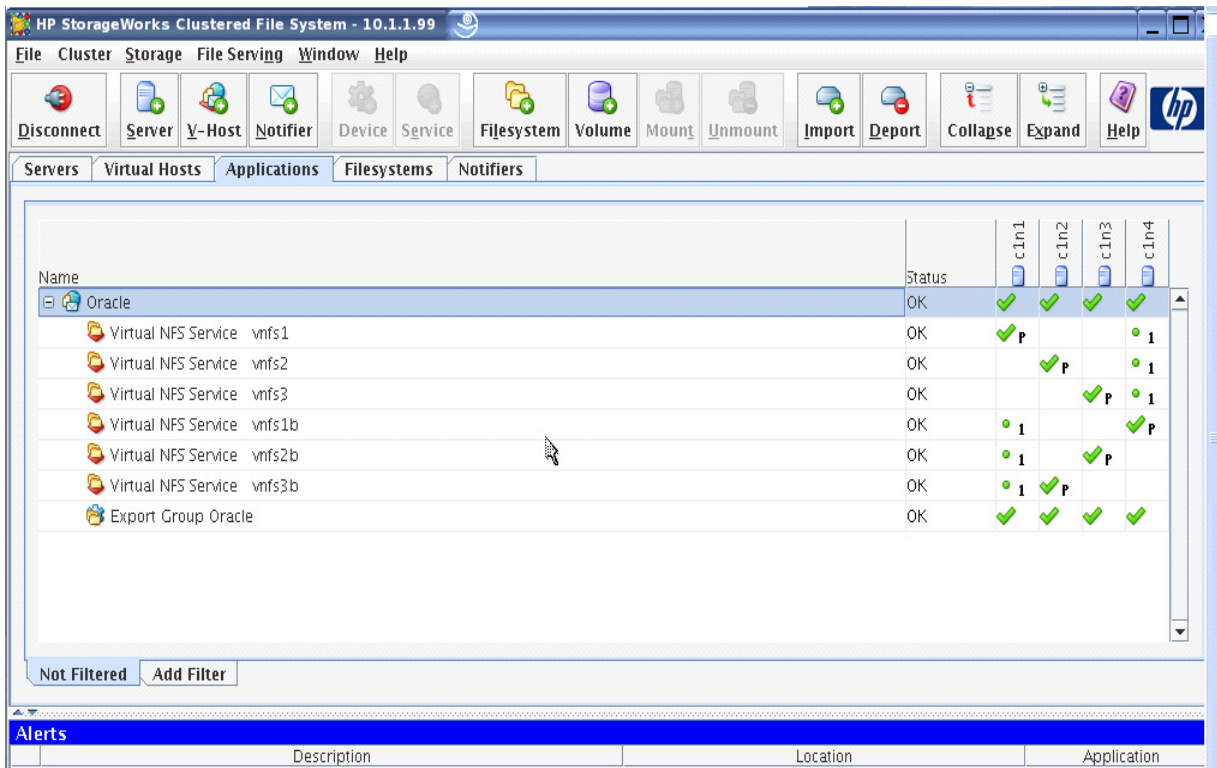
Figure 4 shows the EFS Clustered Gateway Management GUI with an example of associating an Export Group with a Virtual NFS Service as well as the NAS heads that will act as the primary and 1st backup in the event of a NAS head failure. The screen shot shows:

- There is a DNS entry for the Virtual NFS Service called vnfs3
- The Export Group that will be presented through the VNFS is called "Oracle"
- The EFS Clustered Gateway NAS heads for this VNFS are c1n3 as the primary and c1n4 as the 1st backup.



**Figure 4** Associating export groups with NAS heads in the EFS Clustered Gateway

Figure 5 shows a portion of the EFS Clustered Gateway management GUI. On the horizontal plane are a set of Virtual NFS Services. On the right-hand side along the vertical plane are the NAS heads by name. In this case there are four NAS heads (c1n1 through c1n4). For instance, the VNFS called vnfs1, and therefore all the filesystems presented by vnfs1, are currently hosted by NAS head number 1 (c1n1). This status is established by the cell for that row, which shows "P", for primary, under the "c1n1" column. It also shows that vnfs1 will fail over to c1n4 as the numeral "1", short for first backup, appears under the "c1n4" column for that same row. Also, the VNFS called vnfs3b and vnfs2 are both concurrently hosted by NAS head number 2 (c1n2). Re-hosting a VNFS from one node to the other is a simple click, drag and drop operation.



**Figure 5** EFS Clustered Gateway Management GUI with 4 NAS heads and 6 Virtual NFS Services

## Special instruction regarding ORACLE\_HOME

As will be discussed in the next section, Oracle uses file locking at instance startup when not running Real Application Clusters. On NFS, this requires NFS Server support for the NLM locking protocol. It is critical that the filesystem containing ORACLE\_HOME possess the following characteristics:

- Single Virtual NFS Service Association. It is imperative that the ORACLE\_HOME filesystem be presented through on a single Virtual NFS Service.
- The EFS Clustered Gateway must be configured to enable NLM

If the ORACLE\_HOME filesystem is exported through multiple Virtual NFS Services, a race condition is possible during VNFS rehosting or failover where an instance startup can be incorrectly granted a lock on the \$ORACLE\_HOME/dbs/lk<DNMAE> file. If ORACLE\_HOME is presented through a single VNFS, this problem will not occur.

Presenting ORACLE\_HOME through a single Virtual NFS Service will limit I/O bandwidth to a single NAS head. This is not an issue as the I/O load on ORACLE\_HOME will not saturate an EFS Clustered Gateway NAS head. Availability will not be impacted as failover and rehosting are certainly functional on filesystems presented through a single VNFS.

## Configuring NLM

NLM is the locking protocol used by NFS. When Real Application Clusters is not being used, Oracle uses file locks on a file in \$ORACLE\_HOME/dbs called lk<DBNAME> to ensure the database is not already opened by another instance. If this lock operation fails, the following errors will be returned:

- ORA-10997
- ORA-09968
- Operating System error ENOLCK

NLM is disabled by default on the EFS Clustered Gateway. To enable NLM, simply log in to each NAS head in the EFS Clustered Gateway and execute the mxnlmconfig command. For more information on the mxnlmconfig command, please refer to the "Using the NLM Protocol" section in the *HP StorageWorks Clustered File System for Linux NFS Configuration installation and administration guide* or the "mxnlmconfig - enable or disable NLM" section in the *HP StorageWorks Clustered File System Command Line reference guide*.



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## 4 Configuring NFS Clients for Oracle on the EFS Clustered Gateway

### NFS mount mptions

The most important document for configuring NFS Clients when using Oracle on the EFS Clustered Gateway is the *Oracle Database Installation Guide* for your specific port of Oracle. For example, the Linux port of Oracle comes with an installation guide which is Oracle Part Number B15667-01. These guides can offer Oracle-port specific mount options.

For this document, the Linux (i.e., x86, x86\_64) port of Oracle will serve as the model. The following mount options are recommended:

```
rw,bg,hard,nointr,tcp,nfsvers=3,timeo=300,rsize=32768,wsiz=32768,actimeo=0
```

### Operating system tunables

Each Oracle port that supports Oracle on Network Attached Storage covers Operating System Tunables for NFS. For example, on Linux, the following kernel parameters need to be set. The installation guide for 10gR1 x86 recommends the following settings:

- ip\_local\_port\_range: 1024 65000
- rmem\_default: 262144
- rmem\_max: 262144
- wmem\_default: 262144
- wmem\_max: 262144

See the *Oracle Installation Guide* for your specific Oracle port for any operating system configuration issues for Oracle on NAS.



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## 5 Configuring Oracle for the EFS Clustered Gateway

### NFS Client Direct I/O

It is important to configure Oracle on the NFS clients to use the `O_DIRECT` flag when it opens files in the Enterprise File Services Clustered Gateway. For Oracle ports that support Oracle on Network Attached Storage, the `init.ora` parameter `filesystemio_options` governs whether certain filesystem features will be used by the server. With NFS, certain ports of Oracle can support Direct I/O; however, native operating system asynchronous I/O is not supported. With this in mind, the HP recommended `init.ora` settings are:

```
filesystemio_options = directIO
```

### Database Writer processes

For write intensive workloads, it will be necessary to increase the number of Database Writer processes. Not to be confused with Database Writer I/O slaves, multiple Database Writers are an efficient way to configure Oracle so that modified SGA buffers can be efficiently flushed to the EFS Clustered Gateway filesystem. A general rule to follow is to configure 4 Database Writer processes per processor on the NFS client. On dual-core processors, that number should be doubled. For instance, an NFS client with 4 dual-core processors would have the `init.ora` parameter for `db_writer_processes` configured as follows:

```
db_writer_processes = 32
```

Configured as such, the NFS client will be able to perform as many as 32 concurrent synchronous writes to the EFS Clustered Gateway filesystems per second. The free buffer waits statistic should be monitored to see if the Database Writer processes are able to sufficiently keep up with the workload. If the number of free buffer waits becomes one of the top five wait events in your STATSPACK reports, simply schedule a reboot and increase the number of writers.



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## 6 NFS client network performance considerations

When it comes to configuring storage bandwidth for Oracle databases, there really is no simple formula that meets the needs of all workloads. However, there are some guidelines. For Online Transaction Processing (OLTP), a commonly accepted ratio of database server to I/O subsystem bandwidth is 100Mb I/O for every 1GHz CPU. While this is a very rough formula, it does stand the test of time and field experience, and is applicable to DAS, NAS, and SAN storage topologies. Consider the fact that with OLTP, the Oracle I/O profile consists largely of random single block transfers (e.g., db file sequential read, DBWR writes), occasional multiblock reads (e.g., small table scans, index range scans) and small sequential writes to the online redo log. Since 100Mb I/O throughput is approximately 12MB/s, using a 4KB blocksize would yield an approximate maximum I/O rate of 3072 I/O operations per second (IOPs). Given these figures, the formula works out to be fairly accurate. Indeed, try to find a server with a single 1GHz processor that drives Oracle OLTP at a rate of 3072 random 4KB transfers per second. Generally speaking, a single CPU clocked at 1GHz would surely bottleneck long before it could drive I/O up to 3072 IOPs due to transactional overhead and activity on cached data.

A more modern, realistic example would be a server configured with 2 dual-core processors each clocked at, for example, 2.4GHz. In this case, there would be some 9.6GHz CPU bandwidth for the formula, and thus 9600 Mb I/O requirement. Rounding up, the formula suggests that the 2-way, dual core server would require a single GigE network path for NFS traffic to the EFS Clustered Gateway. The formula is not perfect, but it is a good guideline.

There is one significant error in the formula having to do with the fact that there is no such thing as an OLTP-only Oracle deployment. The same I/O subsystem that performs satisfactorily for OLTP might not be sufficient for maintenance operations such as backup/restore, bulk data loads, archive log switches, index creation, ad hoc parallel query and reporting.

The tremendous I/O bandwidth capability of the EFS Clustered Gateway cannot be realized if the NFS client network interfaces are under-configured. Given the relative low cost of network interface hardware and switches, it is recommended that NFS clients be configured with a minimum of two network paths to the EFS Clustered Gateway regardless of the "OLTP formula." This ensures that roughly 200MB/s will be sustainable for such activity as Parallel Query, Backup/Restore, index creation, and so on.



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## A References

- For more information on the views Oracle Corporation holds on NAS, see [http://www.oracle.com/technology/products/oracle9i/grid\\_computing/Oracle9iGridCookbook.html](http://www.oracle.com/technology/products/oracle9i/grid_computing/Oracle9iGridCookbook.html) and [http://download-west.oracle.com/docs/cd/B19306\\_01/install.102/b15660/app\\_nas.htm#BCFIDEJA](http://download-west.oracle.com/docs/cd/B19306_01/install.102/b15660/app_nas.htm#BCFIDEJA)
- For more information on OSCP, see <http://www.oracle.com/technology/deploy/availability/htdocs/oscp.html>
- For more information on SAME see the following paper: [http://www.oracle.com/technology//deploy/availability/pdf/OOW2000\\_same\\_ppt.pdf](http://www.oracle.com/technology//deploy/availability/pdf/OOW2000_same_ppt.pdf)
- A good guideline for what to place in EFS-SG DB Optimized filesystems is anything that would have to reside in a raw partition in a RAC deployment where no NAS, CFS or ASM are used. These are the traditional database object files and clusterware files.
- For more information on the `filesystemio_options` `init.ora` parameter, see [http://download-west.oracle.com/docs/cd/B19306\\_01/server.102/b15658/appc\\_linux.htm#sthref895](http://download-west.oracle.com/docs/cd/B19306_01/server.102/b15658/appc_linux.htm#sthref895), [http://download-west.oracle.com/docs/cd/B19306\\_01/server.102/b14237/initparams072.htm#REFRN10061](http://download-west.oracle.com/docs/cd/B19306_01/server.102/b14237/initparams072.htm#REFRN10061), [http://download-west.oracle.com/docs/cd/B19306\\_01/server.102/b14211/ch23\\_os.htm#sthref749](http://download-west.oracle.com/docs/cd/B19306_01/server.102/b14211/ch23_os.htm#sthref749)



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