

SUSE Linux Enterprise High Availability Extension 15 SP5

使用 DRBD 和 Pacemaker 的 高度可用 NFS 存储系统

此文档介绍了如何使用以下组件在双节点群集中设置高度可用的 NFS 存储系统：DRBD*（Distributed Replicated Block Device，分布式复制块设备）、LVM（Logical Volume Manager，逻辑卷管理器）和群集资源管理器 Pacemaker。

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1 使用情形

本文档将帮助您设置高度可用的 NFS 服务器。用于实现高度可用的 NFS 存储的群集具有以下属性：

- 两个节点：alice (IP: 192.168.1.1) 和 bob (IP: 192.168.1.2)，两者之间通过网络彼此相连。
- 两个浮动虚拟 IP 地址 (192.168.1.10 和 192.168.1.11)，这样无论服务在哪个物理节点上运行，客户端都可连接到服务。一个 IP 地址用于使用 Hawk2 进行群集管理，另一个 IP 地址专用于 NFS 导出。
- SBD 用作 STONITH 屏蔽设备，以避免分裂情况。STONITH 对于 HA 群集而言是必需的。
- 当活动的主机发生故障（**主动/被动**设置）时，资源从一个节点故障转移至另一个节点。
- 每个节点上的本地存储。使用 LVM 上的 DRBD 在节点之间同步数据。
- 通过 NFS 导出的文件系统，以及一个用于跟踪 NFS 客户端状态的单独文件系统。

安装并设置好基本的双节点群集后，再使用 NFS 的存储和群集资源对其进行扩展，即可获得一个高度可用的 NFS 存储服务器。

2 准备双节点群集

在设置高度可用的 NFS 存储之前，您必须先准备好一个高可用性群集：

过程 1：为 NFS 存储准备两节点群集

1. 按《安装和设置快速入门》(<https://documentation.suse.com/sle-ha/15-SP5/html/SLE-HA-all/article-installation.html>) 中所述安装并设置一个基本的双节点群集。
2. 在**两个**节点上安装软件包 nfs-kernel-server：

```
# zypper install nfs-kernel-server
```

3 创建 LVM 设备

使用 LVM（逻辑卷管理器）可在多个文件系统上灵活分配存储空间。

使用 `crm cluster run` 同时在两个节点上运行这些命令。

过程 2：为 DRBD 创建 LVM 设备

1. 创建 LVM 物理卷，并将 `/dev/sdb1` 替换为 LVM 的相应设备：

```
# crm cluster run "pvcreate /dev/sdb1"
```

2. 创建包含此物理卷的 LVM 卷组 `nfs`：

```
# crm cluster run "vgcreate nfs /dev/sdb1"
```

3. 在卷组 `nfs` 中创建一个名为 `share` 的逻辑卷：

```
# crm cluster run "lvcreate -n share -L 20G nfs"
```

此卷用于 NFS 导出。

4. 在卷组 `nfs` 中创建一个名为 `state` 的逻辑卷：

```
# crm cluster run "lvcreate -n state -L 8G nfs"
```

此卷用于跟踪 NFS 客户端状态。本示例中使用的 8 GB 卷大小应支持数千个并发 NFS 客户端。

5. 激活卷组：

```
# crm cluster run "vgchange -ay nfs"
```

现在应会在系统上看到以下设备：`/dev/nfs/share` 和 `/dev/nfs/state`。

4 创建 DRBD 设备

本章介绍如何在 LVM 上设置 DRBD 设备。使用 LVM 作为 DRBD 的后端可获得以下好处：

- 比在 DRBD 上使用 LVM 的配置更容易设置。
- 当需要调整 LVM 磁盘的大小或有更多磁盘添加到卷组时，管理起来更容易。

以下过程会创建两个 DRBD 设备：一个设备用于 NFS 导出，另一个设备用于跟踪 NFS 客户端状态。

4.1 创建 DRBD 配置

DRBD 配置文件保存在 `/etc/drbd.d/` 目录中，必须以 `.res` 扩展名结尾。在此过程中，配置文件命名为 `/etc/drbd.d/nfs.res`。

过程 3：创建 DRBD 配置

1. 创建包含以下内容的 `/etc/drbd.d/nfs.res` 文件：

```
resource nfs {
    volume 0 { ❶
        device          /dev/drbd0; ❷
        disk             /dev/nfs/state; ❸
        meta-disk        internal; ❹
    }
    volume 1 {
        device          /dev/drbd1;
        disk             /dev/nfs/share;
        meta-disk        internal;
    }

    net {
        protocol C; ❺
        fencing resource-and-stonith; ❻
    }

    handlers { ❼
        fence-peer "/usr/lib/drbd/crm-fence-peer.9.sh";
        after-resync-target "/usr/lib/drbd/crm-unfence-peer.9.sh";
    }

    connection-mesh { ❽
```

```

    hosts    alice bob;
}
on alice { ⑨
    address  192.168.1.1:7790;
    node-id  0;
}
on bob { ⑨
    address  192.168.1.2:7790;
    node-id  1;
}
}

```

- ① 要创建的每个 DRBD 设备的卷号。
- ② 应用程序要访问的 DRBD 设备。
- ③ DRBD 用于存储实际数据的较低级别块设备。这是在第 3 节 “创建 LVM 设备” 中创建的 LVM 设备。
- ④ 元数据的存储位置。如果使用 internal，元数据将与用户数据一起存储在设备上。有关更多信息，请参见手册页。
- ⑤ 此连接使用的协议。协议 C 提供更好的数据可用性，只有在写入内容进入所有本地和远程磁盘之后，该协议才将写入操作视为已完成。
- ⑥ 指定屏蔽策略。对于配置了 STONITH 设备的群集，请使用 resource-and-stonith。
- ⑦ 启用资源级别屏蔽。如果 DRBD 复制链路的连接中断，Pacemaker 会尝试将 DRBD 资源升级到另一个节点。有关详细信息，请参见《管理指南》，第 22 章 “DRBD”，第 22.6 节 “搭配使用资源级屏蔽与 STONITH”。
- ⑧ 定义网格的所有节点。hosts 参数包含共享相同 DRBD 设置的所有主机名。
- ⑨ 包含每个节点的 IP 地址和唯一标识符。

2. 打开 /etc/csync2/csync2.cfg 并检查其中是否包含以下两行：

```

include /etc/drbd.conf;
include /etc/drbd.d;

```

如果不存在，请将这两行添加到文件中。

3. 将文件复制到其他节点上：

```
# csync2 -xv
```

有关 Csync2 的信息，请参见《管理指南》，第 4 章 “使用 YaST 群集模块”，第 4.7 节 “将配置传输到所有节点”。

4.2 激活 DRBD 设备

准备好 DRBD 配置后，激活设备：

过程 4：激活 DRBD 设备

1. 如果您在群集中使用防火墙，请在防火墙配置中打开端口 7790。
2. 初始化元数据存储：

```
# crm cluster run "drbdadm create-md nfs"
```

3. 创建 DRBD 设备：

```
# crm cluster run "drbdadm up nfs"
```

4. 设备中尚不包含数据，因此您可以运行以下命令来跳过初始同步：

```
# drbdadm new-current-uuid --clear-bitmap nfs/0  
# drbdadm new-current-uuid --clear-bitmap nfs/1
```

5. 将 alice 设为主节点：

```
# drbdadm primary --force nfs
```

6. 检查 nfs 的 DRBD 状态：

```
# drbdadm status nfs
```

此命令将返回以下消息：

```
nfs role:Primary
```

```
volume:0 disk:UpToDate
volume:1 disk:UpToDate
bob role:Secondary
    volume:0 peer-disk:UpToDate
    volume:1 peer-disk:UpToDate
```

您可以访问块设备 `/dev/drbd0` 和 `/dev/drbd1` 上的 DRBD 资源。

4.3 创建文件系统

激活 DRBD 设备后，在其上创建文件系统：

过程 5：为 DRBD 创建文件系统

1. 在 `/dev/drbd0` 上创建 `ext4` 文件系统：

```
# mkfs.ext4 /dev/drbd0
```

2. 在 `/dev/drbd1` 上创建 `ext4` 文件系统：

```
# mkfs.ext4 /dev/drbd1
```

5 创建群集资源

以下过程说明如何配置高度可用的 NFS 群集所需的资源。

群集资源概述

DRBD 原始资源和可升级克隆资源

这些资源用于复制数据。群集资源管理器认为有必要时，会将可升级克隆资源在主次角色之间切换。

文件系统资源

这些资源将管理要导出的文件系统，以及要跟踪 NFS 客户端状态的文件系统。

NFS 内核服务器资源

此资源管理 NFS 服务器守护程序。

NFS 导出

此资源用于将目录 `/srv/nfs/share` 导出到客户端。

虚拟 IP 地址

初始安装会创建用于 Hawk2 的管理虚拟 IP 地址。创建另一个专用于 NFS 导出的虚拟 IP 地址。这样，以后便可更轻松地应用安全限制。

示例 NFS 情形

- 下列配置示例假设 `192.168.1.11` 是用于为 `192.168.1.x/24` 子网中的客户端传递数据的 NFS 服务器的虚拟 IP 地址。
- 服务导出从 `/srv/nfs/share` 传递的数据。
- 群集将 DRBD 设备 `/dev/drbd1` 中的 `ext4` 文件系统挂载到此导出目录中。此 DRBD 设备位于名为 `/dev/nfs/share` 的 LVM 逻辑卷上。
- DRBD 设备 `/dev/drbd0` 用于共享 `/var/lib/nfs` 中的 NFS 客户端状态。此 DRBD 设备位于名为 `/dev/nfs/state` 的 LVM 逻辑卷上。

5.1 创建 DRBD 原始资源和可升级克隆资源

创建一个群集资源用于管理 DRBD 设备，并创建一个可升级克隆资源，使此群集资源可在两个节点上运行：

过程 6：为 NFS 创建 DRBD 资源

1. 启动 `crm` 交互外壳：

```
# crm configure
```

2. 为 DRBD 配置 `nfs` 创建原始资源：

```
crm(live)configure# primitive drbd-nfs ocf:linbit:drbd \  
  params drbd_resource="nfs" \  
  op monitor interval=15 role=Promoted \  
  op monitor interval=30 role=Unpromoted
```

3. 为 `drbd-nfs` 原始资源创建一个可升级克隆资源：

```
crm(live)configure# clone cl-drbd-nfs drbd-nfs \
    meta promotable="true" promoted-max="1" promoted-node-max="1" \
    clone-max="2" clone-node-max="1" notify="true" interleave=true
```

4. 提交此配置：

```
crm(live)configure# commit
```

Pacemaker 将激活两个节点上的 DRBD 资源，并将其升级为其中一个节点上的主要角色。使用 `crm status` 命令检查群集的状态，或运行 `drbdadm status`。

5.2 创建文件系统资源

创建群集资源来管理要导出的文件系统 and 用于状态跟踪的文件系统：

过程 7：为 NFS 创建文件系统资源

1. 在 `/dev/drbd0` 上创建一个用于跟踪 NFS 客户端状态的原始资源：

```
crm(live)configure# primitive fs-nfs-state Filesystem \
    params device=/dev/drbd0 directory=/var/lib/nfs fstype=ext4
```

2. 在 `/dev/drbd1` 上为要导出的文件系统创建一个原始资源：

```
crm(live)configure# primitive fs-nfs-share Filesystem \
    params device=/dev/drbd1 directory=/srv/nfs/share fstype=ext4
```

请**仅在**添加并置约束和顺序约束之后才提交此配置。

3. 将这两个资源添加到名为 `g-nfs` 的资源组：

```
crm(live)configure# group g-nfs fs-nfs-state fs-nfs-share
```

资源按照它们在组中的添加顺序启动，并按照相反的顺序停止。

4. 添加共置约束，以确保资源组始终在 DRBD 可升级克隆资源充当主要角色的节点上启动：

```
crm(live)configure# colocation col-nfs-on-drbd inf: g-nfs cl-drbd-
nfs:Promoted
```

5. 添加顺序约束，以确保 DRBD 可升级克隆资源始终在资源组之前启动：

```
crm(live)configure# order o-drbd-before-nfs Mandatory: cl-drbd-nfs:promote  
g-nfs:start
```

6. 提交此配置：

```
crm(live)configure# commit
```

Pacemaker 将 `/dev/drbd0` 挂载到 `/var/lib/nfs`，将 `/dev/drbd1` 挂载到 `srv/nfs/share`。使用 `mount` 或通过查看 `/proc/mounts` 来确认是否如此。

5.3 创建 NFS 内核服务器资源

创建一个群集资源来管理 NFS 服务器守护程序：

过程 8：创建 NFS 内核服务器资源

1. 创建一个原始资源来管理 NFS 服务器守护程序：

```
crm(live)configure# primitive nfserver nfserver \  
params nfs_server_scope=SUSE nfs_shared_infodir="/var/lib/nfs"
```

在群集中运行 NFS 服务器的所有节点上，`nfs_server_scope` 必须相同，但默认情况下并非采用这种设置。所有使用 SUSE 软件的群集都可以使用相同的范围，因此我们建议将该值设置为 `SUSE`。



警告：过短的租用时间可能会导致文件状态丢失

NFS 客户端定期与 NFS 服务器续订其状态。如果租用时间过短，系统或网络延迟可能会导致计时器在续订完成之前失效，从而导致发生 I/O 错误并丢失文件状态。

`NFSV4LEASETIME` 是在 NFS 服务器上的 `/etc/sysconfig/nfs` 文件中设置的。默认值为 90 秒。如果有必要缩短租用时间，我们建议将值设置为 60 或更大。强烈反对设置小于 30 的值。

2. 将此资源追加到现有的 `g-nfs` 资源组：

```
crm(live)configure# modgroup g-nfs add nfsserver
```

3. 提交此配置：

```
crm(live)configure# commit
```

5.4 创建 NFS 导出资源

创建一个群集资源来管理 NFS 导出：

过程 9：创建 NFS 导出资源

1. 为 NFS 导出创建原始资源：

```
crm(live)configure# primitive exportfs-nfs exportfs \  
  params directory="/srv/nfs/share" \  
  options="rw,mountpoint" clientspec="192.168.1.0/24" fsid=101 \① \  
  op monitor interval=30s timeout=90s ②
```

- ① fsid 对于每个 NFS 导出资源必须是唯一的。
- ② op monitor timeout 的值必须大于 stonith-timeout 的值。要查找 stonith-timeout 值，请运行 `crm configure show` 并查看 property 部分。



重要：不要设置 `wait_for_leasetime_on_stop=true`

在高度可用的 NFS 设置中将此选项设置为 `true` 可能会导致不必要的延迟和锁丢失。

`wait_for_leasetime_on_stop` 的默认值为 `false`。如果已按本指南中所述配置了 `/var/lib/nfs` 和 `nfsserver`，则无需将其设置为 `true`。

2. 将此资源追加到现有的 `g-nfs` 资源组：

```
crm(live)configure# modgroup g-nfs add exportfs-nfs
```

3. 提交此配置：

```
crm(live)configure# commit
```

4. 确认 NFS 导出设置正确：

```
# exportfs -v  
/srv/nfs/share    IP_ADDRESS_OF_CLIENT(OPTIONS)
```

5.5 为 NFS 导出创建虚拟 IP 地址

创建一个群集资源来管理 NFS 导出的虚拟 IP 地址：

过程 10：为 NFS 导出创建虚拟 IP 地址

1. 为虚拟 IP 地址创建原始资源：

```
crm(live)configure# primitive vip-nfs IPaddr2 params ip=192.168.1.11
```

2. 将此资源追加到现有的 g-nfs 资源组：

```
crm(live)configure# modgroup g-nfs add vip-nfs
```

3. 提交此配置：

```
crm(live)configure# commit
```

4. 退出 crm 交互外壳：

```
crm(live)configure# quit
```

5. 检查集群的状态。g-nfs 组中的资源应按以下顺序显示：

```
# crm status  
[...]  
Full List of Resources  
[...]  
* Resource Group: g-nfs:  
  * fs-nfs-state    (ocf:heartbeat:Filesystem):  Started alice  
  * fs-nfs-share    (ocf:heartbeat:Filesystem):  Started alice
```

```
* nfsserver      (ocf:heartbeat:nfsserver): Started alice
* exportfs-nfs   (ocf:heartbeat:exportfs): Started alice
* vip-nfs        (ocf:heartbeat:IPaddr2): Started alice
```

6 使用 NFS 服务

本章概述如何从 NFS 客户端使用高度可用的 NFS 服务。

要连接到 NFS 服务，请务必使用**虚拟 IP 地址**来连接群集，而不要使用其中一个群集节点的网络接口上配置的物理 IP。出于兼容性原因，请使用服务器上 NFS 导出的**完整**路径。

用于挂载 NFS 导出的命令如下：

```
# mount 192.168.1.11:/srv/nfs/share /home/share
```

如果您需要配置其他挂载选项，例如特定的传输协议 (proto)、最大读写请求大小 (rsize 和 wsizesize) 或特定的 NFS 版本 (vers)，请使用 -o 选项。例如：

```
# mount -o proto=tcp,rsize=32768,wsizesize=32768,vers=3 \
192.168.1.11:/srv/nfs/share /home/share
```

要了解更多 NFS 挂载选项，请参见 nfs 手册页。



注意：回写挂载

只有 NFS 版本 3 支持回写挂载，而 NFS 版本 4 则**不支持**。有关详细信息，请参见

<https://www.suse.com/support/kb/doc/?id=000018709>。

7 将更多 NFS 共享添加到群集

如果需要增加可用存储，您可以将更多 NFS 共享添加到群集。

在此示例中，名为 /dev/drbd2 的新 DRBD 设备位于名为 /dev/nfs/share2 的 LVM 逻辑卷上。

过程 11：将更多 NFS 共享添加到群集

1. 为新共享创建 LVM 逻辑卷：

```
# crm cluster run "lvcreate -n share2 -L 20G nfs"
```

2. 更新文件 `/etc/drbd.d/nfs.res` 以在现有卷下添加新卷：

```
volume 2 {  
    device          /dev/drbd2;  
    disk            /dev/nfs/share2;  
    meta-disk       internal;  
}
```

3. 将已更新的文件复制到其他节点：

```
# csync2 -xv
```

4. 初始化新卷的元数据存储：

```
# crm cluster run "drbdadm create-md nfs/2 --force"
```

5. 更新 `nfs` 配置以创建新设备：

```
# crm cluster run "drbdadm adjust nfs"
```

6. 跳过新设备的初始同步：

```
# drbdadm new-current-uuid --clear-bitmap nfs/2
```

7. NFS 群集资源自创建后可能已转移到其他节点。使用 `drbdadm status nfs` 检查 DRBD 状态，并记下哪个节点充当 `Primary` 角色。

8. 在充当 `Primary` 角色的节点上的 `/dev/drbd2` 中创建 `ext4` 文件系统：

```
# mkfs.ext4 /dev/drbd2
```

9. 启动 `crm` 交互外壳：

```
# crm configure
```

10. 在 `/dev/drbd2` 上为要导出的文件系统创建一个原始资源：

```
crm(live)configure# primitive fs-nfs-share2 Filesystem \
```

```
params device="/dev/drbd2" directory="/srv/nfs/share2" fstype=ext4
```

11. 将新文件系统资源添加到 g-nfs 组中的 nfsserver 资源之前:

```
crm(live)configure# modgroup g-nfs add fs-nfs-share2 before nfsserver
```

12. 为新共享中的 NFS 导出创建原始资源:

```
crm(live)configure# primitive exportfs-nfs2 exportfs \  
  params directory="/srv/nfs/share2" \  
  options="rw,mountpoint" clientspec="192.168.1.0/24" fsid=102 \  
  op monitor interval=30s timeout=90s
```

13. 将新的 NFS 导出资源添加到 g-nfs 组中的 vip-nfs 资源之前:

```
crm(live)configure# modgroup g-nfs add exportfs-nfs2 before vip-nfs
```

14. 提交此配置:

```
crm(live)configure# commit
```

15. 退出 crm 交互外壳:

```
crm(live)configure# quit
```

16. 检查集群的状态。g-nfs 组中的资源应按以下顺序显示:

```
# crm status  
[...]  
Full List of Resources  
[...]  
* Resource Group: g-nfs:  
  * fs-nfs-state      (ocf:heartbeat:Filesystem): Started alice  
  * fs-nfs-share      (ocf:heartbeat:Filesystem): Started alice  
  * fs-nfs-share2     (ocf:heartbeat:Filesystem): Started alice  
  * nfsserver         (ocf:heartbeat:nfsserver): Started alice  
  * exportfs-nfs      (ocf:heartbeat:exportfs): Started alice  
  * exportfs-nfs2     (ocf:heartbeat:exportfs): Started alice  
  * vip-nfs           (ocf:heartbeat:IPAddr2): Started alice
```


17. 确认 NFS 导出设置正确：

```
# exportfs -v
/srv/nfs/share    IP_ADDRESS_OF_CLIENT(OPTIONS)
/srv/nfs/share2   IP_ADDRESS_OF_CLIENT(OPTIONS)
```

8 更多信息

- 有关本指南中所述步骤的更多细节，请参见 <https://www.suse.com/support/kb/doc/?id=000020396>。
- 有关 NFS 和 LVM 的详细信息，请参见 《SUSE Linux Enterprise Server 存储管理指南》 (<https://documentation.suse.com/sles/html/SLES-all/book-storage.html>)。
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