使用 OpenFiler 来模拟存储配置 RAC 中 ASM 共享盘及多路径（multipath）的测试

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第 1 章　本篇总览

之前发布了一篇《Oracle_lhr_RAC 12cR1 安装》，但是其中的存储并没有使用多路径，而是使用了 VMware 自身提供的存储。所以，年前最后一件事就是把多路径学习一下，本文介绍了 OpenFiler、iSCSI 和多路径的配置。

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第 2 章　安装 OpenFiler

OpenFile 是在 rPath Linux 基础上开发的，它能够作为一个独立的 Linux 操作系统发行。Openfiler 是一款非常好的存储管理操作系统，开源免费，通过 web 界面对存储磁盘的管理，支持现在流行的网络存储技术 IP-SAN 和 NAS，支持 iSCSI、NFS、SMB/CIFS 及 FTP 等协议。

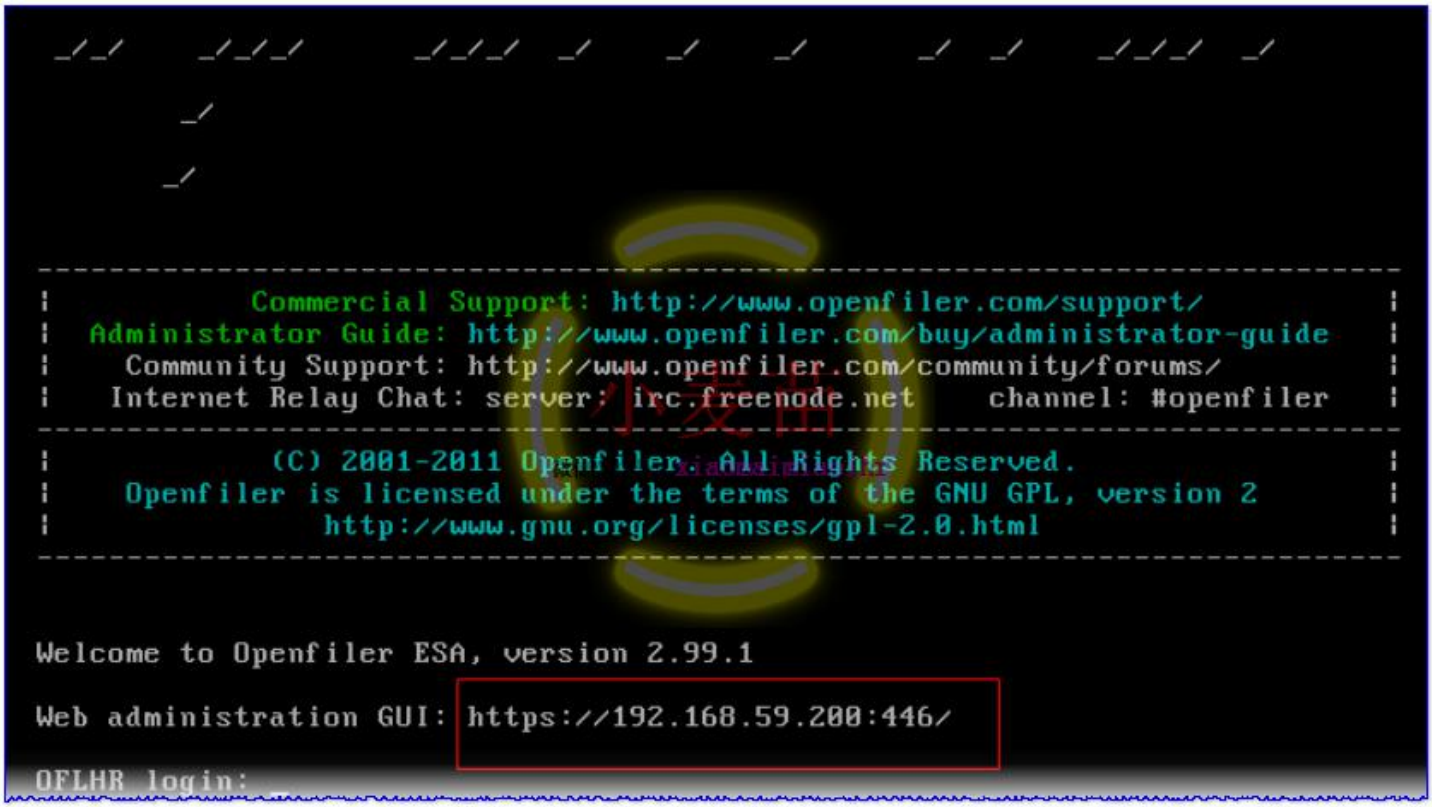
本次安装 OpenFiler 锁需要的软件如下所示：

序号	类型	内容
1	openfiler	openfileresa-2.99.1-x86_64-disc1.iso

注：这些软件小麦苗已上传到腾讯微云（http://blog.itpub.net/26736162/viewspace-1624453/），各位朋友可以去下载。另外，小麦苗已经将安装好的虚拟机上传到了云盘，里边已集成了 rlwrap 软件。

2.1 安装

详细安装过程小麦苗就不一个一个截图了，网上已经有网友贴出了一步一步的过程，OpenFiler 的内存设置为 1G 大小或再小点也无所谓，磁盘选用 IDE 磁盘格式，由于后续要配置多路径，所以需要安装 2 块网卡。安装完成后，重新启动，界面如下所示：



注意，方框中的内容，可以在浏览器中直接打开。可以用 root 用户登录进行用户的维护，若进行存储的维护则只能使用 openfiler 用户。openfiler 是在远程使用 Web 界面进行管理的，小麦苗这里的管理地址是 https://192.168.59.200:446，其管理的初始用户名是 **openfiler**（小写的），密码是 **password**，可以在登录之后，修改这个密码。

2.2 基本配置

2.2.1 网卡配置

配置静态网卡地址：

```
[root@OFLHR ~]# more /etc/sysconfig/network-scripts/ifcfg-eth0
# Advanced Micro Devices [AMD] 79c970 [PCnet32 LANCE]
DEVICE=eth0
BOOTPROTO=static
BROADCAST=192.168.59.255
HWADDR=00:0C:29:98:1A:CD
IPADDR=192.168.59.200
NETMASK=255.255.255.0
NETWORK=192.168.59.0
ONBOOT=yes
[root@OFLHR ~]# more /etc/sysconfig/network-scripts/ifcfg-eth1
DEVICE=eth1
MTU=1500
USERCTL=no
ONBOOT=yes
BOOTPROTO=static
IPADDR=192.168.2.200
NETMASK=255.255.255.0
HWADDR=00:0C:29:98:1A:D7
[root@OFLHR ~]# ip a
```

```
1: lo: <LOOPBACK,UP,10000> mtu 16436 qdisc noqueue
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
    inet6 ::1/128 scope host
       valid lft forever preferred lft forever
2: eth0: <BROADCAST,MULTICAST,UP,10000> mtu 1500 qdisc pfifo fast qlen 1000
    link/ether 00:0c:29:98:1a:cd brd ff:ff:ff:ff:ff:ff
    inet 192.168.59.200/24 brd 192.168.59.255 scope global eth0
    inet6 fe80::20c:29ff:fe98:1acd/64 scope link
       valid lft forever preferred lft forever
3: eth1: <BROADCAST,MULTICAST,UP,10000> mtu 1500 qdisc pfifo_fast qlen 1000
    link/ether 00:0c:29:98:1a:d7 brd ff:ff:ff:ff:ff:ff
    inet 192.168.2.200/24 brd 192.168.2.255 scope global eth1
    inet6 fe80::20c:29ff:fe98:1ad7/64 scope link
       valid_lft forever preferred_lft forever
[root@OFLHR ~]#
```

2.2.2 添加硬盘

添加一块 100G 大小的 IDE 格式的硬盘作为存储。


```
[root@OFLHR ~]# fdisk -l

Disk /dev/sda: 10.7 GB, 10737418240 bytes
255 heads, 63 sectors/track, 1305 cylinders, total 20971520 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x000adc2c

   Device Boot      Start         End      Blocks   Id  System
/dev/sda1   *          63      610469      305203+  83  Linux
/dev/sda2          610470    17382329     8385930   83  Linux
/dev/sda3        17382330    19486844     1052257+  82  Linux swap / Solaris

Disk /dev/sdb: 107.4 GB, 107374182400 bytes
255 heads, 63 sectors/track, 13054 cylinders, total 209715200 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
```

```
Disk identifier: 0x00000000

Disk /dev/sdb doesn't contain a valid partition table
[root@OFLHR ~]#
```

2.3 iscsi target 配置

为 openfiler 服务器配置了两块硬盘，其中 10GB 的硬盘已经用来安装 openfiler 操作系统，而 200GB 的硬盘则会用做数据存储。

2.3.1 创建逻辑卷

登录地址：https://192.168.59.200:446
初始用户名和密码：**openfiler/password**

在独立存储设备中，LUN（Logical Unit Number）是最重要的基本单位。LUN 可以被 SAN 中的任何主机访问，不管是透过 HBA 或是 iSCSI。就算是软件激活的 iSCSI，也可以在不同的操作系统之下，在操作系统启动之后利用软件的 iSCSI initiator 访问 LUN。在 OpenFiler 之下，LUN 被称为 Logical Volume（LV），因此在 OpenFiler 下创建 LUN 就是创建 LV。

当你安装好 OpenFiler 之后，接下来就是要将 OpenFiler 下的磁盘分享出来给虚拟机或网络上的其他主机使用了。在标准的 SAN 之后，这些可以在 RAID 层面完成，但 VG 的好处及弹性是 RAID 无法比较的，下面看看 OpenFiler 下的 VG 是如何一步一步创建的。

创建 VG 的步骤：

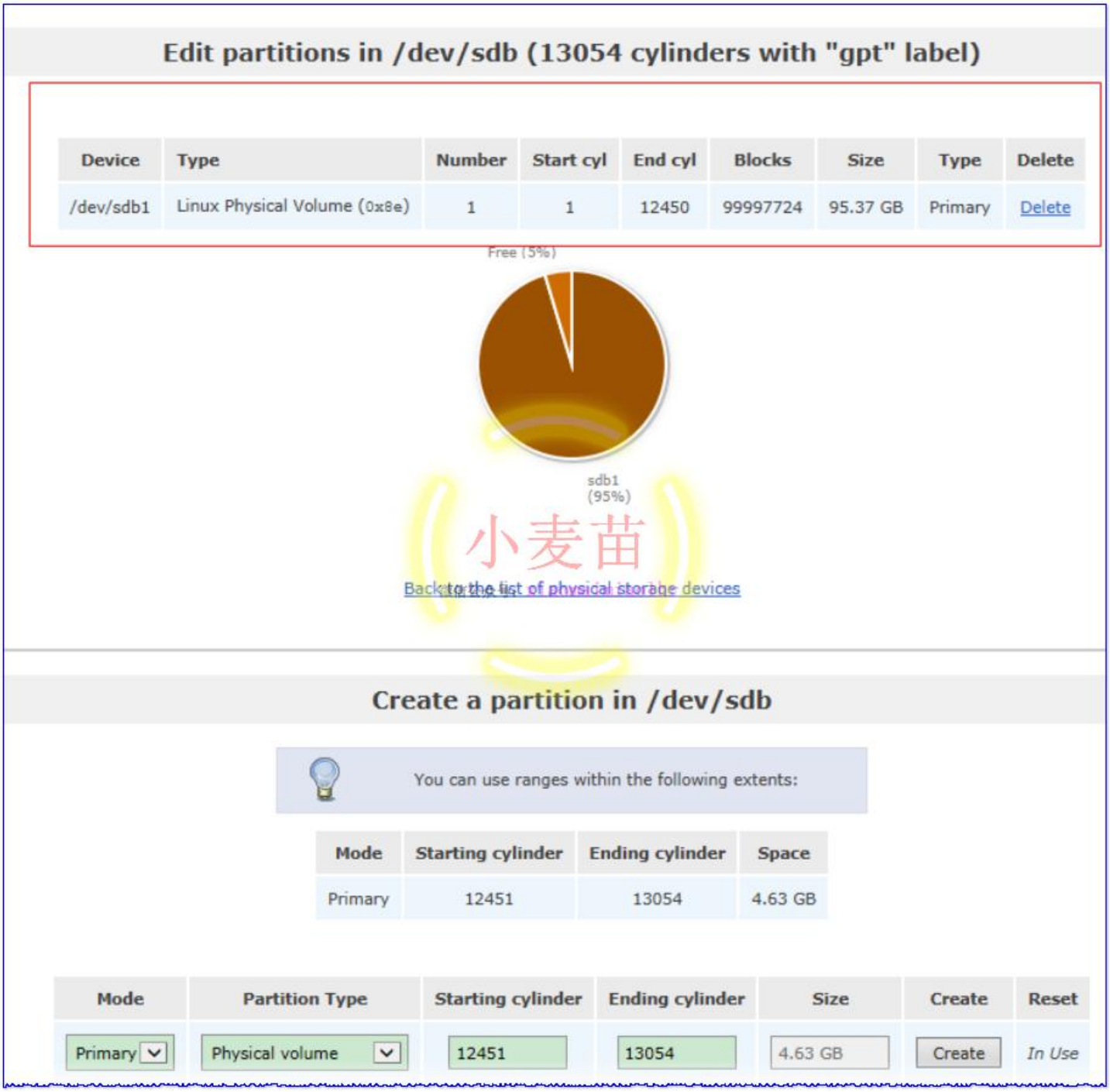
（1）进入 OpenFiler 的接口，并且选择要使用的实体硬盘。
（2）将要加入的实体硬盘格式化成 Physical Volume 格式。
（3）创建一个 VG 组，并且将格式化成为 PV 格式的实体硬盘加入。
（4）加入完毕之后，就成为一个大的 VG 组，被视为系统的一个大实体硬盘。
（5）在这个 VG 中添加逻辑分割区 LUN，在 OpenFiler 中称为 Logical Volume。
（6）指定 LUN 的文件格式，如 iSCSI、ext3 或是 NFS，并且格式化。
（7）如果是 iSCSI 则需要再配置，如果是其他文件格式，就可以用 NAS 的方式分享出去而

登录后，点击 Volumes 标签

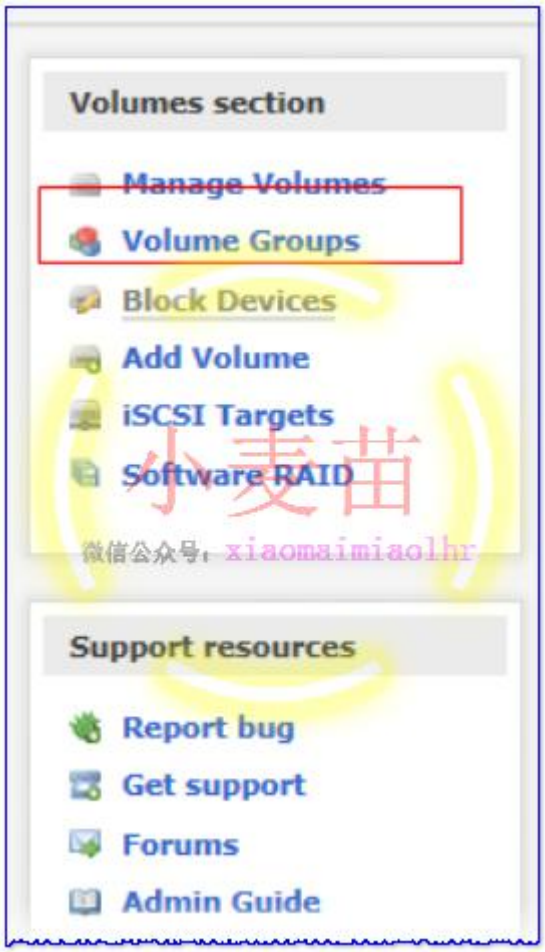
为 openfiler 服务器配置了两块硬盘，其中 10GB 的硬盘已经用来安装 openfiler 操作系统，而 200GB 的硬盘则会用做数据存储。

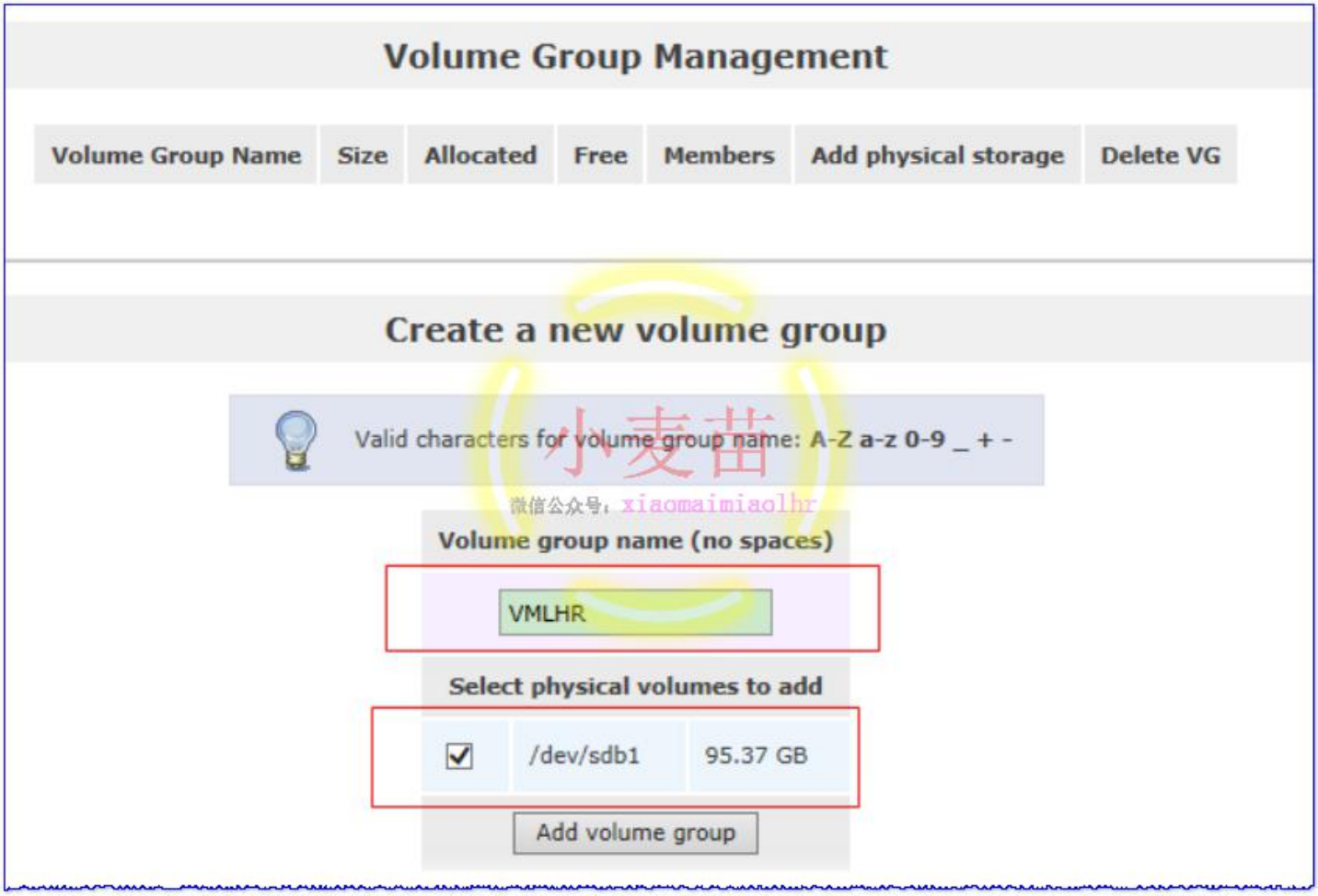
点击 create new physical volumes 后点击/dev/sdb

点击页面右下角 Reset，然后点击 Create。分区类型为 Physical volume



点击 Volume Groups





输入名称，勾选复选框，单击 Add volume group


```
[root@OFLHR ~]# fdisk -l

Disk /dev/sda: 10.7 GB, 10737418240 bytes
255 heads, 63 sectors/track, 1305 cylinders, total 20971520 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x000adc2c

   Device Boot      Start         End      Blocks   Id  System
/dev/sda1   *          63      610469      305203+  83  Linux
/dev/sda2          610470    17382329     8385930   83  Linux
/dev/sda3        17382330    19486844     1052257+  82  Linux swap / Solaris

WARNING: GPT (GUID Partition Table) detected on '/dev/sdb'! The util fdisk doesn't support GPT. Use GNU Parted.


Disk /dev/sdb: 107.4 GB, 107374182400 bytes
255 heads, 63 sectors/track, 13054 cylinders, total 209715200 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x00000000

   Device Boot      Start         End      Blocks   Id  System
/dev/sdb1               1   209715199   104857599+  ee  GPT
[root@OFLHR ~]# pvs
  PV         VG    Fmt  Attr PSize  PFree
  /dev/sdb1  vmlhr lvm2 a-   95.34g 95.34g
[root@OFLHR ~]#
```

点击 Add Volume

输入内容，调整磁盘大小为 10G，卷类型选择 block（iSCSI，FC，etc）

Select Volume Group

Please select a volume group to create a volume in.

vmlhr Change

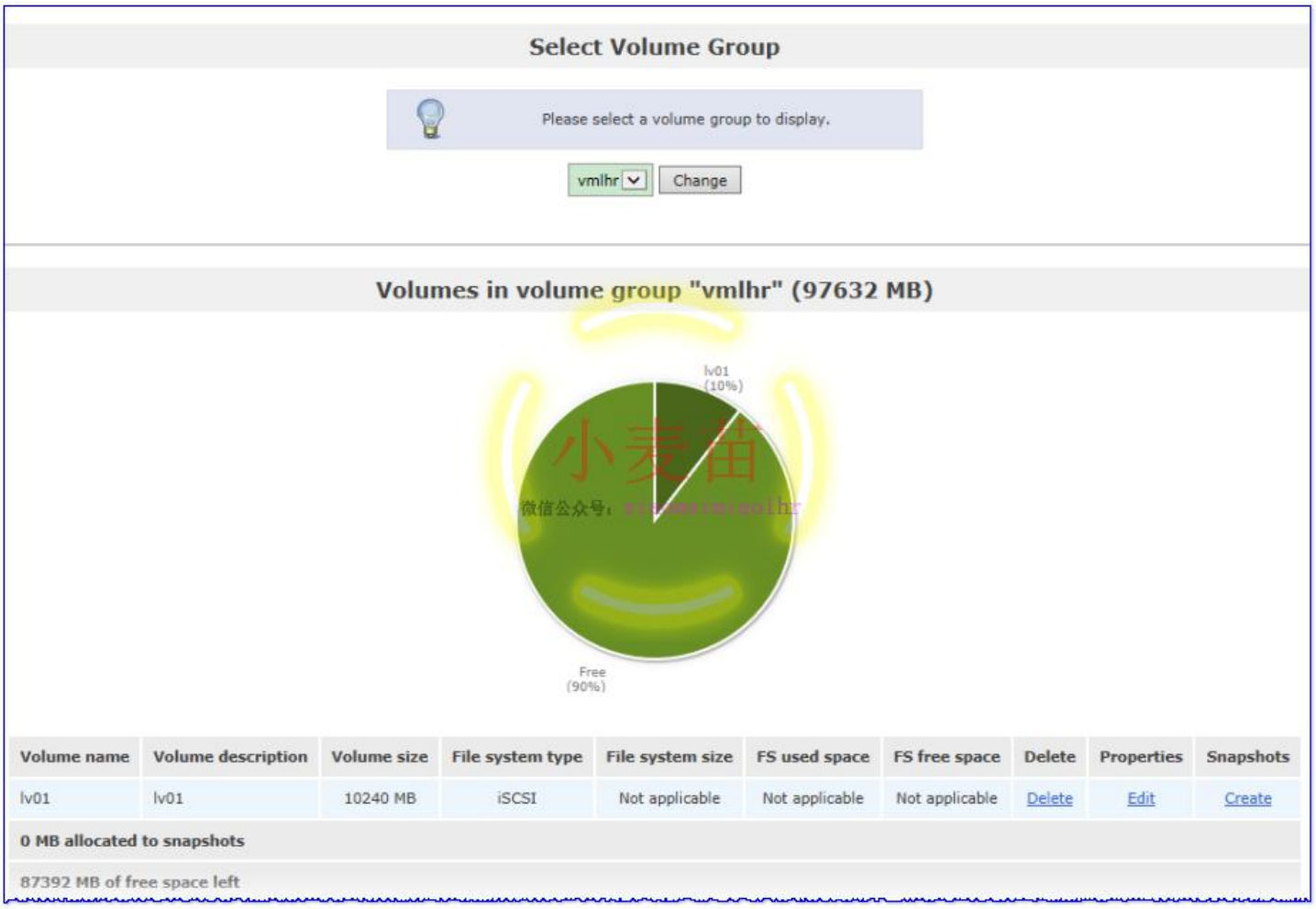
Block storage statistics for volume group "vmlhr"

Total Space	Used Space	Free Space
99975168 bytes (97632 MB)	0 bytes (0 MB)	99975168 bytes (97632 MB)

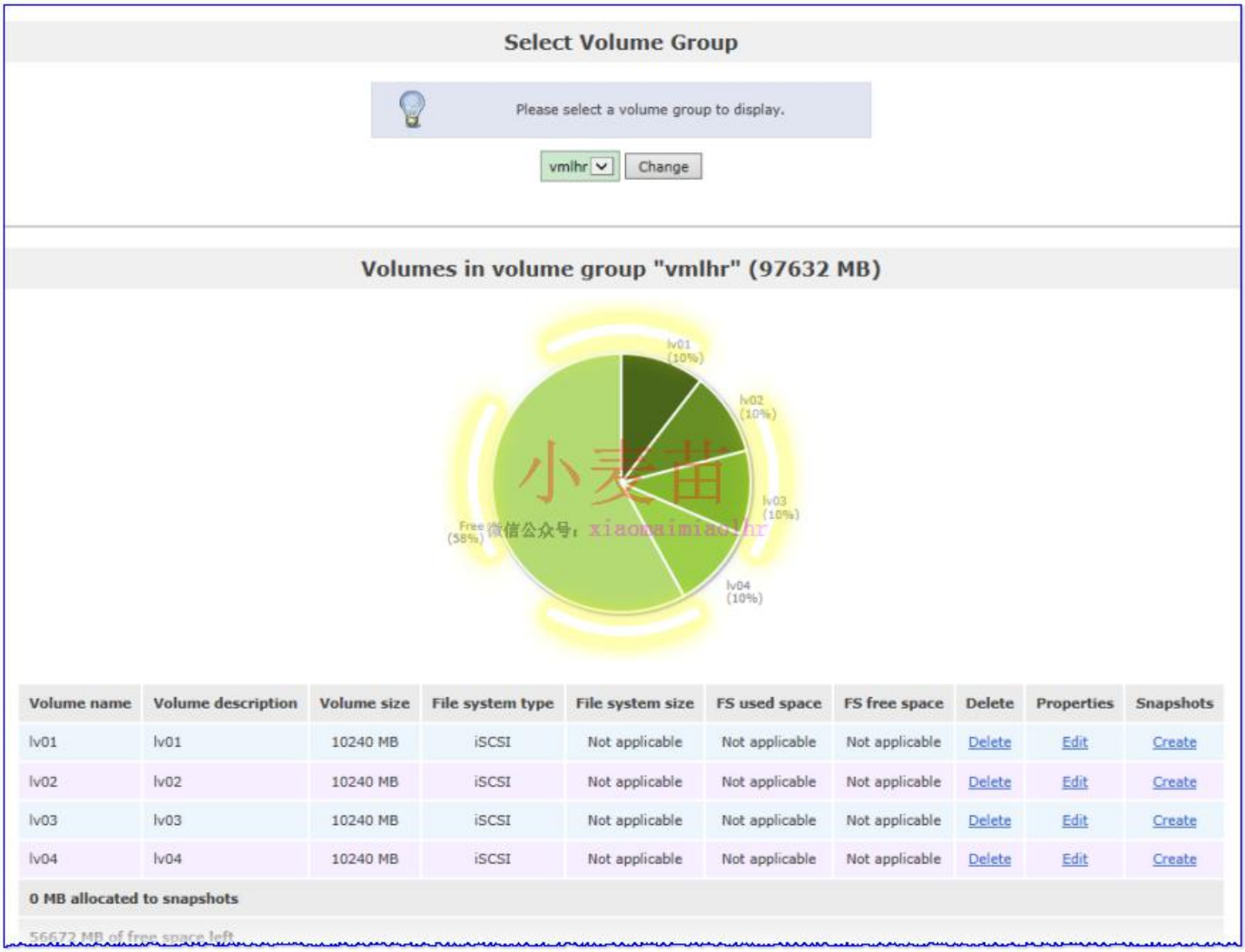
Create a volume in "vmlhr"

Volume Name (*no spaces*. Valid characters [a-z,A-Z,0-9]):	lv01
Volume Description:	lv01
Required Space (MB):	10240
Filesystem / Volume type:	block (iSCSI,FC,etc)

Create


Select Volume Group
Please select a volume group to display.
vmlhr
Change
Volumes in volume group "vmlhr" (97632 MB)
lv01
(10%)
Free
(90%)
Volume name
Volume description
Volume size
File system type
File system size
FS used space
FS free space
Delete
Properties
Snapshots
lv01
lv01
10240 MB
iSCSI
Not applicable
Not applicable
Not applicable
Delete
Edit
Create
0 MB allocated to snapshots
87392 MB of free space left

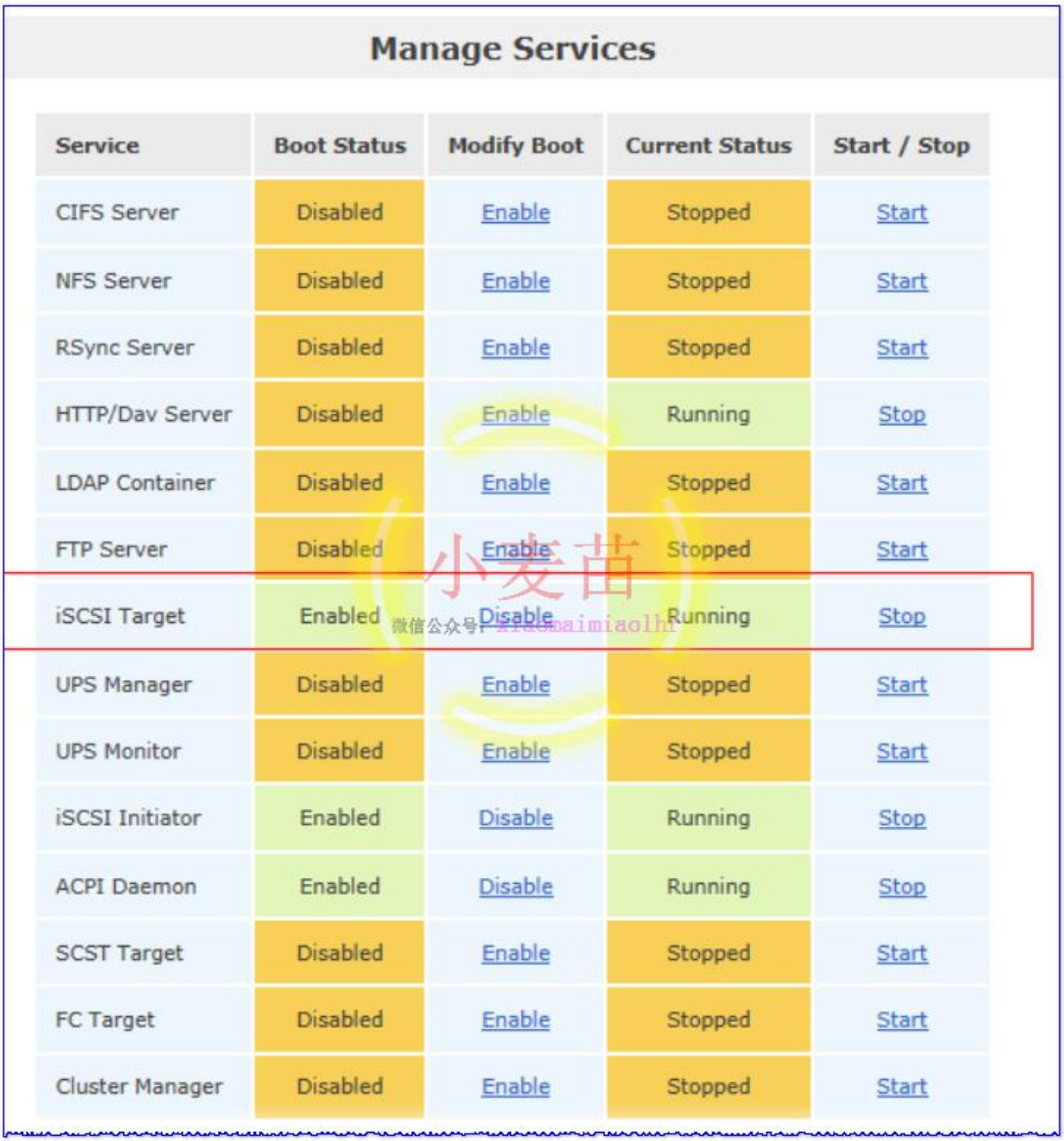
依次共创建 4 个逻辑卷：




```
[root@OFLHR ~]# vgs
  VG    #PV #LV #SN Attr   VSize  VFree
  vmlhr   1   4   0 wz--n- 95.34g 55.34g
[root@OFLHR ~]# pvs
  PV         VG    Fmt  Attr PSize  PFree
  /dev/sdb1  vmlhr lvm2 a-   95.34g 55.34g
[root@OFLHR ~]# lvs
  LV   VG    Attr   LSize  Origin Snap%  Move Log Copy%  Convert
  lv01 vmlhr -wi-a- 10.00g
  lv02 vmlhr -wi-a- 10.00g
  lv03 vmlhr -wi-a- 10.00g
  lv04 vmlhr -wi-a- 10.00g
[root@OFLHR ~]# fdisk -l

Disk /dev/sda: 10.7 GB, 10737418240 bytes
255 heads, 63 sectors/track, 1305 cylinders, total 20971520 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x000adc2c

   Device Boot      Start         End      Blocks   Id  System
/dev/sda1   *          63      610469      305203+  83  Linux
/dev/sda2          610470    17382329     8385930   83  Linux
/dev/sda3        17382330    19486844     1052257+  82  Linux swap / Solaris

WARNING: GPT (GUID Partition Table) detected on '/dev/sdb'! The util fdisk doesn't support GPT. Use GNU Parted.
```

```
Disk /dev/sdb: 107.4 GB, 107374182400 bytes
255 heads, 63 sectors/track, 13054 cylinders, total 209715200 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x00000000

   Device Boot      Start         End      Blocks   Id  System
/dev/sdb1               1   209715199   104857599+  ee  GPT

Disk /dev/dm-0: 10.7 GB, 10737418240 bytes
255 heads, 63 sectors/track, 1305 cylinders, total 20971520 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x00000000

Disk /dev/dm-0 doesn't contain a valid partition table

Disk /dev/dm-1: 10.7 GB, 10737418240 bytes
255 heads, 63 sectors/track, 1305 cylinders, total 20971520 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x00000000

Disk /dev/dm-1 doesn't contain a valid partition table

Disk /dev/dm-2: 10.7 GB, 10737418240 bytes
255 heads, 63 sectors/track, 1305 cylinders, total 20971520 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x00000000

Disk /dev/dm-2 doesn't contain a valid partition table

Disk /dev/dm-3: 10.7 GB, 10737418240 bytes
255 heads, 63 sectors/track, 1305 cylinders, total 20971520 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x00000000

Disk /dev/dm-3 doesn't contain a valid partition table
[root@OFLHR ~]#
```

2.3.2 开启 iSCSI Target 服务



Manage Services

Service	Boot Status	Modify Boot	Current Status	Start / Stop
CIFS Server	Disabled	Enable	Stopped	Start
NFS Server	Disabled	Enable	Stopped	Start
RSync Server	Disabled	Enable	Stopped	Start
HTTP/Dav Server	Disabled	Enable	Running	Stop
LDAP Container	Disabled	Enable	Stopped	Start
FTP Server	Disabled	Enable	Stopped	Start
iSCSI Target	Enabled	Disable	Running	Stop
UPS Manager	Disabled	Enable	Stopped	Start
UPS Monitor	Disabled	Enable	Stopped	Start
iSCSI Initiator	Enabled	Disable	Running	Stop
ACPI Daemon	Enabled	Disable	Running	Stop
SCST Target	Disabled	Enable	Stopped	Start
FC Target	Disabled	Enable	Stopped	Start
Cluster Manager	Disabled	Enable	Stopped	Start

点击 Services 标签栏设置 iSCSI Target 为 Enable 开启服务 Start。

2.3.3 LUN Mapping 操作

返回 Volumes 标签页，点击 iSCSI Targets

点击 Add

选择 LUN Mapping 标签 点击 Map

2.3.4 Network ACL

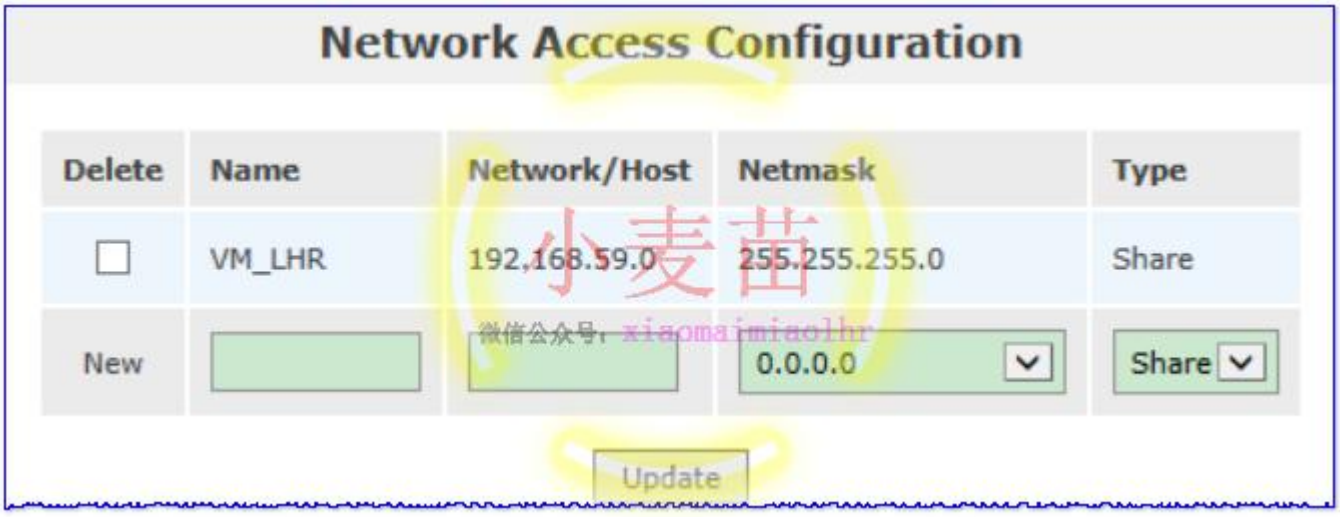
由于 iSCSI 是走 IP 网络，因此我们要允许网络中的计算机可以透过 IP 来访问。下面就是 OpenFiler 中 IP 网络和同一网段中其他主机的连接方法。

1．进入 OpenFiler 中的 System，并且直接拉到页面的下方。

2．在 Network Access Configuration 的地方输入这个网络访问的名称，如 VM_LHR。

3．输入主机的 IP 段。注意不可以输入单一主机的 IP，这样会都无法访问。我们在这边输入 192.168.59.0，表示从 192.168.59.1 一直到 192.168.59.254 都能访问。

4．在 Netmask 中选择 255.255.255.0，并且在 Type 下拉列表框中选择 Share，之后即可以单击 Update 按钮。



选择完之后就更新

至此就可以在这个 OpenFiler 中看到被授权的网段了。

在 iSCSI Targets 中，点击 Network ACL 标签

设置 Access 为 Allow 然后点击 Update

到此存储的配置已经完成

2.3.5 /etc/initiators.deny

注释掉 iqn.2006-01.com.openfiler:tsn.5e423e1e4d90 ALL：

```
[root@OFLHR ~]# more /etc/initiators.deny

# PLEASE DO NOT MODIFY THIS CONFIGURATION FILE!
#      This configuration file was autogenerated
#      by Openfiler. Any manual changes will be overwritten
#      Generated at: Sat Jan 21 1:49:55 CST 2017


#iqn.2006-01.com.openfiler:tsn.5e423e1e4d90 ALL


# End of Openfiler configuration

[root@OFLHR ~]#
```

第 3 章 RAC 中配置共享

3.1 RAC 节点配置 iSCSI

iSCSI（Internet Small Computer System Interface）。iSCSI 技术由 IBM 公司研究开发，是一个供硬件设备使用的、可以在 IP 协议的上层运行的 SCSI 指令集，这种指令集合可以实现在 IP 网络上运行 SCSI 协议，使其能够在诸如高速千兆以太网上进行路由选择。iSCSI 技术是一种新储存技术，该技术是将现有 SCSI 接口与以太网络(Ethernet)技术结合，使服务器可与使用 IP 网络的储存装置互相交换资料。iSCSI 是一种基于 TCP/IP 的协议，用来建立和管理 IP 存储设备、主机和客户机等之间的相互连接，并创建存储区域网络（SAN）。

iSCSI target：就是储存设备端，存放磁盘或 RAID 的设备，目前也能够将 Linux 主机模拟成 iSCSI target 了！目的在提供其他主机使用的『磁盘』；

iSCSI initiator：就是能够使用 target 的用户端，通常是服务器。也就是说，想要连接到 iSCSI target 的服务器，也必须要安装 iSCSI initiator 的相关功能后才能够使用 iSCSI target 提供的磁盘。

3.1.1 iSCSI target

```
[root@OFLHR ~]# service iscsi-target start
Starting iSCSI target service: [  OK  ]
[root@OFLHR ~]# more /etc/ietd.conf
#####   WARNING!!! - This configuration file generated by Openfiler. DO NOT MANUALLY EDIT.  #####


Target iqn.2006-01.com.openfiler:tsn.5e423e1e4d90
       HeaderDigest None
       DataDigest None
       MaxConnections 1
       InitialR2T Yes
       ImmediateData No
       MaxRecvDataSegmentLength 131072
       MaxXmitDataSegmentLength 131072
```

```
        MaxBurstLength 262144
        FirstBurstLength 262144
        DefaultTime2Wait 2
        DefaultTime2Retain 20
        MaxOutstandingR2T 8
        DataPDUInOrder Yes
        DataSequenceInOrder Yes
        ErrorRecoveryLevel 0
        Lun 0 Path=/dev/vmlhr/lv01,Type=blockio,ScsiSN=22llvD-CacO-MOMA,ScsiId=22llvD-CacO-MOMA,IOMode=wt
        Lun 1 Path=/dev/vmlhr/lv02,Type=blockio,ScsiSN=BgLpy9-u7PH-csDC,ScsiId=BgLpy9-u7PH-csDC,IOMode=wt
        Lun 2 Path=/dev/vmlhr/lv03,Type=blockio,ScsiSN=38KsSC-REKL-yPgW,ScsiId=38KsSC-REKL-yPgW,IOMode=wt
        Lun 3 Path=/dev/vmlhr/lv04,Type=blockio,ScsiSN=aN5blo-NyMp-L4Jl,ScsiId=aN5blo-NyMp-L4Jl,IOMode=wt


[root@OFLHR ~]# ps -ef|grep iscsi
root      937    2  0 01:01 ?       00:00:00 [iscsi_eh]
root      946    1  0 01:01 ?       00:00:00 iscsid
root      947    1  0 01:01 ?       00:00:00 iscsid
root    13827  1217  0 02:43 pts/1    00:00:00 grep iscsi
[root@OFLHR ~]# cat /proc/net/iet/volume
tid:1 name:iqn.2006-01.com.openfiler:tsn.5e423e1e4d90
        lun:0 state:0 iotype:blockio iomode:wt path:/dev/vmlhr/lv01
        lun:1 state:0 iotype:blockio iomode:wt path:/dev/vmlhr/lv02
        lun:2 state:0 iotype:blockio iomode:wt path:/dev/vmlhr/lv03
        lun:3 state:0 iotype:blockio iomode:wt path:/dev/vmlhr/lv04
[root@OFLHR ~]# cat /proc/net/iet/session
tid:1 name:iqn.2006-01.com.openfiler:tsn.5e423e1e4d90
[root@OFLHR ~]#
```

3.1.2 iSCSI initiator

3.1.2.1 安装 iSCSI initiator

RAC 的 2 个节点分别安装 iSCSI initiator。

```
[root@raclhr-12cR1-N1 ~]# rpm -qa|grep iscsi
iscsi-initiator-utils-6.2.0.873-10.el6.x86_64
[root@raclhr-12cR1-N1 ~]#
```

若未安装可使用 yum install iscsi-initiator-utils*进行安装。

3.1.2.2 iscsiadm

iscsi initiator 主要通过 iscsiadm 命令管理，我们先查看提供服务的 iscsi target 机器上有哪些 target:

```
[root@raclhr-12cR1-N1 ~]# iscsiadm --mode discovery --type sendtargets --portal 192.168.59.200
[  OK  ] iscsid: [  OK  ]
192.168.59.200:3260,1 iqn.2006-01.com.openfiler:tsn.5e423e1e4d90
192.168.2.200:3260,1 iqn.2006-01.com.openfiler:tsn.5e423e1e4d90
[root@raclhr-12cR1-N1 ~]# ps -ef|grep iscsi
root      2619    2  0 11:32 ?       00:00:00 [iscsi_eh]
root      2651    1  0 11:32 ?       00:00:00 iscsiuio
root      2658    1  0 11:32 ?       00:00:00 iscsid
```

```
root     2659    1  0 11:32 ?       00:00:00 iscsid
root     2978 56098  0 11:33 pts/1    00:00:00 grep iscsi
[root@raclhr-12cR1-N1 ~]#
```

到这一步就可以看出，你服务端创建的 iSCSI Target 的编号和名称。这条命令只需记住-p 后面跟 iSCSI 服务的地址就行了，也可以是主机名，都可以！3260 是服务的端口号，默认的！

然后就可以登陆某个 target 了，登陆成功某个 target 后，这个 target 下的硬盘也就都共享过来了：

```
[root@raclhr-12cR1-N1 ~]# fdisk -l | grep dev
Disk /dev/sda: 21.5 GB, 21474836480 bytes
/dev/sda1   *         1         26      204800   83  Linux
/dev/sda2            26       1332    10485760   8e  Linux LVM
/dev/sda3          1332       2611    10279936   8e  Linux LVM
Disk /dev/sdb: 107.4 GB, 107374182400 bytes
/dev/sdb1             1       1306    10485760   8e  Linux LVM
/dev/sdb2          1306       2611    10485760   8e  Linux LVM
/dev/sdb3          2611       3917    10485760   8e  Linux LVM
/dev/sdb4          3917      13055    73399296    5  Extended
/dev/sdb5          3917       5222    10485760   8e  Linux LVM
/dev/sdb6          5223       6528    10485760   8e  Linux LVM
/dev/sdb7          6528       7834    10485760   8e  Linux LVM
/dev/sdb8          7834       9139    10485760   8e  Linux LVM
/dev/sdb9          9139      10445    10485760   8e  Linux LVM
/dev/sdb10        10445      11750    10485760   8e  Linux LVM
/dev/sdb11        11750      13055    10477568   8e  Linux LVM
Disk /dev/sde: 10.7 GB, 10737418240 bytes
Disk /dev/sdc: 6442 MB, 6442450944 bytes
Disk /dev/sdd: 10.7 GB, 10737418240 bytes
Disk /dev/mapper/vg_rootlhr-Vol02: 2147 MB, 2147483648 bytes
Disk /dev/mapper/vg_rootlhr-Vol00: 10.7 GB, 10737418240 bytes
Disk /dev/mapper/vg_orasoft-lv_orasoft_u01: 21.5 GB, 21474836480 bytes
Disk /dev/mapper/vg_orasoft-lv_orasoft_soft: 21.5 GB, 21474836480 bytes
Disk /dev/mapper/vg_rootlhr-Vol01: 3221 MB, 3221225472 bytes
Disk /dev/mapper/vg_rootlhr-Vol03: 3221 MB, 3221225472 bytes
[root@raclhr-12cR1-N1 ~]# iscsiadm --mode node --targetname iqn.2006-01.com.openfiler:tsn.5e423e1e4d90 -
portal 192.168.59.200:3260 --login
Logging in to [iface: default, target: iqn.2006-01.com.openfiler:tsn.5e423e1e4d90, portal:
192.168.59.200,3260] (multiple)
Logging in to [iface: default, target: iqn.2006-01.com.openfiler:tsn.5e423e1e4d90, portal:
192.168.2.200,3260] (multiple)
Login to [iface: default, target: iqn.2006-01.com.openfiler:tsn.5e423e1e4d90, portal: 192.168.59.200,3260]
successful.
Login to [iface: default, target: iqn.2006-01.com.openfiler:tsn.5e423e1e4d90, portal: 192.168.2.200,3260]
successful.
[root@raclhr-12cR1-N1 ~]#
[root@raclhr-12cR1-N1 ~]# fdisk -l | grep dev
Disk /dev/sda: 21.5 GB, 21474836480 bytes
/dev/sda1   *         1         26      204800   83  Linux
/dev/sda2            26       1332    10485760   8e  Linux LVM
/dev/sda3          1332       2611    10279936   8e  Linux LVM
Disk /dev/sdb: 107.4 GB, 107374182400 bytes
/dev/sdb1             1       1306    10485760   8e  Linux LVM
/dev/sdb2          1306       2611    10485760   8e  Linux LVM
/dev/sdb3          2611       3917    10485760   8e  Linux LVM
/dev/sdb4          3917      13055    73399296    5  Extended
/dev/sdb5          3917       5222    10485760   8e  Linux LVM
/dev/sdb6          5223       6528    10485760   8e  Linux LVM
/dev/sdb7          6528       7834    10485760   8e  Linux LVM
/dev/sdb8          7834       9139    10485760   8e  Linux LVM
/dev/sdb9          9139      10445    10485760   8e  Linux LVM
/dev/sdb10        10445      11750    10485760   8e  Linux LVM
/dev/sdb11        11750      13055    10477568   8e  Linux LVM
```

```
Disk /dev/sde: 10.7 GB, 10737418240 bytes
Disk /dev/sdc: 6442 MB, 6442450944 bytes
Disk /dev/sdd: 10.7 GB, 10737418240 bytes
Disk /dev/mapper/vg rootlhr-Vol02: 2147 MB, 2147483648 bytes
Disk /dev/mapper/vg rootlhr-Vol00: 10.7 GB, 10737418240 bytes
Disk /dev/mapper/vg orasoft-lv orasoft u01: 21.5 GB, 21474836480 bytes
Disk /dev/mapper/vg orasoft-lv orasoft soft: 21.5 GB, 21474836480 bytes
Disk /dev/mapper/vg rootlhr-Vol01: 3221 MB, 3221225472 bytes
Disk /dev/mapper/vg rootlhr-Vol03: 3221 MB, 3221225472 bytes
Disk /dev/sdf: 10.7 GB, 10737418240 bytes
Disk /dev/sdi: 10.7 GB, 10737418240 bytes
Disk /dev/sdh: 10.7 GB, 10737418240 bytes
Disk /dev/sdl: 10.7 GB, 10737418240 bytes
Disk /dev/sdj: 10.7 GB, 10737418240 bytes
Disk /dev/sdg: 10.7 GB, 10737418240 bytes
Disk /dev/sdk: 10.7 GB, 10737418240 bytes
Disk /dev/sdm: 10.7 GB, 10737418240 bytes
```

这里多出了 8 块盘，在 openfiler 中只 map 了四次，为什么这里是 8 块而不是 4 块呢？因为 openfiler 有 2 块网卡，使用两个 IP 登录两次 iscsi target，所以这里有两块是重复的

要查看各个 iscsi 的信息：

```
# iscsiadm -m session -P 3
```

```
[root@raclhr-12cR1-N1 ~]#
[root@raclhr-12cR1-N1 ~]# iscsiadm -m session -P 3
iSCSI Transport Class version 2.0-870
version 6.2.0-873.10.el6
Target: iqn.2006-01.com.openfiler:tsn.5e423e1e4d90
       Current Portal: 192.168.59.200:3260,1
       Persistent Portal: 192.168.59.200:3260,1
              **********
              Interface:
              **********
              Iface Name: default
              Iface Transport: tcp
              Iface Initiatorname: iqn.1994-05.com.redhat:61d32512355
              Iface IPaddress: 192.168.59.160
              Iface HWaddress: <empty>
              Iface Netdev: <empty>
              SID: 1
              iSCSI Connection State: LOGGED IN
              iSCSI Session State: LOGGED_IN
              Internal iscsid Session State: NO CHANGE
              *********
              Timeouts:
              *********
              Recovery Timeout: 120
              Target Reset Timeout: 30
              LUN Reset Timeout: 30
              Abort Timeout: 15
              *****
              CHAP:
              *****
              username: <empty>
              password: ********
              username in: <empty>
              password in: ********
              ************************
              Negotiated iSCSI params:
              ************************
              HeaderDigest: None
              DataDigest: None
```

```
        MaxRecvDataSegmentLength: 262144
        MaxXmitDataSegmentLength: 131072
        FirstBurstLength: 262144
        MaxBurstLength: 262144
        ImmediateData: No
        InitialR2T: Yes
        MaxOutstandingR2T: 1
        ************************
        Attached SCSI devices:
        ************************
        Host Number: 4  State: running
        scsi4 Channel 00 Id 0 Lun: 0
              Attached scsi disk sdg        State: running
        scsi4 Channel 00 Id 0 Lun: 1
              Attached scsi disk sdj        State: running
        scsi4 Channel 00 Id 0 Lun: 2
              Attached scsi disk sdk        State: running
        scsi4 Channel 00 Id 0 Lun: 3
              Attached scsi disk sdm        State: running
Current Portal: 192.168.2.200:3260,1
Persistent Portal: 192.168.2.200:3260,1
        **********
        Interface:
        **********
        Iface Name: default
        Iface Transport: tcp
        Iface Initiatorname: iqn.1994-05.com.redhat:61d32512355
        Iface IPaddress: 192.168.2.100
        Iface HWaddress: <empty>
        Iface Netdev: <empty>
        SID: 2
        iSCSI Connection State: LOGGED IN
        iSCSI Session State: LOGGED_IN
        Internal iscsid Session State: NO CHANGE
        *********
        Timeouts:
        *********
        Recovery Timeout: 120
        Target Reset Timeout: 30
        LUN Reset Timeout: 30
        Abort Timeout: 15
        *****
        CHAP:
        *****
        username: <empty>
        password: ********
        username_in: <empty>
        password_in: ********
        ************************
        Negotiated iSCSI params:
        ************************
        HeaderDigest: None
        DataDigest: None
        MaxRecvDataSegmentLength: 262144
        MaxXmitDataSegmentLength: 131072
        FirstBurstLength: 262144
        MaxBurstLength: 262144
        ImmediateData: No
        InitialR2T: Yes
        MaxOutstandingR2T: 1
        ************************
        Attached SCSI devices:
        ************************
        Host Number: 5  State: running
```

```
            scsi5 Channel 00 Id 0 Lun: 0
                  Attached scsi disk sdf        State: running
            scsi5 Channel 00 Id 0 Lun: 1
                  Attached scsi disk sdh        State: running
            scsi5 Channel 00 Id 0 Lun: 2
                  Attached scsi disk sdi        State: running
            scsi5 Channel 00 Id 0 Lun: 3
                  Attached scsi disk sdl        State: running
[root@raclhr-12cR1-N1 ~]#
```

登陆之后要对新磁盘进行分区，格式化，然后在挂载即可

完成这些命令后，iscsi initator 会把这些信息记录到/var/lib/iscsi 目录下：

/var/lib/iscsi/send_targets 记录了各个 target 的情况，/var/lib/iscsi/nodes 记录了各个 target 下的 nodes 情况。下次再启动 iscsi initator 时（service iscsi start），就会自动登陆各个 target 上。如果想让重新手工登陆各个 target，需要把/var/lib/iscsi/send_targets 目录下的内容和 /var/lib/iscsi/nodes 下的内容全部删除掉。

3.2 多路径 multipath

3.2.1 RAC 的 2 个节点上分别安装 multipath 软件

1、安装多路径软件包：

```
[root@raclhr-12cR1-N1 ~]# mount /dev/sr0 /media/lhr/cdrom/
mount: block device /dev/sr0 is write-protected, mounting read-only
[root@raclhr-12cR1-N1 ~]# cd /media/lhr/cdrom/Packages/
[root@raclhr-12cR1-N1 Packages]# ll device-mapper-*.x86_64.rpm
-r--r--r-- 104 root root  168424 Oct 30  2013 device-mapper-1.02.79-8.el6.x86_64.rpm
-r--r--r-- 104 root root  118316 Oct 30  2013 device-mapper-event-1.02.79-8.el6.x86_64.rpm
-r--r--r-- 104 root root  112892 Oct 30  2013 device-mapper-event-libs-1.02.79-8.el6.x86_64.rpm
-r--r--r-- 104 root root  199924 Oct 30  2013 device-mapper-libs-1.02.79-8.el6.x86_64.rpm
-r--r--r--  95 root root  118892 Oct 25  2013 device-mapper-multipath-0.4.9-72.el6.x86_64.rpm
-r--r--r--  95 root root  184760 Oct 25  2013 device-mapper-multipath-libs-0.4.9-72.el6.x86_64.rpm
-r--r--r--  96 root root 2444388 Oct 30  2013 device-mapper-persistent-data-0.2.8-2.el6.x86_64.rpm
[root@raclhr-12cR1-N1 Packages]# ll iscsi*
-r--r--r-- 101 root root 702300 Oct 29  2013 iscsi-initiator-utils-6.2.0.873-10.el6.x86_64.rpm
[root@raclhr-12cR1-N1 Packages]# rpm -qa|grep device-mapper
device-mapper-persistent-data-0.2.8-2.el6.x86_64
device-mapper-1.02.79-8.el6.x86_64
device-mapper-event-libs-1.02.79-8.el6.x86_64
device-mapper-event-1.02.79-8.el6.x86_64
device-mapper-libs-1.02.79-8.el6.x86_64
[root@raclhr-12cR1-N1 Packages]# rpm -ivh device-mapper-1.02.79-8.el6.x86_64.rpm
warning: device-mapper-1.02.79-8.el6.x86_64.rpm: Header V3 RSA/SHA256 Signature, key ID fd431d51: NOKEY
Preparing...                ########################################### [100%]
       package device-mapper-1.02.79-8.el6.x86_64 is already installed
[root@raclhr-12cR1-N1 Packages]# rpm -ivh device-mapper-event-1.02.79-8.el6.x86_64.rpm
warning: device-mapper-event-1.02.79-8.el6.x86_64.rpm: Header V3 RSA/SHA256 Signature, key ID fd431d51:
NOKEY
Preparing...                ########################################### [100%]
       package device-mapper-event-1.02.79-8.el6.x86_64 is already installed
[root@raclhr-12cR1-N1 Packages]# rpm -ivh device-mapper-multipath-0.4.9-72.el6.x86_64.rpm
warning: device-mapper-multipath-0.4.9-72.el6.x86_64.rpm: Header V3 RSA/SHA256 Signature, key ID fd431d51:
NOKEY
error: Failed dependencies:
       device-mapper-multipath-libs = 0.4.9-72.el6 is needed by device-mapper-multipath-0.4.9-72.el6.x86_64
       libmpathpersist.so.0()(64bit) is needed by device-mapper-multipath-0.4.9-72.el6.x86_64
       libmultipath.so()(64bit) is needed by device-mapper-multipath-0.4.9-72.el6.x86_64
[root@raclhr-12cR1-N1 Packages]# rpm -ivh device-mapper-multipath-libs-0.4.9-72.el6.x86_64.rpm
```

```
warning: device-mapper-multipath-libs-0.4.9-72.el6.x86_64.rpm: Header V3 RSA/SHA256 Signature, key ID
fd431d51: NOKEY
Preparing...                ########################################### [100%]
   1:device-mapper-multipath################################################ [100%]
[root@raclhr-12cR1-N1 Packages]# rpm -ivh device-mapper-multipath-0.4.9-72.el6.x86_64.rpm
warning: device-mapper-multipath-0.4.9-72.el6.x86_64.rpm: Header V3 RSA/SHA256 Signature, key ID fd431d51:
NOKEY
Preparing...                ########################################### [100%]
   1:device-mapper-multipath################################################ [100%]
[root@raclhr-12cR1-N1 Packages]# rpm -qa|grep device-mapper
device-mapper-multipath-0.4.9-72.el6.x86_64
device-mapper-persistent-data-0.2.8-2.el6.x86_64
device-mapper-1.02.79-8.el6.x86_64
device-mapper-event-libs-1.02.79-8.el6.x86_64
device-mapper-event-1.02.79-8.el6.x86_64
device-mapper-multipath-libs-0.4.9-72.el6.x86_64
device-mapper-libs-1.02.79-8.el6.x86_64
[root@raclhr-12cR1-N2 Packages]#
```

```
rpm -ivh device-mapper-multipath-libs-0.4.9-72.el6.x86_64.rpm
rpm -ivh device-mapper-multipath-0.4.9-72.el6.x86_64.rpm
```

3.2.2 启动 multipath

将多路径软件添加至内核模块中

```
modprobe dm-multipath
modprobe dm-round-robin
```

检查内核添加情况

```
[root@raclhr-12cR1-N1 Packages]# lsmod |grep multipath
dm_multipath          17724  1 dm_round_robin
dm_mod                84209  16 dm_multipath,dm_mirror,dm_log
[root@raclhr-12cR1-N1 Packages]#
```

将多路径软件 multipath 设置为开机自启动

```
[root@raclhr-12cR1-N1 Packages]# chkconfig  --level 2345 multipathd on
[root@raclhr-12cR1-N1 Packages]#
[root@raclhr-12cR1-N1 Packages]# chkconfig  --list|grep multipathd
multipathd      0:off   1:off   2:on    3:on    4:on    5:on    6:off
[root@raclhr-12cR1-N1 Packages]#
```

启动 multipath 服务

```
[root@raclhr-12cR1-N1 Packages]# service multipathd restart
ux_socket_connect: No such file or directory
Stopping multipathd daemon: [FAILED]
Starting multipathd daemon: [  OK  ]
[root@raclhr-12cR1-N1 Packages]#
```

3.2.3 配置多路径软件/etc/multipath.conf

1、配置 multipath 软件，编辑/etc/multipath.conf

注意:默认情况下，/etc/multipath.conf 是不存在的，需要用如下命令生成 multipath.conf 文件:

```
/sbin/mpathconf --enable --find_multipaths y --with_module y --with_chkconfig y
```

```
[root@raclhr-12cR1-N1 ~]# multipath -ll
Jan 23 12:52:54 | /etc/multipath.conf does not exist, blacklisting all devices.
Jan 23 12:52:54 | A sample multipath.conf file is located at
Jan 23 12:52:54 | /usr/share/doc/device-mapper-multipath-0.4.9/multipath.conf
Jan 23 12:52:54 | You can run /sbin/mpathconf to create or modify /etc/multipath.conf
[root@raclhr-12cR1-N1 ~]# multipath -ll
Jan 23 12:53:49 | /etc/multipath.conf does not exist, blacklisting all devices.
Jan 23 12:53:49 | A sample multipath.conf file is located at
Jan 23 12:53:49 | /usr/share/doc/device-mapper-multipath-0.4.9/multipath.conf
Jan 23 12:53:49 | You can run /sbin/mpathconf to create or modify /etc/multipath.conf
[root@raclhr-12cR1-N1 ~]# /sbin/mpathconf --enable --find multipaths y --with module y --with chkconfig y
[root@raclhr-12cR1-N1 ~]#
[root@raclhr-12cR1-N1 ~]# ll /etc/multipath.conf
-rw------- 1 root root 2775 Jan 23 12:55 /etc/multipath.conf
[root@raclhr-12cR1-N1 ~]#
```

2、查看并获取存储分配给服务器的逻辑盘 lun 的 wwid 信息

```
[root@raclhr-12cR1-N1 multipath]# multipath -v0
[root@raclhr-12cR1-N1 multipath]# more /etc/multipath/wwids
# Multipath wwids, Version : 1.0
# NOTE: This file is automatically maintained by multipath and multipathd.
# You should not need to edit this file in normal circumstances.
#
# Valid WWIDs:
/14f504e46494c455232326c6c76442d4361634f2d4d4f4d41/
/14f504e46494c455242674c7079392d753750482d63734443/
/14f504e46494c455233384b7353432d52454b4c2d79506757/
/14f504e46494c4552614e35626c6f2d4e794d702d4c344a6c/
[root@raclhr-12cR1-N1 multipath]#
```

将文件/etc/multipath/wwids 和/etc/multipath/bindings 的内容覆盖节点 2:

```
[root@raclhr-12cR1-N2 ~]# multipath -v0
[root@raclhr-12cR1-N2 ~]# more /etc/multipath/wwids
# Multipath wwids, Version : 1.0
# NOTE: This file is automatically maintained by multipath and multipathd.
# You should not need to edit this file in normal circumstances.
#
# Valid WWIDs:
/14f504e46494c455232326c6c76442d4361634f2d4d4f4d41/
/14f504e46494c455242674c7079392d753750482d63734443/
/14f504e46494c455233384b7353432d52454b4c2d79506757/
/14f504e46494c4552614e35626c6f2d4e794d702d4c344a6c/
[root@raclhr-12cR1-N1 ~]# more /etc/multipath/bindings
# Multipath bindings, Version : 1.0
# NOTE: this file is automatically maintained by the multipath program.
# You should not need to edit this file in normal circumstances.
#
# Format:
# alias wwid
#
mpatha 14f504e46494c455232326c6c76442d4361634f2d4d4f4d41
```

```
mpathb 14f504e46494c455242674c7079392d753750482d63734443
mpathc 14f504e46494c455233384b7353432d52454b4c2d79506757
mpathd 14f504e46494c4552614e35626c6f2d4e794d702d4c344a6c
[root@raclhr-12cR1-N1 ~]#
```

```
[root@raclhr-12cR1-N2 ~]#
[root@raclhr-12cR1-N1 multipath]# multipath -ll
mpathd (14f504e46494c4552614e35626c6f2d4e794d702d4c344a6c) dm-9 OPNFILER,VIRTUAL-DISK
size=10G features='0' hwhandler='0' wp=rw
|-+- policy='round-robin 0' prio=1 status=active
| `- 5:0:0:3 sdk 8:160 active ready running
`-+- policy='round-robin 0' prio=1 status=enabled
  `- 4:0:0:3 sdm 8:192 active ready running
mpathc (14f504e46494c455233384b7353432d52454b4c2d79506757) dm-8 OPNFILER,VIRTUAL-DISK
size=10G features='0' hwhandler='0' wp=rw
|-+- policy='round-robin 0' prio=1 status=active
| `- 5:0:0:2 sdj 8:144 active ready running
`-+- policy='round-robin 0' prio=1 status=enabled
  `- 4:0:0:2 sdl 8:176 active ready running
mpathb (14f504e46494c455242674c7079392d753750482d63734443) dm-7 OPNFILER,VIRTUAL-DISK
size=10G features='0' hwhandler='0' wp=rw
|-+- policy='round-robin 0' prio=1 status=active
| `- 4:0:0:1 sdh 8:112 active ready running
`-+- policy='round-robin 0' prio=1 status=enabled
  `- 5:0:0:1 sdi 8:128 active ready running
mpatha (14f504e46494c455232326c6c76442d4361634f2d4d4f4d41) dm-6 OPNFILER,VIRTUAL-DISK
size=10G features='0' hwhandler='0' wp=rw
|-+- policy='round-robin 0' prio=1 status=active
| `- 4:0:0:0 sdf 8:80  active ready running
`-+- policy='round-robin 0' prio=1 status=enabled
  `- 5:0:0:0 sdg 8:96  active ready running
[root@raclhr-12cR1-N1 multipath]# fdisk -l | grep dev
Disk /dev/sda: 21.5 GB, 21474836480 bytes
/dev/sda1   *         1         26      204800   83  Linux
/dev/sda2            26       1332    10485760   8e  Linux LVM
/dev/sda3          1332       2611    10279936   8e  Linux LVM
Disk /dev/sdb: 107.4 GB, 107374182400 bytes
/dev/sdb1             1       1306    10485760   8e  Linux LVM
/dev/sdb2          1306       2611    10485760   8e  Linux LVM
/dev/sdb3          2611       3917    10485760   8e  Linux LVM
/dev/sdb4          3917      13055    73399296    5  Extended
/dev/sdb5          3917       5222    10485760   8e  Linux LVM
/dev/sdb6          5223       6528    10485760   8e  Linux LVM
/dev/sdb7          6528       7834    10485760   8e  Linux LVM
/dev/sdb8          7834       9139    10485760   8e  Linux LVM
/dev/sdb9          9139      10445    10485760   8e  Linux LVM
/dev/sdb10        10445      11750    10485760   8e  Linux LVM
/dev/sdb11        11750      13055    10477568   8e  Linux LVM
Disk /dev/sdc: 6442 MB, 6442450944 bytes
Disk /dev/sdd: 10.7 GB, 10737418240 bytes
Disk /dev/sde: 10.7 GB, 10737418240 bytes
Disk /dev/mapper/vg rootlhr-Vol02: 2147 MB, 2147483648 bytes
Disk /dev/mapper/vg rootlhr-Vol00: 10.7 GB, 10737418240 bytes
Disk /dev/mapper/vg orasoft-lv orasoft u01: 21.5 GB, 21474836480 bytes
Disk /dev/mapper/vg orasoft-lv orasoft soft: 21.5 GB, 21474836480 bytes
Disk /dev/mapper/vg rootlhr-Vol01: 3221 MB, 3221225472 bytes
Disk /dev/mapper/vg_rootlhr-Vol03: 3221 MB, 3221225472 bytes
Disk /dev/sdf: 10.7 GB, 10737418240 bytes
Disk /dev/sdg: 10.7 GB, 10737418240 bytes
Disk /dev/sdh: 10.7 GB, 10737418240 bytes
Disk /dev/sdi: 10.7 GB, 10737418240 bytes
```

```
Disk /dev/sdj: 10.7 GB, 10737418240 bytes
Disk /dev/sdk: 10.7 GB, 10737418240 bytes
Disk /dev/sdl: 10.7 GB, 10737418240 bytes
Disk /dev/sdm: 10.7 GB, 10737418240 bytes
Disk /dev/mapper/mpatha: 10.7 GB, 10737418240 bytes
Disk /dev/mapper/mpathb: 10.7 GB, 10737418240 bytes
Disk /dev/mapper/mpathc: 10.7 GB, 10737418240 bytes
Disk /dev/mapper/mpathd: 10.7 GB, 10737418240 bytes
[root@raclhr-12cR1-N1 multipath]#
```

3.2.4 编辑/etc/multipath.conf

```
for i in f g h i j k l m ;
do
echo "KERNEL==\"sd*\", BUS==\"scsi\", PROGRAM==\"/sbin/scsi_id --whitelisted
--device=/dev/\$name\",RESULT==\"`scsi_id --whitelisted
--device=/dev/sd$i`\",NAME=\"asm-disk$i\",OWNER=\"grid\",GROUP=\"asmadmin\",MODE=\"0660\""
done
```

```
[root@raclhr-12cR1-N1 multipath]# for i in f g h i j k l m ;
> do
> echo "KERNEL==\"sd*\", BUS==\"scsi\", PROGRAM==\"/sbin/scsi_id --whitelisted
--device=/dev/\$name\",RESULT==\"`scsi_id --whitelisted
--device=/dev/sd$i`\",NAME=\"asm-disk$i\",OWNER=\"grid\",GROUP=\"asmadmin\",MODE=\"0660\""
> done
KERNEL=="sd*", BUS=="scsi", PROGRAM=="/sbin/scsi_id --whitelisted
--device=/dev/$name",RESULT=="14f504e46494c455232326c6c76442d4361634f2d4d4f4d41",NAME="asm-diskf",OWNER="grid",GROUP="asmadm
in",MODE="0660"
KERNEL=="sd*", BUS=="scsi", PROGRAM=="/sbin/scsi_id --whitelisted
--device=/dev/$name",RESULT=="14f504e46494c455232326c6c76442d4361634f2d4d4f4d41",NAME="asm-diskg",OWNER="grid",GROUP="asmadm
in",MODE="0660"
KERNEL=="sd*", BUS=="scsi", PROGRAM=="/sbin/scsi_id --whitelisted
--device=/dev/$name",RESULT=="14f504e46494c455242674c7079392d753750482d63734443",NAME="asm-diskh",OWNER="grid",GROUP="asmadm
in",MODE="0660"
KERNEL=="sd*", BUS=="scsi", PROGRAM=="/sbin/scsi_id --whitelisted
--device=/dev/$name",RESULT=="14f504e46494c455242674c7079392d753750482d63734443",NAME="asm-diski",OWNER="grid",GROUP="asmadm
in",MODE="0660"
KERNEL=="sd*", BUS=="scsi", PROGRAM=="/sbin/scsi_id --whitelisted
--device=/dev/$name",RESULT=="14f504e46494c455233384b7353432d52454b4c2d79506757",NAME="asm-diskj",OWNER="grid",GROUP="asmadm
in",MODE="0660"
KERNEL=="sd*", BUS=="scsi", PROGRAM=="/sbin/scsi_id --whitelisted
--device=/dev/$name",RESULT=="14f504e46494c4552614e35626c6f2d4e794d702d4c344a6c",NAME="asm-diskk",OWNER="grid",GROUP="asmadm
in",MODE="0660"
KERNEL=="sd*", BUS=="scsi", PROGRAM=="/sbin/scsi_id --whitelisted
--device=/dev/$name",RESULT=="14f504e46494c455233384b7353432d52454b4c2d79506757",NAME="asm-diskl",OWNER="grid",GROUP="asmadm
in",MODE="0660"
KERNEL=="sd*", BUS=="scsi", PROGRAM=="/sbin/scsi_id --whitelisted
--device=/dev/$name",RESULT=="14f504e46494c4552614e35626c6f2d4e794d702d4c344a6c",NAME="asm-diskm",OWNER="grid",GROUP="asmadm
in",MODE="0660"
[root@raclhr-12cR1-N1 multipath]#
[root@raclhr-12cR1-N1 multipath]# more   /etc/multipath.conf
defaults {
       find_multipaths yes
       user_friendly_names yes
}

blacklist {
```

```
     wwid 3600508b1001c5ae72efe1fea025cd2e5
     devnode "^hd[a-z]"
     devnode "^sd[a-e]"
     devnode "^sda"
}

multipaths {
      multipath {
            wwid                14f504e46494c455232326c6c76442d4361634f2d4d4f4d41
            alias               VMLHRStorage000
            path_grouping_policy   multibus
            path_selector         "round-robin 0"
            failback             manual
            rr_weight            priorities
            no_path_retry         5
     }
      multipath {
            wwid                14f504e46494c455242674c7079392d753750482d63734443
            alias               VMLHRStorage001
            path_grouping_policy   multibus
            path_selector         "round-robin 0"
            failback             manual
            rr_weight            priorities
            no_path_retry         5
      }
      multipath {
            wwid                14f504e46494c455233384b7353432d52454b4c2d79506757
            alias               VMLHRStorage002
            path_grouping_policy   multibus
            path_selector         "round-robin 0"
            failback             manual
            rr_weight            priorities
            no_path_retry         5
      }
      multipath {
            wwid                14f504e46494c4552614e35626c6f2d4e794d702d4c344a6c
            alias               VMLHRStorage003
            path_grouping_policy   multibus
            path_selector         "round-robin 0"
            failback             manual
            rr_weight            priorities
            no_path_retry         5
      }
}
devices {
      device {
            vendor              "VMWARE"
            product             "VIRTUAL-DISK"
            path_grouping_policy   multibus
            getuid_callout        "/lib/udev/scsi_id --whitelisted --device=/dev/%n"
            path_checker          readsector0
            path_selector         "round-robin 0"
            hardware_handler       "0"
            failback             15
            rr_weight            priorities
            no_path_retry         queue
      }
}
[root@raclhr-12cR1-N1 multipath]#
```

启动 multipath 配置

```
[root@raclhr-12cR1-N1 ~]# service multipathd restart
ok
Stopping multipathd daemon: [  OK  ]
Starting multipathd daemon: [  OK  ]
[root@raclhr-12cR1-N1 ~]# multipath -ll
VMLHRStorage003 (14f504e46494c4552614e35626c6f2d4e794d702d4c344a6c) dm-9 OPNFILER,VIRTUAL-DISK
size=10G features='1 queue if no path' hwhandler='0' wp=rw
|-+- policy='round-robin 0' prio=1 status=active
| `- 5:0:0:3 sdk 8:160 active ready running
`-+- policy='round-robin 0' prio=1 status=enabled
  `- 4:0:0:3 sdm 8:192 active ready running
VMLHRStorage002 (14f504e46494c455233384b7353432d52454b4c2d79506757) dm-8 OPNFILER,VIRTUAL-DISK
size=10G features='1 queue_if_no_path' hwhandler='0' wp=rw
|-+- policy='round-robin 0' prio=1 status=active
| `- 5:0:0:2 sdj 8:144 active ready running
`-+- policy='round-robin 0' prio=1 status=enabled
  `- 4:0:0:2 sdl 8:176 active ready running
VMLHRStorage001 (14f504e46494c455242674c7079392d753750482d63734443) dm-7 OPNFILER,VIRTUAL-DISK
size=10G features='1 queue_if_no_path' hwhandler='0' wp=rw
|-+- policy='round-robin 0' prio=1 status=active
| `- 4:0:0:1 sdh 8:112 active ready running
`-+- policy='round-robin 0' prio=1 status=enabled
  `- 5:0:0:1 sdi 8:128 active ready running
VMLHRStorage000 (14f504e46494c455232326c6c76442d4361634f2d4d4f4d41) dm-6 OPNFILER,VIRTUAL-DISK
size=10G features='1 queue_if_no_path' hwhandler='0' wp=rw
|-+- policy='round-robin 0' prio=1 status=active
| `- 4:0:0:0 sdf 8:80  active ready running
`-+- policy='round-robin 0' prio=1 status=enabled
  `- 5:0:0:0 sdg 8:96  active ready running
[root@raclhr-12cR1-N1 ~]#
[root@raclhr-12cR1-N1 ~]# multipath -ll|grep LHR
VMLHRStorage003 (14f504e46494c4552614e35626c6f2d4e794d702d4c344a6c) dm-9 OPNFILER,VIRTUAL-DISK
VMLHRStorage002 (14f504e46494c455233384b7353432d52454b4c2d79506757) dm-8 OPNFILER,VIRTUAL-DISK
VMLHRStorage001 (14f504e46494c455242674c7079392d753750482d63734443) dm-7 OPNFILER,VIRTUAL-DISK
VMLHRStorage000 (14f504e46494c455232326c6c76442d4361634f2d4d4f4d41) dm-6 OPNFILER,VIRTUAL-DISK
[root@raclhr-12cR1-N1 ~]#
```

启用 multipath 配置后,会在/dev/mapper 下生成多路径逻辑盘

```
[root@raclhr-12cR1-N1 ~]# cd /dev/mapper
[root@raclhr-12cR1-N1 mapper]# ll
total 0
crw-rw---- 1 root root 10, 58 Jan 23 12:49 control
lrwxrwxrwx 1 root root     7 Jan 23 12:49 vg_orasoft-lv_orasoft_soft -> ../dm-3
lrwxrwxrwx 1 root root     7 Jan 23 12:49 vg_orasoft-lv_orasoft_u01 -> ../dm-2
lrwxrwxrwx 1 root root     7 Jan 23 12:50 vg_rootlhr-Vol00 -> ../dm-1
lrwxrwxrwx 1 root root     7 Jan 23 12:50 vg_rootlhr-Vol01 -> ../dm-4
lrwxrwxrwx 1 root root     7 Jan 23 12:49 vg_rootlhr-Vol02 -> ../dm-0
lrwxrwxrwx 1 root root     7 Jan 23 12:50 vg_rootlhr-Vol03 -> ../dm-5
lrwxrwxrwx 1 root root     7 Jan 23 13:55 VMLHRStorage000 -> ../dm-6
lrwxrwxrwx 1 root root     7 Jan 23 13:55 VMLHRStorage001 -> ../dm-7
lrwxrwxrwx 1 root root     7 Jan 23 13:55 VMLHRStorage002 -> ../dm-8
lrwxrwxrwx 1 root root     7 Jan 23 13:55 VMLHRStorage003 -> ../dm-9
[root@raclhr-12cR1-N1 mapper]#
```

至此，多路径 multipath 配置完成。

3.2.5 配置 multipath 设备的权限

在 6.2 之前配置 multipath 设备的权限只需要在设备配置里增加 uid,gid,mode 就可以

```
uid 1100 #uid
```

gid 1020 #gid

如：

```
      multipath {
            wwid                    360050763008101d4e00000000000000a
            alias                   DATA03
            uid                     501                                     #uid
            gid                     501                                     #gid
}
```

在 6.2 之后配置 multipath 配置文件里去掉 uid,gid,mode 这三个参数，需要使用 udev 使用,示例文件在 /usr/share/doc/device-mapper-version 中有一个模板文件,名为 12-dm-permissions.rules,您可以使用它并将其放在 /etc/udev/rules.d 目录中使其生效。

```
[root@raclhr-12cR1-N1 rules.d]# ll /usr/share/doc/device-mapper-1.02.79/12-dm-permissions.rules
-rw-r--r--. 1 root root 3186 Aug 13  2013 /usr/share/doc/device-mapper-1.02.79/12-dm-permissions.rules
[root@raclhr-12cR1-N1 rules.d]#
[root@raclhr-12cR1-N1 rules.d]# ll
total 24
-rw-r--r-- 1 root root  77 Jan 23 18:06 12-dm-permissions.rules
-rw-r--r-- 1 root root 190 Jan 23 15:40 55-usm.rules
-rw-r--r-- 1 root root 549 Jan 23 15:17 70-persistent-cd.rules
-rw-r--r-- 1 root root 585 Jan 23 15:09 70-persistent-net.rules
-rw-r--r-- 1 root root 633 Jan 23 15:46 99-oracle-asmdevices.rules
-rw-r--r-- 1 root root 916 Jan 23 15:16 99-oracleasm.rules
[root@raclhr-12cR1-N1 rules.d]# more /etc/udev/rules.d/12-dm-permissions.rules
ENV{DM_NAME}=="VMLHRStorage*", OWNER:="grid", GROUP:="asmadmin", MODE:="660"
[root@raclhr-12cR1-N1 rules.d]#
```

将文件/etc/udev/rules.d/12-dm-permissions.rules 复制到节点 2 上。

3.2.6 配置 udev 规则

脚本如下所示：

```
for i in f g h i j k l m ;
do
echo "KERNEL==\"dm-*\", BUS==\"block\", PROGRAM==\"/sbin/scsi_id --whitelisted --replace-whitespace
--device=/dev/\$name\",RESULT==\"`scsi_id --whitelisted --replace-whitespace
--device=/dev/sd$i`\",NAME=\"asm-disk$i\",OWNER=\"grid\",GROUP=\"asmadmin\",MODE=\"0660\"" >>
/etc/udev/rules.d/99-oracleasm.rules
done
```

由于多路径的设置 WWID 有重复，所以应该去掉文件/etc/udev/rules.d/99-oracleasm.rules 中的重复的行。

在节点 1 执行以下操作：

```
[root@raclhr-12cR1-N1 rules.d]# for i in f g h i j k l m ;
> do
> echo "KERNEL==\"dm-*\", BUS==\"block\", PROGRAM==\"/sbin/scsi_id --whitelisted --replace-whitespace
--device=/dev/\$name\",RESULT==\"`scsi_id --whitelisted --replace-whitespace
--device=/dev/sd$i`\",NAME=\"asm-disk$i\",OWNER=\"grid\",GROUP=\"asmadmin\",MODE=\"0660\"" >>
/etc/udev/rules.d/99-oracleasm.rules
> done
```

打开文件/etc/udev/rules.d/99-oracleasm.rules，去掉 WWID 重复的行只保留一行即可。

```
[root@raclhr-12cR1-N1 ~]# cat /etc/udev/rules.d/99-oracleasm.rules
KERNEL=="dm-*", BUS=="block", PROGRAM=="/sbin/scsi_id --whitelisted --replace-whitespace
--device=/dev/$name",RESULT=="14f504e46494c455232326c6c76442d4361634f2d4d4f4d41",NAME="asm-diskf",OWNER="grid",GROUP
="asmadmin",MODE="0660"
KERNEL=="dm-*", BUS=="block", PROGRAM=="/sbin/scsi_id --whitelisted --replace-whitespace
--device=/dev/$name",RESULT=="14f504e46494c455242674c7079392d753750482d63734443",NAME="asm-diskh",OWNER="grid",GROUP
="asmadmin",MODE="0660"
KERNEL=="dm-*", BUS=="block", PROGRAM=="/sbin/scsi id --whitelisted --replace-whitespace
--device=/dev/$name",RESULT=="14f504e46494c455233384b7353432d52454b4c2d79506757",NAME="asm-diskj",OWNER="grid",GROUP
="asmadmin",MODE="0660"
KERNEL=="dm-*", BUS=="block", PROGRAM=="/sbin/scsi_id --whitelisted --replace-whitespace
--device=/dev/$name",RESULT=="14f504e46494c4552614e35626c6f2d4e794d702d4c344a6c",NAME="asm-diskk",OWNER="grid",GROUP
="asmadmin",MODE="0660"
[root@raclhr-12cR1-N1 ~]#
```

将文件/etc/udev/rules.d/99-oracleasm.rules 的内容拷贝到节点 2，然后重启 udev。

```
[root@raclhr-12cR1-N1 ~]# start_udev
Starting udev: [  OK  ]
[root@raclhr-12cR1-N1 ~]#
[root@raclhr-12cR1-N1 ~]# ll /dev/asm-*
brw-rw---- 1 grid asmadmin   8, 32 Jan 23 15:50 /dev/asm-diskc
brw-rw---- 1 grid asmadmin   8, 48 Jan 23 15:48 /dev/asm-diskd
brw-rw---- 1 grid asmadmin   8, 64 Jan 23 15:48 /dev/asm-diske
brw-rw---- 1 grid asmadmin 253,  7 Jan 23 15:46 /dev/asm-diskf
brw-rw---- 1 grid asmadmin 253,  9 Jan 23 15:46 /dev/asm-diskh
brw-rw---- 1 grid asmadmin 253,  6 Jan 23 15:46 /dev/asm-diskj
brw-rw---- 1 grid asmadmin 253,  8 Jan 23 15:46 /dev/asm-diskk
[root@raclhr-12cR1-N1 ~]#
[grid@raclhr-12cR1-N1 ~]$ $ORACLE_HOME/bin/kfod disks=all s=true ds=true
--------------------------------------------------------------------------------
 Disk         Size Header    Path                                     Disk Group   User     Group
================================================================================
   1:       6144 Mb MEMBER    /dev/asm-diskc                           OCR          grid     asmadmin
   2:      10240 Mb MEMBER    /dev/asm-diskd                           DATA         grid     asmadmin
   3:      10240 Mb MEMBER    /dev/asm-diske                           FRA          grid     asmadmin
   4:      10240 Mb CANDIDATE /dev/asm-diskf                           #            grid     asmadmin
   5:      10240 Mb CANDIDATE /dev/asm-diskh                           #            grid     asmadmin
   6:      10240 Mb CANDIDATE /dev/asm-diskj                           #            grid     asmadmin
   7:      10240 Mb CANDIDATE /dev/asm-diskk                           #            grid     asmadmin
--------------------------------------------------------------------------------
ORACLE_SID ORACLE_HOME
================================================================================
     +ASM2 /u01/app/12.1.0/grid
     +ASM1 /u01/app/12.1.0/grid
[grid@raclhr-12cR1-N1 ~]$ asmcmd

ASMCMD> lsdg
State    Type    Rebal  Sector  Block       AU  Total_MB  Free_MB  Req_mir_free_MB  Usable_file_MB
Offline_disks  Voting_files  Name
MOUNTED  EXTERN  N         512   4096  1048576    10240    6487            0         6487          0         N  DATA/
MOUNTED  EXTERN  N         512   4096  1048576    10240   10144            0        10144          0         N  FRA/
MOUNTED  EXTERN  N         512   4096  1048576     6144    1672            0         1672          0         Y  OCR/
ASMCMD> lsdsk
Path
/dev/asm-diskc
/dev/asm-diskd
/dev/asm-diske
ASMCMD>  lsdsk --candidate -p
Group_Num  Disk_Num     Incarn  Mount_Stat  Header_Stat  Mode_Stat  State   Path
        0         1          0  CLOSED      CANDIDATE    ONLINE     NORMAL  /dev/asm-diskf
        0         3          0  CLOSED      CANDIDATE    ONLINE     NORMAL  /dev/asm-diskh
        0         2          0  CLOSED      CANDIDATE    ONLINE     NORMAL  /dev/asm-diskj
```

```
       0        0          0  CLOSED     CANDIDATE    ONLINE     NORMAL  /dev/asm-diskk
ASMCMD>
```

3.3 利用新磁盘创建磁盘组

CREATE DISKGROUP FRA external redundancy DISK '/dev/asm-diskf','/dev/asm-diskh' ATTRIBUTE 'compatible.rdbms' = '12.1', 'compatible.asm' = '12.1';

```
SQL> select path from v$asm_disk;

PATH
--------------------------------------------------------------------------------
/dev/asm-diskk
/dev/asm-diskf
/dev/asm-diskj
/dev/asm-diskh
/dev/asm-diske
/dev/asm-diskd
/dev/asm-diskc

7 rows selected.

SQL> CREATE DISKGROUP TESTMUL external redundancy DISK '/dev/asm-diskf','/dev/asm-diskh' ATTRIBUTE
'compatible.rdbms' = '12.1', 'compatible.asm' = '12.1';

Diskgroup created.

SQL>
ASMCMD> lsdg
State    Type    Rebal  Sector  Block       AU  Total_MB  Free_MB  Req_mir_free_MB  Usable_file_MB  Offline_disks  Voting_files  Name
MOUNTED  EXTERN  N         512   4096  1048576    10240     6487                0            6487              0             N  DATA/
MOUNTED  EXTERN  N         512   4096  1048576    10240    10144                0           10144              0             N  FRA/
MOUNTED  EXTERN  N         512   4096  1048576     6144     1672                0            1672              0             Y  OCR/
MOUNTED  EXTERN  N         512   4096  1048576    20480    20381                0           20381              0             N  TESTMUL/
ASMCMD>

[root@raclhr-12cR1-N1 ~]# crsctl stat res -t | grep -2 TESTMUL
               ONLINE  ONLINE       raclhr-12cr1-n1          STABLE
               ONLINE  ONLINE       raclhr-12cr1-n2          STABLE
ora.TESTMUL.dg
               ONLINE  ONLINE       raclhr-12cr1-n1          STABLE
               ONLINE  ONLINE       raclhr-12cr1-n2          STABLE
[root@raclhr-12cR1-N1 ~]#
```

3.3.1 测试磁盘组

```
[oracle@raclhr-12cR1-N1 ~]$ sqlplus / as sysdba

SQL*Plus: Release 12.1.0.2.0 Production on Mon Jan 23 16:17:28 2017

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Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 - 64bit Production
```

```
With the Partitioning, Real Application Clusters, Automatic Storage Management, OLAP,
Advanced Analytics and Real Application Testing options

SQL> create tablespace TESTMUL datafile '+TESTMUL' size 10M;

Tablespace created.

SQL> select name from v$datafile;

NAME
--------------------------------------------------------------------------------
+DATA/LHRRAC/DATAFILE/system.258.933550527
+DATA/LHRRAC/DATAFILE/undotbs2.269.933551323
+DATA/LHRRAC/DATAFILE/sysaux.257.933550483
+DATA/LHRRAC/DATAFILE/undotbs1.260.933550575
+DATA/LHRRAC/DATAFILE/example.268.933550723
+DATA/LHRRAC/DATAFILE/users.259.933550573
+TESTMUL/LHRRAC/DATAFILE/testmul.256.934042679

7 rows selected.

SQL>
```

将存储停掉一块网卡 eth1：

```
[root@OFLHR ~]# ip a
1: lo: <LOOPBACK,UP,10000> mtu 16436 qdisc noqueue
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,10000> mtu 1500 qdisc pfifo_fast qlen 1000
    link/ether 00:0c:29:98:1a:cd brd ff:ff:ff:ff:ff:ff
    inet 192.168.59.200/24 brd 192.168.59.255 scope global eth0
    inet6 fe80::20c:29ff:fe98:1acd/64 scope link
       valid_lft forever preferred_lft forever
3: eth1: <BROADCAST,MULTICAST,UP,10000> mtu 1500 qdisc pfifo_fast qlen 1000
    link/ether 00:0c:29:98:1a:d7 brd ff:ff:ff:ff:ff:ff
    inet 192.168.2.200/24 brd 192.168.2.255 scope global eth1
    inet6 fe80::20c:29ff:fe98:1ad7/64 scope link
       valid_lft forever preferred_lft forever
[root@OFLHR ~]# ifconfig eth1 down
[root@OFLHR ~]# ip a
1: lo: <LOOPBACK,UP,10000> mtu 16436 qdisc noqueue
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
    inet6 ::1/128 scope host
       valid lft forever preferred lft forever
2: eth0: <BROADCAST,MULTICAST,UP,10000> mtu 1500 qdisc pfifo fast qlen 1000
    link/ether 00:0c:29:98:1a:cd brd ff:ff:ff:ff:ff:ff
    inet 192.168.59.200/24 brd 192.168.59.255 scope global eth0
    inet6 fe80::20c:29ff:fe98:1acd/64 scope link
       valid lft forever preferred lft forever
3: eth1: <BROADCAST,MULTICAST> mtu 1500 qdisc pfifo fast qlen 1000
    link/ether 00:0c:29:98:1a:d7 brd ff:ff:ff:ff:ff:ff
    inet 192.168.2.200/24 brd 192.168.2.255 scope global eth1
[root@OFLHR ~]#
```

rac 节点查看日志：

```
[root@raclhr-12cR1-N1 ~]# tail -f /var/log/messages
Jan 23 16:20:51 raclhr-12cR1-N1 iscsid: connect to 192.168.2.200:3260 failed (No route to host)
```

```
Jan 23 16:20:57 raclhr-12cR1-N1 iscsid: connect to 192.168.2.200:3260 failed (No route to host)
Jan 23 16:21:03 raclhr-12cR1-N1 iscsid: connect to 192.168.2.200:3260 failed (No route to host)
[root@raclhr-12cR1-N1 ~]# multipath -ll
VMLHRStorage003 (14f504e46494c4552614e35626c6f2d4e794d702d4c344a6c) dm-8 OPNFILER,VIRTUAL-DISK
size=10G features='1 queue if no path' hwhandler='0' wp=rw
`-+- policy='round-robin 0' prio=1 status=active
  |- 5:0:0:3 sdm 8:192 failed faulty running
  `- 4:0:0:3 sdl 8:176 active ready  running
VMLHRStorage002 (14f504e46494c455233384b7353432d52454b4c2d79506757) dm-9 OPNFILER,VIRTUAL-DISK
size=10G features='1 queue if no path' hwhandler='0' wp=rw
`-+- policy='round-robin 0' prio=1 status=active
  |- 5:0:0:2 sdj 8:144 failed faulty running
  `- 4:0:0:2 sdk 8:160 active ready  running
VMLHRStorage001 (14f504e46494c455242674c7079392d753750482d63734443) dm-7 OPNFILER,VIRTUAL-DISK
size=10G features='1 queue_if_no_path' hwhandler='0' wp=rw
`-+- policy='round-robin 0' prio=1 status=active
  |- 4:0:0:1 sdi 8:128 active ready  running
  `- 5:0:0:1 sdh 8:112 failed faulty running
VMLHRStorage000 (14f504e46494c455232326c6c76442d4361634f2d4d4f4d41) dm-6 OPNFILER,VIRTUAL-DISK
size=10G features='1 queue_if_no_path' hwhandler='0' wp=rw
`-+- policy='round-robin 0' prio=1 status=active
  |- 4:0:0:0 sdf 8:80  active ready  running
  `- 5:0:0:0 sdg 8:96  failed faulty running
[root@raclhr-12cR1-N1 ~]#
```

表空间可以正常访问：

```
SQL> create table tt tablespace TESTMUL as select * from dual;

Table created.

SQL> select * from tt;

D
-
X

SQL>
```

同理，将 eth1 进行 up，而将 eth0 宕掉，表空间依然正常。**重启集群和存储后，集群一切正常。**

第 4 章　测试多路径

重新搭建一套多路径的环境来测试多路径。

最简单的测试方法，是用 dd 往磁盘读写数据，然后用 iostat 观察各通道的流量和状态，以判断 Failover 或负载均衡方式是否正常：

```
# dd if=/dev/zero of=/dev/mapper/mpath0
# iostat -k 2
```

```
[root@orcltest ~]# multipath -ll
VMLHRStorage003 (14f504e46494c4552674a61727a472d523449782d5336784e) dm-3 OPNFILER,VIRTUAL-DISK
size=10G features='1 queue_if_no_path' hwhandler='0' wp=rw
`-+- policy='round-robin 0' prio=1 status=active
  |- 35:0:0:2 sdf 8:80  active ready running
  `- 36:0:0:2 sdg 8:96  active ready running
VMLHRStorage002 (14f504e46494c4552506a5a5954422d6f6f4e652d34423171) dm-2 OPNFILER,VIRTUAL-DISK
size=10G features='1 queue_if_no_path' hwhandler='0' wp=rw
`-+- policy='round-robin 0' prio=1 status=active
  |- 35:0:0:3 sdh 8:112 active ready running
  `- 36:0:0:3 sdi 8:128 active ready running
```

```
VMLHRStorage001 (14f504e46494c4552324b583573332d774e5a622d696d7334) dm-1 OPNFILER,VIRTUAL-DISK
size=10G features='1 queue_if_no_path' hwhandler='0' wp=rw
`-+- policy='round-robin 0' prio=1 status=active
  |- 35:0:0:1 sdd 8:48  active ready running
  `- 36:0:0:1 sde 8:64  active ready running
VMLHRStorage000 (14f504e46494c45523431576859532d643246412d5154564f) dm-0 OPNFILER,VIRTUAL-DISK
size=10G features='1 queue_if_no_path' hwhandler='0' wp=rw
`-+- policy='round-robin 0' prio=1 status=active
  |- 35:0:0:0 sdb 8:16  active ready running
  `- 36:0:0:0 sdc 8:32  active ready running
[root@orcltest ~]# dd if=/dev/zero of=/dev/mapper/VMLHRStorage001
```

重新开一个窗口执行iostat -k 2可以看到：

```
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.00    0.00    5.23   20.78    0.00   73.99

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
sda               9.00         0.00        92.00          0        184
scd0              0.00         0.00         0.00          0          0
sdb               0.00         0.00         0.00          0          0
sdc               0.00         0.00         0.00          0          0
sdd            1197.50      4704.00     10886.00       9408      21772
sde            1197.50      4708.00     10496.00       9416      20992
sdh               0.00         0.00         0.00          0          0
sdi               0.00         0.00         0.00          0          0
sdf               0.00         0.00         0.00          0          0
sdg               0.00         0.00         0.00          0          0
dm-0              0.00         0.00         0.00          0          0
dm-4              0.00         0.00         0.00          0          0
dm-10             0.00         0.00         0.00          0          0
dm-1           2395.00      9412.00     21382.00      18824      42764
dm-2              0.00         0.00         0.00          0          0
dm-3              0.00         0.00         0.00          0          0
dm-5              0.00         0.00         0.00          0          0
dm-6              0.00         0.00         0.00          0          0
dm-7              0.00         0.00         0.00          0          0
dm-8              0.00         0.00         0.00          0          0
dm-9              0.00         0.00         0.00          0          0
```

```
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.00    0.00    5.23   20.78    0.00   73.99

Device:            tps   kB_read/s   kB_wrtn/s   kB_read   kB_wrtn
sda               9.00        0.00       92.00         0       184
scd0              0.00        0.00        0.00         0         0
sdb               0.00        0.00        0.00         0         0
sdc               0.00        0.00        0.00         0         0
sdd            1197.50     4704.00    10886.00      9408     21772
sde            1197.50     4708.00    10496.00      9416     20992
sdh               0.00        0.00        0.00         0         0
sdi               0.00        0.00        0.00         0         0
sdf               0.00        0.00        0.00         0         0
sdg               0.00        0.00        0.00         0         0
dm-0              0.00        0.00        0.00         0         0
dm-4              0.00        0.00        0.00         0         0
dm-10             0.00        0.00        0.00         0         0
dm-1           2395.00     9412.00    21382.00     18824     42764
dm-2              0.00        0.00        0.00         0         0
dm-3              0.00        0.00        0.00         0         0
dm-5              0.00        0.00        0.00         0         0
dm-6              0.00        0.00        0.00         0         0
dm-7              0.00        0.00        0.00         0         0
dm-8              0.00        0.00        0.00         0         0
dm-9              0.00        0.00        0.00         0         0
```

好了，有关使用OpenFiler来模拟存储配置RAC中ASM共享盘及多路径的测试就到此为止了，2016年结束了，今天是1月23日，明天是1月24日，小麦苗回家过年了，o(∩_∩)o~。

4.1 有关多路径其它理论知识

用multipath生成映射后，会在/dev目录下产生多个指向同一条链路的设备：

```
/dev/mapper/mpathn
/dev/mpath/mpathn
/dev/dm-n
```

但它们的来源是完全不同的：

/dev/mapper/mpathn 是multipath虚拟出来的多路径设备，我们应该使用这个设备；/dev/mapper 中的设备是在引导过程中生成的。可使用这些设备访问多路径设备，例如在生成逻辑卷时。

/dev/mpath/mpathn 是udev设备管理器创建的，实际上就是指向下面的dm-n设备，仅为了方便，不能用来挂载；提供 /dev/mpath 中的设备是为了方便，这样可在一个目录中看到所有多路径设备。这些设备是由 udev 设备管理器生成的，且在系统需要访问它们时不一定能启动。请不要使用这些设备生成逻辑卷或者文件系统。

/dev/dm-n 是软件内部自身使用的，不能被软件以外使用，不可挂载。所有 /dev/dm-n 格式的设备都只能是作为内部使用，且应该永远不要使用。

简单来说，就是我们应该使用/dev/mapper/下的设备符。对该设备即可用fdisk进行分区，或创建为pv。

About Me

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