Linux DM Installation Details
A Dell Technical White Paper

PowerVault MD3200, MD3200i, MD3600i and MD3600f Series Storage Arrays
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Device Manager Multipath Overview

This whitepaper describes the steps involved in configuring Device Mapper Multi-Path (DMMP) for the MD3200, MD3200i, MD3600i and MD3600f series (MD32/36 series) of Dell PowerVault Storage Arrays. Device Mapper (DMMP) is a generic framework for block devices provided by the Linux Operating System.

Device Mapper Multipath:

- Provides a single block device node for a multipathed Logical Unit
- Ensures that I/O is re-routed to available paths during path failure event
- Re-establishes previously failed paths (once they return)
- Provides DMMP features for newly added Logical Units

Device Manager Multipath Stack Overview

The Linux DM stack that works with Dell PowerVault MD32/36 series of arrays consists of three main components:

- **DM multipath core**: The generic multipath component that works with all storage devices.
- **RDAC device handler**: The hardware interface between the storage array and DM multipath core stack that performs hardware specific tasks.
- **Multipath User Space Utility**: Contains the multipath daemon `kpartx` utility and the Dell-provided `rescan_dm_devs` script.

Required Patches

The Dell PowerVault MD32/36 series DM Driver Packages includes patches to the DM multipath component and RDAC device handler required for full functionality. These packages are included in the resource DVD included with the product.

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Details for scsi_dh_rdac package installation

The resource DVD included with the storage array automatically installs the RDAC device driver as part of management software installation. Here is the installation procedure for each OS:

**SLES11 Installation:**

1. Install SLES11 with the installation media provided.

2. Install the errata kernel 2.6.27.39-0.1 (available via Novell website) for the architecture. The following steps are for x86_64 architecture. If necessary, replace with the package names specific to your architecture.
   
   ```
   #rpm -Uvh module-init-tools-3.4-70.7.1.x86_64.rpm
   #rpm -ivh kernel-default-base-2.6.27.39-0.3.1.x86_64.rpm
   #rpm -ivh kernel-default-2.6.27.39-0.3.1.x86_64.rpm
   ```

3. Reboot the system to boot up with 2.6.27.39-0.3.1 kernel.

4. Verify the version of the multipath tools package installed on the system using the `rpm -qa |grep multipath-tools` command. The package version should be multipath-tools-0.4.8-40.6.1 or above.

   Use the following commands to install the package.
   
   ```
   #rpm -Uvh multipath-tools-0.4.8-40.6.1.x86_64.rpm
   #rpm -Uvh udev-128-13.3.1.x86_64.rpm
   #rpm -Uvh kpartx-0.4.8-40.6.1.x86_64.rpm
   ```

5. Add the following to the `/etc/multipath.conf` configuration file:

   ```
   defaults
   {
   
   ...
   
   max_fds 8192
   user_friendly_names yes
   
   ...
   
   }
   blacklist {
   
   device {
   
   
   vendor "*
   product "Universal Xport"
   
   }
   
   }
   devices {
   
   device {
   
   vendor "DELL"
   product "MD32xxi"
   path_grouping_policy group_by_prio
   prio rdac
   polling_interval 5
   ```
path_checker   rdac
path_selector   "round-robin 0"
hardware_handler  "1 rdac"
failback    immediate
features    "2 pg_init_retries 50"
no_path_retry   30
rr_min_io   100
prio_callout  "/sbin/mpath_prio_rdac /dev/%n"

device {
  vendor    "DELL"
  product    "MD32xx"
  path_grouping_policy  group_by_prio
  prio    rdac
  polling_interval   5
  path_checker   rdac
  path_selector   "round-robin 0"
  hardware_handler  "1 rdac"
  failback    immediate
  features    "2 pg_init_retries 50"
  no_path_retry   30
  rr_min_io   100
  prio_callout  "/sbin/mpath_prio_rdac /dev/%n"
}

devices {
  device {
    vendor    "DELL"
    product    "MD36xxi"
    path_grouping_policy  group_by_prio
    prio    rdac
    polling_interval   5
    path_checker   rdac
    path_selector   "round-robin 0"
    hardware_handler  "1 rdac"
    failback    immediate
    features    "2 pg_init_retries 50"
    no_path_retry   30
    rr_min_io   100
    prio_callout  "/sbin/mpath_prio_rdac /dev/%n"
  }
  device {
    vendor    "DELL"
    product    "MD36xxf"
    path_grouping_policy  group_by_prio
    prio    rdac
    polling_interval   5
    path_checker   rdac
    path_selector   "round-robin 0"
    hardware_handler  "1 rdac"
    failback    immediate
    features    "2 pg_init_retries 50"
    no_path_retry   30
    rr_min_io   100
    prio_callout  "/sbin/mpath_prio_rdac /dev/%n"
  }
}

6. Add DM-RDAC driver module parameter rdac_blacklist in /etc/modprobe.conf to support RDAC/MPP coexistence.
7. Copy the file named 99-storage-policy-fixed-drives.fdi into /usr/share/hal/fdi/policy/10osvendor/:
8. Install DKMS package from the deployment DVD that was included with the PV array

```bash
#rpm -ivh dkms-2.1.2-1.noarch.rpm
```

9. Lay down the `scsi_dh_rdac` driver, version 1.5.1.2-3.

10. Add the following section to the end of `/etc/init.d/boot.local`

```bash
modprobe scsi_dh;
modprobe scsi_dh_rdac;
modprobe dm-multipath;
/etc/init.d/multipathd start;
```

11. Enable multipathd daemon using the command

```bash
#chkconfig multipathd on
```

12. Rebuild RAMdisk. Reboot the system, then refer to the Owner’s Manual for more information.

**SLES10 SP3 Installation Steps:**

1. Install DKMS package from the deployment DVD that was included with the PV array.

```bash
#rpm -ivh dkms-2.1.2-1.noarch.rpm
```

2. Lay down the `scsi_dh_rdc` driver, version 1.3.1.2-3.

3. Add the following contents into `/etc/multipath.conf`:

```bash
defaults
{
...
    max_fds 8192
    user_friendly_names yes
...
}
blacklist {
...
    device {
        vendor "*"
        product "Universal Xport"
    }
...
}
devices {
```
device {
    vendor    "DELL"
    product   "MD32xxi"
    path_grouping_policy  group_by_prio
    prio      rdac
    polling_interval   5
    path_checker      rdac
    path_selector     "round-robin 0"
    hardware_handler  "1 rdac"
    failback          immediate
    features          "2 pg_init_retries 50"
    no_path_retry     30
    rr_min_io         100
    prio_callout "/sbin/mpath_prio_rdac /dev/%n"
}

device {
    vendor    "DELL"
    product   "MD32xxx"
    path_grouping_policy  group_by_prio
    prio      rdac
    polling_interval   5
    path_checker      rdac
    path_selector     "round-robin 0"
    hardware_handler  "1 rdac"
    failback          immediate
    features          "2 pg_init_retries 50"
    no_path_retry     30
    rr_min_io         100
    prio_callout "/sbin/mpath_prio_rdac /dev/%n"
}

device {
    vendor    "DELL"
    product   "MD36xxi"
    path_grouping_policy  group_by_prio
    prio      rdac
    polling_interval   5
    path_checker      rdac
    path_selector     "round-robin 0"
    hardware_handler  "1 rdac"
    failback          immediate
    features          "2 pg_init_retries 50"
    no_path_retry     30
    rr_min_io         100
    prio_callout "/sbin/mpath_prio_rdac /dev/%n"
}

device {
    vendor    "DELL"
    product   "MD36xxf"
    path_grouping_policy  group_by_prio
    prio      rdac
    polling_interval   5
    path_checker      rdac
    path_selector     "round-robin 0"
    hardware_handler  "1 rdac"
    failback          immediate
    features          "2 pg_init_retries 50"
    no_path_retry     30
    rr_min_io         100
    prio_callout "/sbin/mpath_prio_rdac /dev/%n"
}
}
4. Add DM-RDAC driver module parameter rdac_blacklist in /etc/modprobe.conf to support RDAC/MPP coexistence

5. Add the following section to the end of /etc/init.d/boot.local

```bash
modprobe scsi_dh;
modprobe scsi_dh_rdac;
modprobe dm-multipath;
/etc/init.d/multipathd start;
```

6. Enable multipathd daemon using the command

```bash
#chkconfig multipathd on
```

This command will enable multipathd during the boot up.

7. Rebuild RAMdisk. Reboot the system and then refer to the owner’s Manual for more information.

**RHEL 5.4 Installation Steps:**

1. Install DKMS package from the deployment DVD that was included with the PV array:

```bash
#rpm -ivh dkms-2.1.2-1.noarch.rpm
```

2. Lay down DKMS driver package, version 1.4.1.2-3.

3. Edit /etc/multipath.conf:

   If the default blacklist section is not commented out, comment out this section:

   ```bash
   #blacklist {
   #   Devnode "*"
   #}
   ```

4. Add the following contents to /etc/multipath.conf:

   ```bash
defaults {
   ...
   max_fds 8192
   user_friendly_names yes
   }
   blacklist {
   ...
   device {
   vendor "*"
   product "Universal Xport"
   }
   }
   devices {
   device {
   vendor "DELL"
   product "MD32xxi"
   path_grouping_policy group_by_prio
   prio rdac
   }
   ```
polling_interval 5
path_checker rdac
path_selector "round-robin 0"
hardware_handler "1 rdac"
fallback immediate
features "2 pg_init_retries 50"
no_path_retry 30
rr_min_io 100
prio_callout "/sbin/mpath_prio_rdac /dev/%n"
}
device {
  vendor "DELL"
  product "MD32xx"
  path_grouping_policy group_by_prio
  prio rdac
  polling_interval 5
  path_checker rdac
  path_selector "round-robin 0"
hardware_handler "1 rdac"
fallback immediate
features "2 pg_init_retries 50"
no_path_retry 30
rr_min_io 100
prio_callout "/sbin/mpath_prio_rdac /dev/%n"
}
Device {
  vendor "DELL"
  product "MD36xxi"
  path_grouping_policy group_by_prio
  prio rdac
  polling_interval 5
  path_checker rdac
  path_selector "round-robin 0"
hardware_handler "1 rdac"
fallback immediate
features "2 pg_init_retries 50"
no_path_retry 30
rr_min_io 100
prio_callout "/sbin/mpath_prio_rdac /dev/%n"
}
device {
  vendor "DELL"
  product "MD36xxf"
  path_grouping_policy group_by_prio
  prio rdac
  polling_interval 5
  path_checker rdac
  path_selector "round-robin 0"
hardware_handler "1 rdac"
fallback immediate
features "2 pg_init_retries 50"
no_path_retry 30
rr_min_io 100
prio_callout "/sbin/mpath_prio_rdac /dev/%n"
}

4. Add DM-RDAC driver module parameter rdac_blacklist in /etc/modprobe.conf.local to support RDAC/MPP coexistence.
5. Comment out all lines in `/etc/udev/rules.d/40-multipath.rules`. Add the following lines at the end of the file:

```
# multipath wants the devmaps presented as meaningful device names
# so name them after their devmap name
SUBSYSTEM=="block", GOTO="end_mpath"
# KERNEL!="dm-[0-9]*", ACTION=="add", PROGRAM="/bin/bash -c '/sbin/lsmod | /bin/grep ^dm_multipath'", RUN="/sbin/multipath -v0 %M:%m"
KERNEL!="dm-[0-9]*", GOTO="end_mpath"
PROGRAM!="/sbin/multipath_wait %M %m", GOTO="end_mpath"
PROGRAM="/sbin/dmsetup info -c --noheadings -j %M -m %m", GOTO="end_mpath"
RESULT="*:**:**:**:*:mpath-*", GOTO="kpartx_check"
PROGRAM="/sbin/dmsetup info -c --noheadings -o name -j %M -m %m", RESULT="*:**",
NAME="%k", SYMLINK="mpath/%c", RUN="/sbin/kpartx -a -p p /dev/mapper/%c"
OPTIONS="last_rule"
LABEL="kpartx_check"
RESULT="*:**:**:**:*:part*-mpath-*", GOTO="end_mpath"
PROGRAM="/sbin/dmsetup info -c --noheadings -o name -j %M -m %m", RESULT="*:**",
NAME="%k", SYMLINK="mpath/%c"
OPTIONS="last_rule"
LABEL="end_mpath"
```

6. Enable multipathd daemon using the command

```
# chkconfig multipathd on
```

This command will enable multipathd during the boot up.

7. Rebuild RAMdisk. Reboot the system, then refer to the Owner’s Manual for more information.

**RHEL 5.5 Installation Steps:**

1. Lay down the scsi_dh_rdac driver, version 1.4.2.1-3.

2. Make the following editions to `/etc/multipath.conf`:

   **If the default blacklist section is not commented out, comment out this section:**

   ```
   # blacklist {
   #  Devnode "**"
   #}
   ```

3. Add the following contents into `/etc/multipath.conf`:

   ```
   defaults
   {
       ...
       max_fds 8192
       user_friendly_names yes
       ...
   }
   blacklist {
       ...
   device {
       vendor "**"  
       product "Universal Xport"
   }
   ```
...}
}
devices {
  
  device {
    vendor    "DELL"
    product    "MD32xxi"
    path_grouping_policy  group_by_prio
    prio    rdac
    polling_interval   5
    path_checker   rdac
    path_selector   "round-robin 0"
    hardware_handler    "1 rdac"
    failback   immediate
    features    "2 pg_init_retries 50"
    no_path_retry   30
    rr_min_io   100
    prio_callout " /sbin/mpath_prio_rdac /dev/%n"
  }
  
  device {
    vendor    "DELL"
    product    "MD32xx"
    path_grouping_policy  group_by_prio
    prio    rdac
    polling_interval   5
    path_checker   rdac
    path_selector   "round-robin 0"
    hardware_handler    "1 rdac"
    failback   immediate
    features    "2 pg_init_retries 50"
    no_path_retry   30
    rr_min_io   100
    prio_callout " /sbin/mpath_prio_rdac /dev/%n"
  }
  
  device {
    vendor    "DELL"
    product    "MD36xxi"
    path_grouping_policy  group_by_prio
    prio    rdac
    polling_interval   5
    path_checker   rdac
    path_selector   "round-robin 0"
    hardware_handler    "1 rdac"
    failback   immediate
    features    "2 pg_init_retries 50"
    no_path_retry   30
    rr_min_io   100
    prio_callout " /sbin/mpath_prio_rdac /dev/%n"
  }
  
  device {
    vendor    "DELL"
    product    "MD36xxf"
    path_grouping_policy  group_by_prio
    prio    rdac
    polling_interval   5
    path_checker   rdac
    path_selector   "round-robin 0"
    hardware_handler    "1 rdac"
    failback   immediate
    features    "2 pg_init_retries 50"
    no_path_retry   30
    rr_min_io   100
    prio_callout " /sbin/mpath_prio_rdac /dev/%n"
  }
}
3. Add DM-RDAC driver module parameter rdac_blacklist in `/etc/modprobe.conf.local` to support RDAC/MPP coexistence.

4. Rebuild RAMdisk. Enable multipathd daemon using the command:

   ```bash
   #chkconfig multipathd on
   ```

   This command will enable multipathd during the boot up.

5. Reboot the system and then refer to Owner’s Manual for more information.

**RHEL 6.0 Installation Steps:**

1. Lay down scsi_dh_rdac driver, version 1.6.1.1.
2. Make the following editions to `/etc/multipath.conf`:

   If the default blacklist section is not commented out, comment out this section:

   ```bash
   #blacklist {
   #   Devnode "*"
   #}
   ```

3. Add the following contents into `/etc/multipath.conf`:

   ```bash
   defaults {
   ...
   max_fds 8192
   user_friendly_names yes
   ...
   }
   blacklist {
   ...
   device {
   vendor "*"
   product "Universal Xport"
   }
   ...
   }
   devices {
   device {
   vendor "DELL"
   product "MD32xxi"
   path_grouping_policy group_by_prio
   prio rdac
   polling_interval 5
   path_checker rdac
   path_selector "round-robin 0"
   hardware_handler "1 rdac"
   ```
failback        immediate
features        "2 pg_init_retries 50"
no_path_retry   30
rr_min_io       100
prio_callout    "/sbin/mpath_prio_rdac /dev/%n"
}
device {
  vendor        "DELL"
  product       "MD32xx"
  path_grouping_policy  group_by_prio
  prio          rdac
  polling_interval   5
  path_checker      rdac
  path_selector     "round-robin 0"
  hardware_handler  "1 rdac"
  failback        immediate
  features        "2 pg_init_retries 50"
  no_path_retry   30
  rr_min_io       100
  prio_callout    "/sbin/mpath_prio_rdac /dev/%n"
}
device {
  vendor        "DELL"
  product       "MD36xxi"
  path_grouping_policy  group_by_prio
  prio          rdac
  polling_interval   5
  path_checker      rdac
  path_selector     "round-robin 0"
  hardware_handler  "1 rdac"
  failback        immediate
  features        "2 pg_init_retries 50"
  no_path_retry   30
  rr_min_io       100
  prio_callout    "/sbin/mpath_prio_rdac /dev/%n"
}
device {
  vendor        "DELL"
  product       "MD36xxf"
  path_grouping_policy  group_by_prio
  prio          rdac
  polling_interval   5
  path_checker      rdac
  path_selector     "round-robin 0"
  hardware_handler  "1 rdac"
  failback        immediate
  features        "2 pg_init_retries 50"
  no_path_retry   30
  rr_min_io       100
  prio_callout    "/sbin/mpath_prio_rdac /dev/%n"
}

4. Rebuild RAMinitrd. Enable multipathd daemon using the command:
#dracut --dorce

This command will enable multipathd during the boot up.

5. Reboot the system and then refer to Owner’s Manual for more information.

**SLES11 SP1 Installation Steps:**

1. Lay down scsi_dh_rdac driver, version 1.5.2.1-3.
2. Make the following editions to `/etc/multipath.conf`:

3. If the default `blacklist` section is not commented out, comment out this section:

   ```
   #blacklist {
   #   Devnode "*"
   #}
   ```

4. Add the following contents into `/etc/multipath.conf`:

   ```
   defaults {
   ...
   max_fds 8192
   user_friendly_names yes
   ...
   }
   blacklist {
   ...
   device {
      vendor "*"
      product "Universal Xport"
   }
   ...
   }
   devices {
   device {
      vendor "DELL"
      product "MD32xxi"
      path_grouping_policy group_by_prio
      prio rdac
      polling_interval 5
      path_checker rdac
      path_selector "round-robin 0"
      hardware_handler "1 rdac"
      fallback immediate
      features "2 pg_init_retries 50"
      no_path_retry 30
      rr_min_io 100
      prio_callout "/sbin/mpath_prio_rdac /dev/%n"
   }
   device {
      vendor "DELL"
      product "MD32xx"
      path_grouping_policy group_by_prio
      prio rdac
      polling_interval 5
      path_checker rdac
      path_selector "round-robin 0"
      hardware_handler "1 rdac"
   }
   ```
failback immediate
features "2 pg_init_retries 50"
o_path_retry 30
rr_min_io 100
prio_callout "/sbin/mpath_prio_rdac /dev/%n"
}
device {
  vendor "DELL"
  product "MD36xxi"
  path_grouping_policy group_by_prio
  prio rdac
  polling_interval 5
  path_checker rdac
  path_selector "round-robin 0"
  hardware_handler "1 rdac"
  failback immediate
  features "2 pg_init_retries 50"
  no_path_retry 30
  rr_min_io 100
  prio_callout "/sbin/mpath_prio_rdac /dev/%n"
}
device {
  vendor "DELL"
  product "MD36xxf"
  path_grouping_policy group_by_prio
  prio rdac
  polling_interval 5
  path_checker rdac
  path_selector "round-robin 0"
  hardware_handler "1 rdac"
  failback immediate
  features "2 pg_init_retries 50"
  no_path_retry 30
  rr_min_io 100
  prio_callout "/sbin/mpath_prio_rdac /dev/%n"
}

4. Add DM-RDAC driver module parameter rdac_blacklist in /etc/modprobe.conf to support RDAC/MPP coexistence

5. Enable multipathd daemon using the command

```
#chkconfig multipathd on
```

This command will enable multipathd during the boot up.

6. Copy file named 99-storage-policy-fixed-drives.fdi into /usr/share/hal/fdi/policy/10osvendor/:

```xml
<?xml version="1.0" encoding="UTF-8" ?>
<!-- SGML -->
<deviceinfo version="0.2">
  <device>
    <match key="@block.storage_device:storage.hotpluggable" bool="false">
      <match key="@block.storage_device:storage.removable" bool="false">
        <merge key="volume.ignore" type="bool">true</merge>
      </match>
    </match>
  </device>
</deviceinfo>
```
7. Add the following section to the end of `/etc/init.d/boot.local`:

```bash
modprobe scsi_dh;
modprobe scsi_dh_rdad;
modprobe dm-multipath;
/etc/init.d/multipathd start;
```

8. Rebuild RAMdisk. Reboot the system and then refer to the Owner's Manual for more information.

**Oracle Cluster Parameters**

In Oracle cluster configurations, avoid LUN thrashing between multiple initiators by setting the `failback` parameter in the MD32/36 device section to `manual` in `/etc/multipath.conf`. This change will disable LUN failback.