Spectra Tape Libraries

Path Failover Guide

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Part Number

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Revision History

Revision	Date	Description
A	August 2021	Initial release.

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Table of Contents

Legal Notices 2

Contacting Spectra Logic 7

Table of Contents 8

About This Guide 10

- Related Publications 10
- Spectra Tape Libraries 10
- LTO Ultrium Tape Drives 10
- TS11xx Technology Drives 11
- Typographical Conventions 11

Product overview 12

Installing the Tape Failover Wrapper Driver 13

- Prerequisites 13
- Distribution Package 13
- Driver Installation 15

Testing the Installation 18

Management Utility Reference 19

- tfw_mgr add 19
- tfw_mgr update 20
- tfw_mgr path-list 21
- tfw_mgr clear-rsv 22
- tfw_mgr status 22
- tfw_mgr remove 23
- tfw_mgr set-trace 23
- tfw_mgr set 23
- tfw_mgr var 24
- tfw_mgr insert 24

tfw_mgr eject 25
Load and Unload Script Reference 26
Load Script Example 26
Unload script example 27
Logs 28
Udev – Persistent Names 29

About This Guide

This manual provides information for installing and using the Spectra Tape Failover Wrapper Driver.

Related Publications

For additional information about Spectra tape libraries, refer to the following publications.

Spectra Tape Libraries

The most current version of this guide and the following documents related to Spectra tape libraries are available on the Spectra Logic website at support.spectralogic.com/documentation.

- The *User Guide* for each library describes the configuration and operation of the library.
- The *Release Notes and Documentation Updates* for each library provides the most up-to-date information about the library, drives, and media.

LTO Ultrium Tape Drives

The following documents provide information that is applicable to all IBM LTO tape drives.

- *IBM Tape Device Drivers Installation and User's Guide*

  Note: This guide also provides information about using the IBM Tape Diagnostic Tool (ITDT) to troubleshoot drive problems.

- *IBM TotalStorage LTO Ultrium Tape Drive: SCSI Reference* (LTO-1 through LTO-4)
- *IBM TotalStorage LTO Ultrium Tape Drive: SCSI Reference* (LTO-5 and LTO-6)

For drive-specific information, search for the product name (for example, LTO 5) on the documentation page on the IBM website. You can also search the IBM Support Portal at ibm.com/support/entry/portal/Documentation.

TS11*xx* Technology Drives

The following documents provide information that is applicable to TS11*xx* technology drives.

- *IBM Operator Guide 3592 Models J1A, E05, E06, EU6, J70 and C06 at* publibfp.dhe.ibm.com/epubs/pdf/a86opg02.pdf
- *IBM System Storage Tape Drive 3592 SCSI Reference* at ibm.com/support/docview.wss?uid=ssg1S7003248
- *IBM Tape Device Drivers Installation and User's Guide* at ibm.com/support/docview.wss?rs=577&uid=ssg1S7002972

Note: This guide also provides information about using the IBM Tape Diagnostic Tool (ITDT) to troubleshoot drive problems.

Typographical Conventions

This document uses the following conventions to highlight important information:

WARNING Read text marked by the "Warning" symbol for information you must know to avoid personal injury.

CAUTION Read text marked by the "Caution" symbol for information you must know to avoid losing data.

IMPORTANT Read text marked by the "Important" symbol for information that helps you complete a procedure or avoid extra steps.

Note: Read text marked with "Note" for additional information or suggestions about the current topic.

Product overview

The Tape Failover Wrapper (TFW) provides path failover for IBM LTO-4 and higher generation, and IBM TS-11*xx* technology tape drives developed for Linux operating systems. It acts as a wrapper implementing character device driver callbacks (e.g. open, close, read, write, ioctl...) and pass through calls to the underlying IBM's lin_tape driver, and it keeps track of tape position. When an underlying call fails, a fail-over procedure takes place and TFW tries to open the next configured device path, reposition the tape to the original position if needed, and retry the operation. Each TFW device can have a maximum of 8 fail-over paths configured. TFW works with tape devices as well as changer (ADI) devices.

TFW consists of :

- A kernel module
- A management utility
- Load and unload scripts

Installing the Tape Failover Wrapper Driver

Prerequisites

Operating System

TFW was developed on Centos 8 x86_64 and also supports RHEL 8 x86_64 and Ubuntu 18.04.4 LTS x86_64.

IBM lin_tape Driver

Because TFW works above the IBM lin_tape driver, this driver must be installed and loaded on the target operating system. The TFW driver was tested with the 3.0.55 version of lin_tape driver on the above operating systems. The TFW distribution file includes a configuration file for the lin_tape driver, which sets the type of tape drive reservation to persistent.

Physical Interface

TFW was tested and works with following physical interfaces:

Device	Supported interfaces
LTO	Fibre Channel, SAS
TS11*XX* technology	Fibre Channel
Changer	Fibre Channel, SAS

Distribution Package

TFW is distributed as a tar.gz file, which consists of a kernel module, a management utility, a lin_tape.conf file, load and unload scripts, and a readme file. The name of the distribution package is: `tfw_yyyy-mm-dd_HH-MM_srcversion.tar.gz` where:

- `tfw` is the prefix
- `yyyy-mm-dd_HH-MM` is the time stamp of compilation: year, month, day, hour, minute
- `srcversion` is the source version of the kernel module (this can be also viewed using the Linux `modinfo` command).

The following is an example of TFW distribution package contents:

```
#tar tvzf tfw_2020-11-04_15-28_7C5388DAEACF60FC3975E7B.tar.gz
drwxr-xr-x root/root 0 2020-11-04 15:28:12 tfw_2020-11-04_15-28_
7C5388DAEACF60FC3975E7B/
-rw-r--r-- root/root 2318464 2020-11-04 15:28:12 tfw_2020-11-04_15-28_
7C5388DAEACF60FC3975E7B/tfw.ko
-rwxr-xr-x root/root 48040 2020-11-04 15:28:12 tfw_2020-11-04_15-28_
7C5388DAEACF60FC3975E7B/tfw_mgr
-rw-r--r-- root/root 46 2020-11-04 15:28:12 tfw_2020-11-04_15-28_
7C5388DAEACF60FC3975E7B/lin_tape.conf
-rwxr-xr-x root/root 311 2020-11-04 15:28:12 tfw_2020-11-04_15-28_
7C5388DAEACF60FC3975E7B/load.sh.EXAMPLE
-rw-r--r-- root/root 7448 2020-11-04 15:28:12 tfw_2020-11-04_15-28_
7C5388DAEACF60FC3975E7B/tfw.README
-rwxr-xr-x root/root 60 2020-11-04 15:28:12 tfw_2020-11-04_15-28_
7C5388DAEACF60FC3975E7B/unload.sh.EXAMPLE
-rw-r--r-- root/root 148 2020-11-04 15:28:12 tfw_2020-11-04_15-28_
7C5388DAEACF60FC3975E7B/tfw.INFO.buildenv
#
```

Kernel Module

The kernel module has the file name `tfw.ko` and is the main component of the driver. The module is dependent on the kernel version. The kernel version for which the module was compiled is included in the name of the distribution package and can also be found using the `modinfo` Linux command as shown in following example:

```
# modinfo ./tfw.ko
filename:    /opt/tfw_2020-11-04_12-15_7C5388DAEACF60FC3975E7B/./tfw.ko
version:     1.0
license:     Proprietary
author:      devel@wittee.sk
description: Virtual Tape Fail-over Driver
rhelversion: 8.2
srcversion:  7C5388DAEACF60FC3975E7B
depends:
name:        tfw
vermagic:    4.18.0-193.14.2.el8_2.x86_64 SMP mod_unload modversions
#
```

Management Utility

The management utility is a Linux executable file, which is used for:

- Management of the kernel module
- Adding / removing / viewing paths for tape and changer devices
- Viewing the status of a device
- Setting trace levels
- Changing timeouts

The file name of the management utility is `tfw_mgr`. Best practice is to add this file to a directory included in the PATH environment variable. For more information about the management utility with examples, see Management Utility Reference on page 19

lin_tape.conf File

This file is the configuration file for the lin_tape driver and sets the type of tape drive reservation to persistent. This is required for TFW to work correctly.

Load and Unload Scripts

Load and unload scripts contained in the distribution package show basic usage of loading, configuring, and unloading the TFW driver. See Load and Unload Script Reference on page 26 for more information.

Driver Installation

Use the following instructions to install the Tape Failover Wrapper.

1. Untar the distribution package.

   Example:

```
#tar xvzf tfw_2020-11-04_15-28_7C5388DAEACF60FC3975E7B.tar.gz
tfw_2020-11-04_15-28_7C5388DAEACF60FC3975E7B/
tfw_2020-11-04_15-28_7C5388DAEACF60FC3975E7B/tfw.ko
tfw_2020-11-04_15-28_7C5388DAEACF60FC3975E7B/tfw_mgr
tfw_2020-11-04_15-28_7C5388DAEACF60FC3975E7B/lin_tape.conf
tfw_2020-11-04_15-28_7C5388DAEACF60FC3975E7B/load.sh.EXAMPLE
tfw_2020-11-04_15-28_7C5388DAEACF60FC3975E7B/tfw.README
tfw_2020-11-04_15-28_7C5388DAEACF60FC3975E7B/unload.sh.EXAMPLE
tfw_2020-11-04_15-28_7C5388DAEACF60FC3975E7B/tfw.INFO.buildenv
#
```

```
#ls -l tfw_2020-11-04_15-28_7C5388DAEACF60FC3975E7B
total 1164
-rw-r--r-- 1 root root 46 Nov 4 15:28 lin_tape.conf
-rwxr-xr-x 1 root root 311 Nov 4 15:28 load.sh.EXAMPLE
-rw-r--r-- 1 root root 148 Nov 4 15:28 tfw.INFO.buildenv
-rw-r--r-- 1 root root 7448 Nov 4 15:28 tfw.README
-rw-r--r-- 1 root root 2318464 Nov 4 15:28 tfw.ko
-rwxr-xr-x 1 root root 48040 Nov 4 15:28 tfw_mgr
-rwxr-xr-x 1 root root 60 Nov 4 15:28 unload.sh.EXAMPLE
#
```

2. Place the files in the correct directories.
   - `tfw.ko` - The kernel module path can be defined in the load script. If no path is defined, the load script searches for the file in the current directory.
   - `tfw_mgr` - The management utility is an executable file, therefore its placement should be in a directory path defined by the PATH environment variable, for example `/usr/local/bin`.
   - `lin_tape.conf` - The `lin_tape.conf` file should be placed in the `/etc/modprobe.d` directory where the `lin_tape` driver searches for its configuration. You must restart `lin_tape` after placing `lin_tape.conf` in that directory.
3. Customize the load script. The example load script assumes that the kernel module is in the current directory and that there is only one tape drive with the following paths: `/dev/IBMtape0` and `/dev/IBMtape1`. Use the information in Load Script Example on page 26 and Management Utility Reference on page 19 to customize the load script for your environment.
4. Run the load script.

   ./load.sh.EXAMPLE

   ```
   tfw: major=237
   path[0]: /dev/IBMtape0n [2:0:0:0]
   path[1]: /dev/IBMtape1n [5:0:0:0]
   add tape [237:0] logical=tfw0 use-path=0
   ```

   The load script defines control, rewind, and no-rewind tape devices in the `/dev` directory:

   ```
   # ls -l /dev |egrep 'root root.*237'
   crw-rw-rw-. 1 root root 237, 0 Jan 12 11:49 tfw0
   crw-rw-rw-. 1 root root 237, 1 Jan 12 11:49 tfw0n
   crw-rw-rw-. 1 root root 237, 288 Jan 12 11:49 tfwctrl
   #
   ```

In this case. 237 is the major number for the TFW devices. This number can also be found in the `/proc/devices` file.

```
# grep tfw /proc/devices
237 tfw
#
```

5. Set up udev rules for persistent names if necessary. See Udev – Persistent Names on page 29.

Testing the Installation

Use the following steps to test the driver.

1. Create a library partition with one drive and a small number of storage slots.

   Each path from the host bus adapter (HBA) and tape drive appears multiple times to the host. For example, a dual-port HBA and dual-port tape drive connected to a switch result in four paths to the tape drive. The TFW driver manages those paths.

2. Retrieve information about the library, tape slots, and drives.

   ```
   # mtx -f /dev/spectra/<changerfile> status
   ```

3. Load a tape in a drive.

   ```
   # mtx -f /dev/spectra/<changerfile> load <slot> <drive>
   ```

   where `<slot>` is the tape slot number, and `<drive>` is the drive number

4. Retrieve information about the drive and the position of the tape.

   ```
   # mt -f /dev/tfw<drive> status
   ```

5. Write data to the tape. While the data is being written, disconnect a cable from the HBA to the drive to verify that the driver recovers correctly.

   ```
   # tar -czf /dev/tfw<drive> <path2testdata>
   ```

6. Reconnect the disconnected cable.

7. Move the test data or change the name of the test data folder.

8. Restore the data. While the data is restored, disconnect a cable from the HBA to the drive to verify that the driver recovers correctly.

   Note: You may need to use `mt` to position the drive at the beginning of the file on tape.

   ```
   # tar -xzf /dev/tfw<drive> <path2testdata>
   ```

9. Reconnect the disconnected cable.

10. Rewind the tape.

    ```
    # mt -f /dev/tfw<drive> rewind
    ```

11. Unload the tape.

    ```
    # mtx -f /dev/spectra/<changerfile> unload <slot> <drive>
    ```

12. Check `/var/log/messages` or `dmesg` for any errors generated when installing and testing the driver.

Management Utility Reference

The management utility, `tfw_mgr`, is the main utility to manage the TFW driver. It is a Linux executable file, which is used for:

- Adding drive / changer paths. See tfw_mgr add.
- Updating drive / changer paths. See tfw_mgr update on page 20.
- Displaying drive / changer paths. See tfw_mgr path-list on page 21.
- Clearing reservations. See tfw_mgr clear-rsv on page 22.
- Displaying the status of a drive / changer device. See tfw_mgr status on page 22.
- Removing drive / changer paths. See tfw_mgr remove on page 23.
- Setting / changing trace level. See tfw_mgr set-trace on page 23.
- Setting timeouts and retries values. See tfw_mgr set on page 23.
- Viewing timeouts and retries values. See "tfw_mgr var" on page 24.
- Inserting media into a drive. See "tfw_mgr insert" on page 24.
- Ejecting media from a drive. See "tfw_mgr eject" on page 25.

tfw_mgr add

Use the `tfw_mgr add` command to add a TFW device with paths as a TFW failover device for all drives, including changers (ADI exporters). In the case of a changer, `sg` devices are used when defining paths.

Note: To make changes, such as adding / updating / removing paths, use the `tfw_mgr update` command. See "tfw_mgr update" on the next page.

This command is also used in the example load script.

Syntax

```
tfw_mgr add tape|changer <logical-name> (-p[n] <path>)+
```

Example

Add a TFW device with the name tfw1 and two paths: /dev/IBMtape2 and /dev/IBMtape3

```
# ./tfw_mgr add tape tfw1 -p0 /dev/IBMtape2 -p1 /dev/IBMtape3
path[0]: /dev/IBMtape2n
path[1]: /dev/IBMtape3n
add tape [237:4] logical=tfw1 use-path=0
#
# ls -l /dev/tfw1*
crw-rw-rw-. 1 root root 237, 4 Jan 12 12:51 /dev/tfw1
crw-rw-rw-. 1 root root 237, 5 Jan 12 12:51 /dev/tfw1n
#
```

Example 2

Add a changer device cfw0 with two paths: /dev/sg6 and /dev/sg8

```
# ./tfw_mgr add changer cfw0 -p0 /dev/sg6 -p1 /dev/sg8
path[0]: /dev/sg6
path[1]: /dev/sg8
add changer [237:256] logical=cfw0 use-path=0
#
```

tfw_mgr update

The `tfw_mgr update` command is used to update configuration of tfw device paths . Supported operations are adding new path, remove path and change current path.

Syntax

```
tfw_mgr update tape|changer <logical-name> (-p[n] <path>)* [-d[n]] [-c[n]]
```

Example

Delete path1 from tfw1 device:

```
# ./tfw_mgr update tape tfw1 -d1
path[1]: <delete>
update tape [237:0] logical=tfw1 current_path=-1
#
```

Example 2

Add path1 back to tfw1 device (this path becomes the current path):

```
# ./tfw_mgr update tape tfw1 -p1 /dev/IBMtape3
path[1]: /dev/IBMtape3n
update tape [237:0] logical=tfw1 current_path=-1
#
```

Example 3

Change current path to path0. You can view the current path using the `tfw_mgr path-list` command (see tfw_mgr path-list on page 21):

```
# ./tfw_mgr update tape tfw1 -c0
update tape [237:0] logical=tfw1 current_path=0
#
```

tfw_mgr path-list

Use the tfw_mgr update command to display configured paths for TFW devices. It also indicates the current path.

Syntax

```
tfw_mgr path-list tape|changer <logical-name>
```

Example

Displaying the configuration of paths for tfw1 device:

```
# ./tfw_mgr path-list tape tfw1
path[0]: /dev/IBMtape2n enabled=Y current-path
path[1]: /dev/IBMtape3n enabled=Y
path[2]: <EMPTY>
path[3]: <EMPTY>
path[4]: <EMPTY>
path[5]: <EMPTY>
path[6]: <EMPTY>
path[7]: <EMPTY>
#
```

tfw_mgr clear-rsv

Use the `tfw_mgr clear-rsv` command to clear a reservation for a device created by other software and left in error. This is typically handled by the software that created the reservation.

Note: If the reservation was generated by the TFW driver, it is also cleared by the TFW driver if no longer needed (closing device).

Syntax

```
tfw_mgr clear-rsv tape <logical-name>
```

Example

```
# ./tfw_mgr clear-rsv tape tfw1
#
```

tfw_mgr status

Use the `tfw_mgr status` command to display the status of TFW devices.

Syntax

```
tfw_mgr status tape|changer <logical-name>
```

Example

Display the status of tfw1, where the device is closed.

```
# ./tfw_mgr status tape tfw1
Status..............closed
Last op.............no op
Current position.....unknown
#
```

Example 2

Display the status of tfw1, during a write operation.

```
# ./tfw_mgr status tape tfw1
Status..............open
Last op.............write
Current position.....7327
#
```

tfw_mgr remove

Use the `tfw_mgr status` command to remove a TFW device. It removes all of the paths for the selected device from the TFW configuration as well as the device files from /dev/ directory.

Syntax

```
tfw_mgr remove tape|changer <logical-name>
```

Example

Removing tfw1 device.

```
# ./tfw_mgr remove tape tfw1
#
```

tfw_mgr set-trace

Use the `tfw_mgr set-trace` command to set or change the trace level. The distribution load script sets the trace level to 1. Higher trace levels (2-3) display more trace details and are for troubleshooting and problem solving. It is a best practice to disable trace levels in production environments by setting it to a value of 0. In that case only log_info … log_emerg are logged.

Syntax

```
tfw_mgr set-trace=<n>
```

Example

Set trace level to 1.

```
# ./tfw_mgr set-trace=1
#
```

tfw_mgr set

Use the `tfw_mgr set` command to set values such as SCSI timeouts and retries. See tfw_mgr var to see what values can be set.

Syntax

```
tfw_mgr set (<name> <value>)+
```

Example

Set TUR retries to 4.

```
# ./tfw_mgr set test-unit-ready-retries 4
#
```

tfw_mgr var

Use the `tfw_mgr var` command to display values such as SCSI timeouts and retries. Without an argument the command displays all values.

Syntax

```
tfw_mgr var (<name>)
```

Example

Display all current values.

```
# ./tfw_mgr var
trace-level=1
test-unit-ready-timeout=12000
test-unit-ready-retries=4
read-reservation-timeout=60000
read-reservation-retries=2
register-reservation-timeout=60000
register-reservation-retries=2
persistent-reserve-timeout=60000
clear-reservation-timeout=60000
clear-reservation-retries=2
#
```

tfw_mgr insert

Use the `tfw_mgr insert` command to insert a tape cartridge in to a tape drive. This is typically done using other storage management software.

Note: If the reservation was generated by the TFW driver, it is also cleared by the TFW driver if no longer needed (closing device).

Syntax

```
tfw_mgr insert tape <logical-name>
```

Example

```
# ./tfw_mgr insert tape tfw1
#
```

tfw_mgr eject

Use the `tfw_mgr eject` command to eject a tape from a tape drive. This is typically done using other storage management software.

Syntax

```
tfw_mgr eject tape <logical-name>
```

Example

```
# ./tfw_mgr eject tape tfw1
#
```

Load and Unload Script Reference

Load Script Example

```
# cat load.sh.EXAMPLE
#!/bin/bash

insmod tfw.ko

tfw_major=`grep tfw /proc/devices | awk '{ print $1 }'`
echo "tfw: major=$tfw_major"
mknod /dev/tfwctrl c $tfw_major 288
chmod 666 /dev/tfwctrl

./tfw_mgr set-trace=1
./tfw_mgr add tape tfw0 -p0 /dev/IBMtape0 -p1 /dev/IBMtape1
#./tfw_mgr add changer cfw0 -p0 /dev/sg4 -p1 /dev/sg6
```

- The `instmod` command installs the kernel module.
- The next section creates the supporting control device `tfw_ctrl`.
- The `tfw_mgr set-trace` command defines the tracing level.
- The `tfw_mgr add tape` command adds tape device `tfw0` with two paths `/dev/IBMtape0` and `/dev/IBMtape1`
- The commented `tfw_mgr add changer` is an example of how to add a changer device.

Notes:

- You can use the command `cat /proc/scsi/IBMtape` to match IBMtapeX devices and physical devices using serial numbers.
- You can use `lsscsi -g` and `sg_inq` to match sgX changer devices and physical changer devices using serial numbers.
- It is a best practice is to use "tfw" for tape devices and "cfw" for changer devices, however it is possible to define your own names for tape and changer devices.

Unload script example

The unload script removes tape and changer devices, and unloads the driver from the kernel.

```
# cat unload.sh.EXAMPLE
#!/bin/bash
rm -f /dev/tfw*
rm -f /dev/cfw*
rmmod tfw.ko
```

- The `rm -f /dev/tfw*` and `rm -f /dev/cfw*` commands remove all tape and changer devices.

  Note: If you used names other than "tfw" and "cfw" for the tape and changer devices, you need to modify the unload script accordingly.

- The `rmmod` command unloads the TFW driver from the kernel.

Logs

The TFW driver writes logs and traces using syslog to `/var/log/messages` (RHEL / Centos) or `/var/log/syslog` (Ubuntu). You can change the trace level using `tfw_mgr set-trace` command. See tfw_mgr set-trace on page 23.

Udev – Persistent Names

In order to keep device names persistent you can set up udev rules. This is helpful with some backup software. The following example explains the use of udev rules for changer devices.

1. Get the SG device numbers for the changer:

```
# lsscsi -g |grep SPECTRA
   [33:0:1:1] mediumx SPECTRA PYTHON 2000 /dev/sch1 /dev/sg11
   [34:0:2:1] mediumx SPECTRA PYTHON 2000 /dev/sch0 /dev/sg10
   #
```

2. Use the `udevadm` utility to get the serial number for the drive:

```
   # udevadm info /dev/sg10 |grep -i ID_SCSI_SERIAL
   E: ID_SCSI_SERIAL=91120033DE
   # udevadm info /dev/sg11 |grep -i ID_SCSI_SERIAL
   E: ID_SCSI_SERIAL=91120033DE
   #
```

   The serial numbers are the same, because it is the same changer visible via 2 paths.

3. Create a udev rule to define a persistent name for the changer device. The rule is stored as a file in the directory: `/etc/udev/rules.d/`.

```
# cat /etc/udev/rules.d/99-tape_library.rules
   KERNEL=="sg*", ENV{ID_SCSI_SERIAL}=="91120033DE",  SYMLINK+="spectra/t50",
   OWNER="tsminst1", GROUP="tape"
   #
```

   The `SYMLINK` parameter represents the link that will be created in `/dev directory`, in this case, `/dev/spectra/t50`. This symlink is automatically regenerated as the device is seen using different paths. In other words, it will always point to the changer device if there is at least one active path.

4. Udev can also be used to set the owner and group for the devices . Below is an example for IBMtape and tfw devices. You must set ownership for rewinding as well as for non-rewinding devices.

```
   KERNEL=="IBMtape*[!n]", OWNER="tsminst1", GROUP="tape"
   KERNEL=="IBMtape*n", OWNER="tsminst1", GROUP="tape"
   KERNEL=="tfw*n", OWNER="tsminst1", GROUP="tape"
   KERNEL=="tfw*[!n]", OWNER="tsminst1", GROUP="tape"
```

5. To apply the changes use the `udevadm` utility:

```
   # udevadm trigger
```