Category:OpenSTLinux filesystem

Contents

Stable: 17.06.2020 - 15:26 / Revision: 16.01.2020 - 13:19

A quality version of this page, approved on *17 June 2020*, was based off this revision.

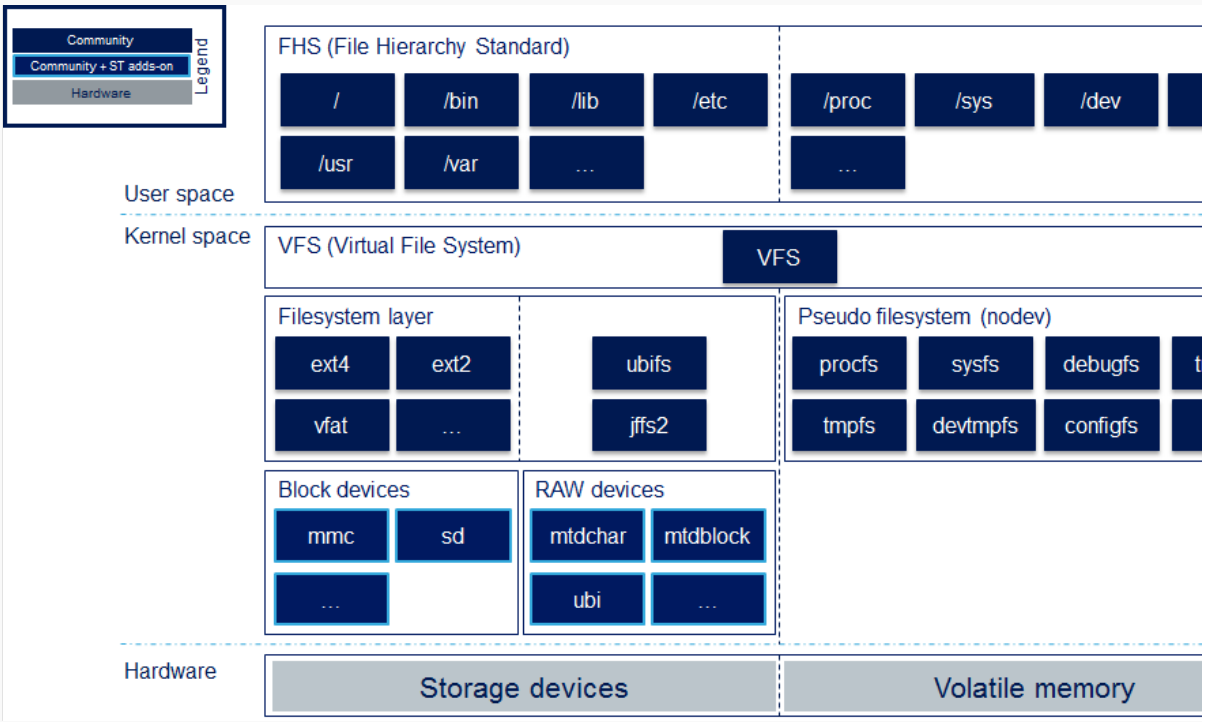
OpenSTLinux filesystem follows the Standard Linux® filesystem, represented on the below diagram.

It is based on the File Hierarchy Standard (FHS) at user space level.

Both physical storage devices and volatile memory file systems are supported, by using two paths:

- Filesystem layers which are associated to a device (with both block and raw interfaces), and which manage persistent data
- Pseudo filesystem which manages volatile data linked to the current running session

The Virtual File System[1] is a Linux core feature which proposes an abstraction layer for the Linux user space.



OpenSTLinux filesystem overview

References

- Documentation/filesystems/vfs.rst

Pages in category "OpenSTLinux filesystem"

The following 6 pages are in this category, out of 6 total.

- File Hierarchy Standard (FHS)
- Pseudo filesystem
- Configfs
- Debugfs
- How to access information in sysfs
- OpenSTLinux directory structure

Stable: 03.02.2020 - 08:43 / Revision: 03.02.2020 - 08:31

A quality version of this page, approved on *3 February 2020*, was based off this revision.

Contents

1 Introduction

Configfs[1] is a RAM-based filesystem that provides the converse of sysfs functionality.

While sysfs provides a filesystem-based view of kernel objects, configfs is a filesystem-based manager of kernel objects or config_items (every object in configfs is a config_item). This means that kernel objects can be created, managed and destroyed from the user space.

2 Installing configs on your target board

Configfs can be enabled and ready to be used in all STM32MPU Embedded Software distribution, via the Linux® kernel configuration **CONFIG_CONFIGFS_FS** (set to yes by default):

```
Symbol: CONFIGFS_FS
Location:
  File systems --->
    Pseudo filesystems -->
      -*- Userspace-driven configuration filesystem
```

Please refer to Menuconfig or how to configure kernel article for instructions for modifying the configuration and recompiling the Linux kernel image in the Distribution Package context.

3 Getting started

3.1 How to mount configfs

Use the following command to mount **Configfs** at */sys/kernel/config*:

```
Board $> mount -t configfs none /sys/kernel/config
```

3.2 How to set and manage configfs from Linux kernel drivers and user space

Refer to the Linux documentation[1] for detailed information.

Configfs is used by the USB framwework. Refer to USB API description for an example.

4 References

- 1.01.1 Documentation/filesystems/configfs/configfs.txt

Random Access Memory (Early computer memories generally hadserial access. Memories where any given address can be accessed when desired were then called "random access" to distinguish them from the memories where contents can only be accessed in a fixed order. The term is used today for volatile random-acces ssemiconductor memories.)

System File System (See https://en.wikipedia.org/wiki/Sysfs for more details)

Configuration File System (See https://en.wikipedia.org/wiki/Configfs for more details)

Stable: 04.02.2020 - 07:47 / Revision: 04.02.2020 - 07:34

A quality version of this page, approved on *4 February 2020*, was based off this revision.

Contents

1 Introduction

Debugfs is a simple-to-use RAM-based file system, specially designed for debugging purposes.

It is provided as a simple way for kernel developers to make information available to the user space.

It is part of a pseudo filesystem. Unlike procfs, which is only meant for process information, or sysfs, which has strict one-value-per-file rules, debugfs has no rules at all.

Developers are free to put any information into debugfs.

2 Installing debugfs on your target board

Debugfs is enabled and ready to be used in all STM32MPU Embedded Software distributions, via the Linux® kernel configuration **CONFIG_DEBUG_FS**, set to yes by default.

```
Symbol: DEBUG_FS
Location:
  Kernel Hacking --->
    Compile-time checks and compiler options -->
      [*] Debug Filesystem
```

Please refer to the Menuconfig or how to configure kernel article for instructions on modifying the configuration and recompiling the Linux kernel image in the distribution package context.

3 Getting started

3.1 How to mount debugfs

Debugfs is typically mounted at */sys/kernel/debug* with a command such as:

```
Board $> mount -t debugfs none /sys/kernel/debug
```

3.2 How to use debugfs in Linux kernel drivers

Debugfs is a simple way for kernel drivers to make information available to user space.

It can be manipulated using several calls from the C header file *include/linux/debugfs.h* , such as:

```
debugfs_create_file → for creating a file in the debug filesystem.
debugfs_create_dir → for creating a directory in the debug filesystem.
debugfs_create_symlink → for creating a symbolic link in the debug filesystem.
debugfs_create_u32 → for creating a file containing a single 32-bit unsigned integer value
debugfs_remove → for removing a debugfs entry from the debug filesytem.
...
```

For further details, refer to the Linux kernel documentation for debugfs[1].

For example, you can refer to an OpenSourceForU article: [2].

3.3 How to visualize debugfs information

On the target board, go the debugfs mount directory:

```
Board $> cd /sys/kernel/debug
```

There you will find all the debugfs entries created by Linux kernel frameworks

```
Board $> ls -l
```

```
drwxr-xr-x   2 root root 0 Jan  1  1970 49000000.usb-otg
drwxr-xr-x   4 root root 0 Jan  1  1970 asoc
drwxr-xr-x  40 root root 0 Jan  1  1970 bdi
drwxr-xr-x  10 root root 0 Jan  1  1970 block
drwxr-xr-x   2 root root 0 Jan  1  1970 bluetooth
drwxr-xr-x   3 root root 0 May 28 15:52 cec
drwxr-xr-x 225 root root 0 Jan  1  1970 clk
drwxr-xr-x   2 root root 0 Jan  1  1970 dma_buf
drwxr-xr-x   3 root root 0 Jan  1  1970 dri
drwxr-xr-x   2 root root 0 Jan  1  1970 dynamic_debug
drwxr-xr-x   2 root root 0 Jan  1  1970 extfrag
-rw-r--r--   1 root root 0 Jan  1  1970 fault_around_bytes
drwxr-xr-x   3 root root 0 May 28 15:52 gc
-r--r--r--   1 root root 0 Jan  1  1970 gpio
```

```
drwxr-xr-x   2 root root 0 Jan  1  1970 hid
drwxr-xr-x   2 root root 0 Jan  1  1970 ieee80211
drwxr-xr-x   7 root root 0 Jan  1  1970 iio
-r--r--r--   1 root root 0 Jan  1  1970 irq_domain_mapping
drwxr-xr-x   2 root root 0 Jan  1  1970 memblock
drwxr-xr-x   3 root root 0 Jan  1  1970 mmc0
drwxr-xr-x   3 root root 0 Jan  1  1970 mmc1
drwxr-xr-x  11 root root 0 Jan  1  1970 mtd
drwxr-xr-x   4 root root 0 Jan  1  1970 pinctrl
drwxr-xr-x   4 root root 0 Jan  1  1970 pm_genpd
drwxr-xr-x   2 root root 0 Jan  1  1970 pm_qos
-r--r--r--   1 root root 0 Jan  1  1970 pwm
drwxr-xr-x   2 root root 0 Jan  1  1970 ras
drwxr-xr-x  13 root root 0 Jan  1  1970 regmap
drwxr-xr-x  21 root root 0 Jan  1  1970 regulator
drwxr-xr-x   3 root root 0 Jan  1  1970 remoteproc
-r--r--r--   1 root root 0 Jan  1  1970 sleep_time
drwxr-xr-x   3 root root 0 Jan  1  1970 stmmaceth
-r--r--r--   1 root root 0 Jan  1  1970 suspend_stats
dr-xr-xr-x   3 root root 0 Jan  1  1970 tracing
drwxr-xr-x   2 root root 0 Jan  1  1970 ubi
drwxr-xr-x   2 root root 0 Jan  1  1970 ubifs
drwxr-xr-x   4 root root 0 Jan  1  1970 usb
-r--r--r--   1 root root 0 Jan  1  1970 wakeup_sources
```

You can then browse to find the requested information.

Please note that the different Linux software frameworks available in STM32MP15 Linux kernel overview provide specific trace and debug information in a "*How to trace and debug the framework*" dedicated chapter, incuding debugfs.

Some examples:

- To list the wakeup sources:

```
Board $> cat /sys/kernel/debug/wakeup_sources
name            active_count    event_count     wakeup_count    expire_count
active_since    total_time      max_time        last_change     prevent_suspend_time
5c002000.i2c:stpmu1@33:onkey    0               0               0
0               0               0               0               4075            0
0-0033          0               0               0               0
0               0               0               3949            0
alarmtimer      0               0               0               0
0               0               0               3901            0
5c004000.rtc    1               1               0               0
0               0               0               5246            0
deleted         0               0               0               0
0               0               0               0               0
```

- To obtain a summary of the clock settings:

```
Board $> cat /sys/kernel/debug/clk/clk_summary
  clock                         enable_cnt  prepare_cnt        rate   accuracy   phase
----------------------------------------------------------------------------------------
ck_usbo_48m                              1            1    48000000          0 0
   usbo_k                                1            1    48000000          0 0
ck_dsi_phy                               1            1           0          0 0
   dsi_k                                 1            1           0          0 0
i2s_ckin                                 0            0           0          0 0
clk-csi                                  1            1     4000000          0 0
   ck_csi                                1            1     4000000          0 0
      rng2_k                             0            0     4000000          0 0
```

```
      rng1_k                          0          0     4000000          0 0
clk-lsi                               1          1       32000          0 0
   ck_lsi                             1          1       32000          0 0
      dac12_k                         0          0       32000          0 0
clk-lse                               1          1       32768          0 0
   ck_lse                             1          1       32768          0 0
      ck_rtc                          2          2       32768          0 0
         rtc_lsco                     1          1       32768          0 0
      lptim5_k                        0          0       32768          0 0
      lptim4_k                        0          0       32768          0 0
      cec_k                           0          0       32768          0 0
clk-hsi                               1          1    64000000          0 0
   clk-hsi-div                        1          1    64000000          0 0
      ck_hsi                          2          2    64000000          0 0
         ck_mco1                      0          0    64000000          0 0
         uart8_k                      0          0    64000000          0 0
         uart7_k                      0          0    64000000          0 0
         uart6_k                      0          0    64000000          0 0
         uart5_k                      0          0    64000000          0 0
         uart4_k                      1          1    64000000          0 0
         usart3_k                     0          0    64000000          0 0
         usart2_k                     1          1    64000000          0 0
         usart1_k                     0          0    64000000          0 0
         i2c6_k                       0          0    64000000          0 0
         i2c4_k                       0          0    64000000          0 0
         i2c5_k                       0          0    64000000          0 0
         i2c3_k                       0          0    64000000          0 0
         i2c2_k                       0          0    64000000          0 0
         i2c1_k                       0          0    64000000          0 0
         spi6_k                       0          0    64000000          0 0
         spi5_k                       0          0    64000000          0 0
         spi4_k                       0          0    64000000          0 0
clk-hse                               1          1    24000000          0 0
   ck_hse                             7          7    24000000          0 0
      ck_hse_rtc                      0          0     1000000          0 0
      stgen_k                         1          1    24000000          0 0
      usbphy_k                        1          1    24000000          0 0
      ck_per                          1          1    24000000          0 0
         adc12_k                      1          1    24000000          0 0
      ref4                            1          1    24000000          0 0
         pll4                         1          1   594000000          0 0
            pll4_r                    0          0    74250000          0 0
            pll4_q                    1          1    31263158          0 0
               ltdc_px                1          1    31263158          0 0
               dsi_px                 0          0    31263158          0 0
               fdcan_k                0          0    31263158          0 0
            pll4_p                    0          0    74250000          0 0
      ref3                            1          1    24000000          0 0
         pll3                         2          3   786431640          0 0
            pll3_r                    1          1    98303955          0 0
               sdmmc3_k               0          0    98303955          0 0
               sdmmc2_k               1          1    98303955          0 0
               sdmmc1_k               0          0    98303955          0 0
            pll3_q                    0          1    49151978          0 0
               adfsdm_k               0          0    49151978          0 0
               sai4_k                 0          0    49151978          0 0
               sai3_k                 0          0    49151978          0 0
               sai2_k                 0          2    49151978          0 0
               sai1_k                 0          0    49151978          0 0
               spi3_k                 0          0    49151978          0 0
               spi2_k                 0          0    49151978          0 0
               spi1_k                 0          0    49151978          0 0
               spdif_k                0          0    49151978          0 0
            pll3_p                    1          1   196607910          0 0
               ck_mcu                 6         16   196607910          0 0
                  dfsdm_k             0          0   196607910          0 0
                  gpiok               0          0   196607910          0 0
```

```
                gpioj                   0            0   196607910          0 0
                gpioi                   0            1   196607910          0 0
                gpioh                   0            1   196607910          0 0
                gpiog                   0            1   196607910          0 0
                gpiof                   0            1   196607910          0 0
                gpioe                   0            1   196607910          0 0
                gpiod                   0            1   196607910          0 0
                gpioc                   0            1   196607910          0 0
                gpiob                   0            1   196607910          0 0
                gpioa                   0            1   196607910          0 0
                ipcc                    2            2   196607910          0 0
                hsem                    0            0   196607910          0 0
                crc2                    0            0   196607910          0 0
                rng2                    0            0   196607910          0 0
                hash2                   0            0   196607910          0 0
                cryp2                   0            0   196607910          0 0
                dcmi                    0            0   196607910          0 0
                sdmmc3                  0            0   196607910          0 0
                usbo                    0            0   196607910          0 0
                adc12                   1            1   196607910          0 0
                dmamux                  1            1   196607910          0 0
                dma2                    0            0   196607910          0 0
                dma1                    1            1   196607910          0 0
                pclk3                   1            1    98303955          0 0
                   lptim3_k             0            0    98303955          0 0
                   lptim2_k             0            0    98303955          0 0
                   hdp                  0            0    98303955          0 0
                   pmbctrl              0            0    98303955          0 0
                   tmpsens              0            0    98303955          0 0
                   vref                 0            0    98303955          0 0
                   syscfg               1            1    98303955          0 0
                   sai4                 0            0    98303955          0 0
                   lptim5               0            0    98303955          0 0
                   lptim4               0            0    98303955          0 0
                   lptim3               0            0    98303955          0 0
                   lptim2               0            0    98303955          0 0
                pclk2                   0            0    98303955          0 0
                   fdcan                0            0    98303955          0 0
                   dfsdm                0            0    98303955          0 0
                   sai3                 0            0    98303955          0 0
                   sai2                 0            0    98303955          0 0
                   sai1                 0            0    98303955          0 0
                   usart6               0            0    98303955          0 0
                   spi5                 0            0    98303955          0 0
                   spi4                 0            0    98303955          0 0
                   spi1                 0            0    98303955          0 0
                   tim17                0            0    98303955          0 0
                   tim16                0            0    98303955          0 0
                   tim15                0            0    98303955          0 0
                   tim8                 0            0    98303955          0 0
                   tim1                 0            0    98303955          0 0
                   ck2_tim              0            0   196607910          0 0
                      tim17_k            0            0    196607910          0 0
                      tim16_k            0            0    196607910          0 0
                      tim15_k            0            0    196607910          0 0
                      tim8_k             0            0   196607910          0 0
                      tim1_k             0            0   196607910          0 0
                pclk1                   0            2    98303955          0 0
                   lptim1_k             0            0    98303955          0 0
                   mdio                 0            0    98303955          0 0
                   dac12                0            0    98303955          0 0
                   cec                  0            0    98303955          0 0
                   spdif                0            0    98303955          0 0
                   i2c5                 0            0    98303955          0 0
                   i2c3                 0            0    98303955          0 0
                   i2c2                 0            0    98303955          0 0
                   i2c1                 0            0    98303955          0 0
```

```
                  uart8                0          0    98303955          0 0
                  uart7                0          0    98303955          0 0
                  uart5                0          0    98303955          0 0
                  uart4                0          0    98303955          0 0
                  usart3               0          0    98303955          0 0
                  usart2               0          0    98303955          0 0
                  spi3                 0          0    98303955          0 0
                  spi2                 0          1    98303955          0 0
                  lptim1               0          0    98303955          0 0
                  tim14                0          0    98303955          0 0
                  tim13                0          0    98303955          0 0
                  tim12                0          0    98303955          0 0
                  tim7                 0          0    98303955          0 0
                  tim6                 0          0    98303955          0 0
                  tim5                 0          0    98303955          0 0
                  tim4                 0          0    98303955          0 0
                  tim3                 0          0    98303955          0 0
                  tim2                 0          0    98303955          0 0
                  ck1_tim              0          1   196607910          0 0
                     tim14_k            0          0   196607910           0 0
                     tim13_k            0          0   196607910           0 0
                     tim12_k            0          0   196607910           0 0
                     tim7_k             0          0   196607910          0 0
                     tim6_k             0          1   196607910          0 0
                     tim5_k             0          0   196607910          0 0
                     tim4_k             0          0   196607910          0 0
                     tim3_k             0          0   196607910          0 0
                     tim2_k             0          0   196607910          0 0
ref1                                    2          2    24000000          0 0
   pll2                                 2          2   533000000          0 0
      pll2_r                            1          1   533000000          0 0
      pll2_q                            0          0   533000000          0 0
         gpu_k                          0          0   533000000          0 0
      pll2_p                            1          1   266500000          0 0
         ck_axi                         8          9   266500000          0 0
            ck_trace                    0          0   133250000          0 0
            ck_sys_dbg                  0          0   266500000          0 0
            qspi_k                      0          0   266500000          0 0
            fmc_k                       0          0   266500000          0 0
            ethstp                      0          0   266500000          0 0
            usbh                        1          1   266500000          0 0
            crc1                        0          0   266500000          0 0
            sdmmc2                      0          0   266500000          0 0
            sdmmc1                      0          0   266500000          0 0
            qspi                        0          0   266500000          0 0
            fmc                         0          0   266500000          0 0
            ethmac                      1          1   266500000          0 0
            ethrx                       1          1   266500000          0 0
            ethtx                       1          1   266500000          0 0
            gpu                         0          0   266500000          0 0
            mdma                        1          1   266500000          0 0
            bkpsram                     0          0   266500000          0 0
            rng1                        0          0   266500000          0 0
            hash1                       0          0   266500000          0 0
            cryp1                       0          0   266500000          0 0
            gpioz                       0          1   266500000          0 0
            tzc2                        0          0   266500000          0 0
            tzc1                        0          0   266500000          0 0
            pclk5                       1          1    66625000          0 0
               stgen                    0          0    66625000          0 0
               bsec                     0          0    66625000          0 0
               iwdg1                    0          0    66625000          0 0
               tzpc                     0          0    66625000          0 0
               rtcapb                   2          2    66625000          0 0
               usart1                   0          0    66625000          0 0
               i2c6                     0          0    66625000          0 0
               i2c4                     0          0    66625000          0 0
```

```
                    spi6                0            0    66625000          0 0
                 pclk4                  1            1   133250000          0 0
                    stgenro             0            0   133250000          0 0
                    usbphy              0            0   133250000          0 0
                    iwdg2               1            1   133250000          0 0
                    dsi                 0            0   133250000          0 0
                    ltdc                0            0   133250000          0 0
         pll1                           1            1   650000000          0 0
            pll1_p                      1            1   650000000          0 0
               ck_mpu                   1            1   650000000          0 0
                  ck_mco2               0            0   650000000          0 0
      clk-hse-div2                      0            0    12000000          0 0
ethptp_k                                0            0           0          0 0
ethck_k                                 0            0           0          0 0
```

- To obtain a summary of the regulator settings:

```
Board $> cat /sys/kernel/debug/regulator/regulator_summary
regulator                       use open bypass voltage current     min     max
---------------------------------------------------------------------------------
regulator-dummy                   0   11      0     0mV     0mA     0mV     0mV
   49000000.usb-otg                                                 0mV     0mV
   49000000.usb-otg                                                 0mV     0mV
   5a000000.dsi.0                                                   0mV     0mV
   vddcore                        0    0      0  1200mV     0mA   800mV  1350mV
   vdd_ddr                        0    1      0  1350mV     0mA  1350mV  1350mV
      vtt_ddr                     0    0      0   675mV     0mA   675mV   675mV
   vdd                            0    1      0  3300mV     0mA  3300mV  3300mV
      vref                        1    1      0  2500mV     0mA  2500mV  2500mV
         48003000.adc                                               0mV     0mV
   v3v3                           0    5      0  3300mV     0mA  3300mV  3300mV
      0-004a                                                        0mV     0mV
      58007000.sdmmc                                             3300mV  3300mV
      58005000.sdmmc                                             3300mV  3300mV
      v1v8_audio                  0    3      0  1800mV     0mA  1800mV  1800mV
         0-004a                                                     0mV     0mV
         0-004a                                                     0mV     0mV
         0-004a                                                     0mV     0mV
      v1v2_hdmi                   0    1      0  1200mV     0mA  1200mV  1200mV
         0-0039                                                     0mV     0mV
   v3v3_hdmi                      0    1      0  3300mV     0mA  3300mV  3300mV
      0-0039                                                        0mV     0mV
   vdd_usb                        2    2      0  3300mV     0mA  3300mV  3300mV
      phy-5a006000.usbphyc.1                                        0mV     0mV
      phy-5a006000.usbphyc.0                                        0mV     0mV
   vdda                           0    0      0  2900mV     0mA  2900mV  2900mV
   bst_out                        0    2      0  5000mV     0mA     0mV     0mV
      vbus_otg                    0    0      0  5000mV     0mA     0mV     0mV
      vbus_sw                     0    0      0  5000mV     0mA     0mV     0mV
reg11                             1    1      0  1100mV     0mA  1100mV  1100mV
   5a006000.usbphyc                                             0mV     0mV
reg18                             2    2      0  1800mV     0mA  1800mV  1800mV
   5a006000.usbphyc                                             0mV     0mV
   5a000000.dsi                                                 0mV     0mV
usb33                             1    1      0  3300mV     0mA  3300mV  3300mV
   49000000.usb-otg                                             0mV     0mV
vref_ddr                          0    0      0   675mV     0mA     0mV     0mV
```

- To list the pin control settings:

```
Board $> cat /sys/kernel/debug/pinctrl/soc\:pin-controller@50002000/pinconf-pins
Pin config settings per pin
Format: pin (name): configs
pin 0 (PA0): analog
pin 1 (PA1): alternate 11 (ETH1_GMII_RX_CLK ETH1_MII_RX_CLK ETH1_RGMII_RX_CLK
ETH1_RMII_REF_CLK) - push pull - floating - low speed
pin 2 (PA2): alternate 11 (ETH1_MDIO) - push pull - floating - very high speed
pin 3 (PA3): alternate 14 (LCD_B5) - push pull - floating - high speed
pin 4 (PA4): analog
pin 5 (PA5): analog
pin 6 (PA6): analog
pin 7 (PA7): alternate 11 (ETH1_GMII_RX_DV ETH1_MII_RX_DV ETH1_RGMII_RX_CTL
ETH1_RMII_CRS_DV) - push pull - floating - low speed
pin 8 (PA8): analog
pin 9 (PA9): analog
pin 10 (PA10): output - high - push pull - floating - low speed
pin 11 (PA11): analog
pin 12 (PA12): analog
pin 13 (PA13): output - low - open drain - floating - very high speed
pin 14 (PA14): input - high - floating
pin 15 (PA15): analog
pin 16 (PB0): alternate 11 (ETH1_GMII_RXD2 ETH1_MII_RXD2 ETH1_RGMII_RXD2) - push pull -
floating - low speed
pin 17 (PB1): alternate 11 (ETH1_GMII_RXD3 ETH1_MII_RXD3 ETH1_RGMII_RXD3) - push pull -
floating - low speed
pin 18 (PB2): alternate 8 (UART4_RX) - push pull - floating - low speed
pin 19 (PB3): alternate 9 (SDMMC2_D2) - push pull - pull up - very high speed
pin 20 (PB4): alternate 9 (SDMMC2_D3) - push pull - pull up - very high speed
pin 21 (PB5): analog
pin 22 (PB6): alternate 5 (CEC) - open drain - floating - low speed
pin 23 (PB7): analog
pin 24 (PB8): alternate 14 (LCD_B6) - push pull - floating - high speed
pin 25 (PB9): analog
pin 26 (PB10): analog
pin 27 (PB11): alternate 11 (ETH1_GMII_TX_EN ETH1_MII_TX_EN ETH1_RGMII_TX_CTL ETH1_RMII_TX
_EN) - push pull - floating - very high speed
pin 28 (PB12): analog
pin 29 (PB13): analog
pin 30 (PB14): alternate 9 (SDMMC2_D0) - push pull - pull up - very high speed
pin 31 (PB15): alternate 9 (SDMMC2_D1) - push pull - pull up - very high speed
pin 32 (PC0): alternate 14 (LCD_R5) - push pull - floating - high speed
pin 33 (PC1): alternate 11 (ETH1_MDC) - push pull - floating - very high speed
pin 34 (PC2): alternate 11 (ETH1_GMII_TXD2 ETH1_MII_TXD2 ETH1_RGMII_TXD2) - push pull -
floating - very high speed
pin 35 (PC3): analog
pin 36 (PC4): alternate 11 (ETH1_GMII_RXD0 ETH1_MII_RXD0 ETH1_RGMII_RXD0 ETH1_RMII_RXD0)
- push pull - floating - low speed
pin 37 (PC5): alternate 11 (ETH1_GMII_RXD1 ETH1_MII_RXD1 ETH1_RGMII_RXD1 ETH1_RMII_RXD1)
- push pull - floating - low speed
pin 38 (PC6): analog
pin 39 (PC7): analog
pin 40 (PC8): analog
pin 41 (PC9): analog
pin 42 (PC10): analog
pin 43 (PC11): analog
pin 44 (PC12): analog
pin 45 (PC13): analog
pin 46 (PC14): analog
pin 47 (PC15): analog
pin 48 (PD0): analog
pin 49 (PD1): analog
pin 50 (PD2): analog
pin 51 (PD3): alternate 7 (USART2_CTS USART2_NSS) - push pull - floating - low speed
pin 52 (PD4): alternate 7 (USART2_RTS USART2_DE) - push pull - floating - very high speed
pin 53 (PD5): alternate 7 (USART2_TX) - push pull - floating - very high speed
```

```
pin 54 (PD6): alternate 7 (USART2_RX) - push pull - floating - low speed
pin 55 (PD7): analog
pin 56 (PD8): alternate 14 (LCD_B7) - push pull - floating - high speed
pin 57 (PD9): alternate 14 (LCD_B0) - push pull - floating - high speed
pin 58 (PD10): alternate 14 (LCD_B3) - push pull - floating - high speed
pin 59 (PD11): output - low - push pull - floating - low speed
pin 60 (PD12): alternate 5 (I2C1_SCL) - open drain - floating - low speed
pin 61 (PD13): analog
pin 62 (PD14): analog
pin 63 (PD15): analog
pin 64 (PE0): alternate 10 (SAI2_MCLK_A) - push pull - floating - high speed
pin 65 (PE1): analog
pin 66 (PE2): alternate 11 (ETH1_GMII_TXD3 ETH1_MII_TXD3 ETH1_RGMII_TXD3) - push pull -
floating - very high speed
pin 67 (PE3): alternate 9 (SDMMC2_CK) - push pull - pull up - very high speed
pin 68 (PE4): output - high - push pull - floating - low speed
pin 69 (PE5): alternate 14 (LCD_G0) - push pull - floating - high speed
pin 70 (PE6): alternate 14 (LCD_G1) - push pull - floating - high speed
pin 71 (PE7): analog
pin 72 (PE8): analog
pin 73 (PE9): analog
pin 74 (PE10): analog
pin 75 (PE11): analog
pin 76 (PE12): analog
pin 77 (PE13): analog
pin 78 (PE14): analog
pin 79 (PE15): alternate 14 (LCD_R7) - push pull - floating - high speed
pin 80 (PF0): analog
pin 81 (PF1): analog
pin 82 (PF2): input - high - floating
pin 83 (PF3): analog
pin 84 (PF4): analog
pin 85 (PF5): analog
pin 86 (PF6): analog
pin 87 (PF7): analog
pin 88 (PF8): analog
pin 89 (PF9): analog
pin 90 (PF10): alternate 14 (LCD_DE) - push pull - floating - high speed
pin 91 (PF11): alternate 10 (SAI2_SD_B) - push pull - floating - low speed
pin 92 (PF12): analog
pin 93 (PF13): analog
pin 94 (PF14): analog
pin 95 (PF15): alternate 5 (I2C1_SDA) - open drain - floating - low speed
pin 96 (PG0): analog
pin 97 (PG1): input - high - floating
pin 98 (PG2): analog
pin 99 (PG3): analog
pin 100 (PG4): alternate 11 (ETH1_GMII_GTX_CLK ETH1_RGMII_GTX_CLK) - push pull - floating
- very high speed
pin 101 (PG5): alternate 11 (ETH1_GMII_CLK125 ETH1_RGMII_CLK125) - push pull - floating -
very high speed
pin 102 (PG6): alternate 10 (SDMMC2_CMD) - push pull - pull up - very high speed
pin 103 (PG7): alternate 14 (LCD_CLK) - push pull - floating - high speed
pin 104 (PG8): analog
pin 105 (PG9): output - high - push pull - floating - low speed
pin 106 (PG10): alternate 14 (LCD_B2) - push pull - floating - high speed
pin 107 (PG11): alternate 6 (UART4_TX) - push pull - floating - low speed
pin 108 (PG12): alternate 14 (LCD_B1) - push pull - floating - high speed
pin 109 (PG13): alternate 11 (ETH1_GMII_TXD0 ETH1_MII_TXD0 ETH1_RGMII_TXD0
ETH1_RMII_TXD0) - push pull - floating - very high speed
pin 110 (PG14): alternate 11 (ETH1_GMII_TXD1 ETH1_MII_TXD1 ETH1_RGMII_TXD1
ETH1_RMII_TXD1) - push pull - floating - very high speed
pin 111 (PG15): analog
pin 112 (PH0): analog
pin 113 (PH1): analog
pin 114 (PH2): alternate 14 (LCD_R0) - push pull - floating - high speed
pin 115 (PH3): alternate 14 (LCD_R1) - push pull - floating - high speed
```

```
pin 116 (PH4): output - high - push pull - floating - low speed
pin 117 (PH5): analog
pin 118 (PH6): analog
pin 119 (PH7): analog
pin 120 (PH8): alternate 14 (LCD_R2) - push pull - floating - high speed
pin 121 (PH9): alternate 14 (LCD_R3) - push pull - floating - high speed
pin 122 (PH10): alternate 14 (LCD_R4) - push pull - floating - high speed
pin 123 (PH11): analog
pin 124 (PH12): alternate 14 (LCD_R6) - push pull - floating - high speed
pin 125 (PH13): alternate 14 (LCD_G2) - push pull - floating - high speed
pin 126 (PH14): alternate 14 (LCD_G3) - push pull - floating - high speed
pin 127 (PH15): alternate 14 (LCD_G4) - push pull - floating - high speed
pin 128 (PI0): alternate 14 (LCD_G5) - push pull - floating - high speed
pin 129 (PI1): alternate 14 (LCD_G6) - push pull - floating - high speed
pin 130 (PI2): alternate 14 (LCD_G7) - push pull - floating - high speed
pin 131 (PI3): analog
pin 132 (PI4): alternate 14 (LCD_B4) - push pull - floating - high speed
pin 133 (PI5): alternate 10 (SAI2_SCK_A) - push pull - floating - medium speed
pin 134 (PI6): alternate 10 (SAI2_SD_A) - push pull - floating - medium speed
pin 135 (PI7): alternate 10 (SAI2_FS_A) - push pull - floating - medium speed
pin 136 (PI8): analog
pin 137 (PI9): alternate 14 (LCD_VSYNC) - push pull - floating - high speed
pin 138 (PI10): alternate 14 (LCD_HSYNC) - push pull - floating - high speed
pin 139 (PI11): analog
```

- To obtain the GPIO settings:

```
Board $> cat /sys/kernel/debug/gpio
gpiochip0: GPIOs 0-15, parent: platform/soc:pin-controller@50002000, GPIOA:
 gpio-10  (                    |reset               ) out lo

gpiochip1: GPIOs 16-31, parent: platform/soc:pin-controller@50002000, GPIOB:

gpiochip2: GPIOs 32-47, parent: platform/soc:pin-controller@50002000, GPIOC:

gpiochip3: GPIOs 48-63, parent: platform/soc:pin-controller@50002000, GPIOD:
 gpio-59  (                    |heartbeat           ) out lo

gpiochip4: GPIOs 64-79, parent: platform/soc:pin-controller@50002000, GPIOE:
 gpio-68  (                    |reset               ) out hi

gpiochip5: GPIOs 80-95, parent: platform/soc:pin-controller@50002000, GPIOF:

gpiochip6: GPIOs 96-111, parent: platform/soc:pin-controller@50002000, GPIOG:
 gpio-105 (                    |reset               ) out hi

gpiochip7: GPIOs 112-127, parent: platform/soc:pin-controller@50002000, GPIOH:
 gpio-116 (                    |reset               ) out hi

gpiochip8: GPIOs 128-143, parent: platform/soc:pin-controller@50002000, GPIOI:

gpiochip9: GPIOs 400-415, parent: platform/soc:pin-controller-z@54004000, GPIOZ:
```

4 To go further

4.1 Regmap (register map) cache

Debugfs contains a register cache (mirror) for drivers/peripherals based on regmap API[3].

Regmap is a register map abstraction API of the Linux kernel. It is mainly used for serial bus device drivers (I2C and SPI), but can also be used for internal peripheral drivers.

Many of these drivers contain some very similar code for accessing connected-hardware device registers.
The regmap kernel API proposes a solution which factors out this code from the drivers, saving code and making it much easier to share infrastructure.

- Path of the regmap register cache in debugfs

```
Board $> cd /sys/kernel/debug/regmap
```

- List of devices for which drivers are based on regmap API:

```
Board $> ls -la .
total 0
drwxr-xr-x 18 root root 0 Jan  1  1970 .
drwx------ 32 root root 0 Jan  1  1970 ..
drwxr-xr-x  2 root root 0 Jan  1  1970 0-001b
drwxr-xr-x  2 root root 0 Jan  1  1970 0-0042
drwxr-xr-x  2 root root 0 Jan  1  1970 2-0033
drwxr-xr-x  2 root root 0 Jan  1  1970 40004000.timer
drwxr-xr-x  2 root root 0 Jan  1  1970 4000d000.audio-controller
drwxr-xr-x  2 root root 0 Nov 30 12:19 40016000.cec
drwxr-xr-x  2 root root 0 Jan  1  1970 40017000.dac
drwxr-xr-x  2 root root 0 Jan  1  1970 4400b004.audio-controller
drwxr-xr-x  2 root root 0 Jan  1  1970 4400b024.audio-controller
drwxr-xr-x  2 root root 0 Jan  1  1970 4400d000.dfsdm
drwxr-xr-x  2 root root 0 Jan  1  1970 50027004.audio-controller
drwxr-xr-x  2 root root 0 Jan  1  1970 dummy-interrupt-controller@5000d000
drwxr-xr-x  2 root root 0 Jan  1  1970 dummy-pwr@50001000
drwxr-xr-x  2 root root 0 Jan  1  1970 dummy-rcc@50000000
drwxr-xr-x  2 root root 0 Jan  1  1970 dummy-syscon@50020000
drwxr-xr-x  2 root root 0 Jan  1  1970 dummy-tamp@5c00a000
```

- Check for the corresponding driver: example for **2-0033** regmap entry

```
Board $> cat 2-0033/name
stpmic1
```

Then, on the STM32MPU device tree files, you can check for the device, and the corresponding driver

```
pmic: stpmic@33 {
        compatible = "st,stpmic1";
        reg = <0x33>;
        interrupts-extended = <&exti_pwr 55 IRQ_TYPE_EDGE_FALLING>;
        interrupt-controller;
        #interrupt-cells = <2>;
        status = "okay";
```

- Regmap entries stating by ***dummy-***

This kind of entry is set when there are no associated /dev entries (devtmpfs).

To find the corresponding node in the device tree, you can look for the suffix name after ***dummy-***:

Example for dummy-**interrupt-controller@5000d000**

```
exti: interrupt-controller@5000d000 {
        compatible = "st,stm32mp1-exti", "syscon";
        interrupt-controller;
        #interrupt-cells = <2>;
        reg = <0x5000d000 0x400>;
};
```

- List of registers: example for **2-0033** regmap entry

```
Board $> cat 2-0033/registers
01: 10
02: 00
03: 00
04: 00
05: 60
06: 10
10: 04
11: 00
12: 00
13: 00
14: 00
15: c0
16: 00
17: 00
18: 04
19: 00
1a: 00
1b: 00
1c: 00
1d: 0f
1e: 04
20: 61
21: 79
22: d9
23: d9
24: 01
25: 51
26: 4c
27: 7d
28: 01
29: 51
2a: 25
30: 61
31: 50
32: d9
33: d9
34: 00
35: 24
36: 24
37: 24
38: 01
39: 51
3a: 04
40: 35
```

```
50: 00
51: 00
52: 00
53: 80
60: 00
61: 00
62: 00
63: 00
70: 00
71: 00
72: 00
73: 00
80: fc
81: 8f
82: c4
83: cf
90: fc
91: 8f
92: c4
93: cf
a0: 03
a1: 70
a2: 3b
a3: 00
b0: 00
b1: 00
b2: 00
b3: 80
```

The first column representes the register address, and the second column the register value.

For register definitions, please refer to the device specification.

5 References

- Documentation/filesystems/debugfs.txt
- https://opensourceforu.com/2010/10/debugging-linux-kernel-with-debugfs
- https://elinux.org/images/a/a3/Regmap-_The_Power_of_Subsystems_and_Abstractions.pdf

- Useful external links

Document link	Document Type	Description
Wikipedia debugfs	Standard	Wikipedia
Guide to debugfs	Standard	Guide
regmap: Reducing the Redundancy in Linux Code	Article	Guide

Random Access Memory (Early computer memories generally hadserial access. Memories where any given address can be accessed when desired were then called "random access" to distinguish them from the memories where contents can only be accessed in a fixed order. The term is used today for volatile random-acces ssemiconductor memories.)

Process File System (See https://en.wikipedia.org/wiki/Procfs for more details)

System File System (See https://en.wikipedia.org/wiki/Sysfs for more details)

Debug File System (See https://en.wikipedia.org/wiki/Debugfs for more details)

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Receive

Consumer Electronics Control (HDMI standard)

Transmit

Compatibility Test Suite (Android specific) or Clear to send (in UART context)

Serial clock line

Secure digital

Serial DAta line

General-Purpose Input/Output (A realization of open ended transmission between devices on an embedded level. These pins available on a processor can be programmed to be used to either accept input or provide output to external devices depending on user desires and applications requirements.)

Application programming interface

Inter-Integrated Circuit (Bi-directional 2-wire bus standard for efficient inter-IC control.)

Serial Peripheral Interface

Stable: 16.01.2020 - 14:19 / Revision: 16.01.2020 - 14:17

A quality version of this page, approved on *16 January 2020*, was based off this revision.

This article lists and describes the OpenSTLinux file-system hierarchy (Weston and core).

1 Introduction

Linux® is a file-oriented operating system. This means that any application, library, or other information related, for example, to configurations and running applications is stored in files only.

The Filesystem Hierarchy Standard (FHS) defines the directory structure and directory contents in Linux distributions.
It is maintained by the Linux Foundation. The latest version is 3.0, released on June 3rd 2015[1]

The main parts described by the FHS are:

- the physical filesystem: any mass storage devices (NAND/eMMC/... partitions, USB key partitions, and so on)
- pseudo filesystem: created dynamically at boot-up (and/or at runtime) to store various information and configurations related to the software being run
- remote filesystem: rootfs can contain links to a network filesystem

OpenSTLinux images respect the latest FHS definition: 3.0

2 Root filesystem content

- The filesystem root of any Linux Distribution (OpenSTLinux included) is named '/' or 'root' (*do not confuse with the 'root' super user name*).

There are no files in the root path, only directories that shape the Linux FHS, as listed below:

bin/	Essential command binaries
boot/	Static boot loader files
dev/	Device files (*temporary filessytem devtmpfs*)
etc/	Host-specific system configuration
lib/	Essential shared libraries and kernel modules
media/	Mount point for removable media
mnt/	Mount point for temporarily mounting a filesystem
proc/	Kernel and process information (*pseudo filesystem procfs*)
opt/	Add-on application software packages
run/	Data relevant to running processes
sbin/	Essential system binaries
sys/	Kernel and system information (*pseudo filesystem sysfs*))
srv/	Data for system-provided services
tmp/	Temporary files
usr/	Secondary filesystem-hierarchy
var/	Variable data

- As a standard Linux distribution, the OpenSTLinux distribution includes the optional user directories:

/home	User home directories (*optional*)
/root	Home directory for the root user (*optional*)

Details of the directory purpose, content or sub-hierarchy can be found in the official documentation: FHS-3.0

- OpenSTLinux also integrates a vendorfs filesystem, mounted on a dedicated Flash-memory partition (*that is, /dev /mmcblk0p5*):

/vendor	Vendor dedicated directory

This directory allows the storage of specific vendor libraries.

3 References

- http://refspecs.linuxfoundation.org/

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File Hierarchy Standard defines by Linux Fundation

former spelling for e•MMC ('e' in italic)

Flash memory shortened to gain space in titles, tables and block diagrams

Stable: 24.01.2020 - 09:32 / Revision: 24.01.2020 - 09:31

A quality version of this page, approved on *24 January 2020*, was based off this revision.

Contents

1 Article purpose

This article provides some information about the sysfs pseudo filesystem usage from the user space.

2 Sysfs (/sys) pseudo filesystem

Sysfs provides a mean to export kernel data structures, their attributes, and the linkages between them to the user space.

Please refer to sysfs part of pseudo filesystem page.

3 Sysfs usage

Linux kernel provides a documentation[1] about the rules for sysfs usage.

Some examples are also described below with two different approaches for using sysfs entries from the user space:

- Linux application in C language
- bash script.

3.1 Example from Linux application

The below example is a typical sequence for using sysfs entry (here a PWM component):

- open a file descriptor of the sysfs entry file

```
10  len=snprintf(buf, sizeof(buf), "/sys/class/pwm/pwmchip0/pwm%d/duty_cycle", pwm_channel
);
11  fd = open(buf, O_RDWR);
```

- if fd is correctly opened, write/read value in the file: pay attention to the "text" format

```
12  if (fd < 0)
13  {
14      perror("pwm/duty_cycle");
15      return fd;
16  }
```

- read: store data to buffer

```
18  read(fd, buf, sizeof(buf));
```

- write: write data from buffer

```
20  len = snprintf(buf, sizeof(buf), "%d", 900000);
21  write(fd, buf, len);
```

- close file descriptor

```
30  close(fd);
```

3.2 Example for shell command / bash script

Operations on sysfs entries can be done by using command lines (i.e. *echo* for writing, *cat* for reading).

In this way, it is possible to use a bash script to execute a configuration sequence, similarly to what a user would do by typing multiple shell commands.

An example is provided in How_to_use_PWM_with_sysfs_interface.

4 References

- Documentation/admin-guide/sysfs-rules.rst

System File System (See https://en.wikipedia.org/wiki/Sysfs for more details)

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Pulse Width Modulation

Stable: 17.11.2020 - 16:28 / Revision: 12.11.2020 - 16:15

A quality version of this page, approved on *17 November 2020*, was based off this revision.

This article aims at presenting the directory structure of the Linux root file system available on STM32 board.

All files and directories are located under the root directory (*/*), in compliance with the File system Hierarchy Standard.

This root directory corresponds to the Linux root file system (rootfs partition), as defined in Flash partitions. Note also that the user file system (userfs partition), the boot file system (bootfs partition) and the vendor file system (vendorfs partition) can be accessed through the */usr/local* mounting point, through the */boot* mounting point, and through the */vendor* mounting point respectively.

Information

In practice, this article uses the release **STM32MP15-Ecosystem-v2.1.0** for the STM32MPU Embedded Software distribution as an example to illustrate the Linux directory structure. If you are using a different release, the names of the directories and files might differ.

The directories are shown in green, while the files are in black.

```
/                           Root directory (rootfs partition)
├── bin                     Essential user binaries (e.g. /bin/cat, /bin/ls, /bin/cp...)
│   └── [...]
├── boot                    Mounting point for the boot file system (bootfs partition):
see below
├── dev                     Device files (e.g. /dev/null, /dev/tty0, /dev/video0...)
├── etc                     System-wide configuration files (e.g. /etc/xdg/weston/weston.
ini Weston configuration file...)
├── home                    Users' home directories (containing saved files, personal
settings...)
├── lib                     Essential system libraries for the binaries in /bin and /sbin
 (e.g. libncurses.so.5.9...)
│   ├── modules
│   │   └── 5.4.56
│   │       ├── kernel      Linux kernel modules
│   │       │   └── [...]
│   │       ├── modules.dep List of module dependencies (generated by depmod)
│   │       └── [...]
│   └── [...]
├── lost+found
├── media                   Mount points for removable media devices
├── mnt                     Temporarily mounted file systems
├── proc                    Pseudo filesystem providing process and kernel information
as files (e.g. /proc/cpuinfo, /proc/version...)
├── root                    Home directory for the root user)
├── run                     Run-time variable data (information about the running system
since last boot)
```

```
├── sbin                    Essential system binaries (e.g. /sbin/fsck, /sbin/init, /sbin
/modprobe...)
├── sys                     Information about devices, drivers, and some kernel features
(e.g. /sys/kernel/debug akadebgufs...)
├── tmp                     Temporary files
├── usr                     User utilities and applications
│   ├── bin                 Non-essential user binaries (e.g. /usr/bin/lsusb, /usr/bin
/weston...)
│   ├── lib                 Non-essential system libraries for the binaries in /usr/bin
and /usr/sbin
│   ├── local               Mounting point for the user file system (userfs partition):
see below
│   ├── sbin                Non-essential system binaries (e.g. /usr/sbin/alsactl, /usr
/sbin/weston.sh...)
│   ├── share               Architecture-independent (shared) data
│   └── [...]
├── var                     Variable files
└── vendor                  Mounting point for the vendor file system (vendorfs
partition): see below
```

- Boot file system mounting point

```
/boot  bootfs partition
├── stm32mp157a-dk1[*].dtb  Linux kernel device tree blob files → STM32MP157A-DK1
├── stm32mp157c-dk2[*].dtb  Linux kernel device tree blob files → STM32MP157C-DK2
├── stm32mp157c-ev&[*].dtb  Linux kernel device tree blob files → STM32MP157C-EV1
├── uImage                  Linux kernel binary image file (with U-Boot wrapper)
└── [...]
```

- User file system mounting point

```
/usr/local  userfs partition
├── Cube-M4-examples                                    Examples for STM32CubeMP1
Package running on Arm®Cortex®-M4
│   ├── STM32MP157C-DK2                                 Examples of firmwares running
on Arm Cortex-M4 → STM32MP157C-DK2 (see more in STM32CubeMP1 Package)
│   │   ├── Applications
│   │   │   ├── OpenAMP
│   │   │   │   ├── OpenAMP_TTY_echo                    OpenAMP TTY echo application
│   │   │   │   │   ├── fw_cortex_m4.sh                 Script to start/stop this
application
│   │   │   │   │   ├── lib
│   │   │   │   │   │   └── firmware
│   │   │   │   │   │       └── OpenAMP_TTY_echo.elf    Firmware for this application
│   │   │   │   │   └── README                          Helper file for this
application
│   │   │   │   └── [...]                               Other OpenAMP applications
with the same structure (script, helper file and firmware)
│   │   │   └── [...]                                   Other applications with the
same structure (script, helper file and firmware)
│   │   ├── Demonstrations
│   │   │   ├── AI_Character_Recognition                Artificial intelligence
character recognition demonstration
│   │   │   │   └── lib
│   │   │   │       └── firmware
│   │   │   │           └── AI_Character_Recognition.elf  Firmware for this demonstration
│   │   └── Examples
│   │       ├── GPIO
│   │       │   └── GPIO_EXTI                           GPIO EXTI example
│   │       │       ├── fw_cortex_m4.sh                 Script to start/stop this
example
│   │       │       ├── lib
```

```
│   │       │           │   └── firmware
│   │       │           │       └── GPIO_EXTI.elf          Firmware for this example
│   │       │           └── README                          Helper file for this example
│   │       └── [...]                                       Other examples with the same
structure (script, helper file and firmware)
```

```
│   └── STM32MP157C-EV1                          Examples of firmwares running on Arm Cort
ex-M4 → STM32MP157C-EV1 (see more in STM32CubeMP1 Package)
│       ├── Applications
│       │   └── [...]                                       Applications with the same
structure (script, helper file and firmware)
│       ├── Demonstrations
│       │   └── [...]                                       Demonstrations with the same
structure (script, helper file and firmware)
│       └── Examples
│           └── [...]                                       Examples with the same
structure (script, helper file and firmware)
```

```
├── Linux-A7-examples                Examples for Linux® running on Arm®Cortex®-A7
│   ├── GPIO                         GPIO examples
│   │   ├── buttons
│   │   │   ├── button_gpio_exti.sh  Script for this example
│   │   │   └── README.md            Helper file for this example
│   │   └── leds                     Same structure for this example relative to the leds
│   │       └── [...]
│   └── [...]                        Same structure for all the examples
├── demo                             All files needed (e.g. Python scripts, pictures,
media files...) for the GTK demo launcher
│   └── [...]
├── lost+found
└── weston-start-at-startup
    └── start_up_demo_launcher.sh    Script to start the GTK demo launcher
```

- Vendor file system mounting point

```
/vendor    vendorfs partition
├── [*].so  Specific vendor libraries (e.g. Vivante libraries OpenGL ES, OpenVG and EGL)
└── [...]
```

Linux® is a registered trademark of Linus Torvalds.

also known as

Das U-Boot -- the Universal Boot Loader (see U-Boot_overview)

Arm® is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

Cortex®

TeleTYpewriter

Artificial Intelligence

General-Purpose Input/Output (A realization of open ended transmission between devices on an embedded level. These pins available on a processor can be programmed to be used to either accept input or provide output to external devices depending on user desires and applications requirements.)

External Interrupt

Open Graphics Library (See http://www.opengl.org/ for more details)

Open Vector Graphics (See http://www.khronos.org/openvg/ for more details)

Khronos Native Platform Graphics Interface (See http://www.khronos.org/egl/ for more details)

Stable: 31.01.2020 - 13:23 / Revision: 31.01.2020 - 13:16

A quality version of this page, approved on *31 January 2020*, was based off this revision.

Contents

1 Introduction

When running, Linux® operating system creates and populates some filesystems which are not present on the rootfs fileystem of the Linux distribution image:

- **pseudo filesystems**: **sysfs** (/sys), **procfs** (/proc), **debugfs** (/sys/kernel/debug), **configfs** (/sys/kernel/config), **tracefs** (/sys/kernel/tracing)
- **temporary filesystems**: **tmppfs** (/dev/shm, /run, /sys/fs/cgroup, /tmp/, /var/volatile, /run/user/*<id>*), **devtmpfs** (/dev)

Pseudo filesystems contain many informations, configurations and logs about the current running kernel.
Informations from those pseudo filesystems are very helpful and any debugging session should start by browsing them.

These both filesystem groups are part of the File Hierarchy Standard (FHS) for the Linux operating system.

As they are placed in volatile memory, they are only available at run time, and they disappear at shutdown.

2 procfs (/proc) - Kernel and process information

Procfs[1] is enabled and ready to be used in all STM32MPU Embedded Software distribution, via the Linux® kernel configuration **CONFIG_PROC_FS**, set to yes by default.

```
Symbol: PROC_FS
Location:
  File systems --->
    Pseudo filesystems -->
      [*] /proc file system support
```

Please refer to Menuconfig or how to configure kernel article to get instructions for modifying the configuration and recompiling the Linux kernel image in the Distribution Package context.

Procfs is sometimes referred to as a process information pseudo-file system. It does not contain 'real' files but runtime system information (e.g. system memory, devices mounted, hardware configuration, etc).

For this reason it can be seen as a control and information center for the kernel. In fact, quite a lot of system utilities are simply calls to files in this directory.

For example, 'lsmod' is the same as 'cat /proc/modules' while 'lspci' is a synonym for 'cat /proc/pci'. By altering files located in this directory you can even read/change kernel parameters (sysctl) while the system is running.

Procfs is explain in details in The Linux Documentation Project[2], or Wikipedia[3].

2.1 Some procfs useful entries

Name	Description
/proc/<*PID*>/	directory containing information about the kernel process <*PID*>
/prod /cmdline	gives the boot options passed to the kernel
/proc /cpuinfo	provides information about the processor: its type, make, model, and performance
/proc /devices	lists all of the devices (divided into the "block" and "character" categories) available on the currently running system, giving also the major part of the /dev name too
/proc /device-tree	contains devices tree information for all nodes organized as defined in the device-tree source file(s).
/proc /interrupts	shows which interrupts are in use, and how many of each there have been.
/proc	

Name	Description
/iomem	gives information about memory mapping
/proc /kallsyms	contains the dynamic kernel symbol table
/proc /kmsg	holds messages output by the kernel.
/proc /meminfo	contains a summary of how the kernel is managing its memory (both physical and swap).
/proc /misc	Miscellaneous pieces of information, lists also the misc features devices
/proc /modules	one of the most important files in /proc; contains a list of the kernel modules currently loaded. It gives some indication of dependencies.

3 sysfs (/sys) - System filesystem

Sysfs[4] is a RAM-based filesystem initially based on ramfs. It provides a means to export kernel data structures, their attributes, and the linkages between them, to user space.

Sysfs is enabled and ready to be used in all STM32MPU Embedded Software distribution, via the Linux® kernel configuration **CONFIG_SYSFS**, set to yes by default.

```
Symbol: SYSFS
Location:
  File systems --->
    Pseudo filesystems -->
      [*] sysfs file system support
```

Please refer to Menuconfig or how to configure kernel article to get instructions for modifying the configuration and recompiling the Linux kernel image in the Distribution Package context.

Useful information also given in How to access information in sysfs article.

3.1 Top Level sysfs directory layout

Sysfs directory arrangement exposes the relationship of kernel data structures.

/sys has a sub-hierarchy file system:

sub-Directory	Description
/sys/block/	Contains one symbolic link for each block device that has been discovered on the system. The symbolic links point to corresponding directories under /sys/devices.
/sys/bus/	Contains one subdirectory for each of the bus types in the kernel. Each bus's directory contains two subdirectories: ./devices/ ./drivers/
/sys	Contains a single layer of further subdirectories for each of the device classes that have been

sub-Directory	Description
/class/	registered on the system (e.g., terminals, network devices, block devices, graphics devices, sound devices, and so on). Inside each of these subdirectories are symbolic links for each of the devices in this class. These symbolic links refer to entries in the /sys/devices directory
/sys/class/net/	Each of the entries in this directory is a symbolic link representing one of the real or virtual networking devices that are visible in the network namespace of the process that is accessing the directory. Each of these symbolic links refers to entries in the /sys/devices directory
/sys/dev/	This directory contains two subdirectories block/ and char/, corresponding, respectively, to the block and character devices on the system. Inside each of these subdirectories are symbolic links with names of the form major-ID:minor-ID, where the ID values correspond to the major and minor ID of a specific device. Each symbolic link points to the sysfs directory for a device. The symbolic links inside /sys/dev thus provide an easy way to look up the sysfs interface using the device IDs returned by a call to stat tool (or similar)
/sys/devices/	Contains a filesystem representation of the kernel device tree, which is a hierarchy of device structures within the kernel
/sys/firmware/	Contains interfaces for viewing and manipulating firmware-specific objects and attributes
/sys/fs	

sub-Directory	Description
/	Contains subdirectories for some filesystems. A filesystem will have a subdirectory here only if it chose to explicitly create the subdirectory
/sys/kernel/	Contains various files and subdirectories that provide information about the running kernel
/sys/module/	Contains one subdirectory for each module that is loaded into the kernel. The name of each directory is the name of the module

3.2 Zoom to debugfs (/sys/kernel/debug)

Please refer to debugfs article.

3.3 Zoom to configfs (/sys/kernel/config)

Please refer to configfs article.

3.4 Zoom to tracefs (/sys/kernel/tracing)

Tracefs is used with the Linux kernel tracing framework.

Example of usage is given in Ftrace article.

- Command to mount tracefs:

```
Board $> mount -t tracefs nodev /sys/kernel/tracing
```

To find out which tracers are available, simply read available_tracers file in the tracing directory:

```
Board $> cat /sys/kernel/tracing/available_tracers
 function_graph function nop
```

More tracers can be added by kernel build configurations. Please refer to Ftrace#More_tracers paragraph.

4 Information about temporary filesystem

4.1 tmpfs

Tmpfs[5] is a file system which keeps all files in virtual memory.

It is enabled and ready to be used in all STM32MPU Embedded Software distribution, via the Linux® kernel configuration **CONFIG_TMPFS**, set to yes by default.

```
Symbol: TMPFS
Location:
  File systems --->
    Pseudo filesystems -->
      [*] Tmpfs virtual memory file system support (former shm fs)
```

Please refer to Menuconfig or how to configure kernel article to get instructions for modifying the configuration and recompiling the Linux kernel image in the Distribution Package context.

Everything in tmpfs is temporary in the sense that no files will be created on your hard drive. If you unmount a tmpfs instance, everything stored therein is lost.

On the board target, you can check for the directory path mount with the tmpfs:

```
Board $> mount | grep tmpfs
tmpfs on /dev/shm type tmpfs (rw,nosuid,nodev)
tmpfs on /run type tmpfs (rw,nosuid,nodev,mode=755)
tmpfs on /sys/fs/cgroup type tmpfs (ro,nosuid,nodev,noexec,mode=755)
tmpfs on /tmp type tmpfs (rw,nosuid,nodev)
tmpfs on /var/volatile type tmpfs (rw,relatime)
tmpfs on /run/user/0 type tmpfs (rw,nosuid,nodev,relatime,size=43812k,mode=700)
```

For all details you can refer to the Linux documentation about tmpfs[5].

4.2 devtmpfs

Devtmpfs is enabled and ready to be used in all STM32MPU Embedded Software distribution, via the Linux® kernel configuration **CONFIG_DEVTMPFS** and **CONFIG_DEVTMPFS_MOUNT**, set to yes by default.

```
Symbol: DEVTMPFS
Location:
  Device Drivers --->
    Generic Driver Options -->
      [*] Maintain a devtmpfs filesystem to mount at /dev

Symbol: DEVTMPFS_MOUNT
Location:
  Device Drivers --->
    Generic Driver Options -->
      [*] Maintain a devtmpfs filesystem to mount at /dev
        [*] Automount devtmpfs at /dev, after the kernel mounted the rootfs
```

- **/dev** - special or device files

Devtmpfs is mounted on /dev which is the location of special or device files. Many of these are generated at boot time or even on the fly.

It is a very interesting directory that highlights one important aspect of the Linux filesystem: **everything is a file or a directory**.

Look through this directory and you can see device file system entries which represent the various partitions on the first master drive of the system:
For example:

- mmcblk0p<*id*> (microSD Card),
- mmcblk1p<*id*> (eMMC),
- sda<*id*>,
- sdb<*id*> (NAND or USB Key),
- ttySTM<*id*> (tty Serial link),
- etc...

These entries can be both read from and written to.
Take /dev/ttyUSB0, for instance. This file represents the USB Serial port. Sending data to and reading from /dev/ttyUSB0 will allow you to communicate with host PC through the minicom application (or equivalent).

/dev is very helpful, more info could be found in the Linux Documentation Project[6].

5 References

- Documentation/filesystems/proc.txt
- http://www.tldp.org/LDP/Linux-Filesystem-Hierarchy/html/proc.html
- https://en.wikipedia.org/wiki/Procfs
- Documentation/filesystems/sysfs.txt
- 5.05.1 Documentation/filesystems/tmpfs.txt
- http://www.tldp.org/LDP/Linux-Filesystem-Hierarchy/html/dev.html

System File System (See https://en.wikipedia.org/wiki/Sysfs for more details)

Process File System (See https://en.wikipedia.org/wiki/Procfs for more details)

Debug File System (See https://en.wikipedia.org/wiki/Debugfs for more details)

Configuration File System (See https://en.wikipedia.org/wiki/Configfs for more details)

Random Access Memory (Early computer memories generally hadserial access. Memories where any given address can be accessed when desired were then called "random access" to distinguish them from the memories where contents can only be accessed in a fixed order. The term is used today for volatile random-acces ssemiconductor memories.)

Read Only

former spelling for e•MMC ('e' in italic)