USB System Design in Sitara Devices Using Linux

[Part 7]: Debug USB in Linux
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Two categories of USB software issues

- USB software initialization failure:
  - Linux misconfiguration
- USB is not functional as expected:
  - software bugs
  - (Assuming hardware designed correctly)

Support on TI E2E Forums
Guidelines on debugging USB misconfiguration

• Observing the failure:
  – Host mode
    `lsusb`
  – Device mode
    `/sys/class/udc/*/uevent`

• Diagnosis:
  – Kernel boot log
  – Kernel Config
  – `lsmod`
  – Device Tree
  – `chkusb.sh`
Observe misconfiguration failure in host mode

• Use \texttt{lsusb} command.

• In working case:
  \begin{verbatim}
  root@am57xx-evm:~# lsusb
  Bus 002 Device 001: ID 1d6b:0003 Linux Foundation
  Bus 001 Device 001: ID 1d6b:0002 Linux Foundation
  \end{verbatim}

• In failure case:
  \begin{verbatim}
  root@am57xx-evm:~# lsusb
  unable to initialize libusb: -99
  \end{verbatim}
Observe misconfiguration failure in device mode

• Check `/sys/class/udc` folder.

• In working case:
  ```
  root@am57xx-evm:~# ls /sys/class/udc
  48890000.usb
  root@am335x-evm:~# ls /sys/class/udc
  musb-hdrc.0
  ```

• In failure case:
  ```
  root@am57xx-evm:~# ls /sys/class/udc
  <empty>
  ```
Diagnosis 1: Check kernel boot log

- Check kernel `dmesg` log for any USB error message:
  USB PHY, USB controller, Glue driver, USB Core, DMA, Extcon, etc.

```bash
# dmesg | grep usb
```

- Some USB related messages do not have the keyword “usb”
Diagnosis 1: Check kernel configuration

• Ensure all required config options are enabled.
• For MUSB, refer to:
  – The previous module in this training: **MUSB Config in Linux Kernel**
  – Wiki: MUSB Linux Driver Configuration
• For DWC3, refer to:
  – The previous module in this training: **DWC3 Config in Linux Kernel**
  – Wiki: DWC3 Linux Driver Configuration
• Use the default config provided in Processor Linux SDK kernel as the reference.
  tisdk_<xxx-evm>_defconfig
Diagnosis 1: Check USB kernel modules

• Use ‘lsmod’ command to examine loaded USB kernel modules
• If any modules are missing, check to see if the *.ko module exists in the filesystem under
  /lib/modules/$(uname -r)/kernel/drivers/
Diagnosis 1: Check device-tree settings

- Ensure USB-related DT nodes are enabled and \textit{dr\_mode} is set properly.
- Double check Extcon DT nodes with design schematics.
- For MUSB, refer to:
  - The previous module in this training: \textbf{MUSB Config in Linux Kernel}
  - Wiki AM335 MUSB Linux Porting Guide
    \url{http://processors.wiki.ti.com/index.php/MUSB_Linux_Porting_Guide}
  - Wiki: MUSB DT Bindings Kernel Documentation
    - \url{https://www.kernel.org/doc/Documentation/devicetree/bindings/usb/am33xx-usb.txt}
    - \url{https://www.kernel.org/doc/Documentation/devicetree/bindings/usb/da8xx-usb.txt}
- For DWC3, refer to:
  - The previous module in this training: \textbf{DWC3 Config in Linux Kernel}
  - Wiki: OMAP DWC3 DT Bindings Kernel Documentation
    \url{https://www.kernel.org/doc/Documentation/devicetree/bindings/usb/omap-usb.txt}
  - Wiki: DWC3 Core DT Bindings Kernel Documentation
    \url{https://www.kernel.org/doc/Documentation/devicetree/bindings/usb/dwc3.txt}
- Examine \texttt{/sys/firmware/devicetree/} to ensure DTS changes take effect.
Diagnosis 1: *chkusb.sh* script

- The script does most of the checking mentioned previously
- The script is not provided in the Processor SDK filesystem
- How to find it?
  - It is attached in many TI E2E forum threads
  - Search for “chkusb.sh” on [https://e2e.ti.com](https://e2e.ti.com)
Guidelines on debugging USB runtime failures

• Check hardware design
• USB driver logs
• Dynamic debug
• ftrace (function tracer)
• USB register dump
• USB protocol analyzer trace
Diagnosis 2: Check USB hardware design

- Refer to the previous module in this training: USB Hardware Design
- Review schematics
- Review layout
- USB EYE Diagram test
Diagnosis 2: Check kernel logs

• Kernel USB drivers print error messages when USB behaves abnormally:
  – Error messages
  – Kernel crash dump

• These messages might be the first hint of an issue.
Diagnosis 2: Dynamic debug

- To get more kernel debug logs, run dynamic debug:
  - Enable/disable kernel debug logs at Linux runtime
  - More details: https://training.ti.com/debugging-embedded-linux-dynamic-debug

- Suitable for USB core, class/gadget drivers
Diagnosis 2: ftrace log

• Kernel internal tracer is designed to help understand what is going on inside the kernel.

• More details: https://www.kernel.org/doc/Documentation/trace/ftrace.txt

• MUSB/DWC3/xHCI controllers drivers use ftrace event tracing:
  – To expose driver/controller activities at runtime
  – More about event tracing: https://www.kernel.org/doc/Documentation/trace/events.txt
Diagnosis 2: ftrace log in MUSB

```
root@am335x-evm:~# ls /sys/kernel/debug/tracing/events/musb
enable              musb_readb          musb_urb_deq
filter              musb_readl          musb_urb_enq
musb_cppi41_abort   musb_readw          musb_urb_gb
musb_cppi41_alloc   musb_req_alloc      musb_urb_rx
musb_cppi41_config  musb_req_deq        musb_urb_start
musb_cppi41_cont    musb_req_enq        musb_urb_tx
musb_cppi41_done    musb_req_free       musb_writeb
musb_cppi41_free    musb_req_gb         musb_writel
musb_cppi41_gb      musb_req_rx         musb_writew
musb_isr
musb_log
musb_log
```


Diagnosis 2: ftrace log in DWC3

root@am57xx-evm:~# ls /sys/kernel/debug/tracing/events/dwc3/

dwc3_alloc_request  dwc3_ep_queue  dwc3_gadget_giveback
dwc3_complete_trb   dwc3_event    dwc3_prepare_trb

dwc3_core

dwc3_free_request  dwc3_gadget

dwc3_ep0

dwc3_ep_dequeue  dwc3_gadget_ep_cmd  enable

 enable

dwc3_gadget_generic_cmd  filter
Diagnosis 2: ftrace log in xHCI

root@am57xx-evm:~# ls /sys/kernel/debug/tracing/events/xhci-hcd/
enable                    xhci_dbg_context_change
filter                    xhci_dbg_init
xhci_address_ctx          xhci_dbg_quirks
xhci_cmd_completion       xhci_dbg_reset_ep
xhci_dbg_address          xhci_dbg_ring_expansion
xhci_dbg_cancel_urb
Diagnosis 2: Dump USB module registers

- For MUSB controller:
  # cat /sys/kernel/debug/musb-hdrc.0/regdump

- For DWC3 controller:
  # cat /sys/kernel/debug/48890000.usb/regdump

- xHCI controller driver does not have an debugfs entry to dump xHCI registers.
  Use devmem2 or other tool to read registers.

Note: Replace the node in red above accordingly.
Diagnosis 2: USB protocol analyzer trace

Hardware-based USB protocol analyzer:
• USB packet sniffer
• Independent of USB host or device
Seeking support on TI E2E Forums

• Post your queries on Sitara Processors Forum: http://e2e.ti.com/support/arm/sitara_arm/f/791

• Including the keyword “USB” in the post title.

• Watch the video Dos & Don’ts for Communication to TI E2E Forums: https://training.ti.com/dos-donts-posting-to-e2e-community-forums
  Provides tips for efficient E2E communication
For more information

• Debugging Embedded Linux Systems Training Series: https://training.ti.com/debugging-embedded-linux-dynamic-debug

• USB System Design in Sitara Devices Using Linux Training Series: https://training.ti.com/usb-system-design-sitara-linux

• MUSB Linux Driver Configuration http://processors.wiki.ti.com/index.php/MUSB_Linux_Driver_Configuration

• DWC3 Linux Driver Configuration http://processors.wiki.ti.com/index.php/Linux_Core_DWC3_User's_Guide#Driver_Configuration

• For questions about this training, refer to the E2E Community Forums at http://e2e.ti.com