USB System Design in Sitara Devices Using Linux

[Part 5]: Use USB in Host Mode
Bin Liu (EP, Processors)
• Overview of USB host mode
• USB terminology: USB topology, VID:PID, device enumeration
• USB in Kernel boot log
• Hub enumeration log
• Device enumeration log: Thumb drive, webcam, Ethernet dongle
• Examining enumerated devices
USB host mode overview

• USB host mode:
  Presented as a USB host port, like that on a PC

• Should be easy to use:
  – Enumeration is transparent to end users
  – Presents the function of enumerated USB devices to the same as non-USB devices:
    • Thumb drive → /dev/sda
    • Webcam → /dev/video0
    • USB Ethernet dongle → eth0
    • USB UART dongle → /dev/ttyUSB0
    • …
USB topology overview

• Tiered star topology:
  – Hubs
  – Max of 7 tiers
  – 5 hub tiers
  – No hubs on Tier 7

• Point-to-point communication
USB identification: VID/PID

• The VID:PID combination identifies USB devices:
  – Each is a 16-bit number
  – Embedded in USB products
  – Communicated to the USB host during enumeration

• For example: 1d6b:0002

  VID (Vendor ID) assigned by USB-IF
  PID (Product ID) assigned by the manufacturer
USB device enumeration

• Activity that detects and identifies attached/detached USB devices:
  – When USB device is attached
    • Detects device speed
    • Assigns device an unique address
    • Queries device functions/capabilities
  – When USB device is detached
    • Disables the port to which the USB device has been attached
    • Updates local topological information

• Enumeration process:
  – Electrical enumeration
  – Software enumeration:
    • By USB core drivers
    • By USB class drivers
AM335x MUSB log in kernel boot

- [28.082168] 47401300.usb-phy supply vcc not found, using dummy regulator
- [28.225364] usbcore: registered new interface driver usbf
- [28.266910] 47401b00.usb-phy supply vcc not found, using dummy regulator
- [28.452639] usbcore: registered new interface driver hub
- [28.551803] usbcore: registered new device driver usb
- [28.907803] musb-hdrc musb-hdrc.0: MUSB HDRC host driver
- [28.907849] musb-hdrc musb-hdrc.0: new USB bus registered, assigned bus number 1
- [28.909102] hub 1-0:1.0: USB hub found
- [28.909505] hub 1-0:1.0: 1 port detected
- [29.041987] musb-hdrc musb-hdrc.1: MUSB HDRC host driver
- [29.042029] musb-hdrc musb-hdrc.1: new USB bus registered, assigned bus number 2
- [29.079753] hub 2-0:1.0: USB hub found
- [29.079810] hub 2-0:1.0: 1 port detected
**lsusb to check USB buses**

We can also use `lsusb` command to check the USB buses are ready:

If ready:

```bash
root@am335x-evm:~# lsusb
Bus 002 Device 001: ID 1d6b:0002 Linux Foundation
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation
```

If not:

```bash
root@am335x-evm:~# lsusb
unable to initialize libusb: -99
```
AM57x DWC3/xHCI log in kernel boot

[    7.631914] usbcore: registered new interface driver hub
[    7.638051] usbcore: registered new device driver usb
[    7.682830] xhci-hcd xhci-hcd.0.auto: xHCI Host Controller
[    7.689423] xhci-hcd xhci-hcd.0.auto: new USB bus registered, assigned bus number 1
[    7.716336] usb usb1: New USB device found, idVendor=1d6b, idProduct=0002
[    7.723256] usb usb1: New USB device strings: Mfr=3, Product=2, SerialNumber=1
[    7.730854] usb usb1: Product: xHCI Host Controller
[    7.736031] usb usb1: Manufacturer: Linux 4.9.78-02452-gb7f5aa5c64de xhci-hcd
[    7.743301] usb usb1: SerialNumber: xhci-hcd.0.auto
[    7.749929] hub 1-0:1.0: USB hub found
[    7.754527] hub 1-0:1.0: 1 port detected
[    7.759857] xhci-hcd xhci-hcd.0.auto: xHCI Host Controller
[    7.766353] xhci-hcd xhci-hcd.0.auto: new USB bus registered, assigned bus number 2
[    7.782883] usb usb2: New USB device found, idVendor=1d6b, idProduct=0003
[    7.790067] usb usb2: New USB device strings: Mfr=3, Product=2, SerialNumber=1
[    7.797541] usb usb2: Product: xHCI Host Controller
[    7.803148] usb usb2: Manufacturer: Linux 4.9.78-02452-gb7f5aa5c64de xhci-hcd
[    7.803154] usb usb2: SerialNumber: xhci-hcd.0.auto
[    7.810708] hub 2-0:1.0: USB hub found
[    7.810738] hub 2-0:1.0: 1 port detected
USB high-speed hub enumeration log example

[258711.393109] usb 3-1: new high-speed USB device number 2 using xhci-hcd
[258711.564538] usb 3-1: New USB device found, idVendor=2109, idProduct=2812
[258711.571358] usb 3-1: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[258711.578634] usb 3-1: Product: USB2.0 Hub
[258711.583814] usb 3-1: Manufacturer: VIA Labs, Inc.
[258711.595408] hub 3-1:1.0: USB hub found
[258711.599410] hub 3-1:1.0: 4 ports detected
USB high-speed hub enumeration log example

[258711.393109] usb 3-1: new high-speed USB device number 2 using xhci-hcd
[258711.564538] usb 3-1: New USB device found, idVendor=2109, idProduct=2812
[258711.571358] usb 3-1: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[258711.578634] usb 3-1: Product: USB2.0 Hub
[258711.583814] usb 3-1: Manufacturer: VIA Labs, Inc.
[258711.595408] hub 3-1:1.0: USB hub found
[258711.599410] hub 3-1:1.0: 4 ports detected

root@am57xx-evm:~# lsusb -t
/: Bus 04.Port 1: Dev 1, Class=root_hub, Driver=xhci-hcd/1p, 5000M
/: Bus 03.Port 1: Dev 1, Class=root_hub, Driver=xhci-hcd/1p, 480M
   |__ Port 1: Dev 2, If 0, Class=Hub, Driver=hub/4p, 480M
/: Bus 02.Port 1: Dev 1, Class=root_hub, Driver=xhci-hcd/1p, 5000M
/: Bus 01.Port 1: Dev 1, Class=root_hub, Driver=xhci-hcd/1p, 480M
USB super-speed hub enumeration log example

[259442.473217] usb 2-1: new **SuperSpeed** USB device number 2 using xhci-hcd
[259442.735361] usb 2-1: New USB device found, idVendor=2109, idProduct=0812
[259442.742178] usb 2-1: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[259442.750706] usb 2-1: Product: USB3.0 Hub
[259442.756484] usb 2-1: Manufacturer: VIA Labs, Inc.
[259442.775304] hub 2-1:1.0: USB hub found
[259442.779437] hub 2-1:1.0: 4 ports detected
[259442.873117] usb 1-1: new **high-speed** USB device number 2 using xhci-hcd
[259443.044540] usb 1-1: New USB device found, idVendor=2109, idProduct=2812
[259443.051358] usb 1-1: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[259443.059890] usb 1-1: Product: USB2.0 Hub
[259443.065678] usb 1-1: Manufacturer: VIA Labs, Inc.
[259443.079339] hub 1-1:1.0: USB hub found
[259443.083399] hub 1-1:1.0: 4 ports detected
USB thumb drive enumeration log example

[ 203.903495] usb 2-1.4: new SuperSpeed USB device number 3 using xhci-hcd
[ 204.055499] usb 2-1.4: New USB device found, idVendor=13fe, idProduct=5500
[ 204.062404] usb 2-1.4: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[ 204.069769] usb 2-1.4: Product: Silicon-Power32G
[ 204.074421] usb 2-1.4: Manufacturer: UFD 3.0
[ 204.078706] usb 2-1.4: SerialNumber: P1601315070B65BF8EA9BA78
[ 204.129321] usb-storage 2-1.4:1.0: USB Mass Storage device detected
[ 204.136008] scsi host0: usb-storage 2-1.4:1.0
[ 204.140671] usbcore: registered new interface driver usb-storage
[ 205.204613] scsi 0:0:0:0: Direct-Access Silicon-Power32G
[ 205.904591] sd 0:0:0:0: [sda] 60604416 512-byte logical blocks: (31.0 GB/28.9 GiB)
[ 205.912349] sd 0:0:0:0: [sda] Write Protect is off
[ 205.917442] sd 0:0:0:0: [sda] No Caching mode page found
[ 205.922833] sd 0:0:0:0: [sda] Assuming drive cache: write through
[ 205.933794] sd 0:0:0:0: [sda] Attached SCSI removable disk
USB webcam enumeration log example

[ 250.653459] usb 1-1.3: new high-speed USB device number 3 using xhci-hcd
[ 250.934827] usb 1-1.3: New USB device found, idVendor=046d, idProduct=0990
[ 250.941735] usb 1-1.3: New USB device strings: Mfr=0, Product=0, SerialNumber=2
[ 250.950295] usb 1-1.3: SerialNumber: 4C5A2E43
[ 251.015055] media: Linux media interface: v0.10
[ 251.039935] Linux video capture interface: v2.00
[ 251.061589] uvcvideo: Found UVC 1.00 device <unnamed> (046d:0990)
[ 251.173811] input: UVC Camera (046d:0990) as /devices/platform/44000000.ocp/48880000.omap_dwc3_1/48890000.usb/xhci-hcd.0.auto/usb1/1-1/1-1.3/1-1.3:1.0/input/input1
[ 251.189716] usbcore: registered new interface driver uvcvideo
[ 251.195518] USB Video Class driver (1.1.1)
[ 251.598395] usb 1-1.3: Warning! Unlikely big volume range (=3072), cval->res is probably wrong.
[ 251.617012] usbcore: registered new interface driver snd-usb-audio
USB ethernet dongle enumeration log example

[ 8551.173489] usb 2-1.1: new SuperSpeed USB device number 4 using xhci-hcd
[ 8551.204067] usb 2-1.1: New USB device found, idVendor=0bda, idProduct=8153
[ 8551.210972] usb 2-1.1: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[ 8551.219543] usb 2-1.1: Product: USB 10/100/1000 LAN
[ 8551.225069] usb 2-1.1: Manufacturer: Realtek
[ 8551.229358] usb 2-1.1: SerialNumber: 00E01E8100AF

[ 8551.285065] usbcore: registered new interface driver r8152
[ 8551.297324] usbcore: registered new interface driver cdc_ether
[ 8551.406628] usb 2-1.1: reset SuperSpeed USB device number 4 using xhci-hcd
[ 8551.535831] r8152 2-1.1:1.0 eth2: v1.08.9
lsusb command

root@am57xx-evm:~# lsusb
Bus 002 Device 003: ID 13fe:5500 Kingston Technology Company Inc.
Bus 002 Device 004: ID 0bda:8153 Realtek Semiconductor Corp.
Bus 004 Device 001: ID 1d6b:0003 Linux Foundation
Bus 001 Device 003: ID 046d:0990 Logitech, Inc. QuickCam Pro 9000
Bus 001 Device 002: ID 2109:2812 VIA Labs, Inc. VL812 Hub
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation
Bus 002 Device 002: ID 2109:0812 VIA Labs, Inc. VL812 Hub
Bus 002 Device 001: ID 1d6b:0003 Linux Foundation
Bus 003 Device 001: ID 1d6b:0002 Linux Foundation
"lsusb -t" command

root@am57xx-evm:~# lsusb -t

/:  Bus 04. Port 1: Dev 1, Class=root_hub, Driver=xhci-hcd/1p, 5000M
/:  Bus 03. Port 1: Dev 1, Class=root_hub, Driver=xhci-hcd/1p, 480M
/:  Bus 02. Port 1: Dev 1, Class=root_hub, Driver=xhci-hcd/1p, 5000M
   |__ Port 1: Dev 2, If 0, Class=Hub, Driver=hub/4p, 5000M
   |__ Port 1: Dev 4, If 0, Class=Vendor Specific Class, Driver=r8152, 5000M
   |__ Port 4: Dev 3, If 0, Class=Mass Storage, Driver=usb-storage, 5000M
/:  Bus 01. Port 1: Dev 1, Class=root_hub, Driver=xhci-hcd/1p, 480M
   |__ Port 1: Dev 2, If 0, Class=Hub, Driver=hub/4p, 480M
   |__ Port 3: Dev 3, If 0, Class=Video, Driver=uvcvideo, 480M
   |__ Port 3: Dev 3, If 1, Class=Video, Driver=uvcvideo, 480M
   |__ Port 3: Dev 3, If 2, Class=Audio, Driver=snd-usb-audio, 480M
   |__ Port 3: Dev 3, If 3, Class=Audio, Driver=snd-usb-audio, 480M
“lsusb -v” command

root@am57xx-evm:~# lsusb -v -d 13fe:5500
Bus 002 Device 003: ID 13fe:5500 Kingston Technology Company Inc.
Device Descriptor:
   bLength                18
   bDescriptorType         1
   bcdUSB               3.10
   bDeviceClass            0
   bDeviceSubClass         0
   bDeviceProtocol         0
   bMaxPacketSize0         9
   idVendor           0x13fe Kingston Technology Company Inc.
   idProduct          0x5500
   bcdDevice            1.00
   iManufacturer           1 UFD 3.0
   iProduct                2 Silicon-Power32G
   iSerial                 3 P1601315070B65BF8EA9BA78
   bNumConfigurations      1
Configuration Descriptor:
   bLength                9
   ...
For more information

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