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San Francisco 2015

SFO15-311: ConfigFS Gadgets: An Introduction

Presented by

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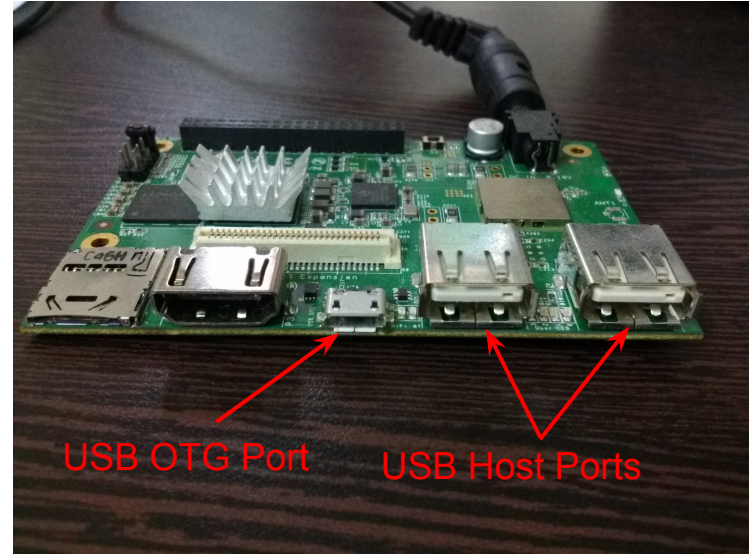
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USB As We Know It!!



Linux USB Gadget Evolution

- Monolithic Gadget Drivers
- Composite (multi-function) Gadget Drivers
- FunctionFS Userspace Gadget Driver
- Android composite gadget driver
- ConfigFS composite gadget driver



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ConfigFS USB Gadgets: Cheat Sheet

- Create the Gadget, supported Functions, Configurations and Strings.
- Set the Strings, link the Functions to required Configurations.
- Enable the Gadget.

Action	FileSystem Commands
Create Gadget/Functions/Configurations..	Make Directory (mkdir)
Destroy Gadget/Functions/Configurations..	Remove Directory (rmdir)
Set Value of Attributes	Write (echo)
Get Value of Attributes	Read (cat)
Group Functions	Symlink (ln -s)
Ungroup Functions	Remove Symlink (rm)

ConfigFS USB Gadgets: How To?

Kernel Config: `CONFIG_USB_CONFIGFS=y`

Userspace Configuration:

- Mount USB gadget ConfigFS
 - `mount -t configfs none /config`
#usb_gadget config subsystem gets initialized at /config/usb_gadget
- Create gadget(s)
 - `mkdir /config/usb_gadget/g1`
#gadget "g1" config group, attributes and other config sub-groups viz. functions/, configs/, strings/, os_desc/ are created.
- Create strings and write to common attributes
 - `echo 0x18d1 > /config/usb_gadget/g1/idVendor`
 - `echo 0x4ee1 > /config/usb_gadget/g1/idProduct`
 - `mkdir /config/usb_gadget/g1/strings/0x409` #0x409 for English language strings
 - `echo 12345678 > /config/usb_gadget/g1/strings/0x409/serialnumber`
 - `echo Dummy > /config/usb_gadget/g1/strings/0x409/manufacturer`
 - `echo Demo > /config/usb_gadget/g1/strings/0x409/product`



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ConfigFS USB Gadgets: How To?

Userspace Configuration (contd.):

- Create gadget configuration(s), strings and write to attributes common to that configuration
 - `mkdir /config/usb_gadget/g1/configs/c1`
 - `mkdir /config/usb_gadget/g1/configs/c.1/strings/0x409`
 - `echo "Conf 1" > /config/usb_gadget/g1/configs/c.1/strings/0x409/configuration`
 - `echo 120 > /config/usb_gadget/g1/configs/c.1/MaxPower`
- Create gadget function(s)
 - `mkdir /config/usb_gadget/g1/functions/eem.f0`
#Create function instance, do initial setup and resource allocation
- Associate the gadget functions with their configuration(s)
 - `ln -s /config/usb_gadget/g1/functions/eem.f0 /config/usb_gadget/g1/configs/c.1/eem.f0`
#USB CDC Ethernet (EEM) function. A function can be used in multiple configurations but only 1 gadget configuration can be active at a time as chosen by the Host.

ConfigFS USB Gadgets: How To?

Userspace Configuration (contd.):

- Enabling the gadget by binding it to a UDC (USB Device Controller)
 - `echo "$UDC_NAME" > /config/usb_gadget/g1/UDC`
#Where UDC_NAME is one of those found in `/sys/class/udc/*`.
#Gadget is finally enabled so that the USB host can enumerate it.
- To stop or disable the USB gadget run:
 - `echo "" > /config/usb_gadget/g1/UDC` #Disable the Gadget
 - `rm /config/usb_gadget/g1/configs/c.1/eem.f0` #Unlink Function from Configuration
 - `rmdir /config/usb_gadget/g1/configs/c.1/strings/0x409` #Remove Configuration Strings
 - `rmdir /config/usb_gadget/g1/configs/c.1/strings`
 - `rmdir /config/usb_gadget/g1/configs/c.1/` #Remove Configuration
 - `rmdir /config/usb_gadget/g1/functions/eem.f0` #Remove Function
 - `rmdir /config/usb_gadget/g1/strings/0x409` #Remove Gadget Strings
 - `rmdir /config/usb_gadget/g1/strings`
 - `rmdir /config/usb_gadget/g1` #Remove Gadget
 - `umount /config` #Unmount USB Gadget ConfigFS Subsystem

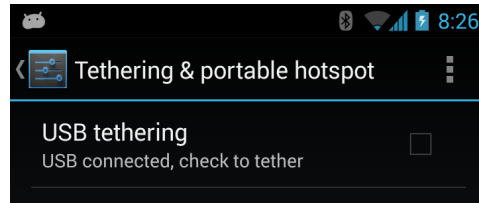
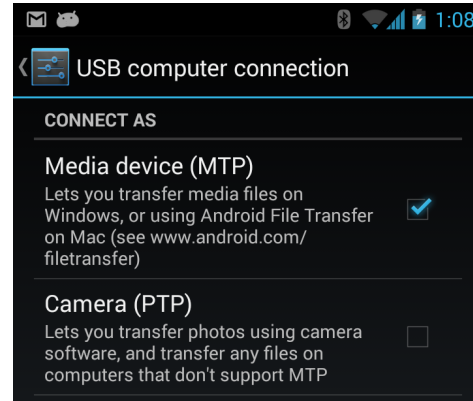
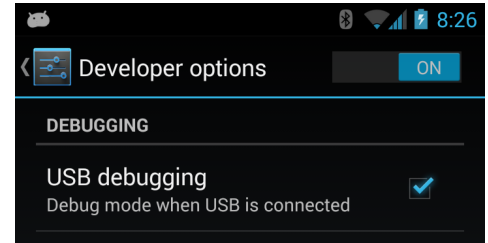


Demo...



Android USB Gadgets

- Android Gadget Functions:
 - ADB (`on property:sys.usb.config=adb`)
 - MTP/PTP (`mtp,ptp`)
 - RNDIS (`rndis`)
 - Audio Source (`audio_source`)
 - Android Accessory (`accessory`)



Android Gadget Driver Upstream Status

- USB state change and Uevent notifications
- MTP/PTP gadget function
- Android Audio gadget function
- Android Accessory gadget function



[Image Credit: Blogspot](#)

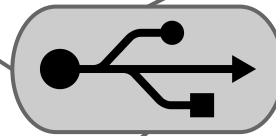
Linux USB Gadget Examples



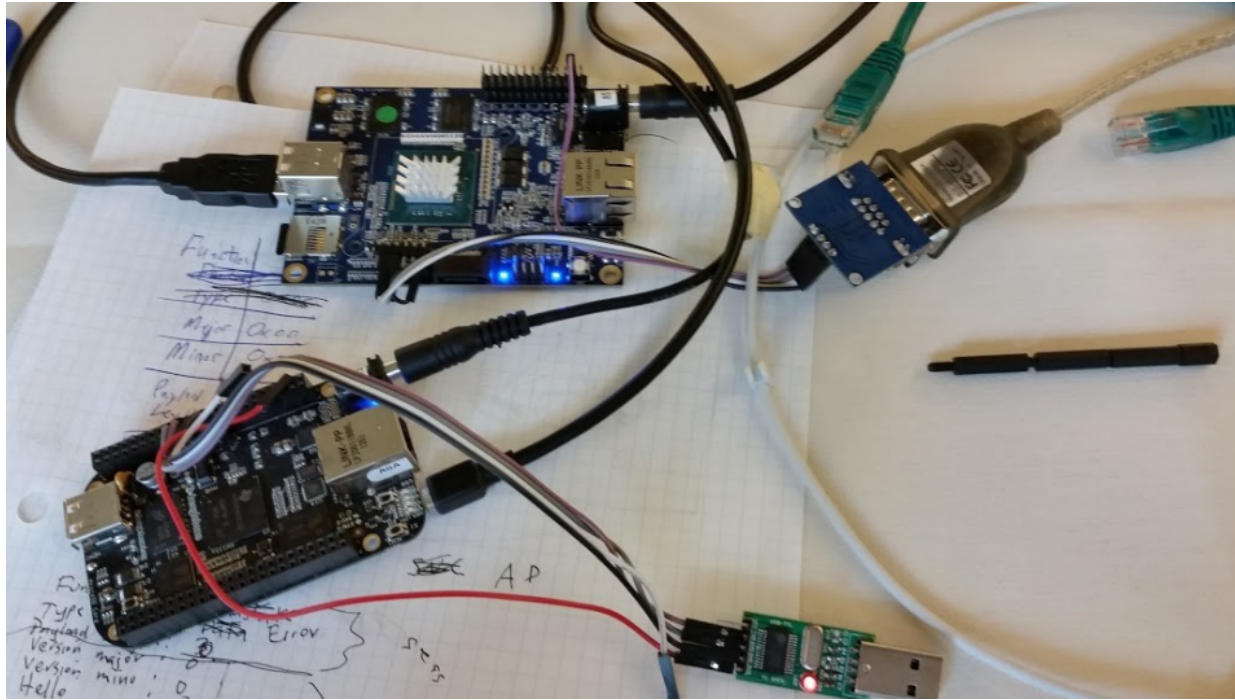
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MTP/PTP Gadgets



Greybus Simulator



[LPC2015: Project Ara: Redefining Handset and Android Architecture](#)

[Greybus Simulator](#)



EHCI Debug port

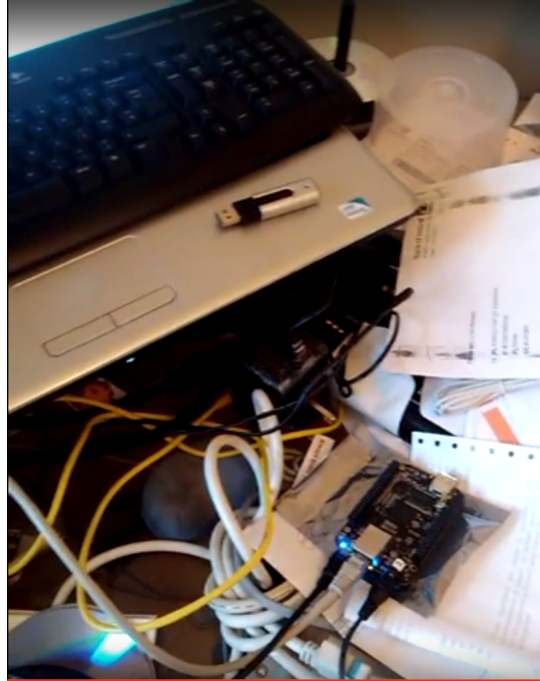
Commercial EHCI debug devices/dongles



NET20DC 2.0 EHCI controller debug device



AMI Debug Rx USB 2.0 EHCI controller device



AMI Debug Rx USB 2.0 EHCI controller device

DIY EHCI debug device running debug gadget driver

References

- [Linux USB Gadgets - linux-usb.org](http://linux-usb.org)
- [The USB Composite Framework - LWN](#)
- [Kernel USB Gadget ConfigFS Interface - Matt Porter - ELC US 2014](#)
- [USB Gadget Composed with ConfigFS - Andrzej Pietrasiewicz - LinuxConNA2013](#)
- [Buteo-MTP and PTP-Gadget](#)
- [Project Ara: Redefining Handset and Android Architecture - Karim Yaghmour - LPC2015](#)
- [EHCI Debug Port](#)