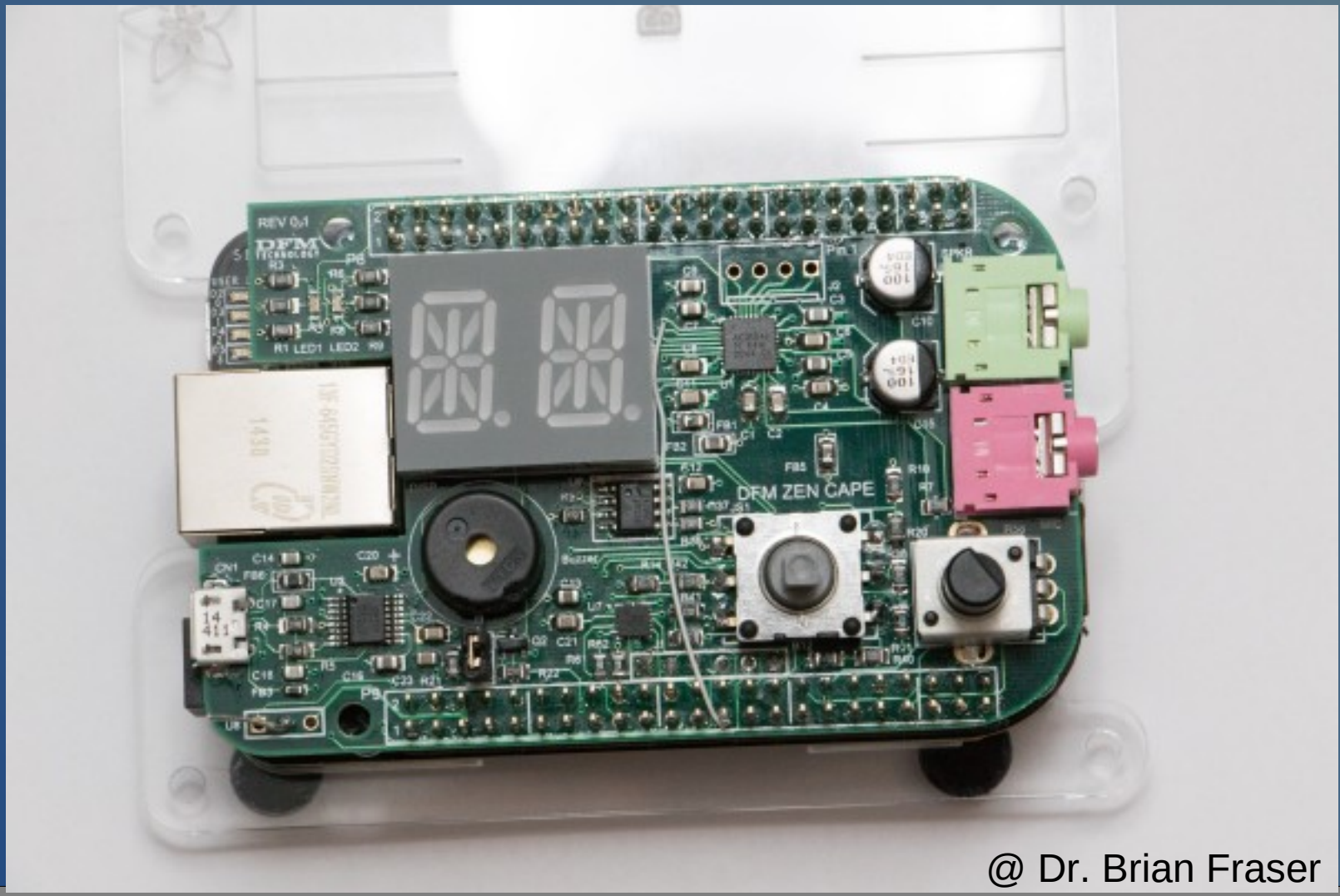
Development Environment

Embedded Linux Primer Ch 1&2



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Topics

1) Systems: Host and Target
2) Host setup
3) Host-Target communication

Host and Target

Host & Target

- Host
  - Development PC
- Target
  - Embedded device
- Native Compiler:
  - Run GCC compiler on host to build for host:

```
$ gcc hello.c -o hello
```

- Cross Compiler:
  - .. Compiler runs on host, but builds for target.

```
$ arm-linux-gnueabihf-gcc hello.c -o hello
```

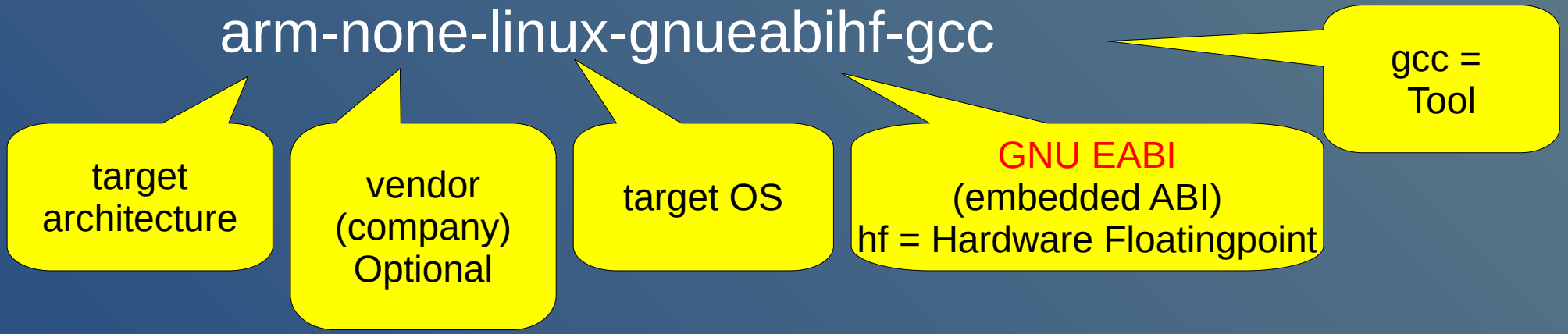
  - Many "cross" tools: Run on host, work with target:
    Ex: arm-linux-gnueabihf-gdb

$ means Linux prompt on host.

Host & Target

- Tool naming:

  arm-none-linux-gnueabihf-gcc



- ABI:.. Application Binary Interface
  - Standard specifying how the program will:
    - layout data types in memory
    - ..function calling conventions (passing arguments, returning values).
    - perform system calls

Host vs Target Resources

Resource	Host	Target (BeagleBone Green)
OS	Debian 11.4+ Linux	Debian 11.3+ Linux
CPU	~3Ghz 12-core x64	1Ghz ARM Cortex-A8, 32 bit
RAM	32,000 MB	512 MB
Storage	4,000 GB harddrive	4GB eMMC
Screen	23" LCD, multi-monitor	None; could use a cape.
Input	Keyboard, mouse	1 button, USB Cape for lots!
Audio	In/out	via USB adapter
Ethernet	1,000 BaseT	100 BaseT
Other	DVD, Card reader	uSD Card, GPIO
Terminal	Screen & Keyboard	Serial port & SSH
Cost	~$1,000	~$50-$100

eMMC:
Embedded
(on a chip)
flash storage
(MultiMedia Card)

Working with Hardware

- Many embedded systems run on custom hardware.
- Interact with the world using:
  - GPIO:.. General Purpose Input/Output
    Set a pin to be on (3.3V) / off (0V), or read it.
  - I^2C:.. Inter-Integrated Circuit (I2C)
    Communicate with chips like an accelerometer.
  - A2D:.. Analog to Digital converter
    Read analog voltages (Ex: battery voltage).
  - PWM:.. Pulse Width Modulation
    Generate a sort-of analog voltage.
- Our HW kit allows us to use all of these!

Host Setup

Host Setup

- Run Linux.
  - A definition of "Crazy":
    Developing for embedded Linux on non-Linux host.
- Run Linux as main OS, or in virtual machine (VM).
  - VirtualBox and VMWare Player: lets you run Linux inside Windows in a VM.
  - Selectively configure resources the VM gets.
  - Able to run multiple VM's on one machine.

Confusion:
Host PC: Computer you code on.
Host OS: *In VM context* means “real” OS on computer.

Basic Linux Commands

Command	Description	Examples
ls	Directory listing. Arguments: -a for all, -l for long (all info)	`ls` `ls -l`
pwd	Show current directory name	`pwd`
mkdir	Make a directory	`mkdir myNewPlace`
cd	Change directory	`cd myDir` `cd \myDir` `cd ..` `cd \`
chmod	Change file permissions	`chmod a+r hello.a`
chown	Change file owner	`chown bfraser hello.a`
sudo	Execute as administrator	`sudo chown bfraser hello.a`
apt-get	Install a program	`sudo apt-get install somepackage`
gedit	Edit a file (new window)	`gedit hello.cpp &`
ifconfig	Configure networking	`ifconfig eth0 192.168.0.1`
mount	Mount a file-system	`mount -t nfs \` `192.168.0.103:/opt/img /mnt/img`
nano	Edit a file in the terminal	`nano hello.cpp`

Basic Linux Commands

Command	Description	Examples
cat	Dump to screen	`cat hello.cpp`
less	Show on screen with "more.." prompt. ('q' to quit)	`less hello.cpp`
tar	Archive management (unzip)	`tar xvfj hello.tar.jz2`
find	List all files in sub-folders	`find`
grep	Search for a string	`grep "Hello world" *.cpp`
| (Shift \)	Pipe: redirect output to second program's input	`find | grep hello.cpp`
>	Redirect output to a file	`ls > listing.txt`
rm	Remove a file (delete)	`rm listing.txt`
echo	Print some text	`echo hello`
dmesg	Show kernel boot messages	`dmesg`

Recommended Linux Shell Tutorial: Ubuntu Command line for Beginners
https://ubuntu.com/tutorials/command-line-for-beginners#1-overview

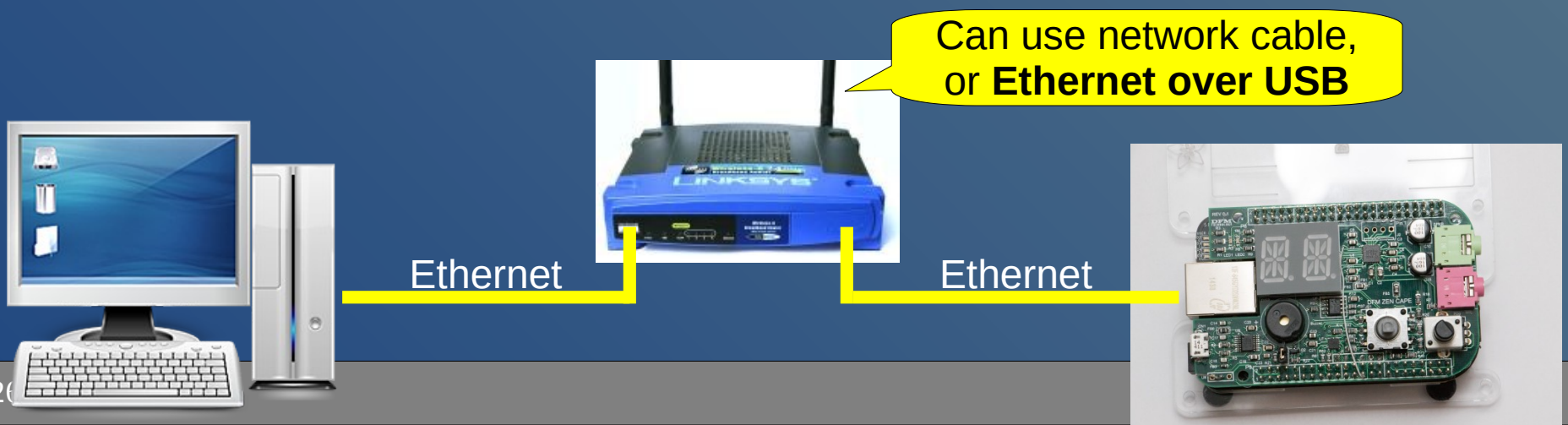
Communication

How can we access the target?
We need a Linux terminal, but how?

Micro-B plug, xxx, Mini-B plug, Standard-A receptacle, Standard-A plug, Standard-B plug

Communications Overview

- Serial Port:
  - Developers often communicate with embedded devices using a serial port
    - RS232: Serial protocol for +/-12V
    - TTL: 0-3V (or 0-5V) serial protocol.
  - We don't need the serial port this semester
- Ethernet Network:
  - SSH, file transfers, and internet access



Network

- BeagleBone can network in two ways:
  - Ethernet
    - Normal “RJ45” Ethernet connection.
    - BBG uses DHCP to get an IP address:
      DHCP =.. Dynamic Host Configuration Protocol

We will mostly use Ethernet over USB

  - Ethernet over USB
    - Micro USB cable allows BeagleBone to mount on host PC as a network connection.
    - Host has IP: 192.168.7.1
    - Target has IP: 192.168.7.2

USB Micro Cable
Power &
Ethernet over USB

Networking Basics

- Find out IP settings:
  ```
  (host)$ ip addr
  (bbg)$  ip addr
  ```
- ssh to open a terminal to the target
  ```
  (host)$ ssh debian@192.168.7.2
  ```
- ping to test TCP/IP connection to board:
  ```
  (host)$ ping 192.168.7.2
  (bbg)$  ping 192.168.7.1
  ```

(host): means host PC command
(bbg): means target command

Files over the Network

- Mounting directory over NFS
  - NFS:...Network File System
  - Use NFS to make application testing MUCH faster:
    - Transferring ~50 meg takes ~1min vs ~1hr.
    - On the target, mount the host's directory and..
      access host's shared files/folders via filesystem

- “Pro” Tip:
  Always look for ways to make development faster.

Review

1. What is cross compiling?
2. What does sudo do?
3. What will we use Ethernet over USB for?
4. Explain why NFS is useful.

Summary

- Develop on host, deploy on target.
  - Cross compile on host for target.
- Target has limited resources, but custom hardware:
  - GPIO, I2C, A2D, PWM.
- Host running Linux in VM or native
- We will communicate to target using Ethernet:
  - DHCP, Ping, TFTP, NFS, ip addr.