ECE 471 – Embedded Systems
Lecture 4

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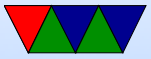
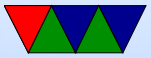
Announcements

- Any questions on HW#1?
- HW#2 will be posted Friday
- Info for loaner Raspberry Pis will be sent out

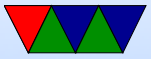


Single Board Computers

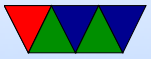
- Small boards with lots of I/O, often for use in embedded systems
- Often put out by companies trying to encourage use of their chips
- Examples
  - TS-7600
  - Pandaboard / Beagleboard/ Beaglebone
  - Gumstix (used in 471 years ago)
  - Raspberry Pi



- Pi clones (Orange, Banana, etc)
- MOS KIM-1 (1976)

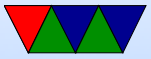


Raspberry Pi



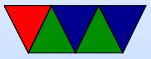
What is a Raspberry Pi?

- Raspberry Pi Foundation wanted small board to encourage CS in schools
- Easy to use and cheap enough that students can experiment without worrying too much about bricking it
- Back in the day small micro-computers encouraged hacking, modern Windows systems not so much
- There are other small embedded boards (Beaglebone, etc.) but Pi is a nice combination of performance, cost, and available software



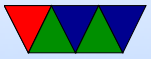
Raspberry Pi Software

- Can run many operating systems. Even write your own (see ECE598) or bare metal.
- We'll be running Linux.



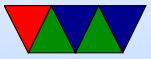
Why use a Raspberry Pi?

- There are many other single-board computers
- Pi has really good software support
  This really matters, many companies give you a blob of code with no support.
- It's also relatively well documented.



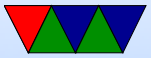
Raspberry Pi Models

- Model Names originally from BBC Micro
- All have more or less same SoC. VideoCore IV GPU runs show (VideoCore VI on pi4)
- First released in 2012

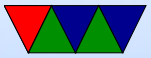


BCM2835/BCM2708 – ARM1176

- **Model 1B** – 700MHz ARM1176, 512MB RAM, SD, USB hub+USB Ethernet
- **Model 1B+** – like B but micro-SD, composite video-out inside of audio jack, 4 USB ports, longer GPIO header, re-arranged outputs, more mounting holes, fewer LEDs, lower power
- **Model 1A / Model 1A+** – less RAM (256MB/512MB), no Ethernet, no USB hub, cheaper, less power

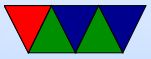


- **Zero** – 1GHz, 512MB, smaller, cheaper, $5
- **Zero W** – 1GHz, has wireless, $10
- **Compute Node** – like B but on SO-DIMM backplane, eMMC



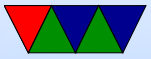
BCM2836/BCM2709 – ARM Cortex A7

- **Model 2B** – like 1B+ but with 1GB RAM, 900MHz Quad-core Cortex A7



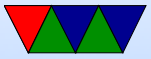
BCM2837/BCM2710 – ARM Cortex A53

- **Model 3B** – 64-bit, 1.2GHz Cortex A53, wireless Ethernet, bluetooth
- **Model 2B (v1.2)** – like Model 2 but with the Cortex A53
- **Compute 3**
- **Model 3B+** – better thermal, faster Ethernet (1GB but maxes at 300MB), power over Ethernet header. Still only 1GB (cost?)
- **Model3 A+**



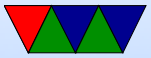
BCM2711 – ARM Cortex A72

- **Model 4B**
- 1.5GHz, Videocore VI at 500MHz
- USB-C power connector
- 1, 2, 4 or 8GB RAM
- USB3, microHDMI*2
- PCIe if you de-solder USB chip
- Real gigabit Ethernet
- GPIO header has more i2c/spi etc options
- **pi400** built into keyboard (4GB 1.8GHz)



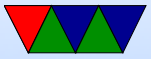
Pi Pico - RP2040

- Completely new design, custom SoC
- Dual core ARM-cortex M0+
- 133MHz
- 264k SRAM
- 2MB Flash
- $4



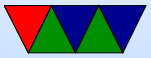
Programming the Pi

- We'll use C on Linux



Why Linux?

- Open source
- Free
- Widely used for ARM-based embedded systems
- I like Linux.



Brief Linux History

- UNIX history, UNIX lawsuit, rise of the BSDs
- Linus Torvalds (from Finland) gets a 386, announces his custom OS in 1991
- No free UNIX? FreeBSD caught up in AT&T lawsuit
- Don't be afraid of Linus (or open-source projects in general)
  The media over-hypes how angry some developers get.
- Just turned 30 years old