ECE 471 – Embedded Systems
Lecture 15

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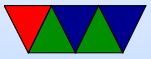
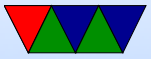
Announcements

- HW#5 was posted

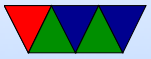


Silly Apple II Demo



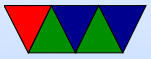
Firmware

- What is firmware?



Device Firmware

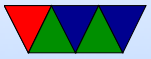
- Devices are their own embedded systems these days. May even have full CPUs, etc.
- Need to run code. Firmware.
- In ROM? Or upgradable? Why might you want to upgrade? (bug fixes, economy, etc.)
- Talk about recent USB firmware malware



Firmware

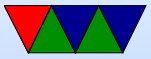
Provides booting, configuration/setup, sometimes provides rudimentary hardware access routines.
Kernel developers like to complain about firmware authors.
Often mysterious bugs, only tested under Windows, etc.

- BIOS – legacy 16-bit interface on x86 machines
- UEFI – Unified Extensible Firmware Interface
  ia64, x86, ARM. From Intel. Replaces BIOS
- OpenFirmware – old macs, SPARC
- LinuxBIOS



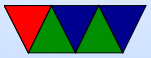
Bootloaders

- Firmware doesn't usually directly load Operating System
- Bootloader (relatively simple code, just smart enough to load OS and jumpt to it) is loaded first
- Bootloader is often on a very simple filesystem (such as FAT) as the code has to be simple (possibly even written in assembly language)
- Bootloader is often just complex enough to load OS kernel from disk/network/etc and jump to it



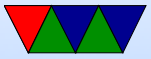
Raspberry Pi Booting

- Unusual
- Small amount of firmware on SoC
- ARM 1176 brought up inactive (in reset)
- Videocore loads first stage from ROM
- This reads `bootcode.bin` from fat partition on SD card into L2 cache. It's actually a RTOS (real time OS in own right "ThreadX")



- This runs on videocard, enables SDRAM, then loads `start.elf`

- This initializes things, the loads and boots Linux `kernel.img`. (also reads some config files there first)



Bootloaders on ARM

- uBoot – Universal Bootloader, for ARM and under embedded systems
- So both BIOS and bootloader like minimal OSes