

# ECE 471 – Embedded Systems

## Lecture 13

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27 September 2017

# Announcements

- How is HW#4 going?
- Midterm coming up next week in Wednesday class.



# Operating Systems Types

- Monolithic kernel – everything in one big address space. Something goes wrong, lose it all. Faster
- Microkernel – separate parts that communicate by message passing. can restart independently. Slower.
- Microkernels were supposed to take over the world. Didn't happen. (GNU Hurd?)
- Famous Torvalds (Linux) vs Tannenbaum (Minix) flamewar



# Common Desktop/Server Operating Systems

- Windows
- OSX
- Linux
- FreeBSD / NetBSD / OpenBSD
- UNIX (Irix/Solaris/AIX/etc.)
- BeOS/Haiku



# Embedded Operating Systems

- Microsoft WinCE, Windows Mobile
- Linux / Android
- VXworks – realtime OS, used on many space probes
- Apple iOS
- QNX – realtime microkernel UNIX-like OS, owned by Blackberry now
- Cisco iOS
- ThreadX – found in Pi GPU



# Embedded Linux Distributions

- linaro – consortium that work on ARM software
- openwrt – small distro initially designed for wireless routers
- yocto – Linux Foundation sponsored embedded distro
- maemo – embedded distro originally by Nokia (obsolete)
- MeeGo – continuation of maemo, also obsolete



- Tizen – Follow up on MeeGo, by Samsung and Intel
- Ångstrom – Merger of various projects
- And many others. It's very easy to put together a Linux distribution



# Linux/UNIX History

- UNIX invented early 70s at Bell Labs
- Widely distributed by academics
- Berkeley makes their own BSD version
- By the 90s many companies selling UNIX workstations. Expensive.
- Linus Torvalds in 1991 wanted own UNIX-like OS. Minix (which he used for development) limited to academic use





and non-free. The various BSDs caught up in lawsuit with AT&T. So he wrote his own.



# i2c

- Inter-Integrated Circuit, Invented by Philips (now NXP) in 1982
- Broadcom and others for some reason call it “Two Wire Interface”
- Two-wires (4 if you include Vdd and Ground)
- Since 2006, no licensing fees (though do have to pay to reserve number)



# Why is i2c popular?

- Stable standard
- Relatively easy to implement
- Not many wires
- Good enough
- Cheap



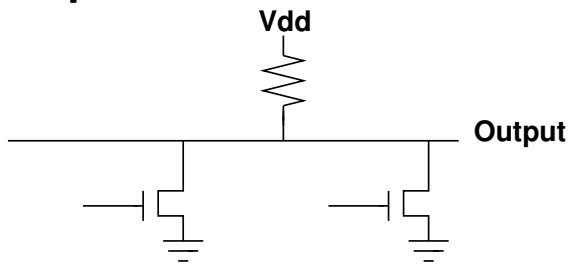
# Uses of i2c

- SMBus
- DDC (VGA/HDMI) (video card / monitor communication)
- Configuring SDRAM
- Temp sensor and fan chips on motherboards
- Wii nunchuck



# Protocol Overview

- Serial Data (SDA) and Serial Clock (SCL), Open Drain, Pulled up by resistors
- Open drain means output can be wired together



- 7-bit (or 10-bit) address
- Standard=100kbits/s, slow=10kbits/s, fast=400kbits/s



fast plus 1Mbits/s, high 3.4Mbits/s (actual transfers slower due to overhead)

- Length of bus limited to a few meters (400pF)



# High-level Protocol

- Master (generates clock, init transaction), Slaves (respond)
- Can be multiple masters and slaves
- Master sends start bit, 7-bit address of slave, then read/write bit
- Slave responds with ACK
- Reads and writes are 8 bits of data, followed by 1 ACK



bit

- Send stop bit when done
- Address and Data set Most-significant Bit first

