ECE 471 – Embedded Systems Lecture 1

Vince Weaver

http://www.eece.maine.edu/~vweaver

vincent.weaver@maine.edu

2 September 2014

Introduction

- Distribute and go over syllabus

- Talk about the class. HWs. Midterm. Final. Project. Class Participation.

- Class notes will be posted on the website.

- We will do some hands-on embedded work this semester. Raspberry Pi Model B. Can purchase own, or will lend out. Still finalizing as large class size this year.

Embedded Systems

What is an embedded system?

- Embedded. Inside of something.
  Traditionally fixed-purpose.
  Why? You can optimize. For cost, for power, for size, for reliability, for performance.

- Resource constrained. Small CPU, Memory, I/O, Bandwidth

- Often real-time constraints.

What are some embedded systems?

- Cellphone (though lines blurring, general purpose)

- Vehicles (Cars/Airplanes)

- Appliances (TVs, Washers), Medical Equipment

- Space Probes

- Video Games?

What Size CPU/Memory?

- Anything from 8-bit/tiny RAM to 32-bit 1GHz 1GB

- Performance has greatly improved over the years. ARM Cortex A9 in an iPad2 scores same on Linpack as an early Cray supercomputer

Common Low-End Embedded Architectures

- Somewhat dated list, from EE Times 2003. Multiple answers so doesn't necessarily sum up to 100%

- 8-bit processors

  - Microchip PIC – 43%
  - AVR, etc. 8051 – 55%
  - Motorola 68xx – 36%
  - Zilog Z80 – 15%

- 16-bit processors

- 8086/80186/80286 – 41%
- 68HC12 – 21%

What Processors Commonly Used?

As reported by IDC at the SMART Technology conference in San Francisco for 2011

- ARM 71%

- MIPS 11%

- Other 9% (Linux supports 20+ architectures)

- x86 8% (at least Intel's desperately trying)

- Power 2%

We'll Mostly Use ARM in this Class

- Widely used

- You'll see if it you move to industry

- Other classes in ECE using it

System-on-a-Chip

- Moore's law allows lots of transistors

- Discrete Chips: CPU, GPU, Northbridge, Southbridge, (and older days, FPU, MMU, etc)

- System-on-a-Chip (SoC): All parts of a computer on-chip
  CPU, DSP, memory, timers, USB, voltage regulators, memory controllers

- System-in-Package (SiP): various chips in one package

Extra Features of Embedded Micro-controllers

- Parallel and Serial I/O
- A/D, D/A converters
- GPIO pins
- i2c, CAN, SPI, 1-wire, USB busses
- FPGA?
- Low-power
- Sound
- Video, GPU

- DSP, Video Codecs
- Timers, PWM

ASIC, FPGA, Micro-controller

- ASIC – Application Specific Integrated Circuit
  direct wiring of state machines / logic on silicon die

- FPGA – reprogrammable low-level logic

- Microcontroller – can do what above do, but in software

- Why use the much more complex latter? Cost. Time to
  market. Bug-fixes (easier to fix in software)

Tradeoffs

It's all about tradeoffs

- Power
- Performance
- Cost
- Compatibility
- Time to Market
- Features