

Embedded Systems and Ubiquitous Computing

The Future of Embedded Systems

CSE 199

Fall 2017

Predictions

Predicting the future of computing is a fool's game.

However, few predictions are safe:

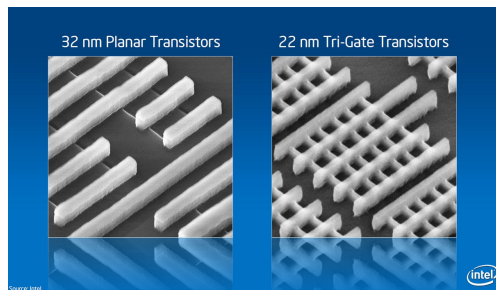
- Computation resources will increase
- Power consumption will decrease
- Communication will get faster
- Connectivity will spread

Computation Resources

Moore's Law doomsaying is popular now.

However, embedded process is generations behind.

Catching up to desktop/mobile will give huge increases.



Power Consumption

The same factors as computation apply here.

Smaller, faster transistors mean lower energy.

Smarter clocking, peripheral management, etc. also apply.

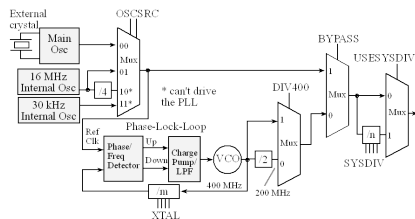


Image J Valvano and R Yerraballi, CC-BY-NC-ND 4.0

Communication Speed

Wi-Fi has gone from 11 Mb/s to 1 Gb/s in ≈ 15 years.

Bluetooth has gone from 1 Mb/s to 50 Mb/s in ≈ 15 years.

Newer **NFC** devices approach 1 Mb/s.

Improved Connectivity

Bluetooth LE reduces power consumption substantially.

LoRa provides low power, long distance connectivity.

Regulations are freeing **spectrum for connected devices**.

Embedded Systems vs. General Computing

Remember this from Lecture 1?

Advances in embedded hardware will drive convergence.

More embedded systems will look like today's:

- tablets
- mobile phones
- notebooks
- *etc.*

That said, realities will intrude!

“Convergence”?

UIs may remain nontraditional while CPUs converge.

- Chromecast v2: 2x 1.3 GHz cores, 4 GB RAM
- Echo: 1 GHz core, 256 MB RAM
- Nest: 1 GHz core
- Tesla S: 4x 2.3 GHz

Chromecast has **only a reset button!**

Nest and Tesla have touch screens.

Embedded Ecosystems on the Rise

Many applications for embedded systems growing rapidly.

Sometimes fields that **didn't exist** before.

Sometimes **improvements to existing technologies**.

Swarms and Meshes

Swarms and **meshes** have long captured imaginations.
(Remember *Twister*?)

They're actually **in use** in places now.

- GE and Nicaragua **instrumented a volcano**
- Commercial sensors for **food distribution temps**
- High speed **mesh networks** for Internet access



Augmented Reality

Remember **Google Glass**?

Augmented reality is **growing fast** in industry.

Fast, lightweight, connected devices provide:

- Instruction
- Information recall
- Communication

Industrial Automation

Entire industries are going automated.

Embedded systems control:

- Supply chain and logistics
- Manufacturing
- Recycling
- ...

Autonomous Vehicles

Self-driving cars are being tested now.

Regulations are being updated.

- 24 states have already adopted some legislation[†]
- 50 bills in 20 states in 2017[†]
- Congress started the process in 2017[‡]

Driving assistance is readily available today.

Sources: [†]USA Today, [‡]Wired

Aiming for Embedded/UC

Focus on:





- “Lower-level” material
- Software quality
- Hardware concerns
- Network communication

Remember that **coursework isn't everything.**




Embedded development tools are **cheap and fun!**

Embedded Resources and Projects

Vendors:

- Adafruit 
- Sparkfun 
- Pololu 
- STMicroelectronics 

Podcasts/Blogs/Web:

- Embedded 
- The Amp Hour 
- Hackaday 

Topics:

- 3-D printing
- Robotics
- Home automation
- Amateur radio

Embedded at UB CSE

- **CSE 241:** Digital Systems
- **CSE 321:** Real-Time and Embedded OS
- **CSE 341:** Computer Organization
- **CSE 379:** Introduction to Microprocessors
- **CSE 421:** Introduction to Operating Systems
- **CSE 442:** Software Engineering
- **CSE 453:** Hardware/Software Integrated Sys. Design
- **CSE 486:** Distributed Systems
- **CSE 489:** Modern Network Concepts

Careers in Embedded Systems

Jobs listed on various services:

Search Term	LinkedIn	glassdoor	Indeed
“embedded systems”	2,718	17,179	11,779
“firmware”	5,436	6,310	6,130
“IoT”	5,326	5,064	5,117

PayScale says that the Embedded Systems Engineer average salary is \$77,050, with a median of \$76,546.

Embedded Systems Engineer

Typical tasks for an Embedded Systems Engineer:

- Act as a tech lead from product start to completion
- Oversee compliance with regulations, standards, *etc.*
- Mentor and train other employees
- Develop software and assign coding modules to other team members

Source: PayScale

Your Connection to Embedded Systems

Remember that embedded systems **do a job**.

You can have an impact from any field!

- Mgmt: Seeking and developing better systems
- Nursing: Provide patient- and human-centered input
- Education: Explore systems to help students learn
- EVS: Collect better data, make targeted changes

Real-World Example: Agriculture

Kyler Laird, developing automated agricultural implements

- Grew up on a farm
- BS CS Purdue University
- MS Agricultural Systems Management Purdue
- Doing hands-on ag as an adult

Using **off-the-shelf and custom parts** to control tractors!

Tractobot 02 

What Should You Get From This Module?

An appreciation for embedded systems':

- Variety
- Utility
- Ubiquity
- Potential

Going Forward

Ubiquitous computing is coming, not going.

You are in a position to make the connected world the world **you want it to be**.

CSE or not, think about making machines work for you.

Thank You

A few minutes for questions.

- Getting started
- Working in industry
- Education
- ...