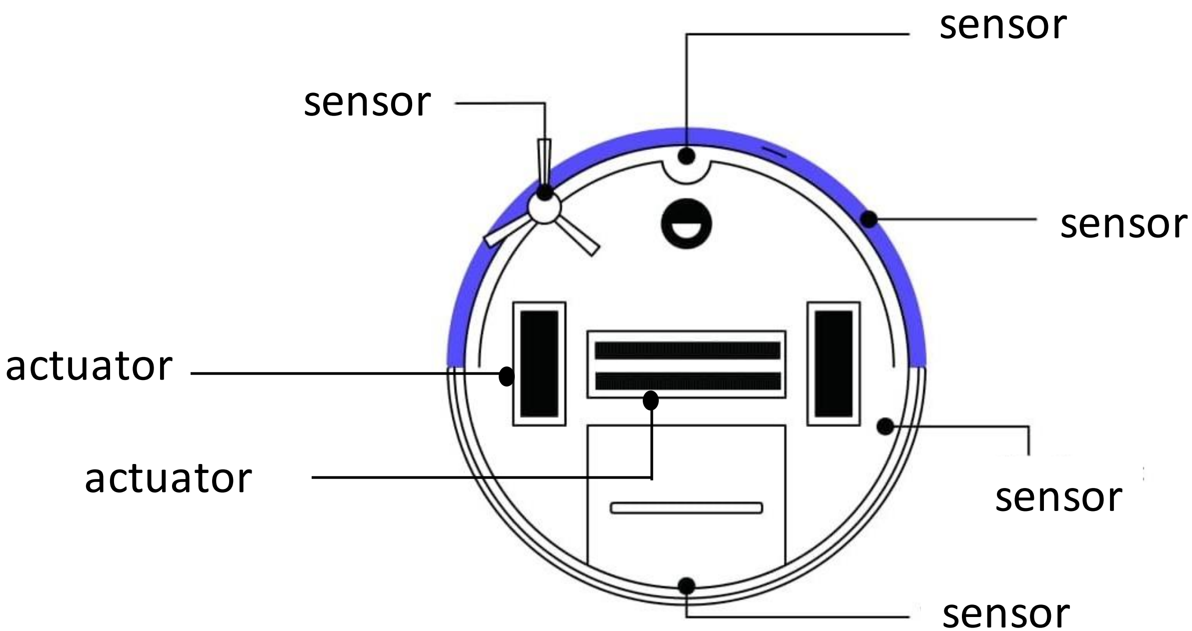
EECS 388: Embedded Systems

Fall 2022


Living Room
Kitchen
Entryway
Dining Room


Cleaning complete!


sensor
sensor
sensor
actuator
actuator
sensor
sensor

What do we learn in EECS 388?

Theory

- How computation take place?
- How processor talk to sensors and actuators?

Experiment

- Read from sensors, compute, control actuators

At the end of this course you have the skills to build a self driving car

Mohammad Alian
Instructor, [website]

Arin Dutta
GTA

Ishraq Islam
GTA

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GTA

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SI

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Grader

EECS388 Staff Fall 2022

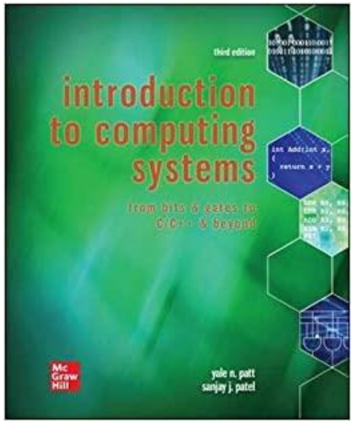
Course website, Canvas, GitLab

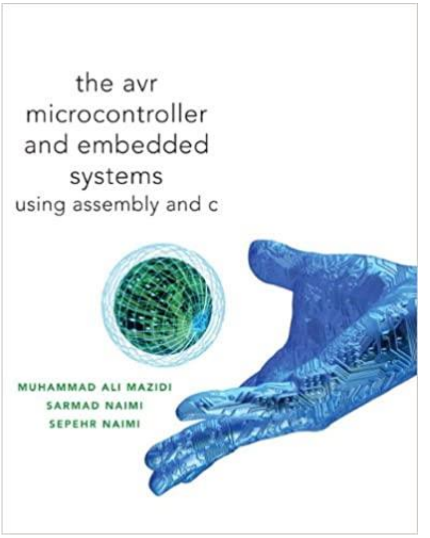
- https://alian-eecs.ku.edu/courses/eecs388/
  - Lecture notes will be posted before each class
  - Homework
- Canvas
  - Announcements
  - In-class quizzes
  - Homework and Lab submission
- MS Teams
  - Discussion

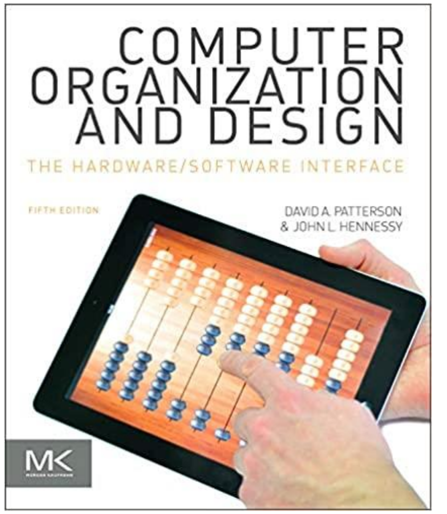
Course Structure

- Lecture (in-person twice a week)
  - Focus on key concepts
  - Office hours right after the lecture (12:15 - 1:00 PM)
- Lab (in-person once a week)
  - Hands-on embedded systems programming experiences
- Homework
  - 2~3 during the semester
- In-class quizzes (none, once or twice per class)
  - On topics discussed in current or previous lectures or labs – just to keep you focused
  - Submit in Canvas or paper

Textbook







- Not required
- Recommended:
  - “Introduction to Computing Systems: From Bits and Gates to C and Beyond" by Y. Patt, S. Patel (any edition)
  - "AVR Microcontroller and Embedded Systems: Using Assembly and C" by M. Mazidi, Sa. Naimi, Se. Naimi (any edition)”
  - “Computer Organization and Design, a Hardware/Software Interface" by D. Patterson, J. Hennessy (any edition)
  - Introduction to Embedded Systems - A Cyber-Physical Systems Approach, by Edward Ashford Lee and Sanjit Arunkumar Seshia.

Question

- Who does not have C/C++ background?

Tentative Grading

- Physical attendance: no need (you'll lose quiz points)
- Homework and quiz: 15%
- Lab: 40%
- Midterm: 20% (TBD 11 – 12:30 PM)
- Final: 25% (Dec 13th 10:30 – 1:00 PM)

Covid-19

- If you have tested positive for COVID, you should not attend lecture/labs/office hours
  - Please inform me/GTA before you miss a class/lab
- Masks + social distancing

Please do not cheat

We will check your lab code against each other and previous semester submissions later. If we find similarities, we report to the Department chair ...

Read the syllabus for detailed course policies

5min Break at the Middle of Class

- Help keep you focused!

Embedded systems

Computers designed for <u>specific purpose</u>

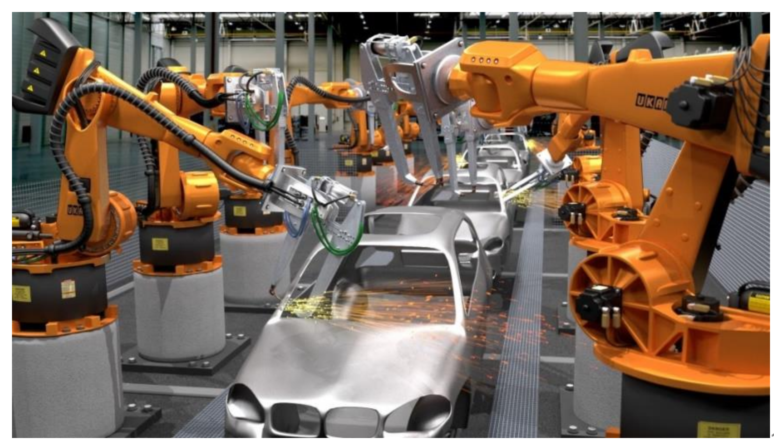


Internet of Things (IoT)

Internet connected embedded systems

Cyber-Physical Systems (CPS)

- Cyber system (Computer) + Physical system (Plant)
- Embedded systems, but integration of physical systems is emphasized



Real-time systems

- Correctness: correct result + the time at which the results are produced
- **A correct value at a wrong time is a fault.**

- CPS are often real-time systems
  - Because physical process depends on time

Embedded vs. general computing systems: Number of applications

Limited

Many

Embedded vs. general computing systems: Programmability

Not end-user programmable

End-user programmable

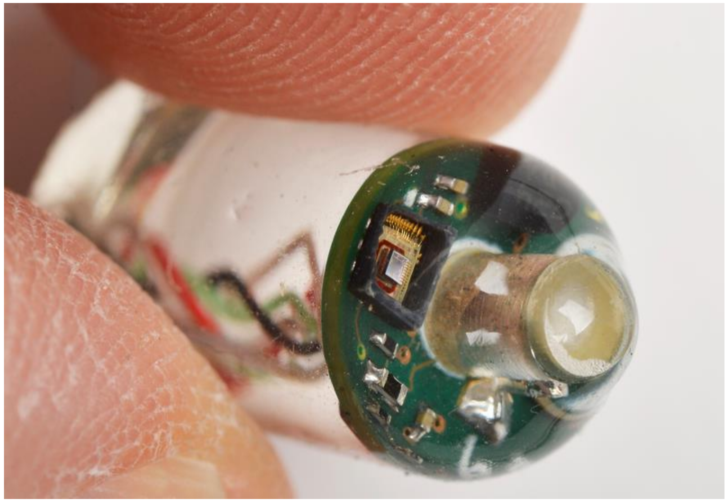
Embedded vs. general computing systems: Run-time constraints

On-time

Faster is always better!

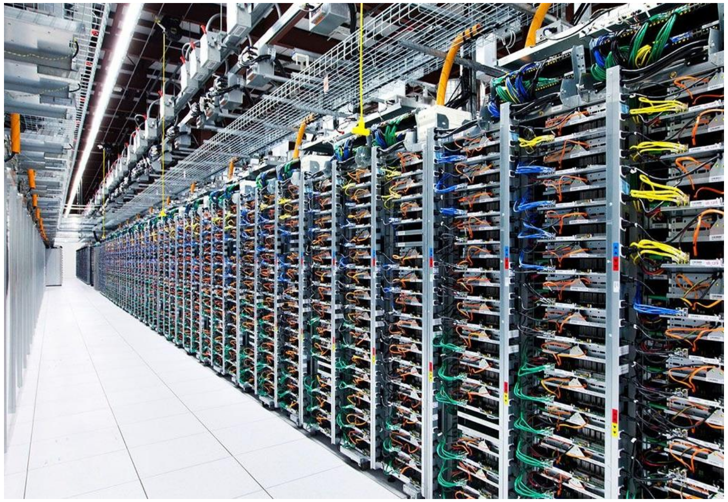
Embedded vs. general computing systems: Resource constraints

Power, memory, & compute limited

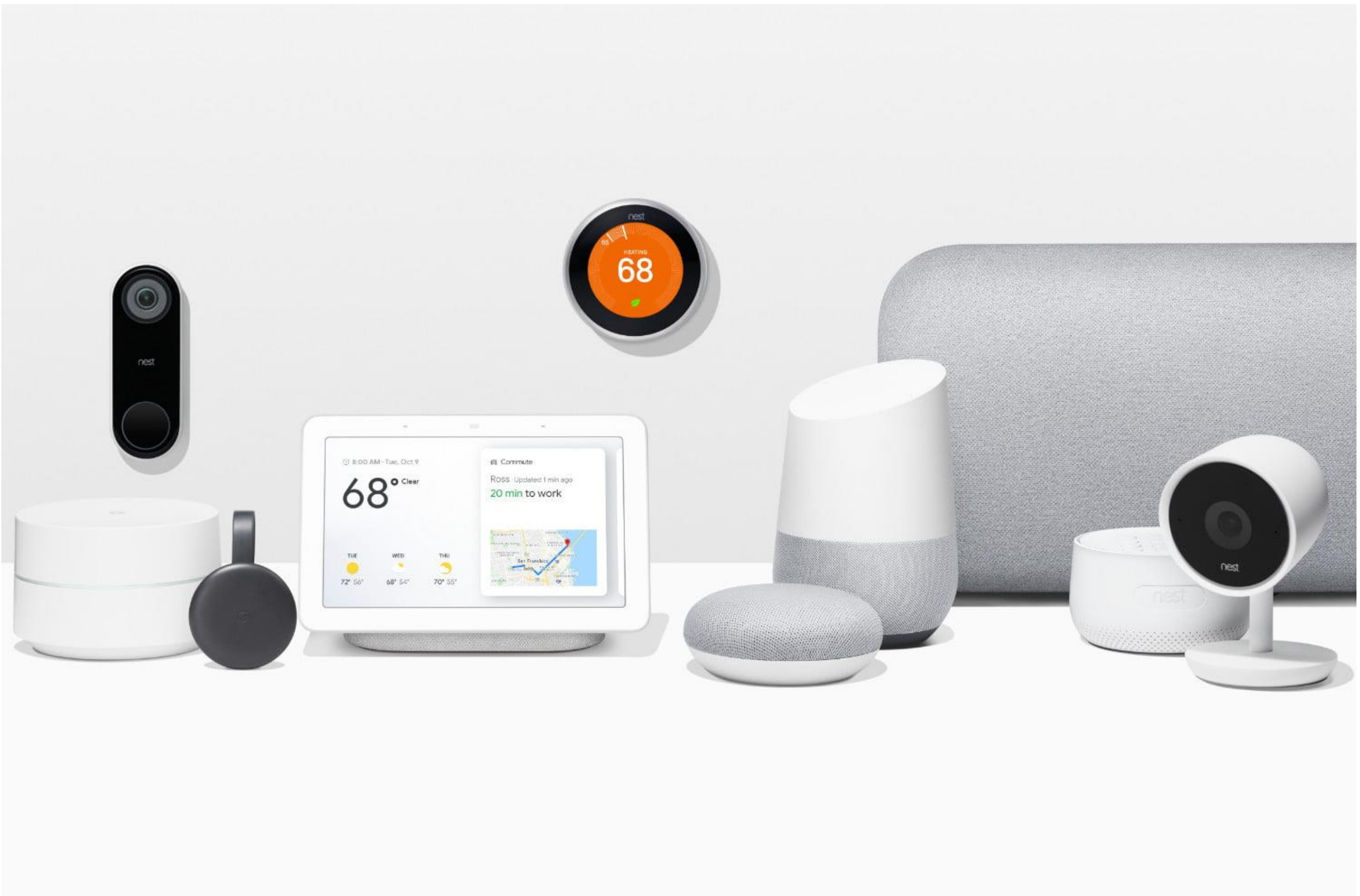


A Tiny Pill Monitors Vital Signs From Deep Inside The Body, NPR

Plugged into an outlet



Trend: Cheaper, more powerful, and more connected computing



Cyber-Physical Systems Requirements

1. Performance
2. Efficiency
3. Safety
4. Security and Privacy

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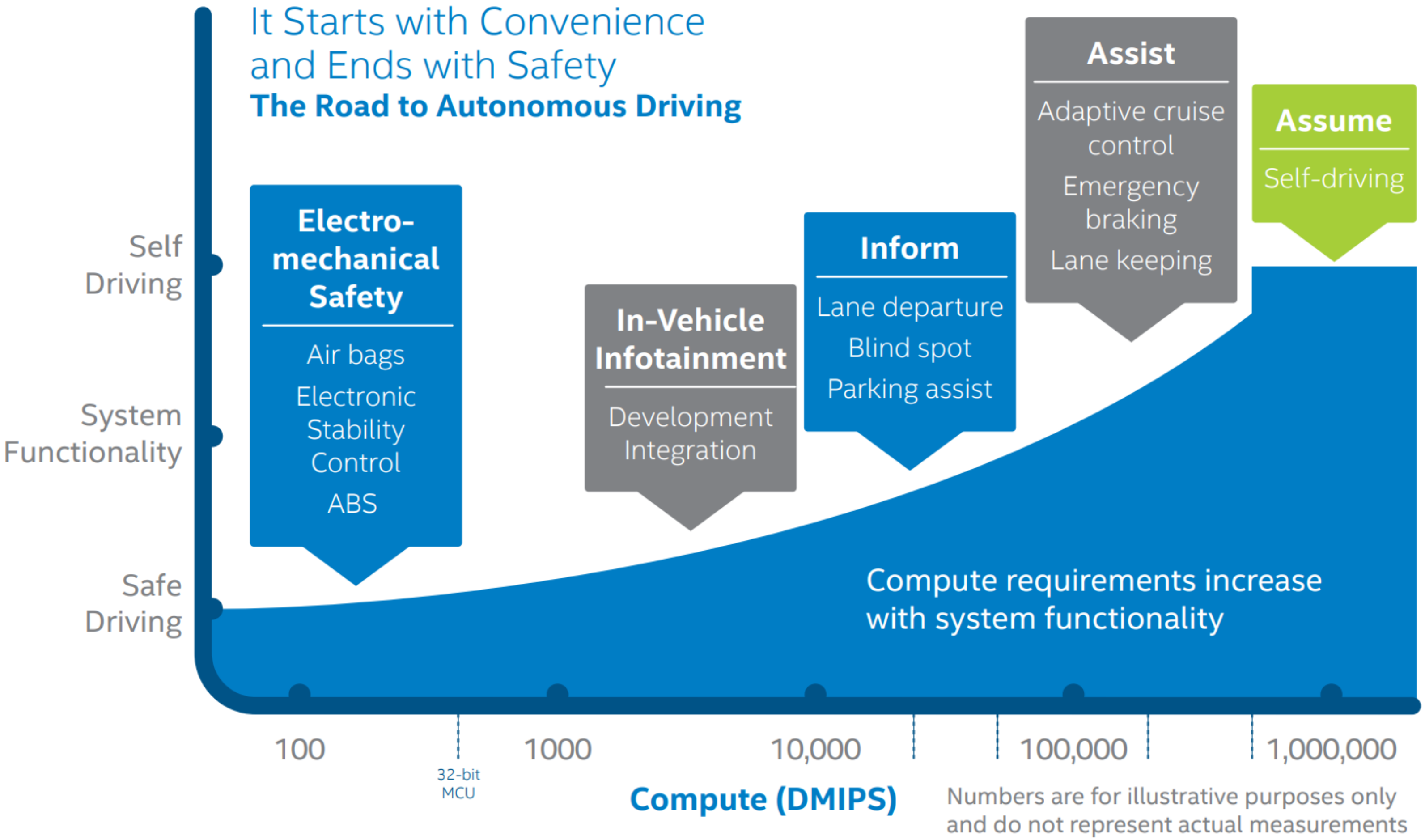
Performance



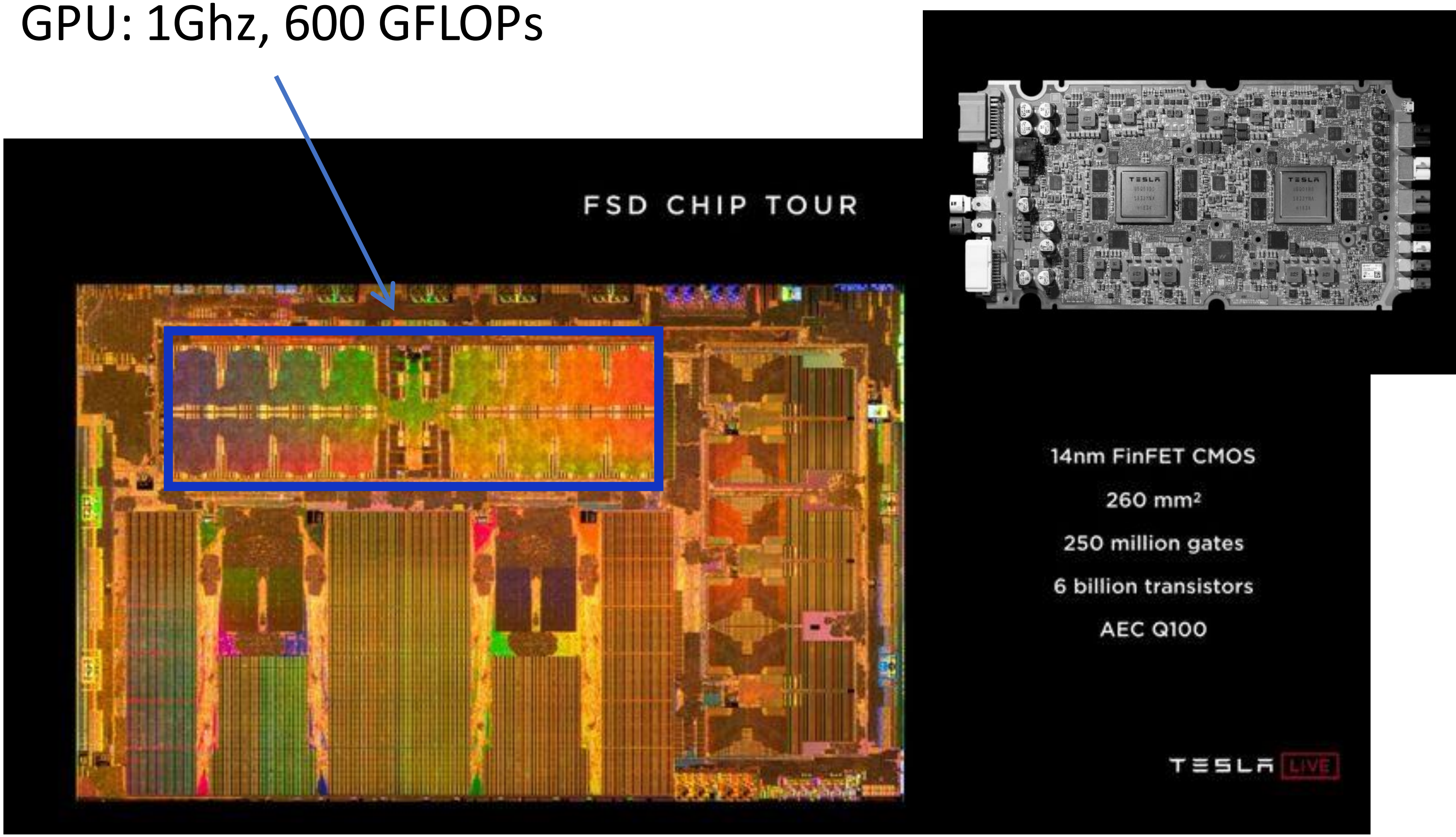
[Intel, "Technology and Computing Requirements for Self-Driving Cars"]

The nervous system of the autonomous vehicle

courtesy of William White, Qualcomm

Super-computer on a car: Tesla FSD chip

GPU: 1Ghz, 600 GFLOPs



https://www.youtube.com/watch?time_continue=4988&v=Ucp0TTmvqOE

Cyber-Physical Systems Requirements

1. Performance
2. **Efficiency**
3. Safety
4. Security and Privacy

Efficiency

Size, weight, power and cost constraints

CMU's "Boss" Self-driving car, circa 2007
10 dual-processor blade servers on the trunk

Audi A8

Audi's zFAS platform. 2016-2018
A single-board computer with multiple CPUs, GPU, FPGA

Cyber-Physical Systems Requirements

1. Performance
2. Efficiency
3. **Safety**
4. Security and Privacy

Safety

Sections

The Washington Post

Democracy Dies in Darkness

Get o

Business

Tesla Autopilot system was on during fatal California crash, adding to self-driving safety concerns

It was the fourth U.S. death involving the Autopilot self-driving car system.

Cyber-Physical Systems Requirements

1. Performance
2. Efficiency
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4. **Security and Privacy**

Security and Privacy

The Colonial Pipeline Cyberattack | What to Know | Pipeline Resumes | $5 Million Ransom | DarkSide Says Shutting Down | Weaknesses in U.S. Cybersecurity

NEWS ANALYSIS

Pipeline Attack Yields Urgent Lessons About U.S. Cybersecurity

The hack underscored how vulnerable government and industry are to even basic assaults on computer networks.

Quiz!

Summary

Embedded systems, cyber-physical systems, real-time systems, IoT

- Limited function computers integrated into physical world
- Requirements: performance, efficiency, safety, security, and privacy

In this course we learn concepts and skills for developing embedded systems