

Computer Architecture: Part 1

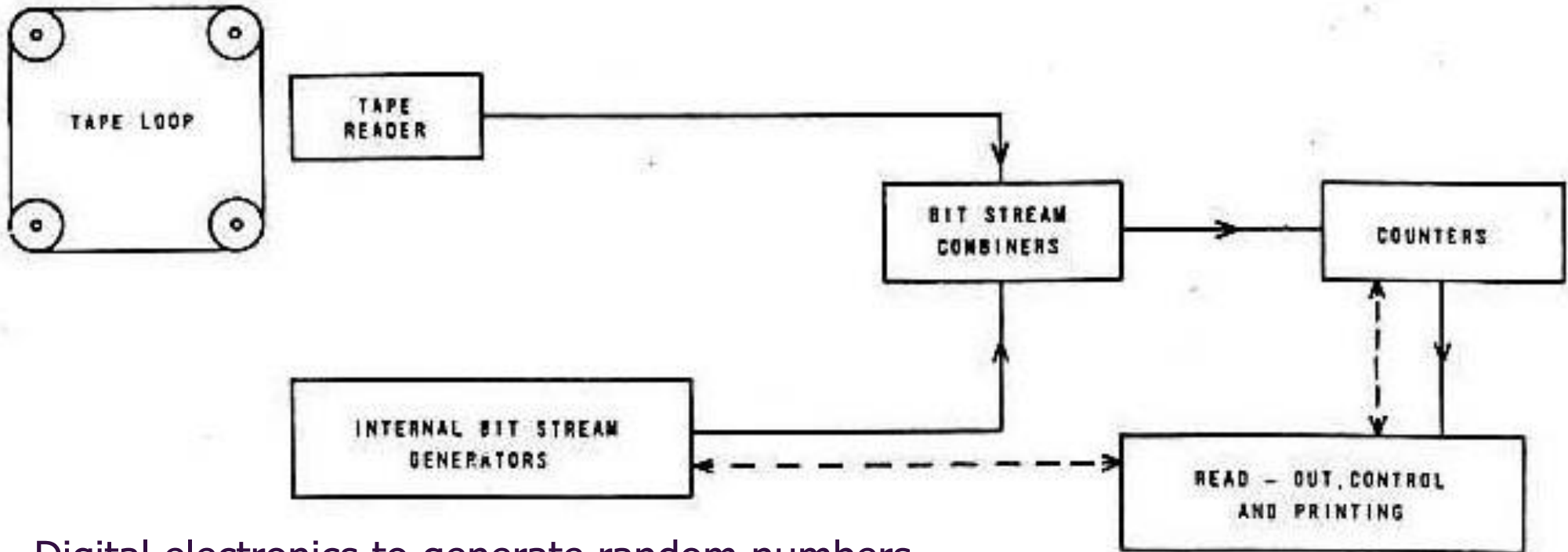
- Lecturer: Wayne Luk
- 9 lectures
- 4 tutorials
- 1 assessed coursework
- 1 exam question
- Homepage: <https://www.doc.ic.ac.uk/~wl/teachlocal/arch1>
- What is a computer?

Over 70 years ago

- Max Newman, Cambridge mathematician
 - tried to automate search for wheel positions of Lorenz, latest Nazi coding machines
- Heath Robinson machine: 2 paper tapes
 - message to be decrypted
 - random numbers for statistical analysis
- synchronising 2 paper tapes was hard
 - slow: up to 2000 characters/second
 - unreliable: answer not always correct
 - **prone to catching fire!**
- entered Tommy Flowers, London engineer...

Eliminate synchronising paper tapes

Message to be deciphered

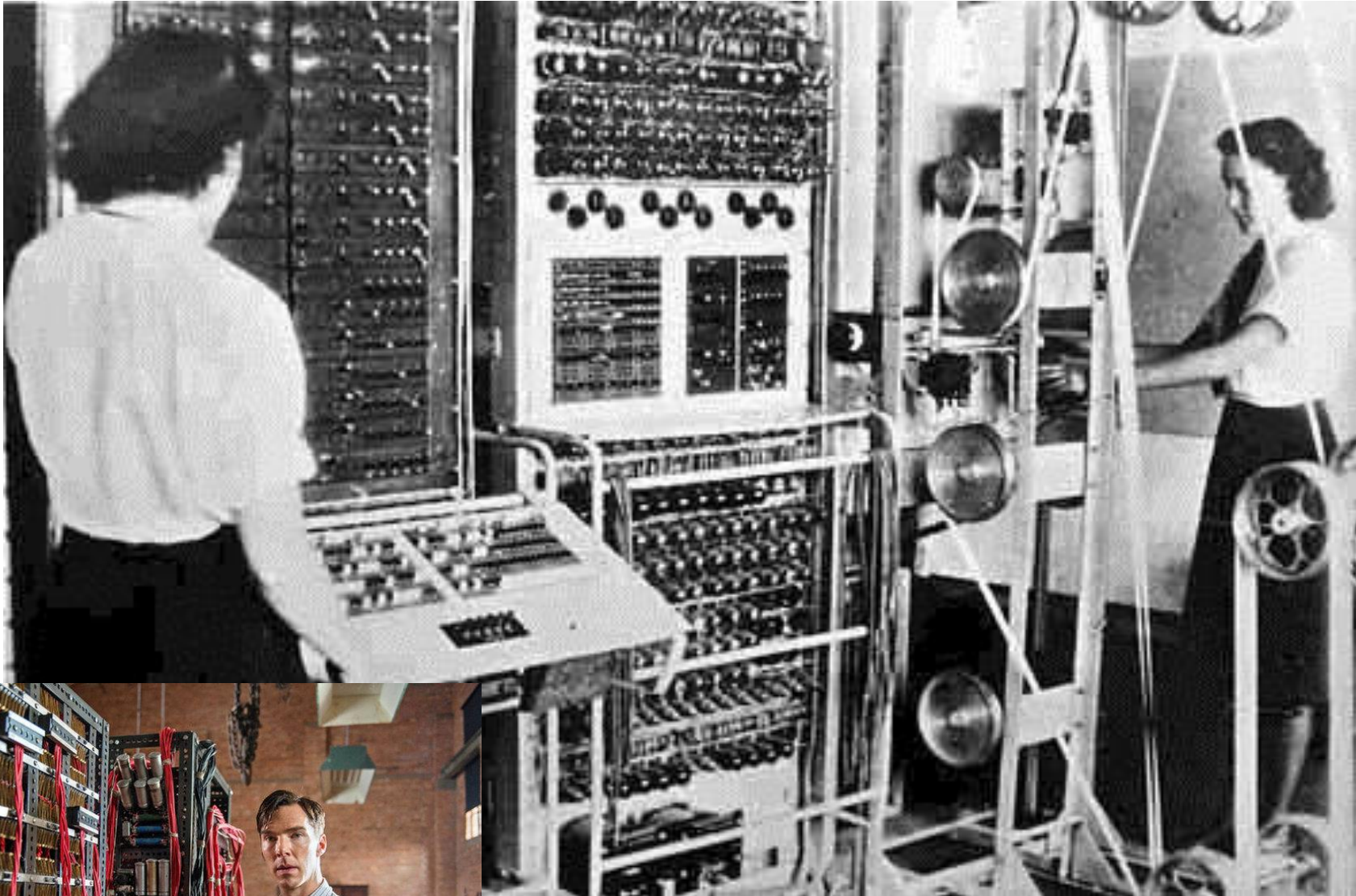


Digital electronics to generate random numbers

From notebook of Tommy Flowers (1905-1998)



Colossus: 1944



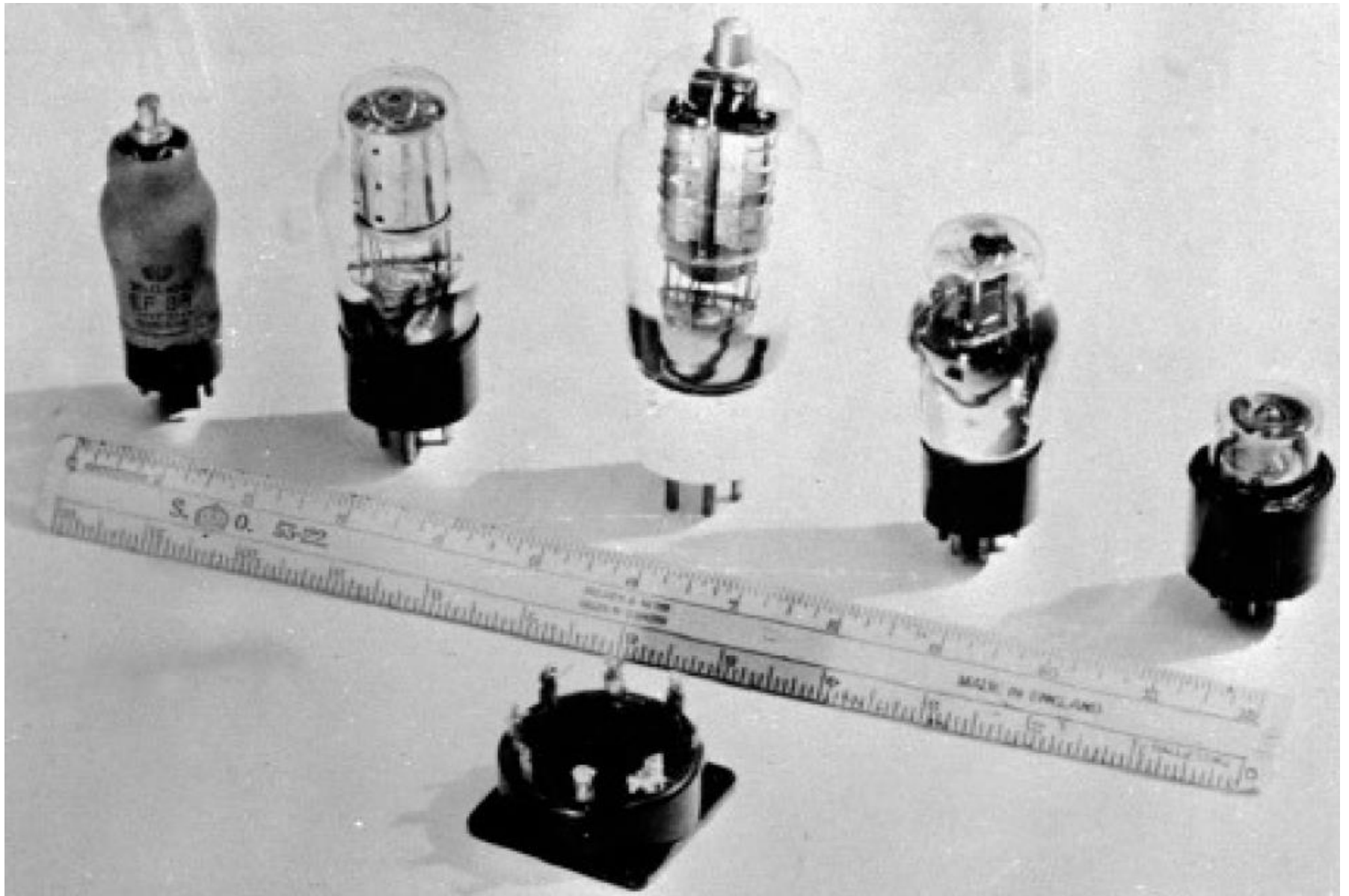
← movie

history →

Colossus features

- prototype operating end of 1943
 - first special-purpose electronic digital computer
 - had shift registers, branch logic, data storage
 - Mark II installed 5 days before D-Day, June 1944
- parallelism
 - 5 processors, consecutive inputs from one tape
 - 25,000 characters per second, more reliable
 - load one tape while processing the other tape
- program: controlled by patch cables and switches
- enabling technology
 - 1500-2400 vacuum tubes

Technology: vacuum tubes



Back to the present





Data Centre: supports Cloud Computing

Source: UC Berkeley



Equipment inside data centre

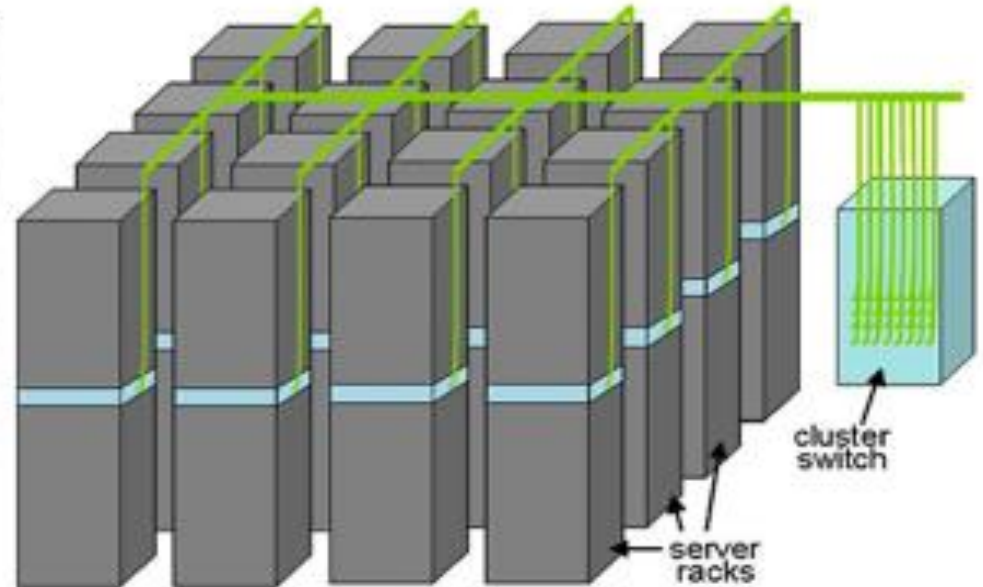


Server:

1 ¾ inches high “1U”,
x 19 inches x 20 inches,
8 cores, 16 GB DRAM,
4x1 TB disk



7 foot rack: 40-80 servers,
Local Ethernet (1-10Gbps) switch
(30\$/1Gbps/server)



Array (aka cluster):

16-32 server racks,
Expensive switch
(10x bandwidth → 100x cost)

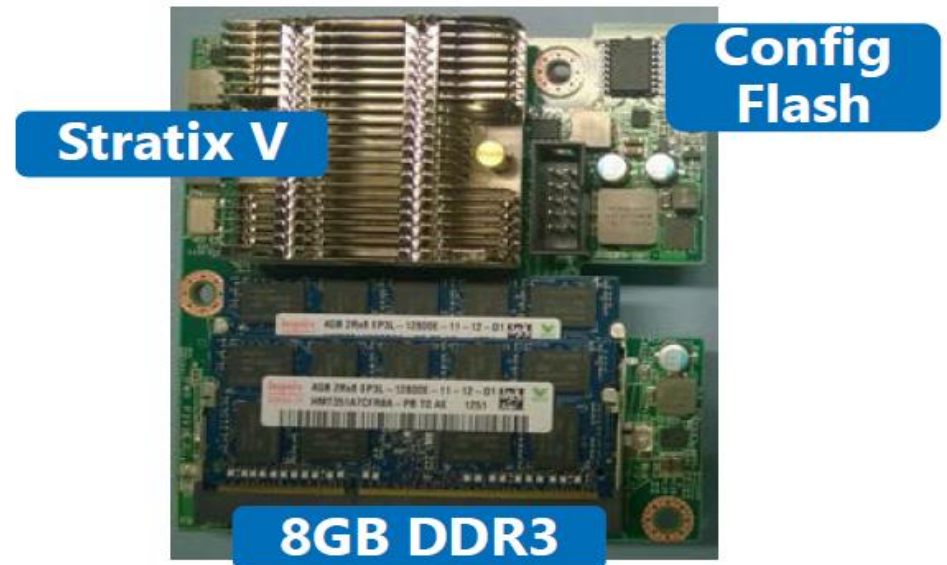
New: accelerators for data centre servers



- Two 8-core Xeon 2.1 GHz CPUs
- 64 GB DRAM
- 4 HDDs @ 2 TB, 2 SSDs @ 512 GB
- 10 Gb Ethernet
- No cable attachments to server

Stratix V: FPGA – what is it?

Source: Microsoft



Accelerate clouds: Microsoft + Amazon



www.top500.org/news/microsoft-goes-all-in-for-fpgas-to-build-out-cloud-based-ai/

Microsoft Goes All in for FPGAs to Build Out AI Cloud

Michael Feldman | September 27, 2016 08:42 CEST

Software giant bets the (server) farm on reconfigurable computing

Microsoft has revealed that Altera FPGAs have been installed across every Azure cloud server, creating what the company is calling “the world’s first AI supercomputer.” The deployment spans 15 countries and represents an aggregated effort. The announcement was made by Microsoft CEO Satya Nadella during the opening keynote at the Ignite Conference in Las Vegas.

Amazon EC2 F1 Instances

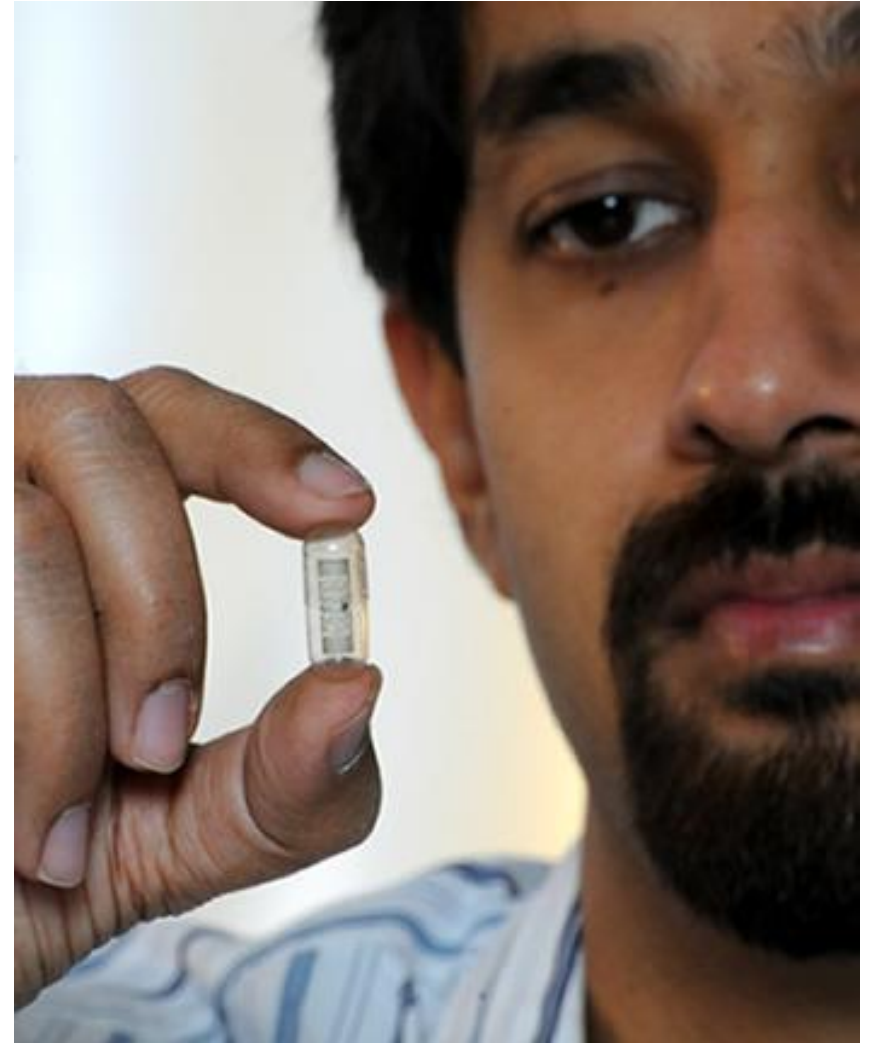
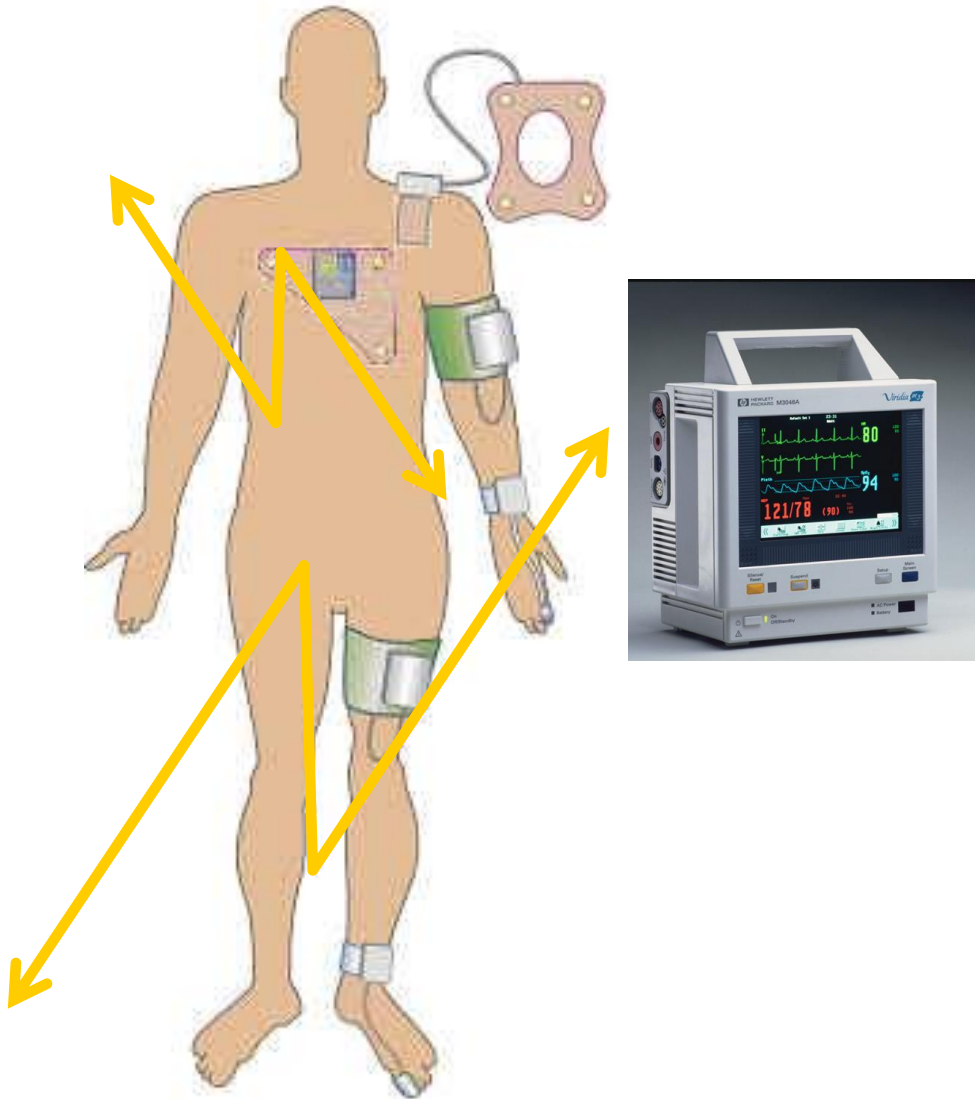
Run Custom FPGAs in the AWS Cloud

Amazon EC2 F1 is a compute instance with field programmable gate arrays (FPGAs) that you can program to create custom hardware accelerations for your application.

aws.amazon.com/ec2/instance-types/f1/

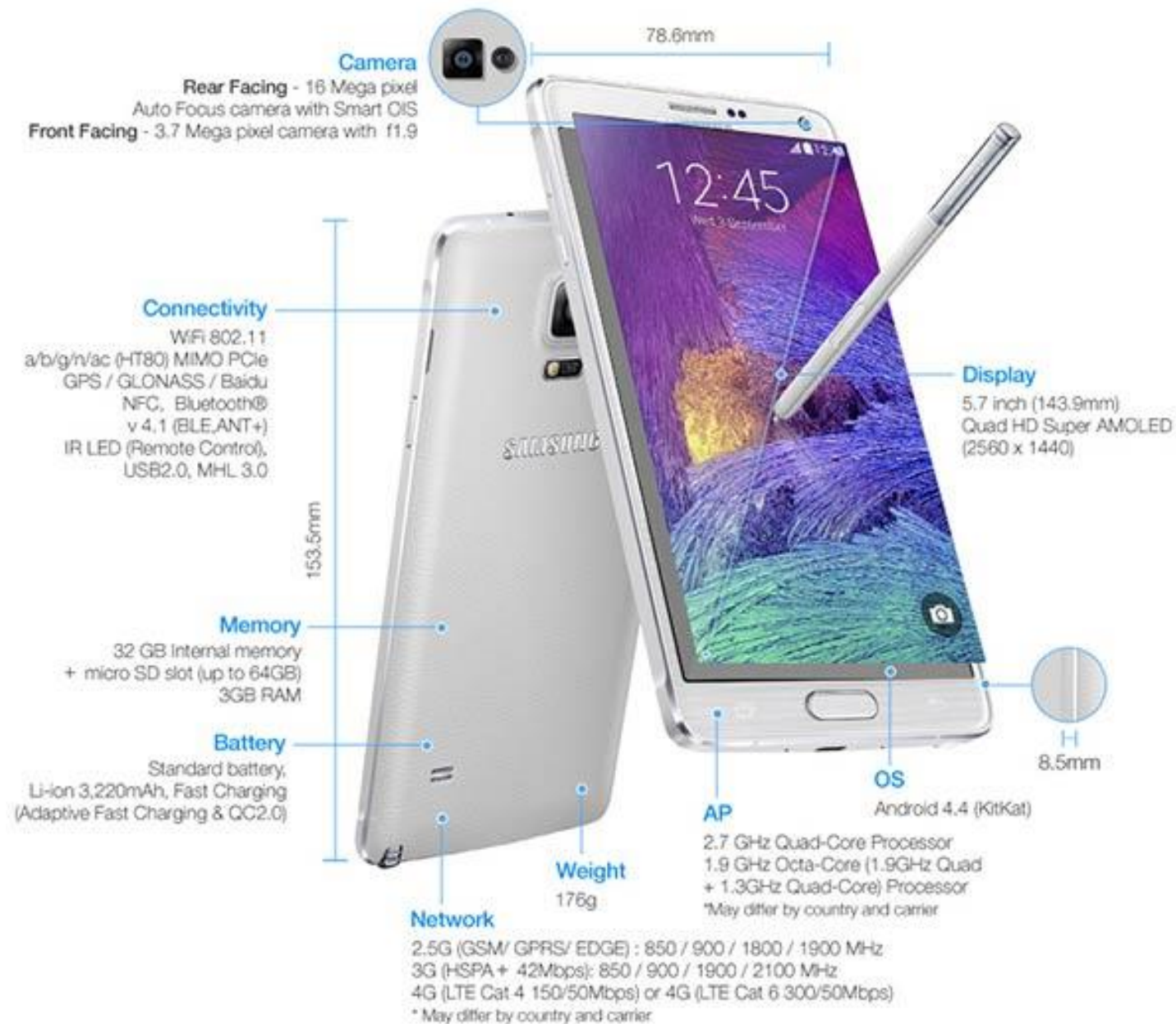


Body Sensor Network and Smart Pills

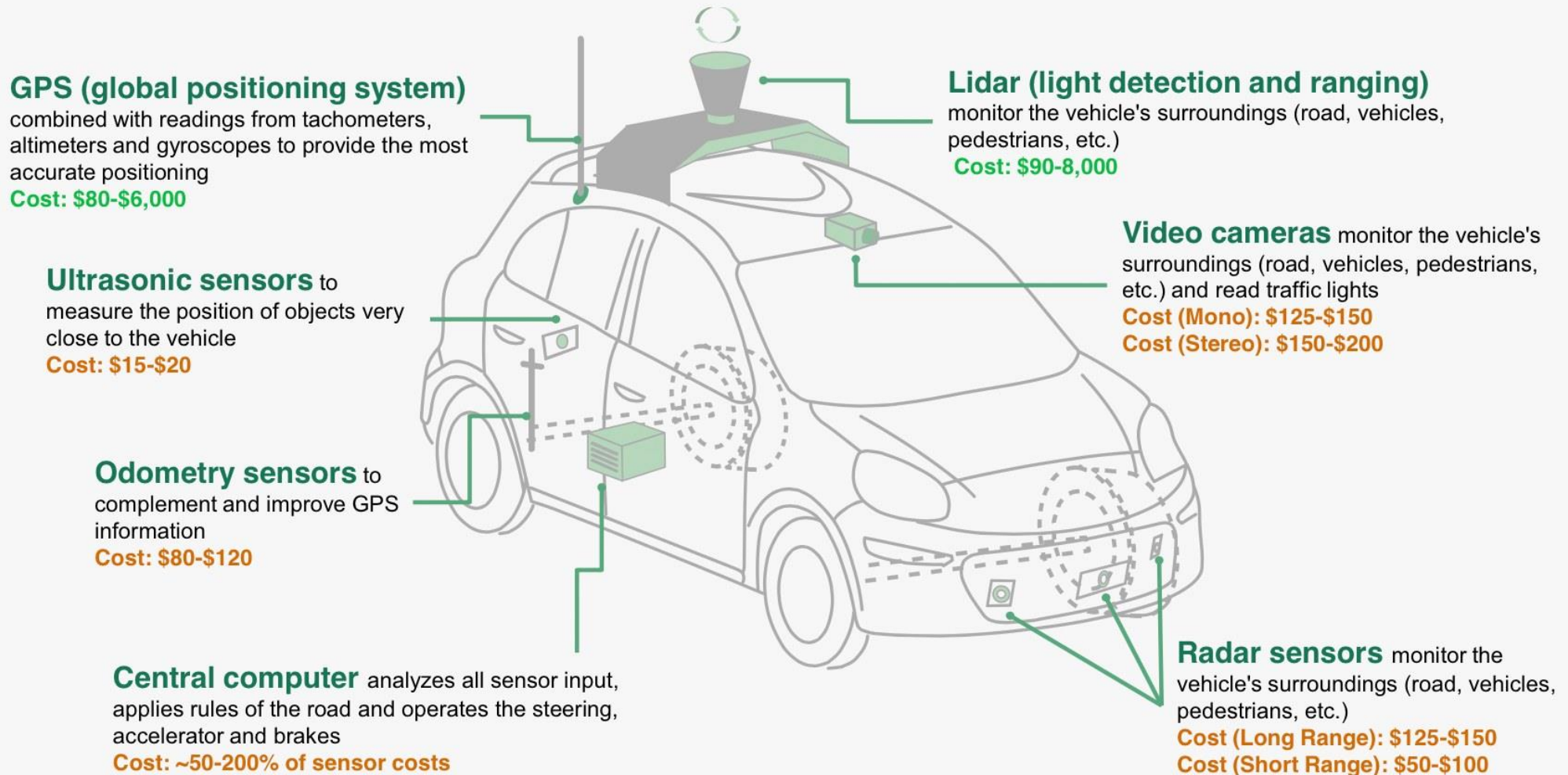


Samsung Galaxy Note 4

Product Specifications

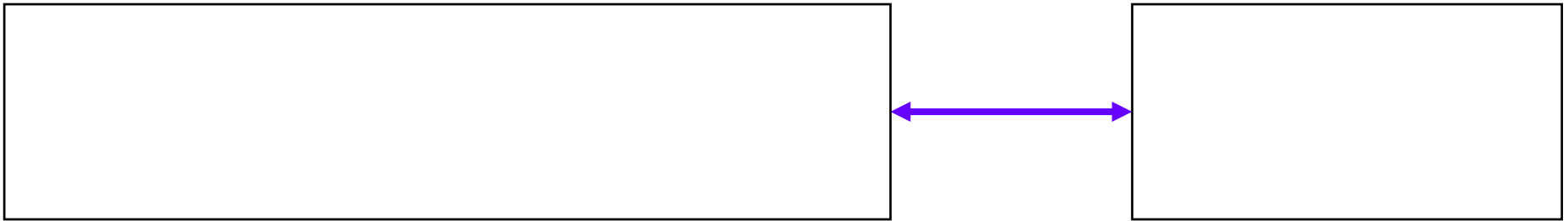


Self-driving cars



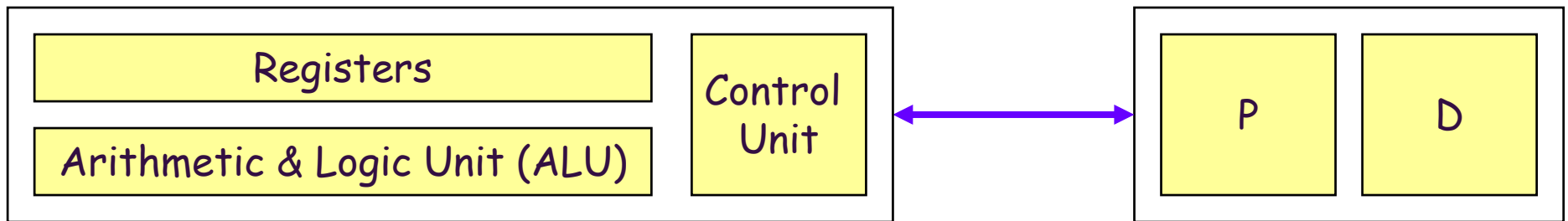
What is a computer?

- simplest description?
- what makes it general purpose?



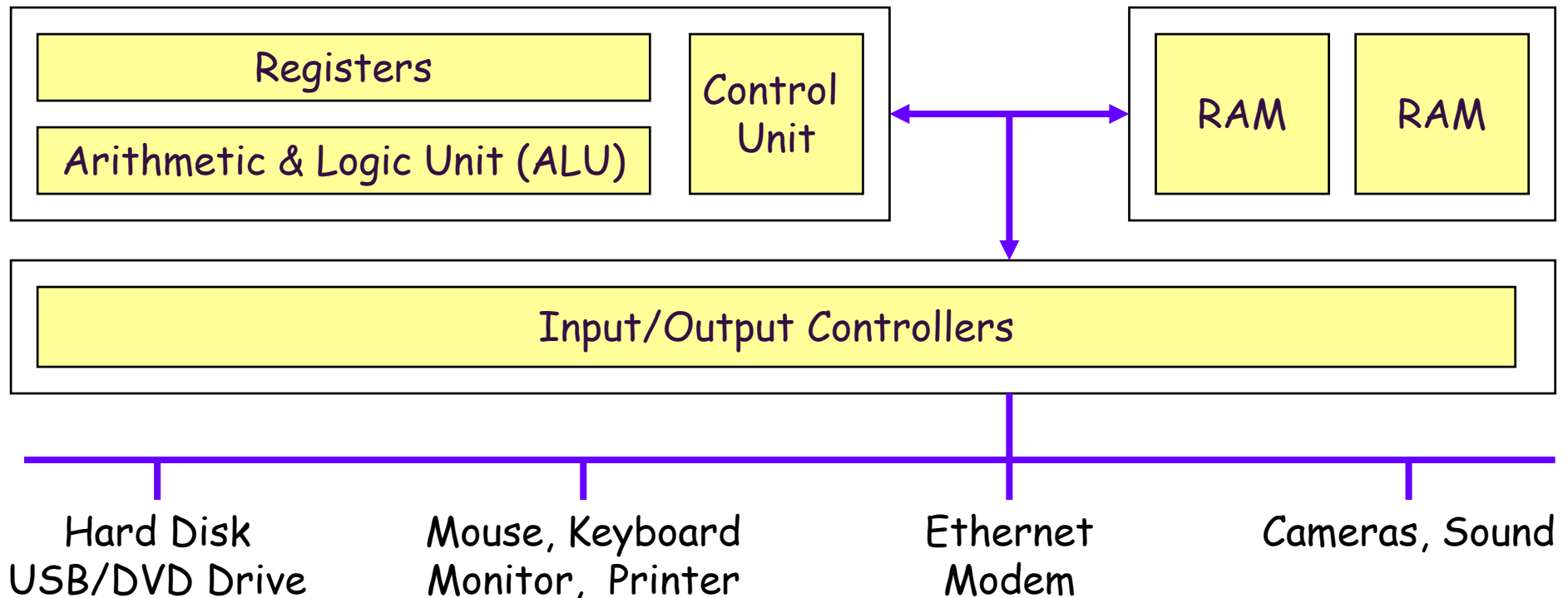
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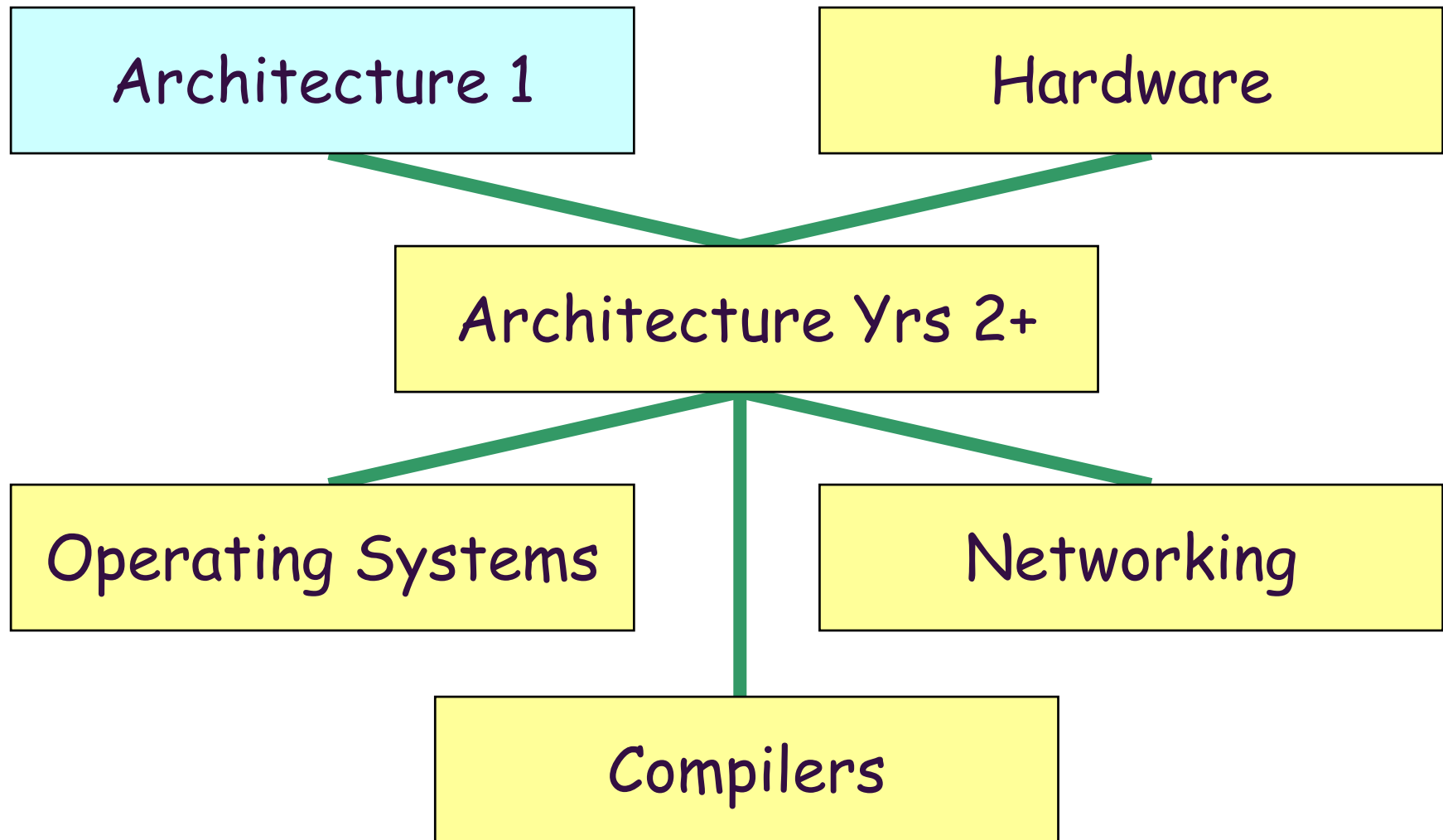


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Big picture



Computer architects – what do they do?

- **Instruction Set** Design
- **CPU** Design
- **I/O Interface** Design
- **Bus** design
- **Motherboard** design
-
- **Emulation & testing** of the Architecture in Software
- **Implementation and testing** of the Architecture in Silicon
- **Performance** Evaluation
- Requirements with input from:
Higher Management,
Compiler writers,
Operating System developers,
Sales and marketing,
Existing and potential
Customers
- **Cost/profitability** analysis

Computer architecture course – for whom?

- **Students** of Computer Architecture
- **Teachers** of Computer Architecture
- **Researchers** of Computer Architecture
- Operating System Developers
- Compiler Writers
- **Repair and Maintenance Technicians**
- **Third Party Vendors** e.g.
 - Peripheral makers,
 - Memory suppliers,
 - Add-on card suppliers,
 - e.g. Co-processors
 - Hardware accelerators
- Sales and Marketing staff
- **CPU Clone Makers**
- **Patent Office Workers**
- Reverse Engineers/Hackers

Course outline: Part 1

Binary Numbers

Radixes (2, 16), Conversions & Arithmetic

Integers and Characters

Integers, Integer Arithmetic, ASCII, Unicode

Main Memory Organisation

Byte-Ordering, Alignment, Interleaving

CPU Organisation & Operation

Instructions, Registers, Fetch-Execute Cycle. Toy1 Programming

Part 2: x86 CPU, input/output, etc

Reference books

Structured Computer Organisation (6th ed)

- A. Tannenbaum and T. Austin, Pearson
- Easy to read, also covers 2nd & 3rd year topics

Computer Organisation & Architecture (10th ed)

- W. Stallings, Pearson
- Detailed, academic, also covers 2nd and 3rd year topics

Think about

- Computers: Past, Present & Future, Visible and Hidden
- Computing Applications: Past, Present & Future
- I/O Devices: Past, Present & Future
- Central Processing Unit
 - What does it do?
 - How does it work?
 - Why does it work?