



# Computer Systems

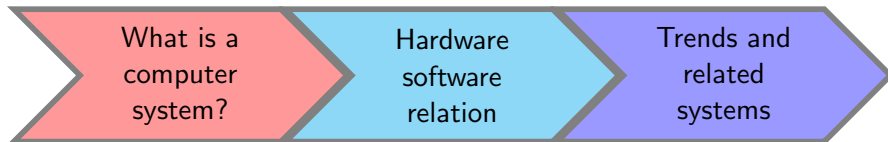
Rasmus Dahlberg

# Recall computers (or, last lecture in TL;DR format)

- A digital computing device that stores and processes data, typically in binary form, according to arithmetic and logical instructions given to it in a variable program
- Binary data is 'easy' to store and process digitally
- Examples that we can express data as we know it in binary
  - ▶ Converting between base 10 and base 2
  - ▶ ASCII
  - ▶ Unicode
- Hardware that composes a basic computer
  - ▶ Processor
  - ▶ Memory
  - ▶ I/O devices
  - ▶ ...



- Describe the role of software in relation to the hardware (ISGA01)
- Describe the relation of the software to the hardware (ISGA06)
- Describe the role of software in relation to the hardware (ISGA90)



- Ett datorsystem är ett system av hårdvara och mjukvara som behandlar data på ett meningsfullt sätt<sup>1</sup>

✗ mjukvara

✗ hårdvara

? meningsfullt

✓ programvara

✓ maskinvara

? TBC

- Dator(er) med ansluten **maskinvara**, se dator. Ordet används ibland synonymt med databehandlingssystem, vilket därutöver omfattar **programvara** samt eventuell organisation för databehandling<sup>2</sup>

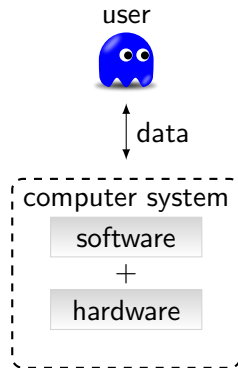
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<sup>1</sup><https://sv.wikipedia.org/wiki/Datorsystem>

<sup>2</sup><https://www.ne.se/uppslagsverk/encyklopedi/l%C3%A5ng/datorsystem>

# Meaningful? Need combination of hardware, software, user, and data<sup>3</sup>

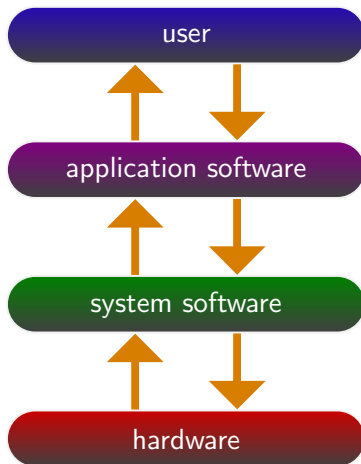
- **Hardware** refers to physical components
- **Software** refers to programs that instruct the hardware what to do step-by-step
- **Data** is supplied and interpreted by a **user**



<sup>3</sup> Some define computer systems like this, see for example: [https://en.wikipedia.org/wiki/Category:Computer\\_systems](https://en.wikipedia.org/wiki/Category:Computer_systems)

# Computer systems are layered to increase usability

- Users use input and output devices to interact with application software (data exchange)
- Application software relies on system software while providing functionality
- System software coordinates the hardware



# Users and application software exchange data via input and output devices

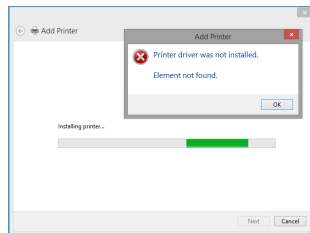


# Application software helps a user perform a given task





# System software provides a platform that application software relies on



- Operating system software

- ▶ Program execution
- ▶ Interrupts
- ▶ System calls
- ▶ ...

- Drivers

- ▶ Bridge between OS and hardware

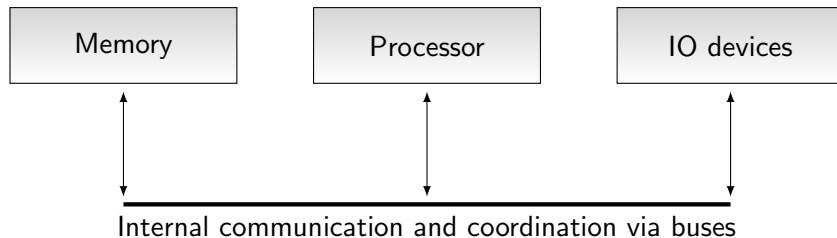
- Firmware

- ▶ Persistently stored program for low-level hardware control
- ▶ Found on most components
- ▶ Recall BIOS on the motherboard

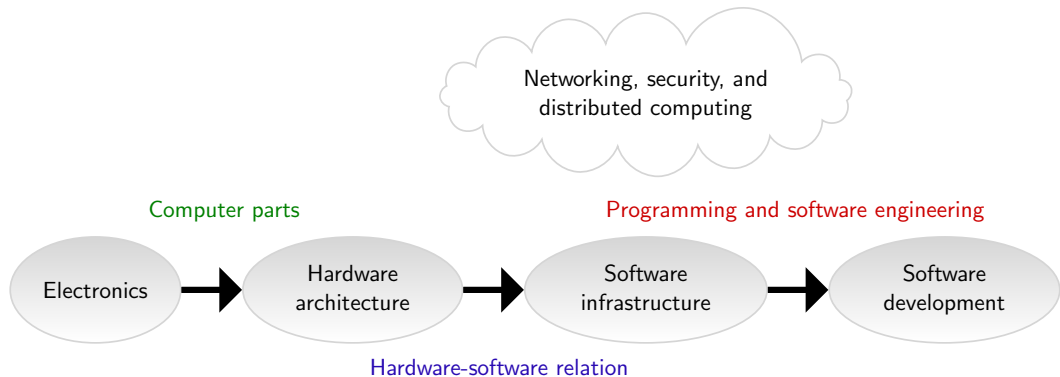
- Window management software

- ...

## Actual hardware finally stores and processes data



# Doh! The more you know, the more you know you don't know



## But we can still say something about the hardware-software relation

Hardware	Software	Outcome
✗	✗	-
✗	✓	useless
✓	✗	unusable
✓	✓	usable

System software abstracts the hardware away, thereby making it easier to use

## Example: what happens on a mouse click?

1. A user provides input data by clicking the mouse
2. The click creates contact with electrical components in the mouse
3. The mouse creates an interrupt signal on the bus: 'I have data to send'
4. The interrupt signal eventually gets CPU priority
  - ▶ Stop current task
  - ▶ Load and execute driver routine
  - ▶ Clear interrupt signal
  - ▶ Context switch back to previous task



Similar: what happens when you press a button on your keyboard?

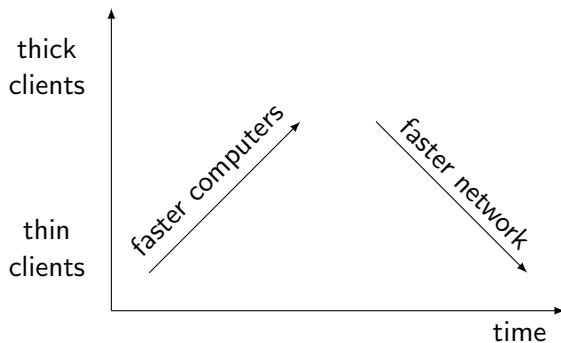
**Example: PlayStation 4 is a computer system**



Interactive demo + whiteboard

# Trends of computer systems

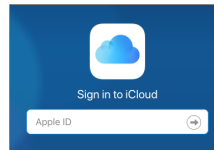
- Thick client
- Thin client
- Outsourced computing



## Azure Cloud Services

Distribuera högtillgängliga, enormt skalbara program och API:er

- ✓ Fokus på appar, inte på maskinvara
- ✓ Stöd för Java, Node.js, PHP, Python, .NET och Ruby
- ✓ Skala automatiskt för att möta efterfrågan och spara pengar
- ✓ Distribuera tusentals instanser på några minuter
- ✓ Integrerad hälsokontroll, övervakning och belastningsutjämning
- ✓ Automatisk uppdatering av operativsystem och program



## Amazon EC2 Instance Types

Amazon EC2 provides a wide selection of instance types optimized to fit different use cases. Instance types comprise varying combinations of CPU, memory, storage, and networking capacity and give you the flexibility to choose the appropriate mix of resources for your applications. Each instance type includes one or more instance sizes, allowing you to scale your resources to the requirements of your target workload.

## High-Performance, Scalable VMs

Google Compute Engine delivers virtual machines running in Google's innovative data centers and worldwide fiber network. Compute Engine's tooling and workflow support **enable scaling from single instances to global**, load-balanced cloud computing.

Compute Engine's **VMs boot quickly**, come with persistent disk storage, and deliver consistent performance. Our virtual servers are available in many configurations including predefined sizes or the option to **create Custom Machine Types optimized for your specific needs**. Flexible pricing and automatic sustained use discounts make Compute Engine the leader in price/performance.

■ Microsoft

■ Apple

■ Amazon

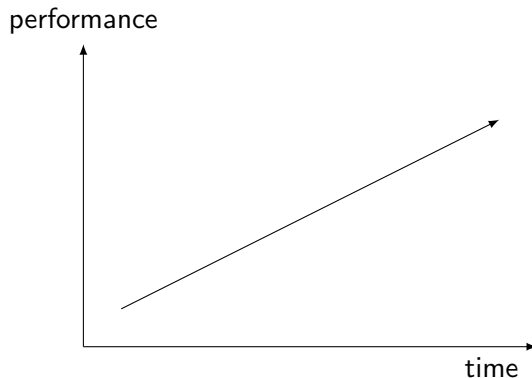
■ Google



# Trends of computer systems continued

Performance metrics:

- MIPS
- MFLOPS
- Bandwidth
- Execution time
- SPEC<sup>4</sup>
- ...



Cause and effect? Hardware improves, software demands more...

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<sup>4</sup>Details for those that are interested: <https://www.spec.org/>

# Systems that are closely related to computers? CS, IS, IT and ICT

- Information System (IS): the study of complementary networks that people and organizations use to collect, filter, process, create, and distribute data
- Computer System (CS): subset of IS
- Information Technology (IT): CS + everything around it in an enterprise
- Information Technology and Communication (ICT): IT + telecom<sup>5</sup>



Figure that depicts these relations?

Be warned: these definitions are no exact science...

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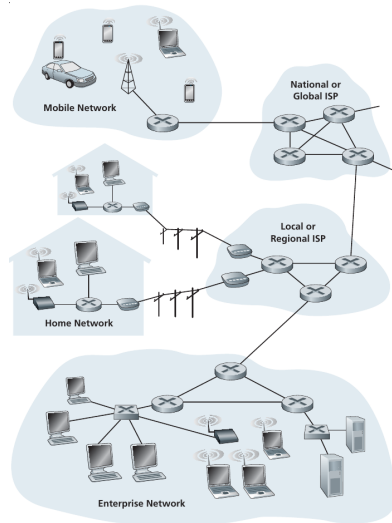
<sup>5</sup> The transmission of data using different types of techniques and mediums, e.g., Ethernet and WiFi.

# Given the status quo of Internet...difference between IT and ICT?

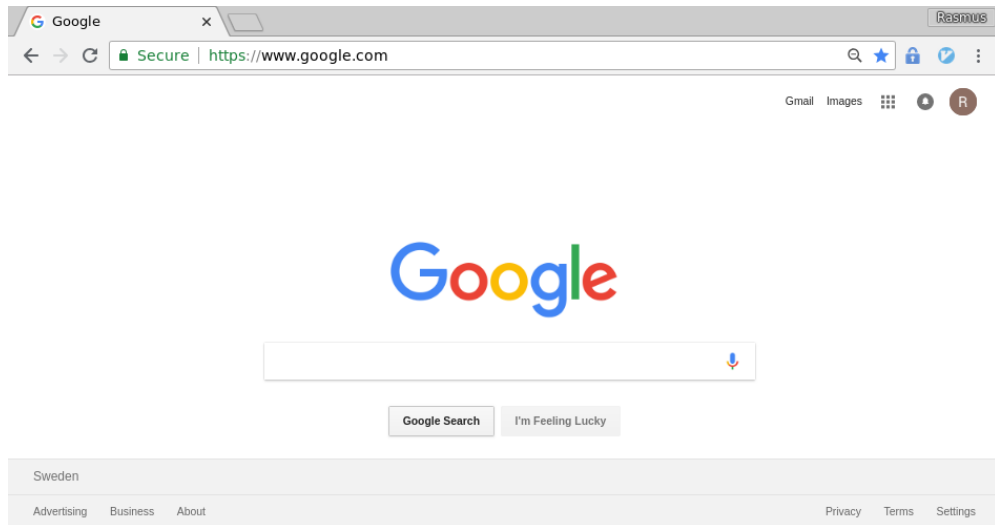
Internet is a network of networks:

- 'Nuts and bolt'
- Protocol stack

Name an IT system without telecommunication?



# Example: what happens when you enter google.com in your browser software?



# Computer systems: present and future?

- Reality
- Internet of things
- Artificial intelligence
- Anarchy
- Monopolism
- Opportunity contra risk



# Any questions?

