FIT 1047

Introduction to computer systems, networks and security

MONASH University

Overview of topics (1/2)

- What is a computer? Core components, numbers, core concepts, Boolean algebra, logic gates, codes, circuits
- What is the structure of a computer? Computer architecture, boot sequences
- What is the core software and core concepts? BIOS, UEFI, operating systems, scheduling, processes, sockets

Overview of topics (2/2)

- How do computers communicate? Networking, network layers, network topologies
- What if there is malicious interference? Introduction to IT security, examples for attacks, security technology, cryptography

What is a computer?

In the 19th and first half of the 20th century a computer was a person doing mathematical calculations.

Towards the middle of the 20th century, automated electronic computers were developed!

Concepts go back to people like Robert Recorde (1512–1558), Gottfried Wilhelm Leibnitz (1646–1716), or Charles Babbage (1791–1871).

Human computers in the NACA High Speed Flight Station Computer Room, at the Dryden Flight Research Center Facilities. (Wikimedia Commons)

History

CSIRAC - One of the first electronic automated computers

(Copyright Museum Victoria, Melbourne)

On Display at Museum Victoria, Melbourne

Generations of automated computers

- First generation: Vacuum Tube Computers (1945 - 1953)
- Second generation: Transistorized Computers (1954 - 1965)
- Third generation: Integrated Circuit Computers (1965-1980)
- Fourth generation: VLSI Computers (1980 - now)
- Fifth generation: Quantum computers (???)

VLSI = very-large-scale integrated

Some examples of current computers

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...before we really start, some organisatorial stuff...

About us

- Carsten Rudolph Associate Professor (Clayton)
  - Own research: Cyber security, network security, formal methods, security protocols, trusted computing
- Guido Tack Senior Lecturer (Caulfield)
  - Own research: combinatorial optimisation (e.g. scheduling, vehicle routing, etc.)
- But: Both of us have long practical experience

Contact

- Moodle forum
- carsten.rudolph@monash.edu
- guido.tack@monash.edu
- Consultation times (TBA)

We try to reply on Moodle forum message within 24h and to e-mail within 48h.

Important:

Only use your Monash email address!

Don't post answers to assignments in forums!

http://moodle.vle.monash.edu/

- Lecture slides, tutorial and lab notes, software downloads
- Assignments
- Discussion forums
- Additional material
- Unit guide

Tutorials

- Tutorials start today
- Mix of new content, revision of lecture material, exercices and hands-on tasks
- Turorials are a great resource! - Your tutors will help you to improve your understanding of the topics - Working in small groups during the tutorial, you can help each other
- Please only attend the allocated tutorial

Assessment

Assessment

5% Participation during lectures (Browser-based, MeLTS)

35% Assignments (04 Sep and 22 Oct)

60% Exam (date TBD)

Requirements to pass

Hurdles:

- 40% or more in exam
- 40% or more in total non-examination assessment
- Overall you need 50% to pass

If you fail a hurdle, you fail the unit!

Lecture participation

- Smart-phone, tablet, laptop
- Browser-based
- Starts in week 2 (trial run on Wednesday)
- Uses Wifi connection in lecture theatre

If you cannot bring a smart-phone or other suitable device, please contact me.

Assignments

- individual work (no group work allowed)
- each worth 17.5% of final mark
- you need 40% (combined) of assignment marks plus MeLTS (=16% of overall marks) to pass the hurdle
- due 04 September and 22 October
- more details in a few weeks

Final exam

- 3 hours
- closed book (just use your brain)
- worth 60% of total unit marks
- you need 40% of exam marks to pass the hurdle (=24% of overall marks)

Note: Just passing the hurdles means 40% overall. This is not sufficient to pass the unit. You need 50% overall!

Academic integrity

- Don't cheat! (It is unfair to your fellow students, to your lecturer, to your tutors)
- Read the policy on cheating (see Moodle)
- Cheating is taken very seriously by Monash

Examples for cheating

- copy and paste answers to assignments
- work together on individual tasks
- use external material in a closed book exam
- login with someon else's username to use

MeLTS

- let someone else write your assignment

How to succeed in FIT1047

Attendance - Come to lectures and tutorials

Participation - Actively take part

Interest - Be interested, find additional material, think ahead

Questions - Ask your lecturers and tutors, ask your fellow students

Time - You should plan 12 hours per week

How to succeed in FIT1047

Seek help

In any case of problems (technical, health, others) there will be help available. Help desks, counselling, medical services, etc.

Don't wait until it is too late!

Lets start to talk about computers

...there are literally thousands of different types of computers ...

...but, the large majority of them are based on the same internal concepts:

1. Information can be expressed by high/low current/voltage (0 and 1) (digital)
2. Electronic circuits can be used to calculate with 0s and 1s (transistors)

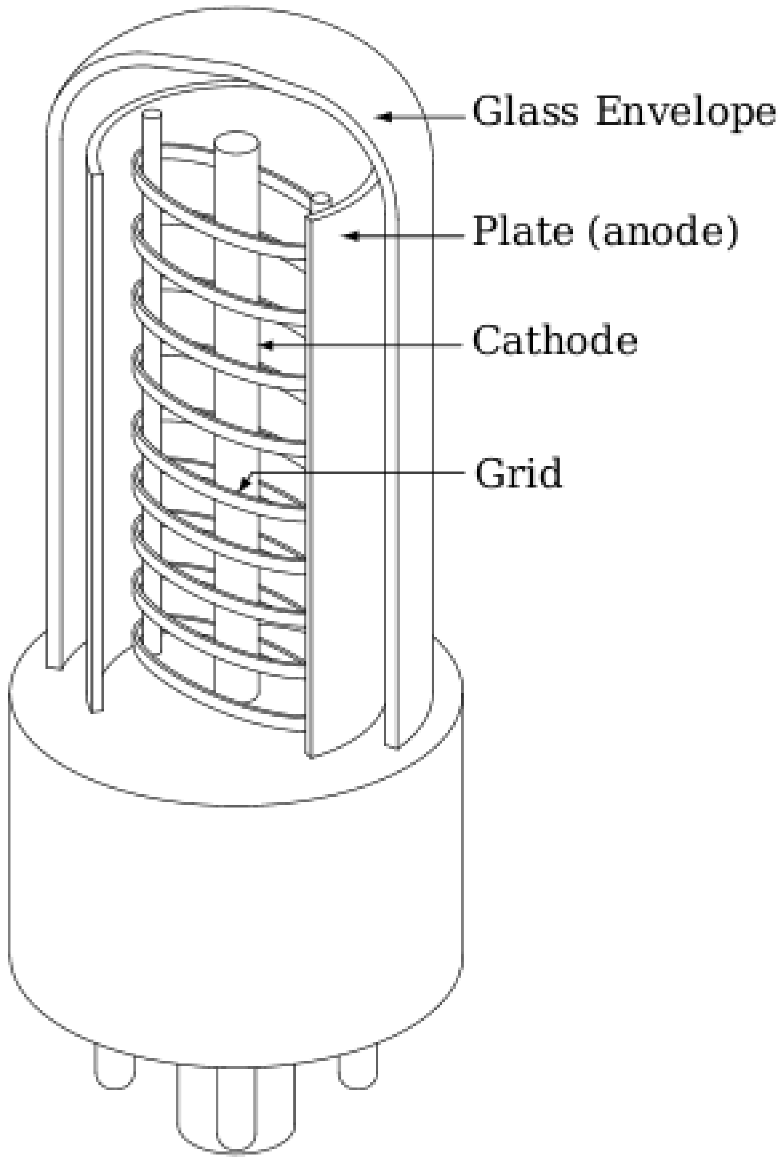
Note: Analogue computers or quantum computers will be largely ignored in this unit.

The vacuum tube

Different types of vacuum tubes

(Wikimedia Commons)

The vacuum tube (triode)



(Wikimedia Commons)

A triode can be used as amplifier or switch:

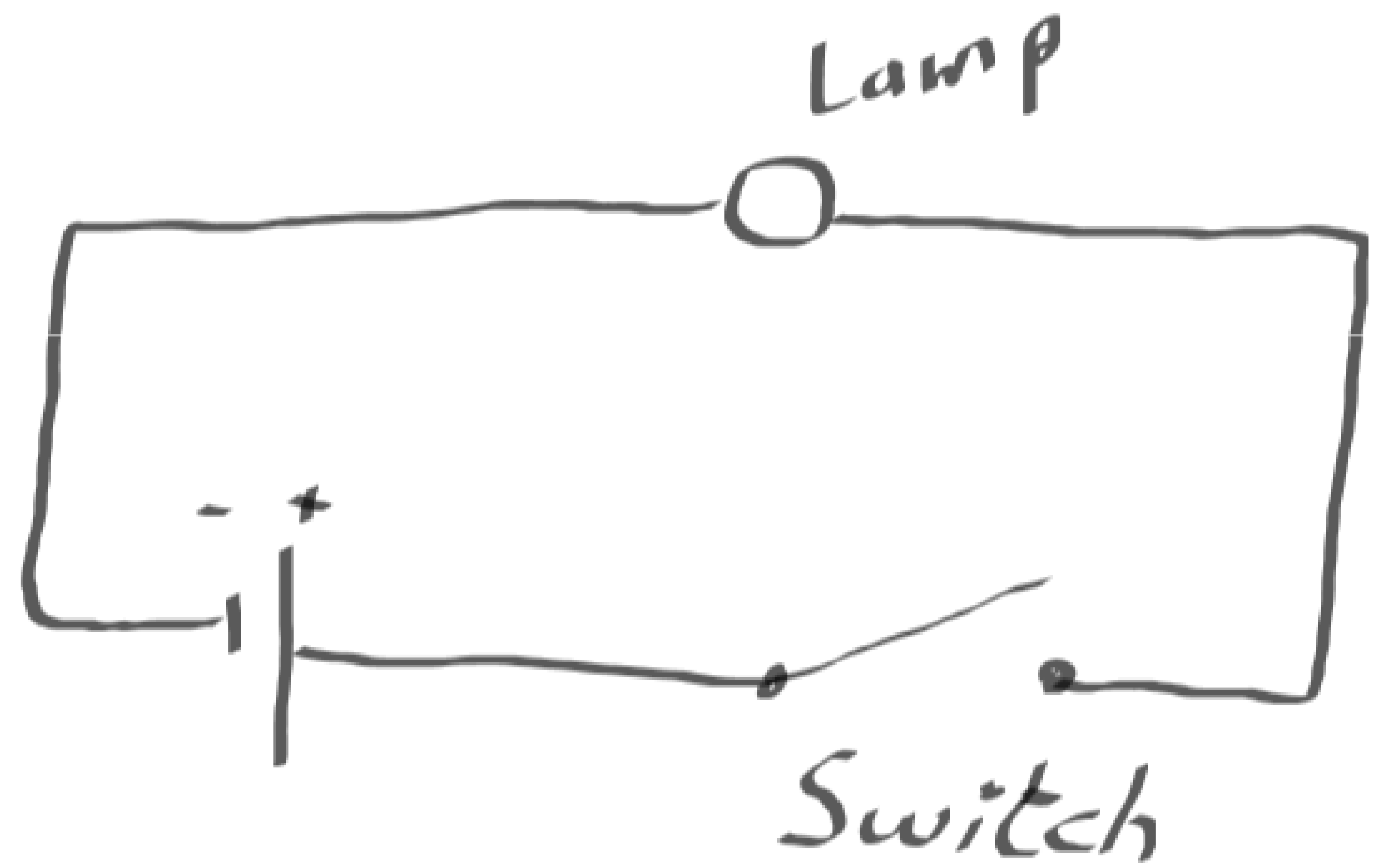
- Very small changes to the control Grid cause much larger changes in the electron flow between Anode and Cathode. A weak signal on the Grid is amplified. (Example: guitar amplifier)
- A large negative charge on the Grid stops the electron flow between Anode and Cathode. Used for computation.

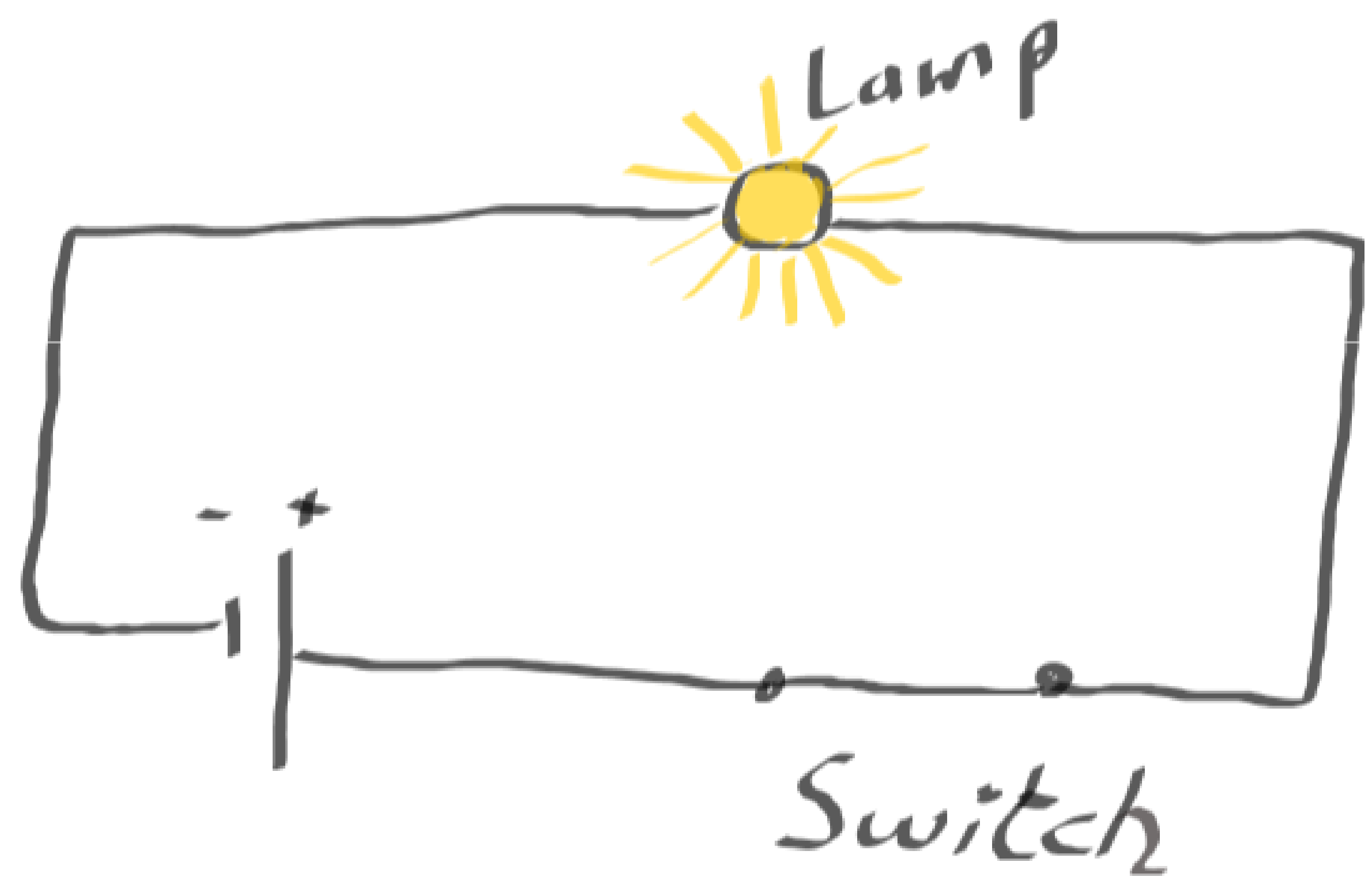
Problems: Large, generates a lot of heat, not dependable (tubes burn out)

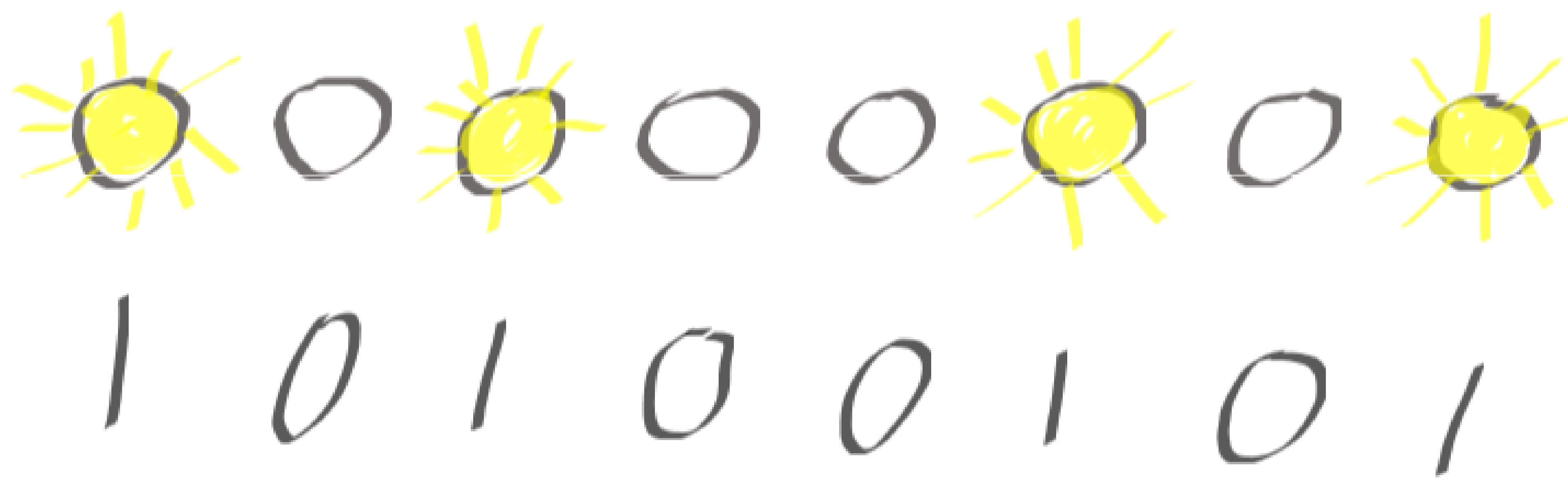
The transistor

Short for transresistance. In principle, a transistor is a solid-state version of the triode.

The solid medium is usually silicium or germanium. Both are semiconductors, which means, that they dont conduct electricity particularly well.


Lamp
- +
Switch

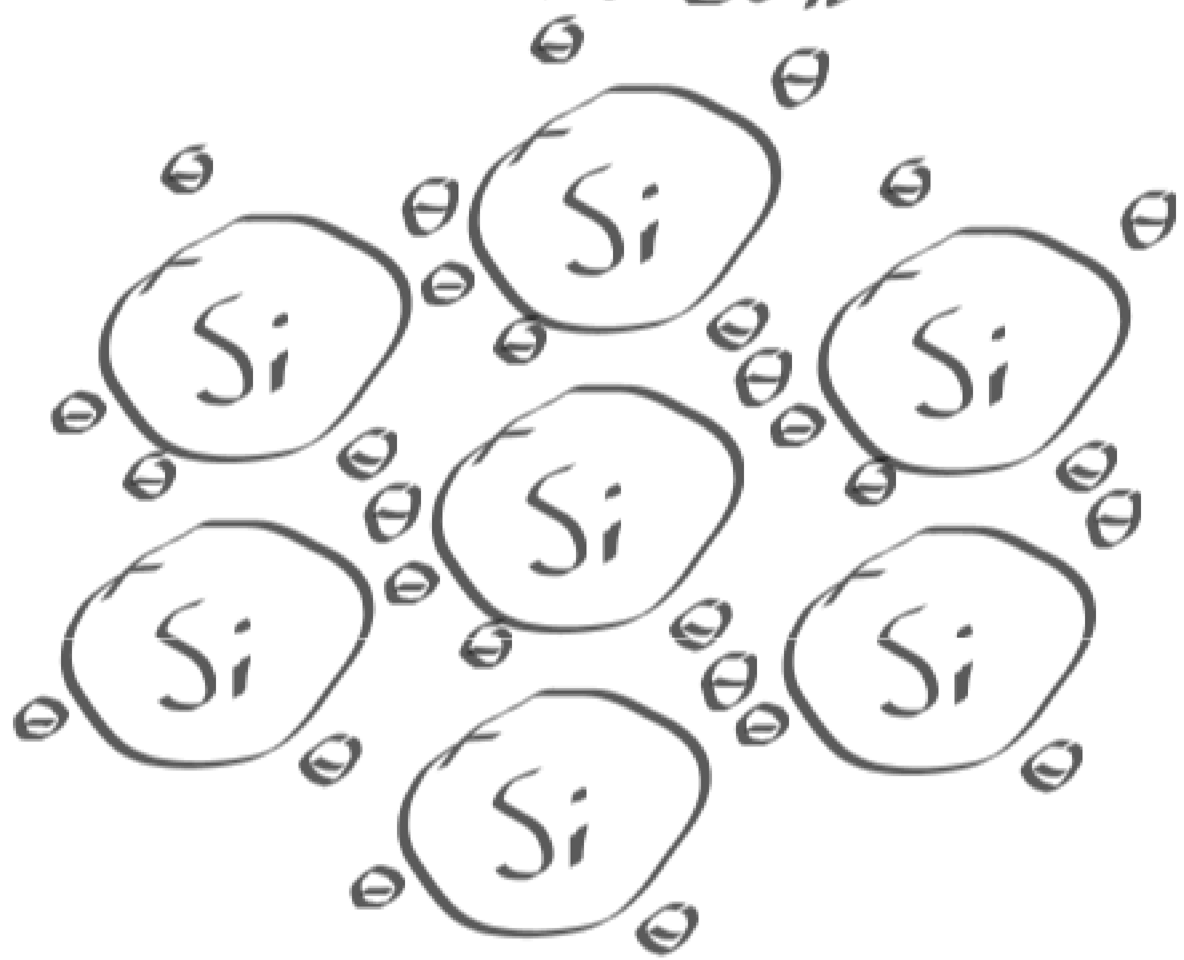

Lamp
- +
Switch


1 0 1 0 0 1 0 1


1 0 1 1 0 1 0 1

Si - Silicon

Si - Silicon



Si - Silicon

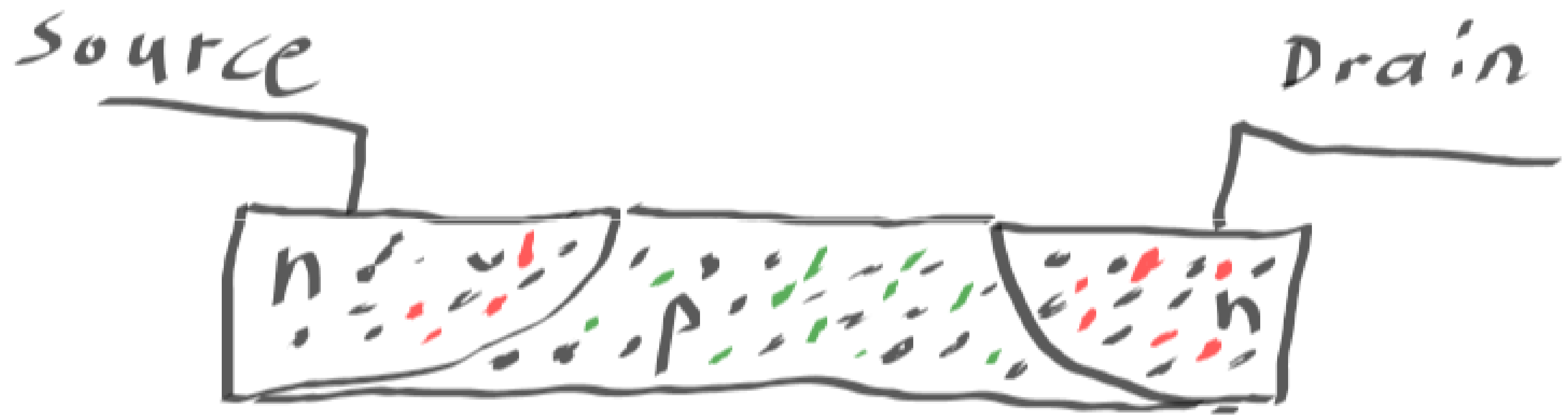
P - Phosphor

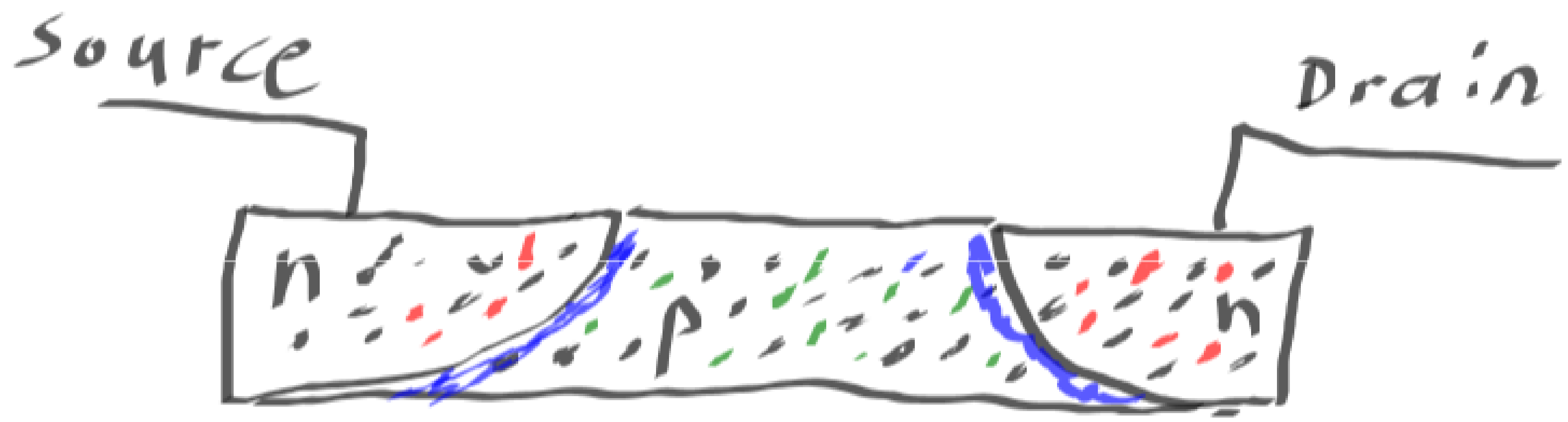
n-type doping

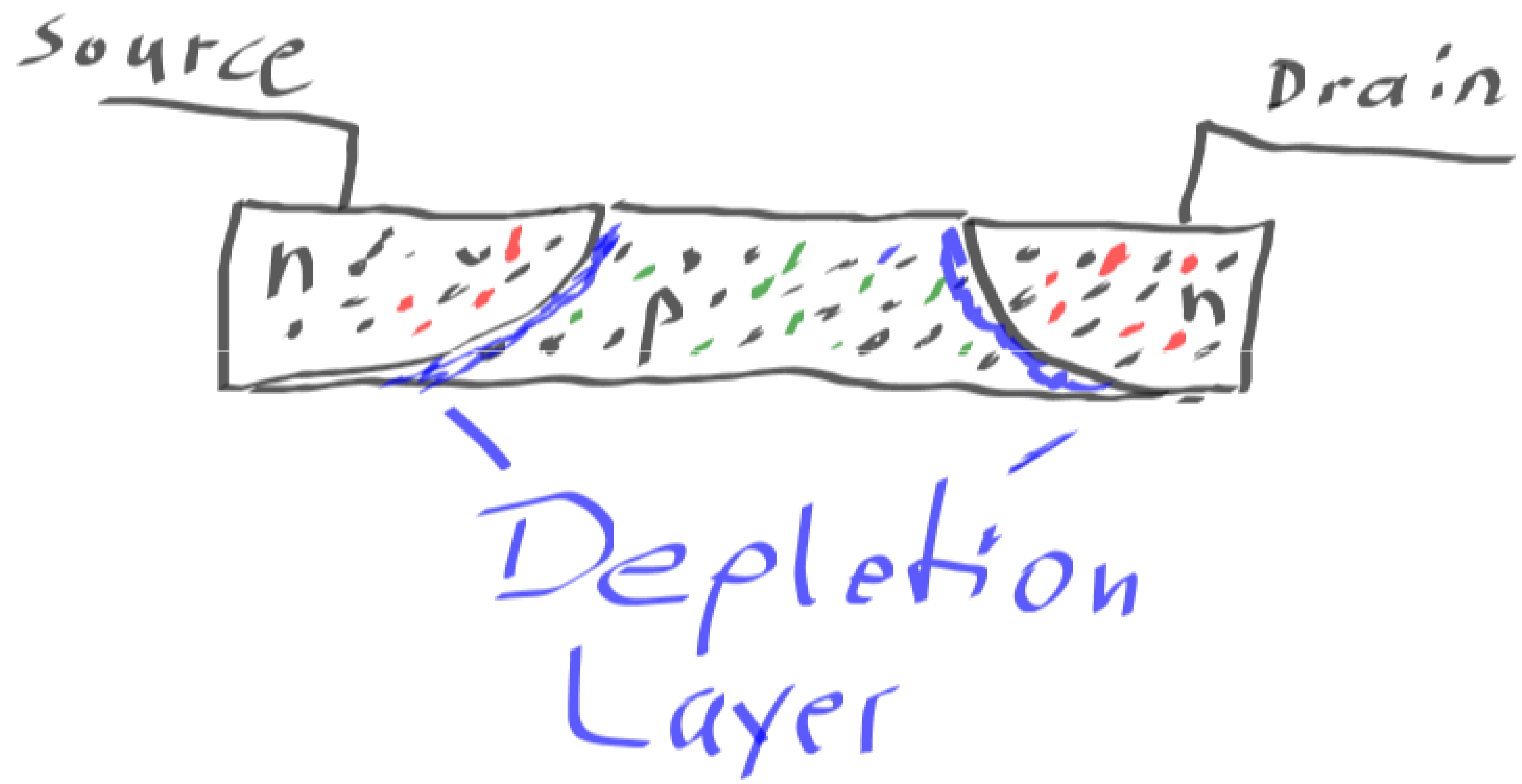
Si - Silicon

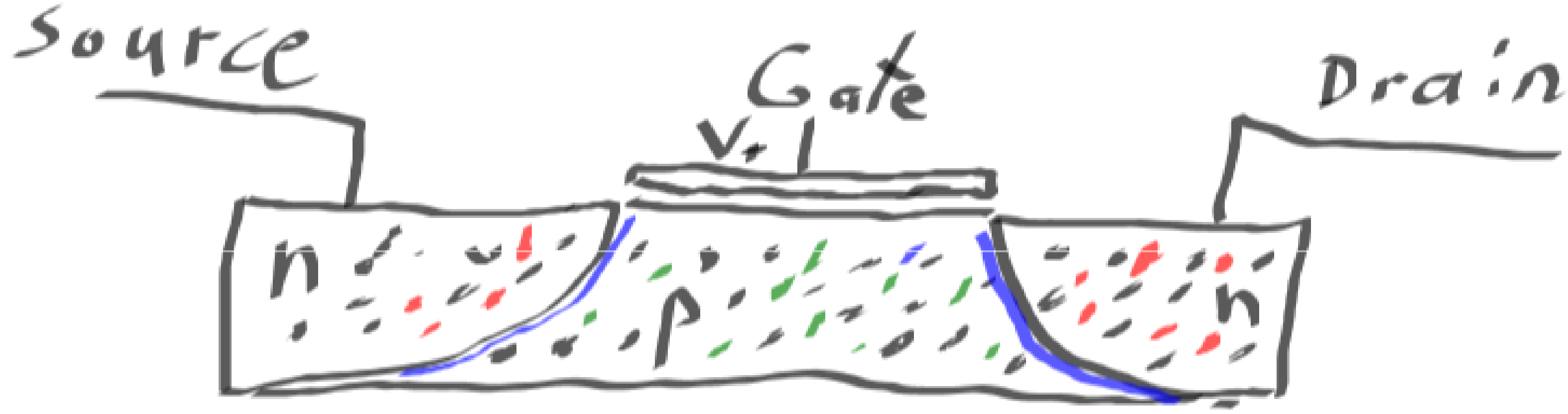
B - Boron

p-type doping


Source
Drain
n
p
n


Source
Drain
n
p
n


Source
Drain
n
p
n
Depletion
Layer


Source
Gate
V+
Drain
n
p
n

Depending on the type of transistor there are different naming conventions:

- Source - Gate - Drain
- Collector - Base - Emitter

Layered design of transistors.

(Tony R. Kuphaldt, published via www.allaboutcircuits.com)

Evolution

	Year	Number of transistors	Area used
CSIRAC	1949	2000 (tubes)	40 m^2
Intel 4004	1971	2300	12 mm^2
Intel 80286	1982	134000	49 mm^2
Intel Core i7	2011	2,270,000,000	434 mm^2

Computers only distinguish 0 an 1.

Is 0 and 1 sufficient to express data and to compute all different algorithms?

1. Data representation
2. Boolean algebra

A closer look at data

Smallest unit: bit

One binary digit (bit) is just on and off (or low and high) in a circuit or memory.

Thus, one bit can be used to express 0 and 1.

Convention: 8 bits are one byte

Introduced by IBM in 1964 as the basic unit of adressable computer storage.

Words

Data is stored, shifted around and computed in a particular data size, called a word. Words are often multiples of eight, 16 bits, 32 bits or 64 bits.

Processors, memory and buses within a computer should be able to efficiently store and transfer complete words for this architecture.

Numbering systems

Numbering systems can be distinguished by their base.

We are used to base 10.

Example:

$$2396 = 2\times10^3 + 3\times10^2 + 9\times10^1 + 6\times10^0$$

Computers use base 2.

$$2396_{10} = 100101011100_2 = 1\text{x}2^{11} + 0\text{x}2^{10} + 0\text{x}2^9 + 1\text{x}2^8 + 0\text{x}2^7 + 1\text{x}2^6 + 0\text{x}2^5 + 1\text{x}2^4 + 1\text{x}2^3 + 1\text{x}2^2 + 0\text{x}2^1 + 0\text{x}2^0$$

How to read binary

1	1	0	1	1	1	0	1

How to read binary

1	1	0	1	1	1	0	1
128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

How to read binary

1	1	0	1	1	1	0	1
128	64	32	16	8	4	2	1
128	64	0	16	8	4	0	1

Adds up to 1+4+8+16+64+128 = 221

Another important base is 16

Hexadecimal numbers can be very easily converted to binary numbers and vice versa.

Four bits in a binary number are directly converted into the matching hex number.

Example for binary to hexadecimal

Convert 2396 = 100101011100 to hexadecimal

Binary	1001	0101	1100
Hex	9	5	C

Thus: $2396_{10} = 95C_{16}$

Important numbers

Decimal	Binary	Hex
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

Summary

- History
- Core elements are transistors (previously vacuum tubes)
- Most computers use a similar architecture
- Basis for all computations and storage is 0 and 1
- Different numbering systems are used
- Base 10, base 2, base 16

Tutorials start today

The tutorial will repeat some topics and introduce methods for conversion between numbering systems.

Next lecture: Wednesday
3pm - 4pm