oueees-201606
Part 1: IoT
device technologies

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14-JUN-2016

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Lecture notes on GitHub

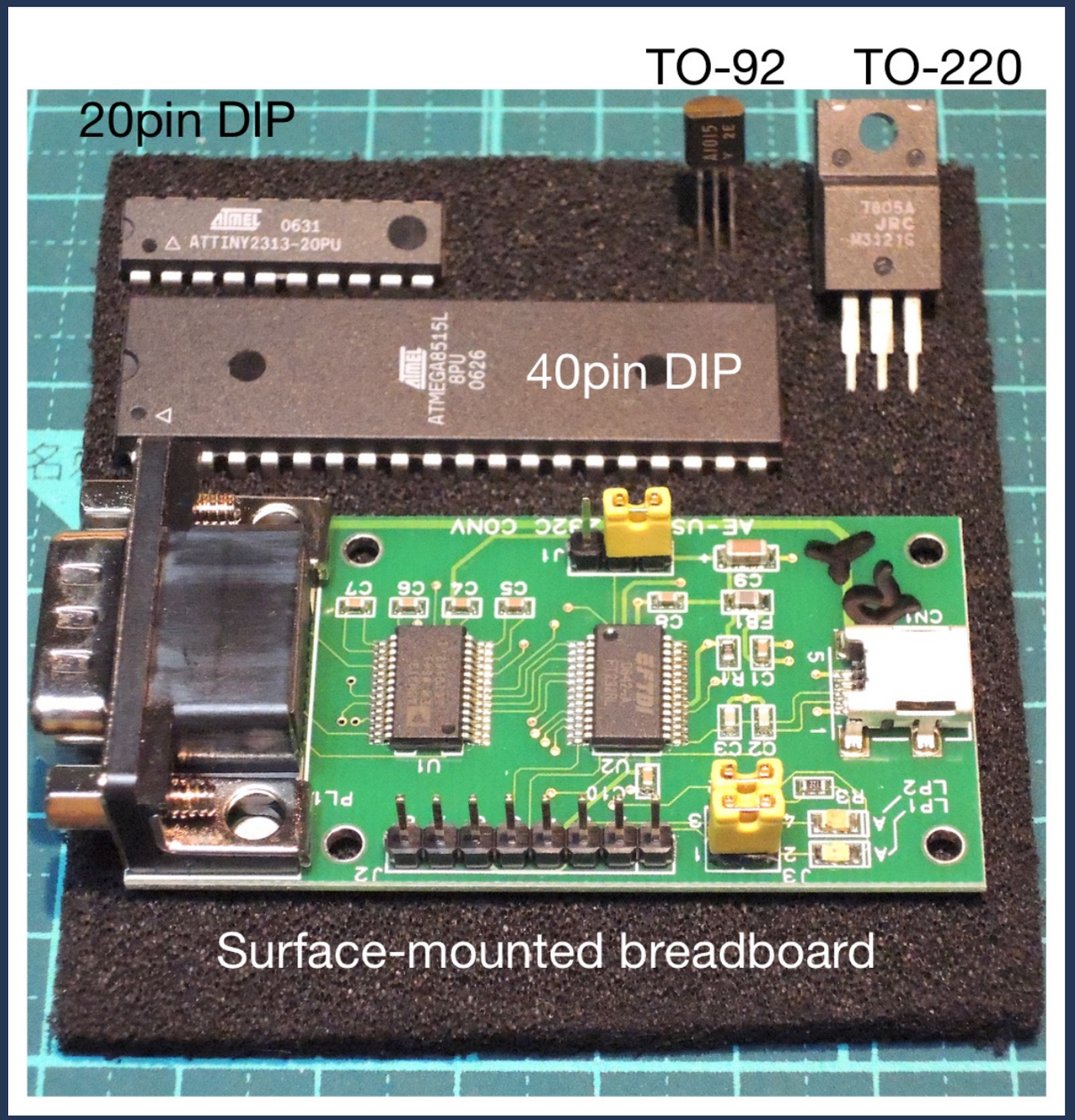
- https://github.com/jj1bdx/oueees-201606-public/
- Don't forget to *check out the issues*!

IoT = electronics

Trends in IoT devices

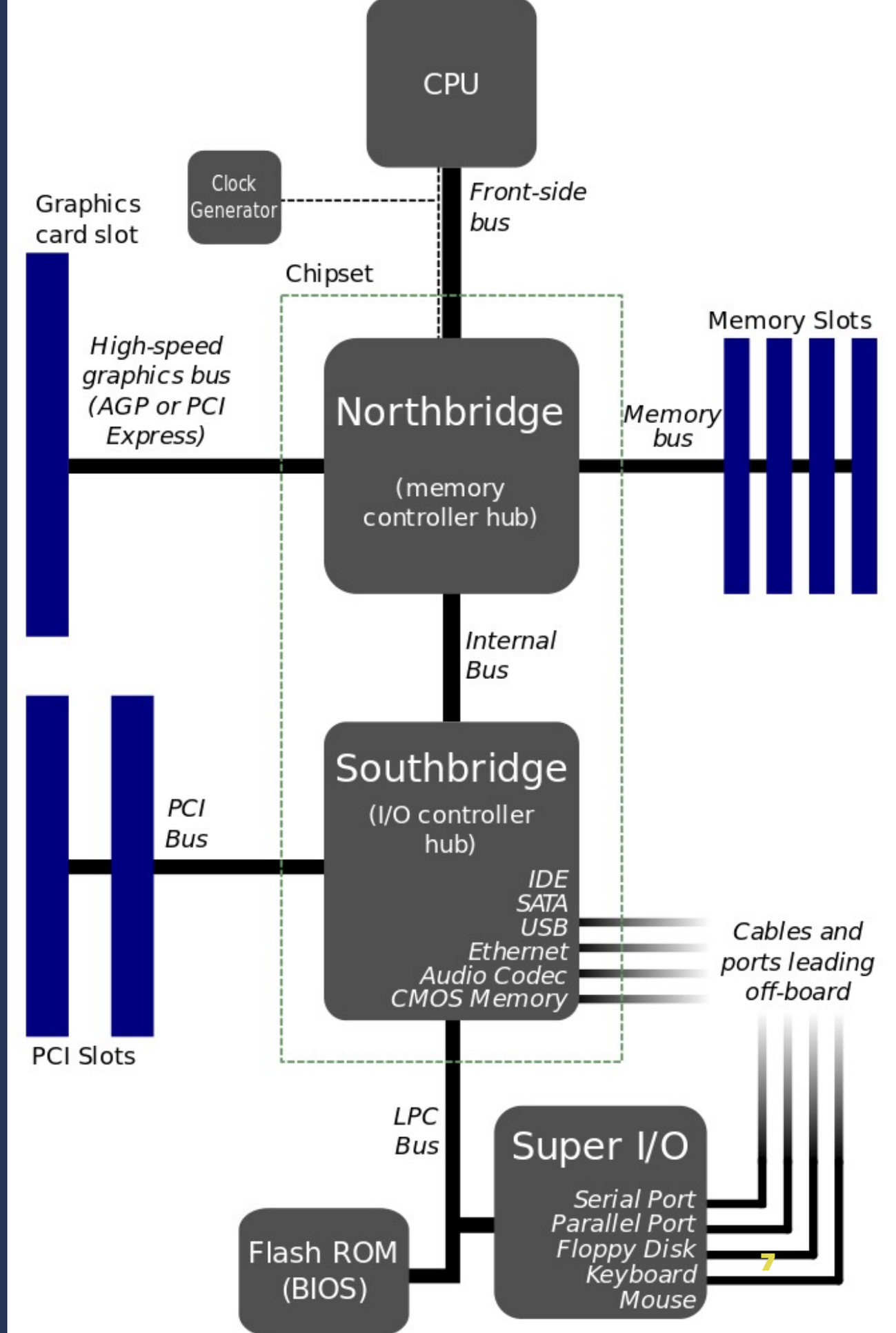
- They are *computers*
- Small, less physical constraints
- Less power, voltage, and heat
- Driven by *software*

Legacy parts

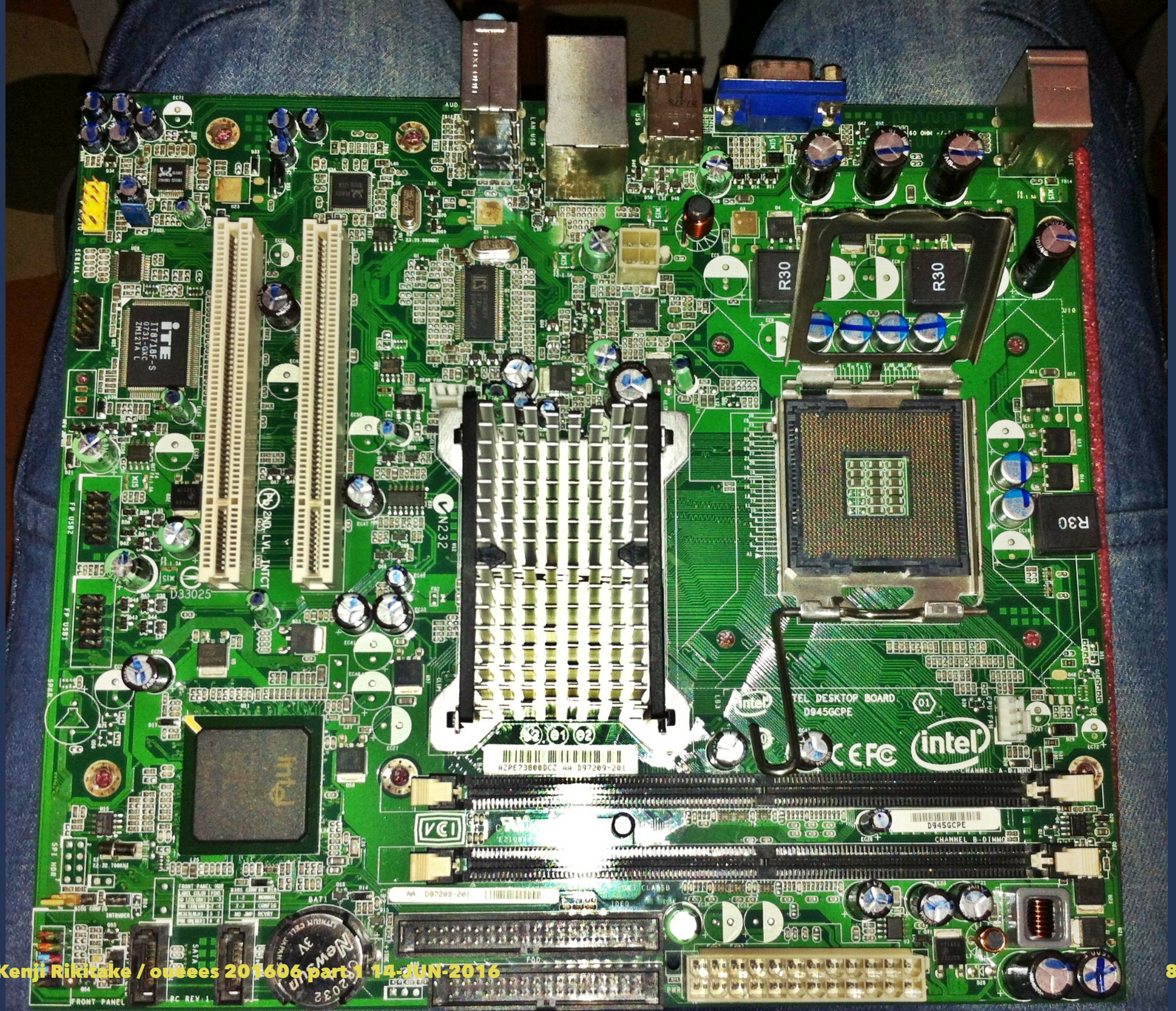


Traditional PC

- Motherboard[1]
- CPU
- Memory
- "Peripherals"
- Video
- Extension bus



[1] Diagram by Moxfyre, CC BY-SA-3.0


R30
R30
R30
ITE
IT8716F-S
Q731-GXC
ZM12TA L
D33025
D945GCPE
INTEL DESKTOP BOARD
D945GCPE
CHANNEL A-DIMM0
CHANNEL B-DIMM0
FRONT PANEL
PC REV:1

Computers for IoT: microcontrollers

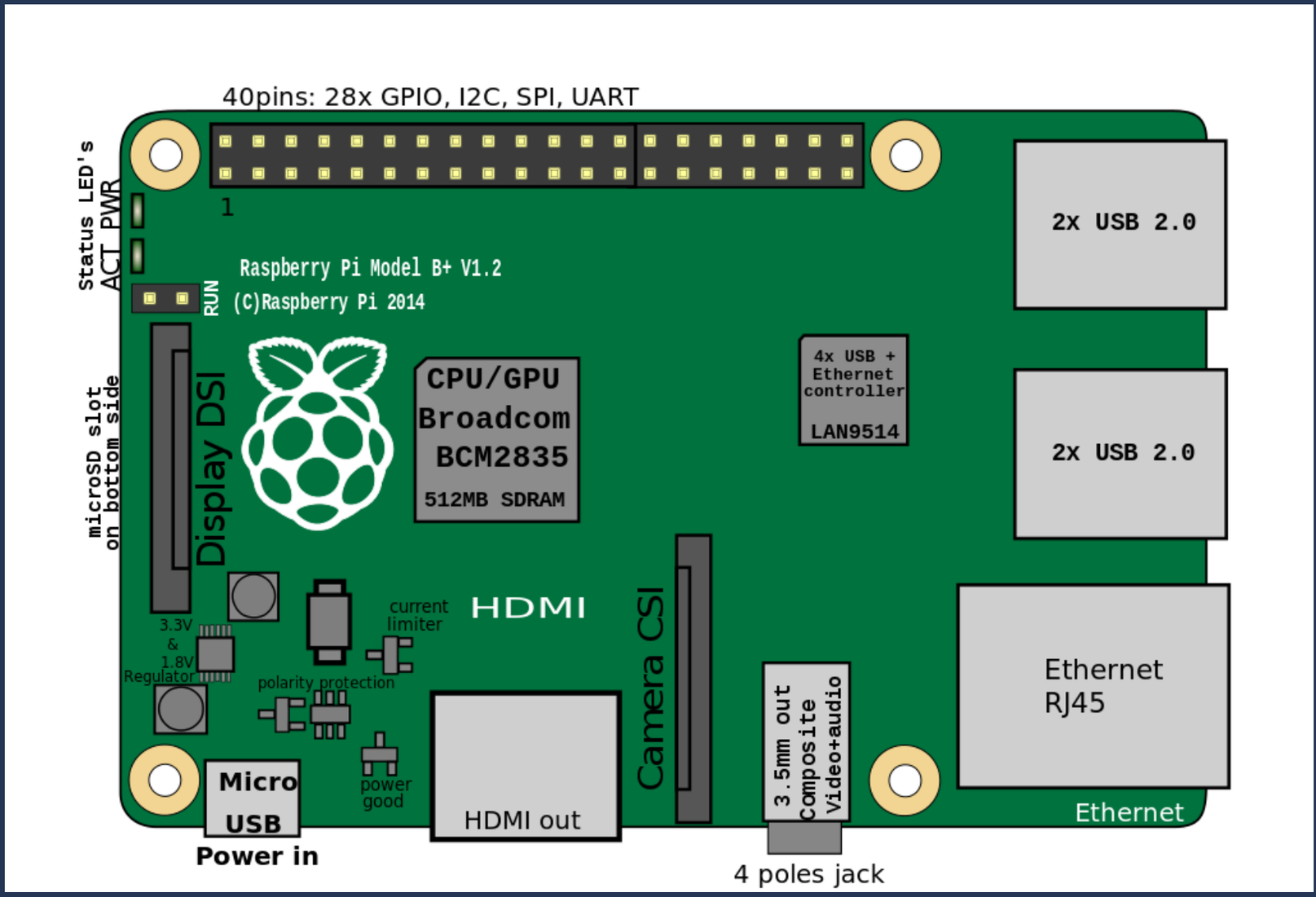
- All in one board or chip
- CPU + ROM + RAM
- GPIO (Digital I/O)
- Analog interface (A/D, D/A)
- Communications (USB, Serial, SPI, I2C)
- Ethernet / WiFi / Bluetooth

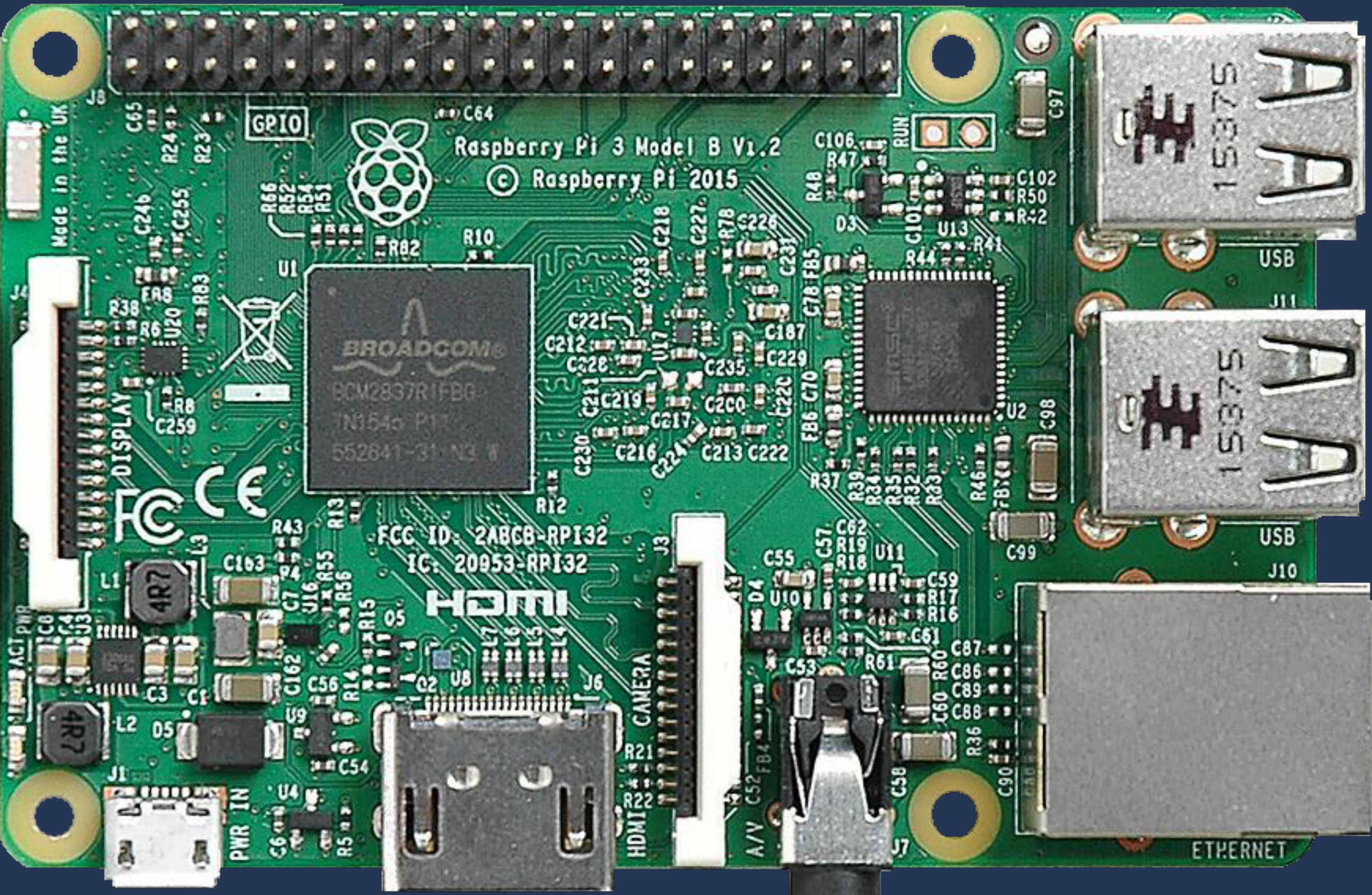
Legacy CPUs .vs. microcontrollers

- Power consumption/management
- Built-in I/O interfaces
- Virtualization and memory protection
- Operating environment
- *Microcontrollers are catching up very fast*

Raspberry Pi

Rasberry Pi 3 Model B

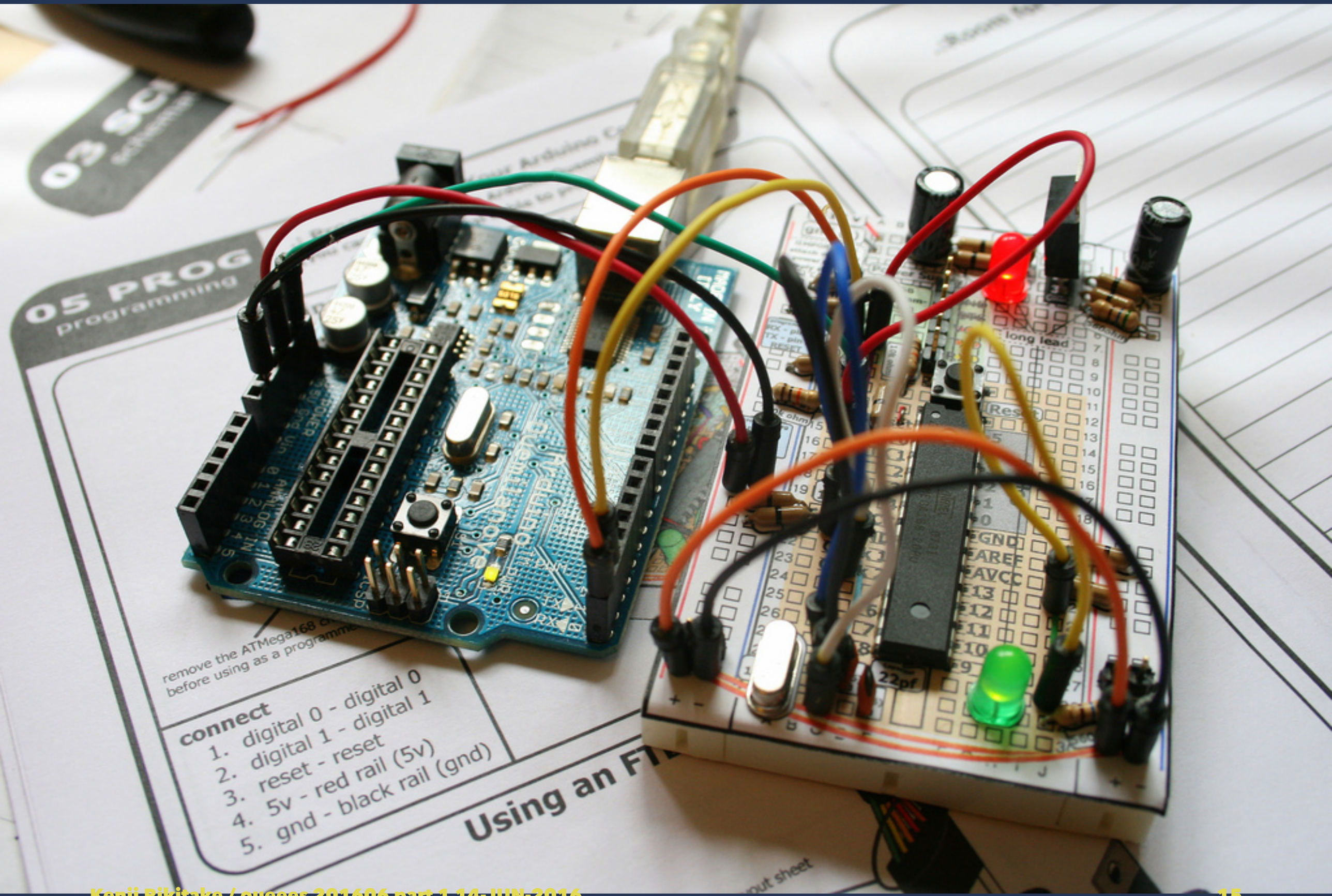



Raspberry Pi 3 Model B V1.2
© Raspberry Pi 2015
GPIO
Made in the UK
BROADCOM
BCM2837B0IFBG
FCC ID: 2ABCB-RPI32
IC: 20953-RPI32
HDMI
CAMERA
DISPLAY
PWR IN
A/V
USB
USB
ETHERNET
RUN

Design and implementation of IoT products

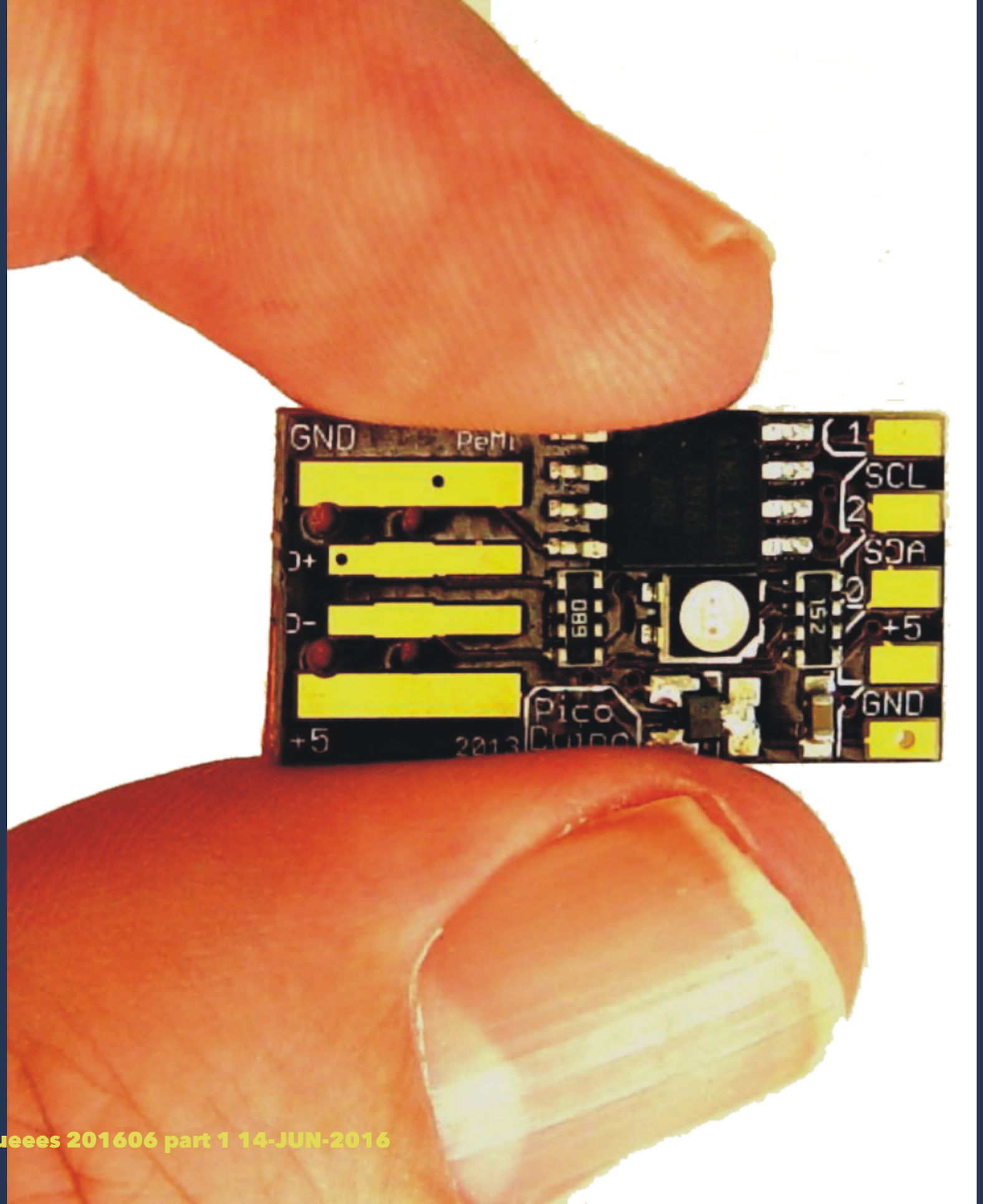
Prototyping

- Using breadboards
- No-solder wiring
- Easy but *unstable*
- Many startup projects haven't got further than this phase
- *Not* production-ready


05 PROG
programming
connect
1. digital 0 - digital 0
2. digital 1 - digital 1
3. reset - reset
4. 5v - red rail (5v)
5. gnd - black rail (gnd)
remove the ATMega168
before using as a programm
long lead
22pf

Building actual products

- Soldering surface-mount chips and parts
- Making *small as possible*
- Factory built
- Minimalize the features
- Physically and electronically stable
- Legally approved (FCC/UL, CE, PSE)


GND
D+
D-
+5
SCL
SDA
+5
GND
Pico

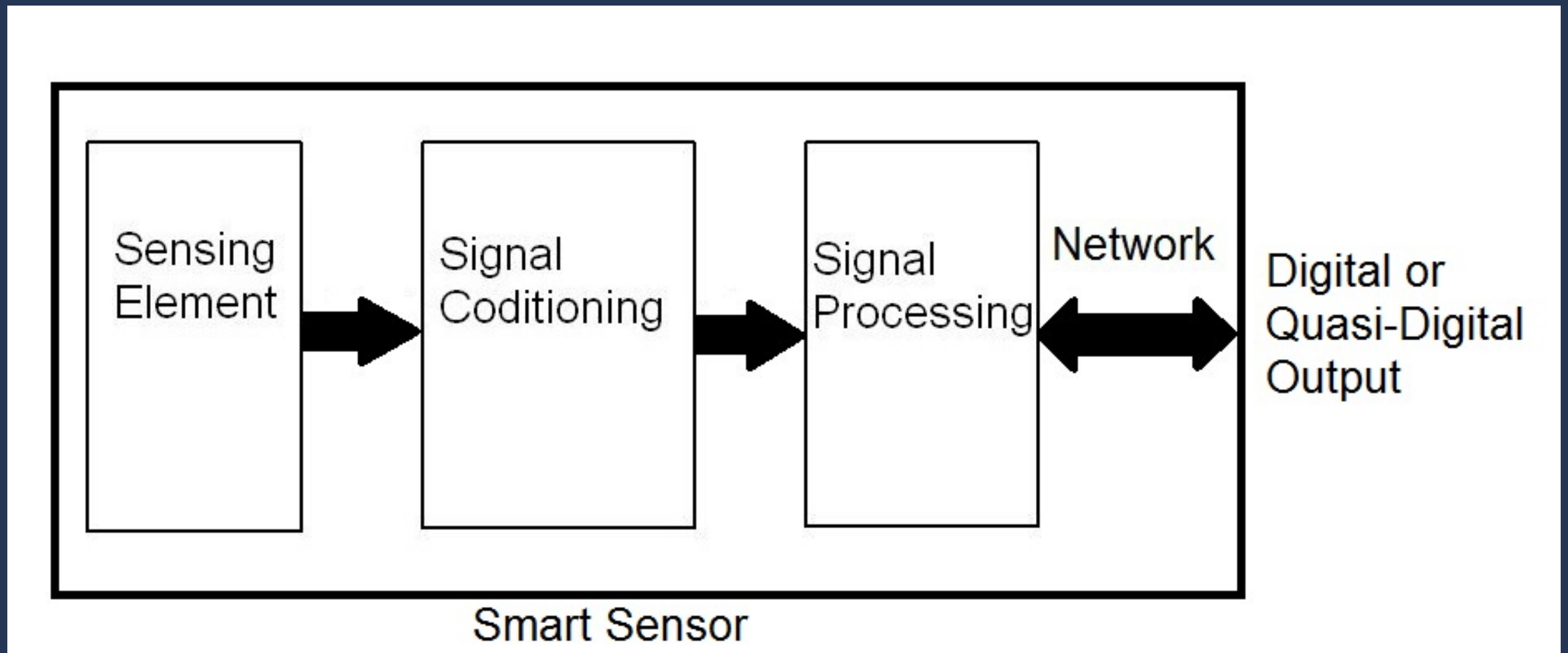
Other issues

- Mechanical alignment and stability
- Long-term reliability
- Product life cycle determination
- Vulnerability assessment
- Security and privacy
- Legal liability

Real-world interface: sensors

What are sensors?

Converting environmental changes into information output

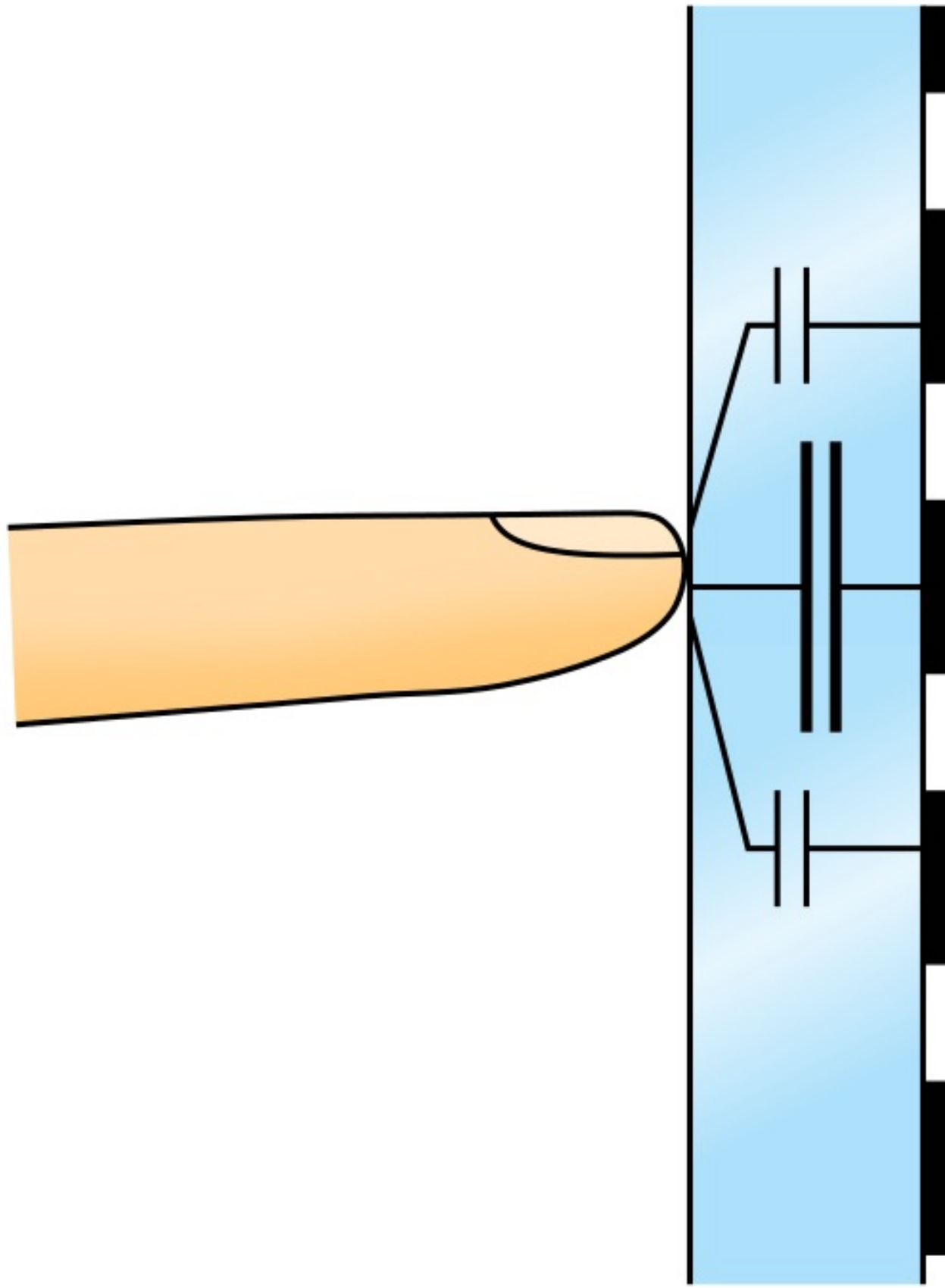


Example: mechanical sensors

- Mechanical switches
- Piezoresistivity
- Piezoelectricity
- Capacitive change
- Inductive change

Projected capacitive sensing on a touch screen

- Touching by fingers change electrostatic capacitance between electrodes
- Popular on tablets and smartphones

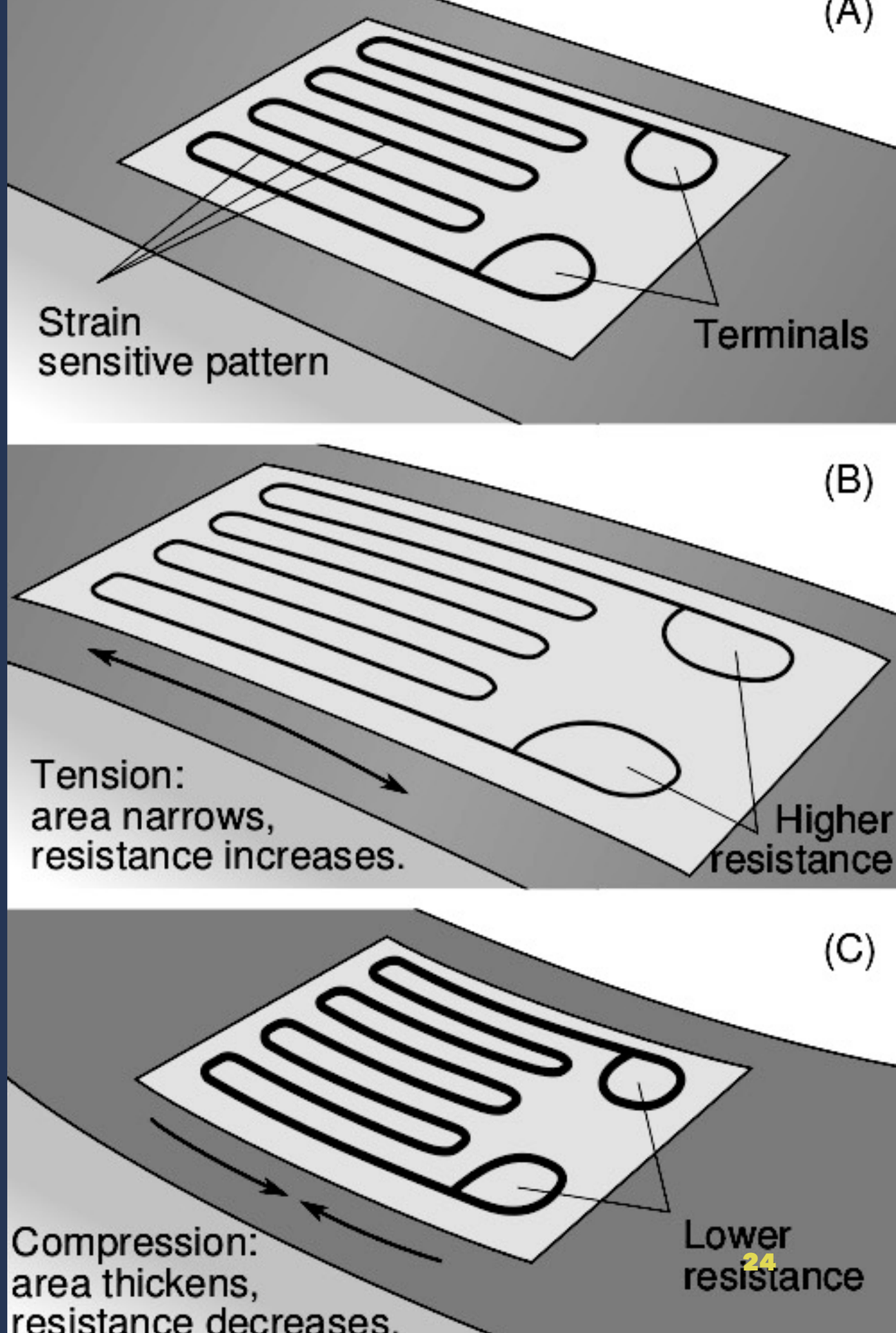


Application of mechanical sensors

- Accelerometer
- Anemometer (wind speed)
- Gyroscope
- Pressure sensor
- Strain gauge

Strain gauge

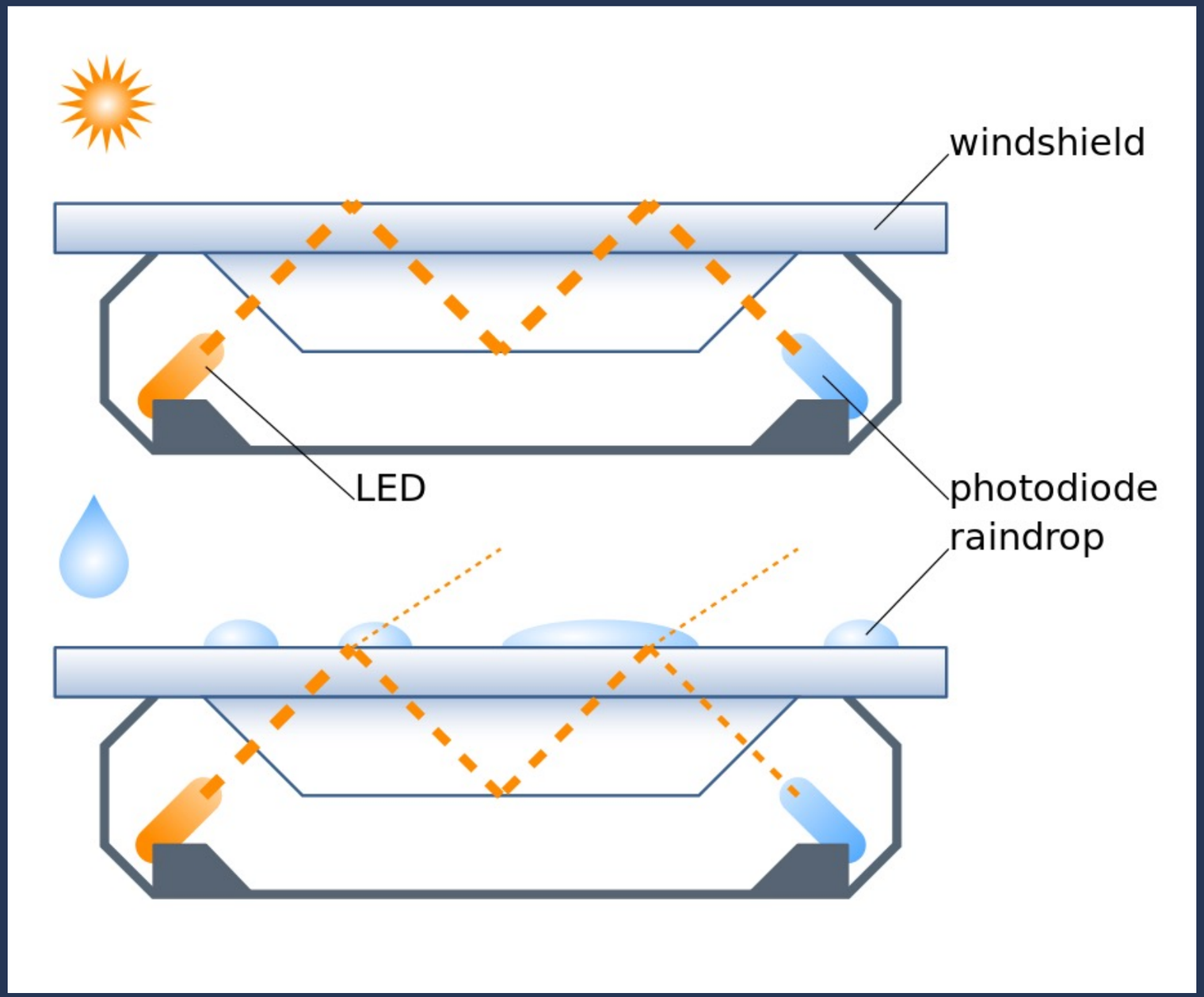
- Sensing deformation
- Widely used for building pressure sensors
- Detecting resistance or capacitance change
- Implemented on metal foils, semiconductors, microelectromechanical systems (MEMS), optical fibers, etc.



Non-contact sensors

- Antenna (electromagnetic / radiowave)
- Geiger-Müller tube (radioactivity)
- Microphone (sound / vibration)
- Photodiode (CCD/CMOS image sensors)
- Thermistor (temperature)

Rain sensor



Passive or active

- Passive sensors
  - stealth
  - taking energy from the object
- Active sensors
  - detectable
  - dynamic measurement methods

How microcontrollers help sensors

- Digital signal processing
  - Calibration
  - Measurement accuracy
  - Noise reduction
- Failure detection
- Storage

Role of sensors on IoT technology: collectivity

Extracting hidden characteristics from the massively collected data

- Correlation analysis
- Geographically different points
- Multiple types of information
- Time series analysis

Question: what kind of new sensor devices will emerge?

Think about the following aspects:

- Collective nature of IoT
- Microcontrollers and sensors
- Anything can be a sensor device

Credits for photos and diagrams

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