Chapter 2

Choosing a specialized CPU

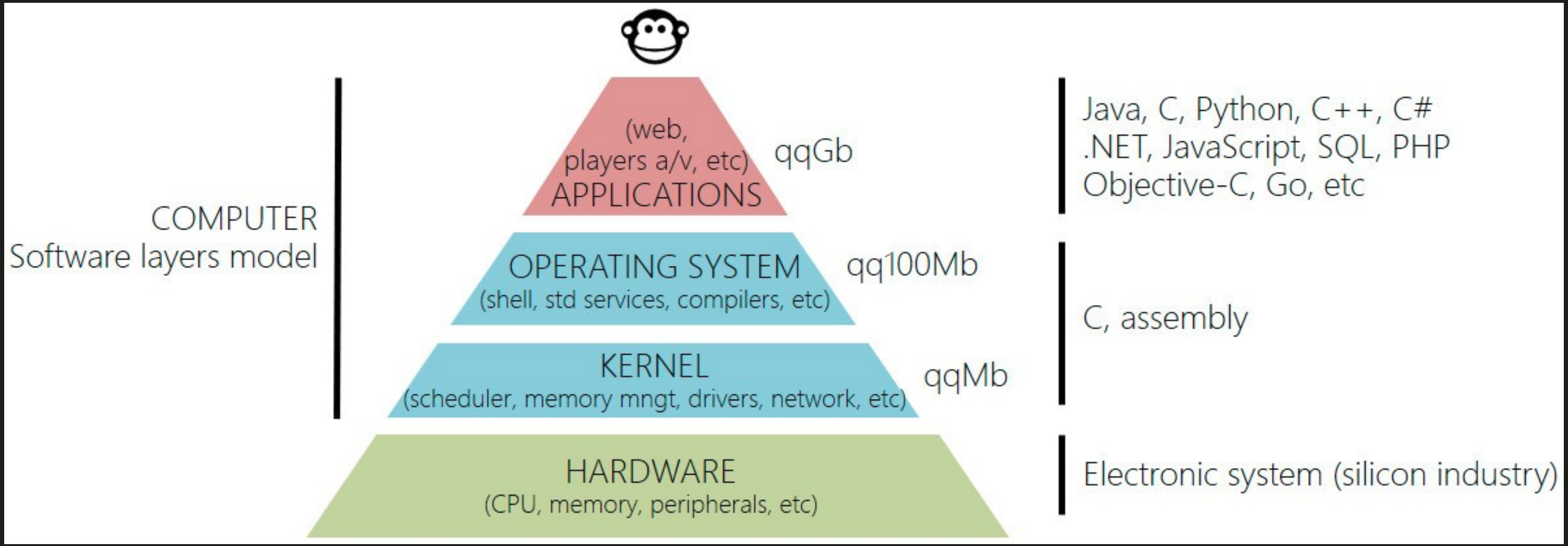
ENSI
CAEN

ÉCOLE PUBLIQUE D'INGÉNIEURS
CENTRE DE RECHERCHE

2021-2022

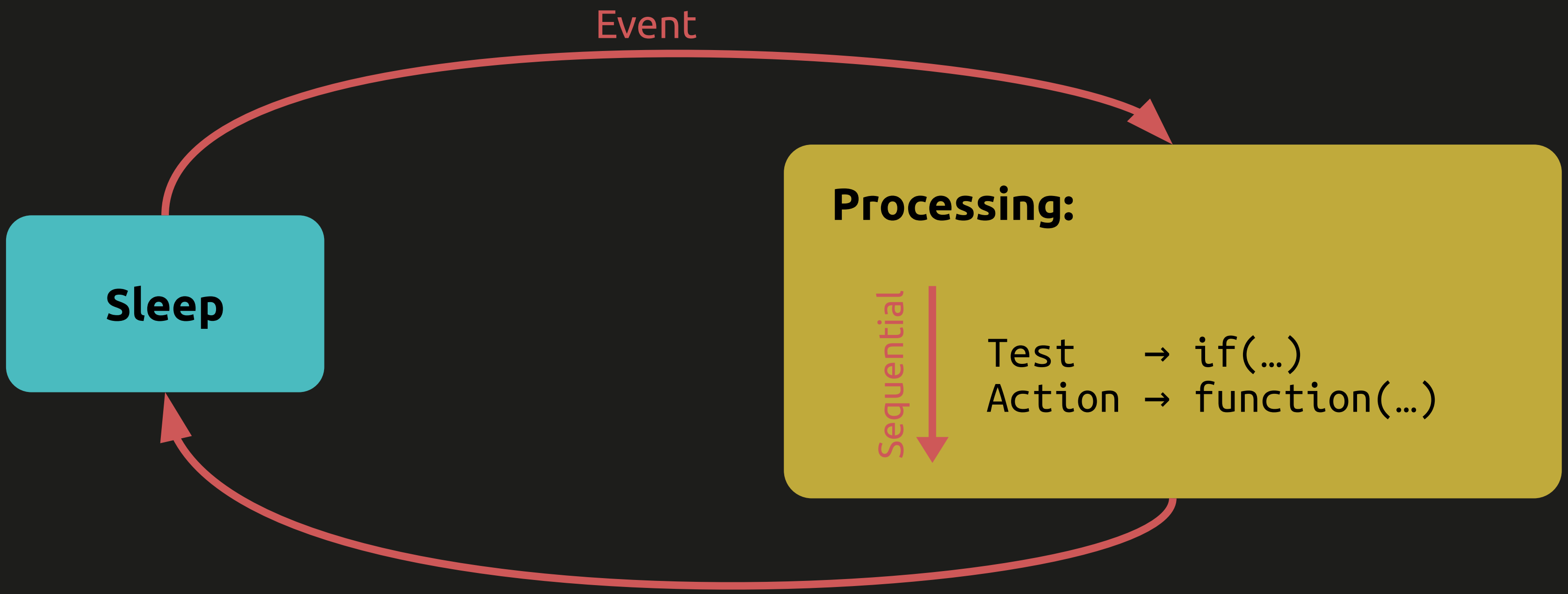
Software: Applications + System

The objective of an application is to fulfill specifications (or requirements).


COMPUTER
Software layers model
(web,
players a/v, etc)
APPLICATIONS
qqGb
OPERATING SYSTEM
(shell, std services, compilers, etc)
qq100Mb
KERNEL
(scheduler, memory mngt, drivers, network, etc)
qqMb
HARDWARE
(CPU, memory, peripherals, etc)
Java, C, Python, C++, C#
.NET, JavaScript, SQL, PHP
Objective-C, Go, etc
C, assembly
Electronic system (silicon industry)

Application

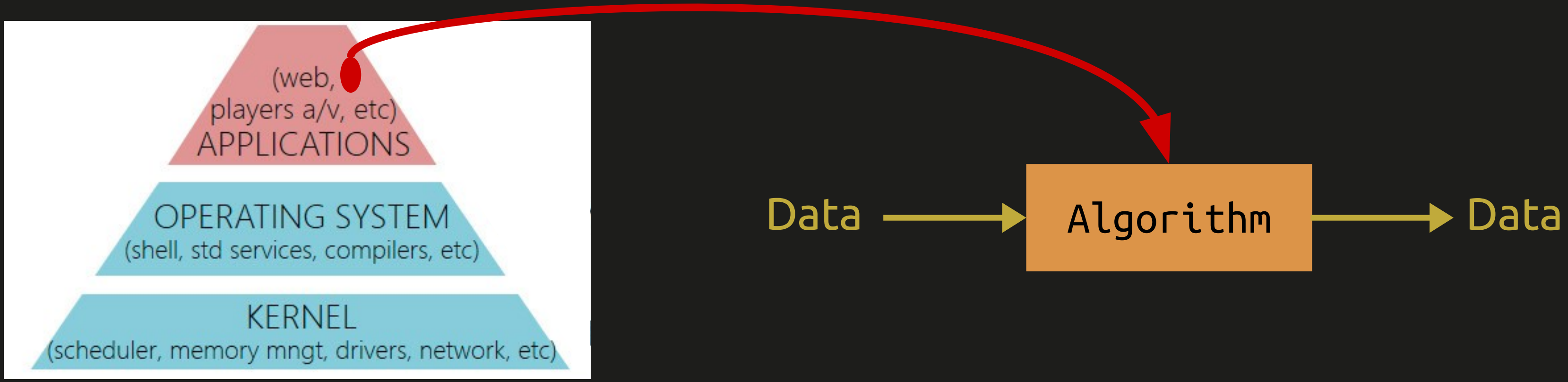
About 90 % of the time, the processing consists of a **simple supervision**.



→ Opt for MCU, AP or GPP architectures

Algorithm

From time to time the function to process might be an algorithm, i.e. apply a processing to a certain amount of data (information).


(web, players a/v, etc)
APPLICATIONS
OPERATING SYSTEM
(shell, std services, compilers, etc)
KERNEL
(scheduler, memory mngt, drivers, network, etc)
Data
Algorithm
Data

Algorithm examples: search, sort, digital signal processing (audio, radar, comms, …), ...

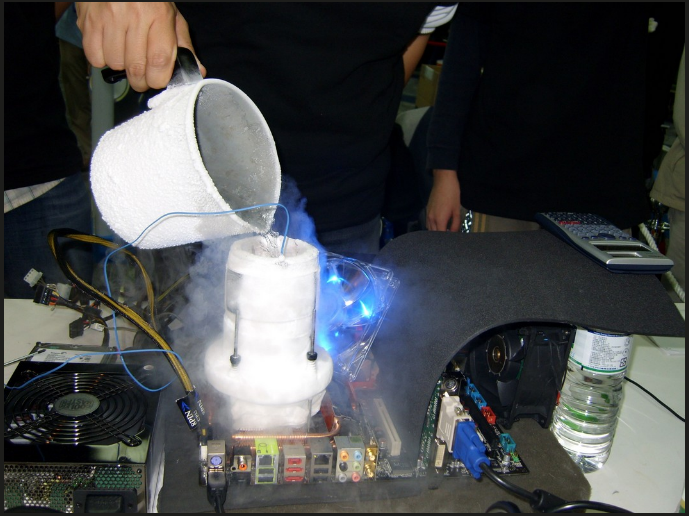
CHOOSING A HIGH-PERFORMANCE CPU

Algorithm

The first choice of processor should always be a general-purpose processor.

However if it does not match the specifications, it is wise to switch to a processing-specialized architecture so that we can:

- Reduce the processing time
- Reduce the code size and/or its memory footprint

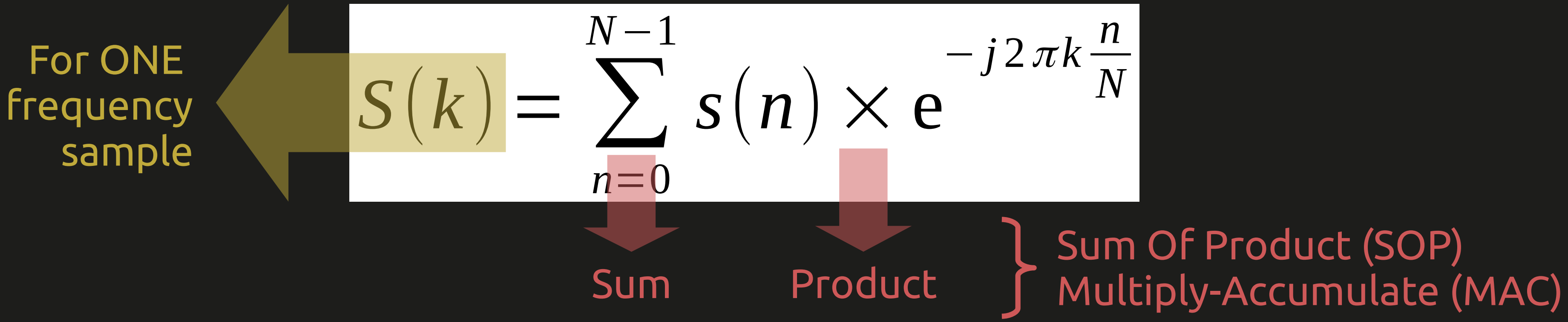


Note that switching to a specialized processor should be justified with measurements.

CHOOSING A HIGH-PERFORMANCE CPU

DFT algorithm example

Take for example the DFT algorithm:



$$S(k) = \sum_{n=0}^{N-1} s(n) \times e^{-j2\pi k \frac{n}{N}}$$

For ONE frequency sample

Sum

Product

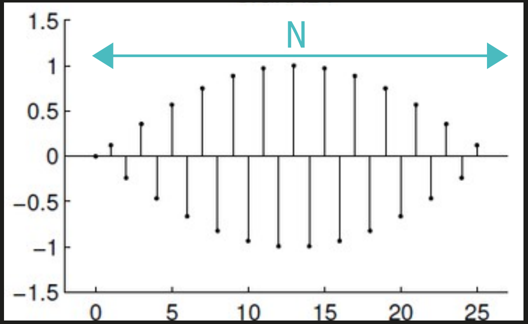
Sum Of Product (SOP)
Multiply-Accumulate (MAC)

- Each product is independent from another
- → Parallelism available!
- Same for the processing every single frequency sample

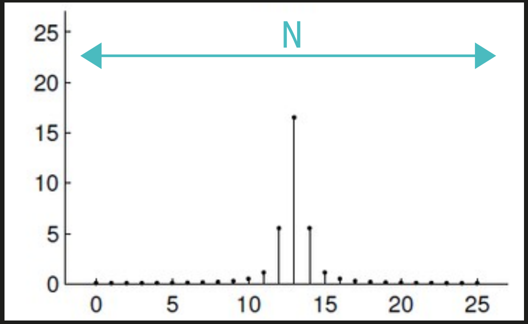
CHOOSING A HIGH-PERFORMANCE CPU

DFT algorithm example

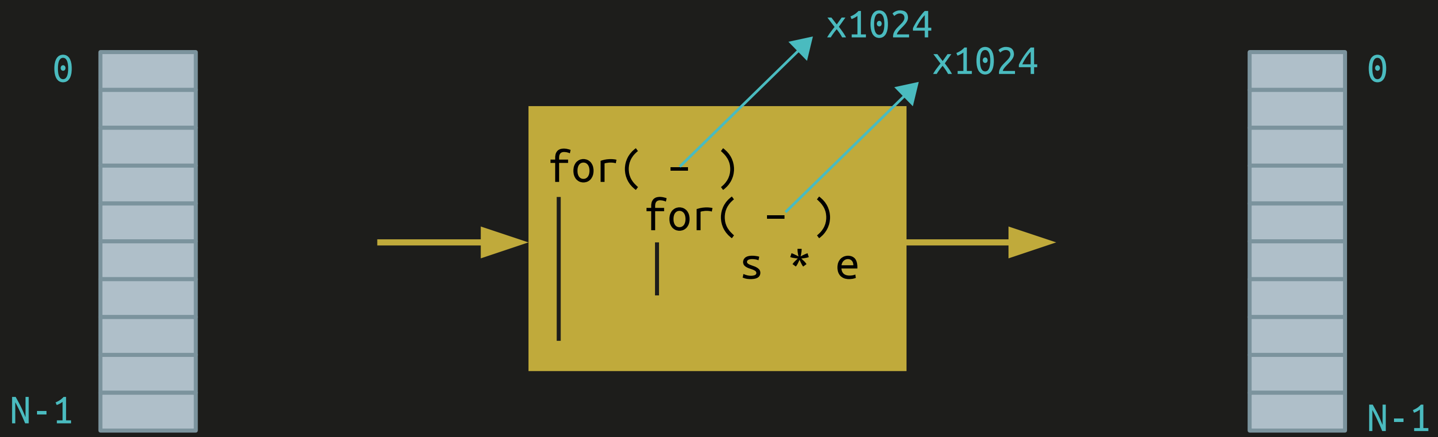
MATH



$\Sigma\Sigma s \times e$



SOFT



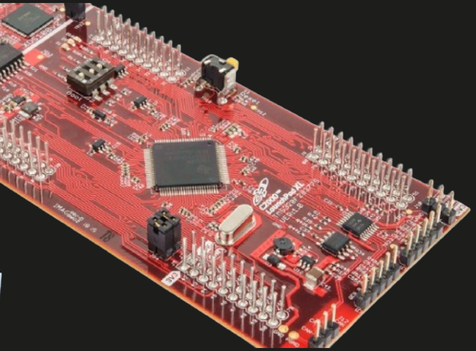
```
for( – )
|    for( – )
|    |    s * e
|
```

CHOOSING A HIGH-PERFORMANCE CPU

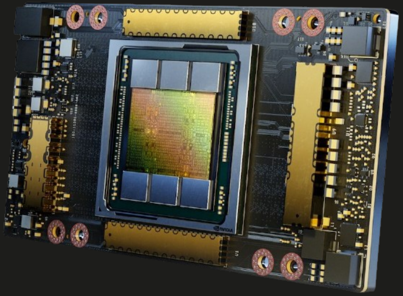
CPU architecture selection

Finally, choose the CPU according to your needs.

DSP: low-power, low-cost, very low-level development (C, asm)



GPU: high-power, high-cost, high-level development (C++, OpenMP, Cuda, …), high-parallelism potential



MPPA: Massively Parallel Processor Array, not widespread yet, but huge potential (dispatch cores to specific algorithms).