Lecture 2

AN OVERVIEW OF OPENCL

It's a Heterogeneous world

A modern computing platform includes:

- One or more CPUs
- One of more GPUs
- DSP processors
- Accelerators
- … other?

E.g. Samsung® Exynos 5:

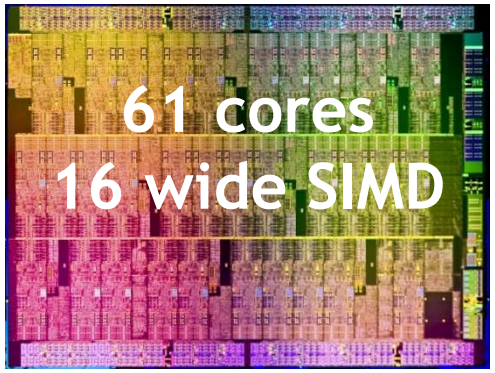
- Dual core ARM A15 1.7GHz, Mali T604 GPU

E.g. Intel XXX with IRIS

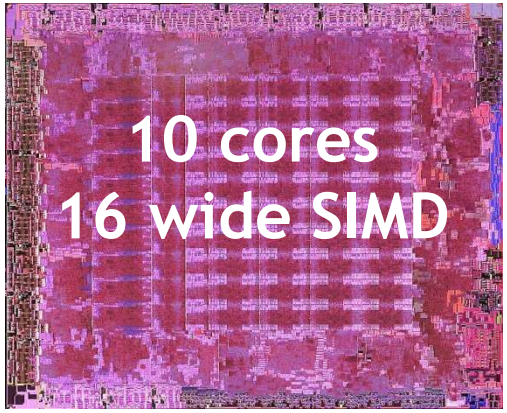
OpenCL lets Programmers write a single portable program that uses ALL resources in the heterogeneous platform

Microprocessor trends

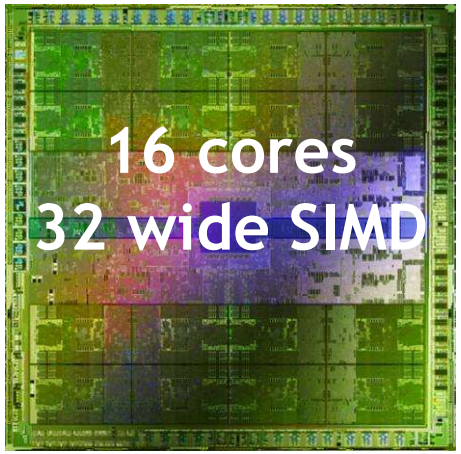
Individual processors have many (possibly heterogeneous) cores.



Intel® Xeon Phi™ coprocessor



ATI™ RV770

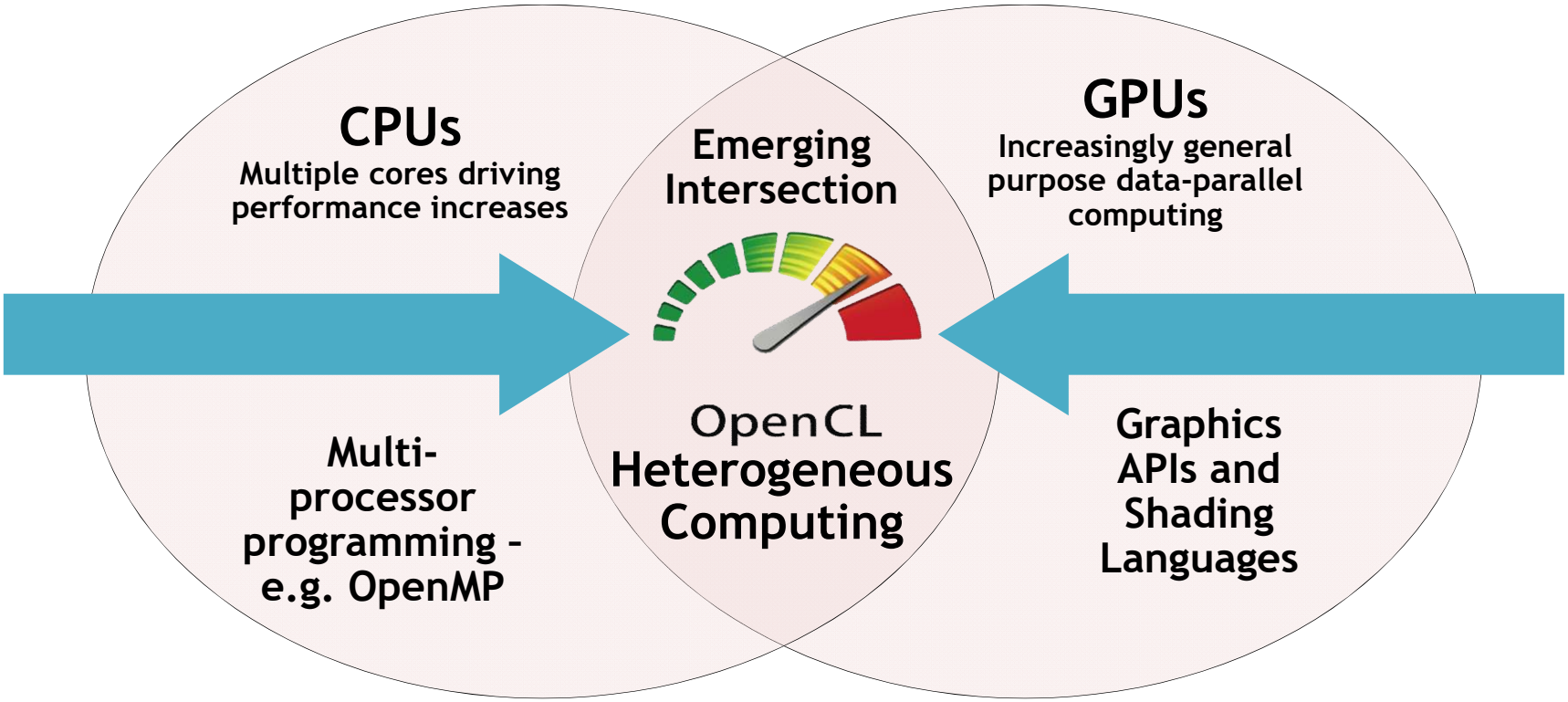


NVIDIA® Tesla® C2090

The Heterogeneous many-core challenge:

How are we to build a software ecosystem for the Heterogeneous many core platform?

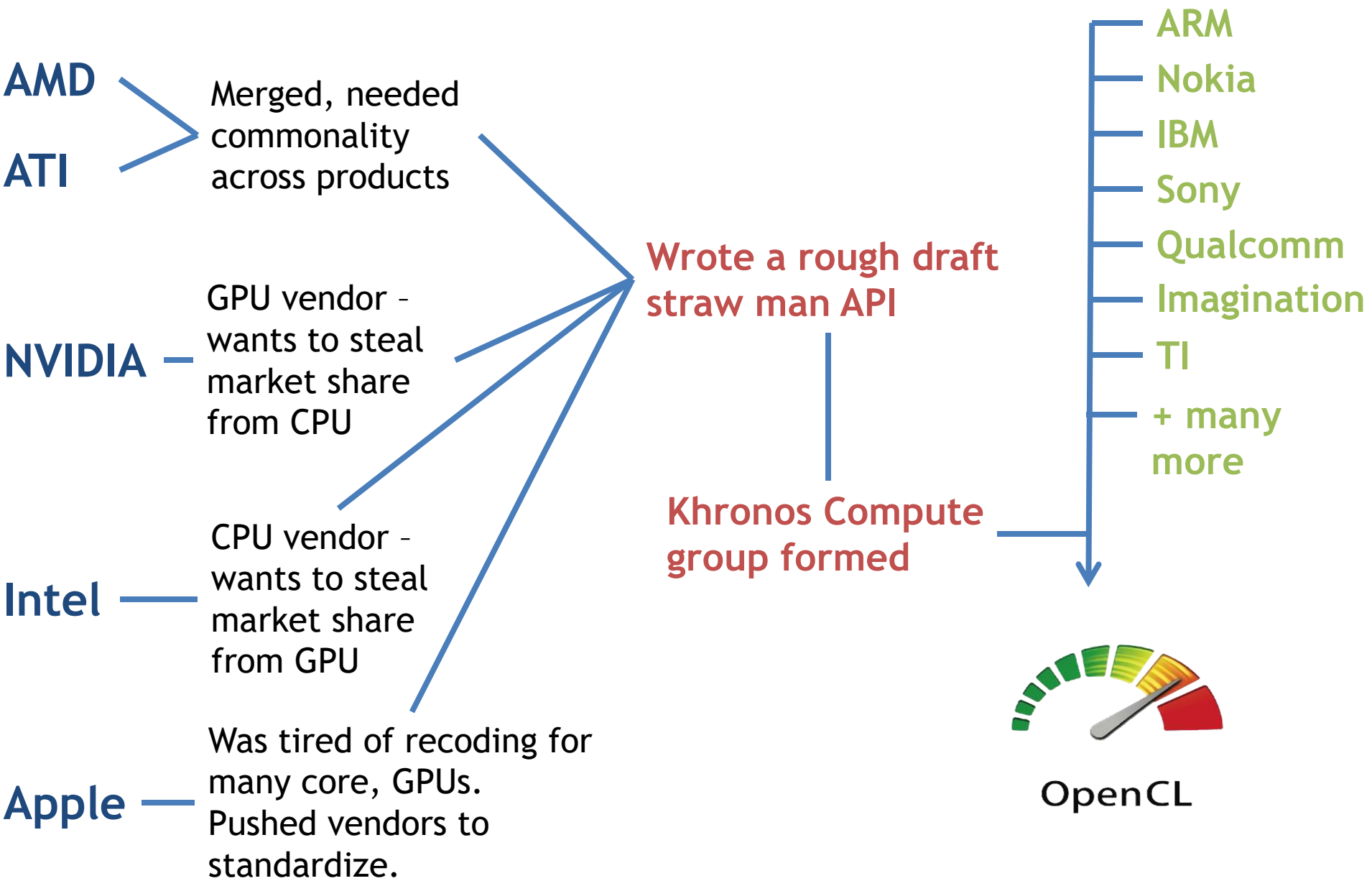
Industry Standards for Programming Heterogeneous Platforms



OpenCL – Open Computing Language

Open, royalty-free standard for portable, parallel programming of heterogeneous parallel computing CPUs, GPUs, and other processors

The origins of OpenCL

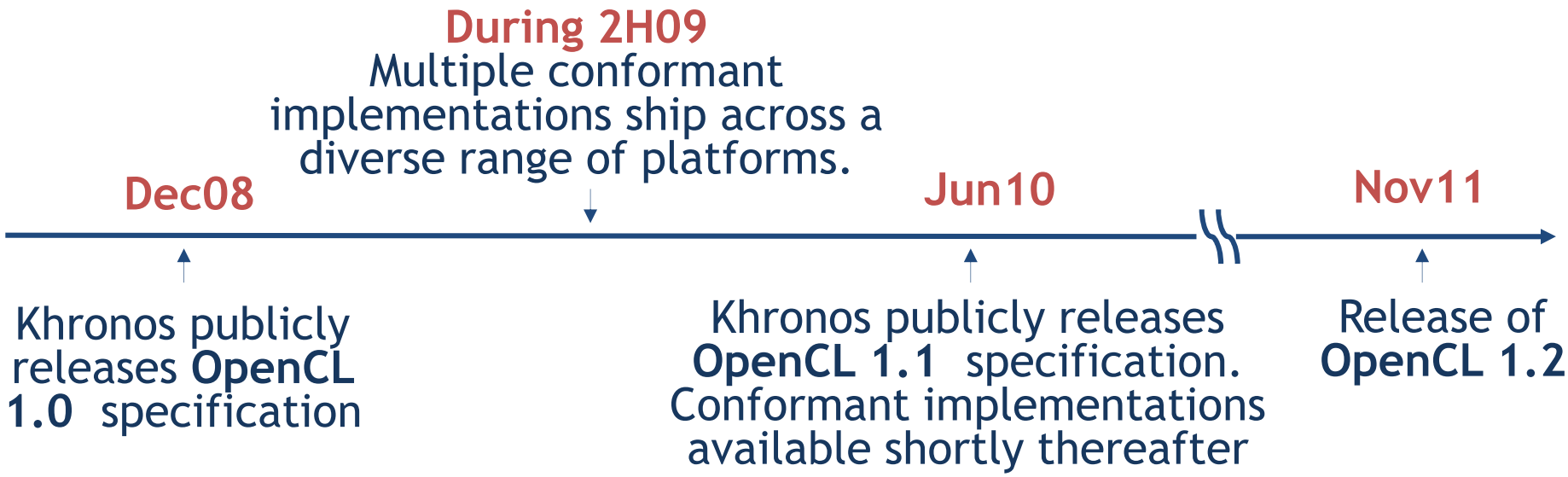


OpenCL Working Group within Khronos

- Diverse industry participation
  - Processor vendors, system OEMs, middleware vendors, application developers.
- OpenCL became an important standard upon release by virtue of the market coverage of the companies behind it.

OpenCL Timeline

- Launched Jun'08 … 6 months from "strawman" to OpenCL 1.0
- Rapid innovation to match pace of hardware innovation
  - 18 months from 1.0 to 1.1 and from 1.1 to 1.2
  - Goal: a new OpenCL every 18-24 months
  - Committed to backwards compatibility to protect software investments



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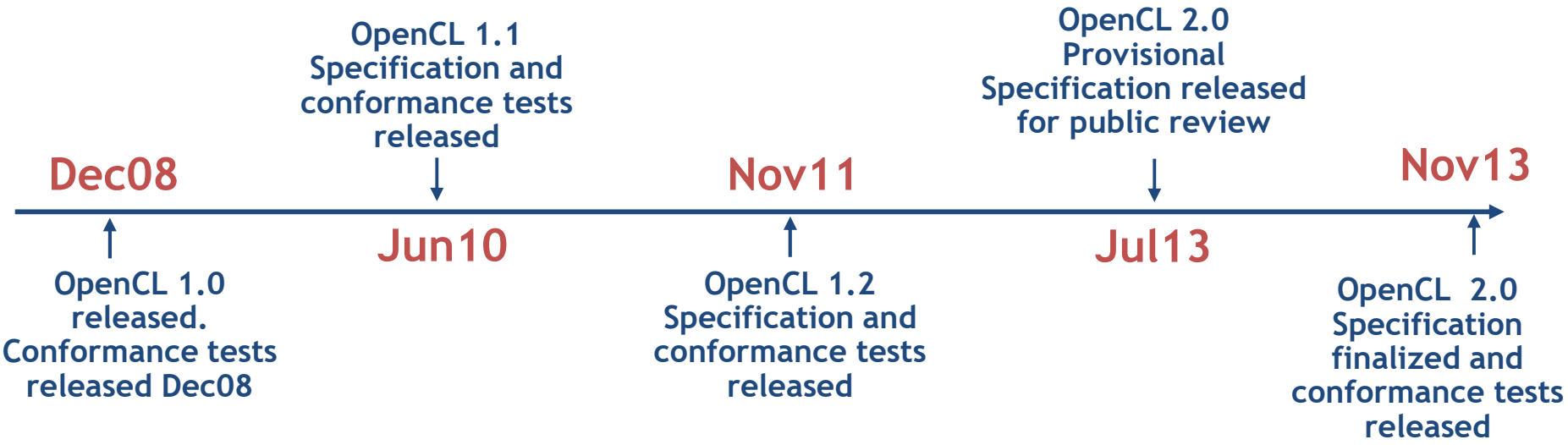
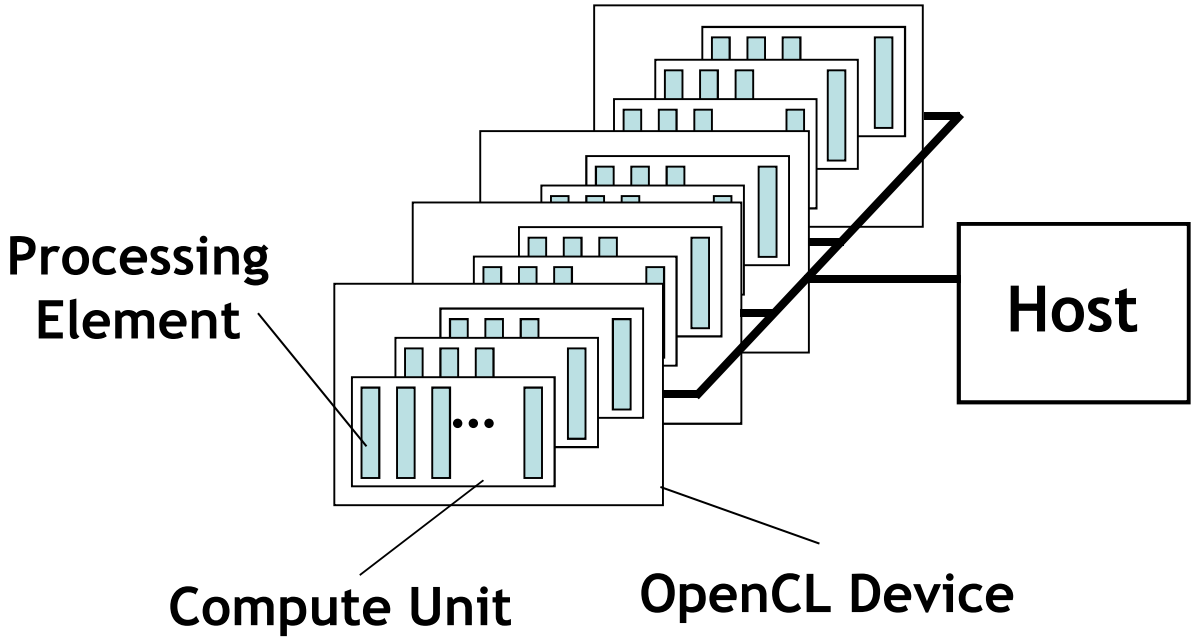


OpenCL: From cell phone to supercomputer

- OpenCL Embedded profile for mobile and embedded silicon
  - Relaxes some data type and precision requirements
  - Avoids the need for a separate “ES” specification
- Khronos APIs provide computing support for imaging & graphics
  - Enabling advanced applications in, e.g., Augmented Reality
- OpenCL will enable parallel computing in new markets
  - Mobile phones, cars, avionics

A camera phone with GPS processes images to recognize buildings and landmarks and provides relevant data from internet

OpenCL Platform Model



- One *Host* and one or more *OpenCL Devices*
  - Each OpenCL Device is composed of one or more *Compute Units*
    - Each Compute Unit is divided into one or more *Processing Elements*
- Memory divided into *host memory* and *device memory*

OpenCL Platform Example (One node, two CPU sockets, two GPUs)

CPUs:

- Treated as one OpenCL device
  - One CU per core
  - 1 PE per CU, or if PEs mapped to SIMD lanes, *n* PEs per CU, where *n* matches the SIMD width
- Remember:
  - the CPU will also have to be its own host!

GPUs:

- Each GPU is a separate OpenCL device
- Can use CPU and all GPU devices concurrently through OpenCL

CU = Compute Unit; PE = Processing Element

Exercise 1: Platform Information

- Goal:
  - Verify that you can run a simple OpenCL program.
- Procedure:
  - Take the provided `DeviceInfo` program, inspect it in the editor of your choice, build the program and run it.
- Expected output:
  - Information about the installed OpenCL platforms and the devices visible to them.
- Extension:
  - Run the command `clinfo` which comes as part of the AMD SDK but should run on all OpenCL platforms. This outputs all the information the OpenCL runtime can find out about devices and platforms.