What’s next?

Advanced OpenMP suggestions and the future of HPC hardware

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Advanced OpenMP directives

Advanced OpenMP directives

OpenMP has always been focused on the maximization of the obtained performances using the most advanced computing devices

At first CPUs where the only focus of OpenMP

Technologic progress is running towards

GPUs and FPGAs

OpenMP is getting ready

We have to define some concepts:

Host and accelerator

An host is the physical computer that contains a group of accelerators.
An host has at least one CPU that manages the accelerators.

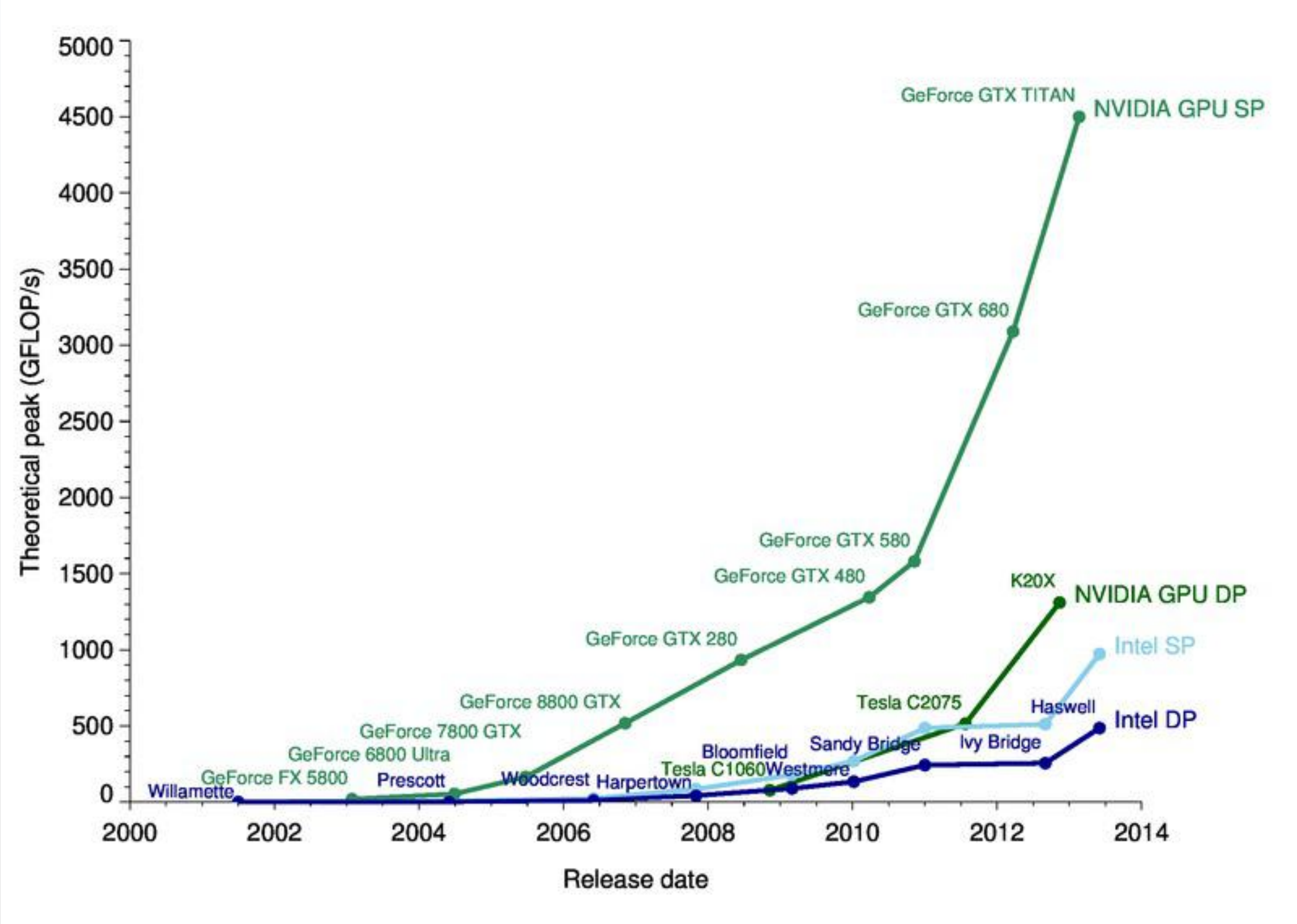
An accelerator is a device, typically equipped with own memory, which presents detached address space.

Often the architecture of an accelerator and the ISA are totally different from typical CPU ones.

Advanced OpenMP directives

Even a modern gaming computer (host) is nowadays equipped with one multi core CPU and at least one quite powerful GPU.

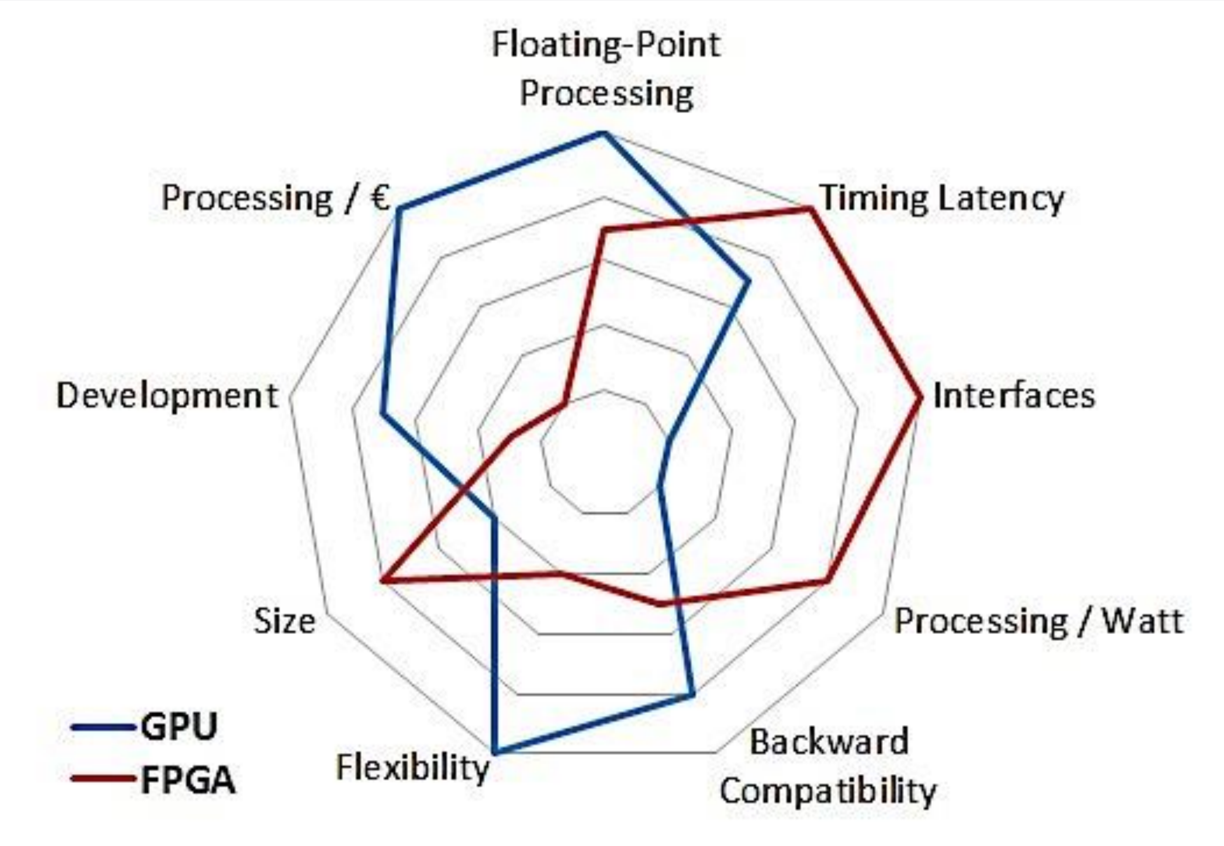
A GPU is an accelerator made for graphics, but not only for that.



Advanced OpenMP directives

FPGAs are rather specialized accelerators, more complex to program.

Due to the low (logic) level pipelining their performances are unrivalled in compatible tasks.



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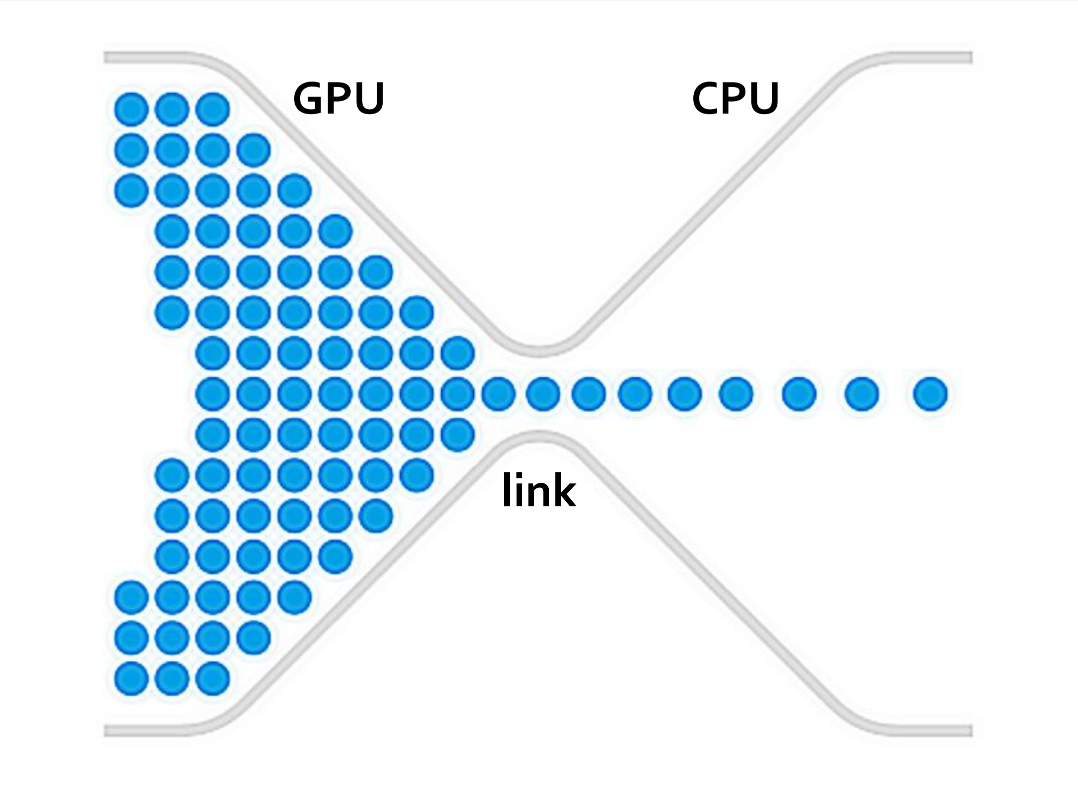
GPUs performance per watt is astonishing with respect even to the latest many core CPUs.

The extraction of such power requires a lot more coding.

The detached memory is a bottleneck for data transfer.



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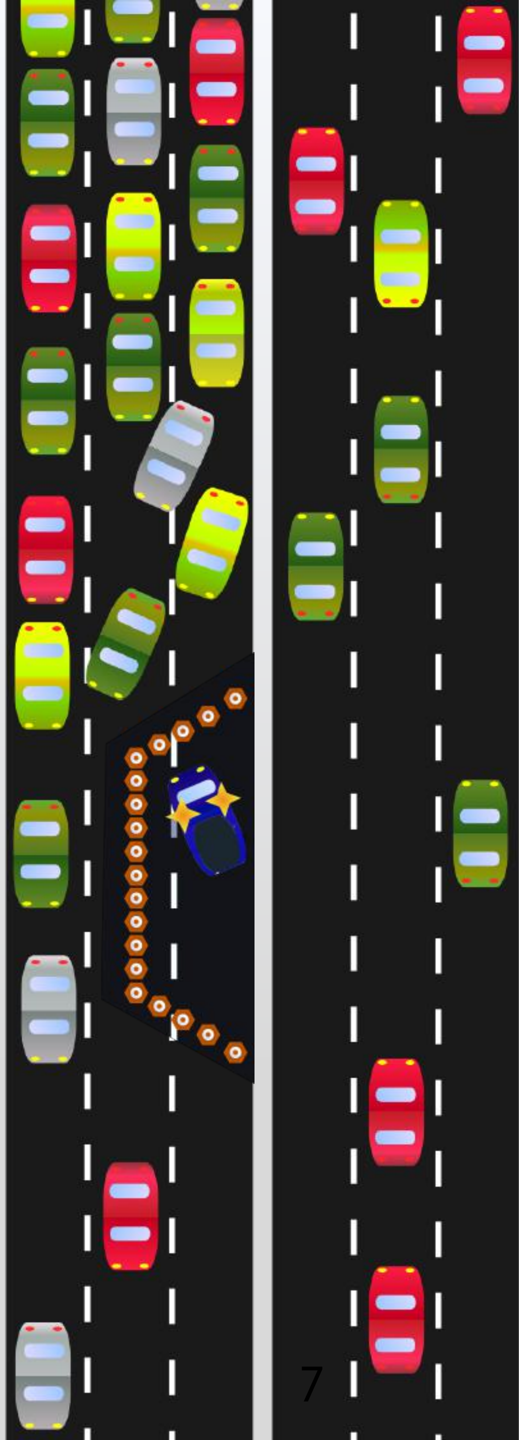

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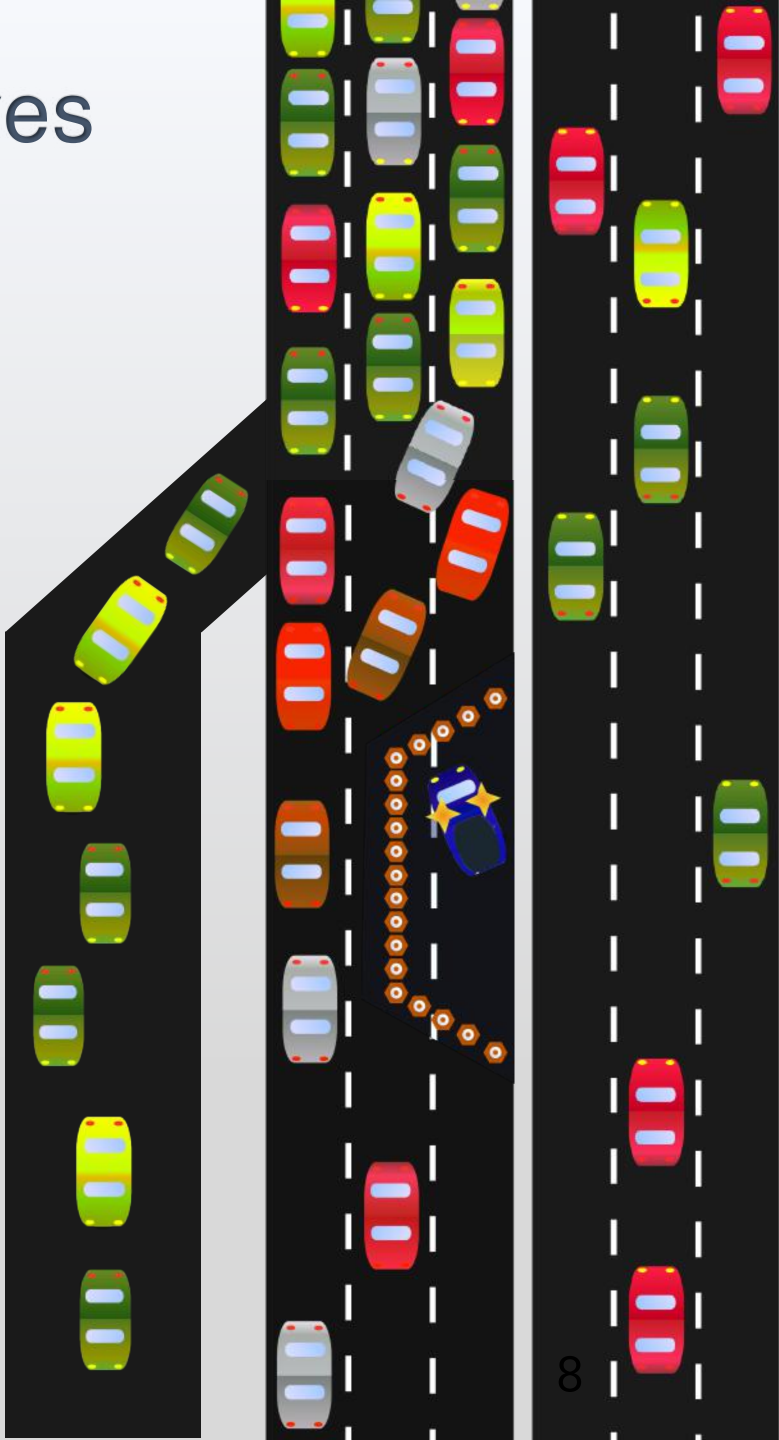
But some companies are letting the greens use a preferential shortcut…

This is a hint of what we can expect if a standard

CPU-to-GPU

link would be introduced



Advanced OpenMP directives

Several GPU-oriented programming API are on the market.

OpenCL is the current standard, being cross-compatible and linked to no specific hardware vendor.

Several proprietary APIs are present as well and well supported by a growing community.

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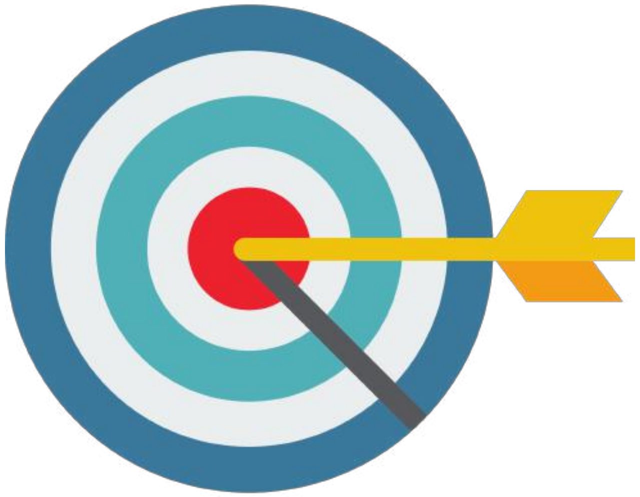
oneAPI

Advanced OpenMP directives

OpenMP is joining this family since version 4.0.

Since this version the `target` directive allows to specify to the compiler what accelerator to use and how to map input and output datasets to the accelerator.

Unlike in OpenCL and CUDA approaches, the overhead due to the transfer of data inside the accelerator memory and back to the host is hidden inside elegant directives.



Wide area computing

Wide area computing

High Energy Physics, and in general HPC applications, require an efficient use of hardware resources.

While OpenMP is a great tool for single-host systems, cluster systems are the real stronghold of HPC.

The communication between all the hosts which constitute a cluster is a crucial aspect to guarantee the best scaling, moving from a single host to thousands of them.

Wide area computing

Since the 80s the Message Passing Interface (MPI) specification is one of the fundamental approaches to connect several network attached hosts into a single large scale computing entity.

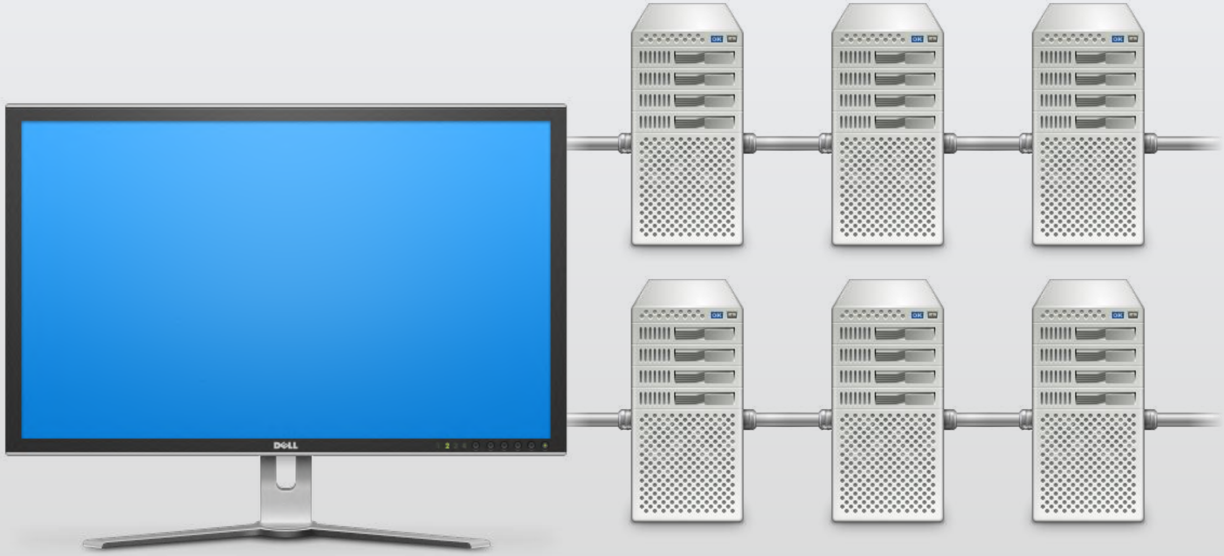
MPI is a specification of which anyone can create his own implementation.

Wide area computing

For what concerns CPU execution, OpenMP is based on threads.

MPI is based on CPU processes which are out-of-the-box equipped with communication channels.

These channels can work inside a host, using a shared memory approach, or between hosts connected via network interfaces of different kinds.



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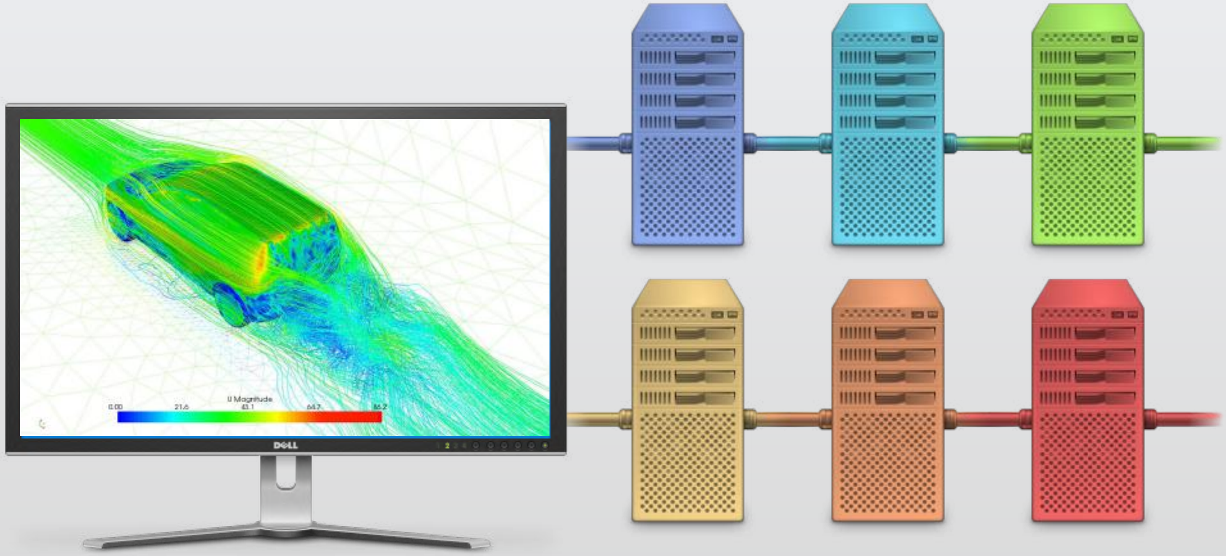

Wide area computing

Considered the growing diffusion of specific and general purpose accelerators supported by custom APIs, given the heterogeneous nature of HPC clusters

MPI is becoming a mere, yet fundamental, communication layer

More and more MPI is used to run a single process on each host which is internally running OpenMP threads on the CPU and accelerator software on GPUs and FPGAs.

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Take home message

Take home message

These two guys are telling us what everyone knew: we have to think again

Take home message

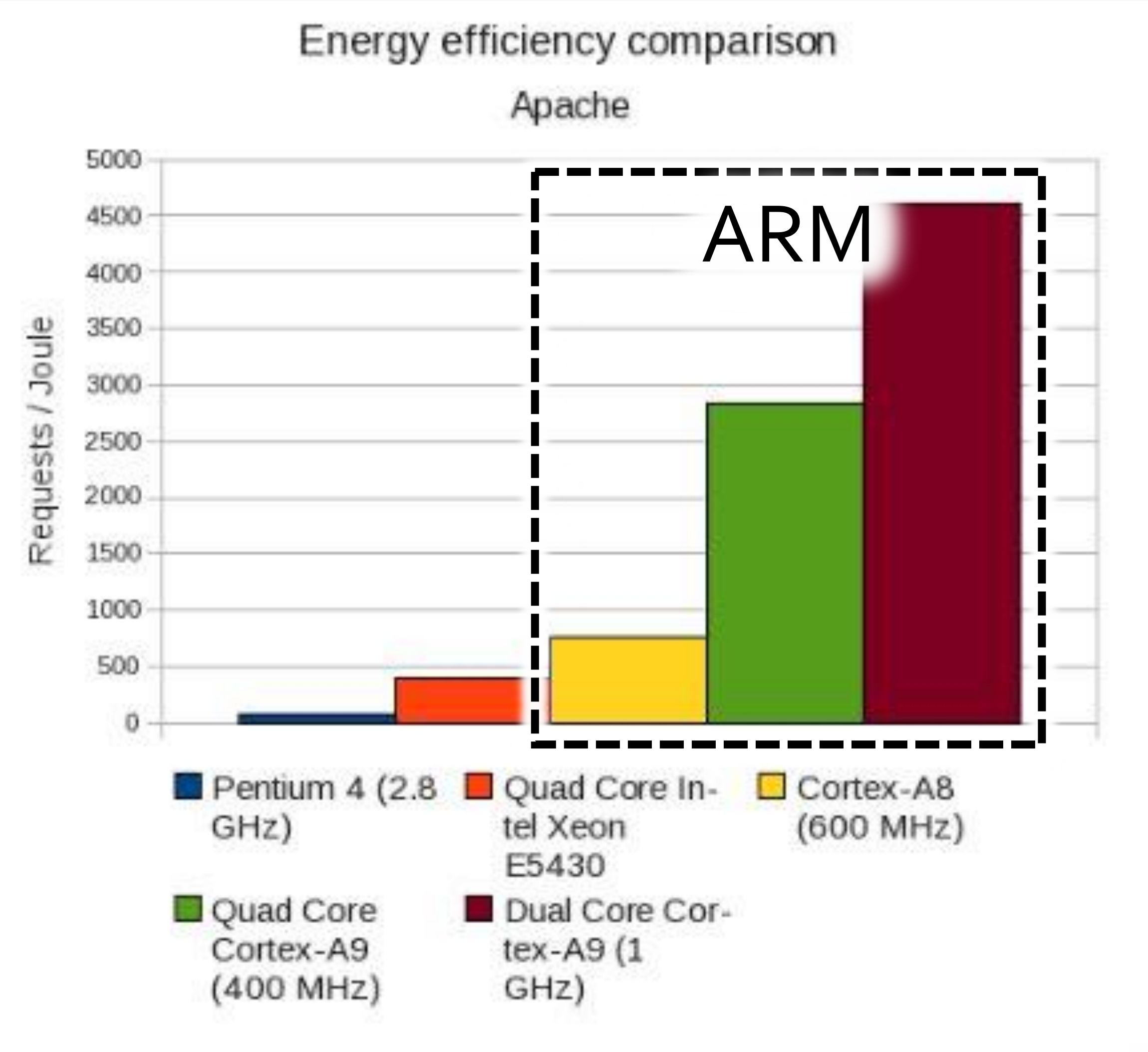
Meltdown and Spectre "hardware bugs" are two inkling of a proven reality.

We have to rework our CPU architecture.

x86 and x86_64 ISAs are getting old.

Newcomers such as ARM and ARM64 are developing fast and getting tons of software support thanks to their diffusion in the mobile and portable diffusion.

In addition ARM processors' energy efficiency is unrivalled.



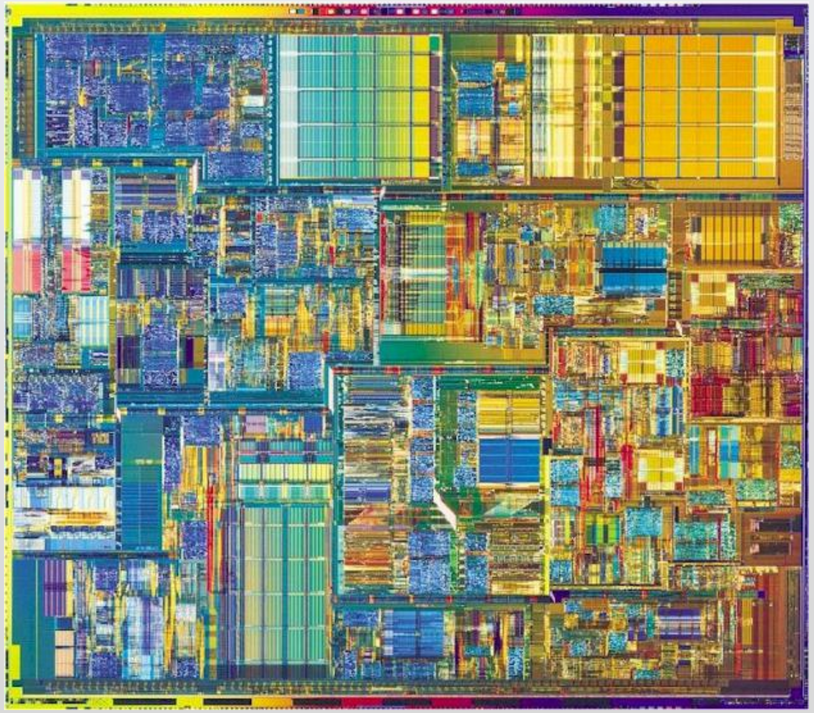
Take home message

AMD latest products brought some fresh air in the CPU market, bringing healthy competition in a slack market.

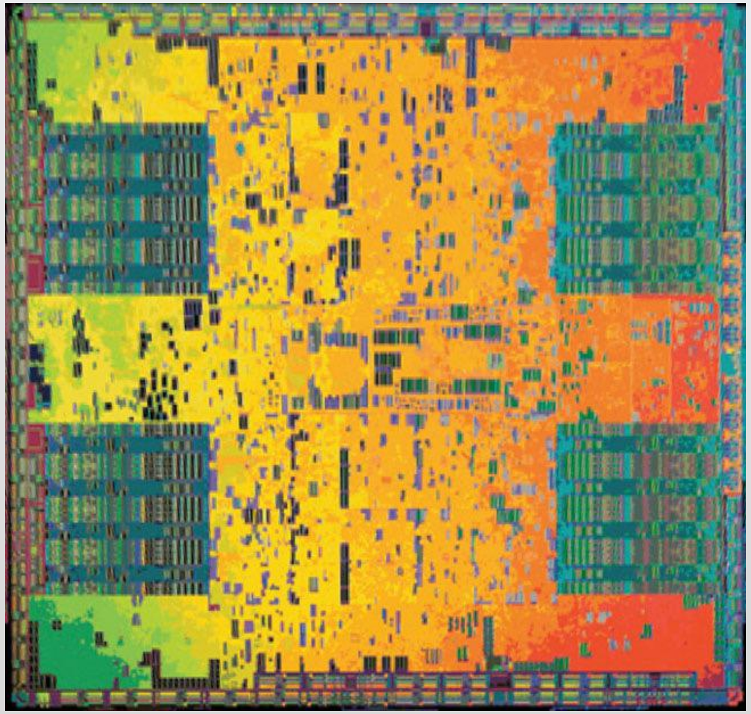
IBM Power9 products are an interesting product which brings new technologies and peculiar approaches to old problems.

Take home message

Once there was the simplicity …



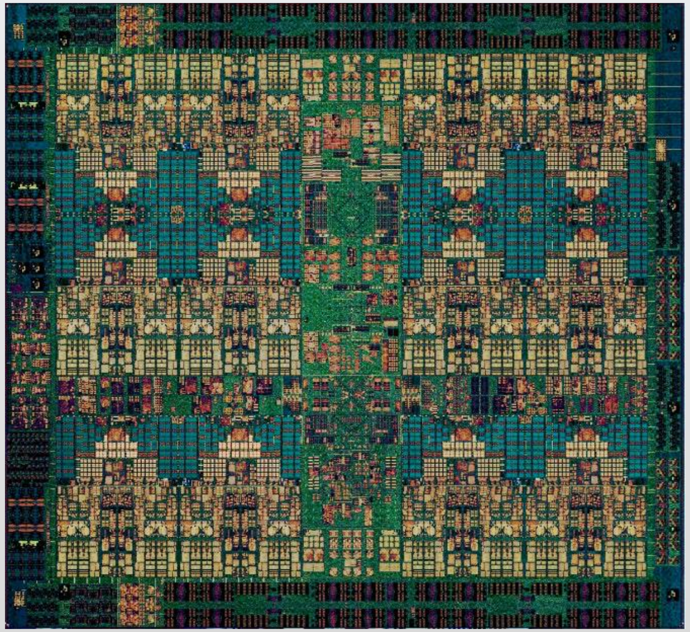
Intel Pentium 4 die, CPU



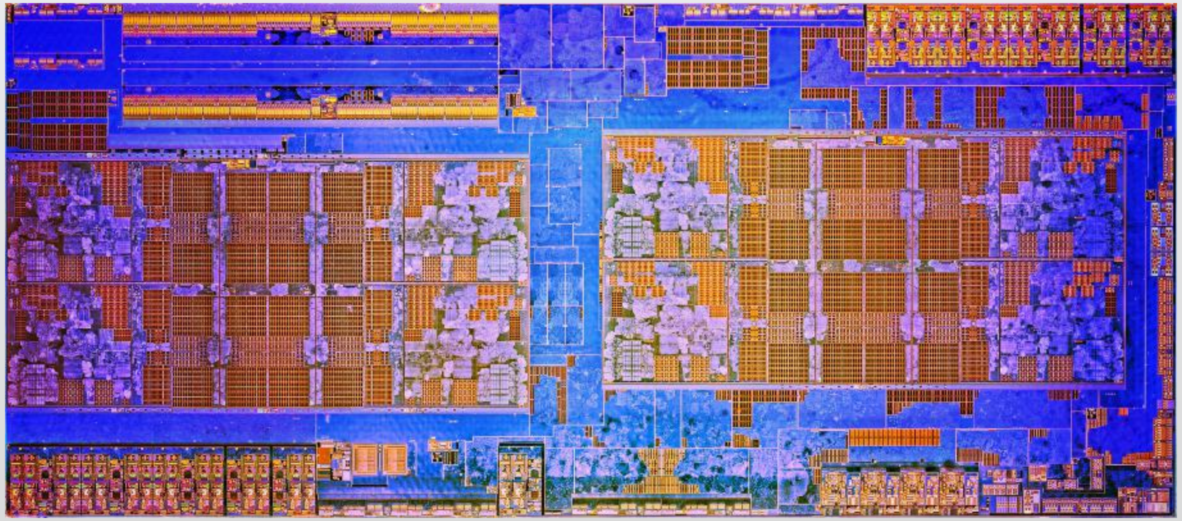
NVidia G80, GPU

Take home message

… today we have complexity …



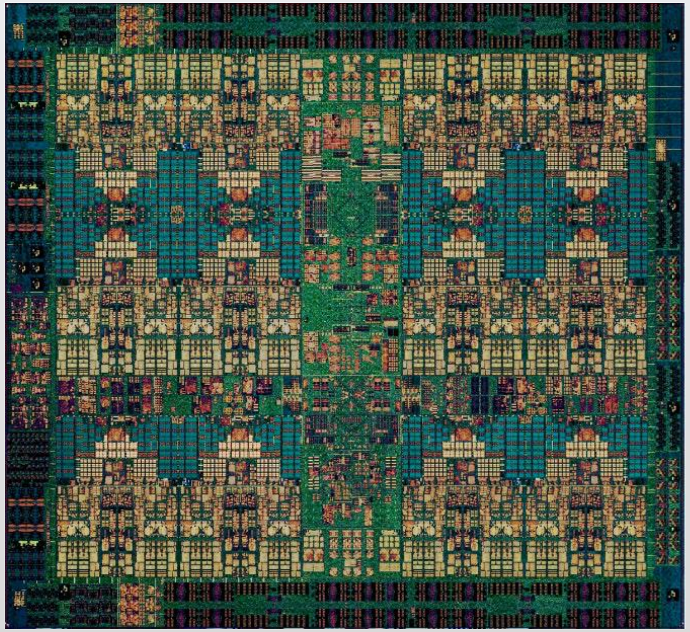
IBM Power9, CPU



AMD Ryzen, CPU

Take home message

… or not?



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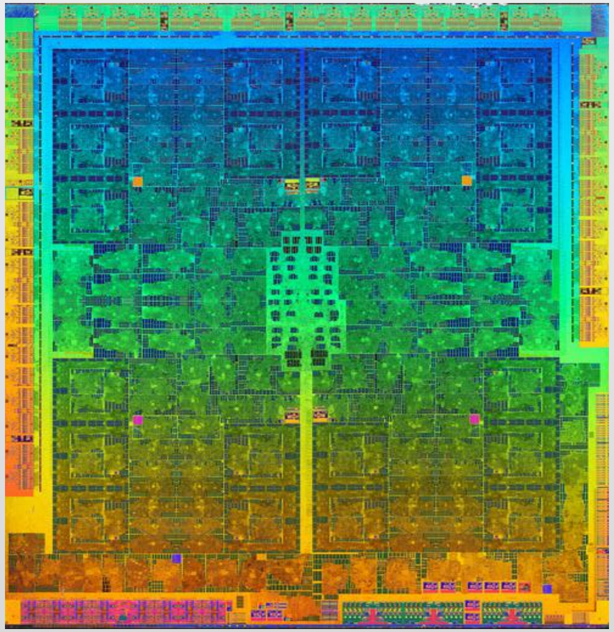

NVidia GP100, GPU

Take home message

Whatever the future brings to us,
you'll be ready to K.I.S.S. it with