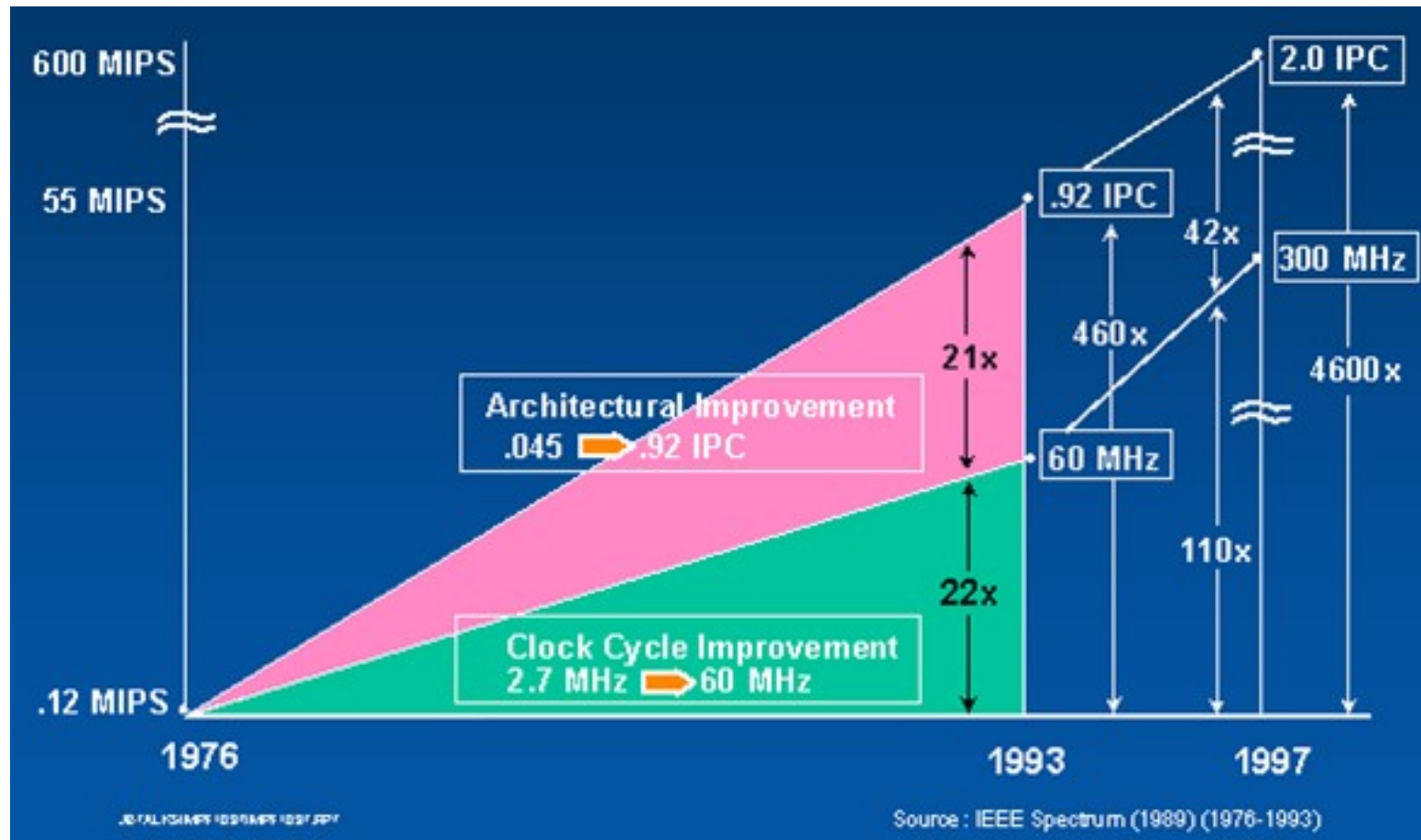


GPU Programming

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The Good Old Days for Software

Source: J. Birnbaum

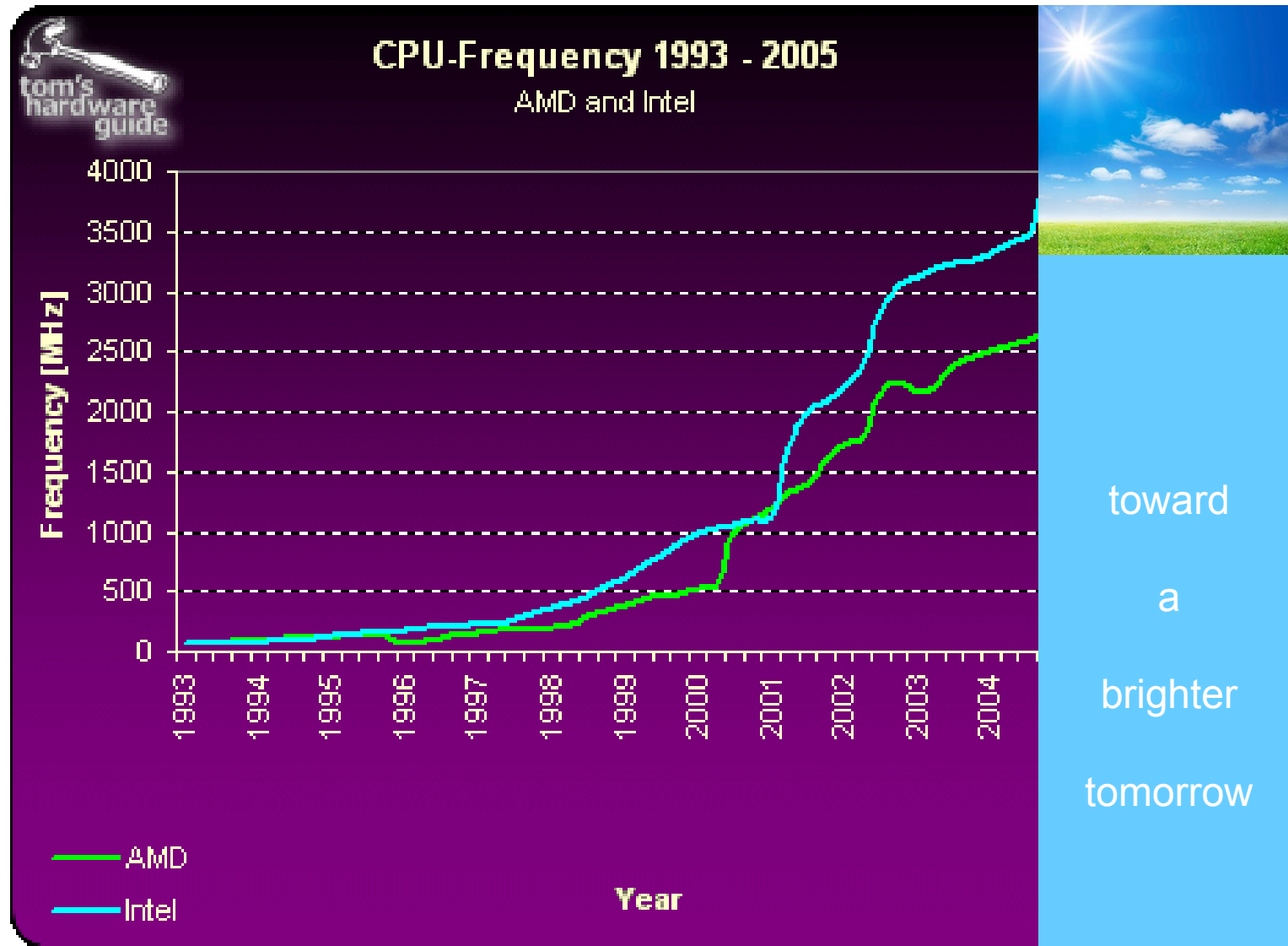


- Single-processor performance experienced dramatic improvements from **clock**, and **architectural improvement** (Pipelining, Instruction-Level-Parallelism).
- Applications experienced **automatic** performance improvement.

As the years pass by, the hardware improvements ² made the programs run faster without the need of coding optimizations. Then we reached

Hitting the Power Wall

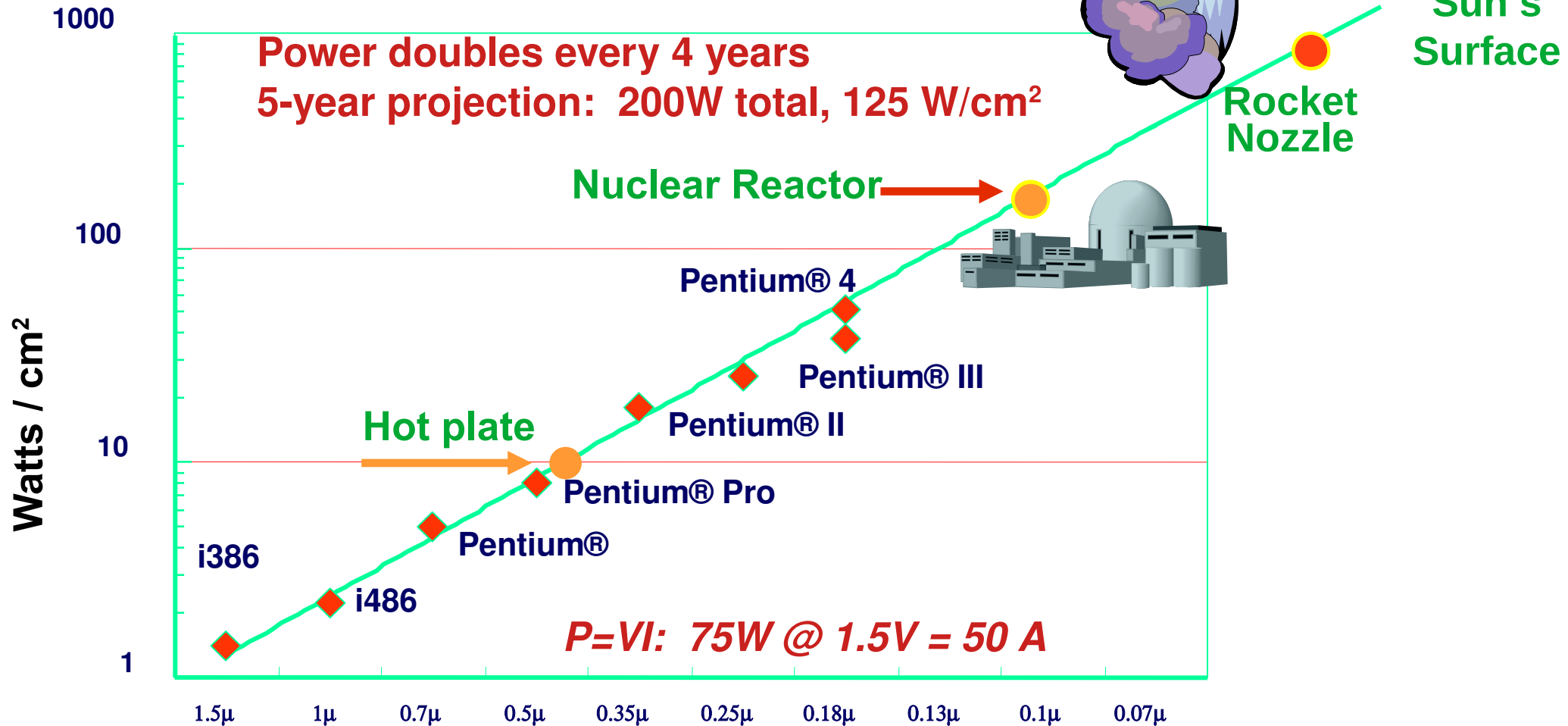
a point where we
can no longer increase



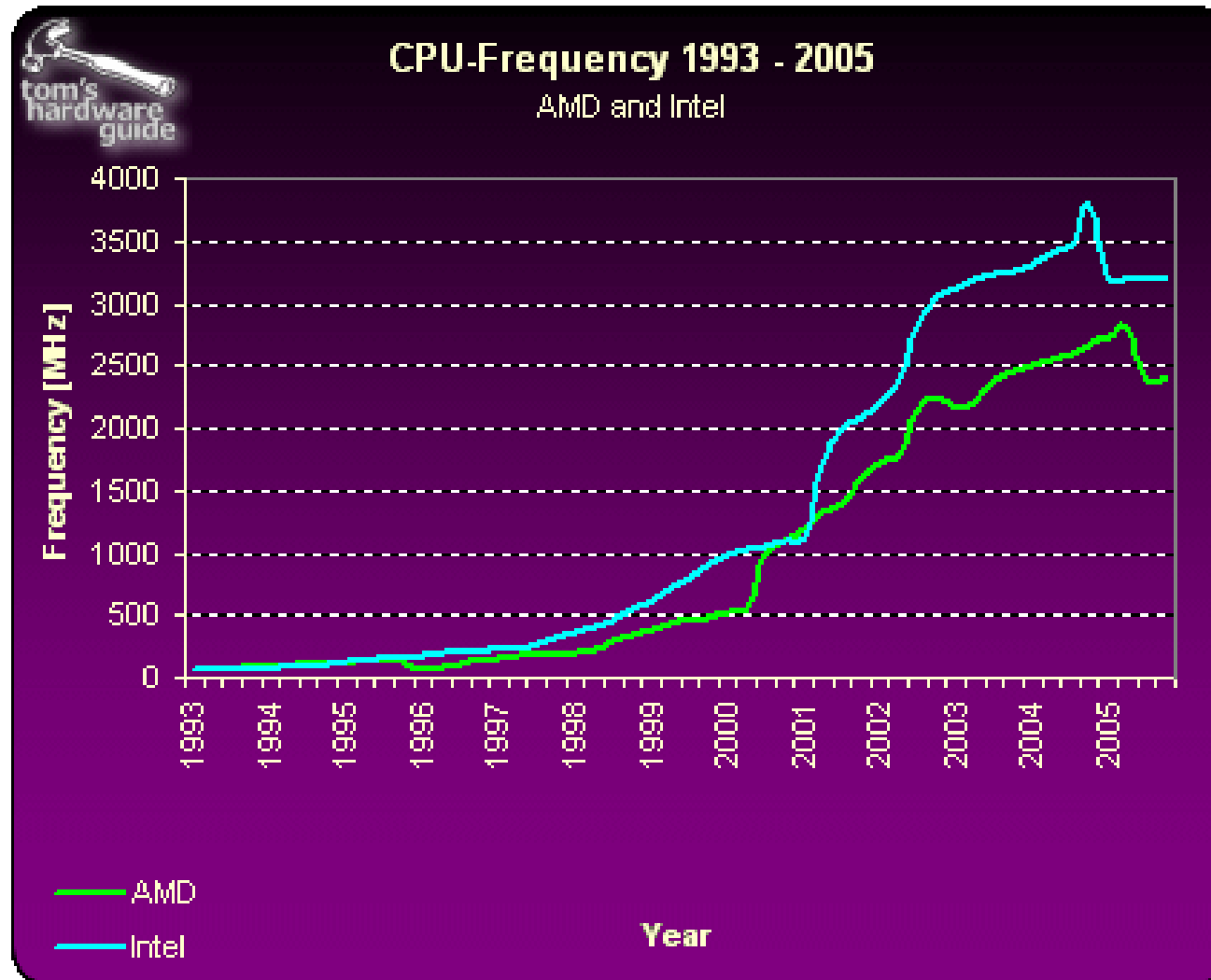
the
hardware
(cpu freq)
now we
are left
with
coding
optimizations
rather than
improving
hardware.

http://img.tomshardware.com/us/2005/11/21/the_mother_of_all_cpu_charts_2005/cpu_frequency.gif

Hitting the Power Wall



Hitting the Power Wall



http://img.tomshardware.com/us/2005/11/21/the_mother_of_all_cpu_charts_2005/cpu_frequency.gif

2004 – Intel cancels Tejas and Jayhawk due to *heat problems due to the extreme power consumption of the core.*

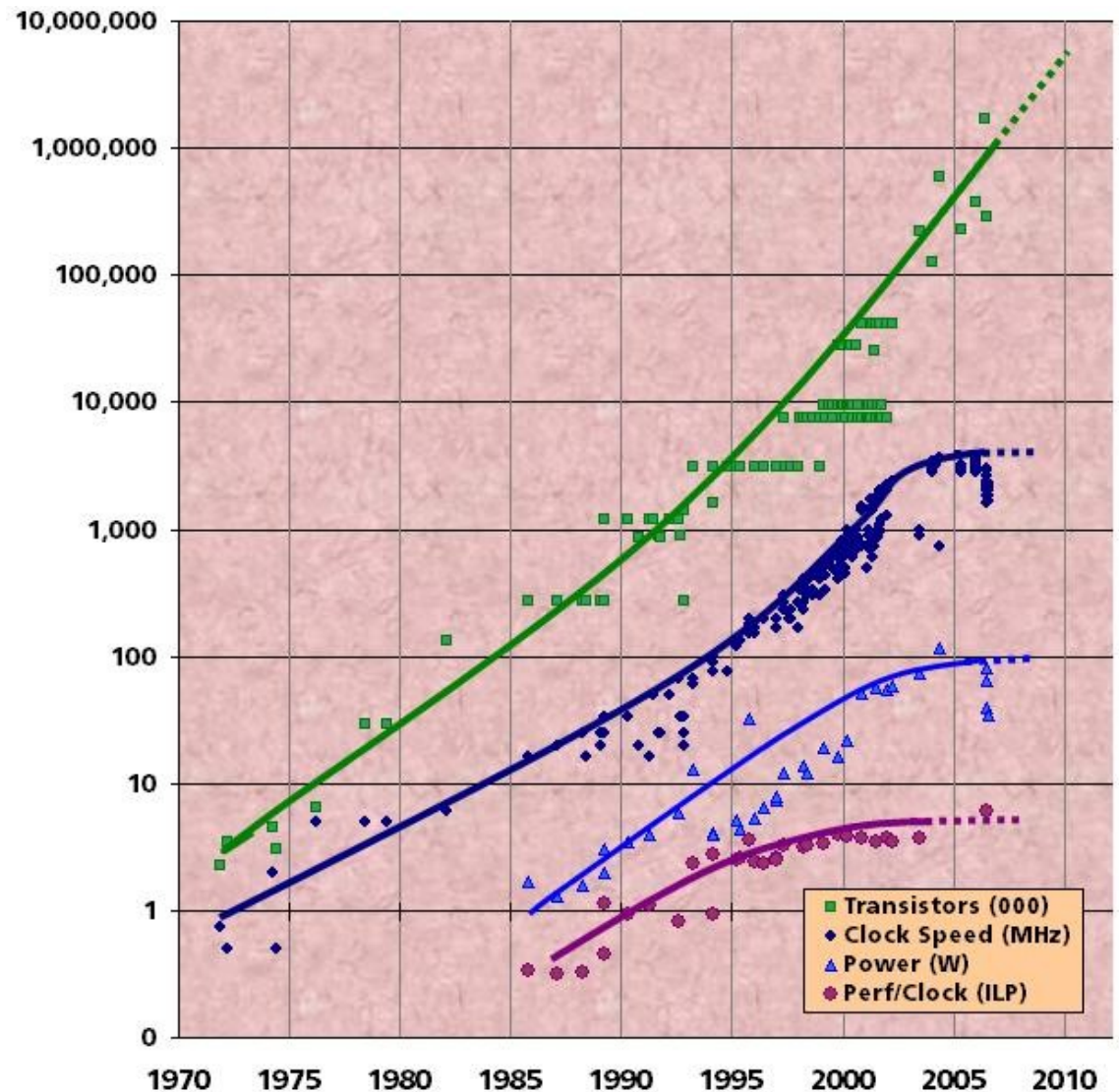
The Only Option: Use Many Cores

Chip density is increasing by
~2x every 2 years

- Clock speed is not
- Number of processor cores may double

There is little or no more hidden parallelism (ILP) to be found

Parallelism must be exposed to
and managed by software



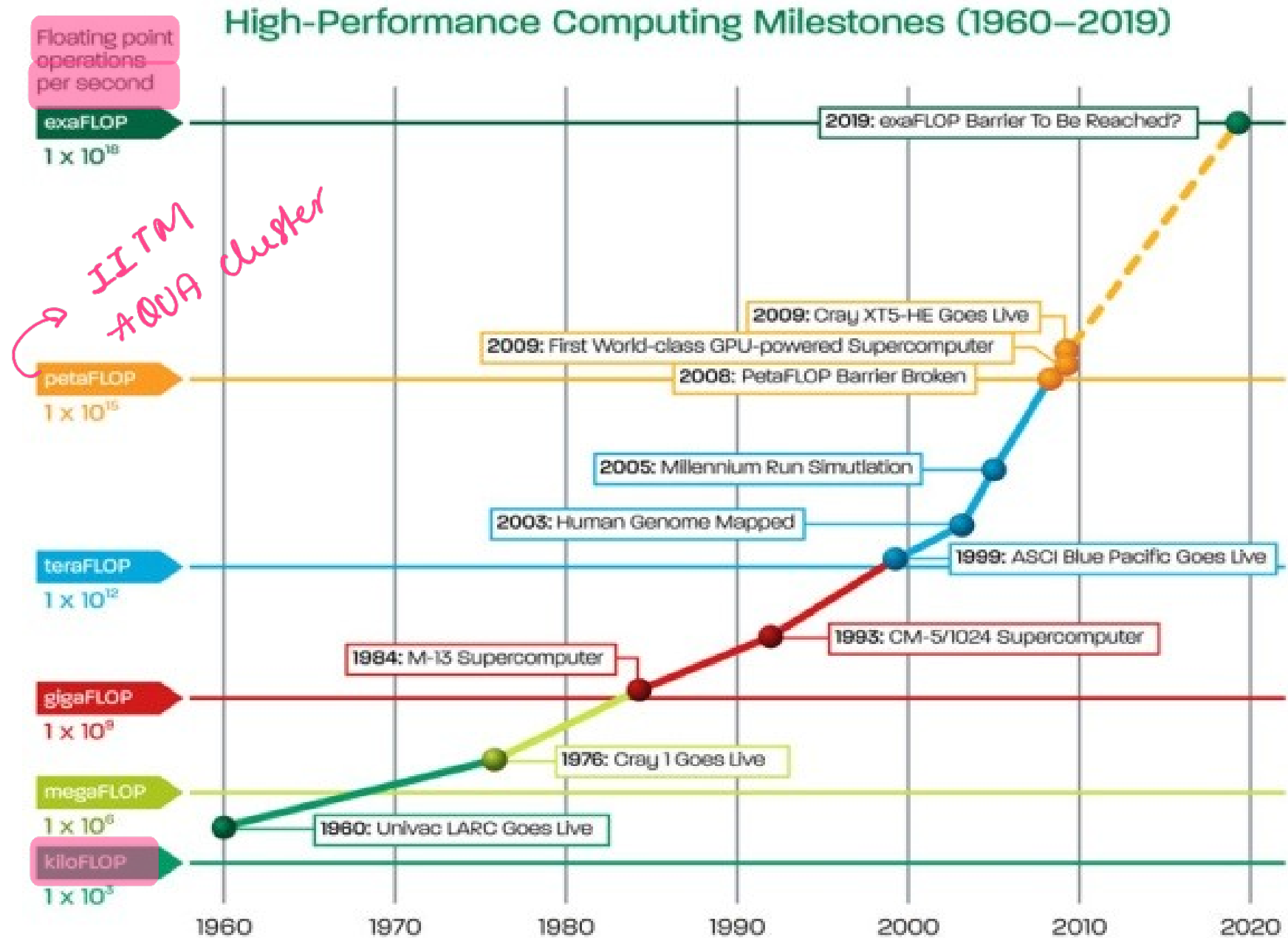
Source: Intel, Microsoft (Sutter) and Stanford (Olukotun, Hammond)

GPU's are also called accelerators.

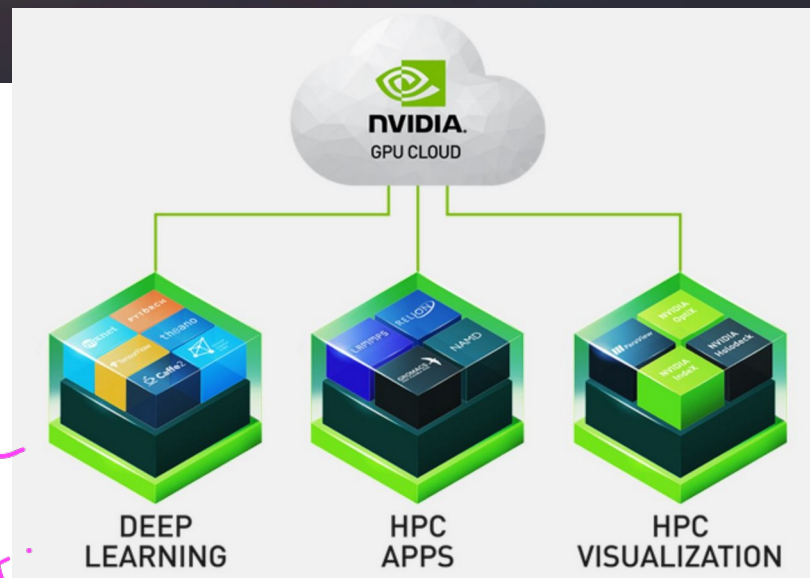
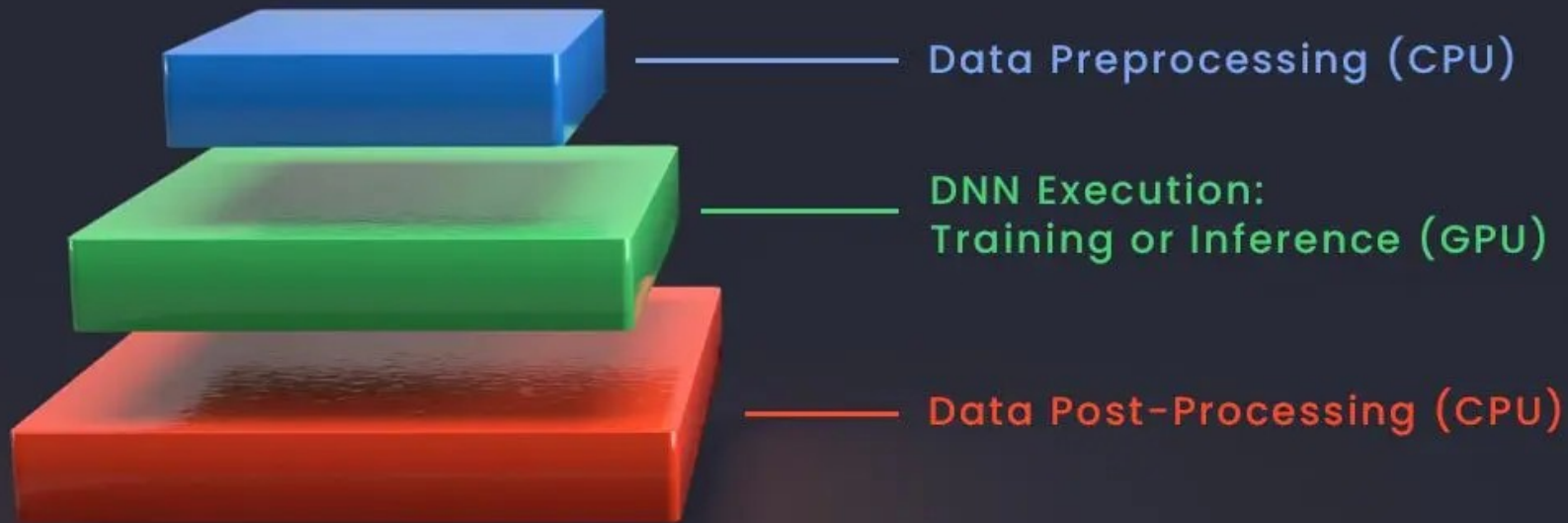
→ Nvidia has 5120 WDA cores

GPU's are also called accelerators.
GPU's will have thousands of cores.

→ intel CPU has 48 cores.
AMD



Typical Deep Learning Pipeline With GPU



Super Computers are distributed systems.

are not the unit.

in it

Parallel Platforms

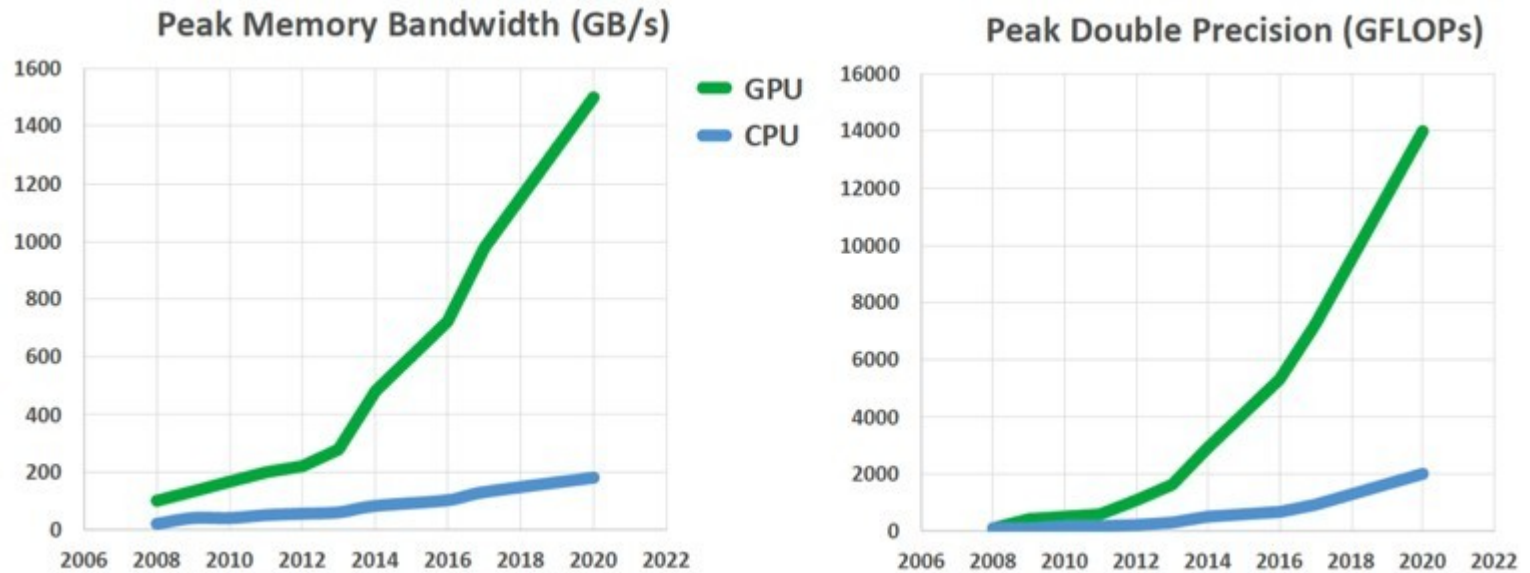
*note: GPUs
Sole processing
it acts as a co-processor.
it works alongside the main
processor unit
i.e. CPU & intel + nvidia*

- Shared memory systems (multi-core) *→ our laptops*
- Distributed systems (cluster) *→ each node will have its own memory. if a node needs to access another nodes data, it makes a request*
- Graphics Processing Units (many-core)
- Field-Programmable Gate Arrays (configurable after manufacturing)
- Application-Specific Integrated Circuits
- Heterogeneous Systems

A system with GPU and CPU is in a sense acts like a distributed system becoz CPU & GPU has its own memory

and also a single GPU processing resembles shared memory systems.

GPU-CPU Performance Comparison



CPU and GPU should be used together to suit different parts of your application.

In this course...

- Basic GPU Programming
 - Computation, Memory, Synchronization, Debugging
- Advanced GPU Programming
 - Streams, Heterogeneous computing, Case studies
- Topics in GPU Programming
 - Unified virtual memory, multi-GPU, peer access

Logistics

- Tutorials and lectures would be intermixed.
 - In-class problem solving sessions
- You need to arrange for your GPU.
 - Your laptop may have one.
 - With gmail account, you get some GPU time on Google cloud or kaggle (preferred by many in the past).
 - You can use the central computing facilities at the institute.

Logistics

- **Evaluation**

- Four assignments (10 + 15 + 15 + **20**)
- MidSem (20) + EndSem (20)
- Dates are on the [course webpage](#).
- You have this week to suggest changes to dates.

- **Moodle**

- Your responsibility to subscribe to it.
- Exams would be pen-paper based, open-book.
- Assignments are to be submitted on moodle.

Reasons for Dropping the Course

- The instructor is strict about attendance. Does not shy giving W grades.
- The course-load is high compared to many other courses in the insti.
- There will be plagiarism checks on the submitted codes. Your grades will be reduced by two grades (S to B, D to U) for copying or for sharing your code or referred to DisCo.
- The assignment deadlines are not extended even when your real brother is getting married (except for specific certified health issues or if you represent IITM in an approved competition).
- The instructor does not cancel the 8 o'clock class.