Lighting Talk on

Computing & Sustainability – a scientific perspective

Dr. Sven Köppel

anabrid
analog-digital hybrid computing

Future of Computing Conference
by INAM Berlin

Workshop: Computing & Sustainability
13:15 – 14:45

Carried out by:
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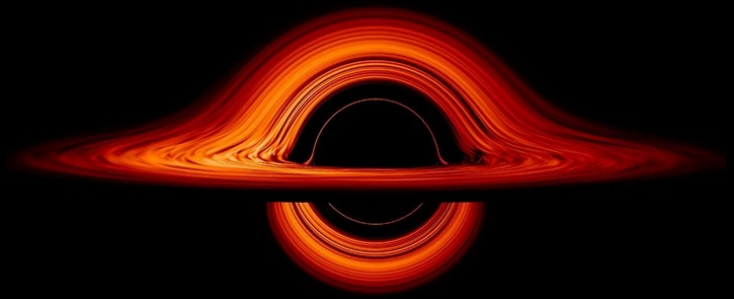
INAM
innovation network for
advanced materials

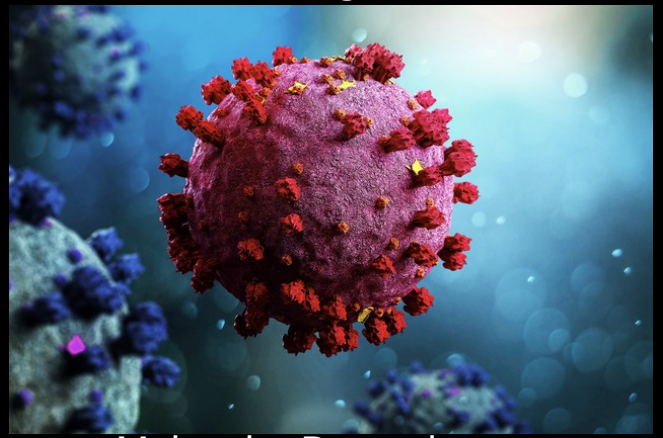
Breakthroughts thanks to Supercomputing (High Performance Computing)

Black Hole Observation 2016-19



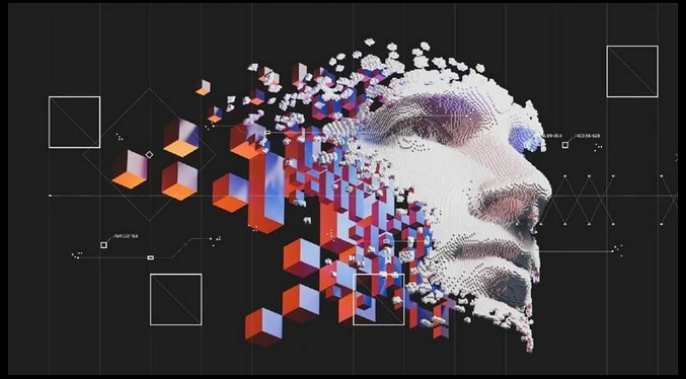
Gravitational Waveform Databases

COVID-19 antigen 2020-21



Molecular Dynamics

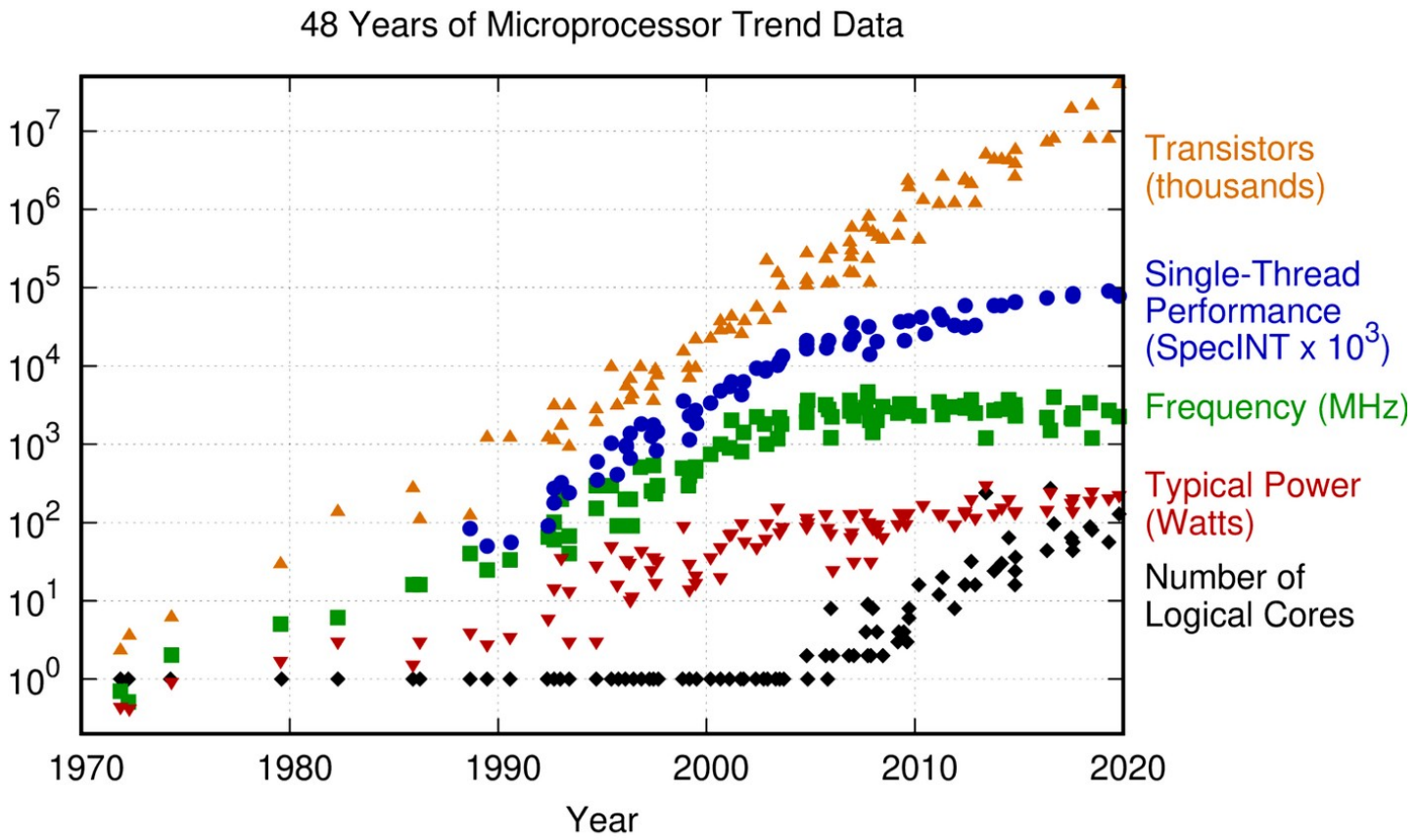
Generative AI 2021-23



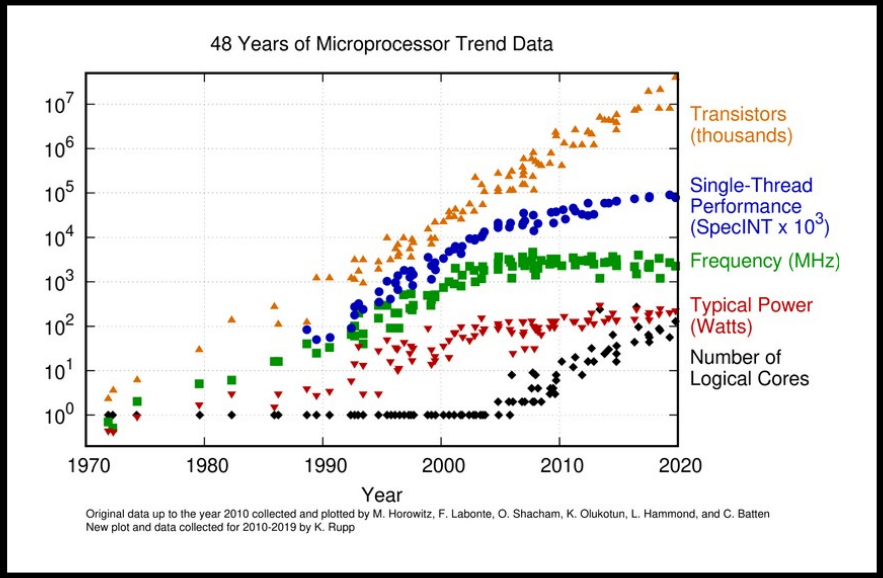
Large Language Models, Image Diffusion

?

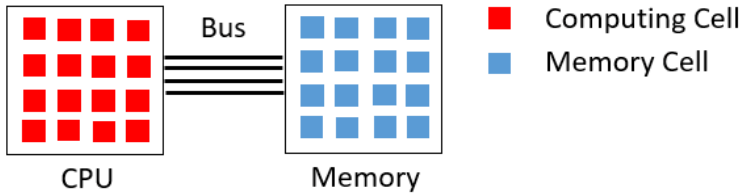
What hinders contemporary computer design to proceed?



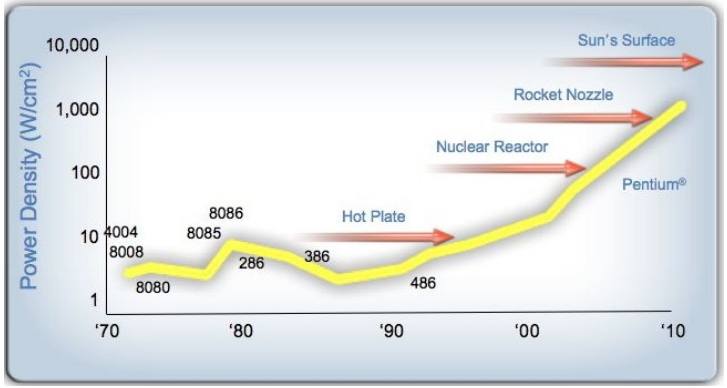
What hinders contemporary computer design to proceed?



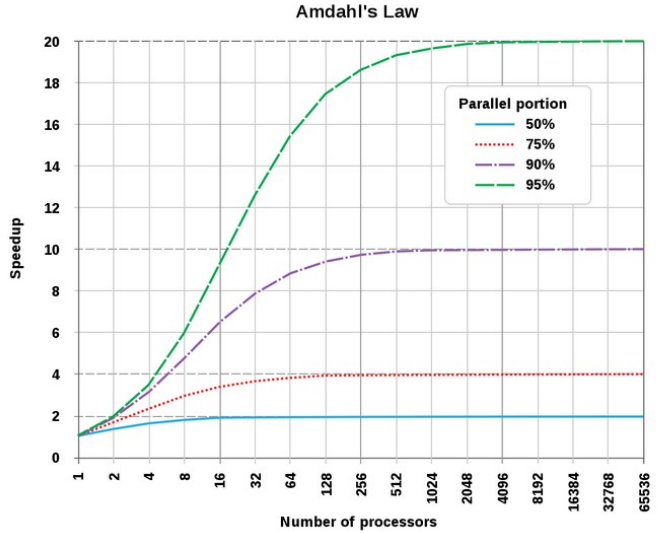
Von-Neumann-Bottleneck



The Energy barrier

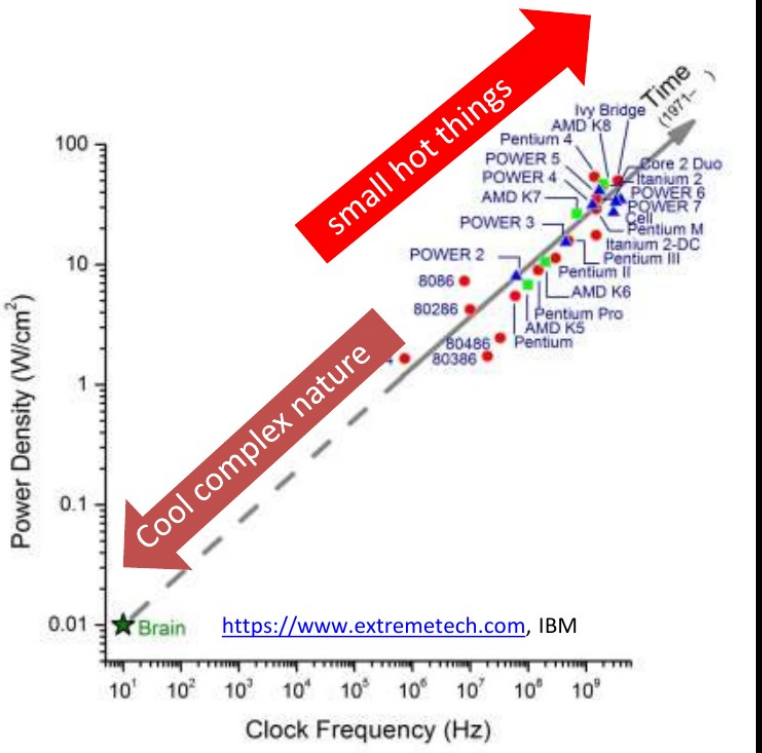


Parallelization has limits

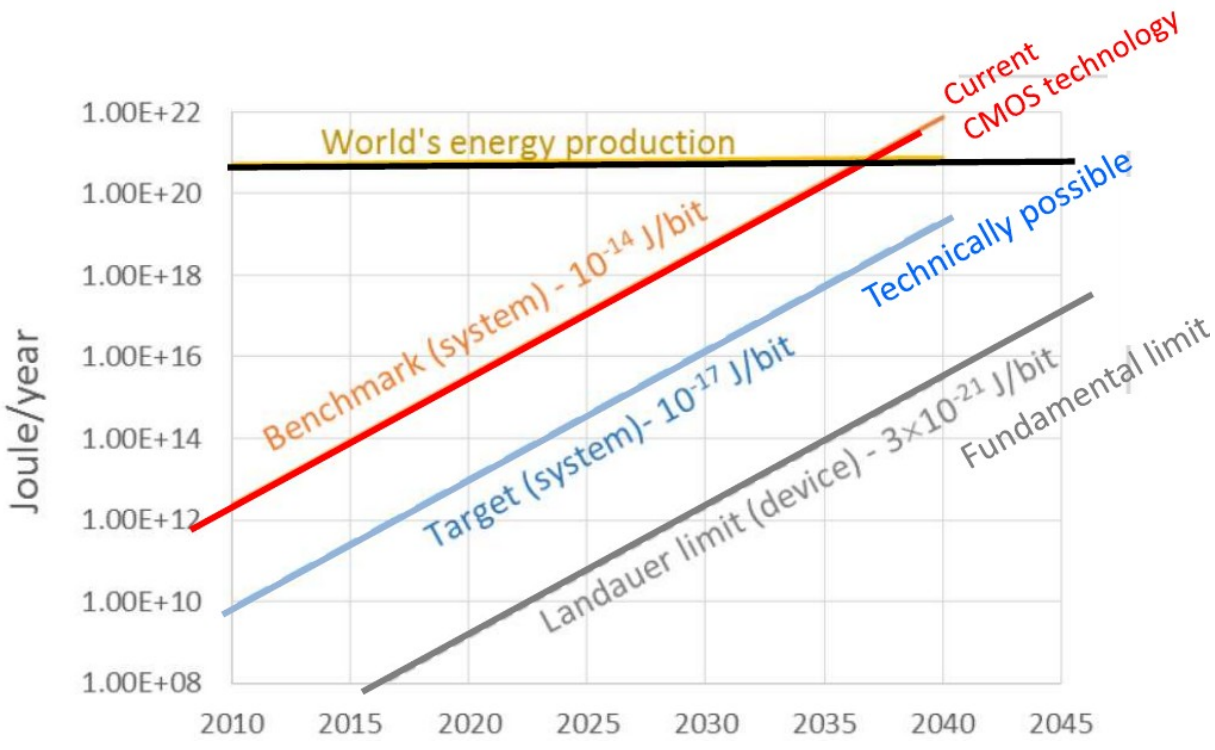


Large scale computing is all about energy

How not to do AI



Computing eats the world



An incomplete survey on the many dimensions of computing

Conceptual	**Software**	**Hardware**	**Society & Culture**
• Communication • Memory/Storage • Power	• Information representation • Algorithms	• Materials • Architecture • Economic Scaling	• Geopolitics • Ressources • Lifetime • Recycling
? Internet + Green Computing ? Clouds and VMs ? IoT + Power prediction + Cooling awareness	−Complexity −Blockchain +Green Code ?Novel computing paradigms	? Node sizes + Beyond-Moore + In-memory comp. + Low power arch. ? CMOS alternatives	?Political Independence +Open Source +Awareness & Responsibility +Make efficiency a value

Opportunities for future computing methods

Technological promises can be:

- Less power requirements
  (=less waste heat, results in less cooling)
- Faster time to solution
  (=less energy even if power is the same)
- Longer lifetime (self-repairable, less wear out, increase of compatibility, can keep up)
- Less demanding (cheaper production, less ressources at same performance)

Energy consumed = Power x Time
E (kWh) = P (kW) x t (h)

But also:

- Challenging for integration (ecosystem)
- „only“ postponing problems

We don’t only have a climate crisis or an energy crisis but will have an information crisis within decades.

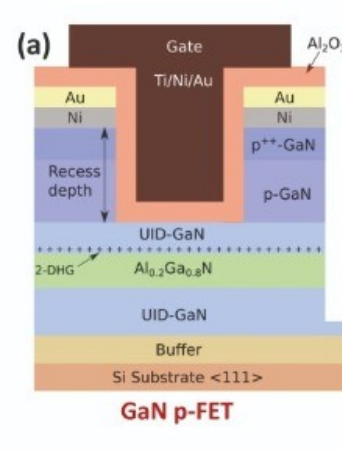
Novel Hardware: An incomplete list of unconventional computing

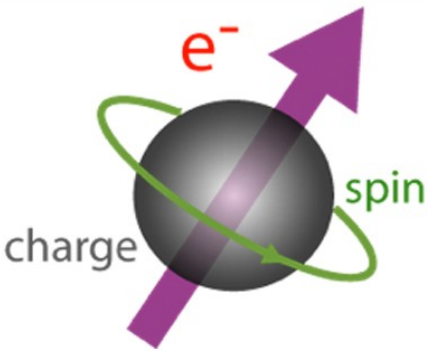
Advances in ICs
- GaN (only power electronics)
- Novel Packaging

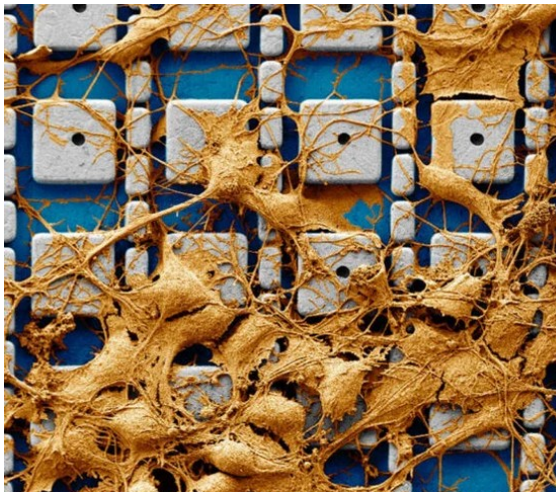
Electromagnetics
- Advances in magnetic storage
- Memristors
- Spintronics
- Photonics/Optical

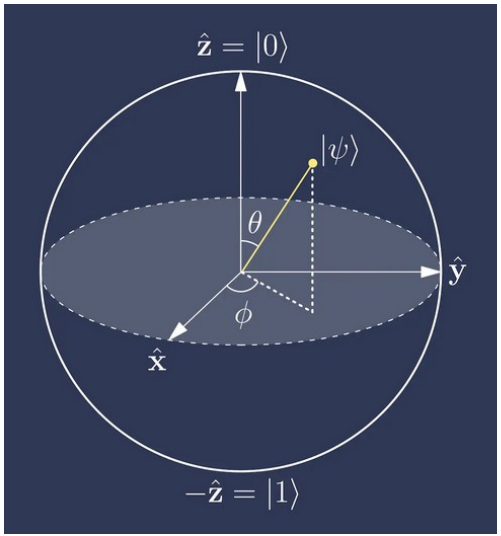
Biological Computing
- Carbon nanotubes
- Molecular electronics
- DNA storage
- Wetware

Non-Digital
- Quantum Comp.
- Analog Comp.



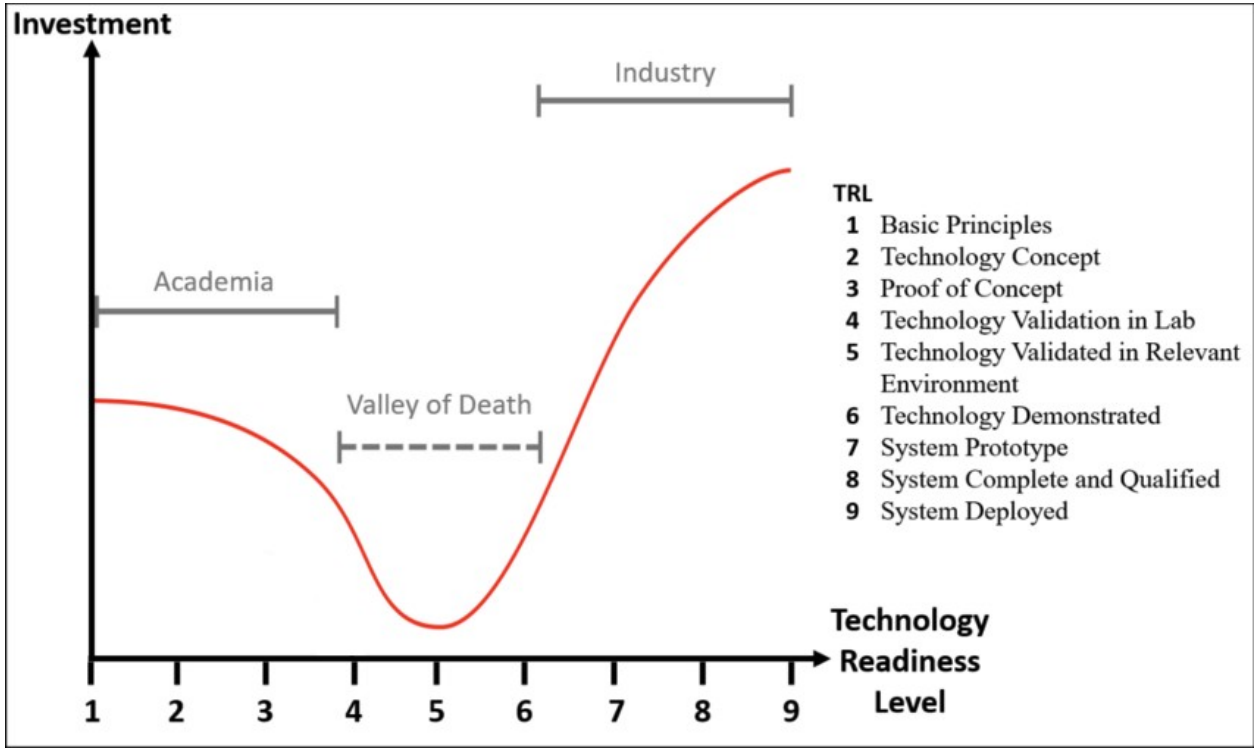






Evaluating novel Hardware: From academia to industry

- Technological Readyness Level
- Prospects of success
- Subsequent effects in Applications; Impact on Culture and Politics



What we are actually doing

anabrid semiconductors

An opionionated review of popular computing paradigms

paradigm	technological maturity	versatility	energy efficiency	integration and portability	scalability	availability of developer talent	potential for performance gains	affordability
digital	+++	+++	−	+++	++	++	−	+
quantum	−	+	−	−	−	−	+++	−
analog	+++	+	++	++	+++	−	++	++