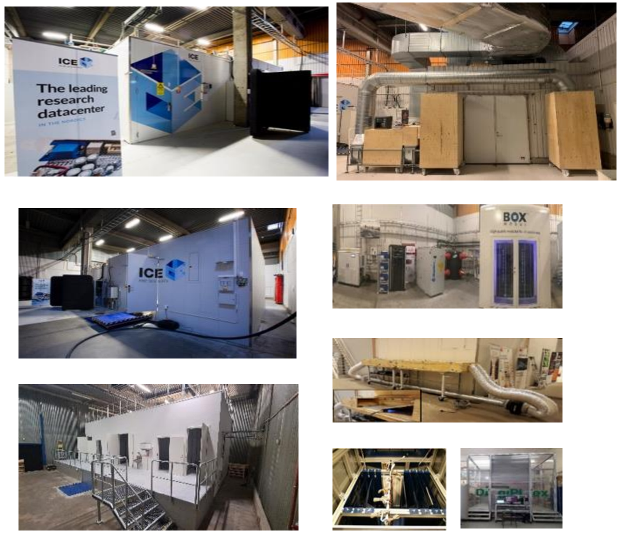
Exploring the HIGHER Standard: Validating European Silicon for the Digital Decade

RISE – Research Institutes of Sweden

RISE

A full-scale research data centre and test environment with the objective to increase knowledge, strengthen the AI & data centre ecosystems and attract researchers.



- 30+ projects, from the ground to the cloud
- 25 employees
- 4 M EUR annual turnover
- Established 2016

Partners: Ericsson, ABB, Vattenfall, Meta, LTU, Region North, Vertiv, BP Castrol…

2018 - 2022 BDV i-Space GOLD

2016, 201 BDV i-Space SILVER

DATACLOUD GLOBAL AWARDS 2019

RISE 2017, 2019

Best Data Center Initiative of the Year
with RISE SICE North Research Data Center
Sponsored by DCPRO

EARTO Innovation Awards 2022

Holistic Cooling

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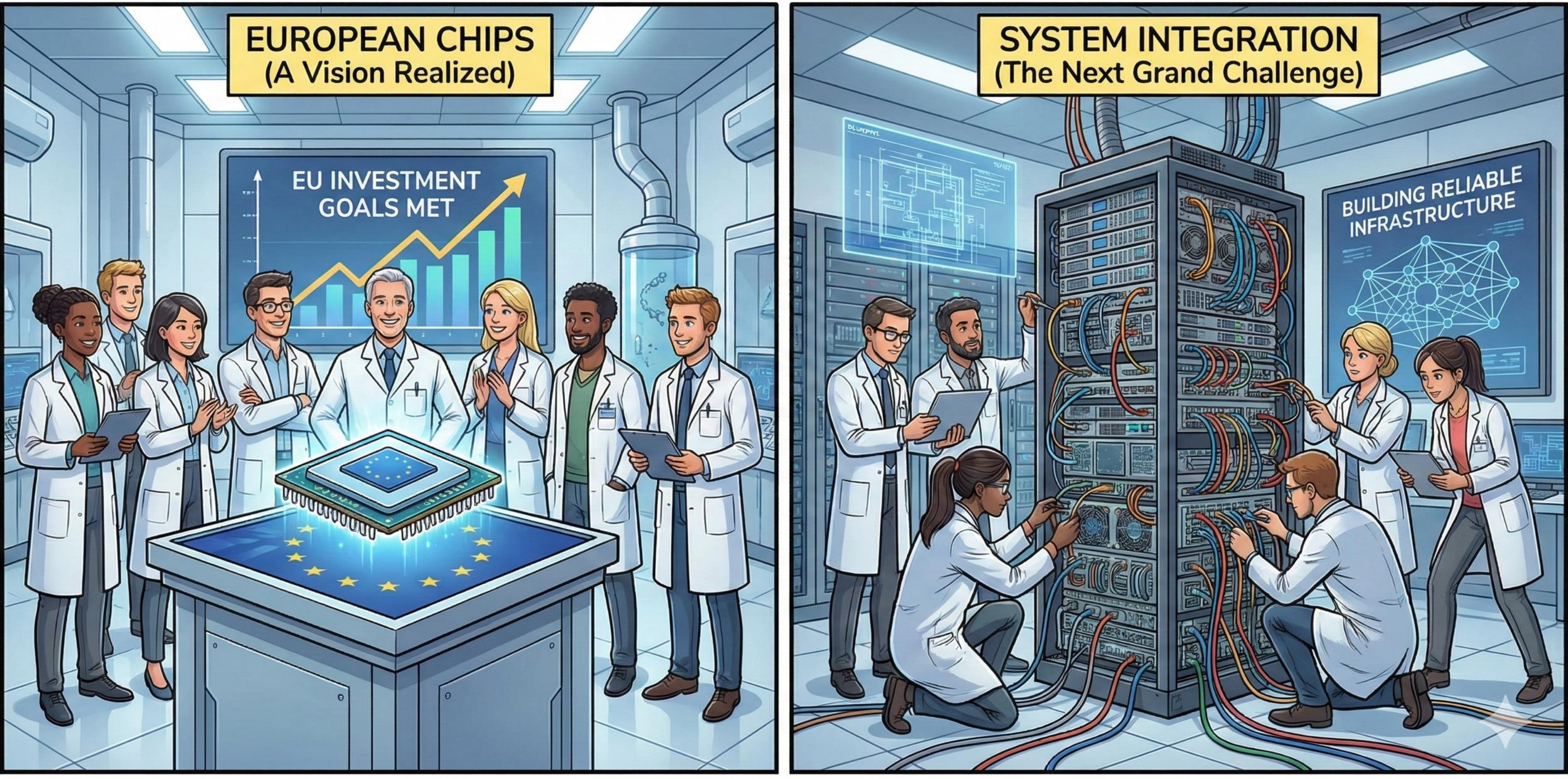
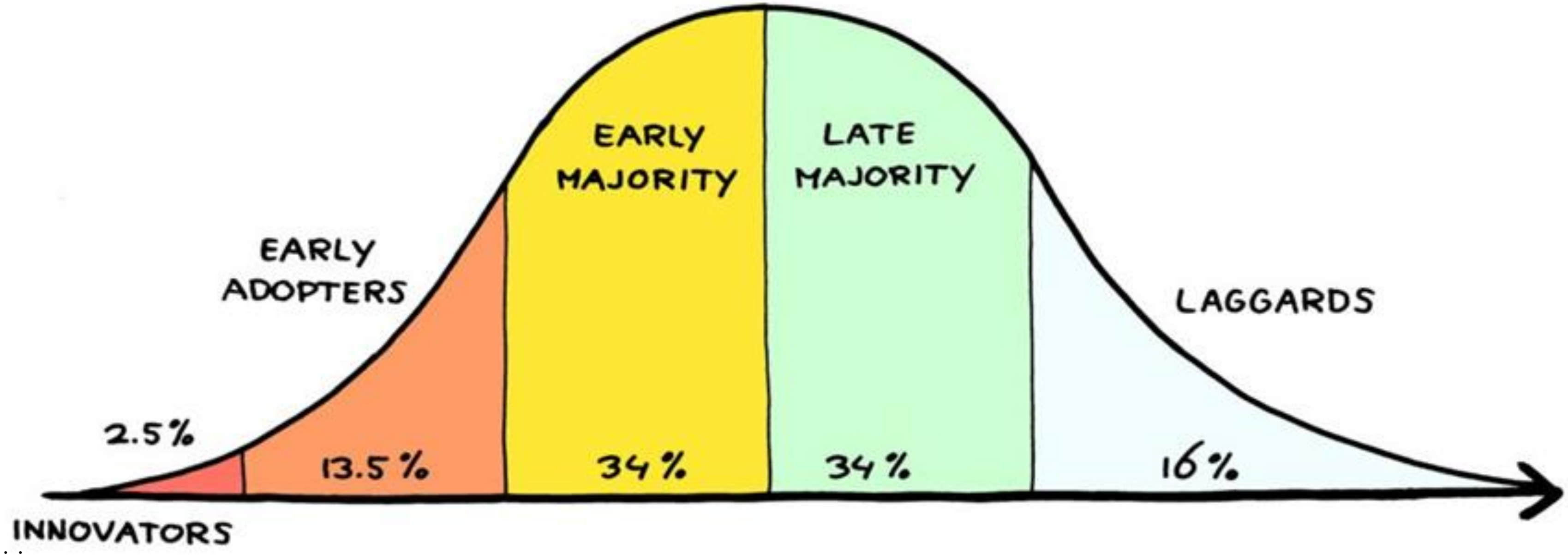
From Silicon Success to System Synergy: The European Digital Decade



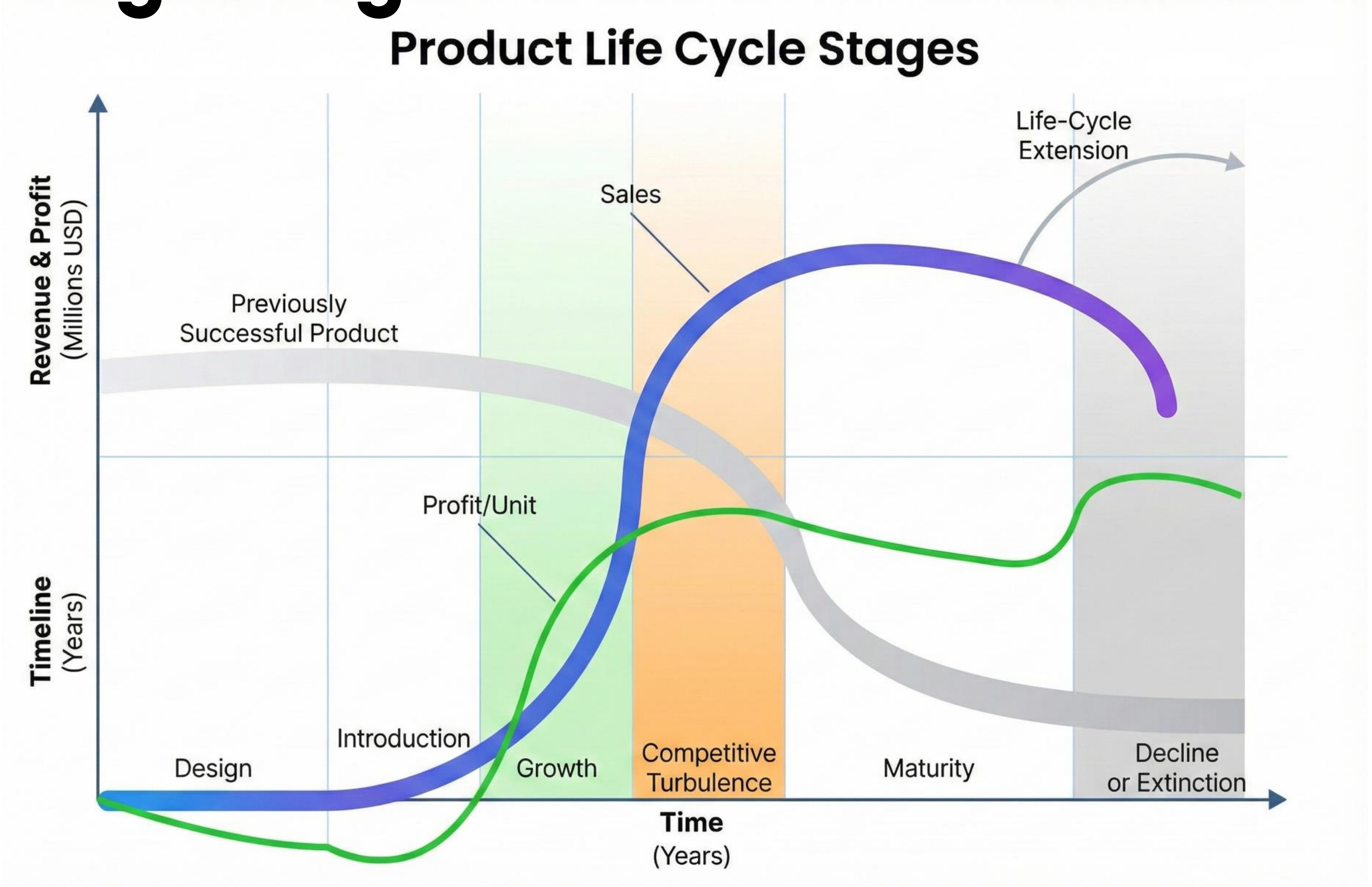
Technology validation

Technology validation is the **process of proving a new technology works as intended and meets real-world needs**, often through **prototypes** and **testing in simulated or actual environments**, to **confirm its feasibility, performance, and value before full-scale development**, ensuring it solves real problems, aligns with goals, and minimizes risk.



Reference: Gemini

The beginning



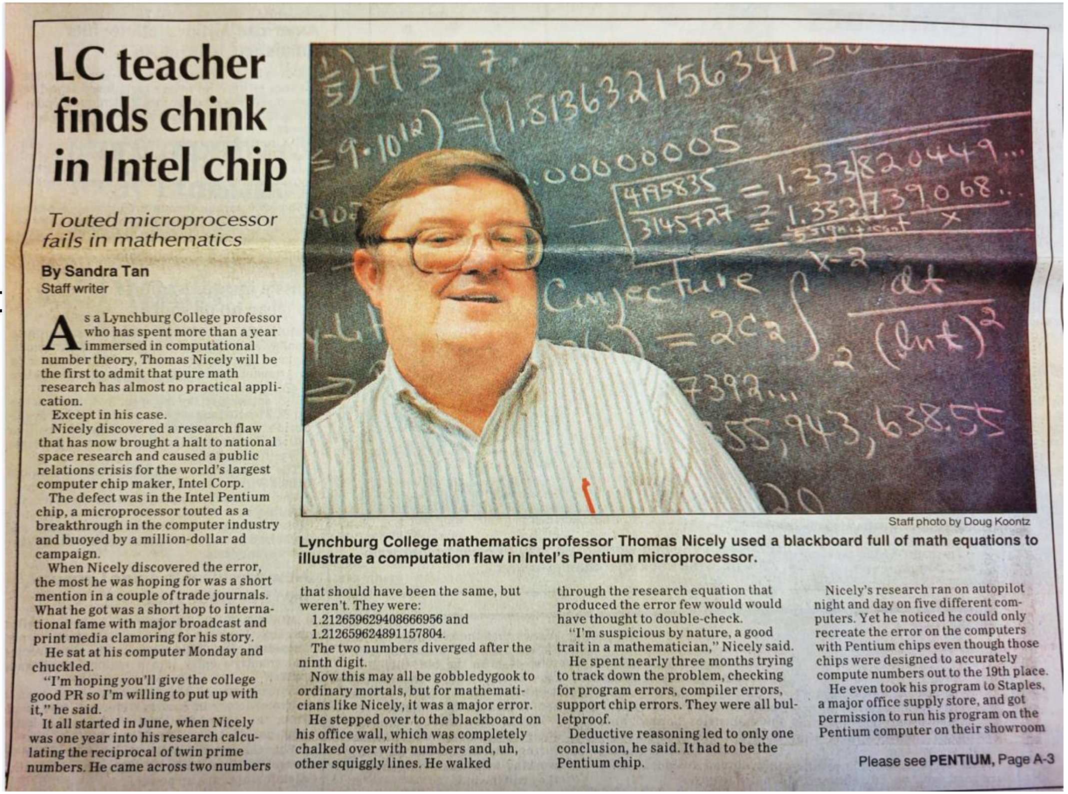
What can go wrong?

$$\frac{4{,}195{,}835}{3{,}145{,}727} = 1.333820449136241002$$

$$\frac{4{,}195{,}835}{3{,}145{,}727} = 1.333739068902037589$$

Intel Pentium FDIV Bug (1994)

- What happened: A flaw in the floating-point unit of early Pentium processors caused incorrect division results.
- The Cost estimation: The bug estimated to cost Intel ~$ 475 million (unadjusted for inflation) to replace the chips.



LC teacher finds chink in Intel chip

Touted microprocessor fails in mathematics

By Sandra Tan
Staff writer

As a Lynchburg College professor who has spent more than a year immersed in computational number theory, Thomas Nicely will be the first to admit that pure math research has almost no practical application.

Except in his case.

Nicely discovered a research flaw that has now brought a halt to national space research and caused a public relations crisis for the world's largest computer chip maker, Intel Corp.

The defect was in the Intel Pentium chip, a microprocessor touted as a breakthrough in the computer industry and buoyed by a million-dollar ad campaign.

When Nicely discovered the error, the most he was hoping for was a short mention in a couple of trade journals. What he got was a short hop to international fame with major broadcast and print media clamoring for his story.

He sat at his computer Monday and chuckled.

"I'm hoping you'll give the college good PR so I'm willing to put up with it," he said.

It all started in June, when Nicely was one year into his research calculating the reciprocal of twin prime numbers. He came across two numbers that should have been the same, but weren't. They were:

1.212659629408666956 and
1.212659624891157804.

The two numbers diverged after the ninth digit.

Now this may all be gobbledygook to ordinary mortals, but for mathematicians like Nicely, it was a major error.

He stepped over to the blackboard on his office wall, which was completely chalked over with numbers and, uh, other squiggly lines. He walked through the research equation that produced the error few would would have thought to double-check.

"I'm suspicious by nature, a good trait in a mathematician," Nicely said.

He spent nearly three months trying to track down the problem, checking for program errors, compiler errors, support chip errors. They were all bulletproof.

Deductive reasoning led to only one conclusion, he said. It had to be the Pentium chip.

Nicely's research ran on autopilot night and day on five different computers. Yet he noticed he could only recreate the error on the computers with Pentium chips even though those chips were designed to accurately compute numbers out to the 19th place.

He even took his program to Staples, a major office supply store, and got permission to run his program on their Pentium computer on their showroom

Staff photo by Doug Koontz

Lynchburg College mathematics professor Thomas Nicely used a blackboard full of math equations to illustrate a computation flaw in Intel's Pentium microprocessor.

Please see **PENTIUM**, Page A-3

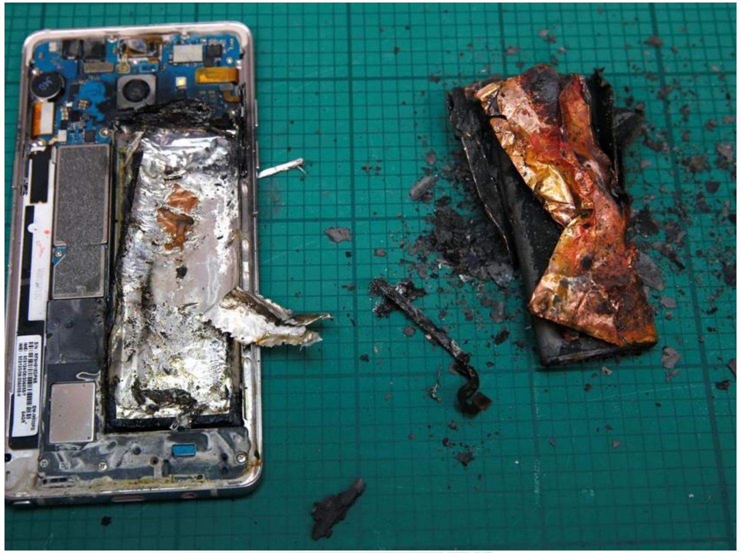
Reference: https://en.wikipedia.org/wiki/Pentium_FDIV_bug
https://www.facebook.com/groups/LivingInLynchburg/posts/3464126760513113/

What can go wrong?

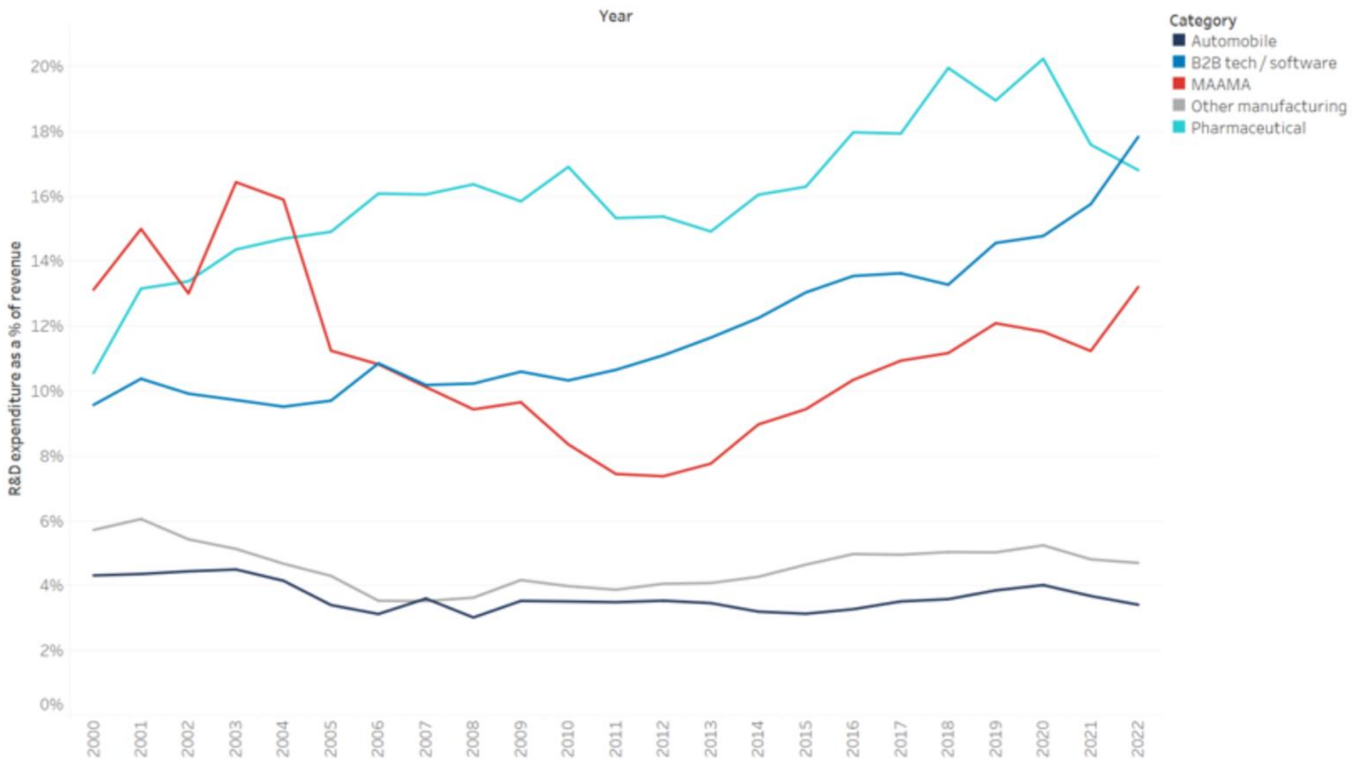
Samsung's investigation into the Galaxy Note7 incidents concluded that the batteries were the cause of the fires. The company identified two separate battery faults from different suppliers that led to the same outcome: overheating and combustion.

Samsung accepted responsibility for failing to identify these design and manufacturing issues during their validation processes. As a result of the investigation, Samsung implemented new safety measures, including an "8-Point Battery Safety Check," to prevent similar incidents in the future. The recall and discontinuation cost Samsung an estimated $5.3 billion.

Reference: https://news.samsung.com/global/infographic-galaxy-note7-what-we-discovered
https://www.theguardian.com/technology/2016/oct/10/samsung-halts-production-galaxy-note-7-phone-battery-fires



Microsoft, Alphabet, Amazon, Meta, and Apple



Reference: Padilla, J., Ginsburg, D. H., & Wong-Ervin, K. W. (2024). DYNAMIC COMPETITION AND ANTITRUST: QUICK-LOOK INFERENCES FROM THE ANALYSIS OF BIG TECH'S R&D EXPENDITURE RATIOS. Forthcoming in the Antitrust Law Journal.

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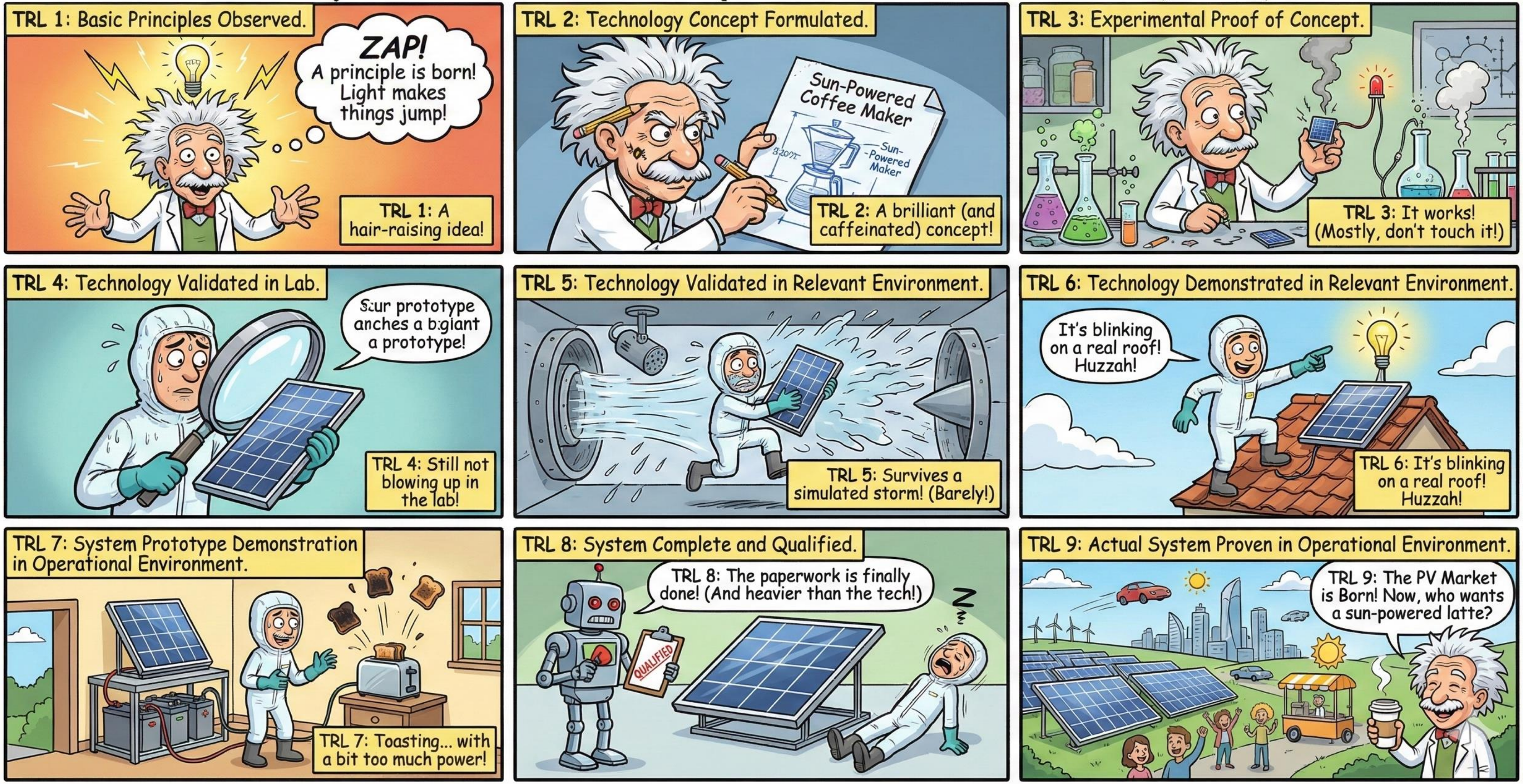
Technology Readiness Levels

G. Technology readiness levels (TRL)

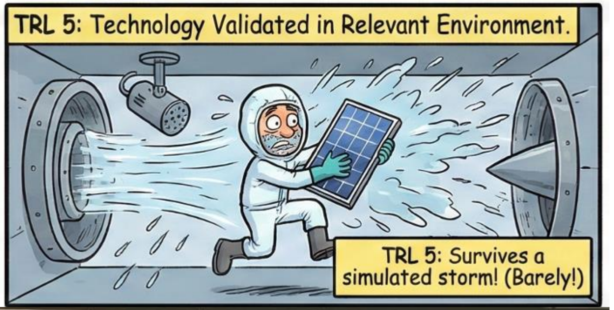
Where a topic description refers to a TRL, the following definitions apply, unless otherwise specified:

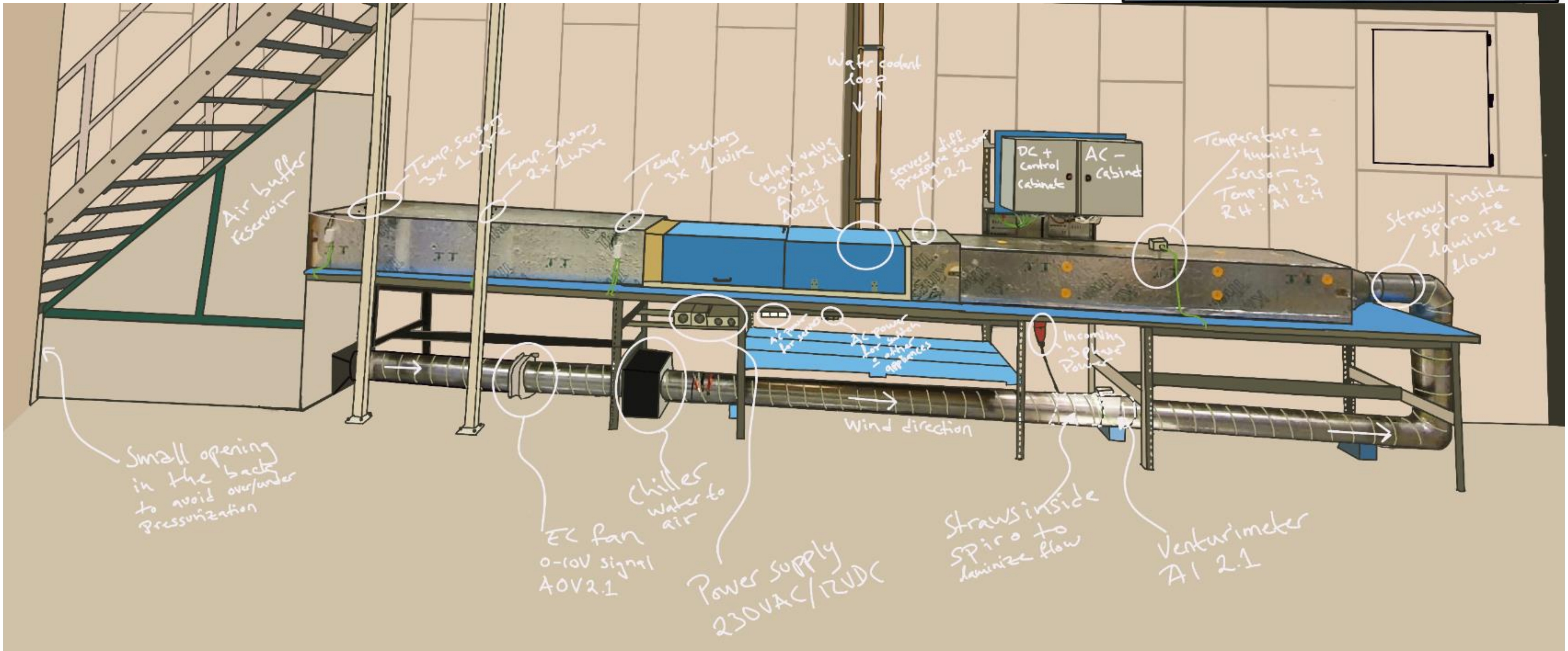
- TRL 1 – basic principles observed
- TRL 2 – technology concept formulated
- TRL 3 – experimental proof of concept
- TRL 4 – technology validated in lab
- TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7 – system prototype demonstration in operational environment
- TRL 8 – system complete and qualified
- TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

The European TRLs: From Spark to Market-Ready Mayhem!

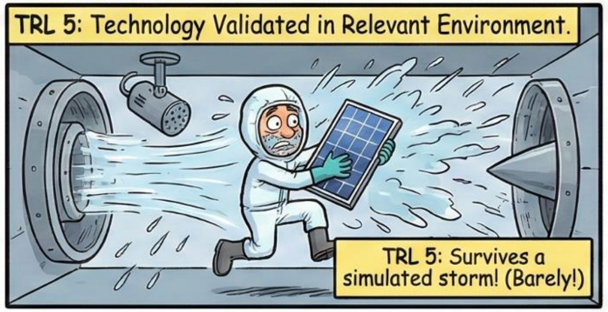


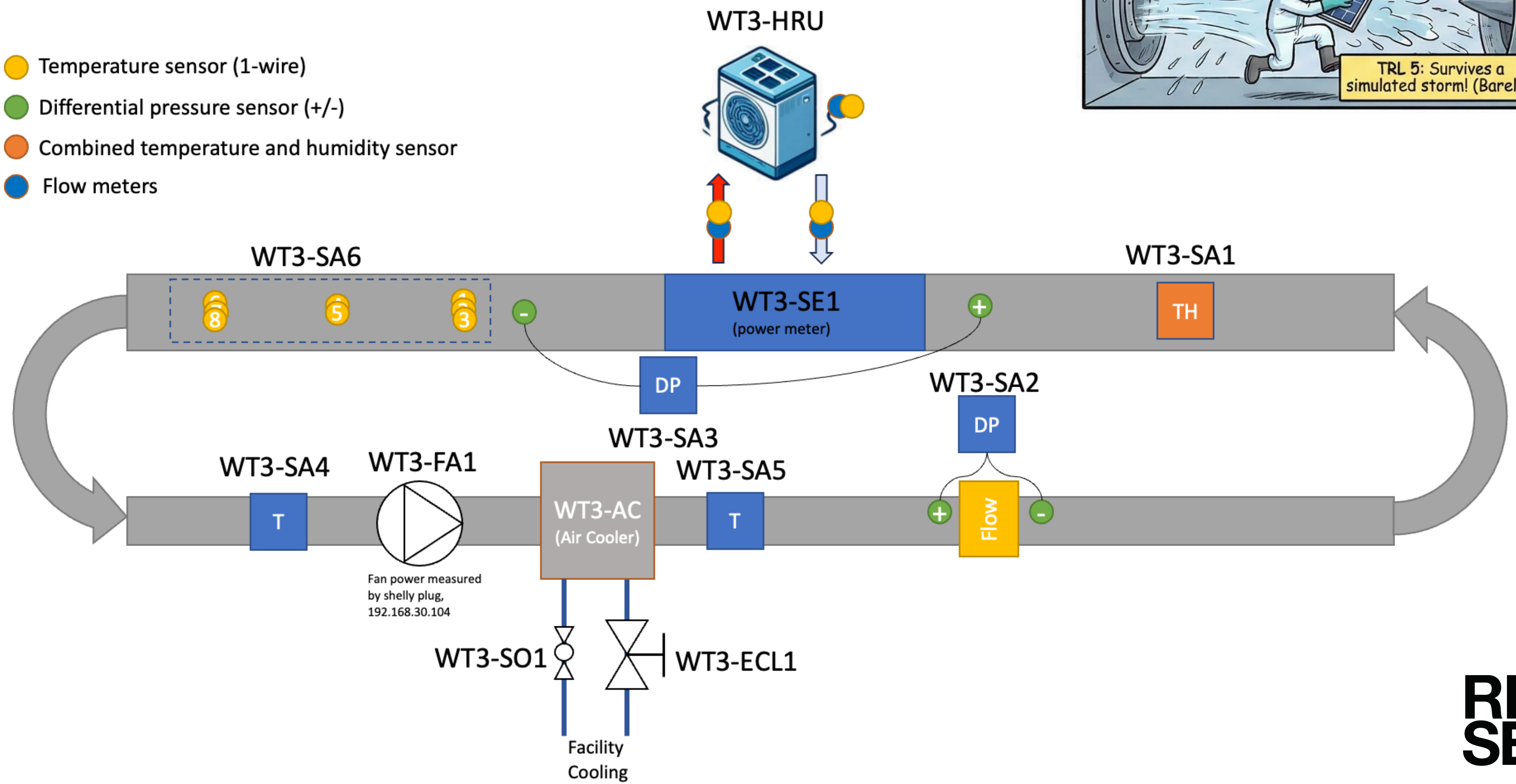
Rerevant environment



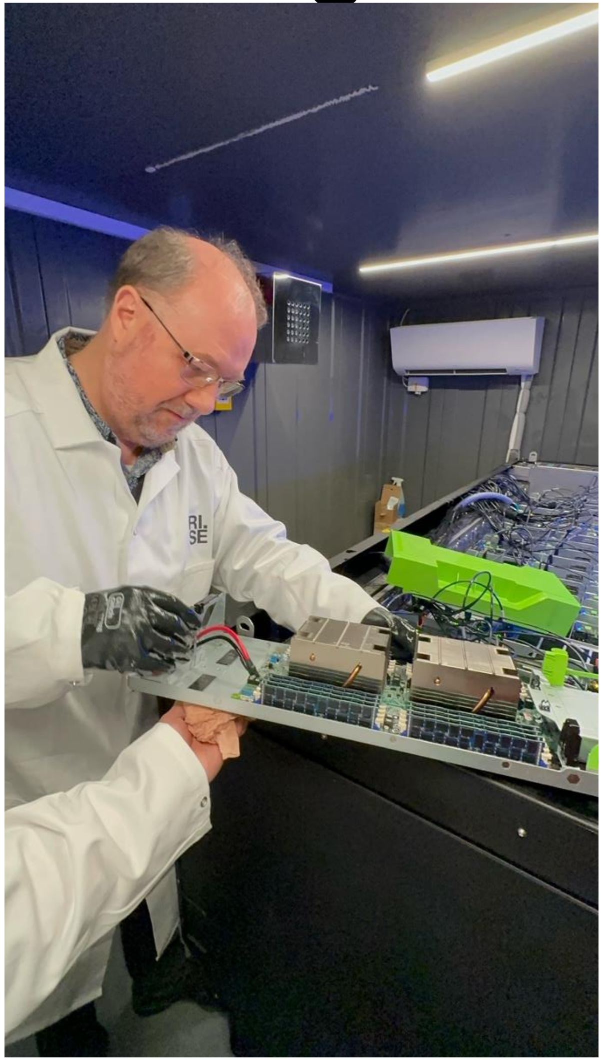


Rerevant environment



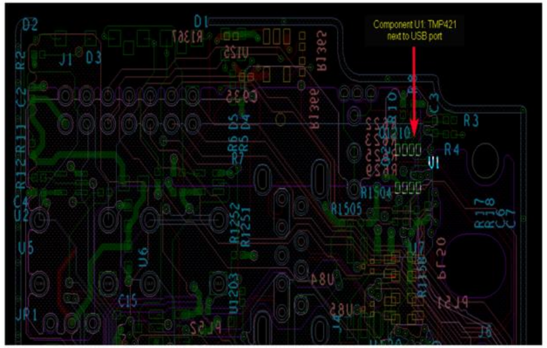


Paying attention to the data



```
ipmitool -I lanplus -U USERID -P PASSW0RD -H 192.168.0.107 sensor
P0 Temp          | 24.000    | degrees C  | ok    | na     | na     | na     | na     | 91.000    | na
P1 Temp          | na        | degrees C  | na    | na     | na     | na     | na     | 104.000   | na
P0 DTSmax        | 95.000    | degrees C  | ok    | na     | na     | na     | na     | na        | na
P1 DTSmax        | na        | degrees C  | na    | na     | na     | na     | na     | na        | na
P0 Therm Margin  | -71.000   | degrees C  | ok    | na     | na     | na     | na     | -4.000    | na
P1 Therm Margin  | na        | degrees C  | na    | na     | na     | na     | na     | -4.000    | na
P3V3             | 3.307     | Volts      | ok    | na     | 2.973  | na     | na     | 3.625     | na
P5V              | 5.009     | Volts      | ok    | na     | 4.501  | na     | na     | 5.493     | na
P12V             | 12.120    | Volts      | ok    | na     | 11.340 | na     | na     | 13.200    | na
P1V05_STBY       | 1.049     | Volts      | ok    | na     | 0.951  | na     | na     | 1.147     | na
P1V8_AUX         | 1.793     | Volts      | ok    | na     | 1.627  | na     | na     | 1.980     | na
P3V3_AUX         | 3.323     | Volts      | ok    | na     | 2.973  | na     | na     | 3.625     | na
P5V_AUX          | 5.009     | Volts      | ok    | na     | 4.501  | na     | na     | 5.493     | na
P3V_BAT          | 3.045     | Volts      | ok    | na     | 2.726  | na     | na     | 3.596     | na
Inlet Temp       | 25.000    | degrees C  | ok    | na     | na     | na     | na     | 40.000    | na
Outlet Temp      | 18.000    | degrees C  | ok    | na     | na     | na     | na     | 80.000    | na
PCH Temp         | 31.000    | degrees C  | ok    | na     | na     | na     | na     | 66.000    | na
HSC Input Volt   | 11.900    | Volts      | ok    | na     | 11.300 | na     | na     | 13.200    | na
HSC Input Power  | 51.000    | Watts      | ok    | na     | na     | na     | na     | 501.000   | na
HSC Temp         | 16.000    | degrees C  | ok    | na     | na     | na     | na     | 86.000    | na
HSC Sts Low      | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
HSC Sts High     | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
HSC Output Curr  | 4.200     | Amps       | ok    | na     | na     | na     | na     | 47.800    | na
SYS FAN0         | 2000.000  | RPM        | ok    | na     | 500.000| na     | na     | 9000.000  | na
SYS FAN1         | 2000.000  | RPM        | ok    | na     | 500.000| na     | na     | 9000.000  | na
P0 VR Temp       | 24.000    | degrees C  | ok    | na     | na     | na     | na     | 92.000    | na
P0 core VR Vol   | 1.810     | Volts      | ok    | na     | 1.350  | na     | na     | 1.960     | na
P0 core VR Curr  | 8.500     | Amps       | ok    | na     | na     | na     | na     | 108.000   | na
P0 core VR POUT  | 15.000    | Watts      | ok    | na     | na     | na     | na     | 240.000   | na
P0 core VR PIN   | 19.000    | Watts      | ok    | na     | na     | na     | na     | 240.000   | na
P1 VR Temp       | na        | degrees C  | na    | na     | na     | na     | na     | 92.000    | na
P1 core VR Vol   | na        | Volts      | na    | na     | 1.350  | na     | na     | 1.960     | na
P1 core VR Curr  | na        | Amps       | na    | na     | na     | na     | na     | 108.000   | na
P1 core VR POUT  | na        | Watts      | na    | na     | na     | na     | na     | 240.000   | na
P1 core VR PIN   | na        | Watts      | na    | na     | na     | na     | na     | 240.000   | na
P0 DIMM VR0 Temp | 24.000    | degrees C  | ok    | na     | na     | na     | na     | 83.000    | na
P0 DIMM VR0 Vol  | 1.220     | Volts      | ok    | na     | 1.150  | na     | na     | 1.250     | na
P0 DIMM VR0 Curr | 2.000     | Amps       | ok    | na     | na     | na     | na     | 69.000    | na
P0 DIMM VR0 POUT | 3.000     | Watts      | ok    | na     | na     | na     | na     | 47.000    | na
P0 DIMM VR0 PIN  | 6.000     | Watts      | ok    | na     | na     | na     | na     | 47.000    | na
P0 DIMM VR1 Temp | 25.000    | degrees C  | ok    | na     | na     | na     | na     | 83.000    | na
P0 DIMM VR1 Vol  | 1.220     | Volts      | ok    | na     | 1.150  | na     | na     | 1.250     | na
P0 DIMM VR1 Curr | 2.000     | Amps       | ok    | na     | na     | na     | na     | 69.000    | na
P0 DIMM VR1 POUT | 3.000     | Watts      | ok    | na     | na     | na     | na     | 47.000    | na
P0 DIMM VR1 PIN  | 6.000     | Watts      | ok    | na     | na     | na     | na     | 47.000    | na
P1 DIMM VR0 Temp | na        | degrees C  | na    | na     | na     | na     | na     | 83.000    | na
P1 DIMM VR0 Vol  | na        | Volts      | na    | na     | 1.150  | na     | na     | 1.250     | na
P1 DIMM VR0 Curr | na        | Amps       | na    | na     | na     | na     | na     | 69.000    | na
P1 DIMM VR0 POUT | na        | Watts      | na    | na     | na     | na     | na     | 47.000    | na
P1 DIMM VR0 PIN  | na        | Watts      | na    | na     | na     | na     | na     | 47.000    | na
P1 DIMM VR1 Temp | na        | degrees C  | na    | na     | na     | na     | na     | 83.000    | na
P1 DIMM VR1 Vol  | na        | Volts      | na    | na     | 1.150  | na     | na     | 1.250     | na
P1 DIMM VR1 Curr | na        | Amps       | na    | na     | na     | na     | na     | 69.000    | na
P1 DIMM VR1 POUT | na        | Watts      | na    | na     | na     | na     | na     | 47.000    | na
P1 DIMM VR1 PIN  | na        | Watts      | na    | na     | na     | na     | na     | 47.000    | na
P0 Package Power | 14.000    | Watts      | ok    | na     | na     | na     | na     | na        | na
P1 Package Power | na        | Watts      | na    | na     | na     | na     | na     | na        | na
P0 DIMM01 Temp   | 20.000    | degrees C  | ok    | na     | na     | na     | na     | 81.000    | na
P0 DIMM23 Temp   | 22.000    | degrees C  | ok    | na     | na     | na     | na     | 81.000    | na
P1 DIMM01 Temp   | na        | degrees C  | na    | na     | na     | na     | na     | 81.000    | na
P1 DIMM23 Temp   | na        | degrees C  | na    | na     | na     | na     | na     | 81.000    | na
C1 Local Temp    | 0.000     | degrees C  | ok    | na     | na     | na     | na     | 94.000    | na
C1 Remote Temp   | 82.000    | degrees C  | ok    | na     | na     | na     | na     | 95.000    | na
C2 Local Temp    | na        | degrees C  | na    | na     | na     | na     | na     | 94.000    | na
C2 Remote Temp   | na        | degrees C  | na    | na     | na     | na     | na     | 83.000    | na
C3 Local Temp    | na        | degrees C  | na    | na     | na     | na     | na     | 94.000    | na
C3 Remote Temp   | na        | degrees C  | na    | na     | na     | na     | na     | 83.000    | na
C4 Local Temp    | na        | degrees C  | na    | na     | na     | na     | na     | 94.000    | na
C4 Remote Temp   | na        | degrees C  | na    | na     | na     | na     | na     | 83.000    | na
CPU0 Error       | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
CPU1 Error       | na        | discrete   | na    | na     | na     | na     | na     | na        | na
P0_CH0DIMM0_Sts  | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
P0_CH0DIMM1_Sts  | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
P0_CH1DIMM0_Sts  | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
P0_CH1DIMM1_Sts  | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
P0_CH2DIMM0_Sts  | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
P0_CH2DIMM1_Sts  | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
P0_CH3DIMM0_Sts  | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
P0_CH3DIMM1_Sts  | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
P1_CH0DIMM0_Sts  | na        | discrete   | na    | na     | na     | na     | na     | na        | na
P1_CH0DIMM1_Sts  | na        | discrete   | na    | na     | na     | na     | na     | na        | na
P1_CH1DIMM0_Sts  | na        | discrete   | na    | na     | na     | na     | na     | na        | na
P1_CH1DIMM1_Sts  | na        | discrete   | na    | na     | na     | na     | na     | na        | na
P1_CH2DIMM0_Sts  | na        | discrete   | na    | na     | na     | na     | na     | na        | na
P1_CH2DIMM1_Sts  | na        | discrete   | na    | na     | na     | na     | na     | na        | na
P1_CH3DIMM0_Sts  | na        | discrete   | na    | na     | na     | na     | na     | na        | na
P1_CH3DIMM1_Sts  | na        | discrete   | na    | na     | na     | na     | na     | na        | na
SEL Status       | 0x0       | discrete   | 0x0081| na     | na     | na     | na     | na        | na
DCMI Watchdog    | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
NTP Status       | 0x0       | discrete   | 0x0180| na     | na     | na     | na     | na        | na
Chassis Pwr Sts  | 0x0       | discrete   | 0x0180| na     | na     | na     | na     | na        | na
VR HOT           | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
CPU_DIMM HOT     | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
Airflow          | na        | CFM        | na    | na     | na     | na     | na     | na        | na
Sys booting sts  | 0x0       | discrete   | 0x0080| na     | na     | na     | na     | na        | na
System Status    | 0x0       | discrete   | 0x0180| na     | na     | na     | na     | na        | na
```

Inlet Temperature at Component U1 next to USB port on Front (U1 is visible on top on board):



The IPMI sensor command reports a lot of sensor data. Leopard V2 servers' board management system collects data from 144 points. The BMC, which has direct access to all analogue sensors on the motherboard or through the PCH Management Engine, reports this data for sustainable server operation.

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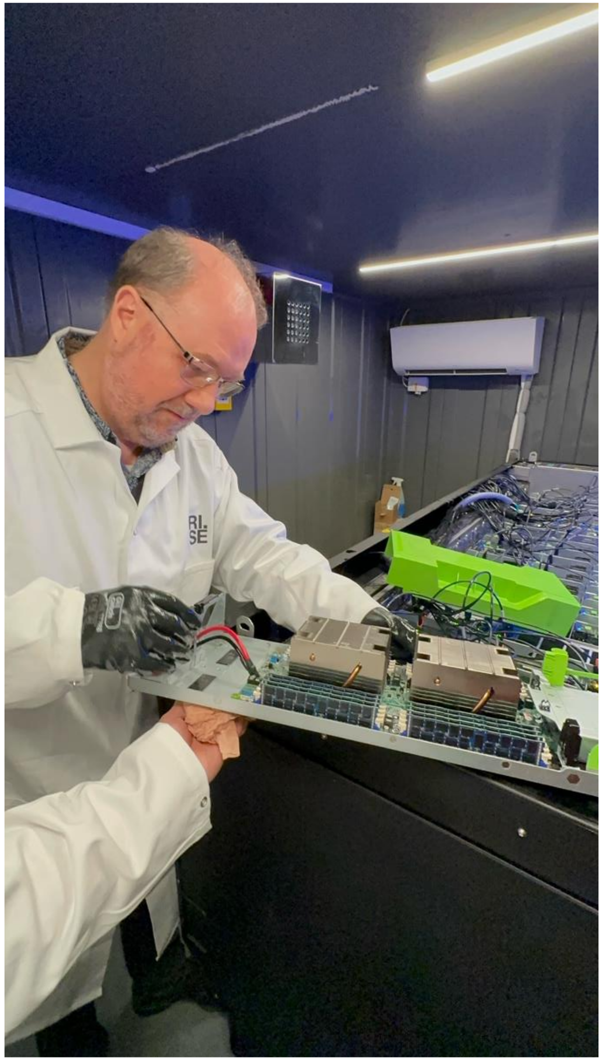
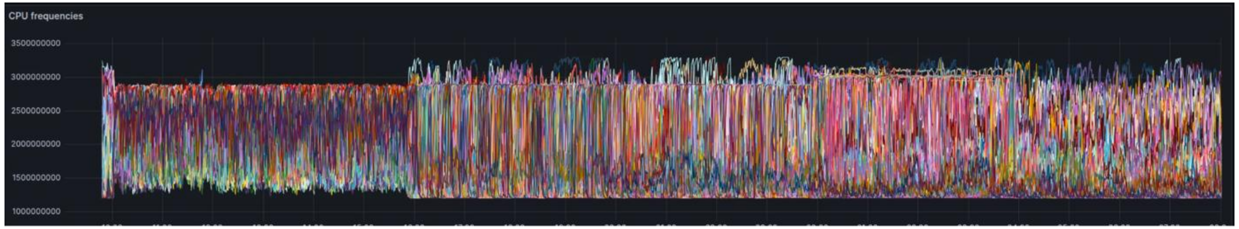
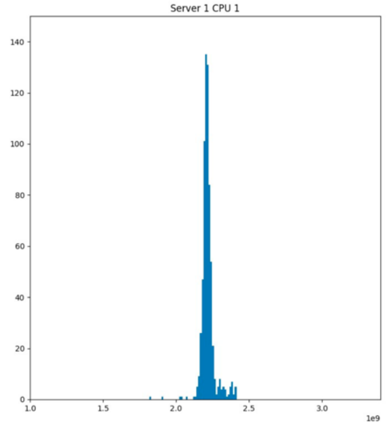
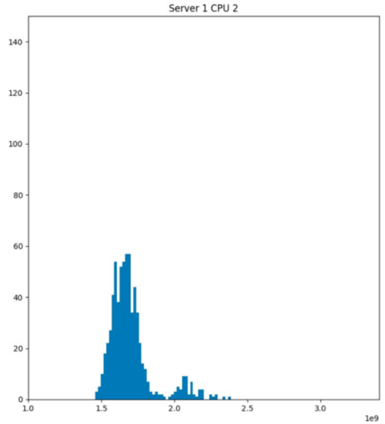
Importance of data

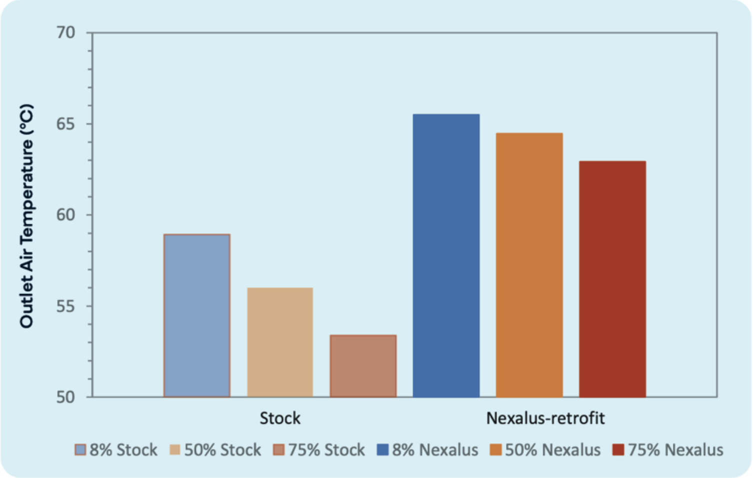


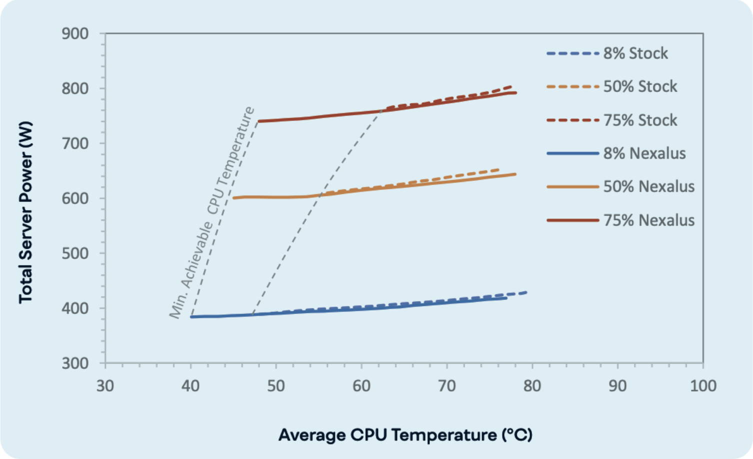


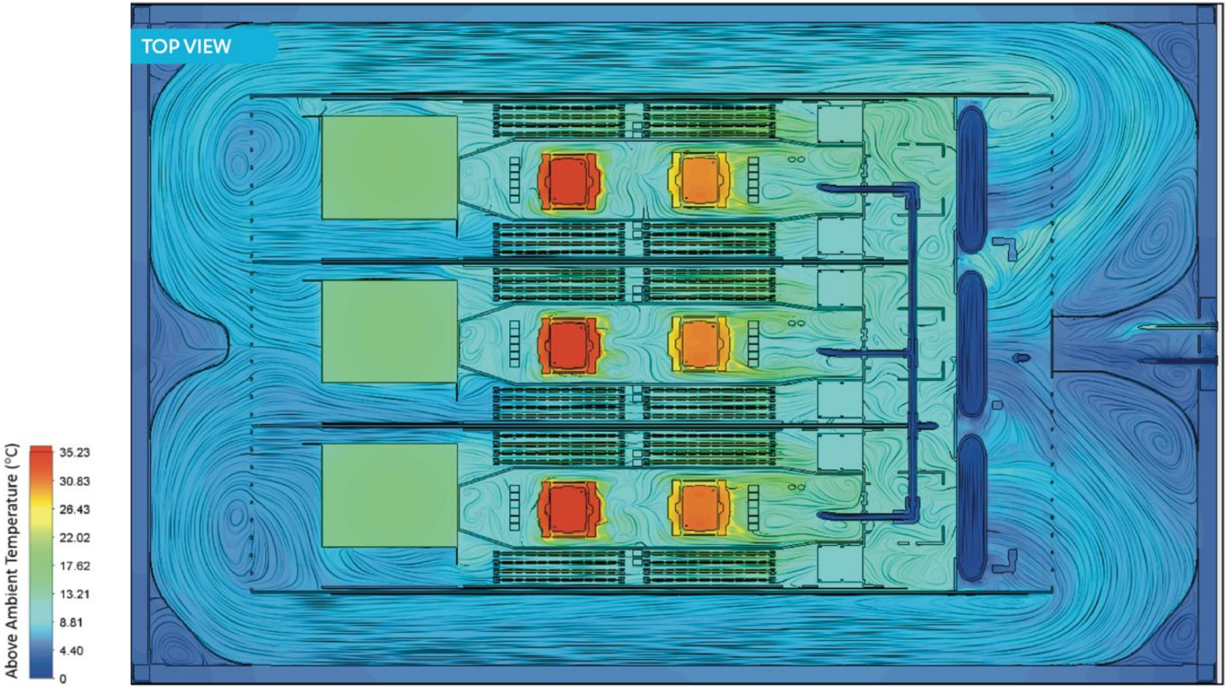




Understanding performance

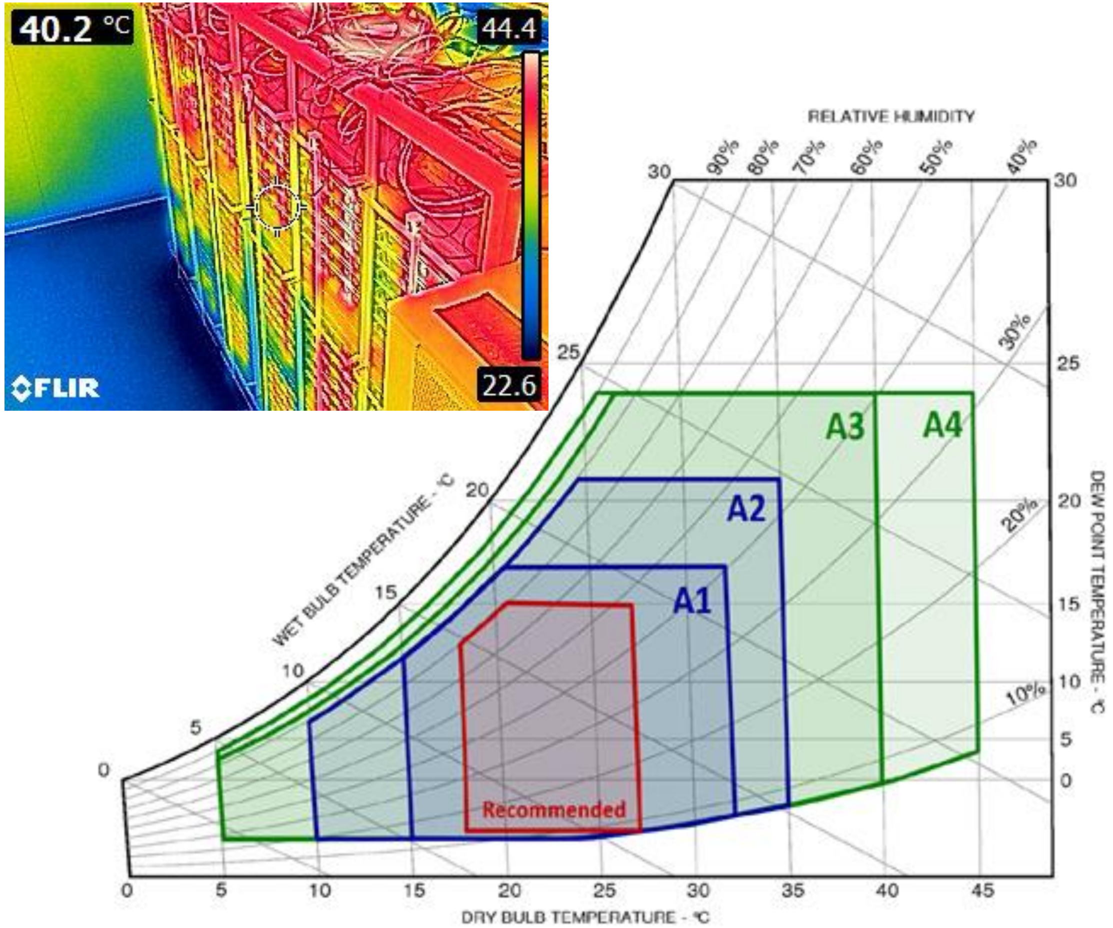


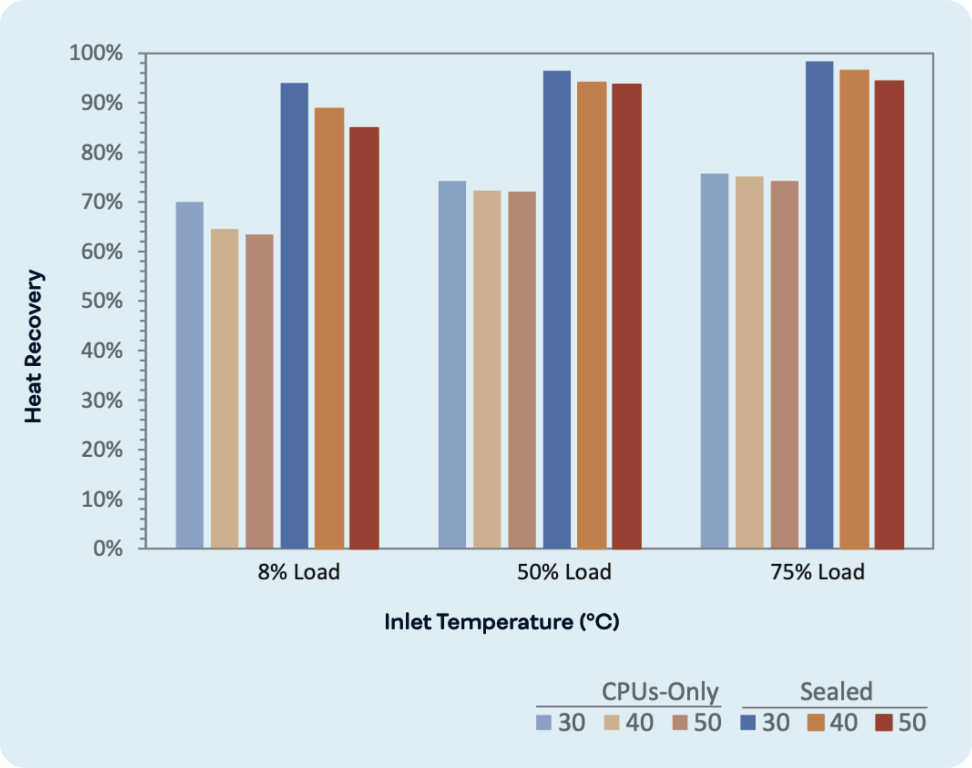




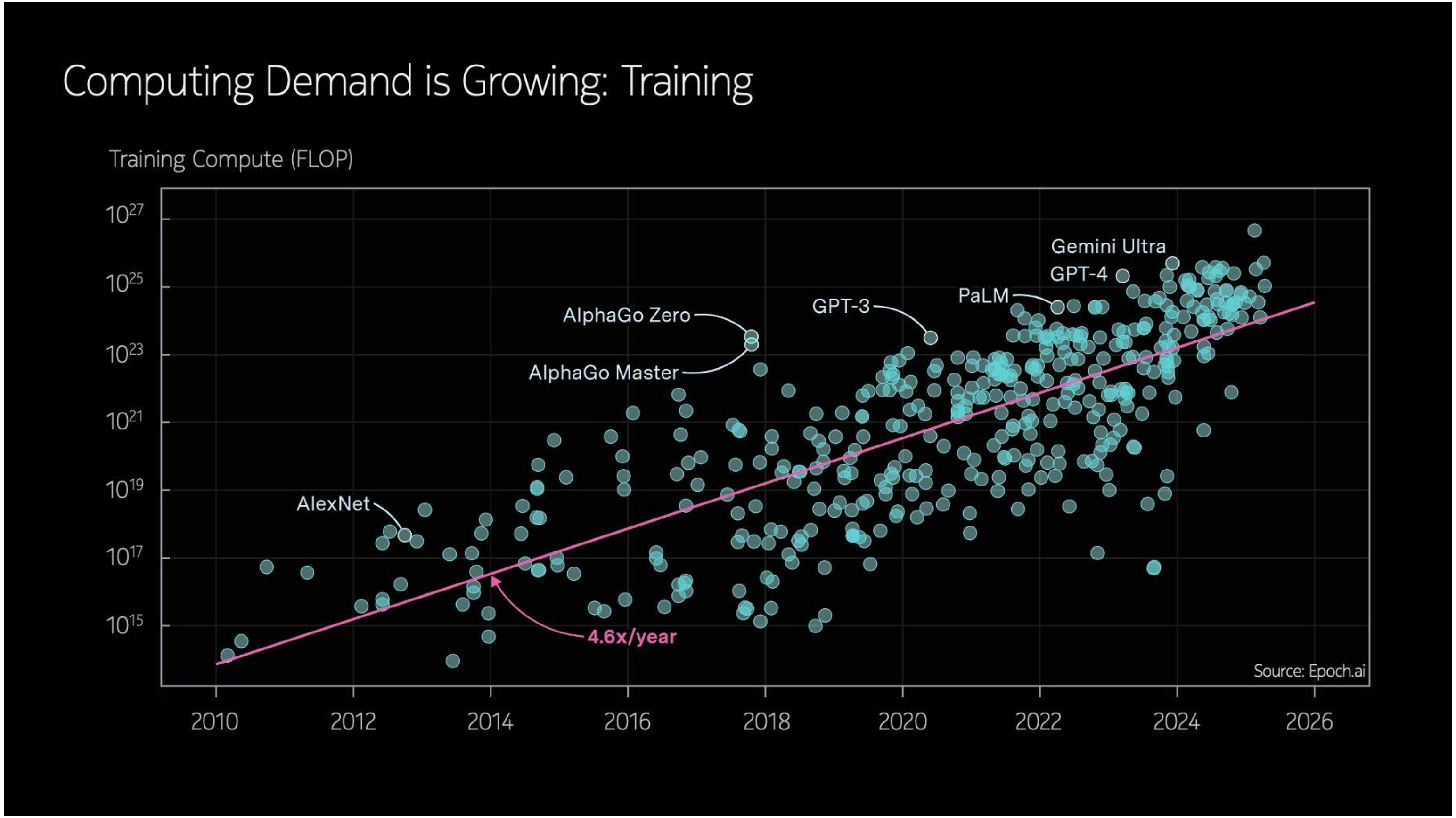
Reference: https://www.nexalus.com/wp-content/uploads/2023/02/Nexalus-RISE-Report.pdf

Complying with the standards



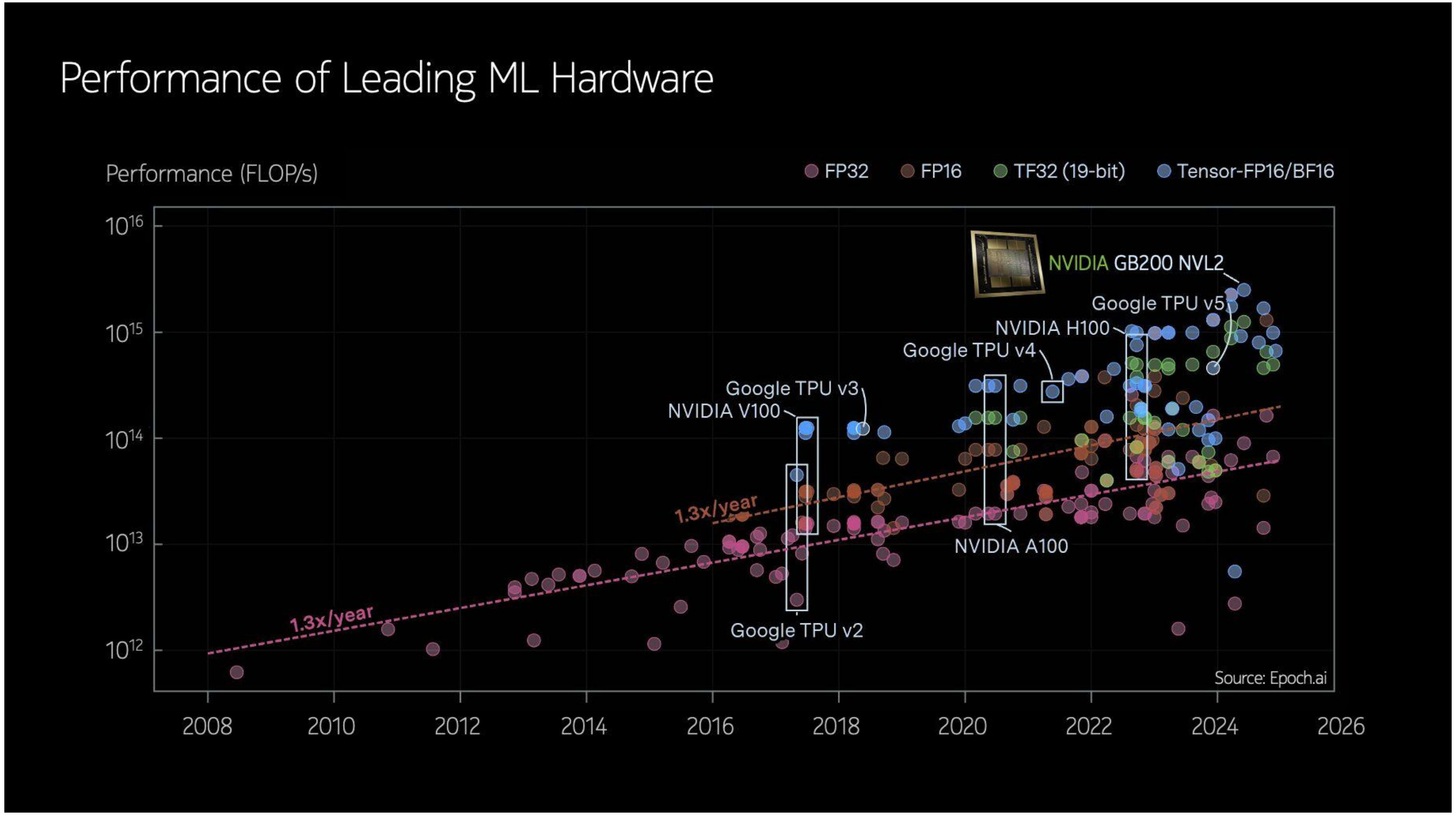


AI model compute requirements



Reference: Anastasiia Nosova at Green Computing in the AI Era conference 2025

AI compute hardware capabilities

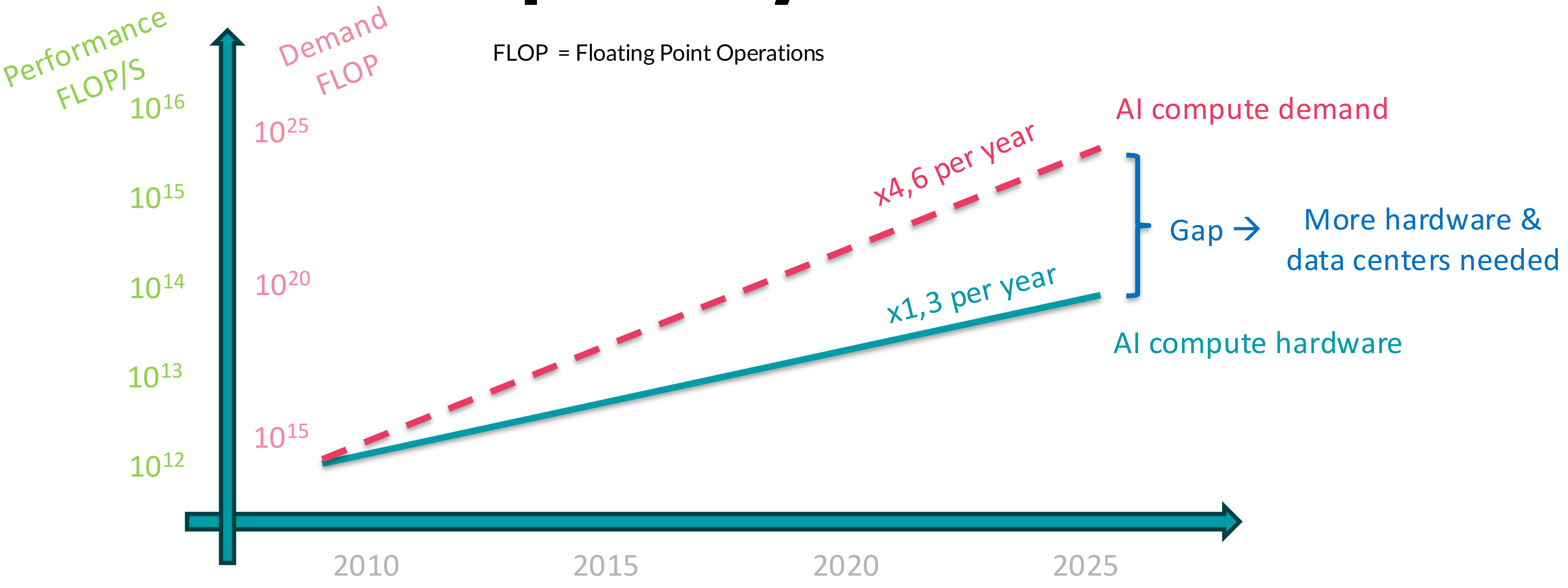


Demand is x4.6 per year

Hardware is x1.3 per year

Reference: Anastasiia Nosova at Green Computing in the AI Era conference 2025

AI compute demand & hardware capability



Message: The widening gap between AI compute demand and the pace of hardware performance improvements is a key driver behind rising energy use and the surge in data centre investments.

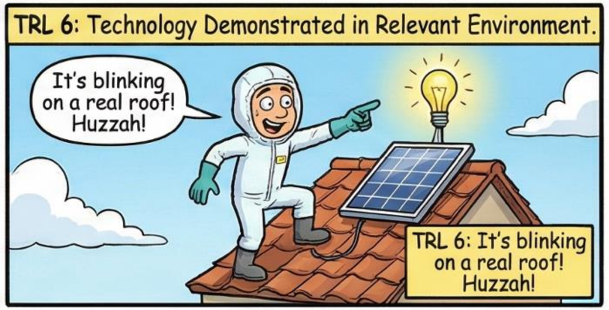
Reference: Anastasiia Nosova at Green Computing in the AI Era conference 2025

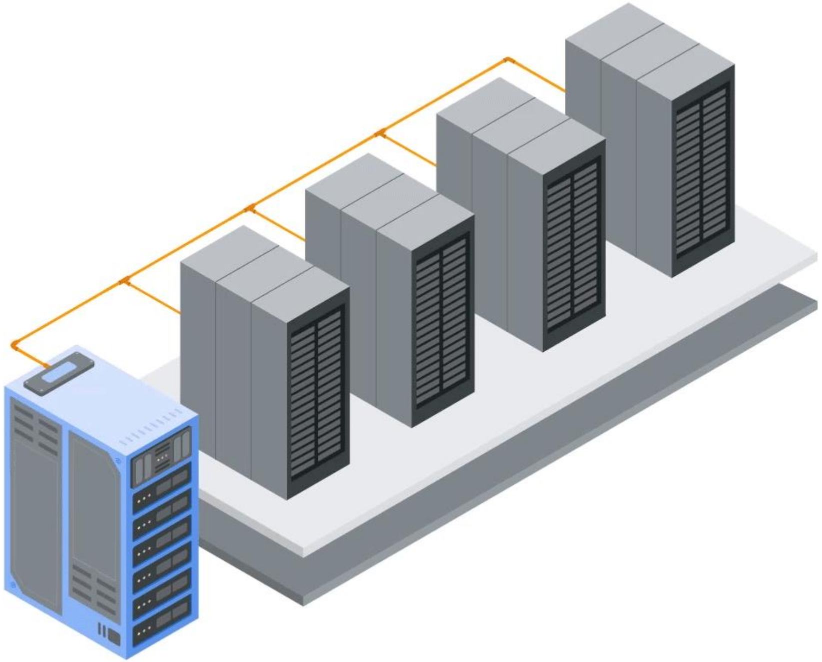
RI.
SE

Google Cloud

AI infrastructure is hot. New power distribution and liquid cooling infrastructure can help

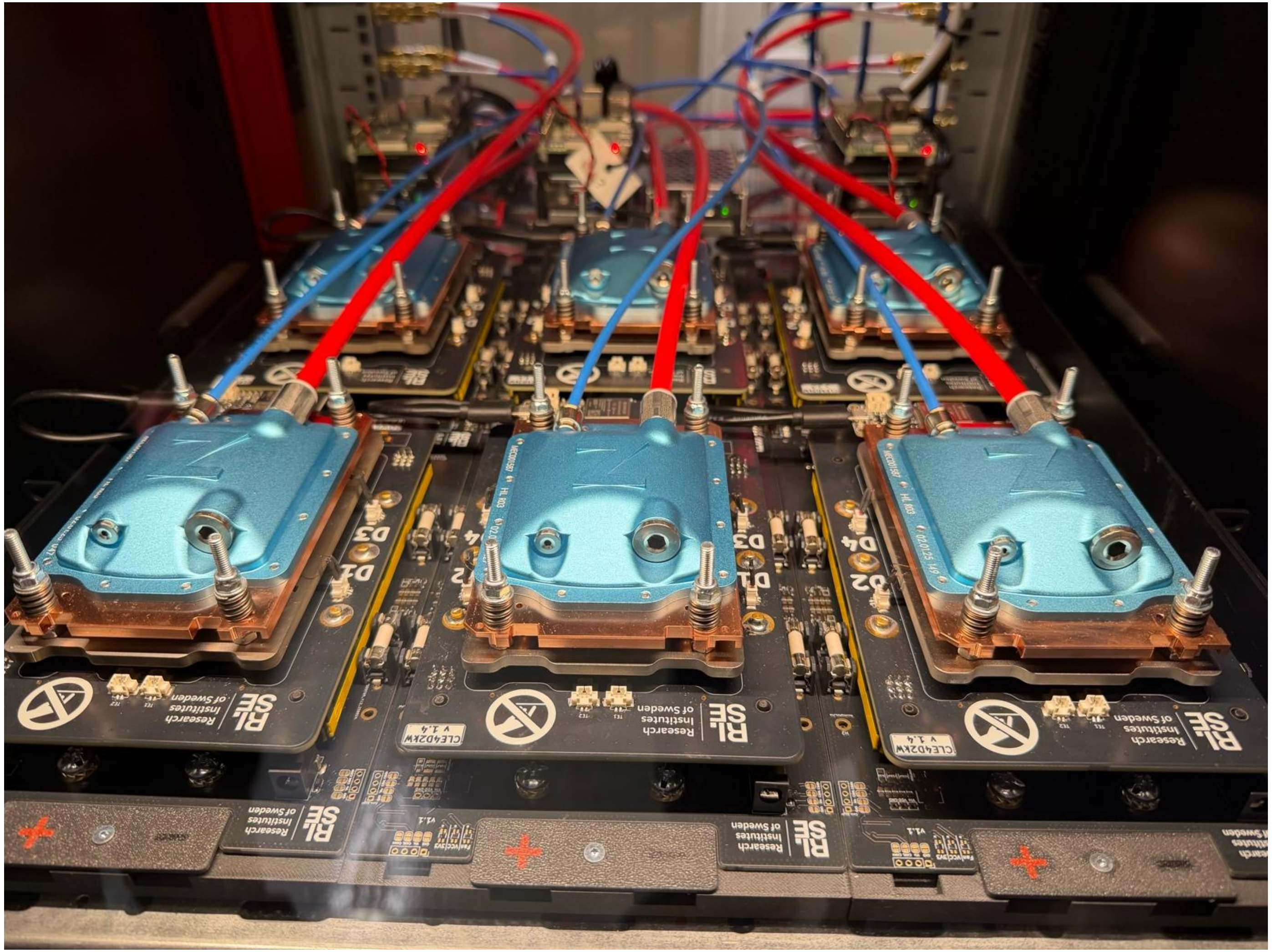
Transforming power delivery with 1 MW per IT rack

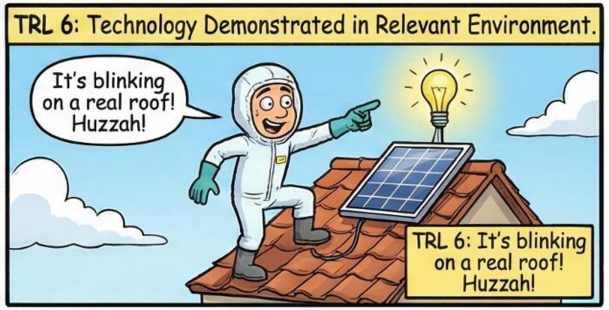




Reference: https://cloud.google.com/blog/topics/systems/enabling-1-mw-it-racks-and-liquid-cooling-at-ocp-emea-summit

RI. SE

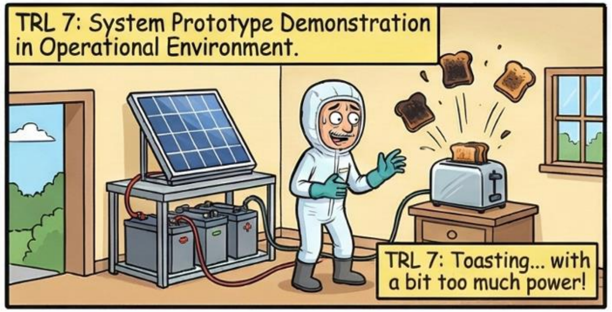


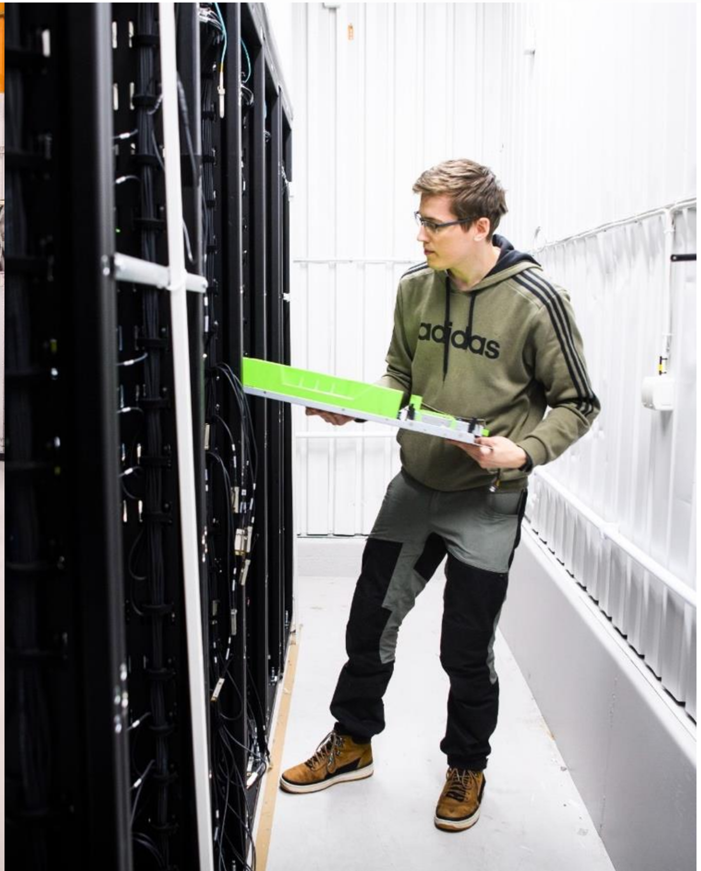


Chip load emulators (CLEs): CLEs, can reach 2kW each. CLEs are fully load and temperature controlled. They are designed to evaluate cooling performance of coldplates, 1- or 2-phase systems cooling systems, immersion solutions, air cooling or hybrid cooling units at high heatflux. It will then be possible to reach 30 kW in 2U or up to 700 kW in a full sized 19" rack.

Reference: https://www.ri.se/en/our-first-2u-server-emulator-of-12-kw-under-test

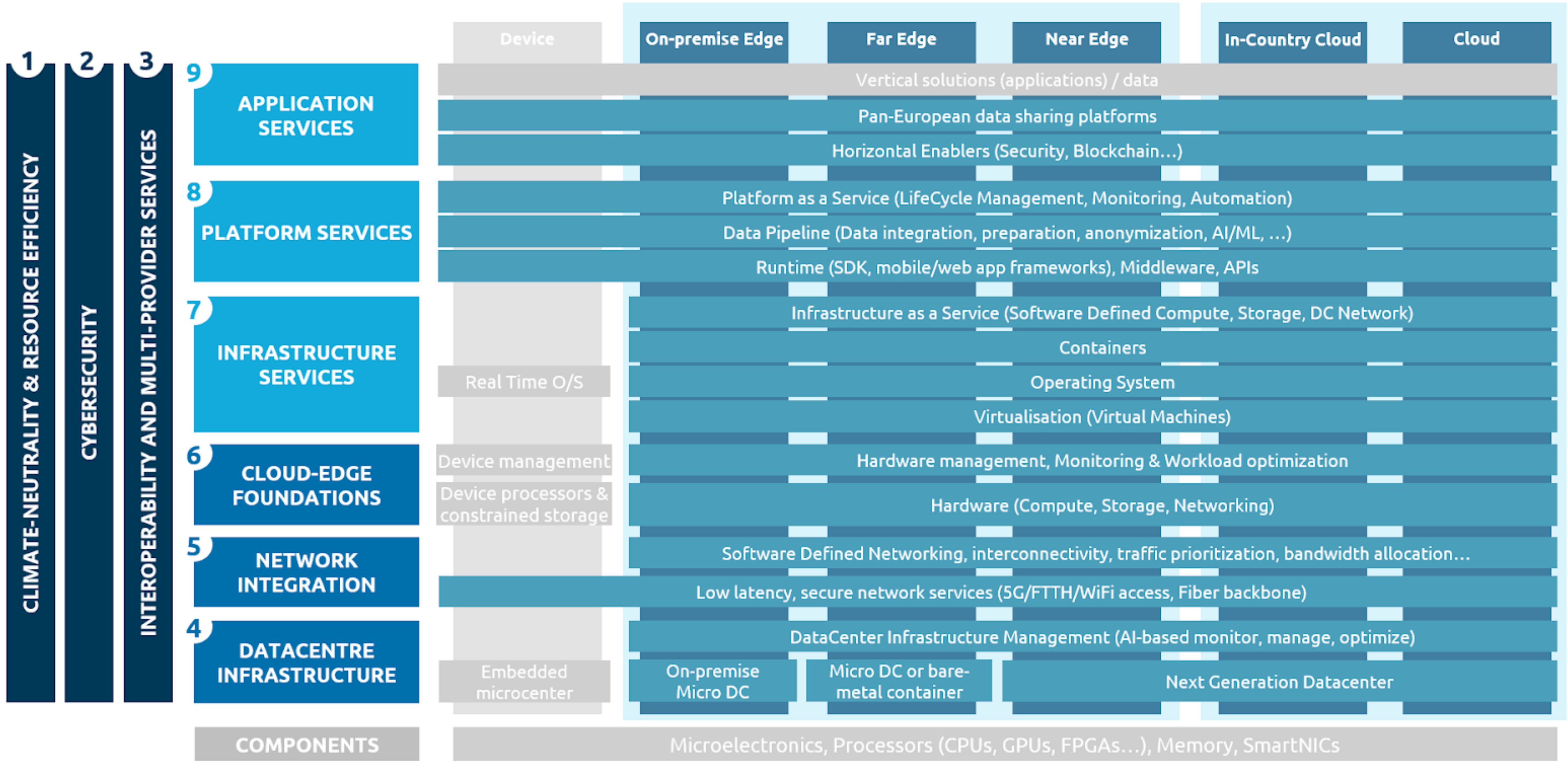
RISE ICE Data Centre





Technical scope of domains covered by the next generation cloud-edge industry roadmap

Out of scope of the Next Generation Cloud-Edge technology roadmap



Reference: European Industrial Technology Roadmap for the Next Generation Cloud-Edge Offering

RISE ICE Data Centre

RI.SE ICE Connect SERVICES PRICING HELP Log in / Sign up

Experimental Compute Cloud

Deploy and manage bare-metal servers or GPU VMs.

Experimental Kubernetes Cluster

Deploy, manage and monitor workloads on GPU Kubernetes cluster using Rancher GUI.

S3 Storage

ICE S3 is an object storage service powered by our Ceph cluster. Click here to manage your S3 storage buckets.

OpenNebula

Build your cloud and edge spanning virtual infrastructure using IaaS powered by OpenNebula.

GitLab

Harbor

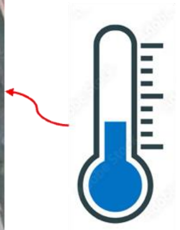
Discourse

ColonyOS

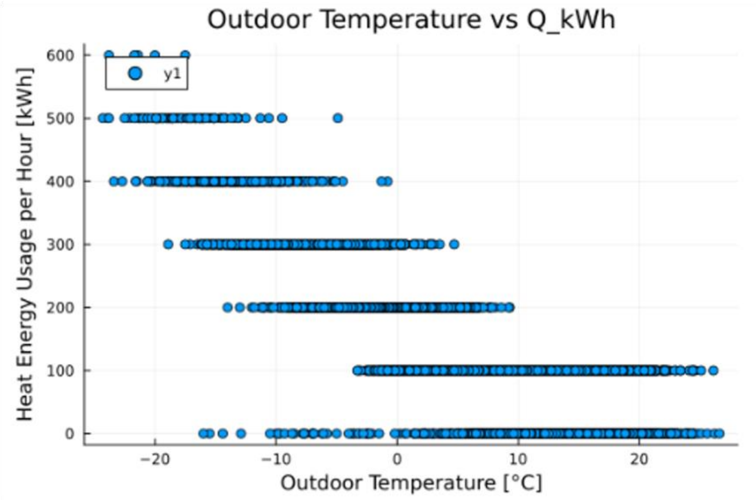
RI.SE

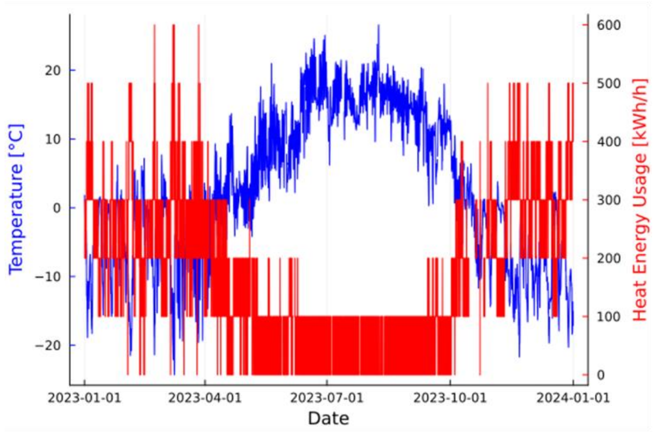
Digital twins

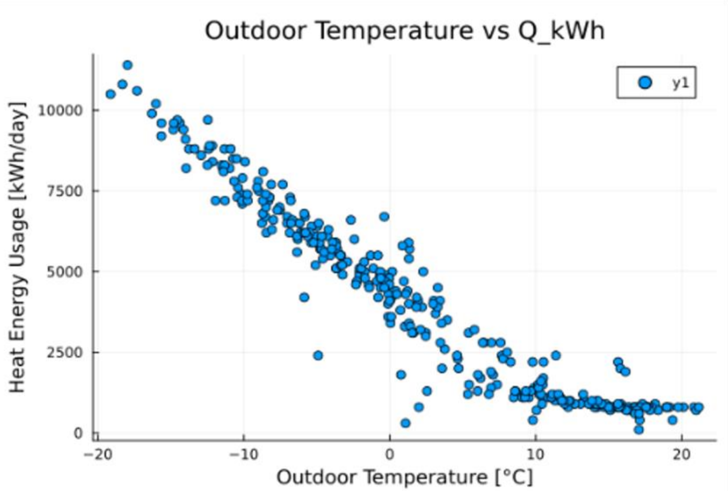
Industrial Building with RISE Pilot



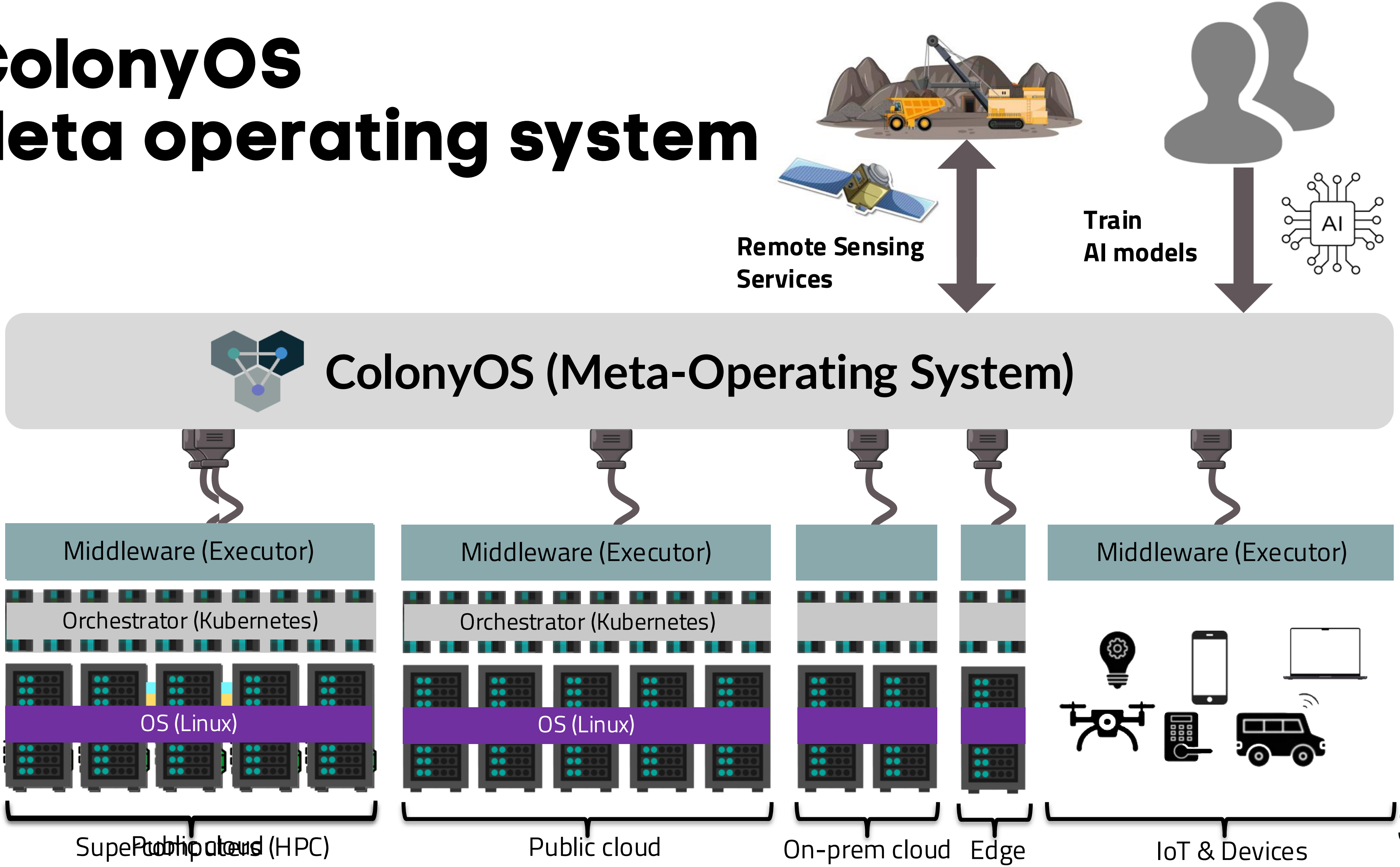
Outdoor temperature



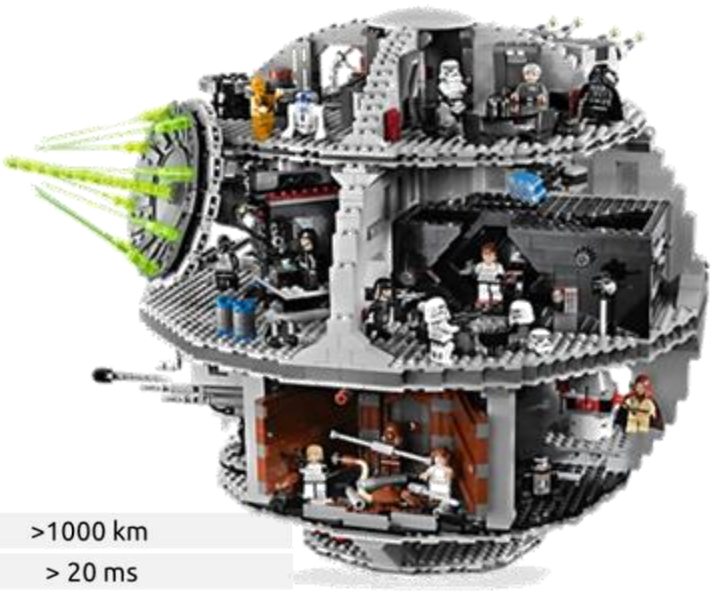


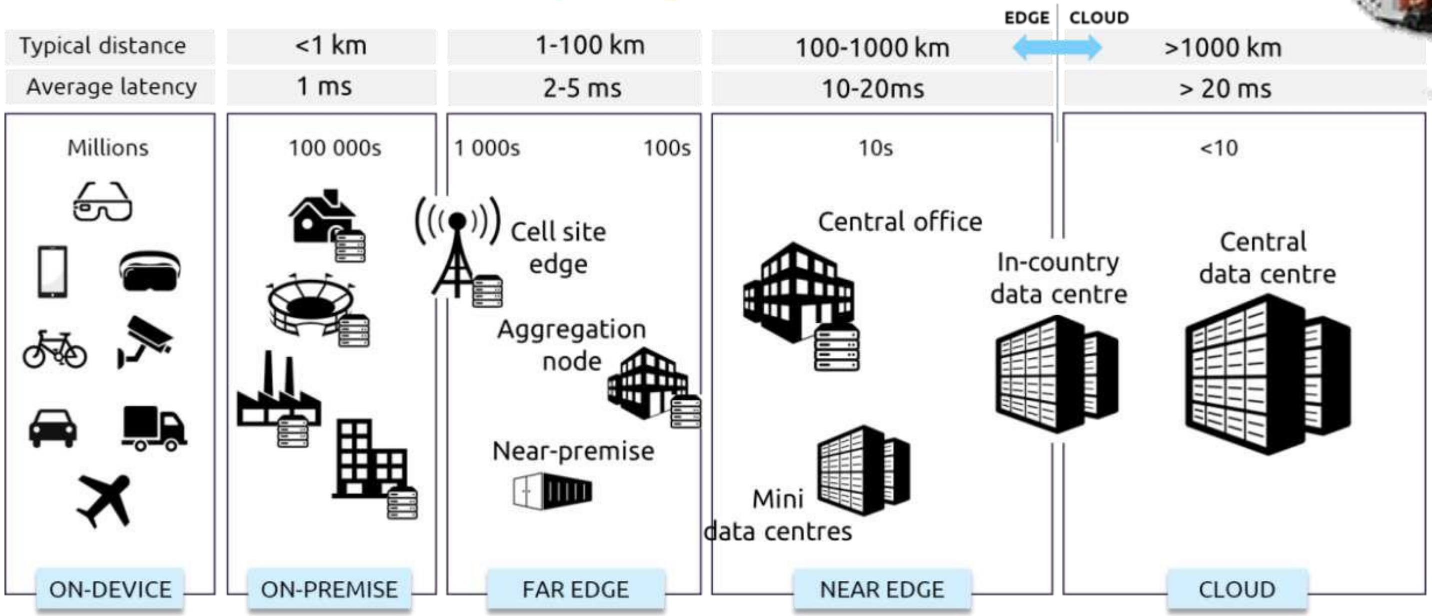


ColonyOS
Meta operating system



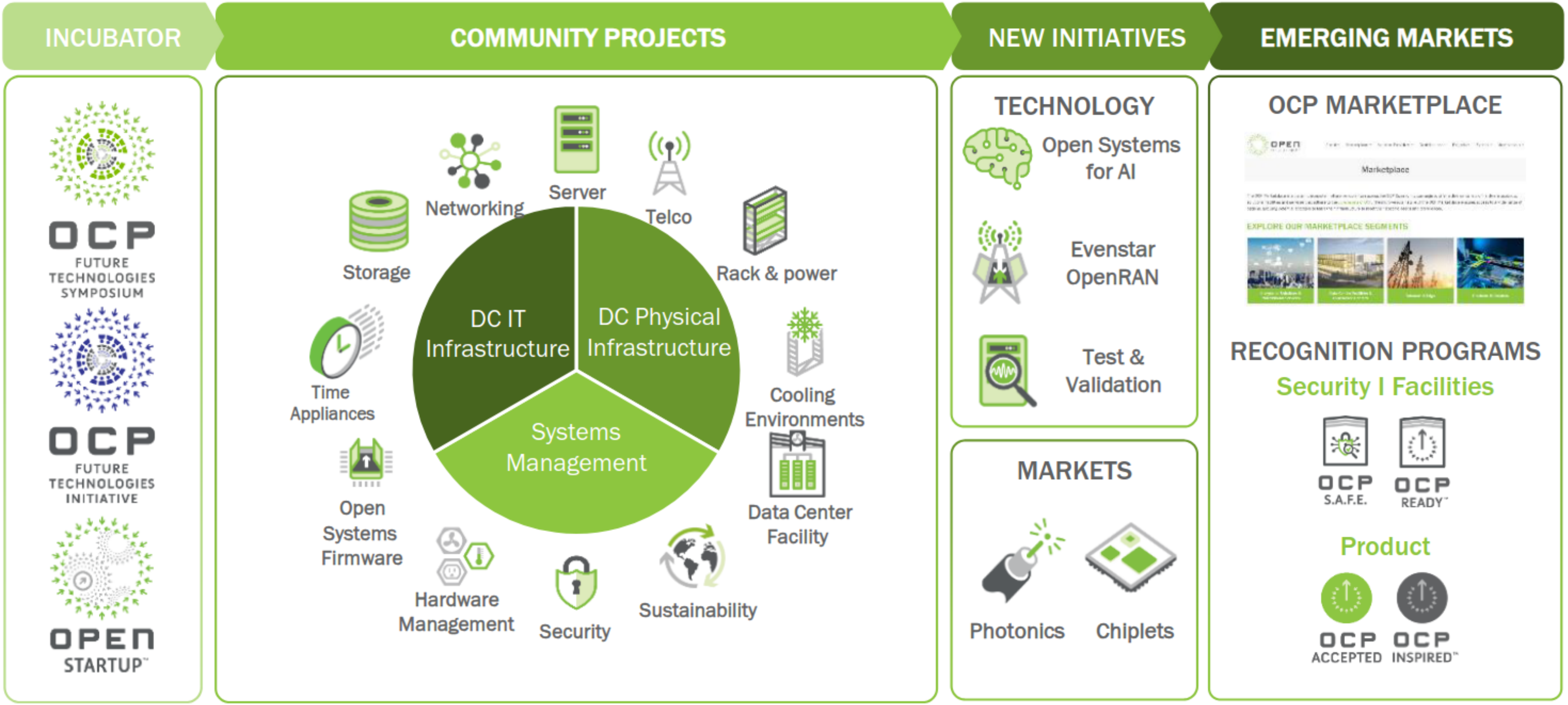
What is next?





Reference: European Industrial Technology Roadmap for the Next Generation Cloud-Edge Offering European Commission

Open Compute Project



Reference: European Industrial Technology Roadmap for the Next Generation Cloud-Edge Offering European Commission

Thank you…

RISE – Research Institutes of Sweden