Ecological Efficiency in Database Servers

Dresden Datenbankforum, Dec 16, 2025

Tilmann Rabl
Data Engineering Systems
Hasso Plattner Institute

Efficiency

- Measured in resources needed to perform a task
  - How many resources do I need for a task
- Not to be confused with performance
  - How much task can I do
  - How fast can I do a task
  - …with a given resource or just in general
- In (systems) research, we typically scale the task to the resource
  - In real life, task sizes are given and do not perfectly align with our resources

Car Analogy for Performance vs Efficiency

- Transport 200 kg cargo over distance S
- Truck needs 1 trip, drives 80km/h
- Super car needs 3 trips
  - Carry 100kg, go back, carry 100kg
- Speed ratio $V_{SC}=3V_T$
  - if $V_{SC}=240$km/h we can choose either

RND+ entdecken Newsletter Ticker US-Wahl 2024 Politik Krieg in N

Startseite › Panorama › Rekordfahrt auf der A2: Multimillionär rast mit 417 Stundenkilometern

Multimillionär rast mit 417 Stundenkilometern über die A2 – und veröffentlicht Video

Auf deutschen Autobahnen gilt kein Tempolimit. Bei freier Strecke kann man also aufs Gas drücken. Das dachte sich auch ein tschechischer Multimillionär, der mit seinem Bugatti eine Geschwindigkeit von fast 420 Stundenkilometern erreichte. Das Bundesverkehrsministerium kritisiert dieSpritztour.

20.01.2022, 11:41 Uhr

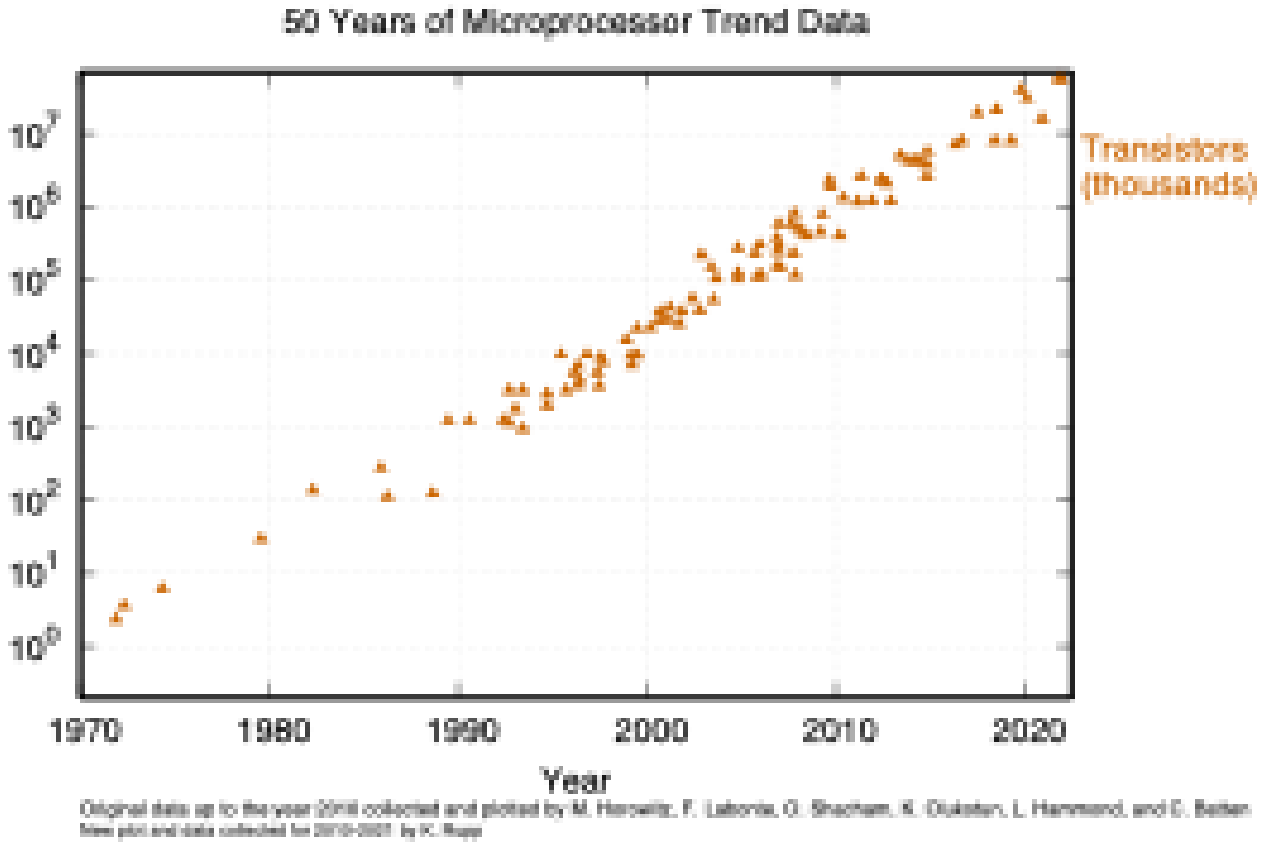
- Super car does 417 km/h

-> Of course we are better off using the super car (2x)

Slide “borrowed“ from Gustavo Alonso

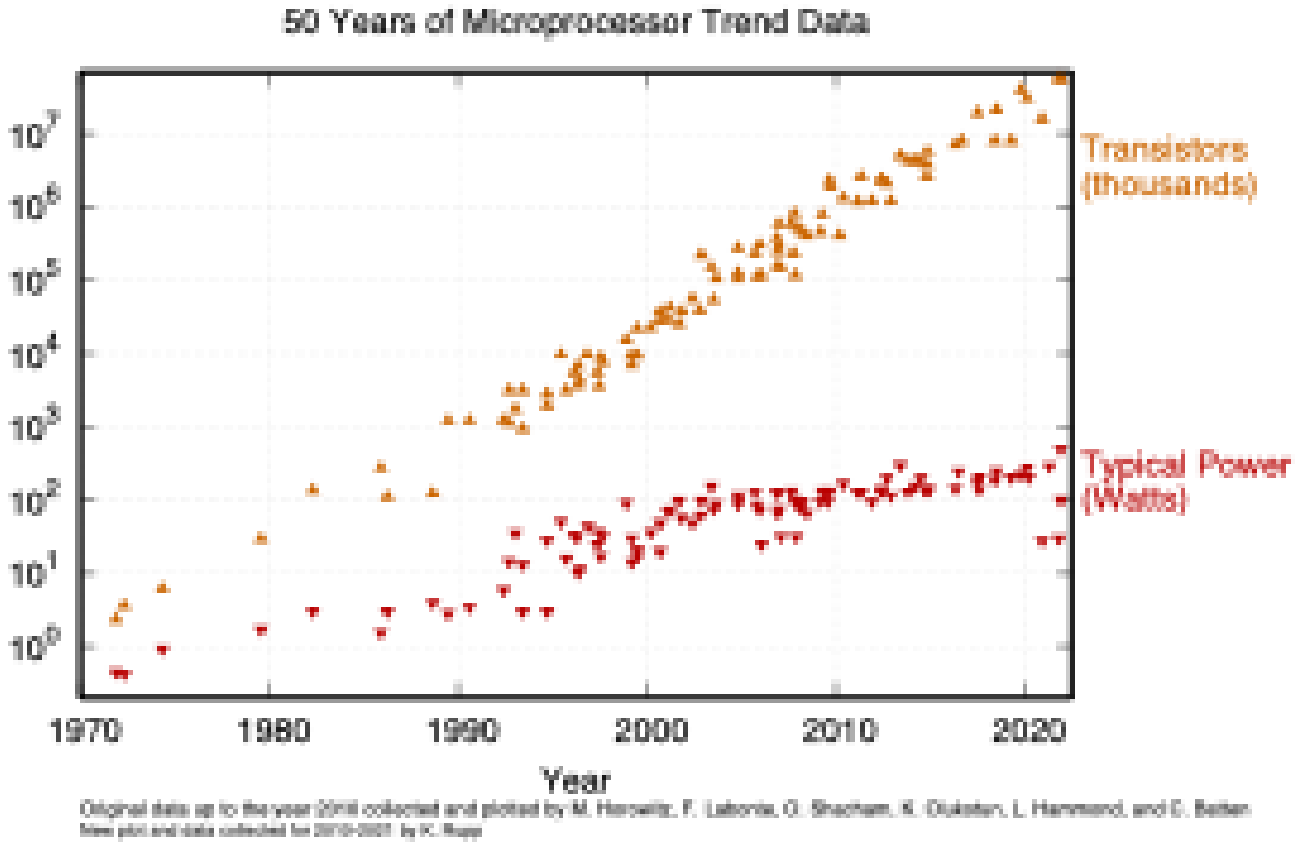
The Hardware Challenge

- Hardware performance is not simply increasing anymore



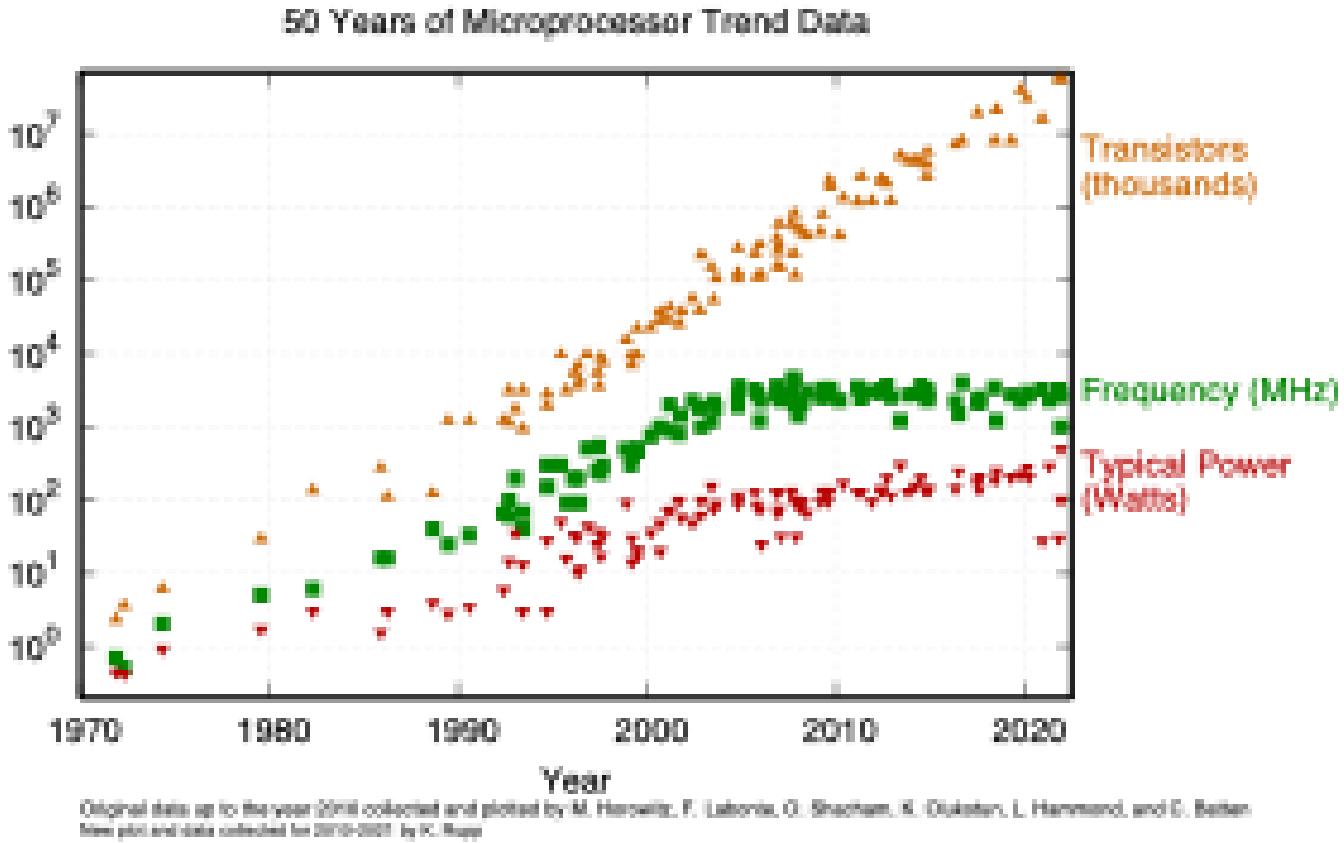
The Hardware Challenge

- Hardware performance is not simply increasing anymore



The Hardware Challenge

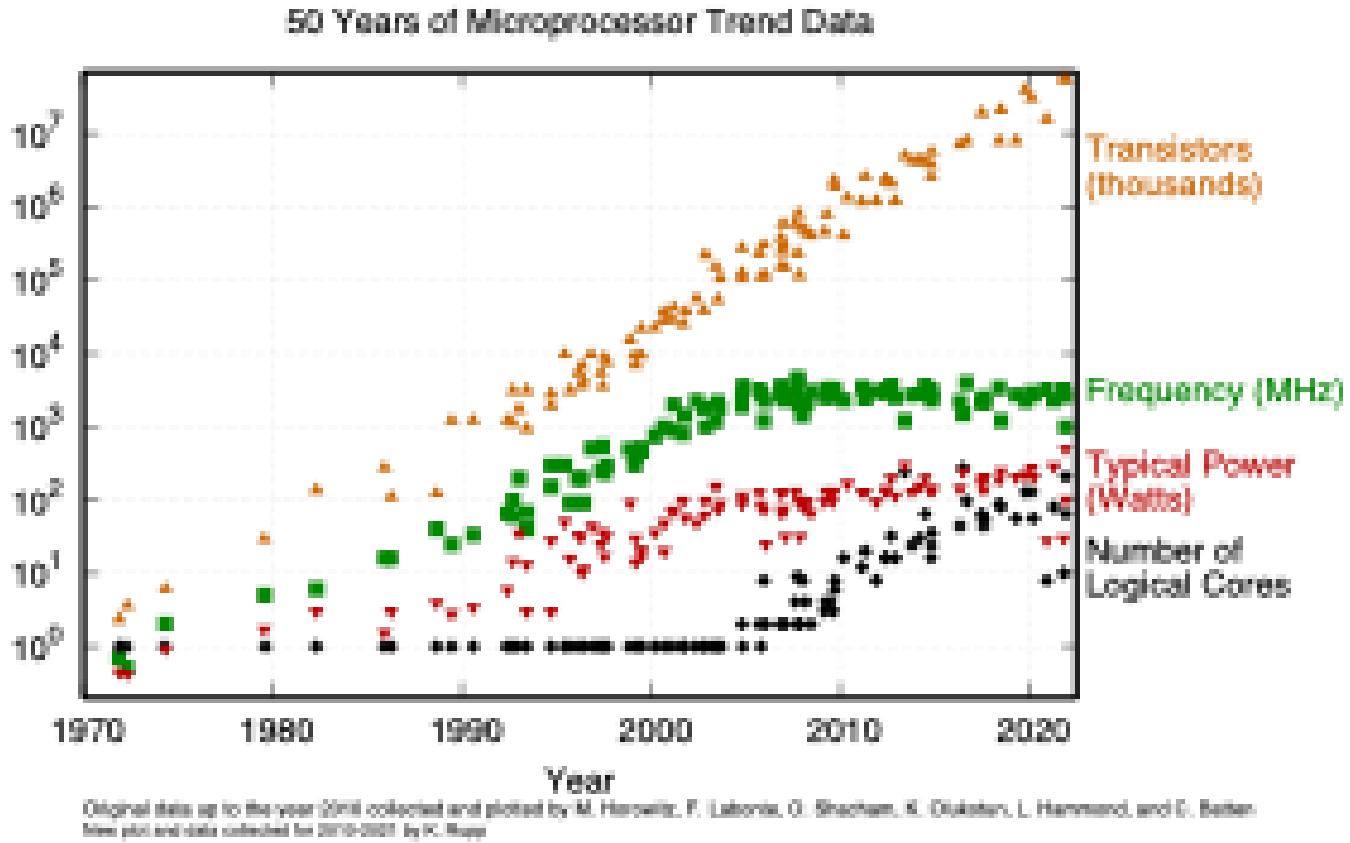
- Hardware performance is not simply increasing anymore



The Hardware Challenge

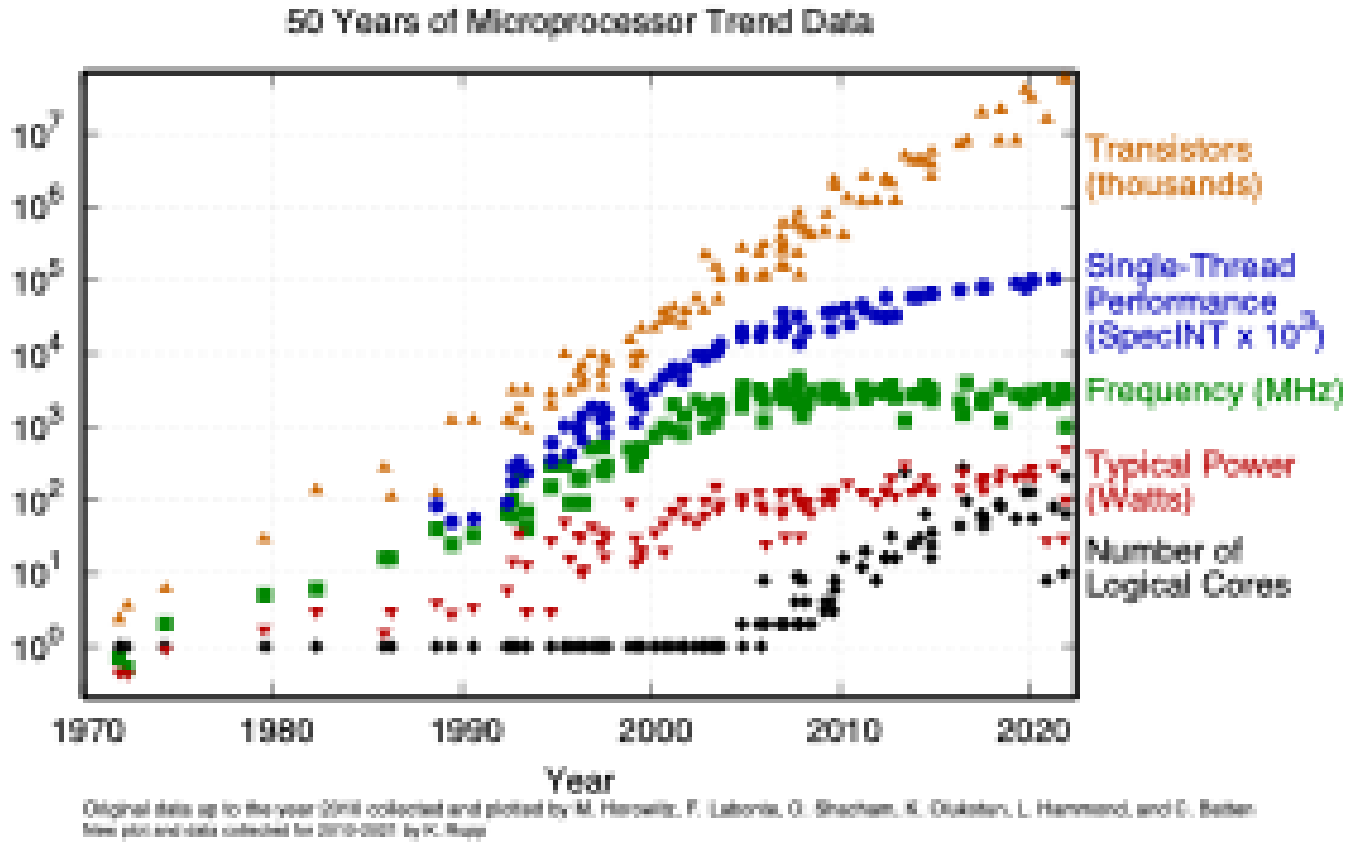
- Hardware performance is not simply increasing anymore

- Single thread
  –> multi thread



The Hardware Challenge

- Hardware performance is not simply increasing anymore
- Single thread
  –> multi thread
- Multi core
  –> specialization
- It is getting harder to be efficient



Wirth’s Law

- Software is getting slower more rapidly than hardware becomes faster

(c) Tyomitch
commons.wikimedia.org/w/index.php?curid=449735

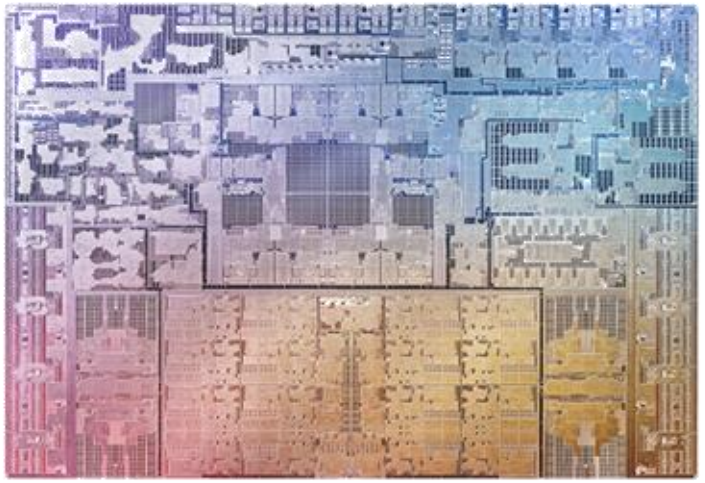
The challenge:

- What to do when hardware does not become faster anymore?

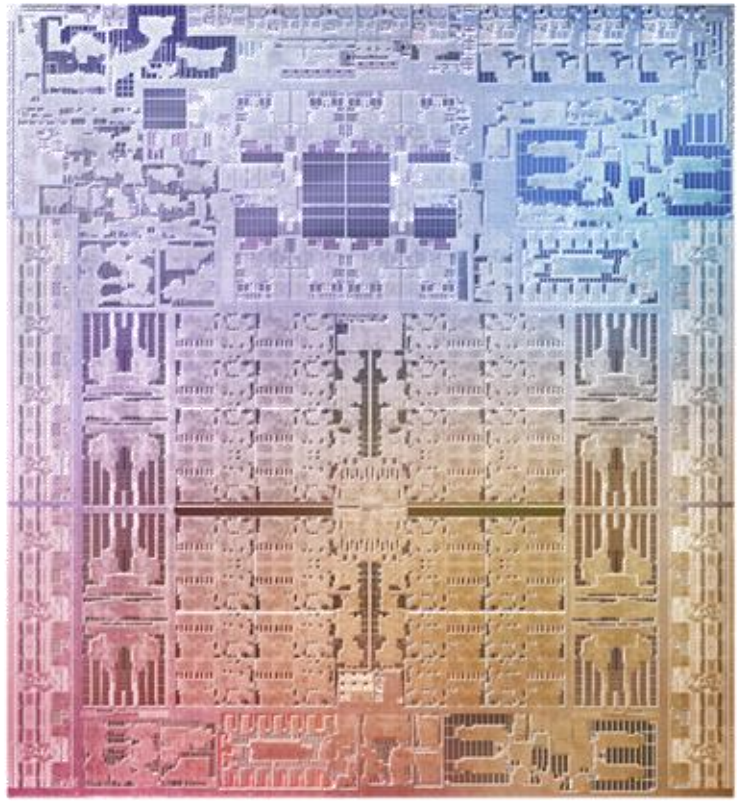
How do we get hardware performance today?

- Size
  - M1 ~ 120mm^2
  - M1 Pro ~ 250 mm^2 (2x)
  - M1 Max ~ 430 mm^2 (3,6x)
  - M1 Ultra ~ 860 mm^2 (7,2x)

M1

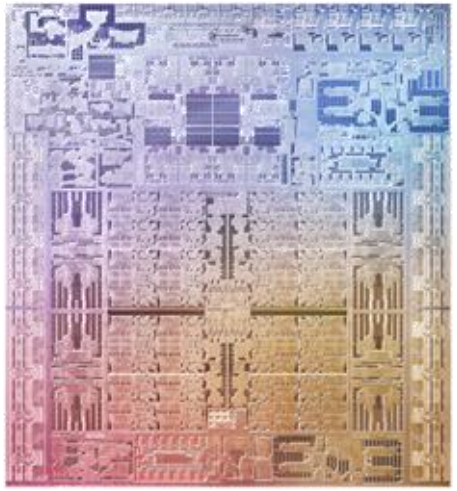


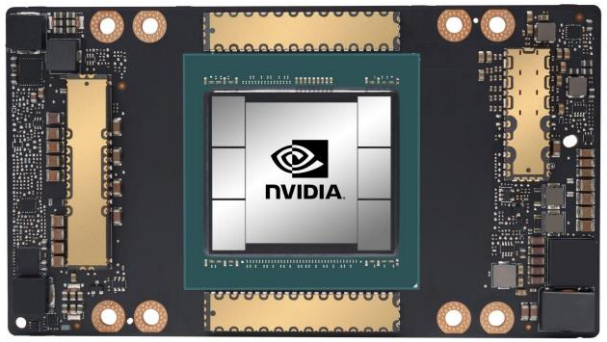
M1 Pro



M1 Max

Power: Thermal Density Power





M1 Max*

- 92 W
- 430 mm²
- TDP/mm² = 0,21

NVIDA H100 SMX$

- 700 W
- 814 mm²
- TDP/mm² = 0,86

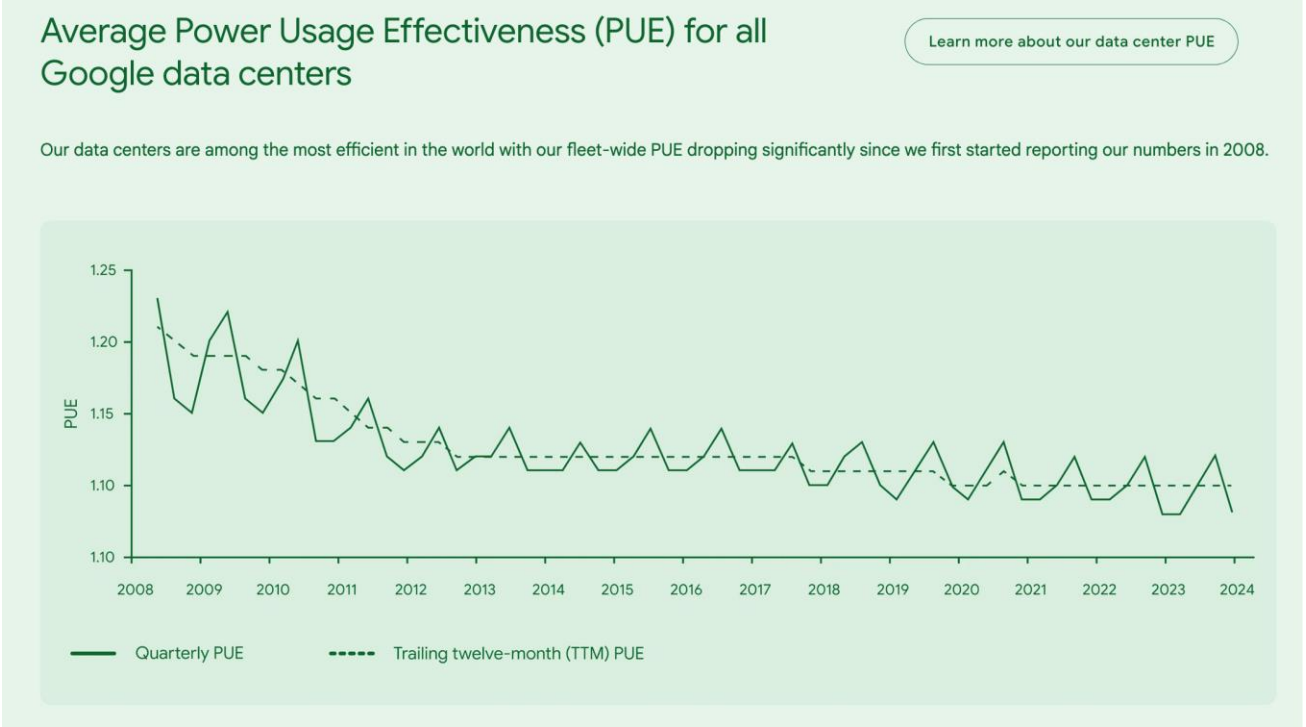
Hot plate+

- 1520 W
- 180 mm diameter ~25400 mm²
- TDP/mm² = 0,06

+https://www.mediamarkt.de/de/product/_ok-osp-1520-w-2606514.html
*https://www.anandtech.com/show/17024/apple-m1-max-performance-review/3
$https://hawkvelt.id.au/post/2024-08-04-nvidia-h100/

Data Center Trends

- Data centers are becoming more efficient in terms of cooling and operation
- Google's PUE = 1.1
- PUE = 1 means all energy goes to servers



https://datacenters.google/operating-sustainably/

- A typical car's AC increases fuel consumption by 10%
- Does this say anything about fuel economy?

Google Data Center Eemshaven

Side note: Gaming

PS1 1995
10W

PS2 2000
46W

PS3 2009
190W

PS4 2013
150W

PS5 2020
200 W