Performance and consumption of cpu-bound workloads over various architectures

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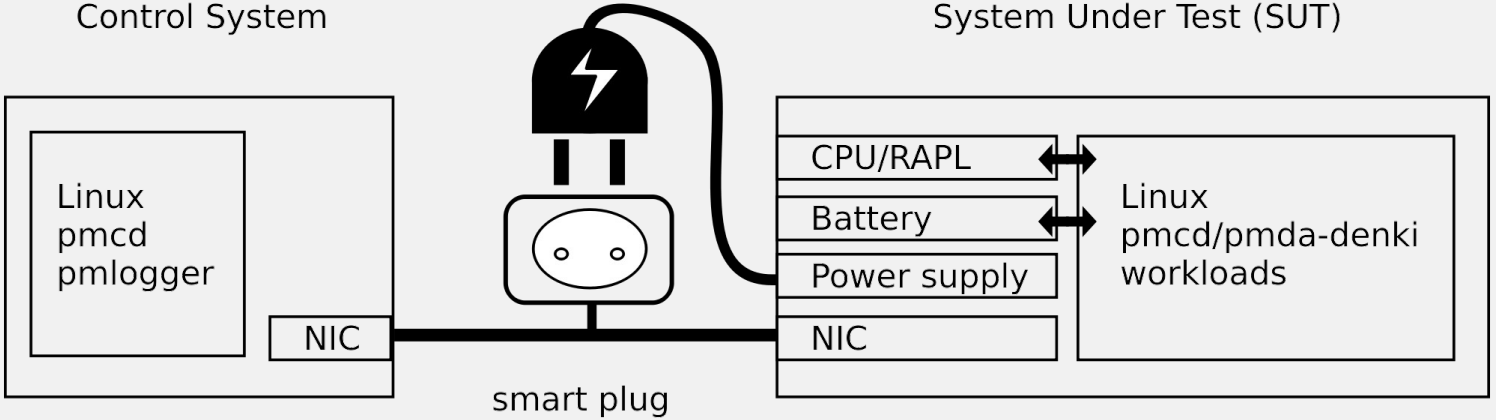
- What
  - Motivation:
    - Since inception of pmda-denki, new research projects keep appearing.
    - I looked at my Star64 (RISC-V board), a Thinkpad T590, Apple MacBook M2, Raspi4, SteamDeck. The Raspi4 is slower than the MacBook, but also uses less power.. is it more efficient?
  - How compare these systems regarding performance and efficiency?

- Why?
  - There is a climate crisis going on. We are directly impacted. Our children are asking us what we are doing about it.

The Test Setup

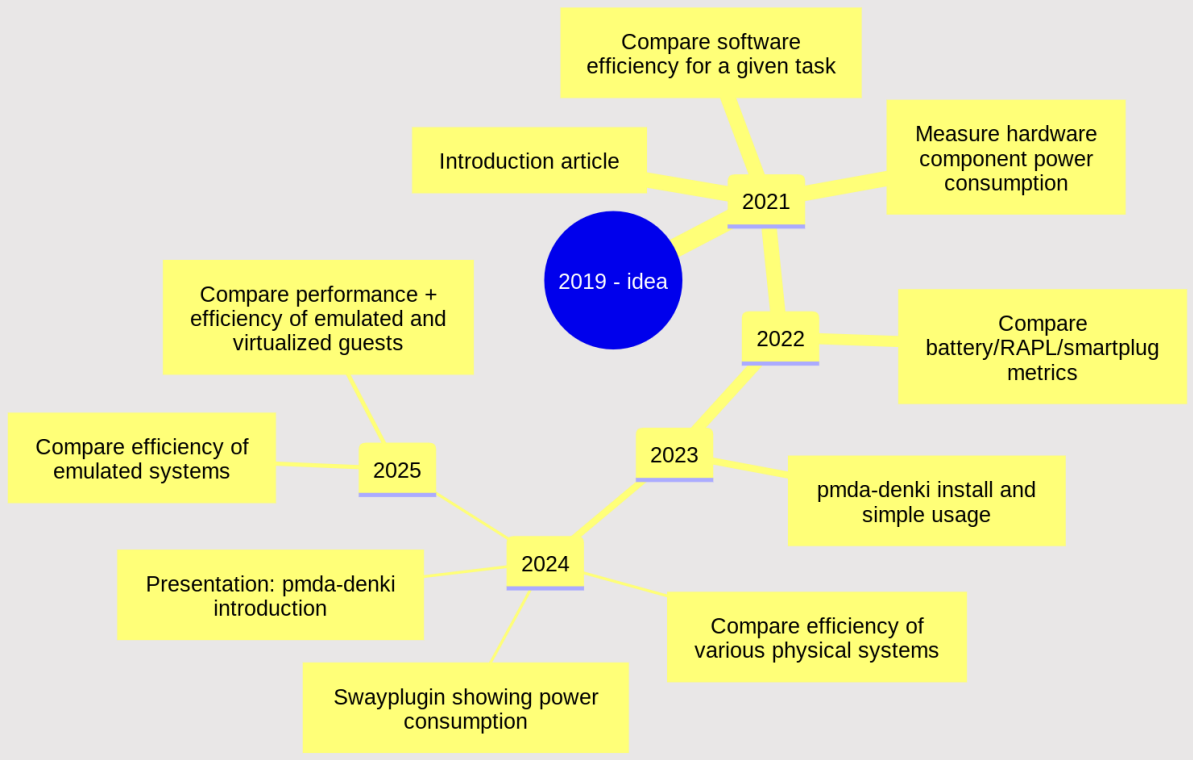


- Control System: Linux, Ansible
- SUT: Thinkpad, Raspi4 etc.

pmda-denki history

Stack:

- Ansible
- Python
- Performance Co-Pilot (PCP) w/ pmda-denki
- Bash



What makes a good test workload?

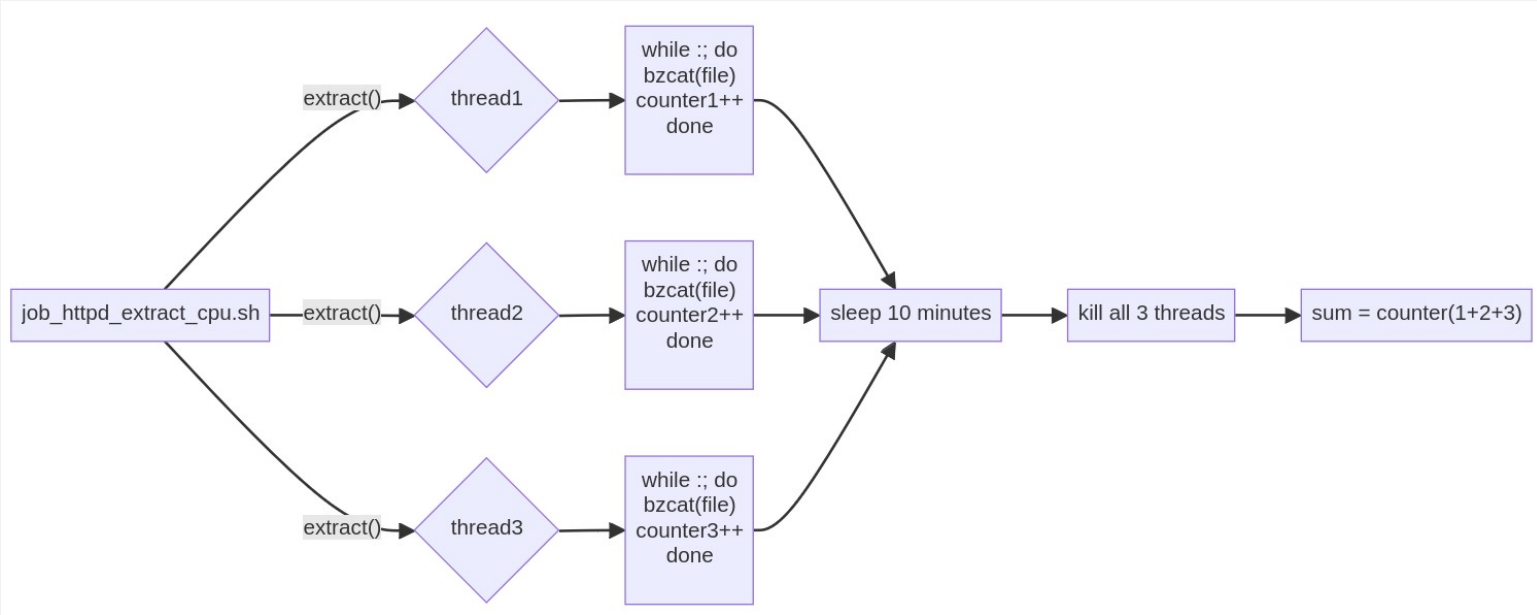
- Network, Memory size, Memory throughput, storage I/O:
  - Not the bottleneck in most cases
  - Consumes not much power
  - Can often easily be replaced, i.e. NIC’s
- CPU
  - major bottleneck
  - main power consumer

  => Let’s look at that.

Selecting the best CPU workload

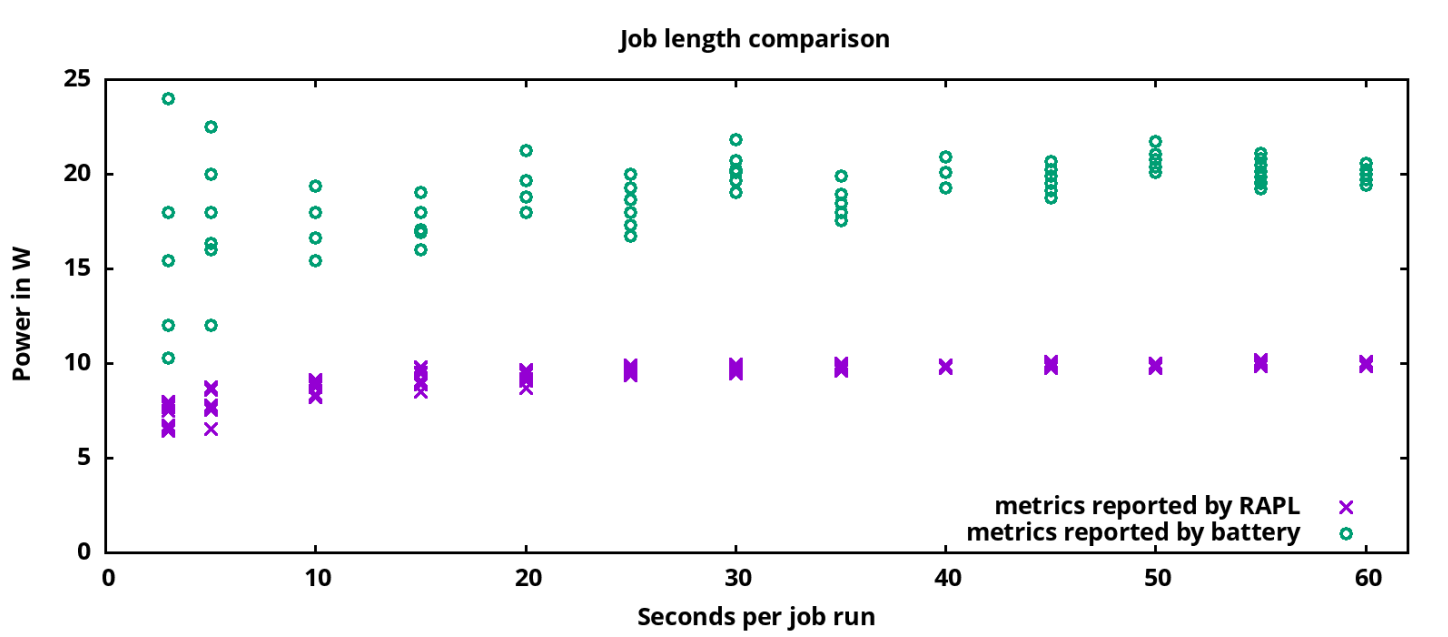
Workload	Short runtime?	Includes various workloads?	Easy setup?
SPEC suite	---	+++	---
OpenSSL's ("openssl speed")	-	-	++
make world	--	+	-
bzcat uncompression ("bzcat <file.bz2>")	++	-	++

Job Loops



- Let’s start multiple loops, each constantly extracting data
- After 10 minutes count the completed extract operations

Find optimal job runtime

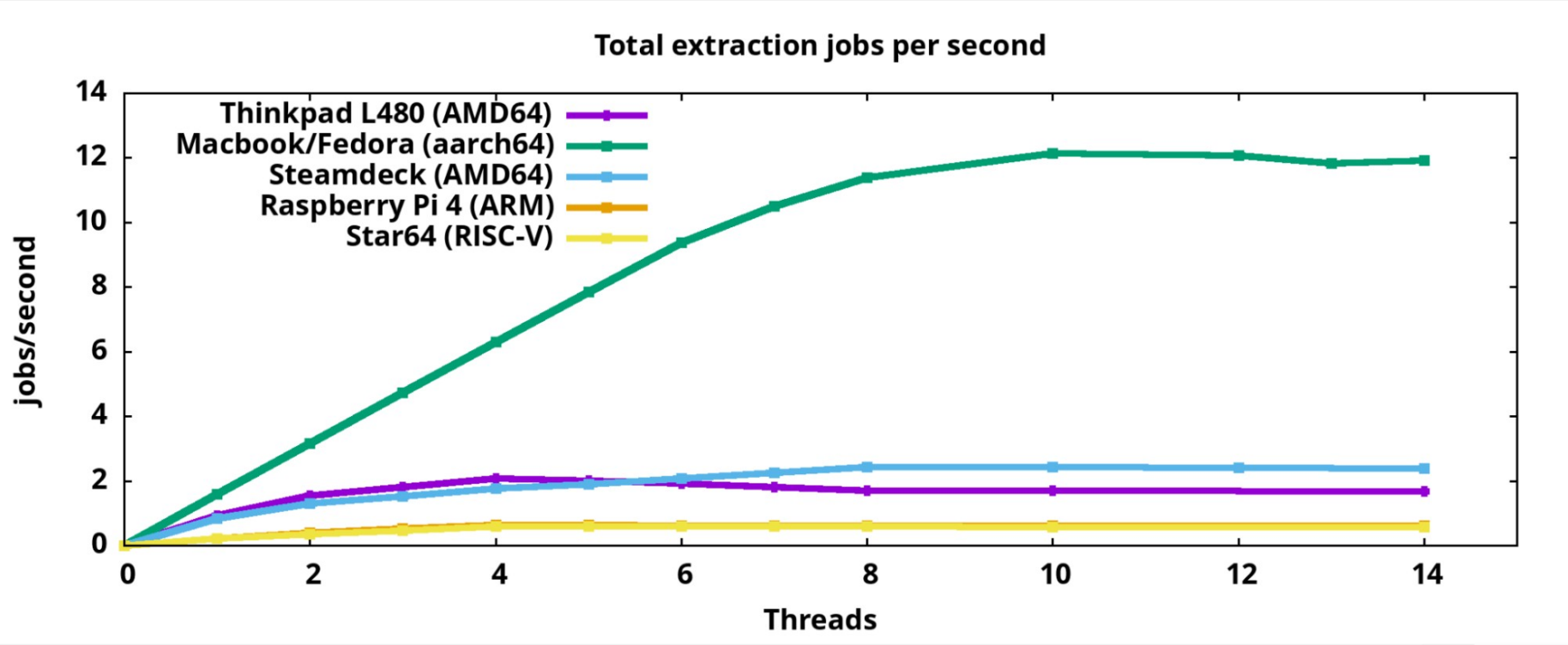


- Which job runtime do we need to get reliable results?
- => 60sec looks good as per this graph, so I used 300sec to be sure.

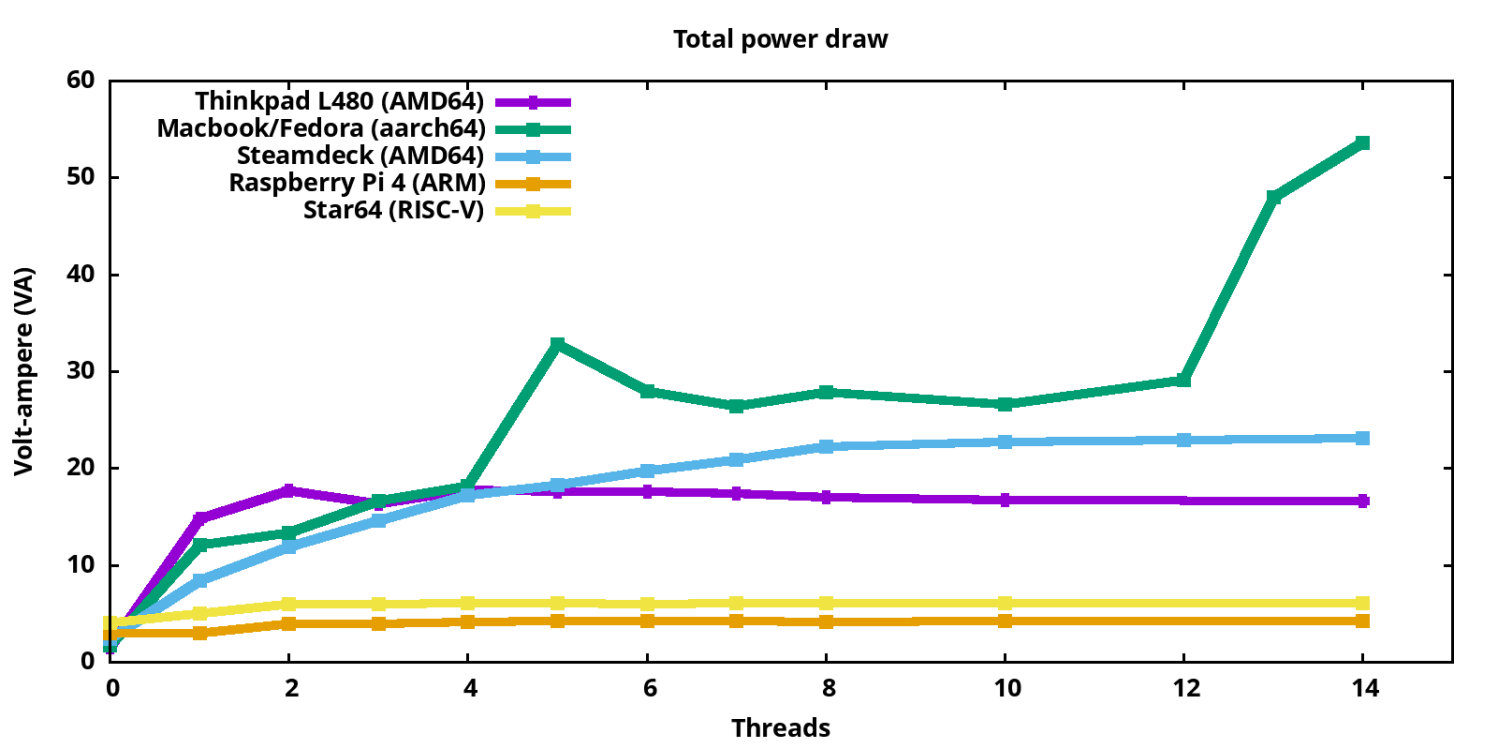
Our contenders:

- Thinkpad L480: x86_64, model released 2018, an 8th gen Intel i5-8250U CPU (14nm), configured for 4 cores without hyperthreading. For this system, all three sources to measure power consumption are usable.
- Macbook Pro Asahi Fedora remix: 10 core AppleSilicon M2 CPU (5nm), which is an aarch64 design. Model from 2023. Due to the high number of cores, up to 10 threads can be run on separate cores.
- Steam Deck: AMD CPU with 4 cores/8 threads (7nm), released 2022
- Raspberry Pi 4: 4 core (16nm) aarch64 system from 2019
- Star 64: RISC-V board with 4 cores, introduced 2023
- Sun Ultra5: sparc64, 1 core UltraSPARC IIi (270Mhz, 0.35 µm (350nm)), released 1998, running Linu^WNetBSD

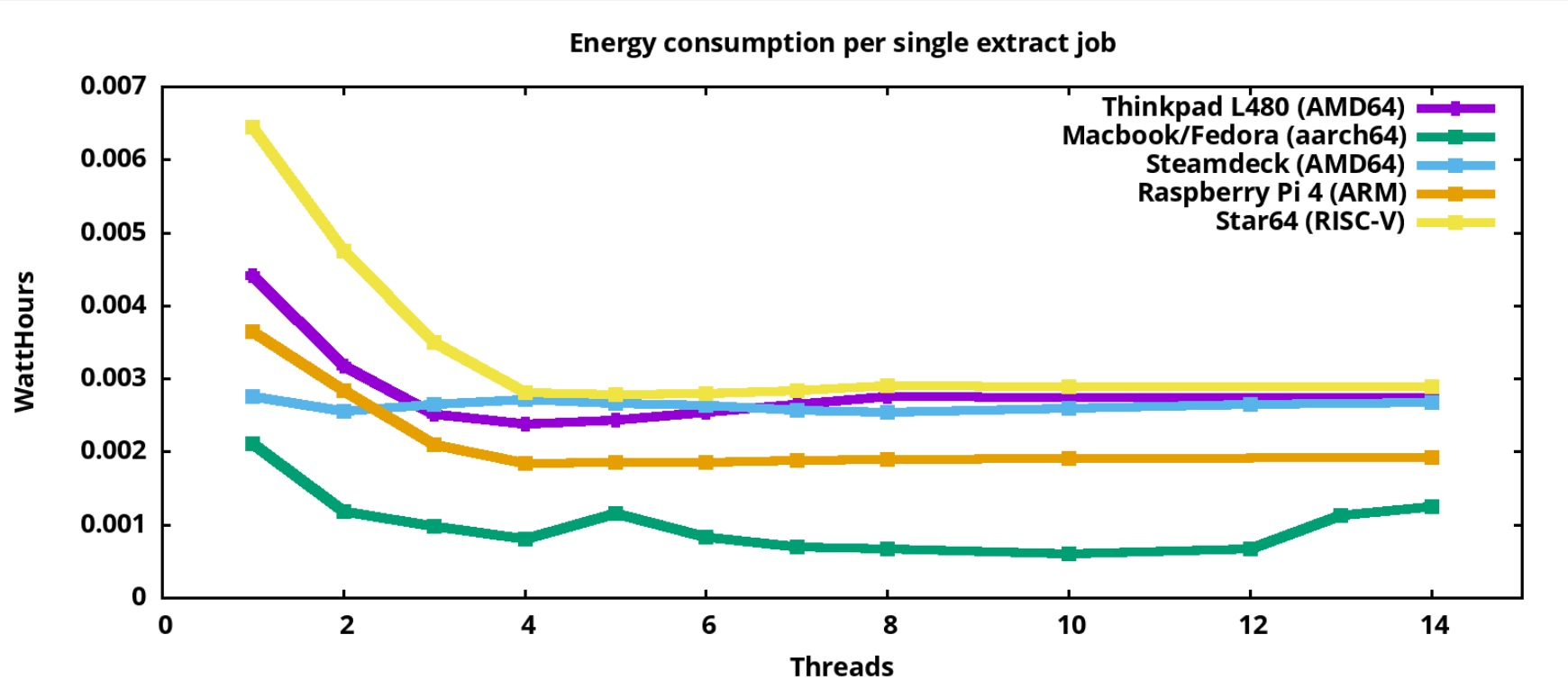
Results: performance



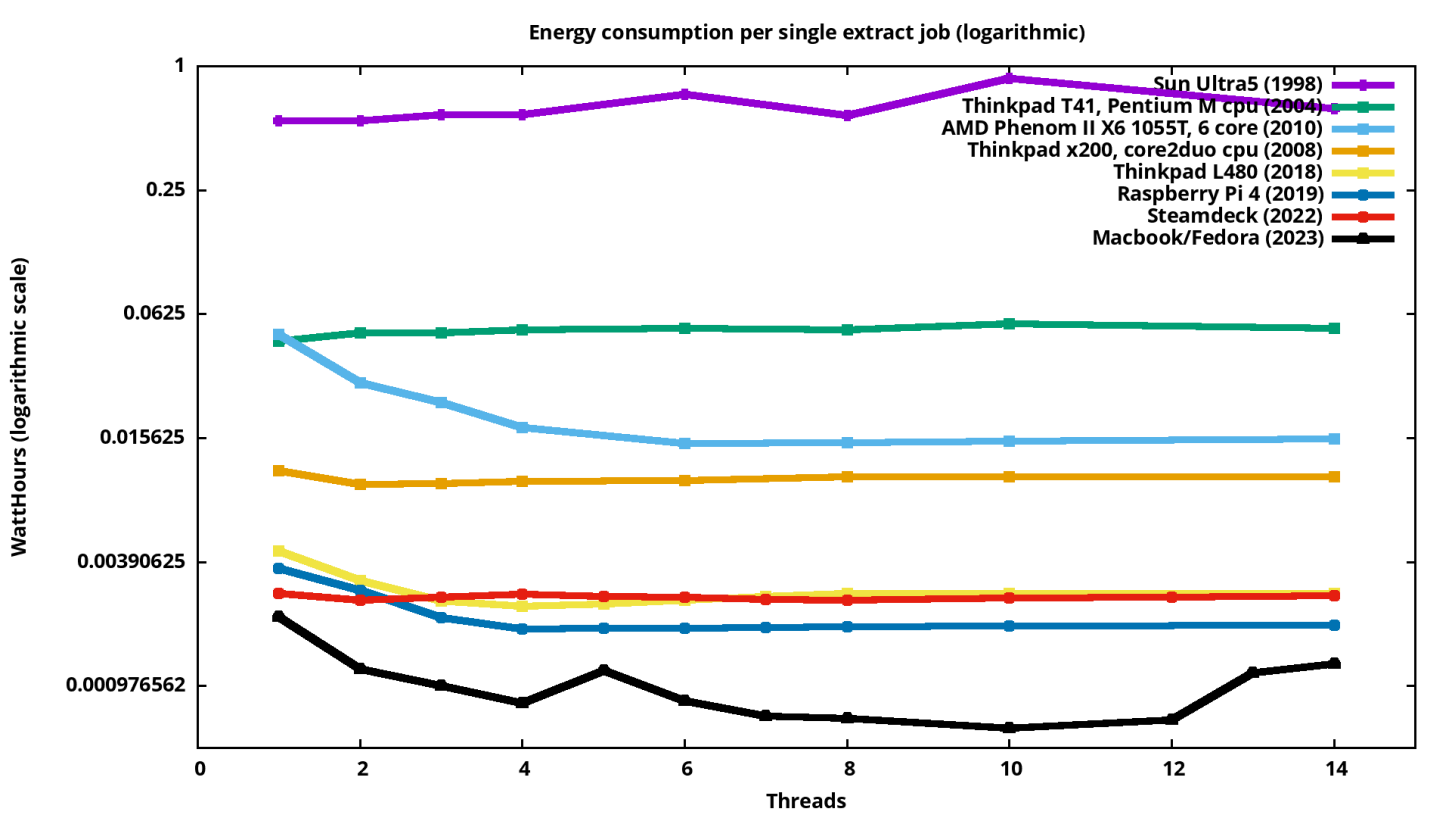
Results: total power draw



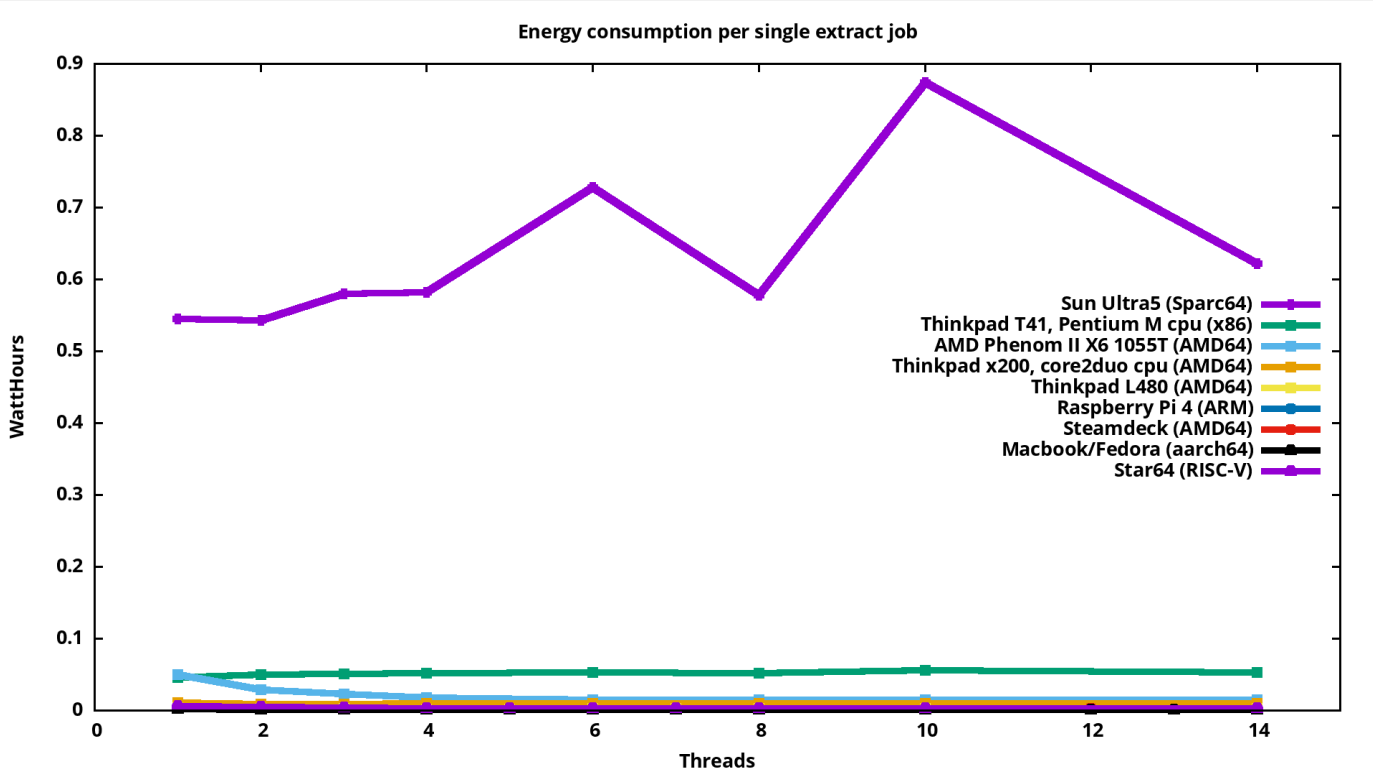
Results: Efficiency



Results: Efficiency + UltraSPARC



Results: Efficiency + UltraSPARC



Links

- This topic as article:

  Is a slow but low-consumption system more energy efficient?

- The pmda-denki handbook links to various investigations around pmda-denki
- The code: https://github.com/christianhorn/smallhelpers
- More on pmda-denki on the blog

Thanks!

ありがとうございます

Danke!

Спасибо

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