



Energy-Aware Computing Team at the Professorship for Operating Systems and Middleware



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We try to understand energy demand as a critical operating resource of computer systems, under the consideration of hardware aspects.

osm.hpi.de/energy

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Chart 2

How to control power consumption of computing lab operation?

- 1. Work differently:** Use fewer/additional compute resources
(commonly used to scale depending on operating requirements)
- 2. Work another time:** Defer/pick jobs with matching energy profile
(popular research in embedded systems, requires known and deferrable jobs)
- 3. Work elsewhere:** Use other hardware components

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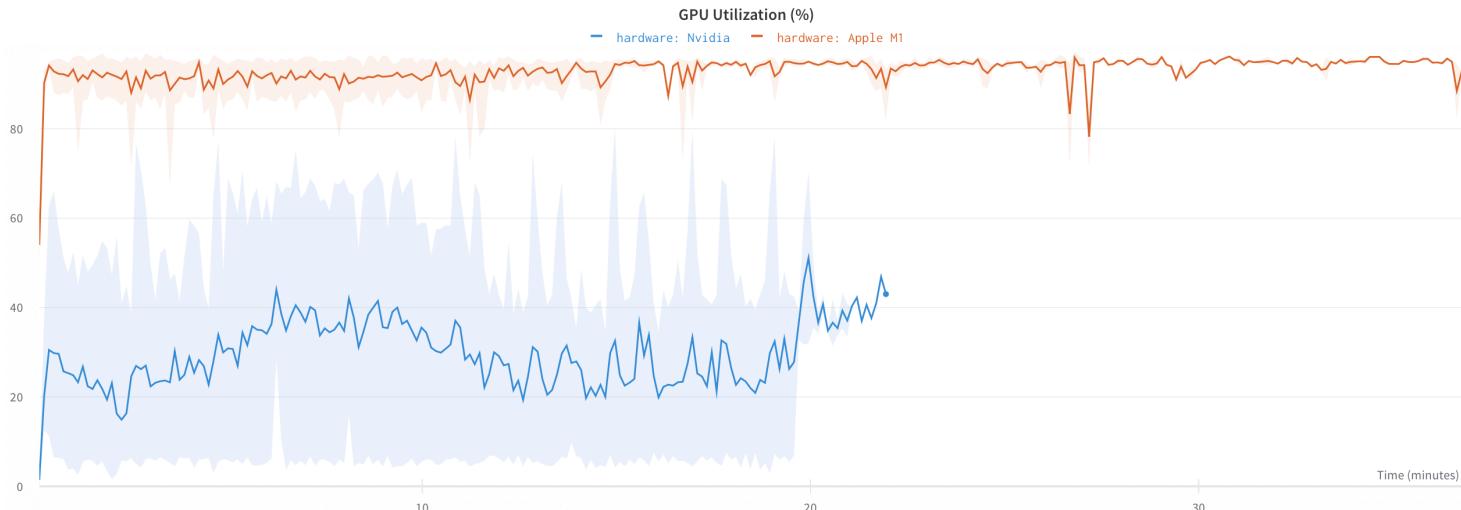
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Chart 3

Focus of our research at the OSM group

Approach 1: Balanced Hardware for the Workload at Hands

- Observation: Many workloads are unable to exhaust high-end GPUs
- Approach: Use balanced hardware that is optimized for efficiency.



[Image source: <https://wandb.ai/vanpelt/m1-benchmark/reports/Can-Apple-s-M1-help-you-train-models-faster-cheaper-than-NVIDIA-s-V100--VmlldzozNTkyMzg>]

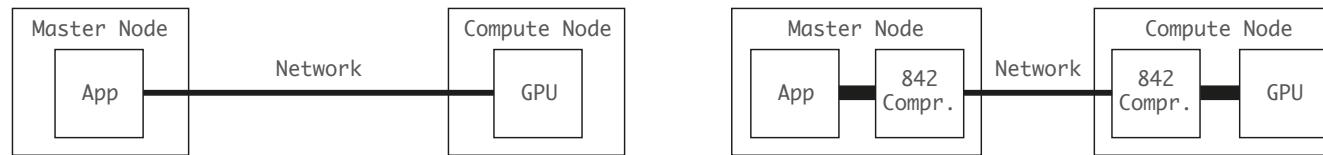
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Chart 4

Approach 1: Balanced Hardware for the Workload at Hands

- Case study: using compression to increase data transfer efficiency



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SPECIAL ISSUE PAPER

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Improved data transfer efficiency for scale-out heterogeneous workloads using on-the-fly I/O link compression

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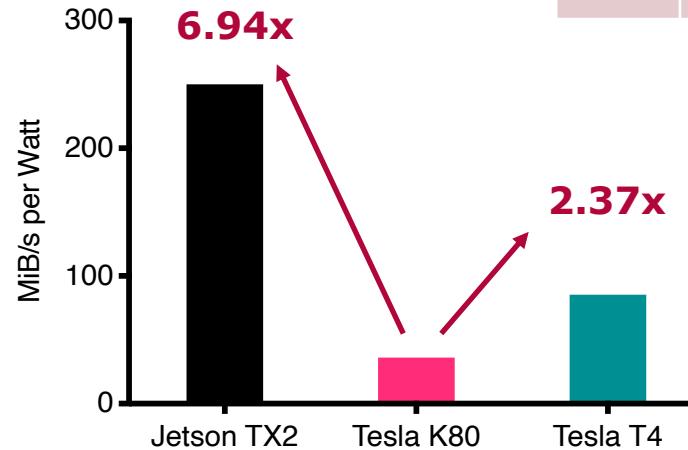
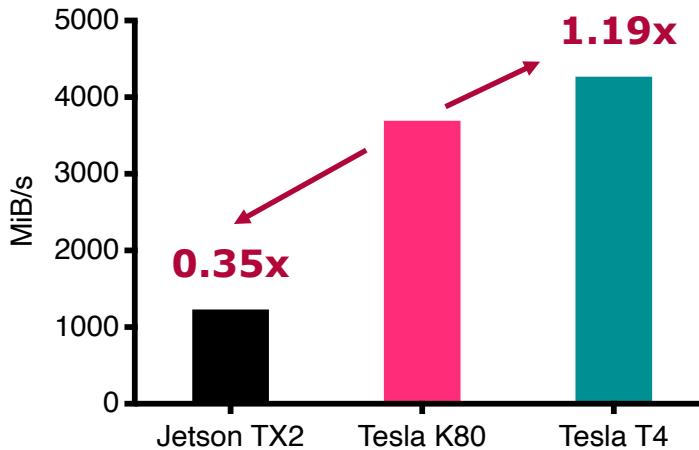
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Chart 5

Approach 1: Balanced Hardware for the Workload at Hands

- Key component: GPU-based decompression for 842 compression scheme
 - Baseline: Tesla K80
- Jetson TX2: maximum efficiency at 1/3 of the baseline performance
- Tesla T4: doubling efficiency at slightly increased baseline performance



GPU	TDP
K80	300 W
TX2	20 W
T4	70 W

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Chart 6

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Focus of our research at the OSM group

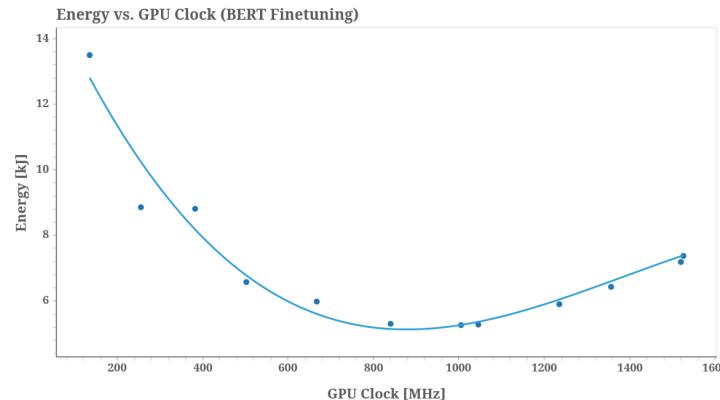
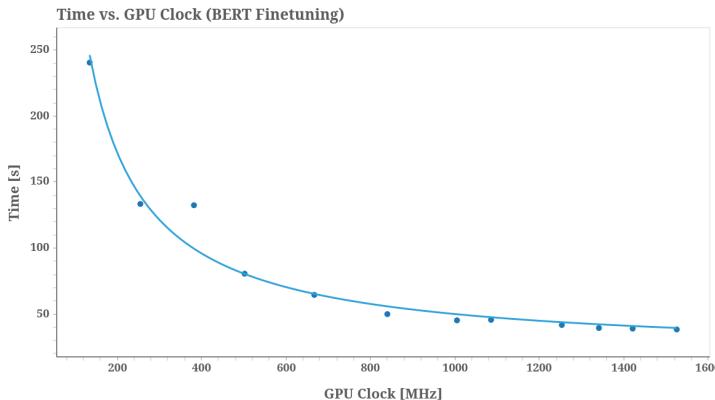
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Chart 7

Approach 2: Trading in Time for Energy Efficiency

- Ongoing Master's Thesis by Felix Grzelka: for some workloads, energy efficiency can be improved notably by operating HW at lower power profiles.
- Example: BERT machine learning finetuning workload on a NVIDIA Tesla V100 GPU

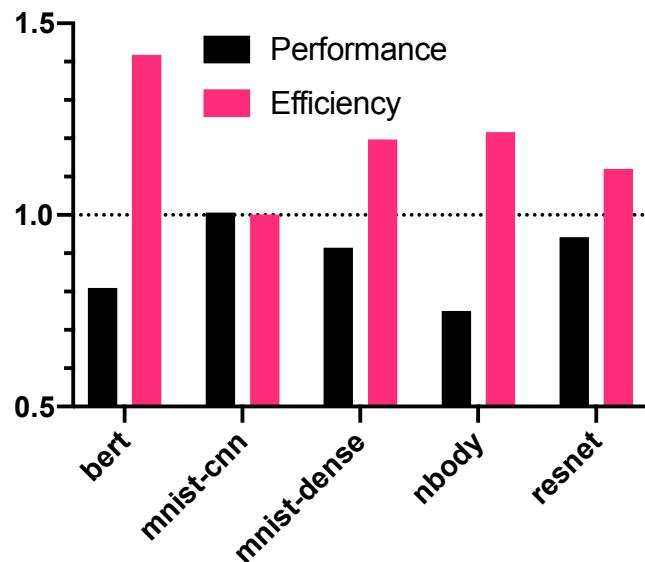


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Chart 8

Approach 2: Trading in Time for Energy Efficiency

- Relative impact of additional workloads at more efficient power profiles compared to high performance settings on a NVIDIA Tesla V100 GPU



Workload	Performance	Efficiency
bert	-19%	+42%
mnist-cnn	+/- 0%	+/- 0%
mnist-dense	-9%	+20%
nbody	-24%	+22%
resnet	-6%	+12%

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Chart 9

Conclusion

- **GPU-based virtualization** techniques are still **not as capable as CPU-based virtualization**
 - Efficiency can not be improved by increasing utilization through consolidation
- **Make sure your workload can fully utilize your GPU. If it does not,**
(and optimizing the implementation is not an option,) ...
 - ... choosing a **lower power state** may have **little effect on performance**
 - ... consider using **balanced hardware** for **boosting efficiency** notably
- Try not to keep dated hardware in service for an overextended period of time
 - more **recent hardware** usually is **much more efficient**

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Chart 10