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Andreas Herten, Stepan Nassyr
Jülich Supercomputing Centre

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Dedicated versions of MAELSTROM apps benchmarked on:

**Jülich system:** JUWELS (mostly Booster, but also Cluster)

**E4 system:** *Lido Adriano* system

Benchmarks run by application owners, guided by WP3 systems staff

**Metrics selected in cooperation**

**Objective:** Assess status, identify points of improvement, study hardware

**Final goal:** Provide bespoke W&C ML system design; fitting W&C ML applications

*Workpackage timeline not to scale; mileage may vary*
Metrics

Time-related

- Total runtime
- Total training time
- Training time per epoch (avg, min, max)
- Training time per iteration (avg, min, max)
- Training time of first epoch
- Model saving time

Learning-related

- Final loss (training, validation)

Energy-related

- GPU power draw (max)
- Energy consumption (GPU, node)
Result Highlights: AP1

**JUWELS Booster**
- 10 experiments
- 350 s per experiment; ½ training, ¾ data loading, 2% other

**JUWELS Cluster**
- 3 experiments
- 700 s per experiment, similar distribution

**Lido Adriano**
- 5 experiments
- 450 s per experiment, 28% training, 72 % data loading, 1% other

Mostly stable results over various experiments; first epoch always ~30% (JUWELS) / 2× (E4) slower

**Summary:**
- Bound by filesystem, not using GPUs very efficiently
- GPFS > NFS
- E4-A100 slower than JSC-A100

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![JUWELS Booster: Total Time Split](image-url)

![E4: Epoch Comparison](image-url)
Result Highlights: AP3

JUWELS Booster

- 440 s runtime; 98% training time; largely stable over 3 repetitions
- Experiments with various configurations: synthetic data; disabled cache in Tensorflow; different GPU number (1 or 2), different batch size (512 or 1024)
  - Disable cache: runtime increase 20%
  - GPU+batch size: runtime decrease 25%
- Energy: 9.25 Wh/GPU (2-1024) vs 12.32 Wh/GPU (1-512)

JUWELS Cluster

- 824 s runtime, ~86 % slower than A100

Lido Adriano

- Slightly faster: 390 s runtime
- Extra experiment: clear filesystem (NFS) cache by rebooting → 2.5 × slower; benefits from streaming data

Additional tests with inference on JUWELS Booster

Summary:

- Compute-intensive application (little I/O impact)
- 2-GPU study (benefits from larger batch size)
- Caches used during streaming-in data important
Result Highlights: AP4

**JUWELS Booster**
- 6400 s runtime; 70% training time, significant unaccounted time
- 150 Wh energy consumed, GPU max draw 400 W

**Lido Adriano**
- Batch size: 2 (JUWELS Booster: 1)
- 25729 s runtime; 88% training time

**Summary:**
- Long runtime for easy statistical measurements
- Good GPU usage
- Investigate run 1 outlier
Result Highlights: AP5

**JUWELS Booster**
- Small data set: 75 s runtime, 92% training
- Large data set: 1500 s runtime, 98% training
- First epoch $1.75 \times$ (large) / $20 \times$ (small) slower
- 300 W max, 45 Wh consumed

**JUWELS Cluster**
- Large data set: 2700 s runtime
- 300 W max, 190 Wh

**Lido Adriano**
- Various experiments
- Large data set: 1600 s runtime, 94% training

Additional tests with inference on JUWELS Booster

**Summary:**
- Small data set: Too short runtimes with curious behaviors
- Faster GPU, less energy
Conclusion

• Examples shown of selected MAELSTROM application benchmarks
• Applications × Configurations × Hardware = Many data points
• Investigation ongoing, already many specific (and interesting!) features identified
• Also spotted curiosities for further investigation

Much more data and results then presented here!

→ See maelstrom-eurohpc.eu website for D3.4, soon