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CENTRE OF EXCELLENCE IN SIMULATION OF WEATHER AND CLIMATE IN EUROPE

NGI Initiative
Toward a bridge to the semantic gap

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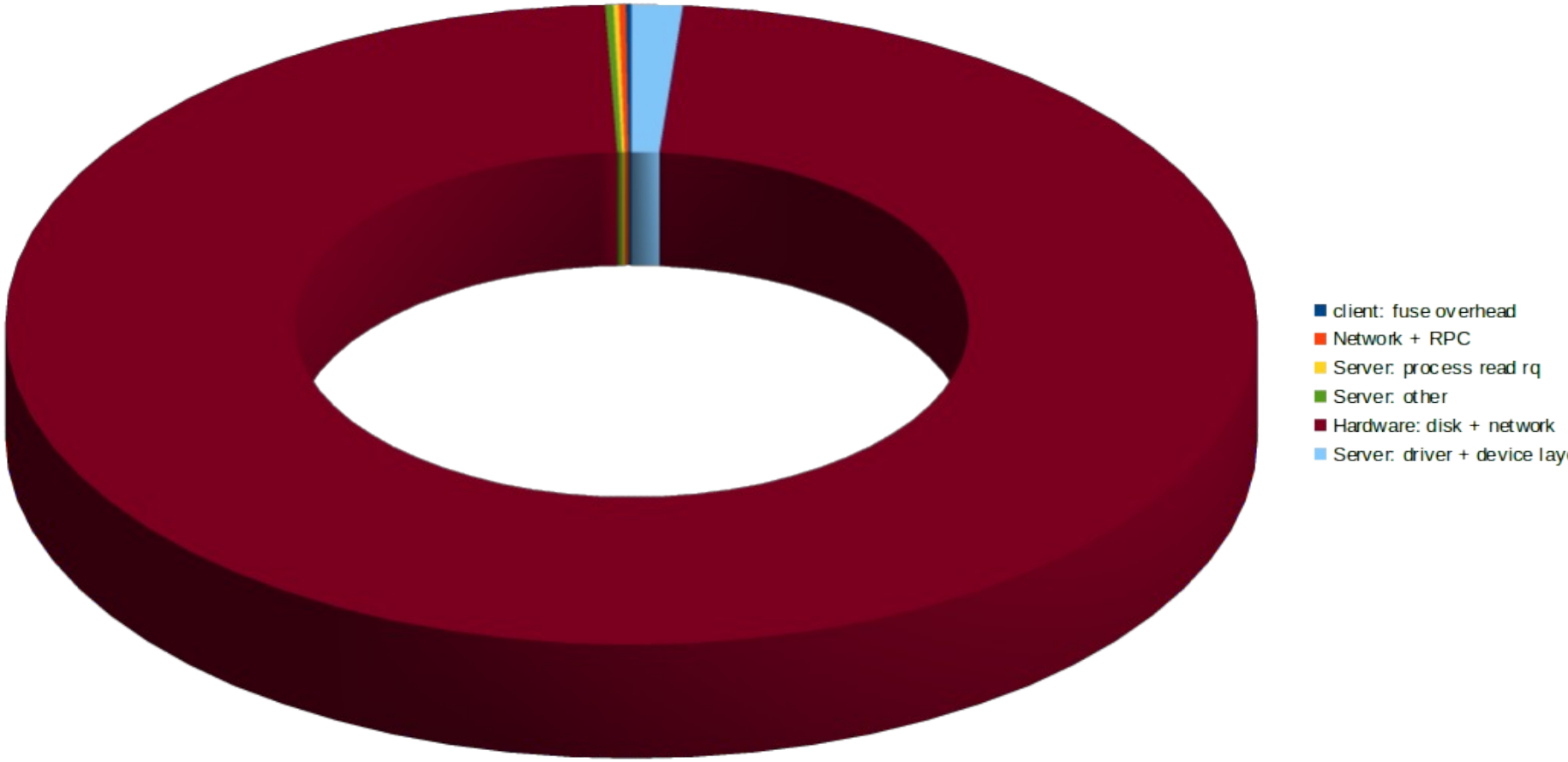
Breakdown of the I/O Critical Path



HDD dominates I/O latency

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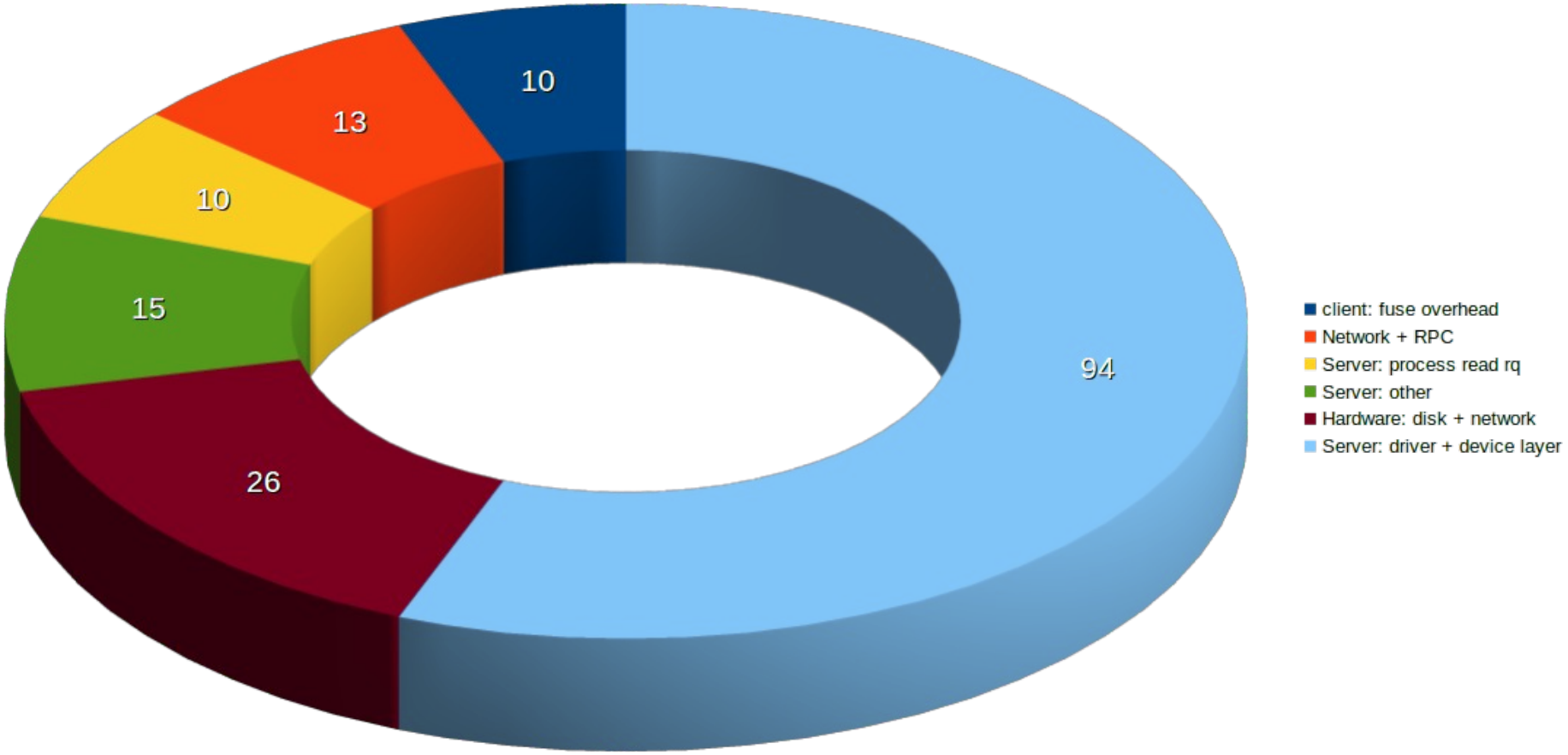
Breakdown of the I/O Critical Path



Software layer is the bottleneck

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Lessons learned from Object Storage

Object is an appealing and generic concept

Adding semantic over object layer

→ Burden shifted to the application dev.

→ or add a component to provide a link

obj-uuid ↔ my-semantic

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Lessons learned from Object Storage

obj-uuid ↔ my-semantic

→ Add some extra software layers
→ Hey, *my-semantic* is criticial for data interpretation

→ Let‘s add High Availability and Fault Tolerant to the mechanism
→ HA database is complicated let‘s use standard software component
→ HDFS comes into play
→ Performance get killed by the Software

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TensorFlow

Multi-backend Approach

www.tensorflow.org/guide/extend/filesystem

TensorFlow already includes many filesystem implementations, such as:

- → A standard POSIX filesystem (NFS)
- → HDFS - the Hadoop File System
- → GCS - Google Cloud Storage filesystem
- → S3 - Amazon Simple Storage Service filesystem
- → A "memory-mapped-file" filesystem

It is possible to implement a custom filesystem

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Software is sentitive to I/O pattern

IO500

SUMMIT (IBM) EFFICIENCY

#1 on IO500 at SC18

ior_easy_read	1788.320 GB/s
ior_hard_read	27.403 GB/s

→ 1.53% efficiency!

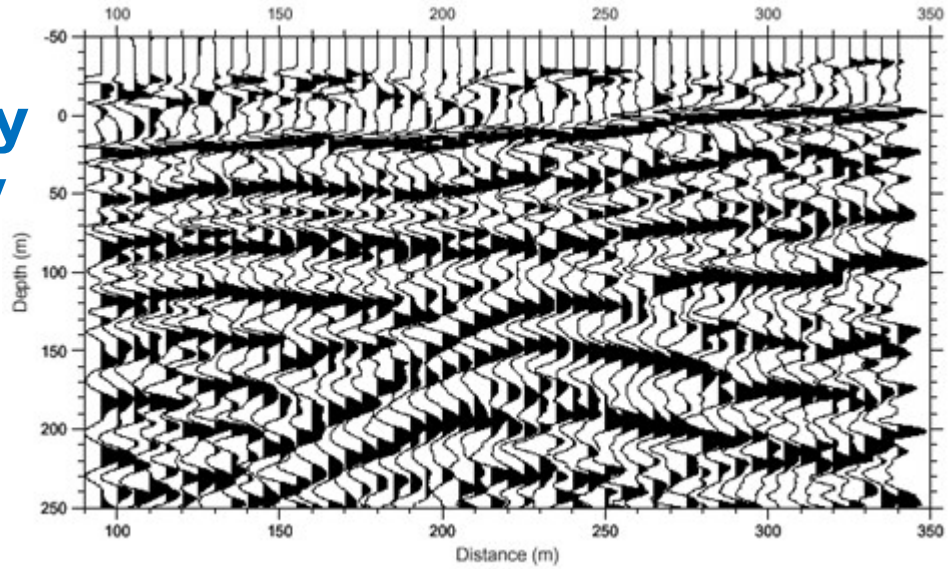
ior_easy_write	2158.700 GB/s
ior_hard_write	0.572 GB/s

→ hey that's 0.025% efficiency!

Don't worry that much, ADIOS lib will shield the FS from such pattern

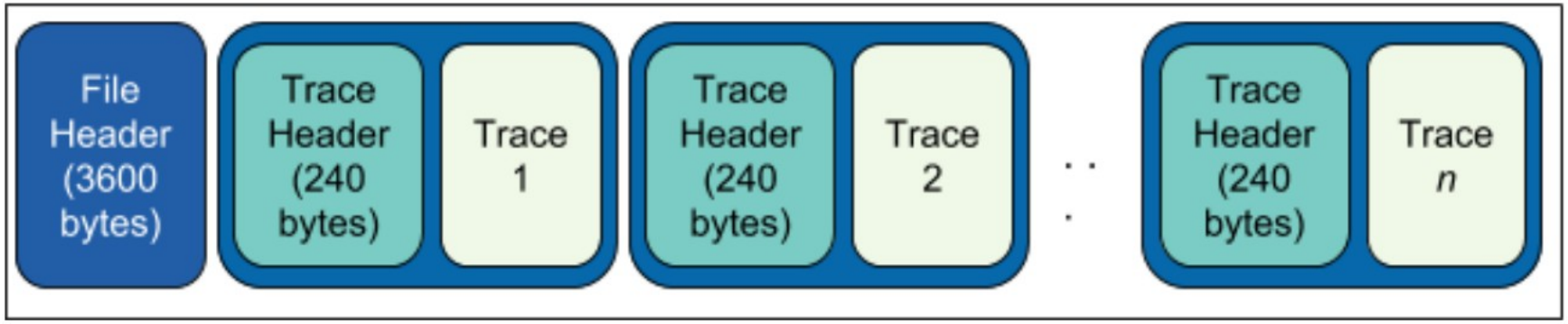
[Summary] Data files in /gpfs/alpine/stf007/scratch/gmarkoma/io-500-dev/datafiles/io500.2018.11.09-03.12.50

SEG-Y example



SEG-Y is a file format heavily used in the O&G community
→ Originally to store Seismic data on Tape
→ Large legacy (and new) software base
→ Huge *data* legacy

A segy file contains a header and a sequence of data which describes the trace coordinates etc and the trace data itself:



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ExaSeisDat

Brings the known advantages of specialized lib.

- Easy to use, geophysicist-friendly C++ and C APIs
- Reduces maintenance → Reduces codebase sizes substantially
- Multi-Layer solution → separate file-format processing, layout and
- Scalable / Performance

- Computational geophysicists / software engineers writing seismic processing software on HPC clusters
→ without needing to HPC hardware experts (but actually they still are)

Science Foundation Ireland sfi For what's next

NUI Galway OÉ Gaillimh

lero

ICHEC Irish Centre for High-End Computing

TULLOW OIL plc

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References

"ExSeisDat: A set of parallel I/O and workflow libraries for petroleum seismology" Dec. 2018 in Journal Oil & Gas Science and Technology - Rev. IFP Energies nouvelles. Numerical Method and HPC. https://doi.org/10.2516/ogst/2018048

"ExSeisPIOL: A Seismic Parallel I/O Library for Increasing Developer Productivity". Oct 2017, In Third EAGE Workshop on High Performance Computing for Upstream. http://www.earthdoc.org/publication/publicationdetails/?publication=90173

"ExSeisPIOL: Extreme-Scale Parallel I/O for Seismic Workflows", RICE O&G HPC, 2017 https://www.youtube.com/watch?v=Y00Js6uPWI0

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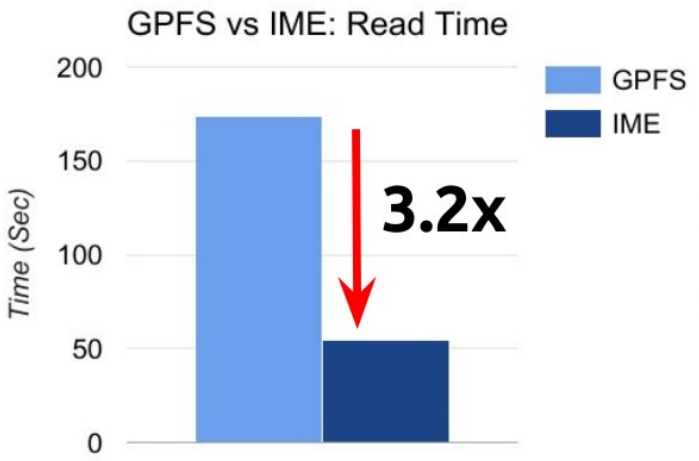
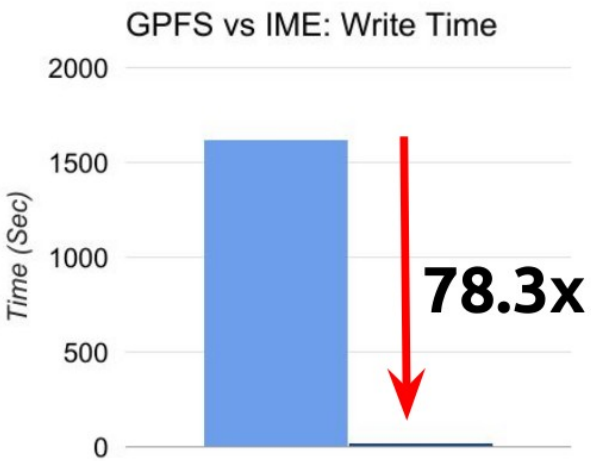
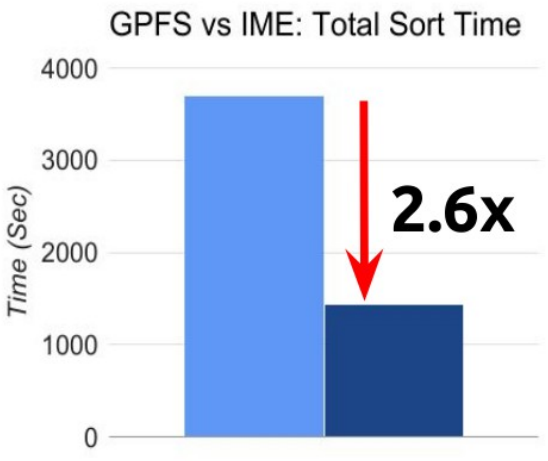
ExaSeisDat: Results

- **Transparent insertion of a new storage layer in the workflow**







- Comparing GPFS against an IME setup.
- Sort of a 400 GiB SEG-Y file (400 GiB read, 400 GiB write), 4 nodes.
- Total Time: 63% GPFS I/O, only 5% IME I/O for sort

Courtesy of Cathal O'Broin

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Next Generation Interface

Goals:

→ Maintain / increase SW developer productivity and code reliaility

→ Deliver Robust performance

- → Protect file system from deviant I/O patterns
- → Internal support of hardware diversity
- → Log structured has proven to be fairly good

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Next Generation Interface

→ Keep the software stack under control
→ Keep semantic close to end-user
    → Specialized layout have a strong track record
    → Object are too generic (slightly controversial!)

→ Semantic gap
    → Storage stores 0 and 1
    → Not possible to bring computation to 0 & 1
    → Parallel File System with data slicing are making things worse

→ Bringing compute closer to storage semantic
    → Semantic Storage Layer tools
    → Earth System Data Middle Ware
Layout has to be though jointly with workflow

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