ADMIRE User Day

Extra-P With I/O Modeling Capabilities

Ahmad Tarraf
Technical University Darmstadt

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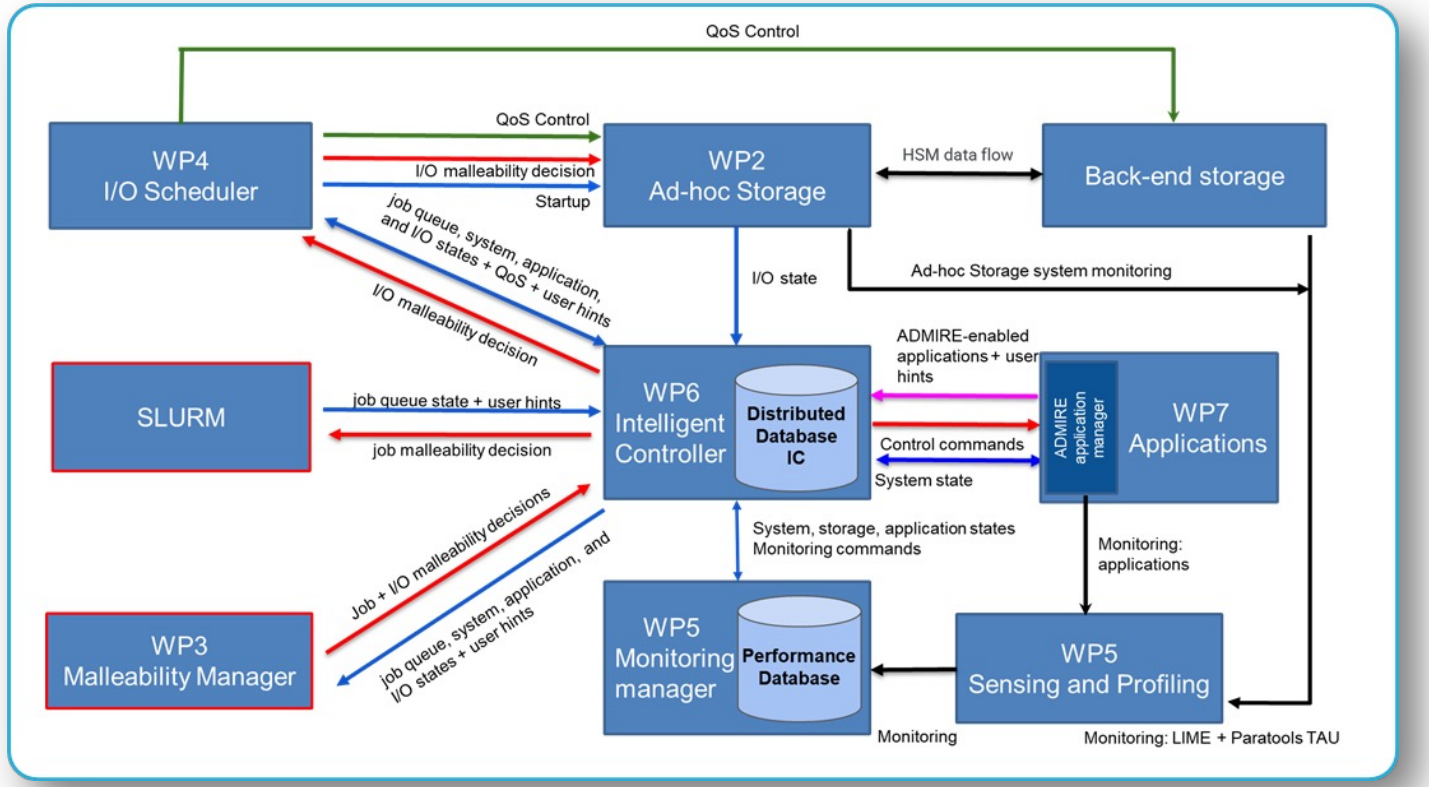
EuroHPC Joint Undertaking

Performance Models in ADMIRE

ADMIRE global architecture:

- Intelligent controller acts as the main component forwarding and processing data
- Key aspects examined in the ADMIRE project is **job malleability**

- Malleability manager needs:
  - Current state of the system
  - Jobs in the queue
  - User hints
  - **Scaling performance of an application**



Objective: balance both compute and I/O resources
→Performance models that cover the scaling behavior applications in both regards

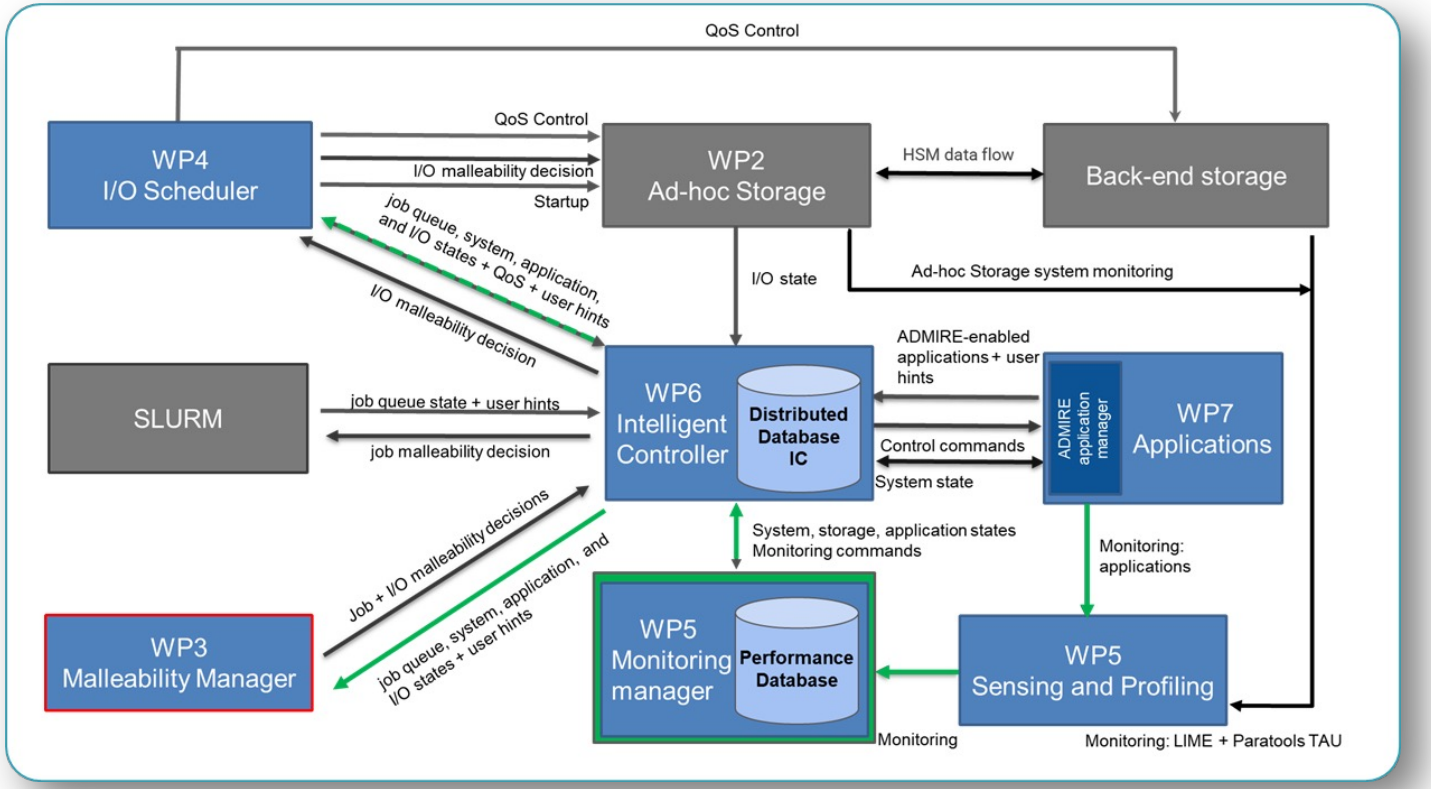
Performance Models in ADMIRE (cont')

Generate performance models with Extra-P

- Components that directly influence or interact with the performance models from Extra-P are colored (in blue)
- Data flow of the models is colored in green

So far, Extra-P focuses on modeling the scaling behavior of computational and communicational parts of an applications

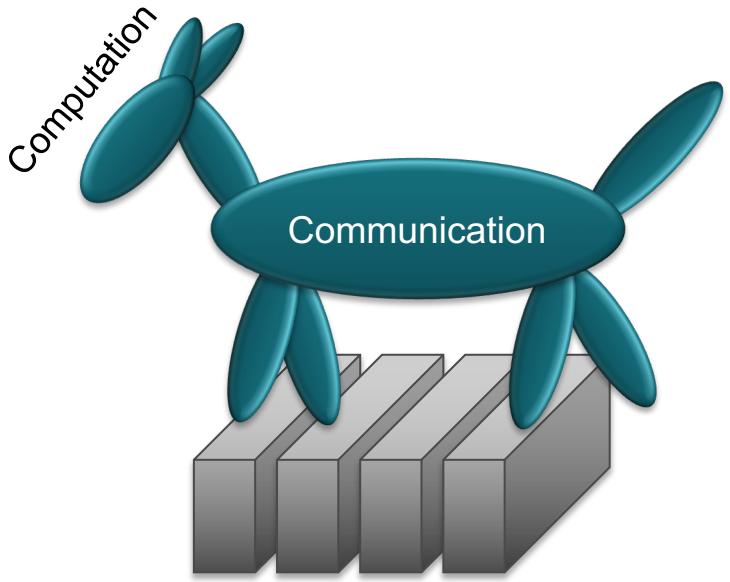
Extend Extra-P to model I/O!

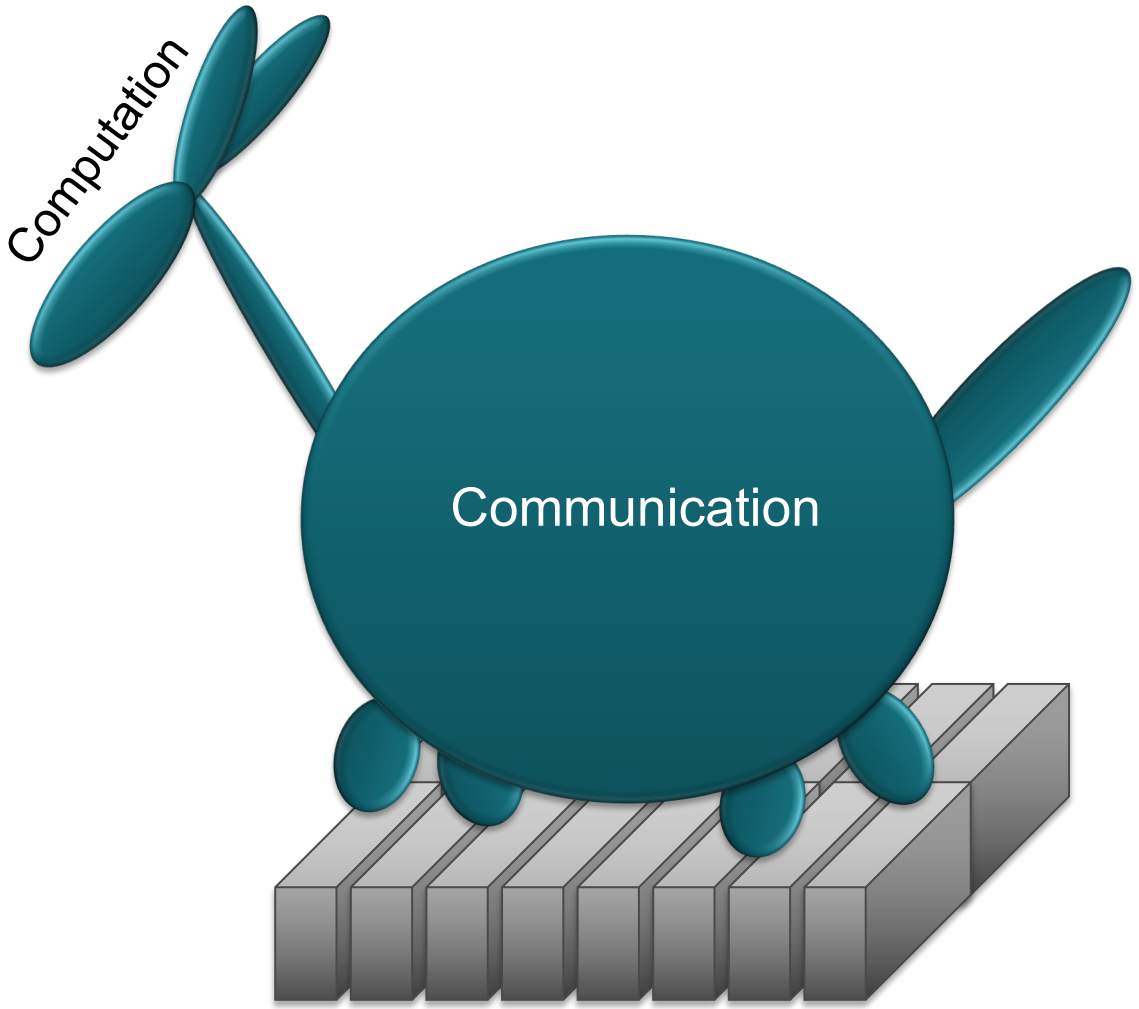


But before, let's have a quick look at Extra-P and performance models in general …

Scaling your code can harbor performance surprises*…

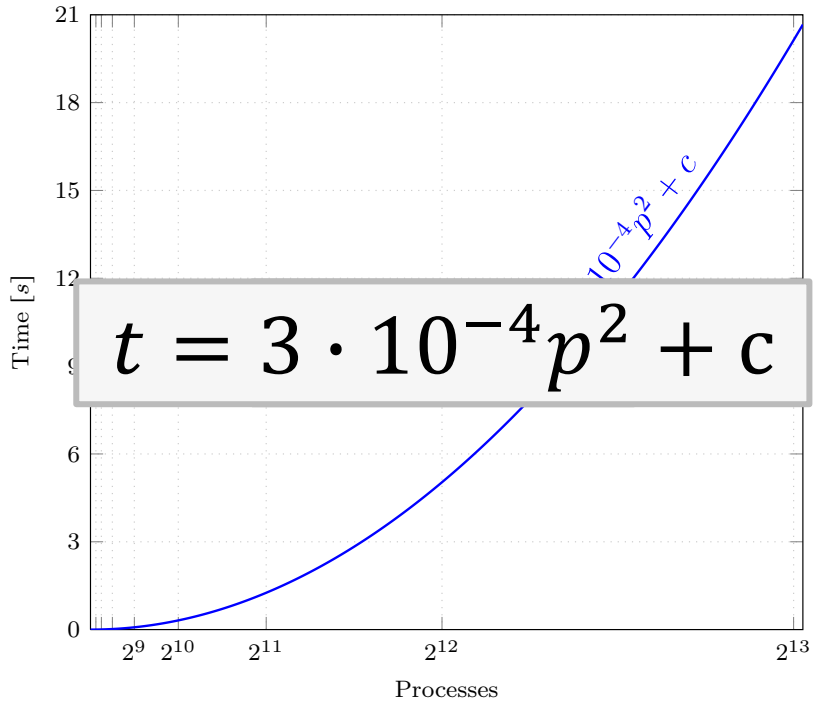
*Goldsmith et al., 2007





Performance Models

Performance Model: Formula that expresses a relevant performance metric as a function of one or more execution parameters



Analytical (i.e., manual) creation
→ challenging for entire programs

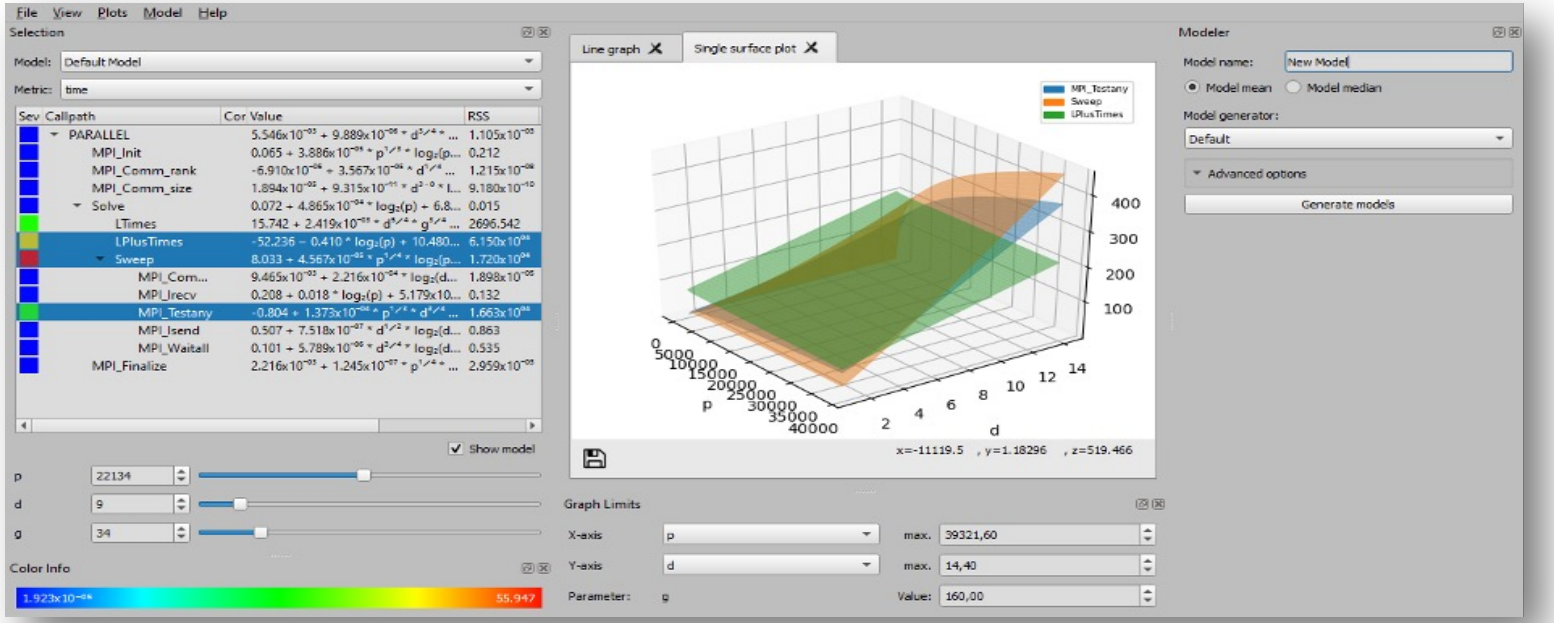
- Identify kernels
  - Incomplete coverage
- Create models
  - Laborious, difficult

Extra-P

Extra-P in a nutshell:

- Automatic performance-modelling tool
- Generates **empirical performance models** that predict the scaling behavior of the different parts of an application
- Supports the user in identifying scalability bugs

Part of the program whose scaling behavior is unintentionally poor



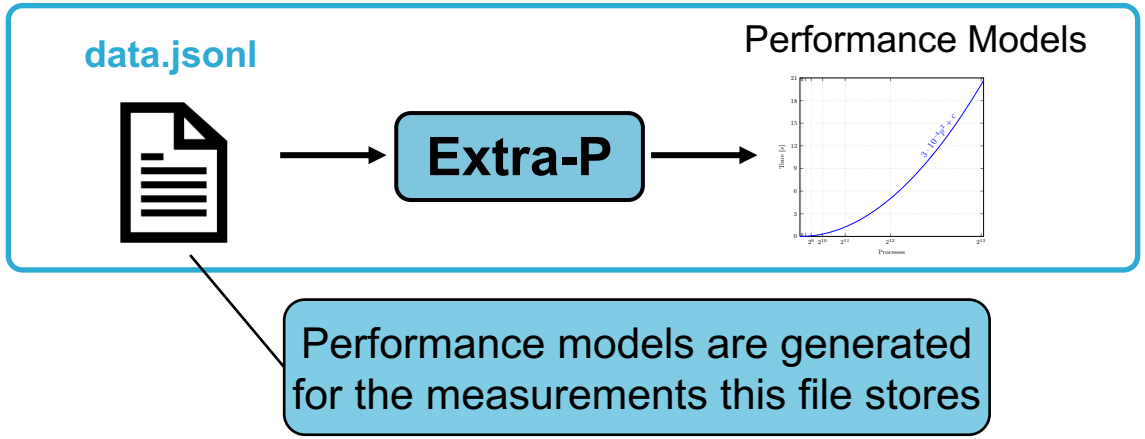
https://github.com/extra-p/extrap

New

YouTube https://youtu.be/Cv2YRCMWqBM

Extra-P in ADMIRE: Continuous Modeling

- In ADMIRE: No human in the loop
  →Use Extra-P **programming interface**
- Whenever **new traces** are available, just **reinvoke** Extra-P



- **Storesfine graded I/O data in the JSONL file**
  → new profiles can be simply appended
- **Model fine graded I/O function up till metrics like total I/O time**

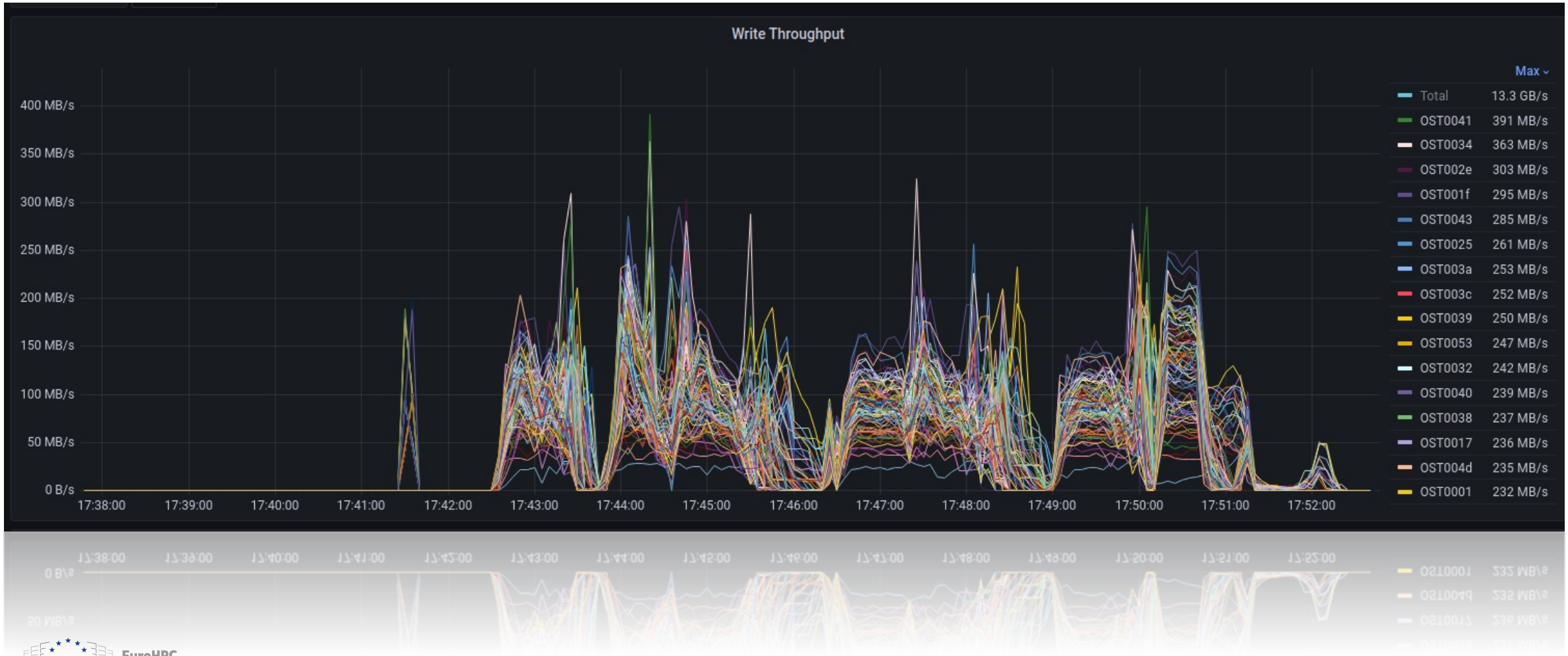
```python
# Imports
from extrap.entities.callpath import Callpath
from extrap.entities.metric import Metric
from extrap.fileio.file_reader.jsonlines_file_reader import read_jsonlines_file
from extrap.modelers.model_generator import ModelGenerator
import numpy as np

# Load the JSONL data. For different file formats, there are
# different read libraries in extrap.fileio
experiment = read_jsonlines_file("./data.jsonl")

# Initialize model generator
model_generator = ModelGenerator(experiment)

# Create models from data
model_generator.model_all()

# ------ At this point, the models are generated
# Next, let's see how to evaluate them

# 1) Specify the metric and call path,e.g., default and root, respectively
cp0 = Callpath("<root>"), Metric("<default>")
pm = model_generator.models[cp0].hypothesis.function
print(f"Model evaluated at x = 5 and y = 5:\n{pm.evaluate([5,5])}\n")

# 2) Or iterate over all of them:
for model in model_generator.models.values():
    # Measurment points
    pts = model.measurements
    print(f"Measurement points are:\n{pts}\n")

    # Evaulated function @ measurement points
    pred = model.predictions
    print(f"Prediction points are:\n{pred}\n")

    # The actual model
    print(f"Model is:\n{model.hypothesis.function}\n")

    # Evaluate at specific points
    # Here, data.jsonl is a 2D data set, hence, a 2d array must be provided
    m = model.hypothesis.function.evaluate(
        np.array([[1, 24, 58], [1, 29, 30]]))
    print(f"Model evaluated at x = [1 24 58] and y = [1 29 30] is:\n{m}\n")

    # Or evaluate just at a single point [x,y]
    pm = model.hypothesis.function.evaluate([2, 3])
    print(f"Model evaluated at x = 2 and y = 3:\n{pm}\n\n")
```

Monitoring Proxy: Application Side

Monitoring Proxy Captures traces at different levels for each application (example: IMB-IO)

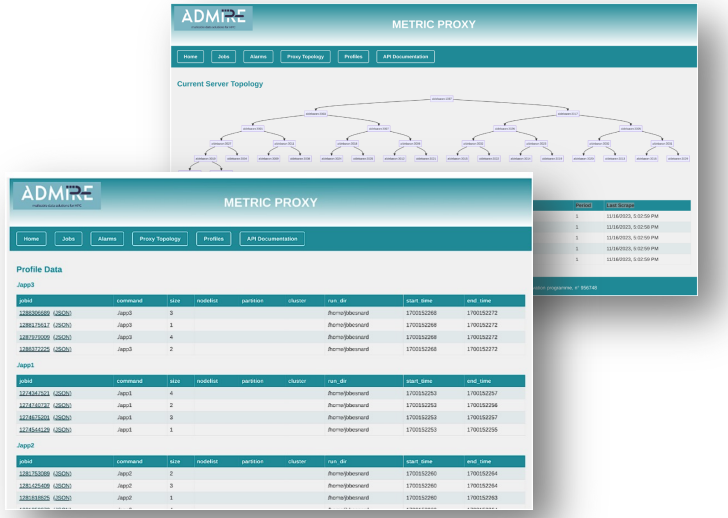
Tracing I/O: File System Side

File system side is also available, but currently not used for performance modeling (Ex: HACC-IO)



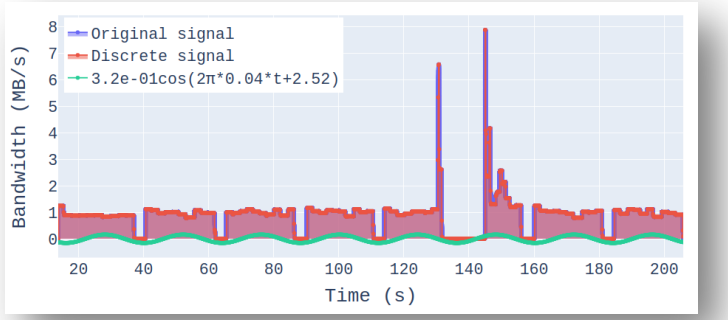
Modeling I/O With Extra-P

- Support for four new tools has been added
  - TMIO (Tracing MPI-IO)
  - Darshan
  - Tau metric proxy
  - FTIO



Metric proxy: Graphical user interface

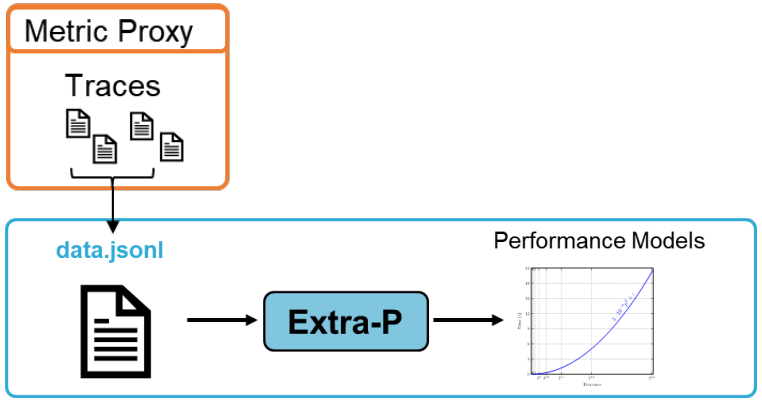
Source	Key Advantage
TMIO	Async I/O, I/O requirements, flexibility
Darshan	Universal support
Metric proxy	Very detailed traces, **on-the-fly modeling**
FTIO	Modeling I/O phases



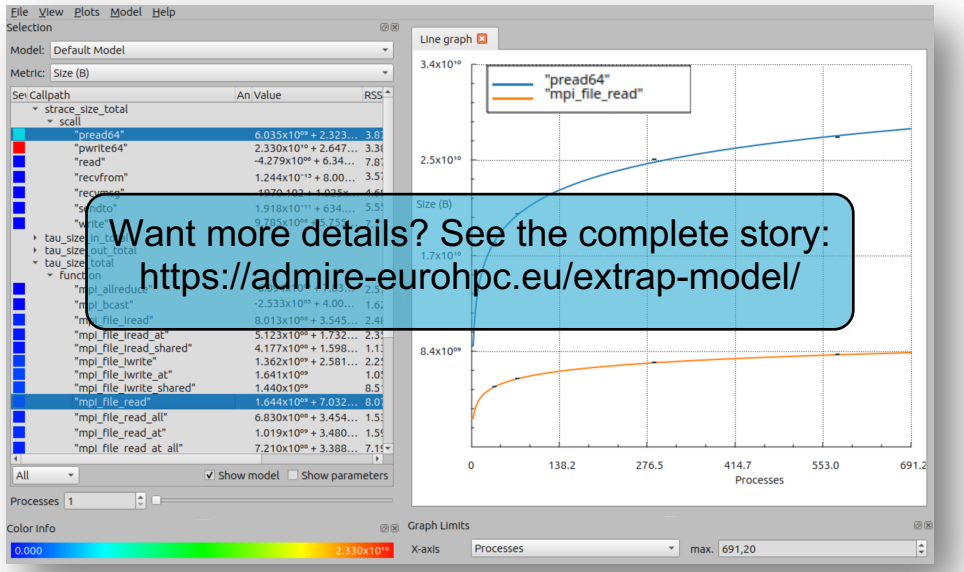
FTIO: Frequency techniques for I/O

Extra-P and Tau Metric Proxy

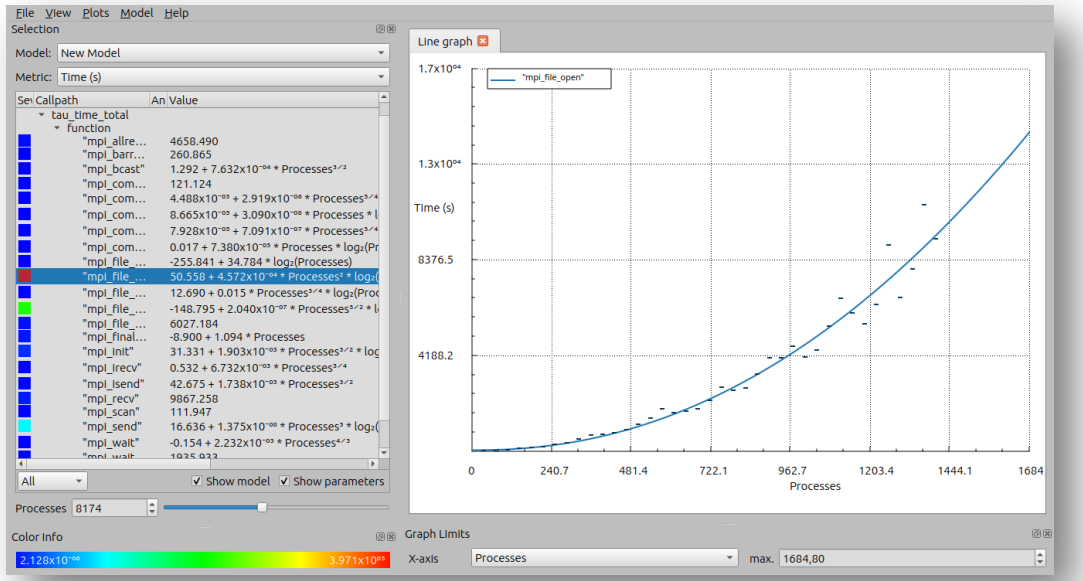
- Metric proxy:
  - Provides traces at different levels
  - Groups traces into a single profile
  - Different methods for grouping exist



IMB-IO

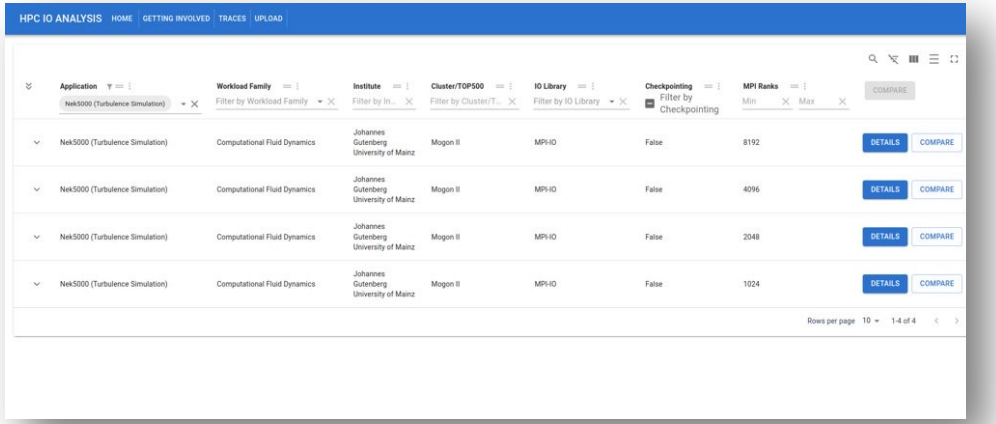


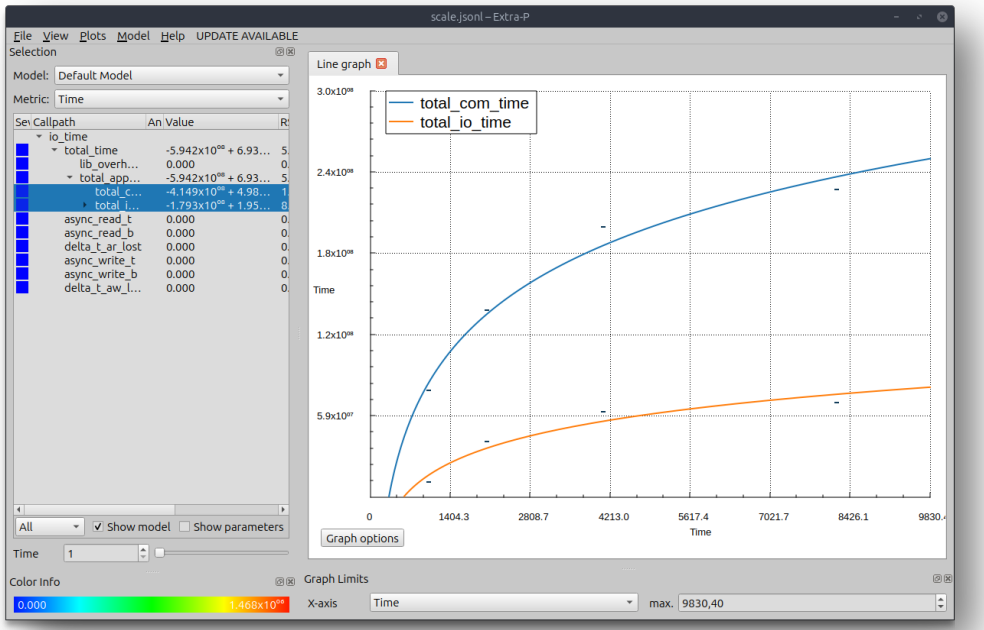
Nek5000



Extra-P and Darshan

- Nek5000 simulation from Mainz trace Website
- Generate a performance model from any Darshan File (with and without heatmap)





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Thank you for your attention!

Questions?