NSF/IUCRC CAC PROJECT

Monitoring Power Usage of Jobs Running on Quanah Cluster

Jie Li
PhD Student, TTU
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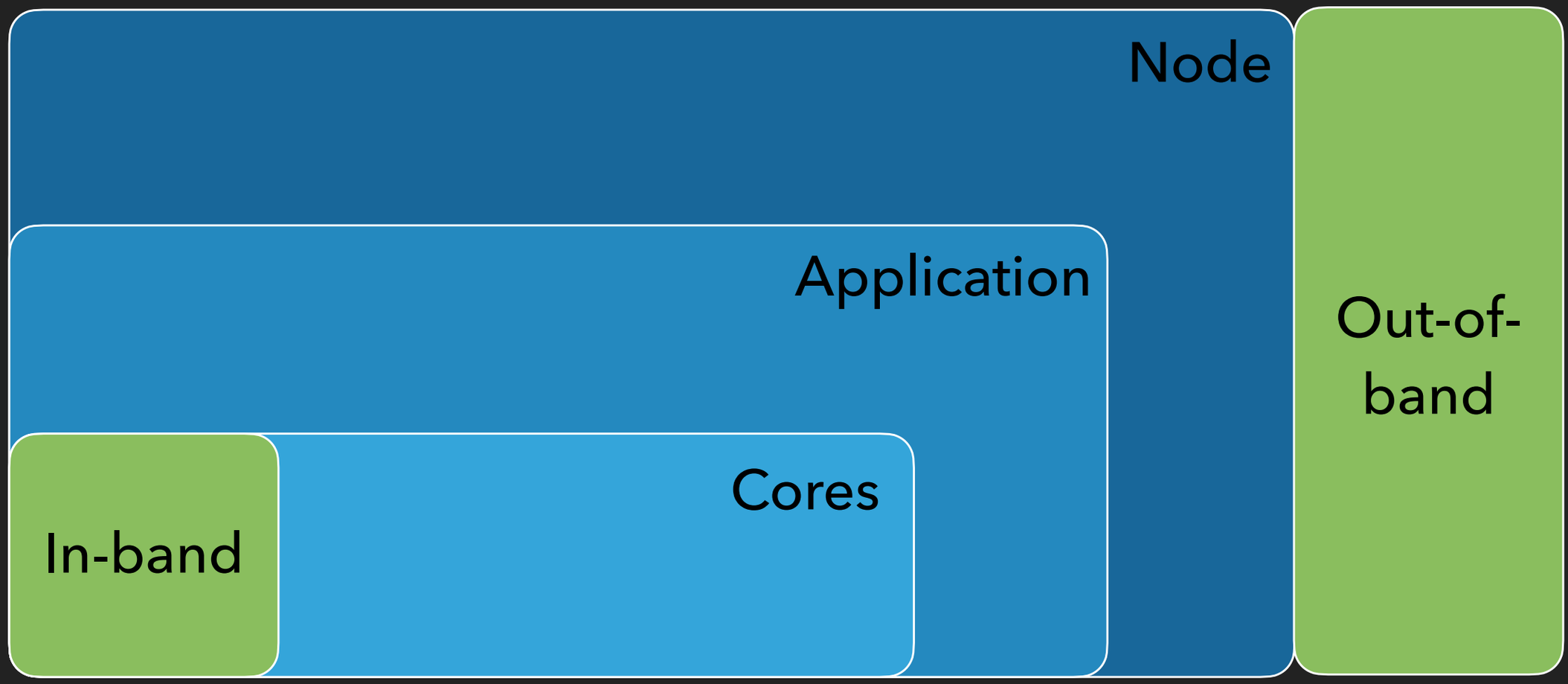
Advisors:
Mr. Jon Hass, SW Architect, Dell Inc.
Dr. Alan Sill, Managing Director, HPCC, TTU
Dr. Yong Chen, Associate Professor, CS Dept, TTU

AGENDA

- Background
- Power Measurement Techniques
- Implementation
- Results and Future Work

Out-of-band Measurement	In-band Measurement
Use external equipment	Use device-level integrated measurement capabilities
Not provide easily accessible information to the running processes	Provide both CPU and memory subsystem energy measurement
Avoid perturbing the ongoing computation	Require active participation of the compute cores
Capture whole node energy profiles more easily	Not possible to capture whole node energy profiles


Node
Application
Cores
In-band
Out-of-band

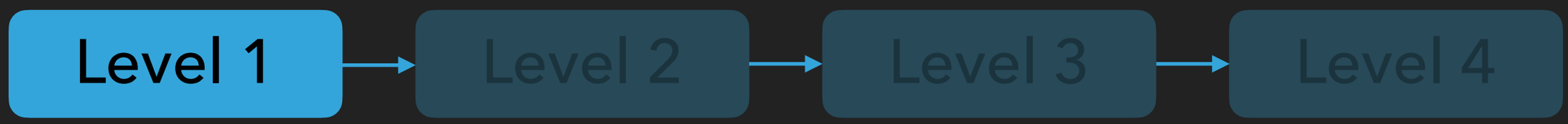
POWER MEASUREMENT TECHNIQUES[1]

- Job-wide Aggregate Information
- Periodic Sampling
- Application Instrumentation
- Multi-Level Correlation

Reference: [1] Grant, Ryan E., James H. Laros, Michael Levenhagen, Stephen L. Olivier, Kevin Pedretti, Lee Ward, and Andrew J. Younge. "Evaluating energy and power profiling techniques for HPC workloads." In *2017 Eighth International Green and Sustainable Computing Conference (IGSC)*, pp. 1-8. IEEE, 2017.

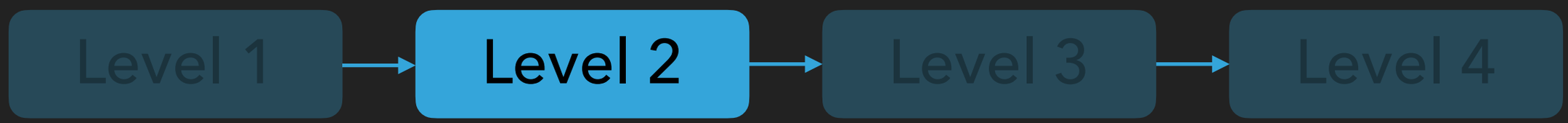
JOB-WIDE AGGREGATE INFORMATION

- Coarse-grained power and energy, total energy usage by each application.
- Information from each component is aggregated over an entire application run rather than point-in-time samples or per-node information.
- Help to understand how energy-to-solution changes for different application optimizations.
- It only provides insight into energy usage behavior in aggregate, not the varying rates of energy consumption throughout an application's execution.



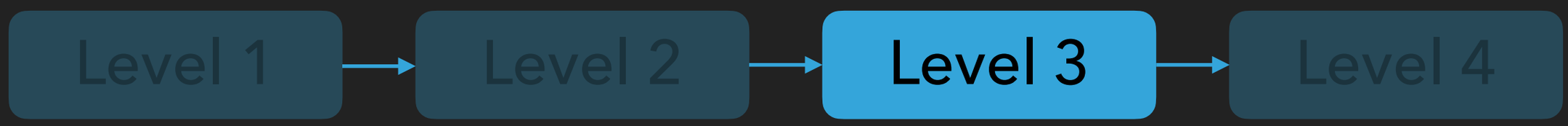
PERIODIC SAMPLING

- Fine-grained detail is provided by periodically sampling power levels and energy usage over time.
- Sampling may be implemented in-band or out-of-band.
- Information can be used to plot power usage versus time.
- Retain potentially large volume of point-in-time sample information



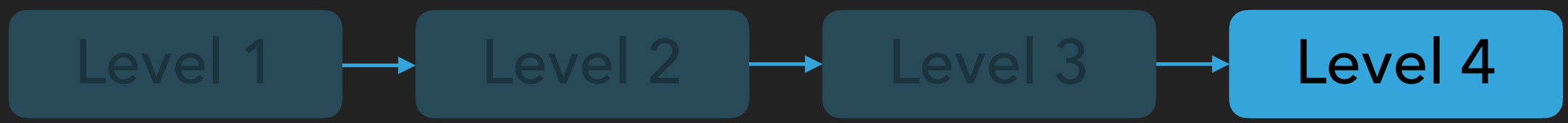
APPLICATION INSTRUMENTATION

- A finer level, use application knowledge to interpret the recorded information
- Modify an application to instrument code regions of interest.
- Information can be analyzed to characterize each instrumented region's power and energy usage behavior.
- Require application modifications and may reduce performance due to instrumentation overhead.



MULTI-LEVEL CORRELATION

- Cross-correlated information gathered from previous levels.
- Difficult to Align in-band and out-of-band periodic sampling measurements can be difficult.



POWER MEASUREMENT TECHNIQUES

L1: Aggregate Information

Pros: Easily obtainable, quick summary info

Cons: Coarse-grained information

L2: Periodic Sampling

Pros: In-band or out-of-band sampling

Cons: Retain large volume of information

L3: Application Instrumentation

Pros: Users mark app regions, more info

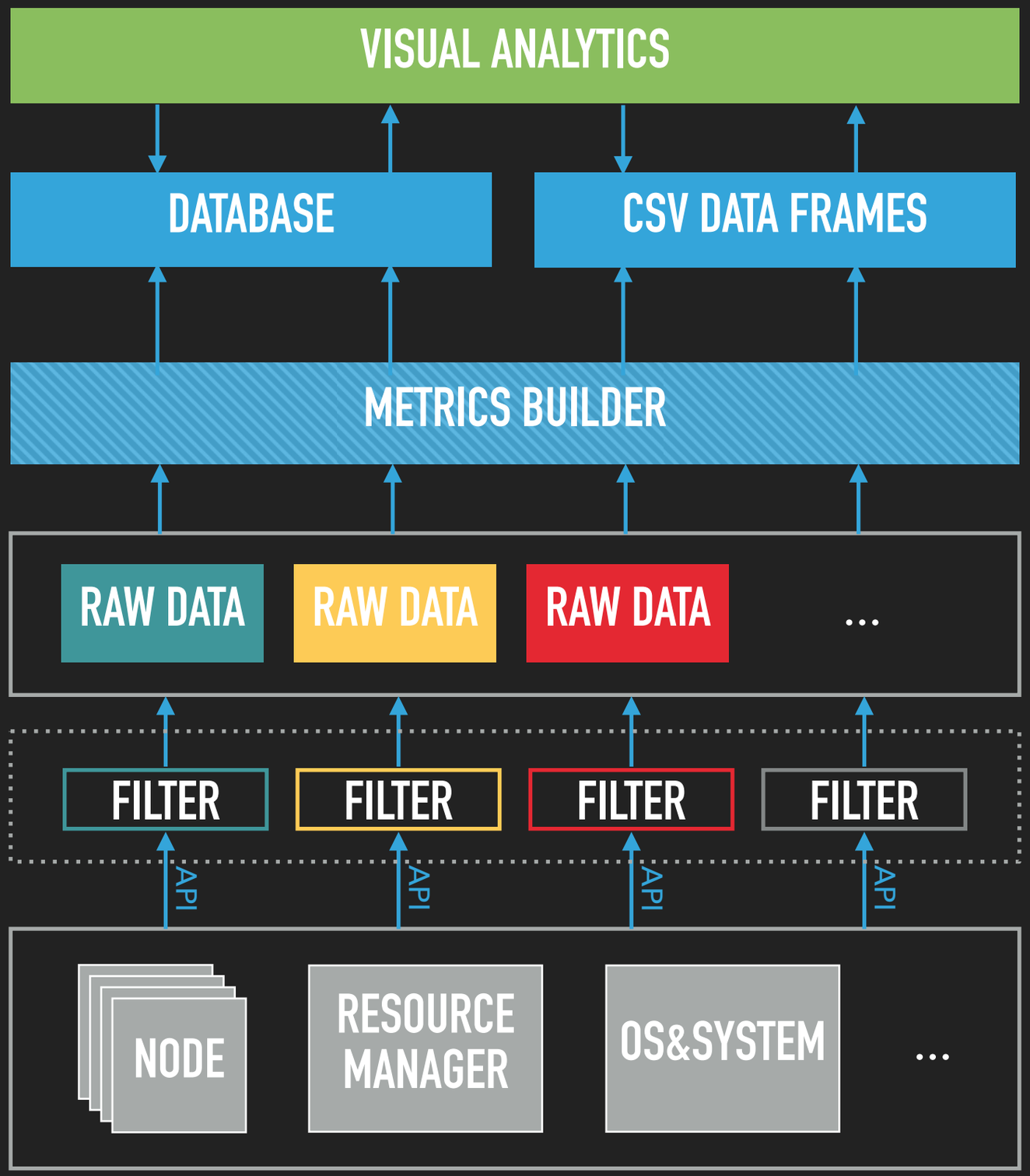
Cons: Degrade application performance

L4: Multi-level Correlation

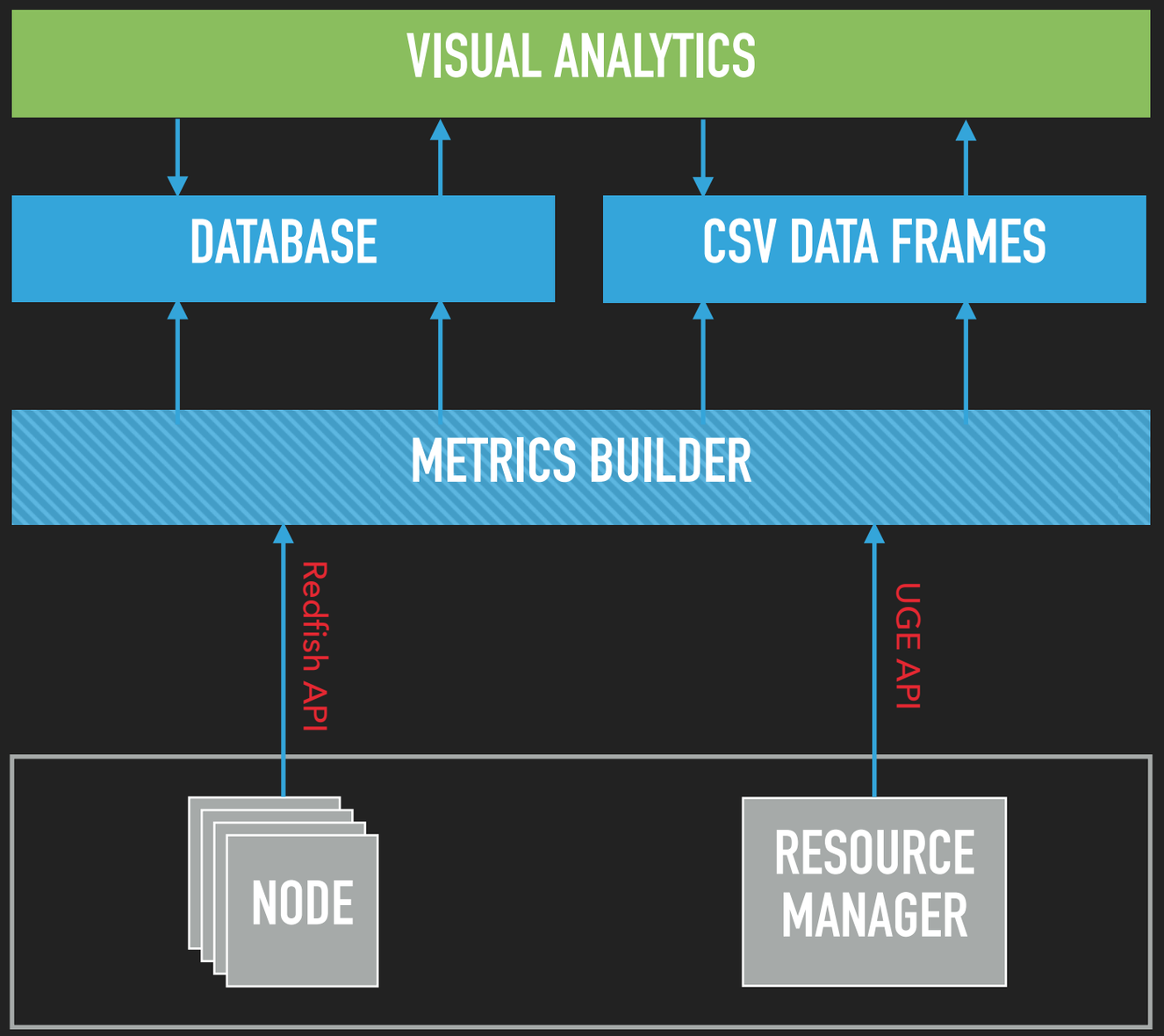
Pros: Information Fusion, intra-region insight

Cons: Synchronize metrics

MONITORING FRAMEWORK

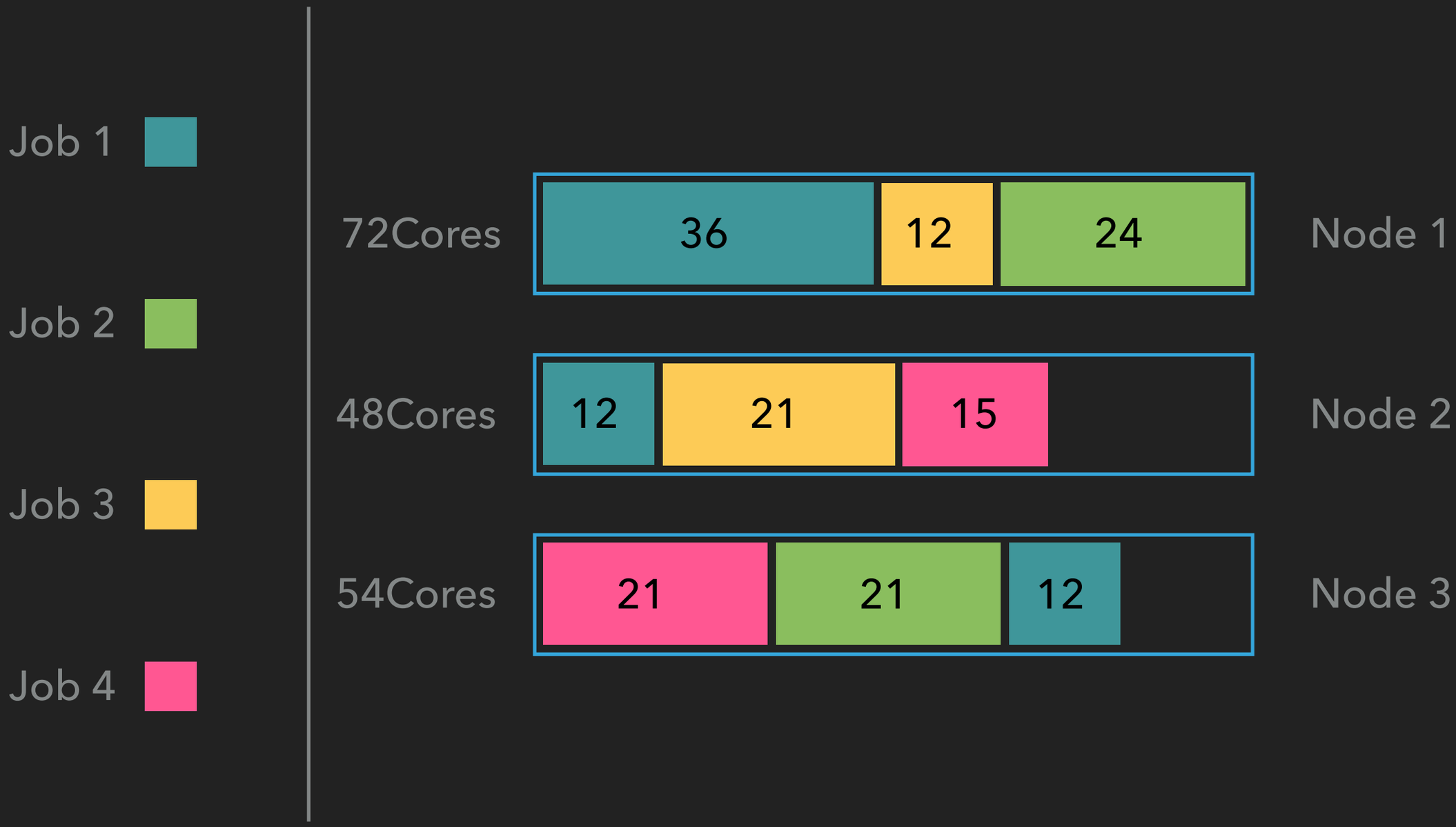


IMPLEMENTATION



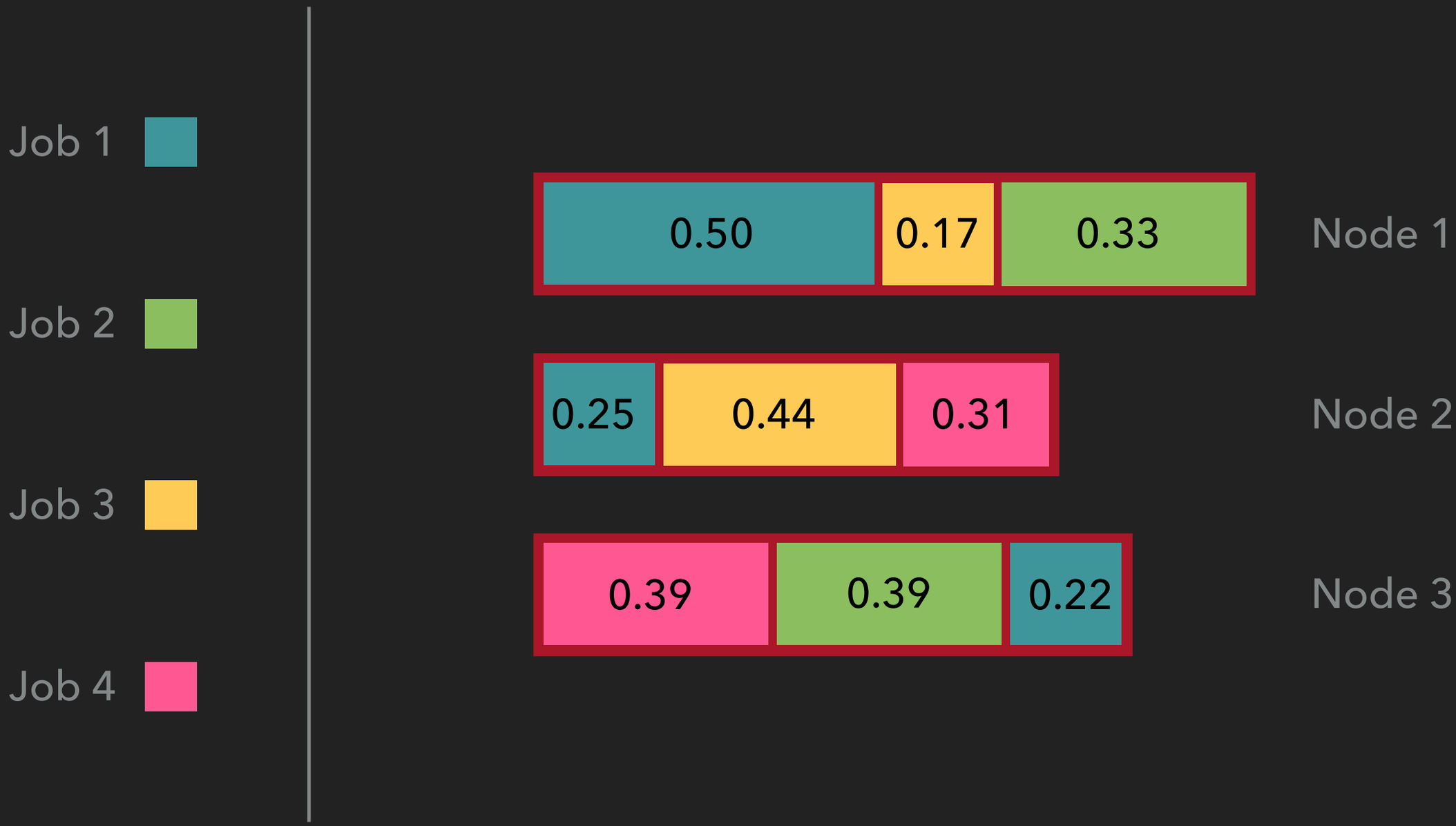
How to get/estimate the power usage of each job?

METHODOLOGY

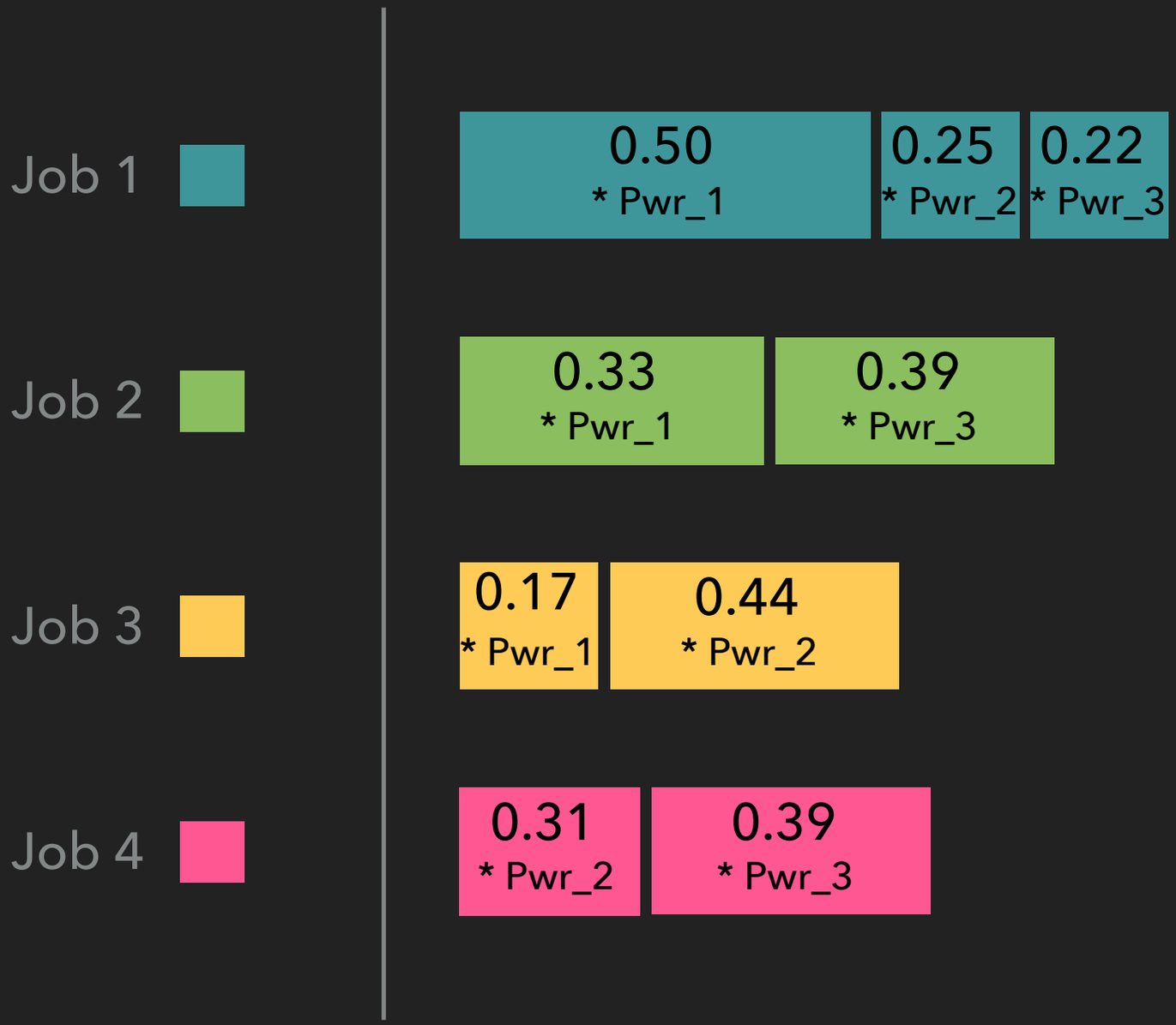


Assume power usage is proportional to the core usage!

METHODOLOGY

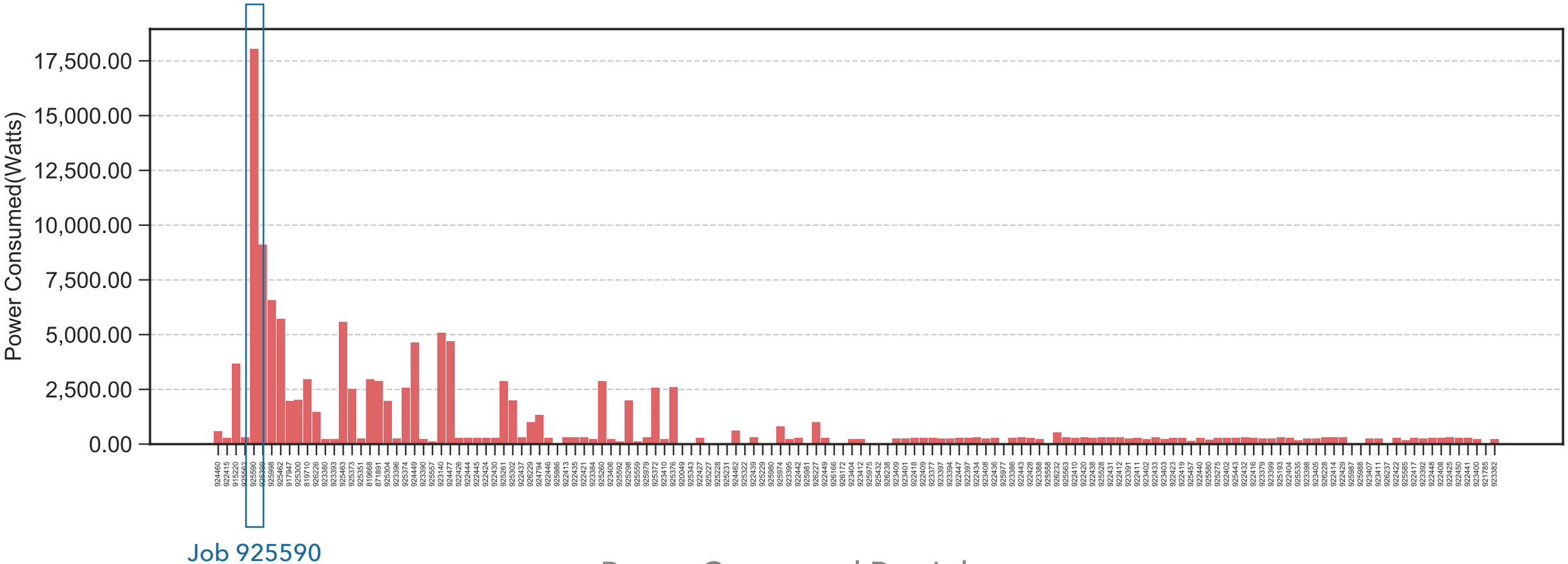


METHODOLOGY



Demo

RESULTS

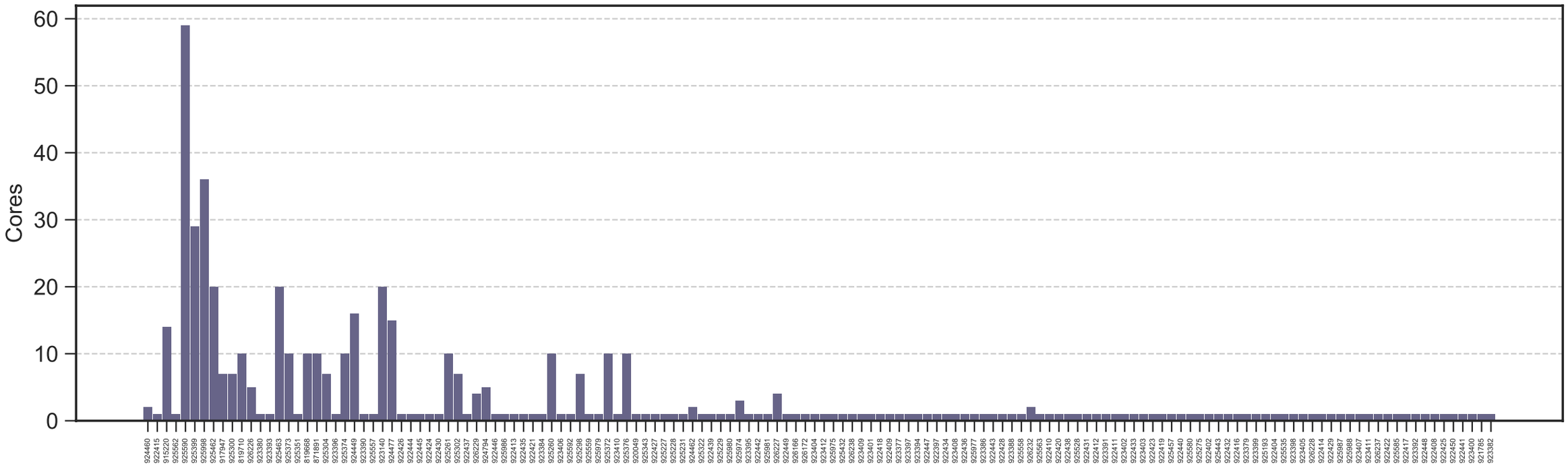


Power Consumed Per Job

Total Jobs: 144

Data Collected on Sept 16, 12:18:12

RESULTS

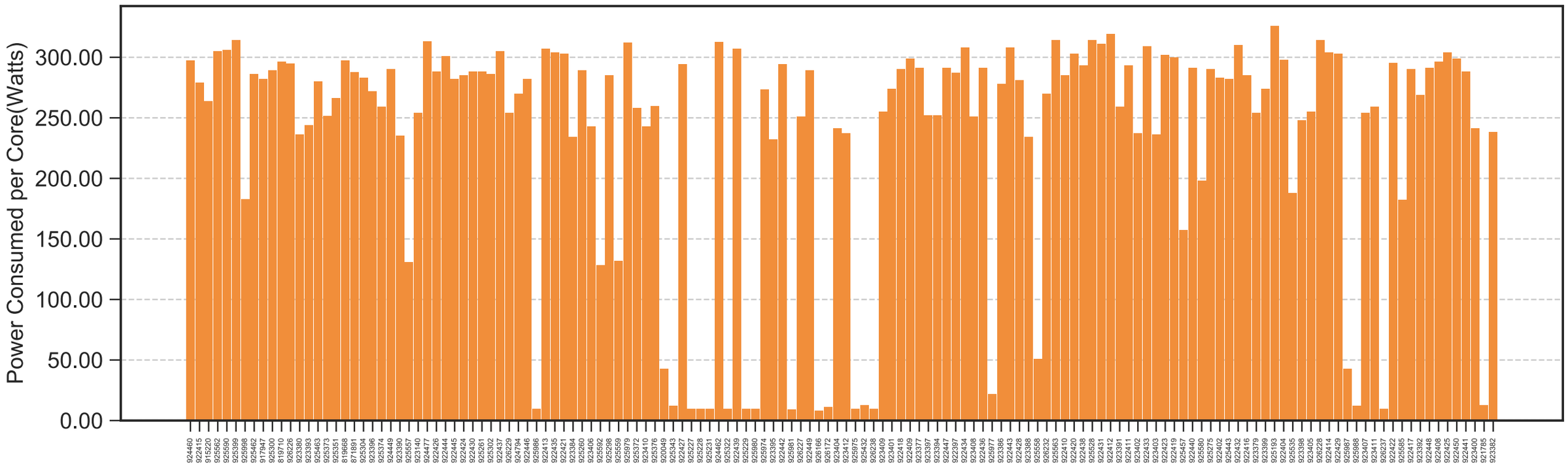


Cores Used Per Job

Total Jobs: 144

Data Collected on Sept 16, 12:18:12

RESULTS

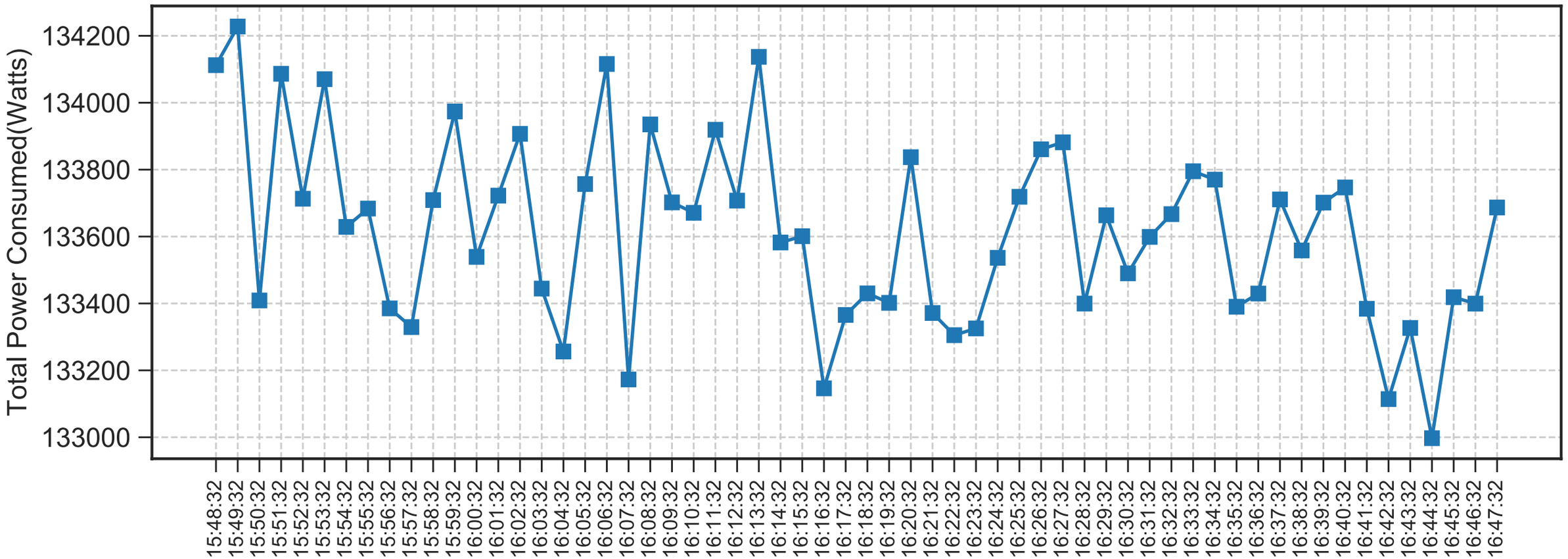


Average Power Used Per Core of Each Job

Total Jobs: 144

Data Collected on Sept 16, 12:18:12

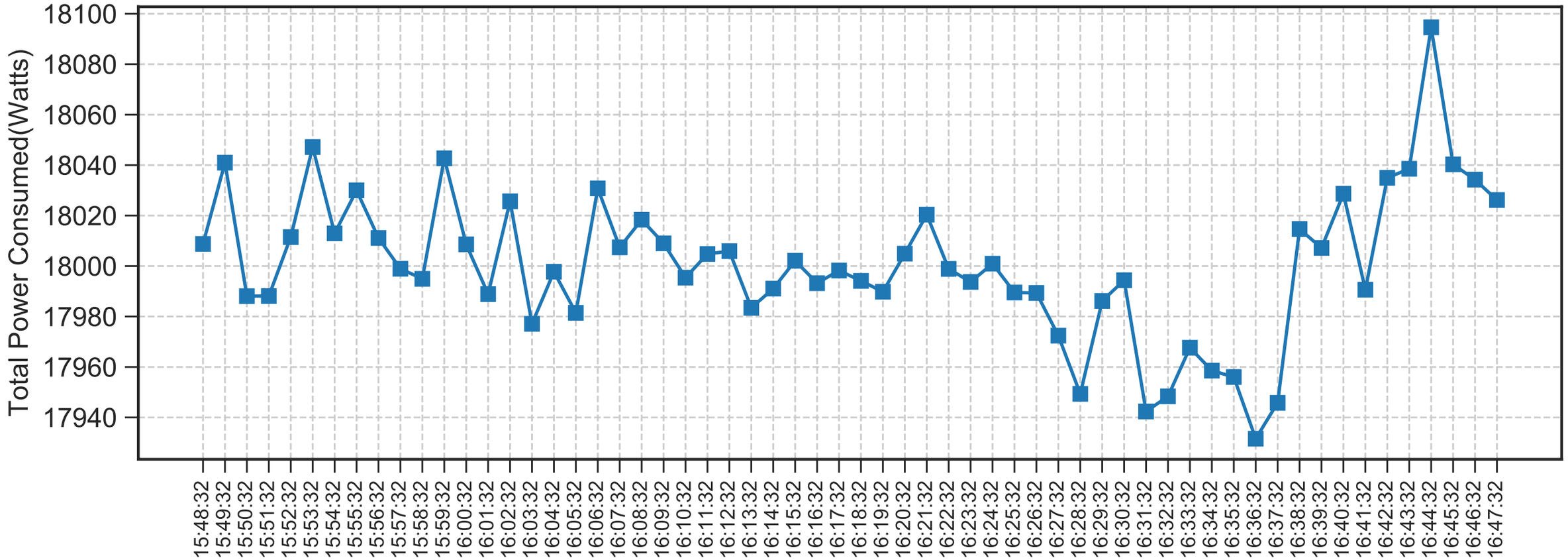
RESULTS



Total Power Consumed on Quanah Cluster

Data Collected on Sept 16, 15:48:32-16:47:32

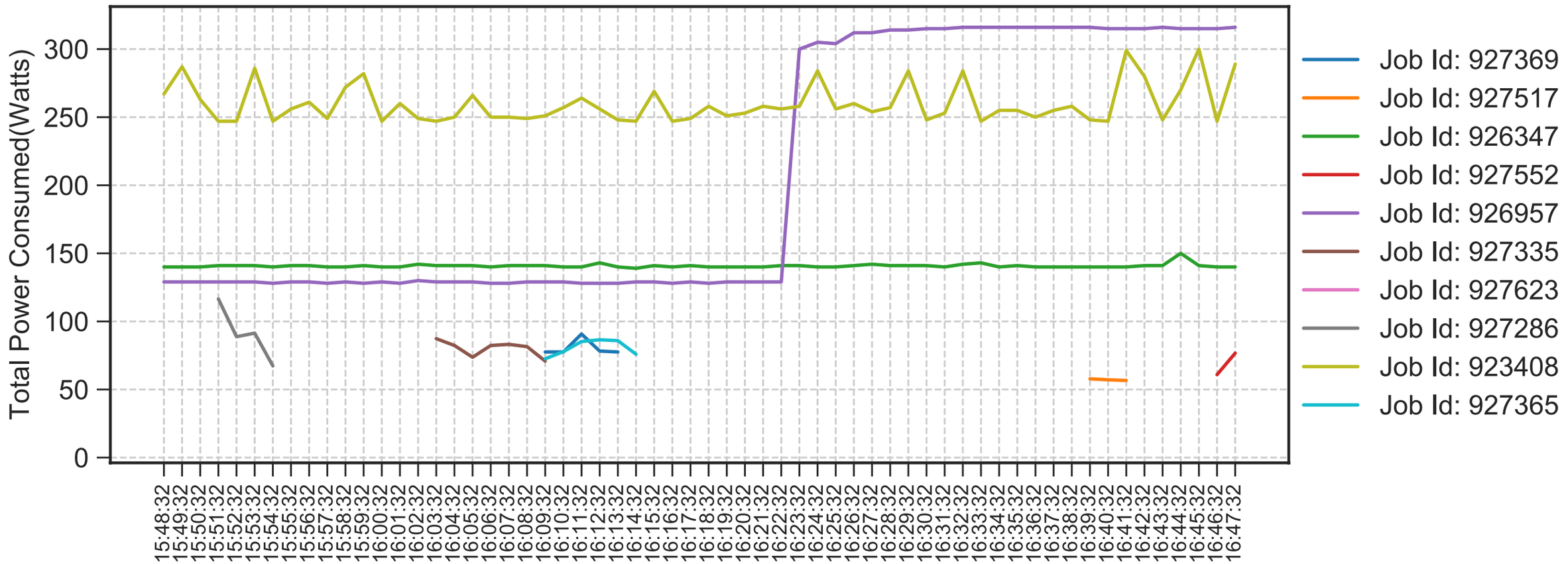
RESULTS



Total Power Consumed of Job 925590

Data Collected on Sept 16, 15:48:32-16:47:32

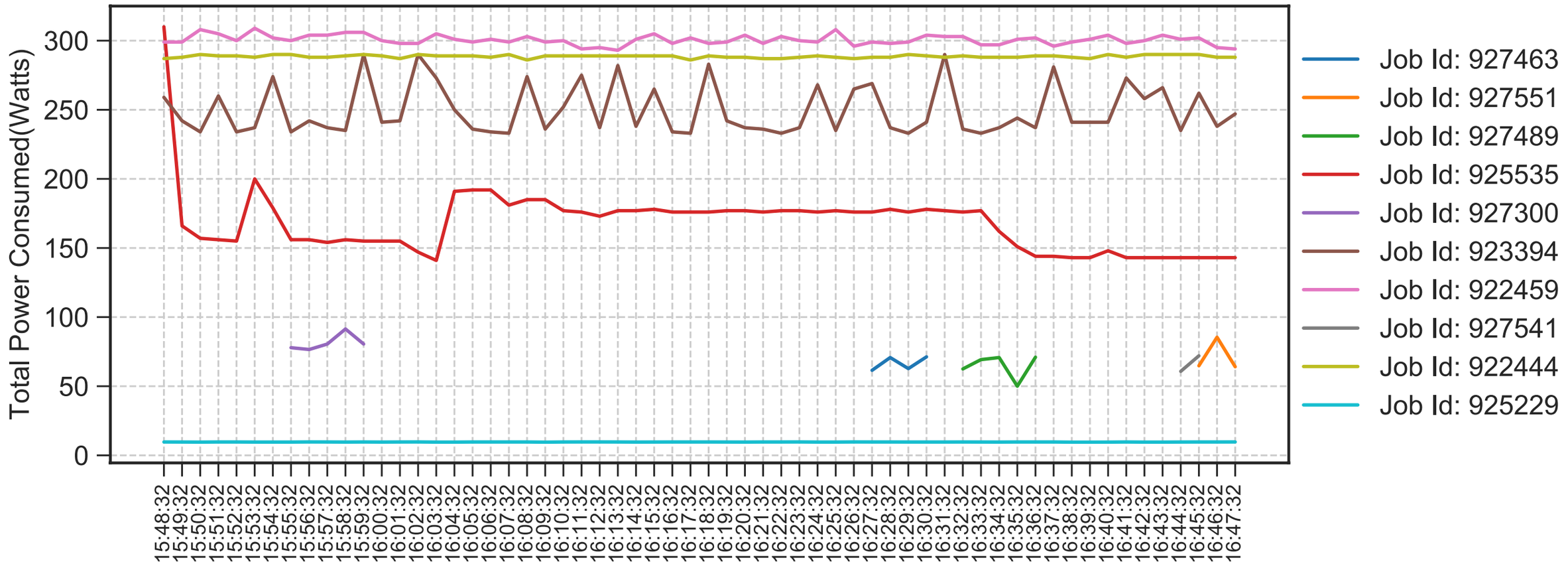
RESULTS



Total Power Consumed of Some Random SelectedJobs

Data Collected on Sept 16, 15:48:32-16:47:32

RESULTS



Total Power Consumed of Some Random SelectedJobs

Data Collected on Sept 16, 15:48:32-16:47:32

FUTURE WORK

- Work with data visualization team to nail down the data frame structure
- Implement the filters
- Research on reducing the latency of fetching BMC metrics

QUESTIONS?/COMMENTS?