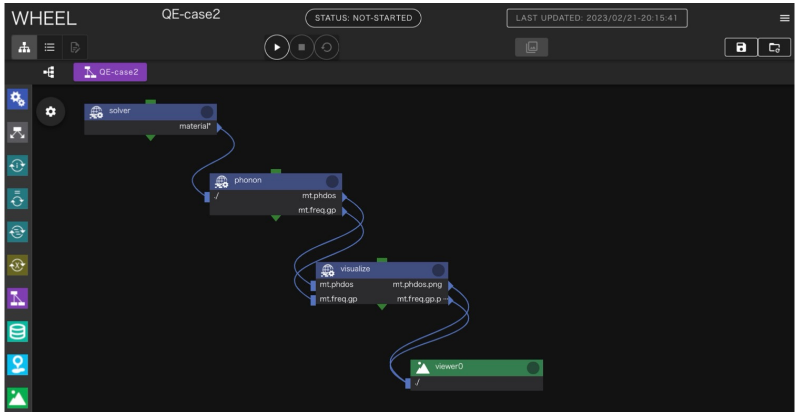
Study on Handling Dark Data in HPCI Shared Storage System using the WHEEL Workflow Tool

International Data Week 2025
Data and Research & Data Science and Data Analysis
2025/10/13

RIKEN R-CCS
- Hidetomo Kaneyama
- Tomohiro Kawanabe
- Hiroshi Harada

Outline

- RIKEN operates the HPCI Shared Storage, providing free storage for HPC/supercomputing research data in Japan.
- Currently storing ”35+ PB” and ”200M+ research files”.
- Many files have not been accessed for over a year and are now considered “cold data.
- Dark data: data unused for analysis/decision-making, with unclear value or risk. And, significant dark data exists in HPCI Shared Storage.
  - https://www.gartner.com/en/information-technology/glossary/dark-data
- Issues:
  - Dark Data blocking “effective use” of storage, causes storage pressure.
- Our approach:
  - Extend WHEEL workflow tools for HPC/supercomputers.
    - Automatically capture information and automatically add extended metadata to HPC datasets
    - Data and extended metadata is stored in HPCI shared storage.



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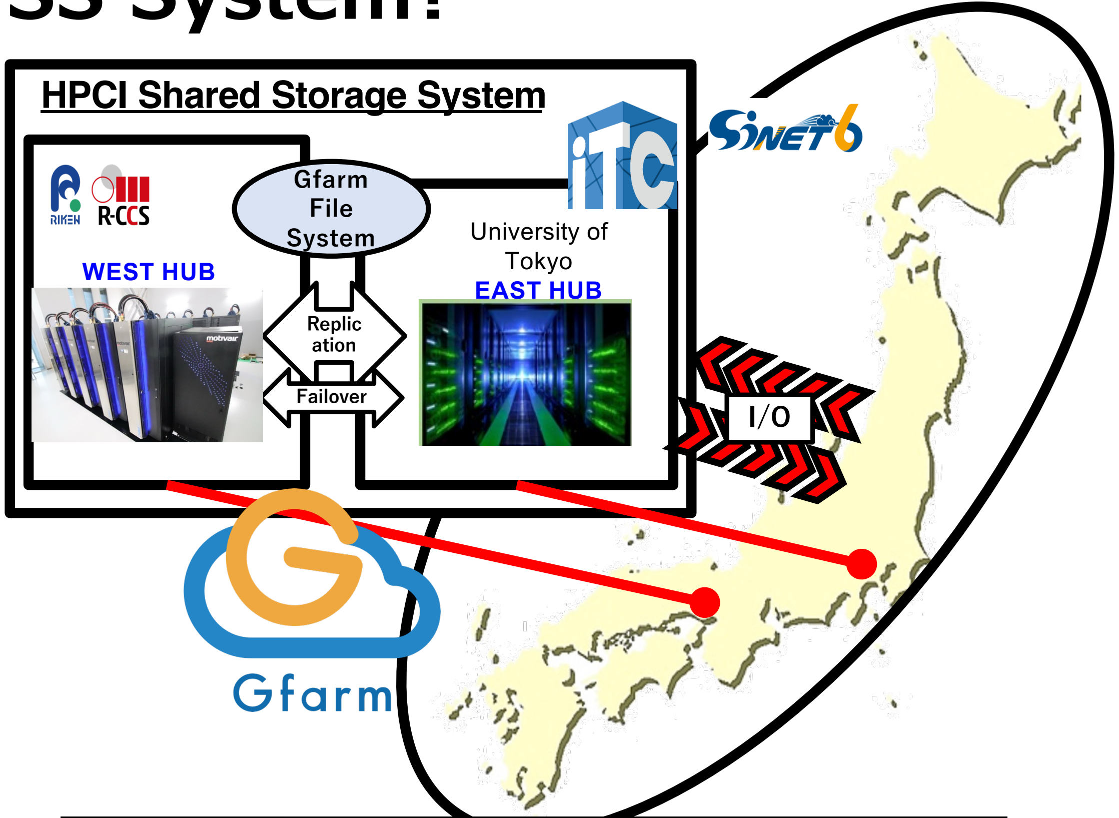
What is HPCI-SS System?

HPSS(HPCI Shared Storage) System for Preserving and Sharing Data from Japanese Supercomputers.

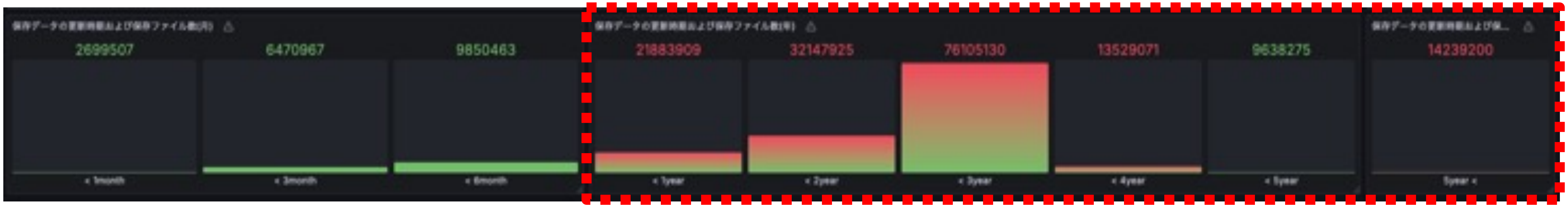
- **Objectives**
  - Data sharing between supercomputers (computational resources)
  - Long-term preservation of research data
  - Public dissemination of research data (utilization of open/public datasets)
- **Core Software**
  - **Gfarm File System**
    https://github.com/oss-tsukuba/gfarm
- **Key Features**
  - Parallel data I/O transfer from HPCI resources
  - Disaster recovery through inter-site data replication
  - High availability (operational uptime >99%, downtime/unavailability <1%)
  - High-performance network storage capable of transfers exceeding
    200 Gbps



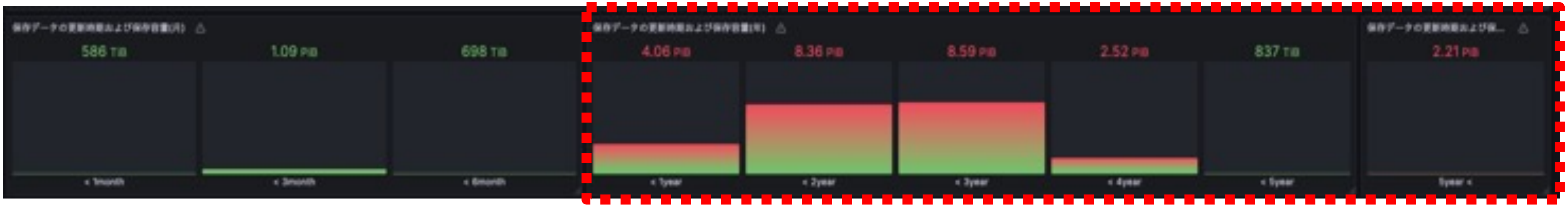
Gen	Periods	Capacity(Logical)
1st	FY2012 – FY2018	10PB → 15PB
2nd	FY2018 - FY2024	45PB → 50PB
3rd(now)	FY2025 -	95PB+

https://www.hpci-office.jp/info/pages/viewpage.action?pageId=111380786

Cold Data in HPCI-SS



Number of Files



※Cold data is 'File not Accessed in over ONE YEAR'

Capacity

Total	Capacity	33PB
	Number of files	188 million
Cold data ratio (include Dark data)	Capacity	90.2%
	Number of files	88.8 %

Cold data grow in HPCI Shared Storage.

- Users face heavy burden in identifying unnecessary files
- Some data has been inherited (e.g., from former members)
- Lack of metadata makes deletion decisions difficult

Discussion and Approach to Dark Data in HPCI-SS

CJK Project(A3)

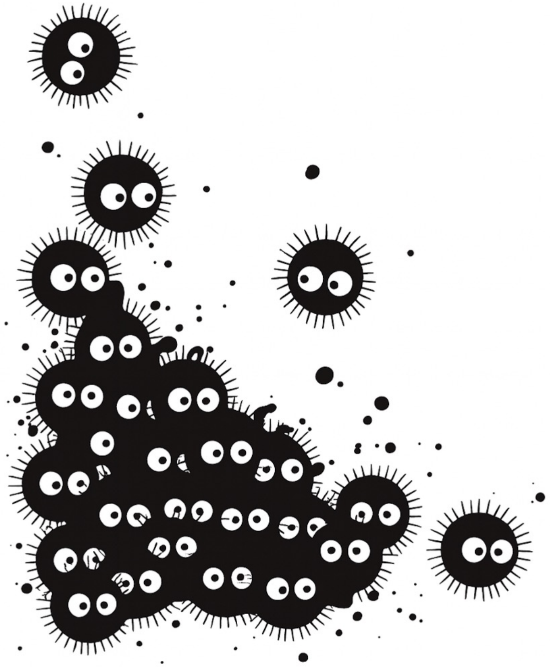
Operational Concerns
→ Need to provide environments for extended metadata attachment / methods for automatic enrichment

[1] Approach to Cold Data

- **Ask users to delete very old, unused data**
- **Dark data is harder: unidentified data, high user burden to judge deletion**
- **Actual volume of dark data remains unknown (only discovered when users clean up)**
- **Visualization provides usage/capacity/file counts, but not data content or usefulness**

[2] Challenges for AI & Open Science

- **AI/Open Science requires labels and metadata**
- **Current HPC & HPCI storage lacks tagging/labeling mechanisms**
- **Object storage often missing or underutilized**
- **Critical info (“who used what, and how data was obtained”) is not preserved**
- **Some users keep records manually (e.g., Excel) → high management burden**



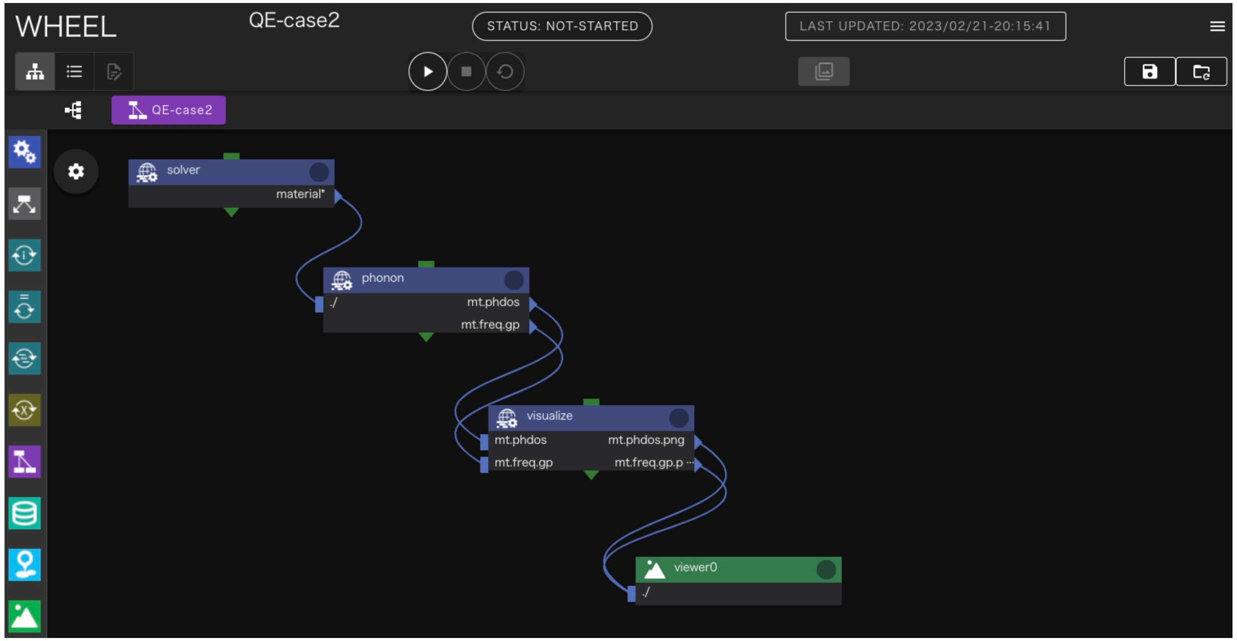
https://sca25.sc-asia.org/wp-content/uploads/2025/04/pos121s1.pdf

Discussion and Approach to Dark Data in HPCI-SS

- **Why Workflow Tools?**
- Data in HPCI-SS is mainly generated on external HPC/supercomputers
- Data management starts **at the point of generation**
- HPC storage (e.g., Lustre, BeeGFS) is fast but lacks metadata functions
- Replacing entire storage systems is **too costly**
- Commercial metadata products (e.g., Starfish, IBM AFM) require:
    - Management authority at each site
    - High license and operational costs
- → Implement metadata management **on the workflow side**
- **What does this solve?**
- Automatically collect information during computation, pre-/post-processing
- Associate **extended metadata** with datasets
- Compress and register datasets in HPCI-SS as manageable units
- Enable metadata-based **search and management** in HPCI-SS (via Gfarm)

Overview of WHEEL

- A web-based GUI workflow build and execution tool
- JavaScript application using Node.js
- Open-source software distributed under the BSD-2 license
  - https://github.com/RIKEN-RCCS/OPEN-WHEEL



CJK Project(A3)

Method

[A] Automatic extended metadata in HPC environments

- Adding functions to job schedulers or HPC storage (e.g., Lustre) is outside our authority
- Commercial tools (e.g., Starfish) involve high licensing/operational costs → Requires discussion at HPCI-wide level

[B] Management software on HPCI-SS side

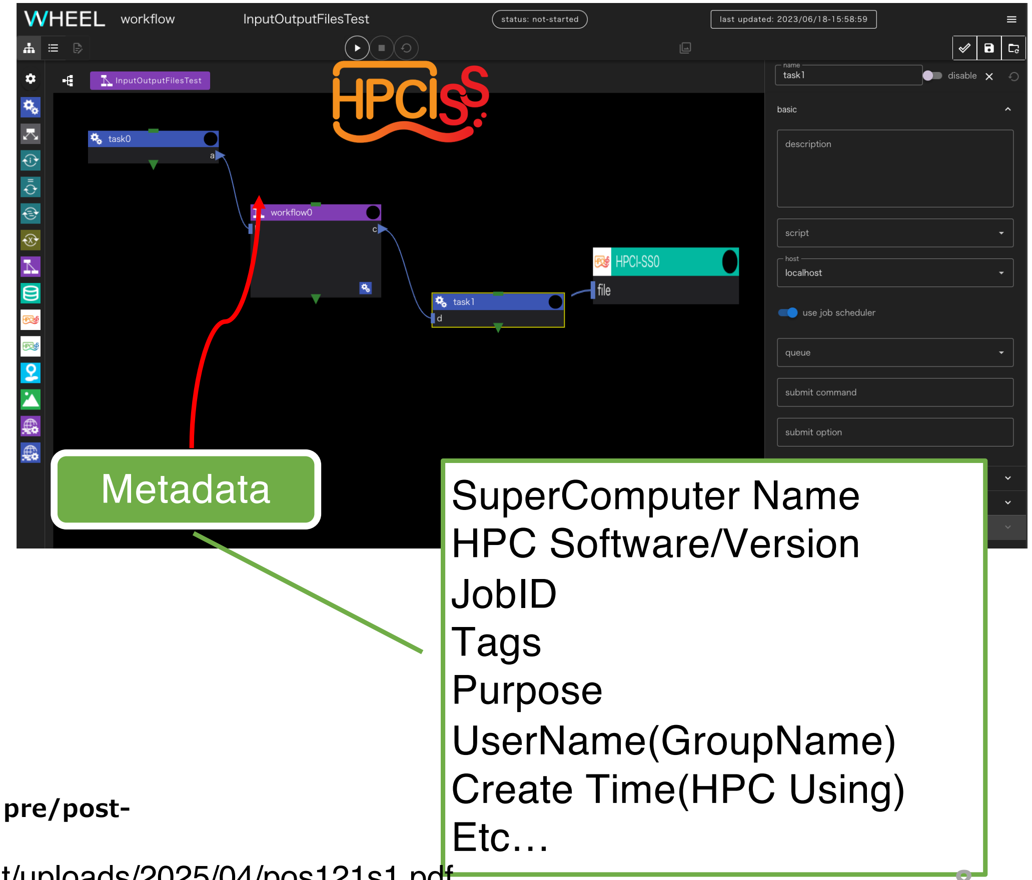
- 3rd-generation system already designed (capacity-first policy)
- High cost, difficult to shift to products like VAST Catalog / IBM AFM

Our Approach

- Seek improvements without direct system modifications
- Collaborate with WHEEL workflow tool (R-CCS, Senior Engineer Kawanabe)
- Automatically collect extended metadata during workflow execution
- Store enriched metadata + datasets into HPCI-SS (Gfarm)
- Long-term goal: integrate with DOI assignment

Progress

- FY2024: Enabled WHEEL I/O to HPCI-SS via Gfarm API
- FY2025: Developing automated metadata collection during HPC compute & pre/post-processing



SuperComputer Name
HPC Software/Version
JobID
Tags
Purpose
UserName(GroupName)
Create Time(HPC Using)
Etc…

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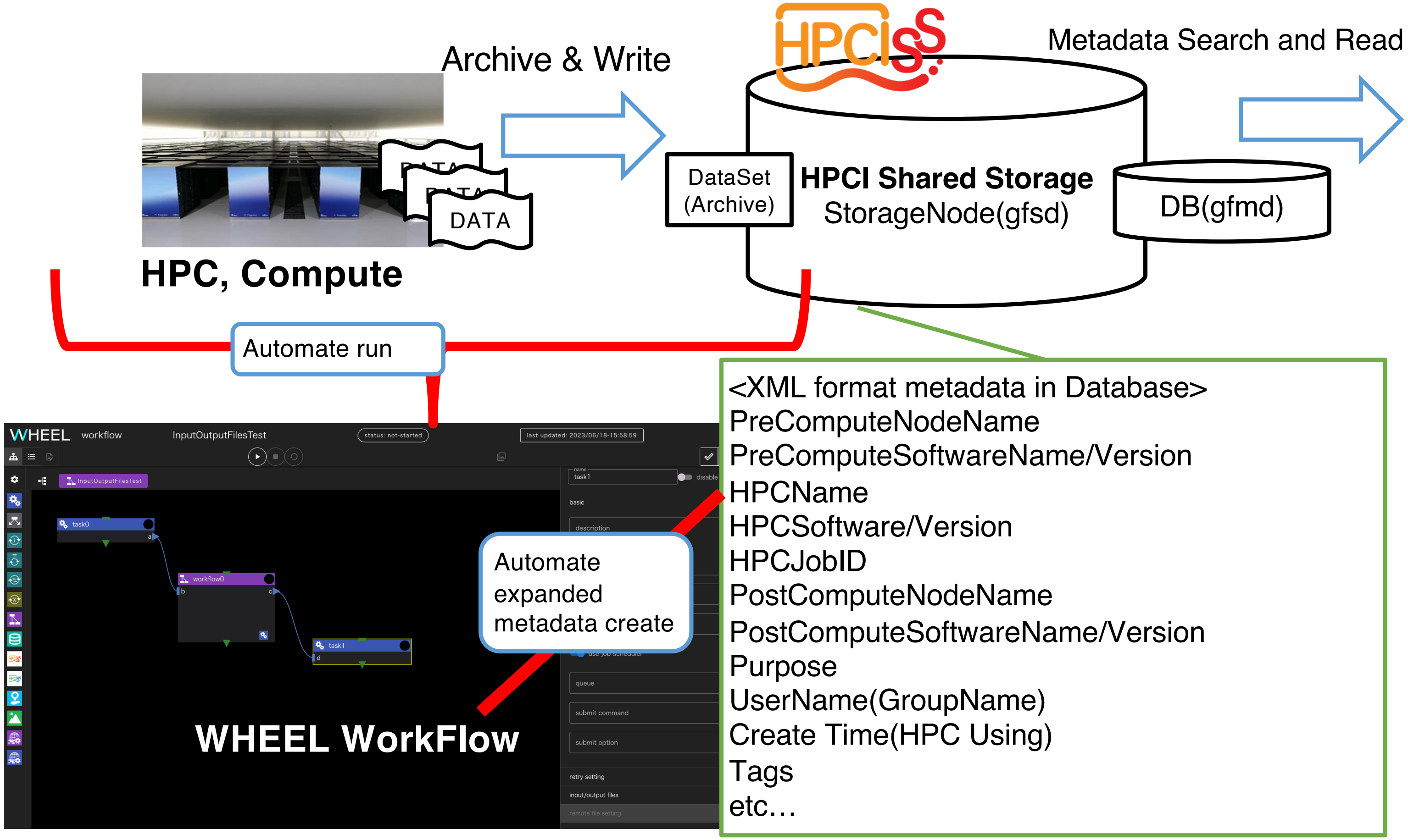
Next Work

Future challenges



<XML format metadata in Database>
PreComputeNodeName
PreComputeSoftwareName/Version
HPCName
HPCSoftware/Version
HPCJobID
PostComputeNodeName
PostComputeSoftwareName/Version
Purpose
UserName(GroupName)
Create Time(HPC Using)
Tags
etc…

[1] Develop Access/Search Platform

[2] Visualization of Expanded Metadata

[3]Collaboration to DOI

[4] Connect to/for RDM or Open Sience S

https://sca25.sc-asia.org/wp-content/uploads/2025/04/pos121s1.pdf

SCA/HPCAsia 2026: Call for Submissions

SCA2026 Supercomputing Asia
Gathering the Best of HPC in Asia

HPC Asia 2026

- Event Overview:
  - Date: January 26-29, 2026
  - Venue: Osaka International Convention Center (Osaka, Japan)
  - Theme: “Everything with HPC –AI, Cloud, QC, and Future Society”
- Call for Submissions: Papers, Posters, Workshops, BoFs, and Tutorials

Papers	Posters	Workshops	Birds of a Feather	Tutorials
Paper abstracts: 29 Aug 2025 Submissions close: 5 Sep 2025 Result notification: 20 Oct 2025	Submissions close: 27 Oct 2025 Result notification: 14 Nov 2025	Submissions close: 30 Jun 2025 Result notification: 31 Jul 2025	Submissions close: 1 Sep 2025 Result notification: 1 Oct 2025	Submissions close: 11 Jul 2025 Result notification: 15 Aug 2025

For more details, please visit our website:
https://www.sca-hpcasia2026.jp/

Thank you