



Distributed Cloud Research Infrastructure and E-Science

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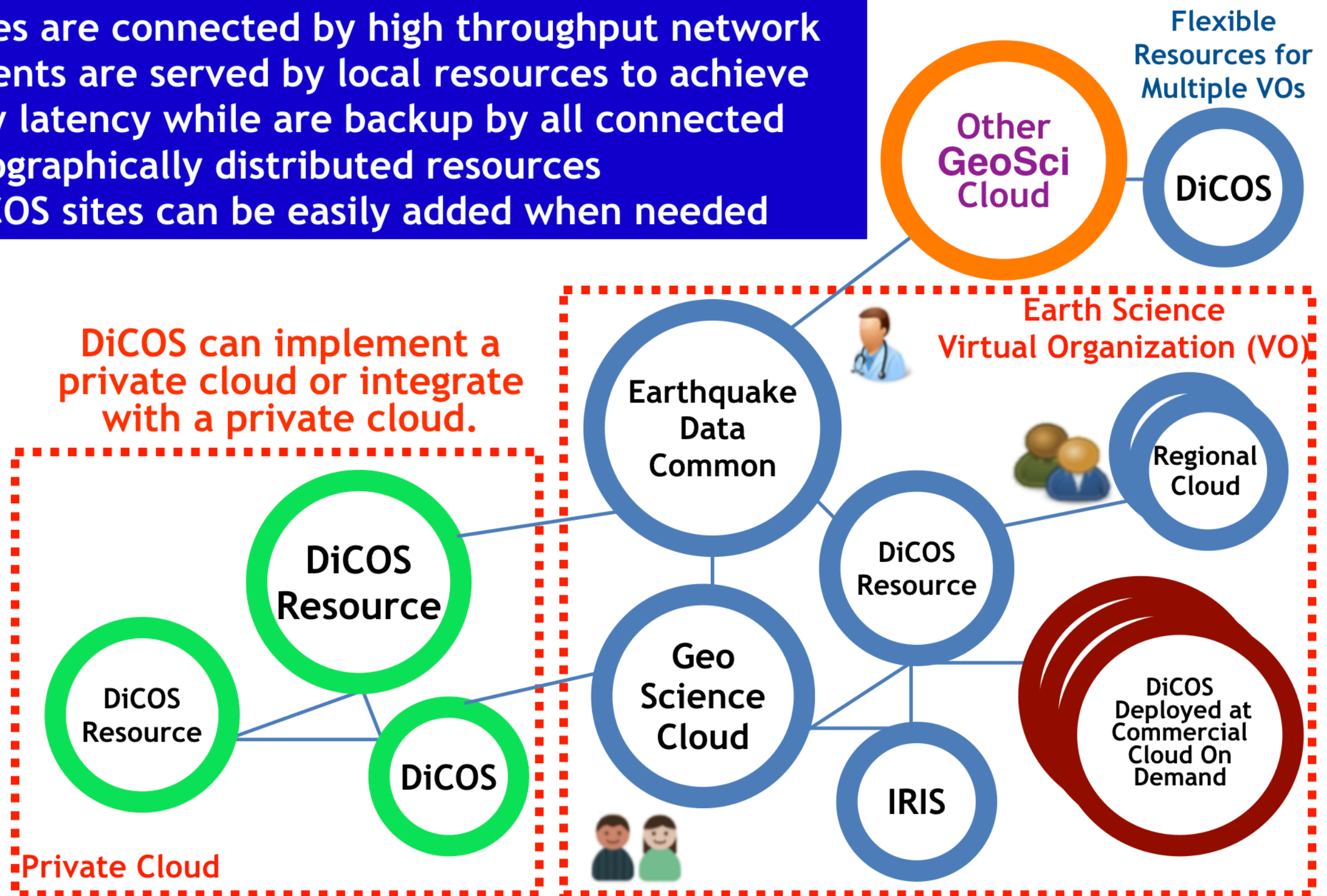
Research Infrastructure

- **Primary Purpose: Fulfill research workflow efficiently**
- **Requirements**
 - **User Interface, Compute, Storage, Network**
 - **Customization; Optimization; On-demand; Production quality**
- **Expectations**
 - **Reproducibility; Data/Knowledge/Toolkit/Facility Sharing; Long-term access; Archive; Collaboration;**
 - **Interoperability; Scalability**
- **Potential**
 - **Cross-disciplinary interactions/collaborations; Open Science; Volunteer computing; Citizen Science; Open Data; ...**

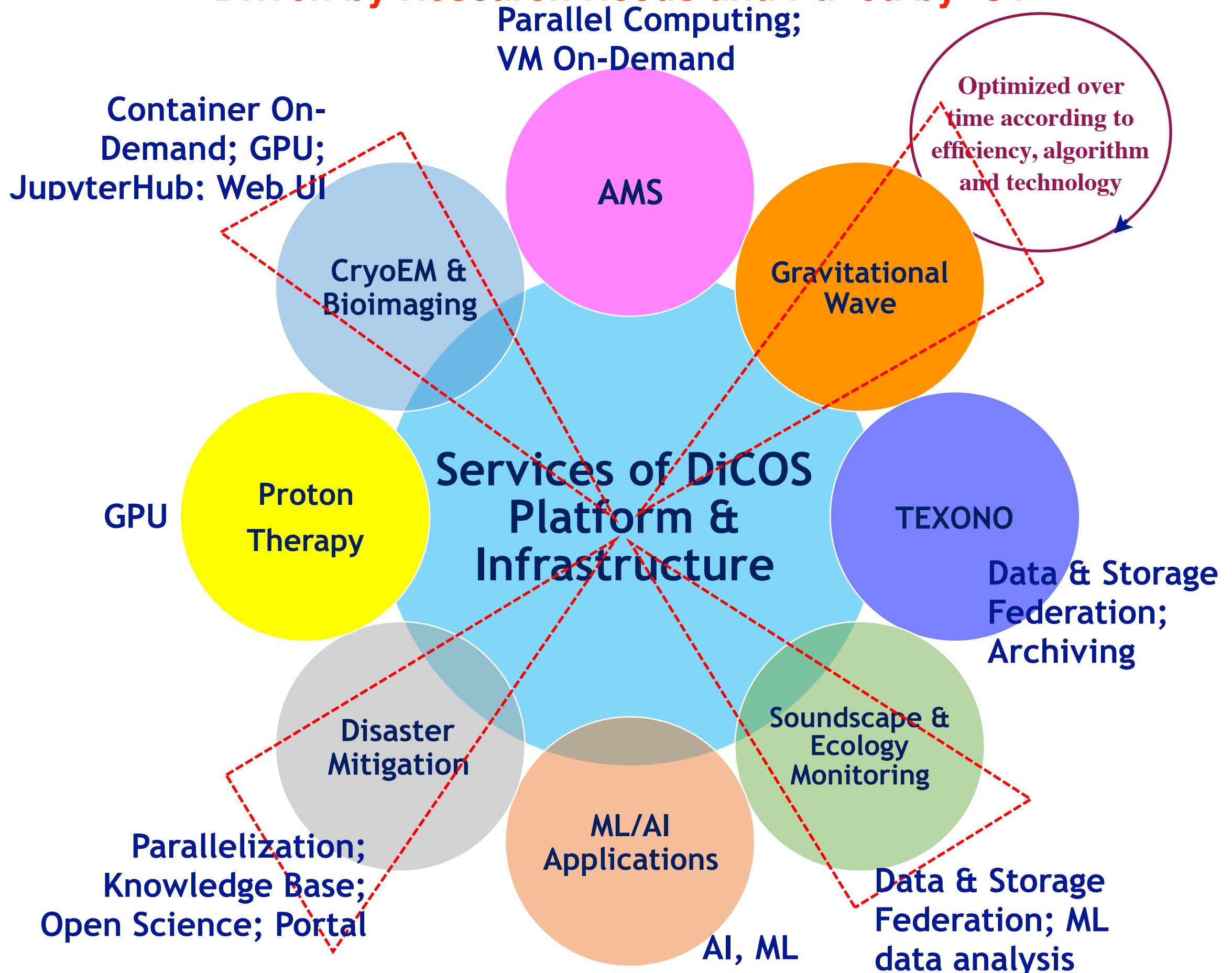
Distributed Cloud Operating System (DiCOS)

Open source middleware developed by ASGC for geographically distributed data commons to share resources

- Sites are connected by high throughput network
- Clients are served by local resources to achieve low latency while are backup by all connected geographically distributed resources
- DiCOS sites can be easily added when needed



Sustainable and Evolving Research Infrastructure: Driven by Research Needs and Pulled by ICT

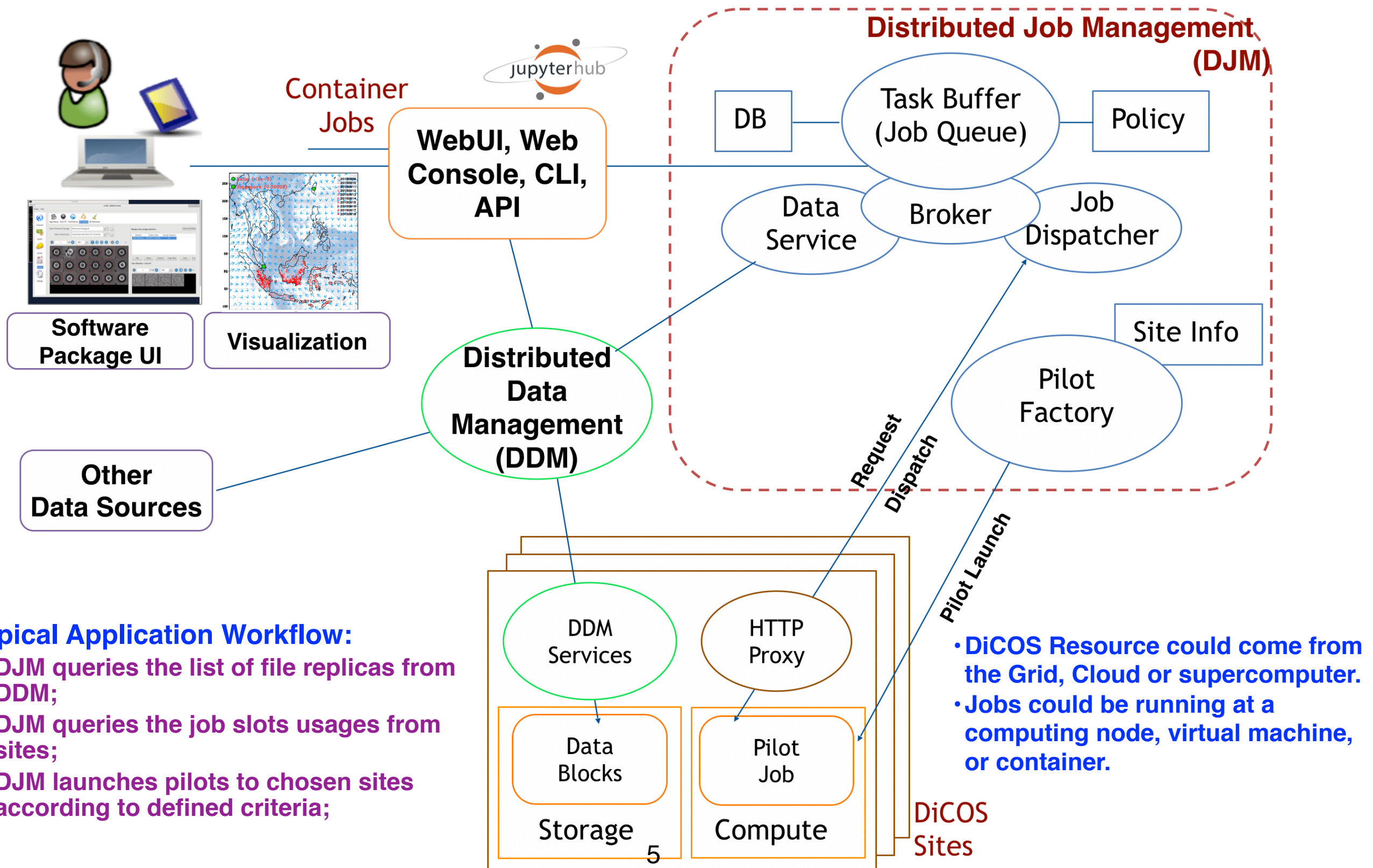


Data Analysis Scenario and Some Core Components of DiCOS

Components are from open source or WLCG collaboration.

They evolve constantly and may be replaced to optimize **system** operation.

Job is run at the best available site and data is moved transparently



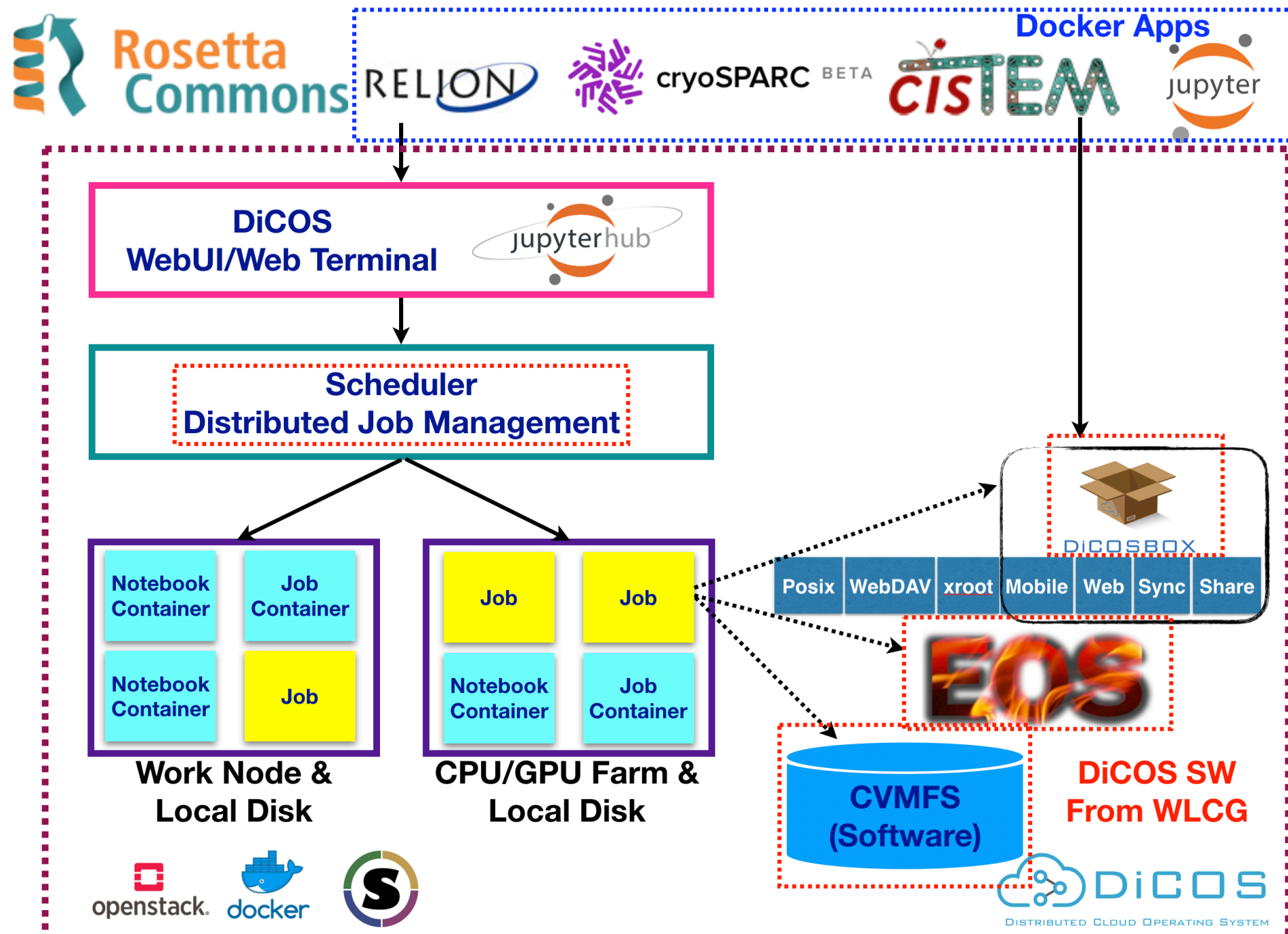
• Typical Application Workflow:

- DJM queries the list of file replicas from DDM;
- DJM queries the job slots usages from sites;
- DJM launches pilots to chosen sites according to defined criteria;

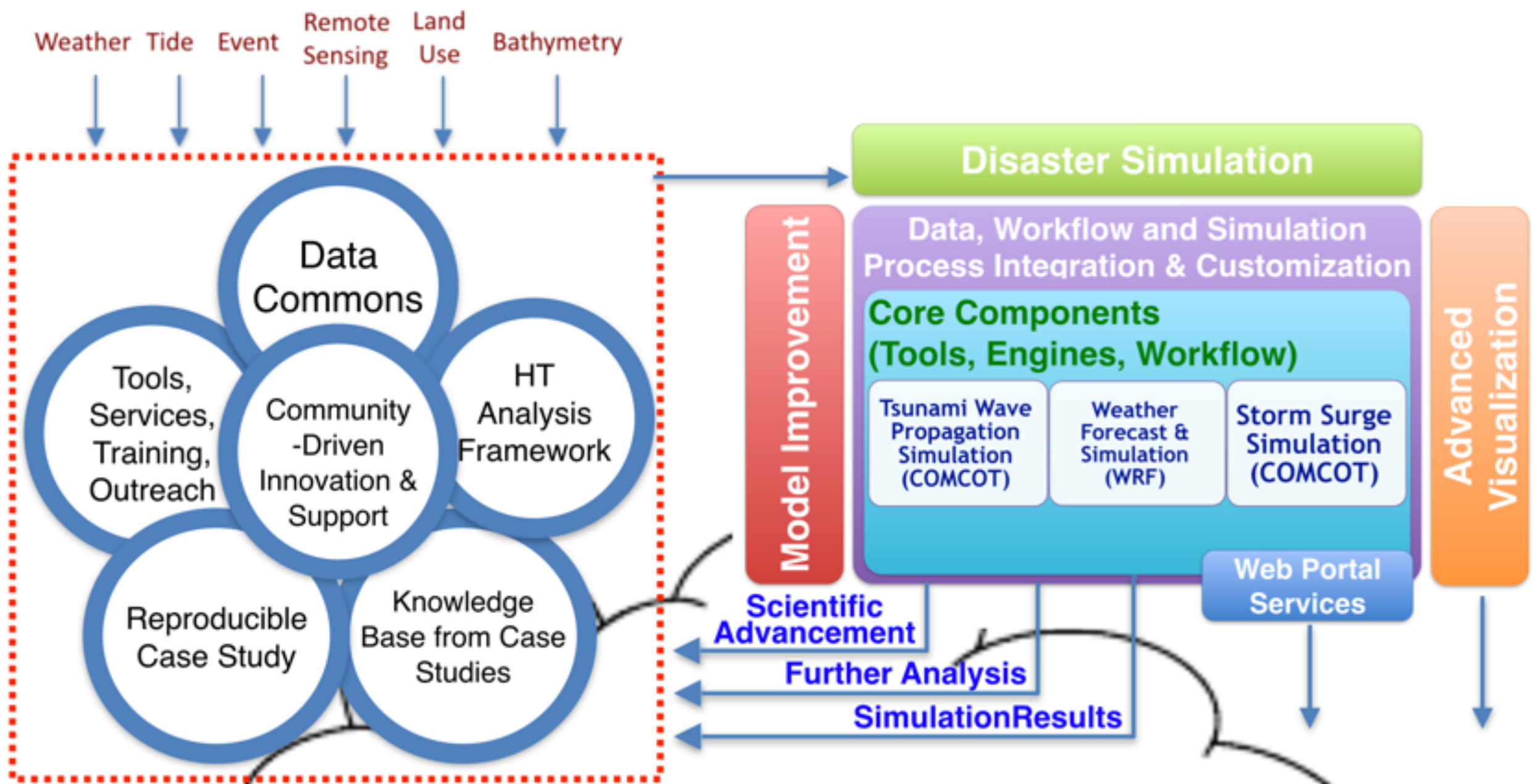
- DiCOS Resource could come from the Grid, Cloud or supercomputer.
- Jobs could be running at a computing node, virtual machine, or container.

Supporting Cryo-EM Applications by DiCOS

- Contributions of ASGC for now
 - Web UI development
 - SW package as container
 - Data flow and performance optimization
 - Mass production over DiCOS



Open Science Platform of DMCC+ (Over Distributed Infrastructure)




e-Science Infrastructure & Distributed Cloud Platform over EGI Integrated Resources in Asia Pacific Region



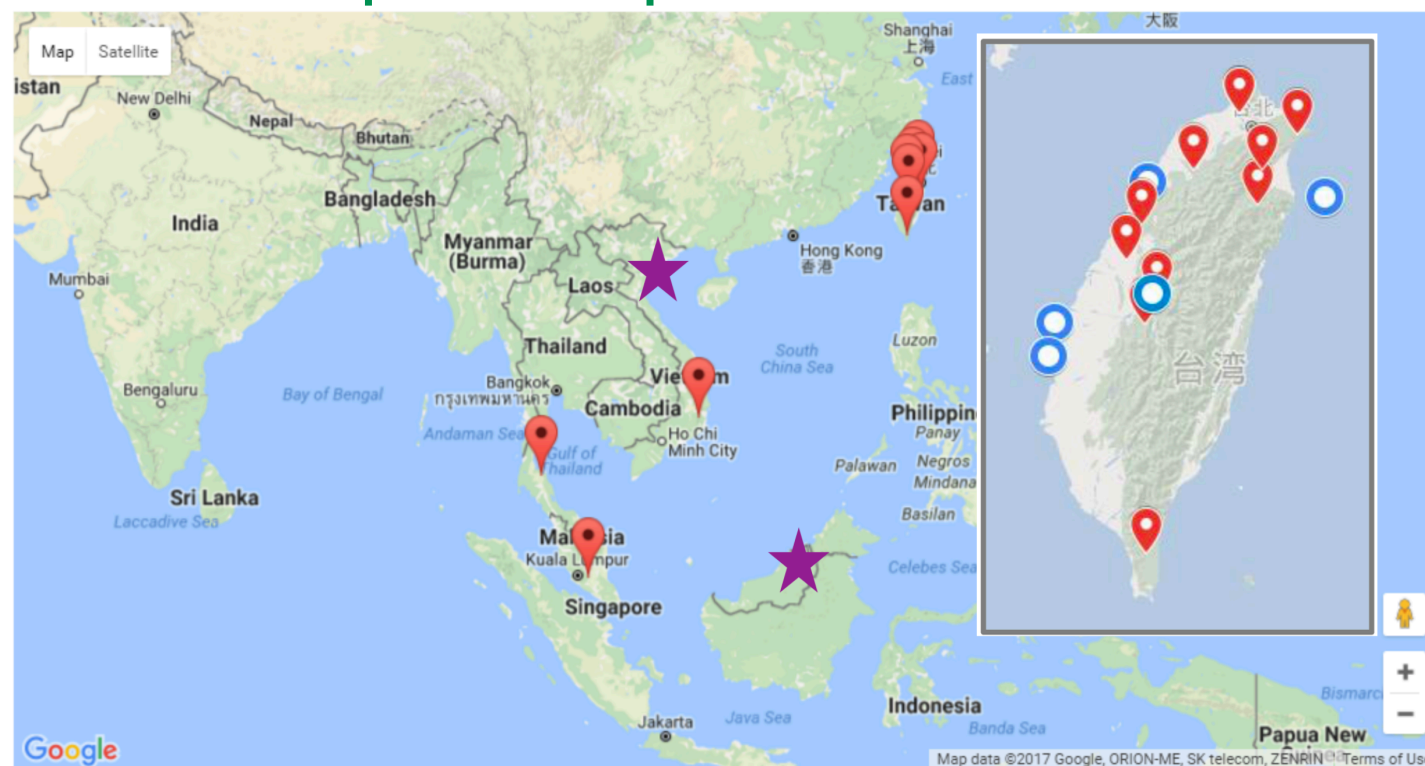


Building Asia Regional Soundscape Monitoring Network

Extend and test DiCOS for international collaboration projects of AS with Asia region

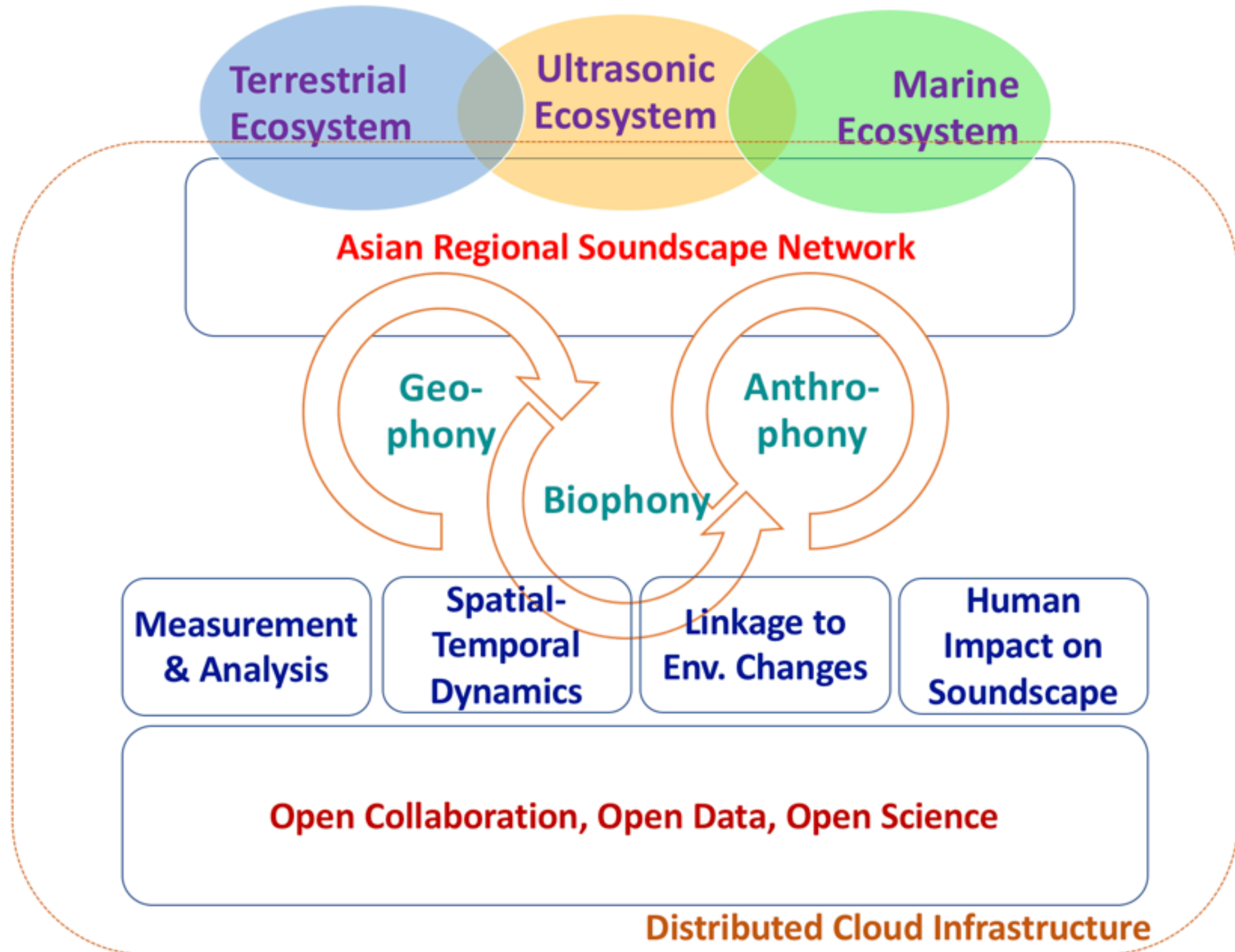
PI: SC Lin, MN Tuanmu, SS Lu, Y Tsao, WH Wang, H Lin, E Yen

- Enhance capacity of ecology and biodiversity monitoring by soundscape for both country-level and Asia regional level by an open science platform over distributed cloud infrastructure
 - Explore dynamics of soundscape
 - Study interactions between wildlife, habitat, and human activities based on soundscape
 - Integration of soundscape data analysis toolkit:
 - Visualization of long-duration recordings using long-term spectrogram
 - Blind source separation using periodicity-coded nonnegative matrix factorization (PC-NMF)
 - Develop soundscape data index



- Operational since Oct 29, 2014
 - 1M+ sound files (33K+ hours, 100TB+) from 18 sites in 4 countries (till May 2018)
- New sites: VN, TH, MY, PH
- ASEAN Center for Biodiversity (ACB) is also a collaborator

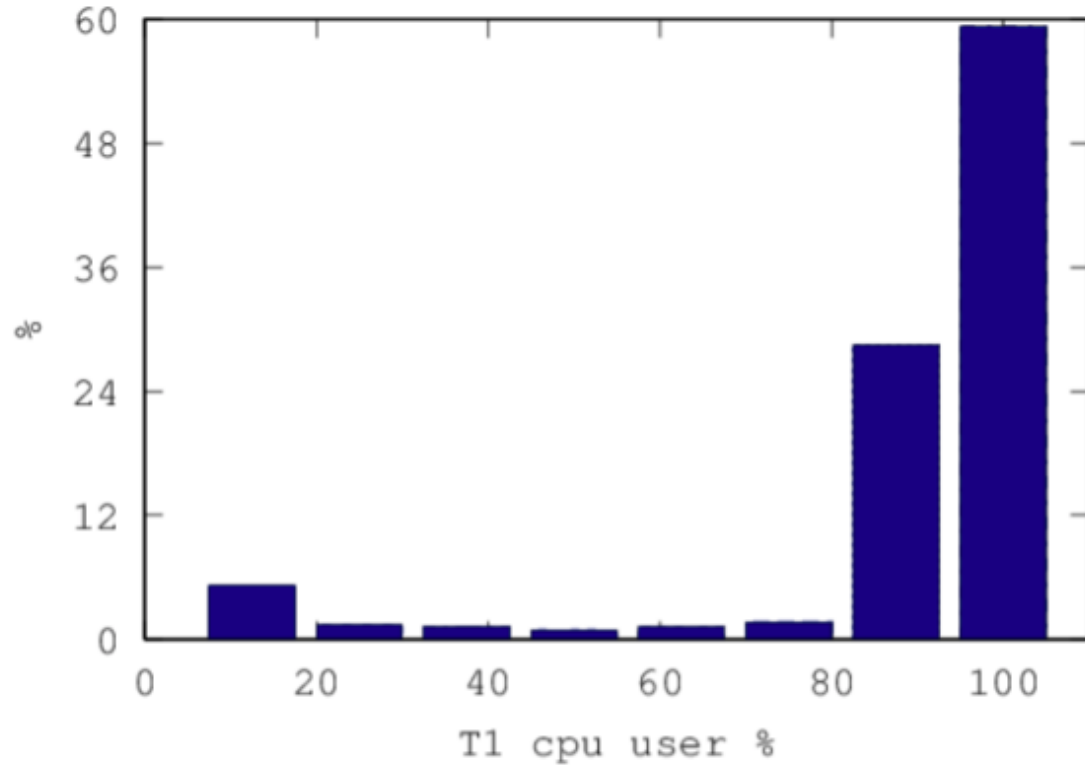
Characterizing Rhythms of Nature



Big Data Analysis for System Efficiency

We monitor all nodes every 10 seconds

21-Oct-2016 08:03:00 to 31-Oct-2016 08:01:00



```

Single core jobs :
finished duration time percentage : 91.60
failed duration time percentage : 8.34
cancelled duration time percentage : 0.05
jobs efficiency : 0.99
stage in time percentage : 0.37
files transfer error time percentage : 1.50
Multi-core jobs :
finished duration time percentage : 65.74
failed duration time percentage : 33.82
cancelled duration time percentage : 0.44
jobs efficiency : 4.74
stage in time percentage : 5.03
files transfer error time percentage : 12.63
single to multi core job slot idle : 24 hours/WN
multi to single core job node idle : 4.18 hours/WN
    
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Some users submit single core jobs to multicore queue

Low Multicore Job Efficiency

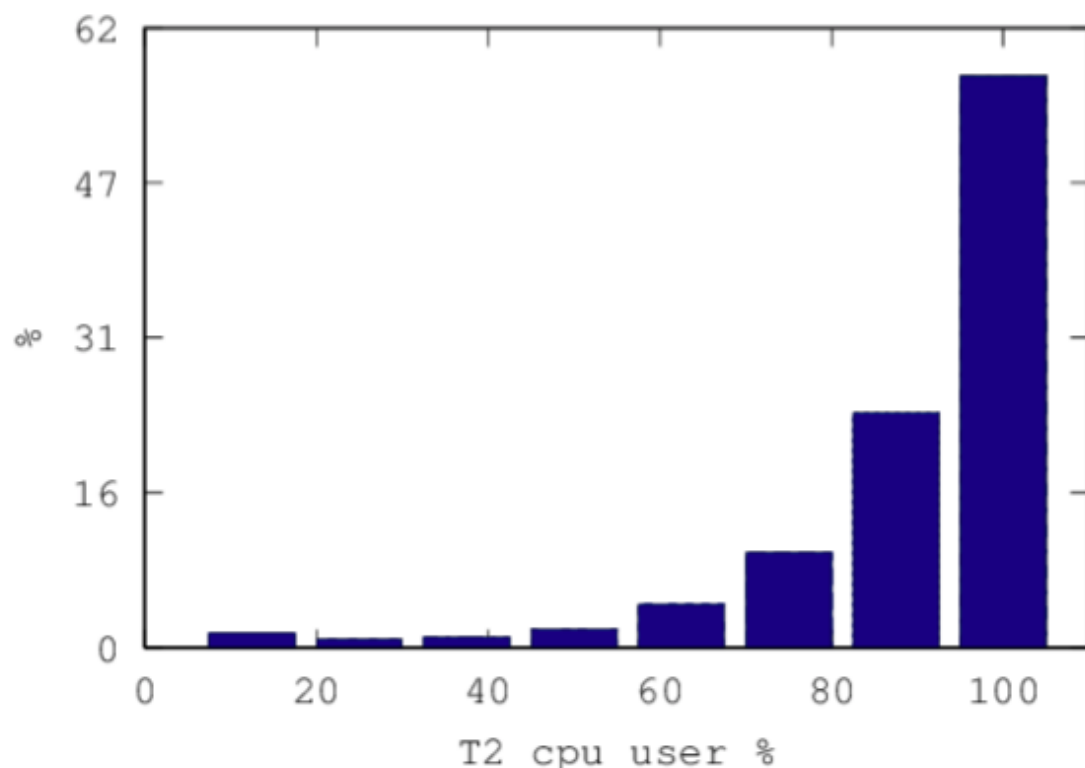
Develop algorithm to improve

Long transition overhead from single core jobs to multicore jobs

Failure mode analysis

High single-core jobs failure ratio

DJM accounting bug found from peculiar data



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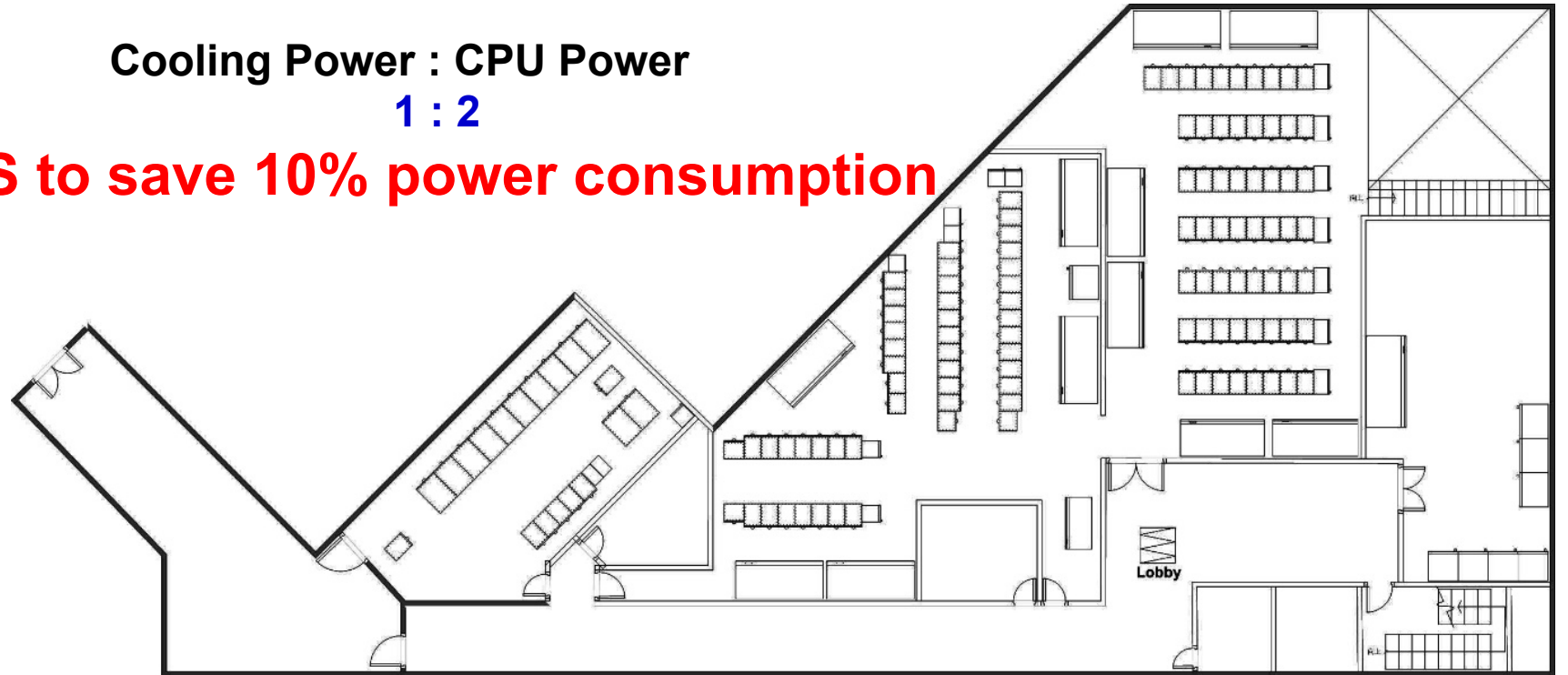
Single core jobs :
finished duration time percentage : 85.74
failed duration time percentage : 14.00
cancelled duration time percentage : 0.26
jobs efficiency : 0.96
stage in time percentage : 3.48
files transfer error time percentage : 2.26
Multi-core jobs :
finished duration time percentage : 89.35
failed duration time percentage : 10.44
cancelled duration time percentage : 0.21
jobs efficiency : 6.38
stage in time percentage : 0.32
files transfer error time percentage : 0.43
single to multi core job slot idle : 2722 hours/WN
multi to single core job node idle : 0.61 hours/WN
    
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ASGC Resources

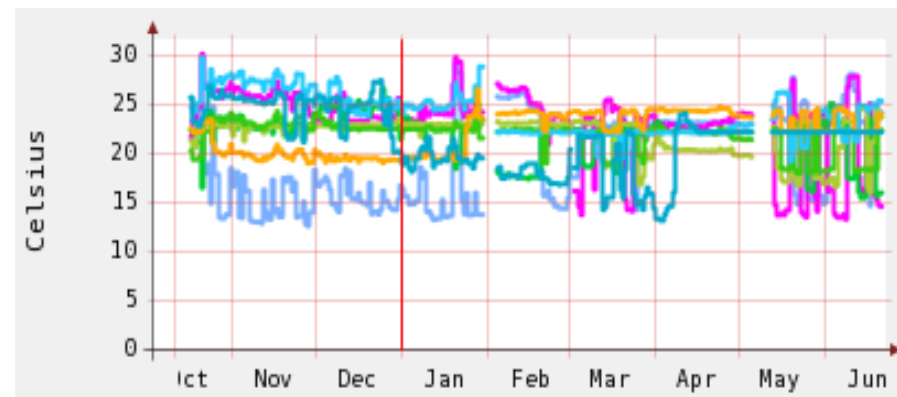
Cooling Power : CPU Power

1 : 2

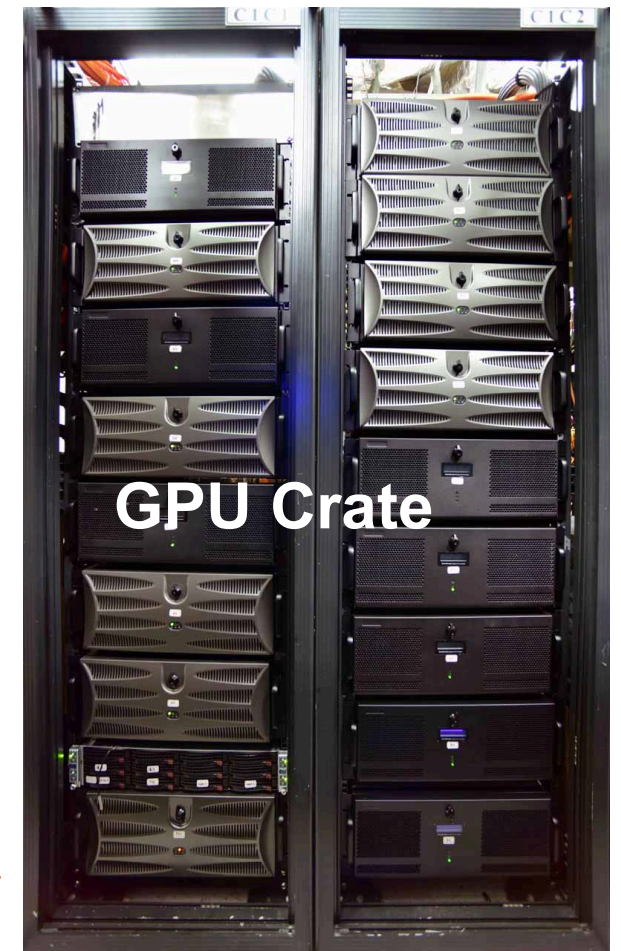
No UPS to save 10% power consumption



- Total Capacity
- 2MW, 400 tons AHUs
- 112 racks
- ~ 800 m²
- Resources (by end 2018)
- 20,922 CPU Cores
- 450,560 GPU Cores
- 20,480 Tensor Cores (GPU)
- 18.8 PB Disk Storage
- Rack Space Usage (Racks)
- AS: 59.2 (53.5%)
 - WLCG: 17
 - e-Science: 42.2
- ASloP: 10.4 (9.4%)
- RCEC: 6.5 (5.9%)
- ASCC: 3.3 (3.0%)
- AI School: 2.2 (1.9%)
- Free: 28.7 (26.3%)



Monitoring the power consumption and temperature of every piece of equipment every 10 seconds.



All software used are open-source codes developed by ASGC and an international collaboration led by CERN

Summary

- **Research infrastructure enables advanced digital services to enhance application efficiency, resource sharing and productivity**
 - **Driven by real case studies and requirements of research applications**
- **By the collaboration framework, discoverable and shareable data can enable collaboration and support repurposing for new discoveries and cross-disciplinary research enabled by data sharing across communities.**
 - **The collaboration framework also promises to transform education, society, and economic development**
- **Knowledge from researches, Simulation facility, knowledge base, science gateway, collaboration framework and even the e-Infrastructure are evolving progressively with more case studies on various disciplines of applications**
- **Aiming for open data, open application and open science**

ASGC is responsible for providing high-throughput research network from Taiwan to Europe

ASGC e-Science Global Network (Sep. 2018)

