

Computing

Sophie King



Silvio Pardi



on behalf of the JENNIFER2 Computing group
(Belle II, T2K and HK Computing members)

18/11/2022

The Grid and associated tools

Quick overview, to aid understanding of the upcoming slides.

WLCG - Worldwide LHC Computing Grid: 'The Grid'

EGI - European Grid Infrastructure

Software that facilitate and manage users/experiments interaction with distributed computing resources:

- **DIRAC** interware - complete **software framework** solution written in **python 3**
 - **Job management** (CPU/GPU queues)
 - DIRAC WMS (workload management system)
 - Note: Not limited to 'Grid' resources (Cloud, batch)
 - **Data management** (For Grid storage)
 - DIRAC DMS (Data management system)
 - Dirac File Catalogue (DFC)
 - Various DIRAC systems that help to **automate and manage tasks**
- **RUCIO**
 - **Data management** (For Grid storage)
 - Plugin available to integrate RUCIO into DIRAC framework (developed mostly by Belle II)

T2K and Hyper-K Computing

- T2K and HK have very similar computing models.
 - Hyper-K requires much larger computing resources and hence more advanced techniques and tools
→ Hyper-K needs are driving our development
 - We are in the process of merging T2K and HK computing tools
→ Any computing developments can benefit both experiments.
- During this talk I will therefore often talk about T2K and HK together, without the need for distinction

Main computing resources

- The Grid - European
- Compute Canada (Grid and non Grid)
- UTokyo (Large internal cluster)

For JENNIFER2 work, we focus on the Grid/DIRAC resources, since this is where we overlap with Belle II

T2K and Hyper-K Computing

The Grid

- DIRAC WMS for job submission
 - MC production, data processing, calibration tasks
 - Investigating use for analysis level jobs
- DIRAC File Catalogue (DFC) for data storage/management
 - Raw and processed data, MC production

GridPP (UK Grid) instance of DIRAC supports multi experiments ('multi-VO') including T2K and HK

- GridPP provide their DIRAC instance as a service. Experiments are end-users.
- T2K and HK have discussed the possibility to contribute to development of GridPP-DIRAC
 - Avoids huge overhead of self hosted custom option
 - But still ensures we have some flexibility to meet our longterm needs, using person power efficiently

T2K and Hyper-K Computing



Resource usage provided by EGI and DIRAC

- EGI - total usages
- DIRAC total and per job type - using for forecasting predictions

Resources status monitoring

(e.g. test various operations/communications on and between sites)

- Not really using anything other than Grid ticket system where you can check if sites are having issues.
→ Looking to develop tools. W

Metadata - Done within the Dirac File Catalogue (DFC)

Git for software development and version control

Software tags are distributed as containers. CVMFS is used to deploy container images for Grid jobs,

Belle II

- All RAW data stored at KEK CC Japan
- Copies also across USA, Italy, Germany, Canada, France

- 56 computing sites - grid, cloud, cluster and both pledge, opportunistic.
- Belle II develop and host their own instance of DIRAC, BelleDIRAC
→ main DIRAC servers hosted at KEK CC

- Belle II software distributed on CVMFS

- RUCIO integrated into DIRAC framework for data management

- AMGA is used for metadata associated with the stored data

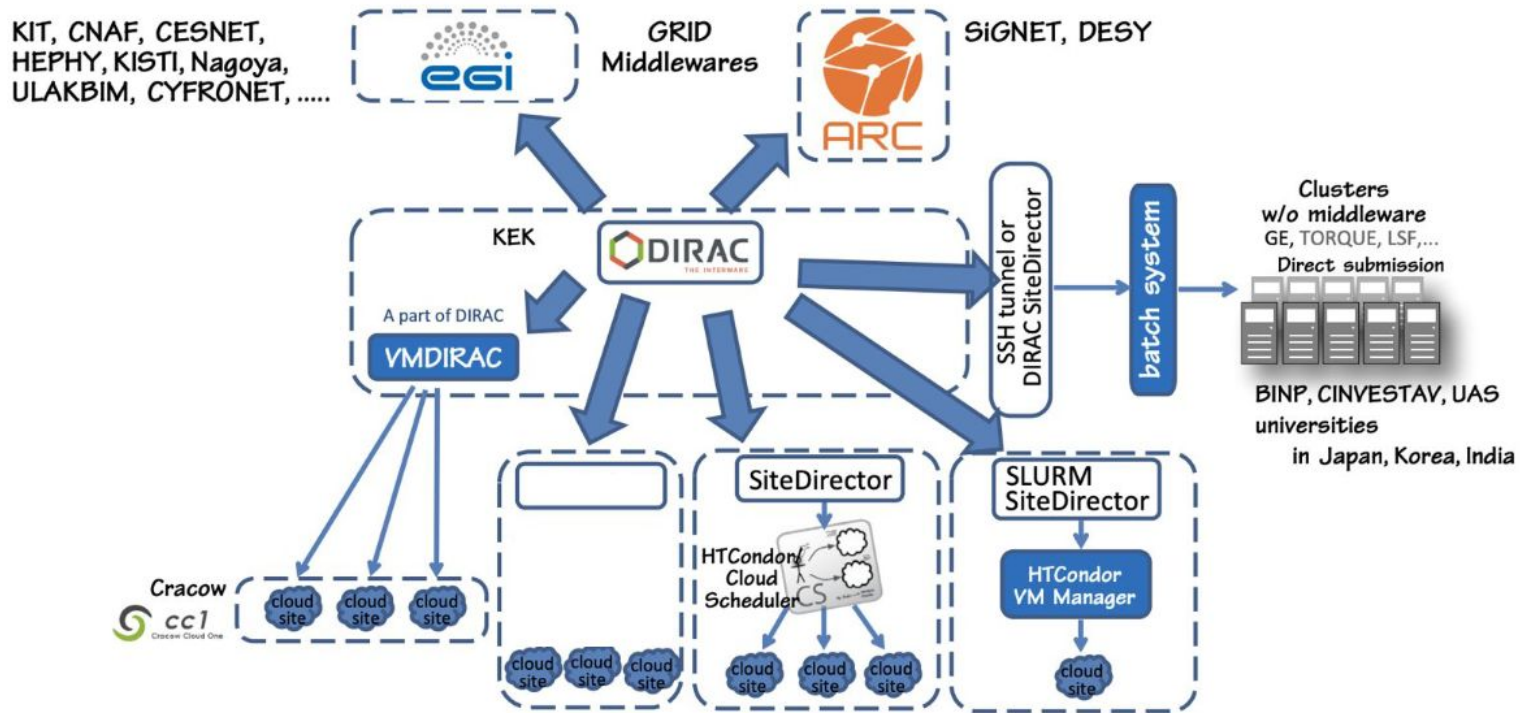
- File Transfer Service (FTS3) used for bulk data transfers

- GitLab for software versioning and continuous integration

Belle II DIRAC Framework

Belle II adopts DIRAC as the main framework to interact with heterogeneous resources distributed over multiple data centers.

WLCG/OSG Technologies adopted by the sites.



T2K, Hyper-K and Belle II



	T2K (ND280)	Hyper-K	Belle II
Job submission	GridPP DIRAC		BelleDIRAC
DIRAC CPU usage [CPU Core yr] (Not official numbers)	Now: <1k 2027: 1-2k	Now: 1-10k 2027: 5k 2037: 20k	Now: 35k CPU Core yr 2027: 225k
Storage management	DFC, FTS3, T2K-metadata		RUCIO, FTS3, AMGA-metadata
Storage estimates	Now: 1.5 PB 2027: 5 PB	Now: 1 PB 2027: 3 PB 2037: 20 PB	Now: 15 PB 2027: 350 PB
DIRAC instance	GridPP- multi-Experiment (With opportunity to contribute)		Belle II In house/KEKCC

T2K, Hyper-K and Belle II



	T2K (ND280)	Hyper-K	Belle II
Resources monitoring (status and usage/forecasting)	EGI/DIRAC/Custom	EGI/DIRAC/custom	EGI/DIRAC/Custom
Software versioning and distribution	Git, containers, EGI-CVMFS	Git, containers, EGI-CVMFS	Git, containers, CVMFS
Continuous integration	GitLab + Docker-in-docker	In development	GitLab

JENNIFER2 Tasks



WP5: This WP address [Computing](#), data acquisition, Statistical methods and theory interface, which are common issues for neutrino and flavour physics experiments. In each of the WP tasks, solutions are required timely, and comparison with state of the art techniques is essential to be competitive.

[Task 5.1: Computing and data handling for Belle II and HyperK](#)

To study a set of [common tools](#) for the computing model of Belle2-T2K-HK experiments, which users from Japanese and European Research centres can use in a transparent way.

The activity will focus on the following technologies:

- a) Computing. Workload Management System based of DIRAC Framework; Data distribution software like CVMFS and Technologies to use Grid and Cloud Resources.
- b) Storage: Data Access protocol (Grid and Cloud) and Data Transfer system FTS.
- c) Software: Tools for software development and versioning.
- d) Network: Common tools for Network Monitoring

Description of Deliverables: Task 5.1 : A common Belle II – HyperK Cloud Computing demonstrator

JENNIFER2 Computing workshop 2019



1 day workshop held at CERN

Indico:

<https://agenda.infn.it/event/20616/?fbclid=IwAR3xLtco1r6OixWzBpPAoIWsxdlVf-7yCxRrvRYGIPjvj5-FqLKIQ7iUWAs>

4 HK members, 5 Belle II members, 2 DIRAC members

Mix of talks and brainstorming/working session

Detailed presentation on tools and frameworks from both collaborations

Compiled a list of cross-over topics which could be interesting to investigate

Discussed in detail plans for the cloud demonstrator

→ Workshop was very successful and we aim to hold another next year

11:00	→ 11:10	Welcome Welcome.pdf
11:10	→ 11:30	Belle II Computing Model - Tools Speaker: Marko Bracko Jennifer2_CompWS...
11:30	→ 11:50	T2K - HK Computing Model - Tools Speaker: Sophie King 2019_12_12_hk_t2k...
11:50	→ 12:10	Data Analysis Tools in Belle II Speaker: Thomas Kuhr Belle2AnalysisTools...
12:10	→ 12:30	ND280 software - emulating CMT with CMAKE Speaker: Dr Alex Finch CMAKEinND280.pdf
12:30	→ 12:50	Containerizing ND280 software Speaker: Dr Mathieu Guigé 20191212_JenniferL...
12:50	→ 14:00	
14:00	→ 14:20	DIRAC Introduction Speaker: Dr Federico Stagni DIRAC -Jennifer2.pdf
14:20	→ 14:40	Cloud Technologies for DIRAC Speaker: Silvio Pardi (NA) Cloud-in-DRAC-Pard...
14:40	→ 15:00	Dynamic On Demand Analysis Service: DODAS Speaker: Daniele Spiga (PG) DODAS-WorkshopJ...
15:00	→ 17:00	Working Session Requirements for Task 5.1 Deliverable (due at month 36) State of the art. Plans Cloud Computing D...

Cloud Demonstrator - Motivation and Aim



Adding more resources to DIRAC allows to increase the resources of an experiment, without additional overhead for separate job submission.

Cloud and Grid offer opportunistic resources that can be used by multiple experiments.

There are various tools available for running DIRAC with cloud, and we want to test one of these and develop it to be more versatile for use on different setups and for multiple experiments to allow the sharing of resources between Belle II and T2K/HK.

Cloud demonstrator - Details



VCYCLE - Cloud based virtual machine lifetime manager for DIRAC pilot (the pilot pulls jobs from the queue) for IaaS cloud infrastructures.

We created a custom setup to extend the software to capabilities to manage a multi-experiment environment. This was developed by Silvo, testing it on INFN-Napoli cloud. These cloud resources were then integrated into BelleDIRAC and the GridPP-DIRAC for T2K and HK.

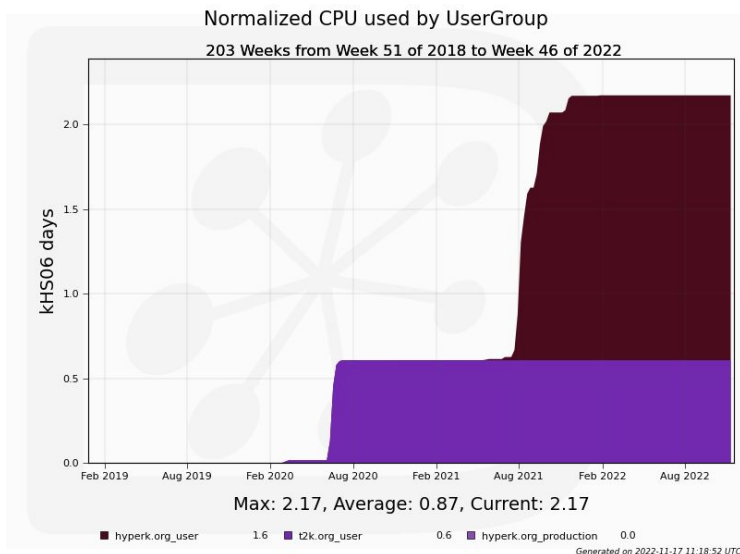
In order to expand the number of usable cloud infrastructures, we extended the software capability by integrating token based authentication in the Openstack module of VCYCLE. With this modification we are able to run jobs on the EGI Federated Infrastructure demonstrating the flexibility of implemented the solution.

Finally, a further test was done, extending to IN2p3 based cloud, where we hope to secure cloud resources longterm.

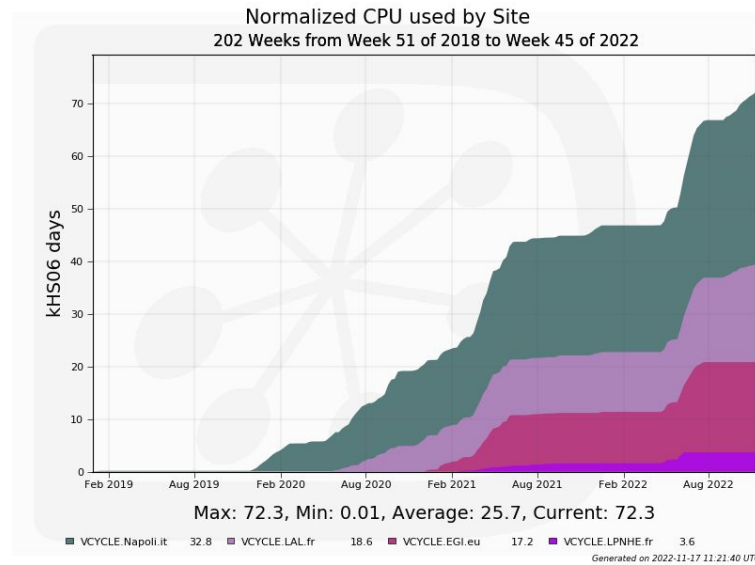
Next we plan to test VCYCLE at KCL on openstack.

Cloud demonstrator - In action

T2K and HK CPU Usage on the cloud resources



T2K and HK CPU Usage on the cloud resources



Cloud demonstrator

EGI Conference:

<https://indico.egi.eu/event/5000/contributions/14307/attachments/13236/16166/JENNIFER2-Demonstrator-Full-Presentation.pdf>

The 11th International Conference on Engineering Mathematics and Physics (ICEMP22):

<http://www.icemp.org/>

- Best presentation awarded
- Proceeding submitted to *International Journal of Applied Physics and Mathematics*

Other conferences:

- A contribution for CHEP2023 is in preparation

Future work

Future work will be discussed at the next workshop (plan for 2023)

Topics to discuss and areas where we may collaborate:

- Further developments using the Workload Management System based of DIRAC Framework
- Further development of tools for cloud computing
- Tools for efficient use of Data distribution software like CVMFS
- Storage solutions and management. Data Access protocol and data transfer systems that use FTS.
- Tools for software development and versioning.
- Common tools for Network Monitoring

Summary

The **2019 JENNIFER2 computing workshop** at CERN was very successful .

The VCYCLE software was adapted to allow for a **multi-experiment setup**, which was tested on multiple **cloud resources** by T2K, HK, Belle II.

This was further developed to allow **token based authentication**, opening the door to more computing resources that can be centrally managed through DIRAC. This was tested on **EGI cloud** resources.

This work has been presented at **multiple conferences**.

We aim to hold another **JENNIFER2 computing workshop in 2023**

Backup