Belle II Computing

Jennifer2 II Computing WorkShop - Task 5.1

20 February 2024

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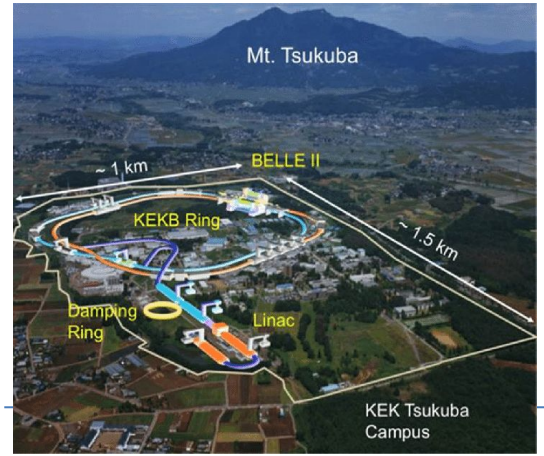
Belle II Experiment

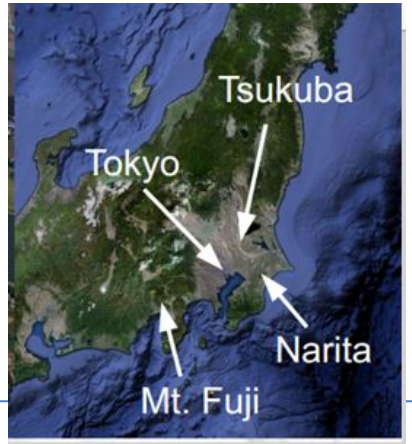
Asymmetric lepton collider.

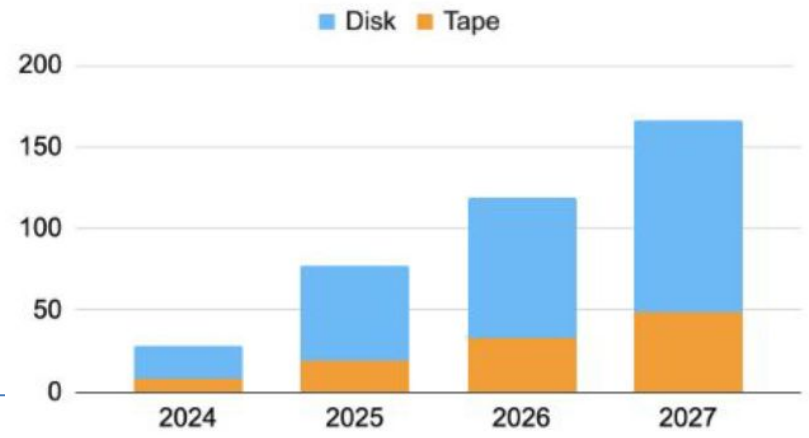
- Upgrade from previous Belle experiment.

  ○ 50 ab -1 at the end of the experiment (x50 than the previous B factories)

  ○ Estimated size of the dataset collected by the experiment is O(10) PB/year.







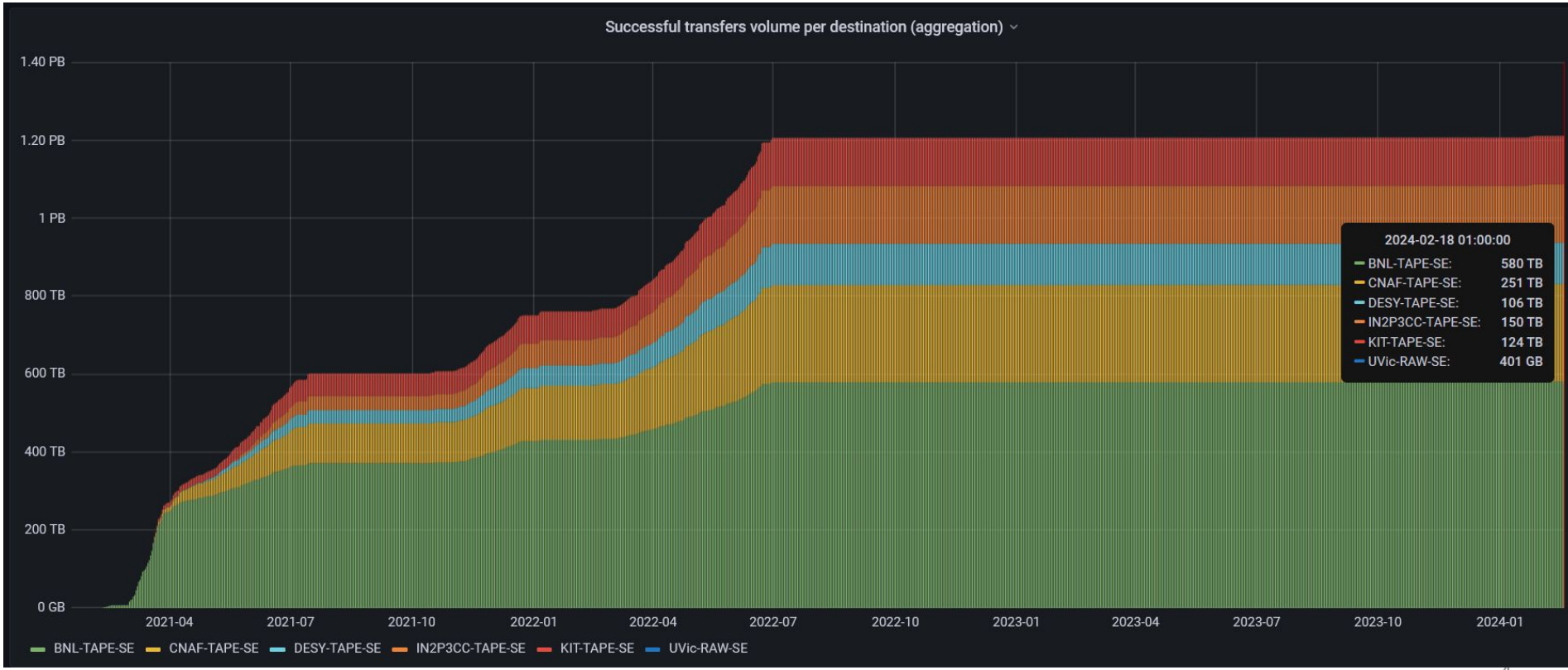
Belle II Status and Plan

Data taking started in 2019.
In July 2022 we started the Long Shutdown 1
Early 2023 Data taking has started with cosmic-ray events.

A full copy of RAW Data is stored at KEK Tier0. The secondary copy was stored at BNL (100%) for the first years, then distributed over the following RAW Data Centers since April 2021. Nominal share:

- BNL 30%
- CNAF 20%
- DESY 10%
- KIT 10%
- IN2P3CC 15%
- UVic 15%

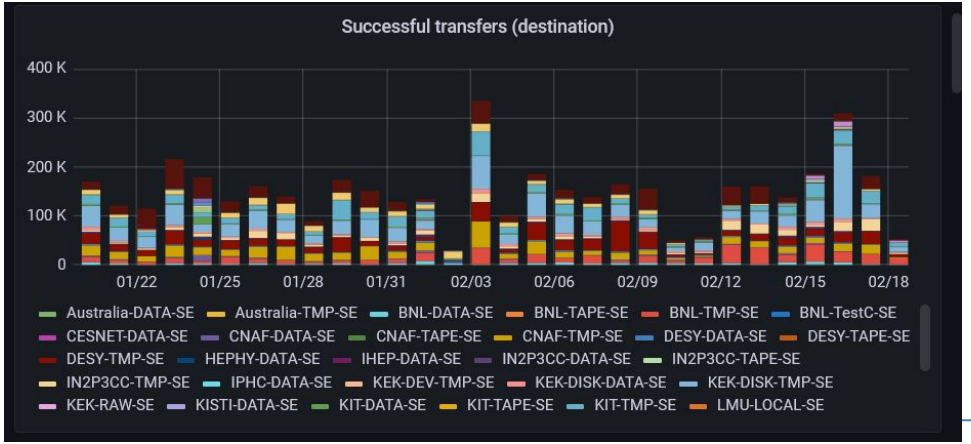
Raw Data Distribution with Rucio since the 2021

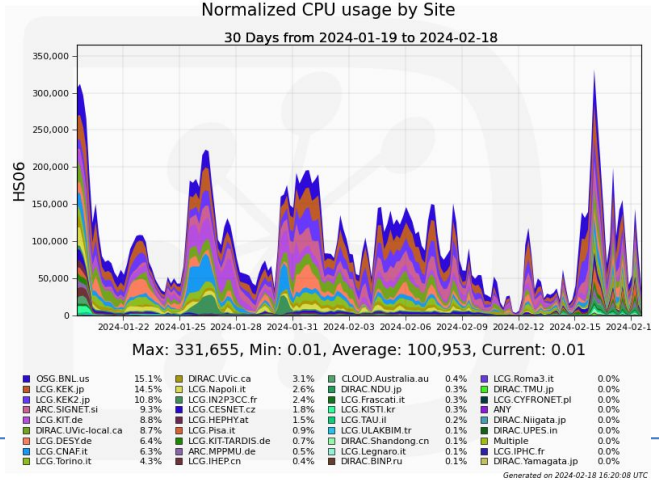


Belle II Computing

Belle II has been using DIRAC for many years + Rucio (for almost 3 years) in production now :

- DIRAC as the main framework with user interface for productions and user jobs
- Rucio used for data management. Direct use of client tools only by the experts
- Configuration (SEs, accounts, etc.) in DIRAC and synchronized into Rucio via dedicated Agents





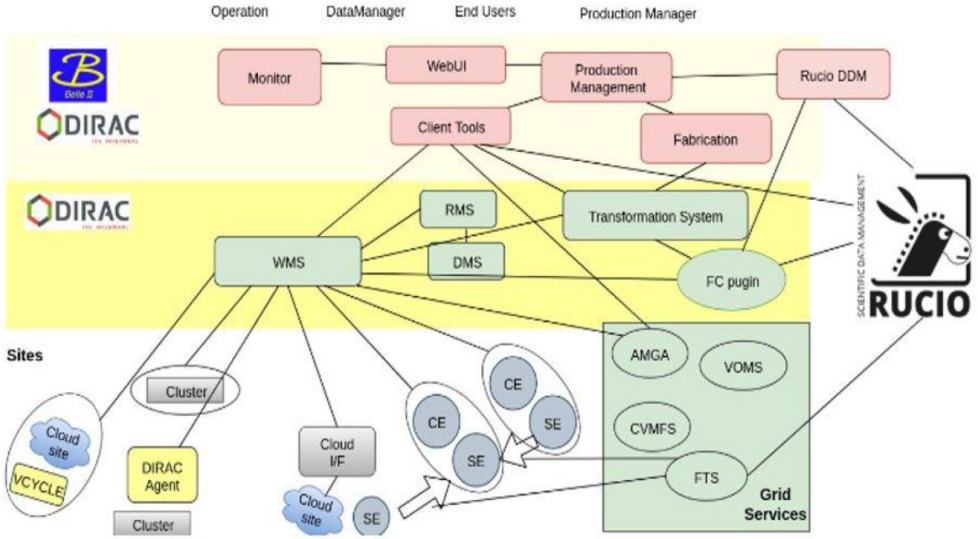
Belle II Computing

Belle II has its own extensions
“BelleDIRAC” :

- Enables a transparent experience using the Belle II Analysis Framework (basf2)
- Provides an interface to other services used by Belle II (AMGA manager, conditions DB via basf2, etc.)
- Implements Production System

“BelleRAWDirac” :

- Take care about registering RAW data



Other Services

- FTS servers (KEK & BNL)
- CVMFS (KEK) for DIRAC distribution + Rucio and (Belle)DIRAC client
- VOMS + Test IAM instances
- ELK stack + Grafana
- AMGA (going to migrate to Rucio)

Belle II Computing Infrastructure

- 55 sites providing pledged and opportunistic resources
- 29 Storages
- 5 Tape systems

TYPE	Resource provided
CPU Pledge	451.6 kHS06/kHS23
CPU Opport.	408.9 kHS06/kHS23
DISK	16.8 PB
TAPE	11.9 PB

For Production: 31 kjobslots pledged and 33 kJobslot opportunistic

*Additional storage under implementation in some of the sites

TYPE	Resource provided
CPU	36,7 kHS06/HS23
DISK	550 TB

Resource for calibration

NEW CHALLENGES FOR SITES

- Token Based Authentication
- End-of-life of storage technologies (DPM, gsiftp, srm)
- Update the Operative system (RHEL9/Almalinux9)
- Network Operation (Link update, Jumbo Frame)

Ongoing activities

- Authentication with token for computing and storages resources
- Currently running DIRAC v7r3, Migration to DIRAC 8.0 and then DIRAC 8.1 ongoing.

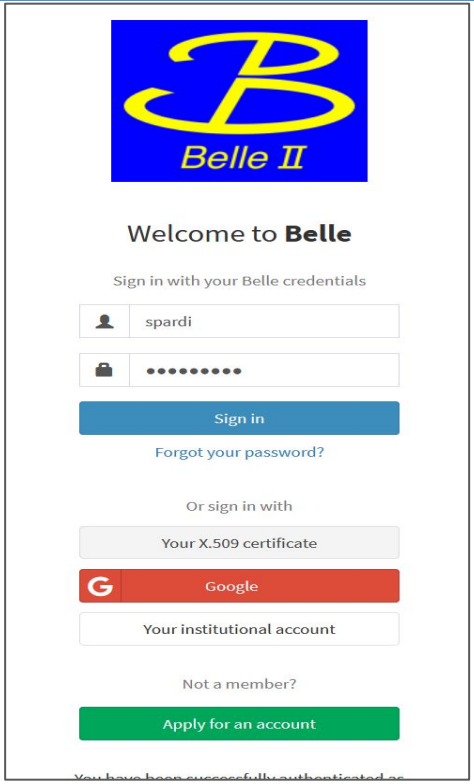
  In the future to DIRACX (not before 2025)
- Migration from AMGA Metadata Catalog to RUCIO
- File transfers: GSIFTP => https/davs, mostly done (incl. staging to DISK endpoints)

  except for some SE.
- Cloud Resources: Exploit new technologies other than VCYCLE.

Challenge in Computing: Token Based Authentication

Following WLCG and OSG agenda, Belle II is working to supports token based authentication in substitution of the Grid Security Infrastructure (GSI)

- Indigo IAM service in place at CNAF for early tests
- Pre-production and Development IAM services in place at KEK.
- Token Based Authentication ongoing vs a selected set of Computing Elements and Storage Elements without DIRAC
- Tests the full workflow with DIRAC after the upgrading to the future versions



Capability based Authorization in Belle II

This is an example of token released by Belle II IAM server. The scope storage.read:/TMP allows to read the directory belle-root/TMP and all the subdirectory on each storage that accept tokens released by belle-auth.cc.kek.jp and support the WLCG profile matching roule https://github.com/WLCG-AuthZ-WG/common-jwt-profile/blob/master/profile.md#capability-based-authorization-scope

```
[spardi@ui-tier1 ~]$ echo $BEARER_TOKEN | cut -d. -f2 | base64 -d 2>/dev/null | jq
{
  "wlcg.ver": "1.0",
  "sub": "edc2f74e-b79c-4f5e-a79c-990a08e260a3",
  "aud": "https://wlcg.cern.ch/jwt/v1/any",
  "nbf": 1702412325,
  "scope": "storage.read:/TMP",
  "iss": "https://belle-auth.cc.kek.jp/",
  "exp": 1702415925,
  "iat": 1702412325,
  "jti": "381d989f-221d-4359-850a-73c8320ac1f5",
  "client_id": "2cded238-a8cf-48e5-87c6-50f592691906"
}
```

Cloud Resources

VCYCLE has been successfully used and integrated in our DIRAC infrastructure, part of the JENNIFER2 demonstrator.

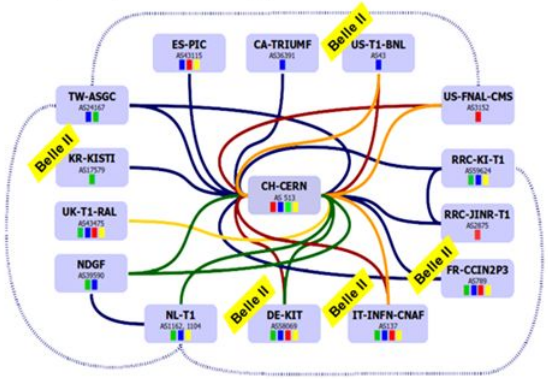
New approaches are now available to interface cloud resources in DIRAC (See the presentation of Andrei)

Explore the usage of Cloud Storage and other services provided under the PaaS/SaaS paradigms by National and European Infrastructures (see Michele Presentation)

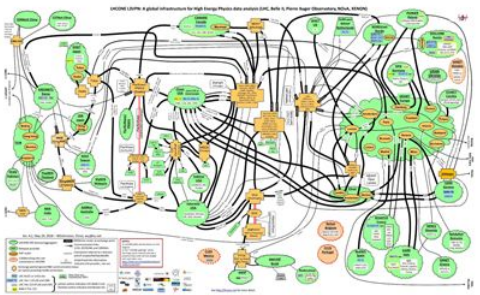
Belle II Network

100G Global Ring via SINET

LHCOPN Optical infrastructure that can be used without jeopardizing resources



LHCONE L3 VPN Connecting all the major Data Centres



Network Overview from site report 2023

Network	#Sites
LHCONE	49%
GeneralIP	51%

More than 80% of kHS06 Running on LHCONE
More than 90% of Storage on LHCONE

IPv6 deployment	#Sites
Storage Dual Stack	43% (was 34%)
WorkerNode Dual Stack	16% (was 13%)

Other	#Sites
Jumbo frame	On 10 sites
Perfsonar	16 instances

Belle II Data Challenge 2024 whitin WLCG DC24

What should be exercised during DC24:

Technology that can be stressed: Network, DDM, FTS, Storages, Monitoring System, Protocols, IAM

Main goal: Emulate data transfer conditions in a Belle II high-lumi scenario

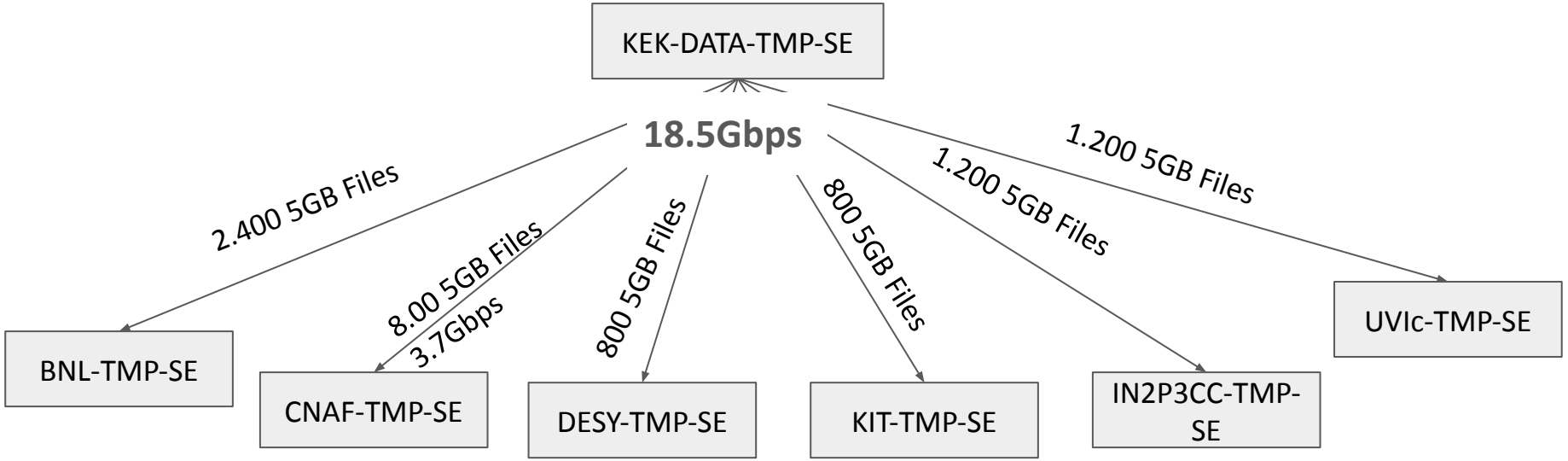
Our current estimation for such scenario is 40 TB per day.

Transfers from KEK to raw data centers according to our distribution schema (30%BNL, 20%CNAF, 15% IN2P3CC, 15%UVic, 10%DESY, 10%KIT)

Considering that the average speed needed to transfer 40TB/day is 3.7Gbit/s in outbound at KEK vs all the Raw Data Centers.

- First Scenario - The target speed to achieve is 3x3.7Gbit/s = 10 Gbit/s
- Maxium Scenario - The target speed to achieve is 5x3.7Gbit/s = 18.5 Gbit/s

Belle II Data Challenge 2024 whitin WLCG DC24



Conclusion

Belle II resarted Data taking early 2024 collecting cosmic-ray events.

There are several ongoing activities to update distributed computing infrastructure, including the upgrade of DIRAC, migration to the token based authentication.

The exploitation of Cloud Computing and Data Challenge activity for the assessment of Network and Distributed Computing infrastructure looks to be new possible candidate topics in which create synergy with T2K / Hyper-K in the future.