SOLARNET

Integrating High Resolution Solar Physics

Big Data storage for ground-based solar data

The KIS Science Data Centre (SDC) Case – Part III

3rd SOLARNET Forum Meeting for Telescopes and Databases

15 Nov 2021

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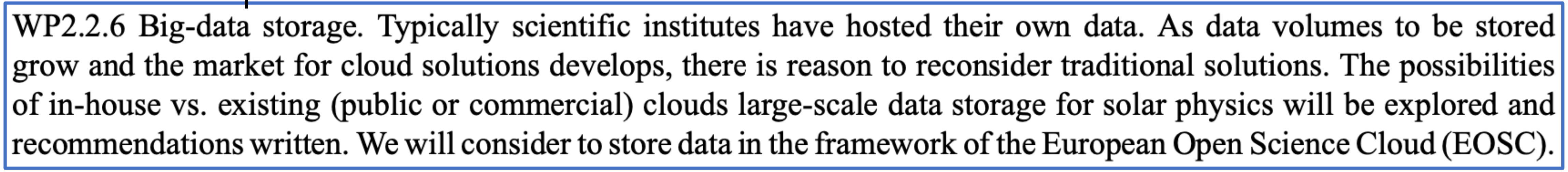
Outline

- Purpose of this contribution (NBG)
- The KIS Science Data Centre Case – Introduction (NBG)
- Big Data at KIS SDC – Storage and management of large data volumes (P. Caligari, SDC Head)
- Big Data at EST Data Centre – A consortium effort (S. Berdyugina, SDC PI)

Purpose

Deliverable D2.22: *Report on Big Data storage possibilities*

Lead: KIS | Due date: month 36



WP2.2.6 Big-data storage. Typically scientific institutes have hosted their own data. As data volumes to be stored grow and the market for cloud solutions develops, there is reason to reconsider traditional solutions. The possibilities of in-house vs. existing (public or commercial) clouds large-scale data storage for solar physics will be explored and recommendations written. We will consider to store data in the framework of the European Open Science Cloud (EOSC).

As many other activities within SOLARNET, this task is part of developing a concept for data storage and processing for EST

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The KIS Science Data Centre Case – Introduction

We are currently developing at KIS the Science Data Centre for calibration, storage, curation, archiving and dissemination of data from

- GRIS-slit & GRIS-IFU (in collaboration with M. Collados/IAC), LARS, BBI, Hellride(2022+) and LEAP (2022+) instruments and ChroTel at the solar observatories in OT (Tenerife)
- DKIST Level 1 data in collaboration with the DKIST DC (agreements in preparation) and possibly Level 0 data in the future

SDC main focus is also the development of new diagnosis tools (e.g., stochastic analysis of fluctuations in physical parameters), data science (e.g., research on statistical properties from solar data all over the GRIS archive 2014-2019) and other high-level data products (e.g., M-E VFISV (Borrero et al. 2011) inversions run over all the GRIS data archive)

The KIS Science Data Centre Case – Introduction

SDC Cooperation with EU & DE projects

- Coordination and participation in the WP5 *Towards a European Science Data Centre*
- Participation in the Virtual Access Programme with the SDC archive

- Participation on WP4 on integrating ground-based solar data in the Astronomical VO
- Participation on the ESFRI Science Analysis Platform (WP5) including high-level ground-based solar data products

- Representing the solar community in the PUNCH4NFDI consortium of the particle, astro-, astroparticle, hadron and nuclear physics community in Germany

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The KIS Science Data Centre Case

Today we are launching the SDC platform as a service for solar community
https://sdc.leibniz-kis.de/en

During this year, we have been building a solid infrastructure foundation for future needs meaning flexibility and scalability for large data amounts, software development and computing power

For the next coming years we aim to bring in new analytic tools and functionalities

We warmly welcome your feedback and suggestions on how to improve

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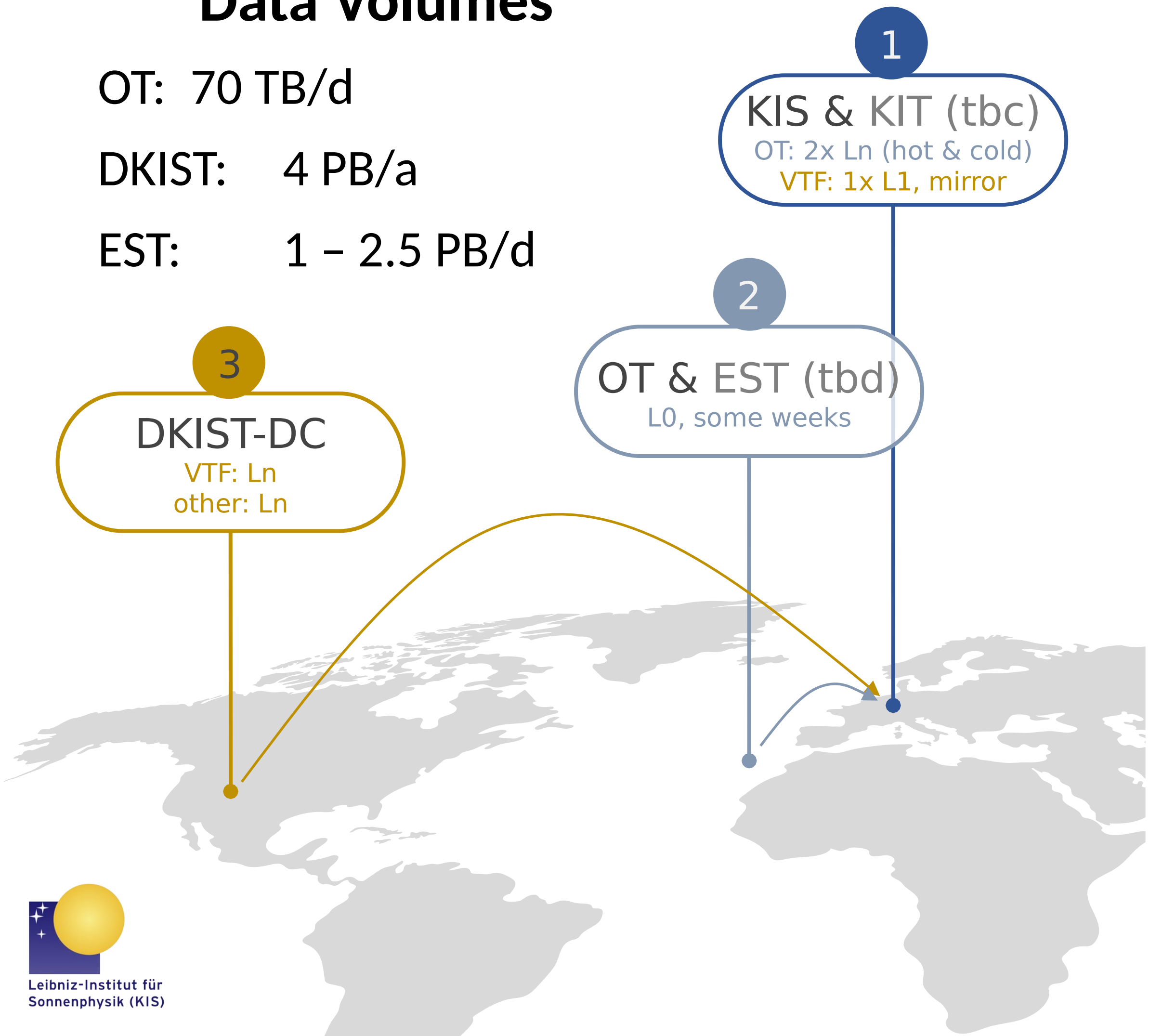
Big Data at KIS SDC

Data Volumes

OT:	70 TB/d
DKIST:	4 PB/a
EST:	1 – 2.5 PB/d



Requires:

- Multi site (edge storage & computation)
- Tiered solution, including
  - Tape libraries
  - Cloud S3 storage
- Flexible replication and data lifetimes

Answer:

- RUCIO & dCache
- Problem: No (native) embargoes

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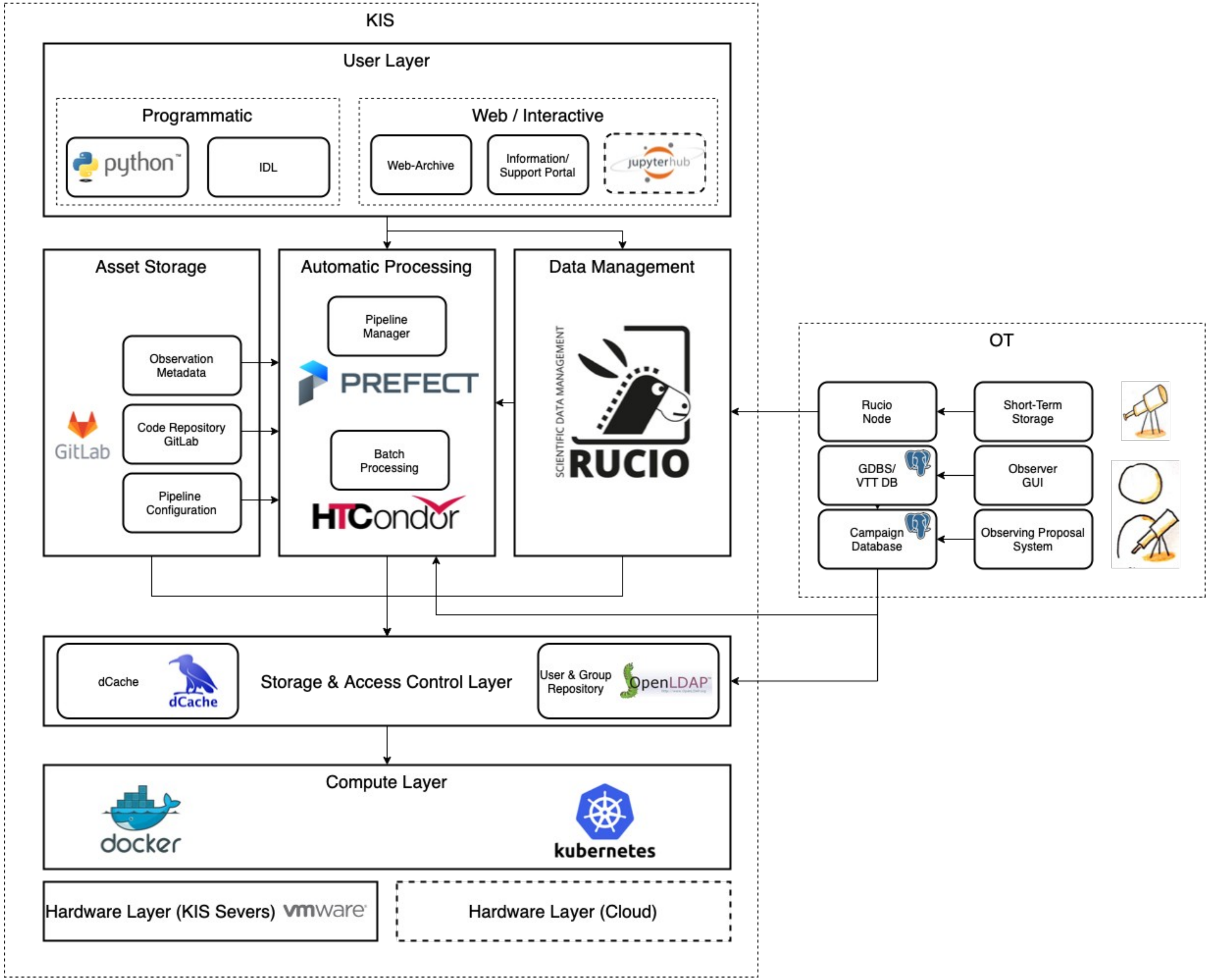


KIS

User Layer

Programmatic: python, IDL

Web / Interactive: Web-Archive, Information/ Support Portal, jupyterhub

Asset Storage: Observation Metadata, Code Repository GitLab, Pipeline Configuration, GitLab

Automatic Processing: Pipeline Manager, PREFECT, Batch Processing, HTCondor

Data Management: SCIENTIFIC DATA MANAGEMENT RUCIO

OT: Rucio Node, Short-Term Storage, GDBS/ VTT DB, Observer GUI, Campaign Database, Observing Proposal System

Storage & Access Control Layer: dCache, dCache, User & Group Repository, OpenLDAP

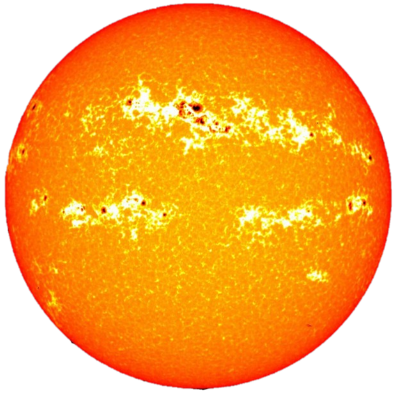
Compute Layer: docker, kubernetes

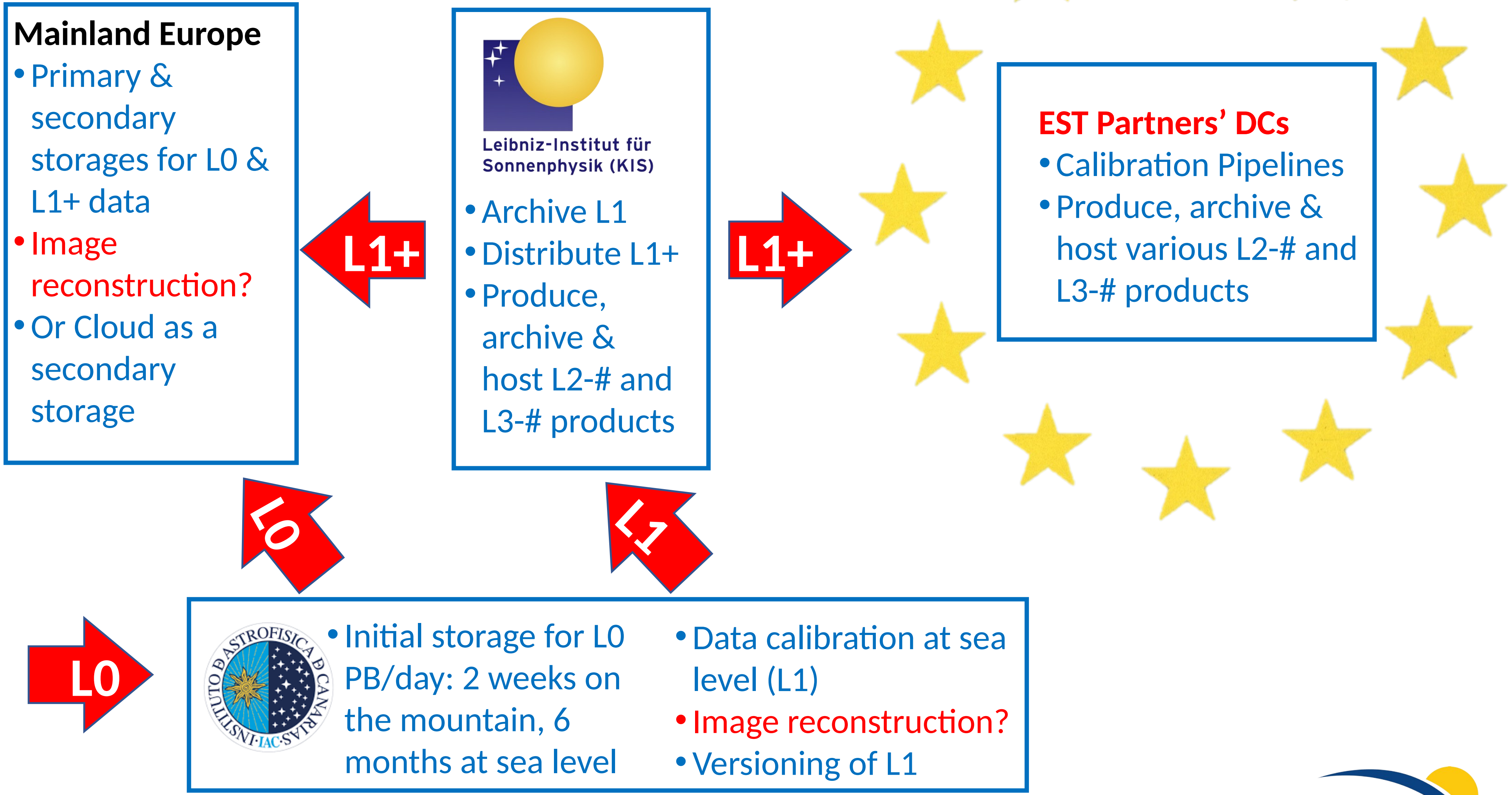
Hardware Layer (KIS Severs) vmware

Hardware Layer (Cloud)

- Scales to multiple sites
  - OT already is an edge (in a sense)
  - Could have more sites similar to KIS
- One data lake managed by Rucio
- Standardized Software & Pipelines
- Open Source!
- Requirements are similar throughout astronomy
- Metadata Standards!

EST-DC vision: Distributed DC





Mainland Europe

- Primary & secondary storages for L0 & L1+ data
- Image reconstruction?
- Or Cloud as a secondary storage

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- Archive L1
- Distribute L1+
- Produce, archive & host L2-# and L3-# products

EST Partners' DCs

- Calibration Pipelines
- Produce, archive & host various L2-# and L3-# products

- Initial storage for L0 PB/day: 2 weeks on the mountain, 6 months at sea level
- Data calibration at sea level (L1)
- Image reconstruction?
- Versioning of L1

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EST DC Consortium

- Science requirements (storage amount, access speed, calibration time, etc)
- Governance, roles & responsibilities of partners
- Data management
  - Primary & secondary storages in mainland Europe (where?)
  - Data transfer (speed, cost, etc)
  - Life-cycle of data
- Software management
- Calibration pipelines
  - Definition of calibration for each instrument
  - Where is image reconstruction done? How much computing power is needed?
- High-level data
  - L2-# & L3-# data definition & production
- DC construction and operation costs at partner institutes

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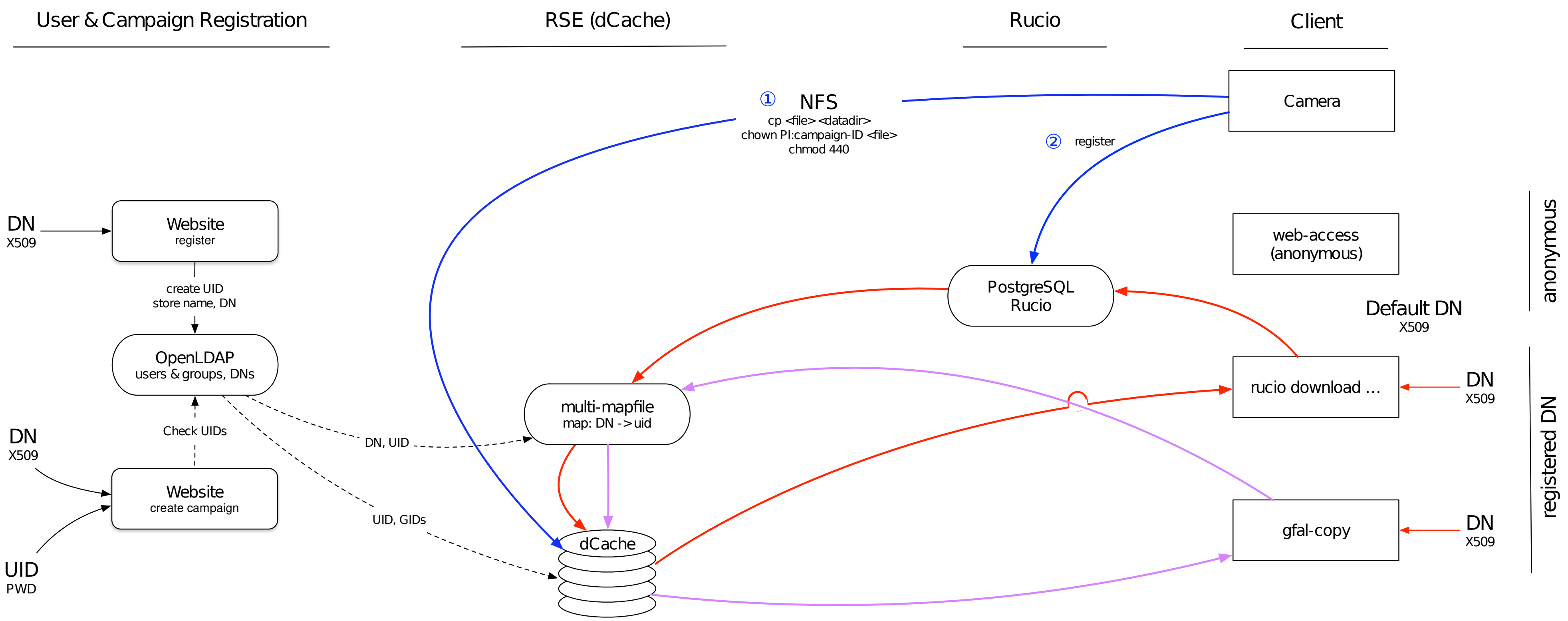
Embargoes & Data Access



User & Campaign Registration

RSE (dCache)

Rucio

Client

① NFS
cp <file> <datadir>
chown PI:campaign-ID <file>
chmod 440

② register

Camera

DN
X509

Website
register

create UID
store name, DN

OpenLDAP
users & groups, DNs

Check UIDs

DN
X509

Website
create campaign

UID
PWD

DN, UID

UID, GIDs

multi-mapfile
map: DN -> uid

dCache

PostgreSQL
Rucio

web-access
(anonymous)

anonymous

Default DN
X509

rucio download …

DN
X509

gfal-copy

DN
X509

registered DN

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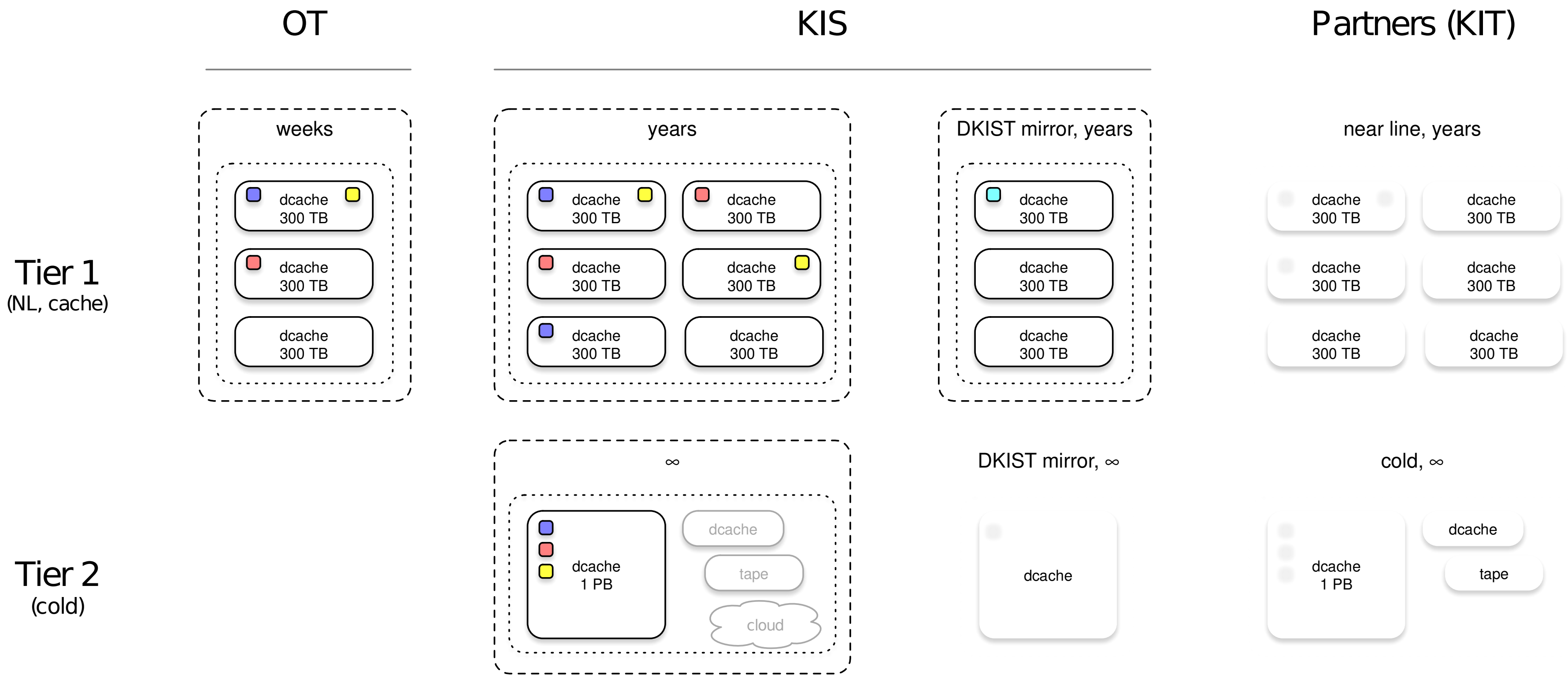
Rucio



OT

KIS

Partners (KIT)

Tier 1
(NL, cache)

weeks
dcache 300 TB
dcache 300 TB
dcache 300 TB

years
dcache 300 TB
dcache 300 TB
dcache 300 TB
dcache 300 TB
dcache 300 TB
dcache 300 TB

DKIST mirror, years
dcache 300 TB
dcache 300 TB
dcache 300 TB

near line, years
dcache 300 TB
dcache 300 TB
dcache 300 TB
dcache 300 TB
dcache 300 TB
dcache 300 TB

Tier 2
(cold)

∞
dcache 1 PB
dcache
tape
cloud

DKIST mirror, ∞
dcache

cold, ∞
dcache 1 PB
dcache
tape

Rucio

- replicate between tiers & sites
- manage lifetimes & deletions