

ASTRON



LOFAR2.0 LTA System

LTA Development Workshop

Utrecht 30-06-2026

Hanno Holties

ASTRON

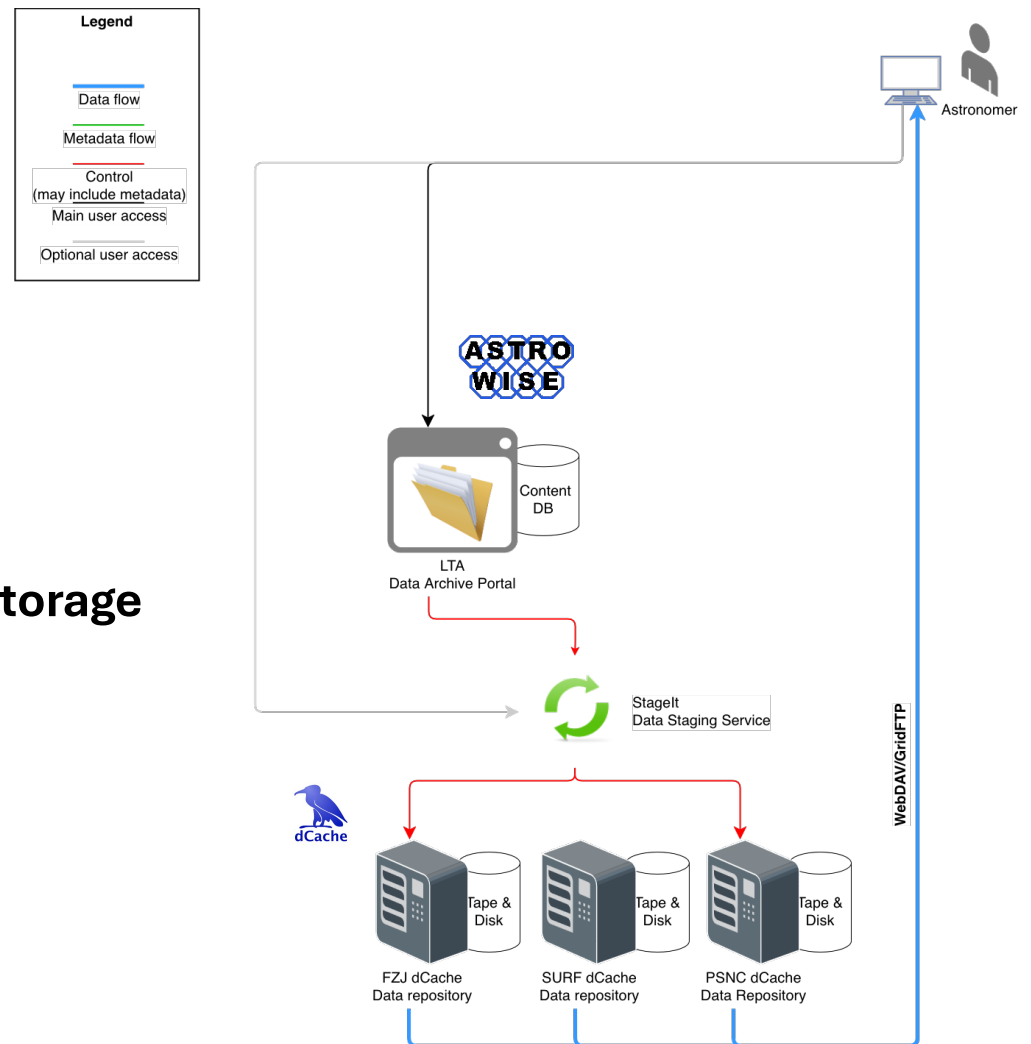
Netherlands Institute for Radio Astronomy



LOFAR

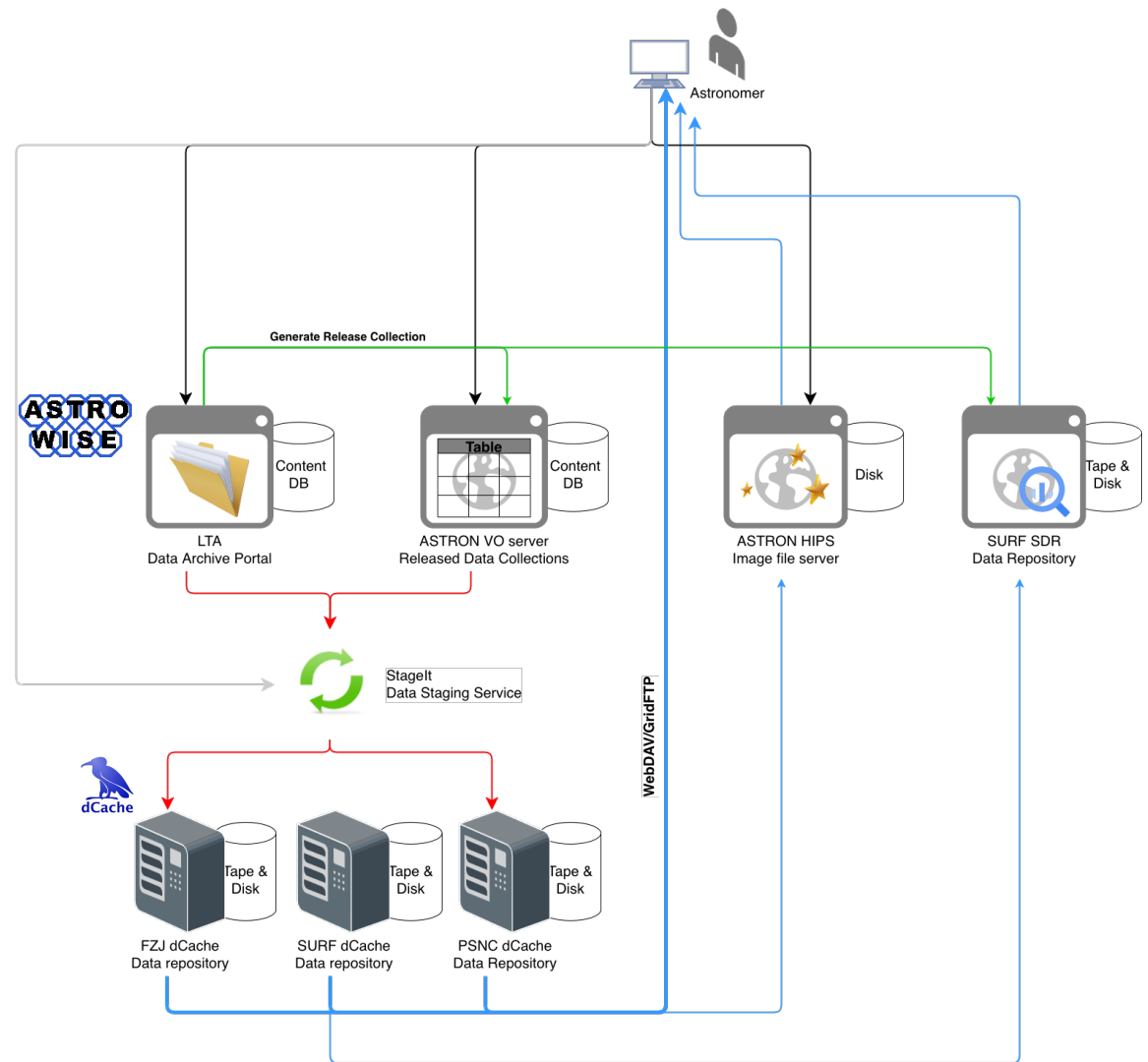
Long-Term Archive

- LOFAR1
 - **Central Catalogue**
 - Database
 - Web interface
 - Python API
 - **Central Staging Service**
 - **Functionally equivalent distributed storage**
 - dCache
 - Access protocols
 - GridFTP protocol
 - WebDAV
 - Authentication & Authorization
 - X509 + VOMS
 - Macaroons (tokens)
 - *Single replica* on tape
 - Disk for buffering & immediate access



LOFAR Long-Term Archive

- LOFAR1
 - **Data Release Hosting**
 - Community generated curated collections of advanced data products
 - VO Server
 - HiPS Server
 - SURF Data Repository (SDR)



LOFAR

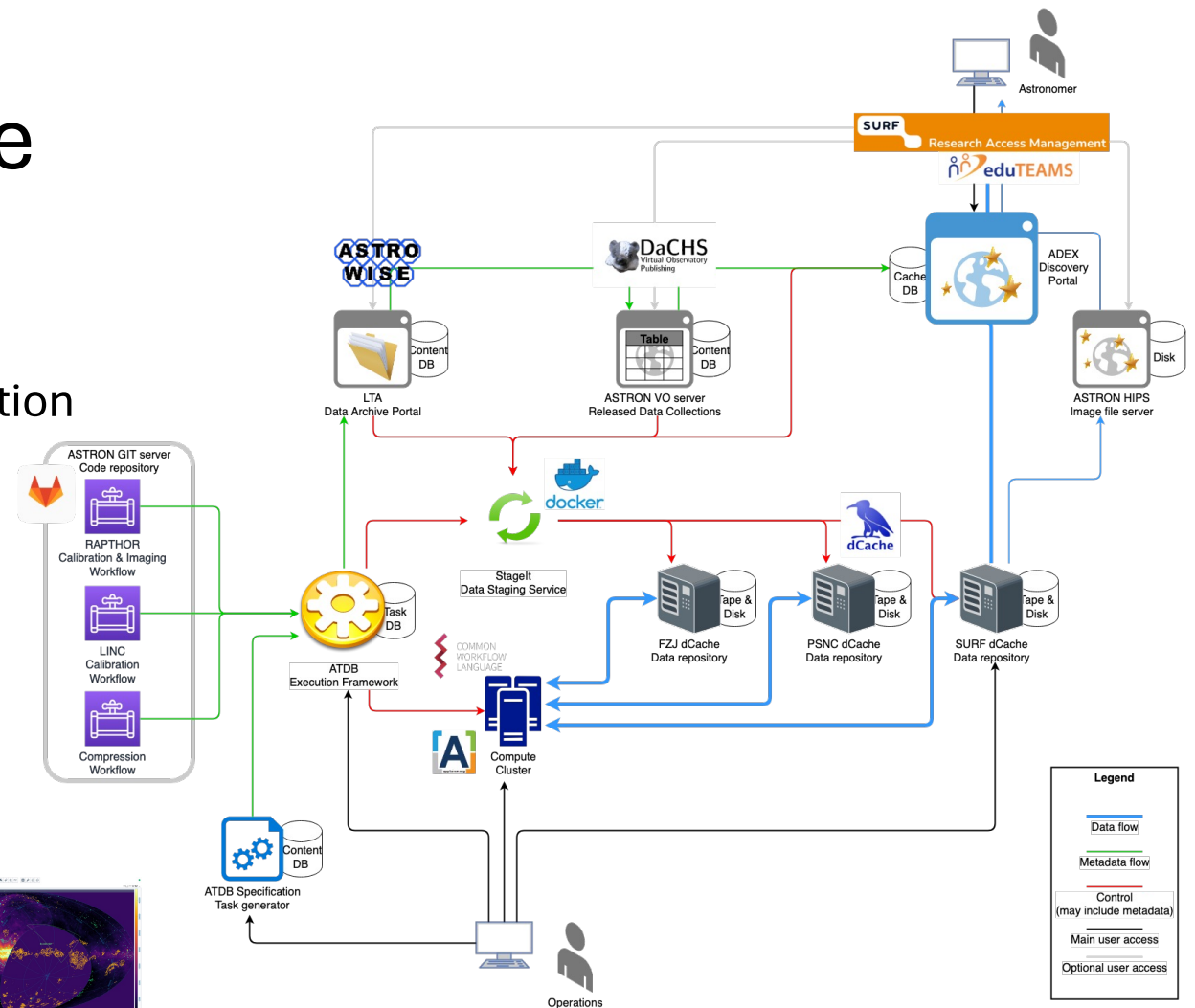
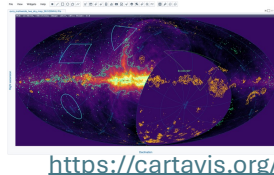
Long-Term Archive

- **New for LOFAR2.0**

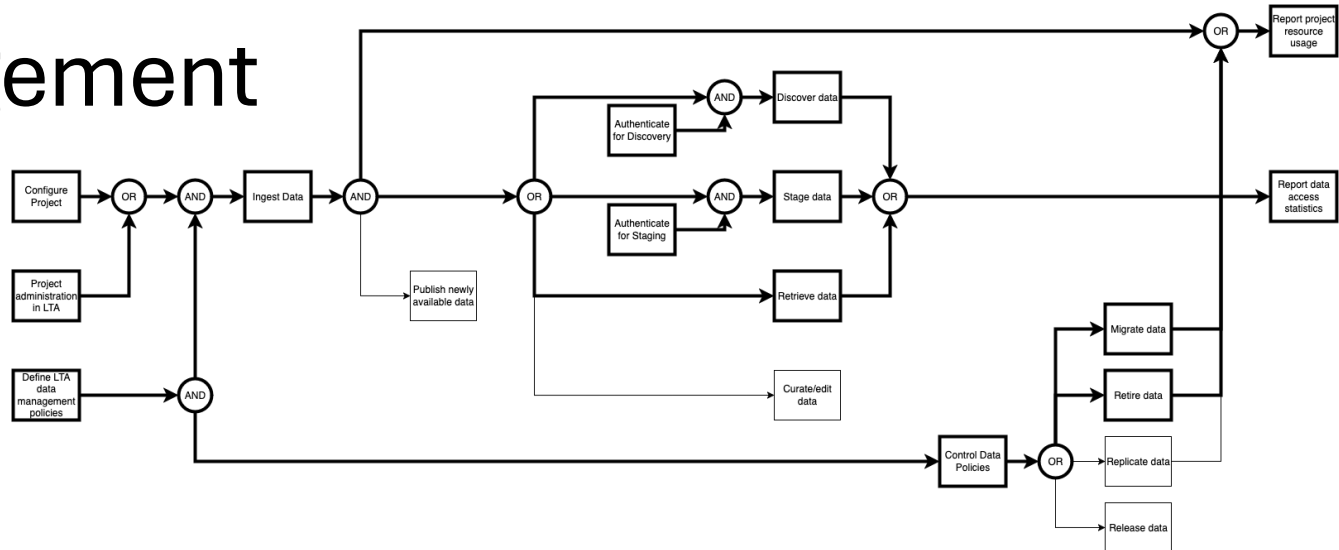
- Full support for **advanced data products**
- **Federated** user authentication
- Centrally operated **data processing**
- **User data ingest**

- **Longer term interests**

- **New Discovery Portal**
 - Incl data release support
- **Interactive analysis**
 - E.g.  jupyter,  CARTA
- **New technologies**, e.g. Rucio, EESSI, SRCnet/SKA



LTA Data Management

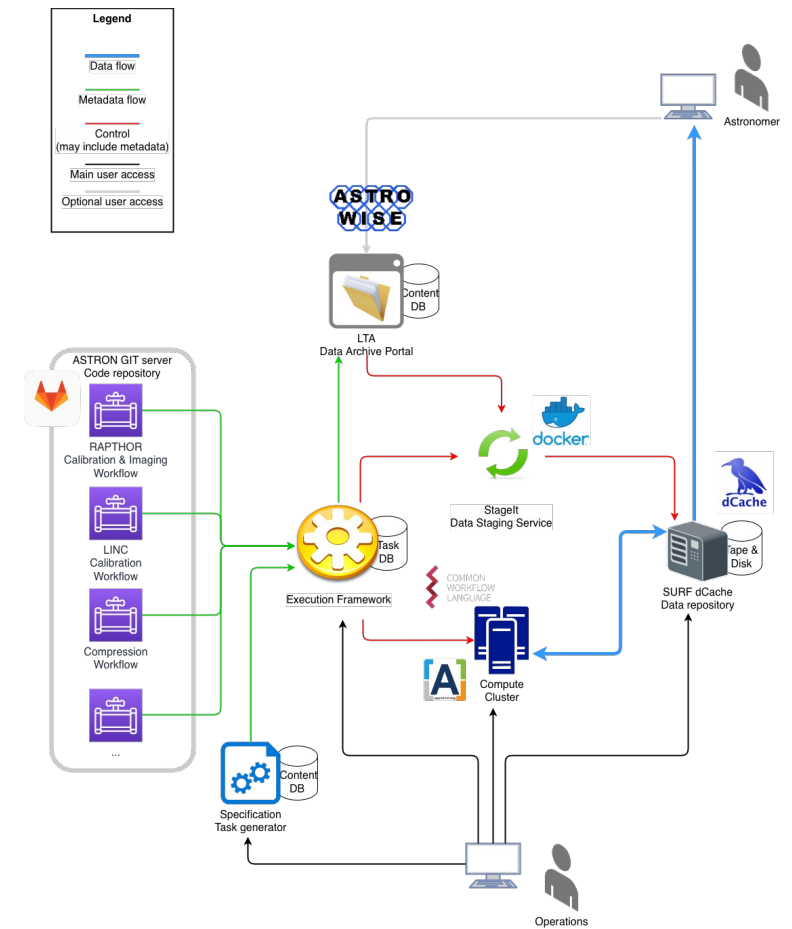


- The LOFAR **LTA provides central archive** for all science data
 - Distributed
 - Full provenance of data products – includes information of the processing chain
- Is **project aware** (resource accounting, exclusive access)
- LOFAR2.0 requires **policy based data lifecycle management**
 - Includes retirement of intermediate data and data w/o legacy value
 - To consider: data security of high value advanced data (replication?)

LOFAR Processing Framework - Overview

- **Current implementation**

- Central PostgreSQL **task database**
- Distributed Python **services**
- CWL **workflow definitions**
- **Singularity/Apptainer** based software
- **Slurm**-based job management
- Uses **available LTA interfaces**
 - Staging
 - Retrieval & storage
 - Ingest

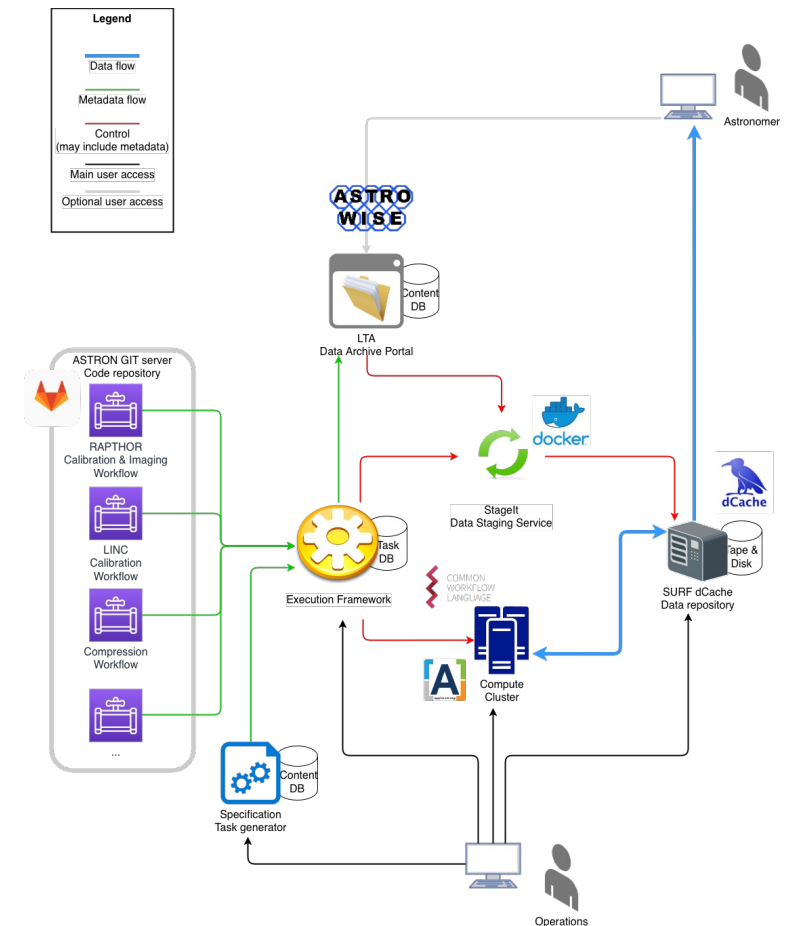


LOFAR Processing Framework - Site deploy

- **Datacenter requirements¹**
 - Good **network to (local) LTA storage**
 - **Disk** capacity for caching/buffering inputs & outputs
 - LTA
 - Shared (local) filesystem
 - Deploy & execute **data management service**
 - Python
 - Connect to central task database @ASTRON
 - Handles transfers between LTA & local (shared) file system
 - Pre-fetch input data from external data sources
 - Deploy & execute **job workflow execution service**
 - Python
 - Connect to central task database @ASTRON
 - Access to local (shared) filesystem
 - Interact with (local) job scheduler
 - Execute Singularity/Apptainer based software²
 - **Service account**
 - local deploy, management, troubleshooting
 - Accessible for (small) operations team

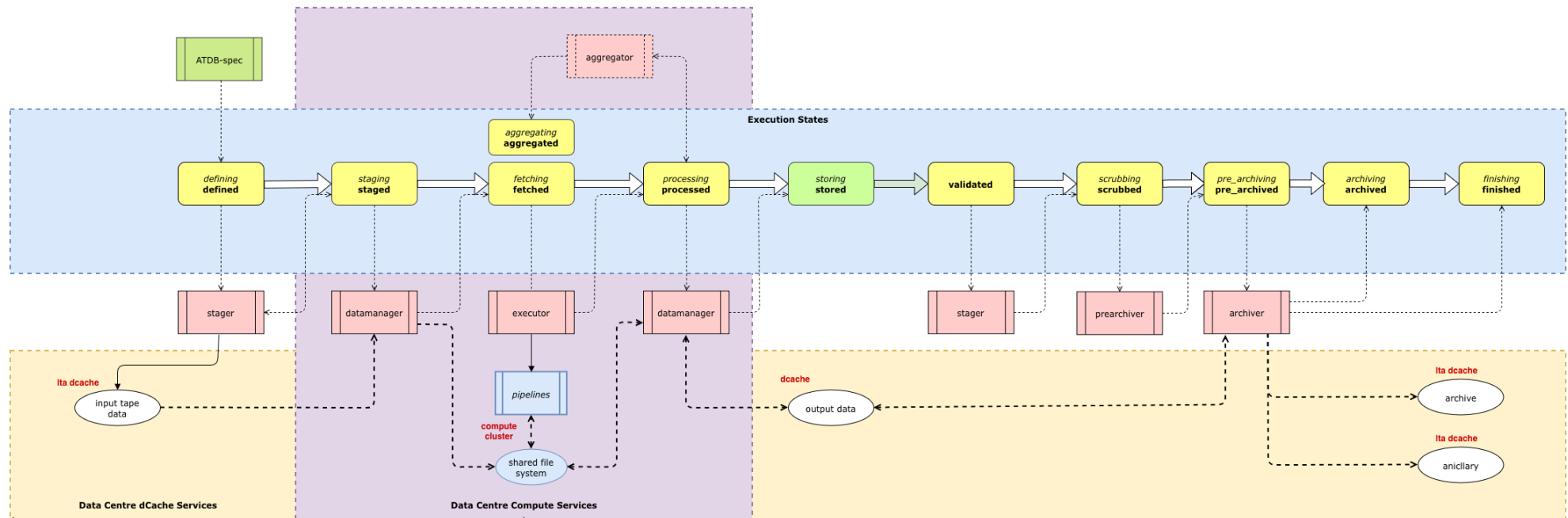
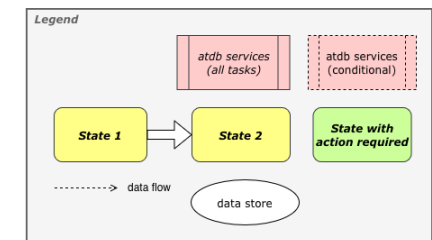
¹ Current implementation – may adopt SKA/SRCnet technology in future

² Containers fetched from (ASTRON) gitlab – looking into CVMFS & EESSI/EasyBuild



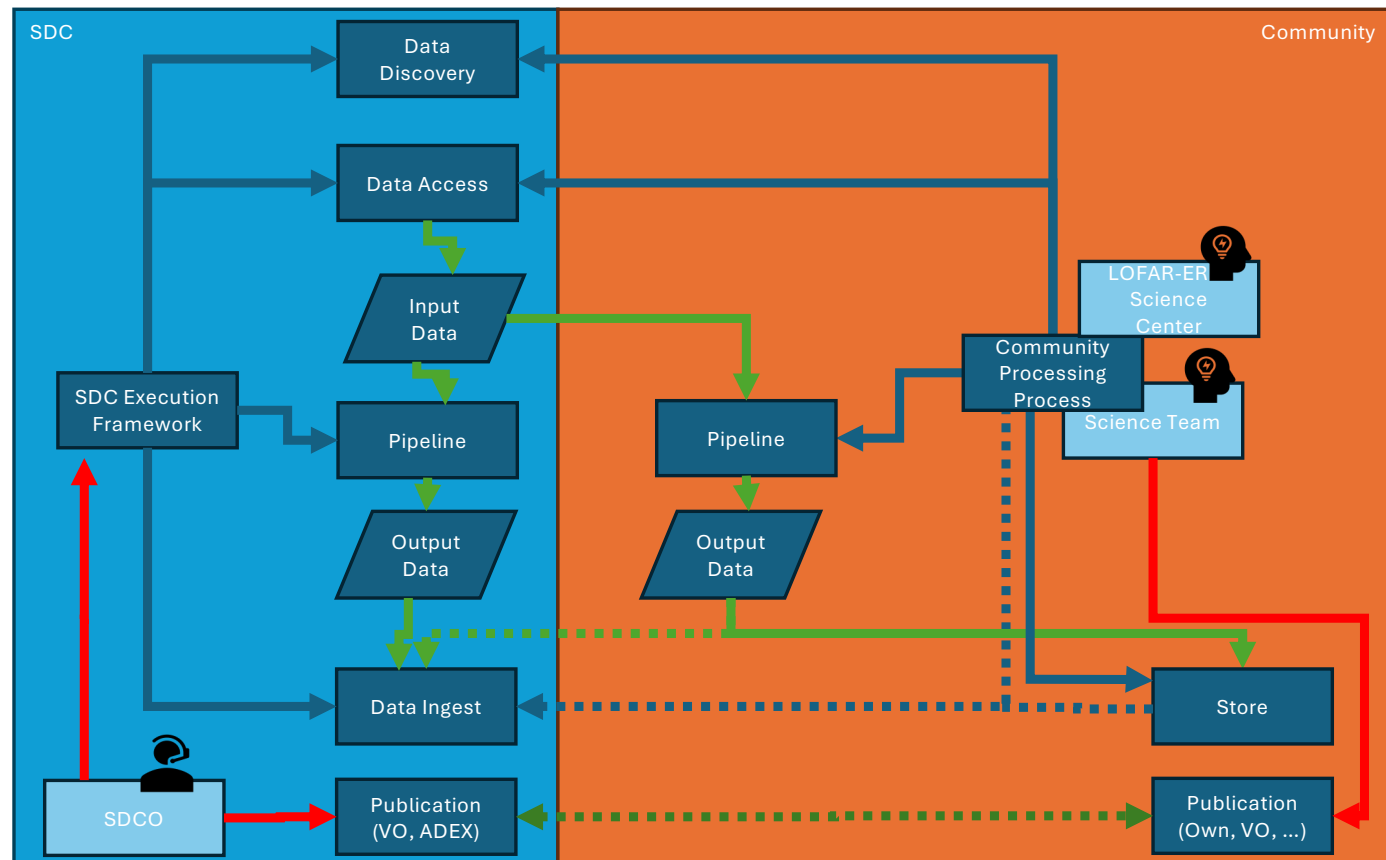
Processing Framework - Site Deploy

- Archive: regular products stored on tape
- Ancillary: smaller products on disk for e.g. inspection & QA



User/federated data processing

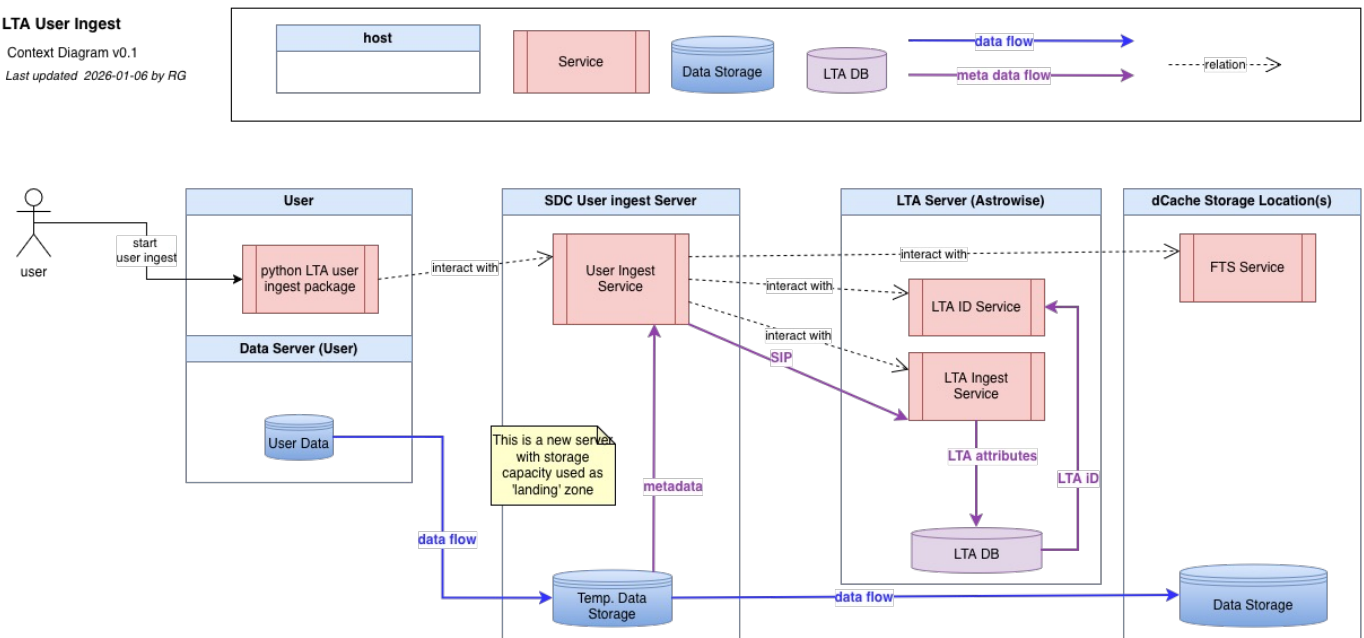
- Data processing **executed by community** - not centrally operated
- Use **same API's as central framework**
 - Discovery
 - Access/retrieval
 - *Ingest*



User data ingest

- **Supported LOFAR data formats only**
- **Landing Zone**
(at destination LTA site)
 - Upload by user
 - Content verification
 - Metadata extraction
 - Update LTA

LTA User Ingest
Context Diagram v0.1
Last updated 2026-01-06 by RG



User data ingest

Implementation underway!

ui

Q

+

Create Request

Project

Site

SURF

Checksum type

ADLER32

Estimated total size in bytes

100000000000

Data product lists (1)

Data product 1

Data product type

Visibility Data

File format

Measurement set

Files (1)

File 1 name

L012345_SB000.M5

Checksum value

23de78

Remove

+ Add file

Remove data product

+ Add data product list

COMPLETE ALL REQUIRED FIELDS BEFORE CREATING THE REQUEST.

+ Create request

Cancel

Request body preview

```
{
  "project_id": "",
  "site": "surf".
}
```

Information in the flow:

User facing User Ingest application
using separate service / library
LTA-side of application
SDC monitoring system

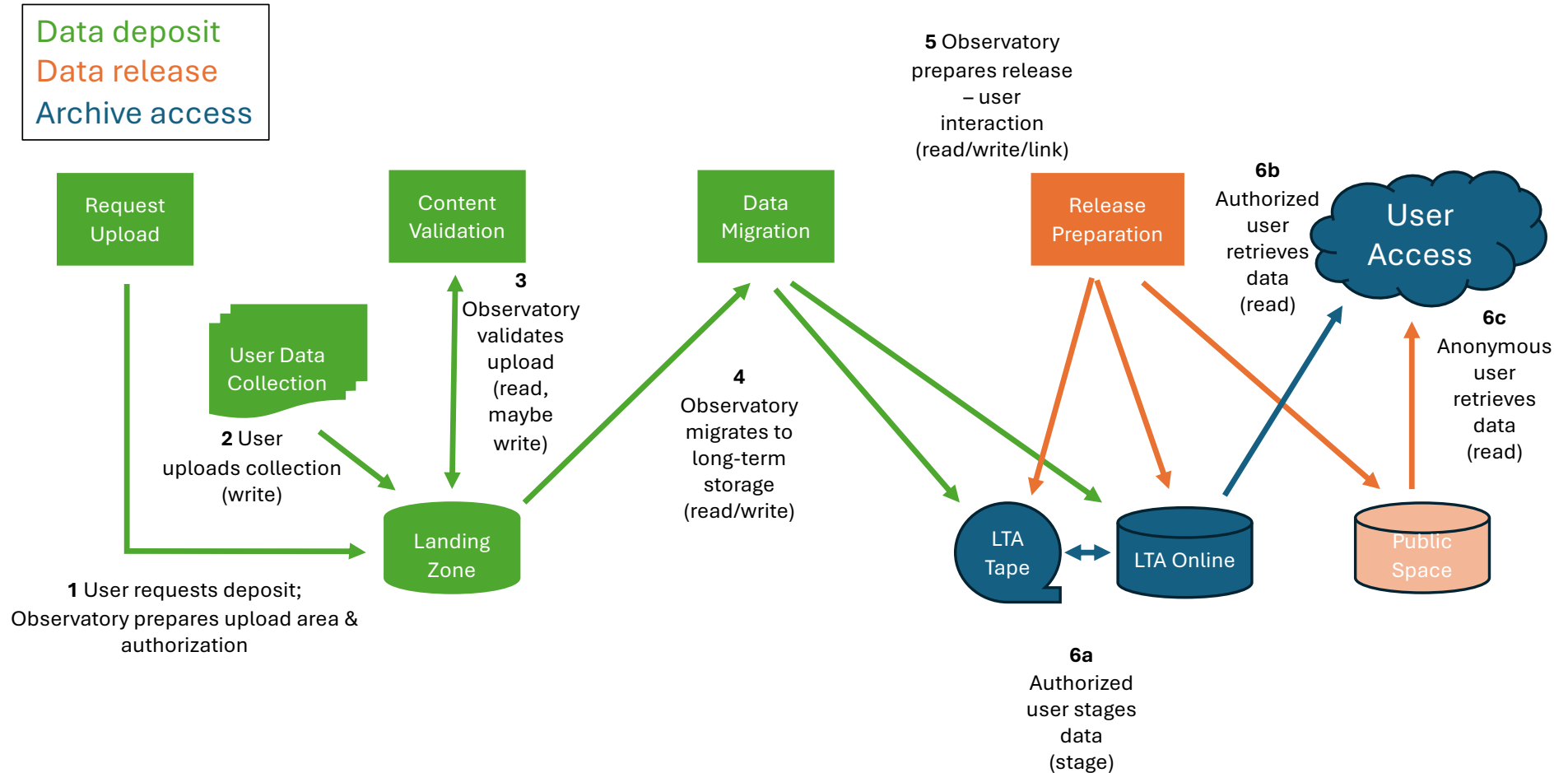
- To be able to perform a User Ingest, a user should be a member (PI or Co-I) of a science project team in the AAI system. Those teams are generated when a proposal is written.

Cycle process					
	Prepare	Initiate	Copy data	Validate and Ingest	Post ingest
External application	User pipeline	SRAM: provide membership info dCache: storage space (to be configured)	Documented copy tool provided to user	Data product type validation Data copy tooling (FTS?)	
Member of science team	Process data on own cluster	Initiate User Ingest job	Copy data into webdav	Trigger validation	Get notification that all worked!
User ingest application		Create User Ingest process, specify relevant metadata Create directory on webdav endpoint Generate macaroon with write access Generate Process ID	Provide upload URL, macaroon and upload ID to user	Check (meta)data consistency Ingest data into LTA	Clean up
SDCO		Check status and monitoring info	Check status and monitoring info	Check status and monitoring info	Check status and monitoring info

Release process for data products – LOFAR1

- Data collection generated & prepared by science team
- Collection uploaded to Landing Zone (hand-over to observatory)
- Validation of content
- Migrate collection to observatory space
- Apply release data policies (e.g. direct access/on disk)
- Create links from publicly exposed paths to ‘archived’ content
- Registration into discovery service (Virtual Observatory)
- Publication of data release
 - Usually accompanied by publication of paper and/or public announcement(s)

Release process for data products – LOFAR1

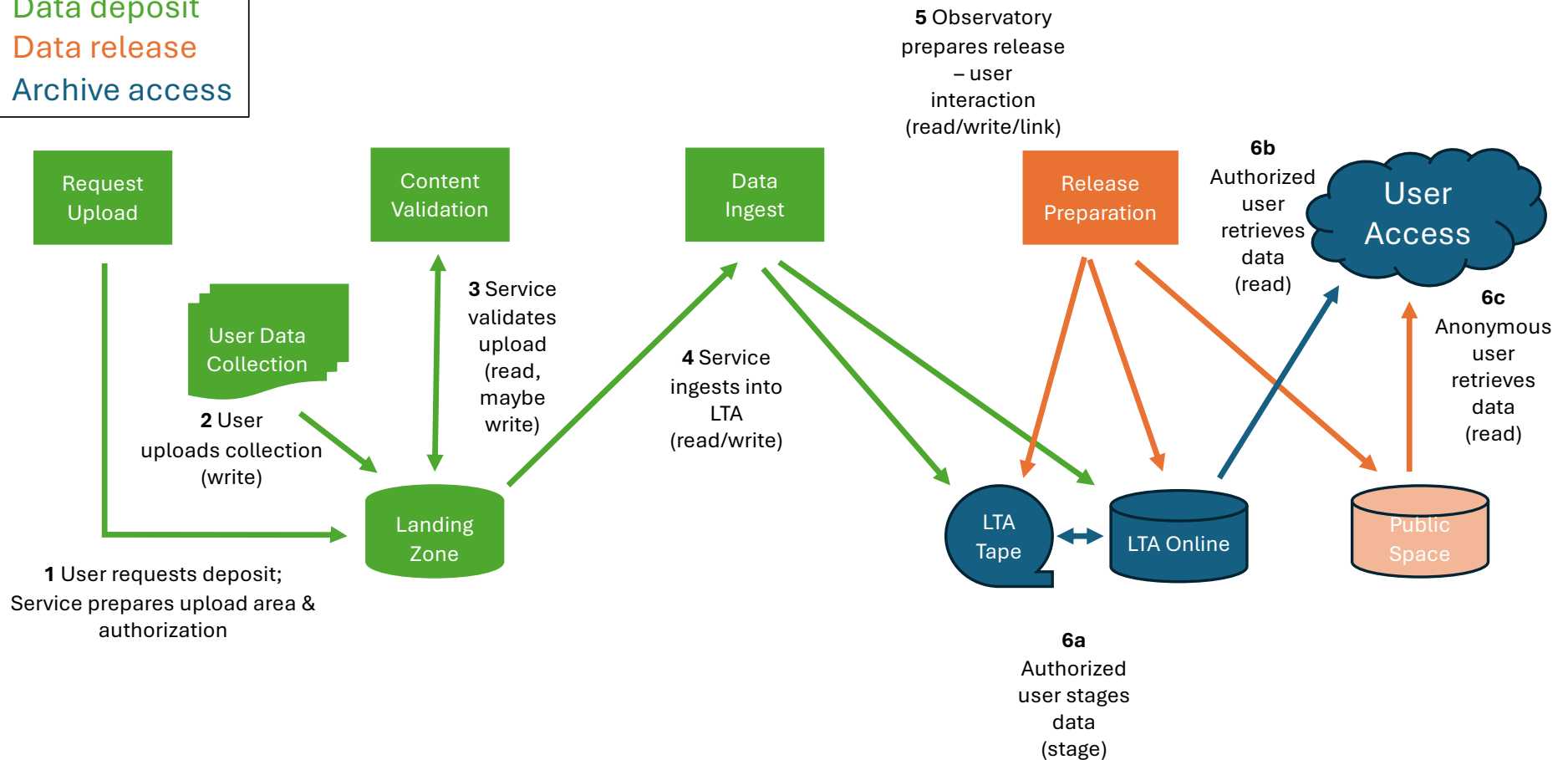


Release process for data products – LOFAR2.0

- Data ingested into archive (by observatory or through user data ingest)
- Apply release data policies (e.g. direct access/on disk)
- Create links from publicly exposed paths to ‘archived’ content
- Registration into discovery service (Virtual Observatory)
- Publication of data release
 - Usually accompanied by publication of paper and/or public announcement(s)

User ingest & release process – LOFAR2.0

Data deposit
Data release
Archive access

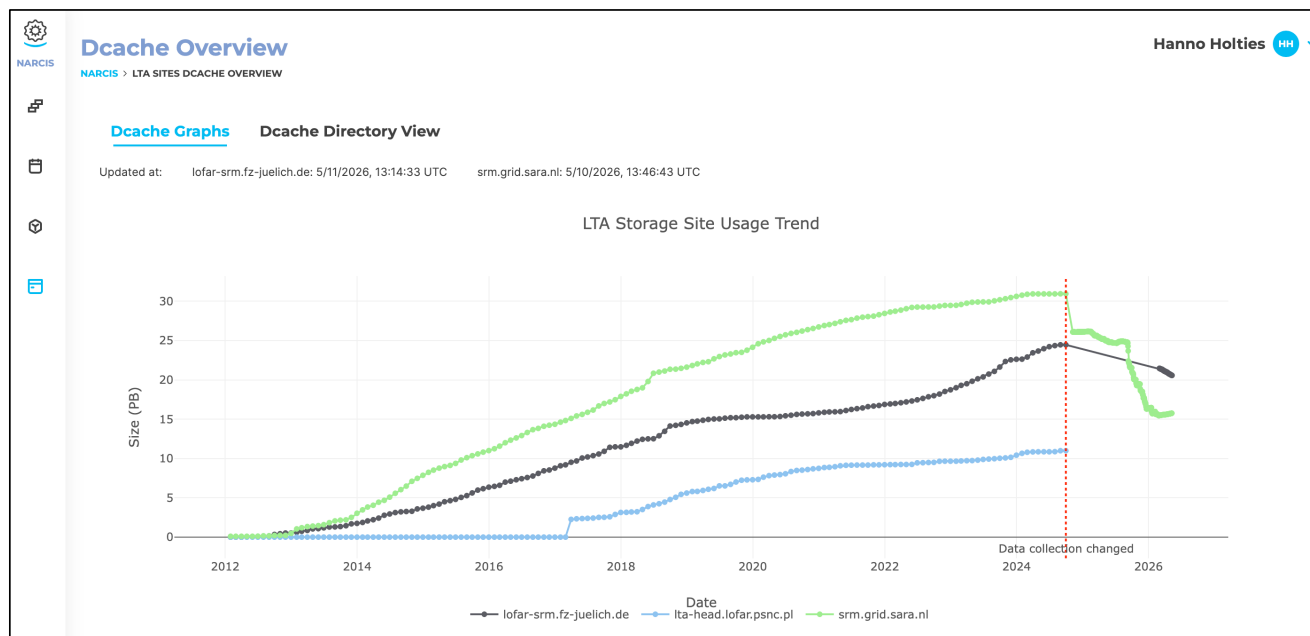


LOFAR2.0 LTA Storage Overview

Purpose	Characteristics	Tape	Disk	Replica
Instrument Data Archive	Large files; Read once or few; Finite retention time	Yes	No (staging only)	No
Advanced Data Archive	Medium to Large files; Legacy value	Yes	Maybe	Maybe
Ancillary Data Archive	Small files; Legacy value; Direct access	Yes (TBC: backed up/package)	Yes (TBC for long-term)	Maybe
Data Release Archive	Small to Medium files; Legacy value; Direct access	Yes (TBC: backed up/package)	Partly	Probably
Temporary Storage • Data Processing • User data ingest • Release deposit	Medium to Large files; Access for Inspection & validation	No	Yes	No

LTA Central observatory operations

- **Resource planning**
- **Manage project administration**
 - Allocations
 - Accounting
- **Manage data policies**
 - Placement
 - Initial
 - Migration
 - Replication (?)
 - Retirement
- **Verification & Curation**
- **Monitoring & Reporting**
 - Service availability
 - Performance
 - Utilization



Observatory needs from data centres

- **Project administration**

- LTA Storage accounting – daily full file listing
 - Paths
 - Sizes
 - Locality (disk, tape, replicas)
- Compute accounting – from Slurm

- **Resource planning** – monthly (TBC) reports

- Allocated/available capacity for disk & tape pool groups
- Used capacity for disk & tape pool groups
- Allocated/used capacity for compute

- **Monitoring**

- Service availability
 - (Un-) planned maintenance
 - Basic testing (reachable, valid certificates)
- Performance
 - TBD