The eXtreme-DataCloud project
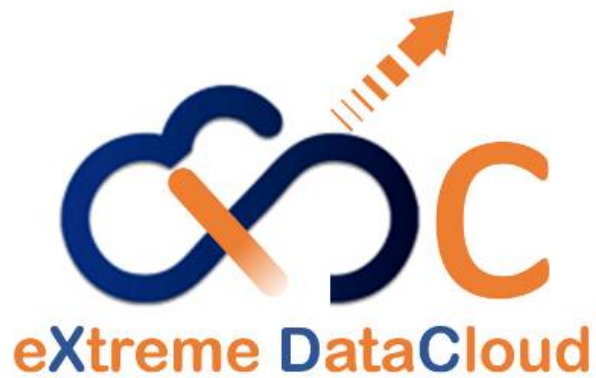
Data Management for extreme scale computing

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European Commission

XDC Objectives

- The eXtreme DataCloud is a software development and integration project

- Develops scalable technologies for federating storage resources and managing data in highly distributed computing environments
  - Focus efficient, policy driven and Quality of Service based DM

- The targeted platforms are the current and next generation e-Infrastructures deployed in Europe
  - European Open Science Cloud (EOSC)
  - The e-infrastructures used by the represented communities

XDC Foundations

✖ XDC take the move from

- ➜ the INDIGO Data management activity
- ➜ the experience of the project partners on data-management

✖ Improve already existing, production quality, Federated Data Management services

- ➜ By adding missing functionalities requested by research communities
- ➜ Must be coherently harmonized in the European e-Infrastructures
- ➜ **TRL 6+ ➜ TRL8** (as requested by the H2020 call)

XDC Consortium

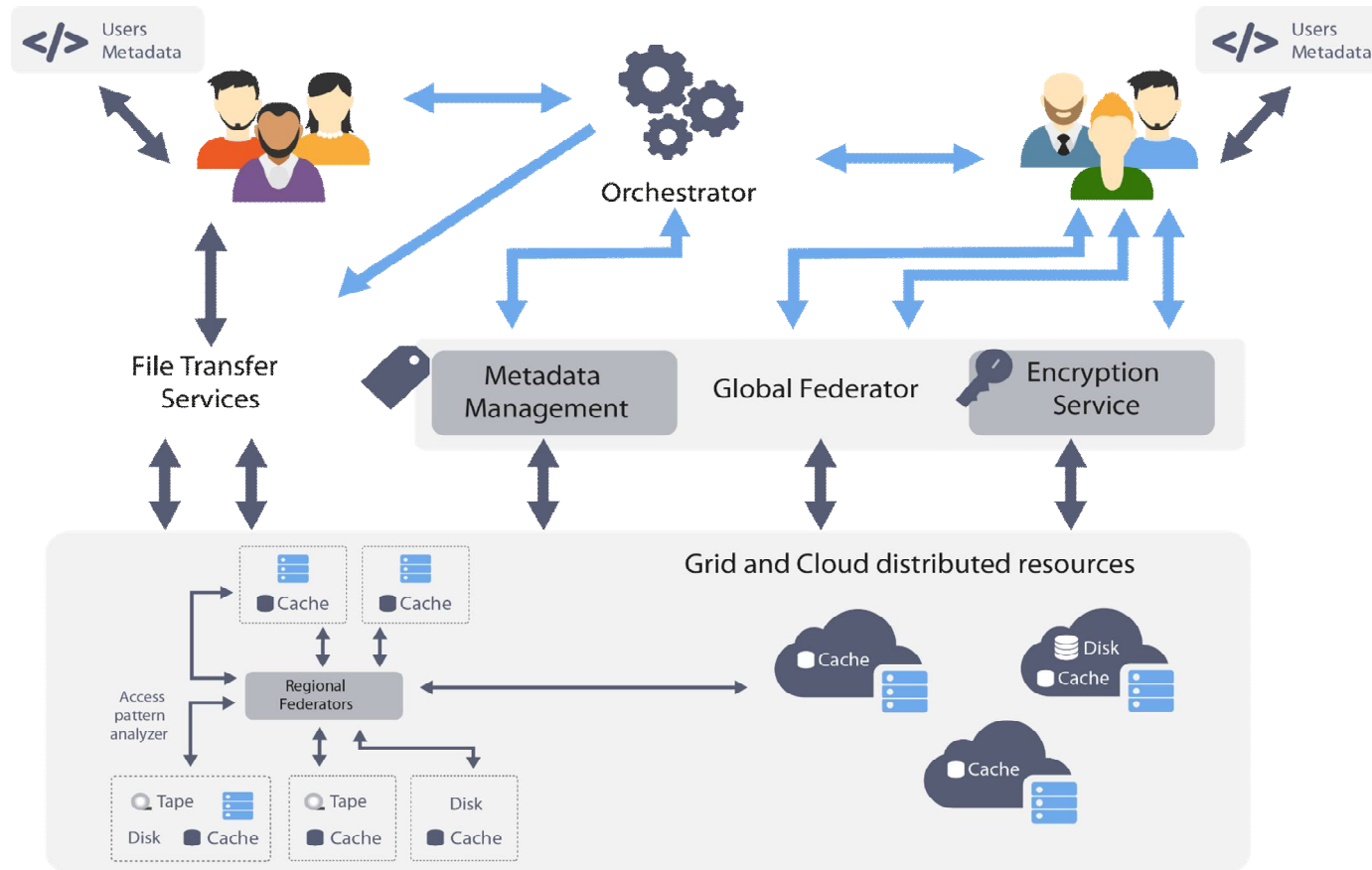| ID	Partner	Country	Represented Community	Tools and system
1	INFN (Lead)	IT	HEP/WLCG	INDIGO-Orchestrator
2	DESY	DE	Research with Photons (XFEL)	dCache
3	CERN	CH	HEP/WLCG	EOS, DYNAFED, FTS
4	AGH	PL		ONEDATA
5	ECRIN	[ERIC]	Medical data	
6	UC	ES	Lifewatch	
7	CNRS	FR	Astro [CTA and LSST]	
8	EGI.eu	NL	EGI communities	
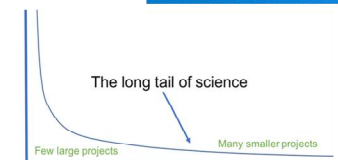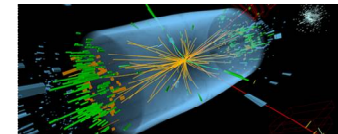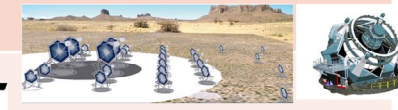
- 8 partners, 7 countries
- 7 research communities represented + EGI
- XDC Total Budget: 3.07Meuros
- XDC started on Nov 1st 2017 – will run for 27 months until Jan 31st 2020

XDC Technical Topics

✖ Intelligent & Automated Dataset Distribution
  ➡ Orchestration to realize a policy-driven data management
  ➡ Data distribution policies based on Quality of Service supporting geographical distributed resources (cross-sites)
    ➡ QoS beyond disk vs tape: availability, reliability, durability, latency
  ➡ Data lifecycle management

✖ Data (pre)processing during ingestion
  ➡ Storage Notifications based on events

✖ Smart caching
  ➡ Transparent access to remote data without the need of a-priori copy

✖ Metadata management

✖ Data management based on access patterns
  ➡ Move to 'glacier-like' storage unused data, move to fast storage "hot" data
    ➡ at infrastructure level

✖ Sensitive data handling
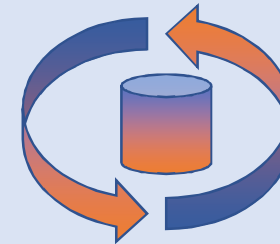 ➡ secure storage and encryption
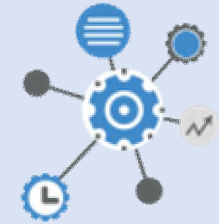
XDC high level architecture

XDC Toolbox

Storage

Orchestration

Federation

dCache

Rucio

INDIGO Orchestrator

EOS

ONEDATA

QoS
CDMI

HTTP Cache

xRootD Cache

FTS3

Dynafed
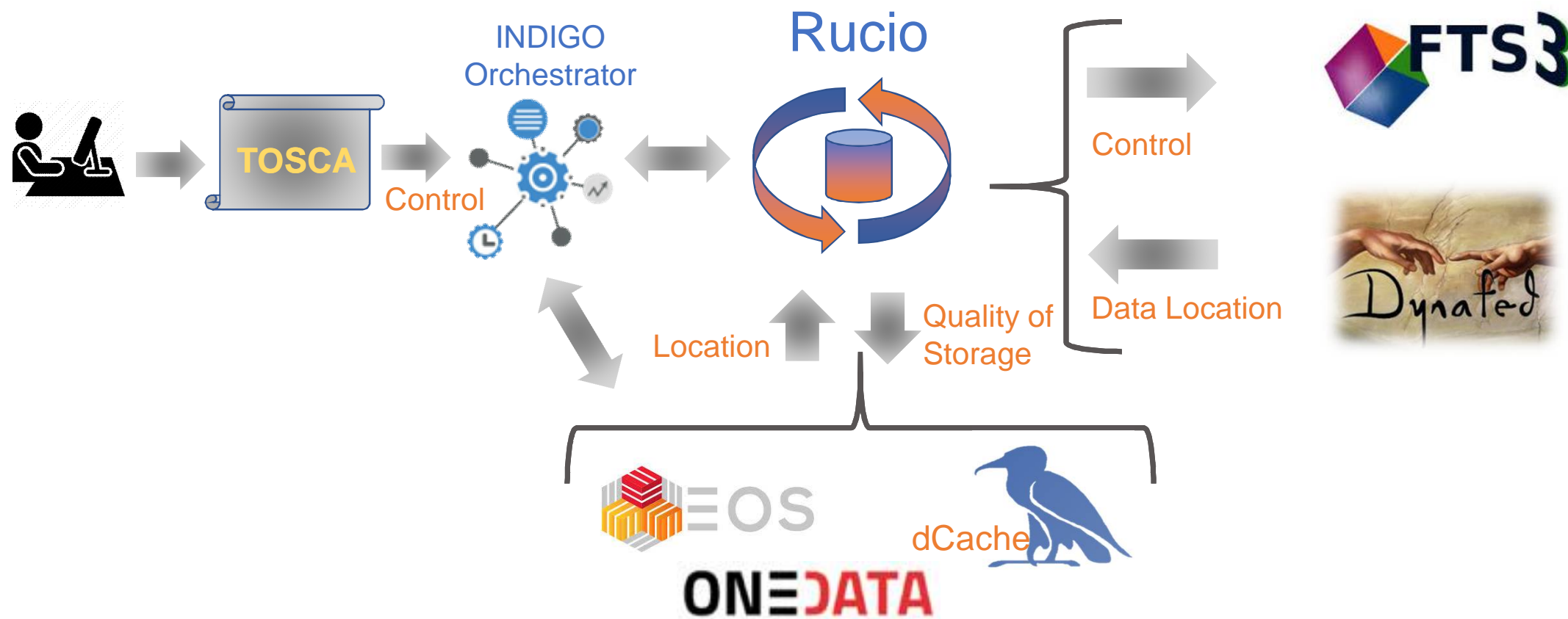
Indigo-IAM

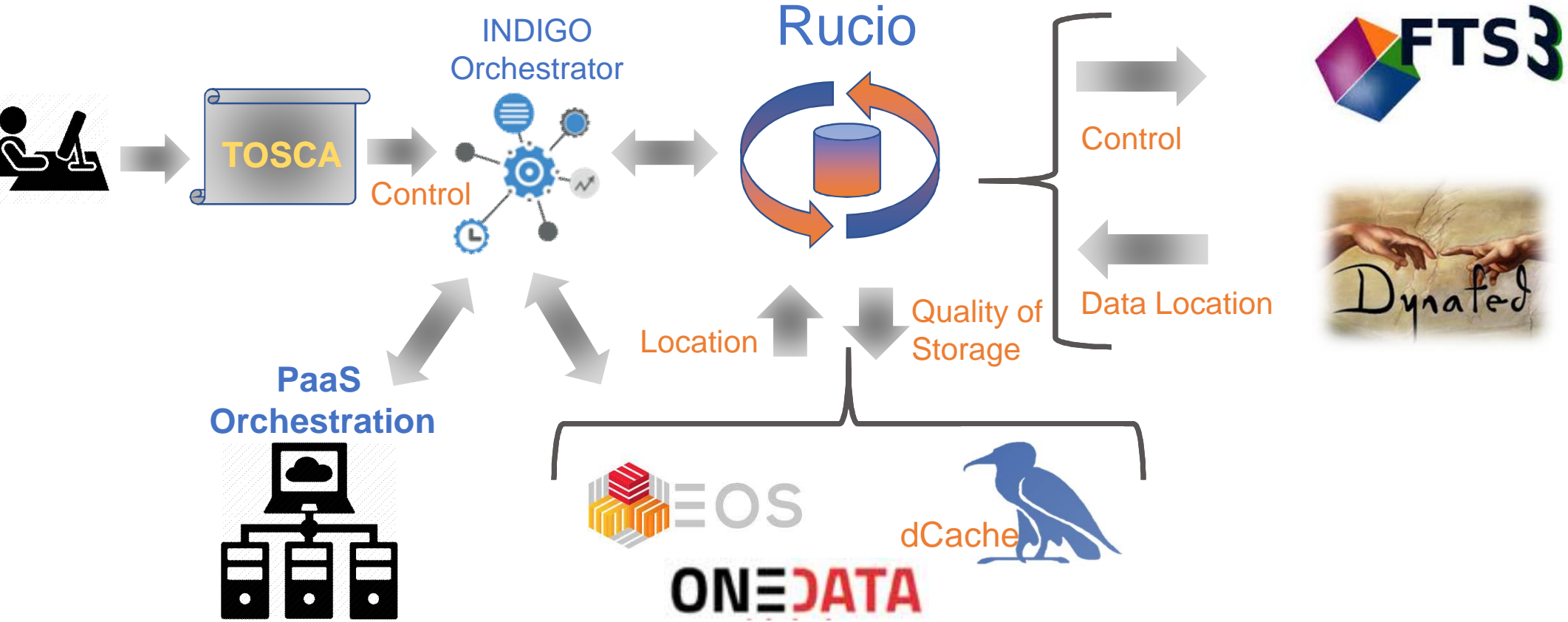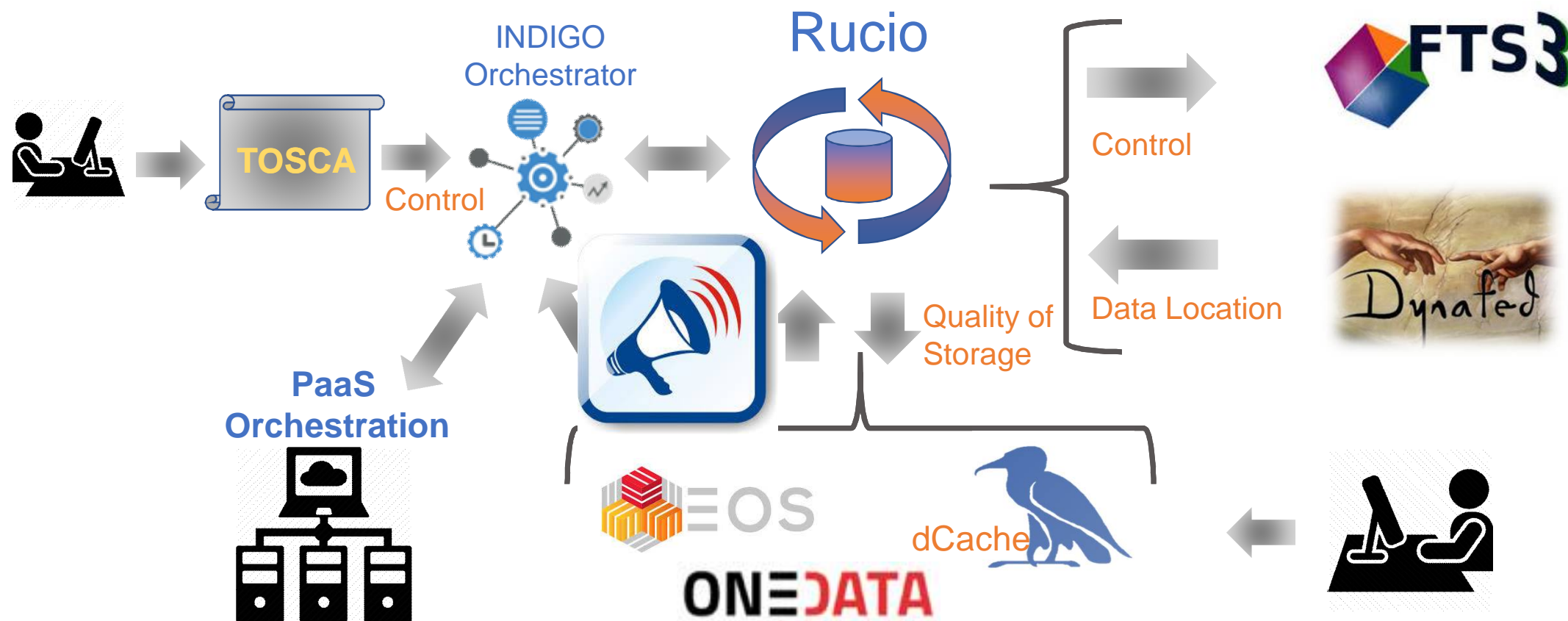# Expected Control Flow for Orchestration and Policy Driven Data Management

# Expected Control Flow for Orchestration and Policy Driven Data Management

Expected Control Flow for Orchestration and Policy Driven Data Management

INDIGO Orchestrator Overview

- The Orchestrator accepts TOSCA requests
- It can run three main workflows in the PaaS:
  - Deploy
  - Undeploy
  - Update
- The Orchestration layer is being extended in order to address the new requirements:
  - move data between distributed storages
  - specify different QoS for replicas
  - launch and monitor user defined processing jobs at ingestion time

XDC extensions
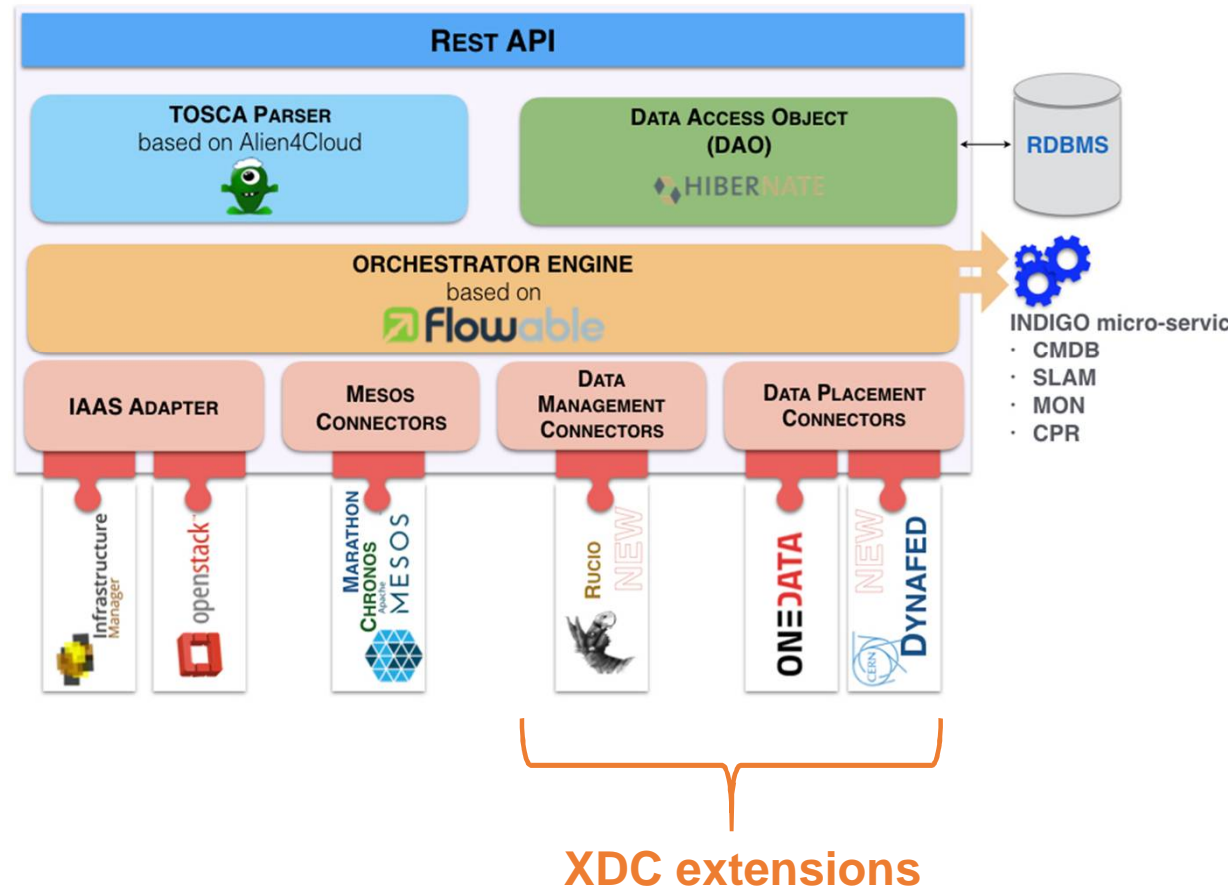
Quality of service in storage

Modern Storage offers go beyond the WLCG model of disk and tape

- Often the actual cloud storage technology is not even known to the end user or might change over time
- Mostly only quality attributes are known, like Glacier:
  - Durability (Retention Policy): 99.999999999%
  - Access Latency : a) 5 minutes, b) 5 hours, c) 12 hours

XDC aims to provide

- help to standardize the different attributes
- a prototype of rendering those attributes through a network protocol
- a set of reference implementations to be used by the Orchestration system

Work is based on INDIGO-DataCloud prerequisites

Work in progress for QoS

✖ Definition currently based on a RDA working group

✖ "Cloud Data Management Interface" chosen as control protocol.
  - Defined by SNIA.
  - INDIGO acknowledged by SNIA as contributor to the reference implementation.

✖ Implementing the defined API into GFAL, dCache, EOS and StoRM

Name	Access Latency [ms]	Number of Copies	Storage Lifetime	Location	Storage type	Available Transitions
disk	100	1		DE	Processing	tape, disk+tape
disk+tape	100	2		DE	Processing	tape
DiskAndTape	50	3	20 years	DE	Processing	
DiskAndTape	50	2		IT	Processing	
DiskOnly	50	3	20 years	DE	Processing	
DiskOnly	50	1		IT	Processing	
profile1	10	3	20 years	DE	Processing	

From INDIGO-DataCloud

- Access Latency [ms]
- Number of Copies
- Storage Lifetime
- Location
- Available Transitions

dCache storage events

✘ Support has been added for storage events
  ⋯➔ Allow non-dCache agent to get notified that something of interest happen inside dCache

✘ Two mechanisms to receive events
  ⋯➔ Kafka
    ⋯➔ exposes dCache internal events (currently) without any security. This is intended for trusted (or otherwise tightly integrated) services.
  ⋯➔ Server Sent Events (SSE)
    ⋯➔ generic interface that requires authentication. Out-of-the-box, it is available to all dCache users (there's no anonymous event subscription).

Smart caching

Smart caching

- Develop a global caching infrastructure supporting the following building blocks:
  - dynamic integration of satellite sites by existing data centres
  - creation of standalone caches modelled on existing http and xrootd solutions
  - federation of the above to create a large scale, regional caching infrastructure

D.Cesini - The eXtreme DataCloud Project – RO-LCG 2018 - Cluj
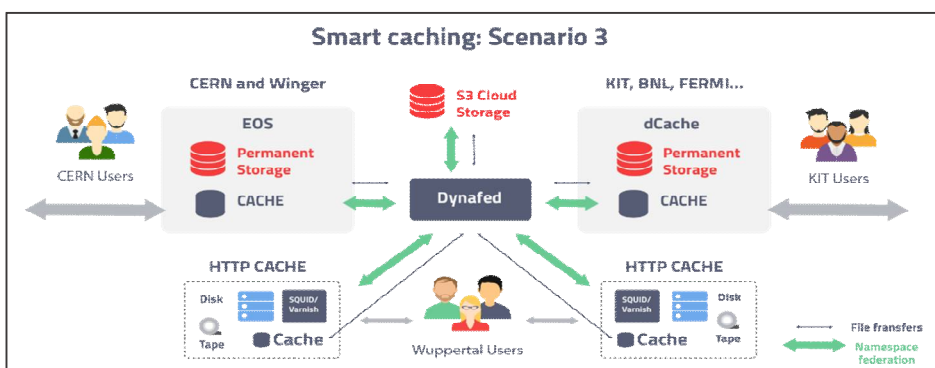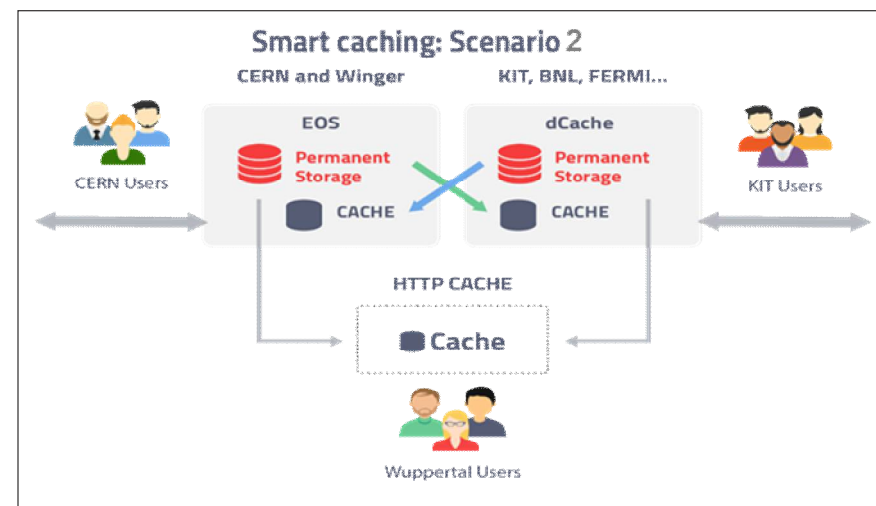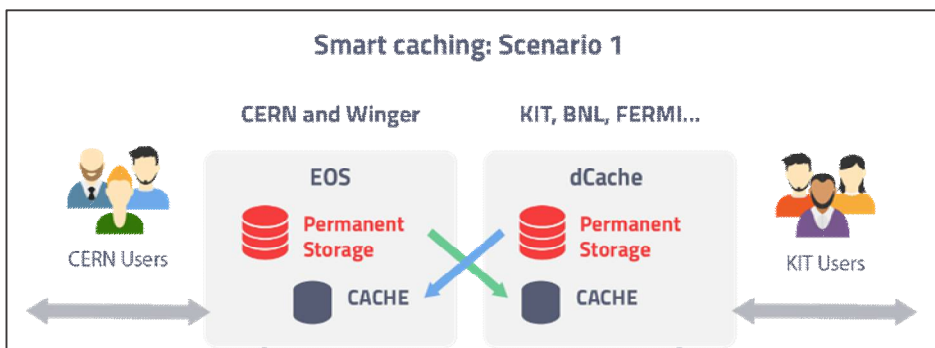
EOS-dCache integration with cached access

CERN
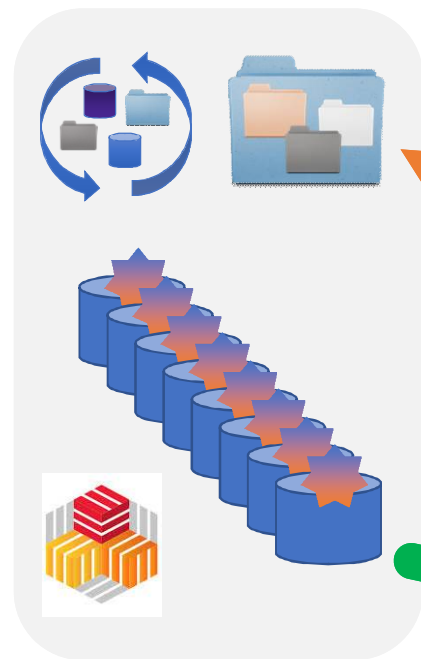
Sync Namespace

Request

DESY
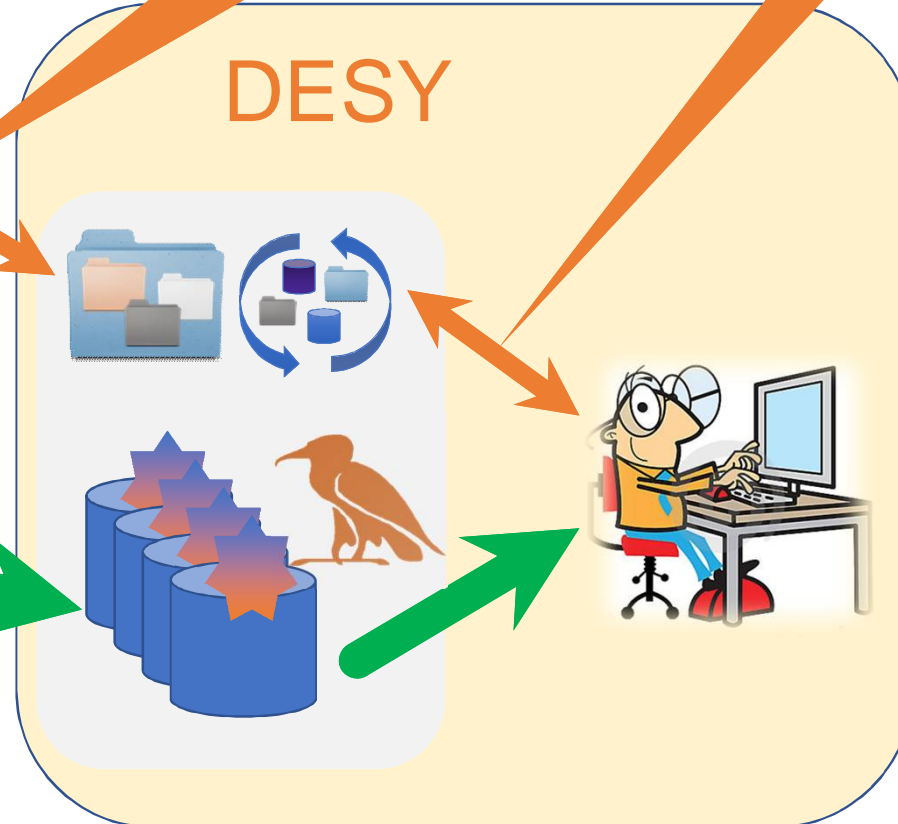
Advantages

- Same software stack as we currently have at the sites.
- After the data has been transferred to the local storage system, a name space entry has been created locally and the data is available at the local site independently of the remote network link and the availability of the central service.

Data in Hybrid Cloud Environments: Onedata

ONEDATA is a storage federator that allows to use resources backed by providers worldwide

https://onedata.org

- Providers deploy *Oneprovider* services near physical storage resources
- Users use *Onezone* web interfaces
  - APIs available
  - Local mounting on users machines available
- Storage is organized into **Zones**
  - federations of providers
  - enable the creation of closed or interconnected communities

XDC Schedule

Pilot tb in place

Architecture finalized

Functionalities and Scalability demonstrated

Kickoff@INFN

Reference Release -1

XDC started

Dissemination event@IFCA

All-Hands@DESY

Reference Release - 2

Nov '17

May'18

Jul '18

Nov '18

Nov '19

Jan '18

Jun '18

Sep'18

Jan '20

XDC end

XDC – Release 1

eXtreme DataCloud
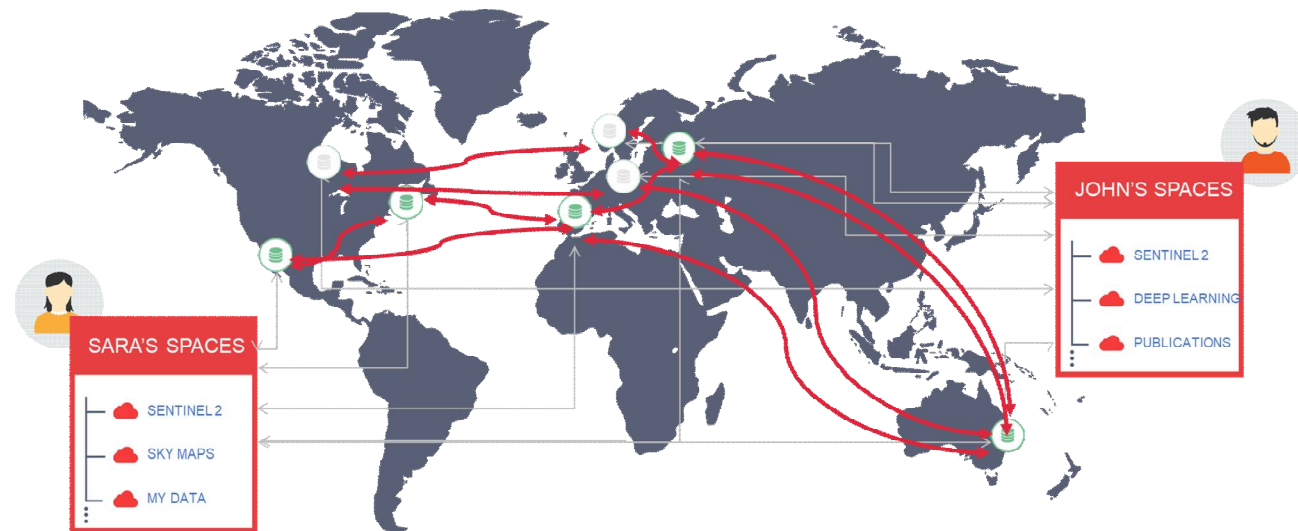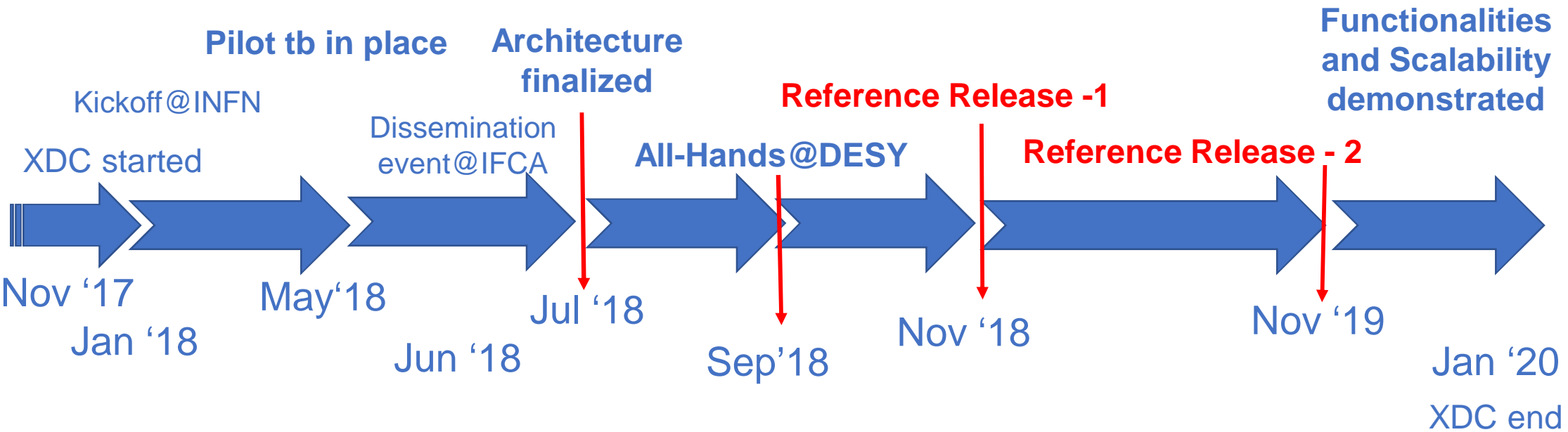
| Component	XDC functionalities
EOS	- Caching with xcache for geographic deployment: Xcache deployed at a remote centre to accelerate its local CPU - External storage adoption (Through an S3 or a WebDAV interface) - External data adoption (Data already present on a system described above can be incorporated into EOS)
dCache	- New QoS types integration, aggregated QoS for storage federations - OpenIDConnect support in dcache_view - dcache storage events (SSE notifications): Allow non-dCache agent to get notified that something of interest happen inside dCache
FTS+gfal	- QoS support: can now accept a QoS job - OpenIDConnect support - QoS in gfal (gfal with basic cdmi client) – python bindings available
Dynafed	- Integration of OIDC authentication
Caching infrastructure based on xCache or http	- deployment receipts for geographically distributed caches (via xcache) - deployment receipts for scalable local caches (via xcache and http)
PaaS Orchestrator	- Implementation of Dynafed plugin – interaction via INDIGO IAM oauth2 token - Enhancement of ONEDATA plugin
ONEDATA	- Performance and stability improvements - new RADOS driver

XDC Contacts

✖ Website: www.extreme-datacloud.eu

✖ **@XtremeDataCloud on Twitter**

✖ **Mailing list: info<at>extreme-datacloud.eu**

Backup slides

LifeWatch Use Case

Problem: Life Cycle Management of data related to **Water Quality** involving heterogeneous data sources

- → Satellite, Real-time monitoring, meteorological stations.

Goal: Integrate data sources and different types of modelling tools to simulate freshwater masses in a FAIR data environment

- → Use of standards like EML (Ecological Metadata Language)

XDC Solution:

- → Onedata
  - → Metadata management and discovery, Digital Identifier minting, storage
- → PaaS Orchestrator
  - → automatic preprocessing for data harmonization and model deployment
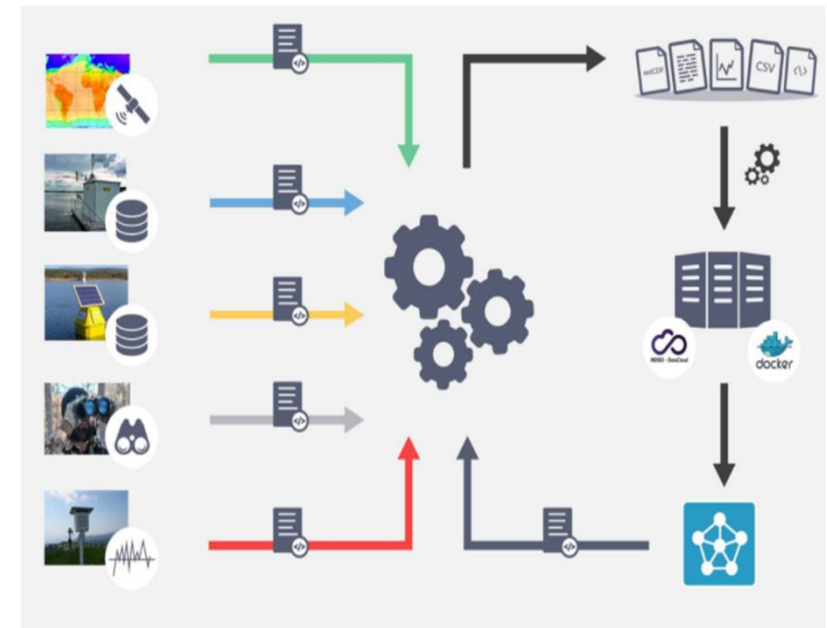
CTA Use Case

✘ **Problem**: Complex and Big Data management in a distributed environment. Data quality Assurance

- ┅➔ The CTA distributed archive lies on the « Open Archival Information System » (OAIS) ISO standard.
- ┅➔ Event data are in files (FITS format) containing all metadata.

✘ **Goal**: Metadata are extracted from the ingested files, with an automatic filling of the metadata database.

- ┅➔ Metadata will be used for querying of archive.
- ┅➔ The system should be able to **manage replicas**, tapes, disks, etc, with data from low-level to high-level

✘ **XDC Solutions**

- ┅➔ Onedata
  - ┅➔ Metadata management and discoverability
- ┅➔ PaaS Orchestrator + QoS