The eXtreme-DataCloud project

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eXtreme DataCloud is co-funded by the Horizon2020 Framework Program – Grant Agreement 777367
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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

<table>
<thead>
<tr>
<th>ID</th>
<th>Partner</th>
<th>Country</th>
<th>Represented Community</th>
<th>Tools and system</th>
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<tr>
<td>1</td>
<td>INFN</td>
<td>IT</td>
<td>HEP/WLCG</td>
<td>INDIGO-Orchestrator</td>
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<tr>
<td>2</td>
<td>DESY</td>
<td>DE</td>
<td>Research with Photons (XFEL)</td>
<td>dCache</td>
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<td>3</td>
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<td>CH</td>
<td>HEP/WLCG</td>
<td>EOS, DYNAFED, FTS</td>
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<td>[ERIC]</td>
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<td>6</td>
<td>UC</td>
<td>ES</td>
<td>Lifewatch</td>
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<td>CNRS</td>
<td>FR</td>
<td>Astro [CTA and LSST]</td>
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<td>EGI.eu</td>
<td>NL</td>
<td>EGI communities</td>
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</table>

- 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
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
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

<table>
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<tr>
<th>Name</th>
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<th>Number of Copies</th>
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<th>Location</th>
<th>Storage Type</th>
<th>Available Transitions</th>
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<td>profile1</td>
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<td>3</td>
<td>20 years</td>
<td>DE</td>
<td>Processing</td>
<td></td>
</tr>
</tbody>
</table>
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

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

Smart caching: Scenario 1

Smart caching: Scenario 2

Smart caching: Scenario 3

9-11/10/2018

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

CERN

Sync Namespace

DESY

Request

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

- 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

https://onedata.org
XDC Schedule

- **XDC started**: Nov ‘17
- **Kickoff@INFN**: Jan ‘18
- **Pilot tb in place**: May ‘18
- **Architecture finalized**: Jun ‘18
- **Dissemination event@IFCA**: Jul ‘18
- **All-Hands@DESY**: Sep ‘18
- **Reference Release -1**: Nov ‘18
- **Reference Release -2**: Nov ‘19
- **Functionalities and Scalability demonstrated**: Jan ‘20
- **XDC end**: Jan ‘20

**Key Events**
- **Jul ‘18**: Reference Release -1
- **Nov ‘18**: Reference Release -2
- **Nov ‘19**: XDC end

**Timeline**
- **Nov ‘17**: XDC started
- **Jan ‘18**: Kickoff@INFN
- **May ‘18**: Pilot tb in place
- **Jun ‘18**: Architecture finalized
- **Jul ‘18**: Dissemination event@IFCA
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<tr>
<th>Component</th>
<th>XDC functionalities</th>
</tr>
</thead>
</table>
| 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