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UNICORE

JÜLICH FORSCHUNGSZENTRUM

UNICORE 7 – Middleware Services for Distributed and Federated Computing

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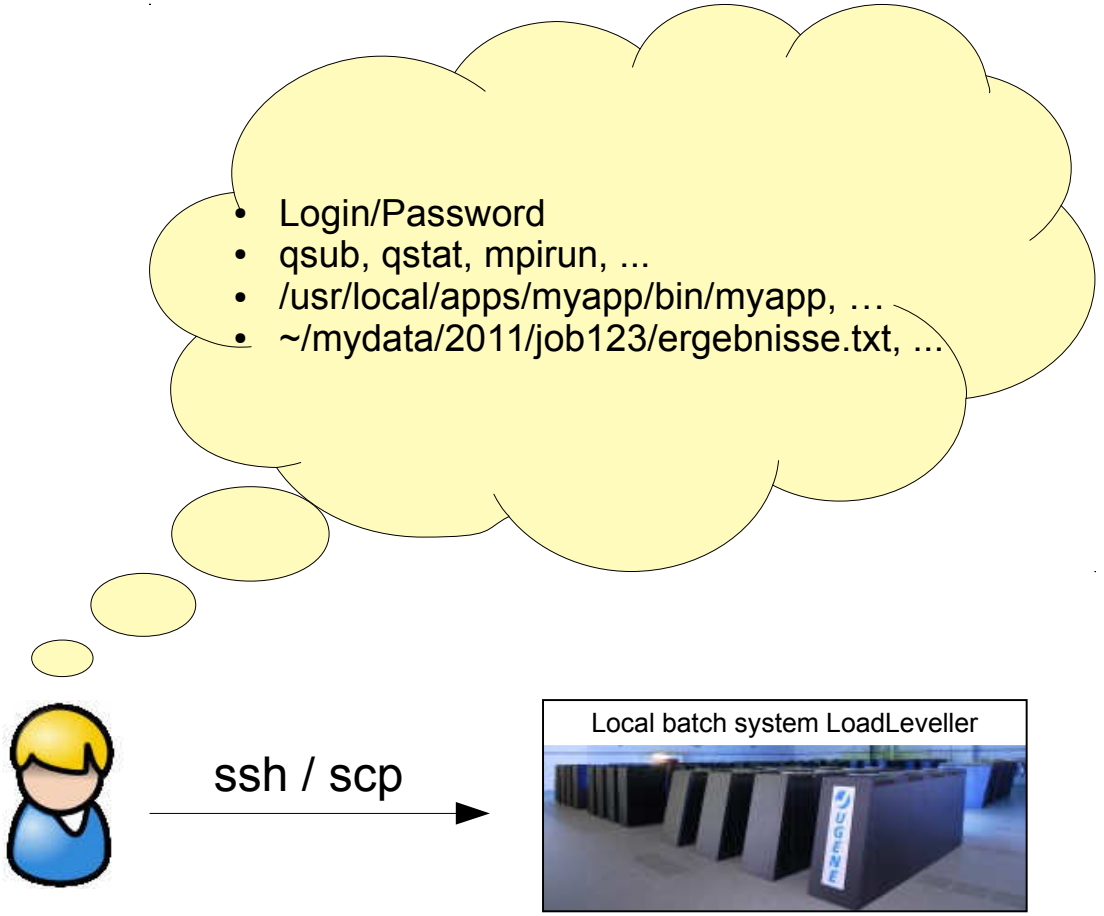
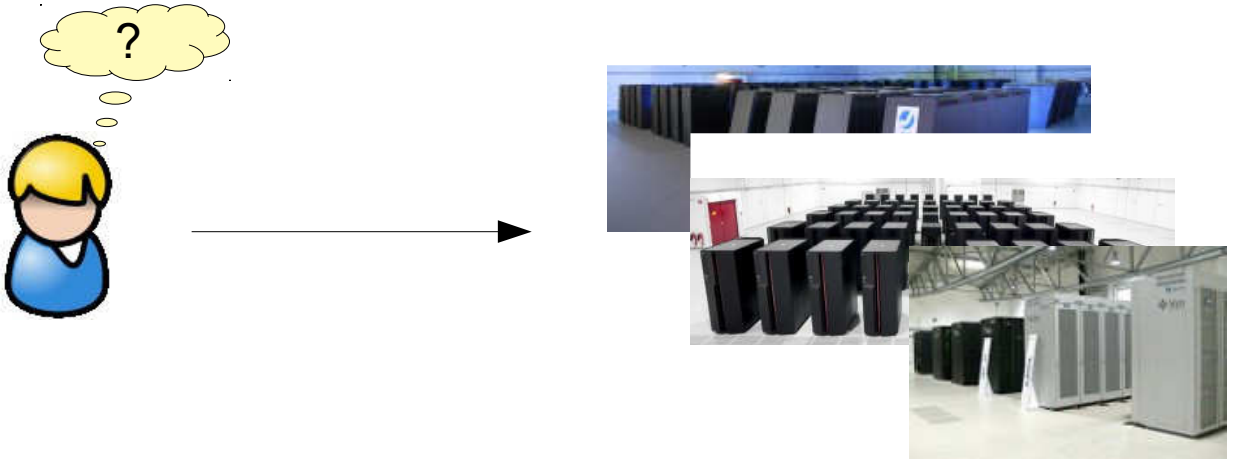
Outline

- UNICORE – UNiform Interface to COmputing and data REsources
- Services for Distributed and Federated computing
  - UNICORE : overview
  - Unity : user authentication and identity management
  - UNICORE Web Portal
  - RESTful APIs
- Summary and outlook


• Login/Password
• qsub, qstat, mpirun, ...
• /usr/local/apps/myapp/bin/myapp, …
• ~/mydata/2011/job123/ergebnisse.txt, ...
ssh / scp
Local batch system LoadLeveller



How can I ...

- … use multiple, heterogeneous systems seamlessly,
- … manage my job input data and results?
- … across multiple systems? Workflows?
- ... integrate HPC and big data into custom applications and portals?

UNICORE

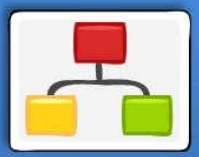

Web


Command line

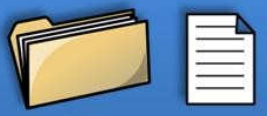

GUI

API

Clients


Workflows


Jobs


Data Management


Discovery

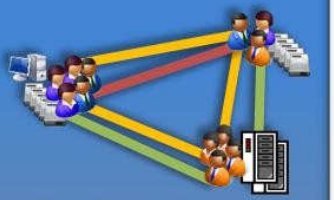
Services


Compute


Storage

Resources

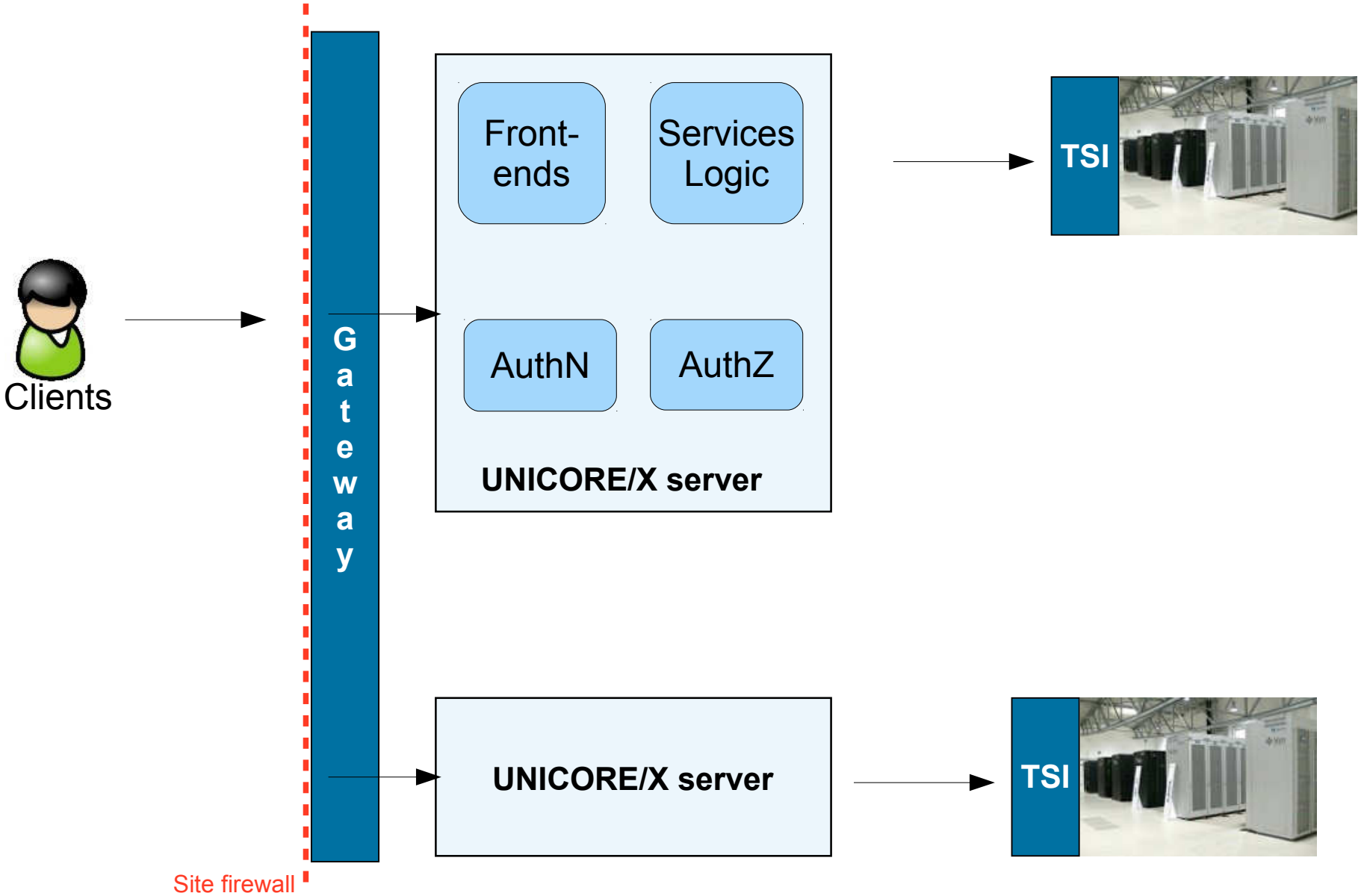

Users


Federations


Policies

Security

Typical UNICORE installation at a HPC center



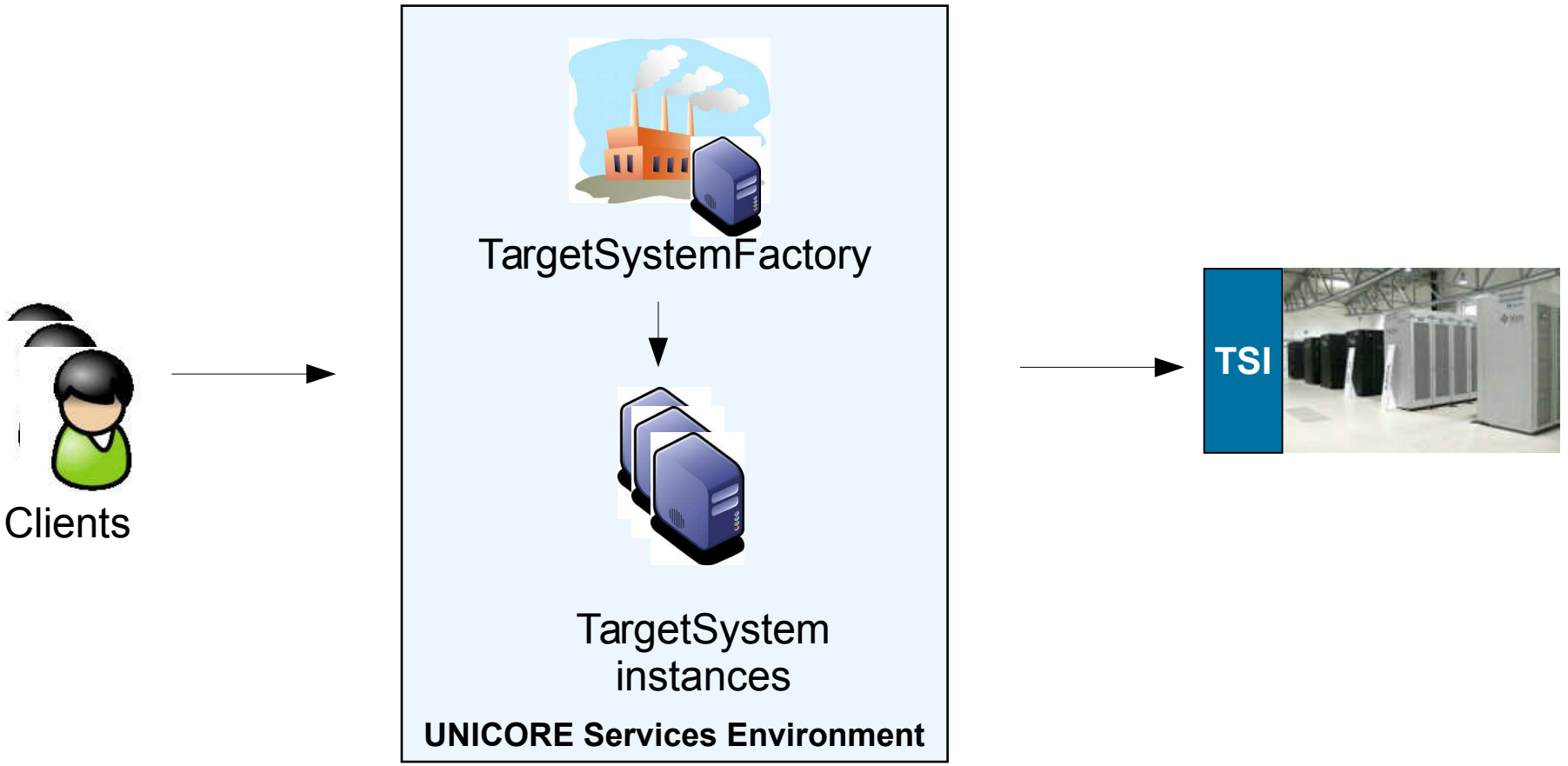
- Workflow enactment
- Task execution

- TargetSystemFactory
- TargetSystem
- JobManagement
- Reservations

- StorageFactory
- StorageManagement
- FileTransfer
- Metadata

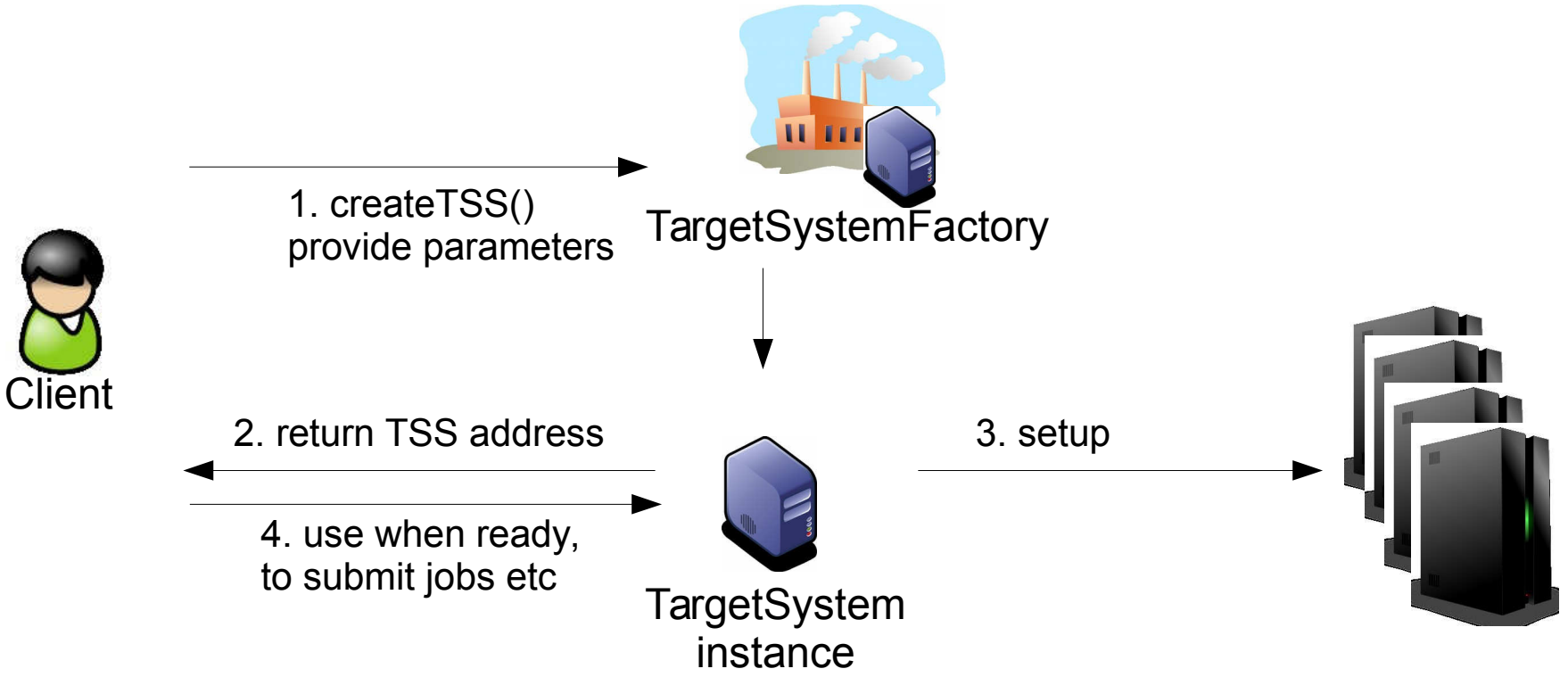
- Registry
- Resource Broker

Default setup



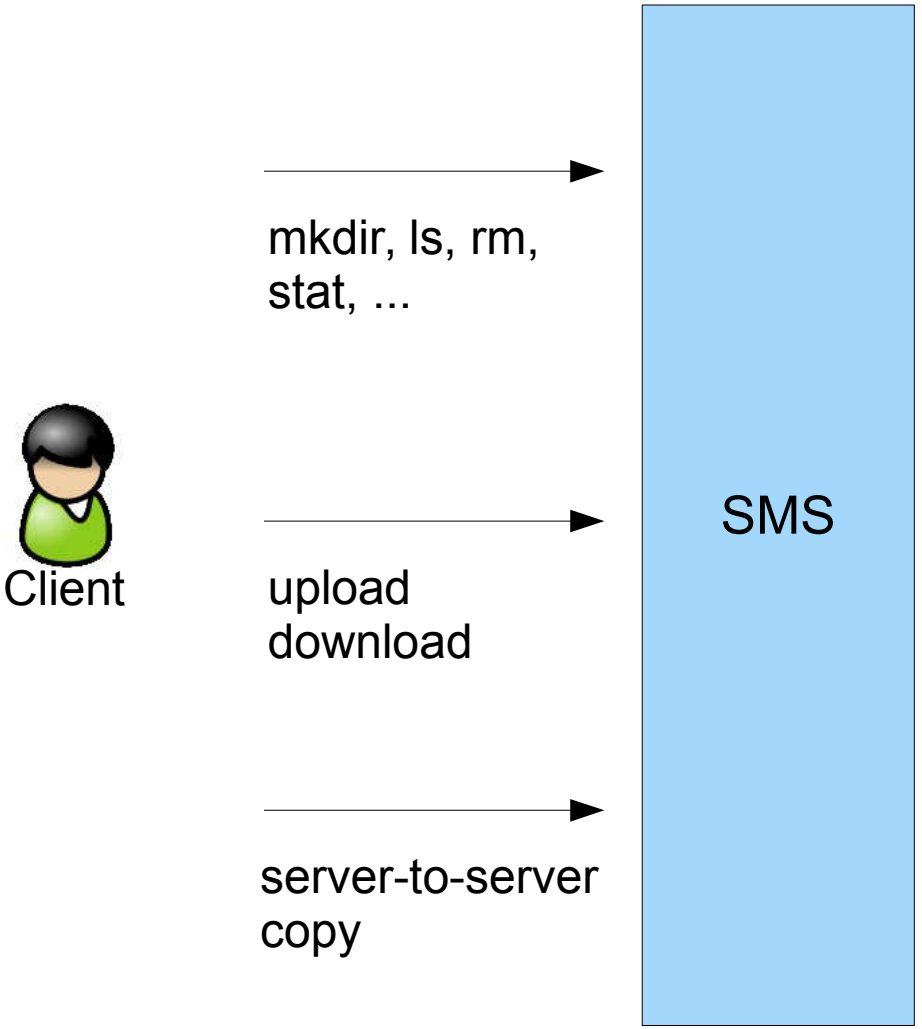
- Access to resource manager and file system via TargetSystemInterface (TSI) daemon installed on the cluster login node(s)

Factory services: virtualisation support



- Set up a virtual image during initialisation phase
- Aim at OpenStack VMs, Amazon EC2, ...

Storage Management Service



- File systems
- Apache HDFS
- S3
- CDMI (prototype)
- ...

Storage Management Service: more than a file system

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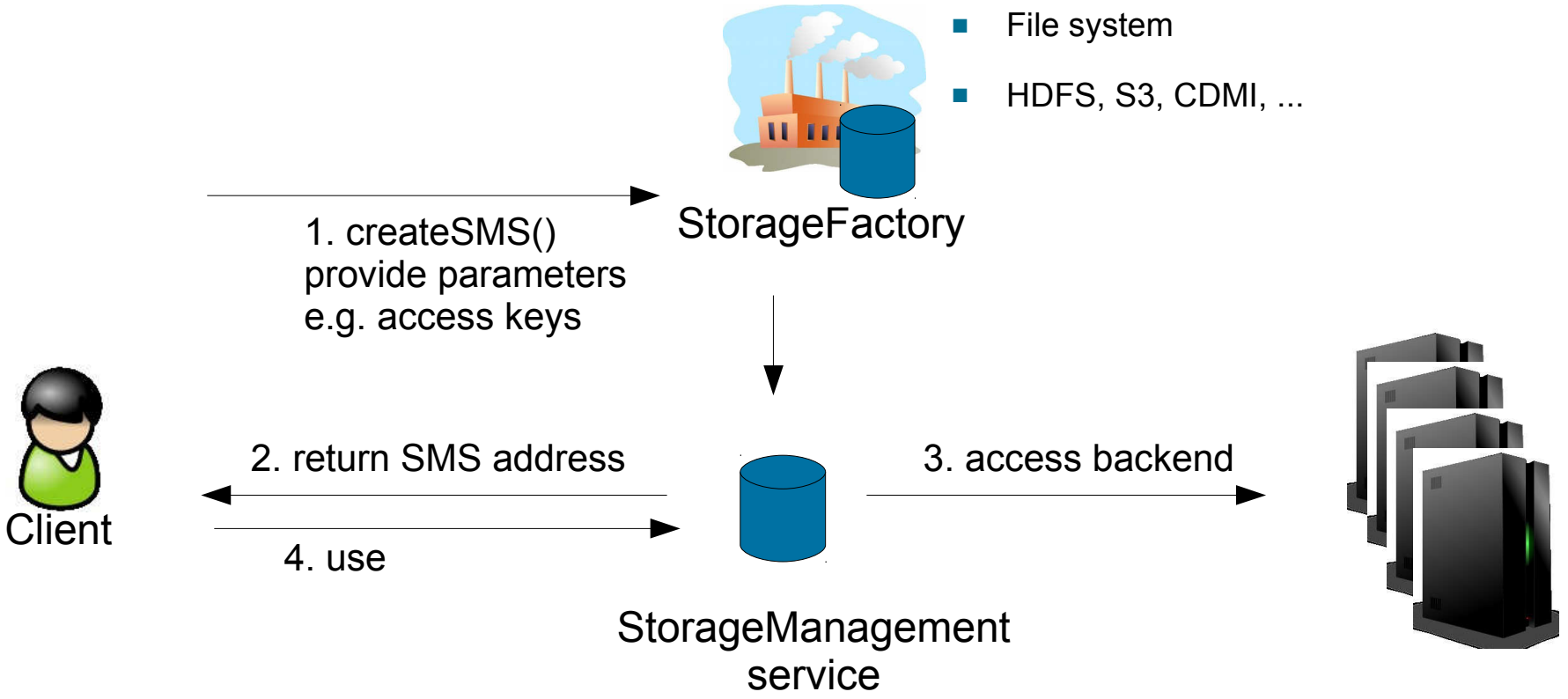
- Initiate file transfers
  - Multi-protocol support
  - Scheduled server-to-server copy
- Metadata management
  - Schema-free, key-value
  - Indexed via Lucene, searchable
- Rule-based data processing
  - New files automatically trigger actions
  - e.g. metadata extraction, compression, etc

Factory services: virtualisation support

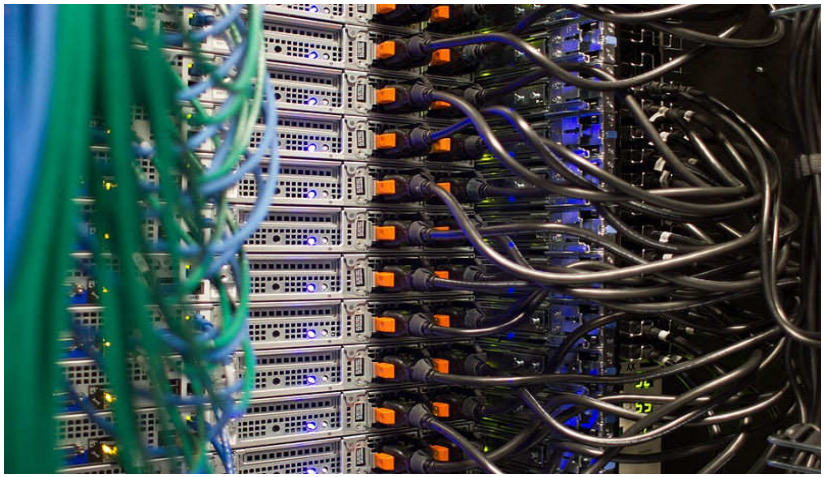


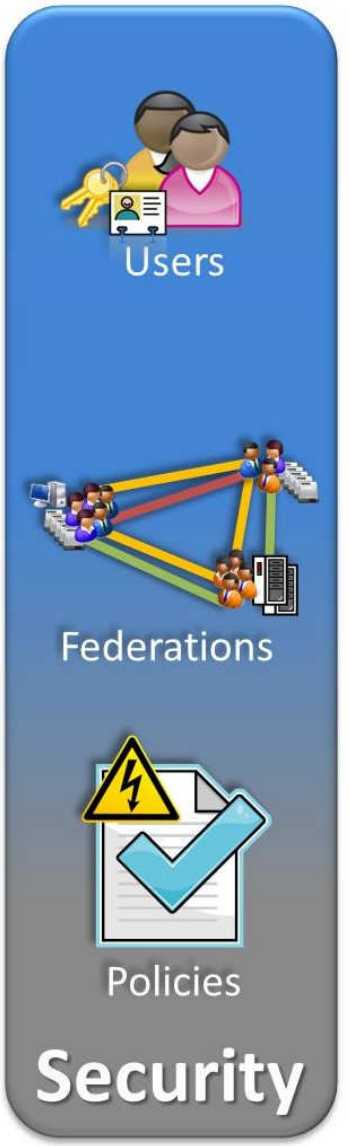
- Different types of storage backends can be supported
- User can select and provide required parameters

- Batch systems (Torque, Slurm, LoadLeveler, GridEngine, ...)
- Apache Hadoop (YARN)
- Direct execution (e.g. on Windows)
- ... (extensible)

- File systems
- Apache HDFS
- S3
- ... (extensible)

Federated access: security is key





UNICORE – Basic security flow

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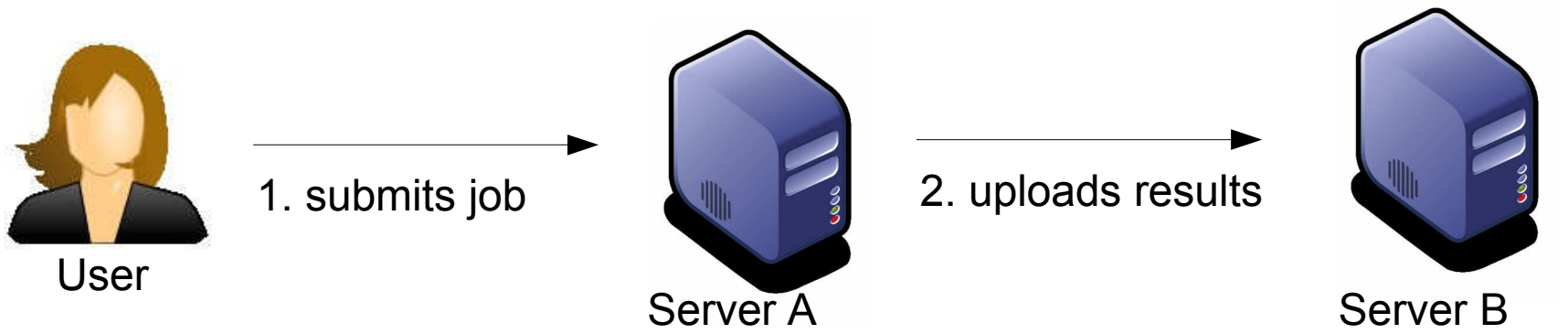
- **Service invocation:** a web service call is made to a UNICORE service
- **Authentication**: who is the user?
  - Results in the user's X.500 DN („CN=..., O=..., OU=…, C=...“)
- **Assign attributes** to the user
  - Standard attributes: role, Unix ID, groups, etc.
  - Custom attributes: (e.g. S3 access and secret keys)
- **Authorisation**
  - Add context: e.g. who owns the resource?
  - Check resource policies (ACLs)
  - Check server policies (XACML)
- → **Allow or deny** the request

Delegation

- Allow Service to work on behalf of the user
- UNICORE solution based on SAML
  - Use chain of signed assertions
  - Trust always delegated to particular server
  - Can be validated and audited



End-user authentication in UNICORE

- Pre-UNICORE 7: X.509 client certificates REQUIRED for end-users
- Users tend to hate them
  - All sorts of usage issues
- Lack of understanding leads to lack of security (sending keys via email etc)
- Users understand passwords
  - and it is relatively easy to teach basic security measures

Certificate-less end-user authentication

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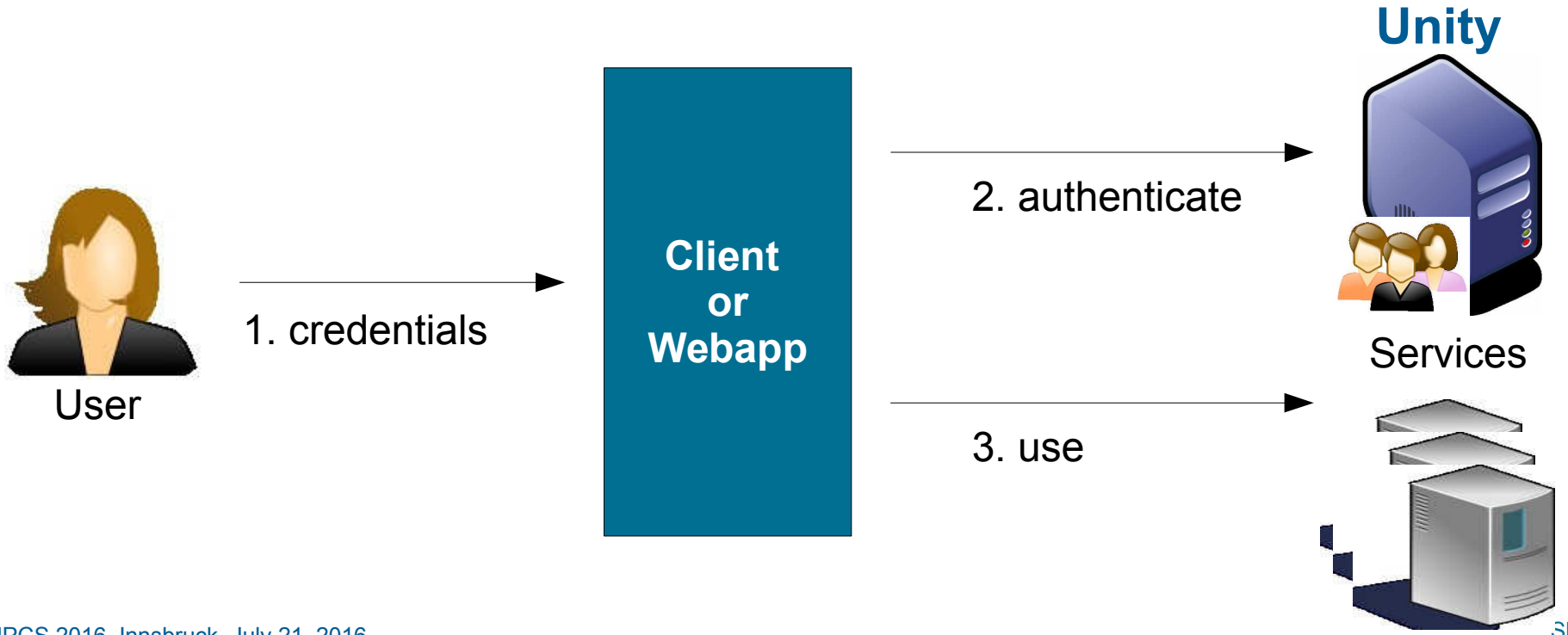
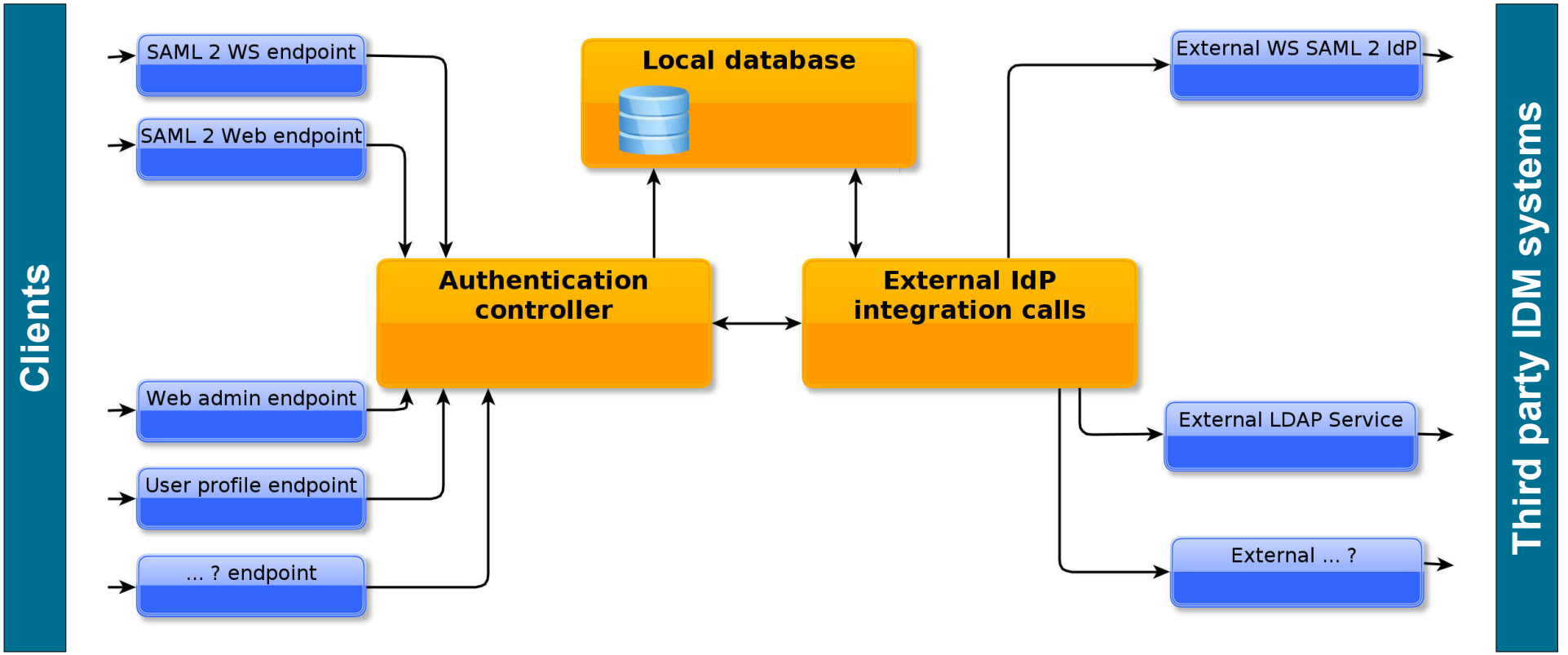
- Goal: **no end-user certificates** (not even short-lived)
- Approach
  - Use **signed SAML assertions** for authentication
  - Issued and signed by a trusted service
  - Flexible solution is required: e.g. want support for existing SAML Identity providers , federations like DFN AAI, OAuth, etc
- Implications
  - Client – server TLS is not client-authenticated
  - End-user cannot sign anything (no „non-repudiation“ guarantee)

Introducing Unity

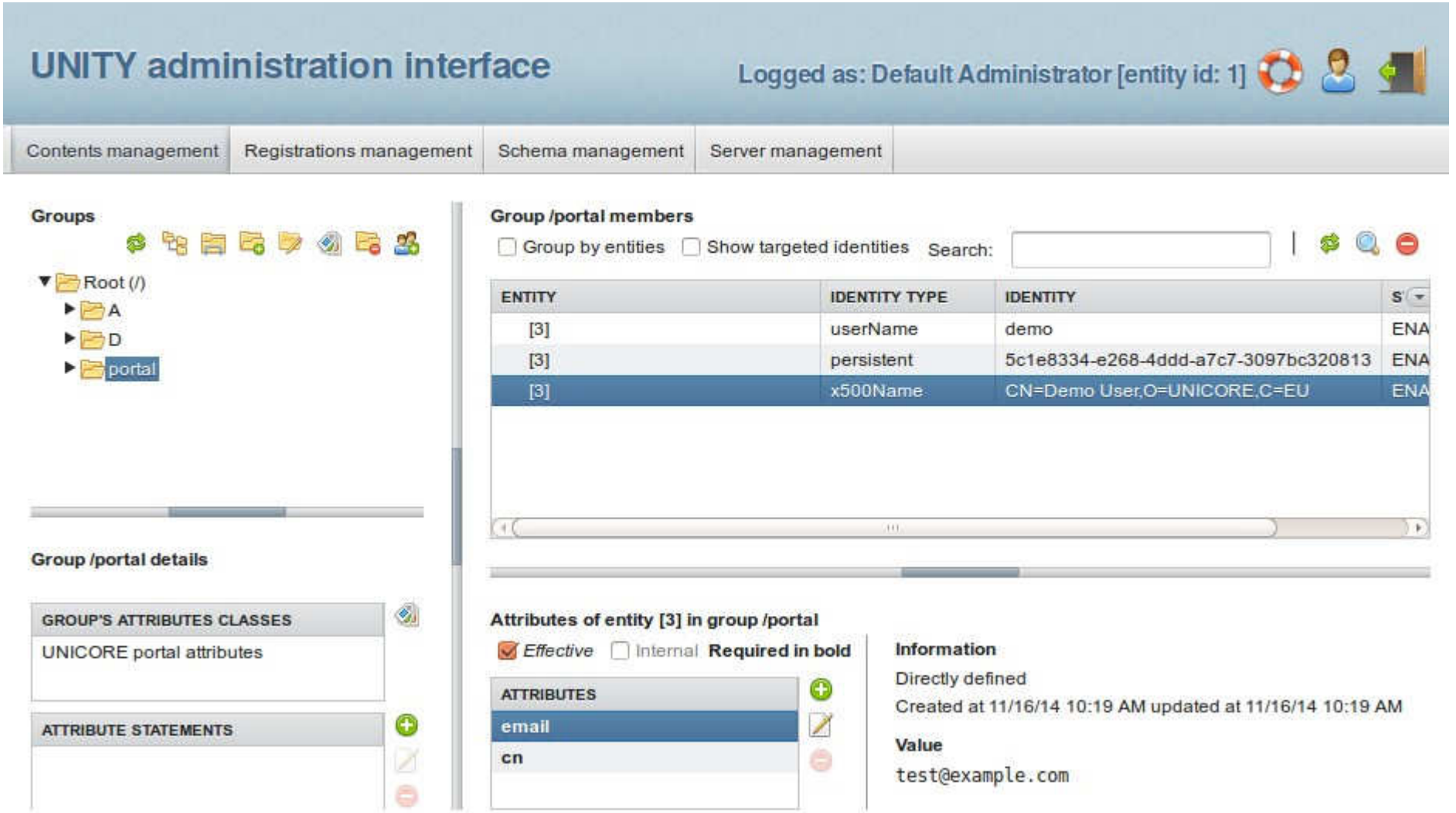
- Complete **Authentication and Identity Management** solution
- Manage users and user attributes, group membership
- Separate, standalone product: www.unity-idm.eu
- Increasing take-up: e.g. HBP, EuDAT



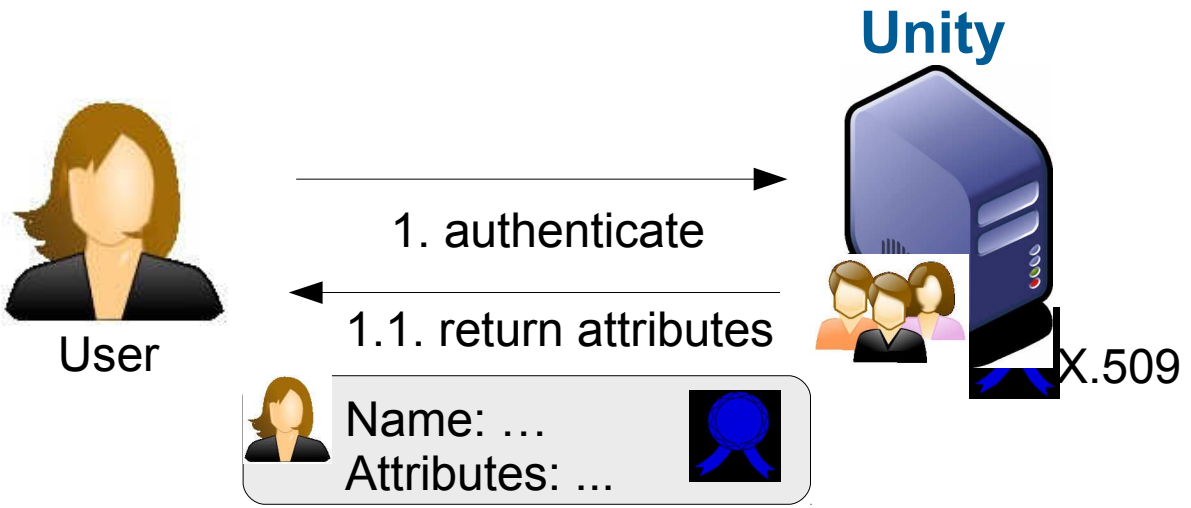
Unity architecture



Managing Unity via web application



Example: Unity authentication assertion

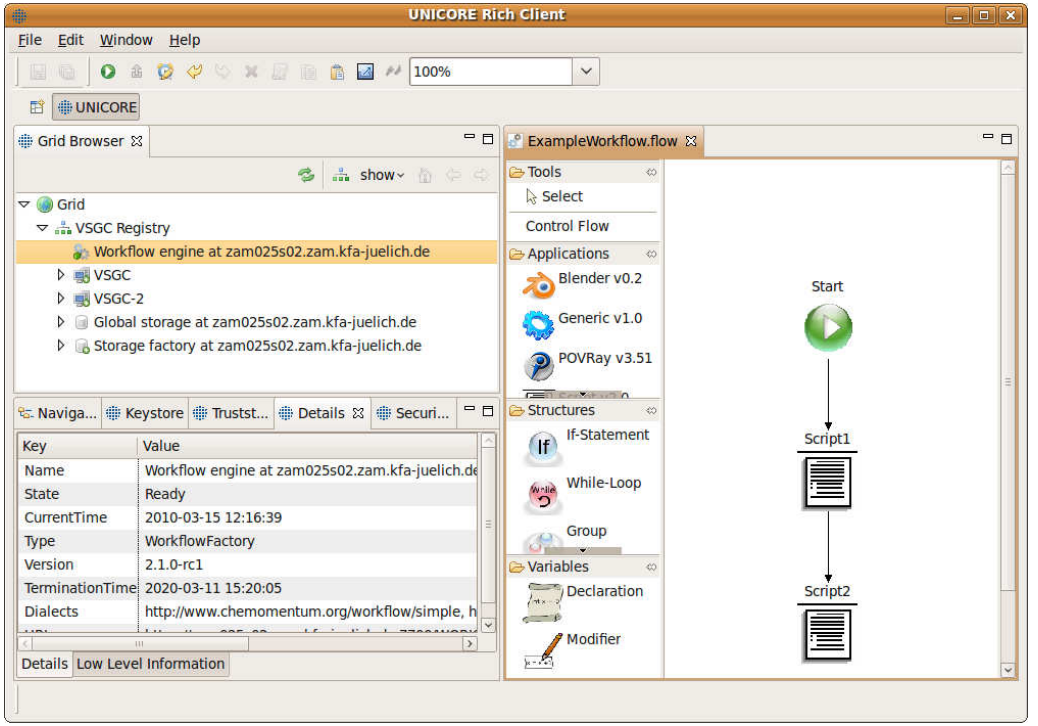



```
<urn:Assertion>...
  <dsig:Signature... </dsig:Signature>
  <urn:Subject>
    <urn:NameID
      Format="urn:oasis:names:tc:SAML:1.1:nameid-format:X509SubjectName">CN=Demo User,O=UNICORE,C=EU</urn:NameID>
    <urn:SubjectConfirmation Method="urn:oasis:names:tc:SAML:2.0:cm:sender-vouches">
      <urn:SubjectConfirmationData NotOnOrAfter="2014-11-16T10:30:23.334Z"/>
    </urn:SubjectConfirmation>
  </urn:Subject>
  <urn:AttributeStatement>
    <urn:Attribute Name="cn">
      <urn:AttributeValue>Demo User</urn:AttributeValue>
    </urn:Attribute>
    <urn:Attribute Name="email">
      <urn:AttributeValue>test@example.com</urn:AttributeValue>
    </urn:Attribute>
    <urn:Attribute Name="memberOf">
      <urn:AttributeValue>/portal</urn:AttributeValue>
      <urn:AttributeValue>/</urn:AttributeValue>
    </urn:Attribute>
  </urn:AttributeStatement>
</urn:Assertion>
```

- Portal
- Third-party science gateways
- UCC
- UFTP
- Eclipse-base Rich Client
- Custom clients
- RESTful API
- Java APIs

UNICORE Rich client

- Based on the Eclipse framework
- Building, submitting and monitoring jobs and workflows
- Integrated data and storage management
- X.509 and Unity for AuthN
- *Mostly targeted at expert users*



UNICORE Portal

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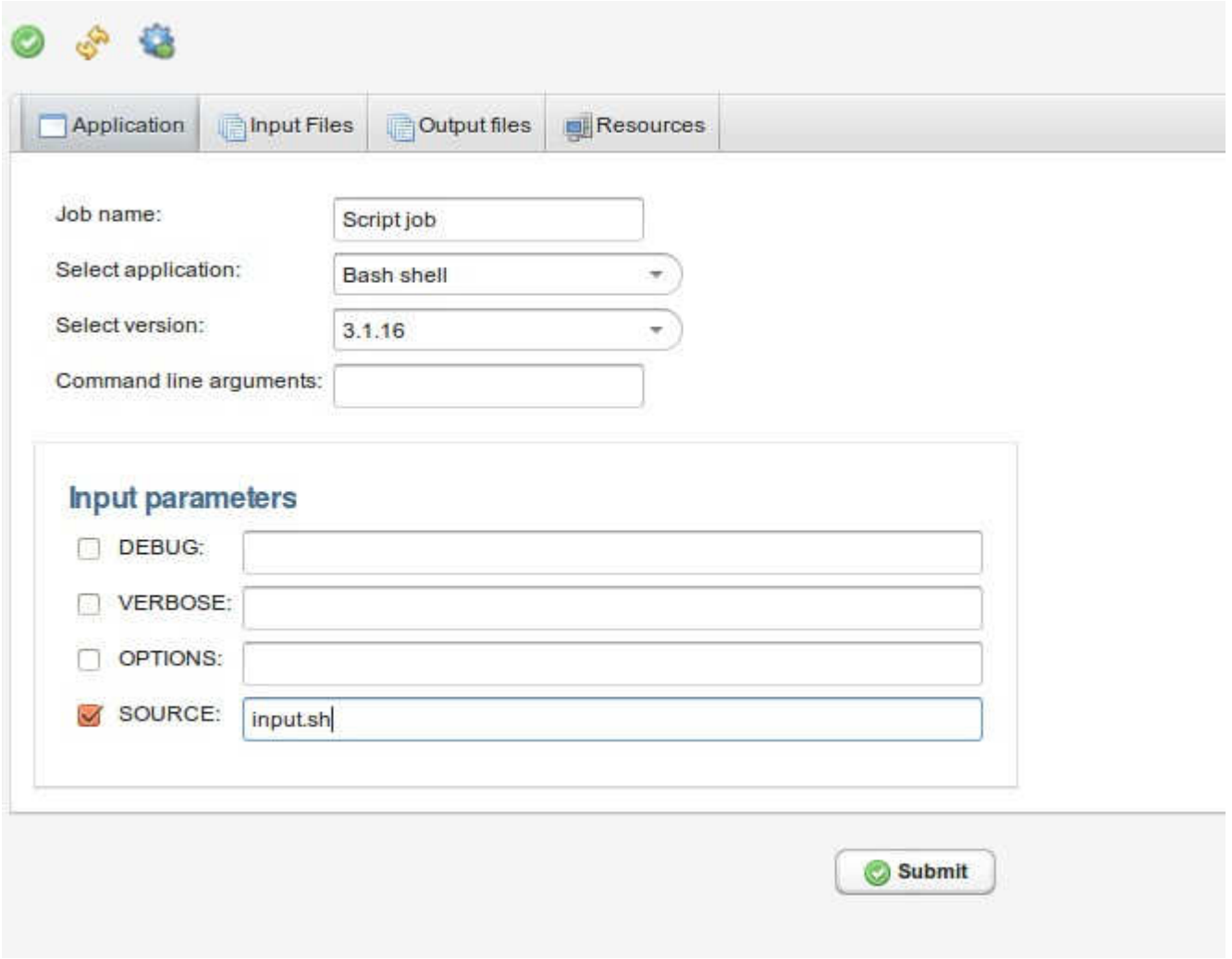
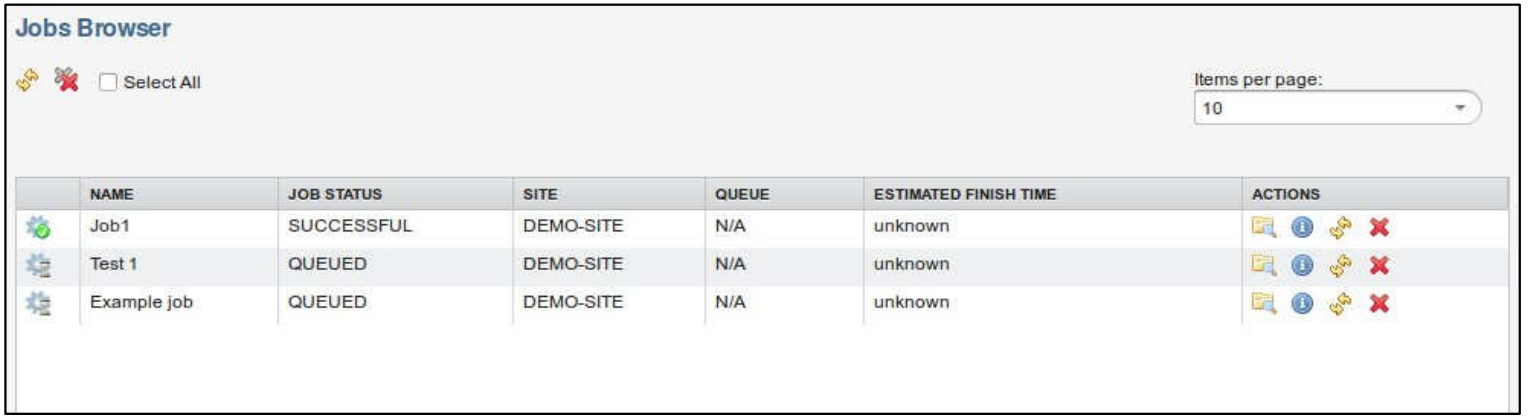
- Aim for a simple, easy-to-use web application
- Simple use cases
  - Job and (limited) workflow management
  - Data management
- Less details exposed to user
- Implementation choices
  - Java-based, VAADIN web framework
  - Use UNICORE SOAP/WS APIs

UNICORE Portal – Job creation view

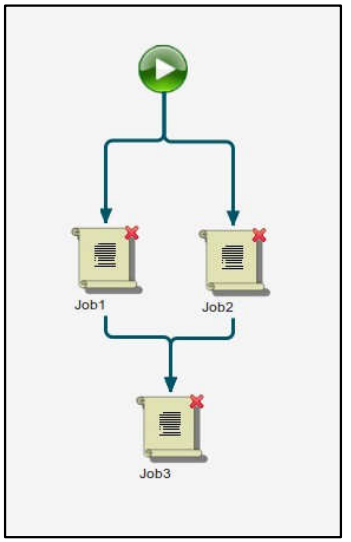


UNICORE Portal – various

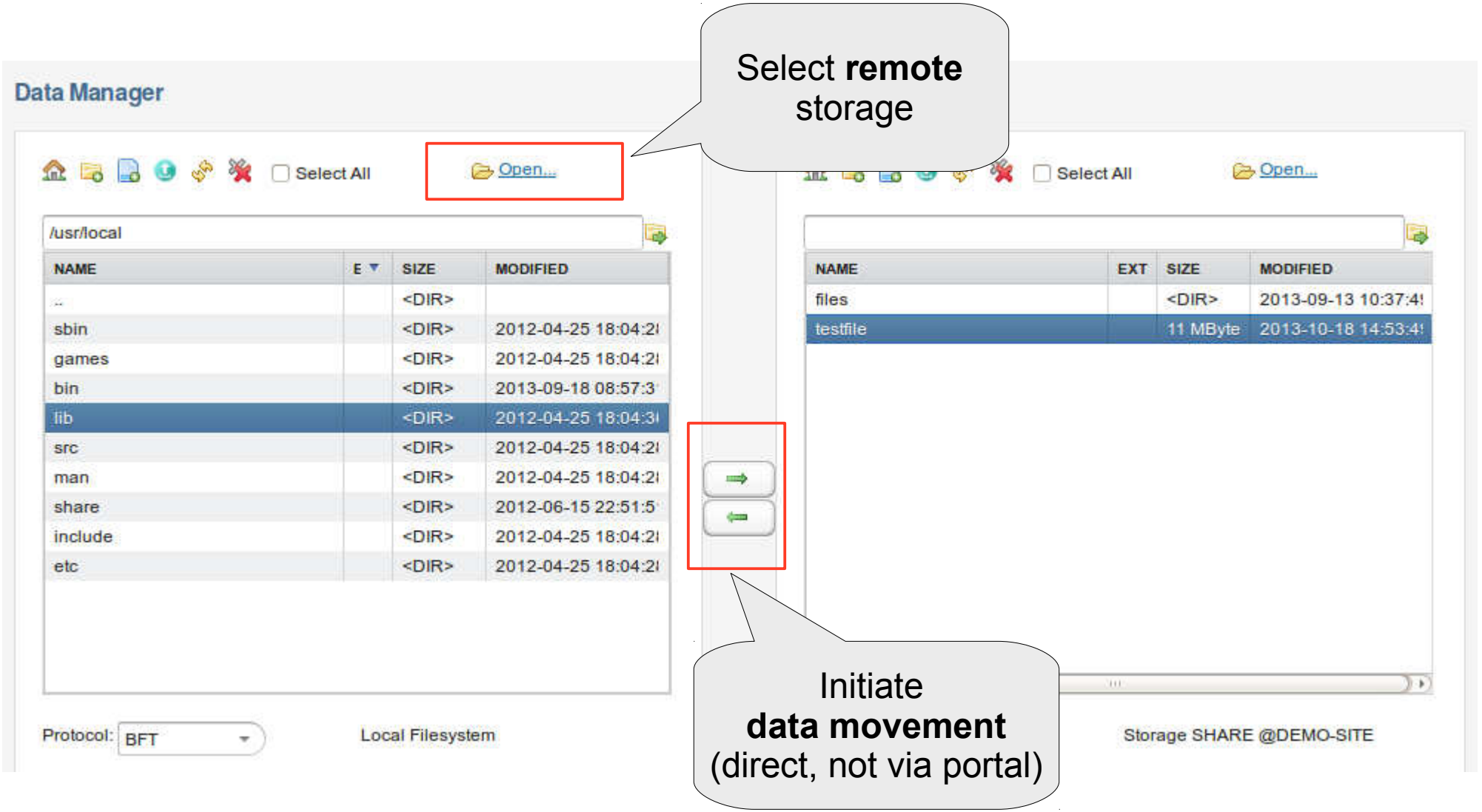
- Several „list“ views, e.g. jobs, sites



- Simple workflow creation
- JavaScript

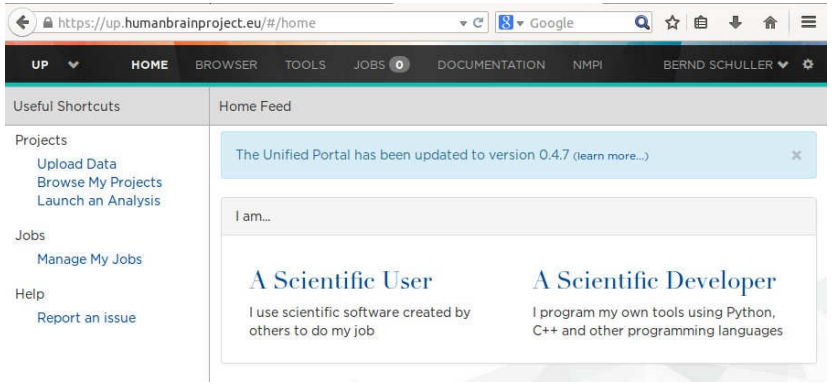


UNICORE Portal: Data manager



RESTful APIs to UNICORE services

Use case: the Human Brain Project's HPAC platform



https://collab.humanbrainproject.eu

1. authenticate

returns OIDC token

OIDC server

3.1 validate OIDC

2. pass OIDC Bearer token

UNICORE

3. OIDC Bearer token

returns signed SAML

Unity

BSC

HPC site

CINECA

HPC site

CSCS

HPC site

JSC

HPC site

KIT

S3 storage

SOAP and WS(RF) – Defining UNICORE since 2004/2005

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- Pros
  - Strongly typed – XML schema based
  - SOAP header/envelope mechanism
  - WS-Security, SAML, etc are well established
- Cons
  - CPU intensive (XML processing, XML signatures)
  - Complex interface (look at a typical WSDL!)
  - Only Java and C# can be realistically used on the client side

RESTful APIs to UNICORE Services

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- REST
  - Document / Resource oriented approach
  - HTTP semantics (GET, PUT, POST, DELETE, error codes, caching, …)
  - Multiple message formats and resource representations can be used
    - *JSON, XML, HTML, …*
  - Several authentication options (HTTP basic, OAuth, ...)
  - Clients in all languages (even *curl* or *wget*)
- Keep SOAP/WS (for backwards compatibility), fully in sync with RESTful APIs

Example: job submission

```
job.u:
{
  "Executable": "/bin/echo" ,
  "Arguments": ["Hello World"],
}
```

```
$> curl -X POST -H "Content-Type: application/json"
   --data-binary @job.u
   https://localhost:8080/DEMO-SITE/rest/core/jobs
```

```
HTTP/1.1 201 Created
Content-Type: application/json;charset=ISO-8859-1
Location: https://localhost:8080/DEMO-SITE/rest/core/jobs/ \
          74198236e970429db55ca7d59c831f14
```

Summary

- UNICORE – a complete solution for building federations
- Main progress in **UNICORE 7**
  - Simplify user experience
    - *Make X.509 user certs obsolete*
    - ***Web portal** targetted at non-expert users*
  - Simplify integration options
    - *Complete set of **RESTful APIs** for computing and data → bringing HPC to the Web!*
  - Widen integration options
    - ***Unity** as a universal solution for federated identify management solution*

Outlook

- Consolidate and simplify
  - Installation and configuration
  - Packaging and automation of deployment
- Add/extend support for
  - Cloud resources (OpenStack, EC2, …)
  - Virtualised applications (Docker)
- http://www.unicore.eu

Team / Thank you

- Björn Hagemeier, Valentina Huber, André Giesler, Boris Orth, Mariya Petrova, Jedrzej Rybicki, Rajveer Saini, Bernd Schuller and many others at JSC
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- Richard Grunzke and others at Technical University Dresden
- Students: Burak Bengi, Maciej Golik, Konstantine Muradov
- … many others who reported bugs, suggested features, contributed code and provided patches

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A federation software suite

- Secure and seamless access to compute and data resources
- Focus on scientific applications and workflows
- Complies with typical HPC centre policies
- Complete solutions: APIs, clients, services, ...
- Java/Python based, supports UNIX, MacOS, Windows and many resource management systems (Torque, Slurm, SGE, …)
- Long development history (since 1997)
- **Open source, BSD licensed, visit http://www.unicore.eu**