Grid Information Systems: Past, Present and Future

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20 Years Of Grid Computing

- CHEP 2000
  - Discussions on the emerging field of Grid computing
  - Two matching fundamental concepts:
    - The integration of distributed computing resources
    - The provision of authentication and authorization
      - Enabling access resources in different administrative domains
- The Globus Tool Kit
  - Grid Resource Information Protocol (GRIP)
  - Grid Resource Registration Protocol (GRRP)
  - Grid Resource Access and Management (GRAM)
  - Grid File Transfer Protocol (GridFTP)
  - Grid Security Infrastructure (GSI)

Grid Information Systems

- Support coordinated resource-sharing and problem-solving
  - VOs need to obtain information about the structure and state of Grid services
    - which are widely distributed geographically.
- Information describing a Grid service is provided by the service itself
  - hence the Grid service is the primary information source
- The information provided conforms to an information model
  - More details later
- Assumption that the information source is up-to-date
  - that is the values represent the real state of the Grid service
- Queries may consider thousands of information sources
  - in order to enable efficient Grid functions that may utilize multiple cooperating services
- The goal is to efficiently execute:
  - many queries
  - from many clients
  - for many information sources

MDS and the BDII

- The Metacomputing Directory Service (MDS) from the Globus project
  - two information protocols (GRIP and GRRP) from the proposed Grid architecture
    - information providers and information indexing services,
    - separation between inquiry and discovery
- The MDS implementation adopted the standard Lightweight Directory Access Protocol (LDAP)
  - GRRP messages mapped onto *LDAP add* operations
  - GRIP where it is used to define the data model, query language and transport protocol

- *Not only is the LDAP data representation extensible and flexible, but LDAP is beginning to play a significant role in Web-based systems. Hence, we can expect wide deployment of LDAP information services, familiarity with LDAP data formats and programming, and the existence of LDAP directories with useful information. – Aug 1997*   DOI: 10.1109/HPDC.1997.626445
  - Predictions are dangerous, especially when related to the future!
- The Berkeley Database Information Index (BDII)
  - Replaced GRRP with an information that static registrations (Fake II)
    - To work around the initial deployment of MDS in DataGrid project
  - Became a component of the EDG Middleware in December 2002

First short term hack becomes a long term solution

Information Models

- Ensure agreement on the meaning of information
- They describe:
  - The real entities
  - The relationships between those entities
  - Their semantics
- A data model
  - Defines the syntax by which information is exchanged
- The MDS information model described
  - the physical and logical components of a compute resource
- The EDG described the Compute (CE) and Storage Elements (SE)

GLUE Information Model

- **G**rid **L**aboratory **U**niform **E**nvironment
  - Defines a uniform representation of Grid resources
    - An information model
      - and LDAP data model
- A collaborative effort between:
  - DataTAG, US-iVDGL, Globus and EDG
  - Enabled transatlantic Grid interoperability
- GLUE 1.3
  - OSG/EGEE interoperability
   - Put the W in WLCG (thanks to Ruth!)

10 Years Of GLUE 2.0

- GLUE Working Group
  - in the Open Grid Forum
  - GFD.147 (2009-03-03)

- Describes Grid Services
  - As opposed to **resources/protocols**

- **Official renderings in XML, JSON and LDIF**
  - GFD.209 Reference Realization to XML Schema
  - GFD.219 Reference Realization to JSON Schema
  - GFD.218 Reference Realization to LDAP Schema

- 45 phone conferences
  - ~ 3 days talking
  - ~ 2 months FTE
- 40 versions of the document
  - 347 days
  - 46 pages, 12787 words
  - 254 Attributes
    - 28 Objects

Information Validation

- Information providers

  - Distributed data sources

- Conformance goes a long way

  - Checks before information is published

- Limitations on information and data models

  - Information missing or not existing?

  - Reflects the actual state of the system?

    - Assumption that the information source is up-to-date

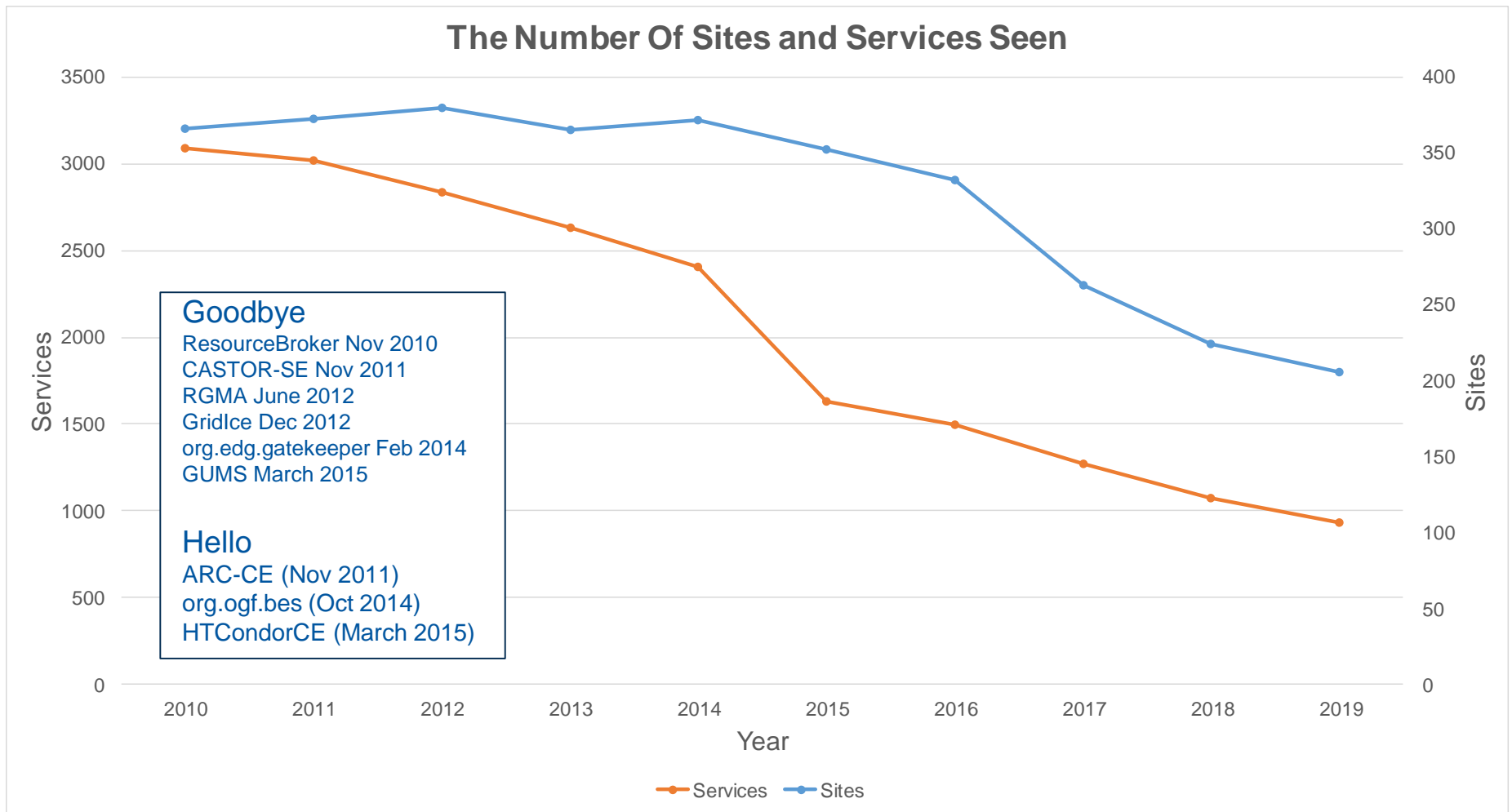   - Correctness (using [bytes] vs [Gbytes])

Architecture and Realisation
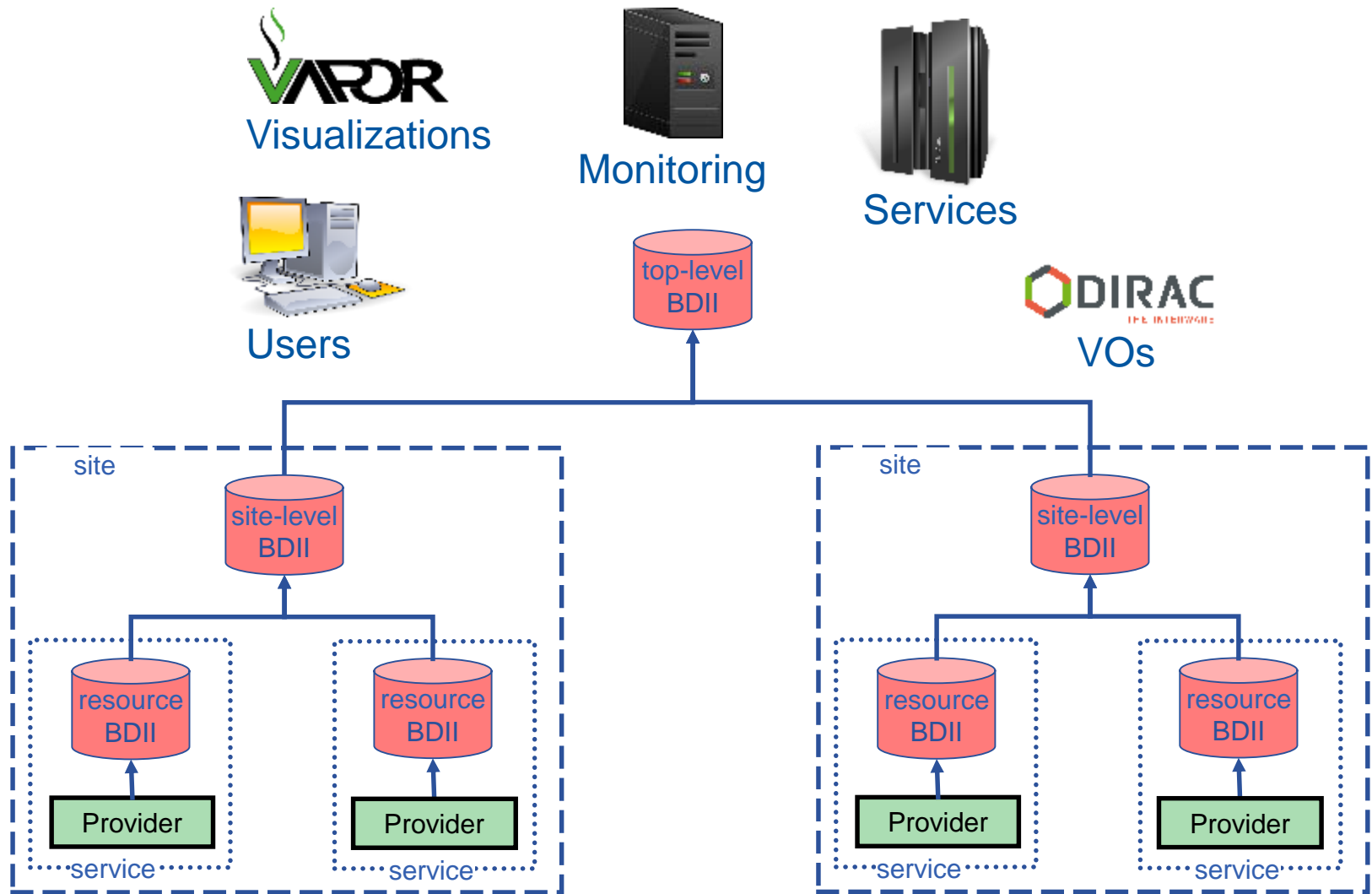
Evolution Of The Grid

- CHEP 2007
    - Scalability and performance analysis of the EGEE information system
        - 251 sites which provided 1428 Services.
        - 2 million connections per day (lcg-bdii.cern.ch)
        - ~100MB in the Top BDII
- Daily snapshots since March 2010
    - Archived !!!
- Sep 2019 (OSG stopped publishing in 2015)
    - 209 sites providing 883 Services (GLUE 2.0)
    - 200 sites providing 909 Services (GLUE 1.3)
    - 1 million queries per day (lcg-bdii.cern.ch)
    - ~32MB in the Top BDII

Evolution Of The Grid

The Number Of Sites and Services Seen

Goodbye
ResourceBroker Nov 2010
CASTOR-SE Nov 2011
RGMA June 2012
GridIce Dec 2012
org.edg.gatekeeper Feb 2014
GUMS March 2015

Hello
ARC-CE (Nov 2011)
org.ogf.bes (Oct 2014)
HTCondorCE (March 2015)

Top Ten Queries

2007

Q/h	Query
6075	Close CE to an SE
5475	VO's SA for an SE
5043	All SRMs
4791	An SE
2432	Close SE to a CE
2117	All Services for a VO
664	All CEs for a VO
638	All SAs for a VO
479	All SubClusters
448	GlueVOView for a CE

2019

Q/h	Query
5960	A specific Cluster
5923	All entries linked to a Cluster
5377	*EEs of a Cluster*
4898	*GLUE2Shares for a VO*
2928	A specific Site
909	SRM endpoint of a SE
305	Find all CEs for a VO
217	Find a specific CEs for a VO
193	*A specific GLUE2 share*
134	Cream CEs for a VO

Italics show GLUE2 queries

HTCondor CE Provider

- New provider required for HTCondorCE
  - Only publishes GLUE 2.0 information
  - Published initially minimal information
    - Responded to requests for additional information
- Included upstream
  - As part of the HTCondor CE distribution
  - Adoption by other sites
- Observations:
  - Compute Service information is required
  - GLUE 1.3 no longer needed
  - GLUE 2.0 is being used

Future

- The system is still used
    - The usage is decreasing
- There still seems to be a need
    - E.g htcondor provider
- Options are the same as presented in 2011*
- Lazy:
    - Do nothing
- The Radical:
    - Decommission
- The Slow and Steady
    - Remove site-bdiis
    - Drop GLUE 1.3
    - Streamline GLUE 2.0 usage
- The Rocky
    - Separate the use cases
    - Centralized and reliable service discovery system
    - Provide a single system for experiment annotation and configuration

*https://indico.cern.ch/event/106645/

Summary

- 20 Years of Grid Computing
- 10 Years of GLUE 2.0
- Service Discovery and Status Still Relevant
  - ~900 services, ~200 sites
- Information providers are necessary!
  - To provide the status of services
    - →information models for complex services
    - Information models matter, representations don't
- The Grid is shrinking
  - Peak ~2012 (in number of sites)
- The roads ahead are the same as 2011
  - Lazy, slow and steady, radical or rocky
- Validation, Validation and Validation
  - Provider, system-wide and cross-checks