Easing Access to Computing Resources for HEP Using GlideinWMS

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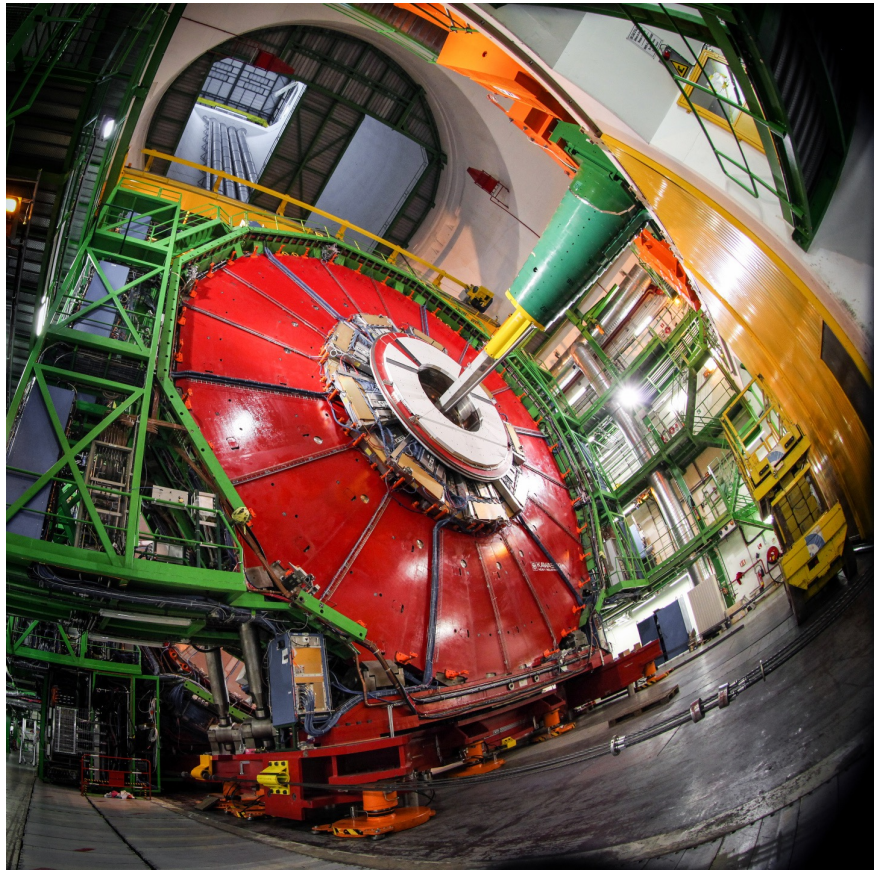
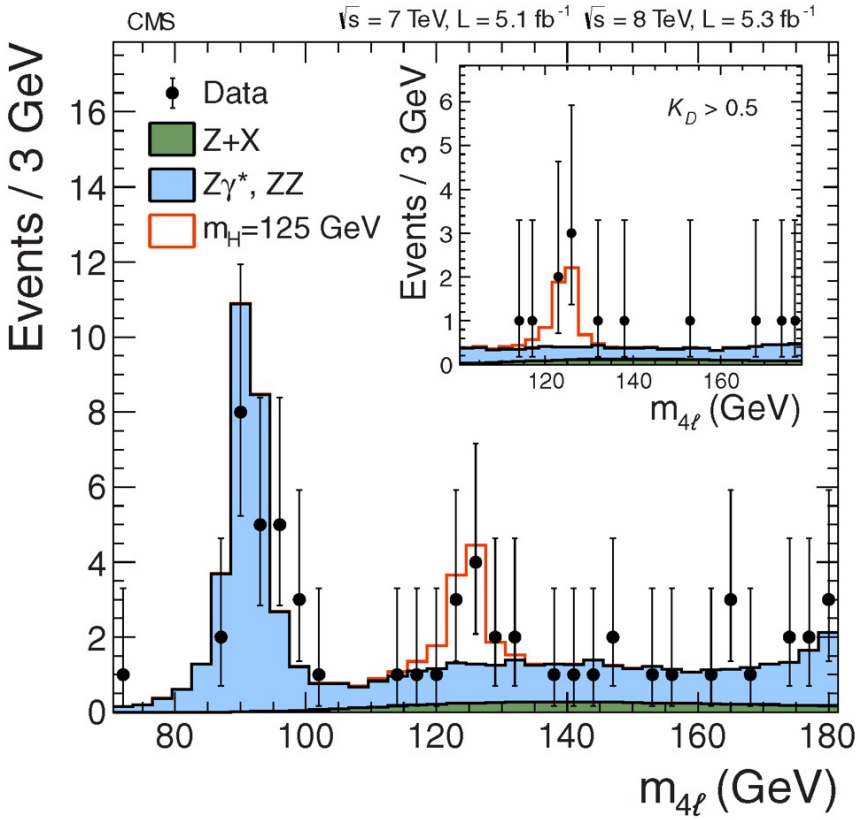
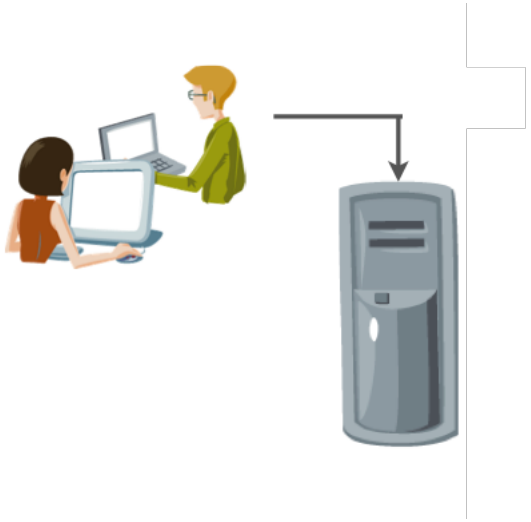
From Data to Analyses!

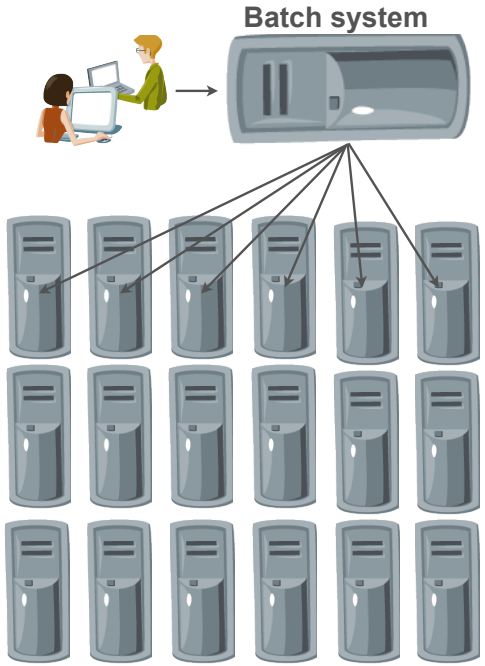


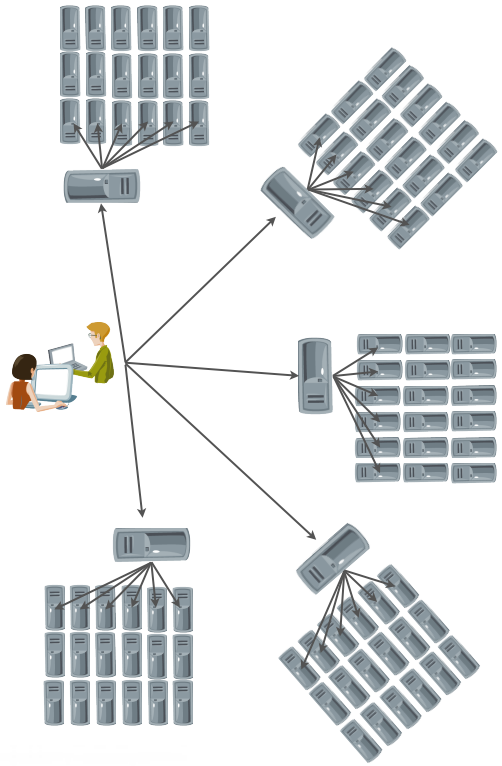


Chatrchyan, Serguei, et al. "Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC." *Physics Letters B* 716.1 (2012): 30-61.

Evolution of Computing Resources







WLCG
Worldwide LHC Computing Grid

Open Science Grid

NORDUGRID
Grid Solution for Wide Area Computing and Data Handling

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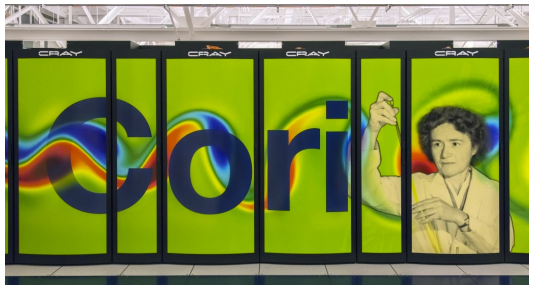
Heterogeneity Continues to Increase

- Clouds
  - On-demand
  - Budget
  - Cost optimization
  - Services
- Supercomputers
  - Allocation
  - One-of-a-kind resource
  - Built for specific scopes



Google Compute Engine

Amazon EC2

High Throughput Computing (HTC) for High Energy Physics

- Make available large amounts of computational processing power over longer periods of time
- Brings increased resource heterogeneity
  - Multiple organizations
  - Different systems
  - Less standard infrastructure
  - Different authentications

Increasing complexity ⇒ More difficult for scientists!

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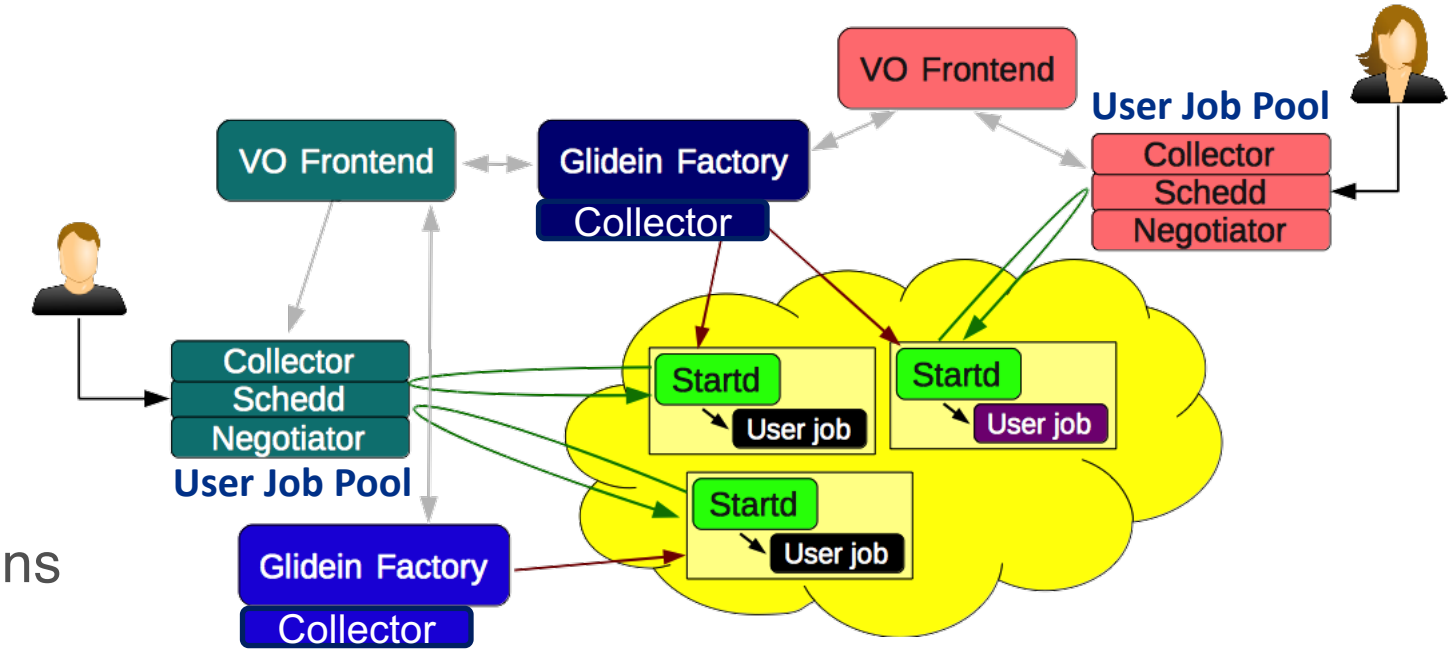
GlideinWMS

- Simplified resource provisioning for distributed HTC
- **Glidein:** provides customized execution environment for jobs
- **Frontend:**
  - advertises for user jobs
  - requests Factory to provide Glideins
  - trigger pilot submissions
- **Factory:**
  - self-advertise
  - listens for requests from Frontend
  - submit pilots (aka Glideins)



Sfiligoi, Igor, et al. "The pilot way to grid resources using glideinWMS." *2009 WRI World congress on computer science and information engineering*. Vol. 2. IEEE, 2009.

- Used by CMS, DUNE and Fermilab experiments

Data access

- Jobs running everywhere also need to access data
  - Experiment software (distribution or container image)
  - Experiment data (raw, reconstructed, …)
  - Calibration data

- Options to access data
  - File transfer
  - File streaming
  - Distributed file system
  - Database access

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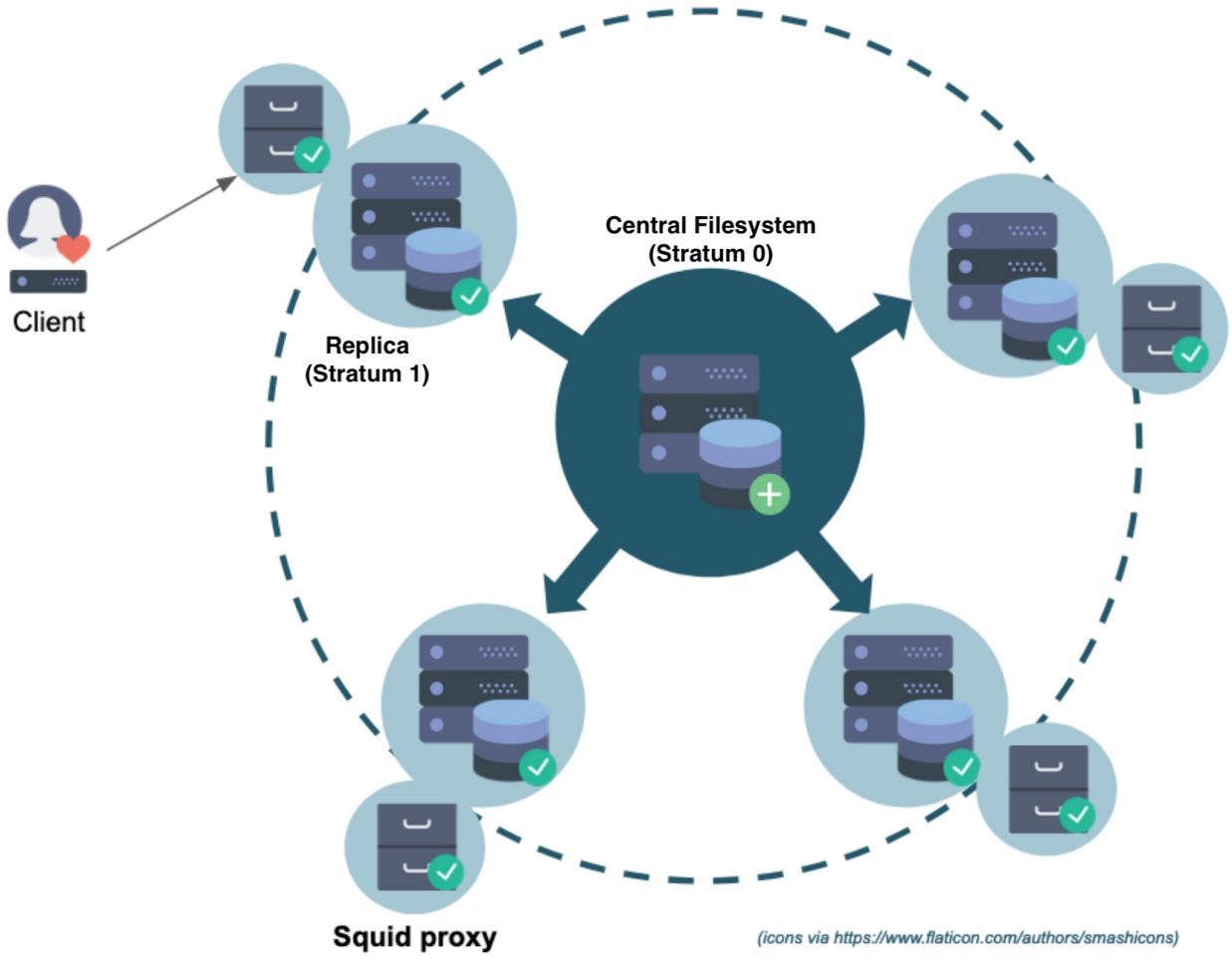
Cern-VM File System (CVMFS)

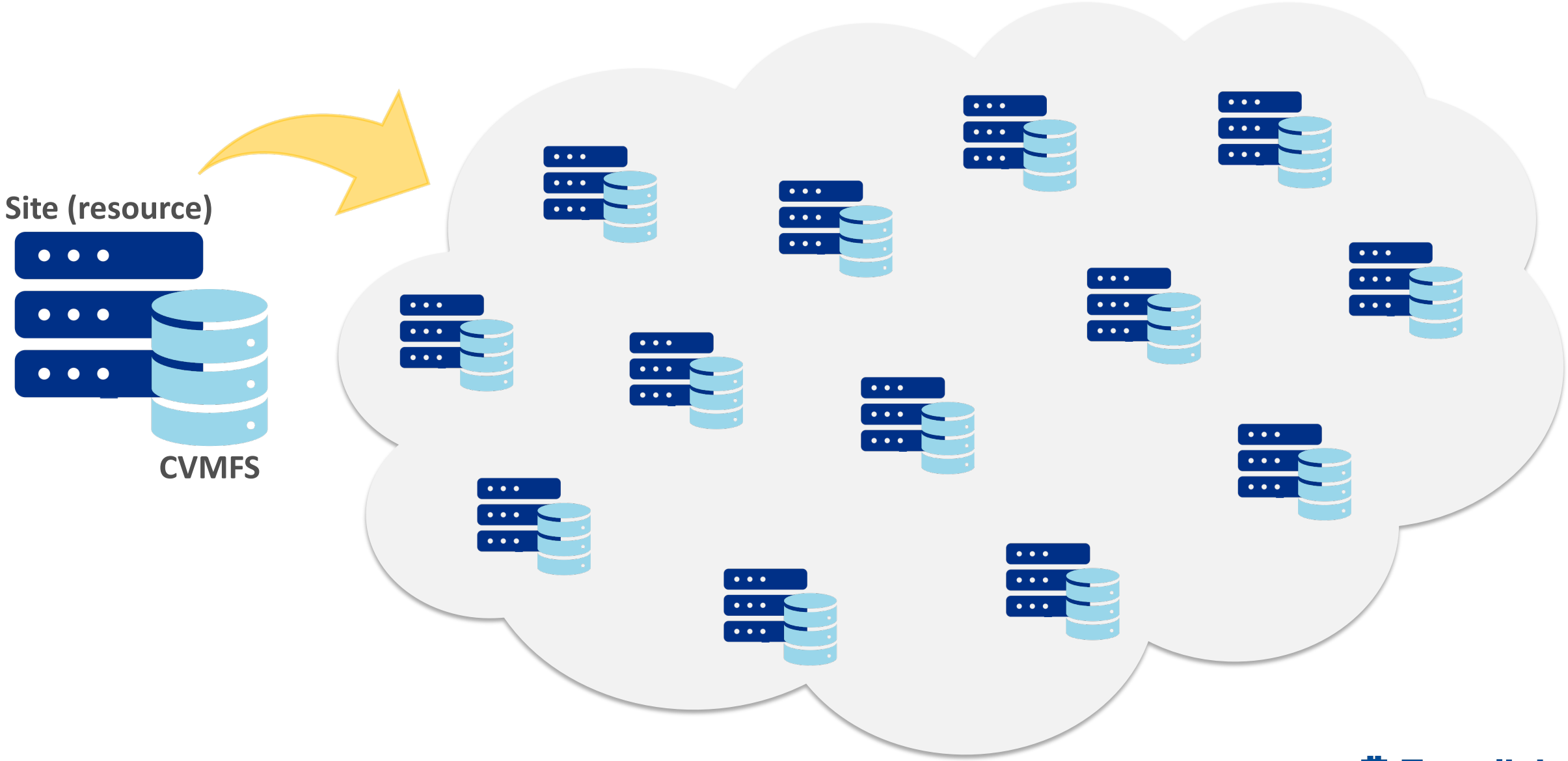
- Prevalent in collaborations within the particle physics community
- Worldwide delivery of scientific *software installations* and auxiliary data
- Based on WORM (Write-Once-Read-Many)
- Scalable and reliable → hundreds of millions of files and tens of thousands of clients



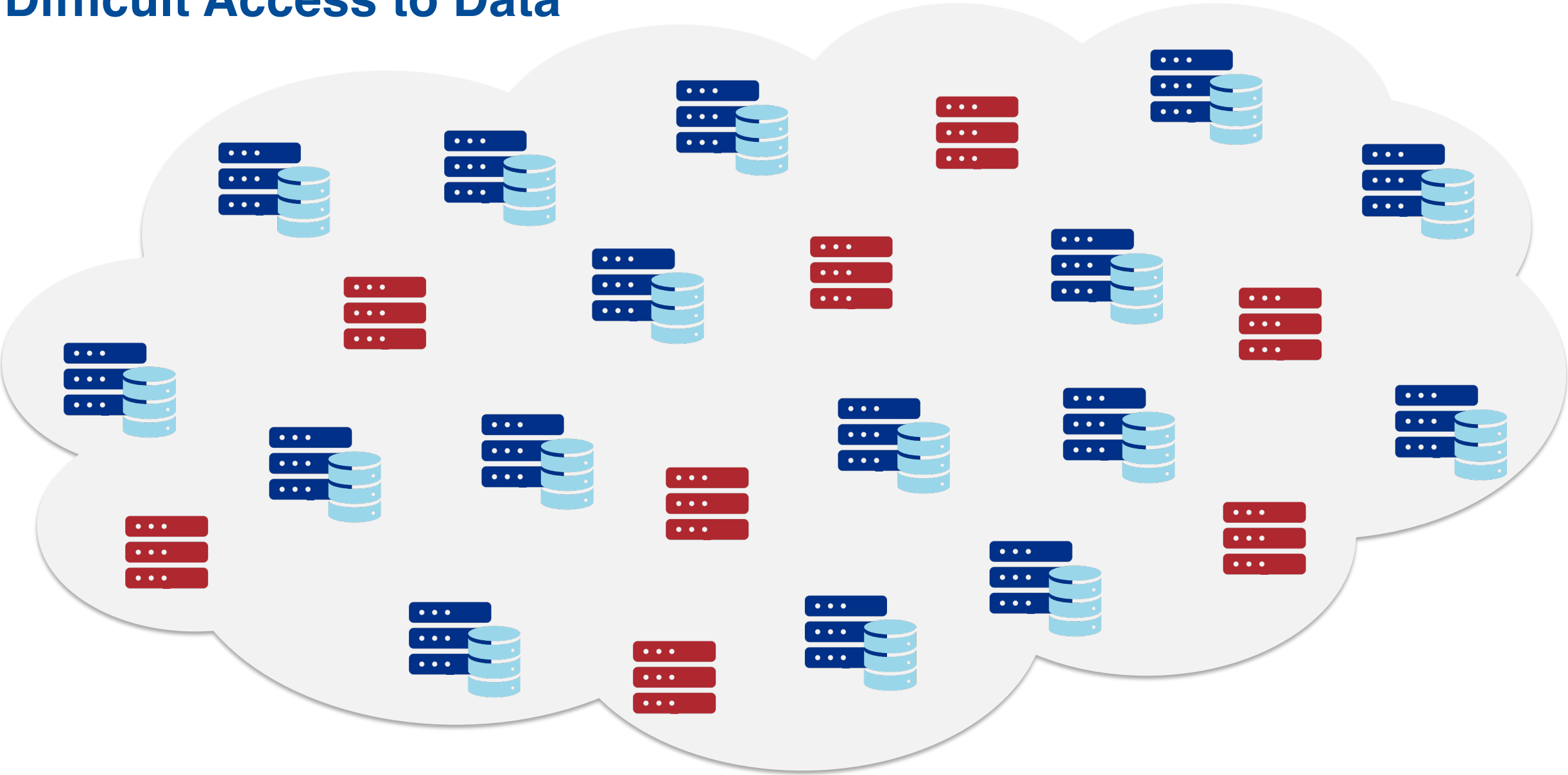
Picture adapted from Cern-VM FS Tutorial

https://cvmfs-contrib.github.io/cvmfs-tutorial-2021/01_introduction/
https://jblomer.web.cern.ch/cvmfstech-2.1-0.pdf

Best Case Scenario



Difficult Access to Data



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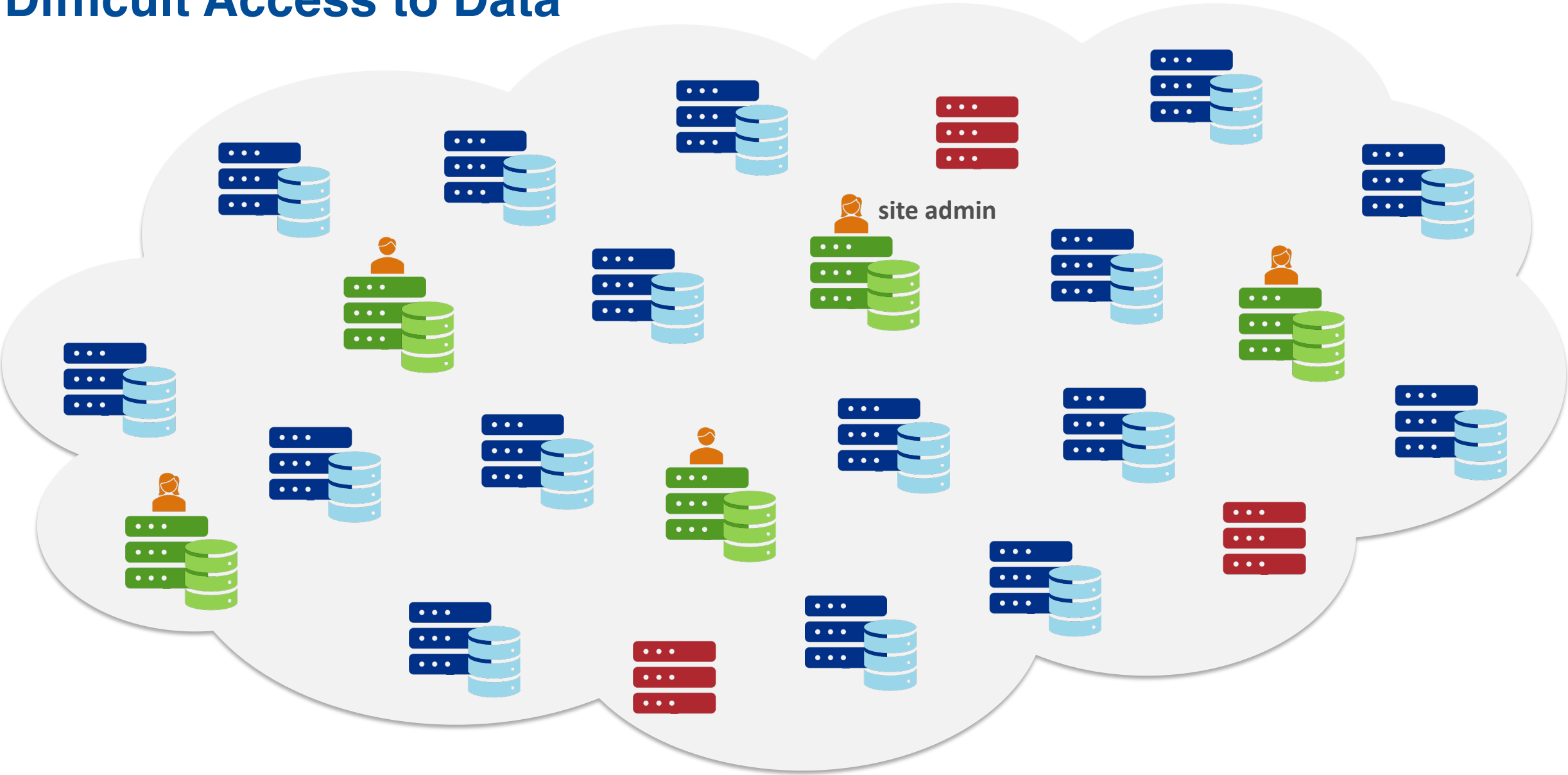

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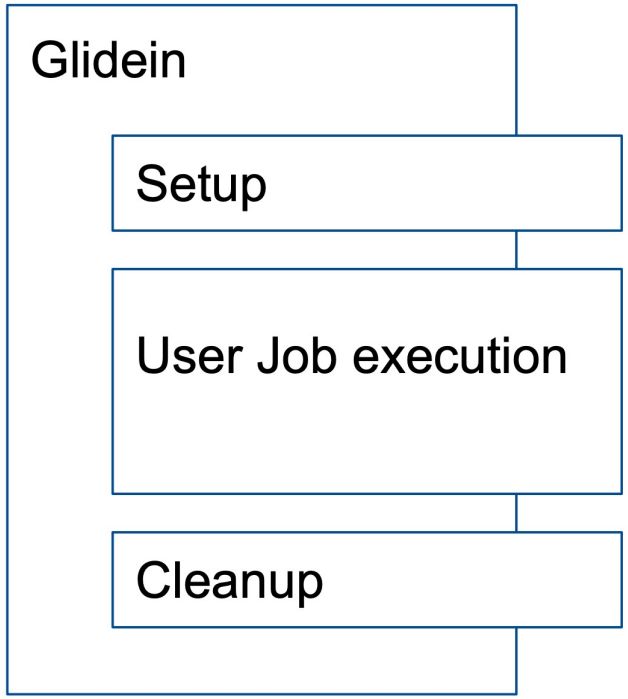
Use GlideinWMS to Dynamically Provide CVMFS

- Provision CVMFS on demand using GlideinWMS
- Extend functionality of Glidein to install CVMFS when unavailable on the site
  - Testing and configuration of nodes by Glidein - just one more task!
- Perform installation in non-root user mode since Glidein has no special privileges
  - Leverage non-root user namespaces and FUSE interface



From a User/Operator Standpoint…

- GlideinWMS with a standard release of Python
- A configuration variable controls whether GlideinWMS should support dynamic provisioning of CVMFS
- Designed as a lightweight wrapper
- Discovers what the resource capabilities are
- Adapts as required to the underlying resource specifications
- Handling and version differences with CVMFS is no longer a concern

Coming soon!

- Include better cleanup of residual CVMFS when jobs are forced shutdown

Acknowledgements

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Dave Dykstra for addressing the simplest of questions, providing clarifications regarding the CVMFS mounting utility and helping with our requests for new features.

Marco Mambelli for his direction, guidance and feedback on this work.

Summary

- Use of heterogeneous computational resources for HTC
- Heterogeneity as a side-effect of HTC
- Significance of CVMFS in the HEP community

- **Problem:** some sites may not provide CVMFS locally
- **Solution:** provision CVMFS on sites on a need/demand basis!
- Benefits
  - Lower overhead for site administrators – less software to install
  - End-user jobs can access software/data distributed by CVMFS
  - Support for HPC resources with a simple extension of GlideinWMS pilot functionality

Thank You!

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GlideinWMS Team