Scalla/xrootd

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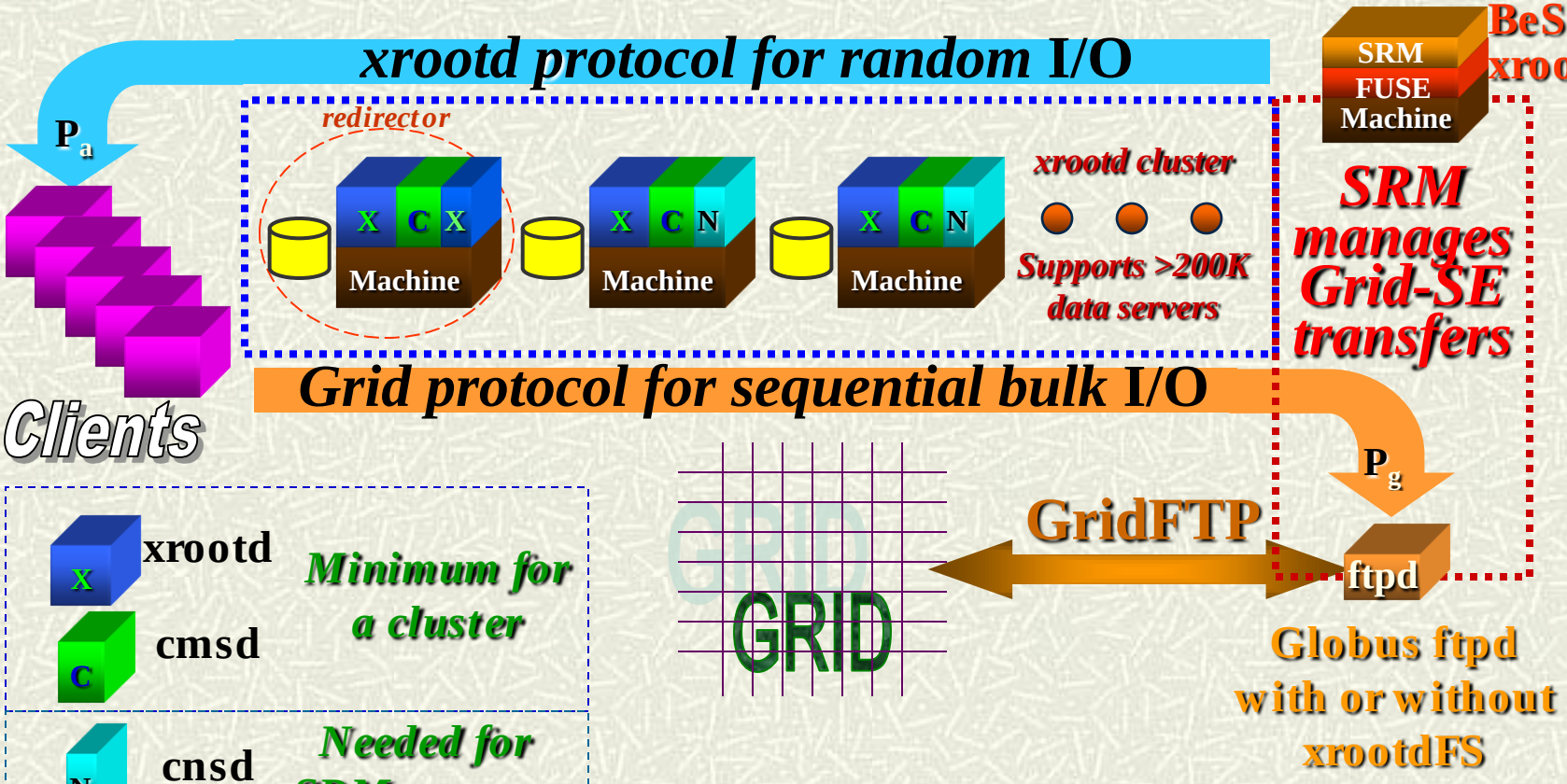
http://xrootd.slac.stanford.edu/

Outline

- System Overview
  - What's it made of and how it works
- Opportunistic Clustering
  - Batch nodes as data providers
- Expansive Clustering
  - Federation for speed and fault tolerance
    - The Virtual Mass Storage System
- Fullness vs Simplification

Full Scalla/xrootd Overview



The Components

- xrootd
  - Provides actual data access
- cmsd
  - Glues multiple xrootd's into a cluster
- cnsd
  - Glues multiple name spaces into one name space
- BeStMan
  - Provides SRM v2+ interface and functions
- FUSE
  - Exports xrootd as a file system for BeStMan
- GridFTP
  - Grid data access either via FUSE or POSIX Preload Library

This might not be needed for typical Tier 3 sites!

Getting to xrootd hosted data

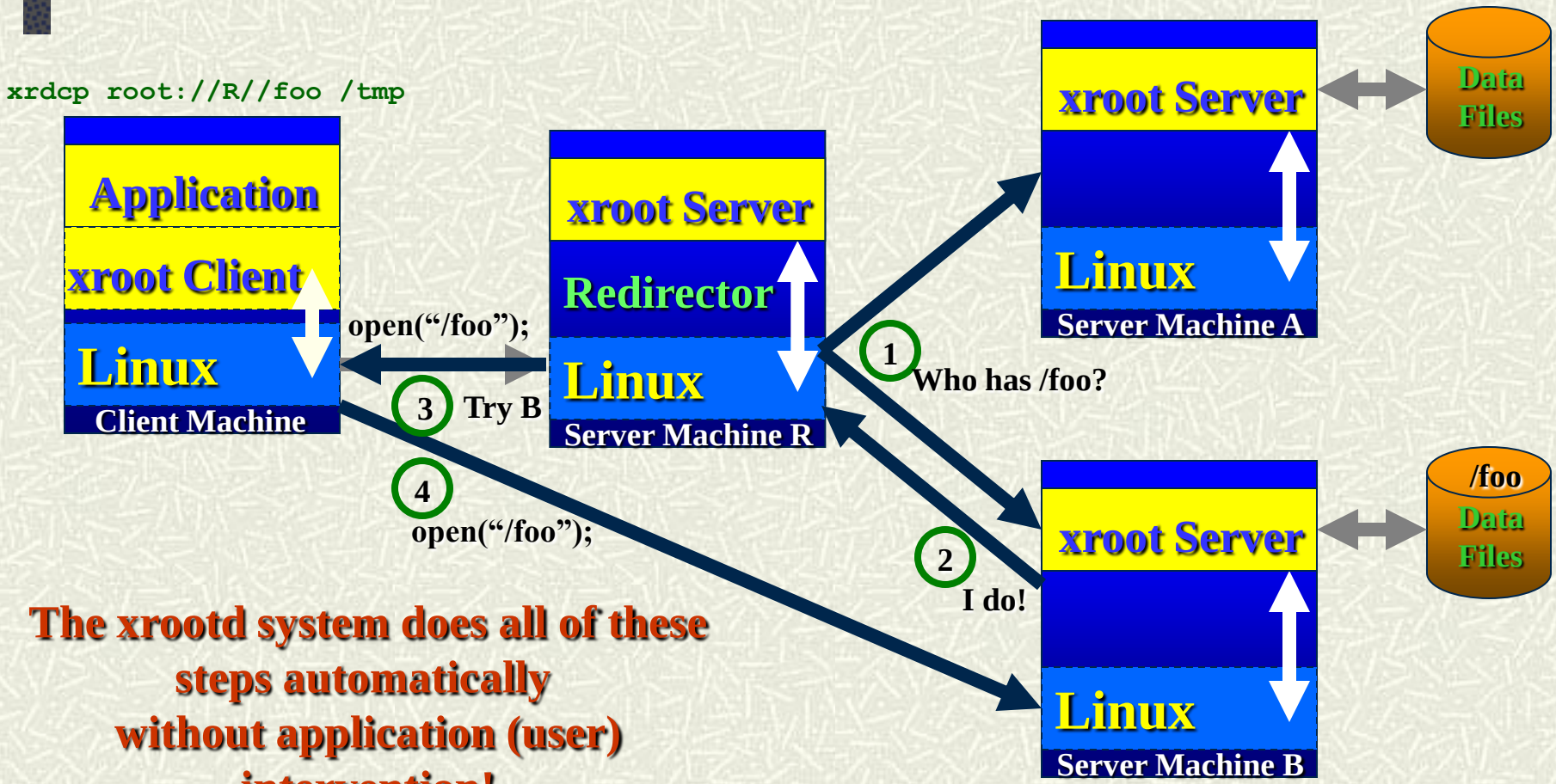
- Via the root framework
  - Automatic when files named root://....
  - Manually, use TXNetFile() object
    - Note: identical TFile() object will not work with xrootd!
- xrdcp
  - The native copy command
- POSIX preload library
  - Allows POSIX compliant applications to use xrootd
- gridFTP
- BeStMan (SRM add-on)
  - srmcp *for srm-to-srm copies*
- FUSE
  - Linux only: xrootd as a mounted file system

Native Set

Simple Add

Intensive Full Grid Set

Cluster Maneuvering



The xrootd system does all of these steps automatically without application (user) intervention!

Corresponding Configuration File

```
# General section that applies to all servers
#
all.export /atlas

if redirector.slac.stanford.edu
all.role manager
else
all.role server
fi
all.manager redirector.slac.stanford.edu 3121

# Cluster management specific configuration
#
cms.allow *.slac.stanford.edu

# xrootd specific configuration
#
xrootd.fslib /opt/xrootd/prod/lib/libXrdOfs.so
xrootd.port 1094
```

File Discovery Considerations

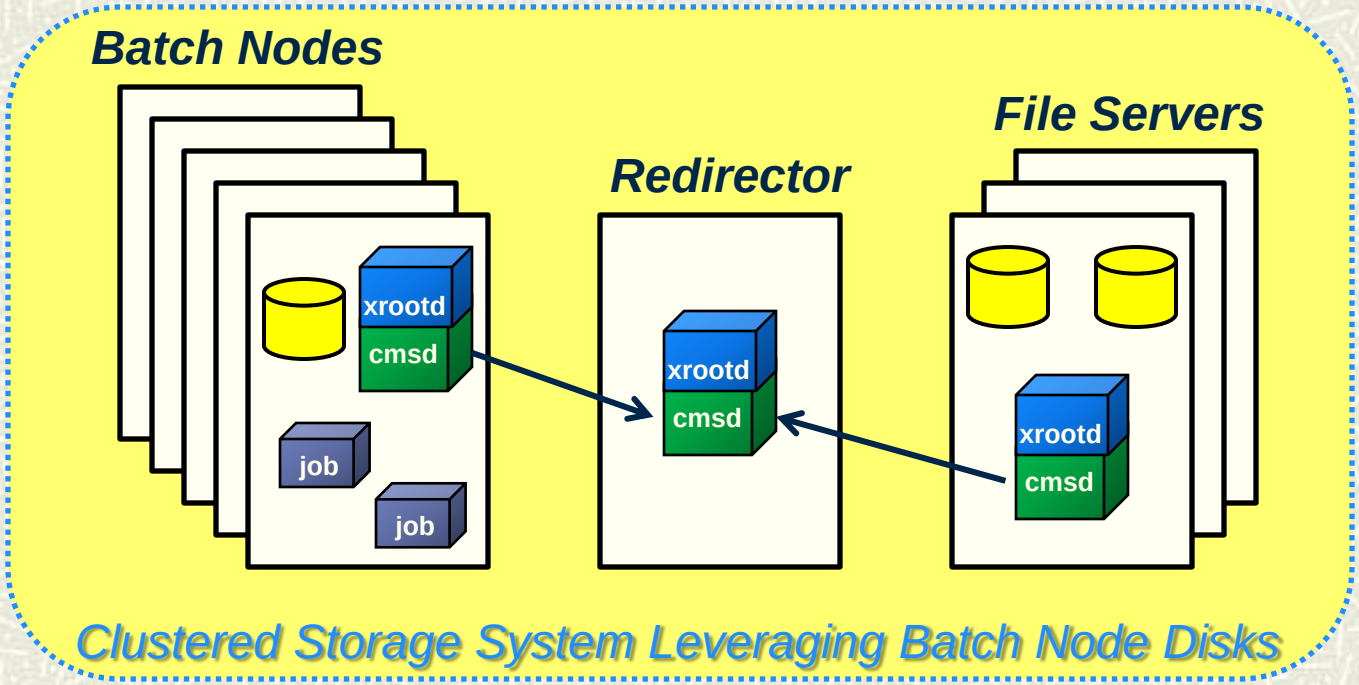
- The redirector does not have a catalog of files
  - It always asks each server, and
  - Caches the answers in memory for a “while”
    - So, it won’t ask again when asked about a past lookup
- Allows real-time configuration changes
  - Clients never see the disruption
- Does have some side-effects
  - The lookup takes less than a millisecond when files exist
  - Much longer when a requested file does not exist!

Why Do It This Way?

- Simple, lightweight, and ultra-scalable
  - Ideal for opportunistic clustering
    - E.g., leveraging batch worker disk space
  - Ideal fit with PROOF analysis
- Has the R^3 property (Real-Time Reality Representation)
  - Allows for ad hoc changes
    - Add and remove servers and files without fussing
    - Restart anything in any order at any time
  - Ideal for expansive clustering
    - E.g., cluster federation & globalization
      - Virtual mass storage systems and torrent transfers

Opportunistic Clustering

- Xrootd *extremely* efficient of machine resources
  - Ultra low CPU usage with a memory footprint 20 ≈ 80MB
    - Ideal to cluster just about anything



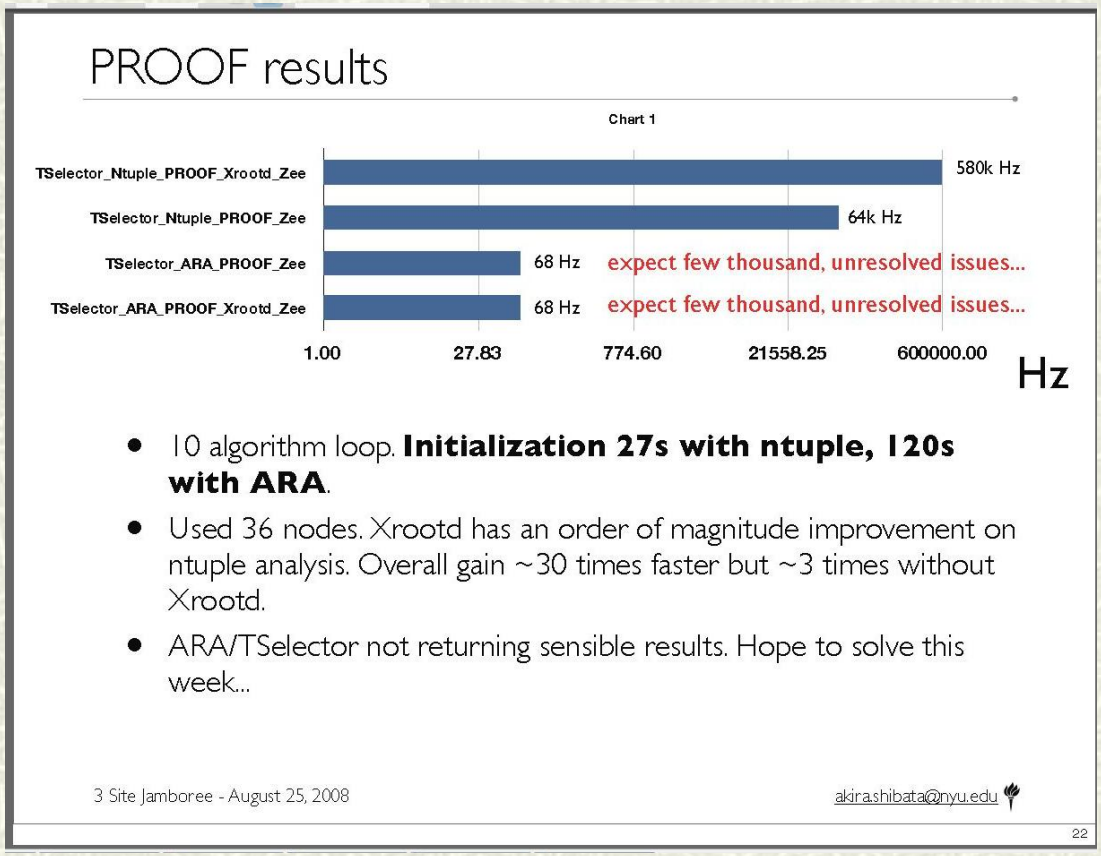
Opportunistic Clustering Caveats

- Using batch worker node storage is problematic
  - Storage services must compete with actual batch jobs
    - At best, may lead to highly variable response time
    - At worst, may lead to erroneous redirector responses
- Additional tuning will be required
  - Normally need to renice the cmsd and xrootd
    - As root: renice –n -10 –p *cmsd_pid*
    - As root: renice –n -5 –p *xroot_pid*
- You must not overload the batch worker node
  - Especially true if exporting local work space

Opportunistic Clustering & PROOF

- Parallel Root Facility layered on xrootd
  - Good architecture for “map/reduce” processing
- Batch-nodes provide PROOF infrastructure
  - Reserve and use for interactive PROOF
    - Batch scheduler must have a drain/reserve feature
  - Use nodes as a parallel batch facility
    - Good for co-locating application with data
  - Use nodes as data providers for other purposes

PROOF Analysis Results



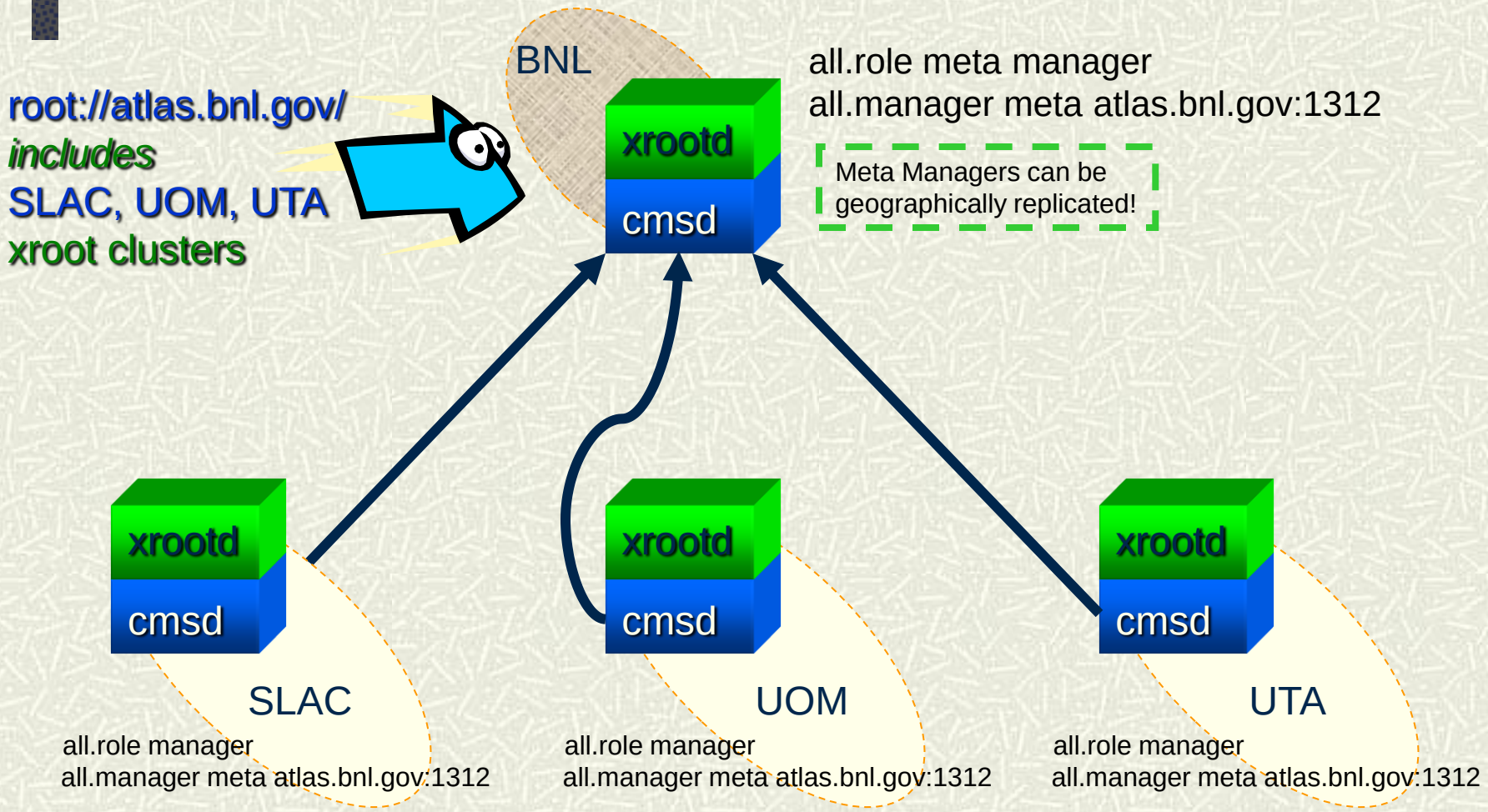
Akira's talk about "Panda oriented" ROOT analysis comparison at the Jamboree

http://indico.cern.ch/getFile.py/access?contribId=10&sessionId=0&resId=0&materialId=slides&confId=38991

Expansive Clustering

- Xrootd can create ad hoc cross domain clusters
  - Good for easily federating multiple sites
    - This is the ALICE model of data management
  - Provides a mechanism for “regional” data sharing
    - Get missing data from close by before using dq2get
      - Architecture allows this to be automated & demand driven
  - This implements a Virtual Mass Storage System

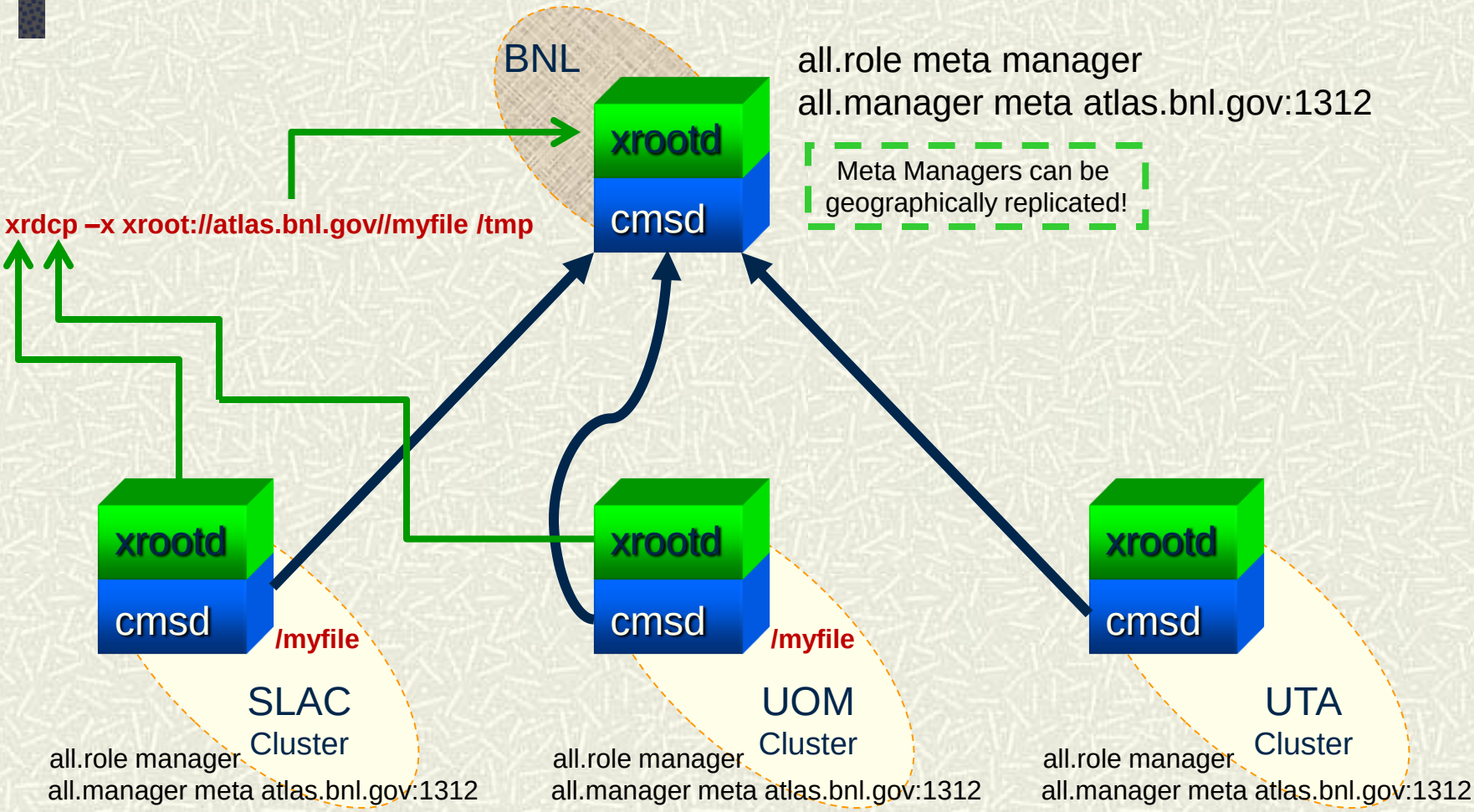
Virtual Mass Storage System



What's Good About This?

- Fetch missing files in a timely manner
  - Revert to dq2get when file not in regional cluster
- Sites can participate in an ad hoc manner
  - The cluster manager sorts out what's available
- Can use R/T WAN access when appropriate
- Can significantly increase WAN xfer rate
  - Using torrent-style copying

Torrents & Federated Clusters



Improved WAN Transfer

- The xrootd already supports parallel TCP paths
  - Significant improvement in WAN transfer rate
    - Specified as xrdcp –S *num*
- Xtreme copy mode uses multiple data sources
  - Specified as xrdcp –x
  - Transfers to CERN; examples:
    - 1 source (.de): 12MB/sec (1 stream)
    - 1 source (.us): 19MB/sec (15 streams)
    - 4 sources (3 x .de + .ru): 27MB/sec (1 stream each)
    - 4 sources + || streams: 42MB/Sec (15 streams each)
    - 5 sources (3 x .de + .it + .ro): 54MB/Sec (15 streams each)

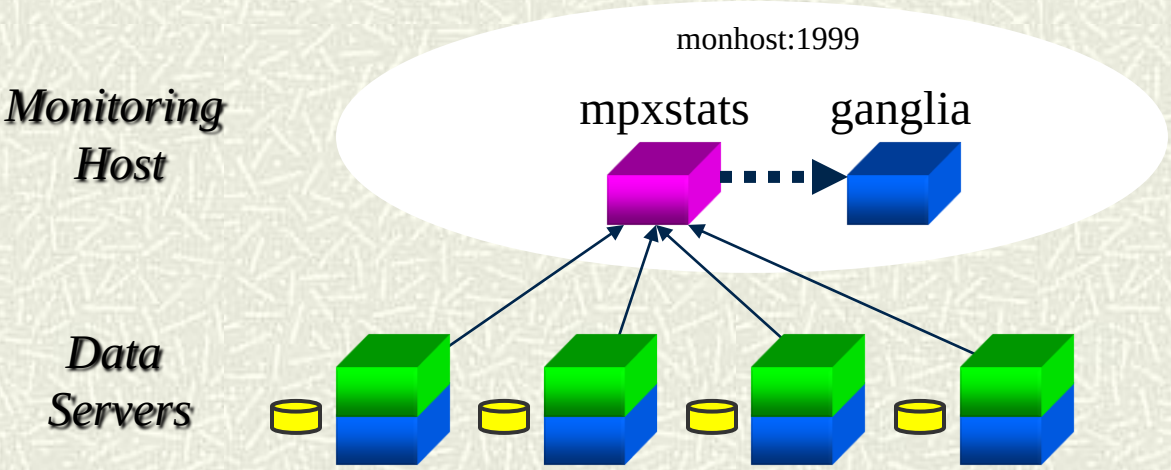
Expansive Clustering Caveats

- Federation & Globalization are easy if . . . .
  - Federated servers are *not* blocked by a firewall
    - No ALICE xroot servers are behind a firewall
- There are alternatives . . . .
  - Implement firewall exceptions
    - Need to fix all server ports
  - Use proxy mechanisms
    - Easy for some services, more difficult for others
- All of these have been tried in various forms
  - Site's specific situation dictates appropriate approach

Summary Monitoring

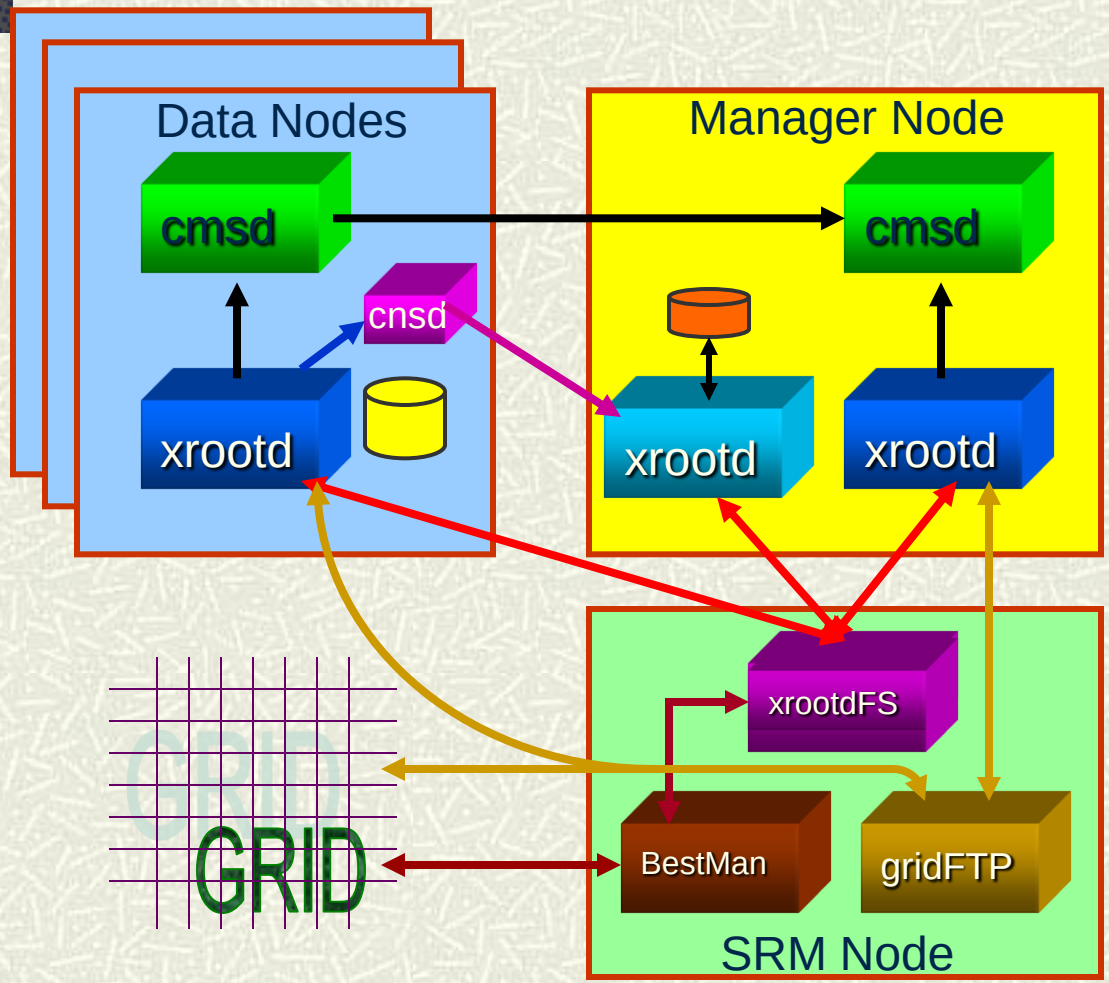
- Needed information in almost any setting
- Xrootd can auto-report summary statistics
  - Specify **xrd.report** configuration directive
- Data sent to one or two locations
  - Use provided **mpxstats** as the feeder program
    - Multiplexes streams and parses xml into key-value pairs
  - Pair it with any existing monitoring framework
    - Ganglia, GRIS, Nagios, MonALISA, and perhaps more

Summary Monitoring Setup



xrd.report monhost:1999 all every 15s

Putting It All Together



Basic **xrootd** Cluster

+

Name Space **xrootd**

+

cnsd

+

SRM Node

(BestMan, **xrootdFS**, gridFTP)

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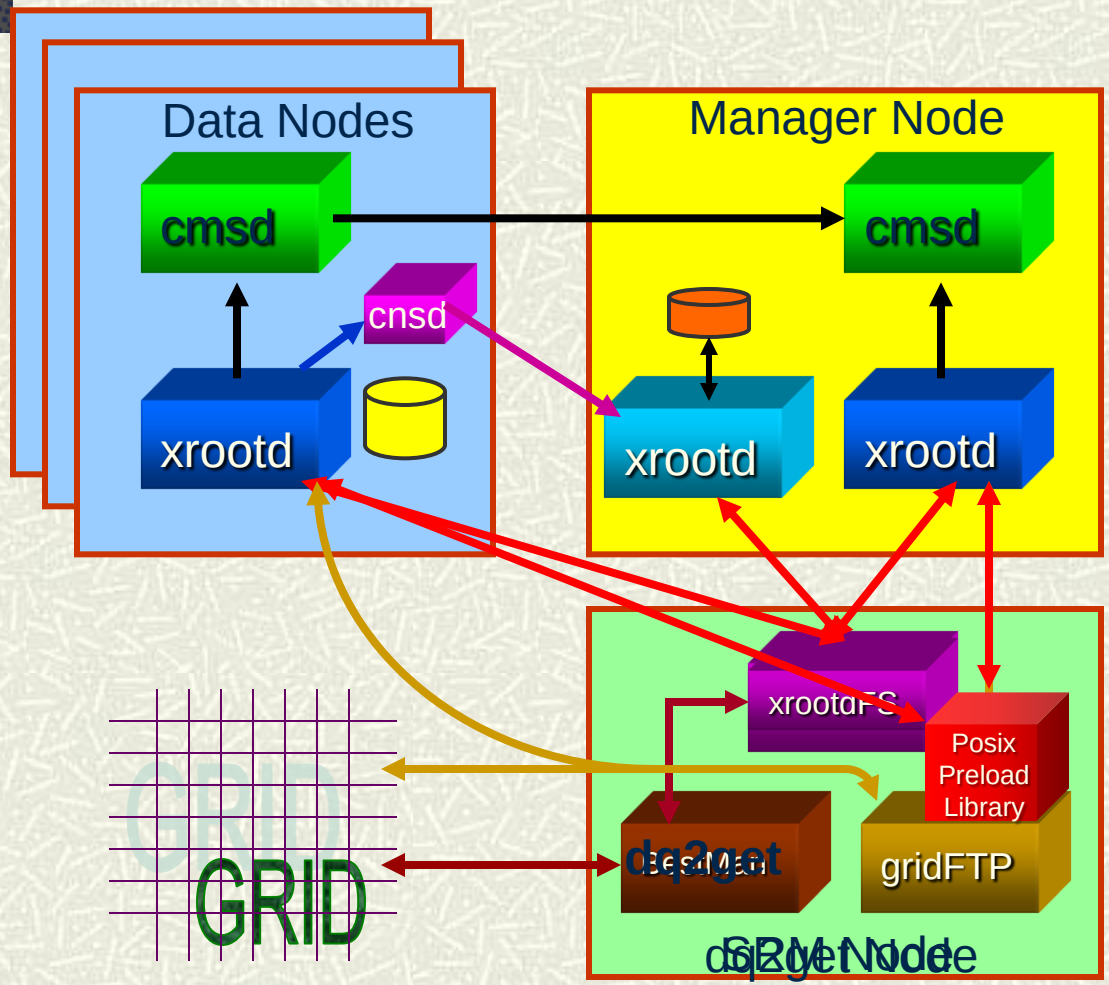
LHC Grid Access

Can't We Simplify This?

- The **cnsd** present for **XrootdFS** support
  - Provide composite name space for "**ls**" command
- **FUSE** present for **XrootdFS** support
- **XrootdFS** & **FUSE** for **BeSTMan** support
- **BeSTMan** for **SRM** support
- **SRM** for push-type grid data management
  - **dq2get** is a pull function and only needs **gridFTP**
- *Answer*: **Yes!** This can be simplified.

Tearing It All Apart



Basic xrootd Cluster

+

dq2get Node

(gridFTP + POSIX Preload Lib)

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Simple Grid Access

Even more effective if using a VMSS

In Conclusion. . .

- Xrootd is a lightweight data access system
  - Suitable for resource constrained environments
    - Human as well as hardware
  - Geared specifically for efficient data analysis
- Supports various clustering models
  - E.g., PROOF, batch node clustering and WAN clustering
  - Has potential to greatly simplify Tier 3 deployments
- Distributed as part of the OSG VDT
  - Also part of the CERN root distribution
- Visit http://xrootd.slac.stanford.edu/

Acknowledgements

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  - Alice: Derek Feichtinger
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