Computer Facilities, Production Grids and Networking

Track Summary

Maria Girone
Daniele Bonacorsi
Andreas Heiss

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Track Summary

Usual disclaimers apply!

(Sorry, no poster coverage, biased, incomplete, my personal view etc.)

Maria Girone
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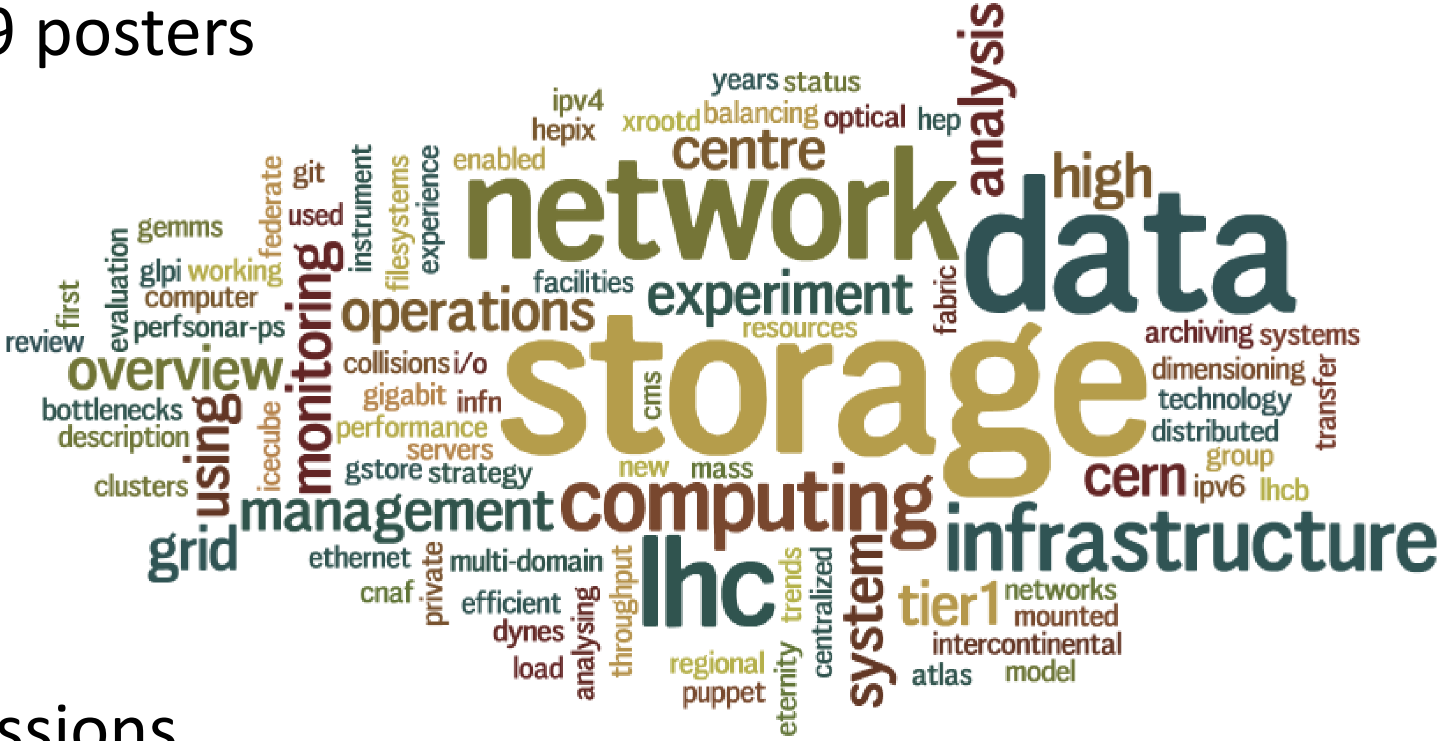
Statistics

98 contributions

- 19 accepted as oral
- 79 posters



4 sessions

Audience:

~ 70 – 80 people

Statistics

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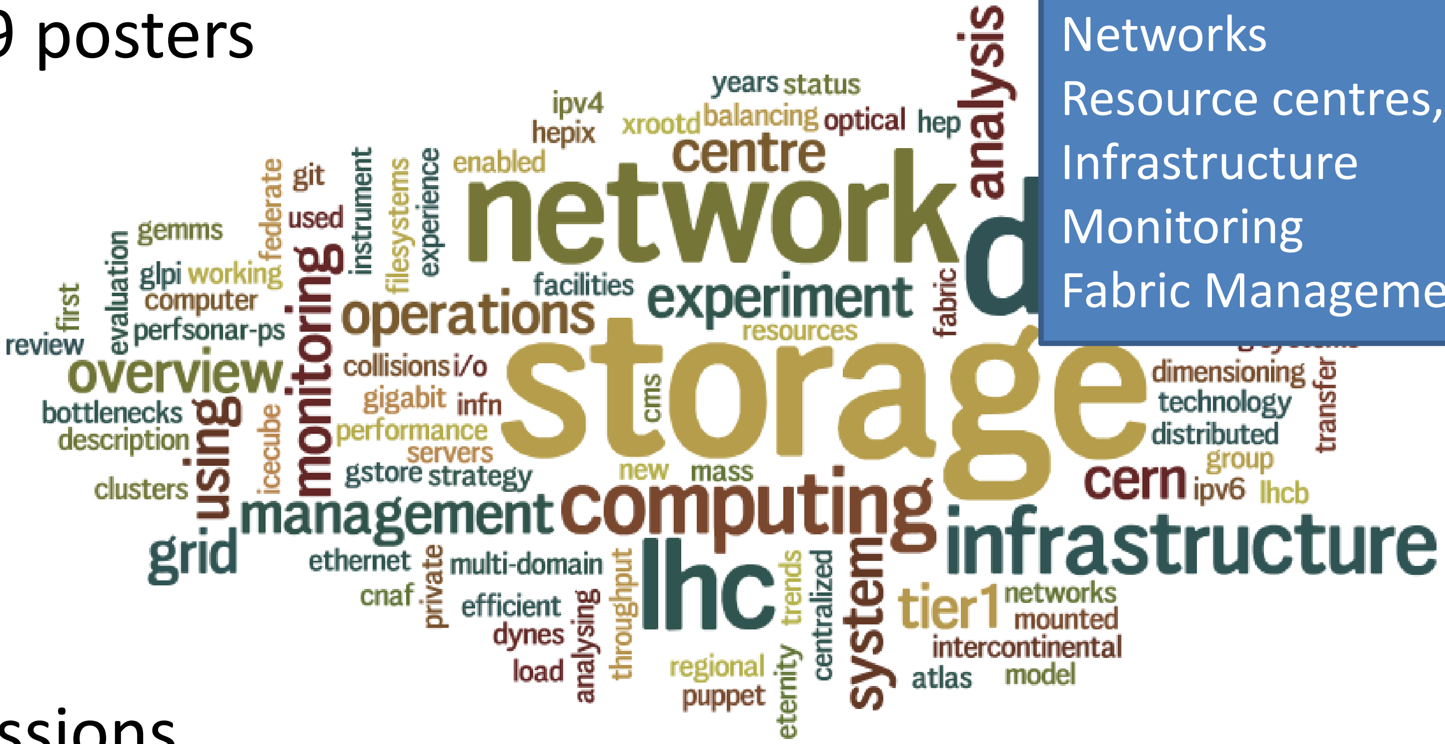
Relative # of occurrences	
Storage	24%
Networks	17%
Resource centres, Infrastructure	16%
Monitoring	10%
Fabric Management	9%



4 sessions

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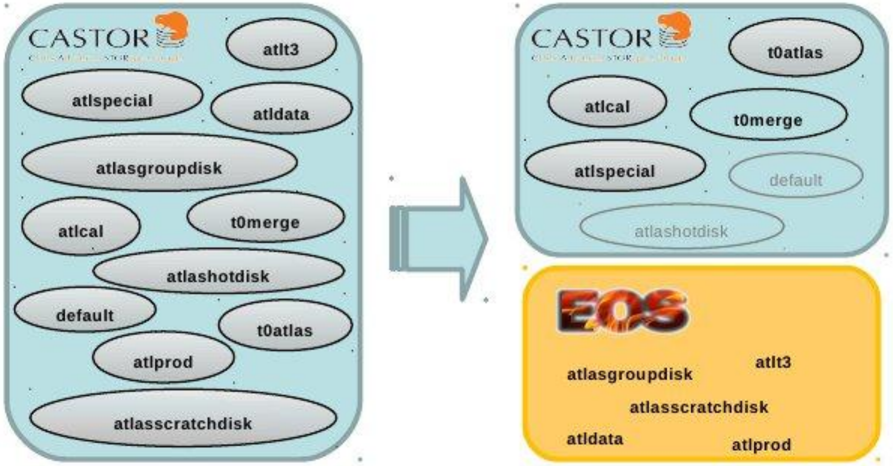
Storage Systems

Jan Iven: Overview of Storage Operations at CERN

- Castor HSM is optimized for Tier-0 flow, not for “random“ user analysis.
- Strong increase in such analysis suggested to introduce second type of storage System. -> EOS = xrootd + in-memory namespace “plugin“.



CASTOR

atlt3

atlspecial

atldata

atlasgroupdisk

atlcal

t0merge

atlashotdisk

default

t0atlas

atlprod

atlasscratchdisk

CASTOR

t0atlas

atlcal

t0merge

atlspecial

default

atlashotdisk

EOS

atlasgroupdisk

atlt3

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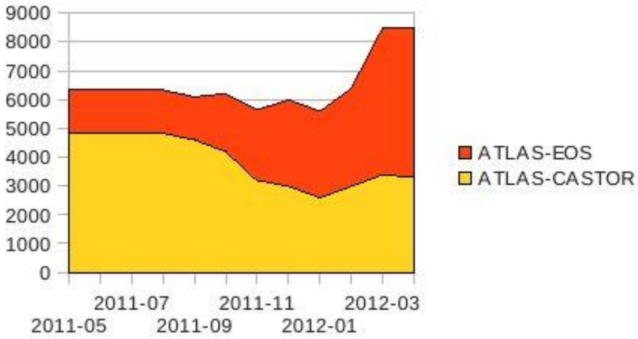
atlprod



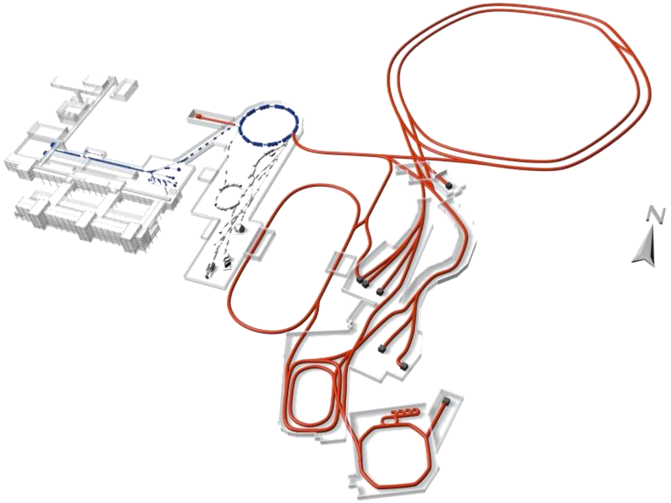
(credit: L.Mascetti)

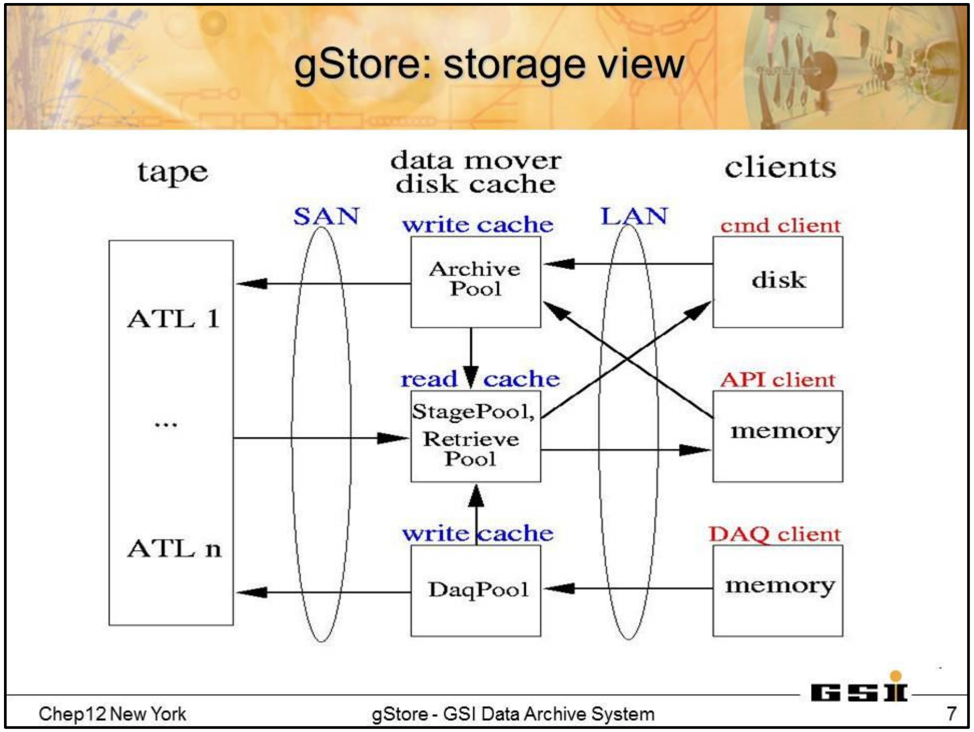
Experience of >1 year of EOS:
- easy setup and updating (no DB components)
- easier server draining
- less support requests

Storage Systems

Horst Göringer, GSI: High Performance Experiment Data Archiving with gStore

- Scaleable, local HSM based on TSM
- Easy scaleable data moving to Lustre for analysis.
- FAIR 2018: 33PB per year





gStore: storage view

tape

data mover
disk cache

clients

SAN

LAN

ATL 1

...

ATL n

write cache

Archive Pool

read cache

StagePool,
Retrieve Pool

write cache

DaqPool

cmd client

disk

API client

memory

DAQ client

memory

Chep12 New York

gStore - GSI Data Archive System

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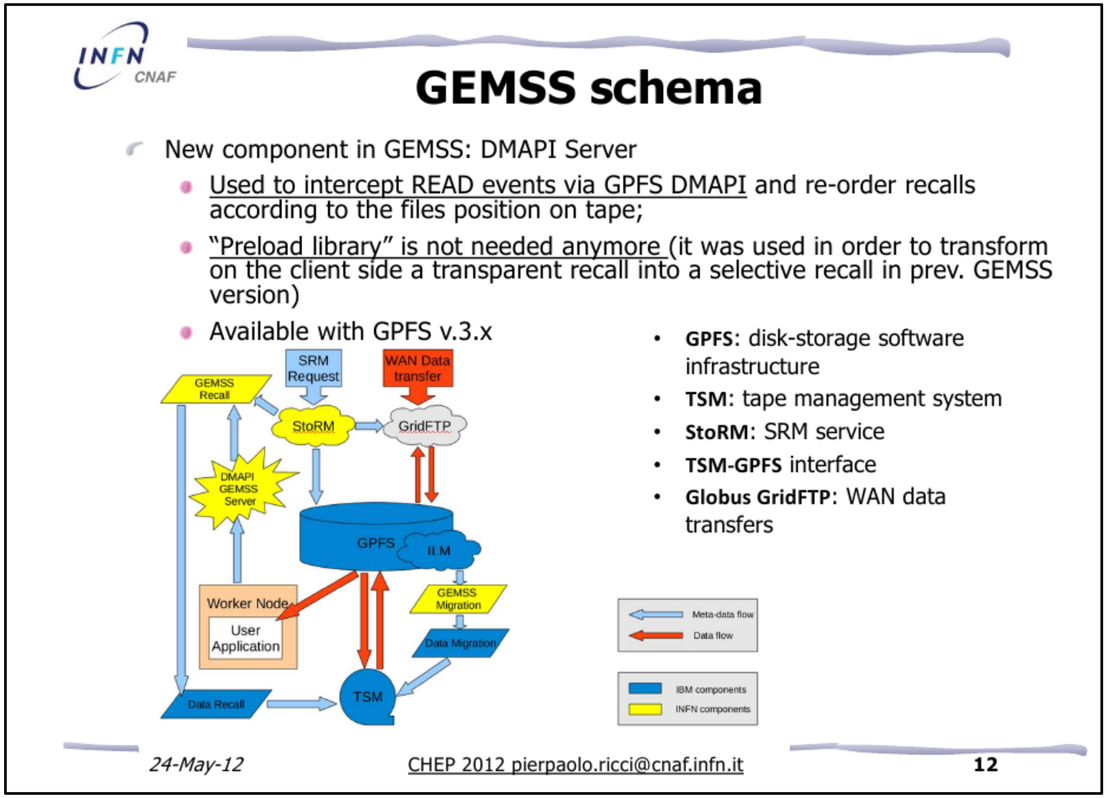
Storage Systems

Pier Paolo Ricci, INFN: The Grid Enabled Mass Storage System (GEMMS): the Storage and Data management system used at the INFN Tier1 at CNAF.

- Full HSM integration of GPFS, TSM and StoRM
- Read events triggered by Storm or by intercepted read requests from WNs.

- Clear improvement of stability compared to the formerly used CASTOR system.



GEMSS schema

- New component in GEMSS: DMAPI Server
  - Used to intercept READ events via GPFS DMAPI and re-order recalls according to the files position on tape;
  - "Preload library" is not needed anymore (it was used in order to transform on the client side a transparent recall into a selective recall in prev. GEMSS version)
  - Available with GPFS v.3.x

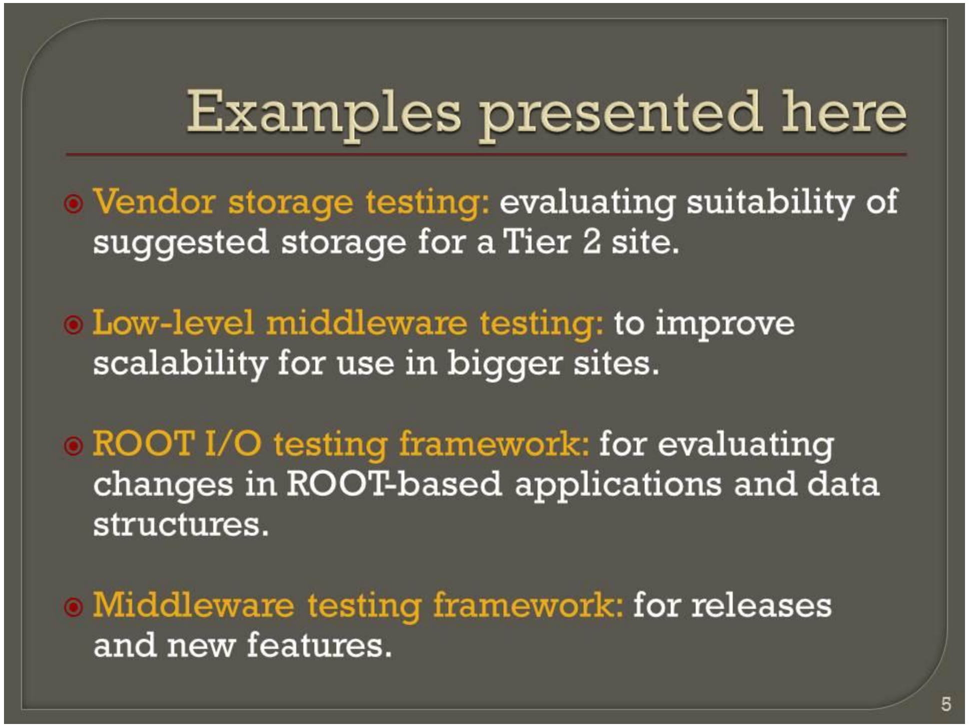
- **GPFS**: disk-storage software infrastructure
- **TSM**: tape management system
- **StoRM**: SRM service
- **TSM-GPFS** interface
- **Globus GridFTP**: WAN data transfers

24-May-12 CHEP 2012 pierpaolo.ricci@cnaf.infn.it **12**

Storage Systems

Wahid Bhimji, University of Edinburgh: Analysing I/O bottlenecks in LHC data analysis on grid storage resources

Set of manual and automated tools to systematically test the I/O performance of different components: HW, middleware (e.g. DPM), application level (ROOT)



Examples presented here

- Vendor storage testing: evaluating suitability of suggested storage for a Tier 2 site.
- Low-level middleware testing: to improve scalability for use in bigger sites.
- ROOT I/O testing framework: for evaluating changes in ROOT-based applications and data structures.
- Middleware testing framework: for releases and new features.

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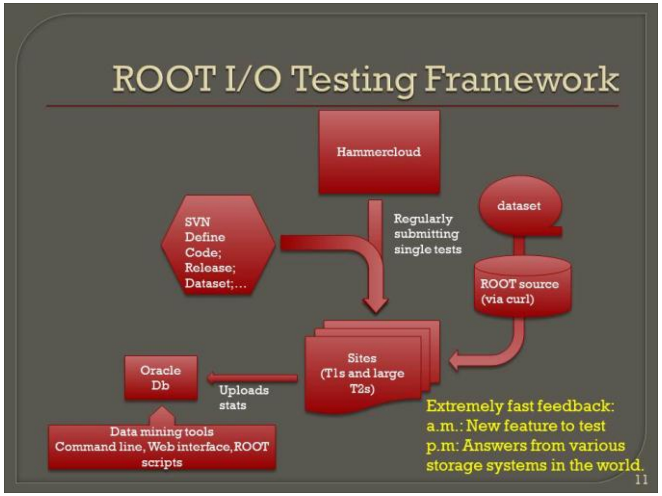

ROOT I/O Testing Framework

Hammercloud

SVN
Define
Code;
Release;
Dataset;...

Regularly submitting single tests

dataset

ROOT source (via curl)

Sites (T1s and large T2s)

Oracle Db

Uploads stats

Data mining tools
Command line, Web interface, ROOT scripts

Extremely fast feedback:
a.m.: New feature to test
p.m: Answers from various storage systems in the world.

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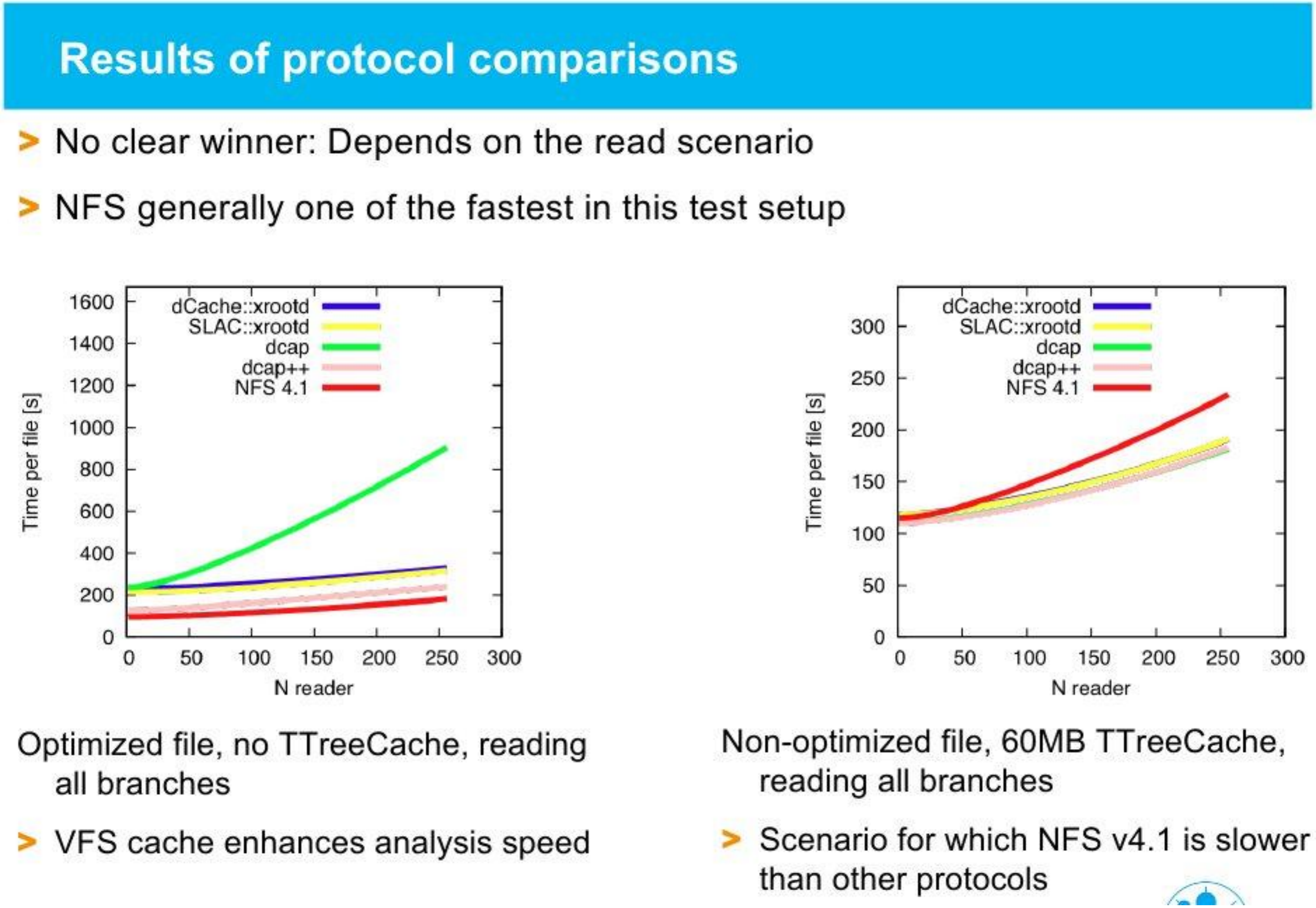
Hammercloud to pull code to a site and execute it.

Storage Systems

Ives Kemp: Experience with HEP analysis on mounted filesystems



Results of protocol comparisons

- No clear winner: Depends on the read scenario
- NFS generally one of the fastest in this test setup

Optimized file, no TTreeCache, reading all branches

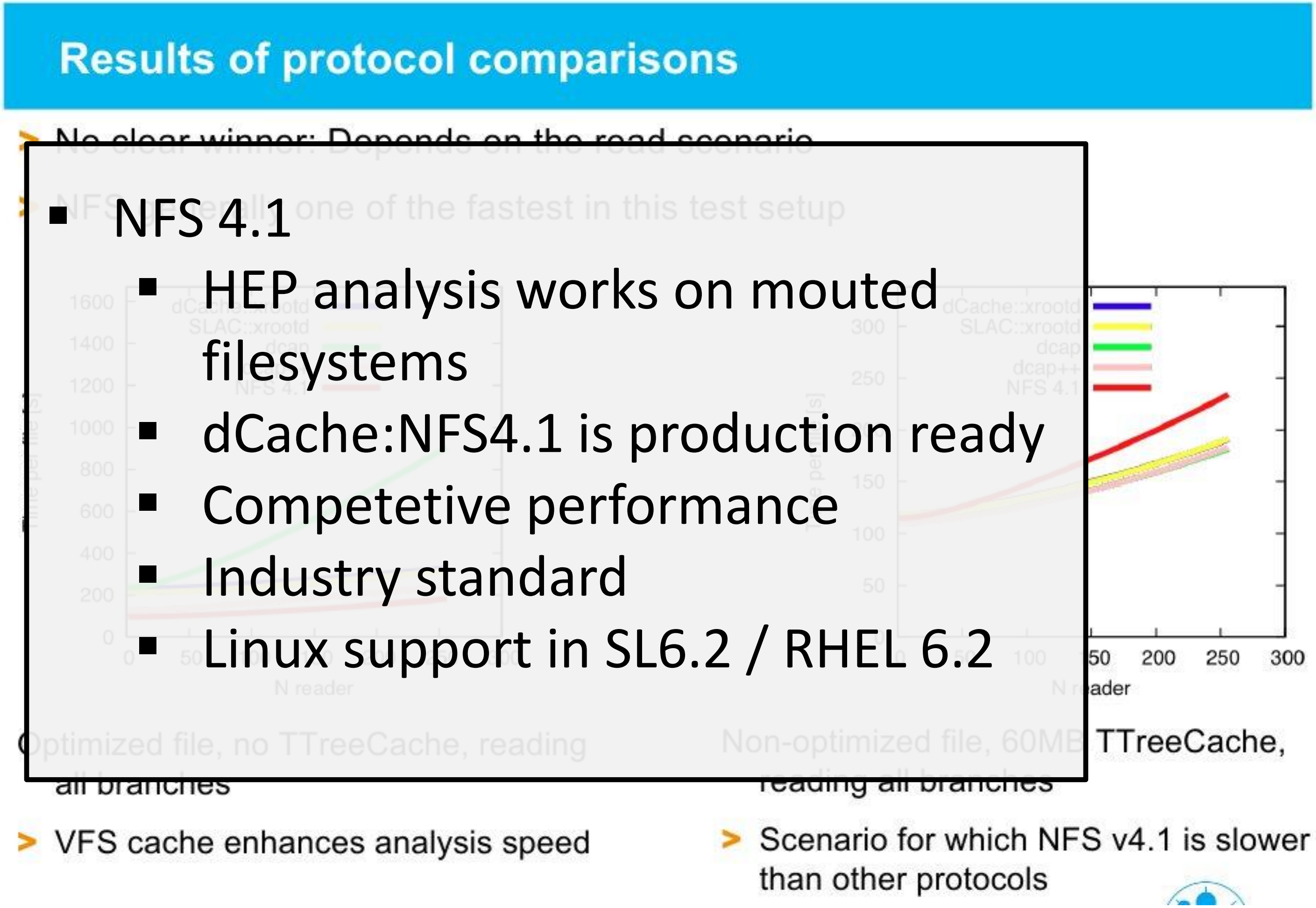
- VFS cache enhances analysis speed

Non-optimized file, 60MB TTreeCache, reading all branches

- Scenario for which NFS v4.1 is slower than other protocols

Storage Systems

Ives Kemp: Experience with HEP analysis on mounted filesystems



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- Scenario for which NFS v4.1 is slower than other protocols

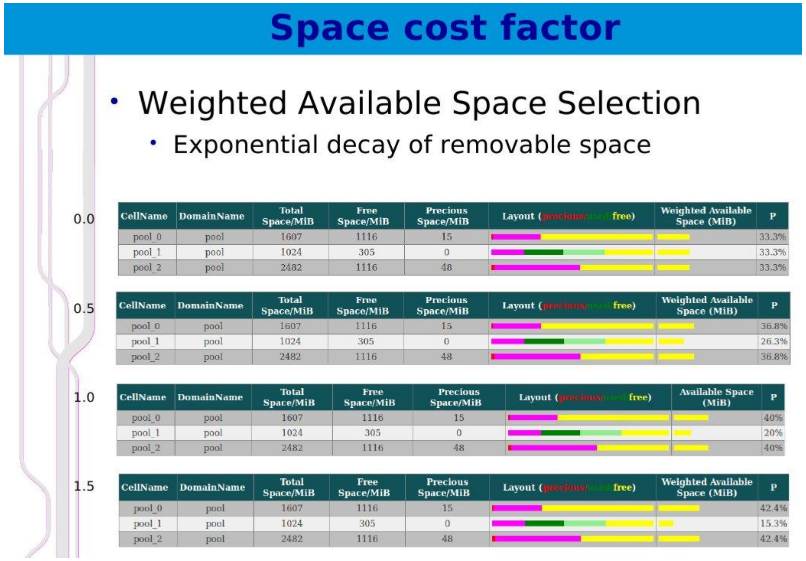
- NFS 4.1
  - HEP analysis works on mouted filesystems
  - dCache:NFS4.1 is production ready
  - Competetive performance
  - Industry standard
  - Linux support in SL6.2 / RHEL 6.2

Storage Systems

Mattias Wadenstein: A strategy for load balancing in distributed storage systems

-> Sometimes difficult to achieve even write pool selection in dCache.

-> New, dynamic pool selection of write pools in dCache to overcome issues like write clumping.



Space cost factor

- Weighted Available Space Selection
  - Exponential decay of removable space

0.0

CellName	DomainName	Total Space/MiB	Free Space/MiB	Precious Space/MiB	Layout (precious/used/free)	Weighted Available Space (MiB)	P
pool_0	pool	1607	1116	15			33.3%
pool_1	pool	1024	305	0			33.3%
pool_2	pool	2482	1116	48			33.3%

0.5

CellName	DomainName	Total Space/MiB	Free Space/MiB	Precious Space/MiB	Layout (precious/used/free)	Weighted Available Space (MiB)	P
pool_0	pool	1607	1116	15			36.8%
pool_1	pool	1024	305	0			26.3%
pool_2	pool	2482	1116	48			36.8%

1.0

CellName	DomainName	Total Space/MiB	Free Space/MiB	Precious Space/MiB	Layout (precious/used/free)	Available Space (MiB)	P
pool_0	pool	1607	1116	15			40%
pool_1	pool	1024	305	0			20%
pool_2	pool	2482	1116	48			40%

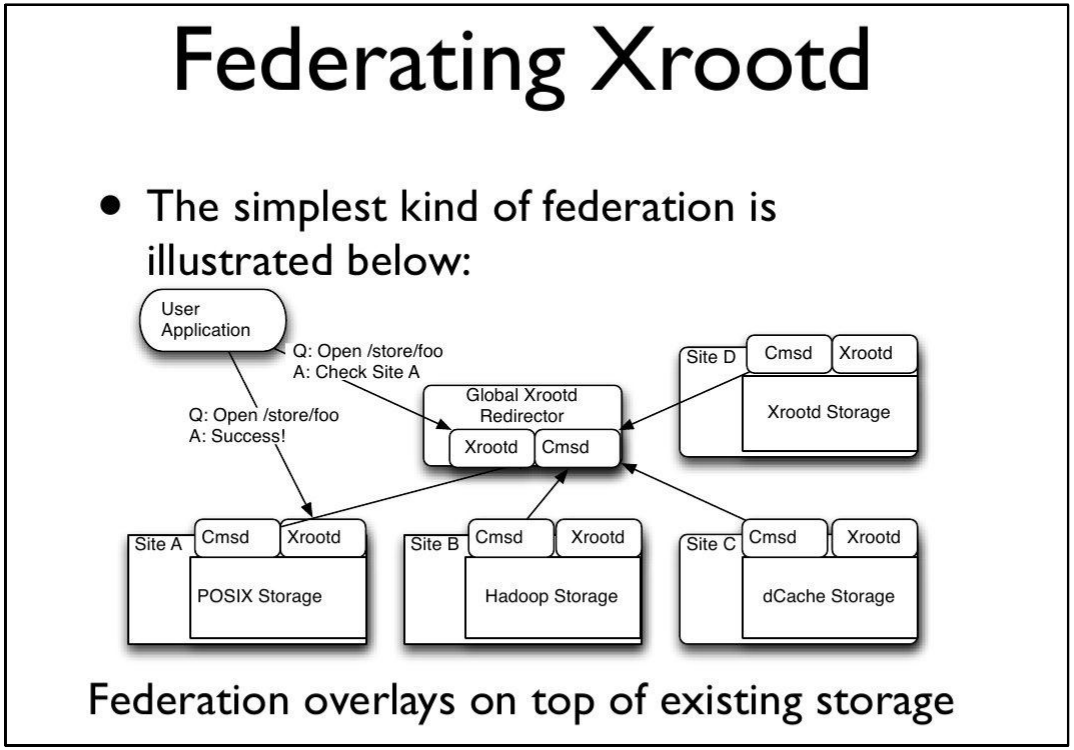
1.5

CellName	DomainName	Total Space/MiB	Free Space/MiB	Precious Space/MiB	Layout (precious/used/free)	Weighted Available Space (MiB)	P
pool_0	pool	1607	1116	15			42.4%
pool_1	pool	1024	305	0			15.3%
pool_2	pool	2482	1116	48			42.4%

New method as default in dCache 2.2

Storage Systems

Brian Bockelman: Using Xrootd to federate regional storage



Federating Xrootd

- The simplest kind of federation is illustrated below:

Federation overlays on top of existing storage

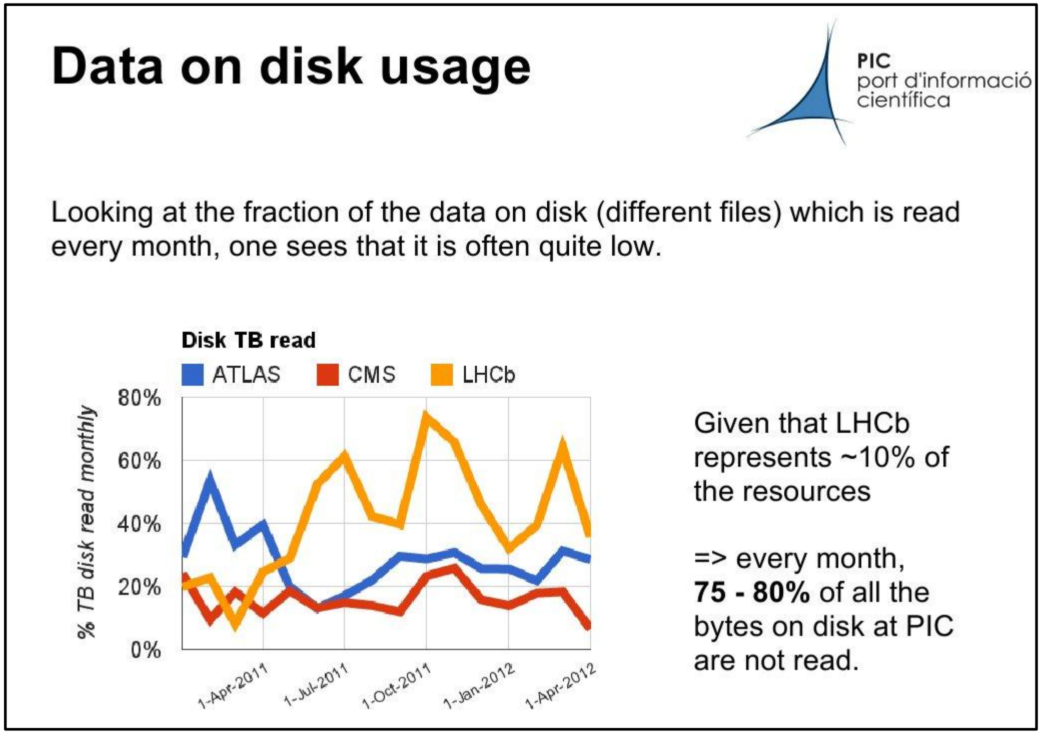
- Any storage system with posix of C interface can be integrated using a specific plugin, e.g. HDFS, Lustre
- Xrootd and dCache SEs can be integrated directly
- Global namespace: plugin to export global filename

Wide-area direct Xrootd access works but clients need to be aware of the sometimes higher network latency.

Storage Systems

Gonzalo Merino: Dimensioning storage and computing clusters for efficient high throughput computing

- PIC T1 infrastructure
- Dimensioning of network backbone and storage systems
- Study of usage of data on disks by analyzing dCache billing logs. Only 20 to 25% of data on disk is touched at least once per month.



Data on disk usage

PIC port d'informació científica

Looking at the fraction of the data on disk (different files) which is read every month, one sees that it is often quite low.

Given that LHCb represents ~10% of the resources

=> every month, **75 - 80%** of all the bytes on disk at PIC are not read.

Networking

Network monitoring

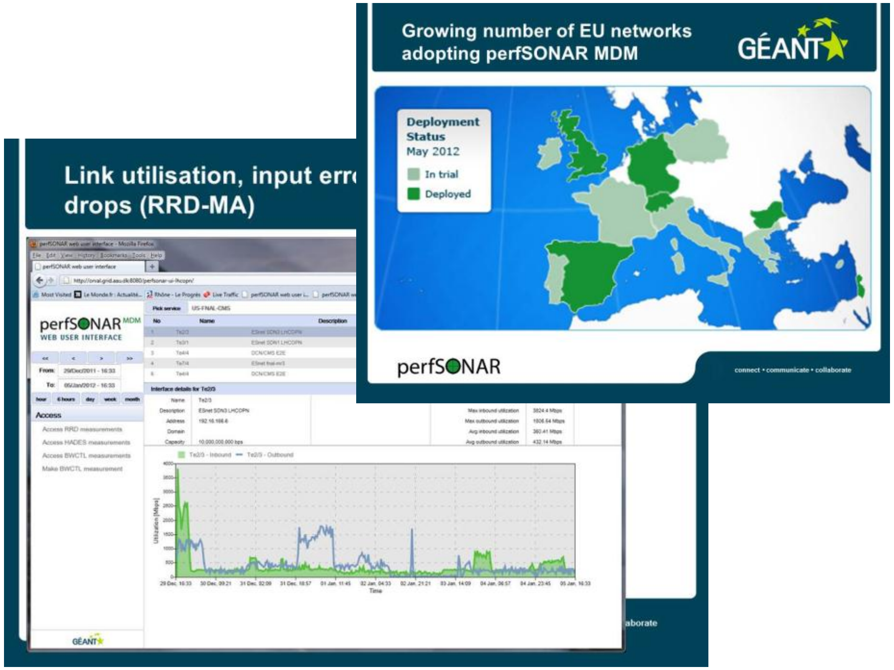
- Modified computing and data distribution models of LHC experiments
- New network infrastructures -> LHCONE

⇒ Demand for better network performance monitoring

Two presentations of the perfSONAR tool in this track.

- Measuring standard network metrics
  - Bandwidth, latency, packet loss, …
- Two interoperable implementations

Networking



Growing number of EU networks adopting perfSONAR MDM

Deployment Status May 2012

🟩 In trial

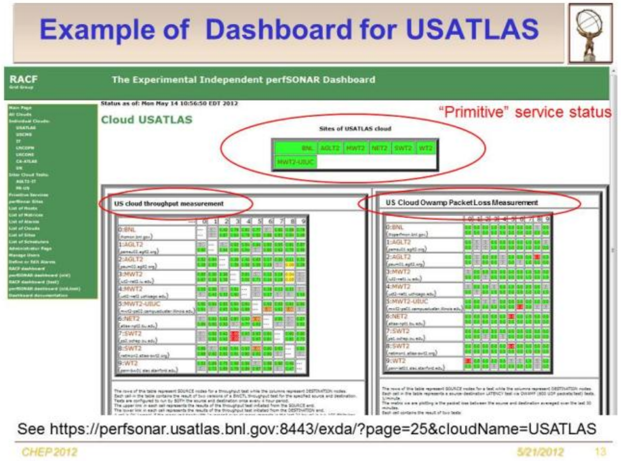
🟩 Deployed

Link utilisation, input erro
drops (RRD-MA)

GÉANT
perfSONAR
connect • communicate • collaborate
perfSONAR web user interface - Mozilla Firefox
http://orval.grid.aau.dk:8080/perfsonar-ui-lhcopn/
perfSONAR MDM WEB USER INTERFACE
Pick service US-FNAL-CMS
From: 29/Dec/2011 - 16:33
To: 05/Jan/2012 - 16:33
hour 6 hours day week month
Access
Access RRD measurements
Access HADES measurements
Access BWCTL measurements
Make BWCTL measurement
Interface details for Te2/3
Te2/3 - Inbound
Te2/3 - Outbound
Utilization [Mbps]
Time
aborate
GÉANT

Domenico Vicinanza, GEANT:

- Differences of perfSONAR-MDM and perfSONAR-PS
- Deployment status in Europe
- Monitoring LHCOPN und LHCONE



Example of Dashboard for USATLAS

RACF

The Experimental Independent perfSONAR Dashboard

Status as of: Mon May 14 10:56:50 EDT 2012

Cloud USATLAS

"Primitive" service status

Sites of USATLAS cloud

US cloud throughput measurement

US Cloud Owamp Packet Loss Measurement

See https://perfsonar.usatlas.bnl.gov:8443/exda/?page=25&cloudName=USATLAS

Shawn McKee, Univ. of Michigan:

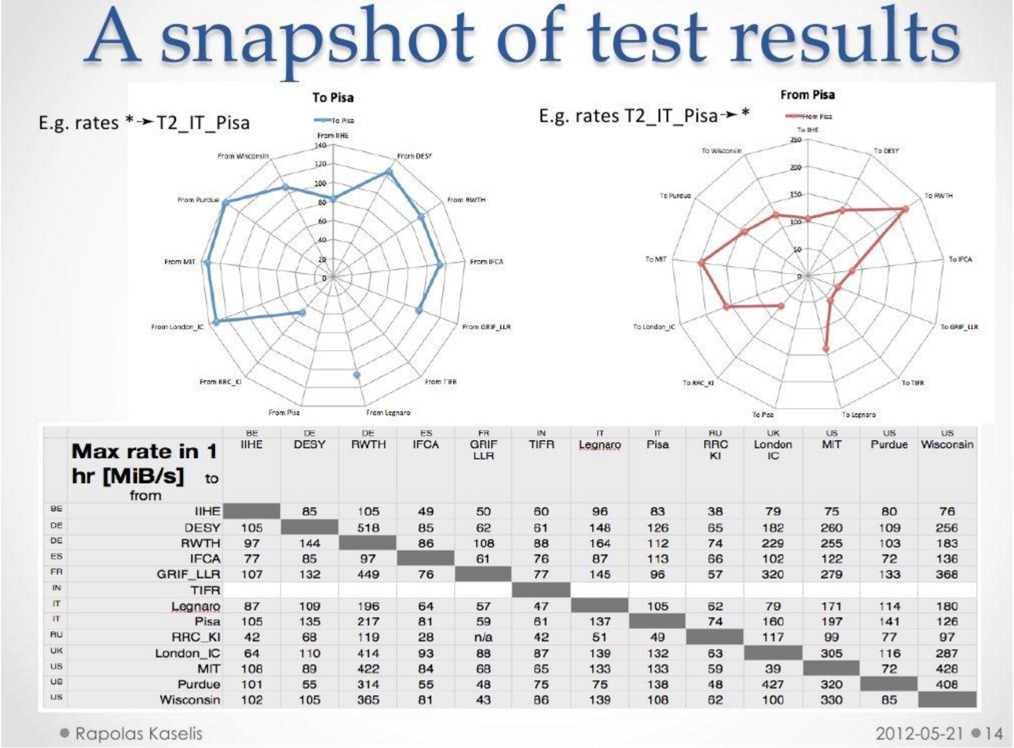
- perfSONAR-PS based monitoring of the US ATLAS network
- Future developments
  - Deployment at US CMS sites
  - Integration in dashboards

Networking

Rapolas Kaselis: CMS data transfer operations after the first year of LHC collisions

- PhEDEx data transfer monitoring
- Troubleshooting
- Test of the LHCONE

⇒ Smooth operations, but monitoring and debugging transfers takes lots of manpower.



A snapshot of test results

E.g. rates * → T2_IT_Pisa

E.g. rates T2_IT_Pisa → *

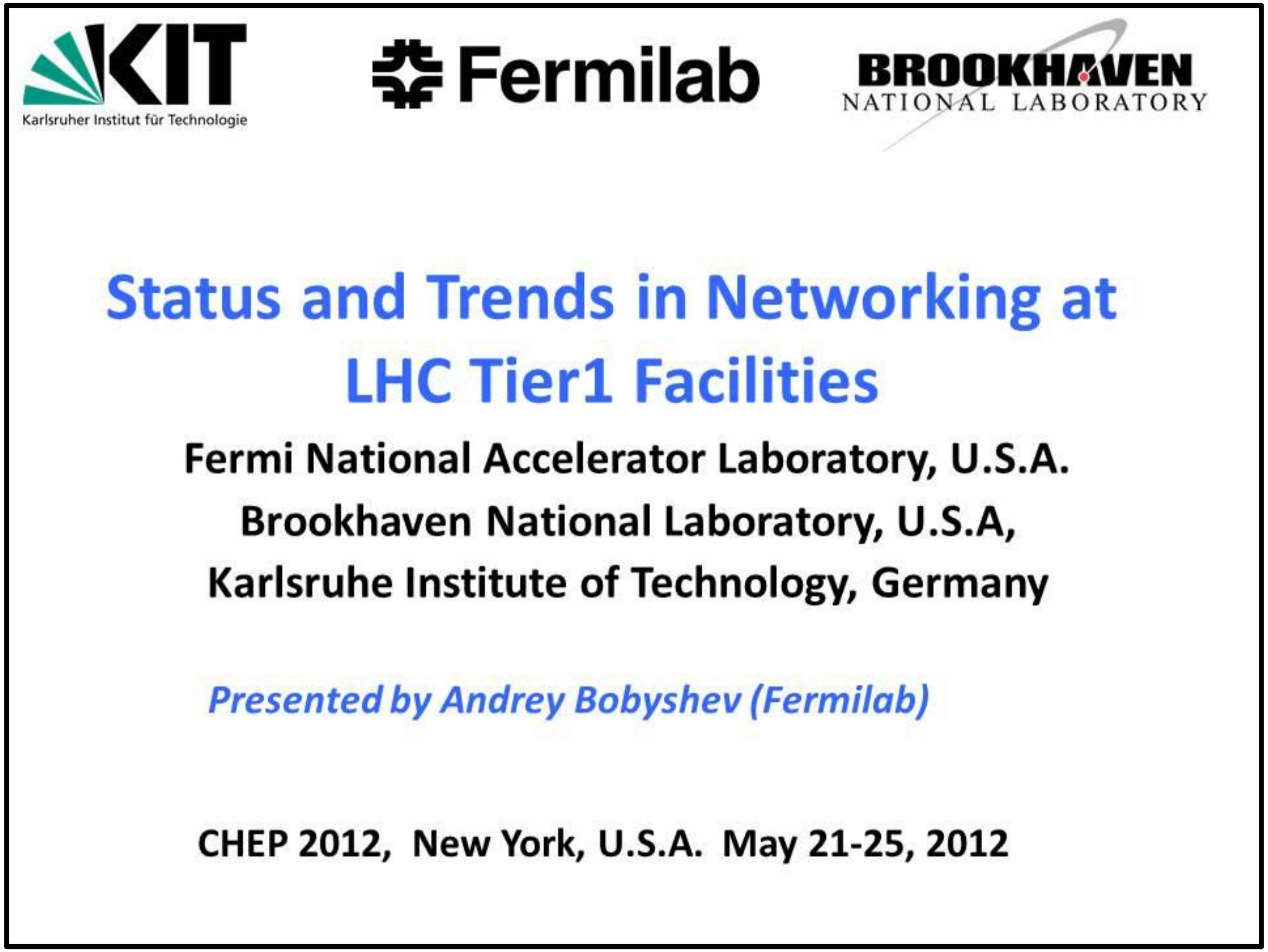
		BE	DE	DE	ES	FR	IN	IT	IT	RU	UK	US	US	US
	Max rate in 1 hr [MiB/s] to from	IIHE	DESY	RWTH	IFCA	GRIF LLR	TIFR	Legnaro	Pisa	RRC KI	London IC	MIT	Purdue	Wisconsin
BE	IIHE		85	105	49	50	60	96	83	38	79	75	80	76
DE	DESY	105		518	85	62	61	148	126	65	182	260	109	256
DE	RWTH	97	144		86	108	88	164	112	74	229	255	103	183
ES	IFCA	77	85	97		61	76	87	113	66	102	122	72	136
FR	GRIF_LLR	107	132	449	76		77	145	96	57	320	279	133	368
IN	TIFR													
IT	Legnaro	87	109	196	64	57	47		105	62	79	171	114	180
IT	Pisa	105	135	217	81	59	61	137		74	160	197	141	126
RU	RRC_KI	42	68	119	28	n/a	42	51	49		117	99	77	97
UK	London_IC	64	110	414	93	88	87	139	132	63		305	116	287
US	MIT	108	89	422	84	68	65	133	133	59	39		72	428
US	Purdue	101	55	314	55	48	75	75	138	48	427	320		408
US	Wisconsin	102	105	365	81	43	86	139	108	62	100	330	85	

● Rapolas Kaselis

2012-05-21 ● 14

Networking

Andrey Bobyshey, FNAL: “Tier-1 LAN party“



KIT Karlsruher Institut für Technologie

Fermilab

BROOKHAVEN NATIONAL LABORATORY

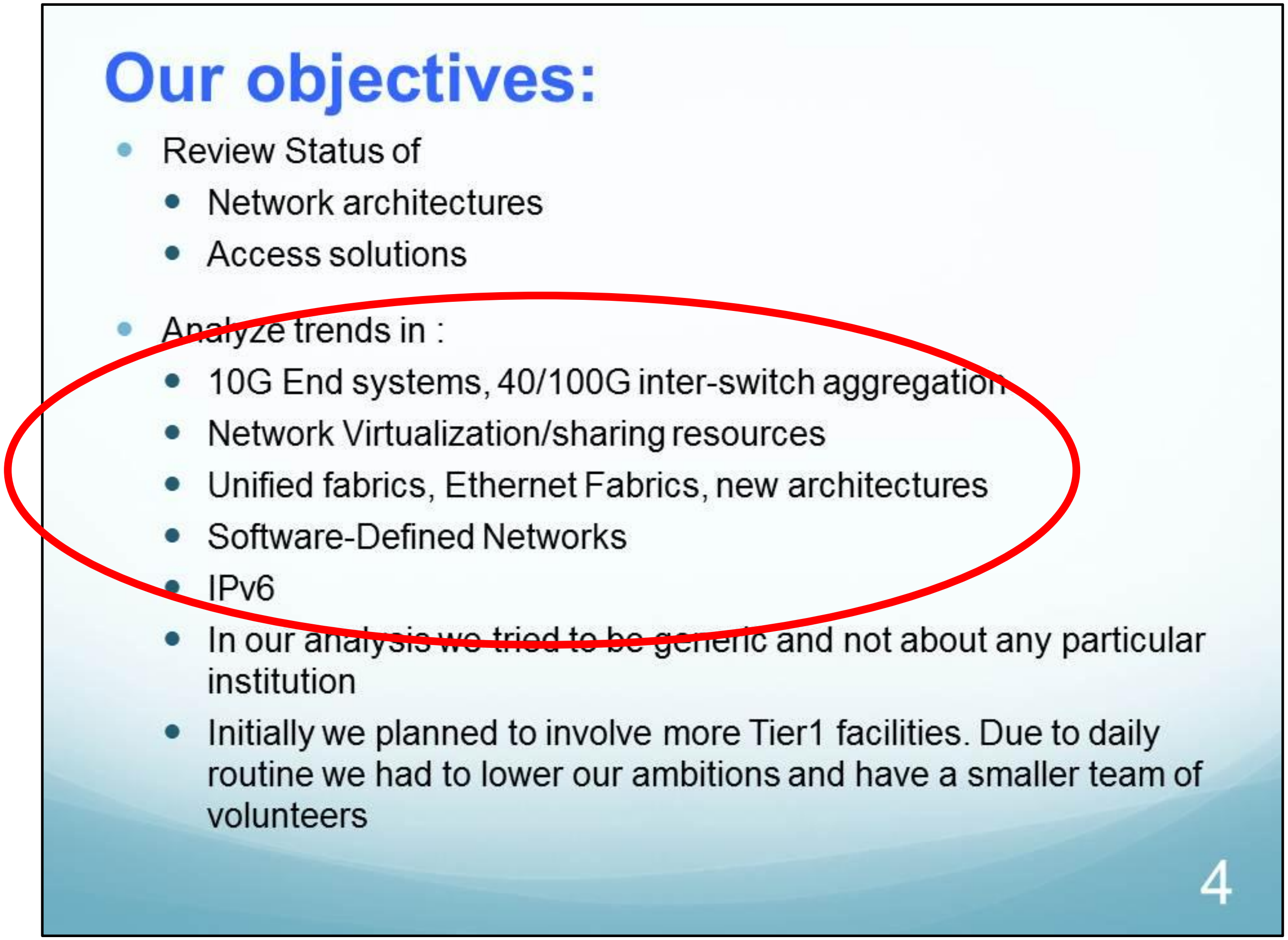
Status and Trends in Networking at LHC Tier1 Facilities

Fermi National Accelerator Laboratory, U.S.A.
Brookhaven National Laboratory, U.S.A,
Karlsruhe Institute of Technology, Germany

Presented by Andrey Bobyshev (Fermilab)

CHEP 2012, New York, U.S.A. May 21-25, 2012

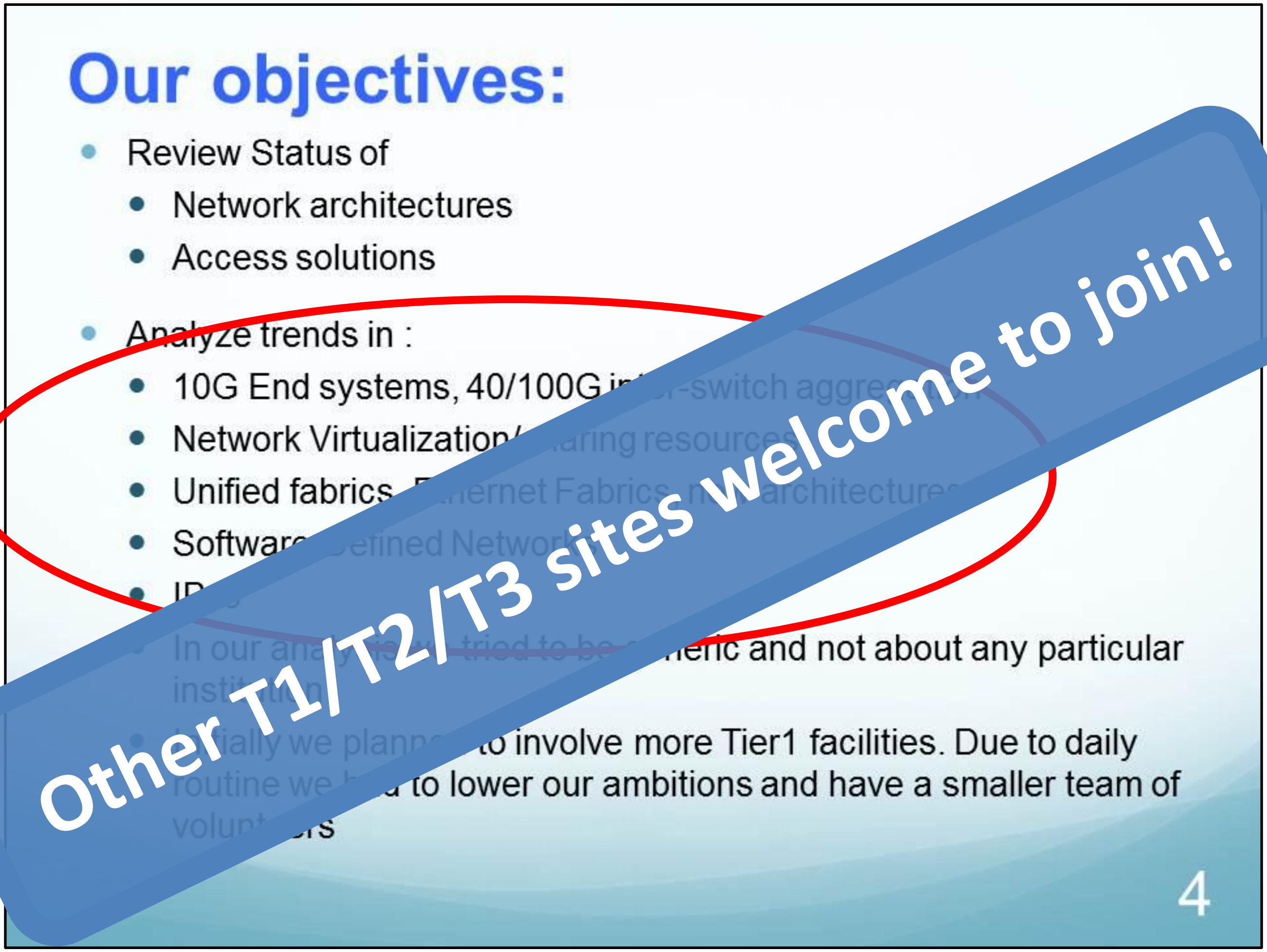
Networking



Our objectives:

- Review Status of
  - Network architectures
  - Access solutions
- Analyze trends in :
  - 10G End systems, 40/100G inter-switch aggregation
  - Network Virtualization/sharing resources
  - Unified fabrics, Ethernet Fabrics, new architectures
  - Software-Defined Networks
  - IPv6
  - In our analysis we tried to be generic and not about any particular institution
  - Initially we planned to involve more Tier1 facilities. Due to daily routine we had to lower our ambitions and have a smaller team of volunteers

Networking



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4

Other T1/T2/T3 sites welcome to join!

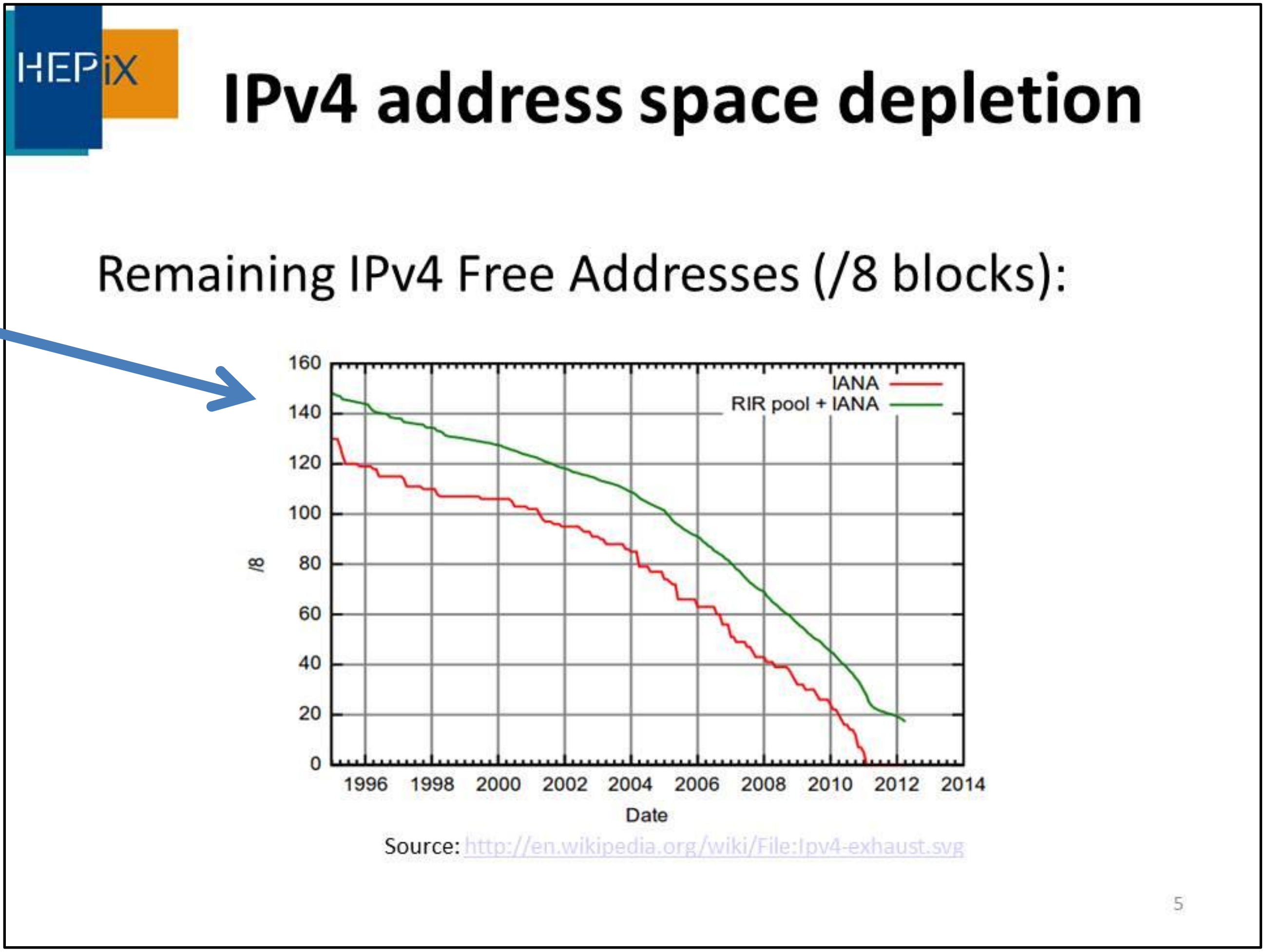
Networking

Eduardo Martelli: “From IPv4 to eternity”: the HEPiX IPv6 working group

Motivation:

1)

2) VM and (commercial) cloud services will require IPv6



IPv4 address space depletion

Remaining IPv4 Free Addresses (/8 blocks):

Source: http://en.wikipedia.org/wiki/File:Ipv4-exhaust.svg

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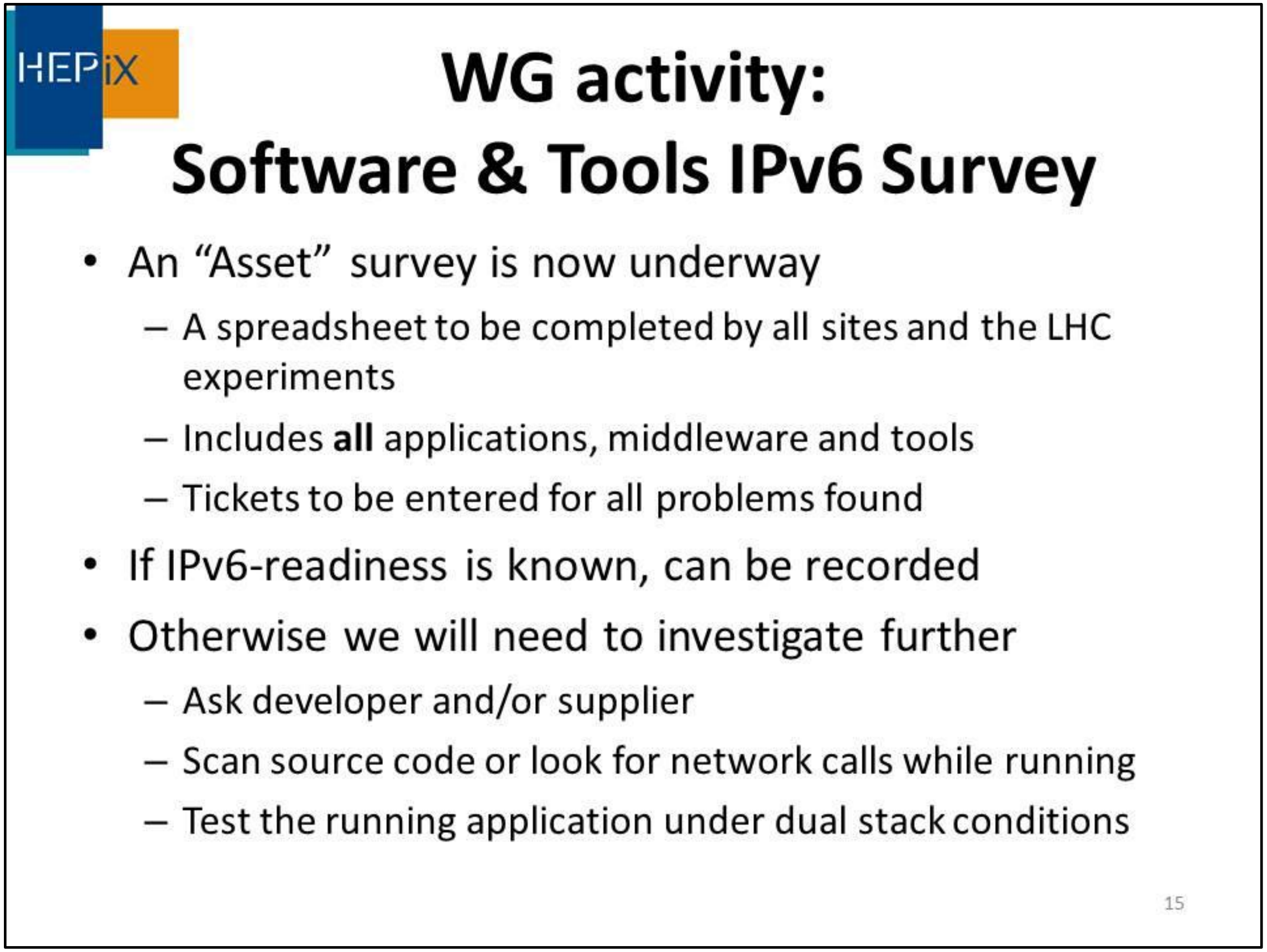
Networking



WG activity: Software & Tools IPv6 Survey

- An "Asset" survey is now underway
  - A spreadsheet to be completed by all sites and the LHC experiments
  - Includes **all** applications, middleware and tools
  - Tickets to be entered for all problems found
- If IPv6-readiness is known, can be recorded
- Otherwise we will need to investigate further
  - Ask developer and/or supplier
  - Scan source code or look for network calls while running
  - Test the running application under dual stack conditions

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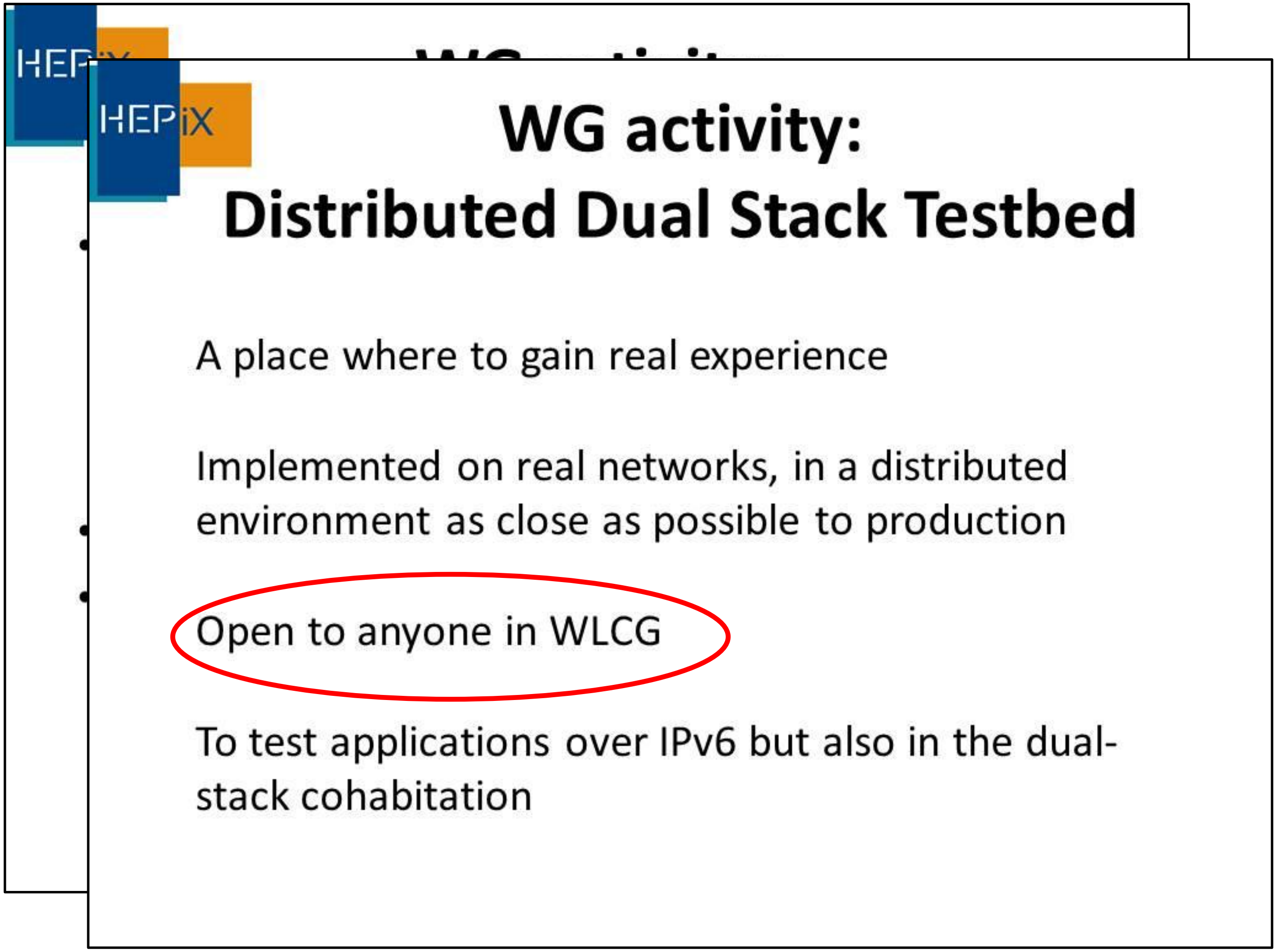
Networking



WG activity: Distributed Dual Stack Testbed

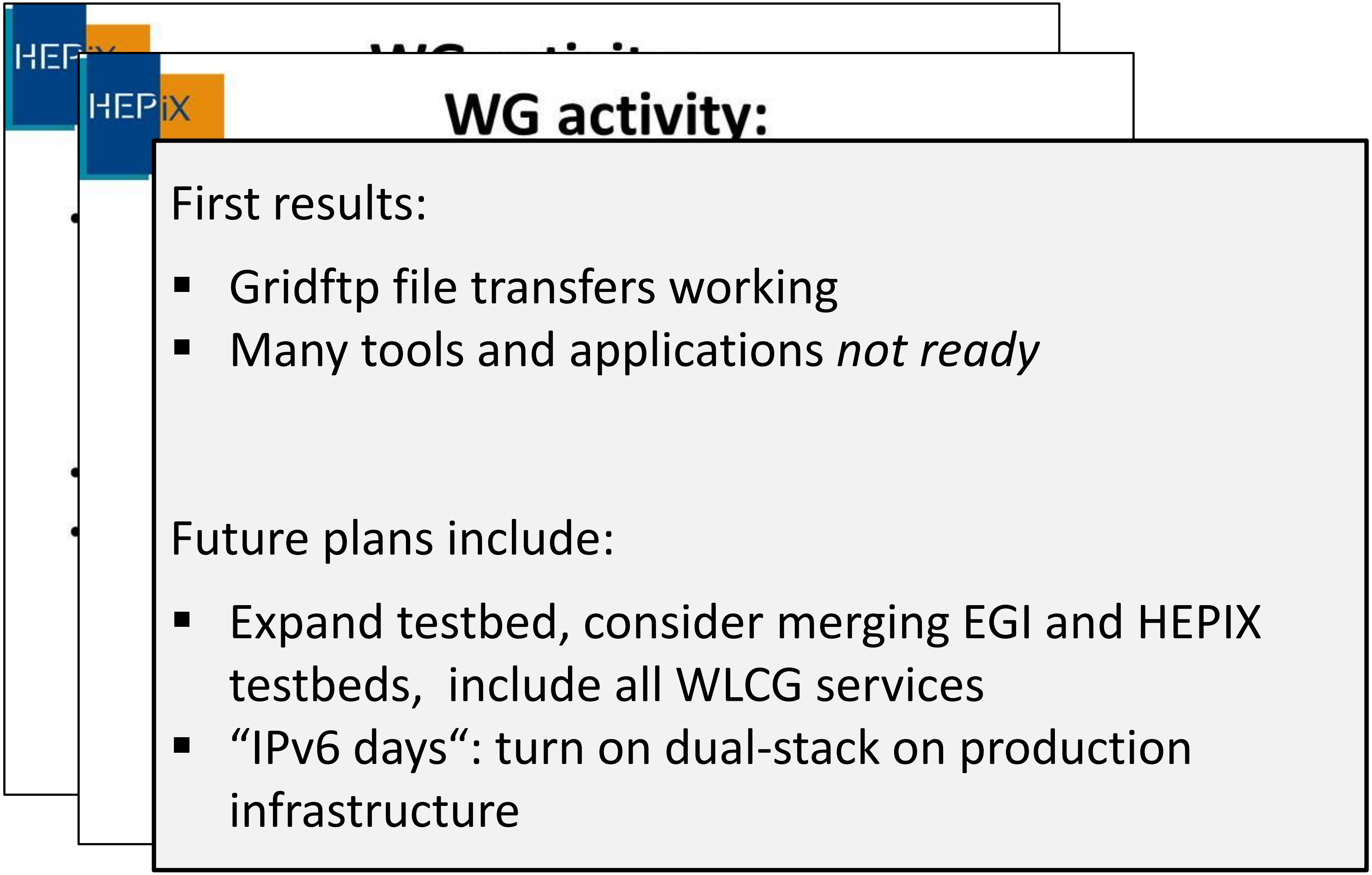
A place where to gain real experience

Implemented on real networks, in a distributed environment as close as possible to production

Open to anyone in WLCG

To test applications over IPv6 but also in the dual-stack cohabitation

Networking



WG activity:

First results:

- Gridftp file transfers working
- Many tools and applications *not ready*

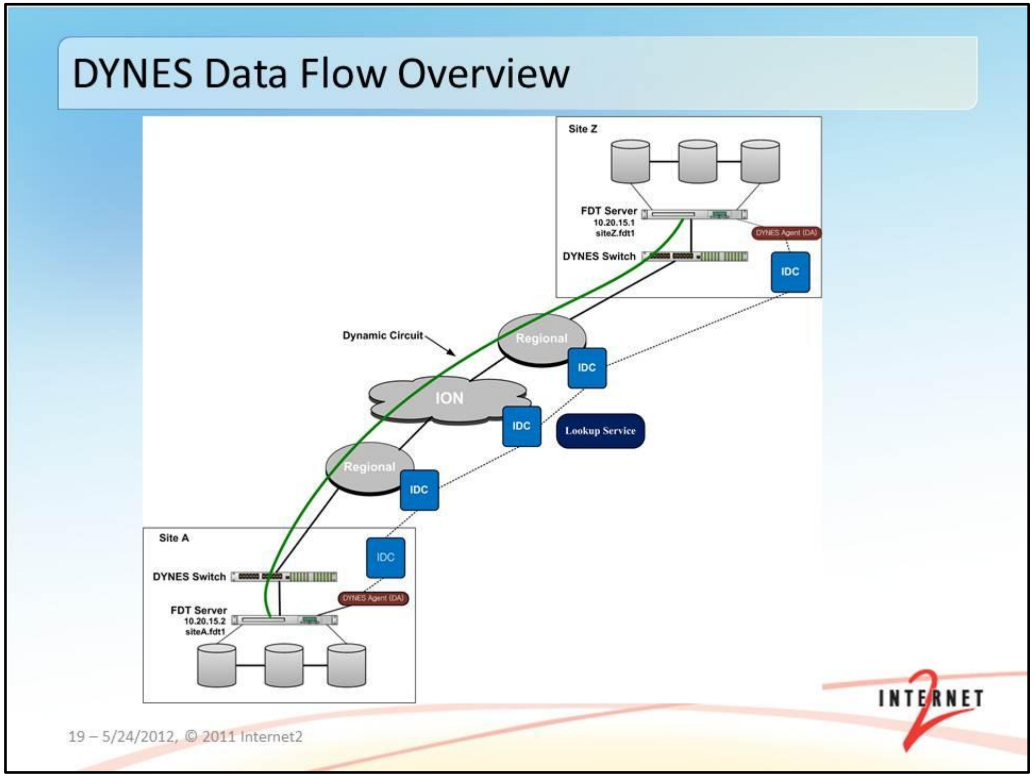
Future plans include:

- Expand testbed, consider merging EGI and HEPIX testbeds, include all WLCG services
- “IPv6 days“: turn on dual-stack on production infrastructure

Networking

Jason Zurawski: The DYNES Instrument: A Description and Overview

- A “Cyber-instrument“ extending Internet2‘s ION (on-demand network) service to regional and campus networks.
- Support large, long-distance science data flows
- ~40 US universities and 12 Internet2 connectors



DYNES Data Flow Overview

19 – 5/24/2012, © 2011 Internet2

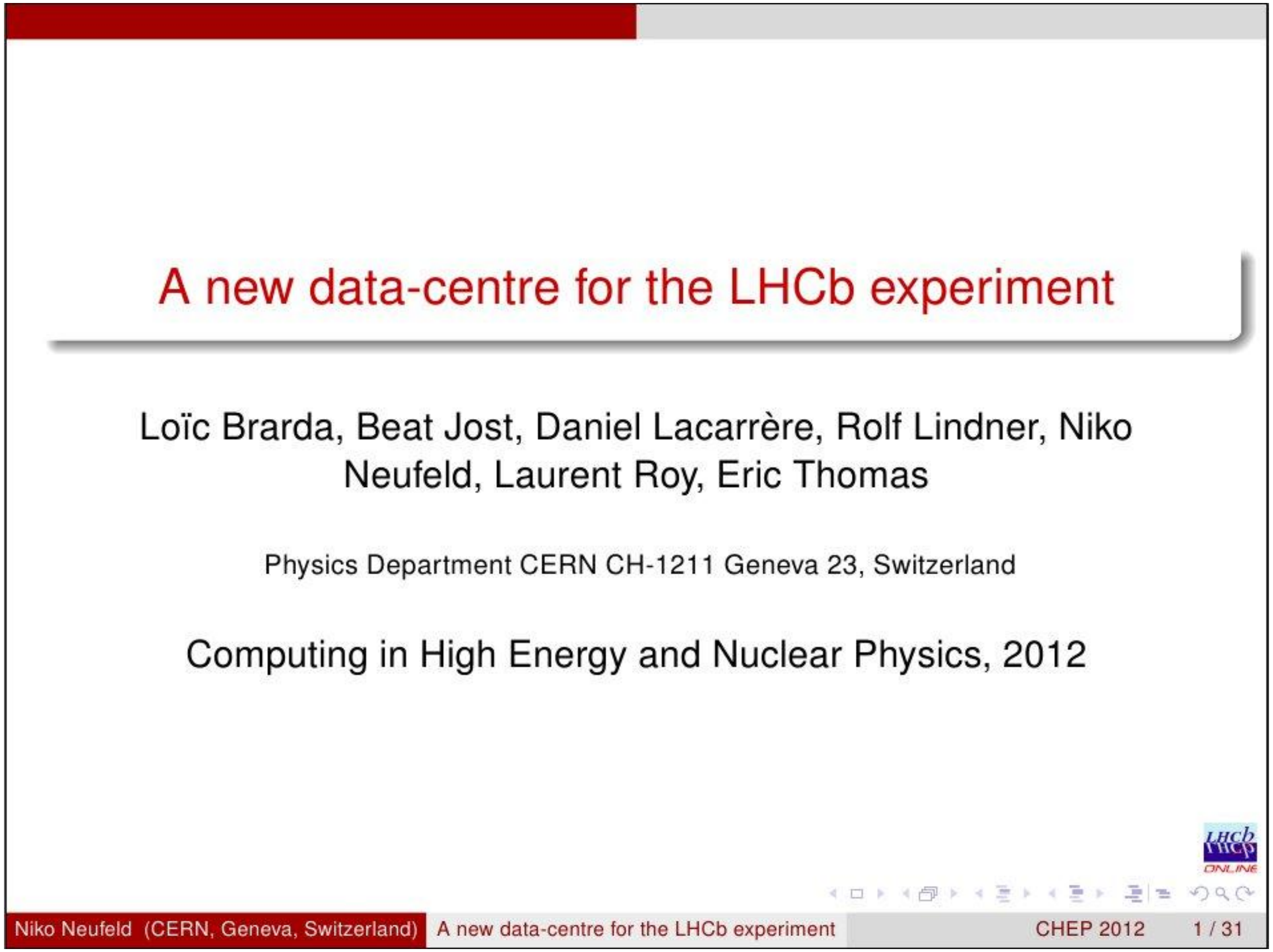
Out-of-the-box solution. Each site needs:

- Inter-domain (IDC) controller
- Dynes switch
- FDT server
- Storage

Resource Centres

New event filter farm and data centre for LHCb for the time after LS2

- Upgraded DAQ capable of reading out the entire detector @ 40 MHz



A new data-centre for the LHCb experiment

Loïc Brarda, Beat Jost, Daniel Lacarrère, Rolf Lindner, Niko Neufeld, Laurent Roy, Eric Thomas

Physics Department CERN CH-1211 Geneva 23, Switzerland

Computing in High Energy and Nuclear Physics, 2012

Niko Neufeld (CERN, Geneva, Switzerland) A new data-centre for the LHCb experiment CHEP 2012 1 / 31

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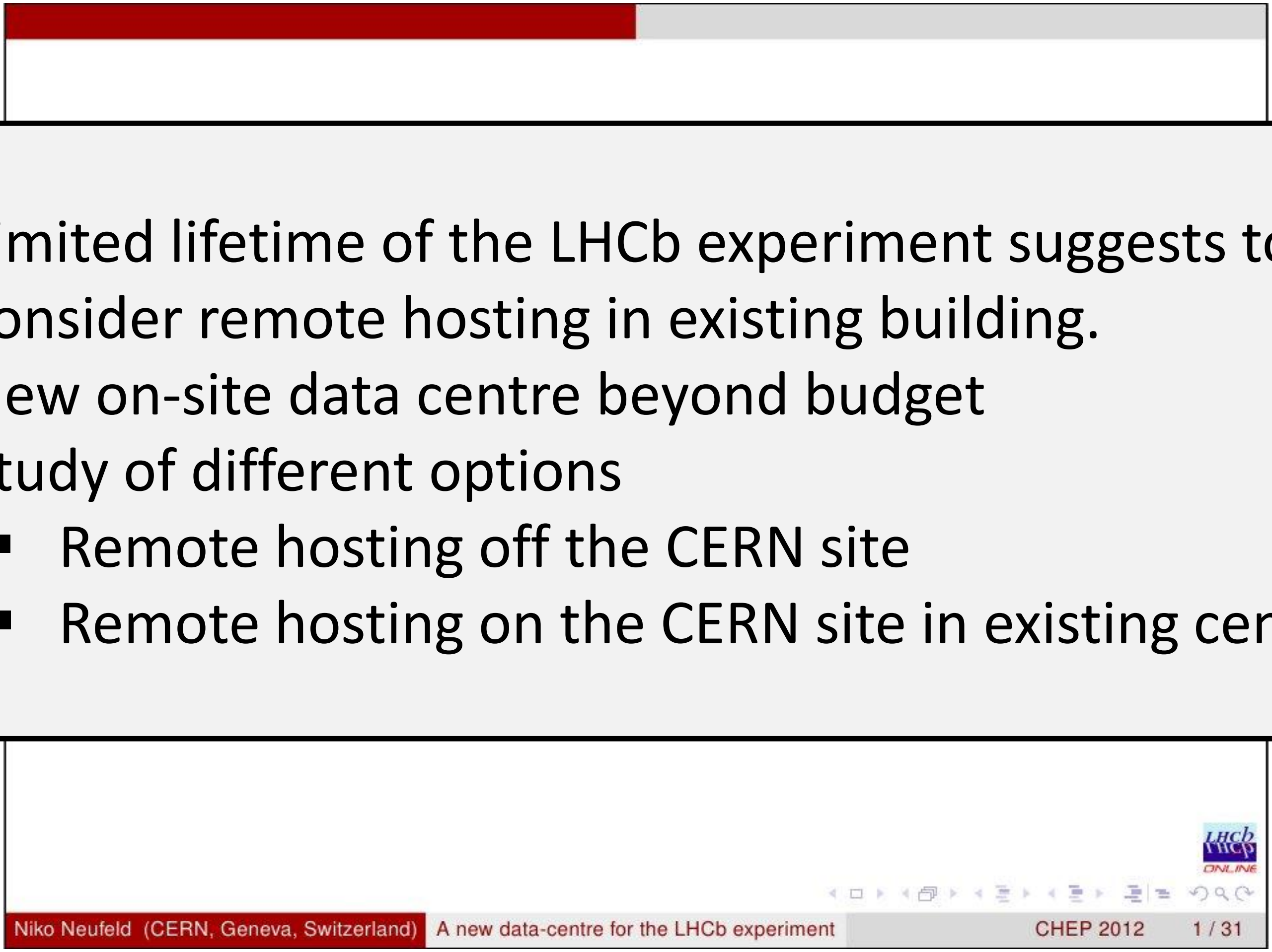

Niko Neufeld (CERN, Geneva, Switzerland) A new data-centre for the LHCb experiment CHEP 2012 1 / 31

- Limited lifetime of the LHCb experiment suggests to consider remote hosting in existing building.
- New on-site data centre beyond budget
- Study of different options
  - Remote hosting off the CERN site
  - Remote hosting on the CERN site in existing centre

Resource Centres

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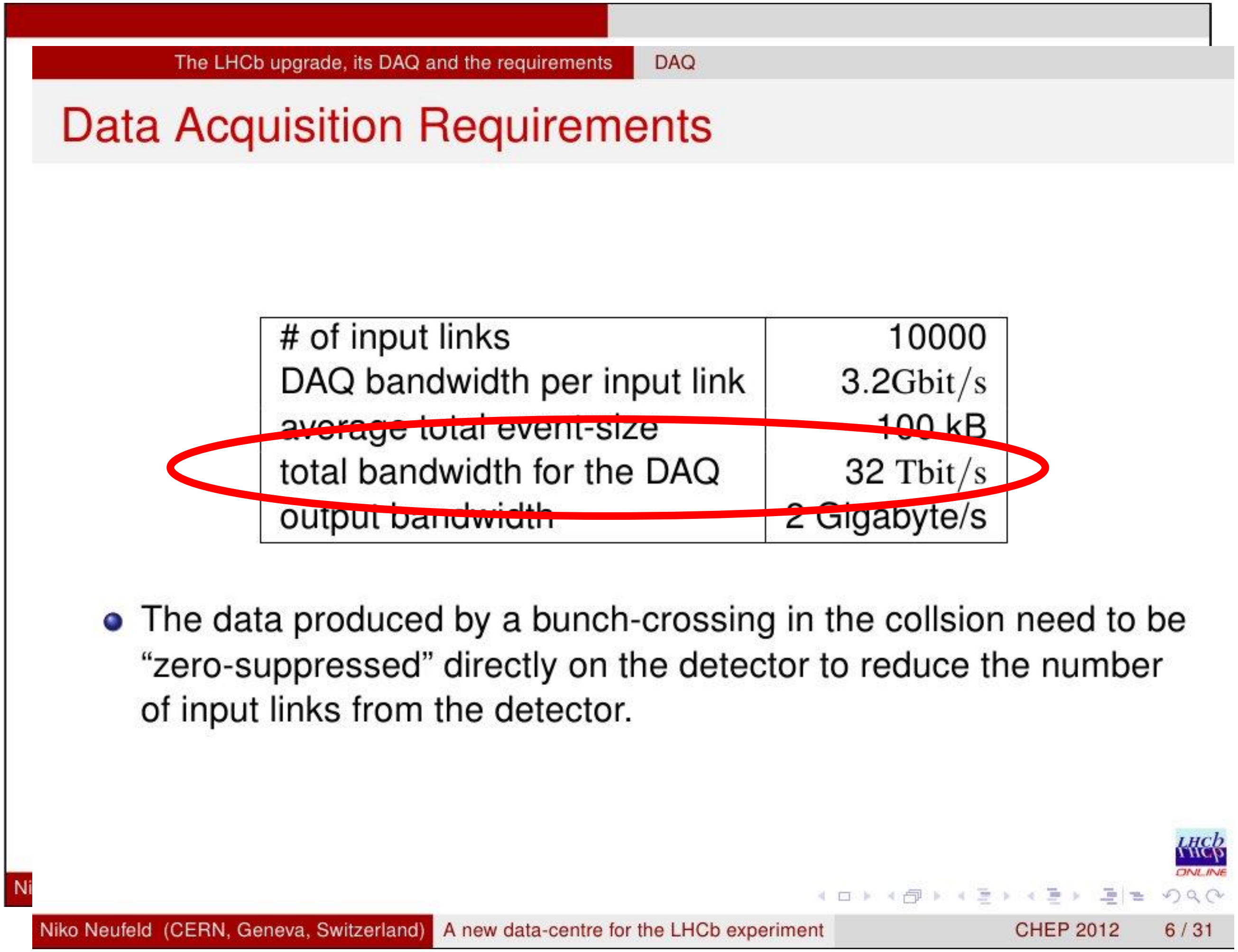

The LHCb upgrade, its DAQ and the requirements DAQ

Data Acquisition Requirements

# of input links	10000
DAQ bandwidth per input link	3.2Gbit/s
average total event-size	100 kB
total bandwidth for the DAQ	32 Tbit/s
output bandwidth	2 Gigabyte/s

- The data produced by a bunch-crossing in the collsion need to be “zero-suppressed” directly on the detector to reduce the number of input links from the detector.

Niko Neufeld (CERN, Geneva, Switzerland) A new data-centre for the LHCb experiment CHEP 2012 6 / 31

Resource Centres

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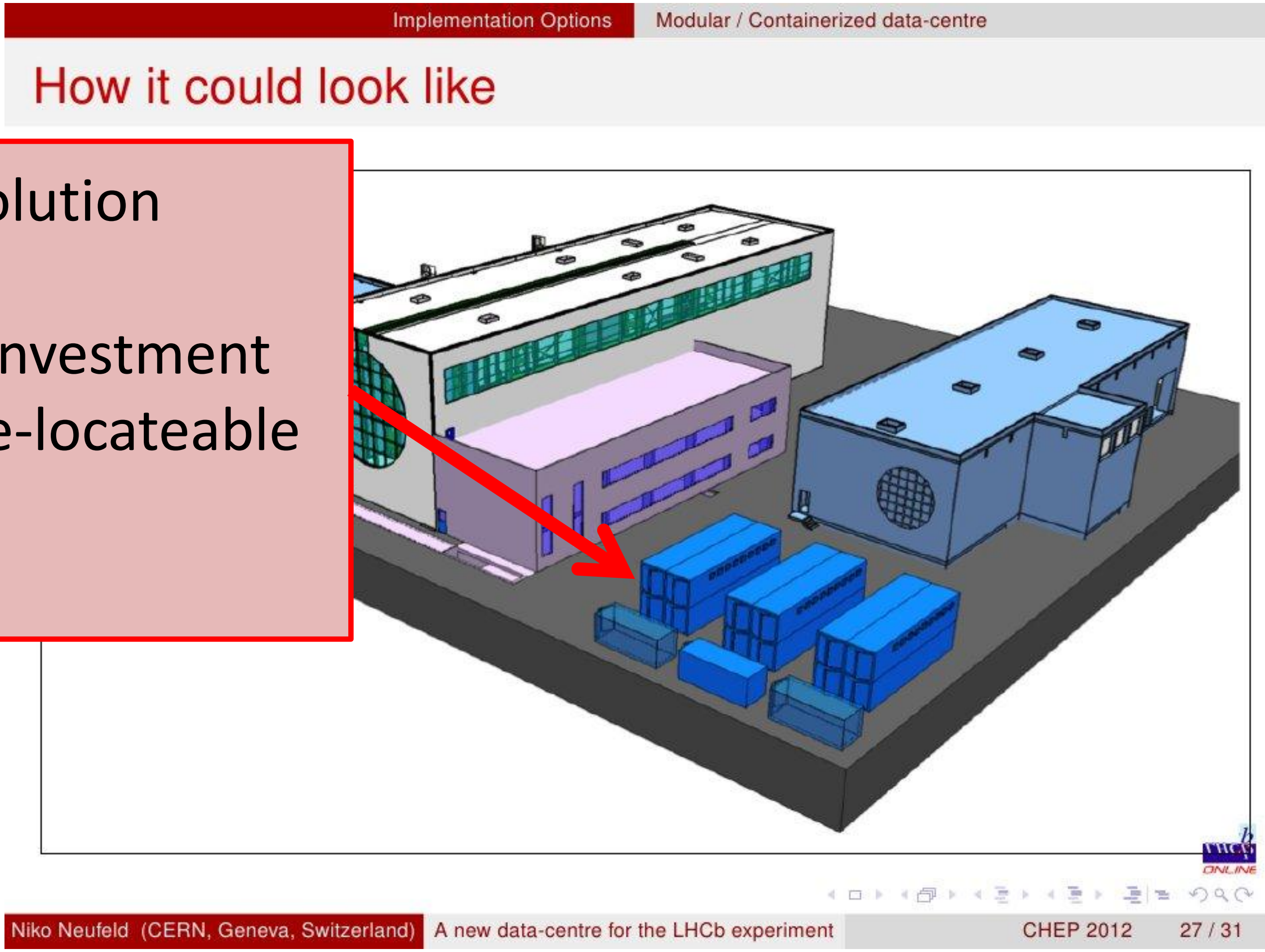


Implementation Options | Modular / Containerized data-centre

How it could look like

Niko Neufeld (CERN, Geneva, Switzerland) | A new data-centre for the LHCb experiment | CHEP 2012 | 27 / 31

- Containerized solution advantages:
  - Low capital investment
  - Re-usable, re-locateable
  - Low PUE
  - On-site

Resource Centres

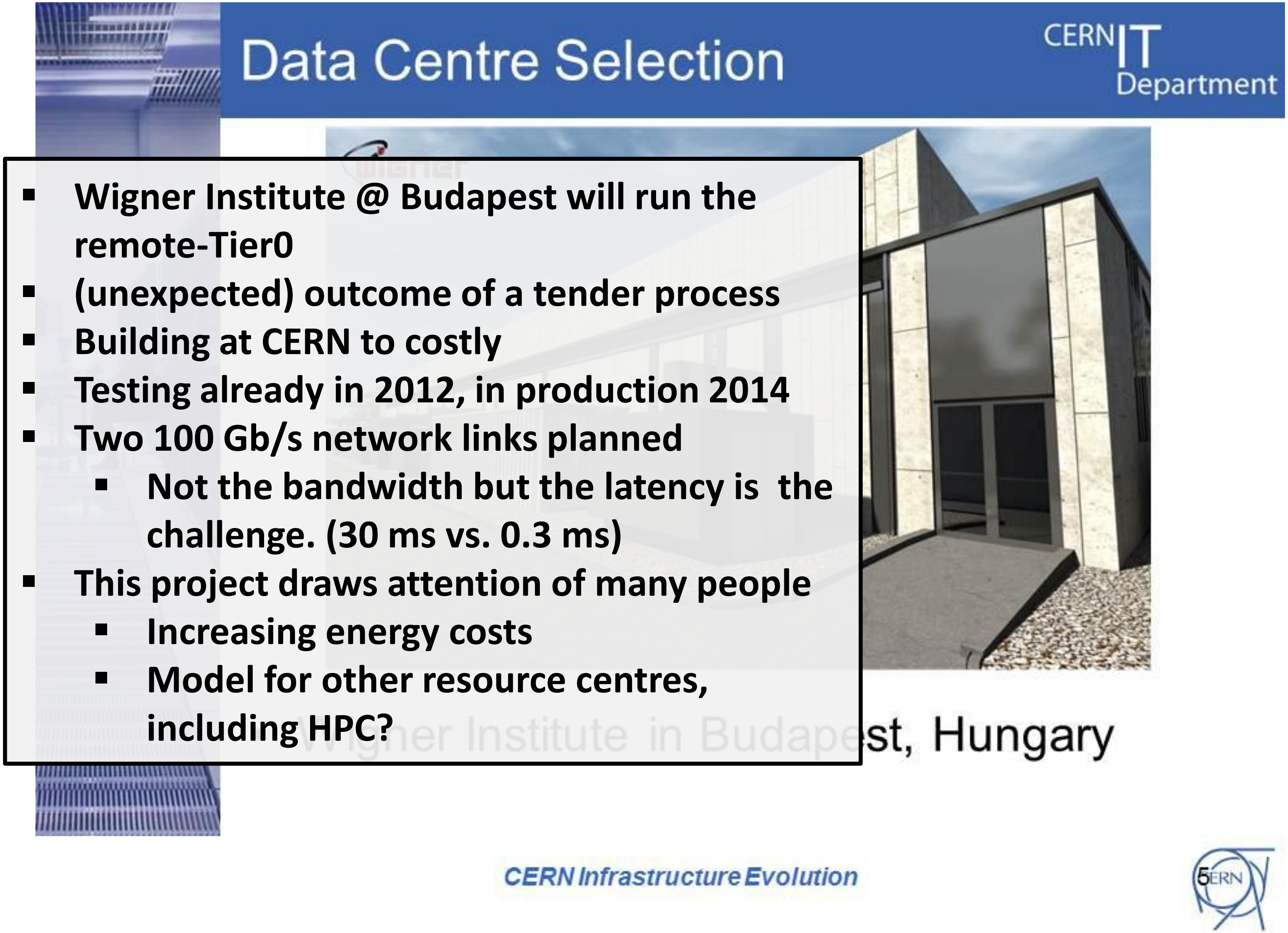
Data Centre Selection

CERN IT Department

- Wigner Institute in Budapest, Hungary

Resource Centres

- Wigner Institute @ Budapest will run the remote-Tier0
- (unexpected) outcome of a tender process
- Building at CERN to costly
- Testing already in 2012, in production 2014
- Two 100 Gb/s network links planned
  - Not the bandwidth but the latency is the challenge. (30 ms vs. 0.3 ms)
- This project draws attention of many people
  - Increasing energy costs
  - Model for other resource centres, including HPC?



Data Centre Selection

CERN IT Department

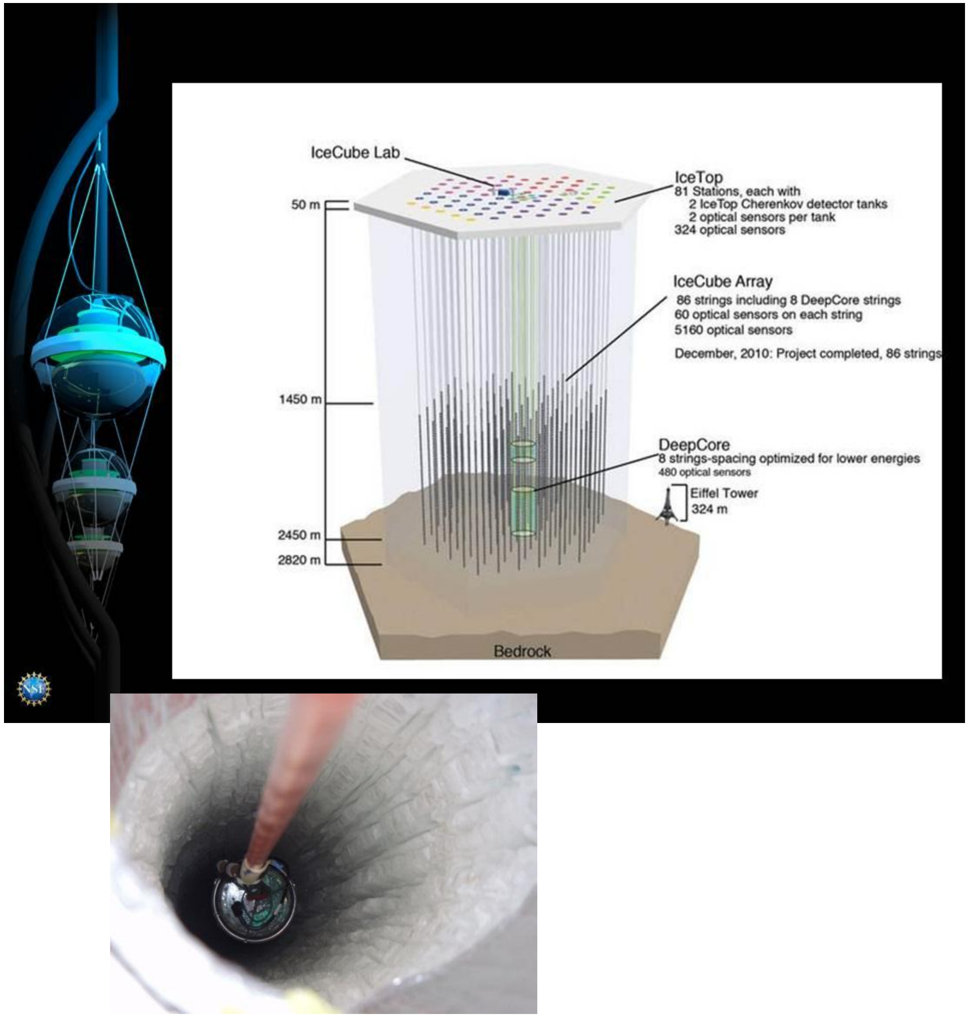
Wigner Institute in Budapest, Hungary

CERN Infrastructure Evolution

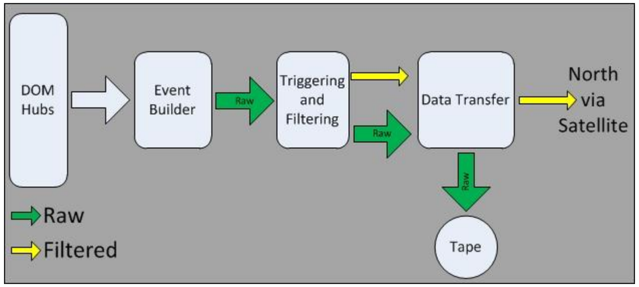
5

Non-LHC projects

Steve Barnet, University of Wisconsin: The Ice Cube Computing Model


IceCube Lab
IceTop
81 Stations, each with
2 IceTop Cherenkov detector tanks
2 optical sensors per tank
324 optical sensors
50 m
IceCube Array
86 strings including 8 DeepCore strings
60 optical sensors on each string
5160 optical sensors
December, 2010: Project completed, 86 strings
1450 m
DeepCore
8 strings-spacing optimized for lower energies
480 optical sensors
Eiffel Tower
324 m
2450 m
2820 m
Bedrock

- 1 TB of RAW data per day
- Satellite capacity: 100 GB per day



Tier-0: Madison, Wisconsin

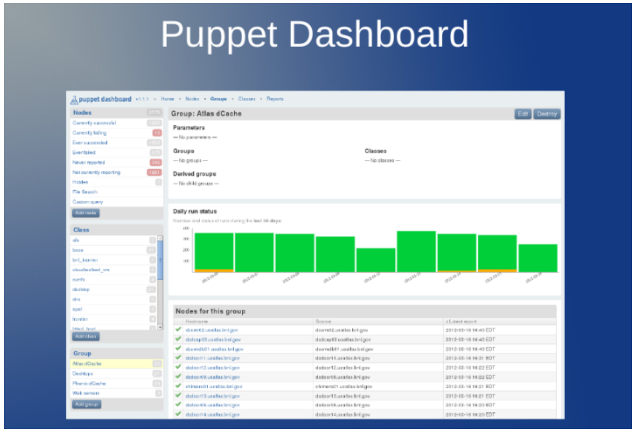
- RAW data
- Event selection

Tier-1: Zeuthen, Germany

- Copy of reconstructed data
- MC production and store

Other Topics

Fabric Management: The winner is …. Puppet (+ GIT + ….)



Group: Atlas dCache

Parameters
— No parameters —

Groups
— No groups —

Classes
— No classes —

Derived groups
— No child groups —

Nodes for this group

	Hostname	Source	Latest report
✓	dcsrm02.usatlas.bnl.gov	dcsrm02.usatlas.bnl.gov	2012-03-16 16:40 EDT
✓	dcdcap03.usatlas.bnl.gov	dcdcap03.usatlas.bnl.gov	2012-03-16 16:40 EDT
✓	dcsrmdb01.usatlas.bnl.gov	dcsrmdb01.usatlas.bnl.gov	2012-03-16 16:40 EDT
✓	dcdoor11.usatlas.bnl.gov	dcdoor11.usatlas.bnl.gov	2012-03-16 16:31 EDT
✓	dcdoor12.usatlas.bnl.gov	dcdoor12.usatlas.bnl.gov	2012-03-16 16:22 EDT
✓	dcdoor08.usatlas.bnl.gov	dcdoor08.usatlas.bnl.gov	2012-03-16 16:22 EDT
✓	chimera01.usatlas.bnl.gov	chimera01.usatlas.bnl.gov	2012-03-16 16:21 EDT
✓	dcdoor13.usatlas.bnl.gov	dcdoor13.usatlas.bnl.gov	2012-03-16 16:21 EDT
✓	dcdoor06.usatlas.bnl.gov	dcdoor06.usatlas.bnl.gov	2012-03-16 16:20 EDT
✓	dcdoor14.usatlas.bnl.gov	dcdoor14.usatlas.bnl.gov	2012-03-16 16:20 EDT

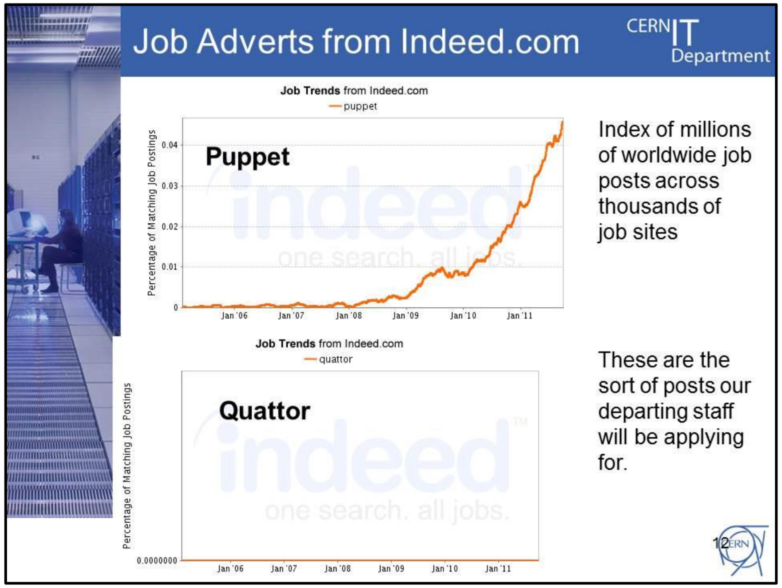
Jason Smith, BNL: Centralized Fabric Management Using Puppet, Git, and GLPI

Jason Smith, BNL:

- Powerful language
- Large user base and developer community
- Dashboard

Tim Bell, CERN:

- Maintenance costs for own tool too high
- CERN compute centre size not longer leading edge
- Meanwhile many open source solutions available
- Puppet: Large user an support community
- Better chances on the job market!



Job Adverts from Indeed.com

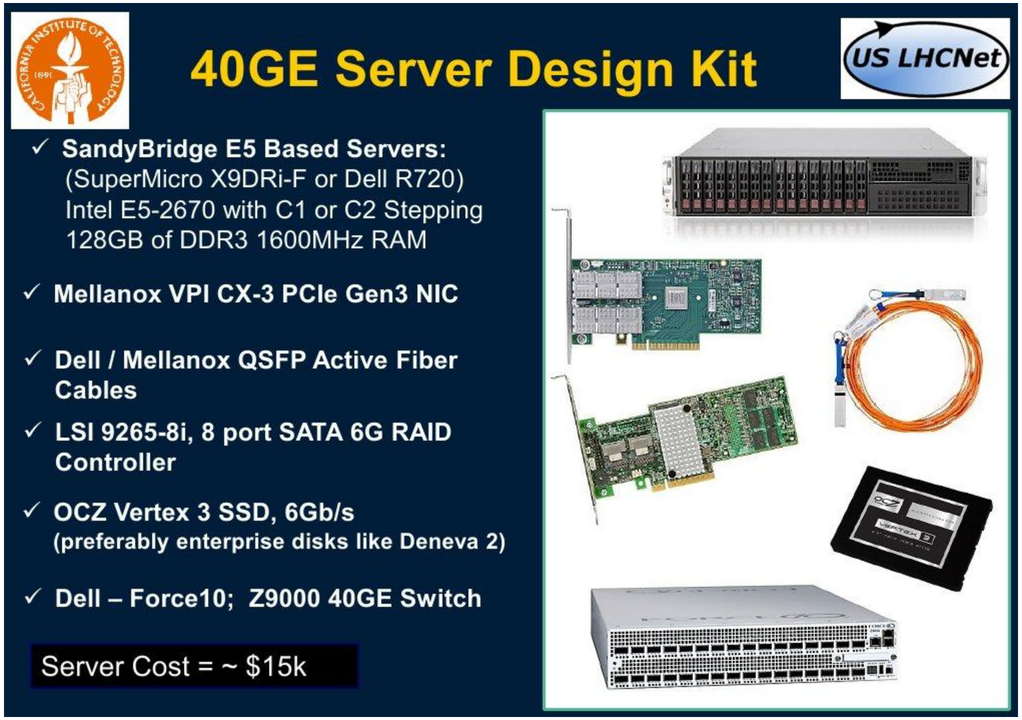
Index of millions of worldwide job posts across thousands of job sites

These are the sort of posts our departing staff will be applying for.

Tim Bell: Review of CERN Computer Centre Infrastructure

Other topics

Azher Mughal, Caltech: Evaluation of 40 Gigabit Ethernet technology for data servers



40GE Server Design Kit

US LHCNet

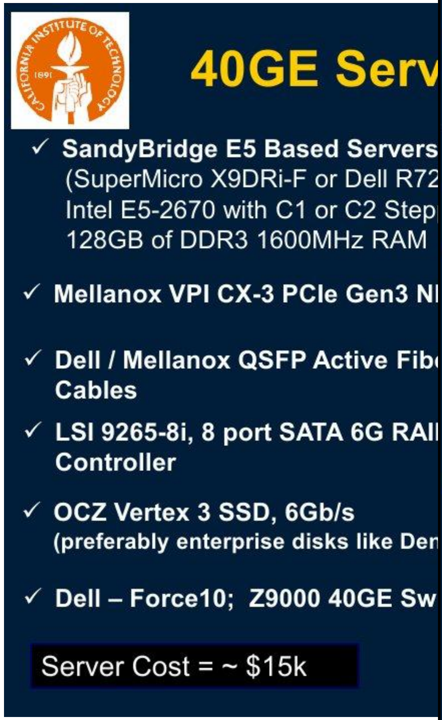
- ✓ SandyBridge E5 Based Servers:
  (SuperMicro X9DRi-F or Dell R720)
  Intel E5-2670 with C1 or C2 Stepping
  128GB of DDR3 1600MHz RAM
- ✓ Mellanox VPI CX-3 PCIe Gen3 NIC
- ✓ Dell / Mellanox QSFP Active Fiber Cables
- ✓ LSI 9265-8i, 8 port SATA 6G RAID Controller
- ✓ OCZ Vertex 3 SSD, 6Gb/s
  (preferably enterprise disks like Deneva 2)
- ✓ Dell – Force10; Z9000 40GE Switch

Server Cost = ~ $15k

- Hardware and software tuning is necessary:
  - Latest firmwares
  - Enable PCIe Gen3
  - Bind NIC driver to CPU where PCIe lane is connected
  - Move raid driver IRQ to second CPU
  - Bind file transfer application (FDT) to second CPU.
  - Change kernel parameters
  - …

Other topics

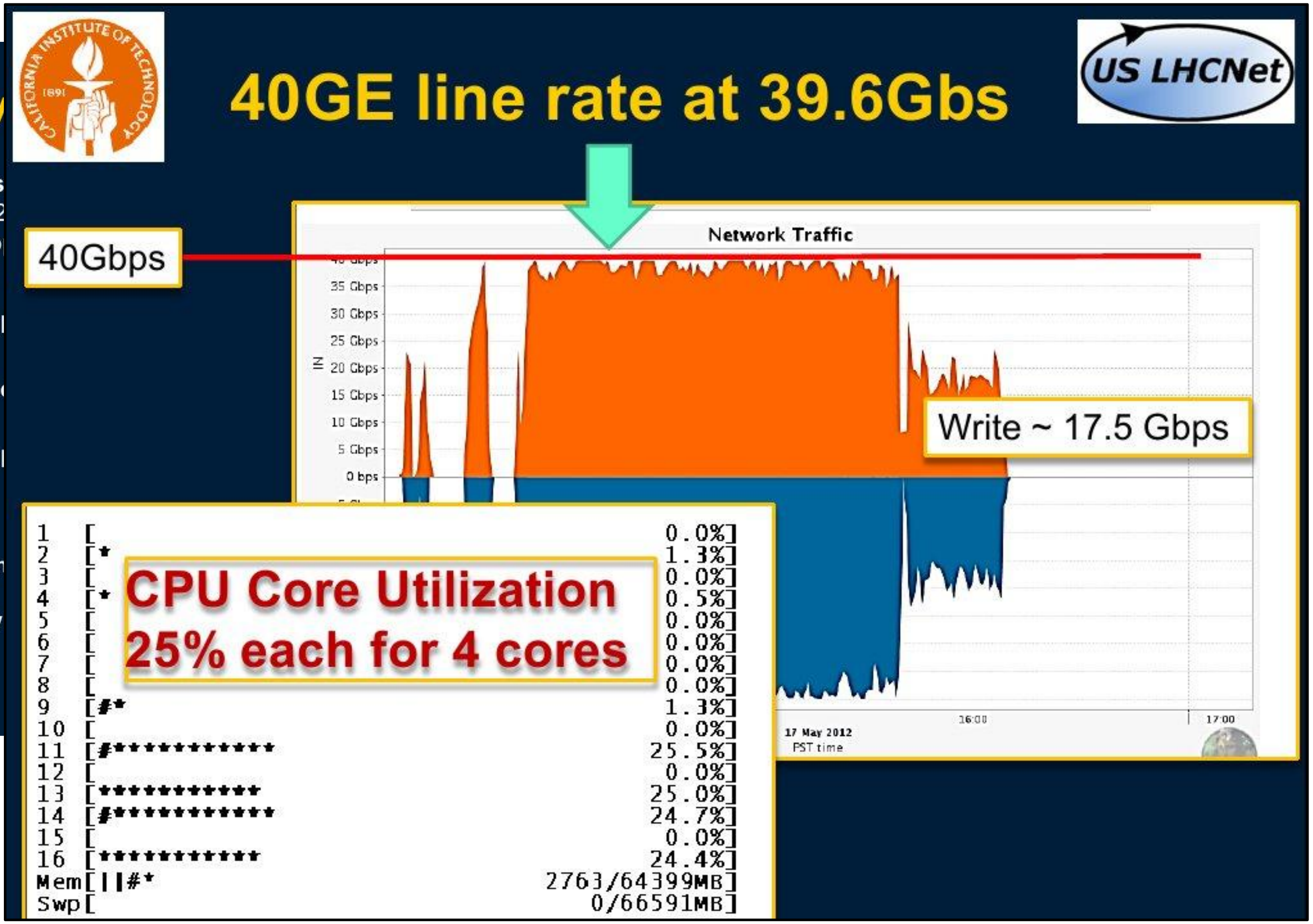
Azher Mughal, Caltech: Evaluation of 40 Gigabit Ethernet technology for data servers



40GE Serv

- ✓ **SandyBridge E5 Based Servers** (SuperMicro X9DRi-F or Dell R72 Intel E5-2670 with C1 or C2 Step 128GB of DDR3 1600MHz RAM
- ✓ **Mellanox VPI CX-3 PCIe Gen3 NI**
- ✓ **Dell / Mellanox QSFP Active Fib Cables**
- ✓ **LSI 9265-8i, 8 port SATA 6G RAI Controller**
- ✓ **OCZ Vertex 3 SSD, 6Gb/s** (preferably enterprise disks like Den
- ✓ **Dell – Force10; Z9000 40GE Sw**

Server Cost = ~ $15k



40GE line rate at 39.6Gbs

Write ~ 17.5 Gbps

CPU Core Utilization
25% each for 4 cores

```
1   [                                           0.0%]
2   [*                                          1.3%]
3   [                                           0.0%]
4   [*                                          0.5%]
5   [                                           0.0%]
6   [                                           0.0%]
7   [                                           0.0%]
8   [                                           0.0%]
9   [#*                                         1.3%]
10  [                                           0.0%]
11  [#************                             25.5%]
12  [                                           0.0%]
13  [************                              25.0%]
14  [#************                             24.7%]
15  [                                           0.0%]
16  [************                              24.4%]
Mem[||#*                               2763/64399MB]
Swp[                                      0/66591MB]
```

Summary of the Summary

- CHEP 2010: many presentations about ‘practical experiences‘ with real data
- CHEP 2012: again more visionary presentations
  - Experiences from data taking still used to optimize systems, storage, networks, …
  - But also a lot of planning for the future
    - High luminosity running, improved detectors => more data
    - Scaling capacity, e.g.
      - CERN remote T0
      - LHCb data centre
      - Exploitation of next generation networks begins (40, 100 Gbit/s, bandwidth on demand).
    - Going mainstream, less custom tools, save (wo)manpower
  - Storage systems are still a hot topic!

Thanks

- to speakers and poster presenters for many interesting presentations
- to the audience of the parallel sessions for their interest and the vital discussions
- to the conference organizers for a great CHEP 2012!