



PNNL-SA-111922



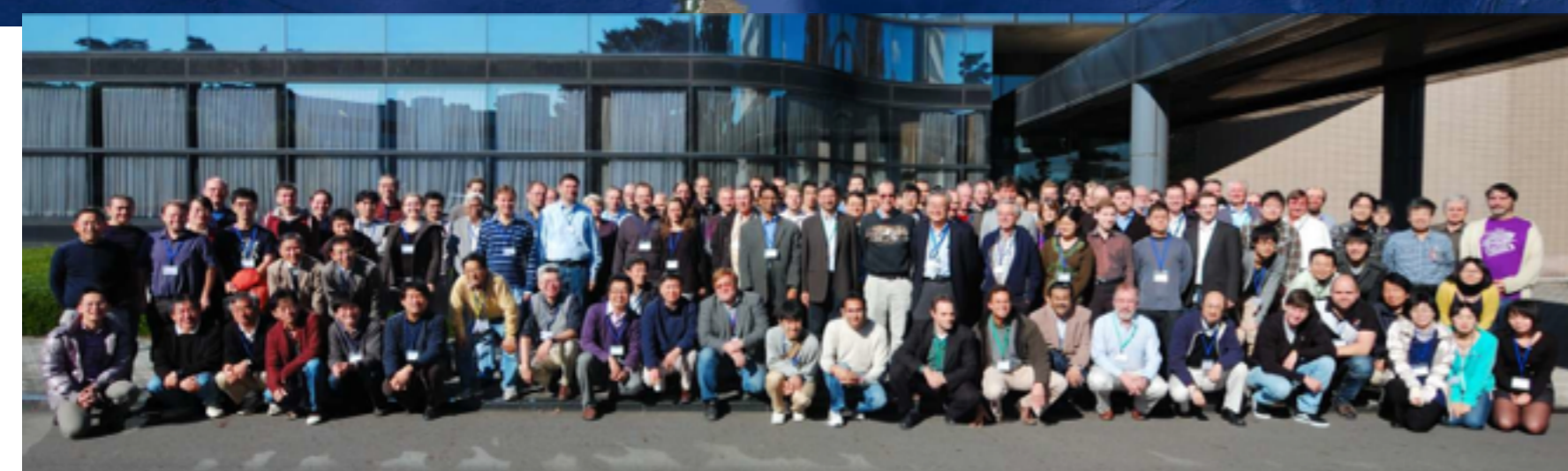
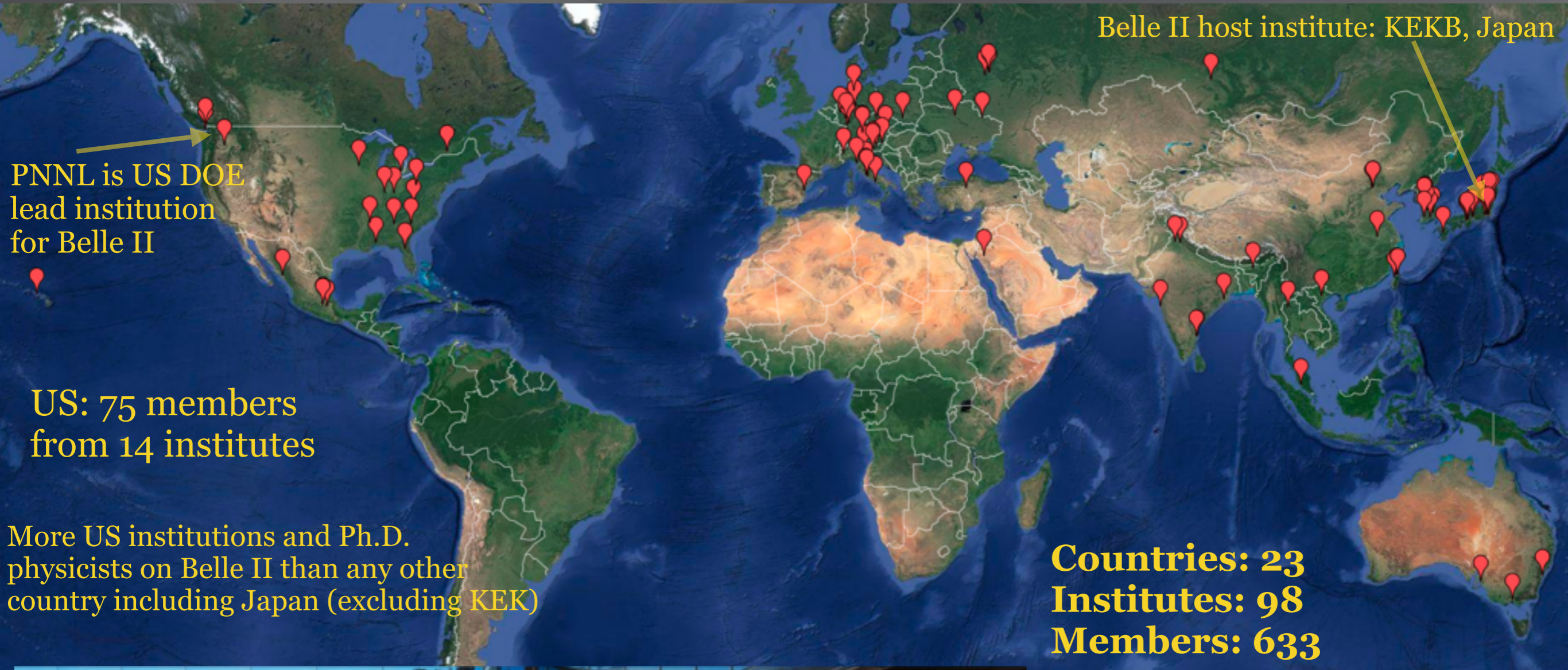
# GRID Computing at Belle II

VIKAS BANSAL

Pacific Northwest National Laboratory, Richland, WA

APS: Particles & Fields, Ann Arbor, MI, August 2015

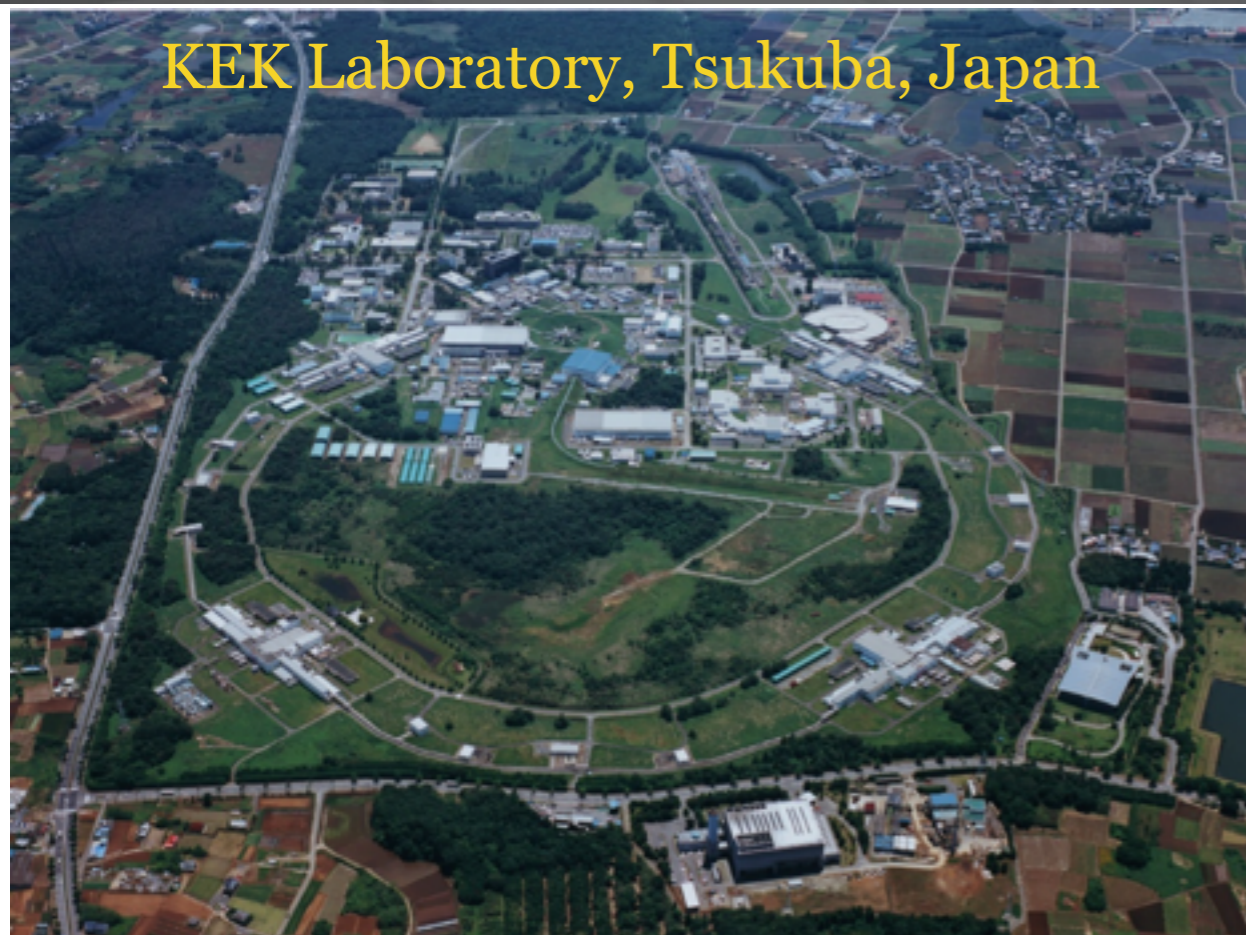
# Belle II Collaboration



c.f. CERN Greybook August 2015  
ATLAS: 40 countries, 215 inst., 7612 members  
CMS: 43 countries, 188 inst., 5868 members  
ALICE: 39 countries, 148 inst., 2422 members  
LHCb: 17 countries, 70 inst., 1358 members

# Computing requirements on par with LHC

## KEK Laboratory, Tsukuba, Japan



- ▶ The Belle II experiment is for Super B factory at KEK in Japan.
- ▶ Complementary physics to the LHC based on precision measurements from high-intensity beams.
- ▶ Total integrated luminosity :  $50 \text{ ab}^{-1}$
- ▶ Collisions start in October 2017.
- ▶ Similar data rate as from LHC experiments.

- ▶ Raw Data Size: 300 KB / event
- ▶ mDST Size: 40 KB / event
- ▶ Skim Size: 40 KB / event
- ▶ User Analysis Data Size: 4 KB / event

Data / Year	2016	2017	2018
Disk [TB]	4000	8000	9000
Tape [TB]	1000	3000	5000
CPU[kHepSPEC06]	200	300	350

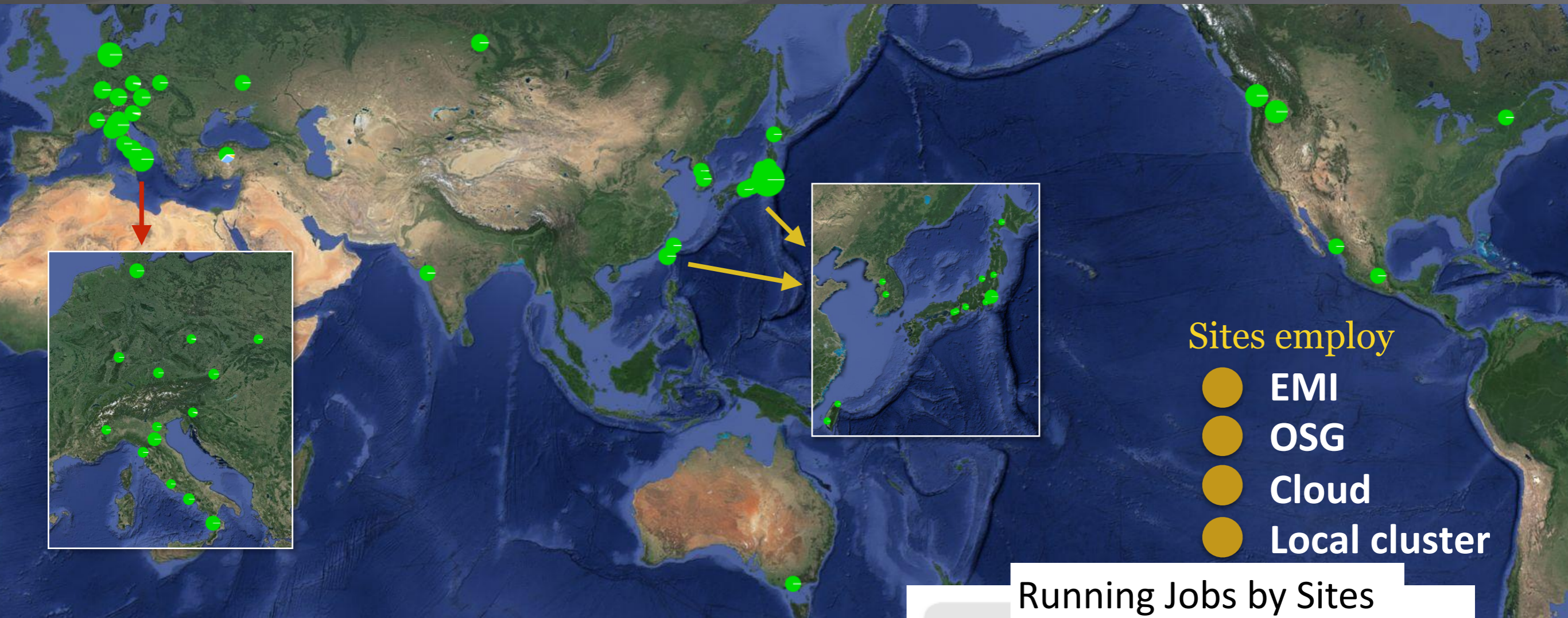
Resource sharing according to PhD count  
Tape storage only at KEK and PNNL

# Belle II computing sites across the globe

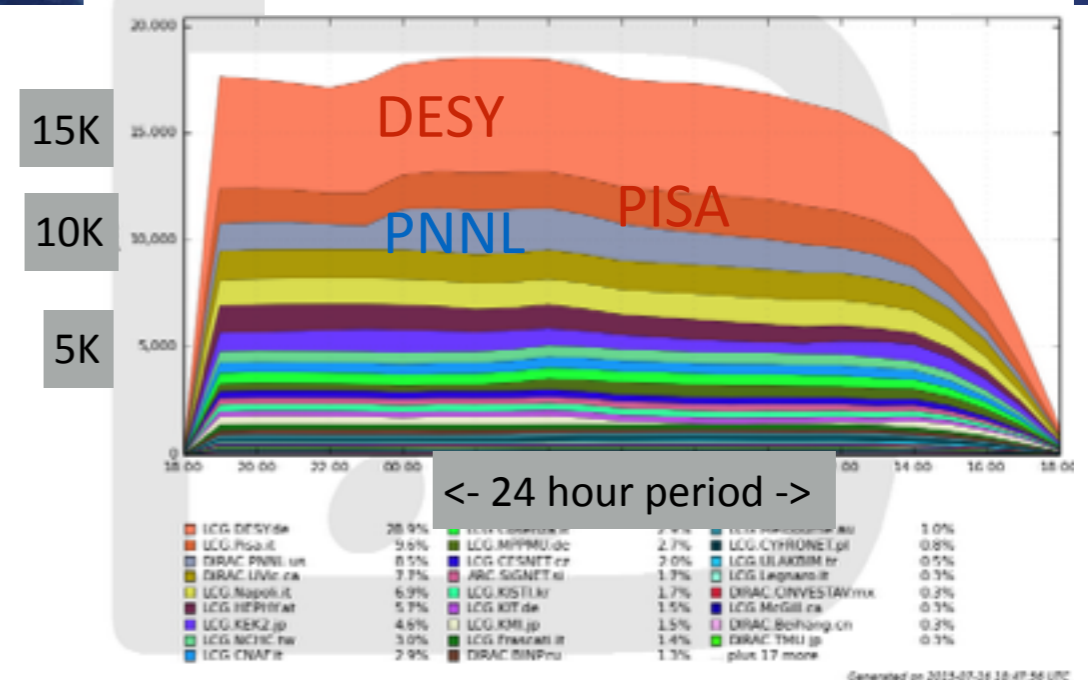


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Running Jobs by Sites



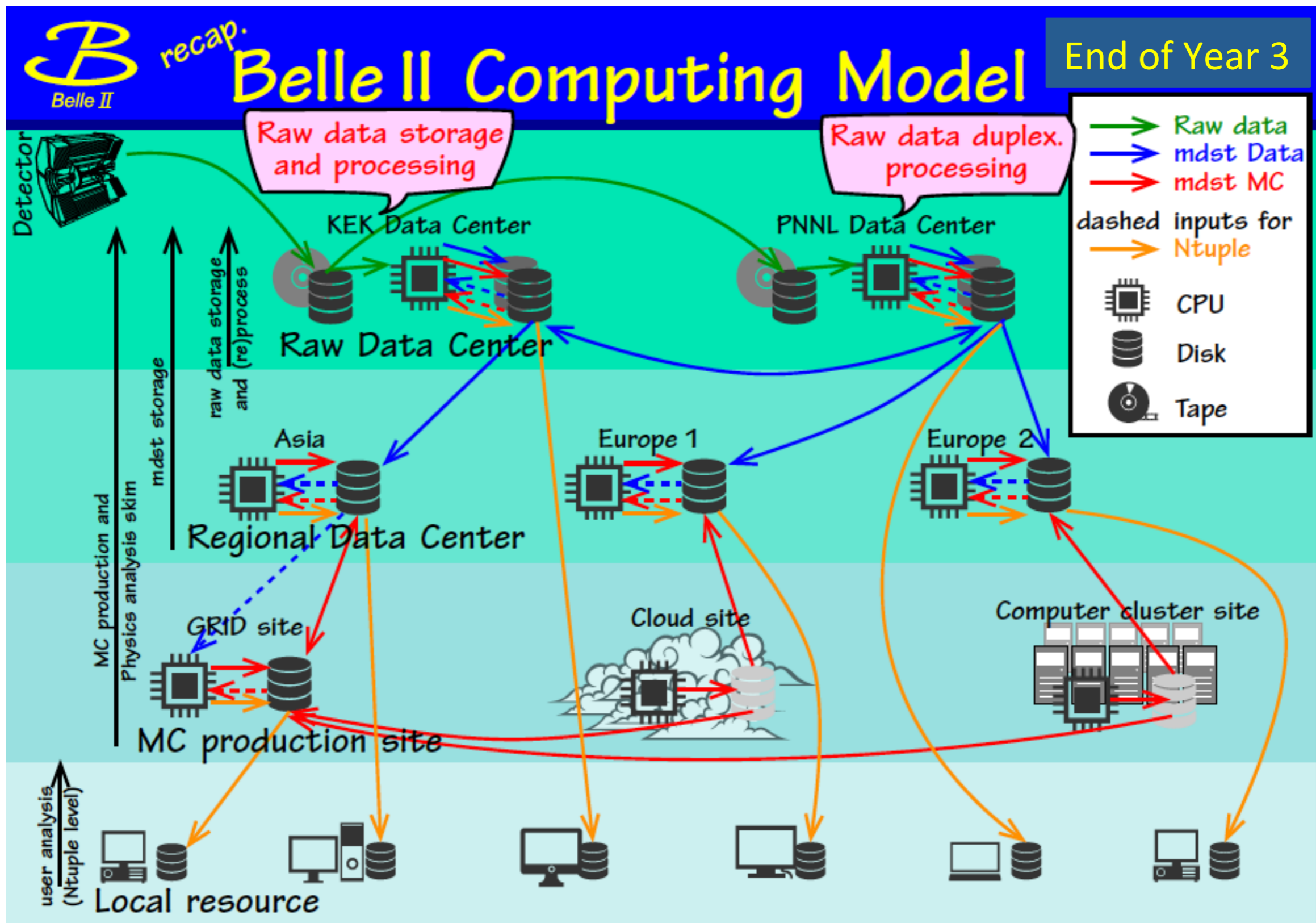
Resources spread across the globe

# Belle II computing model until Year 3



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# Belle II raw data distribution



until Year 3

KEK Data Center  
(100%)

PNNL Data Center  
(100%)



**Scenario 1**  
(copy from KEK)

KEK Data Center  
(100%)

North America

PNNL Data Center  
(30%)

Canada Data Center  
(10%)

India Data Center  
(10%)

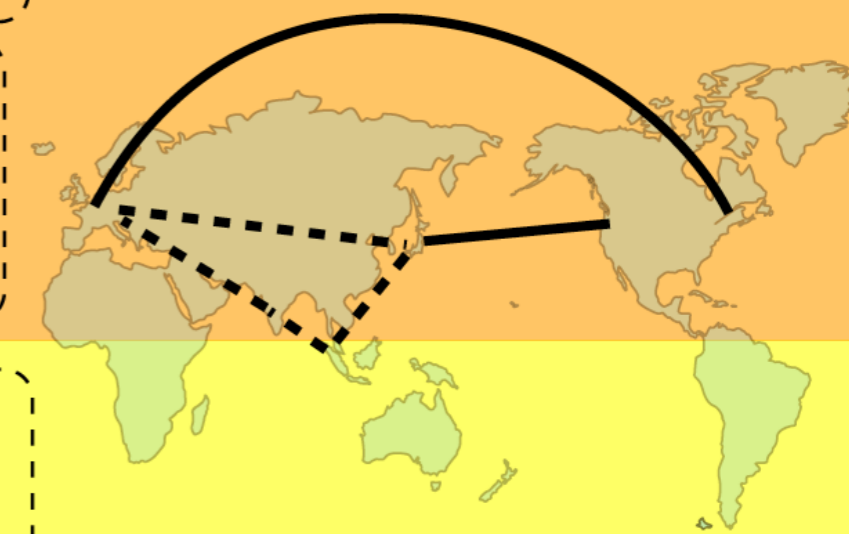
Korea Data Center  
(10%)

Asia

Germany Data Center  
(20%)

Italy Data Center  
(20%)

Europe



**Scenario 2**  
(2step copy, KEK → PNNL → Europe)

KEK Data Center  
(100%)

North America

PNNL Data Center  
(70% → 30%)

Canada Data Center  
(10%)

India Data Center  
(10%)

Korea Data Center  
(10%)

Asia

Germany Data Center  
(20%)

Italy Data Center  
(20%)

Europe

# Belle II grid network requirements

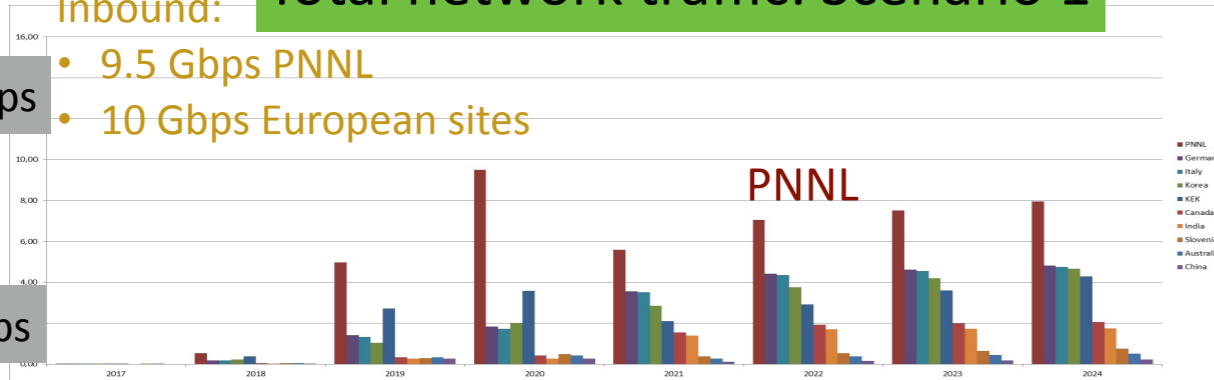
## Total network traffic: Scenario 1

Inbound:

- 9.5 Gbps PNNL
- 10 Gbps European sites

18 Gbps

2 Gbps

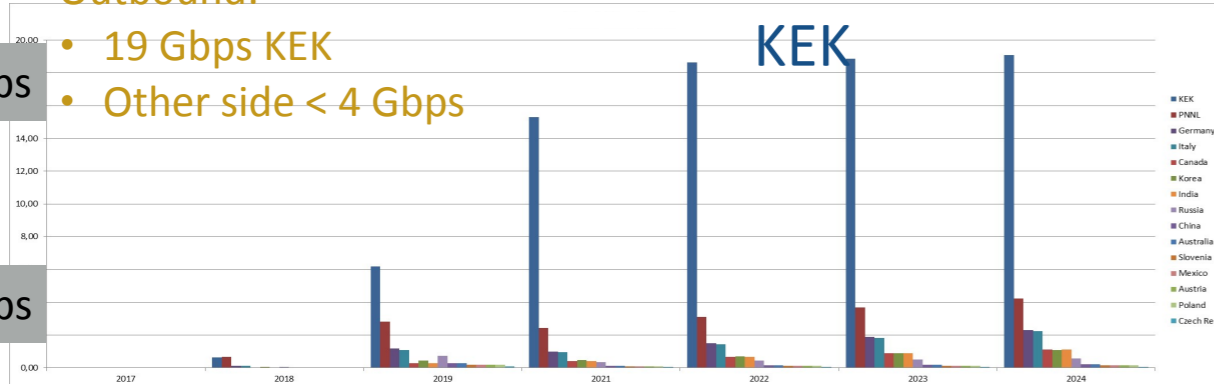


Outbound:

- 19 Gbps KEK
- Other side < 4 Gbps

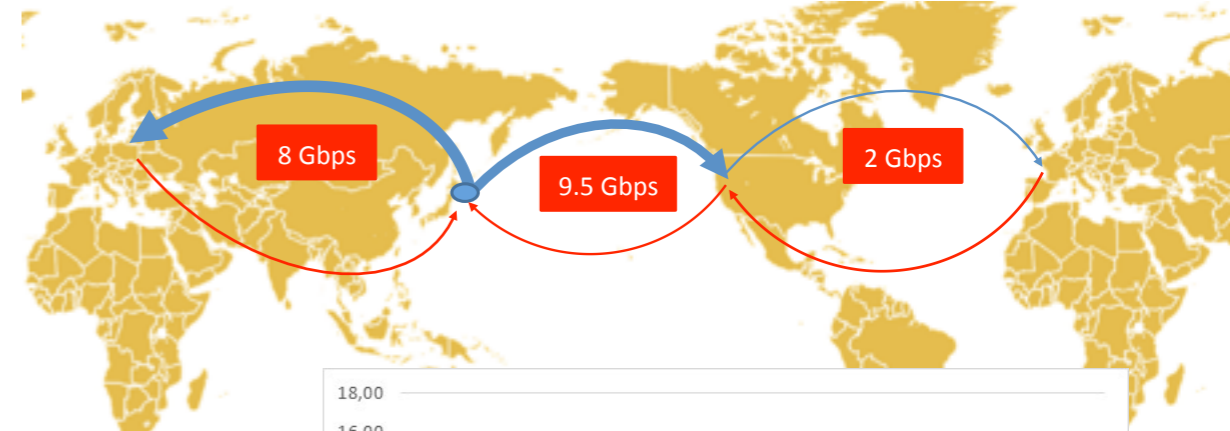
18 Gbps

2 Gbps



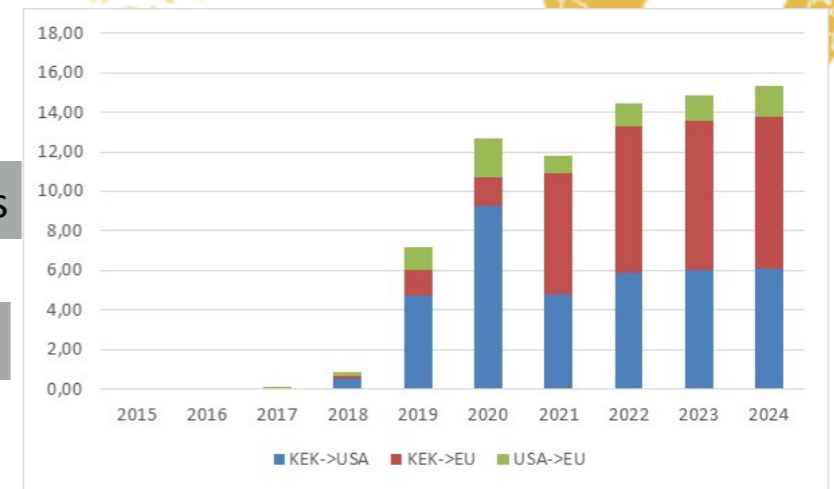
2017 2018 2019 2020 2021 2022 2023

## Trans oceanic links: Scenario 1

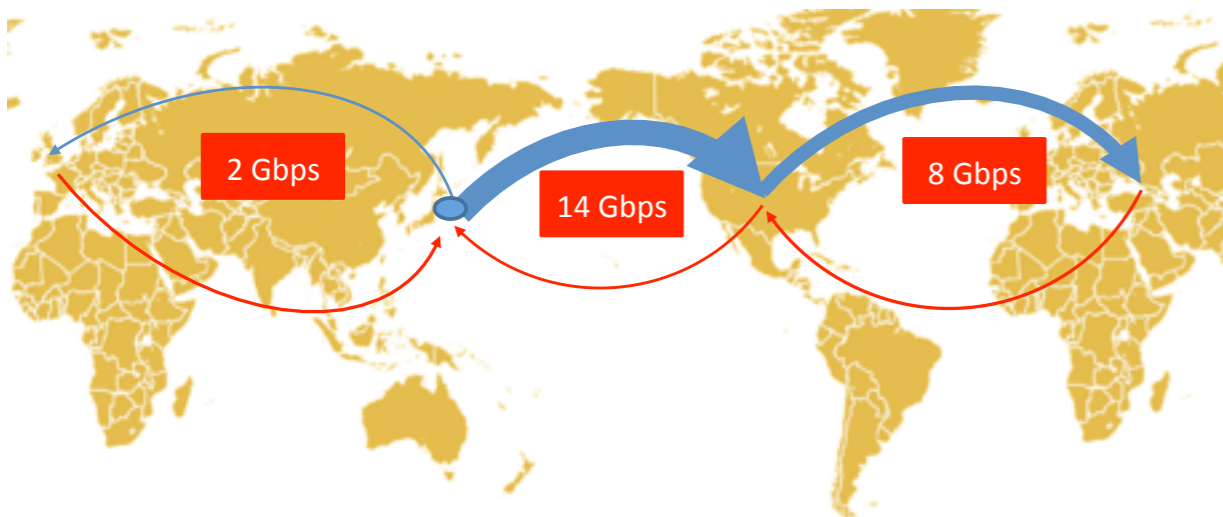


10 Gbps

2 Gbps

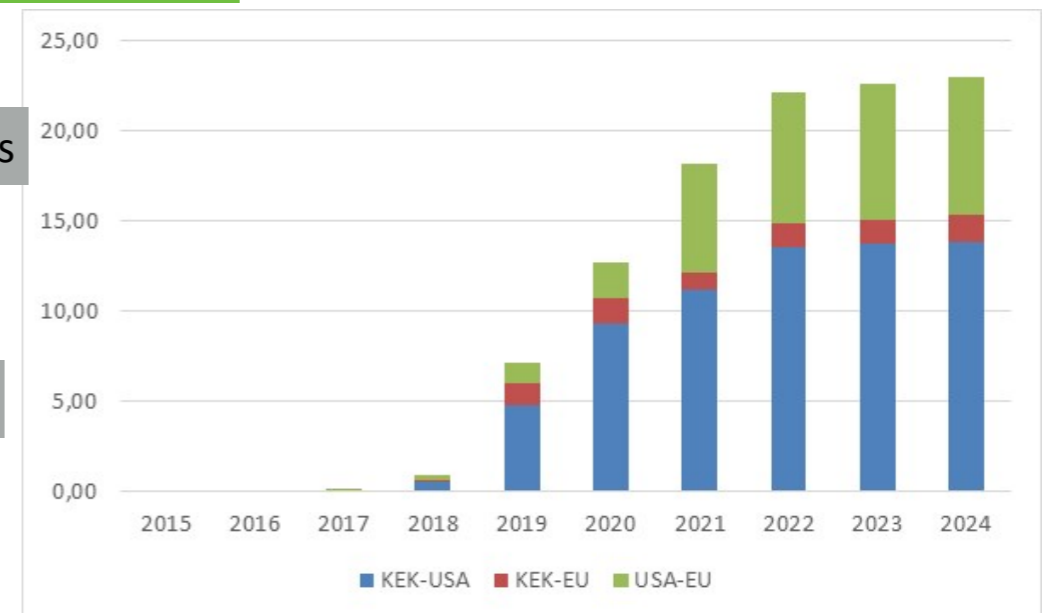


## Trans oceanic links: Scenario 2

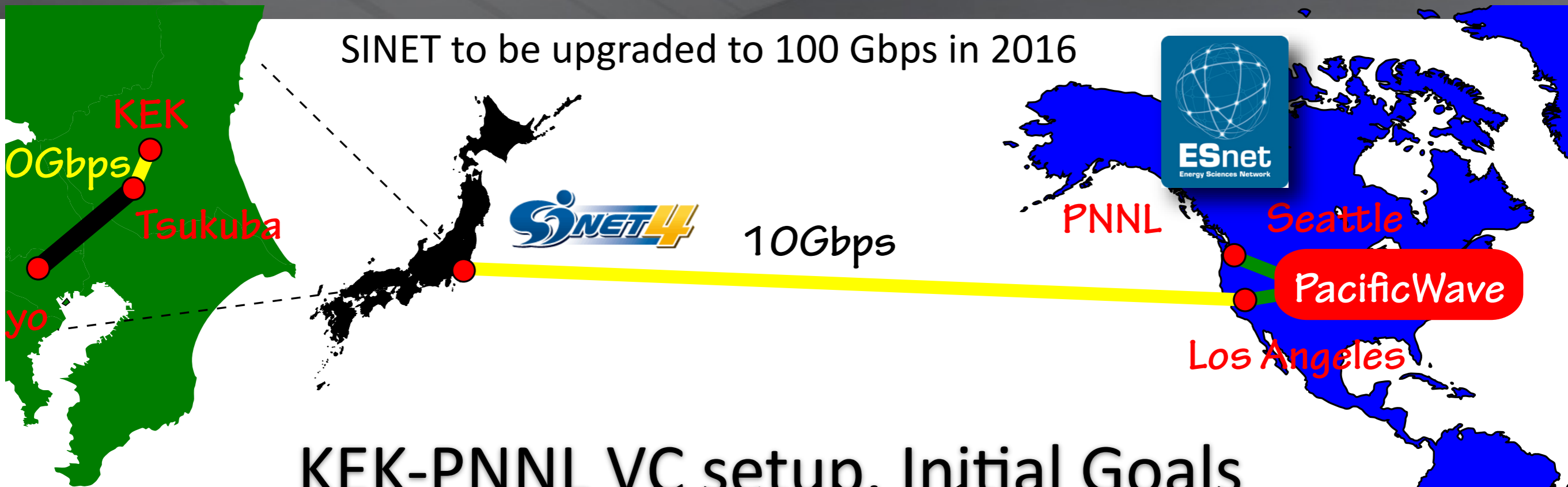


20 Gbps

5 Gbps



# Trans-Pacific data challenge



## KEK-PNNL VC setup. Initial Goals

Date	Summer 2013	Summer 2014	Summer 2015
Rate	100 MB/sec	400 MB/sec	1000 MB/sec <b>Achieved</b>
Duration	24 hours	48 hours	72 hours <b>Very Challenging</b>

**Achieved**

**Achieved**

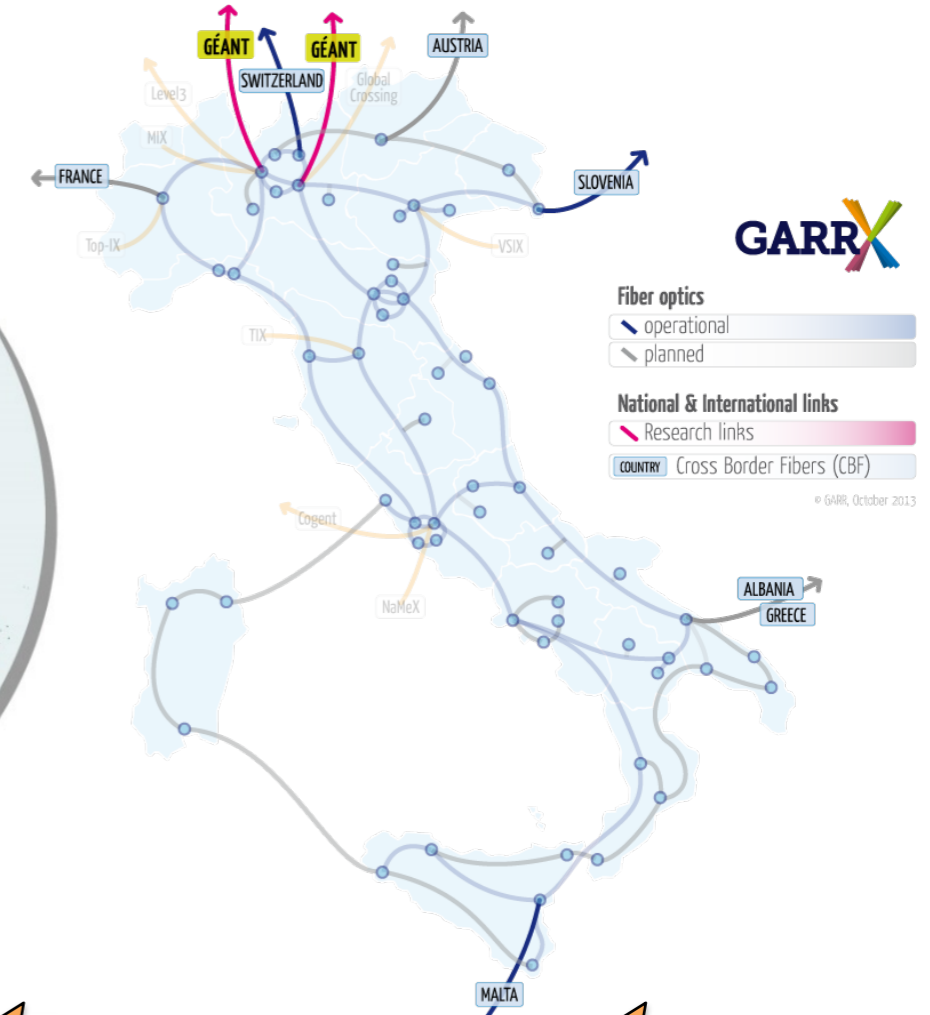
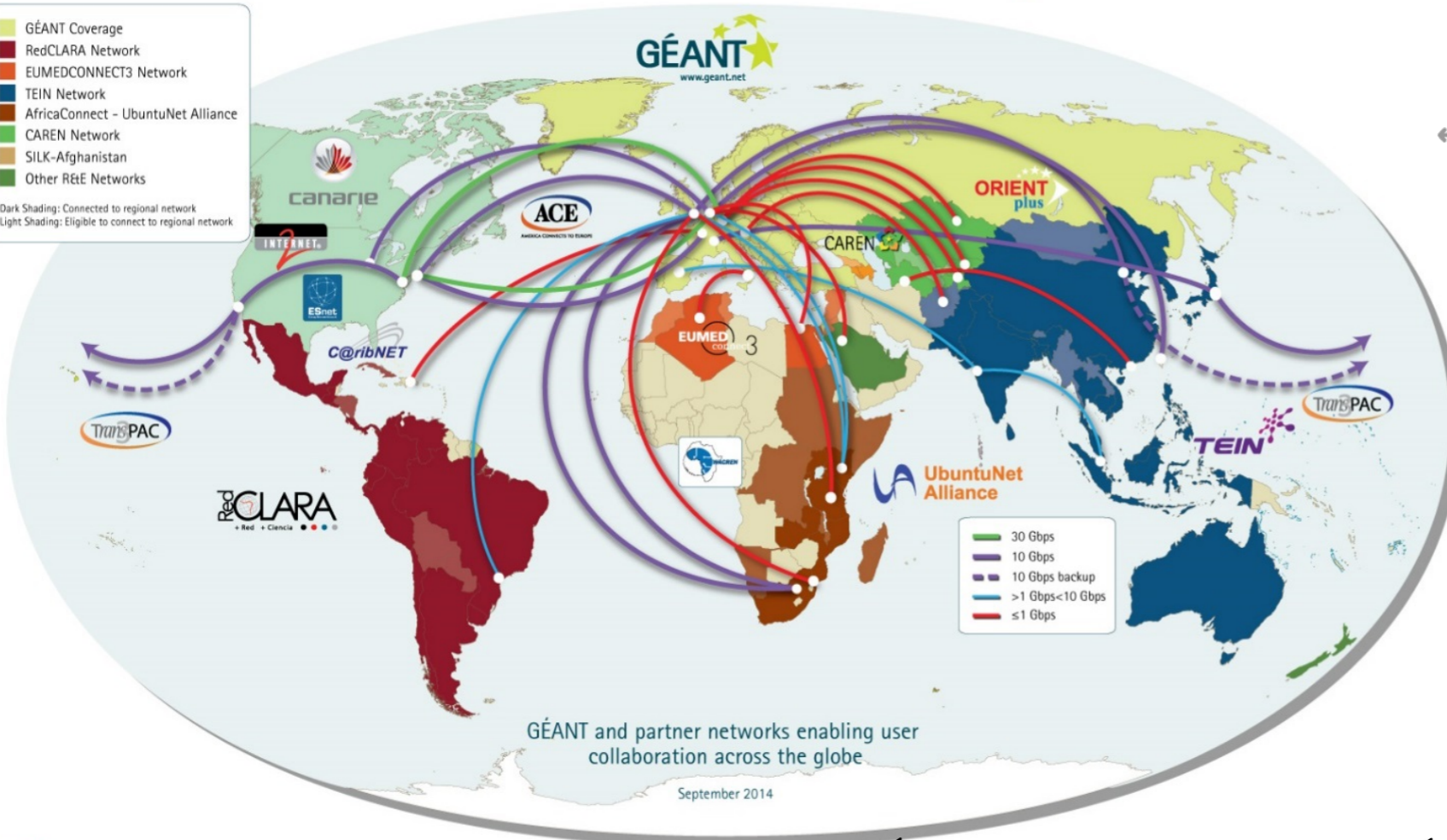
**Achieved**

**Very Challenging**



# Trans-Atlantic data challenge

- GÉANT Coverage
  - RedCLARA Network
  - EUMEDCONNECT3 Network
  - TEIN Network
  - AfricaConnect - UbuntuNet Alliance
  - CAREN Network
  - SILK-Afghanistan
  - Other R&E Networks
- Dark Shading: Connected to regional network  
Light Shading: Eligible to connect to regional network



**Achieved**

**Achieved\***

**Achieved\***

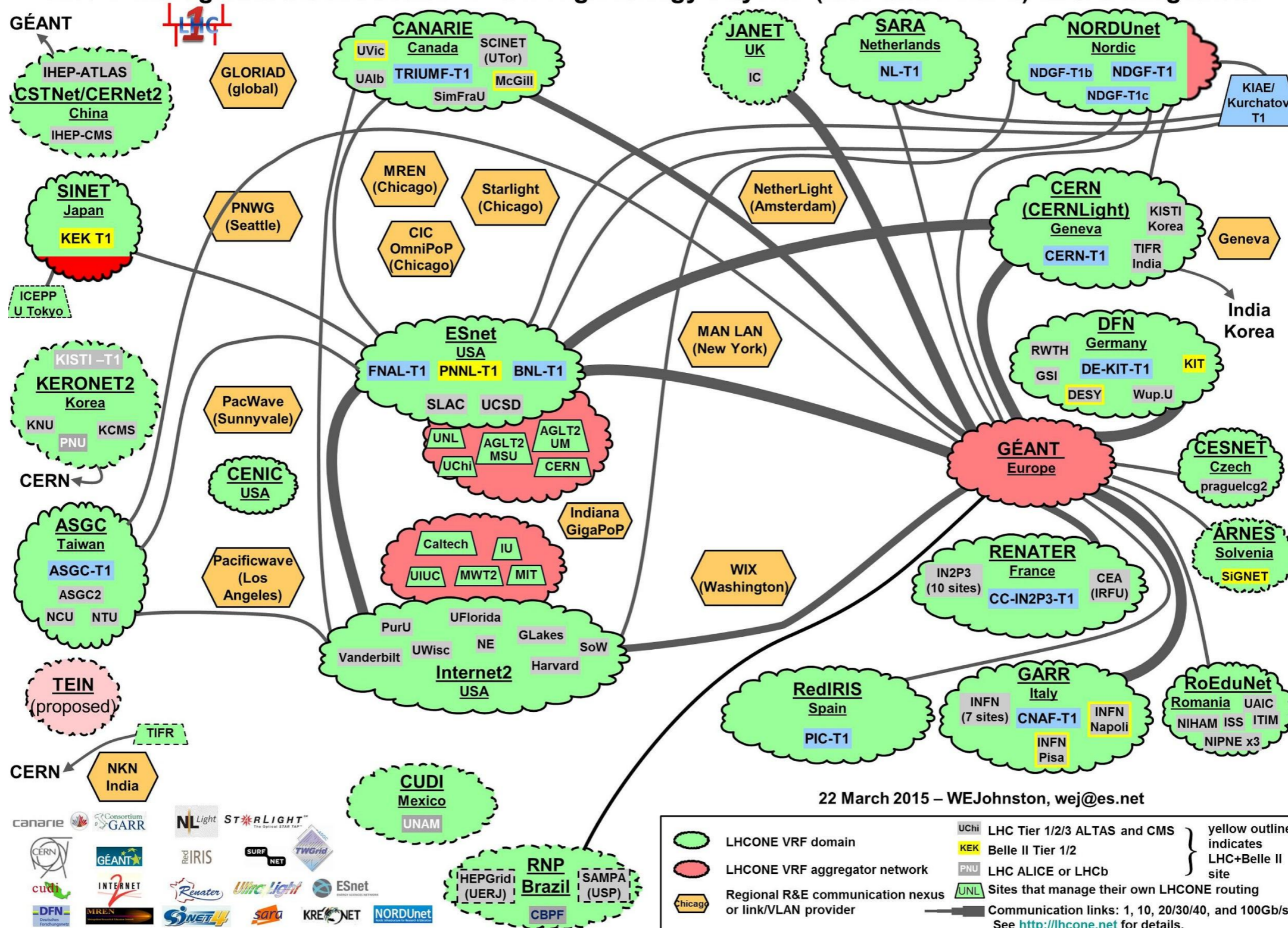
Date	Winter 2013	Summer 2014	Summer 2015
Rate	100 MB/sec	200 MB/sec	400 MB/sec
Duration	24 hours	48 hours	72 hours

\* using ANA-100 link

# Belle II is included into LHCONE

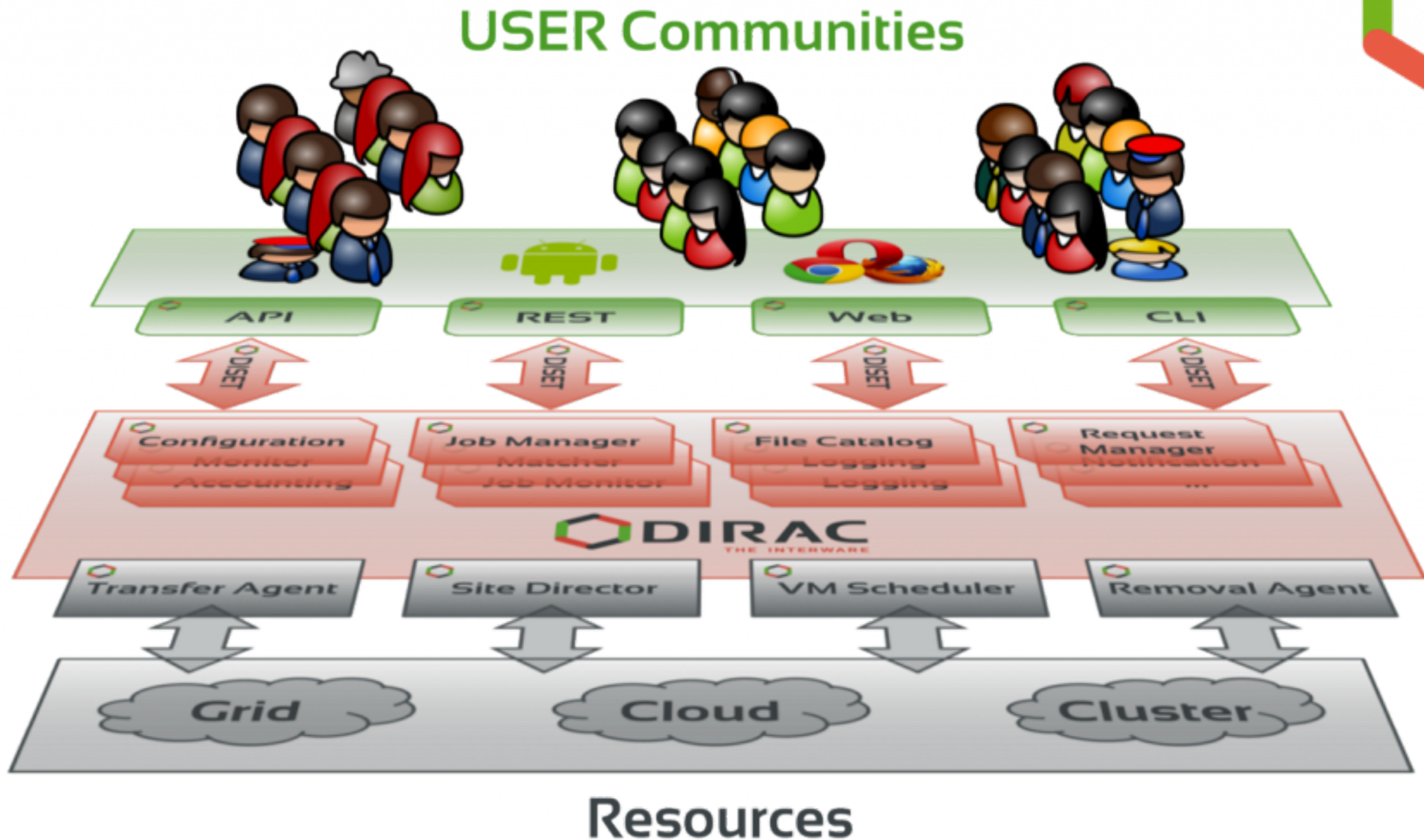


## LHCONE: A global infrastructure for the High Energy Physics (LHC and Belle II) data management



# Belle II computing infrastructure enabler

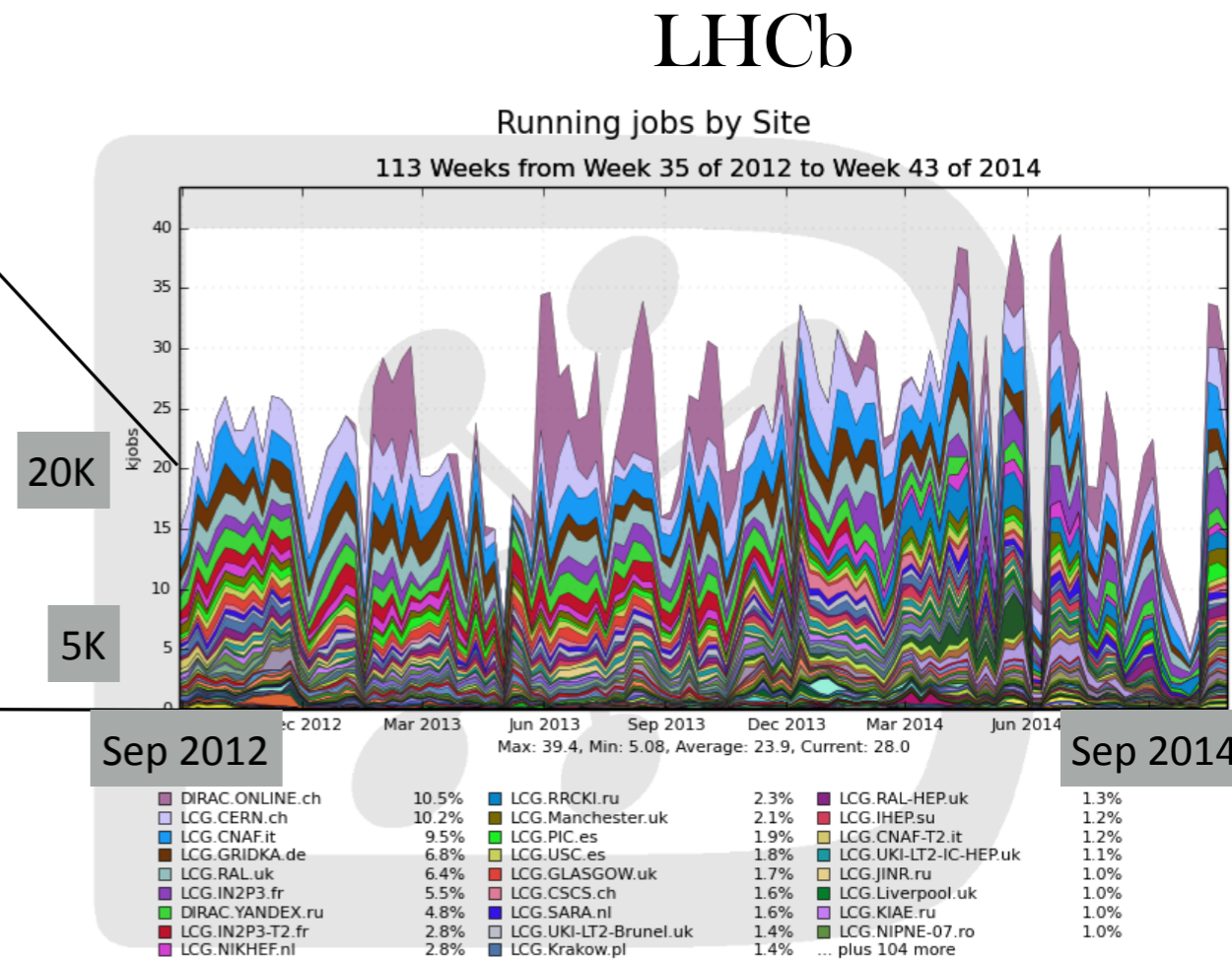
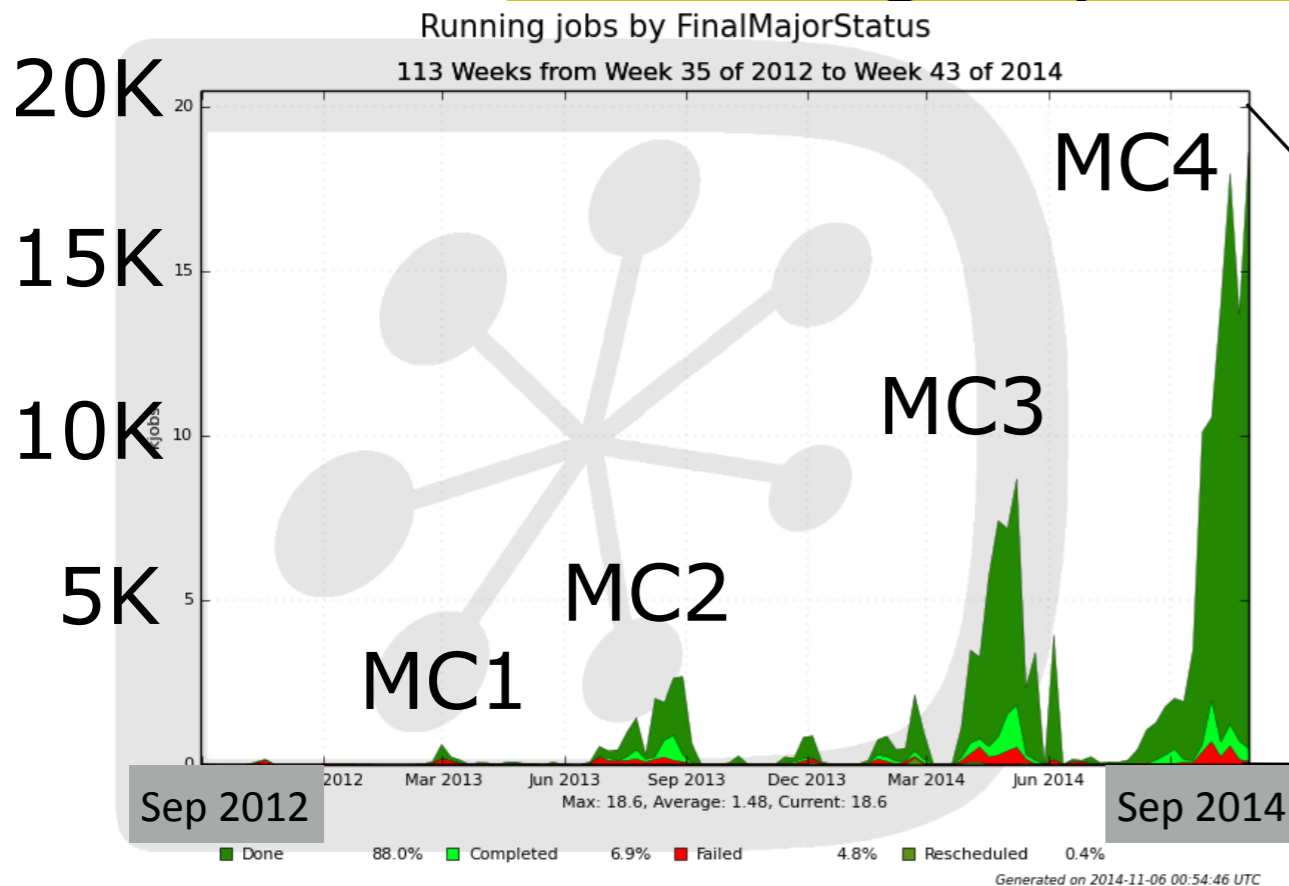
- ▶ DIRAC (Distributed Infrastructure with Remote Agent Control) as the solution of choice
- ▶ Successfully used by LHCb. Adapted on Belle II as BelleDIRAC



# Monte Carlo distributed campaign

- ▶ Exercise of sites resources and DIRAC production system solution
- ▶ Distributed Monte Carlo production and data challenge
- ▶ Jobs scalability tests; upcoming MC5 campaign in Aug-Oct. 2015

- ▶ Total Jobs: 4.7M (4.6M HepSPEC days)
- ▶ Corresponds to 2.9  $ab^{-1}$  generic MC (/ 45 days)
- ▶ Maximum @ 26K jobs and 196 kHepSPEC06

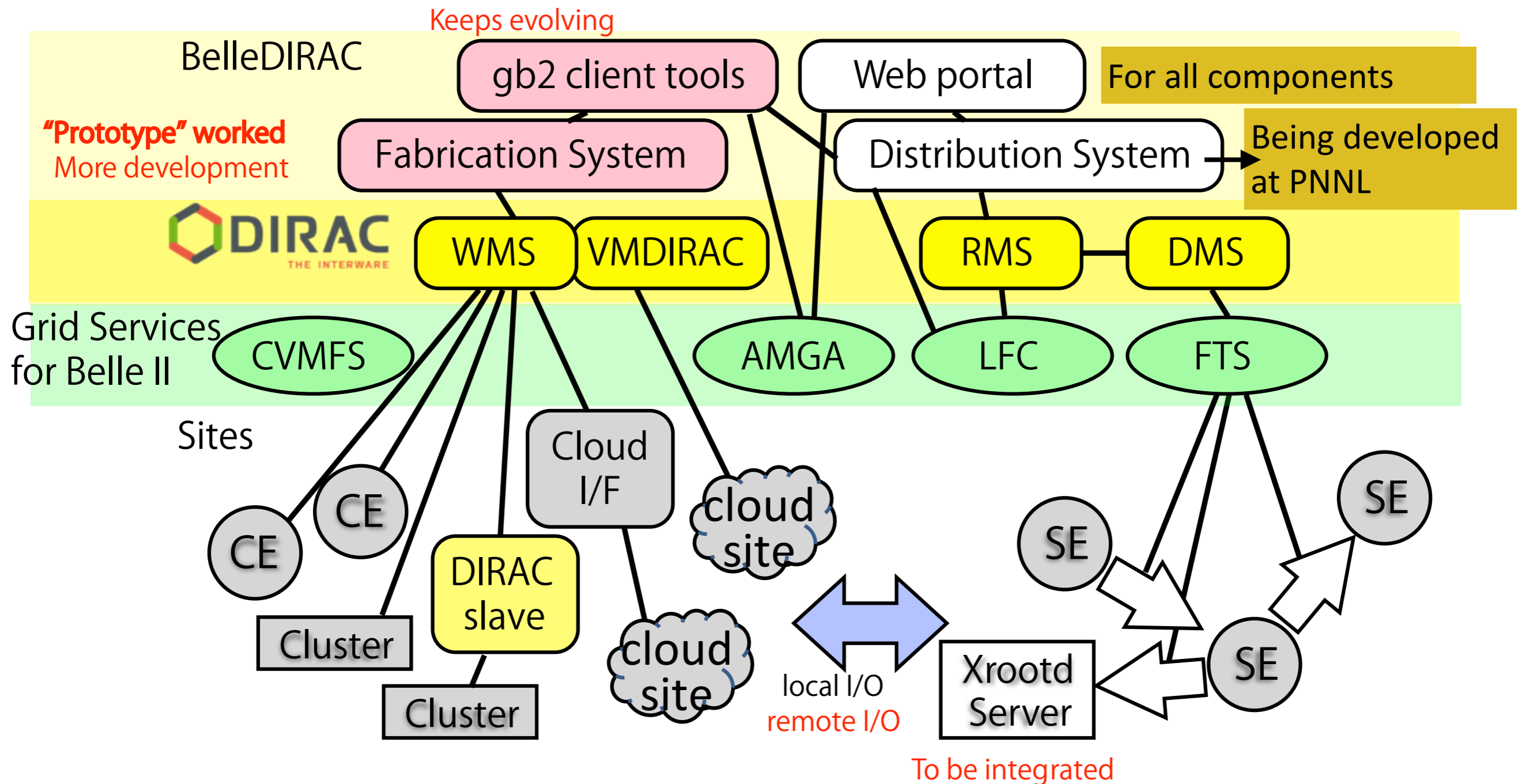


# Belle II distributed computing near future plans

Production Manager

Data Manager

End Users



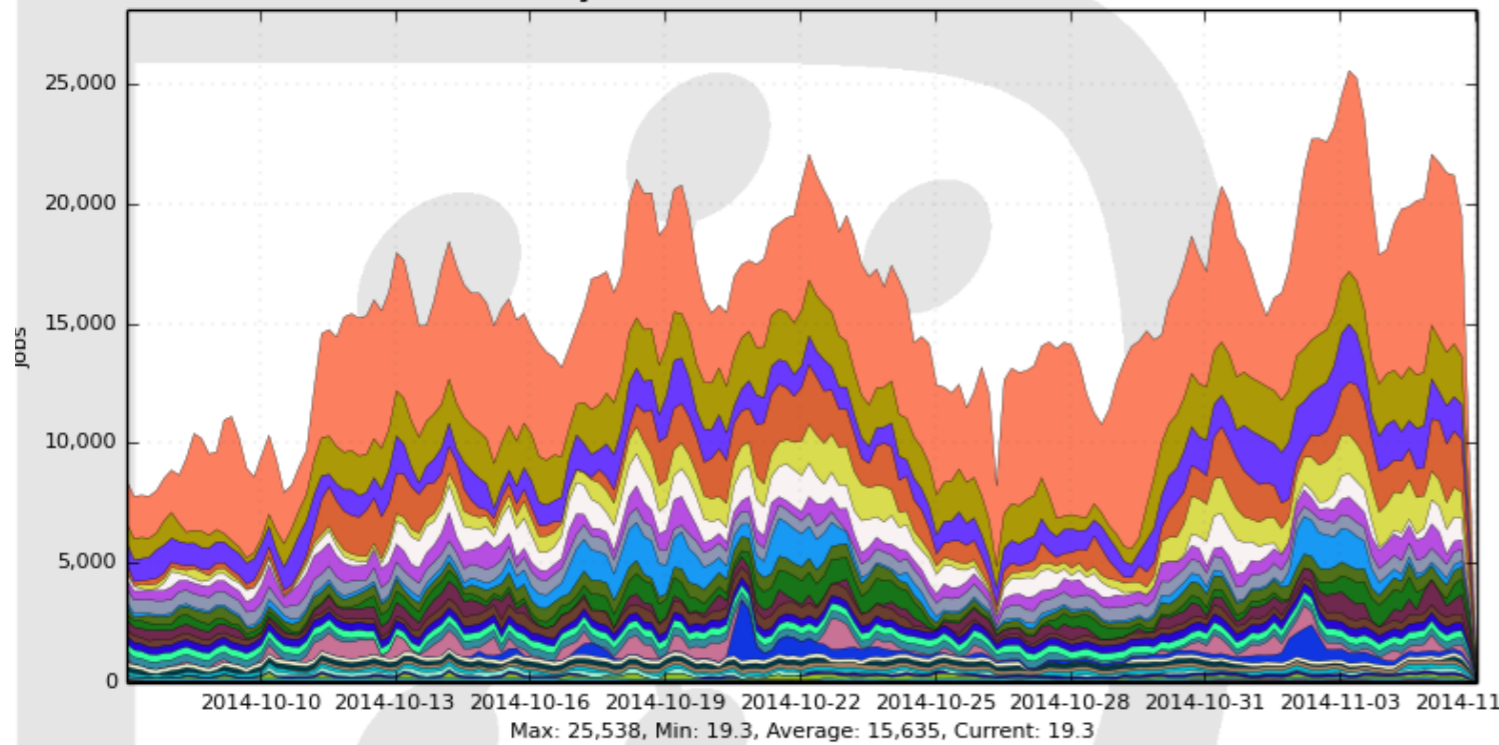
- ▶ Belle II is a world wide collaboration and as such needs distributed computing.
- ▶ Belle II computing needs are on par with the LHC.
- ▶ PNNL will co-host replica of raw data for first three years of Belle II operations.
- ▶ Successfully tested 10 Gbps network bandwidth in trans-pacific and trans-atlantic circuit.
- ▶ LHCONE extended to include Belle II.
- ▶ Belle II computing model is facilitated by DIRAC, developed by LHCb experiment.
- ▶ Belle II distributed computing system prototype has been demonstrated to work on the GRID with successful intensive MC campaign. Next MC campaign upcoming.



# Backup

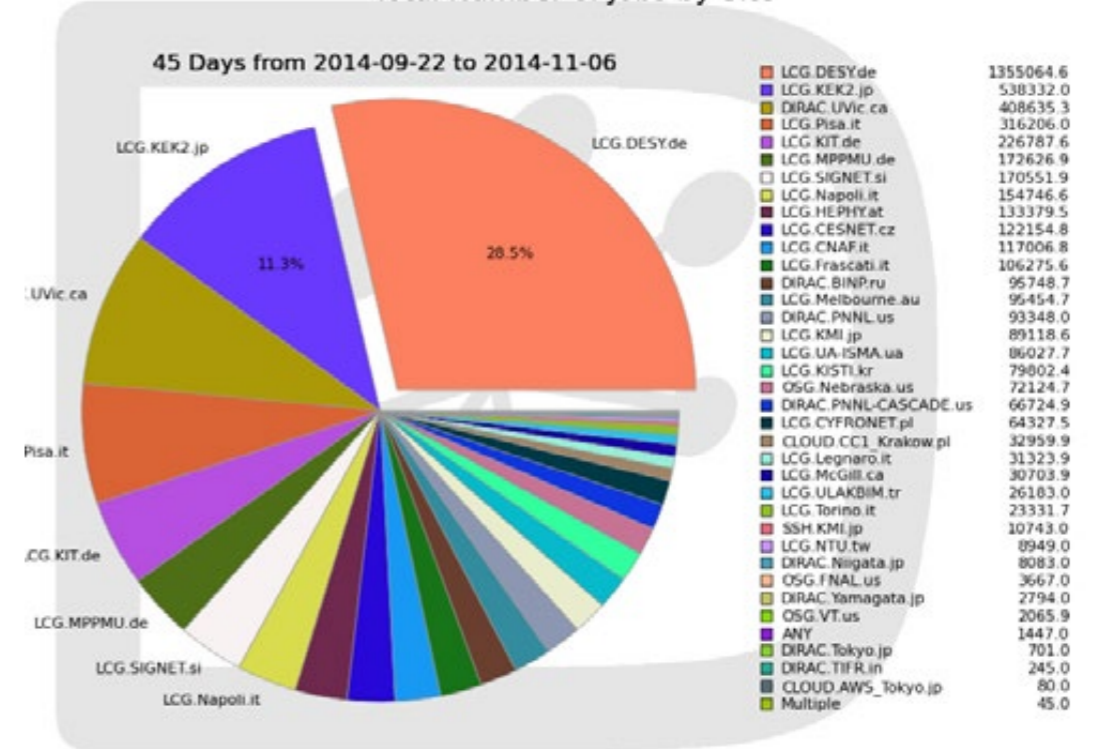
# MC campaign by Belle II sites

Running jobs by Site  
30 Days from 2014-10-07 to 2014-11-06



Generated on 2014-11-06 01:11:00 UTC

Total Number of Jobs by Site



Generated on 2014-11-06 01:09:33 UTC



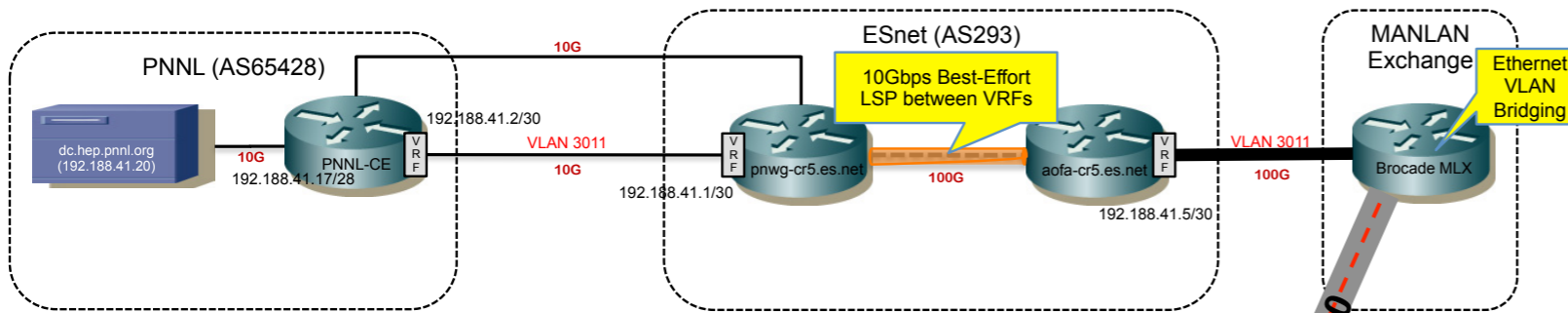
# Trans-Atlantic data challenge



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## US side



Dedicated 10G link between PNNL SE and ESNet  
10G best-effort Label Switched Path in ESNet backbone

Test was done  
in May/June 2014

Network providers setup the VLAN  
Local network providers and sites  
coordinated final configurations

Sites must configure hardware interface  
to match destinations



Vincenzo Capone,  
Aleksandr  
Kurbatov, Mian  
Usman



Chin Guok



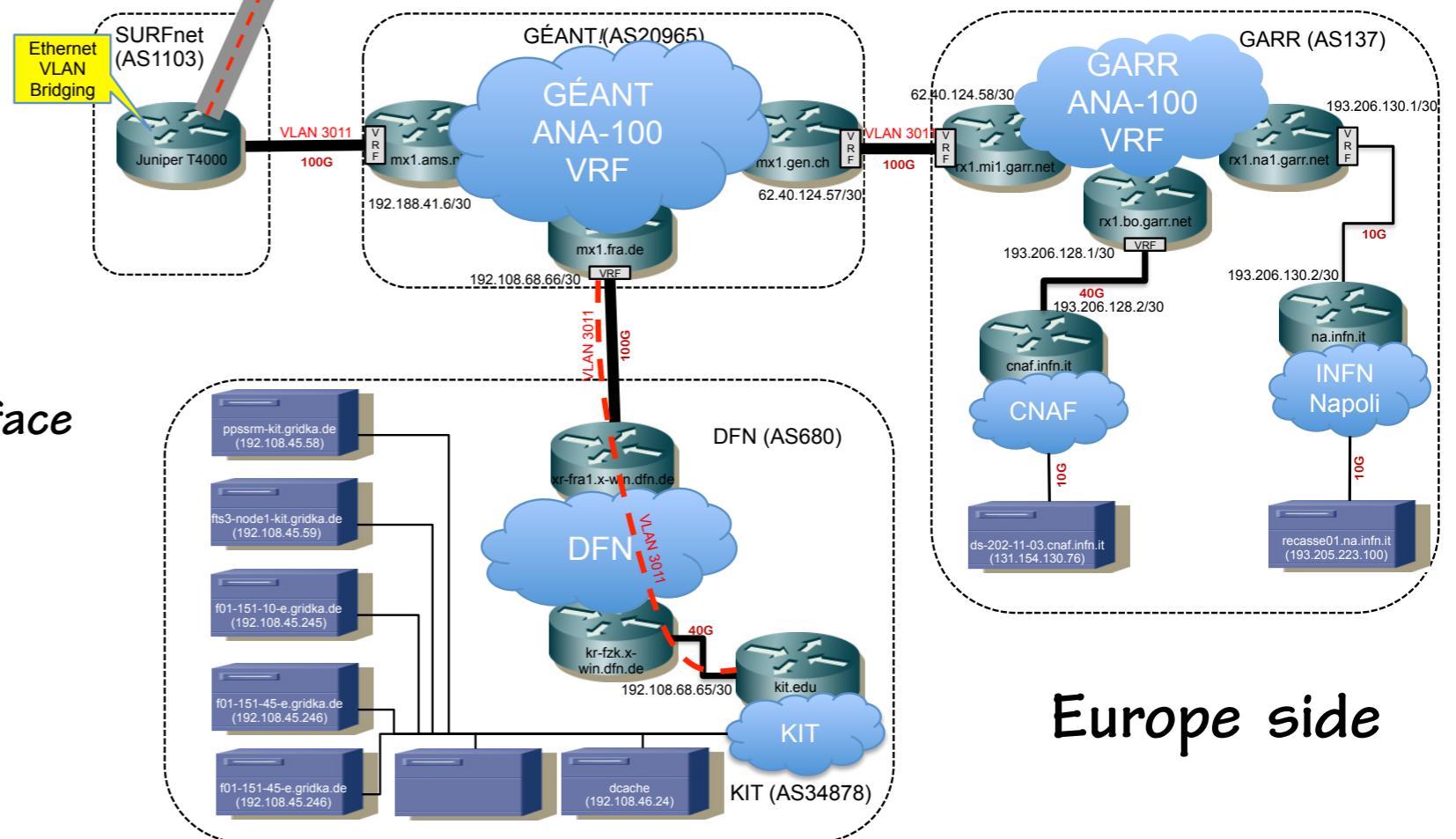
Thomas Schmid, Hubert Weibel

M.Schram  
(PNNL)



Marco Marletta

- “traceroute” was used to confirm the routing to each SE
- “iperf” was used to do initial network transfer rate test
- FTS3 server at GridKa was used to schedule data transfers



## Europe side

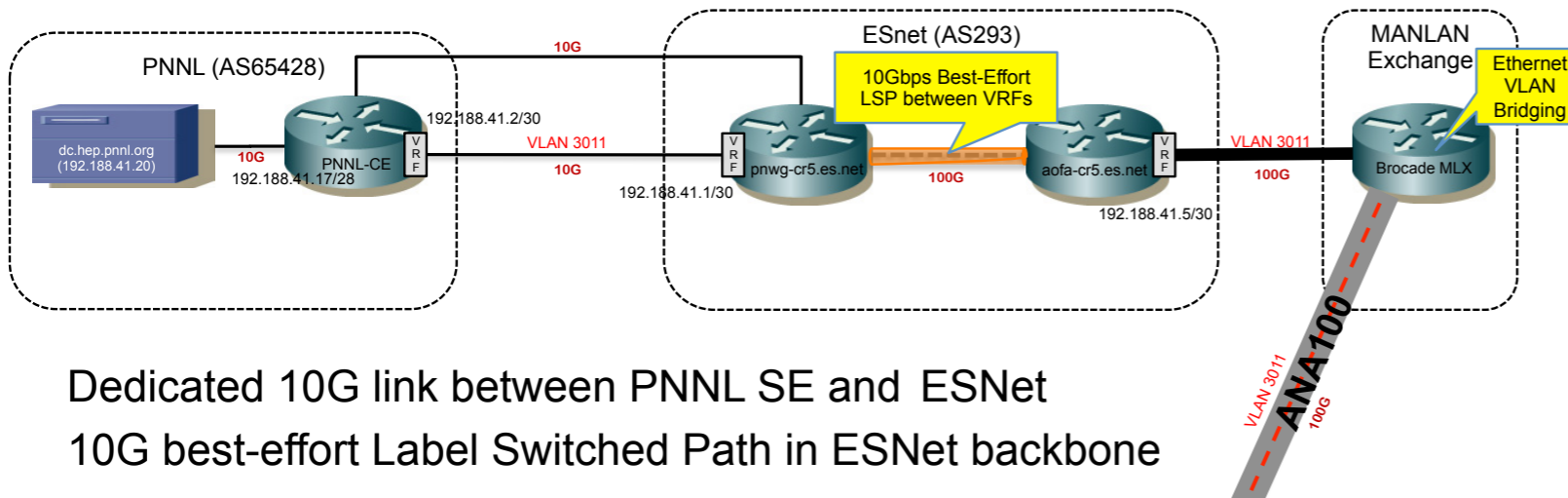
# Trans-Atlantic data challenge II



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## US side

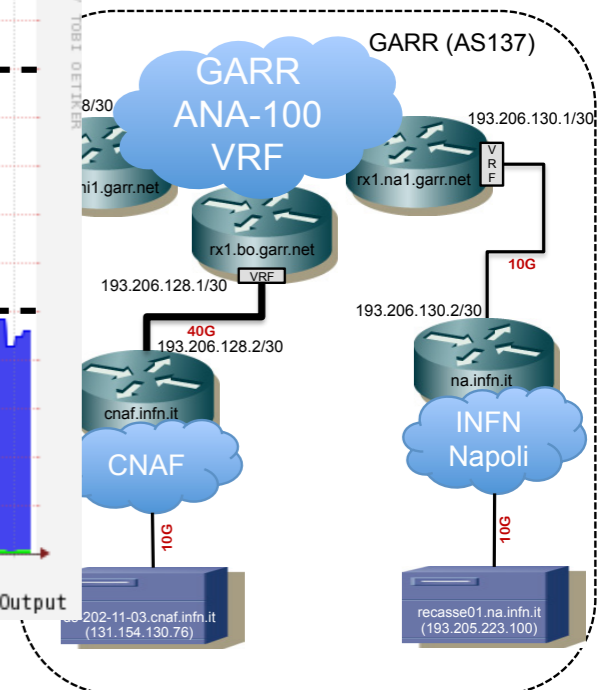
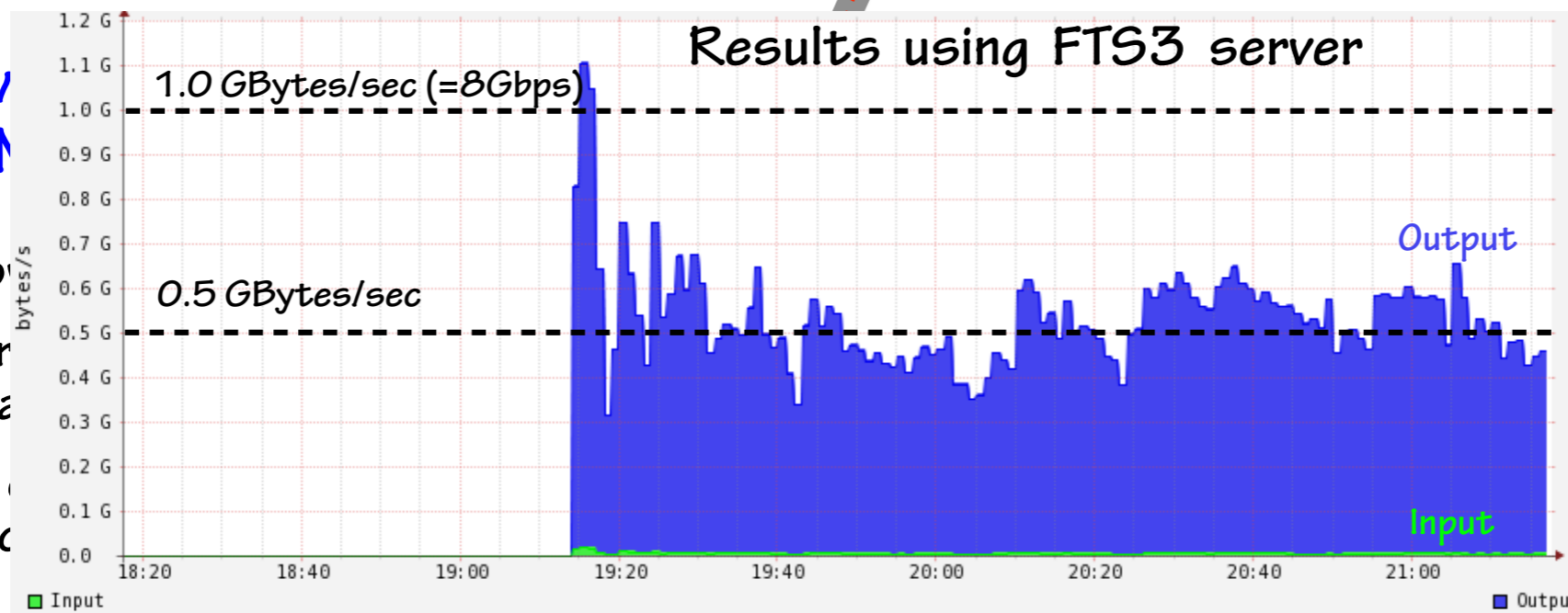


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Test w  
in M

Network pro  
Local network  
coordinat  
Sites must  
to matc



## Europe side



Aleksandr  
Kurbatov, Mian  
Usman

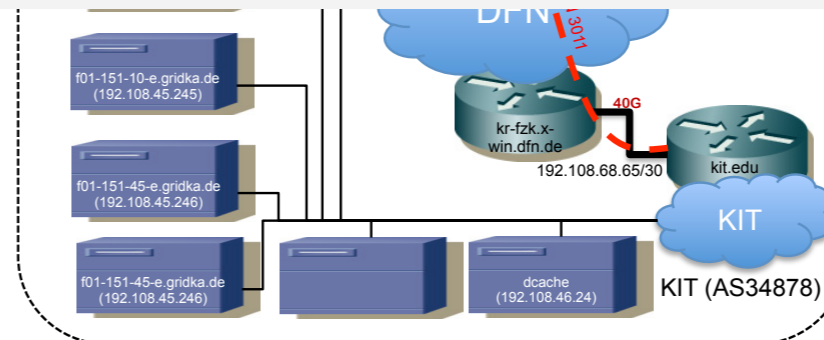


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(PNNL)



Marco Marletta



Vikas Bansal