LHC_7
R&D for ATLAS Grid Computing

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on behalf of the LHC_7 project team

LHC_7: R&D for ATLAS Grid Computing

- Basis
  - Successor of project LHC_2: “ATLAS computing” (2006～2012)
  - Cooperation between French and Japanese teams in R&D on ATLAS distributed computing to prepare LHC Run-2 (2015-2018)
- Goal
  - Important challenges of the next years: New computing model, hardware, software, and networking issues
- Partners
  - The International Center for Elementary Particle Physics (ICEPP), the University of Tokyo (WLCG Japanese Tier-2 center) and French Tier-2 centers

LHC_7 Members

French group	Lab	Japanese group	Lab
E. Lançon*	IRFU	T. Mashimo*	ICEPP
L. Poggioli	LAL	I. Ueda	ICEPP
R. Vernet	CC	T. Nakamura	ICEPP
M. Jouvin	LAL	N. Matsui	ICEPP
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E. Vamvakopoulos	CC		
J.-P. Meyer	IRFU		

2010 Evolution 2013

Network performance breakthrough (eg LHCONE 2011)

- Going away from hierarchical Model (T0-T1s-T2s)
- Dynamic data placement & deletion based on popularity
- T2→N-T1s & T2↔T2 exchanges (T2D)

Planned data distribution

Jobs go to data

Multi-hop data flows

Poor T2 netwking across regions

Planned & dynamic distribution data

Jobs go to data & data to free sites

Direct data flows for most of T2s

Many T2s connected to 10Gb/s link

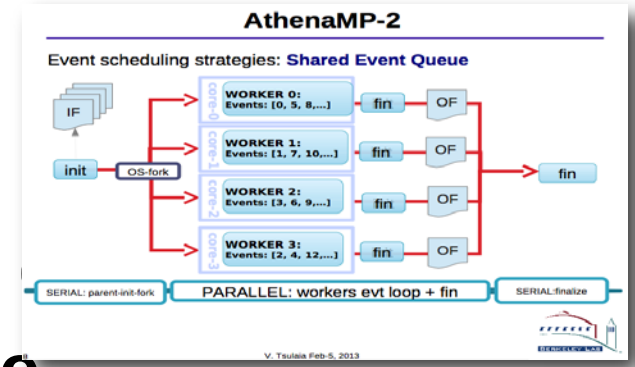
Run-2 (2015-2018) Challenges

- LHC operation
  - Trigger 1 kHz / Pile-up > 30/ 25ns bunch spacing / energy x 2
- 'New' detector
  - To be integrated in simul & reco
- New CPU architecture
  - Clock speed saturates
  - Less memory/core
- Flat budget constraints
  - Both for h/w & operation & dev't
- Challenges
  - More & bigger data to process/store
  - More simulation (w/ more memory& CPU) to process/store

Resources optimization is crucial (CPU/storage)

Working towards solutions

- Simulation: **CPU:** More usage of fast simulation
- Reconstruction: **Memory & CPU**
  - Parallelism, code speedup
  - MP solution to reduce memory footprint



- New Analysis Model: **CPU & Storage**
  - Common analysis data format/ Streamlining analysis flow
- New production system **CPU & Network**
  - Data traffic minimized / Optimized job to resource matching/Better reaction to analysis loads
- Data management **Storage & Network**
  - Develop tape usage/ agressive deletion on non-popular data
- Opportunistic resources **CPU**: HPC, Cloud, HLT

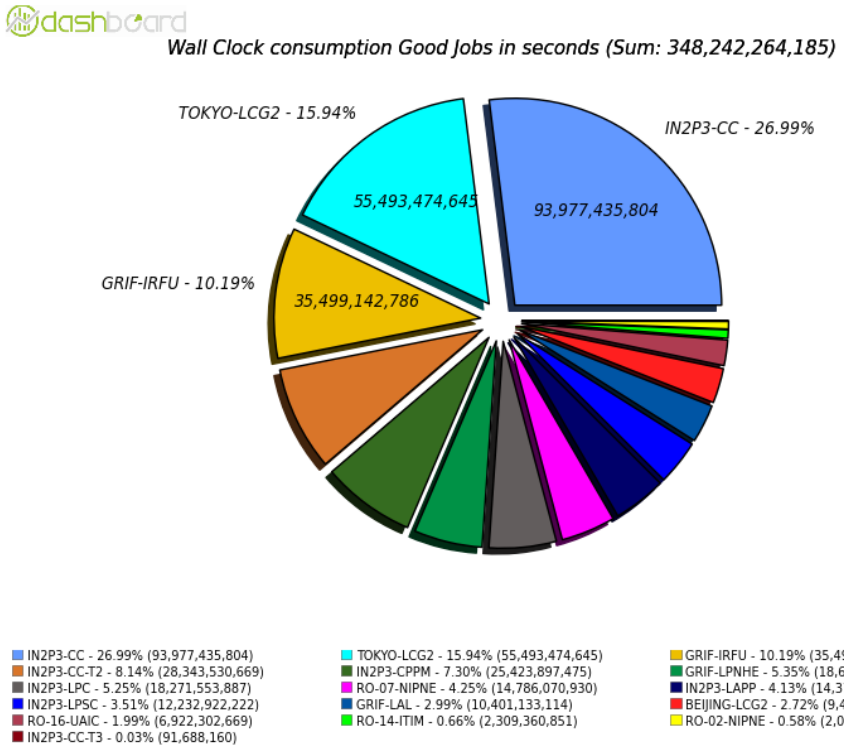
Network potential & usage

- Networking continue its progress
  - **LHCONE** breakthrough (2011). 10Gb/s for big sites
  - x10 every 4.25 yrs - RENATER devt@400Gb/s!
  - Aim at 40/100Gb/s for T1s/T2Ds by Run-2?
- 2 interesting ATLAS initiatives ongoing
  - **Data federation** (FAX, xrootd fed., http fed.)
    - Remote file access over WAN
    - Break the paradigm: Jobs go to data
  - **Event Service**: passing single evts for processing from/to storage cf. ATLAS@home

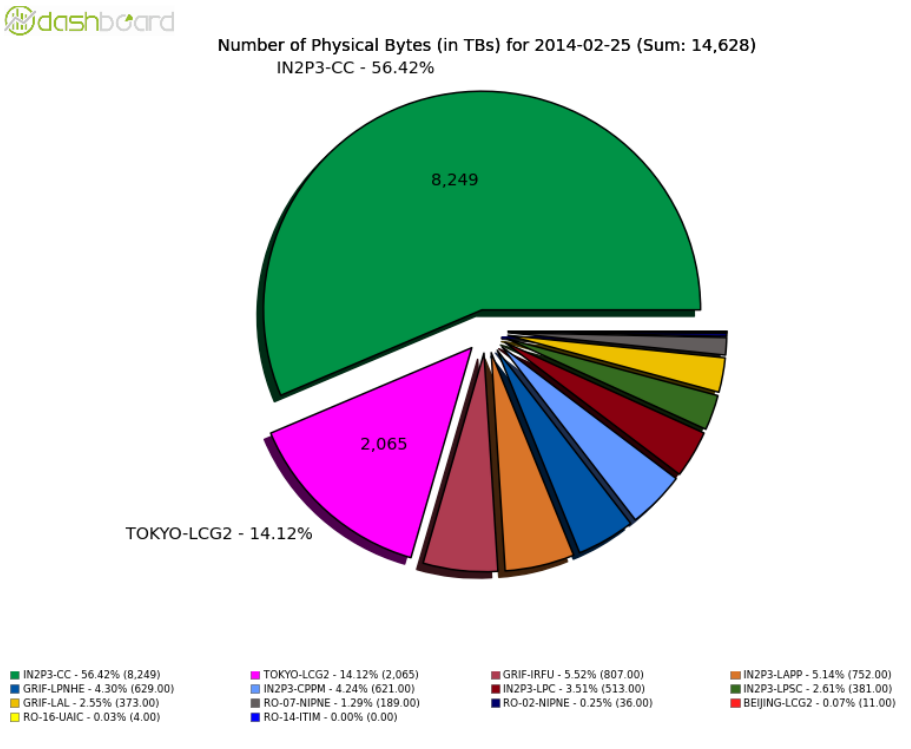
Can optimize our disk space & CPU needs

ATLAS GRID French-cloud

CPU (Apr'13-Apr'14)



Storage (Apr'14)



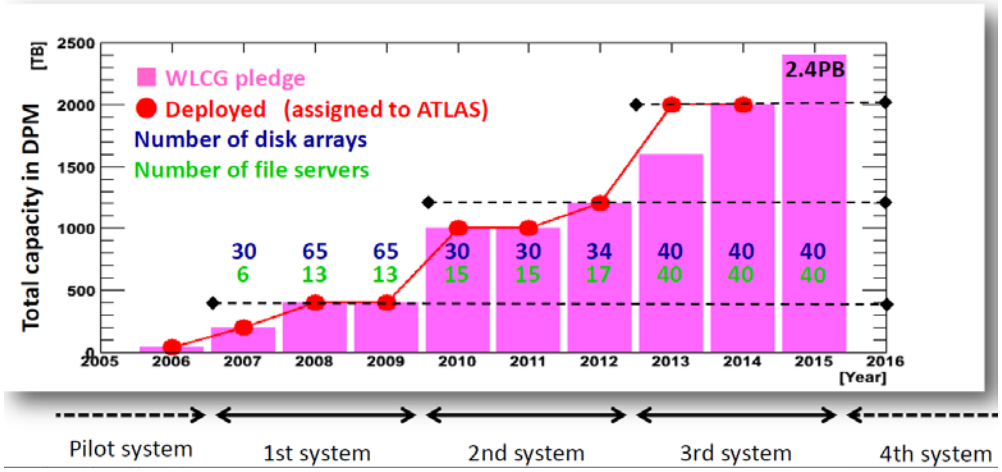
Biggest contributors: IN2P3-CC (Tier-1/Tier-2: 35%) , Tokyo (Tier-2: 16%), GRIF(3xTier-2: 18%)

TOKYO Tier-2

WLCG pledge

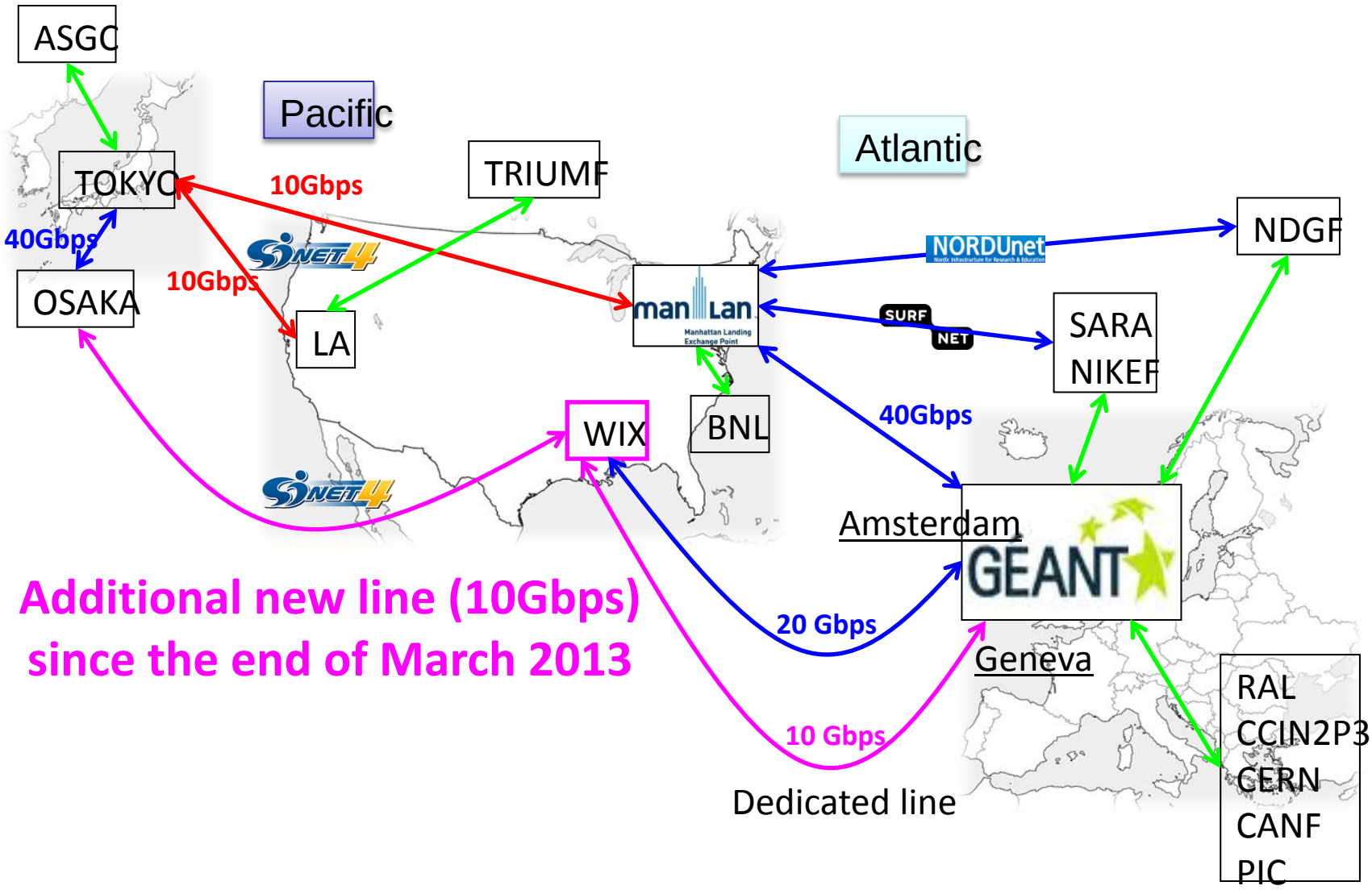
	2013	2014	2015
CPU pledge	16000 [HS06]	20000 [HS06]	24000
CPU deployed	43673.6 [HS06-SL5] (2560core)	46156.8 [HS06-SL6] (2560core)	-
Disk pledge	1600 [TB]	2000 [TB]	2400 [TB]
Disk deployed	2000 [TB]	2000 [TB]	-

Evolution of disk storage capacity for Tier2



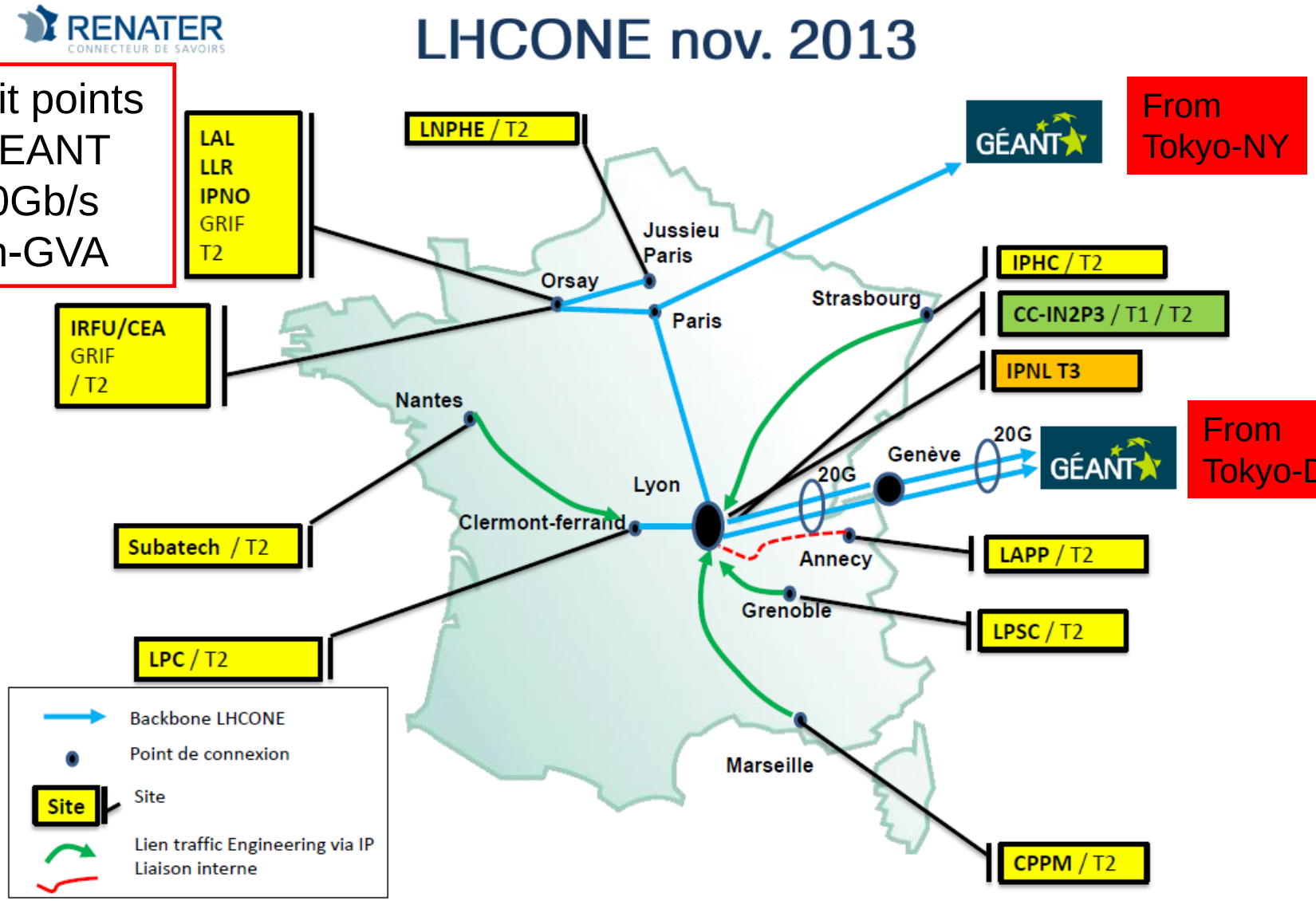
- Pledges
  - Provided CPU above pledges in 2013
  - Net increase for 2014
- I/O study
  - Direct access via Xrootd
  - SSD vs HDD tests
- Batch
  - Deployment of Multi-core queue ongoing

WAN for TOKYO

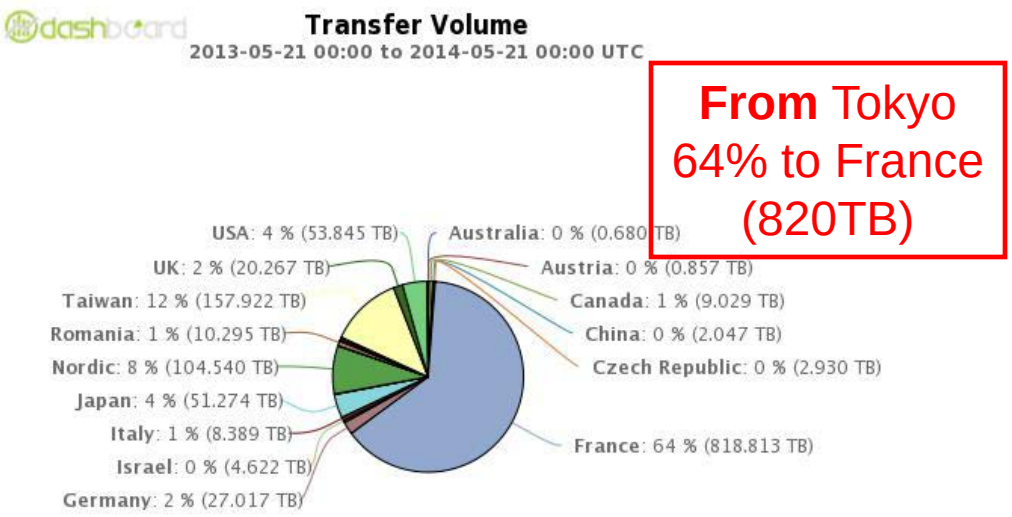


From Tokyo to France

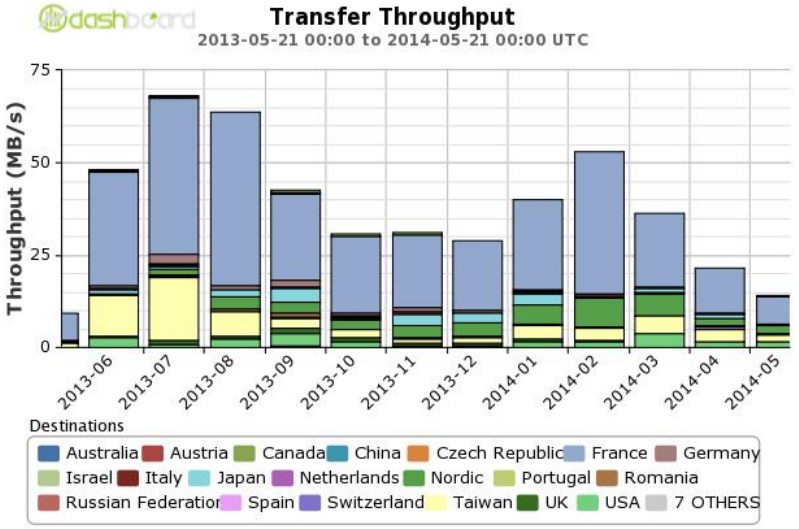
- 2 exit points to GEANT
- 2x10Gb/s Lyon-GVA

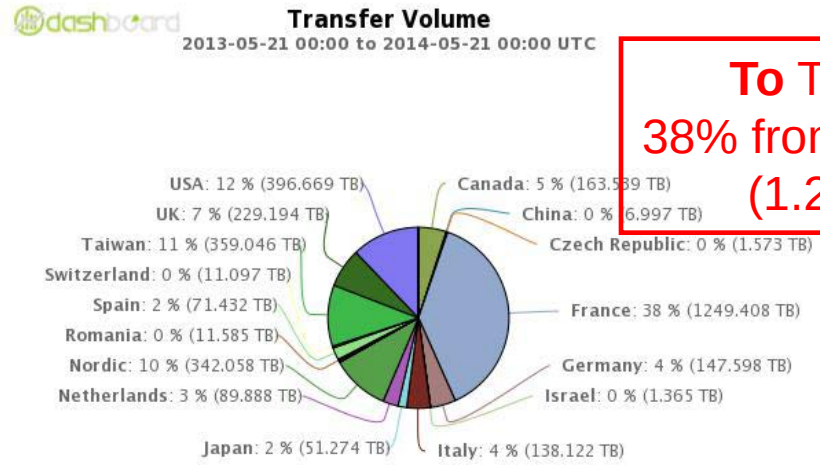


Transfers Tokyo (May'13-May'14)

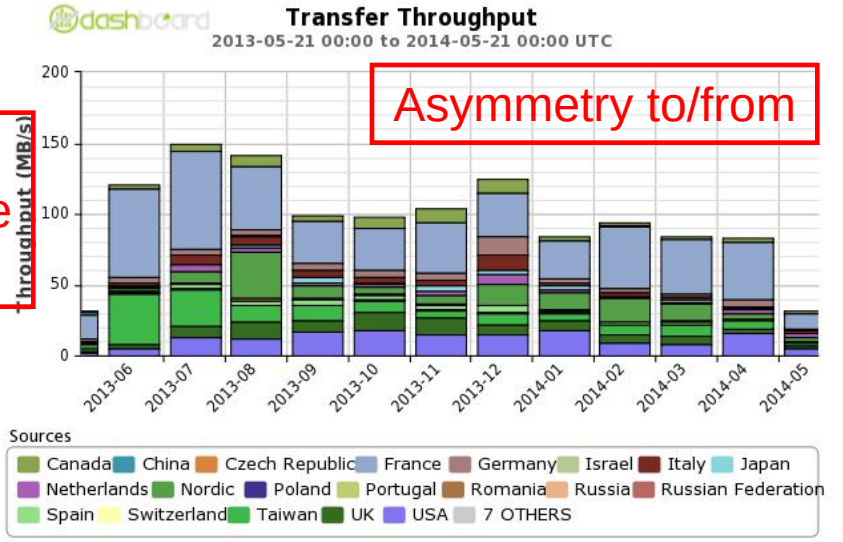


From Tokyo
64% to France
(820TB)





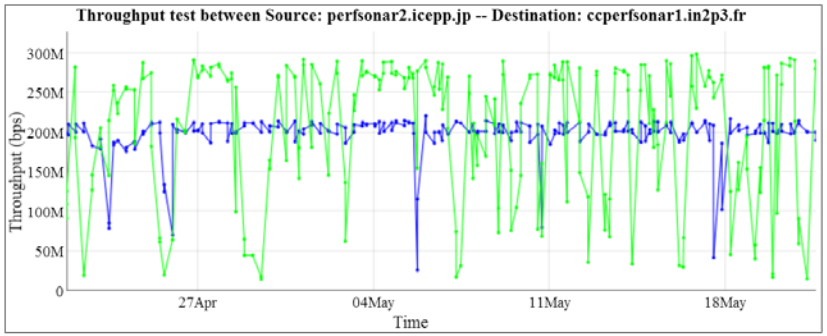
To Tokyo
38% from France
(1.2pB)



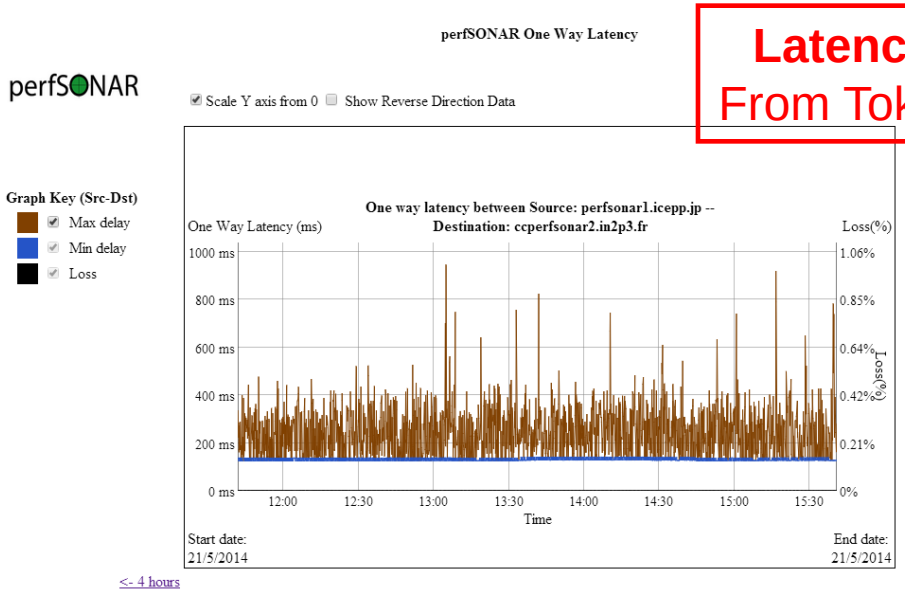
Asymmetry to/from

Network monitoring: perfSonar

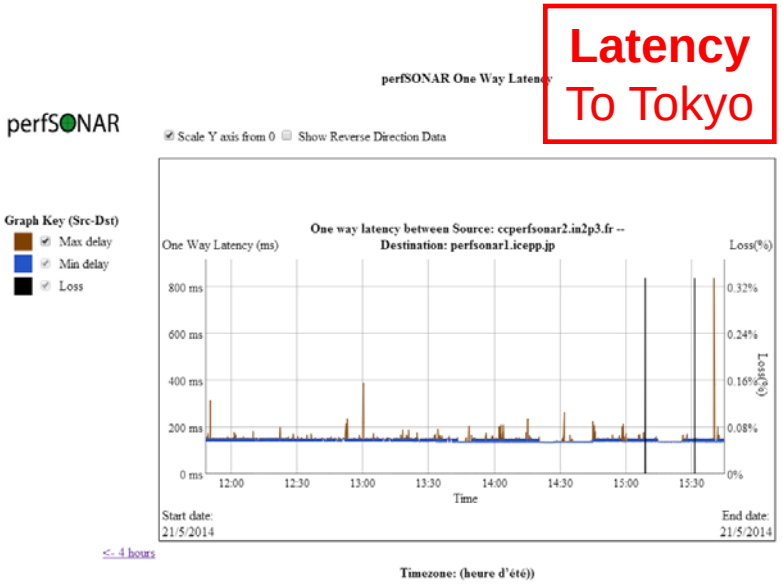
Tokyo-IN2P3-CC Channel



Bandwidth
Asymmetry to/from



Latency
From Tokyo



Latency
To Tokyo

LHC_07: Lines for R&D

- Tokyo is the biggest & remote T2 in FR-cloud
  - Crucial to understand issue & to follow developments (network, data acces,…)
- Lines for R&D
  - Multi-core developments
  - Cloud/Virtual computing
  - Xrootd/http federated storage
  - General I/O studies
  - Batch studies
    - Batch system/ Multicore/ High memory queues
  - Network studies:The most important & critical
    - Use of perfSonar tool
    - Optimization and monitoring of data transfer between remote sites

Cost of the project

- Cost for hardware not needed
  - Use of existing computing facilities at Tier-1 and Tier-2s in France and Japan and of existing network infrastructure provided by NRENs, GEANT...
- Good communication is the key issue
  - e-mails and video-conferences are widely used
    - eg Monthly LCG-TECH meetings
  - Face-to-face meetings are essential usually 1/year (a small workshop), hence cost for travel& stay
    - ATLAS Distributed Computing Technical Interchange Meeting Tokyo, May 2013
    - Regional FR-cloud workshop, Tokyo, December 2013

Budget plan for 2014 (for completeness)

Item		€	Support-ed by	Item		k¥	Support-ed by
Travel	1,000			Travel	160		
Nb travels	3	3,000	IN2P3	Nb travels	3	480	ICEPP
Per-diem	230			Per-diem	22.7		
Nb days	15	3,450	IN2P3	Nb days	12	272	ICEPP
Nb Travels	1	1,000	IRFU				
Nb days	5	1,150	IRFU				
Total		**8,600**				**752**	

Summary

- LHC_7
  - Very fruitful collaboration between ICEPP & IN2P3/IRFU ATLAS computing centers
  - Need to maintain it, eg with regular exchanges & workshops
- Fields of study
  - Use of virtual machines for WLCG services ops
  - Improvement of DPM storage reliability
  - Performance of data access for analysis jobs
  - Investigation of federated Xrootd storage
  - Optimization and monitoring of data transfer