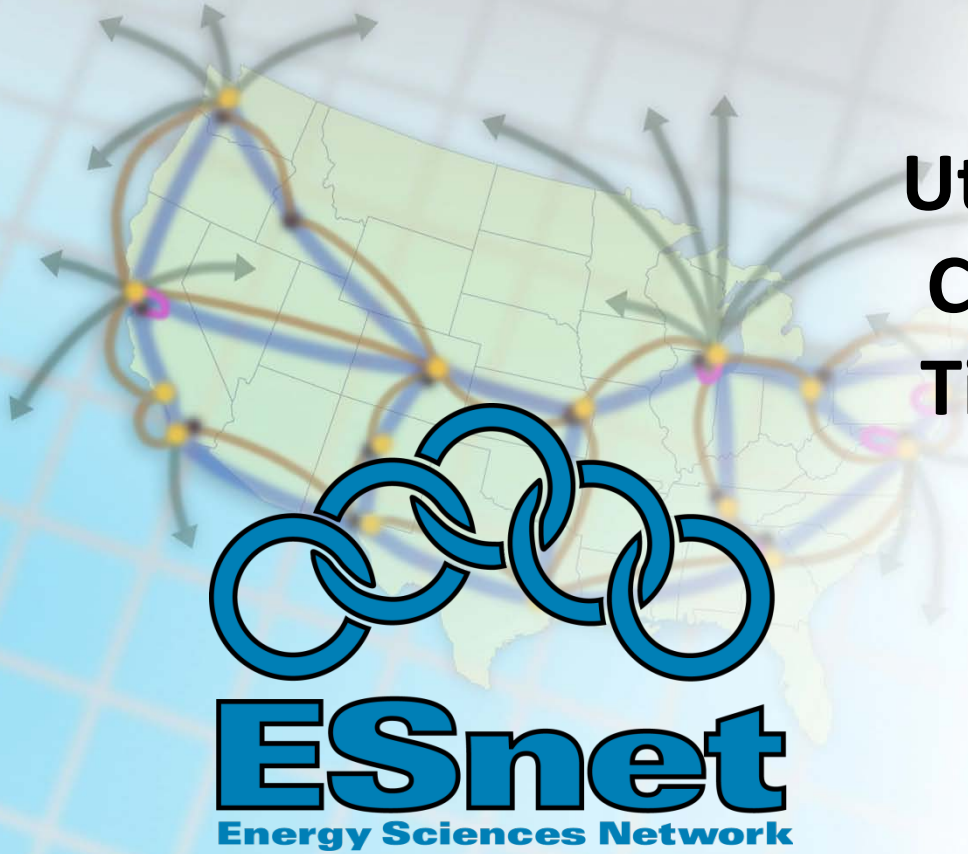

Utilization of Transatlantic Circuits by European LHC Tier 2 Accesses of US LHC Tier 1 Centers

February, 2010

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Managing Transatlantic Capacity Used by non-OPN LHC

- The Tier 2 accesses across the Atlantic (in both directions) utilize a mix of planned and ad hoc capacity as opposed to the carefully managed capacity of the OPN
- GÉANT provides transatlantic capacity for general IP traffic, as does NSF / IRNC (?), and several European countries
- ESnet partnered with USHLCnet some time ago to provide some capacity specifically to support European Tier 2 accesses of US Tier 1 centers

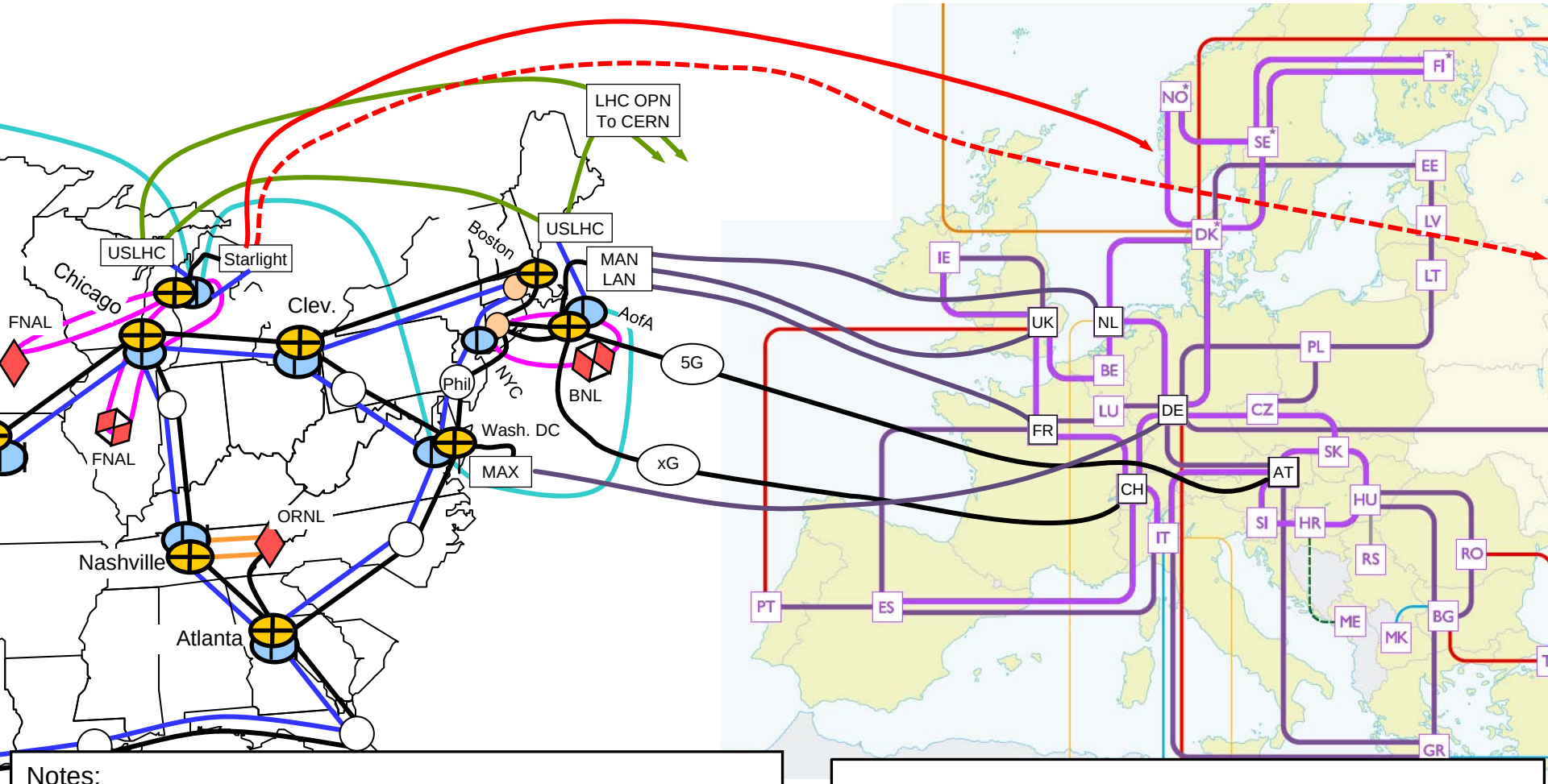
- What ESnet is seeing is LHC traffic coming from Europe on almost every available path, including once or twice over the commercial peerings

Managing Transatlantic Capacity Used by non-OPN LHC

- An analysis of the traffic from ESnet's point of view seems essential in order to understand
  - whether the current planned capacity for this traffic is adequate and
  - how it will need to evolve
- The current exercise (deliberately a bottom up view) is to
  - determine the traffic patterns,
  - see if they are optimal, and
  - establish a baseline for capacity prediction when the LHC starts producing physics data
- Most of the European Tier 2 to US Tier 1 traffic is currently Layer 3 traffic, so focus on that
  - What data is available to determine traffic patterns and how can it be used?

- What is presented here is definitely a work in progress

Layer 3 Paths Related to LHC traffic to ESnet

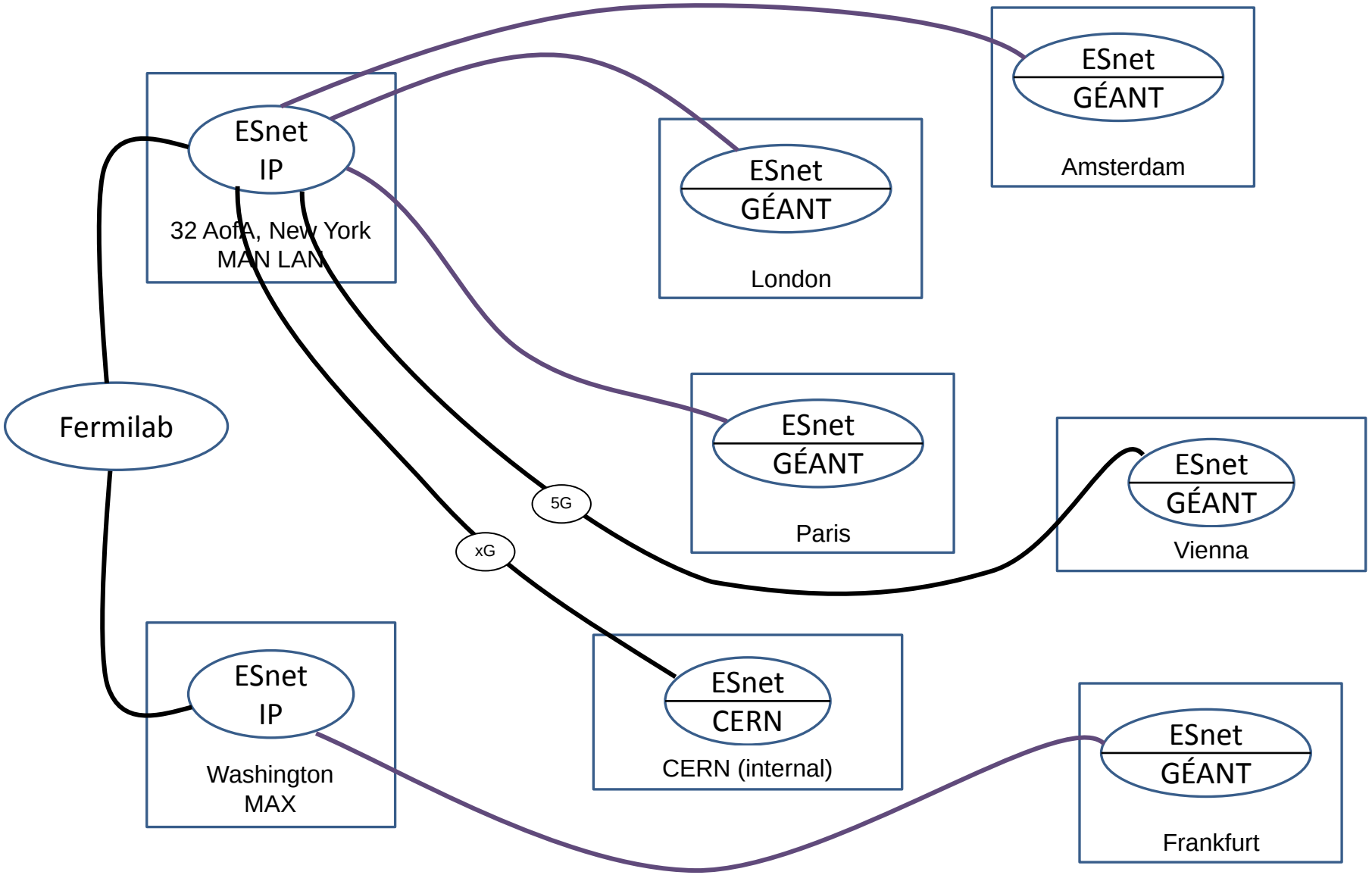


Notes:

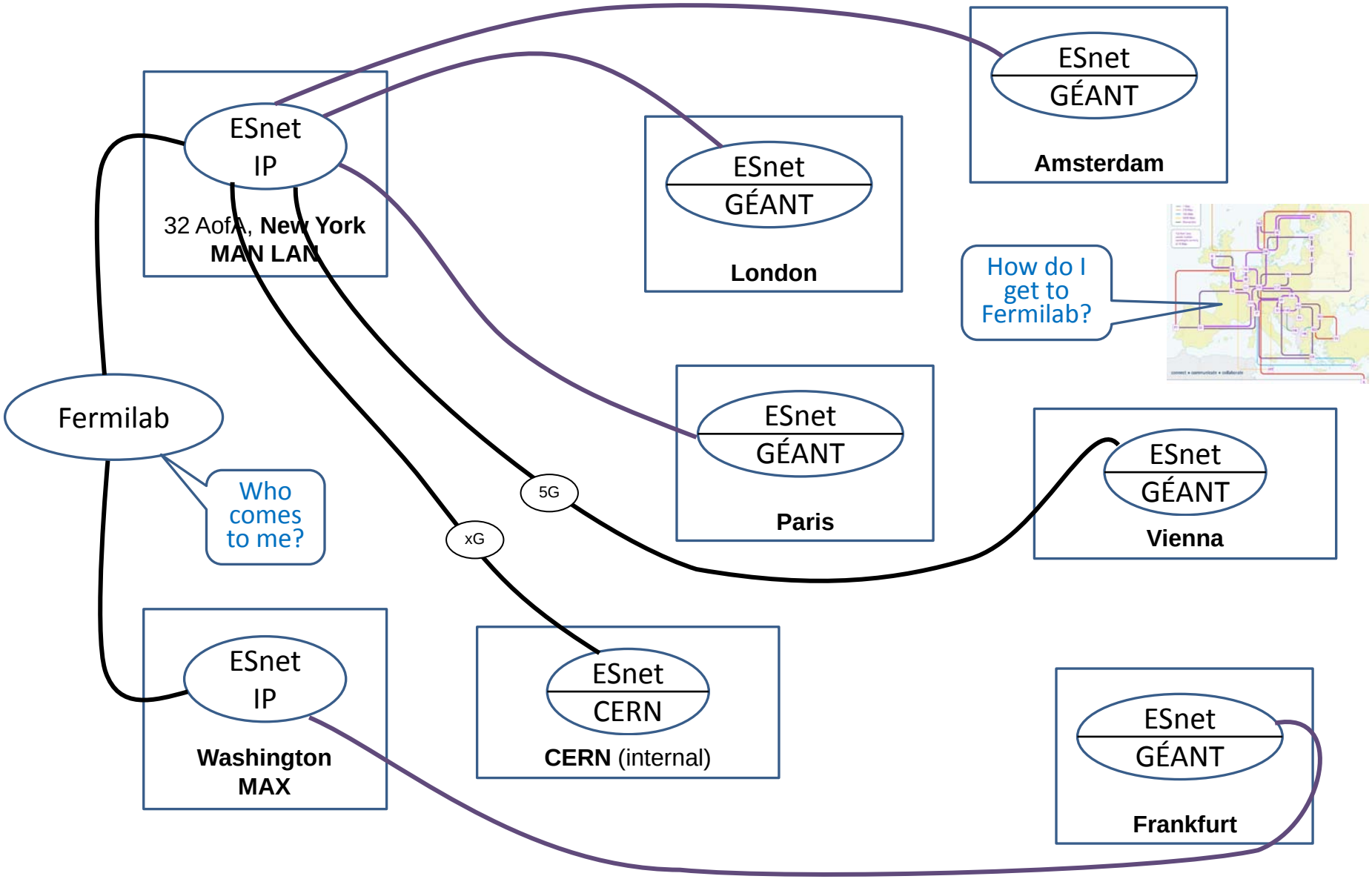
- All paths are 10Gb/s unless noted
- The two ESnet transatlantic paths are carried on virtual circuits provided by USLHCnet to Amsterdam where
  - o GÉANT carries the 3G circuit to Vienna where it advertises ESnet routes
  - o USLHCNet carries the 2G circuit to CERN where CERN advertises ESnet routes internally

- ESnet IP core
- ESnet Science Data Network core (N X 10G)
- ESnet SDN core, NLR links (backup paths)
- Other international
- LHC OPN (USLHCNet)
- Metro ring link
- International GÉANT

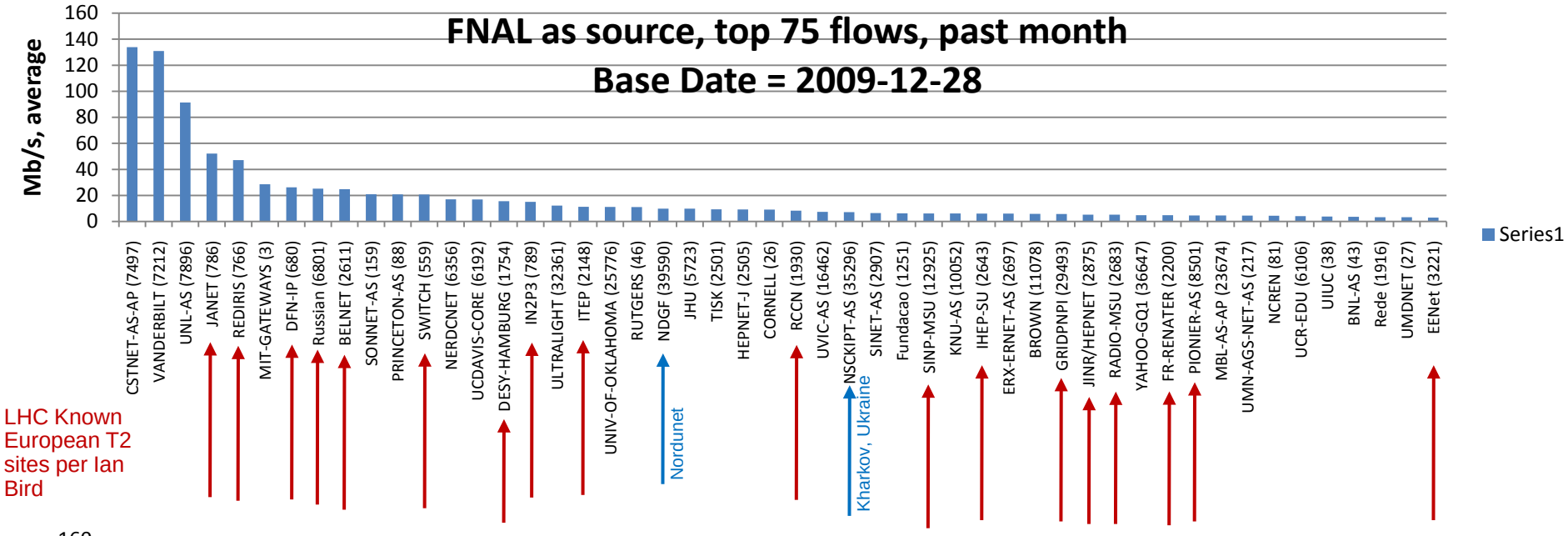
Logical Connectivity for ESnet, GÉANT, and USLHCnet



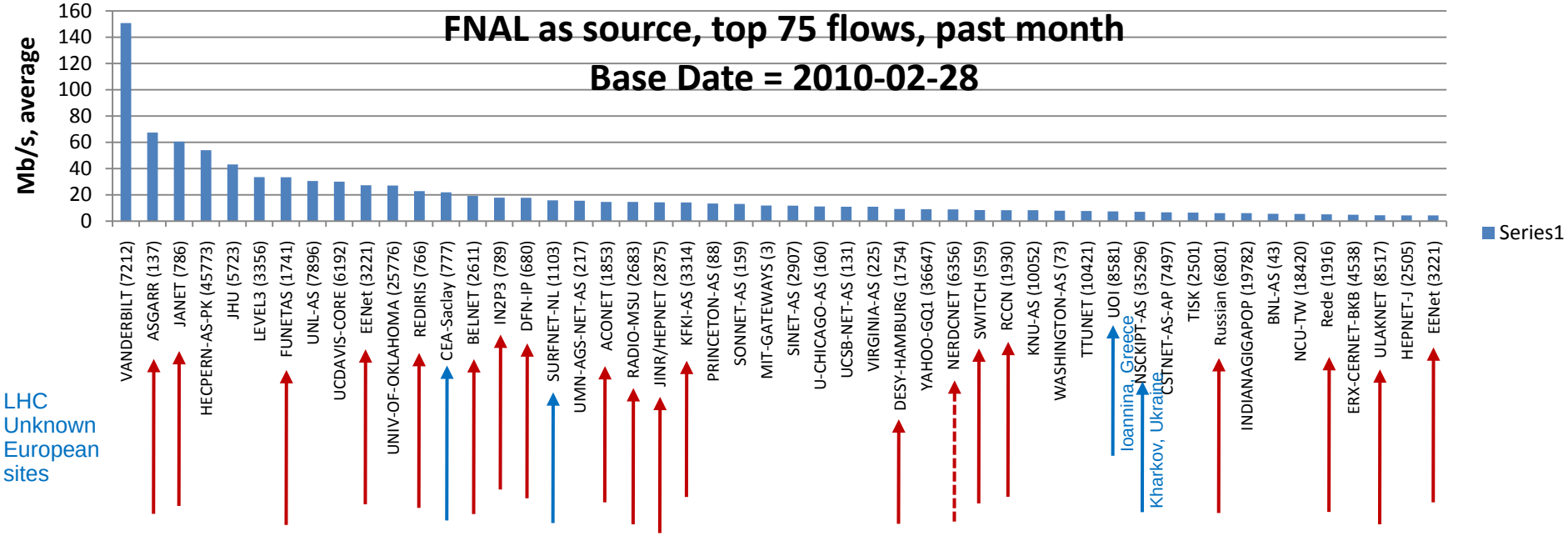
What are Top Level Traffic Patterns?



Who Comes to Fermilab?



LHC Known European T2 sites per Ian Bird



LHC Unknown European sites

How do they get to Fermilab on the US side?

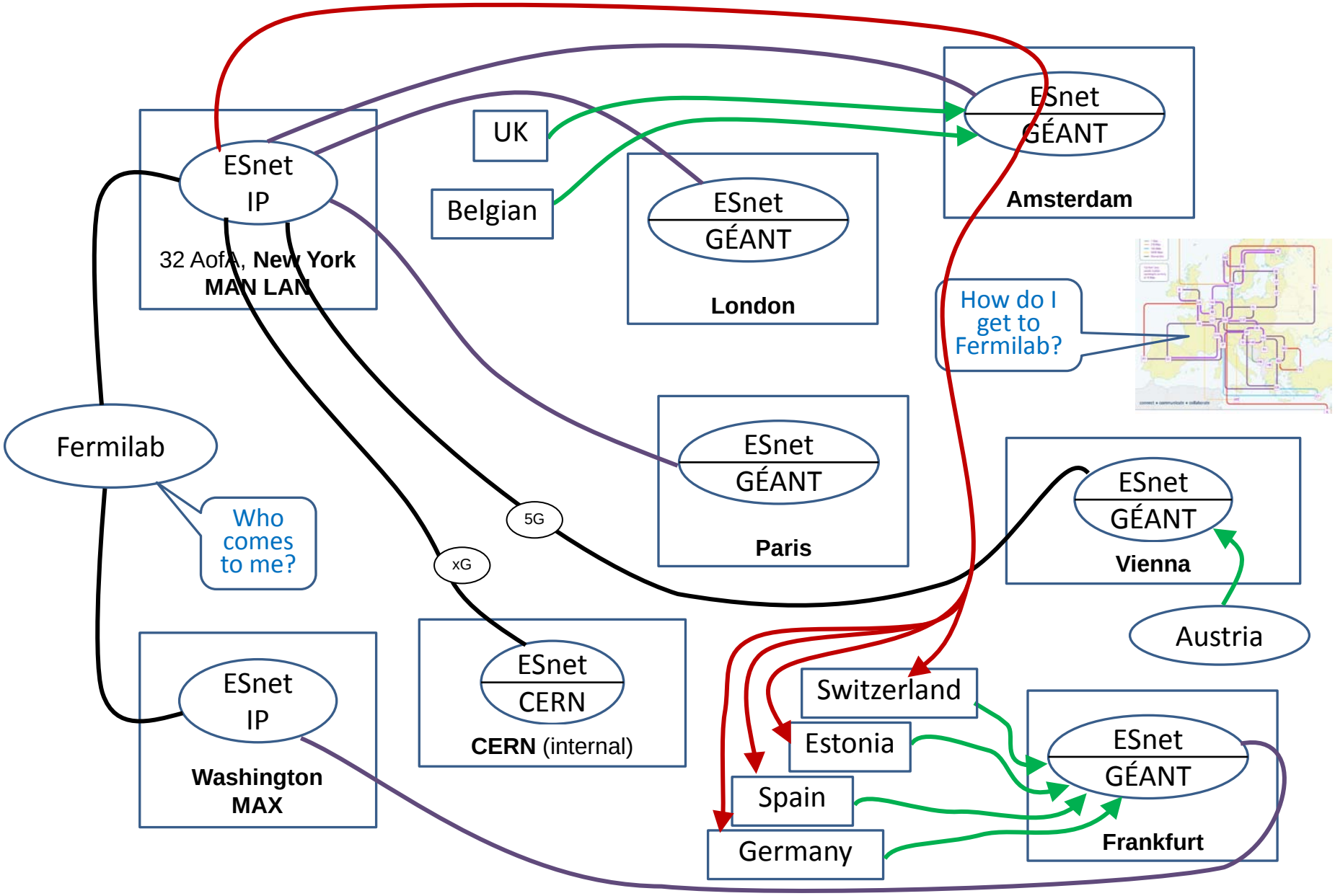
JANET (786) (UK)	aofa-sdn1	JINR/HEPNET (2875)	star-cr1
REDIRIS (766) (Spain)	aofa-sdn1	RADIO-MSU (2683)	star-cr1
DFN (680) (Germany)	aofa-sdn1	FR-RENATER (2200)	aofa-sdn1
Russian (6801)	star-cr1	PIONIER-AS (8501)	aofa-sdn1
BELNET (2611) (Belgian)	aofa-sdn1	EENet (3221)	aofa-sdn1
SWITCH (559) (Switzerland)	aofa-sdn1	ASGARR (137)	aofa-sdn1
		FUNETAS (1741)	aofa-sdn1
DESY-HAMBURG (1754) (Germany)	aofa-sdn1	CEA-Saclay (777)	aofa-sdn1
IN2P3 (789) (France)	aofa-sdn1	SURFNET-NL (1103)	aofa-sdn1
ITEP (2148) (Russia)	star-cr1	ACONET (1853)	aofa-sdn1
NDGF (Nordunet) 39590 (Nordic)	aofa-sdn1	KFKI-AS (3314)	aofa-sdn1
RCCN (1930) (Portugal)	aofa-sdn1	NERDCNET (6356)	star-cr1
NSCKIPT-AS (35296) (Ukraine)	eqx-chi-rt1 (ouch)	UOI (8581)	aofa-sdn1
IHEP-SU (2643)	star-cr1	Rede (1916)	aofa-sdn1
GRIDPNPI (29493) (Russia)	aofa-sdn1	ULAKNET (8517)	aofa-sdn1

How do they get to Fermilab on the US side?

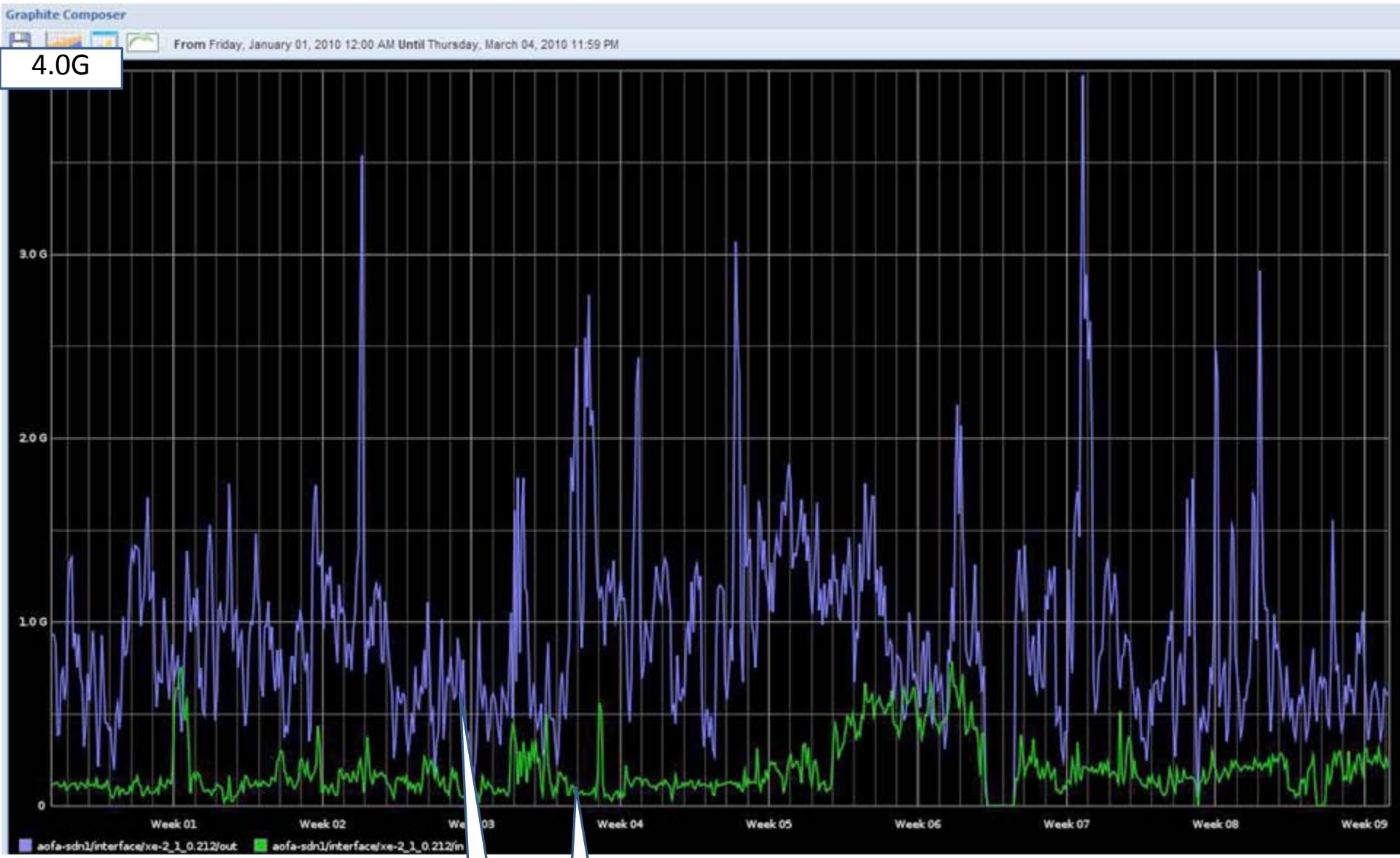
- The traffic through star-cr1 is on an IRNC (?) or country provided path or GLORIAD path
- Not all of FNAL's traffic is LHC, though most of it is (e.g. FNAL is also the data center for the Sloan Digital Sky Survey)

Top Level Traffic Patterns

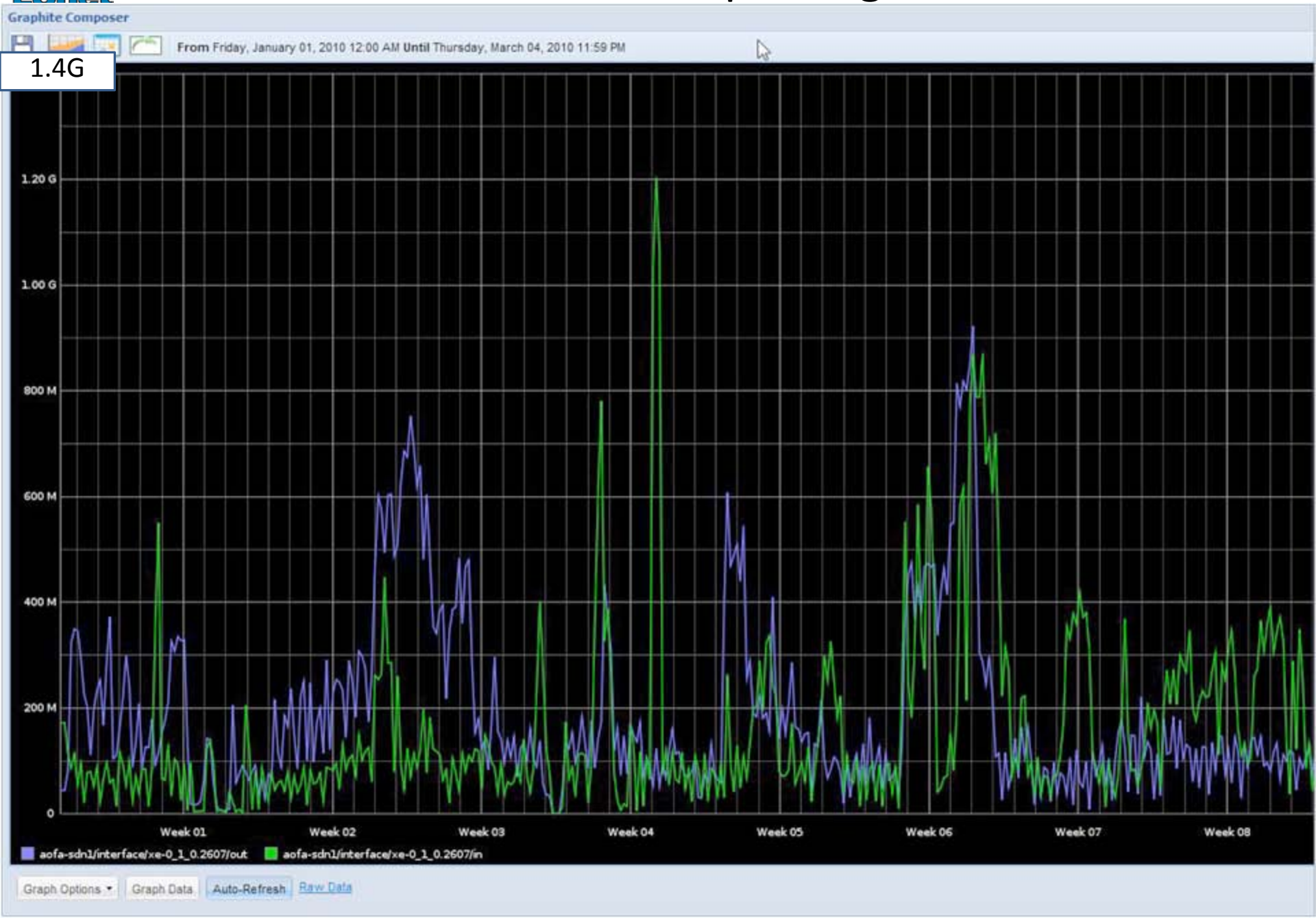
Looking Glass to traceroute from both ends



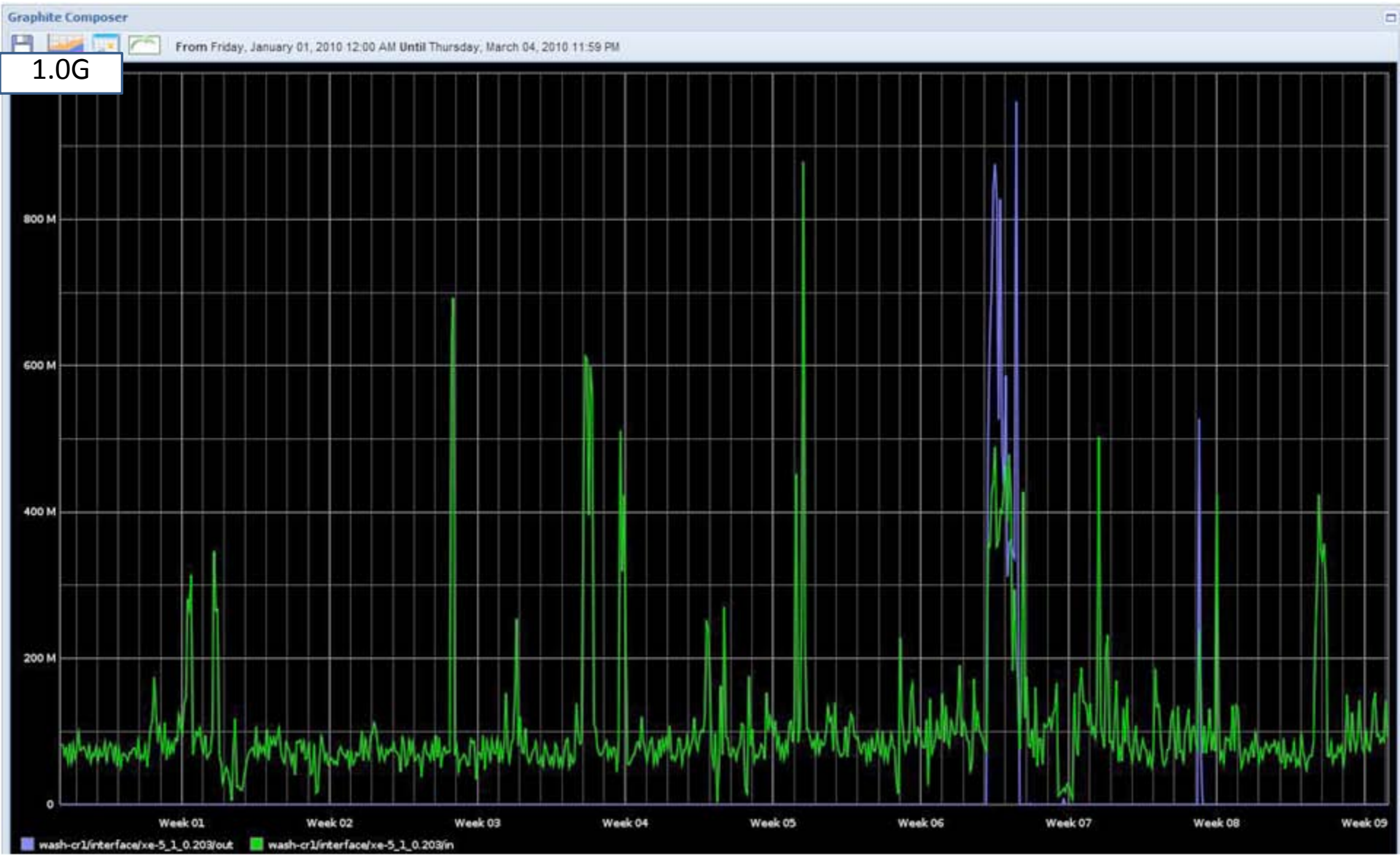
ESnet – GEANT peering in Amsterdam



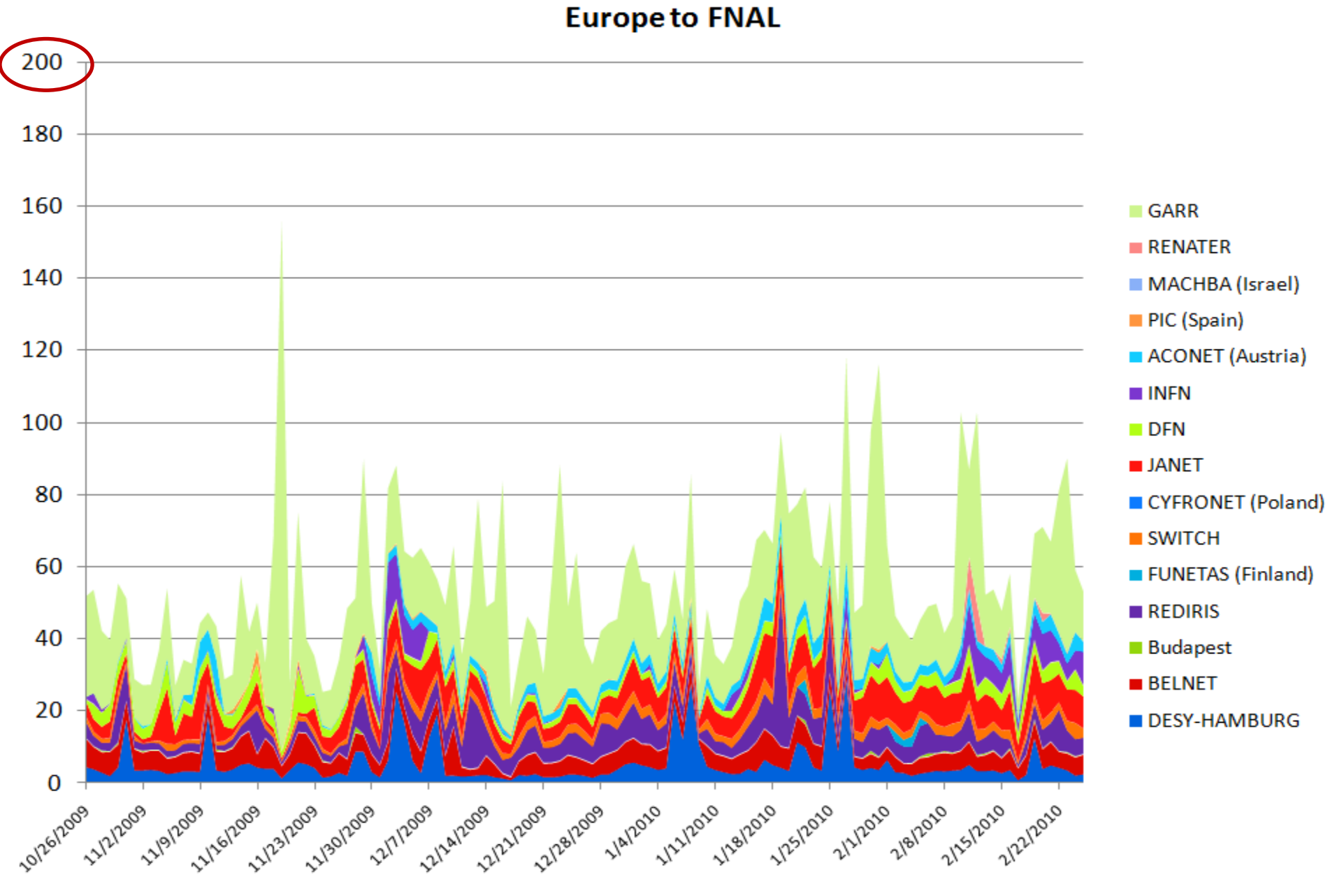
ESnet – GEANT peering in Vienna



ESnet – GEANT peering in Frankfurt

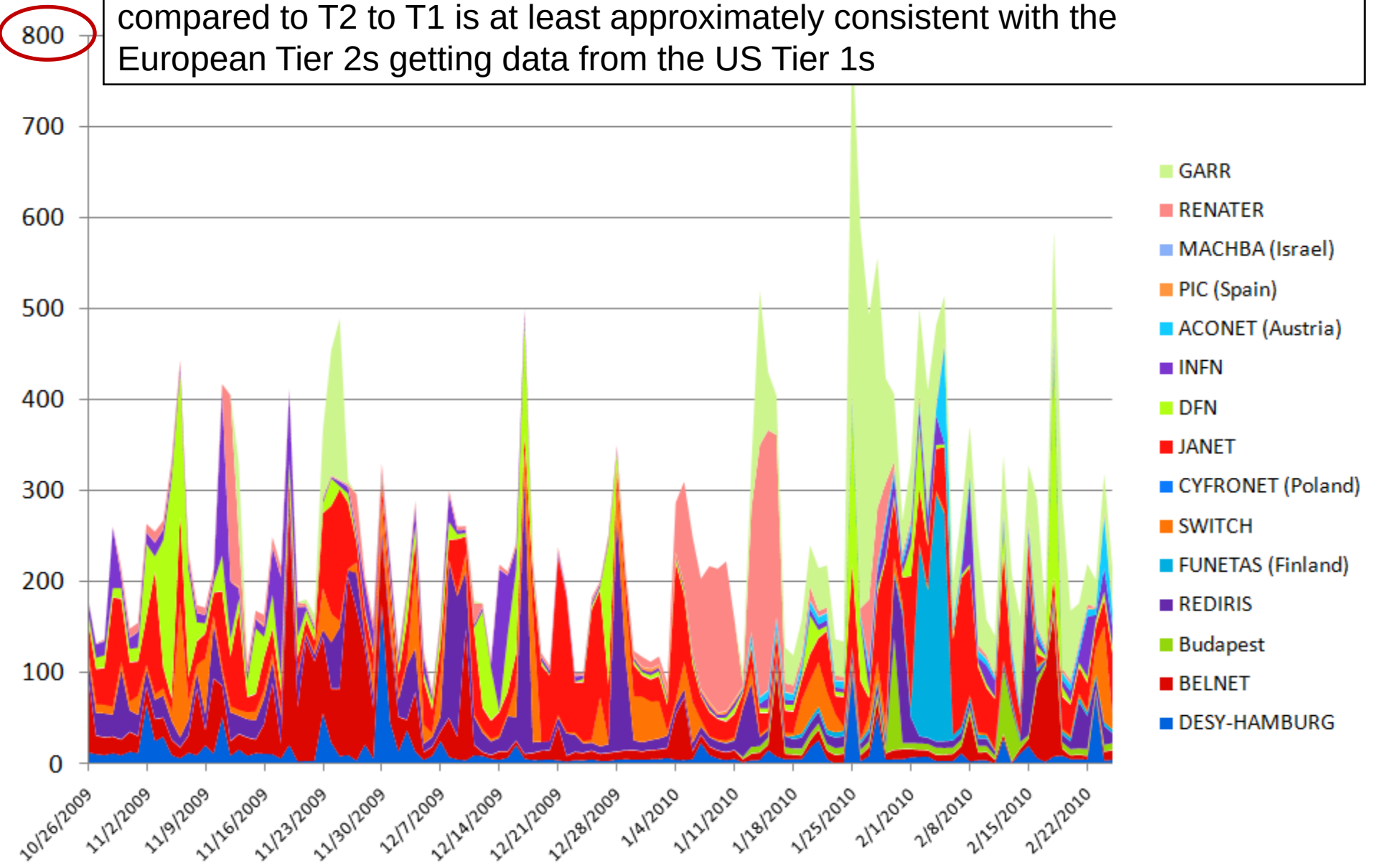


By-Site Traffic: Europe -> FNAL (Mb/s)



By-Site Traffic: FNAL-> Europe

The pattern of substantially more Tier 1 (FNAL) to Tier 2 (Europe) traffic compared to T2 to T1 is at least approximately consistent with the European Tier 2s getting data from the US Tier 1s

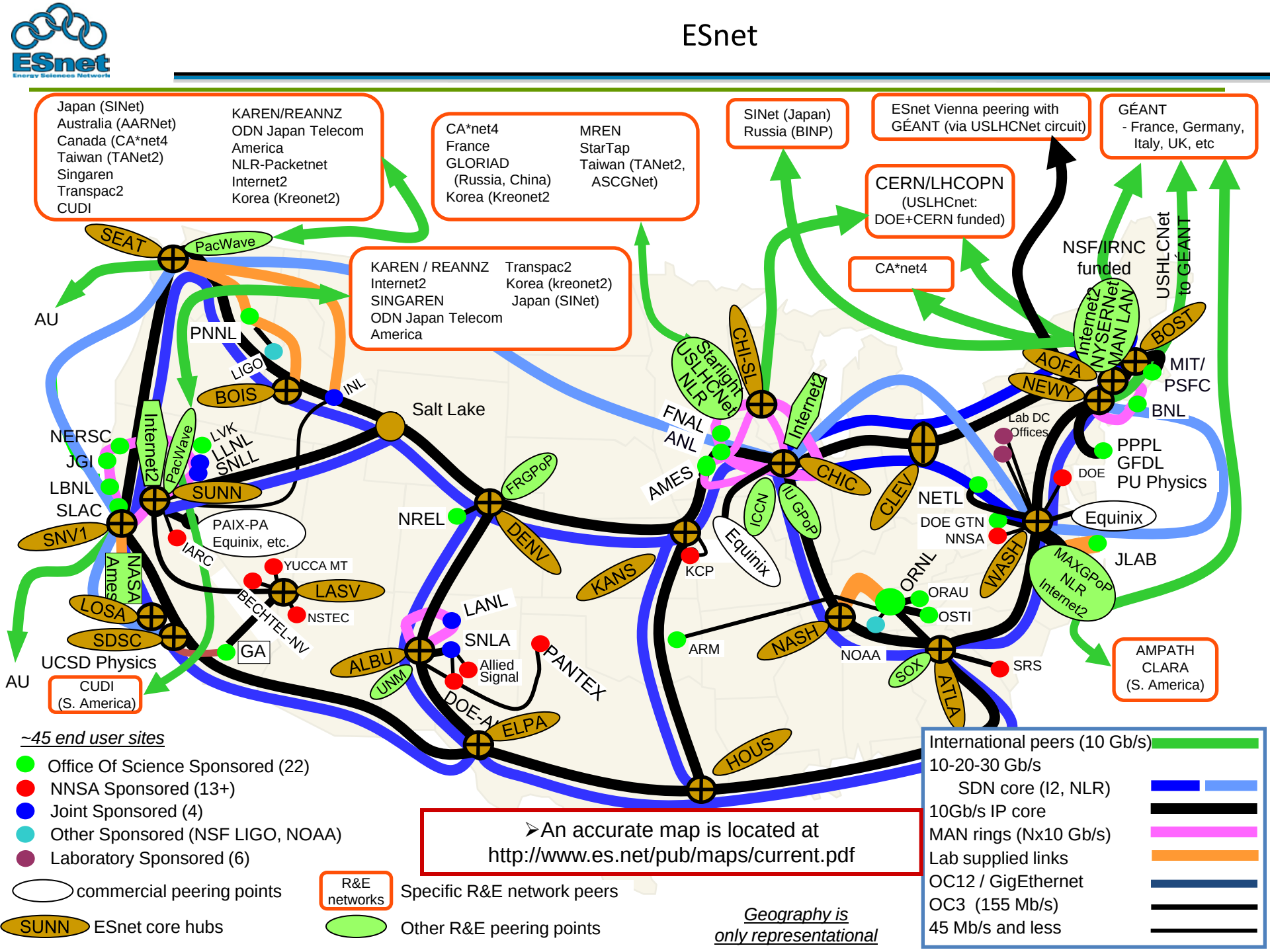


Next Steps

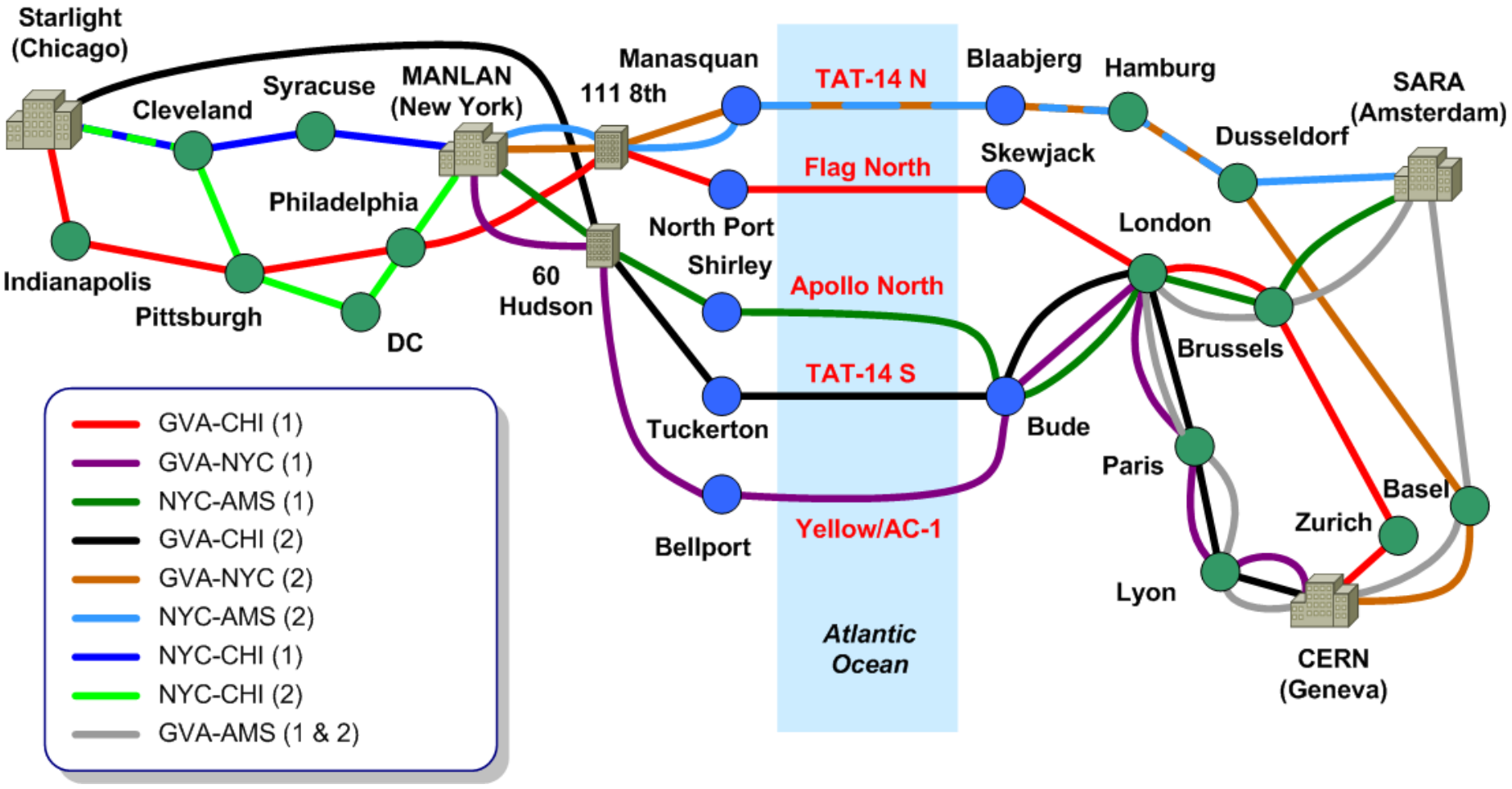
- Sort by-site traffic by path
- Disambiguate LHC site traffic in European ASNs
- Decide what is useful to publish monthly
  - Engage Internet2 to publish similar data for their network
    - Would expect to see the complimentary pattern – US Tier 2s pulling data from European Tier 1s
  - Probably need to also involve NLR and the new IRNC links as some of the US Tier2 connect directly to the New York exchange point (MAN LAN) and if GEANT peers with them, Internet2 would not see the traffic

- END of Slides

ESnet


Japan (SINet)
Australia (AARNet)
Canada (CA*net4
Taiwan (TANet2)
Singaren
Transpac2
CUDI
KAREN/REANNZ
ODN Japan Telecom America
NLR-Packetnet
Internet2
Korea (Kreonet2)
CA*net4
France
GLORIAD (Russia, China)
Korea (Kreonet2
MREN
StarTap
Taiwan (TANet2, ASCGNet)
SINet (Japan)
Russia (BINP)
ESnet Vienna peering with GÉANT (via USLHCNet circuit)
GÉANT - France, Germany, Italy, UK, etc
CERN/LHCOPN (USLHCnet: DOE+CERN funded)
CA*net4
NSF/IRNC funded
USHLCNet to GÉANT
KAREN / REANNZ
Internet2
SINGAREN
ODN Japan Telecom America
Transpac2
Korea (kreonet2)
Japan (SINet)
SEAT
PacWave
AU
PNNL
LIGO
BOIS
INL
Salt Lake
NERSC
JGI
LBNL
SLAC
SNV1
Internet2
PacWave
LVK
LLNL
SNLL
SUNN
PAIX-PA Equinix, etc.
IARC
NASA Ames
LOSA
SDSC
UCSD Physics
CUDI (S. America)
YUCCA MT
LASV
NSTEC
BECHTEL-NV
GA
NREL
FRGPoP
DENV
KANS
LANL
SNLA
Allied Signal
PANTEX
ALBU
UNM
DOE-A
ELPA
HOUS
FNAL
ANL
AMES
Starlight USLHCNet NLR
CHI-SL
Internet2
CHIC
KCP
Equinix
ICCN
IU GPoP
ARM
NASH
ORNL
ORAU
OSTI
NOAA
SOX
ATLA
SRS
CLEV
NETL
DOE GTN
NNSA
Equinix
WASH
MAXGPoP
NLR
Internet2
JLAB
AOFA
NEWY
Internet2
NYSERNet
MAN LAN
BOST
MIT/
PSFC
BNL
Lab DC Offices
DOE
PPPL
GFDL
PU Physics
AMPATH
CLARA
(S. America)
~45 end user sites
Office Of Science Sponsored (22)
NNSA Sponsored (13+)
Joint Sponsored (4)
Other Sponsored (NSF LIGO, NOAA)
Laboratory Sponsored (6)
commercial peering points
SUNN ESnet core hubs
R&E networks
Specific R&E network peers
Other R&E peering points
➢An accurate map is located at http://www.es.net/pub/maps/current.pdf
Geography is only representational
International peers (10 Gb/s)
10-20-30 Gb/s SDN core (I2, NLR)
10Gb/s IP core
MAN rings (Nx10 Gb/s)
Lab supplied links
OC12 / GigEthernet
OC3 (155 Mb/s)
45 Mb/s and less

USLHCNet 1/2010



GEANT International