ESnet International Connections

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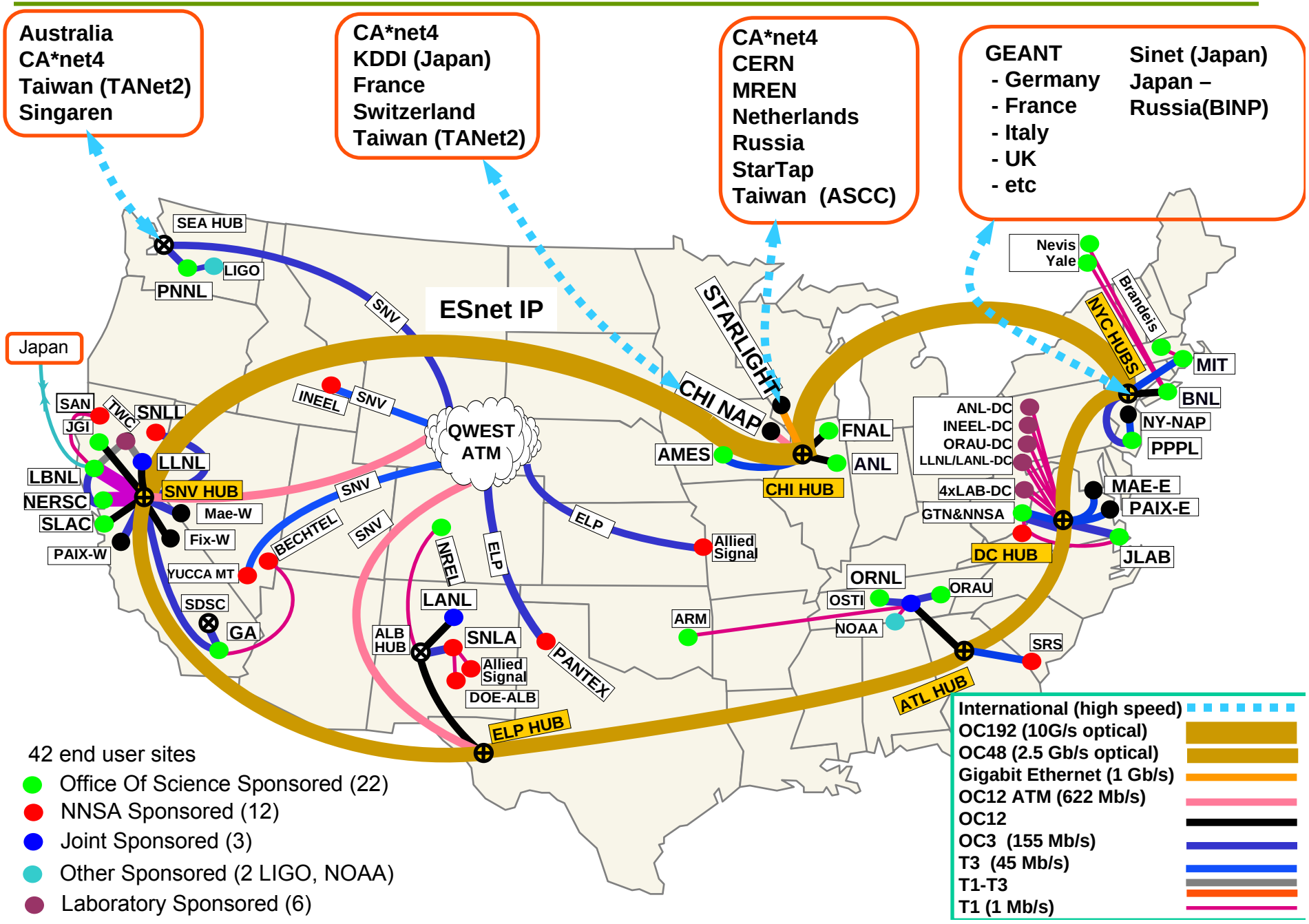
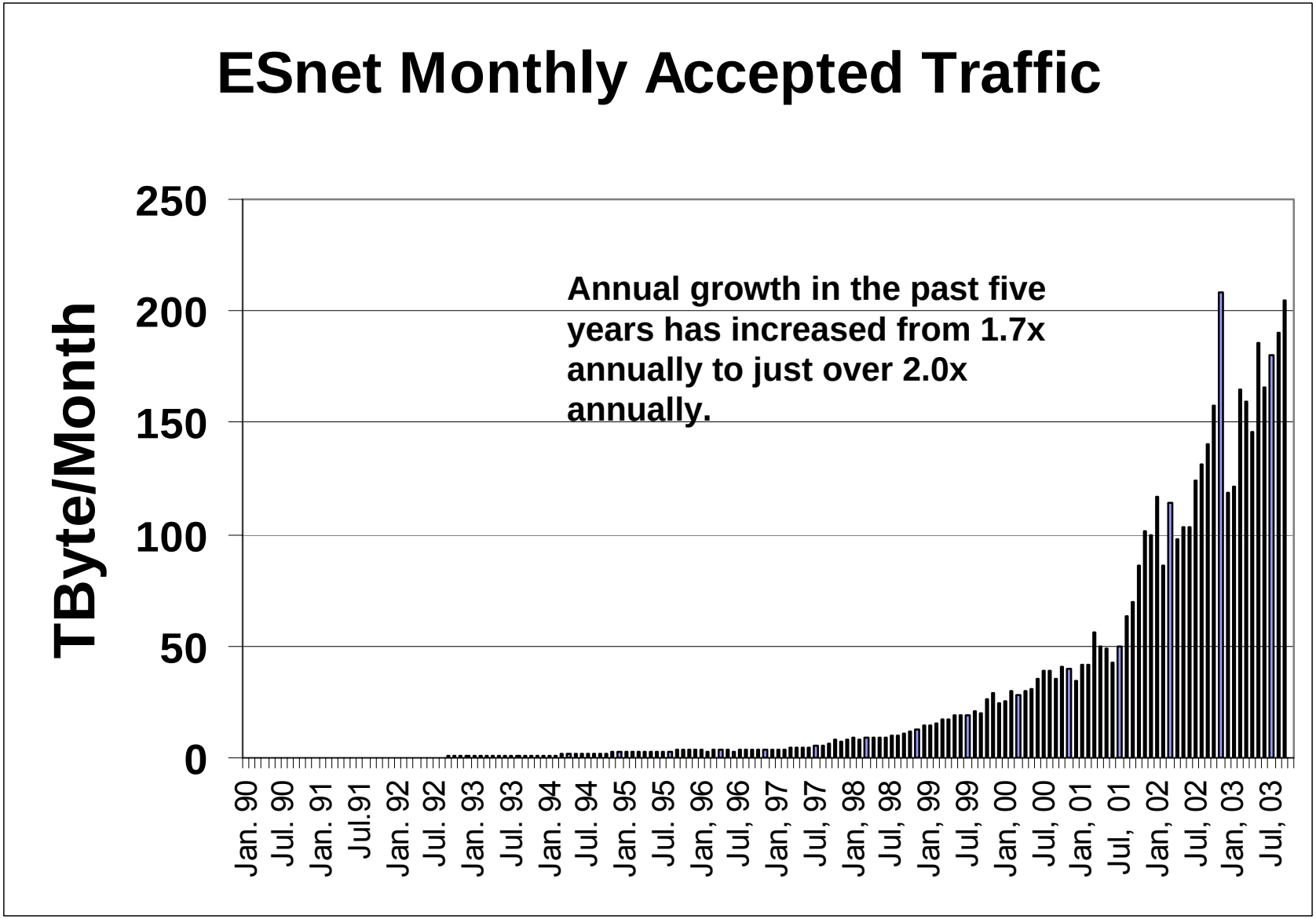
Joseph Burrescia, and James V. Gagliardi, ESnet Leads

and the ESnet Team

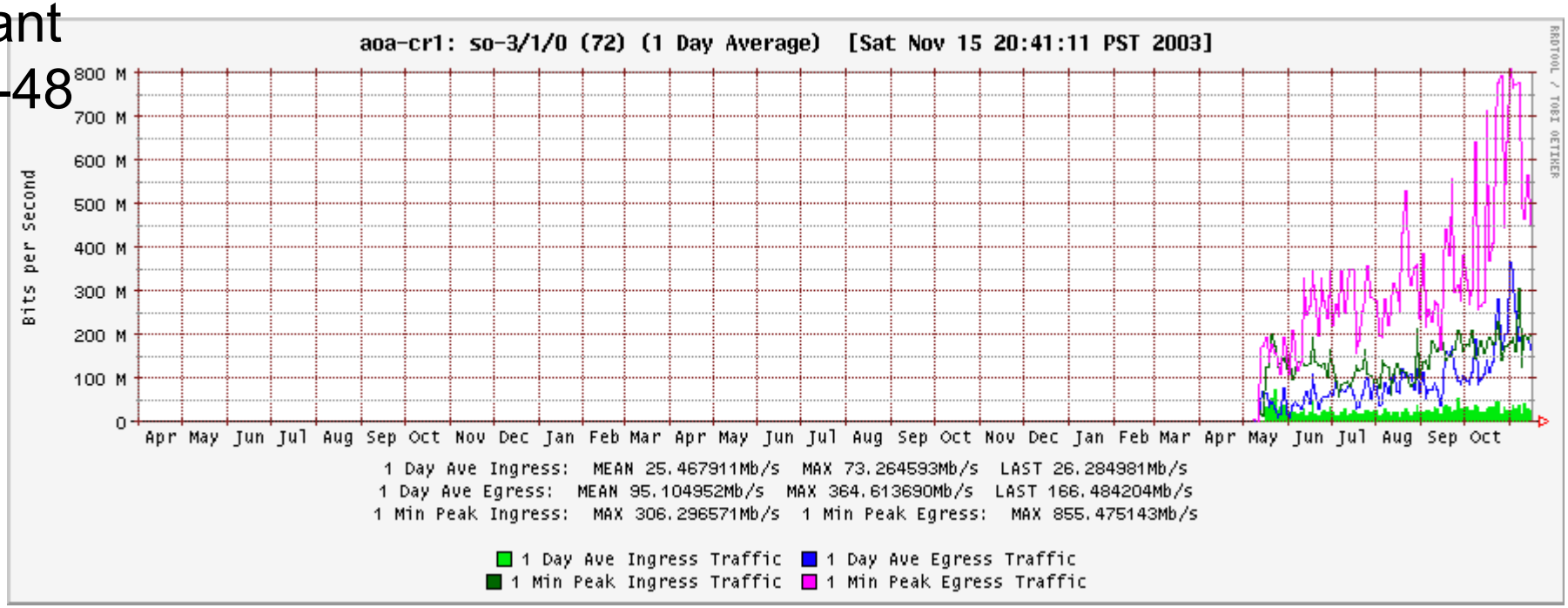
ESnet Connects Facilities and Collaborators



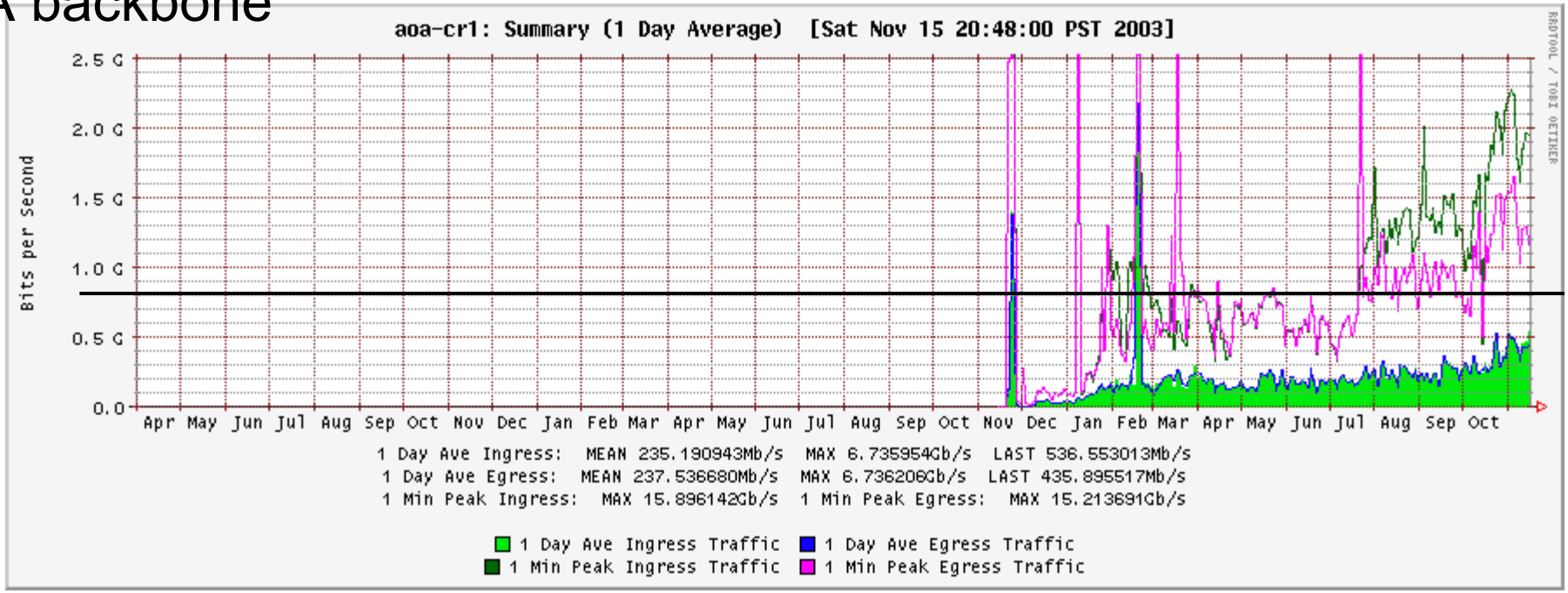
ESnet Has Experienced Exponential Growth Since 1992



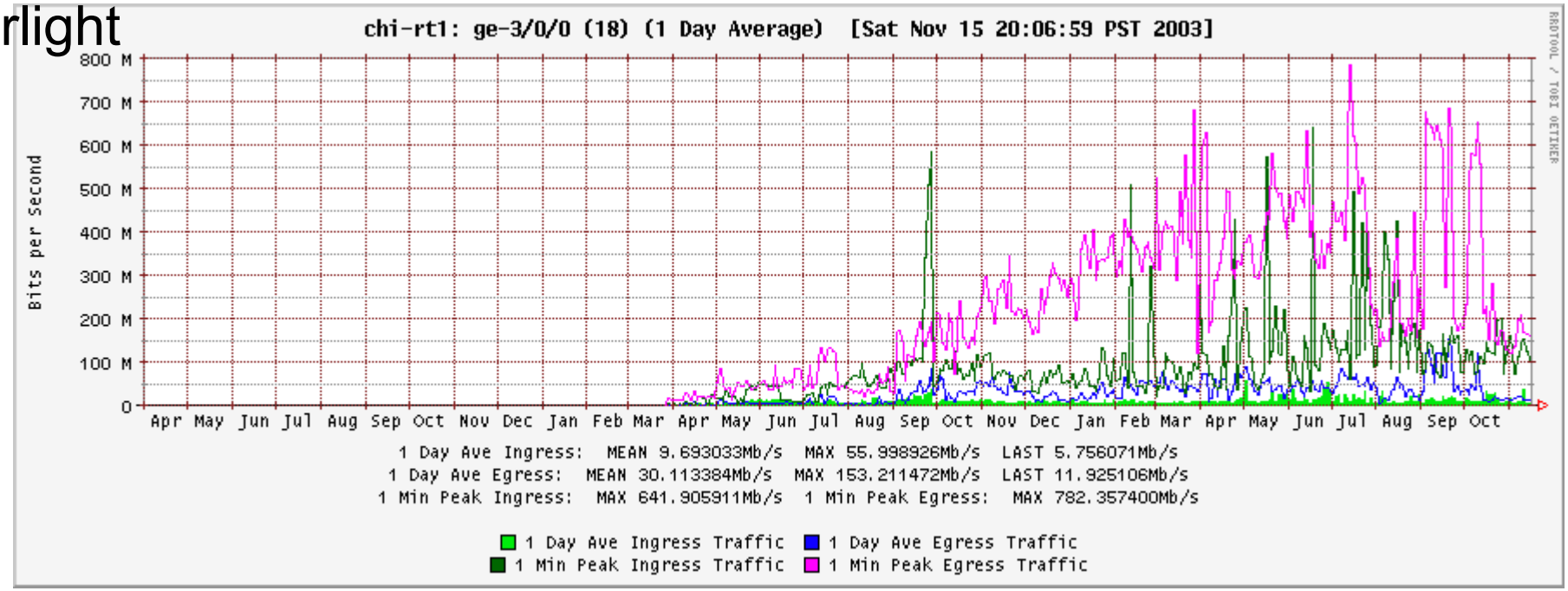
Geant
OC-48



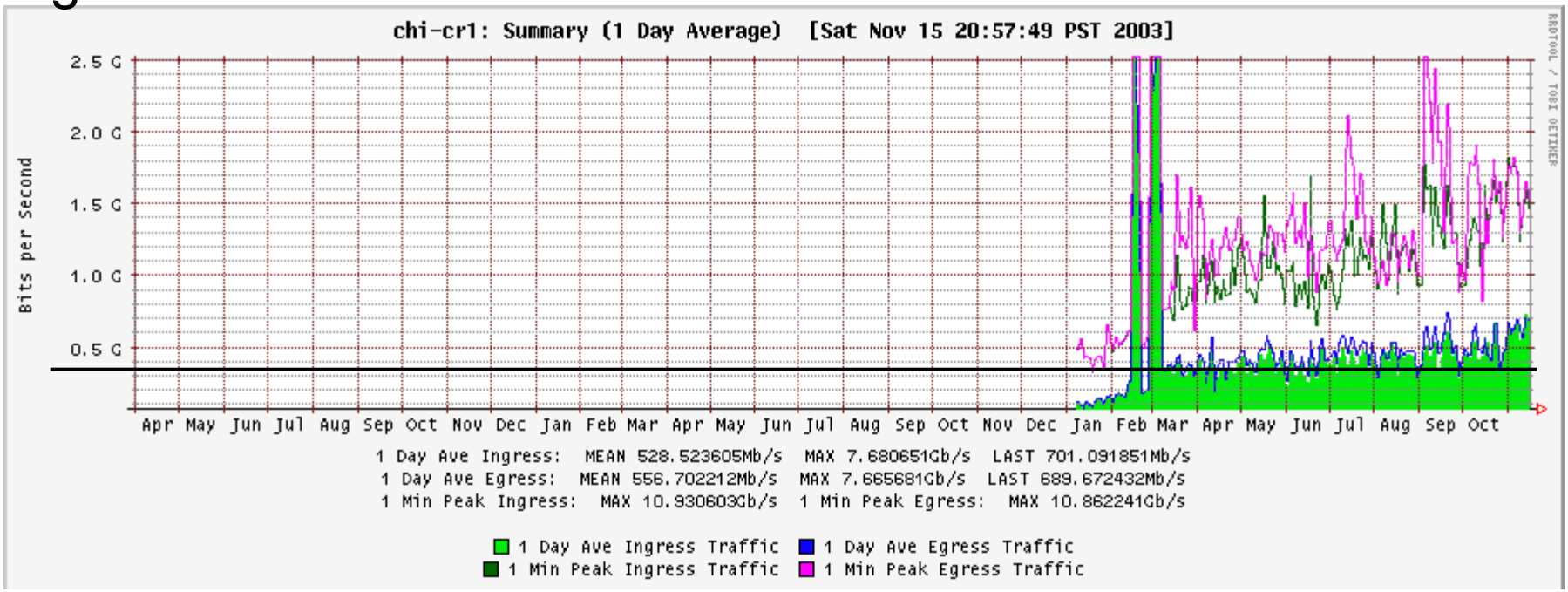
AoA backbone



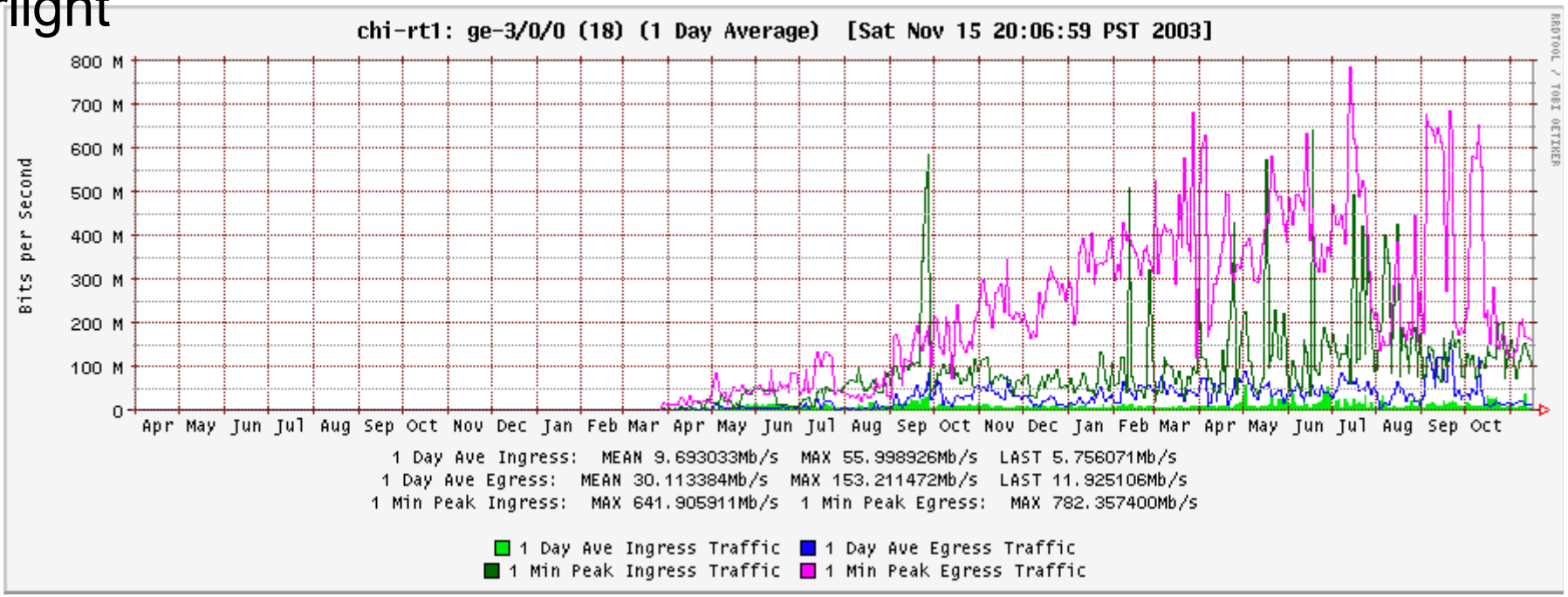
Starlight GE



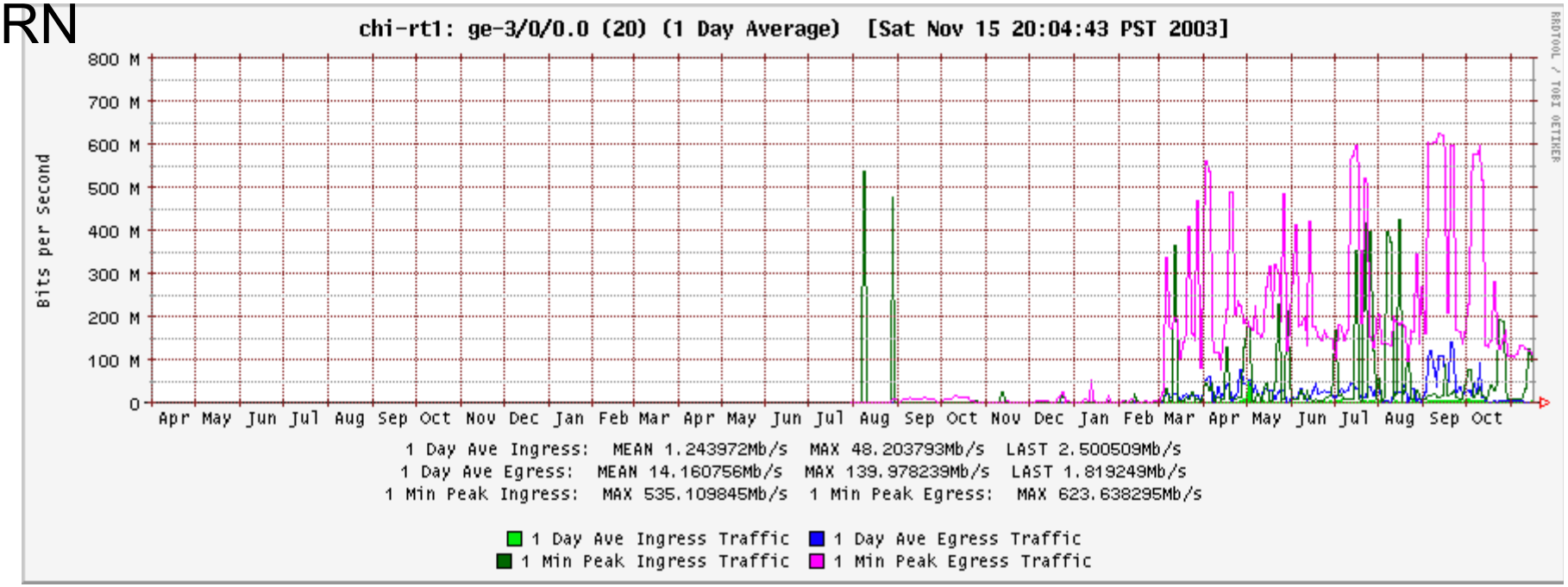
Chicago backbone



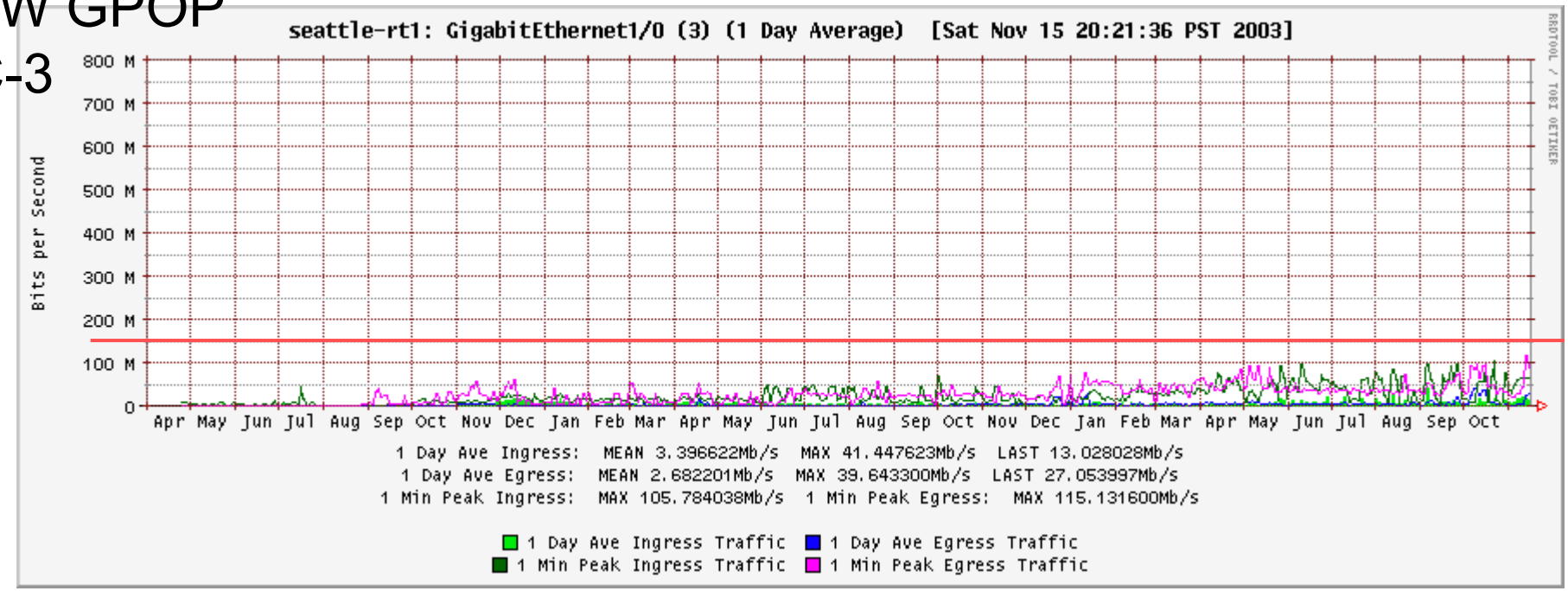
Starlight GE



CERN GE



PNW GPOP OC-3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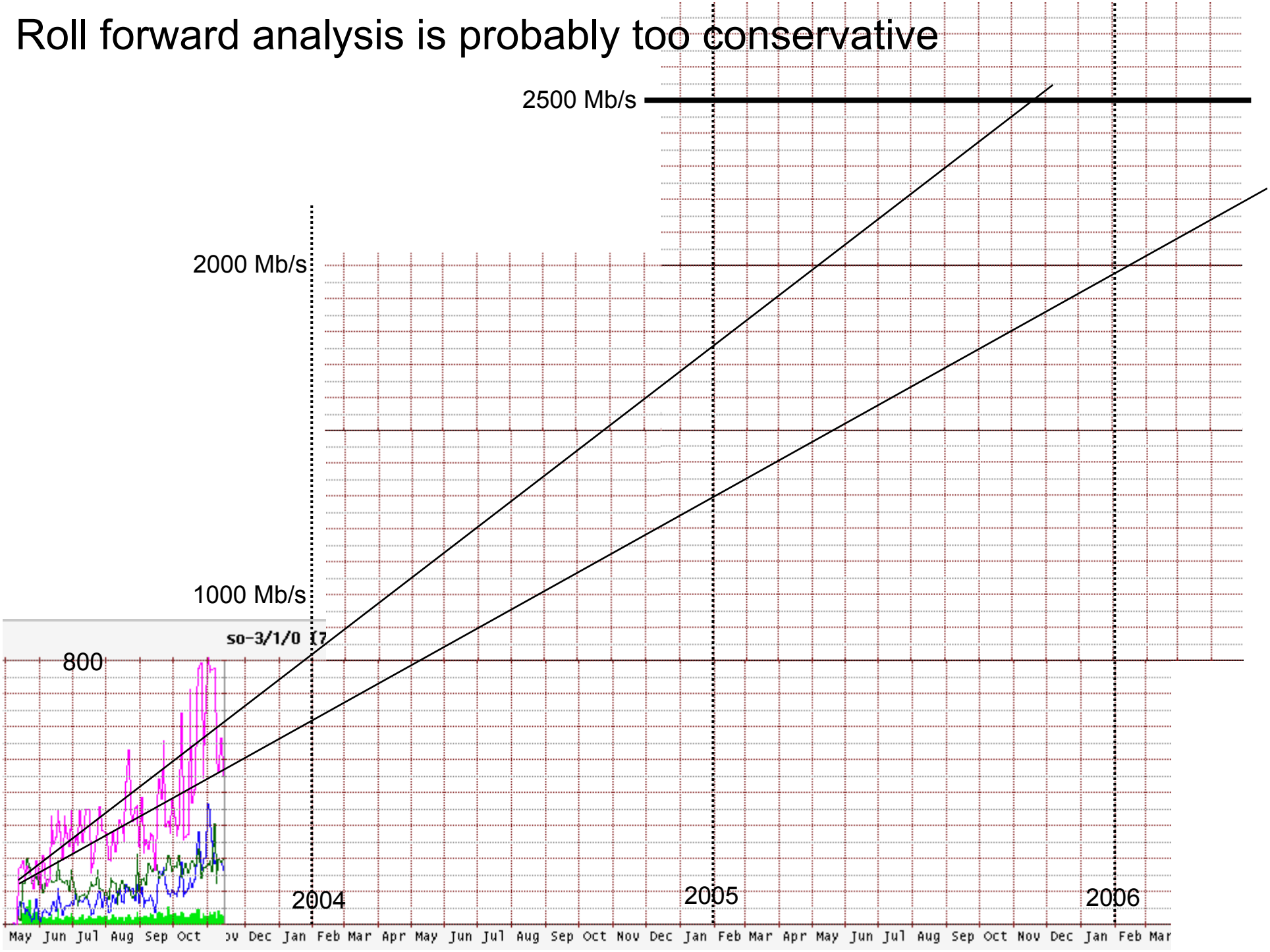
Bits per Second
800 M
700 M
600 M
500 M
400 M
300 M
200 M
100 M
0
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct
1 Day Ave Ingress: MEAN 3.396622Mb/s MAX 41.447623Mb/s LAST 13.028028Mb/s
1 Day Ave Egress: MEAN 2.682201Mb/s MAX 39.643300Mb/s LAST 27.053997Mb/s
1 Min Peak Ingress: MAX 105.784038Mb/s 1 Min Peak Egress: MAX 115.131600Mb/s
1 Day Ave Ingress Traffic
1 Day Ave Egress Traffic
1 Min Peak Ingress Traffic
1 Min Peak Egress Traffic
RRDTOOL / TOBI OETIKER

Roll forward analysis is probably too conservative



Office of Science Data Movement Requirements by 2008

Roll back analysis may be inflated

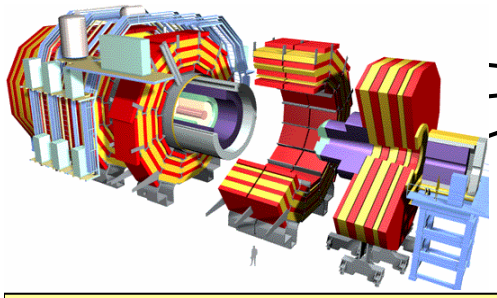
Science Areas	Current End-to-End Throughput	5 years End-to-End Throughput	5-10 Years End-to-End Throughput	General Remarks
High Energy Physics	0.5 Gbps	100 Gbps E2E	1.0 Tbps	high throughput
Climate Data & Computations	0.5 Gbps	160-200 Gbps	*n* Tbps	high throughput
SNS NanoScience	(under construction)	1.0 Gbps steady state	Tbps & control channels	remote control & high throughput
Fusion Energy	500MB/min (burst mode)	500MB/20sec (burst mode)	*n* Tbps	time critical transport
Astrophysics	1TB/week	N*N multicast	1TB+ & stable streams	Computational steering & collaborations
Genomics	1TB/day	100's users	Tbps & control channels	high throughput & steering

What is Happening Now?

- What will be the impact of Grids?
  - The LHC data requirements are coming into focus as LHC moves to more and more realistic simulated production runs (“data challenges”)
  - This provides some clues as to how Grids will impact the network

High Energy Physics Data Management

CERN / LHC Data: One of Science's most challenging data management problems



Online System

~100 MBytes/sec

~PByte/sec

Tier 0 +1

event simulation

HPSS

event reconstruction

- 20% 0f raw data + all reconstructed data ⇒ 600 Mb/s
- experiment specific data ⇒ 1 Gb/s
- Analysis on Grids ⇒ X2
- headroom provisioning ⇒ X1.5-2
- giving 3-4 Gb/s

CERN LHC CMS detector

15m X 15m X 22m, 12,500 tons, $700M.

~2.5 Gbits/sec

Tier 1

French Regional Center

German Regional Center

FermiLab CMS Tier 1

Brookhave Atlas Tier

Italian Center

analysis

~0.6-2.5 Gbps

Tier2 Center

~0.6-2.5 Gbps

Tier 3

Institute ~0.25TIPS

Physics data cache

100 - 1000 Mbits/sec

Tier 4

Workstations

Courtesy Harvey Newman, CalTech

CERN/CMS data goes to 6-8 Tier 1 regional centers, and from each of these to 6-10 Tier 2 centers.

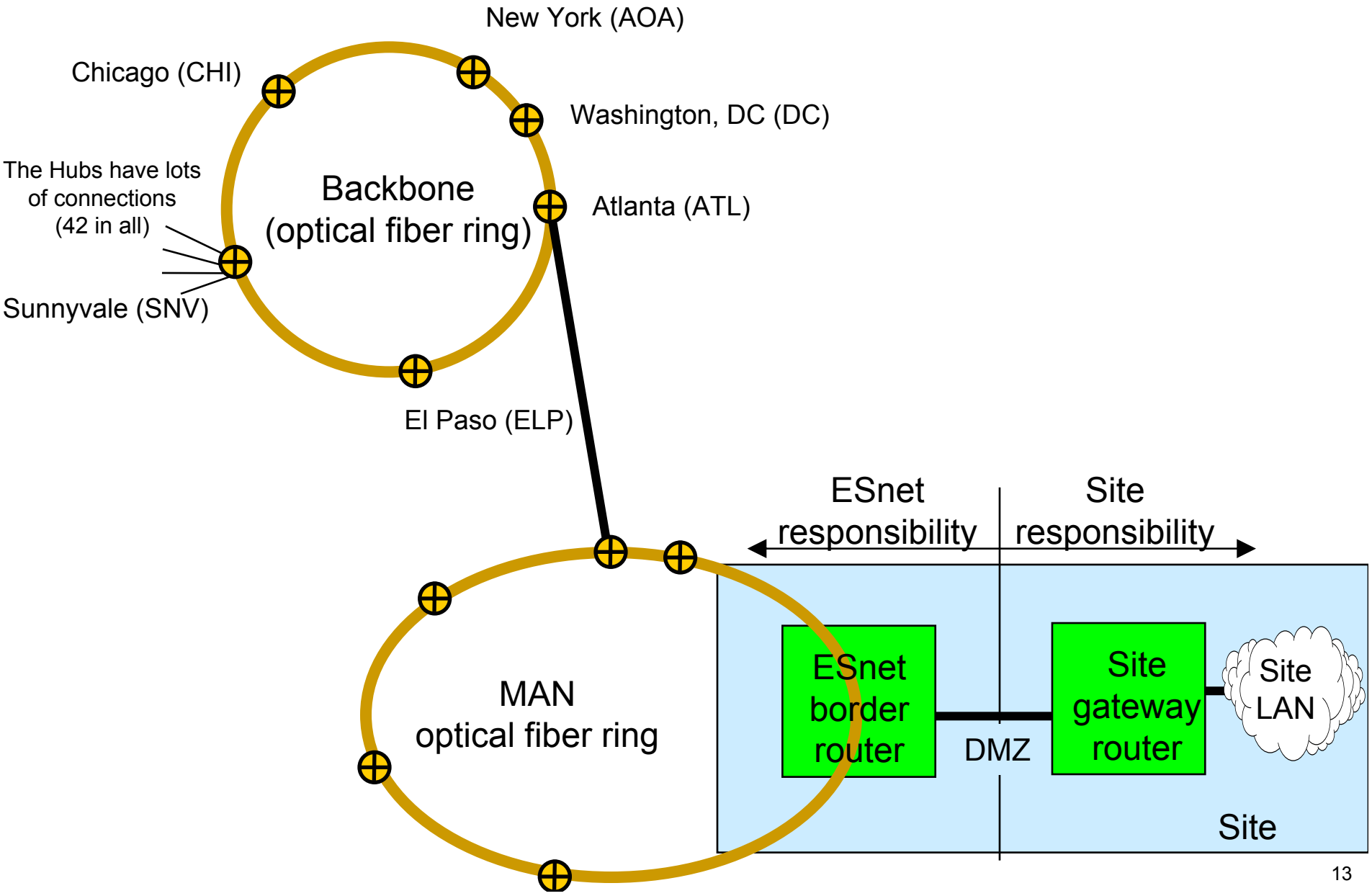
Physicists work on analysis "channels" at 135 institutes. Each institute has ~10 physicists working on one or more channels.

2000 physicists in 31 countries are involved in this 20-year experiment in which DOE is a major player.

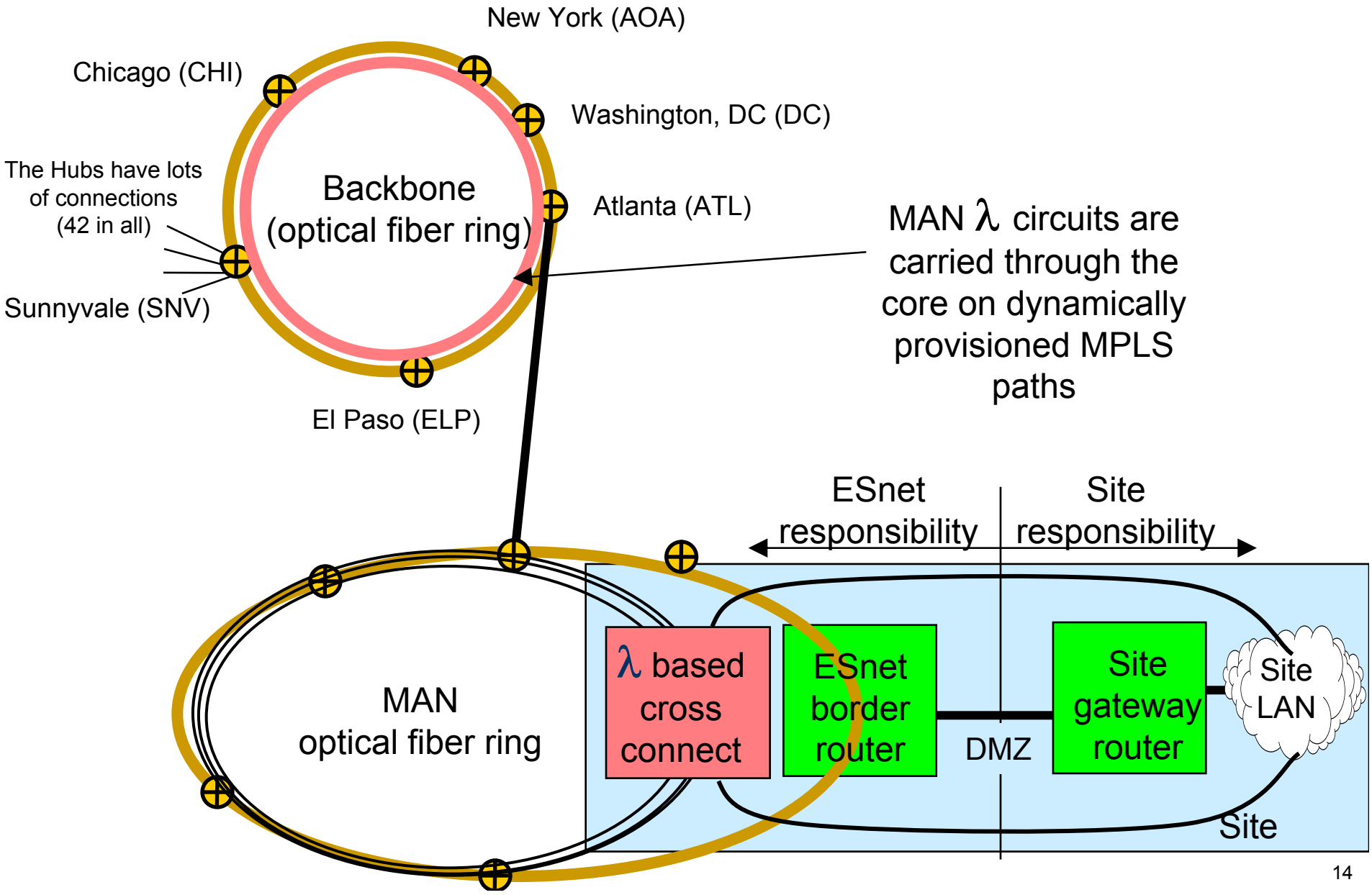
The Challenge

- The LHC (Atlas and CMS) appear to have real and near-term needs for substantial CERN ⟶US bandwidth increases to DOE Labs
- Re-engineer the network to
  - manage the dramatic local loop bandwidth increases
  - accommodate the increases needed at the International peering points

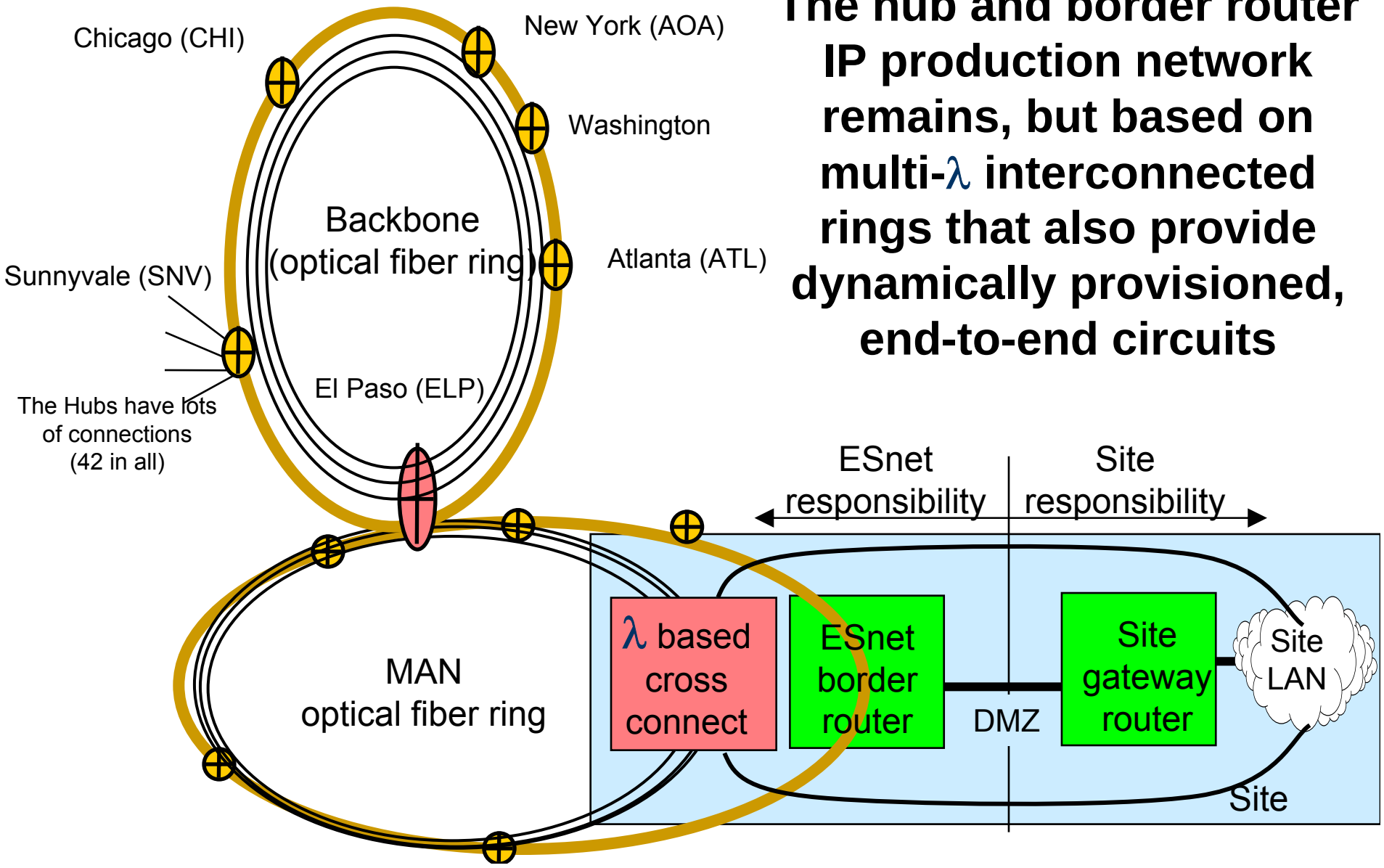
ESnet MAN Based Architecture – Phase1



ESnet MAN Based Architecture – Phase2-3



ESnet Architecture – Future: End-to-End Optical Transparency



The hub and border router IP production network remains, but based on multi-λ interconnected rings that also provide dynamically provisioned, end-to-end circuits

International Connectivity

- Harvey Newman estimates that LHC will need 3-4 λs to CERN to satisfy LHC. Can they afford that? Two might be available now if you can call you network and R&D project, But will that work longterm for HEP?