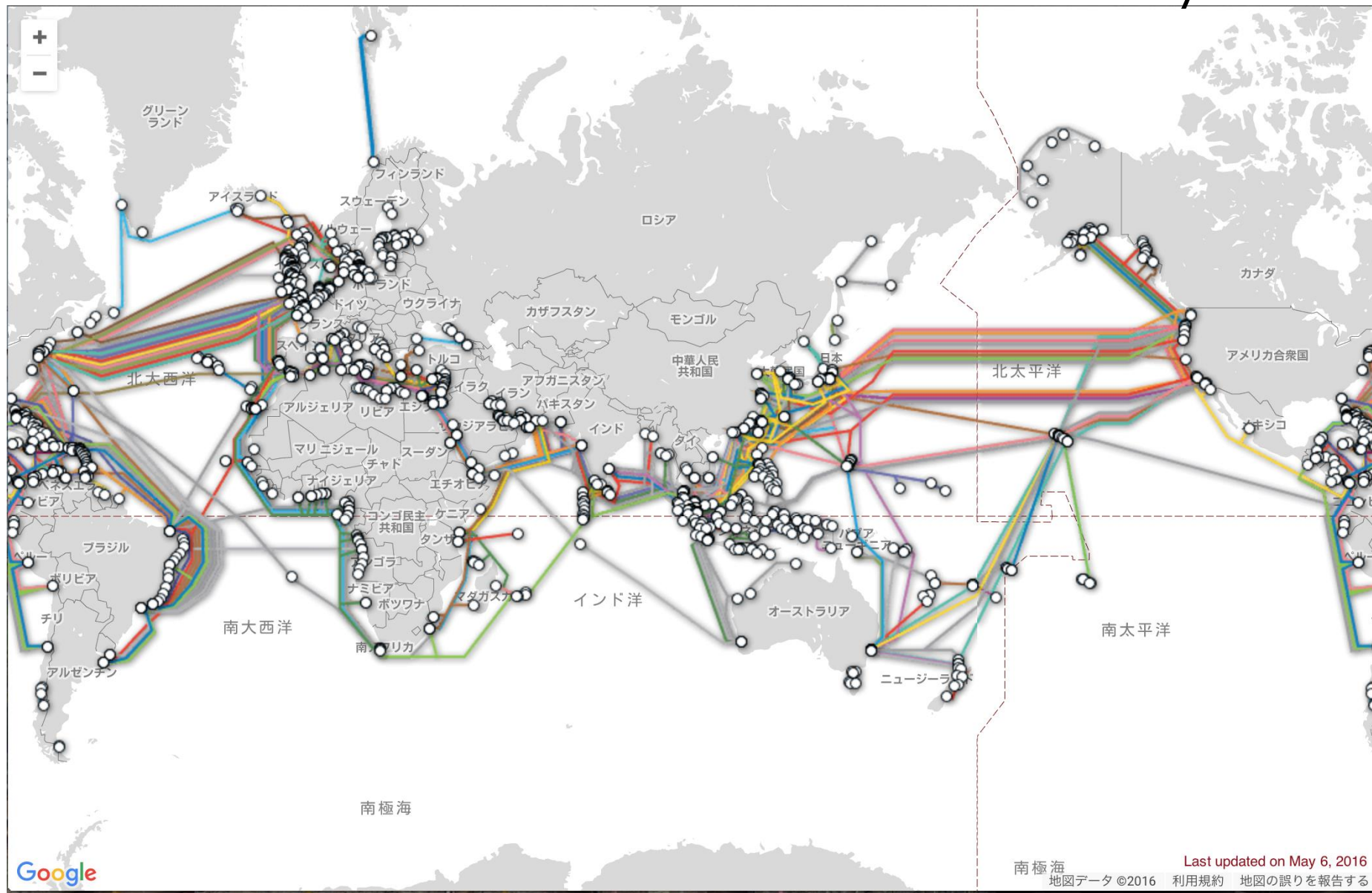


The Fiber Optic Interconnection around the Globe

Kempei Fukuda
NTT Communications Corporation
May 9, 2016

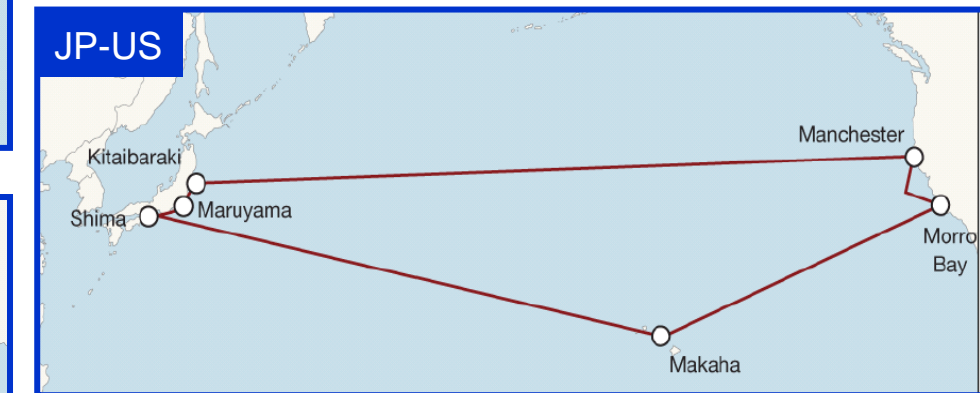
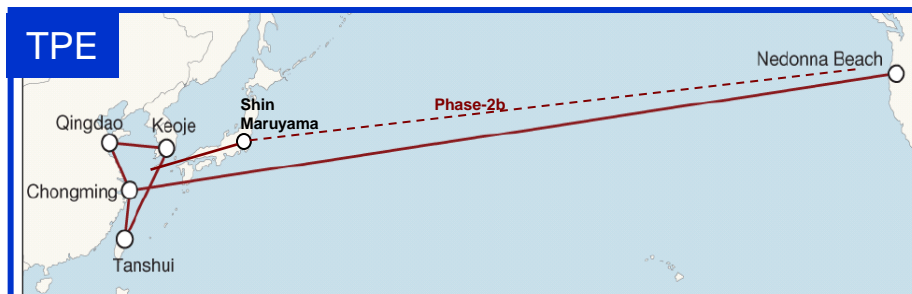
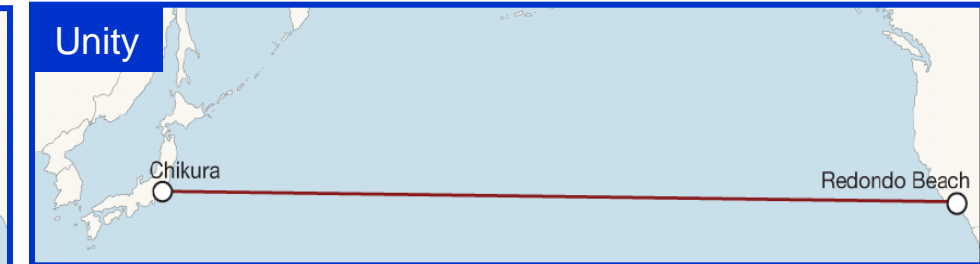
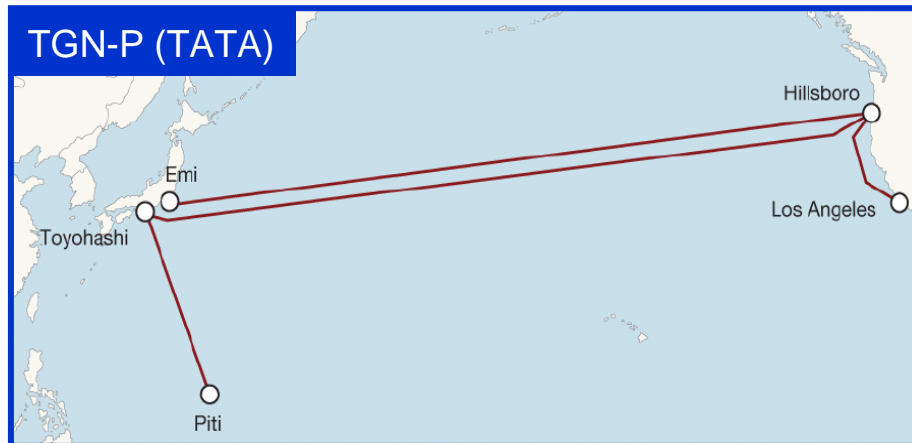
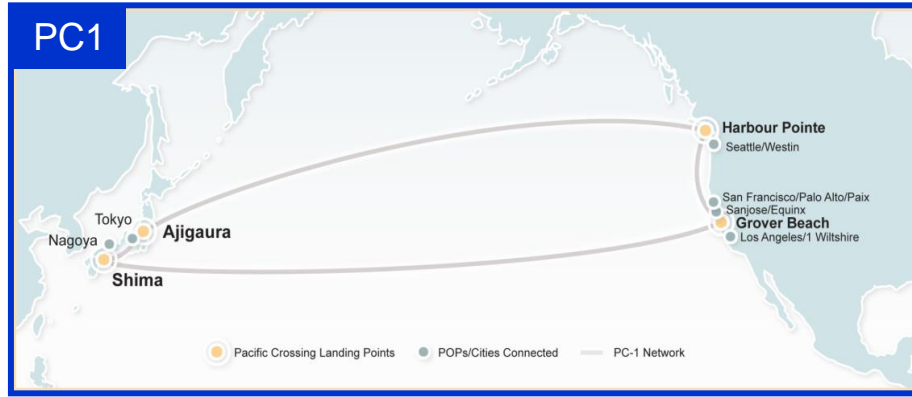
- **How the World Is Inter-Connected Today**
- **Major Cables around the Globe**
- **Our Network (NTTC)**
- **Challenges**
- **Next Areas of Interest**

How the World Is Inter-Connected Today



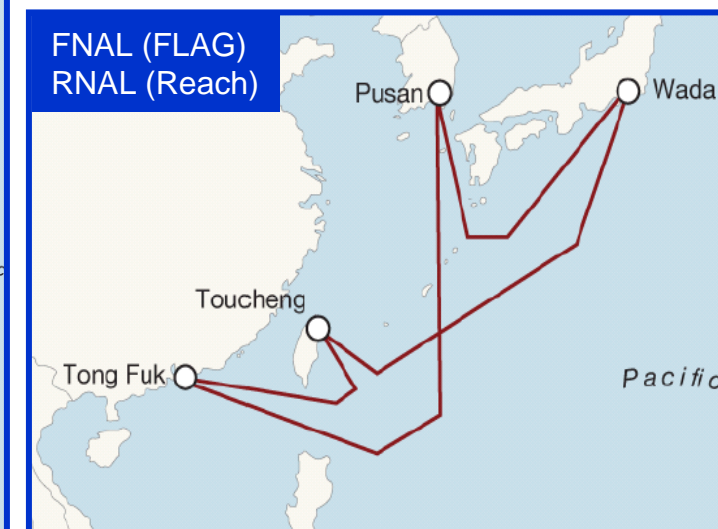
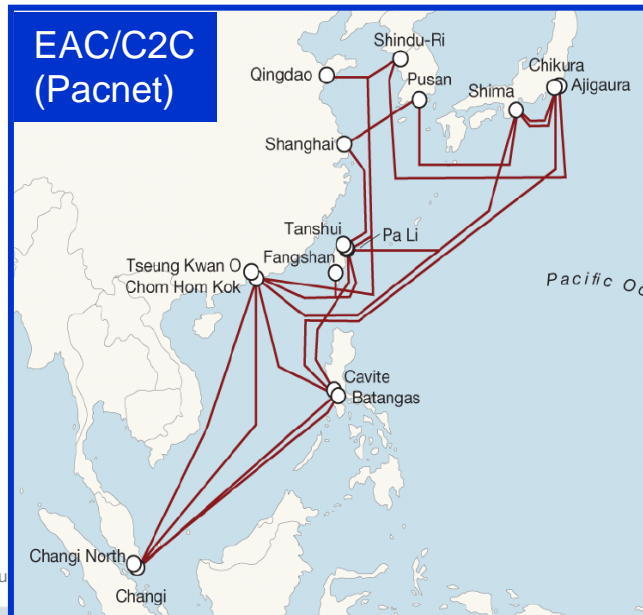
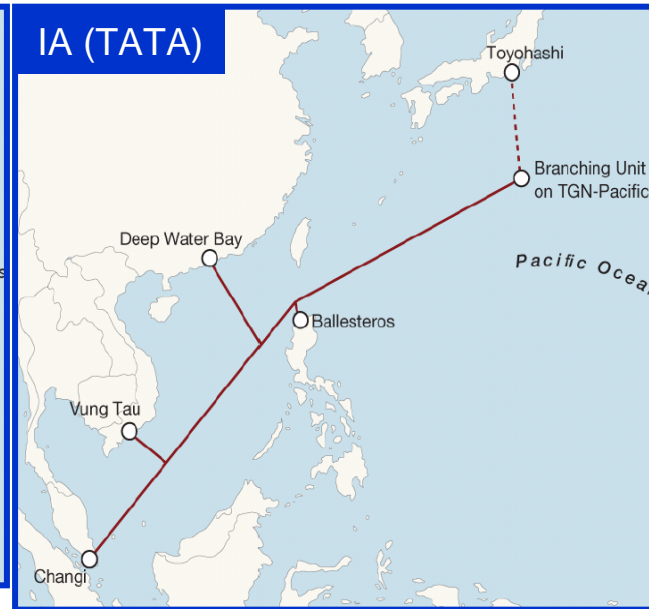
Cable Systems Around the Globe

Major Trans-Pacific Cables (Asia-US)

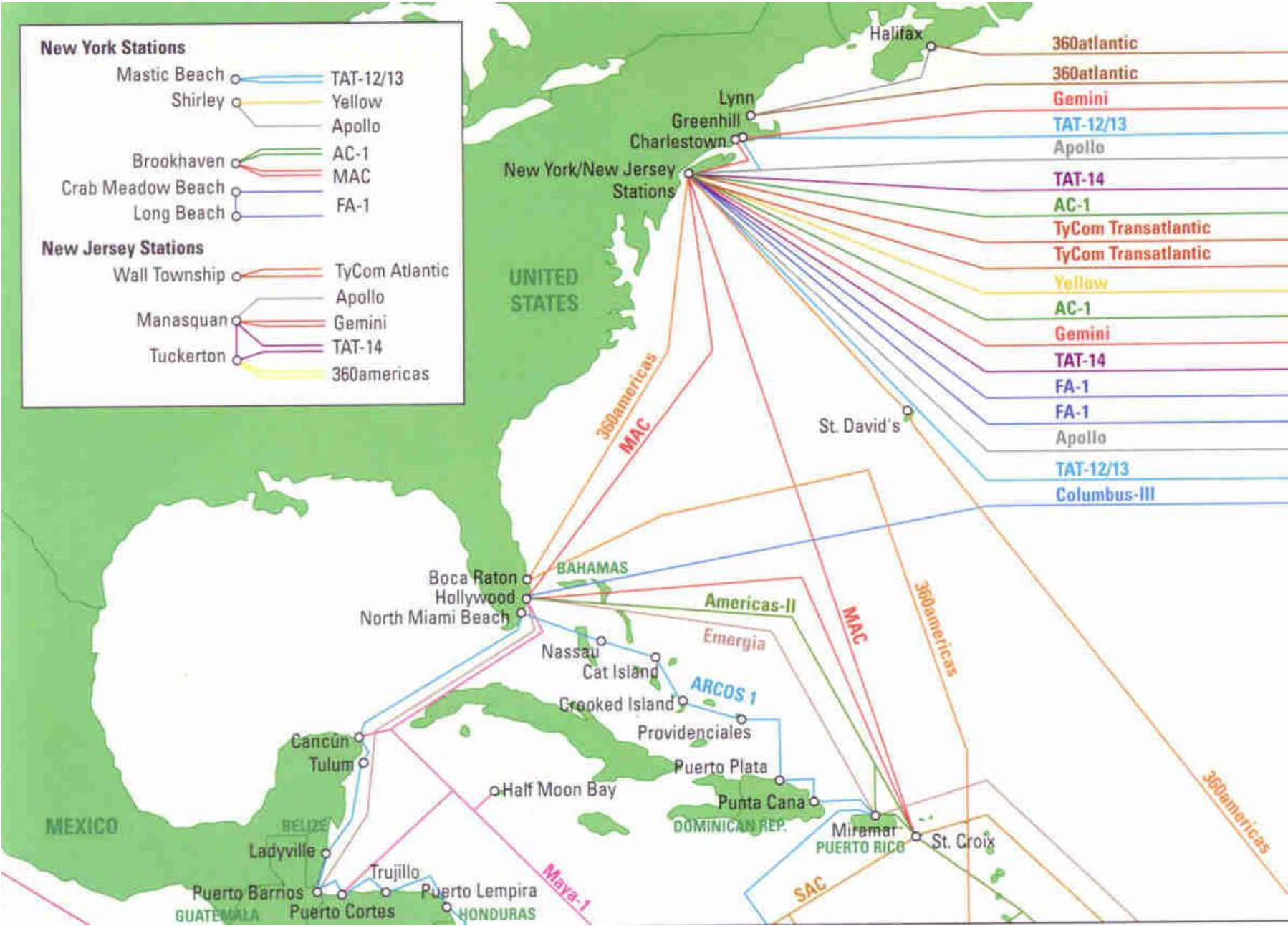


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Major Trans-Pacific Cables (Intra-Asia)



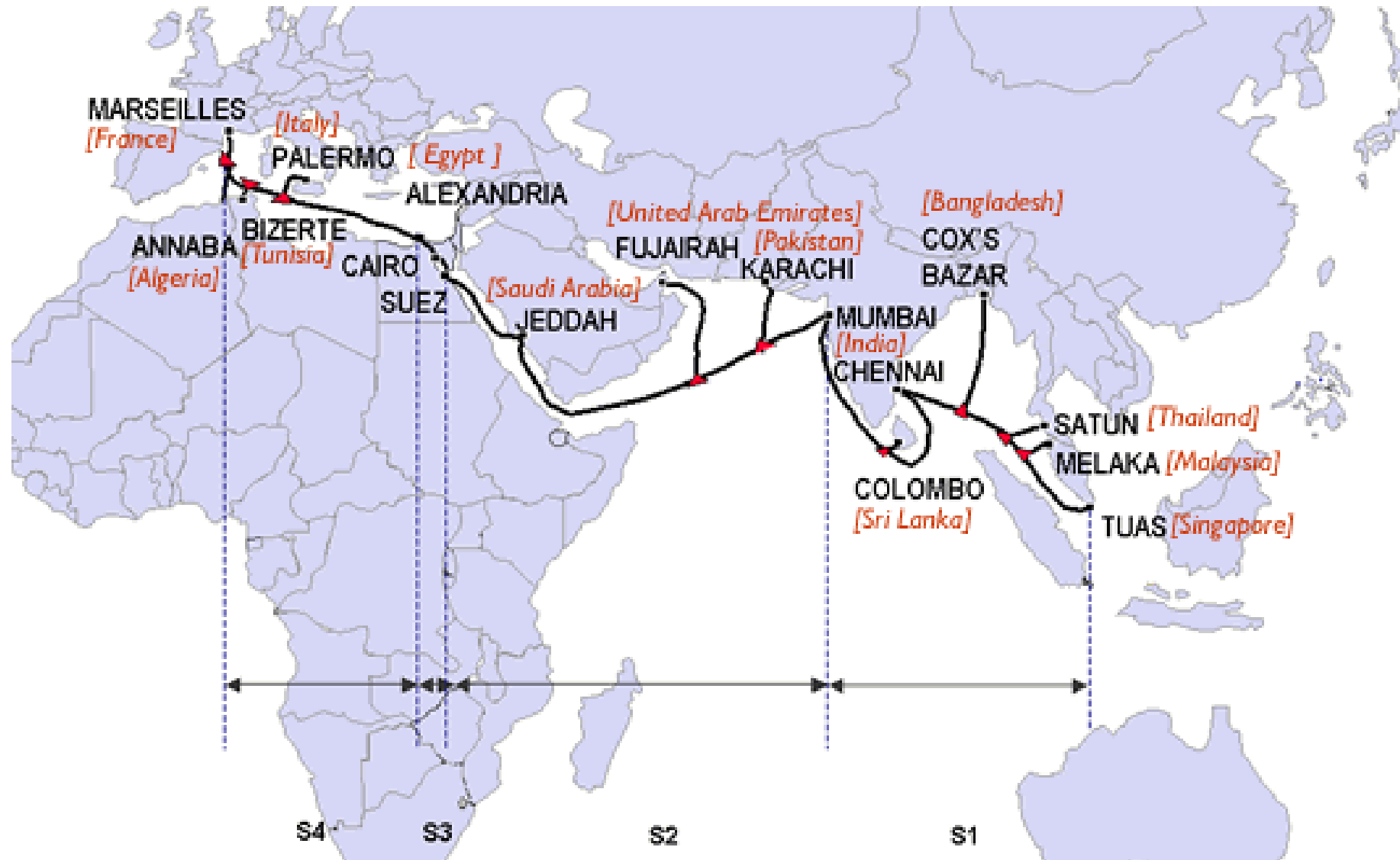
Trans-Atlantic Cables



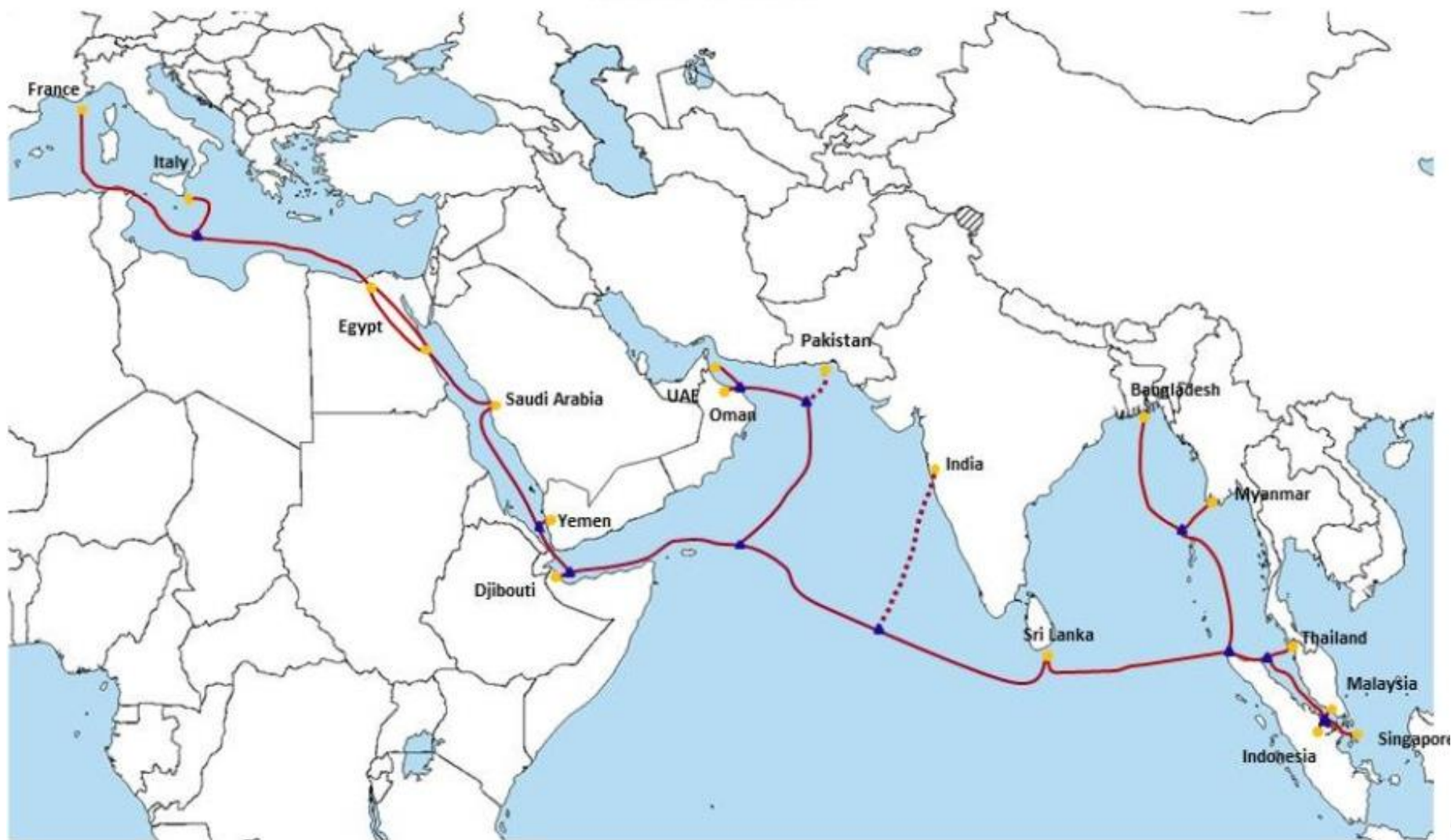
AAE-1



SMW4

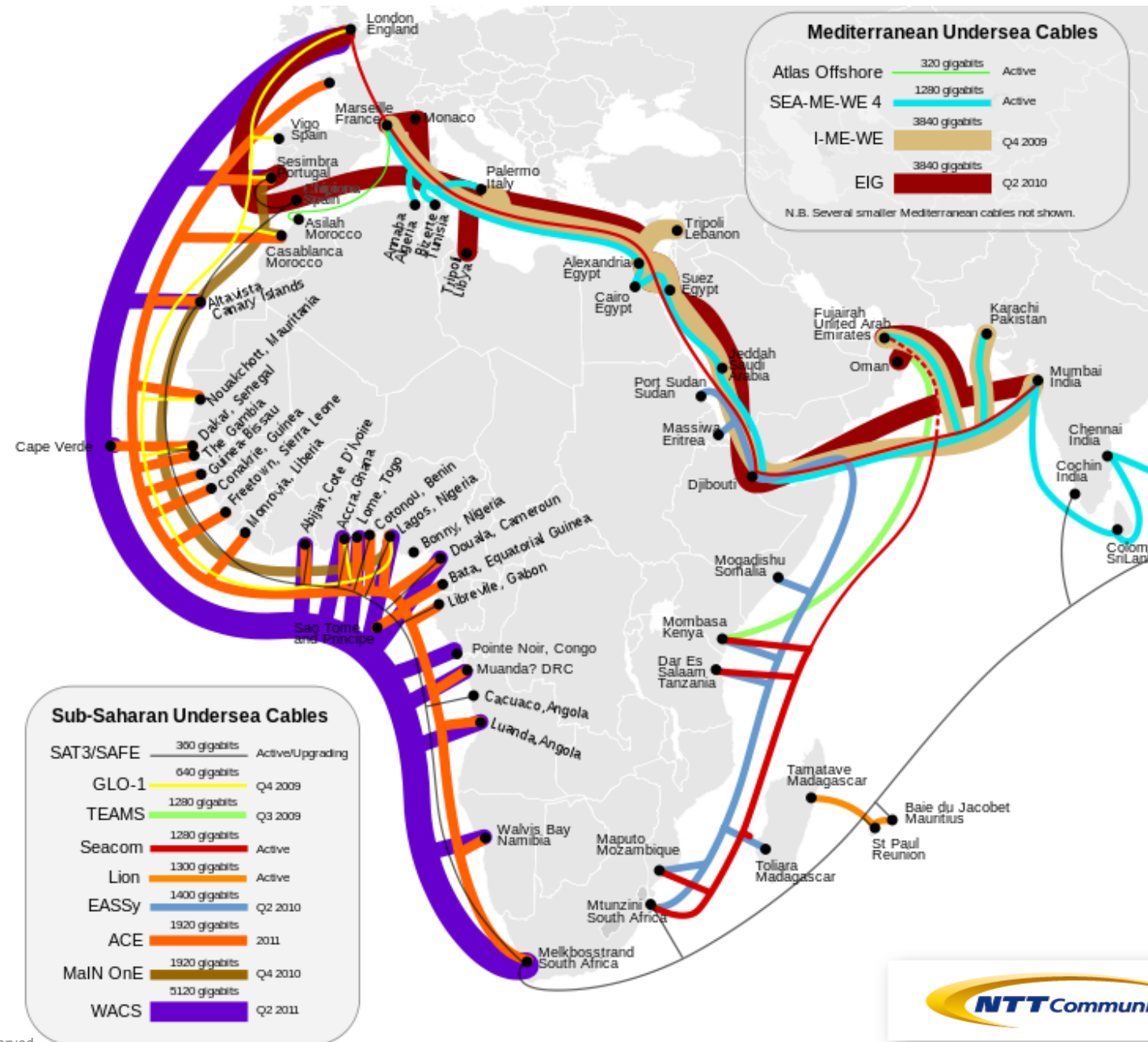


SEA-ME-WE5



BBG

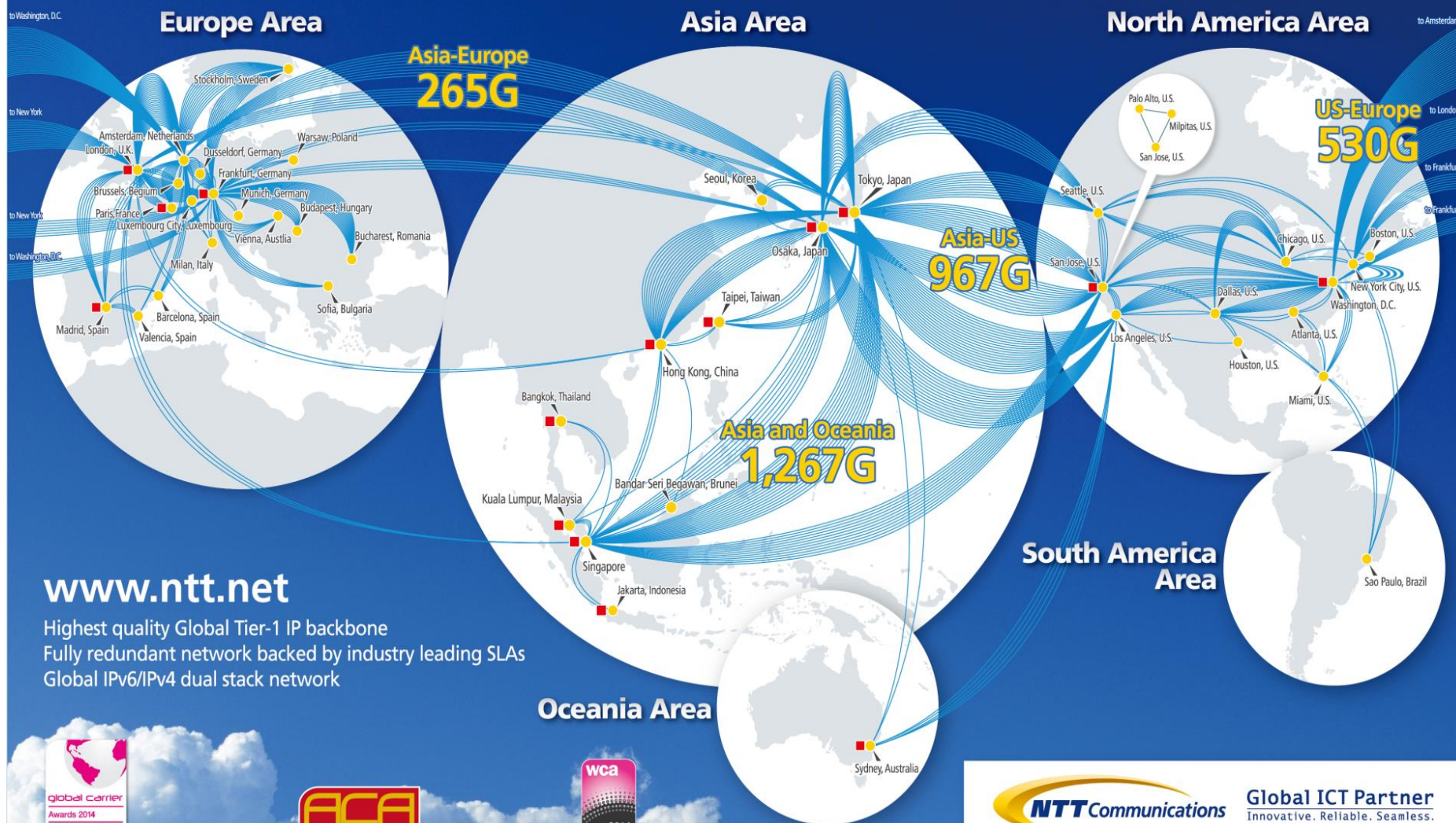




Our Network (NTT Communications)

NTT Communications Global IP Network

● Global IP Network POP
■ NTT Communications Data Center



www.ntt.net

Highest quality Global Tier-1 IP backbone
Fully redundant network backed by industry leading SLAs
Global IPv6/IPv4 dual stack network



Global Carrier Awards
"BEST GLOBAL WHOLESALE CARRIER"



Asia Communication Awards
"WHOLESALE OPERATOR OF THE YEAR"

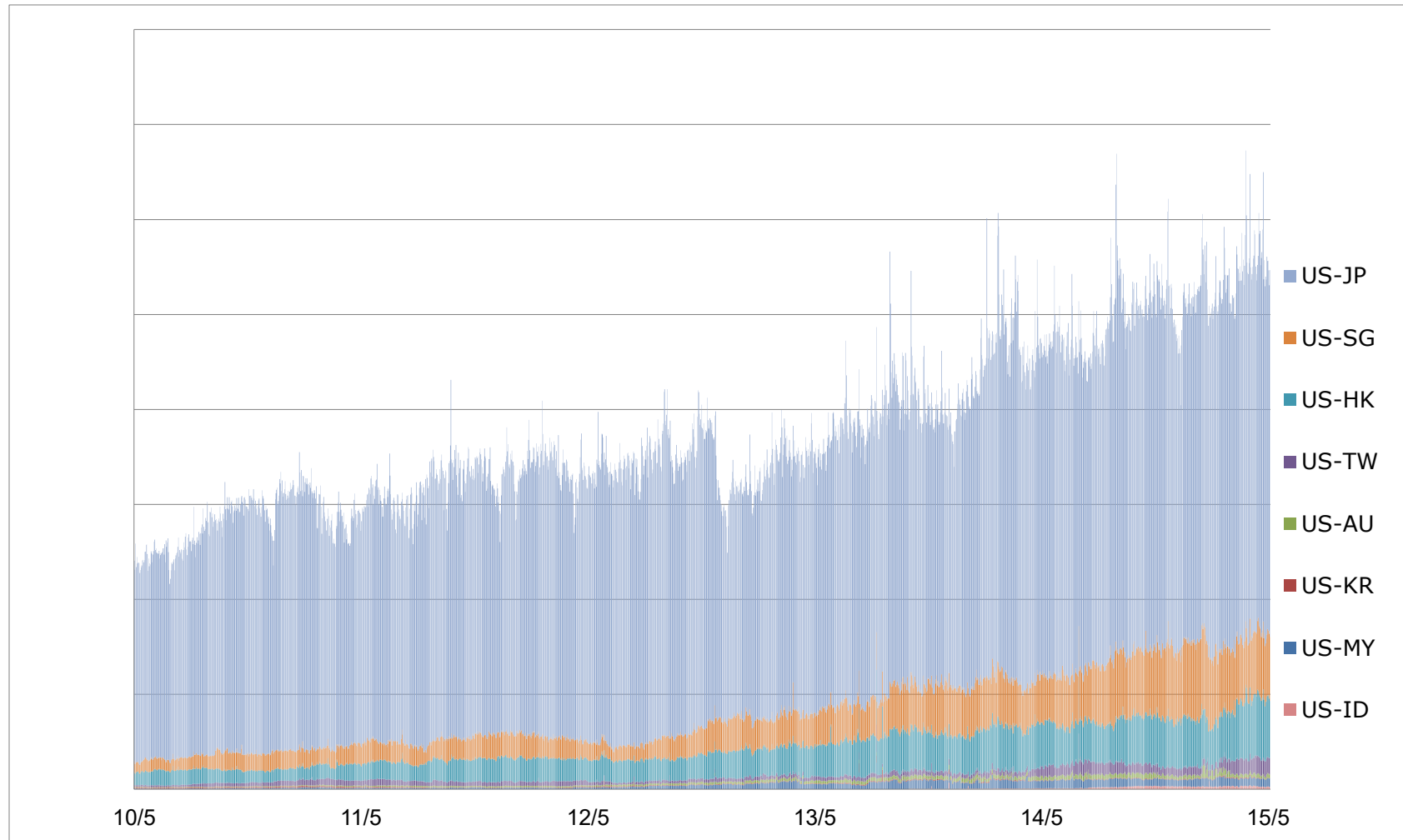


World Communication Awards
"Best Global Operator"

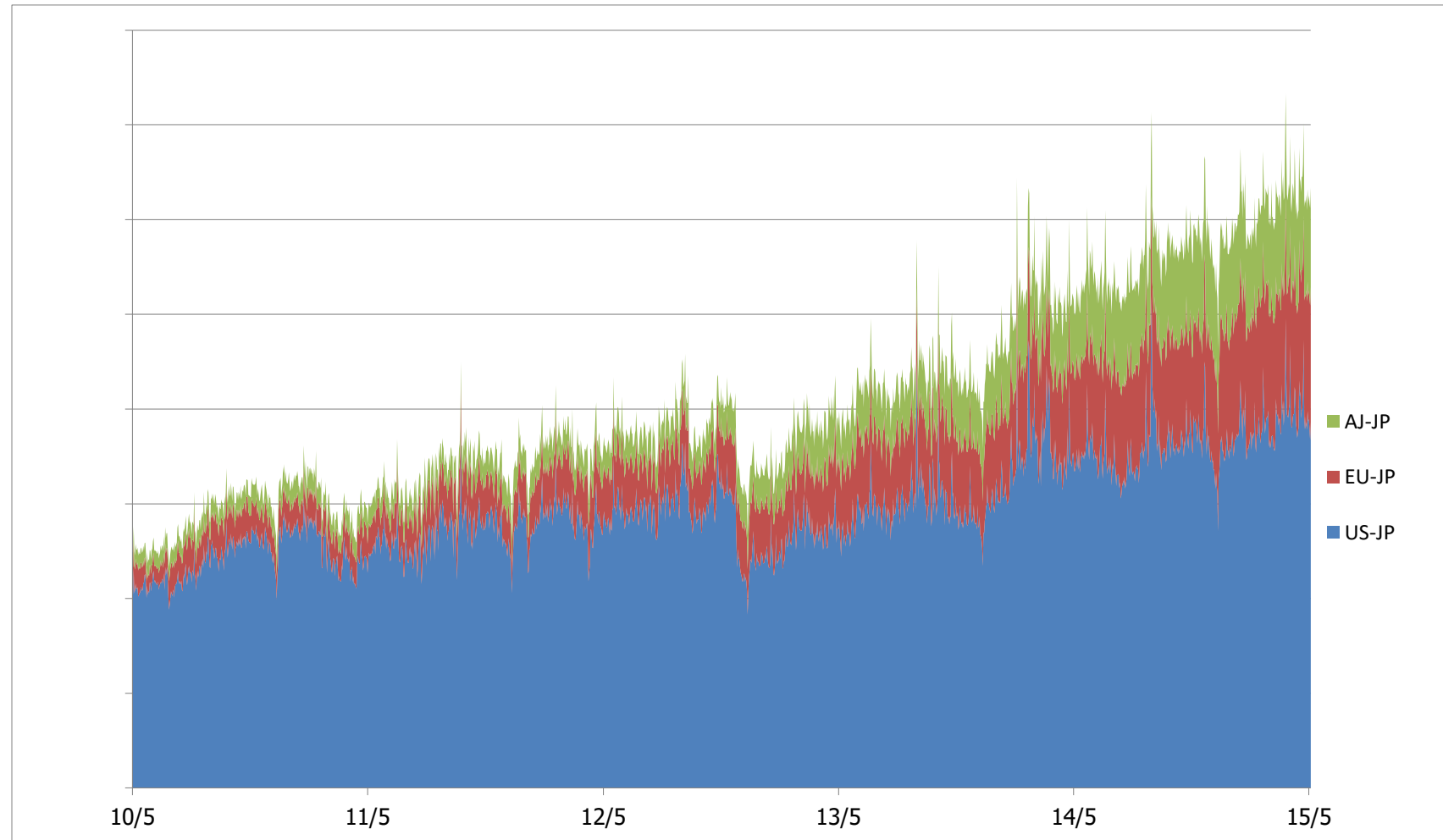


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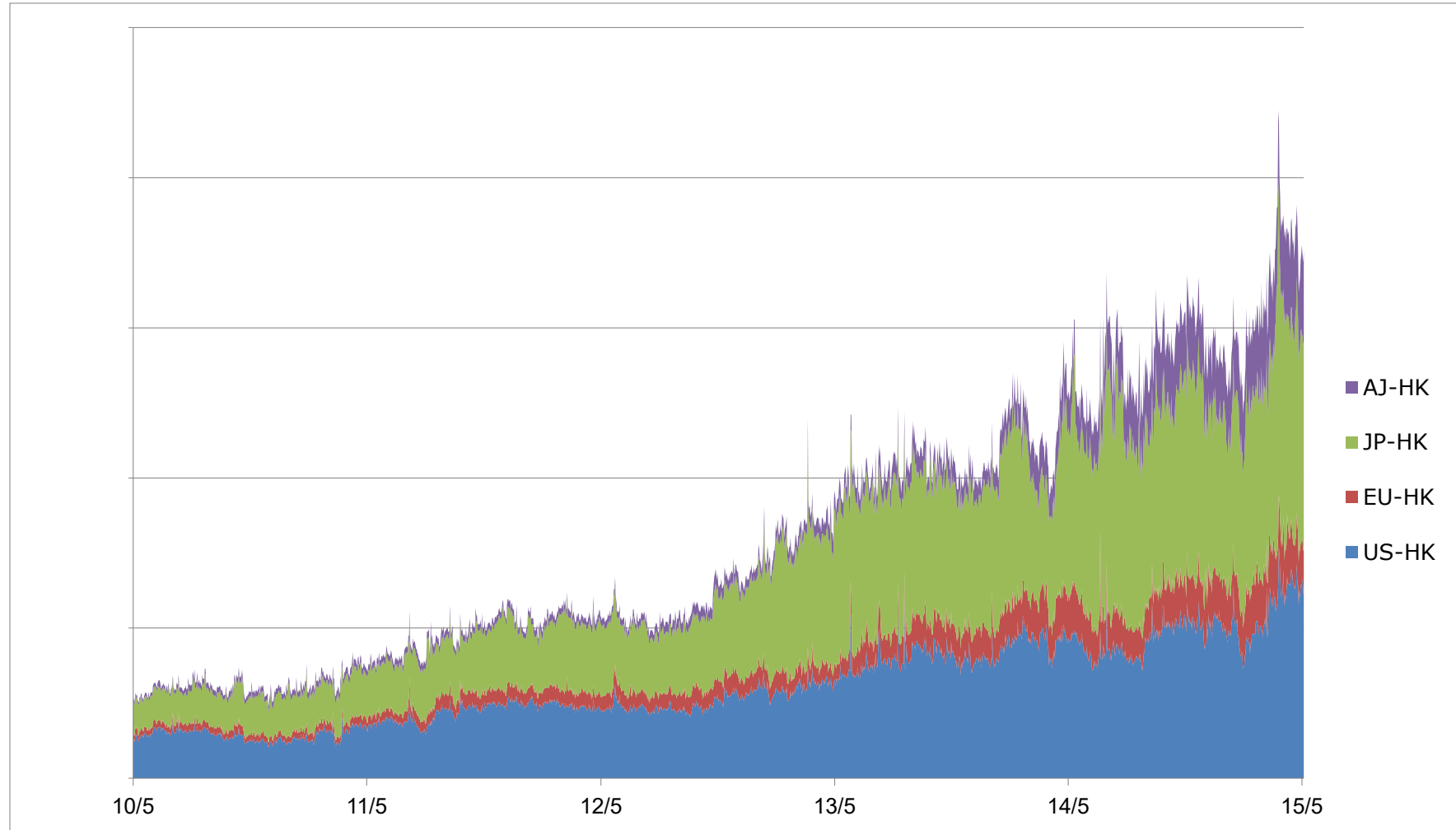
Traffic from US to Asia



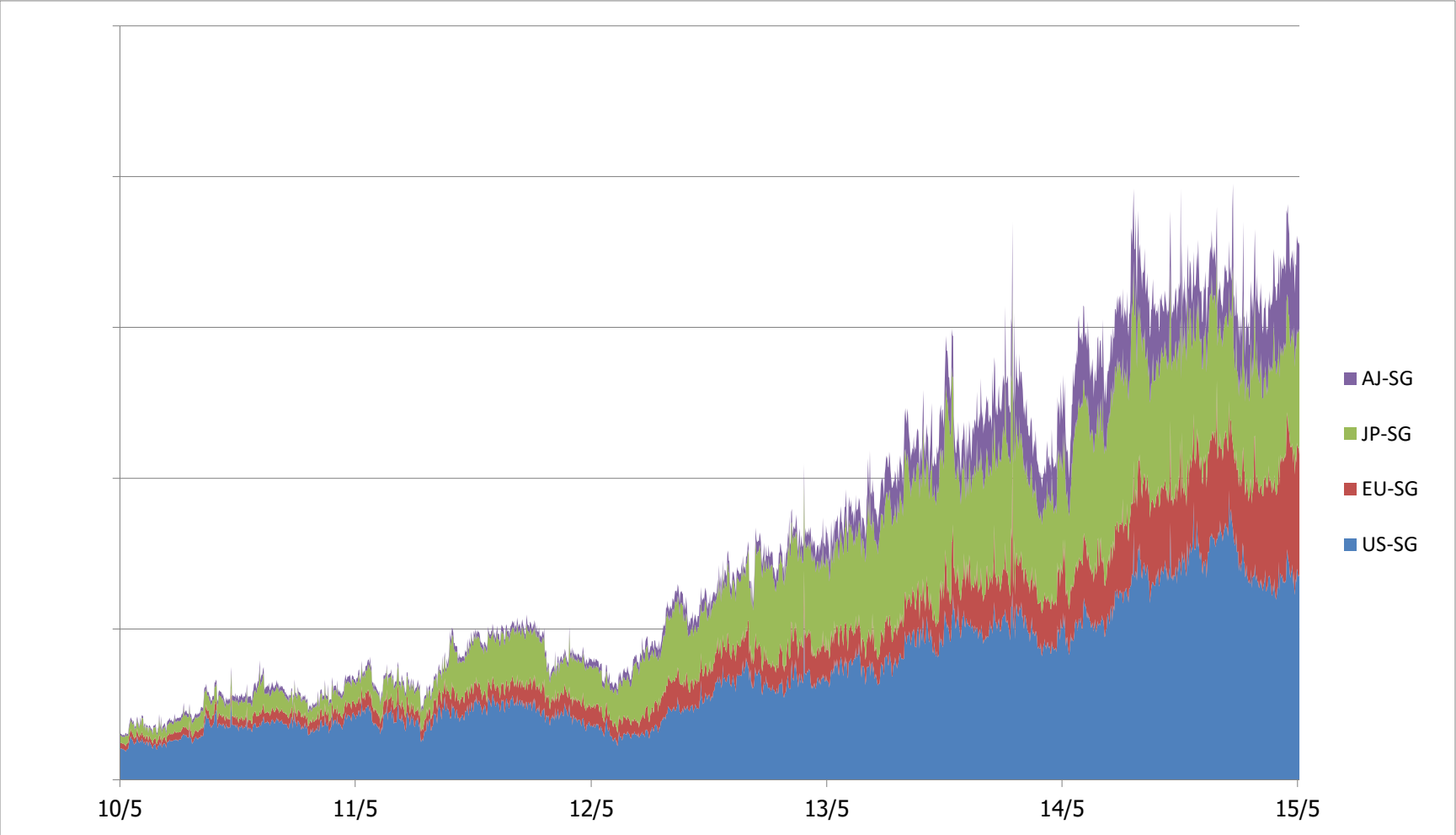
Japan Traffic Profile



Hong Kong Traffic Profile



Singapore Traffic Profile



Our Network (NTT Communications)

Trans-Pacific

PC-1 (N) (S), Japan-US, TGN-P, Unity

Trans-Atlantic

Apollo, TAT-14, AC-1, FA-1, etc

Intra-Asia

ASE, SJC, APCN-2, TPE, etc

West Bound Route and Ocenia

SMW4, BBG+EIG

Our Network (NTT Communications)

Subsea Cable Route Configuration

4 route groups (when more than 4 cable systems)
2 route groups (when less than 4 cable systems)

Upgrade Policy

67% (4 route groups)
50% (2 route groups)

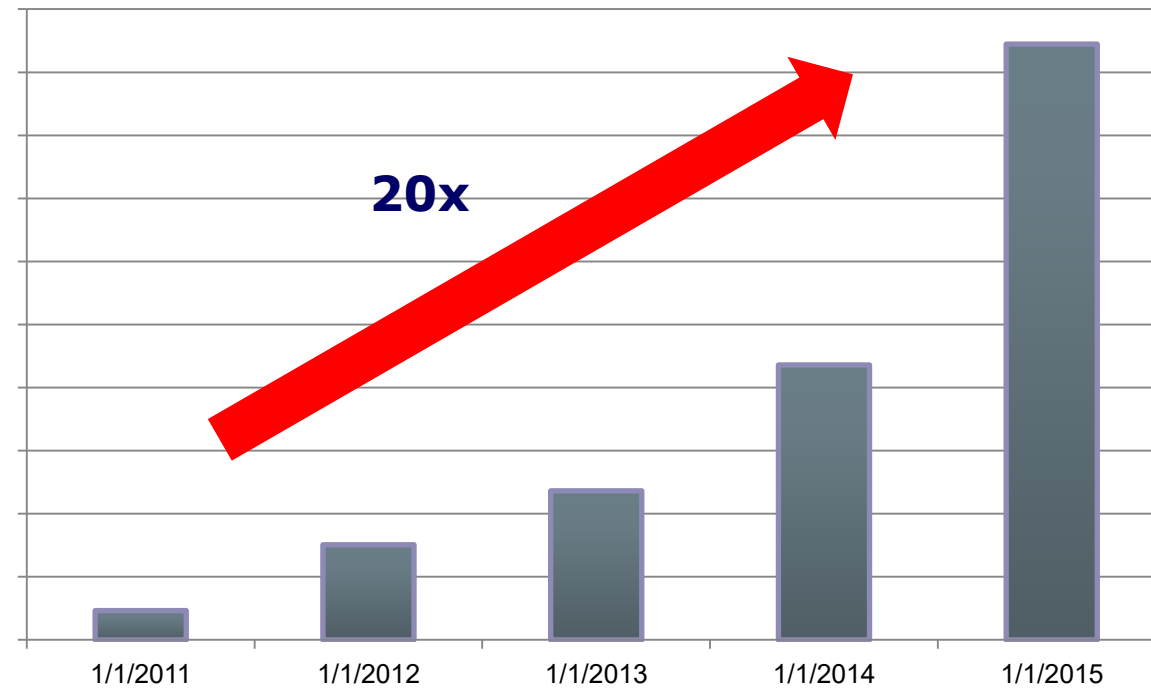
Cost Structure

Combination of self-owned capacity, IRU, and leased capacity

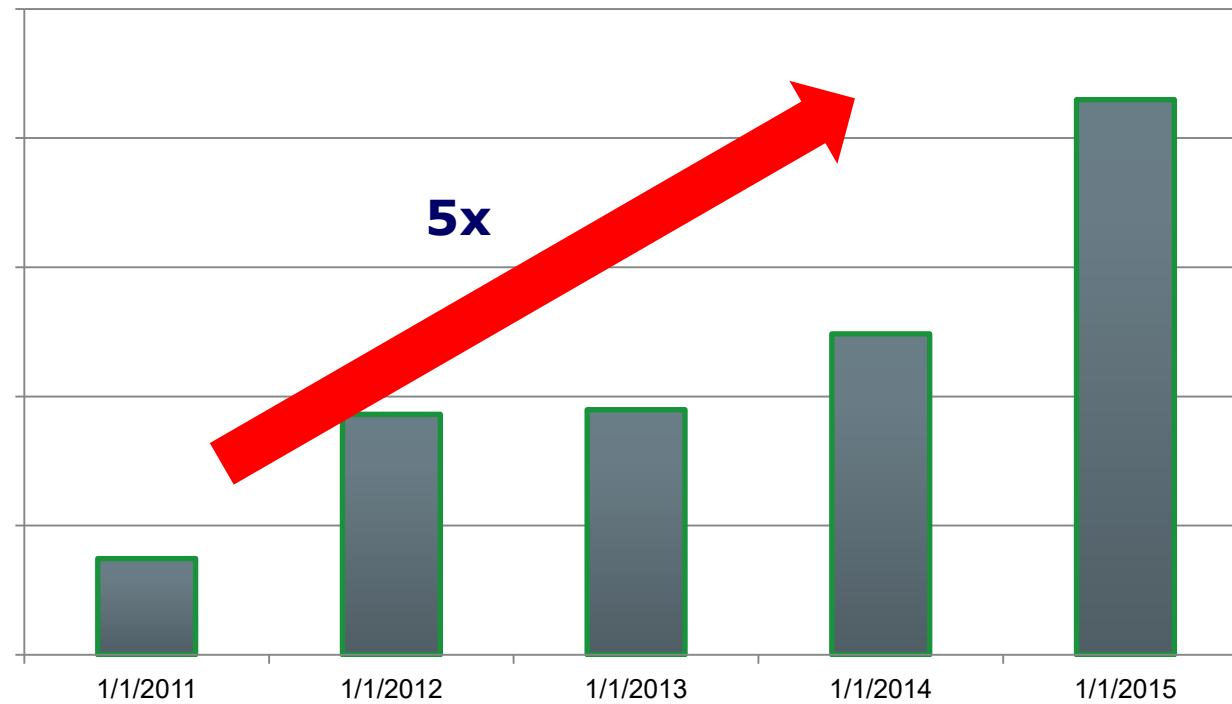
Challenges

- **Cost**
 - **Leased Capacity vs IRU vs Own Cable**
 - **Niche Routes vs Cost**
- **Resiliency**
 - **Intra-Asia cable cuts**
 - **Cost vs Availability**
 - **Mutual restoration**
- **Latency**
 - **Latency sensitive applications (i.e. gaming, video, etc)**
- **OTT/CDN**
 - **Capacity planning**
 - **Cost**

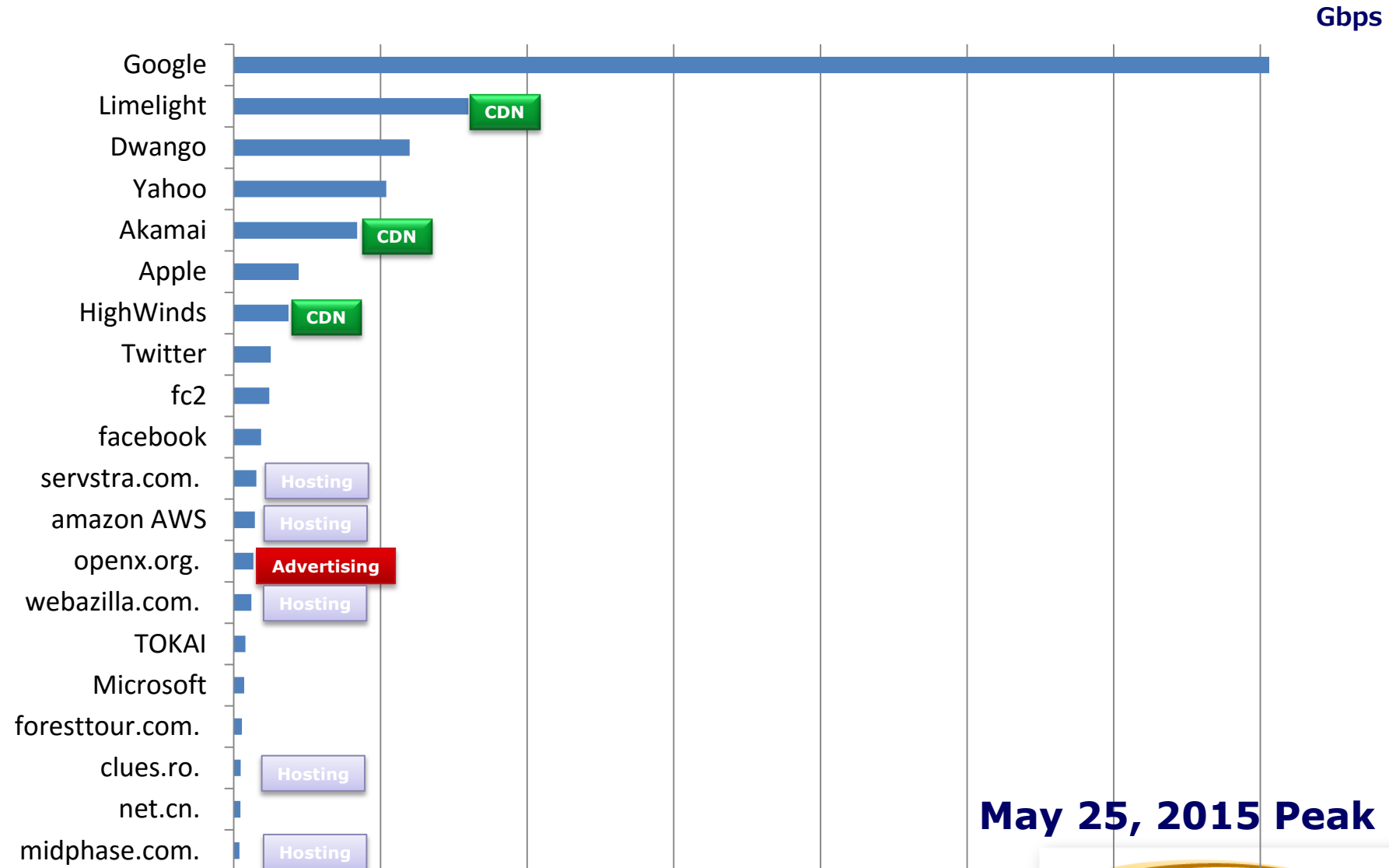
Traffic Growth of OTT/ICP in NTTC NW



Traffic Growth of CDN Players in NTTC NW



NTTC Customer Access Site TOP 20



May 25, 2015 Peak Hour

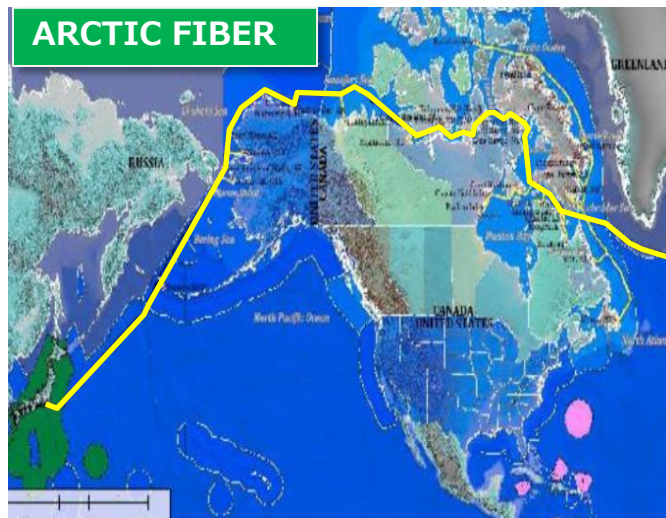
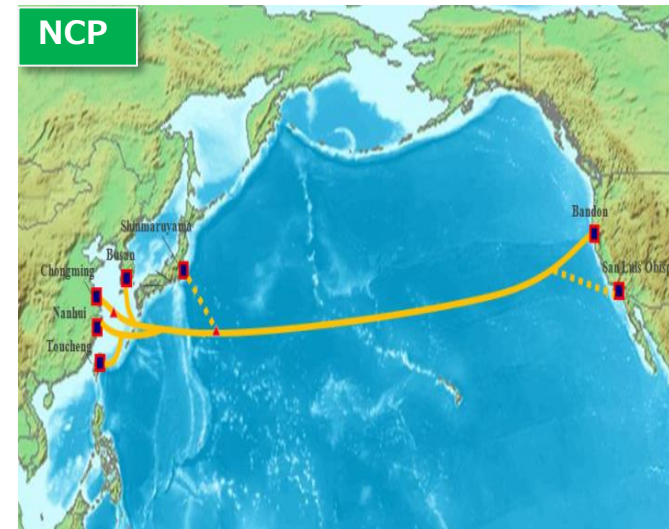


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Next Areas of Interest

- **Beyond 100G Subsea**
 - **400G? 1T?**
- **New Cost model**
 - **Shared capacity model?**
 - **Anything else?**
- **SE Asia to Europe**
 - **Middle East and Africa**
- **Asia to Europe terrestrial**
 - **How to find reliable cable system?**
- **New Cables?**
 - **Where?**

New Trans-Pacific Cables



➡ **Any more coming???**

- Forward-looking statements and projected figures concerning the future performance of NTT Com, NTT and their respective subsidiaries and affiliates contained or referred to herein are based on a series of assumptions, projections, estimates, judgments and beliefs of the management of NTT Com in light of information currently available to it regarding NTT Com, the economy and telecommunications industry in Japan and overseas, and other factors. These projections and estimates may be affected by the future business operations of NTT Com, NTT and their respective subsidiaries and affiliates, the state of the economy in Japan and abroad, possible fluctuations in the securities markets, the pricing of services, the effects of competition, the performance of new products, services and new businesses, changes to laws and regulations affecting the telecommunications industry in Japan and elsewhere, other changes in circumstances that could cause actual results to differ materially from the forecasts contained or referred to herein, as well as other risks included in NTT's most recent Annual Report on Form 20-F and other filings and submissions with the United States Securities and Exchange Commission.
- "FY" in this material indicates the fiscal year ending March 31 of the succeeding year
- Figures in USD are not official but are provided for reference (exchange rate used is USD 1 : JPY 100).

The Fiber Optic interconnection around the Globe



100 Internet Exchange Points And Beyond!

May 2016 – BKNIX
Bangkok Thailand

Douglas Wilson
Hurricane Electric AS6939

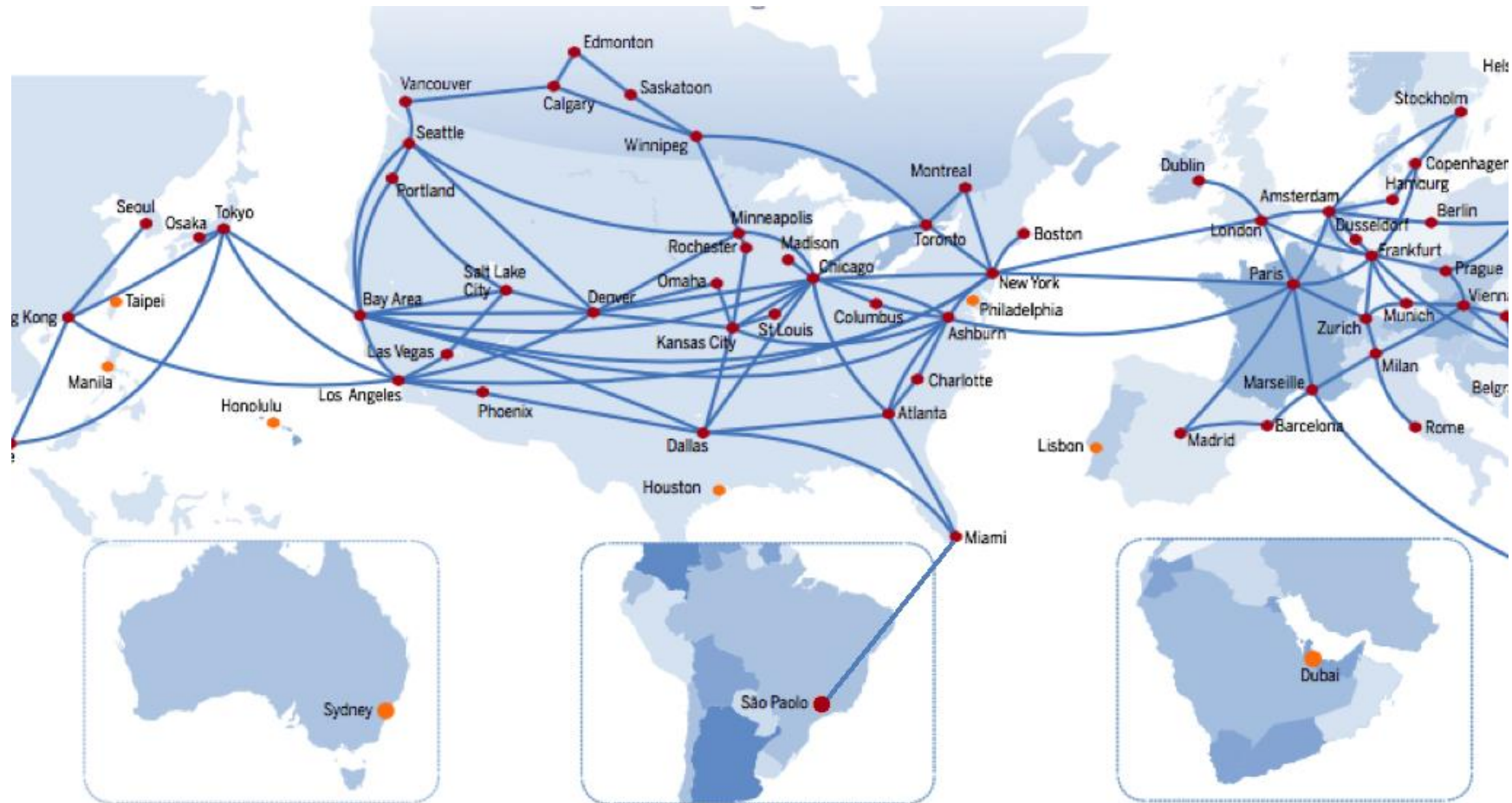
Who is Douglas Wilson?

- ❑ Hurricane Electric AS6939 – the new guy
 - ❑ High Tech Plumber – ~100 routers , ~23 countries , ~132 Internet Exchanges.
- ❑ Layer42 Networks AS8121 – 3 years
 - ❑ Director Network Operations.
 - ❑ Primary focus on USA.
 - ❑ Helped build & run & plan the network.
- ❑ Microsoft AS8075 – 9 years
 - ❑ Sr. Network Architect
 - ❑ Helped build & run & plan the network.
 - ❑ Approx 10 AS#s
- ❑ XO AS2828 - 5 years
 - ❑ High Tech Plumber – approx 10 AS#s

Hurricane Electric – Network History

- Founded 22 years ago - ISP & Datacenter operator
 - 1999 - Nationwide network
 - 2005 - European network expansion
 - 2007 - Native IPv6 backbone
 - 2008 - Ranked #1 IPv6 backbone for BGP adjacencies
 - 2008 - Expanded network into APAC
 - 2015 - Expanded network into Osaka and Seoul
 - 2016 - Expanded network into Honolulu and San Paulo

Hurricane Electric Network



Hurricane Electric - Massive Peering!



Why so many Exchanges?

Expansion is the Answer!

January 2015

90 Internet exchanges
IPv4 3,644 unique adjacencies
IPv6 2,475 unique adjacencies

April 2016

132	Internet exchanges	46.6% increase
IPv4	5,303 unique adjacencies	45.5% increase
IPv6	3,318 unique adjacencies	34.0% increase

Hurricane Electric

I'm here to share with you the following:

- What Hurricane Electric looks for in a new IX
- How IX operators can attract more members

What we look for in a new IX

- Unique ASN adjacencies opportunities
- New countries
- Customer request
- Does it make financial business sense?
- Cost of long-haul circuits
- Datacenter cost
- Dark fiber/metro and cross connect cost
- Local import issues, taxes, ETC...

New exchanges in the next 60 days

- TPIX-TW 14 unique adjacencies
- NAPAfrica IX 86 unique adjacencies
- TPIX Warsaw 85 unique adjacencies

- Total new 185 unique adjacencies

Possible new locations 2016 - 2017

- Bangkok
- Manila
- Guam
- Houston
- Philadelphia
- Nairobi
- Athens
- Istanbul
- Dubai
- Mumbai

And several others

<http://www.he.net/HurricaneElectricNetworkMap.pdf>

This is updated frequently with locations of interest

How IX operators can attract more members

If we don't know about you, how can we connect!

Get Your Exchange Listed Publicly

You put extensive effort into starting and running your exchange:

- ❑ Talk to network operators and recruit the members.
- ❑ Negotiate with data center operators for space to install exchange.
- ❑ Obtain, deploy and maintain hardware for the exchange.
- ❑ Catalyze ongoing communication between your participants.

Taking the last step, publicizing your exchange, maximizes its value both to current participants and future members.

Tell the world about your exchange!

- ❑ www.peeringdb.com
- ❑ <http://www.datacentermap.com/ixps.html>
- ❑ <http://www.internetexchangemap.com/>
- ❑ <https://www.telegeography.com>
- ❑ internet exchange wikipedia

Your IX members page

List participants on your website including:

- ASN
- IPv4 and IPv6 addresses
- Peering and NOC contact details
- Peering policy

Why List Participants?

Current and prospective participants need this information to add peering sessions, increase peered traffic, and for the IX to grow revenue.

Network operators continuously evaluate additional IXPs for potential expansion opportunities. To make this determination they need participant AS numbers and, ideally, to see what prefixes those peers advertise to a route-server at the exchange.

Example: Seattle IX (SIX) Members Page

<https://www.seattleix.net/participants.htm>

206.81.80.10/23	Altopia Corporation	6456	noc@alt.net
206.81.80.11/23	RealNetworks, Inc.	11922	nso@real.com
206.81.80.12/23	NuclearFallout Enterprises, Inc.	32751	noc@nfoe.net
206.81.80.13/23	Beyond the Network (PCCW)	3491	peering@pccwglobal.com
206.81.80.14/23	Mouat's Technology Services, Inc.	3601	peering@mouats.com
206.81.80.16/23	Semaphore Corporation	3742	noc@semaphore.com
206.81.80.17/23	Google	15169	peering@google.com
206.81.80.18/23	Cortland Electronics Corporation	4319	peering@cortland.com
206.81.80.19/23	Zayo (was AboveNet)	6461	peering@zayo.com
206.81.80.20/23	TierPoint Spokane	30340	peering@tierpoint.com
206.81.80.21/23	Metapeer, Inc.	13331	noc@metapeer.com
206.81.80.23/23	RGnet/PSGnet	3130	peering@rg.net
206.81.80.27/23	In2net Network	26753	noc@in2net.com
206.81.80.28/23	Threshold Communications, Inc.	7752	noc@thresholdcommunications.com
206.81.80.29/23	Zillow.com	18888	noc@zillow.com
206.81.80.34/23	Connect Northwest Internet Services	10557	noc@cnw.com
206.81.80.37/23	Wowrack.com	23033	noc@wowrack.com
206.81.80.38/23	Peer 1 Network	13768	peering@peer1.net
206.81.80.40/23	Hurricane Electric	6939	peering@he.net

Conclusions

It is Hurricane Electric goal to continue our expansion globally to as many locations as possible.

I need your help! So please make your IX information public, as membership information is key when making decisions about where to invest next.

Next milestone 150 Internet Exchanges



HURRICANE ELECTRIC
INTERNET SERVICES

Questions?

Douglas Wilson
Hurricane Electric AS6939
doug@he.net