NTT Communications Group
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NTT Communications Global IP Network

Ethernet in the Network Service Provider

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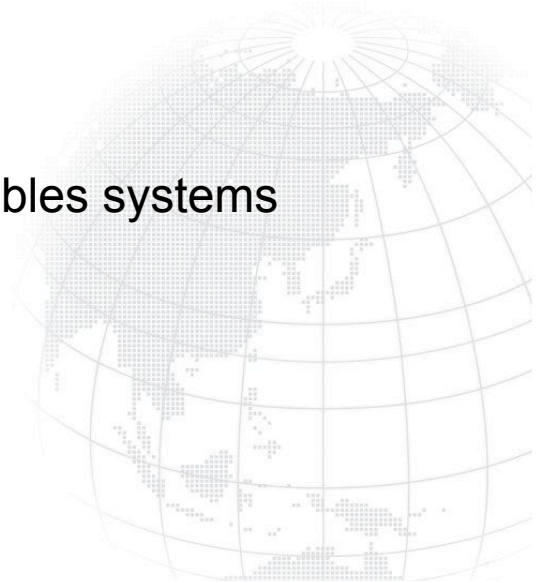
Summary

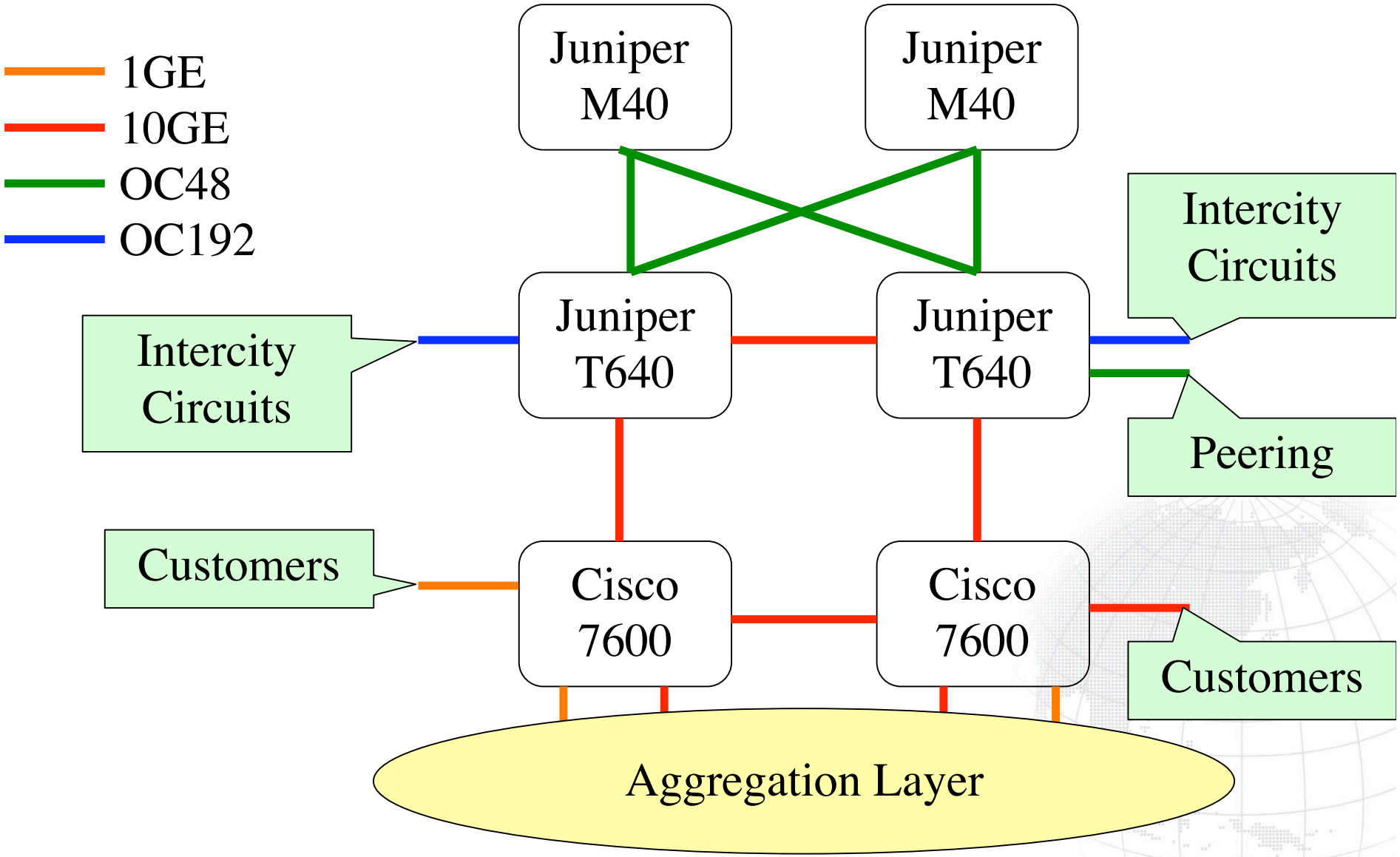
- NTT Communications Global IP Network summary, and Architecture
- How Ethernet is used
- What we like
  - Some of this is IEEE design, some is vendors, and some is dumb luck
- What we would like to see
  - Specific to our application

What is NTT Communications Global IP Network (GIN)

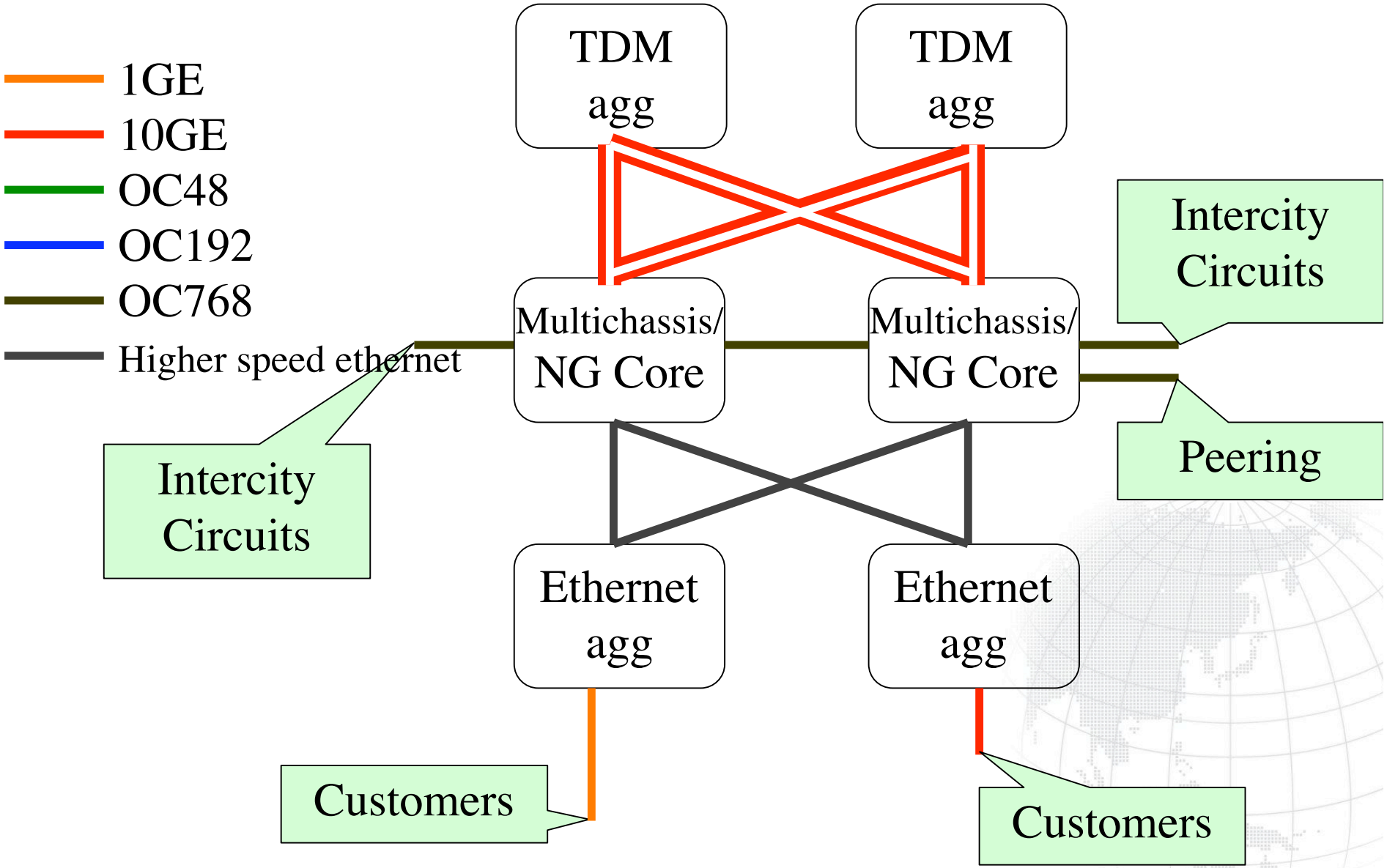
- Global Internet service provider
  - Network in Asia, United States, and Europe
    - Singapore, Hong Kong, Taiwan, Australia, Japan, South Korea, United States, United Kingdom, France, Germany, The Netherlands, and Spain
  - Sonet/SDH network on long haul
    - nxSTM64 (OC192) Domestic United States
    - STM64 nxSTM16 Europe
    - nxSTM1 nxSTM4 nxSTM16 nxSTM64 Asia
    - nxOC192 US-Europe
    - 7xSTM64 US-Japan (10xSTM64 end of 2006)
- Mix of Facilities and Non Facilities based provider
  - Lease capacity in US, Europe, and parts of Asia
  - NTT Communications owns capacity on Transpacific cables systems
  - Facilities based in Japan



Pop Architecture Generation 4 Circa 2005



Next Generation



GIN LAN History

- Dependant on router hardware
  - Must have IP interface to be useful
- >1999
  - FastEthernet
  - FDDI
- 1999
  - First GigabitEthernet deployment
    - Router: Juniper M40, Cisco GSR 12000
    - Ethernet Switch: Packet Engines, Foundry Networks
    - nxFE aggregated to GE
      - Scaling to nxGE aggregated to nxGE LAG
- 2002
  - First 10GigabitEthernet deployment
    - Router: Juniper T640
    - Ethernet Switch: Foundry Networks BI4000, Cisco 7600
    - nxGE aggregated to 10GE
      - Scaling to nx10GE aggregated to nx10GE LAG
- Today
  - 10GigabitEthernet customers aggregated to 2x10GE LAG

Distance increase 10GE (LAN PHY)

- Initially intrapop connections
- Expanded to metro circuits
  - Connected multiple pops in the same MSA
- Evaluating Long haul
  - Lease capacity
    - Dependant on carrier service availability
- Have not used 10GE WAN PHY
  - Delayed availability from vendors

Driving factors

- Rapid customer adoption of 10GE
- Traffic doubles every 12 months in GIN network
  - Growth trend based on empirical data from 1998-Today (9/13/2006)

Benefits of 10GE

- Cost
  - Cheaper than OC192/STM64 interfaces
  - True cost or market position?
- Equivalent to OC192/STM64 speed
  - OC192/STM64 had no performance benefit
    - OC48/STM16 chosen over GigabitEthernet for 2.5 x speed
  - OC192/STM64 troubleshooting advantage
- Standardize on a single optic (10GBase-LR)
  - All connection types
    - Customer interfaces
    - Intra POP interfaces
    - Metro Links

DWDM

- Cost is the Lambda (the amount of bandwidth that will fit into 100Ghz/50Ghz/smaller lambda spacing)
  - 3 Years circuit cost 18x interface hardware costs
    - OC192 unprotected leased circuit <600mi
  - Japan-US 640G capable submarine system
    - 64 x 10G wave lengths
    - New cable system must be built to add more capacity
- Software tunable DWDM 10GE optics
  - Available today in IP routers
- 40G DWDM trails today
  - Multiple vendors have DWDM boxes capable of 40G/lambda
  - Commercial trials are continuing
  - GIN network needs 40G in approximately 18 months
  - Expect to see IXC networks go from nx10G to nx40G

Higher Speed Ethernet

- 100Gbps should be minimum target speed
  - 3 years for development + 3 years for adoption
    - Anything less than 100Gbps will be too small
- Serial interface type would be ideal
  - How much bandwidth can fit into a single lambda
  - If multilane, each lane must be greater than 10G
- 2km meets most of our distance needs
  - Commonality provides better efficiencies in operations