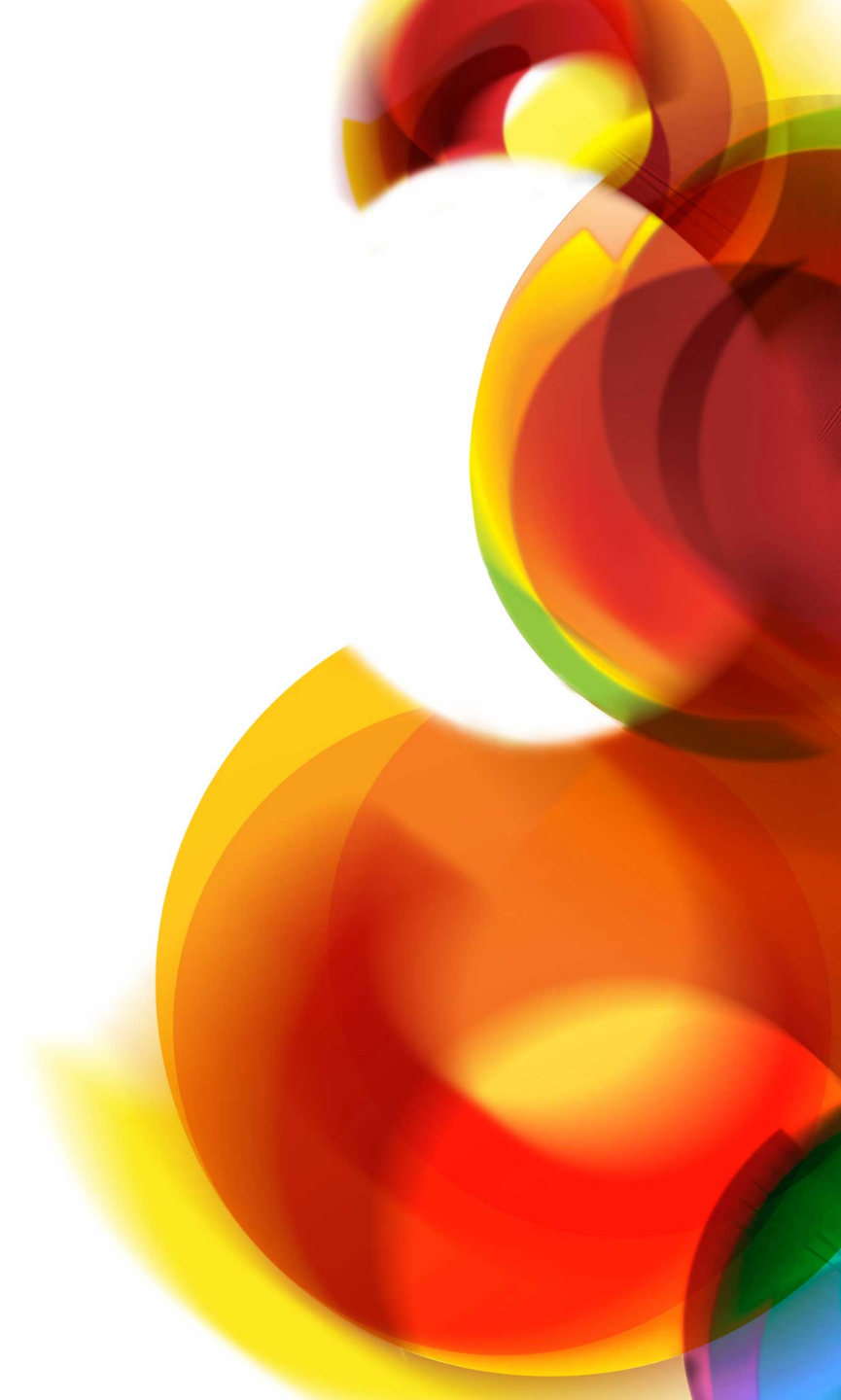




(Almost) Two Years of 100GE on SuperJANET5

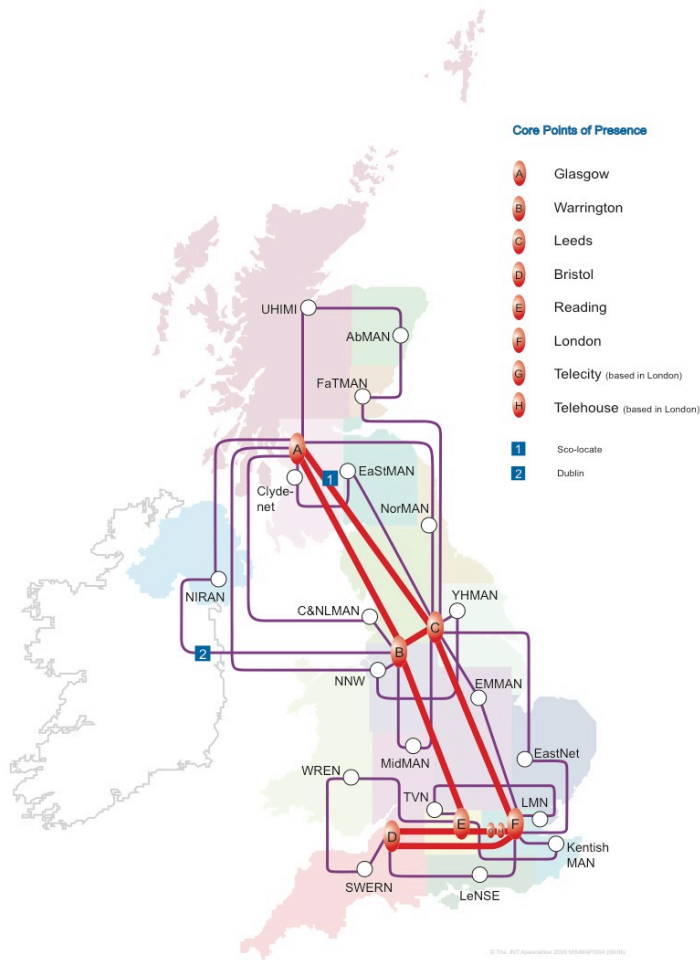
...and what it means for Janet6

Rob Evans
Janet



- Research and Education Network of the United Kingdom
- In operation since 1984
 - R&E networking existed for over a decade before that
- Grown through X.25, SMDS, ATM
 - Let's not talk about the order a domain name should be in
 - Anybody have a contact in the Cocos Islands so I can resurrect my old email address of rhe@uk.ac.ic.cc?
- Up to 18 million have access
 - $\sim 1/4$ of the population

- Provide all Internet connectivity for most of our customers
 - R&E connectivity via GEANT
 - Peering and transit to the rest of the Internet
 - Some customers have additional ISP connections for use outside of our Acceptable Use Policy
- Management model
 - Telco provides circuits
 - From 9.6kbps X.25 through to 100GE on SuperJANET5
 - Janet manages switches and routers
 - Up until now... (more on that later)

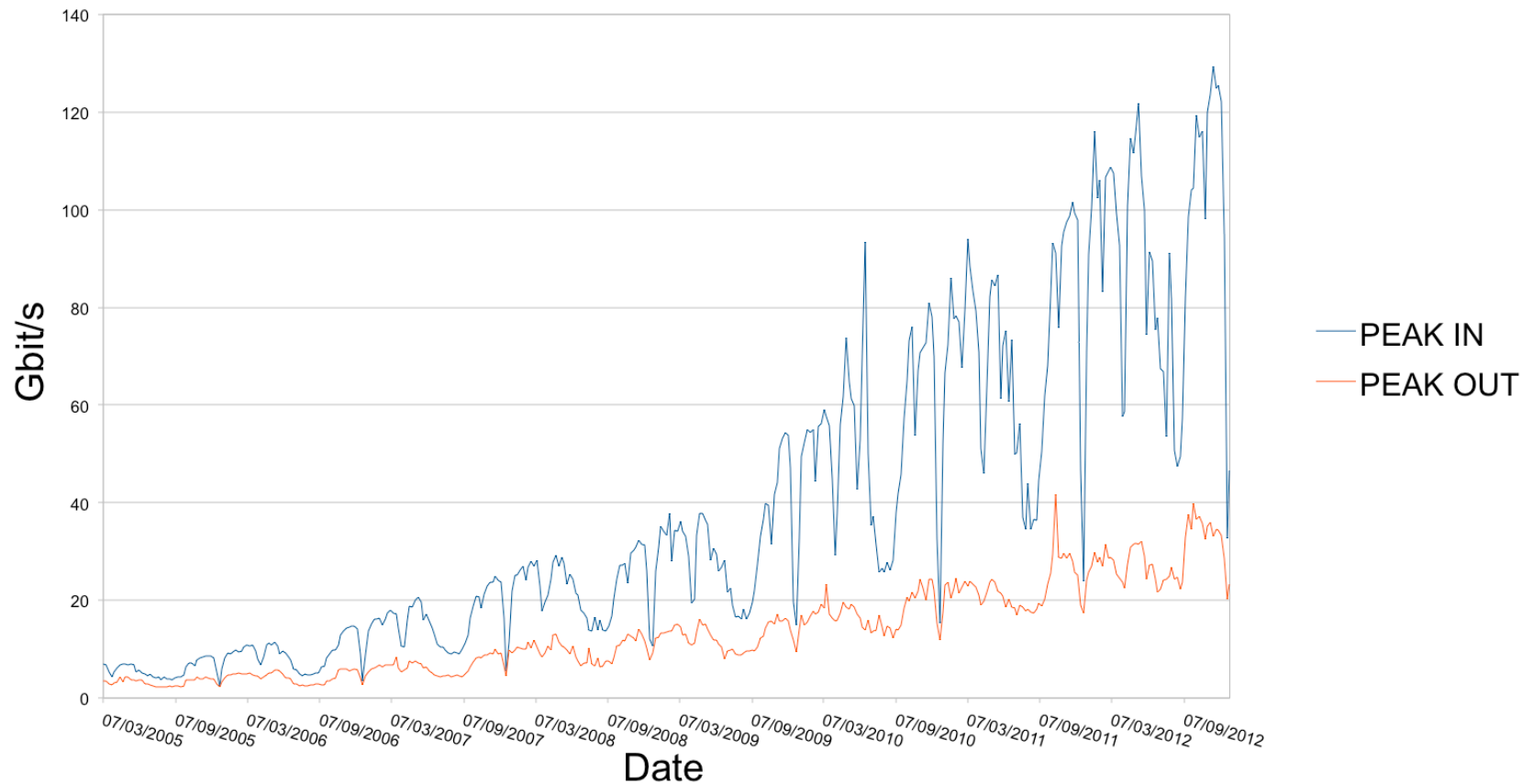


- Old map to show the geography
- Backbone
 - Managed in-house
- Regional Networks
 - Some autonomously managed
 - Connected to backbone via two PoPs for resilience
- Sites (mostly) connect to regional networks

- Periodic funding cycles
 - Networks before mid-2000s were congested or required additional shortcuts towards the end of their life
- Change in R&E network roles
 - No longer the only place to get R&E connectivity
 - High-performance and flexible connectivity
 - 2.5Gbps, 10Gbps
 - “Lightpaths” (point-to-point circuits)

- In service 2006
- Engineered to get ahead of the demand curve
- Dedicated fibre and transmission equipment
 - Supplied and managed by Verizon Business
 - Ciena CoreStream and 4200
- Juniper T series routers for the IP service
- Juniper MX series routers for the point-to-point service
 - Ethernet over MPLS
- Initially 10G SDH (STM-64)
 - Contractual requirement to supply 40G SDH (STM-256)

Weekly 5-minute Traffic Peaks



- Discovered we had old fibre
- Polarisation Mode Dispersion
 - Greater than 12ps on some links
 - Ciena card could only handle 8ps
- Contractual hammer: must supply STM-256
- Add layer of Nortel (as was) OME 6500 on top of the Ciena CoreStream
 - Juniper connected to the Nortel OME 6500 client interface
 - Nortel OME 6500 line interface connected to the Ciena Corestream
 - Channel carried as an “alien wavelength” across the fibre
- In service 2008

- Everything is Ethernet
- Trials of 100Gbps transmission during 2009 and early 2010
 - Ciena and Nortel
 - 112km of fibre between London and Reading
 - 10Gbps, 40Gbps and 100Gbps in adjacent bands
- Nortel OME 6500 was the better solution
 - More 6500s layered on top of CoreStream
 - 250-450GHz of guard band between 100Gbps circuits and 10Gbps circuits

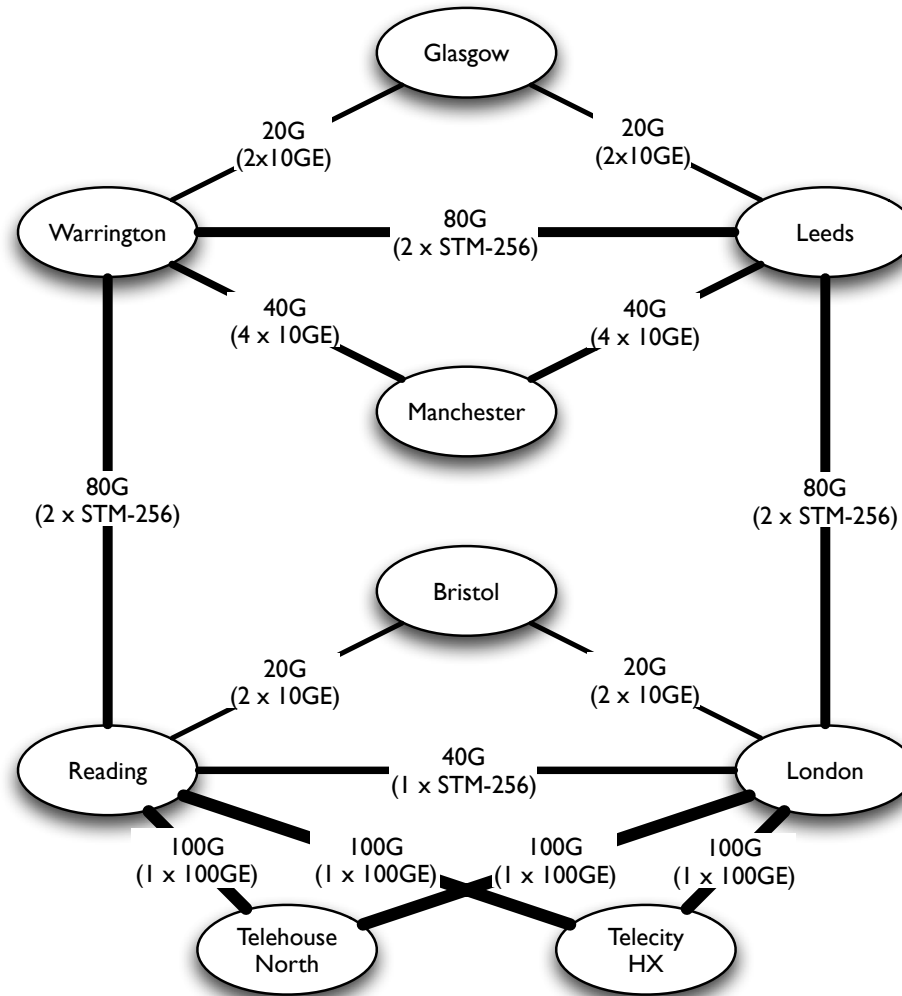
- April 2011
 - Juniper T1600
 - 100Gbit/s per slot, spread over two 50Gbit/s forwarding engines
 - MAC needs to know which forwarding engine to send a packet to
 - Juniper-Juniper: Hash the “multicast” bit in the MAC address
 - Juniper-Other: VLAN steering
 - 100GBASE-LR4 optics
 - Four 100GE circuits in operation



- **Con: $\frac{1}{8}$ of chassis space per interface**
 - 10GE allows for finer-grained upgrade path
 - Helped by higher-density chassis
 - T4000 is now 240Gbit/s per slot
- **Pro: Simpler**
 - What is your min-links setting for bundles of 10s of 10GE?
 - How many single points of failure?
 - How well do the hashing algorithms work for many 10GE links?
- **Con: Price of 100GBASE-LR4 Optics**
 - Helped by 100GBASE-SR10
 - Support only recently being introduced
 - Requires more expensive multi-core cables with MPO connectors
 - ...but still less expensive than LR4 for a short inter-rack patch

- They've just worked...
- No hardware problems since April 2011
- Initial software bug where ISO MTU was ignored
 - Had already been fixed in a point release of Junos.

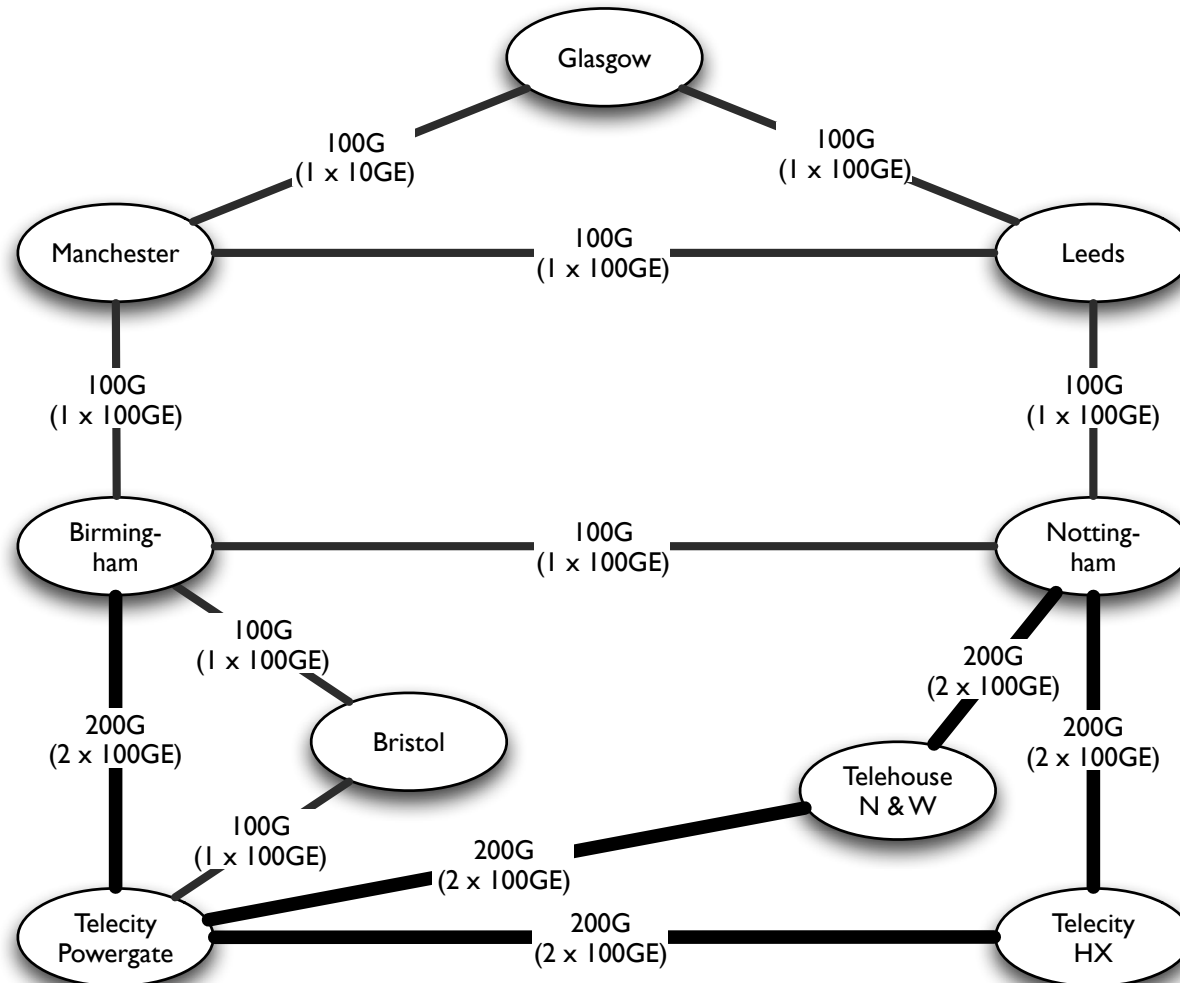
SuperJANET5 at the moment



- SuperJANET5 contract finishes in October 2013
- Construction of Janet6 well underway
 - Dark fibre on 10-15 year lease
 - Ciena 6500 optical equipment managed in-house
 - Change to previous model
 - Day 1
 - 28 x 100GE circuits
 - 130 x 10GE circuits

- All-coherent
 - No dispersion compensation
 - No native 10G circuits
 - 10G supported via 4 x 10 and 10 x 10 multiplexing
 - (And eDCO, but not planning on using them.)
- WSSs everywhere
 - Turn up wavelengths quickly and flexibly
- 100GBASE-SR10
 - Cost saving of ~£1M compared to LR4
 - Requires 6500 release 9.2
 - Due for release Real Soon Now

- Upgrade T1600 to T4000
 - Double the density of 100GE ports
 - Single PFE, so no load-sharing ethernet hacks required
- 100GBASE-SR10
 - Requires Junos 12.3
 - Due for release Real Soon Now
 - Spotting a pattern yet?

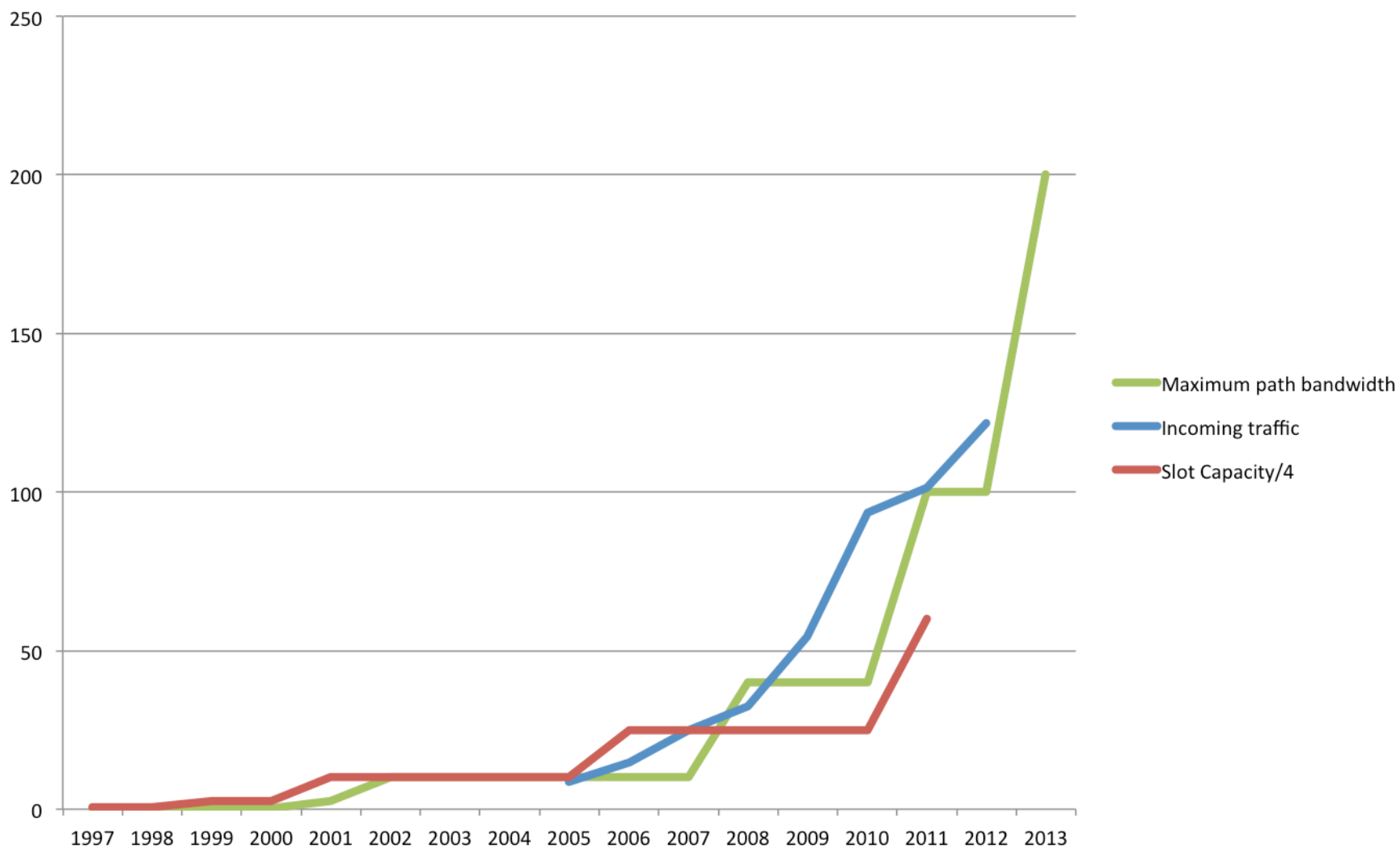


- GEANT moving from committed capacity SDH to capacity planning on EoMPLS
 - Or more expensive committed capacity port on Infinera
- We'll match that
 - Move lower speed point-to-point circuits onto T series platform without guarantees (but with capacity planning)
- Upgrade MX960 switching platform to 100GE interconnects
 - 10GE point-to-point circuits on that

-
- Drive 100GE long-haul directly
 - DWDM 100GE cards not yet available on the routers
 - Install OTN switching on the optical nodes
 - Already have one switching layer
 - Not as useful (for us) as it might have been

- Finish rolling the network out first...
- Following 400Gbit/s and 1Tbit/s transmission
 - Will it require flexgrid?
- Much talk of approaching Shannon limit
 - ...but I'm more concerned with routing density.

Router performance



- Multi-chassis is expensive
 - Power
 - Difficult to persuade telehousing providers to cool 12kW in half a rack
 - Space
 - Empty footprints just for a single router
- Backplane bandwidth isn't scaling as fast as requirements are growing
 - Will demand drop off before we start hitting a wall?
- What happens if we hit the wall?
 - Segregated networks?
 - QoS?
 - There goes network neutrality

Questions? Discussion?

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