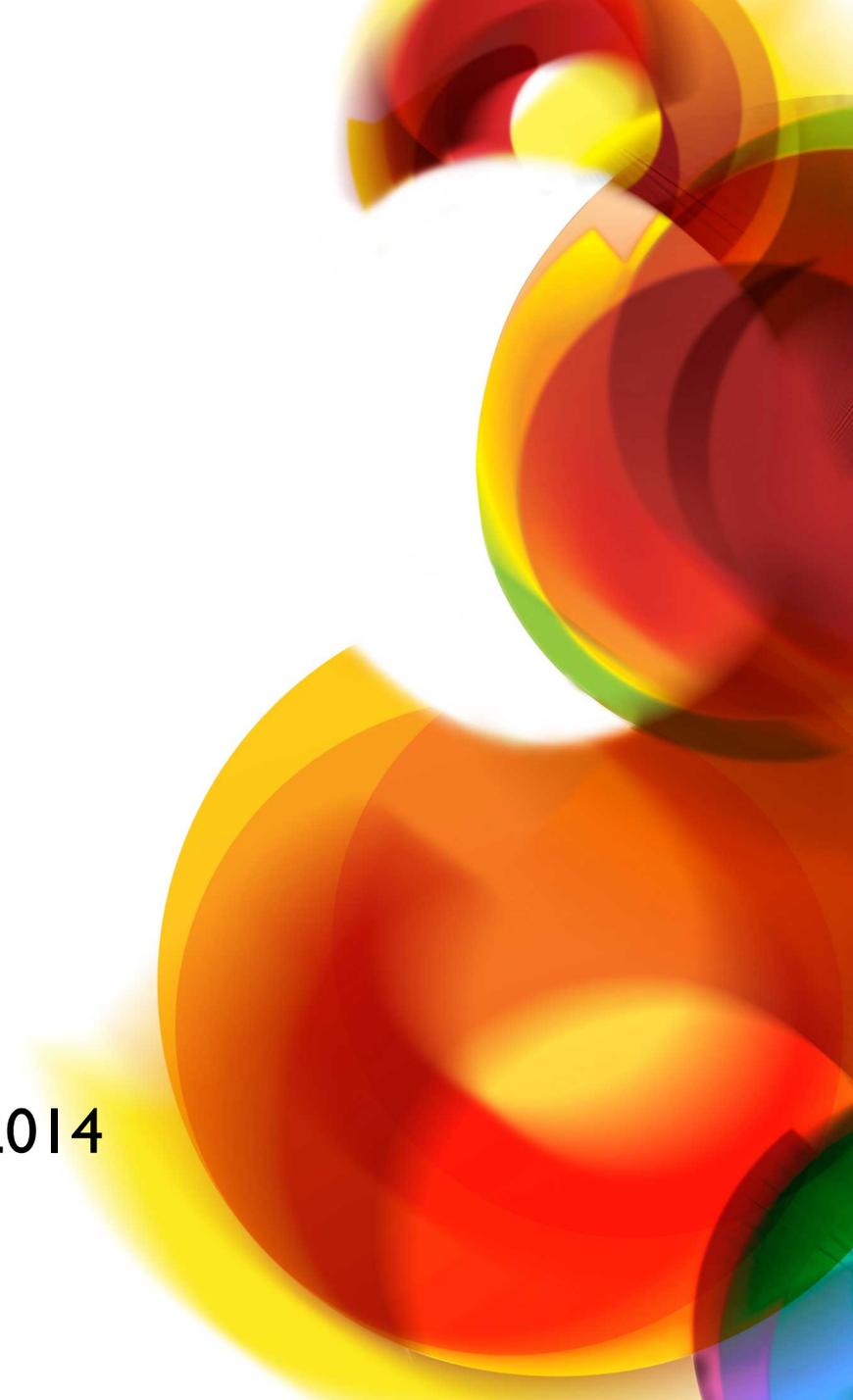# janet

# Building the perfect R&E network.

Rob Evans

Janet

Internet2 Technical Exchange, Oct 2014

- Years of
  - Requirements gathering
    - Workshops
    - Capacity planning &c
  - Government engagement (funding)
  - Procurement
    - Competitive dialogue
  - Building
  - Migration
- Dark fibre
- Coherent optical
- Lots of 100GE
- Ethernet over MPLS
- No OTN switching
- Pretty good, but not the perfect NREN.

Photo from https://www.flickr.com/photos/aldaron/536362686

# What do I mean by 'perfect?'

- A network based on all user requirements, now and for the foreseeable future?
- A network built without making any compromises?
- A network that achieves the right balance between cost, management and features?

*"having all the required or desirable elements, qualities, or characteristics; as good as it is possible to be"*

# What is a perfect NREN?

- High capacity IP provisioning
  - Flexible, statistically multiplexed packet switching
  - Cope with peaks in demand
    - Demanding users
    - Media events
- Rapidly provisioned circuits
  - No bandwidth guarantees, but not congested
- Rapid provision of dedicated bandwidth
  - Mbps, Gbps and many Gbps
- Reliable
  - Multiple failures!
- Meet the needs of production and network research

Photo from https://www.flickr.com/photos/hamur0w0/6984884135

# How might that network be built?

- Dark fibre
- Optical layer
- Switched layer
- Routed layer
- Network management
  - Rapid build of new bandwidth
  - Automated provisioning
  - Network intelligence

# Dark fibre

- Do you need it?
  - Good for high capacity
  - Visibility of underlying network
  - Requires a long-term contract
  - Circuits allow a telco to share fibre
    - Cheaper if you don't need capacity
  - Optical spectrum sharing alternative?
- Can you get it?
  - Fibre market in UK is fairly limited, what's it like elsewhere?
  - 'Fibre glut' of early 2000s is history
    - Telcos driving existing fibre harder rather than laying new fibre
- Will you always be able to get it?
  - Unless new fibre is laid, market is unlikely to open up
    - Telcos prefer to sell services, need to be in a strong position to buy fibre.
  - Will you be able to expand a dark fibre network in five years?

Photo from https://www.flickr.com/photos/98640399@N08/9287370881

# Dark fibre
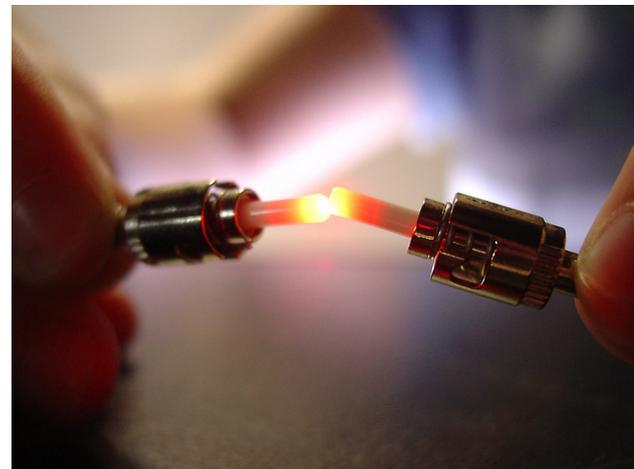
- How much of a mesh?
  - Many routes creates a resilient network
  - More degrees required on ROADMs
  - How do you use all the fibre?
    - Switching and protection at the optical layer?
    - Provision IP paths over all the directions?
      - Lots of router ports!
      - Complex IGP topology
  - Simpler may be better

*janet*
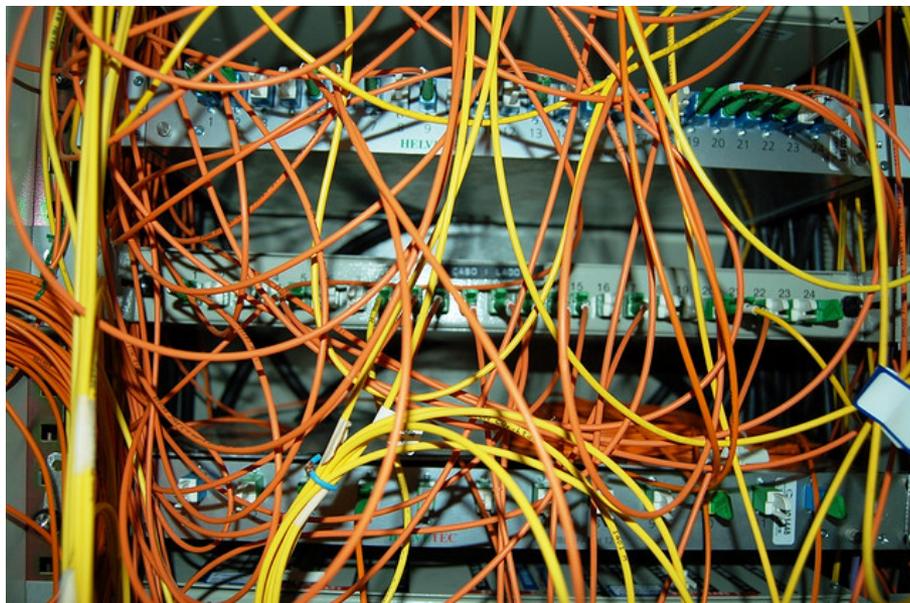
- How 'reconfigurable' do your ROADMs need to be?
  - Less is more
  - Colourless
  - Directionless
  - Contentionless
  - Gridless
    - MEMS or LCOS
- Capacity requirements
  - Are you going to be using a large number of the 88 (96?) channels?
  - Will you want to dynamically reroute wavelengths around the network?
- Where are you building resilience?
  - Protected optical circuits, or at the IP layer?
  - WSSs won't reroute circuits instantly.

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- Coherent
  - Offers 40G and 100G over long distances
  - Single 10G across an uncompensated network can be expensive
- Thick or thin?
  - Transponders in the optical equipment, 'grey' light to the routers
  - OTN optics in the routers
    - Several years behind the optical vendors
    - Coherent requires a lot of DSP
  - Penalty of 'grey' light optics and OEO
    - Especially with the cost of 100GE optics

- 100GE is a lot of traffic to fail in one go
  - 100GBASE-LR4 optics are still expensive, but use normal single-mode fibre.
  - 100GBASE-SR10 are cheaper but require special cabling (multi-core multimode cables with MPO connectors)
  - 10x10MSA may have support issues.
- Parallel 10GE?
  - No single flow larger than 10G
  - Lots of cabling
  - If you require all the capacity, then any one of the optics failing in a bundle might mean you have to take the whole bundle down

# Switched layer

- What do I mean by 'switched layer?'
  - Something between the optical layer and the IP layer
  - Circuits
    - The things we had in X.25 before we binned them.
    - The things we had in ATM before we binned them.
    - The things we will forever reinvent.
- What will you be using it to provide?
  - Dedicated capacity circuits?  How much capacity?
  - Is the fundamental statistically multiplexed aggregation layer of the network here or at IP?
    - 'Pool of available bandwidth'
- Virtual networks
  - Network research

# Switched layer

- Where should it be?
  - In the ROADMs?
    - OTN, ethernet?
  - Dedicated boxes?
    - Yet more rack space and power
  - In the routers?
    - EoMPLS
- The more places you build in switching capacity, the more layers you need a bandwidth overhead to provide it

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- How many backbone routers?
  - Don't want to carry traffic further than is necessary.
  - Don't want to process the packet at lots of hops.
- How far out do you manage?
  - Options for collapsed CE/PE using virtualised functions?
- I don't need to say IPv6, do I?

- Scaling
  - Power, space
  - Vendors suggesting more boxes rather than always meeting demand with one box

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- Content delivery
  - Lots of traffic comes from usual sources
    - Google, Akamai, Limelight, Netflix
  - House servers?
    - Netflix can serve several 30Gbps from a 1RU server
    - Can distribute them around network to reduce carrying traffic
    - Local nodes may be cheap/free, but 'pay' for power, rack space, time spent arranging broken servers to be replaced.
      - Do you need Google servers, Akamai servers, Limelight servers, Netflix servers? What about the next big CDN?
  - Just peer?
    - May not be available in all locations
    - Need to carry traffic around the network
    - Easy to add new peers
- 'Cloud' access and peering

- QoS?
  - "You don't need QoS if you build an adequate network" (Owen Delong commenting on "A reasonable discussion on Net Neutrality")
  - If you're preferring some traffic, that means you're deprioritising everything else.
  - How do you do admission control fairly so only the VoIP traffic is prioritised, but it's open to all VoIP providers?
    - Network neutrality

# SDN

- Where does it fit in the wide-area network?
  - A tool for point-to-point circuits?
- Which layer?
- Testbed or more?
- Multi-domain SDN
  - East-west interfaces

# Rapid provisioning of high bandwidth

- Capacity needs to be lit on the optical layer to use it at higher layers
  - Or at least sitting around…
  - Expensive pre-provisioning
  - May never be used
    - Who has the money?
    - Technology may be obsolete before it is used
  - Flexigrid and dynamic encoding may help here!

# Automated provisioning

- ## Know what you're selling
  - Bandwidth on demand?   Or a circuit on demand?

- ## Heterogeneous networks
  - Vendor-specific solutions are bad
  - How much experience of network operations does your development team have?

- ## Who is the user?  How do we get to them?

# Network intelligence

- How smart should the network be?
- Historically, distributed control planes
  - BGP, LDP, OSPF, IS-IS.
- Towards more centralised control
  - SDN
  - MPLS-TE using centralised software to provision/route LSPs
- Is this a good thing?
  - Trust
  - Simplicity

- Now you have your dark fibre, optical layer, switched layer, routed layer and automated circuit provisioning, how do you see what's going on?
- Each layer may be from a different vendor.
- Expensive commercial tool
  - Does it do what you want?
- Open source
  - Will require customisation
  - Will require interface modules
    - Beware: for the optical equipment they may be expensive!

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# Questions, discussion…

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