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Janet6
Building a national 100GE network

Rob Evans

What is Janet?

- "The UK's research and education network."
  - Connects higher education and further education
  - Schools via local authority aggregation networks
  - Research institutions
- Where do we connect them to?
  - Other research and education networks
    - Via GEANT
      - Pan-European R&E backbone
      - Connects to other global R&E networks
  - The Internet
    - Transit
    - Peering

Since when?

- I'm glad you asked that…
- …since 30 years ago this year.
  - Feel free to burst into a chorus of 'happy birthday.'
- On the backbone, we've seen
  - X.25
    - Who needs IP anyway?
  - IP over X.25
    - Oh, we do. Blasted Internet.
  - SMDS
    - Judging from all our network diagrams, a 'cloud' service.
  - ATM
  - PoS
    - No, not that, packet over SONET
    - 2.5G, 10G, 40G PoS (we liked PoS, lots of counters and alarms)
  - 100GE

SuperJANET5

- Started operation in 2006
- Transmission layer managed by Verizon Business
  - …but dedicated to Janet
- IP layer managed in-house
- POS
  - 10G POS
  - 40G POS
    - See presentation at UKNOF 12
    - I'll be asking questions on POLMUX-QPSK later
- 100GE
  - See presentation at UKNOF 19, I told you I was building capacity to last until 2013
- It's now 2013^H4.
  - All good things must come to an end
    - Especially those bought under a fixed-term contract

- Requirements gathering
- Reliability
  - Application outsourcing
    - Google Apps
    - Microsoft Live@EDU
  - Remote teaching
  - R&E networks haven't been "experimental" for a long time
- Scalability
  - LHC
  - ITER
  - SKA
  - You know, "big data"
  - Costs
    - Power, space, engineering resource
- Flexibility

- Separacy
  - Personal opinion: don't trust the network!
  - PSN
    - ISO27001
    - Impact Levels
    - Confidentiality, Integrity, Availability
  - We have a lot of public sector customers

What did we want?

- Dark fibre.
  - All the cool kids are doing it
  - Some 'novel' requests coming in the research environment
    - Stable frequency distribution
- Control of the transmission equipment
  - Remove one layer of overhead
  - Better knowledge of underlying infrastructure
  - Together with the dark fibre, upgrade when we need to
  - Better understanding of implications of new technologies
- 'Thin' transmission layer?
  - DWDM (coherent?) OTN optics in the routers
  - Getting there for 10G
 - Some way off for 100G
  - Still need to pay the OEO penalty

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- "Competitive dialogue" process
- Two procurements
  - Dark fibre
  - Transmission equipment
- PQQ, ITPD, several rounds of dialogue, final tender
  - Pre-qualification questionnaire
  - Dialogue
    - Prepare (and later refine) requirements
    - Half a day of dialogue per bidder
    - Feed that back into requirements
    - Up to six bidders in each procurement, two procurements
  - 9 month long process
- I swear this is the only slide on EC procurement process

- >6,000km of dark fibre
  - Only ~24km was new dig
    - …but don't ask how close we came to cutting through one of Glasgow's HV cables
  - More aerial fibre for the pylon geeks
    - Less rail-side fibre
- (Almost) All G.652
  - CD (chromatic dispersion) not much of a problem with CD (coherent detection)
  - Wanted to avoid G.652 / G.655 splices
  - G.652 slightly better for us

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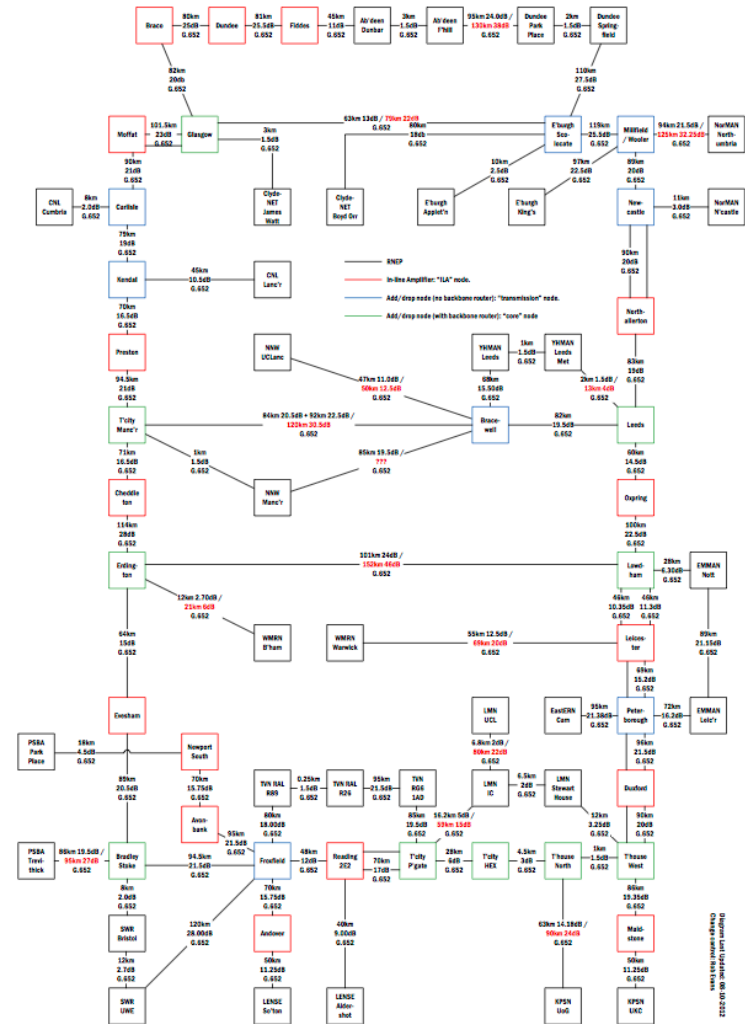
- Ciena 6500 transmission equipment
  - Coherent optical
    - 100GE from one end of the country to the other without regeneration
  - No dispersion compensation
  - Minimum wavelength capacity of 40Gbit/s
    - Also 100Gbit/s
    - 4x10GE, 40GE, 10x10GE, 100GE
    - (There is eDCO 10G, but not worth burning a lambda for.)
  - Up to 88 wavelengths
    - We'll probably run out of rack space first
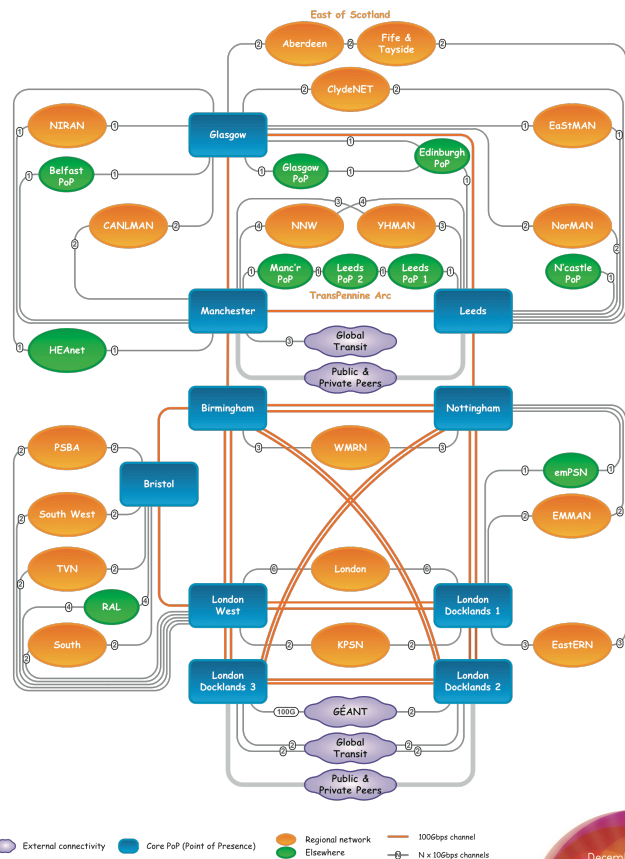
- # 28 x 100GE
  - ## 2 x 100GE on some hot routes
- # 160 x 10GE
  - ## Predominantly regional access

- Juniper T-4000 routers
  - An upgrade from the T-1600 we had already
  - 2x100GE or 24x10GE per slot
  - Cost per 100GE ~ ⅓ that of T-1600
    - Also gets rid of the VLAN steering / multicast bit hack
  - Some have 7 x 100GE interfaces in

- **100GBASE-SR10 or 100GBASE-LR$**
  - Oh, sorry, hanging shift key, 100GBASE-LR4.
  - Just to reach between transmission equipment and routers in neighbouring racks
- **LR4**
  - Uses normal single-mode fibre patch cords
    - Which we have plenty of
    - Which we know how to clean and test
  - Fits in with existing ODFs
- **SR10**
  - Uses 24 core multimode cables with MPO connectors
    - Which we had none of
  - Doesn't fit in with existing ODFs.
  - Is much, much, much less expensive than LR4.
  - Like £1M cheaper across the network.
- **SR10 it is then**

Fibre to Ireland

- Janet's Northern Ireland Region
- Janet / HEAnet peering
- Additional connectivity between HEAnet and GEANT
- 238km/48dB & 203km/44dB unamplified spans

  - Normal spans are between 80-120km
  - Raman amplifiers
    - Armoured distribution frame
    - "Never, ever, ever unplug this fibre"
  - Optical simulation, precise setting of the amplifier bias currents
  - Occasional drop-out
  - More simulation
  - More tuning. More drop-outs
  - More simulation
  - Turn the bias current up to 11

- Fibre to Ireland
  - Long spans and additional amplification reduces channel count
- Aberdeen to Dundee
  - Resilient route is 124km without amplification
  - Submarine amplifiers

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- 6,000km of duplex fibre.
  - 12,000km of fibre
  - Splices (at least) every 2km
  - OTDR reports from each direction on the fibre
    - Check each figure manually
  - Chromatic Dispersions
  - Polarisation Mode Dispersion reports
  - I was in the US for a meeting, optical specialist was with family in India, project manager was in the UK.
- PoPs
  - ~80 of them
  - Rack layouts, cabling, acceptance reports, quality assurance reports.

Some challenges

- Working to a tight schedule
  - The SuperJANET5 contract finished on 23rd October, 2013
  - We had to complete build and migration by that date
- Meetings
  - Someone calculated 512 hours
    - I'm not sure if that is total or per week.
- Emails
  - One of the project managers counted 19,000
- Janet engineers, Ciena engineers, Ciena's installation subcontractor, router installation, DC power installation, fibre engineers
  - Bradley Stoke, 4th March 2013
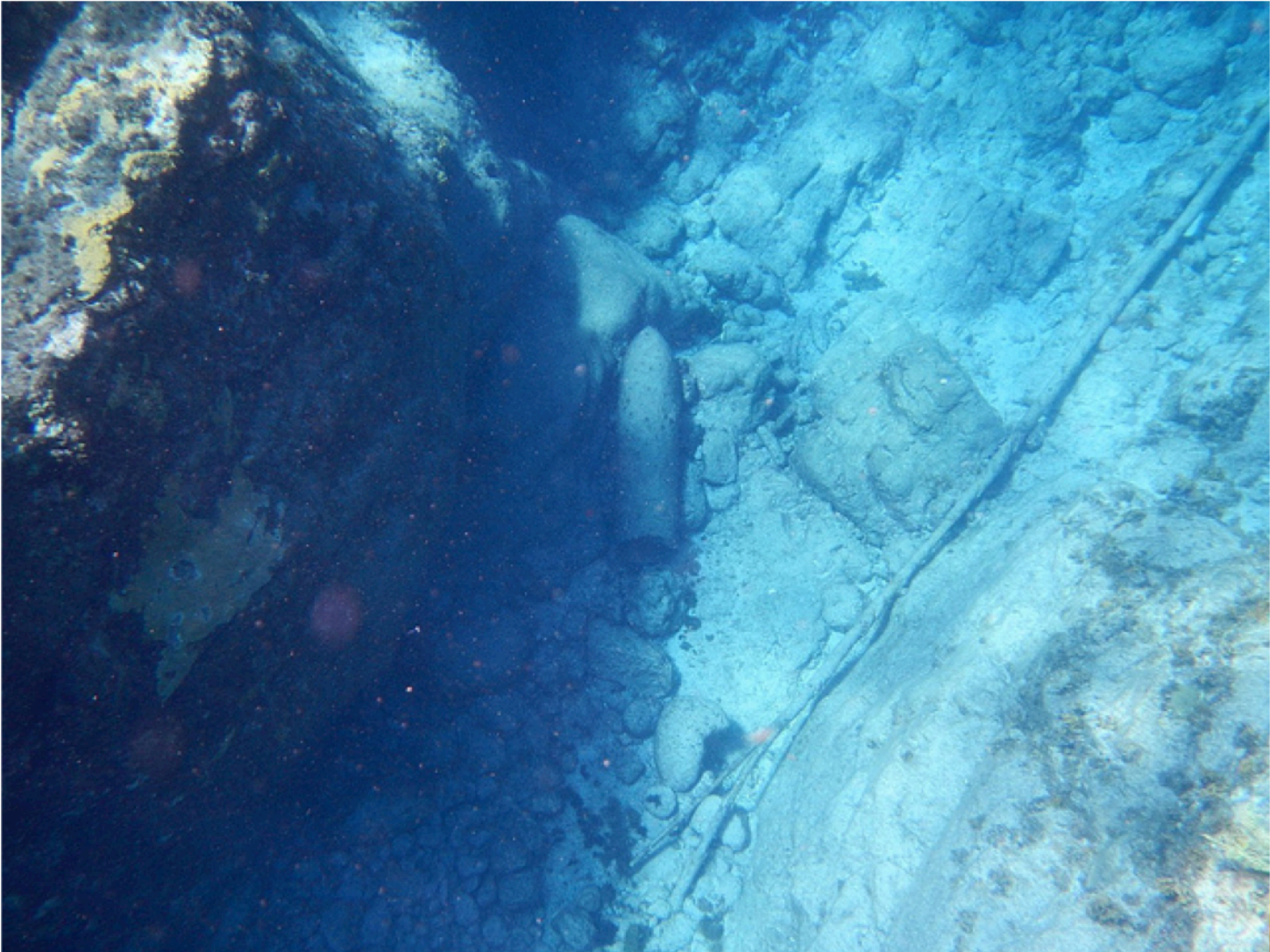 - 22 engineers due on site on same day
- Sandbags

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- We prefer pre-built (welded) racks

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Operational support

- Only managed limited amounts of DWDM until now
- Multiple NMS systems
  - HP OpenView for IP
    - SNIPS as a backup
  - Ciena OnCenter for older transmission equipment
- Lots of windows open
- Bring the alarms together in one place
- Write modules for an open source NMS
- *Work in progress*

Some observations

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- Dark fibre
  - 10-15 year contract
  - Not many potential providers
  - Most prefer to sell services
  - What will it be like when we want to renew?
- What's in a name?
  - Janet6 is nothing to do with IPv6
  - It does IPv6, of course, but so did SJ4 and SJ5
    - Tunnels for more than 15 years, dual-stack for more than 10.

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- Power and cooling still scare some datacentre operators
  - Especially telco-focused colo providers
  - T-4000 requires 12 60A -48V DC feeds
  - Each 6500 shelf requires 2 60A -48V DC feeds
  - Some PoPs have 5/6 shelves
  - Dialogue required to give realistic power draw figures
  - Empty racks
- 155,000ft^2 of colo space just for transmission & routing kit

Where next?

- Expanding fibre footprint
  - 'e-Infrastructure'
  - Met Office, European Bioinformatics Institute, Francis Crick
  - Regions
- Increase density of transmission equipment
  - Adding new chassis is expensive in terms of power and space
  - QAM, flexgrid, LCOS WSS
- Increase density of routers
  - See above
  - Prefer to fit more into one chassis than install more chassis
- Changing how we distribute traffic?
  - More local content delivery
  - More optical bypassing
    - Saves at intermediate hops, but increases interfaces at major PoPs.

Questions?

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