Keeping up the momentum: The importance of innovation to keep networks fit for the future

Dr Tim Whitley

MD Research & Innovation, BT Distinguished Engineer

UBBF Ultra-Broadband Forum 2014

Context

Trends

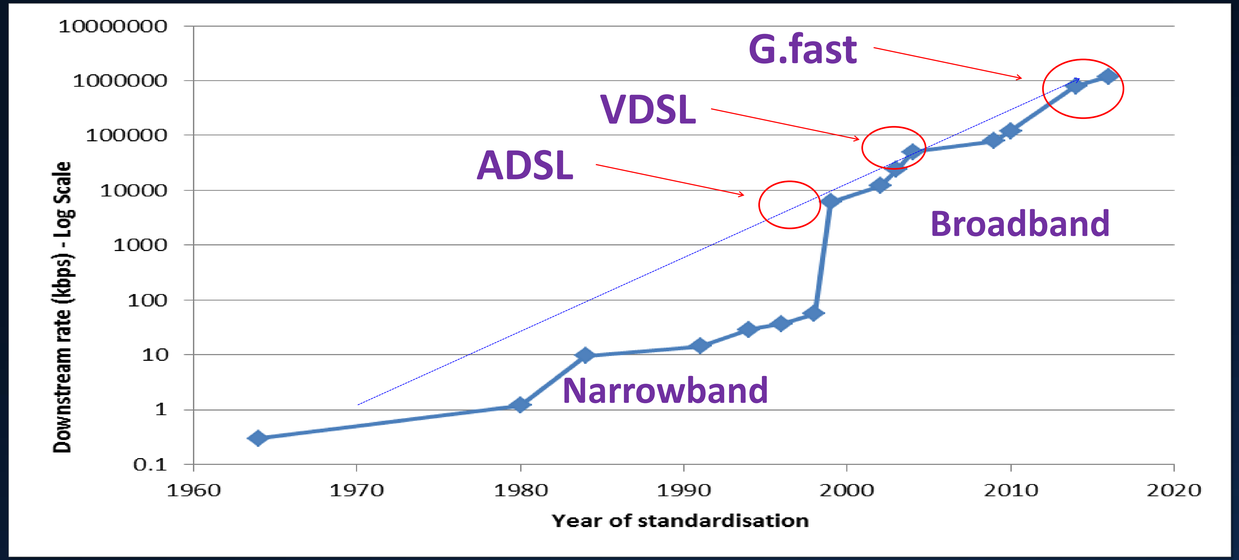
- Increasing consumer and business data usage:
  - Device penetration (tablets, smartphones, smart TVs);
  - Video usage across all device types;
  - Internet of things, ‘wearables’ etc..
- Increased bundling of services:
  - Convergence of content/TV and broadband;
  - Convergence of fixed and mobile;
- Voice heading towards being an application on IP.

Challenges for BT

- To provide enough capacity to keep up with demand.
- To devices that customers want to use, wherever they are and when they want to use it.
- At reasonable cost.
- To offer seamless connectivity requires integration of fixed and mobile networks.
- Manage implications for core network

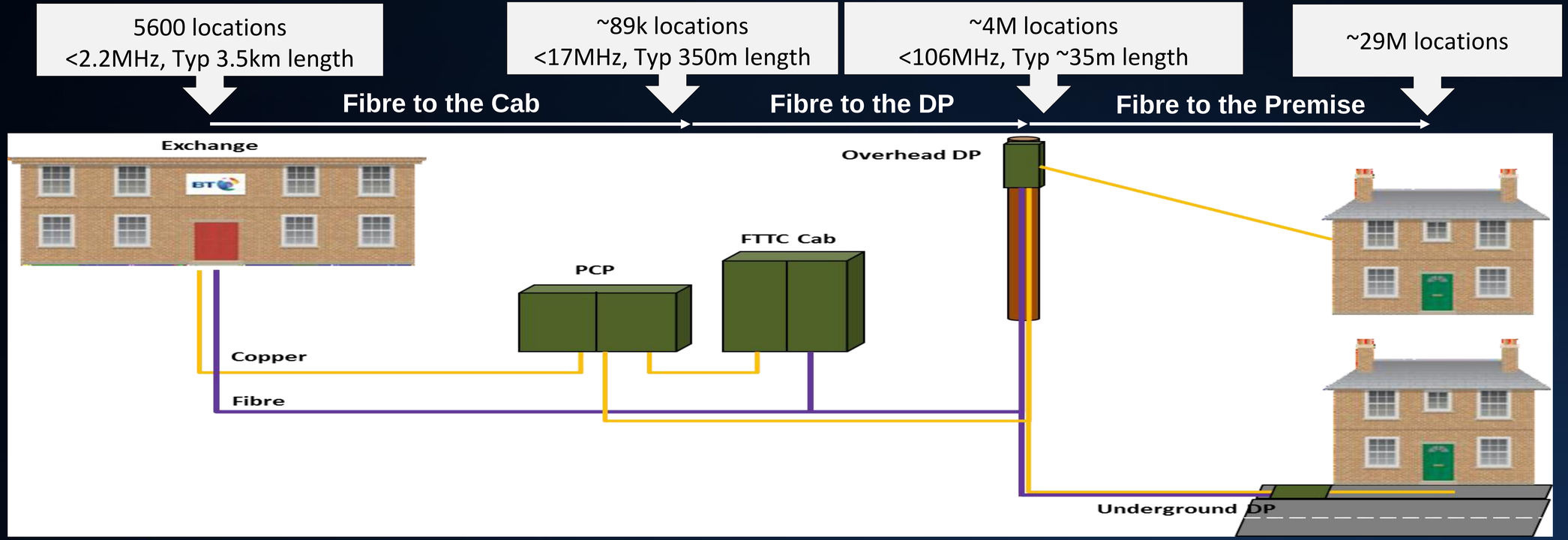
Access – BT's Broadband Heritage

- **August 2000:** BT Launched 500kbps ADSL broadband
- **September 2004:** BT removes distance limitations for ADSL
- **March 2006:** BT Launches 8Mbps DSL Max
- **April 2008:** BT Launches 24M Wholesale Broadband Connect
- **January 2009:** BT Infinity / Fibre Broadband launched
- **April 2012:** 80Mbps FTTC launched
- **November 2012:** 10G PON trial in Cornwall
- **August 2013:** 300Mbps Infinity product launched
- **Spring 2014:** Scale Vectoring Trial
- **Summer 2014:** G.Fast technology trial



Copper speeds: advances over time

The access network



Access – broadband Innovations

Driving faster speeds

- FTTC – Vectoring
- FTTRN – VDSL closer to the customer
- FTTDP – G.Fast
- FTTP

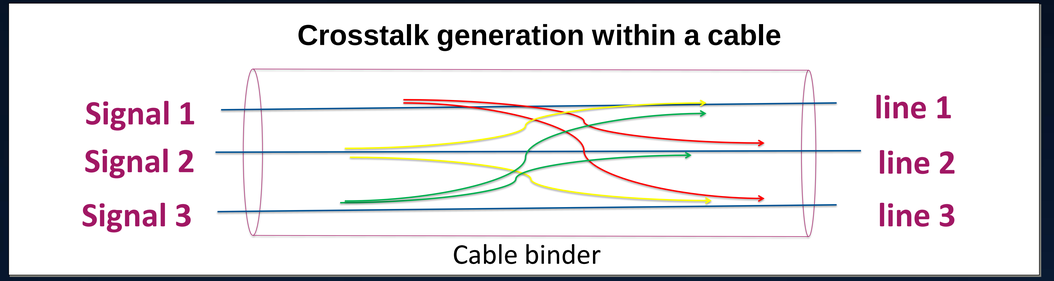
Vectoring Cabinet

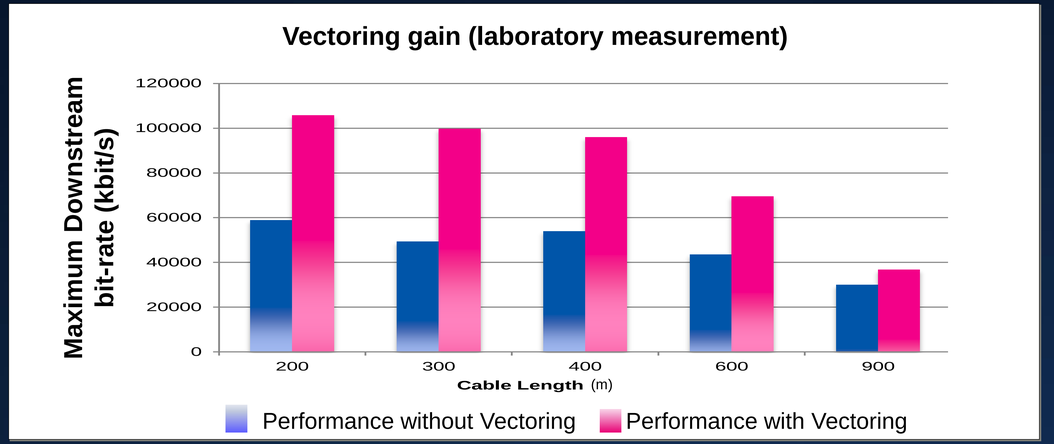
Extending reach

- We are innovating to extend benefits of faster access to the final c. 10% of coverage
- Copper rearrangement
- Broadband regenerators for ADSL
- Microwave wireless to the cabinet
- VDSL amplifiers
- Fibre to the remote node (mini DSLAMs)

The impact of crosstalk and vectoring

- Crosstalk is due to coupling between pairs in a multi-pair copper cable and limits FTTC speeds.
- Increasing cable fill through customer take-up increases crosstalk and reduces line-rates.
- By calculating a “pre-compensation” factor for each line, the crosstalk can be cancelled in the DSLAM.
- The technique for doing this is called “Vectoring”, and is conceptually similar to noise cancelling headphones.
- Openreach has trialled six vectored cabinets with c.1000 live customers in Braintree and Barnet. Phase 2 trials are now underway.

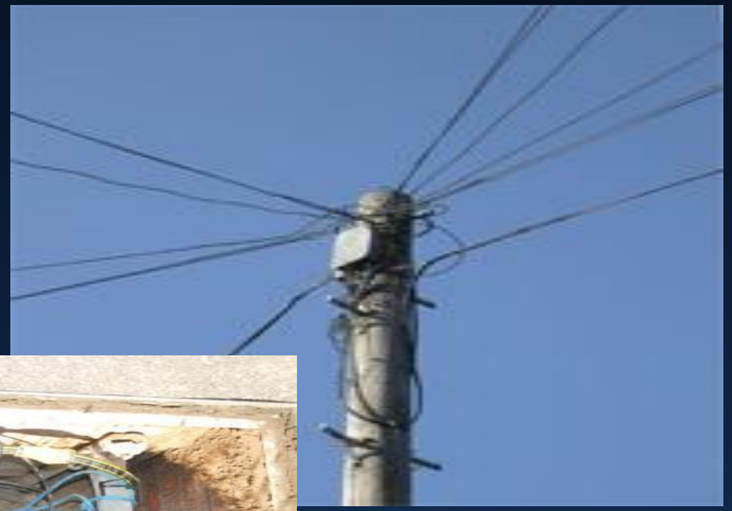




Pushing fibre deeper into the network: the Distribution Point

- Beyond the green cabinets, BT has overhead and underground DPs with:
  - An average of ~8 customers connected;
  - Can have >16 customers in some cases.
- Space is limited and they are exposed to the elements.
- The typical distance from the DP to the customer is ~35m making it the ideal location for delivering very high speeds.
- A new technology (G.fast) is being standardised in the ITU:
  - Enables speeds of up to 1 Gbit/s;
  - Commercial G.Fast equipment is expected in H2 15/16.

Typical pole DP serving 12 customers

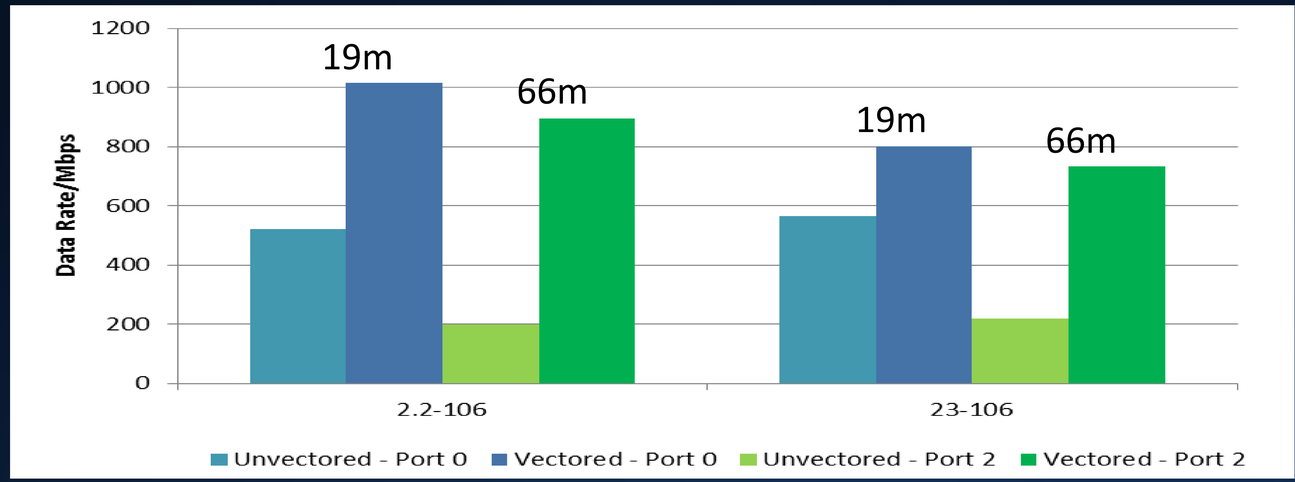


Typical distribution footway joint box

We have trialled G.Fast in the network

- Trial had three customers connected to one DP
- The network was overlaid to prevent harm to existing services, but used existing duct infrastructure

- Chart shows best and worst case performance
- Physics of G.Fast worked as expected
- Vectoring proved to be critical in delivering the top speeds



BT is opening a new, purpose-built, ultrafast broadband lab at our Adastral Park R&D centre in Ipswich

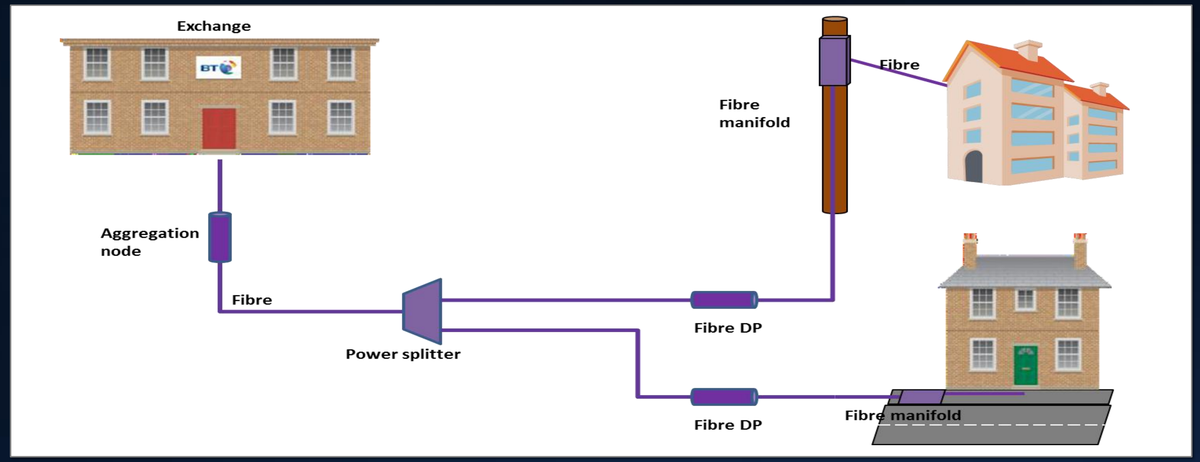
- G.Fast has demonstrated potential that now needs to be tested and verified.
- We will study the full technical capabilities of G.Fast hardware designed by leading system vendors.
- We will continue to play a proactive role in developing G.Fast standards in the ITU.
- It’s crucial that we stay ahead of the curve for the benefit of our customers and shareholders.

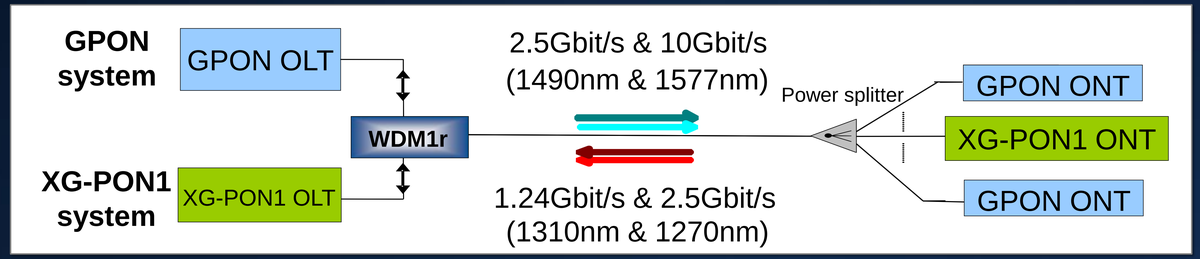
Emulation network enables replication of different real-world final-drop topologies

DP and CPE installations allow a full range of performance and operations tests

FTTP – 10G and beyond

- GPON provides 2.5Gbit/s downstream, 1.2Gbit/s upstream
- XG-PON1 provides 10Gbit/s downstream, 2.5Gbit/s upstream
- Exploiting existing Fibre Network with separated wavelengths
  - XG-PON and GPON coexist on the same fibre
- No change to Optical Distribution Network (ODN)
  - WDM1r (Filter) component already in place
- We are working on NG-PON2 which provides 40Gbit/s downstream and 10Gbit/s upstream on a single PON





Access fibre deployment and new services will drive future core bandwidth demand

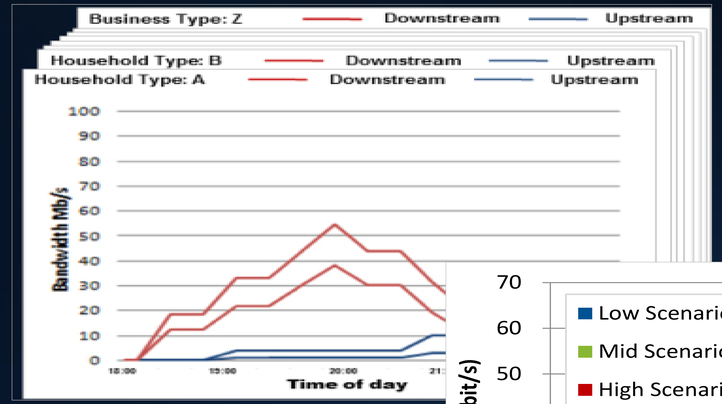
- Current core traffic growth CAGR = 45%.
- Bandwidth demand analysis to 2033 suggests core requirement of c.12Tbit/s by 2020.

Key future demand drivers:

- Over the Top content;
- Video on Demand;
- 4k/8k content delivery;
- Cloud-based applications;
- HD Video-calling;
- Rich media webpages;
- Software package size growth;
- Customer expectations of speed.

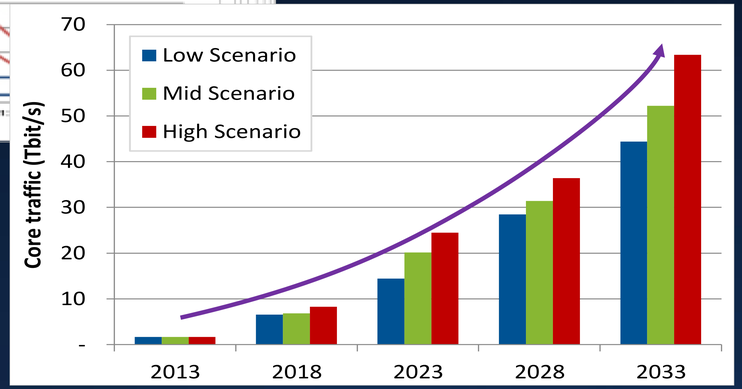
Future demand mitigation:

- Improved video coding;
- Time-shift delivery techniques.



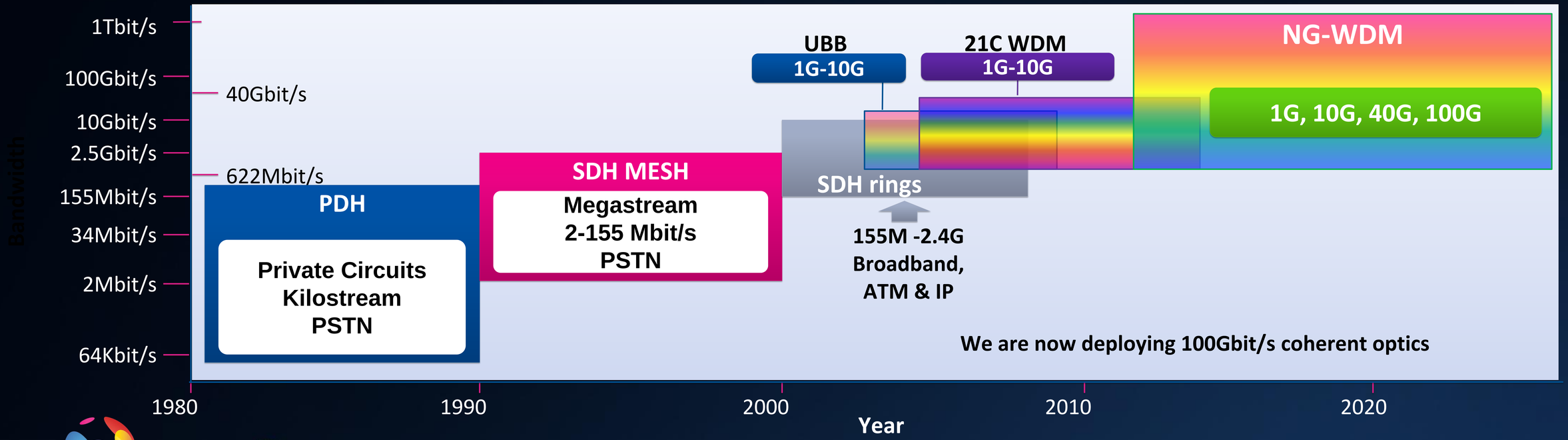
Time of day activity scenarios have been used to model bandwidth demand of different user types

Modelling suggests c 25 to 30 fold core capacity increase over the next ten years



Potential long-term core capacity requirements

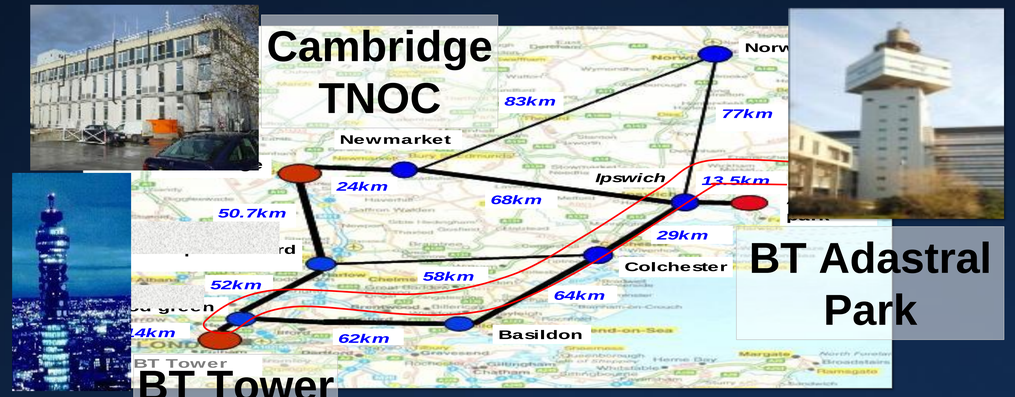
BT's upgrades core transmission roughly every ten years...



The Next Generation: 400G & Terabit Trials


'Fastest ever' broadband passes speed test

By Dave Lee

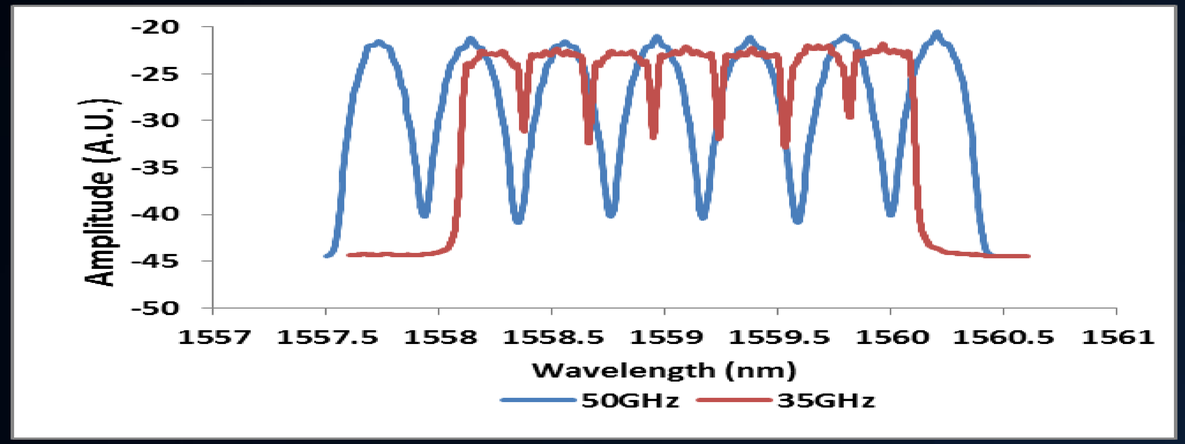


BT

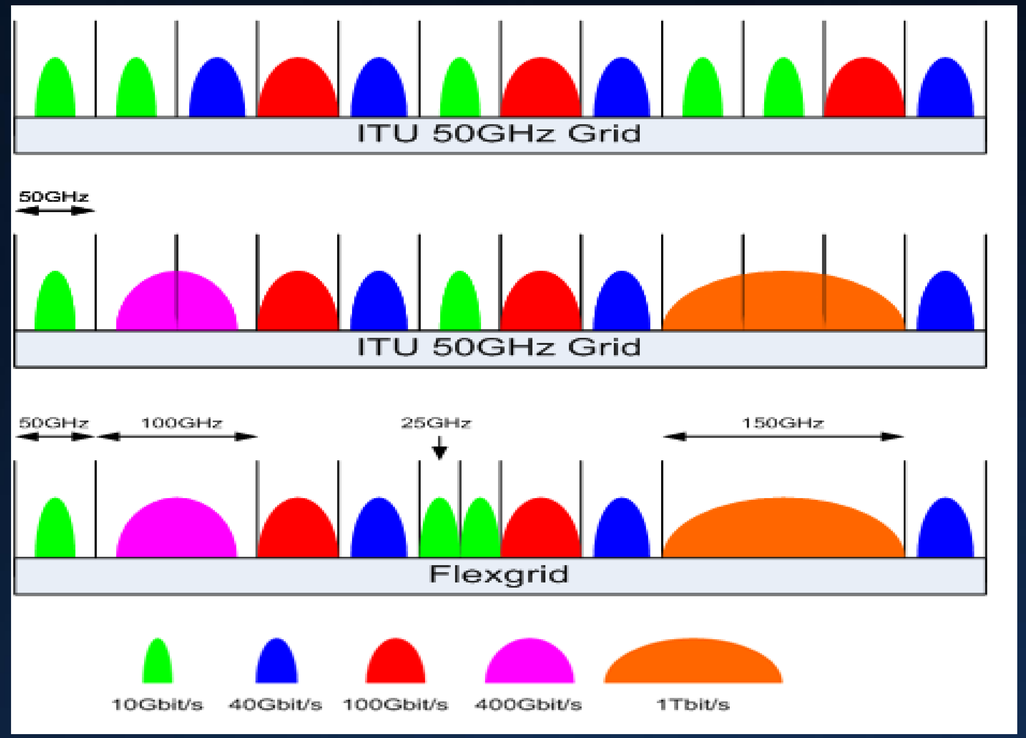
UBBF Ultra-Broadband Forum 2014

The Next Generation: Gridless & Optical Superchannels

- Current WDM has rigid 50GHz grid structure.
- Future gridless infrastructure permits improved fibre utilisation (spectral efficiency).



Example: 1.4T "Superchannel" comprising 7 x 200G (16-QAM) subchannels



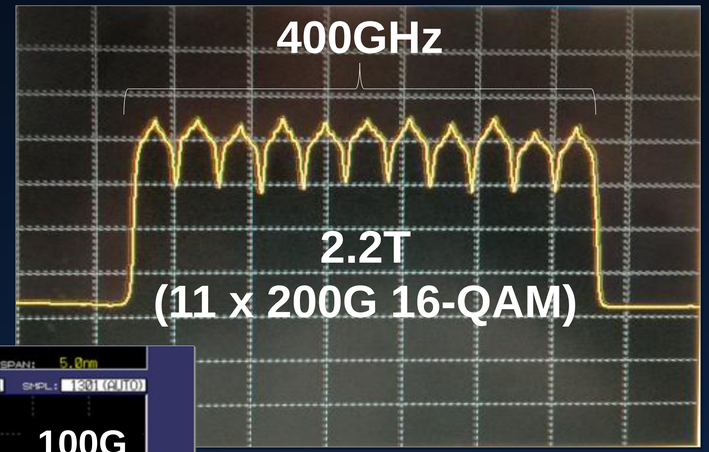
BT

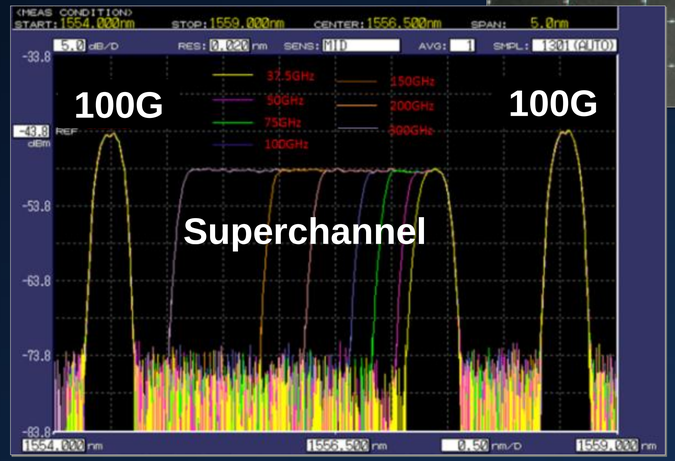
UBBF Ultra-Broadband Forum 2014

Pushing the boundaries

- We have demonstrated real-time 2.2T Transport over managed Flexgrid infrastructure:
  - 11 x 200G 16-QAM Superchannel;
  - 33.5GHz subcarrier spacing giving a spectral efficiency of 5.97bits/s/Hz, more than 49% improvement over conventional 50GHz grid.
- We are working with partners to develop our understanding of capacity management, for example:
  - Demonstrating configurable Superchannel alongside multiple 100G 50GHz grid channels;
  - Working with Huawei U2000 management system.

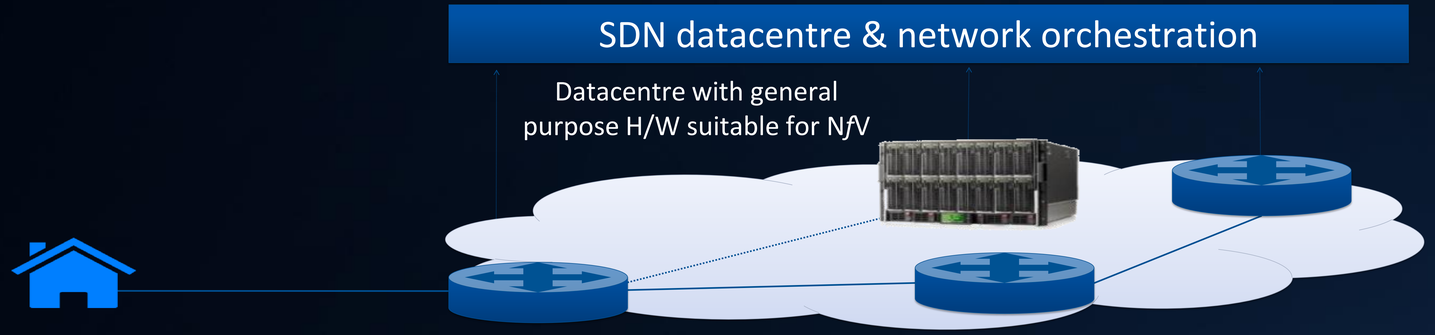
2.2T Superchannel





Configurable Superchannel operating alongside 100G grid channels

The next challenges are control, flexibility and vendor interoperability...



SDN orchestrating the provision of virtualised network functions

Software Defined Networking (SDN)

- Open standard control and orchestration equipment
- Setting up optical and Ethernet circuits on the fly
- Control of flexgrid bandwidth and optical modulation formats
- Multilayer operation allowing time of day router bypass

Network functions Virtualisation (NfV)

- Reduced costs through consolidating functions
- Reduced operational costs
- Rapid provision of new services globally
- Software oriented innovation (including Open Source)

Thank You

BT

UBBF Ultra-Broadband Forum 2014