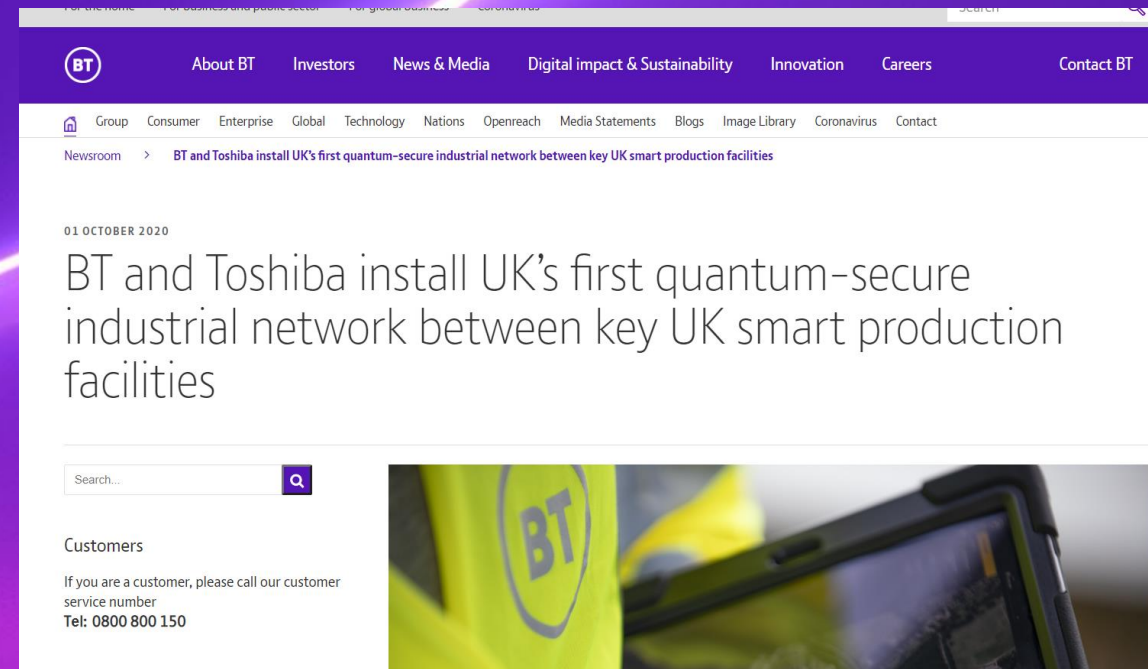




Quantum Communications at BT

Andrew Lord
Senior Manager Optical Research, BT
Date: April 2021

A screenshot of a BT Newsroom article. The page has a dark blue header with the BT logo and navigation links: 'About BT', 'Investors', 'News & Media', 'Digital impact & Sustainability', 'Innovation', 'Careers', and 'Contact BT'. Below the header is a secondary navigation bar with links: 'Group', 'Consumer', 'Enterprise', 'Global', 'Technology', 'Nations', 'Openreach', 'Media Statements', 'Blogs', 'Image Library', 'Coronavirus', and 'Contact'. The main content area shows the article title 'BT and Toshiba install UK's first quantum-secure industrial network between key UK smart production facilities' dated '01 OCTOBER 2020'. There is a search bar with the text 'Search...' and a magnifying glass icon. Below the search bar is a 'Customers' section with the text 'If you are a customer, please call our customer service number Tel: 0800 800 150'. On the right side of the article, there is a photograph of a person wearing a yellow high-visibility vest with the BT logo on it, looking at a tablet device.

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Newsroom > BT and Toshiba install UK's first quantum-secure industrial network between key UK smart production facilities

01 OCTOBER 2020

BT and Toshiba install UK's first quantum-secure industrial network between key UK smart production facilities

Search...

Customers

If you are a customer, please call our customer service number
Tel: 0800 800 150

BT's interest in Quantum Communications

BT has spent several years integrating QKD with mainstream transmission for full-service quantum encryption. We have a lot of experience in doing this now

We have spent a lot of time working with potential customers – educating / understanding requirements

Customer curiosity around quantum has exploded over the past 12 months coupled to QC progress

We have built a range of demonstrators and trials:

Integrated QKD + classical WDM with Toshiba and Adva

Quantum Comms Hub QKD system between Adastral Park and Cambridge – IDQ + Adva

Customer QKD trial with National Composite Centre in Bristol – with Toshiba and Adva – over Openreach commercial fibre product

A range of lab demos

We have more recently been building internal business cases / propositions for a QKD service

Still a Work in Progress

What will be the impact of NIST-approved mathematical solutions in ~ 2 years?

Deep interest in Sat QKD

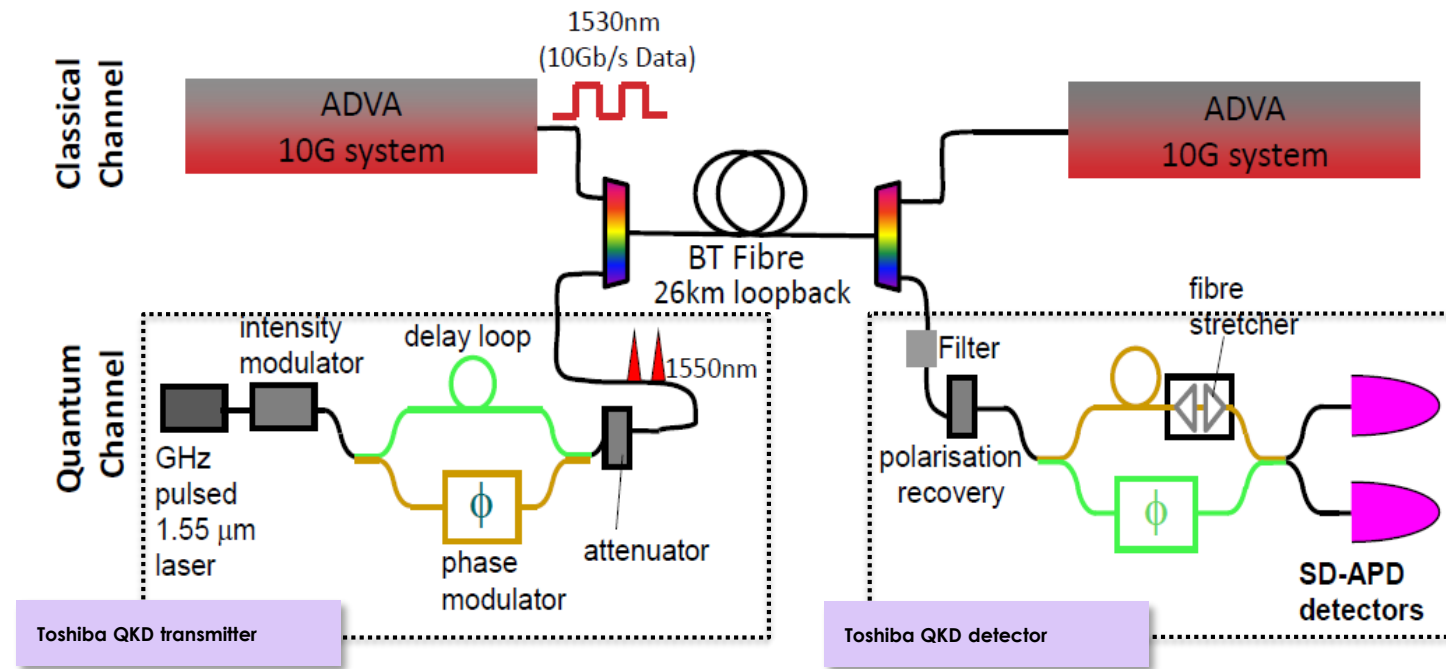
Additionally – close relationship with Toshiba on terrestrial QKD

Other activities include ongoing Penetration Testing / Assurance, Standardisation, Key Management, Overall system integration (Ethernet etc)

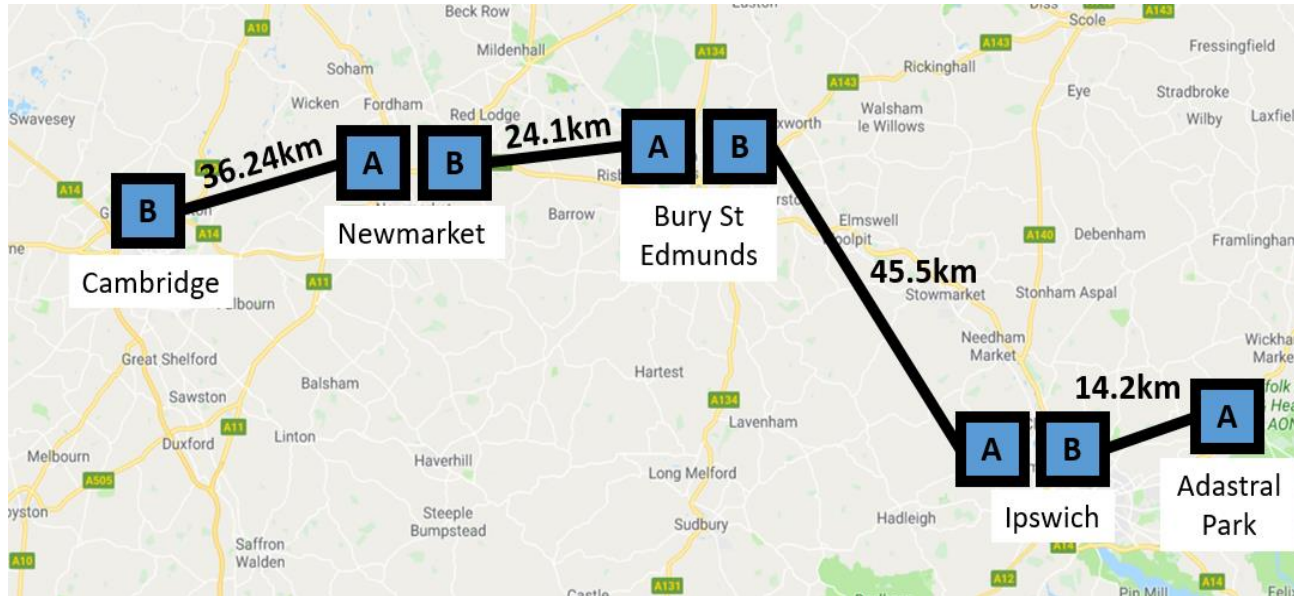


World first real time QKD + 10Gb/s field trial using commercial hardware (2014)

Adastral Park – Ipswich (27km)

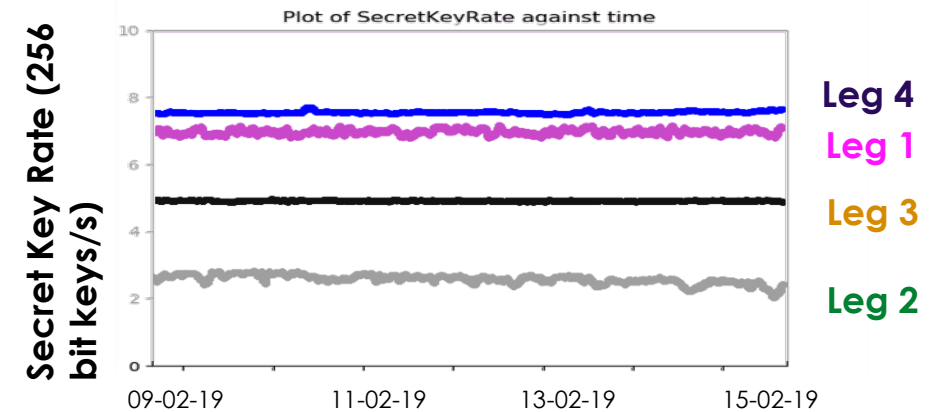


UK's ultra-secure Quantum Network link between Research and Industry



Real world QKD experience on this link for well over two years
 Connections into a wider QKD network to Bristol being built

- Commercial ID-Quantique QKD equipment
- Commercial Adva DWDM – 5 x 100Gb/s
- Full installation over installed BT fibre and in BT exchanges



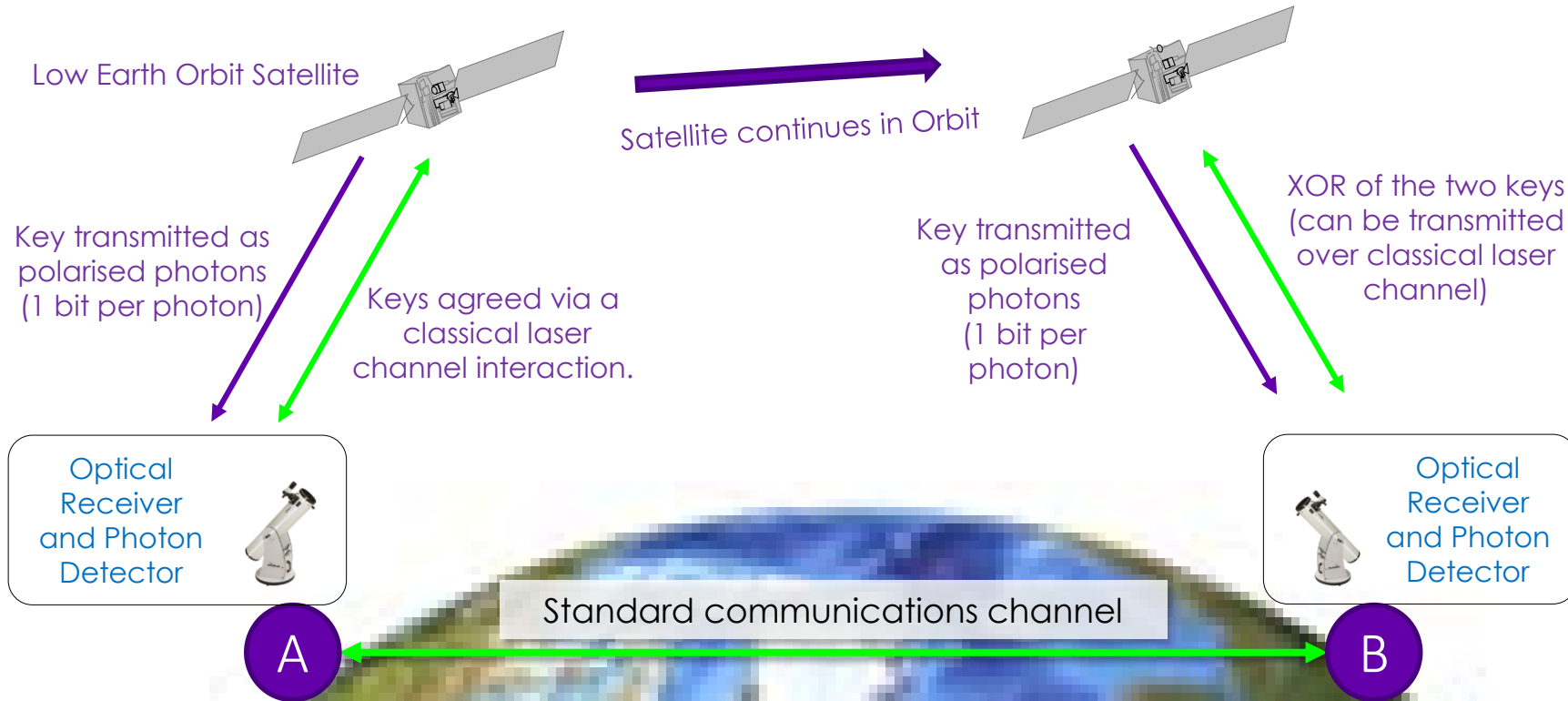
Recent data showing the fluctuations in Secret Key Rate over each link for a week

Satellite QKD

Satellite QKD networks moving to commercial reality in next 2 years.

① Satellite transmits key material to location A via the optical network.

② Satellite transmits key material to B, along with the XOR of both keys.



③ A encodes a message with the key received and sends the cipher text to B via a classical “open” terrestrial channel.

④ B decodes the message with own key and the XOR'ed keys.

First commercial trial of QKD and Industry 4.0

NCC – National Composite Centre based in Bristol
<https://www.nccuk.com/>

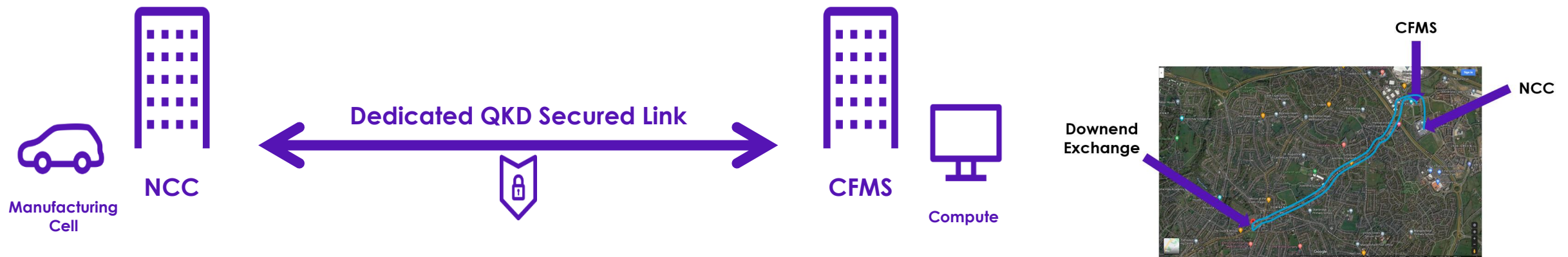
How to design a QKD-secured data link between two NCC buildings

Using all commercially available products, including the fibre access

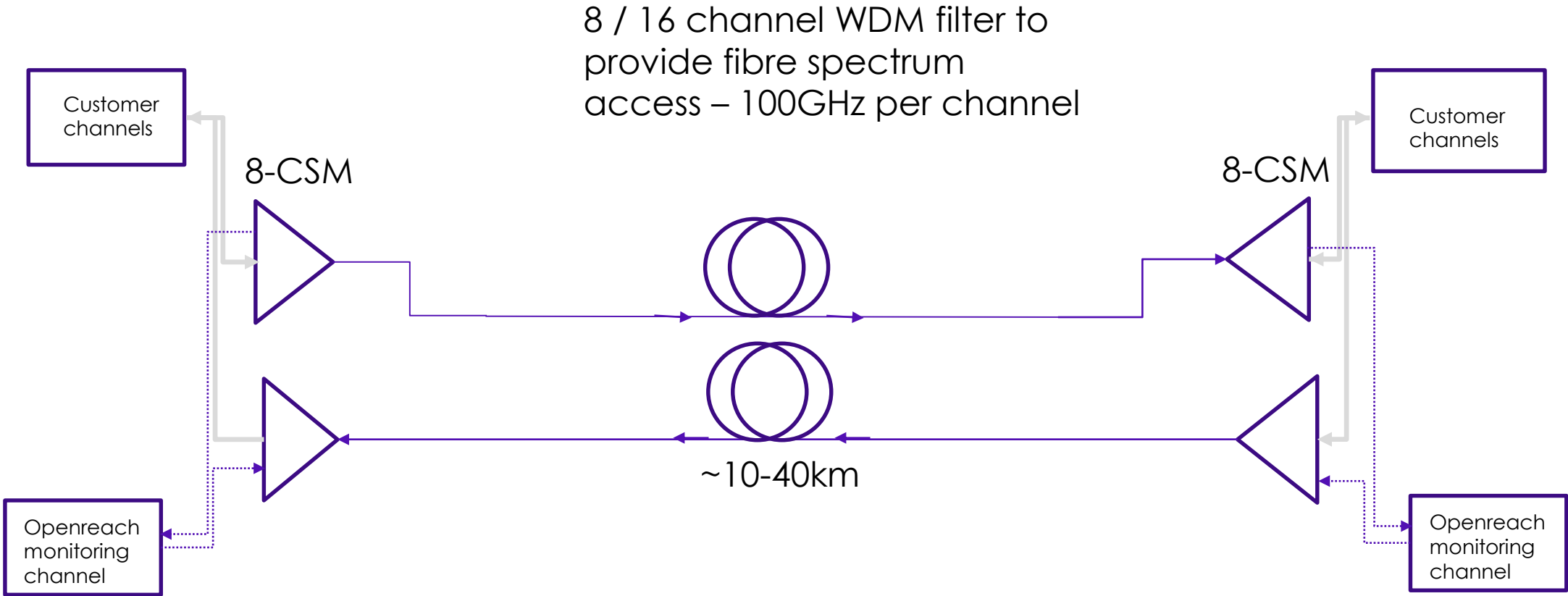
Toshiba QKD solution – carefully designed for working alongside classical channels

Adva ethernet transmission solution – 10GE with external key input feature

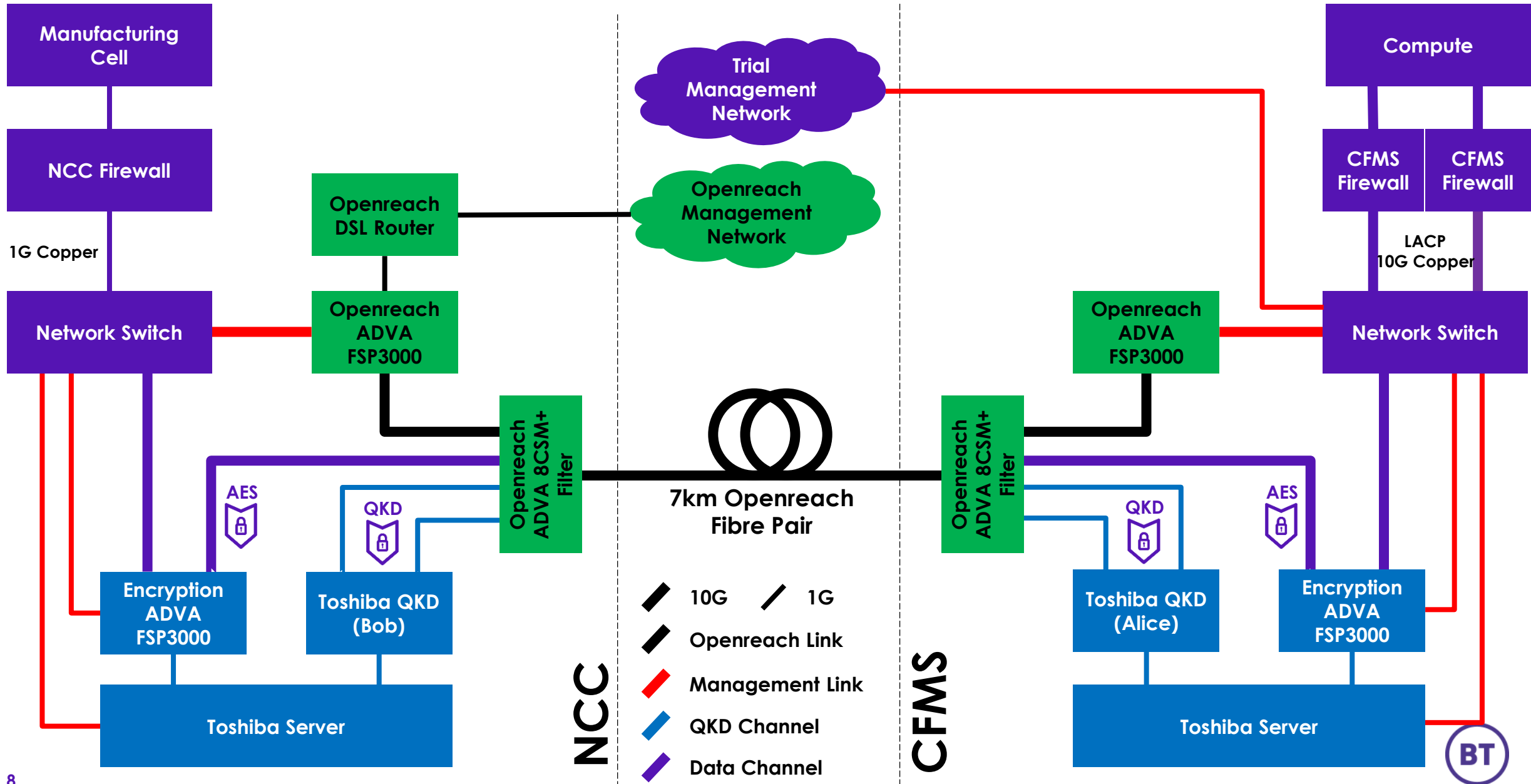
Openreach OSA filter connect fibre product – provides managed access to 8 / 16 channels of optical spectrum



Interfacing QKD with a standard Open Reach fibre product – Optical Filter Connect

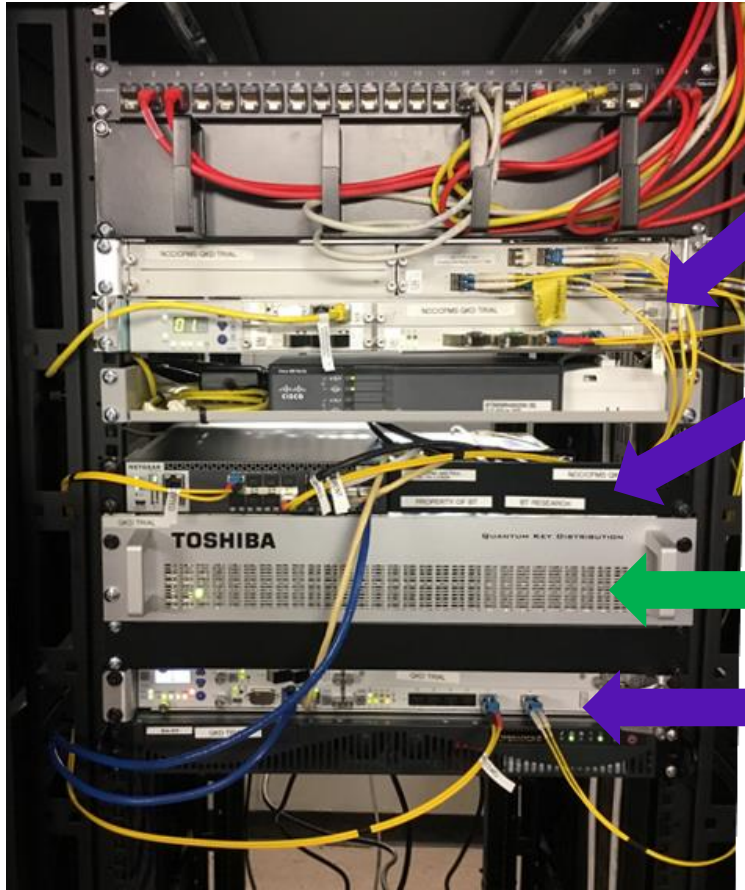


End to End Architecture



The NCC and CFMS PoC Trial

Equipment as Racked
NCC



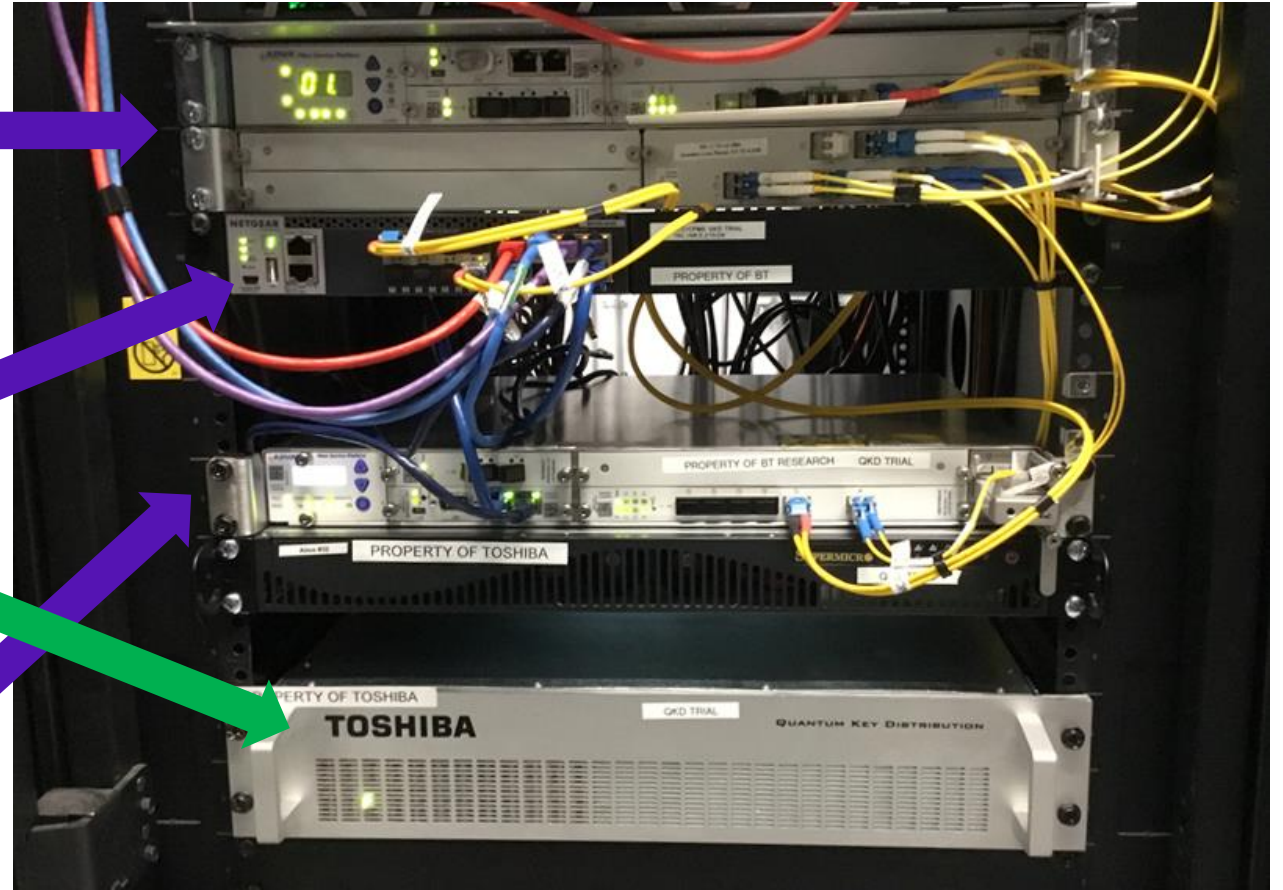
Openreach
OFC

Network
Switch

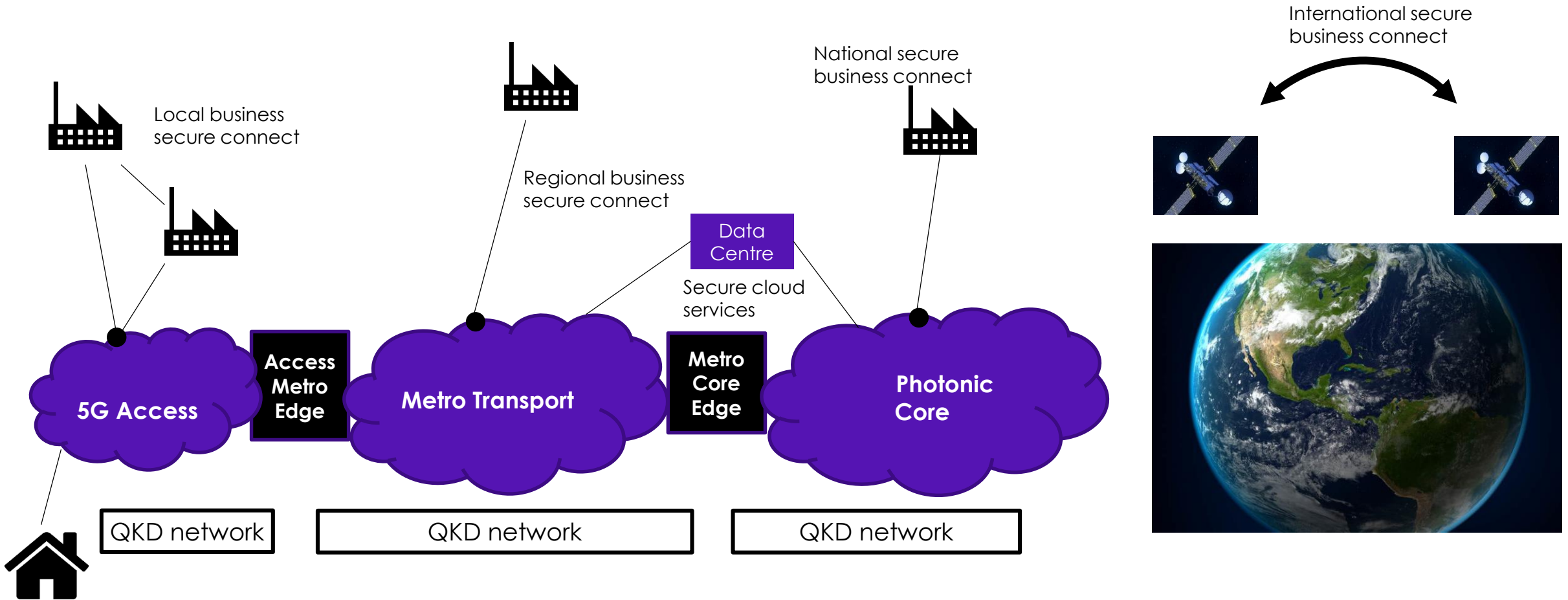
QKD

Encryptor

CFMS



Where will customers want to see QKD in their networks?



- Secure connections between business sites (could be local, regional, national or international)
- Secure back-up to the cloud / DC
- Beyond the access network, connections share fibres
- Metro and Core networks comprise fibres with multiple wavelengths
- IP routers usually used for packet layer traffic networking

Independent national key distribution network – towards the Quantum Internet

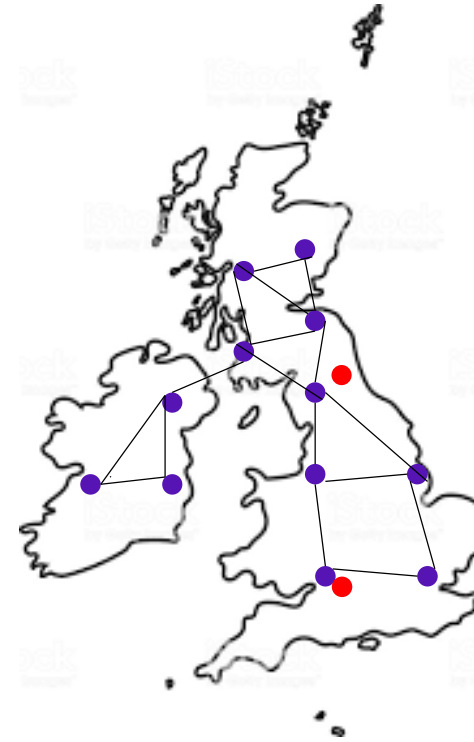
It may be that QKD isn't optimal when slotted in over optical transport networks

Ultimately a separate QKD network, designed to be optimal for QKD, on separate dark fibres, will be more cost effective, have higher key rates and be more robust

But this is a significant undertaking

So we need the early bespoke experience before embarking on something of this scale

Sat QKD stations



QKD 'Core'

Minimise QKD trusted nodes / maximise distance between them

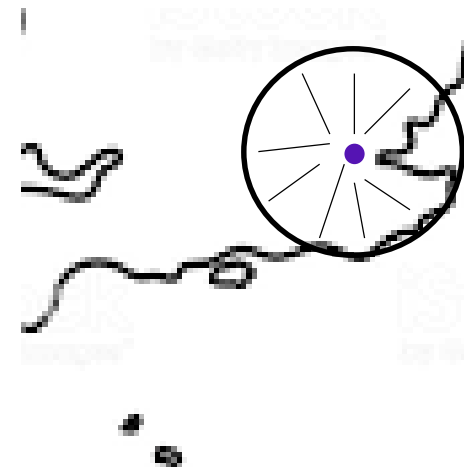
Co-locate with major cities where possible

Resilient routes where possible

QKD 'Metro'

What architecture?
Star / ring etc?

Different technology? E.g. cheaper QKD / integrated photonics?



Standards in quantum – where and when are they needed?

Quantum in in a highly innovative phase – differentiation leads to huge benefits.

Standardising everything TOO EARLY would be a mistake

How would we know WHAT to standardise?

We might inadvertently rule out a transformational technology

Multiple standards compete to standardise too early and I doubt quantum is ready in general for this

Interoperability can be both good and bad

Direct OPTICAL interop is VERY hard even for classical systems (starting to see 'standards' – e.g. OPENROADM – but usually applied to less challenging networks)

Component level standardisation should be ' proceed with caution' – e.g. single photon transmitters are still in a deep innovation cycle

But common INTERFACES potentially help everyone – e.g. helps start-ups with novel devices

Areas where standards could help

Improved optical filters with high out-of-band isolation

Improved attenuation / reflection characteristics for all components (dBs are precious!)

Interfaces for components, sub-systems, QKD boxes (e.g. QRNG) – standardised quantum APIs

Assurance, accreditation etc

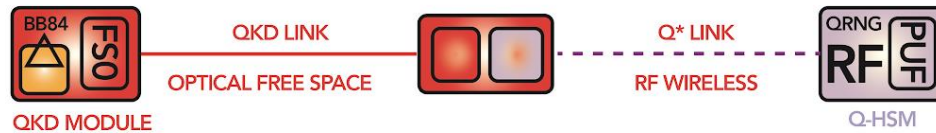
AIRQKD – BT-led Innovate UK ISCF project

AIRQKD

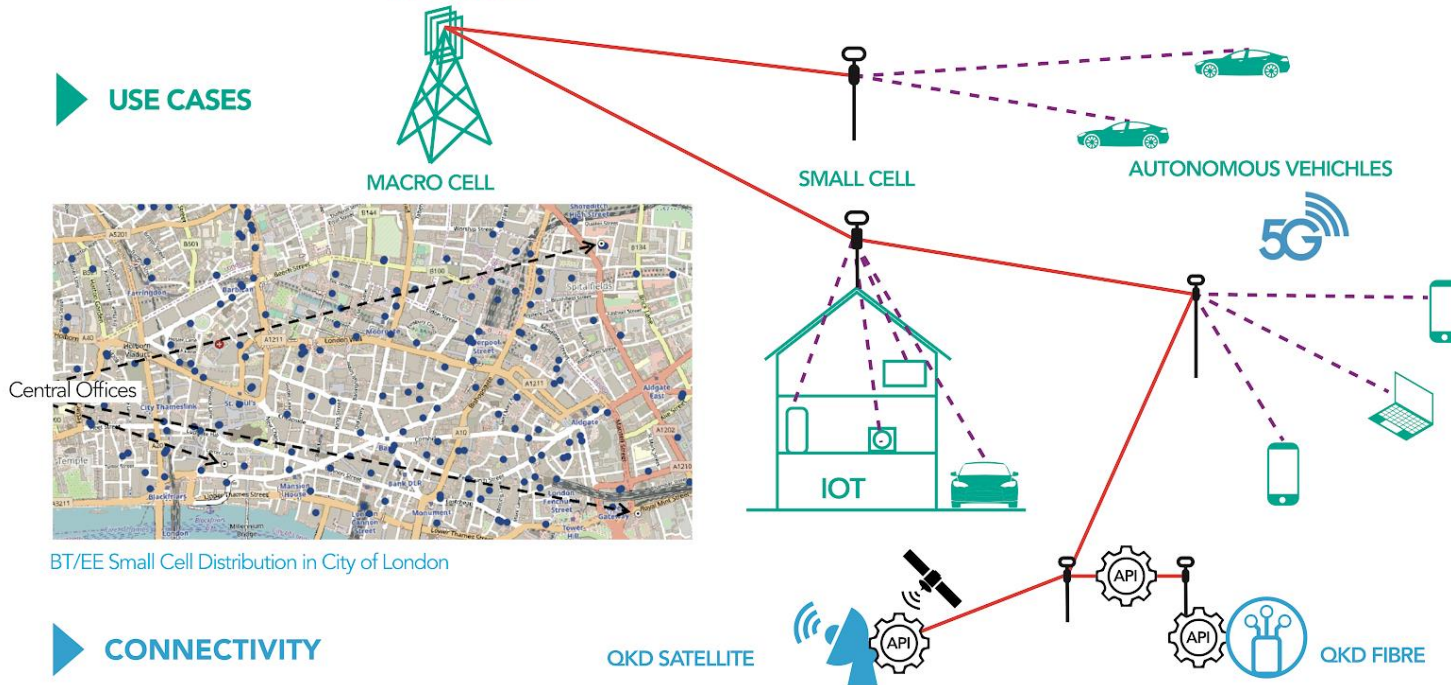
QUANTUM COMPONENTS



SYSTEMS



USE CASES



CONNECTIVITY

- Free Space Optics provides high bandwidths (100G) over ~100m
- Best used for static pt-pt connectivity
- Ease of access to hackers requires high security such as QKD
- Potentially 10,000s links – prohibitively expensive for fibre (which is already committed to residential access)
- AIRQKD provides key innovation at component, system and application layers
- And E2E, all-UK solution for 5G and associated networks

Conclusions

QKD making a great deal of progress

Industrialisation of QKD is an active topic with fully commercial solutions now available

But QKD is only one part of the ultimate solution

Next steps are about extension from pt-pt through to network capability

But there is stiff competition from PQC

Network operators may need to take a lead – using QKD to secure the underlying infrastructure

Roadmap through to a quantum internet is a very long one

Meanwhile – there are customers requiring ultimate security which provides QKD with a niche foothold.

