5G, Whitebox and Programmable Networks: Where does optical transport fit?

Andrew Lord (Head of BT Optical Research)
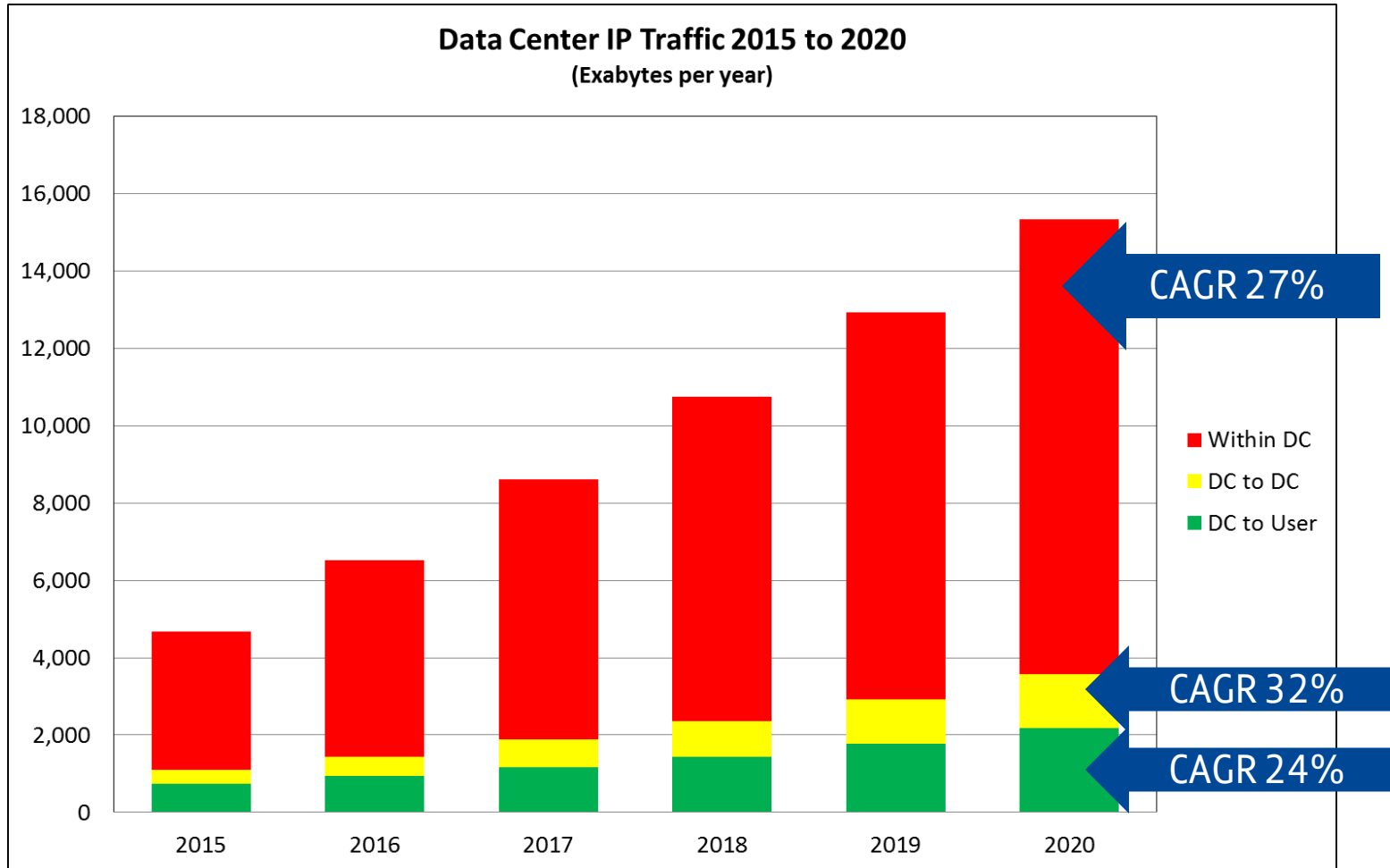
BT

Talk Outline

- 5G / BT network drivers
- Optical network architectures in the light of 5G
- Whitebox
- Conclusions

- Acknowledgements
  - My BT team
  - Metro-Haul EU project partners

Inter/Intra data centre traffic

Data Center IP Traffic 2015 to 2020
(Exabytes per year)

CAGR 27%

CAGR 32%

CAGR 24%

Within DC
DC to DC
DC to User

Source: Cisco CGI, 2015-2020

5G PPP published KPIs and Use Cases

- 1000 times higher mobile data volume per geographical area
- 10 to 100 times higher typical user data rate
- 10 times lower energy consumption
- End to end latency < 1ms
- Scalable management framework enabling fast deployment of novel applications
- Reduction of the network management OPEX by at least 20% compared to today

https://5g-ppp.eu/kpis/
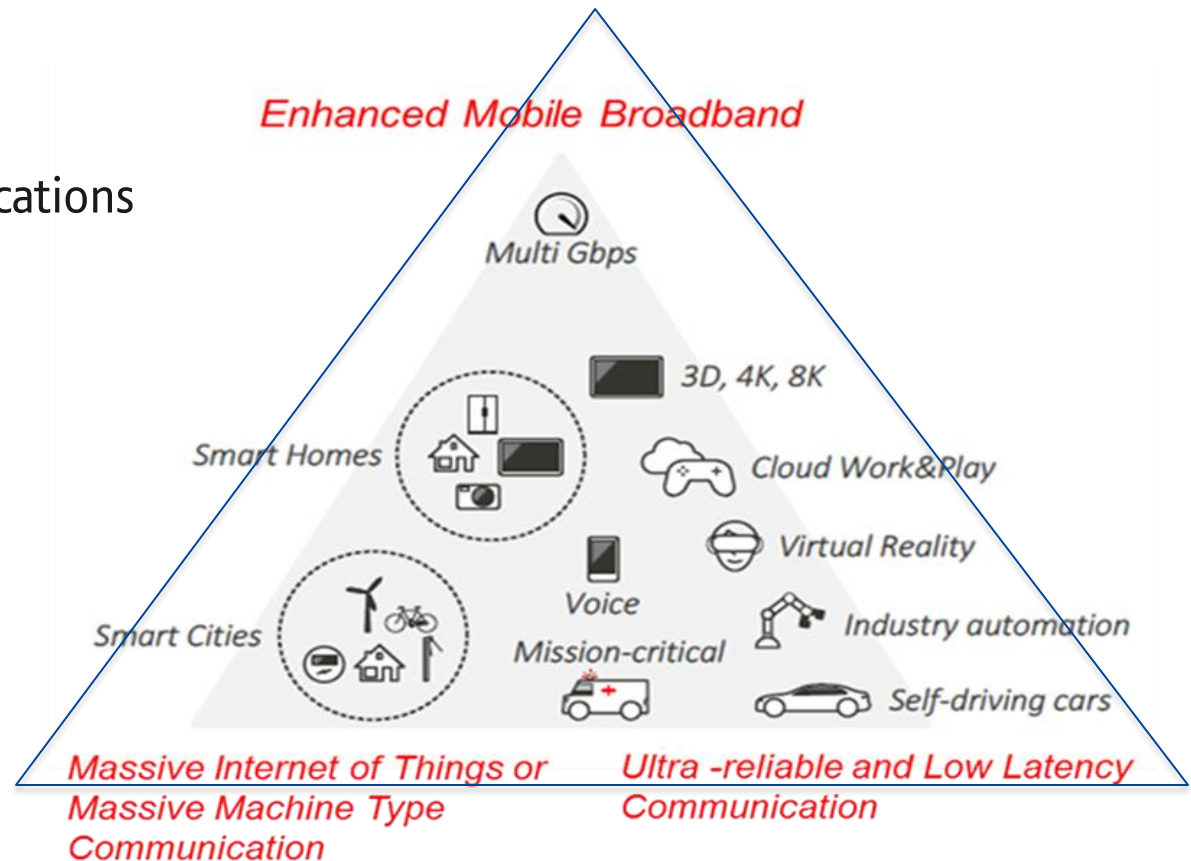
Metro-Haul architecture and scope
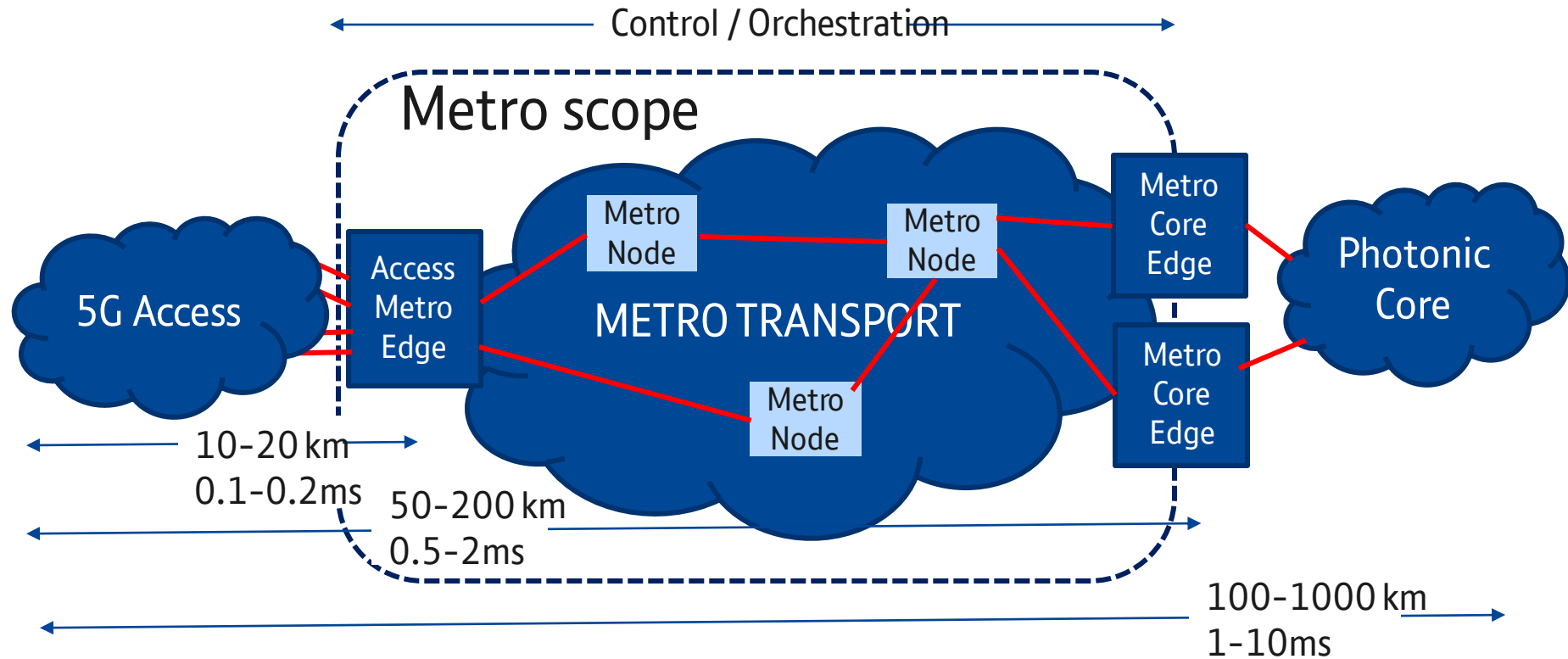
Access Metro Edge Node (AMEN) – multiple ubiquitous access technologies, cloud enabled (storage, compute)

Metro Transport Network – metro node: pure transport

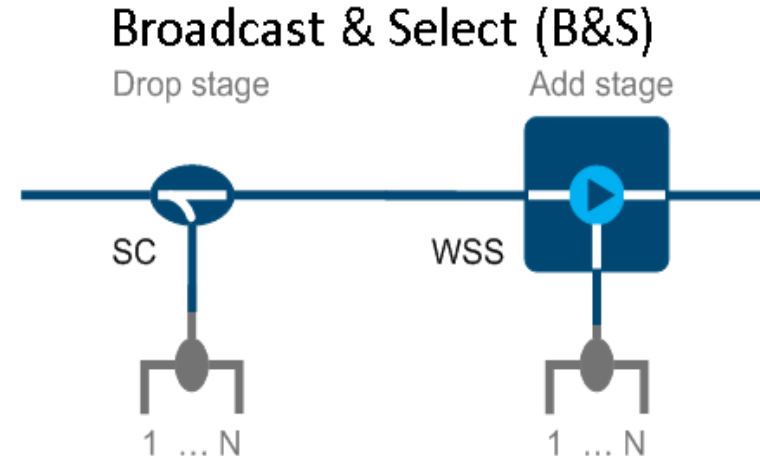**Metro Core Edge Node (MCEN)** – Larger cloud capabilities
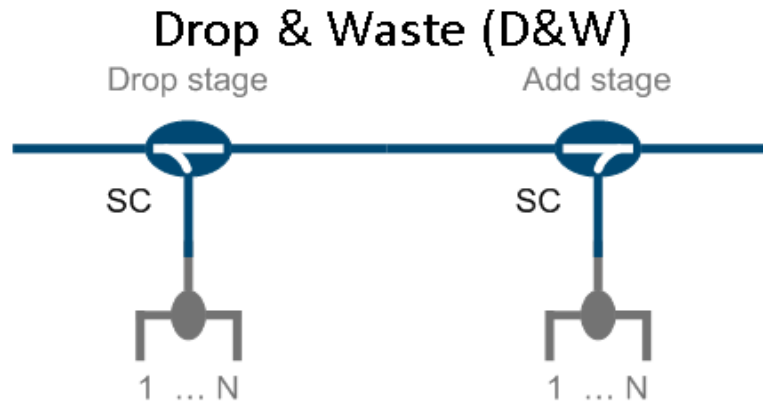
Metro Control Plane – full orchestration

Metro networks – ripe for innovation

- Vast numbers of femtocells needed to provide future 5G bandwidth
- Backhaul = deep fibre
  - Potentially hundreds of 10G + circuits over shortish range (20km typical)
- Requirements will be
  - Ultra cost effective optical transport
  - Short reach DWDM
  - Some dynamic / optical switching capability
- Existing WSS ROADMs too expensive
- Recent research starting to focus on this critical area
  - PON-based technology?
  - New modulation schemes – PAM4 and others – focused on chromatic dispersion tolerance
  - Novel optical filters
  - Filtered and filterless (and hybrid) networks
  - Fixed vs tunable lasers? G.Metro?

But we will need v low cost, short range, flexible high speed DWDM

Types of metro optical network

- Main requirement here is **very low cost** 10G-25G WDM with limited reach (<50km) and some switching. Low cost coherent 100G transport also needs deep research.
- Architecture
  - Meshed, chains, horse shoes…
  - Traffic flows expected to be hubbed from the Access Metro Nodes to the Metro Core node
  - Resilience – increased streamed traffic likely to mean increased resilience requirements
- Flexibility – optical switching technology
  - Considerable attention to filterless network architectures – requiring coherent transmission
  - Fixed filter approaches AWG etc) or cost effective WSS filters with some flexibility
  - C+L band

Drop & Waste (D&W)

Drop stage   Add stage

SC   SC

1 … N   1 … N

Broadcast & Select (B&S)

Drop stage   Add stage

SC   WSS

1 … N   1 … N

Integrated silicon photonics

- **Ericsson technology**
- Integration onto chips will enable huge cost reduction
- Performance doesn't have to match LCoS-based WSS
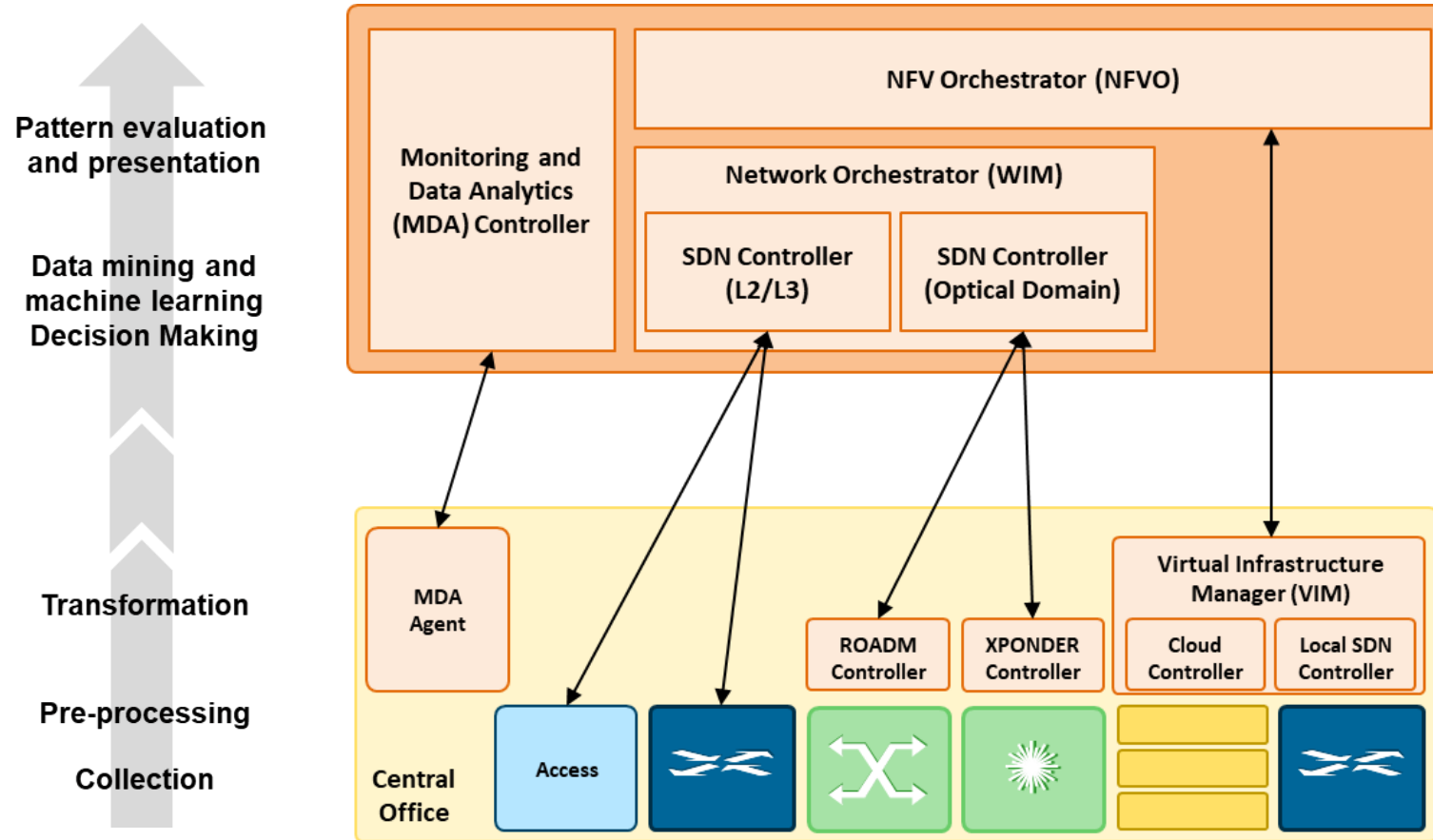- 200 mm wafer realization
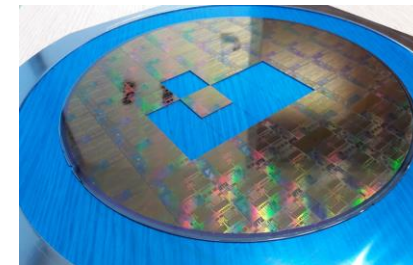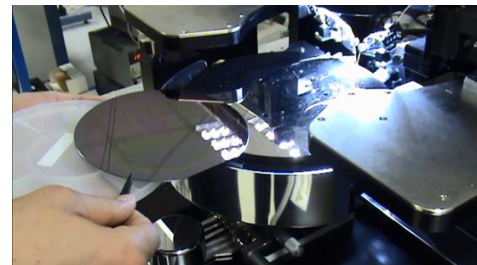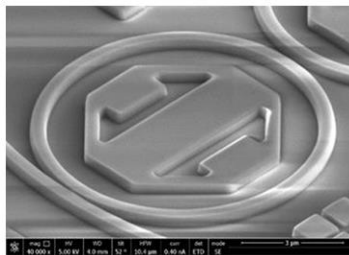
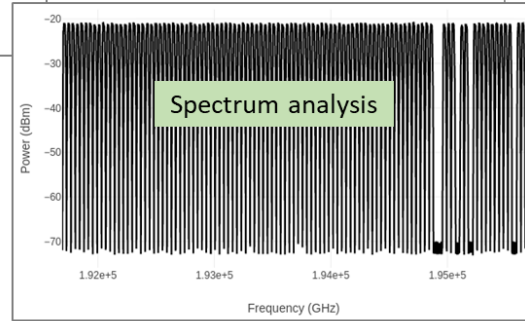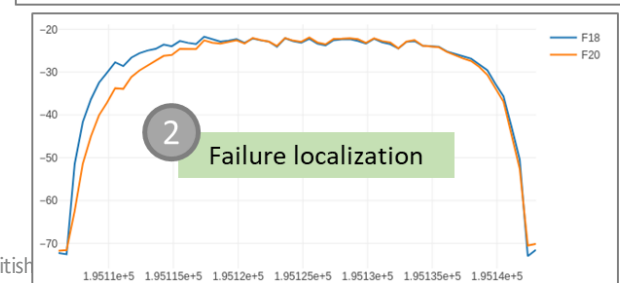With CNIT...turned into a **whitebox** optical switch allowing fast open innovation

4,5 cm x **4,5 cm**
packaging

10 mm

8 mm
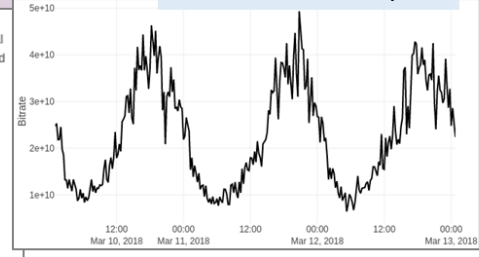
Conceptual COM Architecture
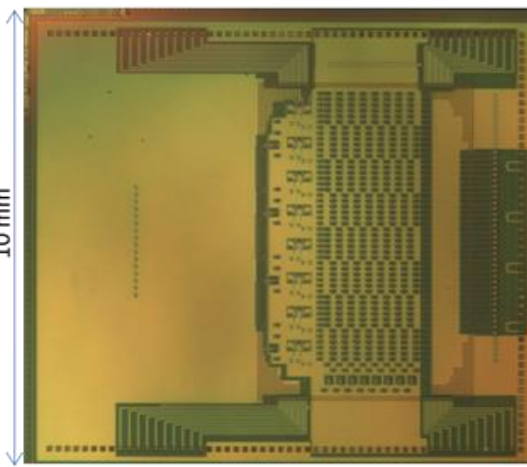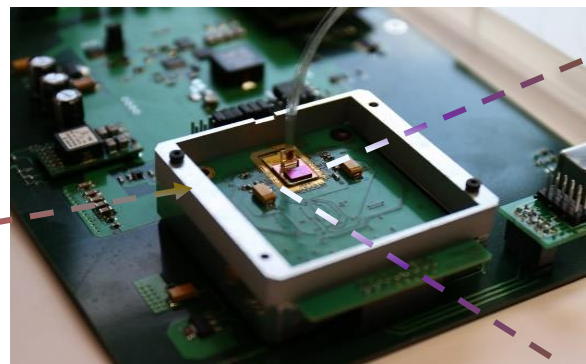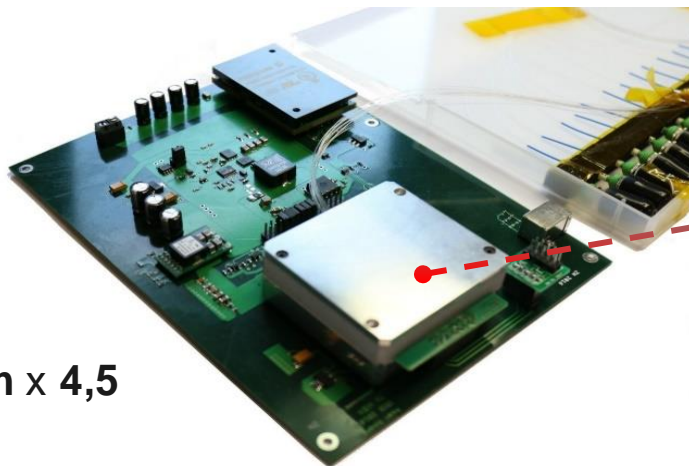
- **MDA agent** collects monitoring data from all the different sources, process them locally and conveys data to the MDA controller.
- **COM** = Control, Orchestration and Management

Typical results

1. Traffic projection for Planning purposes
2. Failure localization
3. BER analysis for failure root cause identification

MPLS Traffic analysis

Spectrum analysis

Failure localization
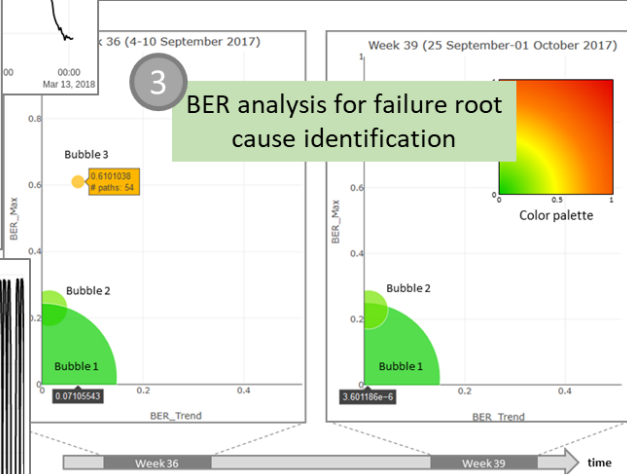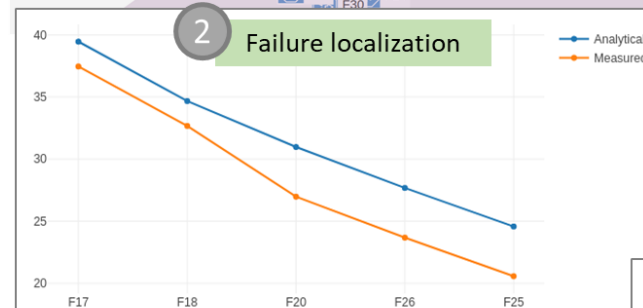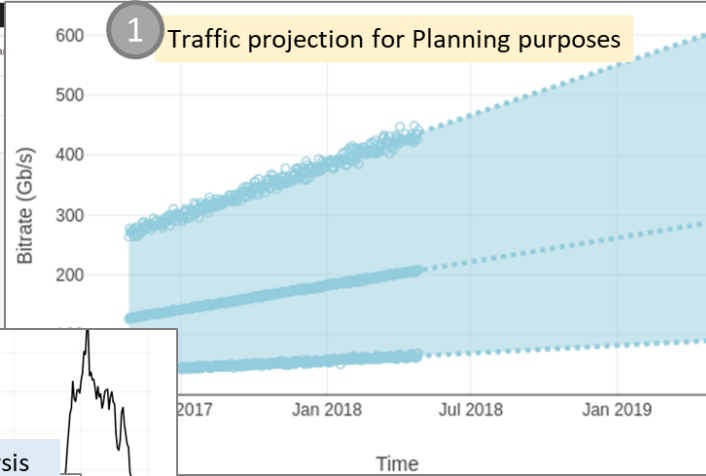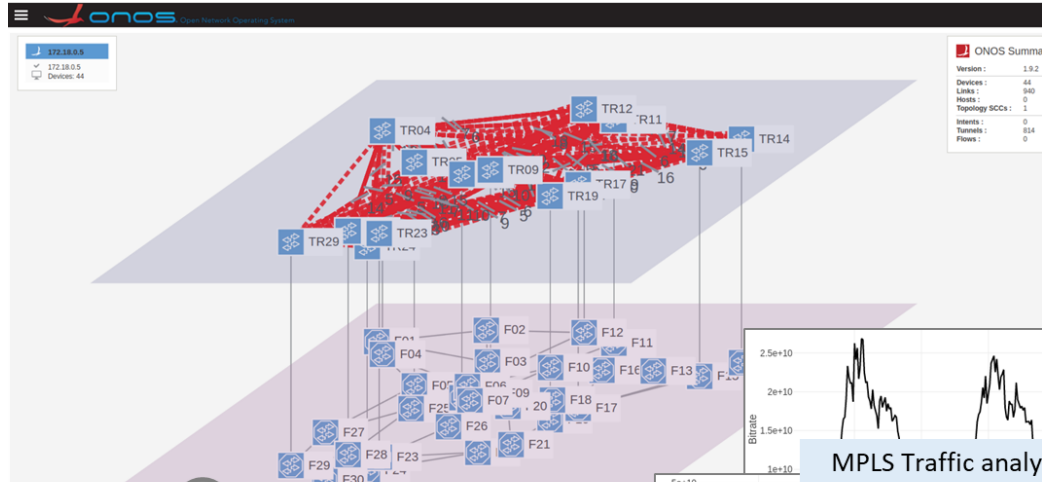
Machine Learning?

- Huge current hype around this subject

- Concept relates to huge, unpredictable data sets

- Networks have potentially hundreds of nodes, each generating a huge amount of monitoring data

  - Every optical and electrical component on every board

  - Every sub-system, transceiver, EDFA, WSS...

  - Every network component, equipment card, rack, shelf...

- Can all this data be harnessed together to analyse and predict overall network performance

- Potentially TOO much data for a 'linear' analysis ?

- Machine Learning could assist in optimising performance and providing warnings of future problems

- Issues –

  - Is there sufficient data for the ML algorithm to learn?

  - Is the data available from the DCN control that manages the network

  - If the algorithm makes a wrong prediction, that might be catastrophic for a Carrier Class network

  - Vendors don't have networks to trial the algorithms they have developed

  - There is no explanation 'why' a specific decision is arrived at

Area needs some careful analysis to see if conventional 'linear' analysis isn't sufficient

Conclusions

- Continued bandwidth growth means continued pressure on optical networks
- Focus moved discernibly from core to metro – though both need attention
- 5G requires radical changes to metro networks
  - Intelligence to handle KPIs
  - Dynamic capability
  - Extended monitoring
  - Deep fibre – cost effective transport
  - Power and space challenges are huge
  - Whitebox could definitely have a role in the metro
- Core
  - C band close to exhaustion (will fill up too quickly)
  - Growing interest in multiple bands (eg. Where fibre is exhausted)
  - Multicore a much longer term option

THANK YOU