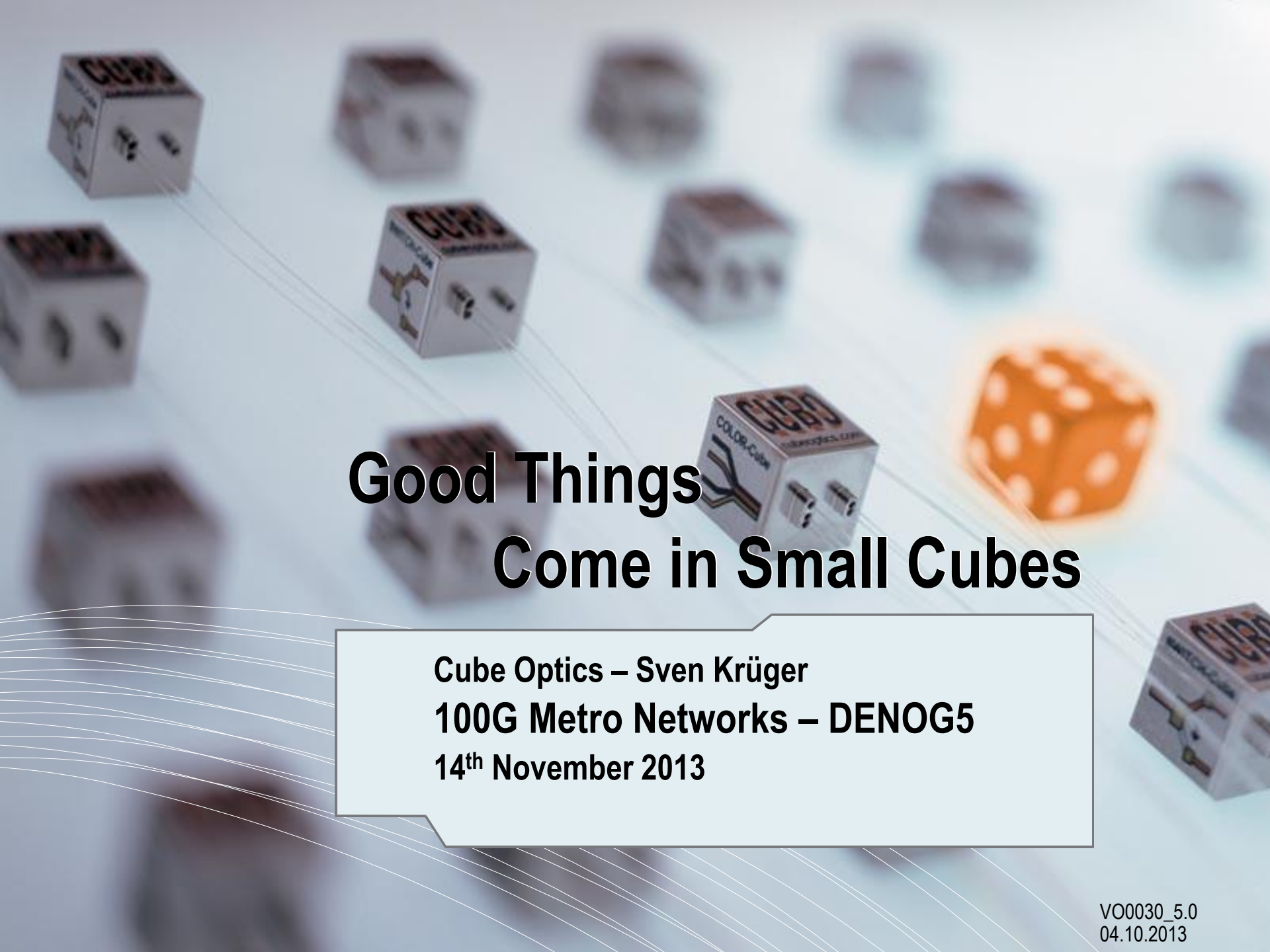


Good Things Come in Small Cubes

Cube Optics – Sven Krüger

100G Metro Networks – DENOG5

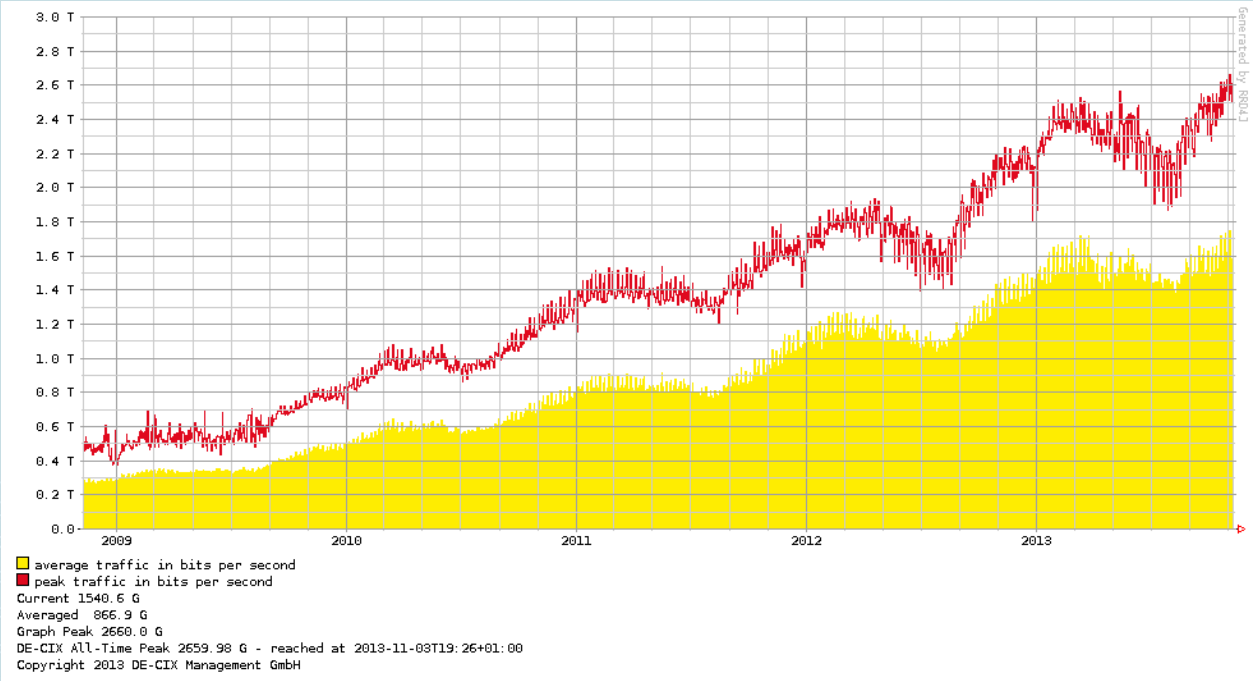
14th November 2013

VO0030_5.0
04.10.2013

Why 100G in Metro?

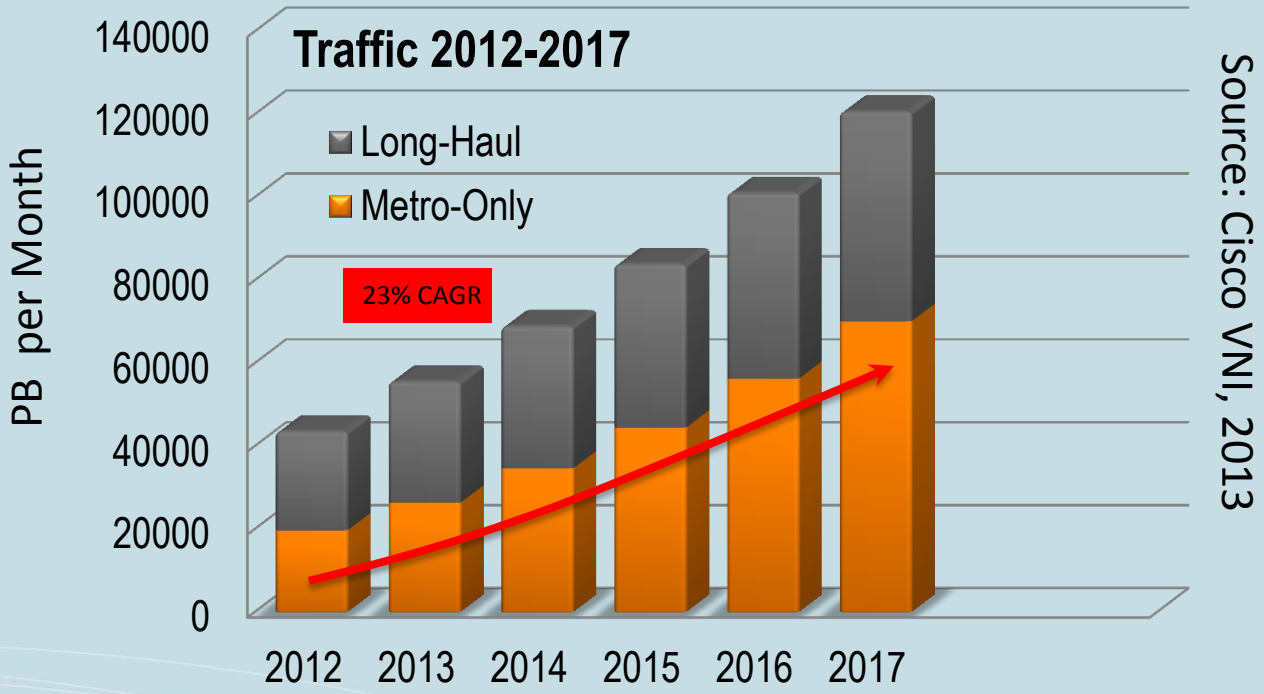
Data / IP Traffic grows and grows and grows…

- E.g. Peering inside at DE-CIX grew ca. 6x in past 4y



- Not only in DC's or WAN but every part of the network, especially Metro Networks traffic is growing..

Metro traffic to grow 3x over next 5 years…



- Metro-only traffic will surpass long-haul traffic in 2014.
- Metro-only traffic will grow nearly twice as fast as long-haul traffic from 2012 to 2017.
- If you have a 40-channel 10G DWDM system filled at 50% capacity (= 200 Gbps) today, you will need to upgrade that system in the next two years

Is 100Gbps Today's Solution for Everything?

- NO! It depends…
- 100G price / bps is still (and will be for some time) higher than at 1G/10G
  - E.g. 100GBase-LR4 roughly 100x 10GBase-LR pricing ("only" ca. 40x at DWDM)
  - Higher complexity of 100G transport may add further cost (e.g. DCUs etc)
- So when does it make sense today / nearer term future?
- Andrew Schmitt from Infonetics, October 2013:
  "*It is only used (today) when service providers must use it, which means 1 of 2 situations:*
  - *insufficient fiber (and WDM) capacity to deploy more 10G traffic*
  - *a 100G private line service that needs to be delivered—a 100G router port that must be sent across the metro* "

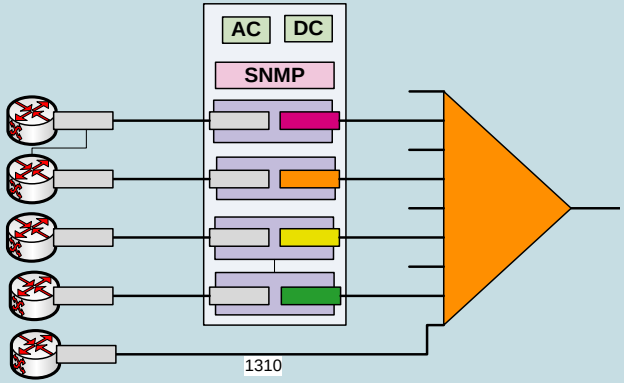
If You Need 100G Metro – Which Form is Best?

- **2 Different Transport Means:**
  - Active versus Passive Transport
- **Competing transceiver / transponder technologies:**
  - Coherent versus Direct Detection

Active vs. Passive Transport

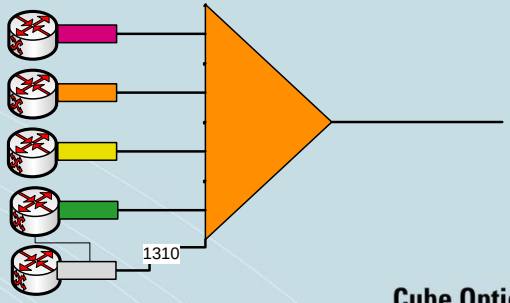
Active Transport:

- Conversion from client (“grey transceivers”) to line (“colored transceivers”) signals by transponder cards
- Requires additional hardware: transponder cards, power supplies, management cards (+ software)
- 3x amount of transceivers required



Passive Transport – ca. 50% lower CAPEX & OPEX:

- No conversion, transport transceivers are plugged straight into terminal equipment
- Less active elements => higher reliability, less latency
- Transceivers are managed by terminal equipment (Switch, Router, etc.)



Coherent vs. Direct Detection (Pluggables)

Coherent:

- Developed for Ultra-Long Haul, adaption for metro
- Complex phase & amp modulation, hence less less sensitive to CD & PMD so wider reach
- 1 lambda per 100G used
- NOT available as pluggable, “street” availability not before 2016 (cost remains a BIG challenge)

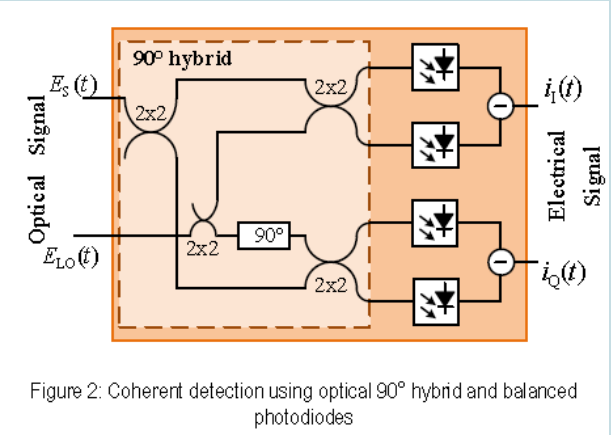
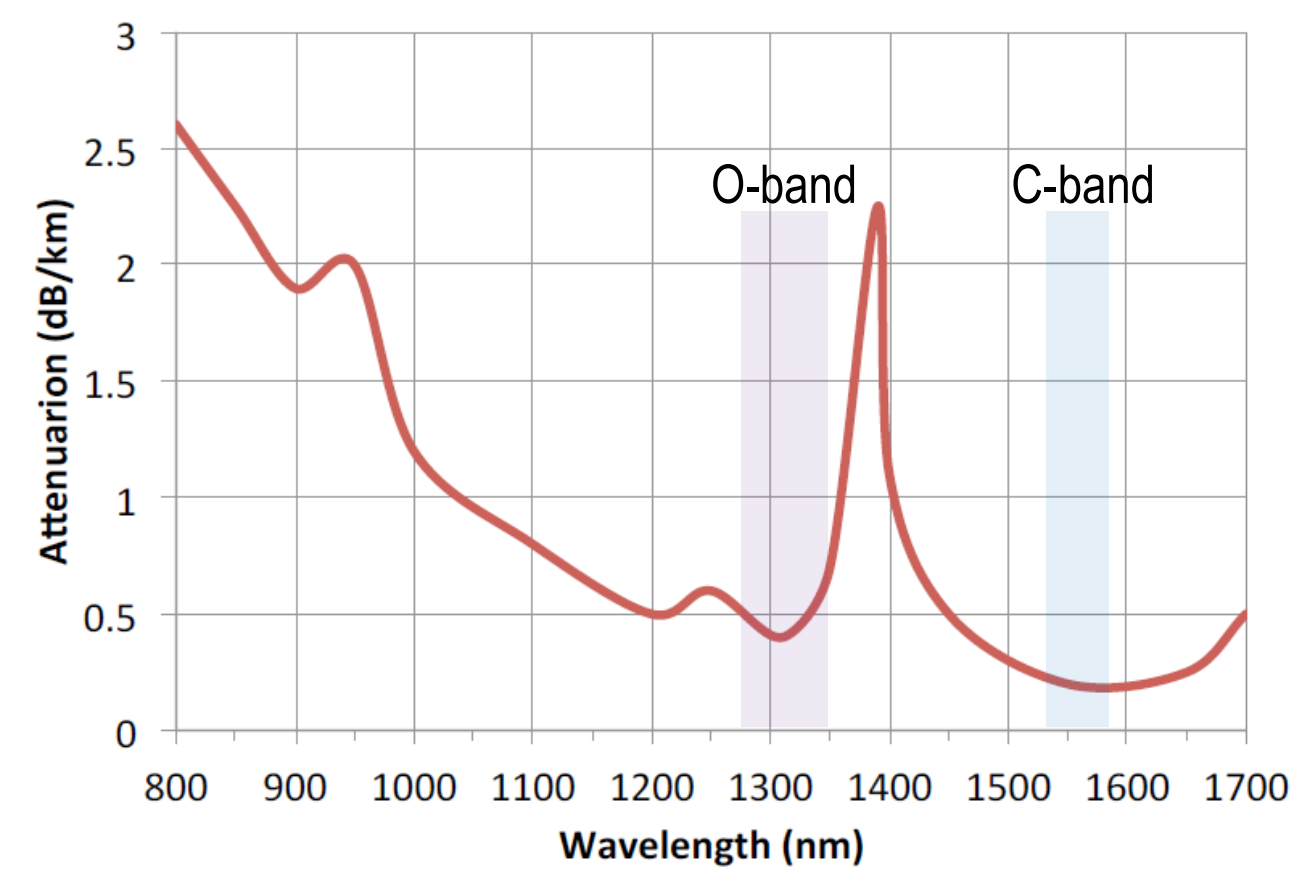


Figure 2: Coherent detection using optical 90° hybrid and balanced photodiodes

Direct Detection

- Emerging from LR/ER (10-40km) Datacom
- Based on simpler PDs, reach limited by CD & PMD
- 4 lambdas per 100G used
- Produced by >5 module makers in 100Ks since 2011

Transmission Window



100G Passive Metro Network Architectures

	100G in O Band		100G in C Band	
	Single Circuit 100G	10G DWM + 100G overlay	10G DWDM + 100G DWDM overlay	100G DWDM
Maximum capacity	**100 Gbps** (= 1*100G)	**500 Gbps** (= 1*100G+40*10G)	**1.6 Tbps** (=12*4*25G+40*10G)	**2.4 Tbps** (= 24*4*25G)
Number of wavelengths	1	41	88	96
Number of transceivers	1	41 (1*100G, 40*10G)	52 (12*100G, 40x 10G)	24 (24*100G)
Maximum distance	10 kms (no amp) Up to 80 kms (SOA)	<10 kms (no amp) Up to 80 kms (SOA)	~10 kms (no amp) 10-100 kms (EDFA)	~10 kms (no amp) 10-100 kms (EDFA)
Typical transceiver	CFP 100GBASE-LR4	CFP 100GBASE-LR4	CFP DWDM (direct detect)	CFP DWDM (direct detect)

Single Circuit 100G over O-band

Requirements:

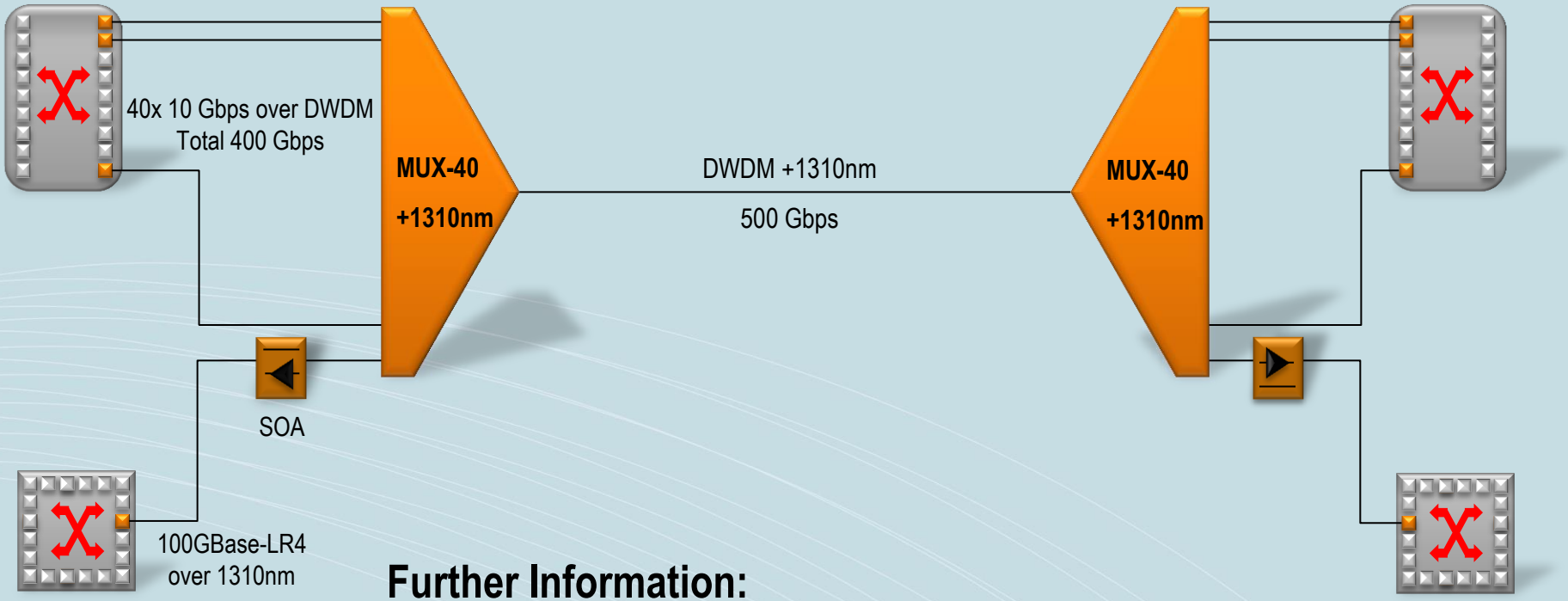
- 100GBase-LR4 transceiver module
  - Transports 4x25Gbps via integrated optical 4 channel (de)mux
  - One single mode duplex fiber
  - SC/PC connectors for SMF fiber pair
  - Reach < 10km

- *SOA Semiconductor Optical Amplifier*
  - Extends the reach of 100GBase-LR4 transceivers up to 80km
  - Very good BER of 10^{-16} at >50km

Powering ca. 50x 100G links in European and US metro regions, e.g. at AMSIX, NETNOD

Overlaying 10G DWDM with 100G (O-Band)

- Up to 40 DWDM channels at 10G - Additional 100G link over 1310nm O-Band
- Optional 100G LR4 reach extension via SOA
- Up to 500Gbps per fiber pair



Further Information:

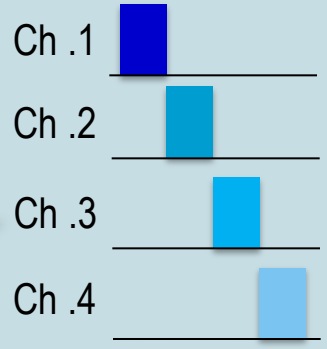
http://www.cubeoptics.com/evolution1310

Cube Optics AG

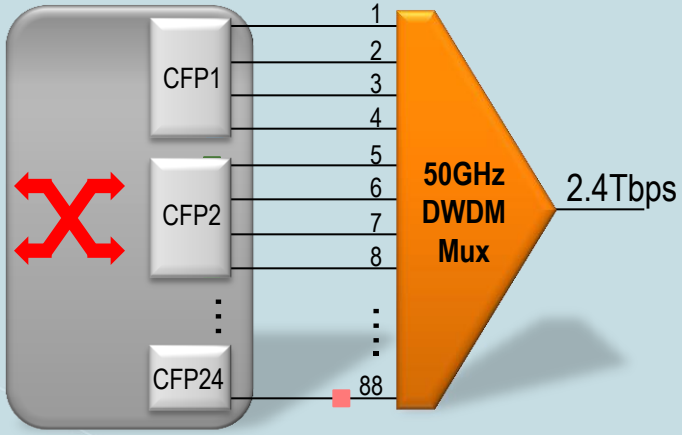
100G DWDM over C-band

Requirements:

- *100Gbps DWDM CFP transceiver module*
  - Transports 4x25Gbps.
  - Four single mode duplex fibers.
  - Employs 4 tunable lasers in the 50GHz ITU-T channel grid (DWDM) and 4 receivers.



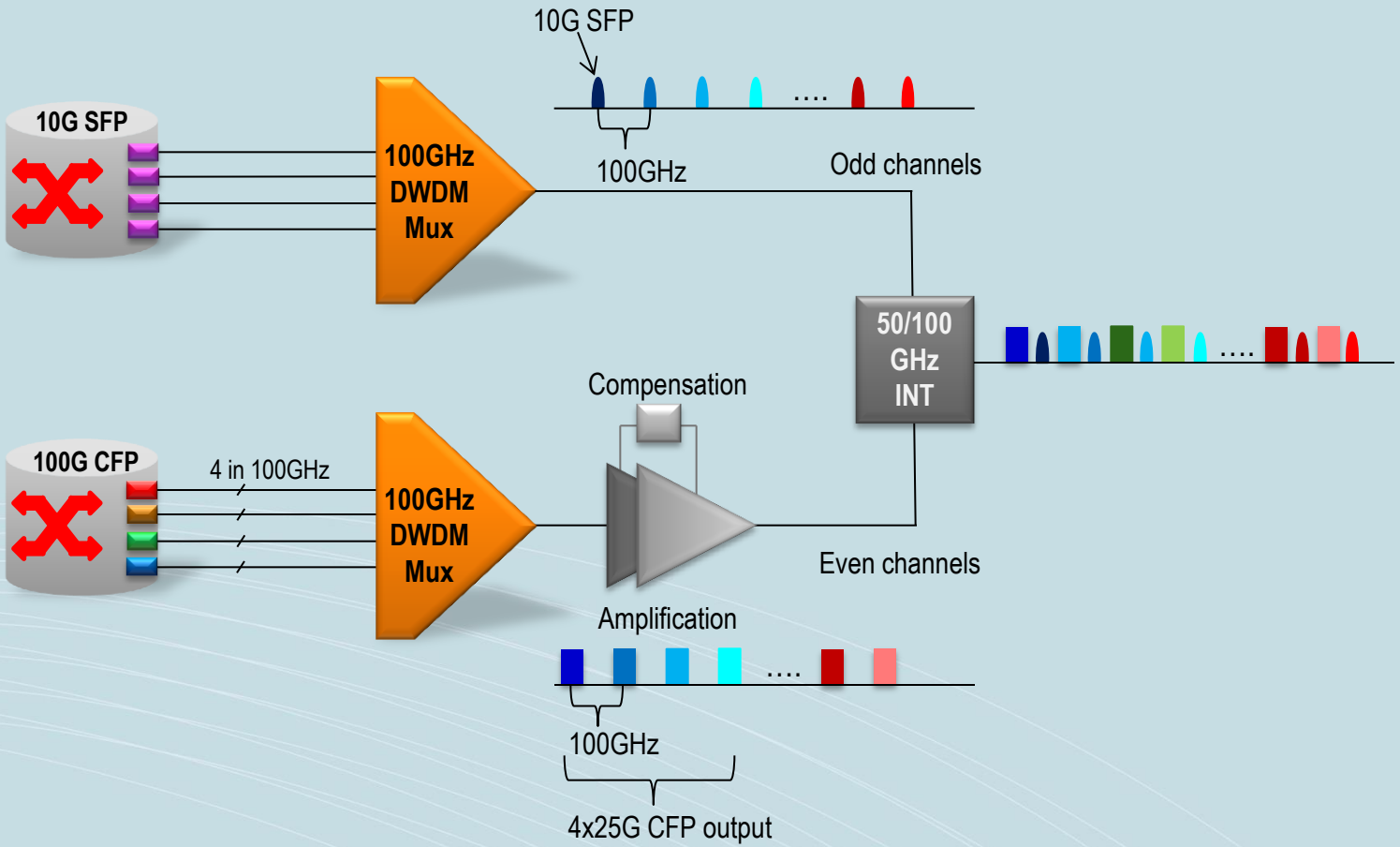
- *96 Channel DWDM multiplexers/demultiplexers*
  - Passive DWDM mux/demux with 50GHz grid over a single mode fiber pair.
  - Up to 24 "differently colored" 100Gbps DWDM CFP transceivers can be transported via a 96 channel MUX



- Reach extendable with standard, stand-alone ***EDFA***s to >100kms

Overlaying 10G DWDM with 100G (C-Band)

- Complementing the existing 10Gbps DWDM system with 100Gbps upgrades



Field proven for >60km reach, first deployments in Nov.13!

Conclusion

- 100Gbps is still not making sense for all Metro connections but has become a valid solution for fiber constraint areas and native 100G port transport
- 100Gbps Passive Transport has become a powerful, simple and low(er) cost alternative to NEM based Active Transport Solutions

- Coherent Pluggables may become a good alternative to Direct Detect Pluggables, but realistically not deployable before 2016

Further Information: http://www.cubeoptics.com/evolution1550

Contact us!

We look forward to providing you with further information.

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