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OFC 2015: Market Watch session

Session: Reality Check on Maturity of Metro 100G and Beyond

Tuesday March 24th, 2015

The high capacity metro network: *Transport requirements and the implications on next generation modems*

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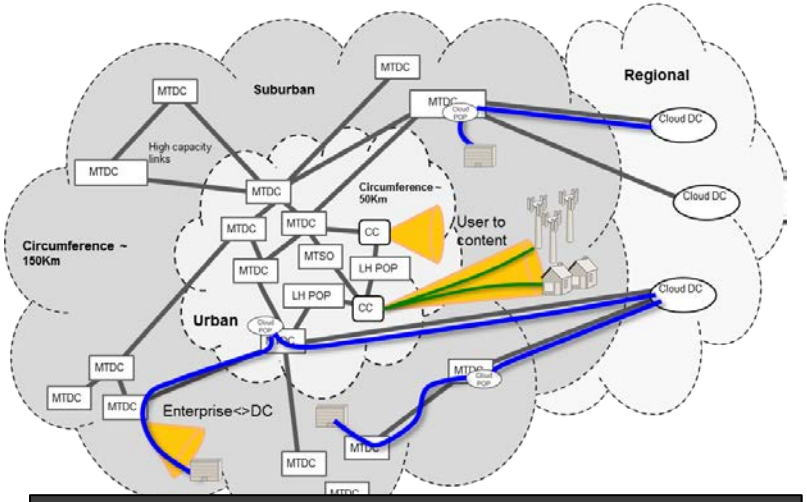
Outline

Agenda

1. Metro network characterization
2. Evaluation of 100G modems against metro characteristics
3. Implications of coherent deployment modem on legacy lines
4. Optimizing the infrastructure for next generation modems
5. Conclusions

Metro Characterization: Demands

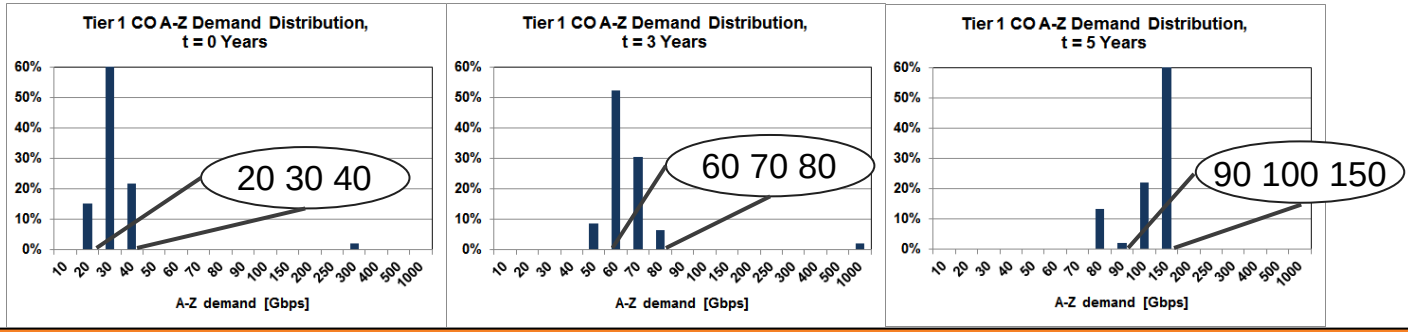
- **Video, cloud access, and data center networking drives large traffic growth in Metro – typically ~35% per year**
- **Services continue to be delivered to the Optical Transport Systems (OTS) at 10G and below – which is expected for some time to come**
- **Impact**
  - → 10G waves are exhausting capacity in metro networks: **Forward looking expansion needed now**
  - → Installing new bandwidth in 10G increments requires excessive manual network operations: **Higher line bandwidth granularity is required**



Empirical Reference Model

Composite model built from learnings of Ciena network studies and designs, with knowledge gained from the metro applications of thousands of delivered circuit packs

Enables detailed understanding of metro transport topology and capacities



Today numerous Tier 1 CO A-Z require 100G interconnection
In 2-3 years the majority of the Tier1 CO A-Z are 100G candidates
In 5 years, all of the Tier 1 A-Z are 100G candidates

Metro Characterization: Topology

Mainly G.652 fibre in USA with typical loss > 0.3dB/Km

- → Several patch panels commonplace in optical path

PMD can be challenging for IM-DD system

From the model, most metro A-Z distances below 150/300Km

- → Advantageous to cover 600/1000Km inter-city distances using a common technology

Lines have intensive ingress/egress

- → **>**10 Ingress/Egress points traversed per A-Z
- → Legacy case: Coloured mux/demux with gridded 50GHz (100GHz) ROADM
- → New build: Colour-less mux/demux with flexible grid ROADM

IM-DD interferers

- → Widespread 10G IM-DD present on lines

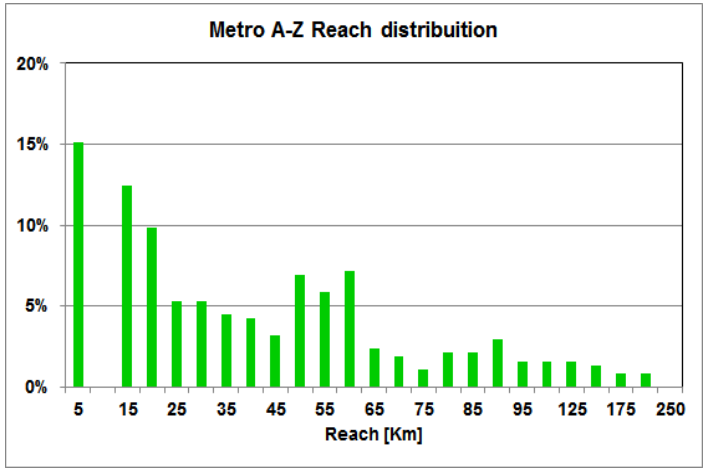
Optical dispersion management with DCM

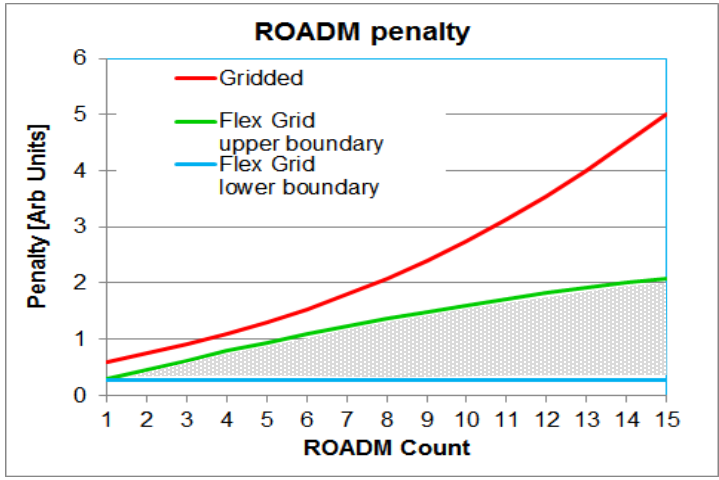
- → 100% compensation map commonplace

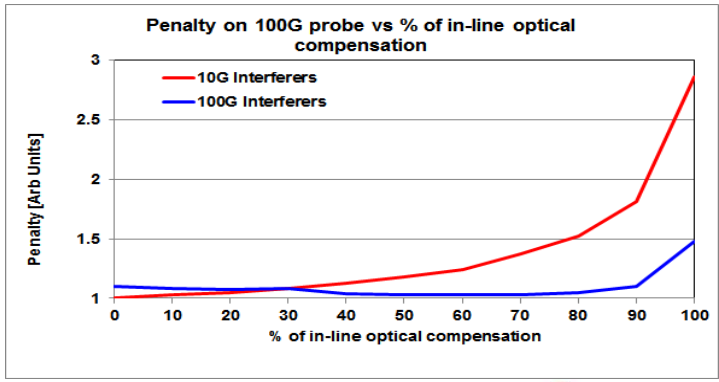
Challenge to coherent systems

Rehabilitation required for coherent system deployment

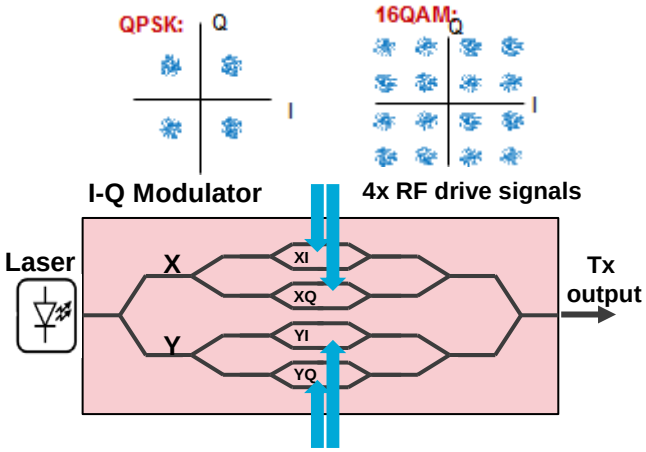
Which 100G modulation techniques are able to improve on current 10G OTS ?

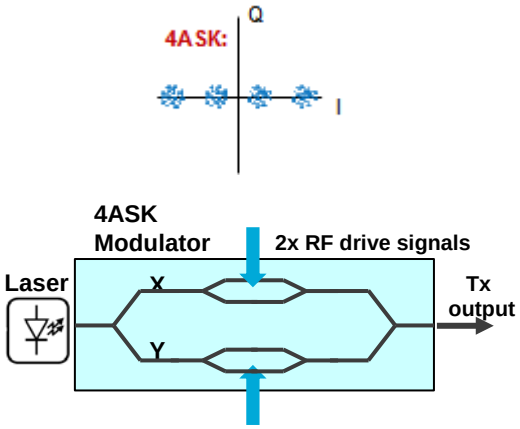


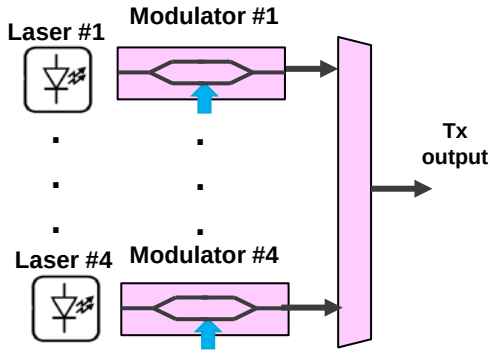




100G Modulation Candidates for Metro







Key infrastructure attributes	2 Pol Coherent QPSK / 16QAM	2 Pol Coherent 4ASK	4X28G Duo-Binary DWDM λ's
Spectral efficiency and system capacity Application coverage	SE ≥ 2B/S/Hz (≥4B/S/Hz) System capacity ≥8T (≥16T) All Metro, inter-city and regional	SE = ≥2 B/S/Hz System capacity ≥8T All Metro, inter-city	SE = 1 B/S/Hz System capacity ~ 4T Partial coverage of metro
Deployability	Full Electronic compensation of CD and PMD Colour-less and Flexible grid compatible	Full Electronic compensation of CD and PMD Colour-less and Flexible grid compatible	Optical CD mitigation required for reach > 20Km PMD is an issue Compatible with 100GHz grid
Legacy system compatibility	50GHz grid and ROADM Differential encoding for non-linear noise tolerance	50GHz High tolerance to non-linear noise from 10G IM-DD λ's on compensated links	Less susceptible to legacy system impairments
Suitability	**Can meet and exceed metro/inter-city network requirements**	**Lower cost, lower power suitable for metro with extension to inter-city**	**Limited capacity solution, low SE with added line cost to mitigate CD/PMD**

Impact of Application-Specific Coherent 100G in the Metro

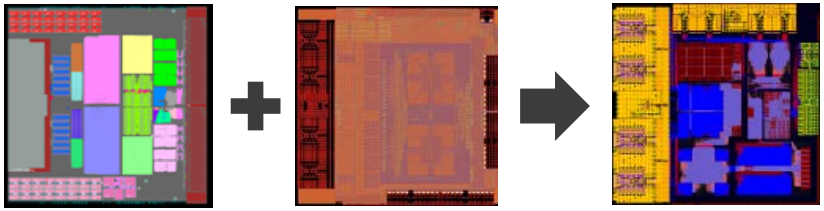
DSP algorithms optimized to meet metro characteristics

Metro focused 100G Coherent modem contributes to power reduction and density improvements

- Coherent 4ASK permits modulator and associated drivers simplification
- Integration of Tx and Rx ASIC
- Application-optimized optical componentry of coherent transceiver

Versatility of design allows for integration in various platforms and evolution to pluggable Coherent optics

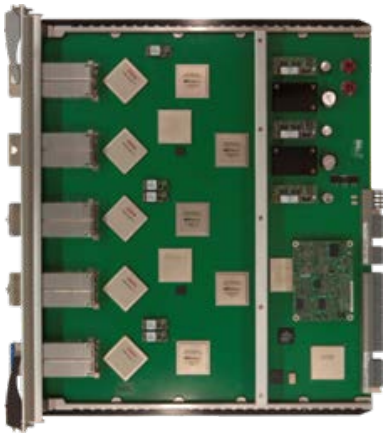
Targeted modem development yields significant system improvements



Metro ASIC

Coherent Rx

CFP2 ACO



Multi-port blade

Practical Considerations for Deployment on Legacy System

Solution Tool box:

Use non-linear noise hardened 100G coherent system

- Easiest to implement

Isolate the coherent modem in spectrum

- Create wavelength gap
- Reduces usable capacity of system

Rehabilitate outside plant to improve compliance to coherent engineering

- Review 10G IM-DD deployment conditions
- Reduce 10G modem count
- Re-deploy 10G services as tributaries on 100G MuxPonder
- DCM removal
- Legacy old ROADM upgrade to Flex grid ones
  - Future proofing

Several optical system upgrade paths are possible

What Constitutes Desirable Evolution Path for Next Generation Modems?

- **Must-haves**
  - Continued improvements in cost per bit for further network cost reduction
  - Readiness to transport higher rate services (Higher = 400G, 1000G)
- **Improvements**
  - Versatility to tailor function to application
  - Simplified planning
  - Compliancy to existing lines

Benefits simpler to achieve using rehabilitated infrastructure

Conclusion

Key Takeaways

1	100G ready today for Metro system deployment (cost effectiveness and performance)
2	Coherent modem mitigates Metro outside plant impairments (CD, PMD), further reducing photonic line cost
3	100G can deliver these benefits on legacy line optimized for 10G IM-DD systems!
4	Optimizing the Metro infrastructure for coherent modems will ease next gen modem technology deployment

Thank You

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