Adtran

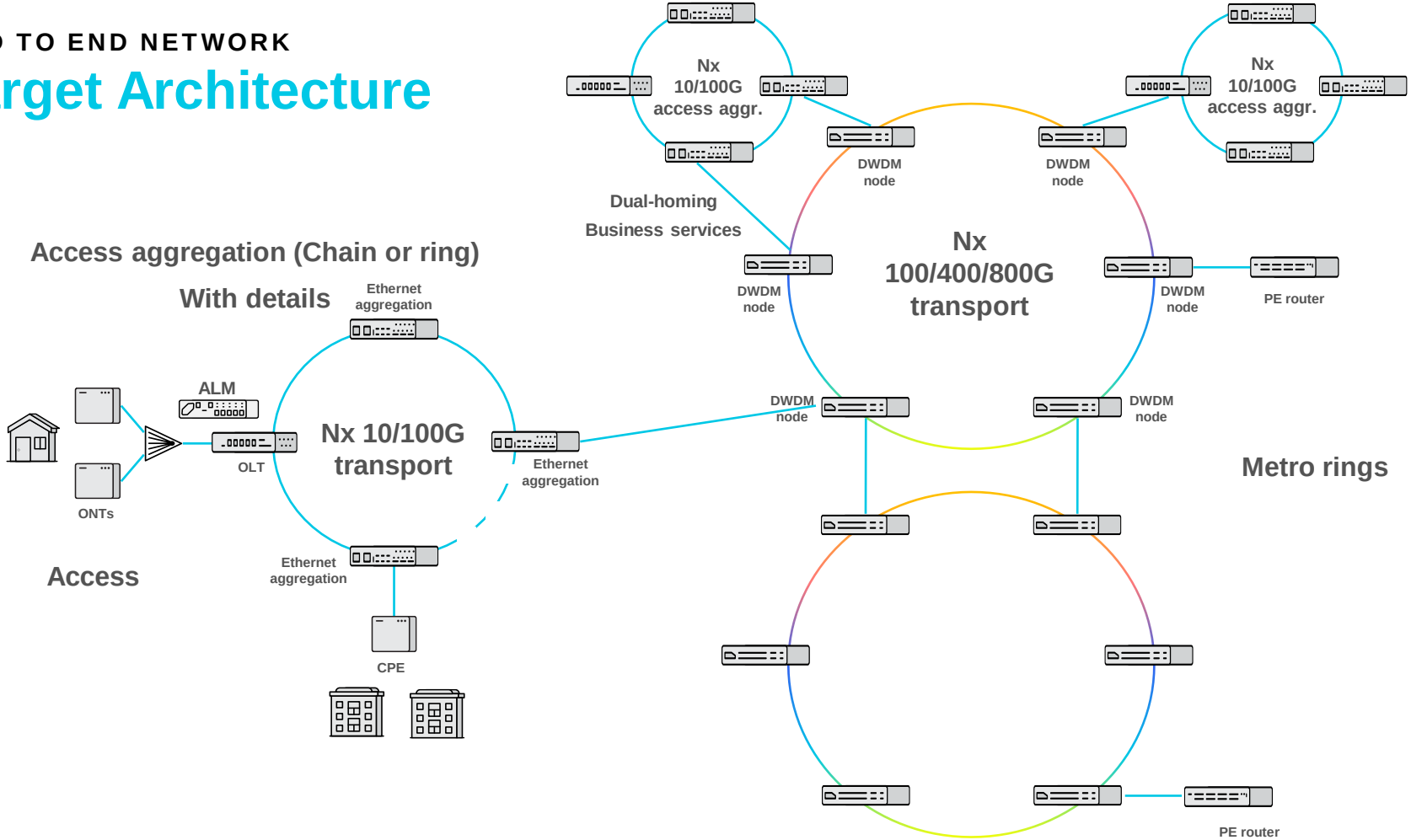
Access/Metro Aggregation

Preparing Aggregation networks for Future growth

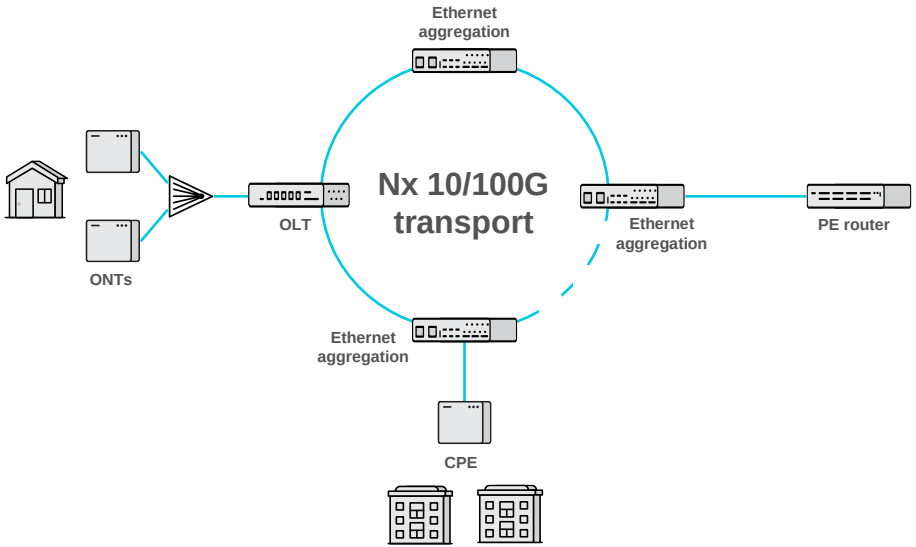
Byren Meintjes

END TO END NETWORK

Target Architecture



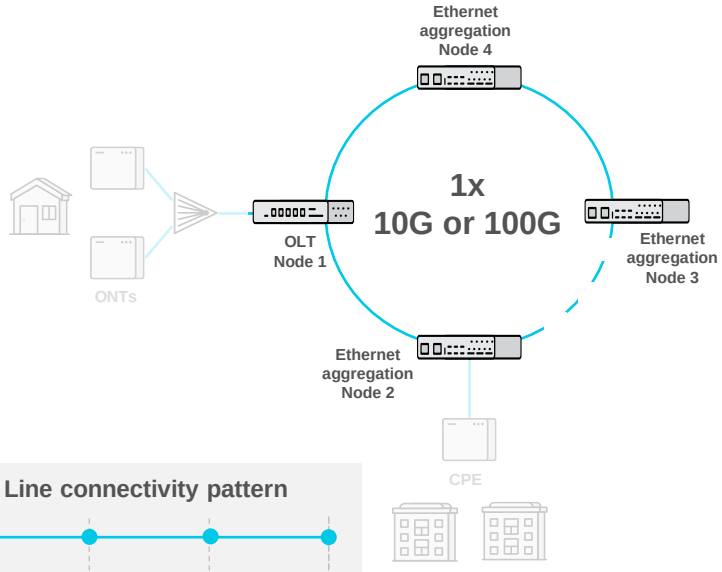
End-to-end SP aggregation network

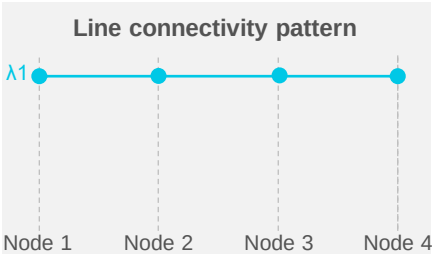


Access

Access aggregation (Chain or ring)

Single wavelength





Fiber consumption

- Dedicated dark fibers

Scalability

- Only 1 channel, either 10G or 100G per fiber
- Only grey optics

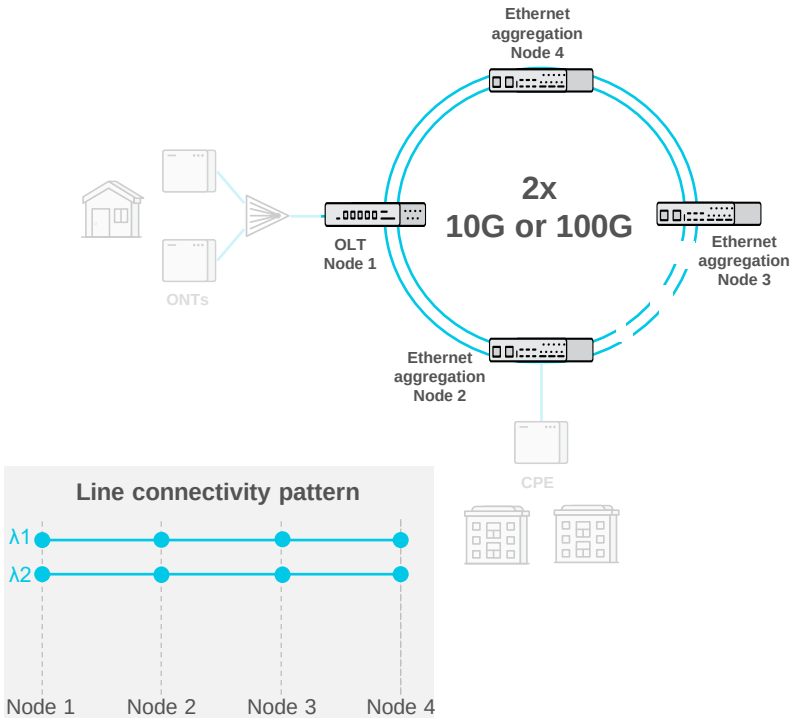
Capacity

- Shared backbone bandwidth
- Statistical capacity aggregation

Cost increment

- No extra optical layer

Two single wavelengths



Fiber consumption

- More dedicated dark fibers
- Adding more channels means adding more fibers

Scalability

- Only 1 channel either 10G or 100G per fiber
- Only grey optics
- Requires additional fiber resources

Capacity

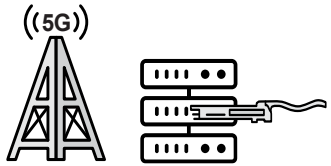
- Shared backbone bandwidth
- Statistical capacity aggregation

Cost increment

- No extra optical layer
- Additional fibers

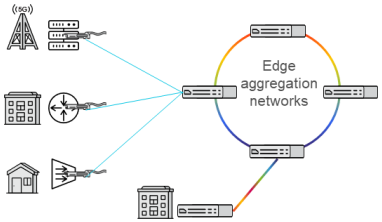
WDM Technologies

O-Band



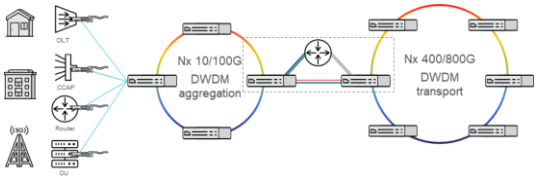
+ Low Cost
+ Built for RAN and 5G Front Haul Access Networks
– Limited Reach
– Low Scaling 16 Channels

CWDM



+ Ease of Setup
+ Access and Aggregation Networks
– Only Direct Detect Optics
– Low Scaling 16 Channels
– Limited Reach (No Amps)

DWDM



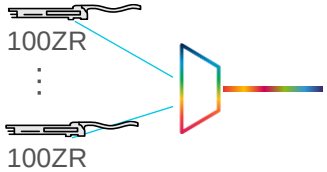
+ Scales to full C-Band
+ Multi Domain Networks
+ Coherent Optics
– Requires precise management

What’s the optimum line system for the optical edge?

Dark fiber

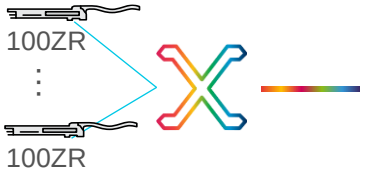
+ Simplest solution without extra equipment
– One fiber pair per service
– Complexity in managing numerous links

FOADM-based



+ One fiber pair (DWDM)
+ Low capex
– Fixed wavelength grid limits maximum baud rate
– Fixed traffic matrix
– On-site, manual provisioning

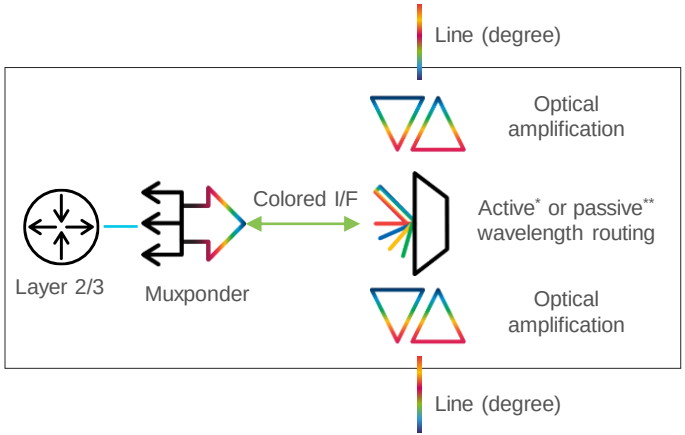
ROADM-based



+ One fiber pair (DWDM)
+ Flexible, reconfigurable
+ For any baud rate
+ Minimum on-site work
– Cost, power and size not ideal for the optical edge

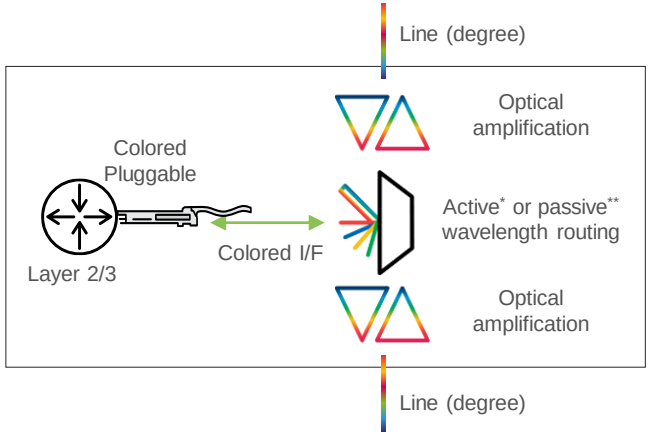
OLD VS NEW

Access WDM

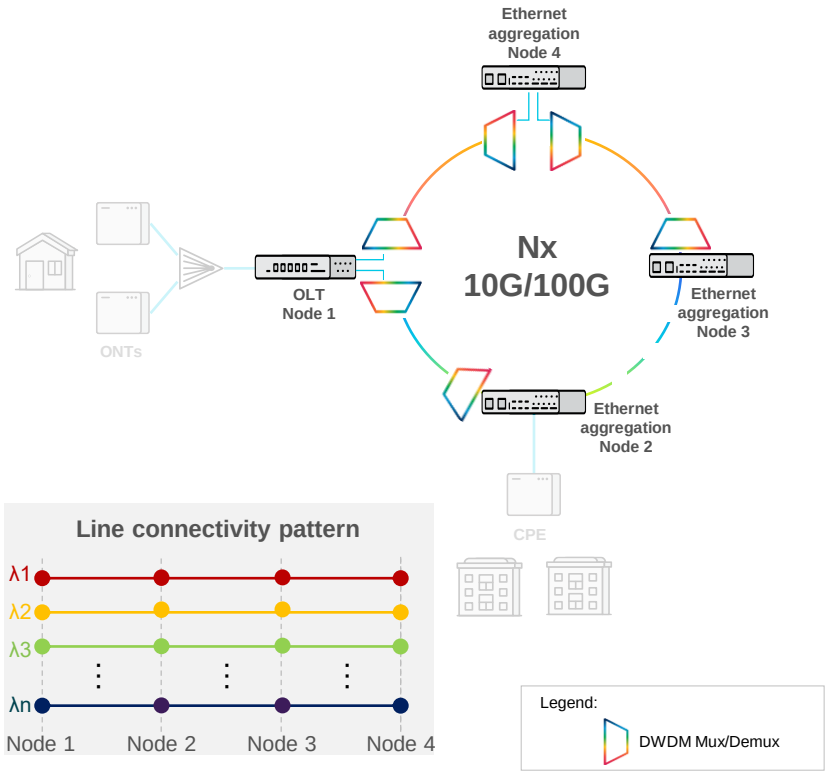


- Traditional Architecture used transponders/muxsponders as grey to color conversion for WDM transport. This added additional cost and complexity
- Pluggable development has removed complexity and layer of equipment allowing for lower cost and complexity within Access WDM networks

- Pluggable-based solutions provide flexibility, a long lifetime and lower cost
  - Edge/Metro/Regional applications will be based on coherent pluggables
  - Allowing for IPoDWDM adoption within multiple markets



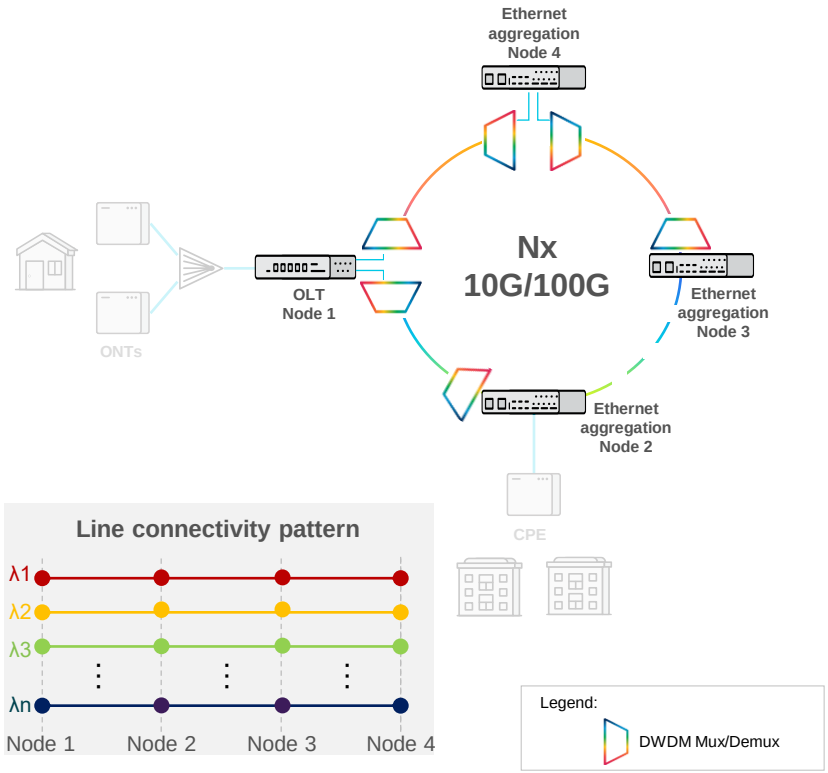
Multiple wavelengths (WDM)



Attribute	Summary
Fiber connectivity	Single fiber or fiber pair per direction
Line capacity	10G or 100G per channel 80G to 4T total line capacity
Line optics	10G: fixed or tunable DWDM 100G: Coherent DWDM 100ZR
Distance between adjacent nodes	< 120km
Client traffic add/drop	Layer 2/3
Line traffic	Layer 1 DWDM
Traffic protection	Layer 2/3 protection

*DWDM = Dense Wavelength Division Multiplexing

Multiple wavelengths (WDM)



Fiber consumption

- DWDM saves fiber resources
- Adding more channels doesn't mean adding more fibers

Scalability

- Pay as you grow model from 1 up to 40 channels
- Leverages existing 10G-based equipment
- Future-proof for 100G per channel

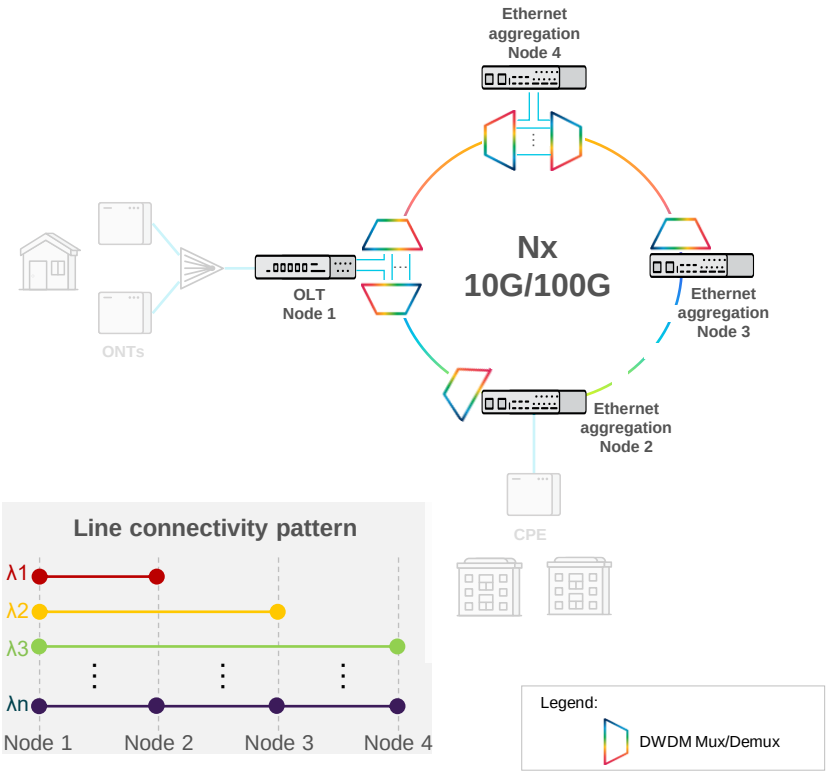
Capacity

- Up to 40x 10G or 100G
- Shared backbone bandwidth
- Statistical capacity aggregation

Cost increment

- Little extra cost by using passive DWDM mux/demux

Multiple wavelengths (WDM)



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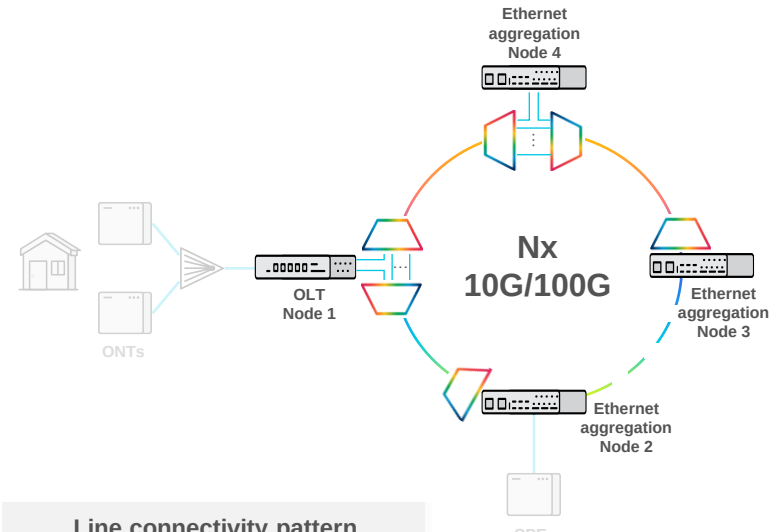
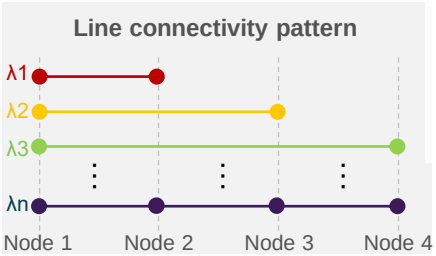
Multiple wavelengths (WDM)





Fiber consumption

- DWDM saves fiber resources
- Adding more channels doesn't mean adding more fibers

Scalability

- Pay as you grow model from 1 up to 40 channels
- Leverages existing 10G-based equipment
- Future-proof for 100G per channel
- Limited number of nodes and end-to-end distance

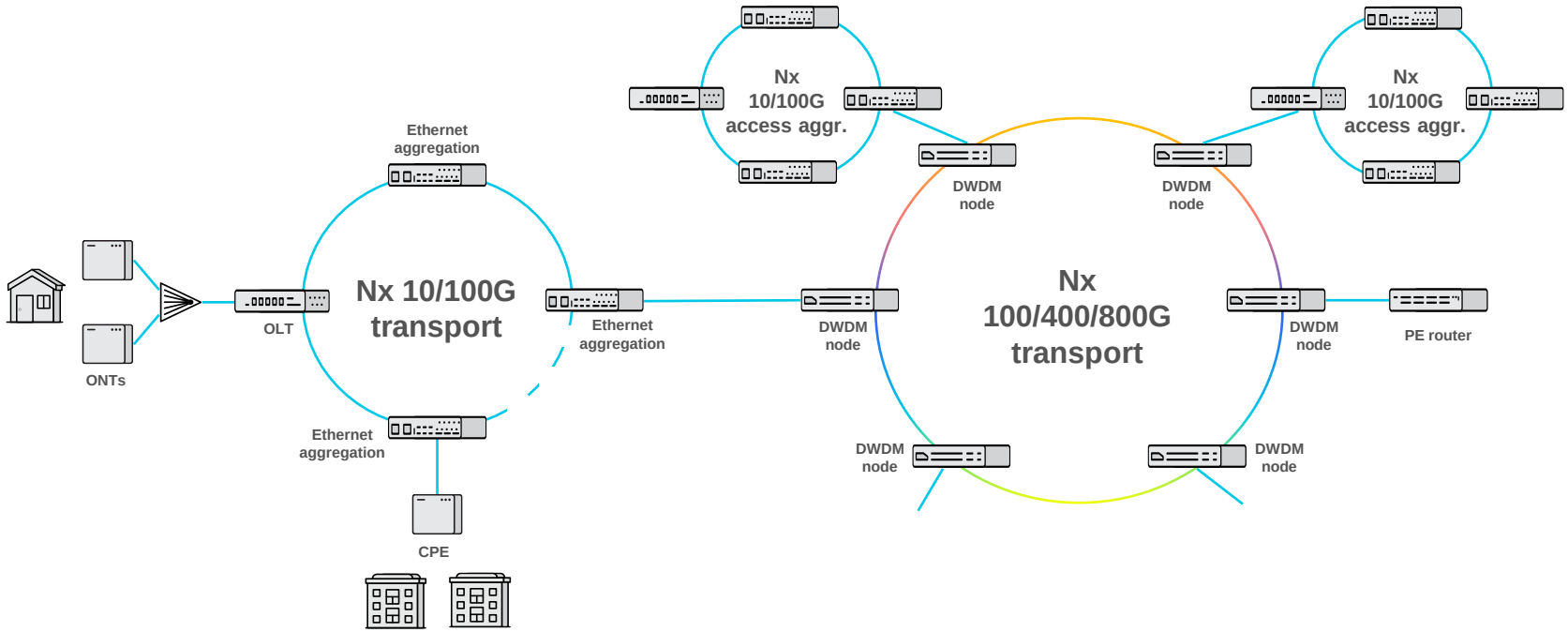
Capacity

- Up to 40x 10G or 100G
- Dedicated bandwidth

Cost increment

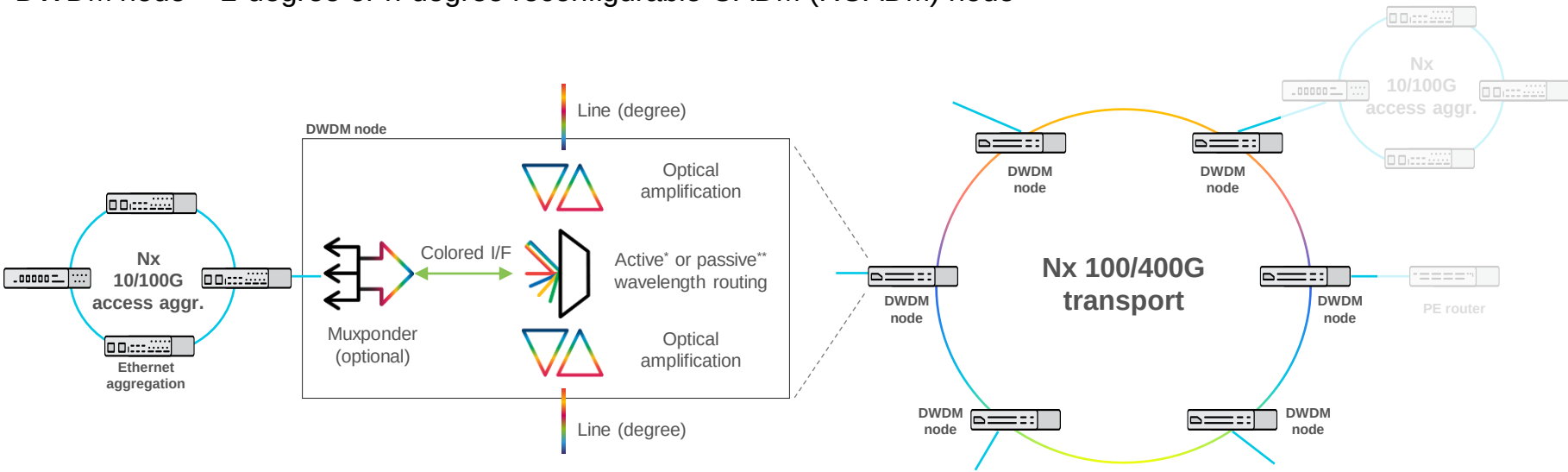
- Little extra cost by using passive DWDM mux/demux
- Bypassing traffic saves optical interfaces

End-to-end SP aggregation network



Metro aggregation

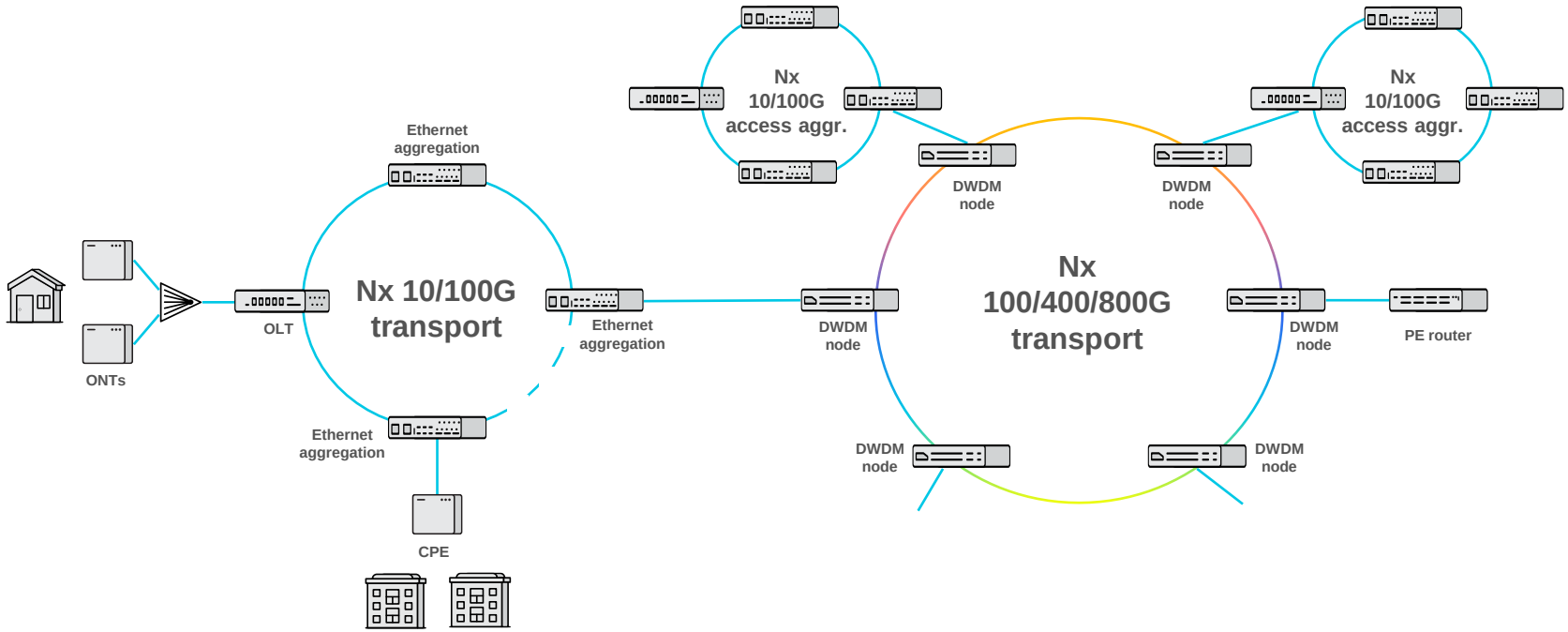
DWDM node = 2-degree or n-degree reconfigurable OADM (ROADM) node



*Active wavelength routing based on wavelength selective switch (WSS)

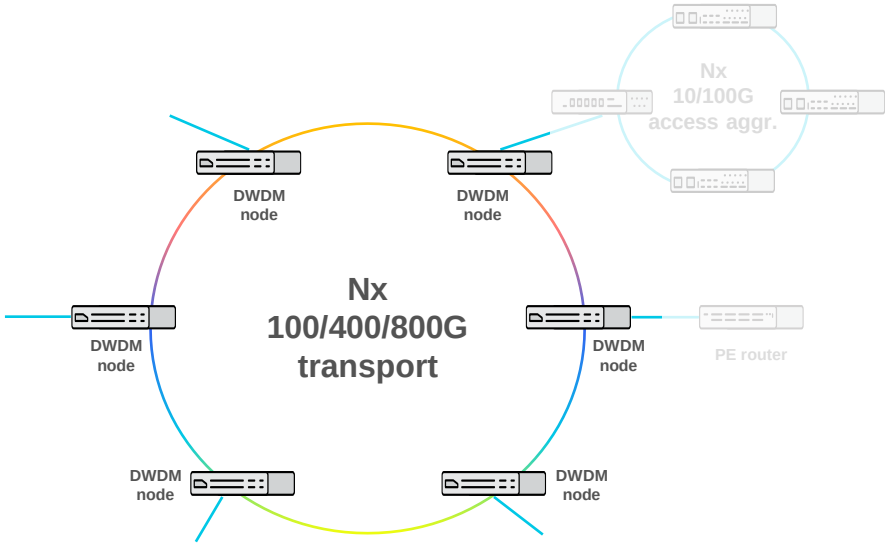
**Passive wavelength routing based on broadcasting power splitter and combiner

End-to-end aggregation network – Metro Aggregation



Metro aggregation

Attribute	Summary
Fiber connectivity	One fiber pair per line degree
Line capacity	100G or 400G per channel Up to 32 channels
Line degrees	2
Wavelength reuse	No
Line optics	Coherent DWDM 100ZR or 400ZR(+)
End-to-end distance	Depends on the line optics
Client traffic add/drop	Layer 1 DWDM
Line traffic	Layer 1 DWDM (Ethernet or OTN)
Traffic protection	Layer 1 DWDM



Metro aggregation (ROADM ring)

Metro aggregation

Fiber consumption

- DWDM saves fiber resources
- Adding more channels doesn't mean adding more fibers

Scalability

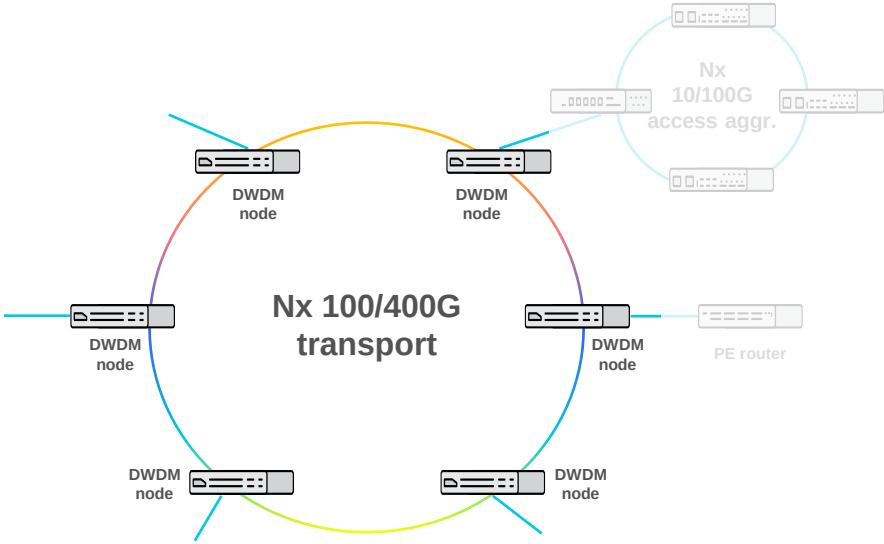
- Only 2-degree nodes

Capacity

- Up to 32x 100G or 400G
- Dedicated bandwidth
- No wavelength reuse

Cost increment

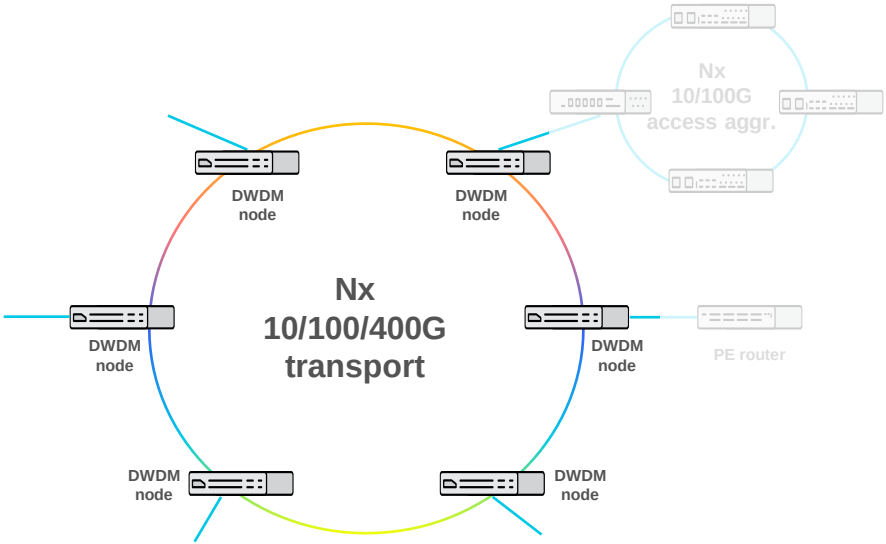
- Extra optical layer
- Passive broadcasting
- Bypassing traffic saves optical interfaces



Metro aggregation (ROADM/FOADM ring)

Metro aggregation

Attribute	Summary
Fiber connectivity	One fiber pair per line degree
Line capacity	10G, 100G, 400G or 800G per channel Up to 40 channels
Line degrees	2 to 8
Wavelength reuse	Yes
Line optics	Direct-detect DWDM 10G Coherent DWDM 100ZR or 400ZR(+)
End-to-end distance	Depends on the line optics
Client traffic add/drop	Layer 1 DWDM
Line traffic	Layer 1 DWDM (Ethernet or OTN)
Traffic protection	Layer 1 DWDM



Metro aggregation (ROADM ring)

Metro aggregation

Fiber consumption

- DWDM saves fiber resources
- Adding more channels doesn't mean adding more fibers

Scalability

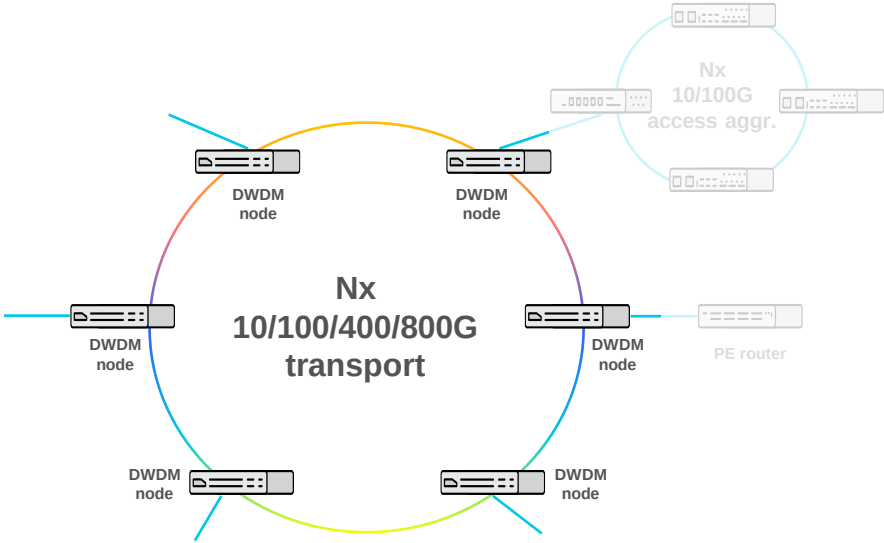
- From 10G to 100G and 400G
- 2-degree or higher-degree nodes

Capacity

- Up to 40x 10G, 100G or 400G
- Dedicated bandwidth
- Wavelength reuse

Cost increment

- Extra optical layer
- Active wavelength routing
- Bypassing traffic saves optical interfaces



Metro aggregation (ROADM ring)

HOW IT ALL FITS TOGETHER

Overall Architecture