IPoDWDM
in
2026

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TransmissionCo

INFINITE WAVES

History

IPoDWDM is a networking technology that integrates IP routing directly with optical transport networks.

Platform Progress

Proof points

Core router

1x OC-768c ITU PLIM

4 x 10GE ITU PLIM



Core/Edge router

1 x 10GE ITU SPA



Edge router

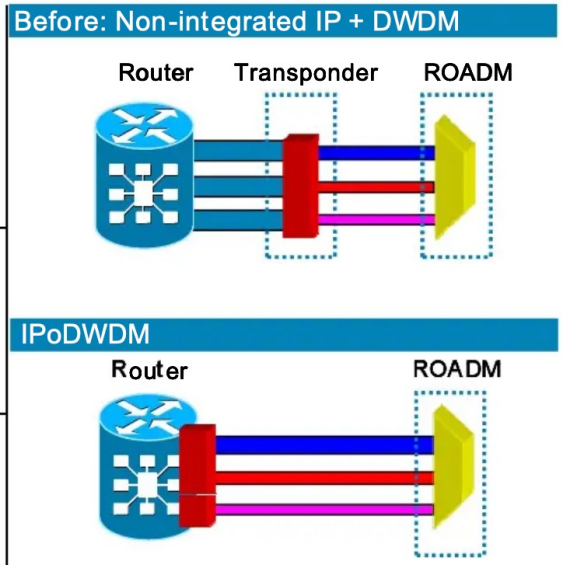
4 x 10GE ITU DWDM XENPAK



DWDM layer

DWDM system fully interoperable w routers





Functional equivalence of 10GbE +G.709 to 10G POS + transponder

Reduced CAPEX and OPEX

Figure 1. Cisco CRS-1 1-Port OC-768C/STM-256C DPSK+ Tunable WDMPOS Interface Module



Figure 1. Cisco CRS-1 4-Port 10GE Tunable WDMPHY Interface Module



Source: Cisco Systems

Why Early IPoDWDM Failed

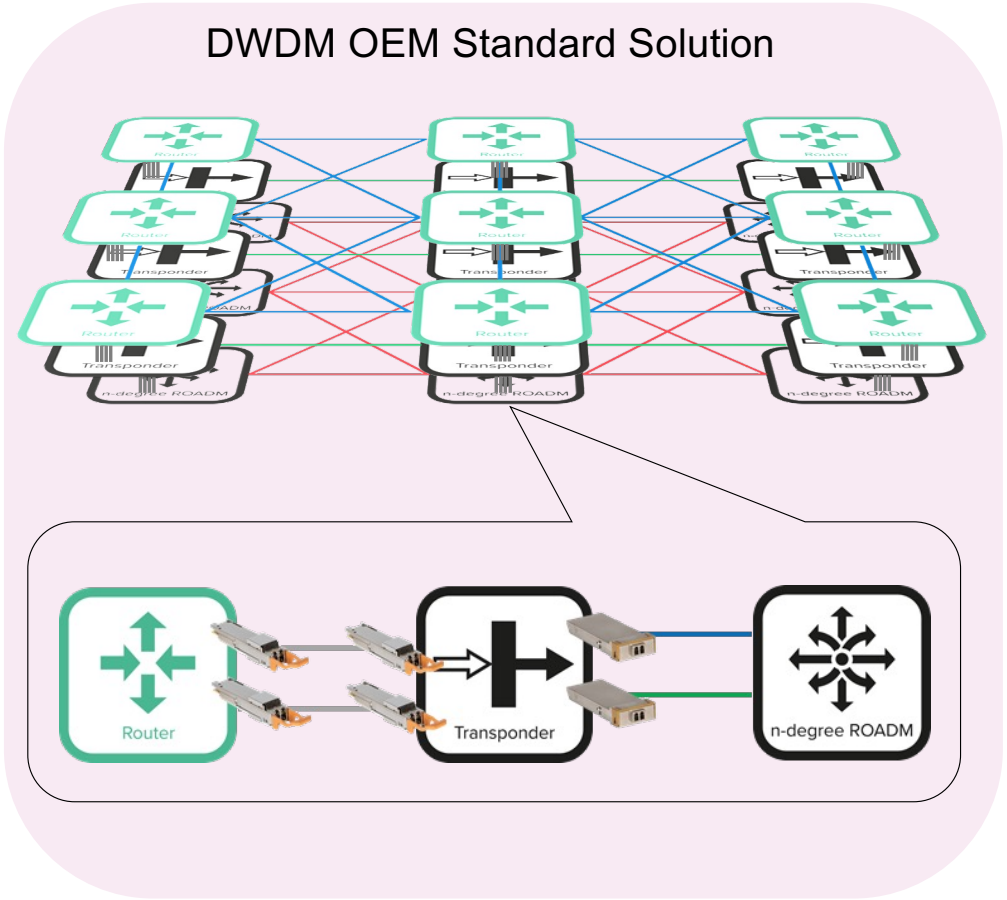


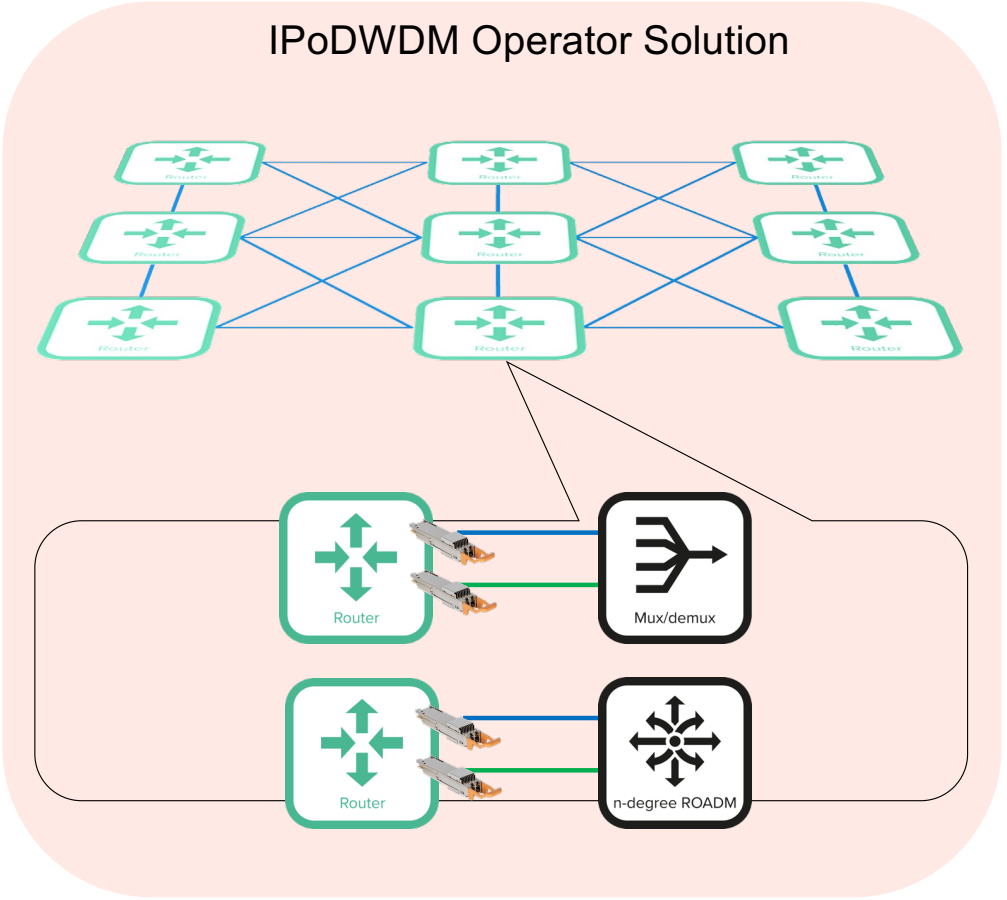
Source: Cisco Systems

- IPoDWDM line cards were large and expensive.
- The routers and line cards consumed a lot of energy.
- The line cards had fixed optical interfaces, i.e., not pluggable.
- The IPoDWDM systems were all proprietary to one vendor.
- Regular router port bandwidth grew faster than DWDM capacity.
- Line-side optics were twice the physical size of the client-side, i.e. waste of space.
- IP and Optical teams both wanted control of their domains.

IPoDWDM in 2026

Source: Smartoptics

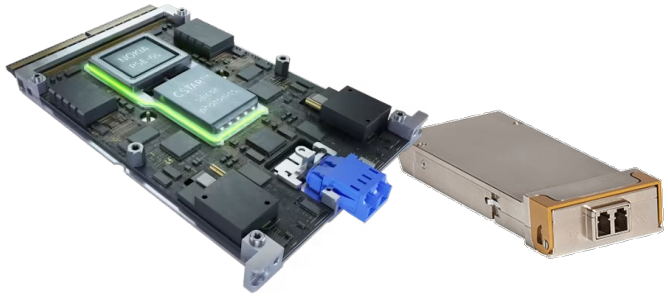




It's All About Pluggables

Coherent pluggables make IPoDWDM a reality.

We have gone from large, hot and power-hungry DWDM plugs and optical engines



… to MSA "xSFP" form factors with DWDM support.



- IP operators do not like fixed ports or large plugs.
- QSFP-DD and OSFP are very attractive because they solve both these problems.
- Brings 400G easily to routers and switches.
- Can run on dark fibre or integrate with a DWDM system for increased reach.
- High output power of 0dB and +1dB make them a good alternative to embeddeds.

It's All About Pluggables

Source: Smartoptics



100G-ZR QSFP28



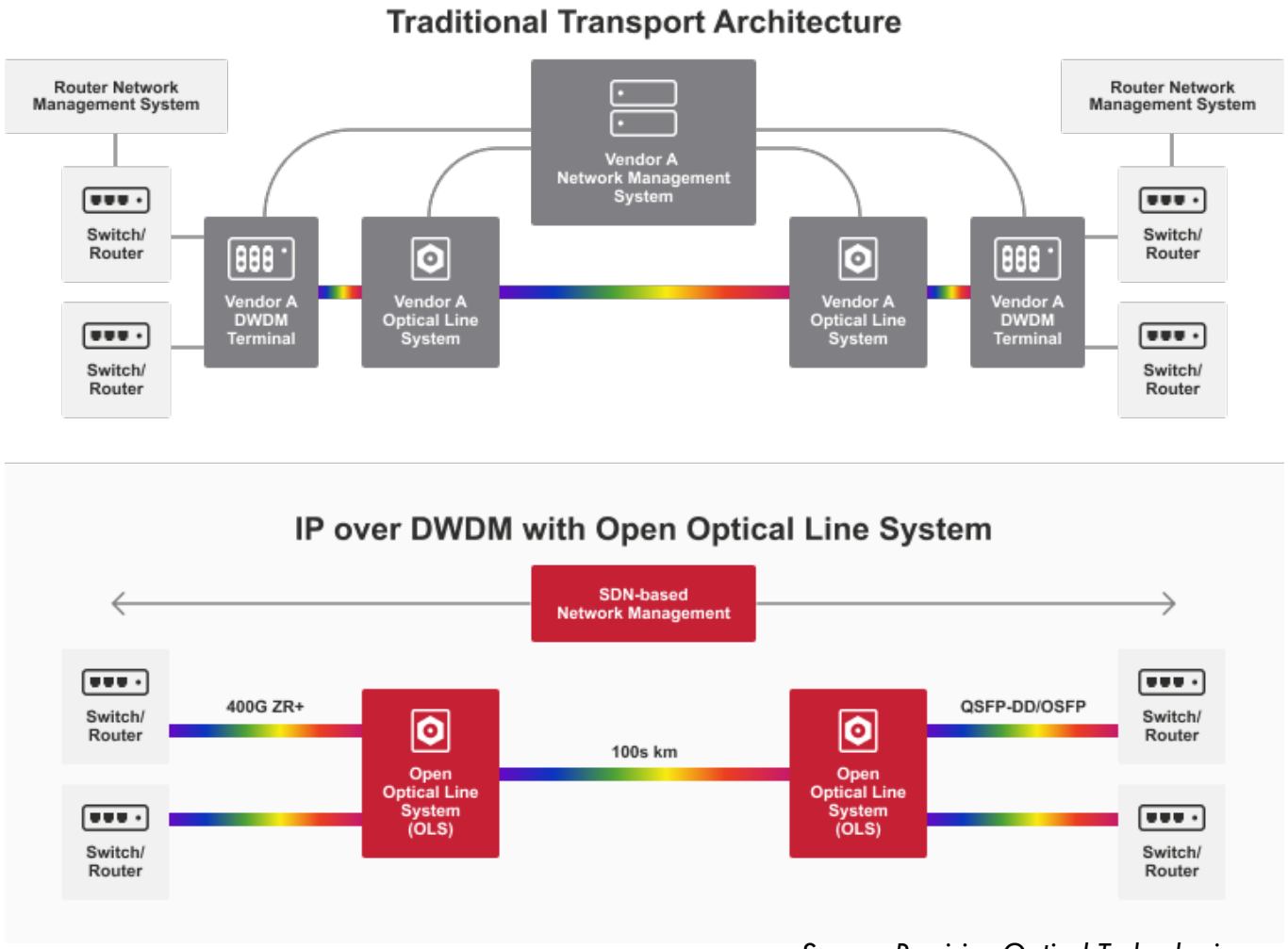
800G-ZR QSFP-DD



800G-ZR OSFP

- With the success of 400G, attention then turned to 100G and 800G.
- 100G coherent plugs come in the operator-friendly QSFP28 form factor.
- 800G coherent plugs come in both QSFP-DD and OSFP form factors (similar to 400G).
- The hyperscalers are converging on OSFP for 800G-ZR due to its superior thermal management.
- All these fit nicely into routers and switches, offering IPoDWDM capability.

What It Looks Like

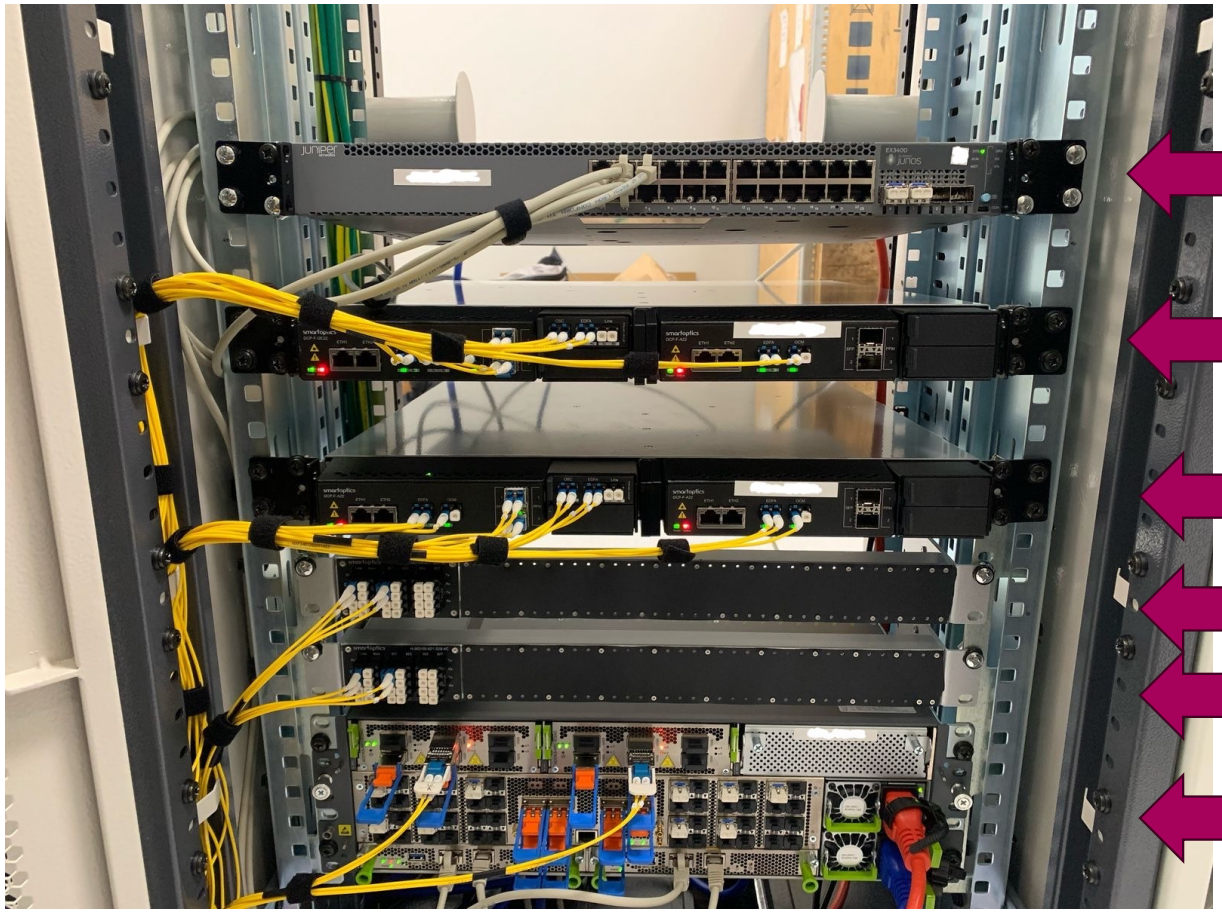


- Largely Driven by the hyperscalers.
- Quick 400GZR adoption.
- High volume, low cost.
- 800G-ZR is now next for them.
- * Performance parity with embeddeds.

Source: Precision Optical Technologies

And In Real Life

This is a live IPoDWDM network in Cape Town, South Africa – 130km fibre span



Juniper Ethernet switch.

Smartoptics optical line system (East)

Smartoptics optical line system (West)

Smartoptics mux/demux (East)

Smartoptics mux/demux (West)

Juniper ACX7300 router
with 2x Smartoptics 400G-ZR+ QSFP-DD
coherent DWDM plugs.

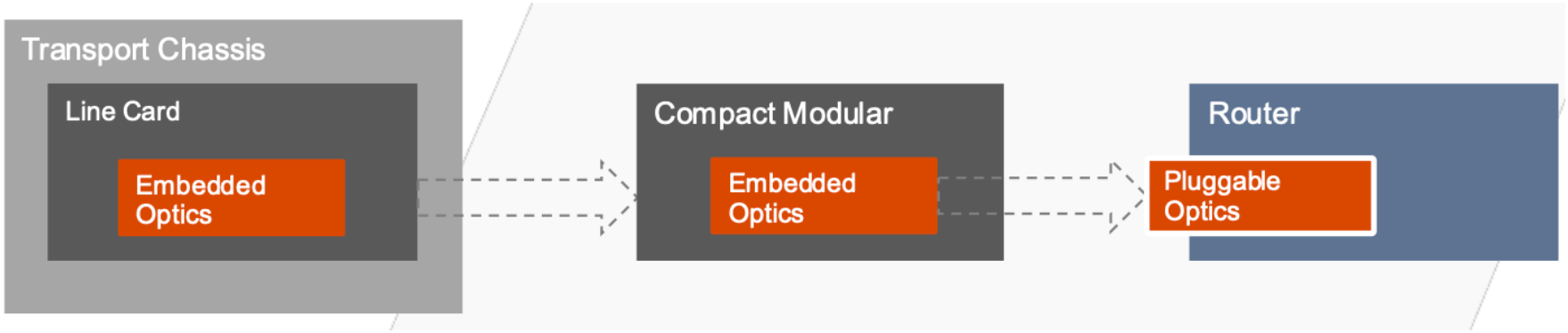
And In Real Life

This is a live IPoDWDM network in Cape Town, South Africa – 130km fibre span

```
Physical interface: et-2/0/2, SNMP ifIndex 625
  Current: 2025-09-10,16:00:00 - current
  Suspect Flag: False
  Reason: Not Applicable
    PM                              CURRENT    MIN        MAX        AVG        THRESHOLD          TCA-ENABLED        TCA-RAISED
                                                                                 (MIN)     (MAX)    (MIN)  (MAX)       (MIN)  (MAX)
  Module temperature(Celsius)       53         52         53         52         0         73       No     No          No     No
  Supply voltage(V)                 3.27       3.26       3.27       3.27       0         0        NA     NA          NA     NA
  Pre-FEC BER                       2.09e-3    2.07e-3    2.49e-2    1.11e-2    0         9.00e-3  NA     No          NA     No
  Uncorrected FER                   0.00e+0    0.00e+0    2.00e+0    7.92e-1    0         0.00e+0  NA     No          NA     No
  SNR(dB)                           15.8       12.2       15.8       14.4       15.0      0        No     NA          No     NA
  Tx power(dBm)                     -10.00     -10.07     0.05       -1.78      -10.00    4.00     No     No          No     No
  Rx total power(dBm)               -5.54      -13.94     -5.52      -7.56      -21.00    4.00     No     No          No     No
  Rx signal power(dBm)              -5.40      -14.30     -5.37      -7.48      -17.50    2.00     No     No          No     No
  Tx bias current(mA)               255.40     255.40     255.40     255.40     0         0        NA     NA          NA     NA
  Carrier frequency offset(MHz)     -191       -201       -150       -181       -3600     3600     No     No          No     No
  Chromatic dispersion(ps/nm)       2263       2260       2269       2264       0         0        NA     NA          NA     NA
  Differential group delay(ps)      1.0        1.0        2.0        1.3        0         0        NA     NA          NA     NA
  SOPMD(ps^2)                       32         25         114        54.4       0         0        NA     NA          NA     NA
  PDL(dB)                           0.4        0.2        0.8        0.5        0         0        NA     NA          NA     NA
  SOP ROC(krad/s)                   0          0          0          0          0         0        NA     NA          NA     NA
  OSNR(dB)                          23.5       14.6       23.6       19.9       0         0        NA     NA          NA     NA
  Modulator bias  X/I(%)           37.70      37.52      37.88      37.69      0         0        NA     NA          NA     NA
  Modulator bias  X/Q(%)           34.18      33.97      34.34      34.16      0         0        NA     NA          NA     NA
  Modulator bias  Y/I(%)           40.96      40.82      41.18      40.99      0         0        NA     NA          NA     NA
  Modulator bias  Y/Q(%)           46.33      46.01      46.33      46.16      0         0        NA     NA          NA     NA
  Modulator bias  X phase(%)       35.57      35.47      35.74      35.60      0         0        NA     NA          NA     NA
  Modulator bias  Y phase(%)       32.70      32.54      32.79      32.67      0         0        NA     NA          NA     NA
  Q value(dB)                       0.0        0.0        0.0        0.0        0         0        NA     NA          NA     NA
```

Junos CLI output of the coherent DWDM plugs

Disaggregation



Source: CignalAI

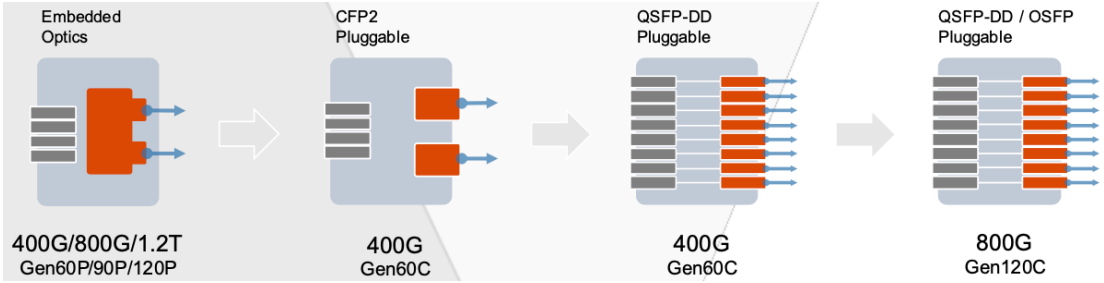
- The hyperscalers had a massive influence on disaggregation.
- Disaggregation = removing the DWDM optic from the host platform.
- In 2025, coherent pluggables outsold proprietary embeddeds by 2:1.
- Today, most 400G-ZR shipments have gone into hyperscaler IPoDWDM deployments.
- Coherent optics account for more than 60% of all optical revenue.

Pluggable Transponders



Source: CignalAI

- Pluggable transponders use plugs for both line- and client-side.
- Hyperscalers love IPoDWDM.
- But network operators are “old school” and want transponders.
- Pluggable transponders bridge the old with the new.



- Transponders provide Layer 1:
  - Aggregation.
  - Demarcation.
  - Protection.
- Pluggables provide:
  - MSA standardization.
  - Space and power savings.
  - Lower cost.



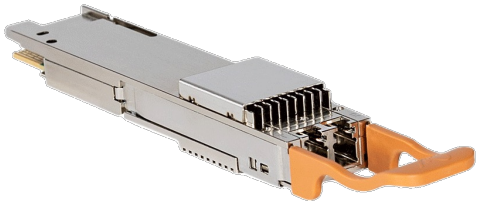
Source: Smartoptics

Benefits of IPoDWDM

Low system capacity DWDM vs. client ports	→	Maximum system capacity for both DWDM and client ports
Dedicated line cards line- and client-side	→	Mix-and-match on same card line- and client-side
Proprietary DWDM ports no inter-op with other OEM's	→	100/400/800GZR standards inter-op with other OEM's
Restrictive alien wave support proprietary OEM systems	→	Open line systems standardized management API's
Scarce router capacity IP traffic outpaces DWDM	→	Sufficient router capacity Moore's Law silicon advancement



Challenges of IPoDWDM



ProLabs Coherent
Pluggable

WILL IT WORK?



Nokia
Router

- Host inter-op is the biggest question.
- C-CMIS (Coherent Common Management Interface Specification). Defined by OIF.
- C-CMIS standardizes how coherent pluggables and hosts communicate for management and control.
- The goal: any plug in any host.
- Router/switch OS requires C-CMIS support. Not always easy unless you are a big customer.

Challenges of IPoDWDM



- In large telco networks, IP and Optical teams each want control of the network.
- IP team does not want Optical team poking around in their routers/switches.
- Optical team does not want IP team sending wavelengths into the DWDM network unsupervised.

Does IPoDWDM Make Sense for Me?

Grey

VS.



- You don't own an optical network.
- You operate a small metro network.
- You require long-haul services.
- You have slow capacity upgrade cycles.
- You don't need more than 100G-sized links.
- You provide only IP-based services.
- You want to limit costs to IP infrastructure only.
- You don't intend to grow too quickly.

- You operate your own optical network.
- You operate a large metro network.
- You require short- and long-haul services.
- You upgrade capacity very regularly.
- You need links in excess of 100G capacity.
- You want to free up costly transponder ports.
- You want a low-cost entry into DWDM.
- You want to aggressdrop per-bit costs.

Future

- Hyperscalers will invest heavily in 800G-ZR IPoDWDM from 2026.
- Network operators will go a bit slow, focusing mainly on 400G-ZR and pluggable transponders.
- Traditional DWDM vendors will see a decline in embedded optical engine sales.
- Traditional DWDM vendors will try to balance legacy technology with pluggables.
- Embedded optical engines will remain for challenging applications, e.g., subsea and ultra long haul.
- Pluggables will be 2 – 3 years behind embedded optical engines. But convergence will speed up.
- Attention has now turned to 1600-ZR (1.6T) coherent pluggables.

Final Thoughts

- IP/MPLS engineers are going to come across IPoDWDM as their networks grow.
- IP/MPLS engineers will need to have a basic understanding of DWDM and coherent technologies.
- IP/MPLS and Optical engineers will need to cooperate more to support IPoDWDM.
- Network operators are going to democratize their vendor pool list for optical equipment.
- Traditional optical vendors are going to have to adapt to the changing landscape.
- The likelihood of encountering IPoDWDM increases as you get to and exceed 100G.



Q & A

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