

TransmissionCo

INFINITE WAVES

IPoDWDM in 2026

Mark Tinka · Managing Director, TransmissionCo

History

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

Before: Non-integrated IP + DWDM





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

IPoDWDM





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

Source: Cisco Systems

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

Reduced CAPEX and OPEX

Why Early IPoDWDM Failed

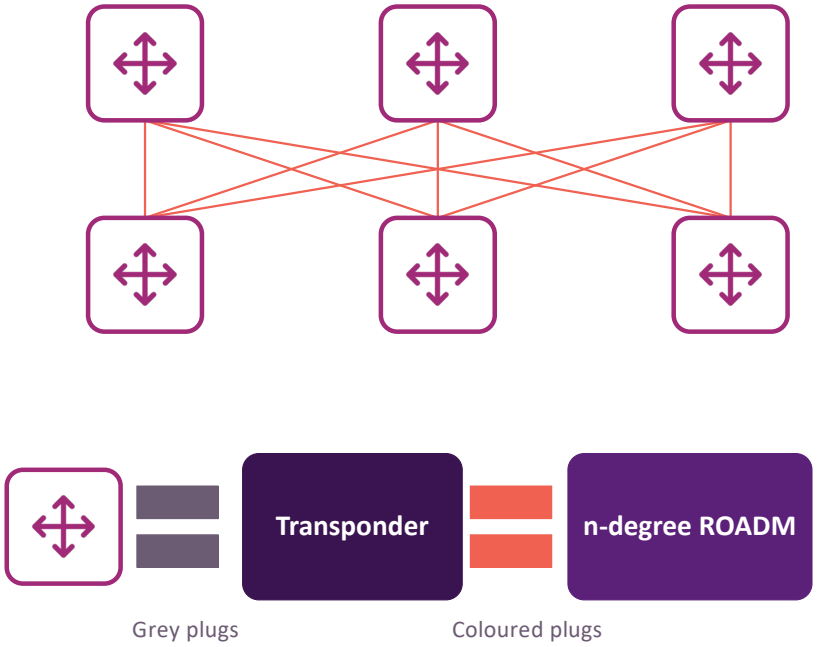


Source: Cisco Systems

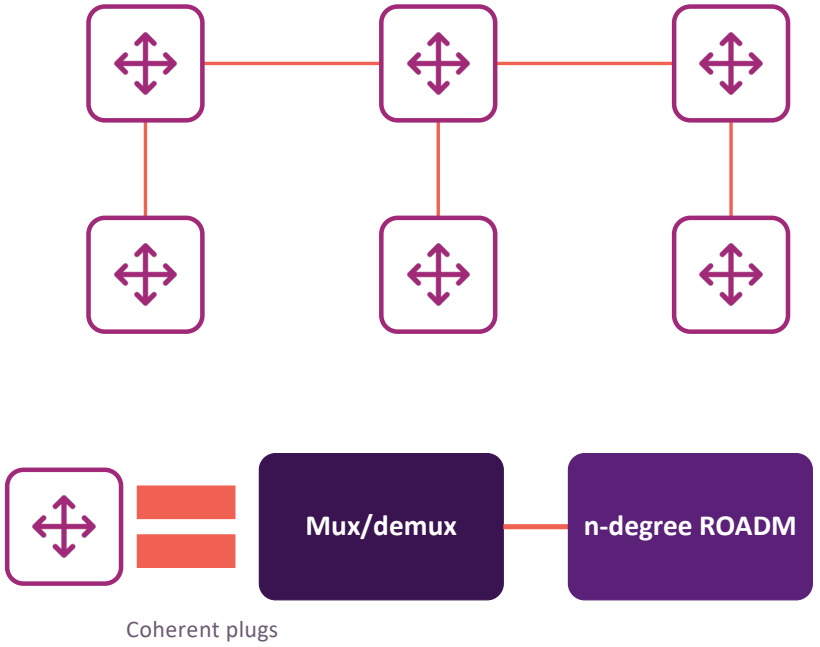
- IPoDWDM line cards were **large and expensive**.
- The routers and line cards **consumed a lot of energy**.
- The line cards had **fixed optical interfaces**, i.e., not pluggable.
- The IPoDWDM systems were **all proprietary** to one vendor.
- Regular router port bandwidth grew **faster** than DWDM 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

DWDM OEM Standard Solution



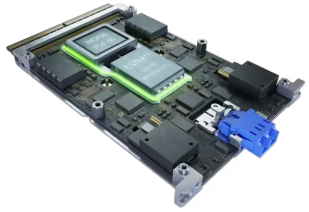
IPoDWDM Operator Solution



It’s All About Pluggables

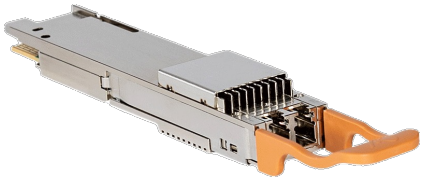
Coherent pluggables make IPoDWDM a reality.

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 embedded.

It’s All About Pluggables



100G-ZR QSFP28



800G-ZR QSFP-DD

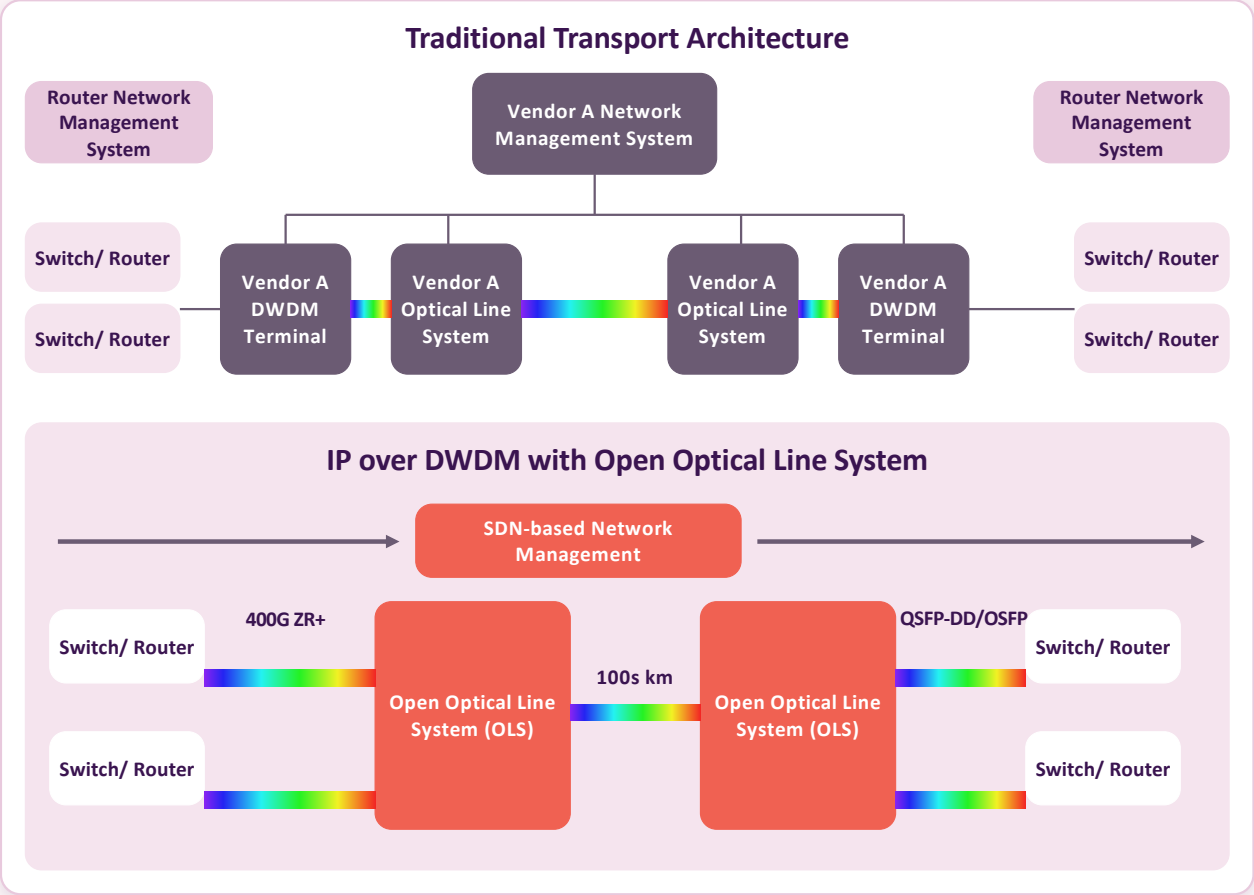


800G-ZR OSFP

Source: Smartoptics

- 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.

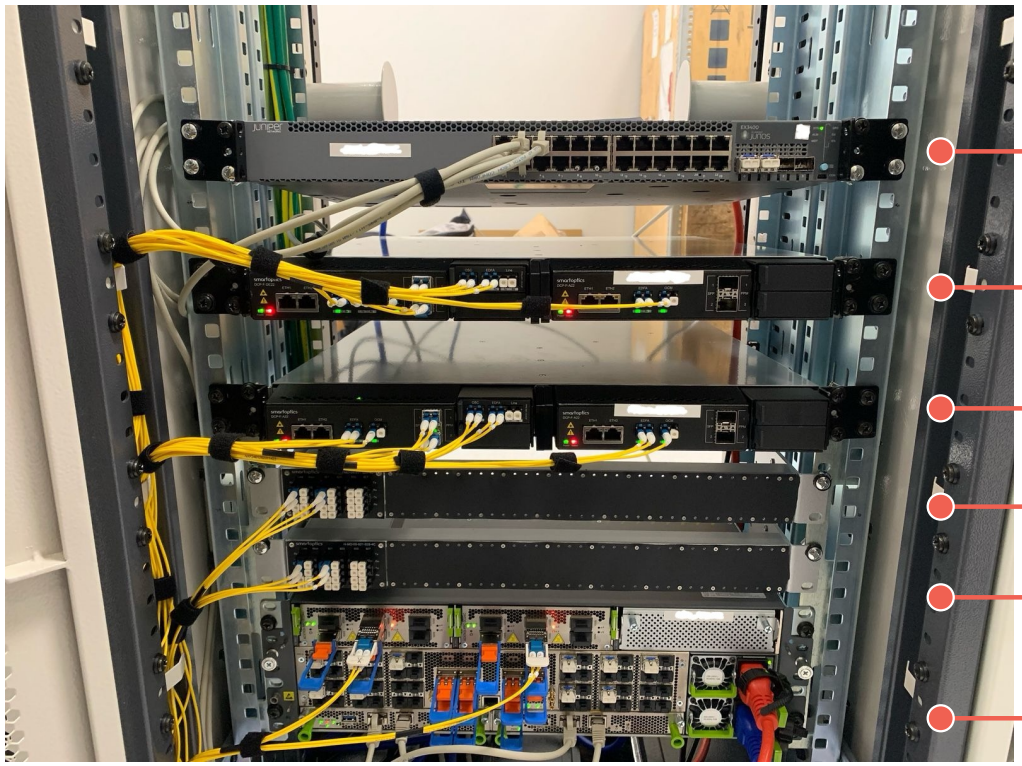
What It Looks Like



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

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

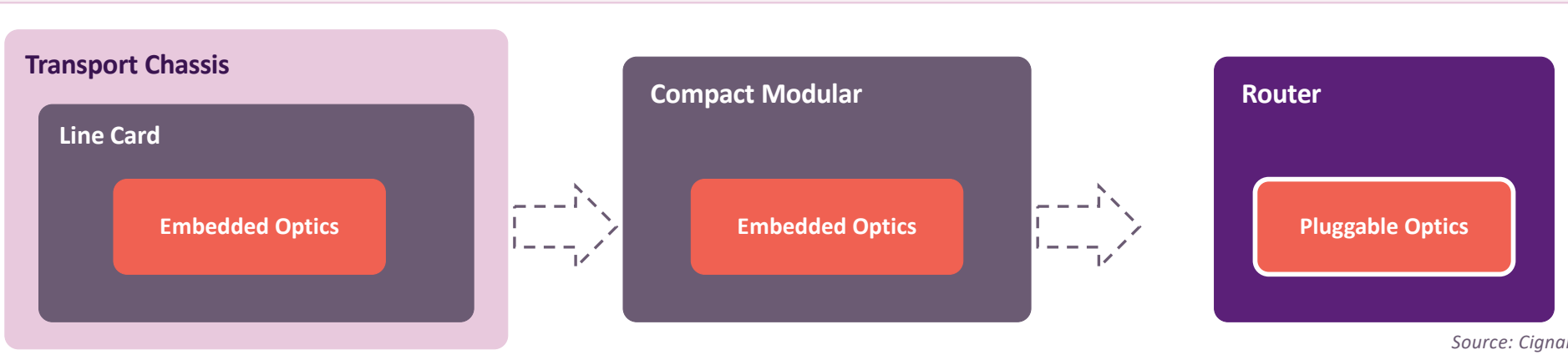
This is a live IPoDWDM network in Cape Town, South Africa – 130km fibre span

```
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 (MIN)	THRESHOLD (MAX)	TCA-ENABLED (MIN)	TCA-ENABLED (MAX)	TCA-RAISED (MIN)	TCA-RAISED (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

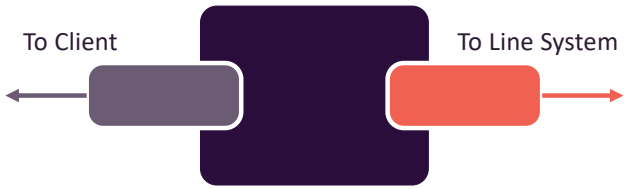
Disaggregation



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 embedded 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



- 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.**

Embedded Optics	CFP2 Pluggable	QSFP-DD Pluggable	QSFP-DD / OSFP Pluggable
400G/800G/1.2T	**400G**	**400G**	**800G**
Gen60P/90P/120P	Gen60C	Gen60C	Gen120C







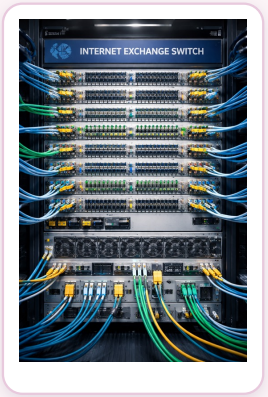
Source: Smartoptics

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

Opportunities for Peering Architectures

400G Peering + IPoDWDM Backhaul to nearest PoP



Internet Exchange Switch

3× 100G



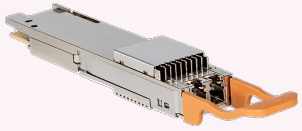
400G-FR4/LR4 QSFP-DD Grey Plug

+



Peering Router

+



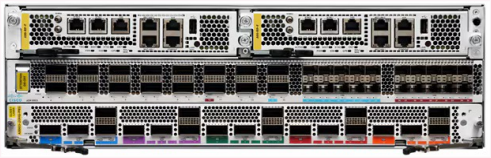
400G-ZR+ QSFP-DD Coherent Plug

+



Edge/Core Router

1× 100G

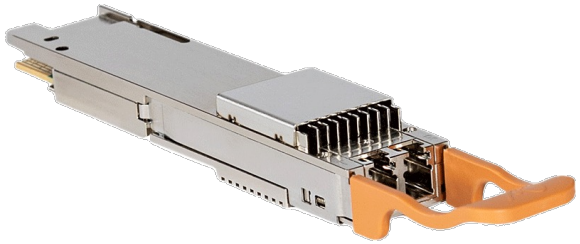


PNI Peering Partner

IPoDWDM
makes Peering Scalable

Challenges of IPoDWDM

- 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.



ProLabs Coherent Pluggable

WILL IT WORK?



Nokia Router

Challenges of IPoDWDM



In this network, **IP** and **Optical** teams each want **control** of the network.

The solution is **two-fold**:

1. **Top-down management** of routing, especially in large networks.

2. **Sharing of modem telemetry data** between both the IP and Optical teams.

The Management Question

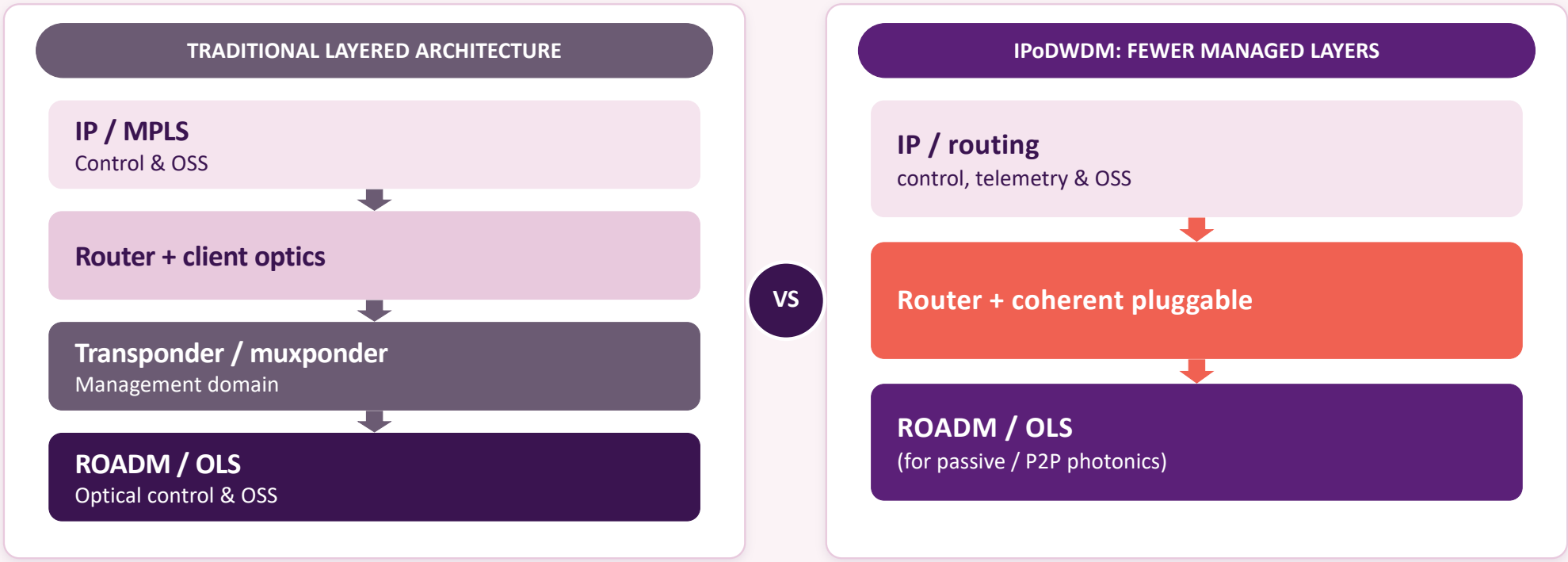
Different API standards solve different problems:

- CMIS looks at host & pluggable.
- OpenConfig looks at common data models.
- NETCONF and gNMI handle data retrieval and configuration.
- SNMP is still widely deployed as a standard management tool.
- REST and Kafka feed data northbound into the OSS.

Could removal of the transponder layer reduce the amount of data the OSS has to present?

- IPoDWDM may not lead to a single management plane.
- But it removes one of the major reasons several management planes existed, in the first place.
- The optical controller has a legitimate role, but the transponder management plane can disappear.

The Management Question



SIMPLER
Fewer layers to manage

FASTER
Streamlined operations

LOWER
Total cost of ownership

GREATER
Flexibility & scalability

The optical domain remains — but the dedicated transponder layer can disappear.

The Management Question

Deterministic Service Mapping

TRADITIONAL APPROACH — Multiple inventory objects and intermediate mappings

Router Port
Initial port where traffic originates

→

Client Optic
Client side optical interface

→

Transponder
Optical layer conversion

→

ROADM / OLS
Optical layer switching

→

Remote Transponder
Final port where service terminates

IPoDWDM APPROACH — Simplified inventory with deterministic mapping

Router Port + Coherent Lambda
Single inventory object (port mapped to wavelength)

→

ROADM / OLS
Optical layer switching

IPoDWDM: interface = wavelength

EXAMPLE FLOW

Source Port (Data Centre A) → 🔒 → **ROADM / OLS** → **IPoDWDM: Destination = Wavelength**

IPoDWDM can reduce the number of independent control and management planes.

Long term, the direction would be common orchestration and shared telemetry, rather than multiple isolated islands.

Does IPoDWDM Make Sense for Me?

Grey	vs.	Coloured
You don’t own an optical network.		You operate your own optical network.
You operate a small metro network.		You operate a large metro network.
You require long-haul services.		You require short- and long-haul services.
You have slow capacity upgrade cycles.		You upgrade capacity very regularly.
You don’t need more than 100G-sized links.		You need links in excess of 100G capacity.
You provide only IP-based services.		You want to free up costly transponder ports.
You want to limit costs to IP infrastructure only.		You want a low-cost entry into DWDM.
You don’t intend to grow too quickly.		You want to aggressively drop per-bit costs.

Future - The Linear Way

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.

Adoption driven more by **operating model** (forward-looking vs. legacy), than anything else.

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** is speeding up.

Attention has now turned to **1600-ZR (1.6T)** coherent pluggables.

Future – The “BYOTx” Way

Wholesale optical service models



Provider owns terminal optics

Shared optical responsibility

Customer owns optical layer

Coherent pluggables expand the practical space for alien wavelengths, spectrum services and BYO terminal equipment.

We are used to buying either dark fibre or capacity.

Spectrum services sit somewhere in the middle.

If I can present a qualified coherent pluggable or optical terminal, a carrier could sell me a defined piece of spectrum and an optical performance envelope, in lieu of a transponder-based Ethernet hand-off.

It’s a “Bring Your Own Transceiver/Terminal” model, where the customer controls the modem, and the carrier controls and assures the photonic path.

Final Thoughts

01	IP/MPLS engineers are going to come across **IPoDWDM** as their networks grow.
02	IP/MPLS engineers will need to have a basic understanding of **DWDM and coherent technologies.**
03	IP & Optical domains will require **top-down management** intervention to collaborate.
04	Network operators are going to **democratize** their vendor pool list for optical equipment.
05	Traditional optical vendors are going to have to **adapt** to the changing landscape.
06	The likelihood of encountering IPoDWDM increases as you get to and exceed **100G.**





TransmissionCo

INFINITE WAVES

Q & A

mark@transmissionco.net

2026