MULTI-PROTOCOL LABEL SWITCHING (MPLS) AND/OR OPTICAL TRANSPORT NETWORK (OTN) ?

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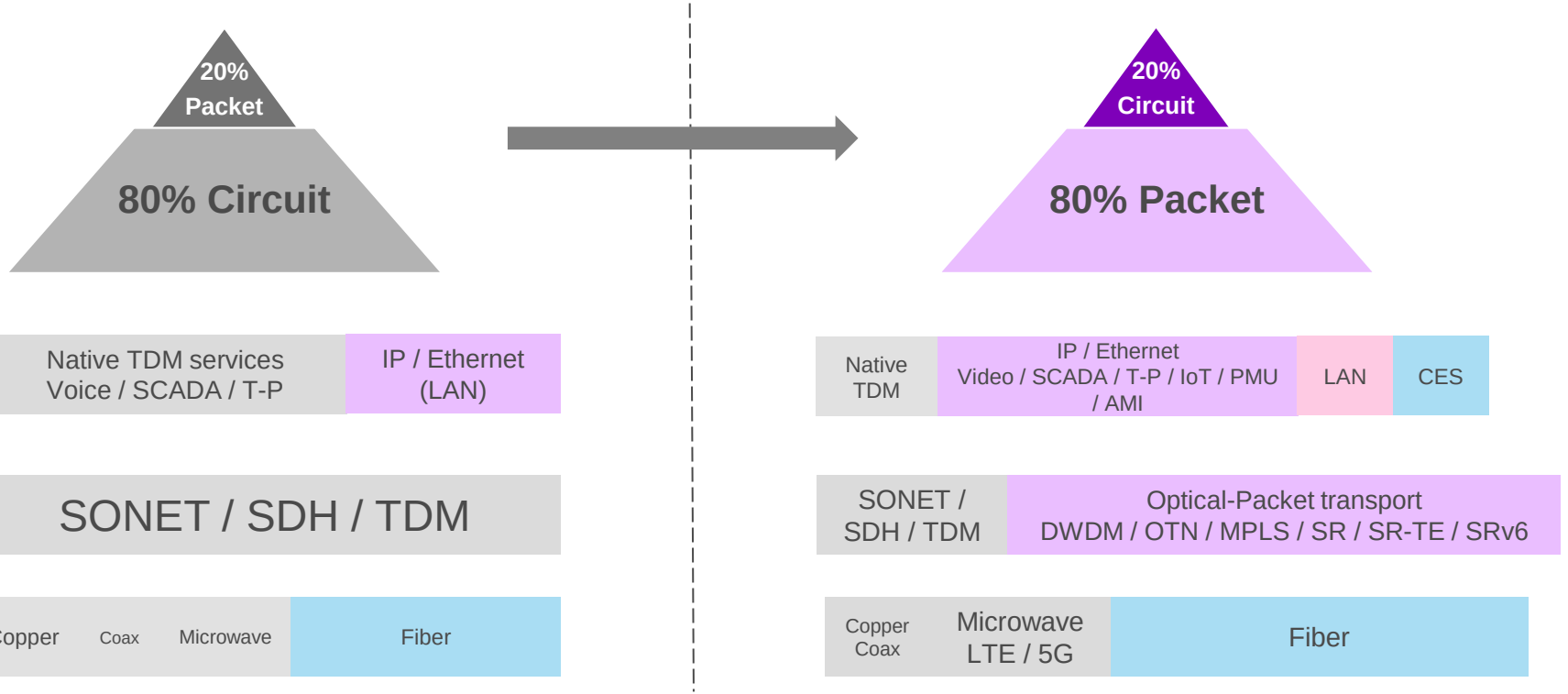
Traffic Pattern & Usage

Traffic Pattern and Usage Evolution



Key Capabilities & Use cases

for

OTN, Ethernet, MPLS(TP) & SR(TE)

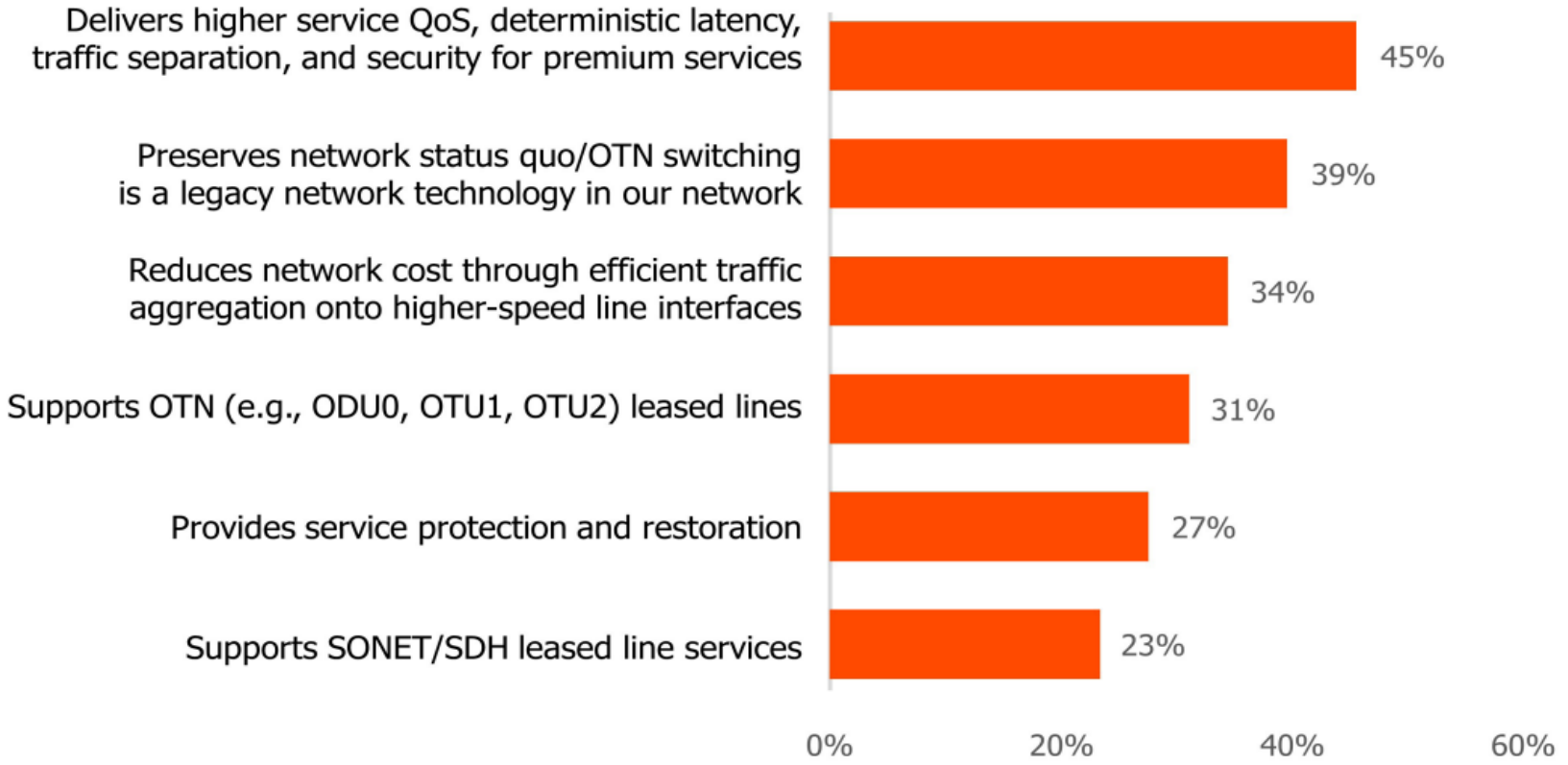
Key Capabilities & Use cases for OTN, Ethernet, MPLS(TP) & SR(TE)

Use Cases & Properties	OTN TRANSPORT	OTN SWITCHING	Ethernet/IP/MPLS(TP)/SR (TE)
Operational Complexity	Low/Medium	Low/Medium	Medium/High
Legacy service transport	Transparent (Framing any Service)	Transparent (Framing any Service)	Transparent(Service Agnostic)
Packet & service transport	Framing data into fixed length frames in fixed data-rate channels, circuit	Framing data into fixed length frames in fixed data-rate channels, circuit	Framing of data of variable bitrate into variable length frames.
Connectivity Type	P2P	P2P, P2MP, MP2MP	P2P, P2MP, MP2MP
ECMP-Aware	N/A	N/A	YES
Acces & Metro Transport	Higher service quality and availability	Higher service quality and availability, Lack of support for higher throughput	Beneficial choice & Higher throughput efficiency than OTN
Mobile Transport	Higher service quality and availability	Higher service quality and availability, Lack of support for higher throughput	Beneficial choice & Higher throughput efficiency than OTN
Long Haul Transport	Beneficial choice & Higher throughput efficiency than Ethernet/MPLS/SR(TE)	Lack of support for higher speed coherent line interfaces	support for higher speed coherent line interfaces in development and test phase

Key Capabilities & Use cases for OTN, Ethernet, MPLS(TP) & SR(TE)

Use Cases & Properties	OTN TRANSPORT	OTN SWITCHING	Ethernet/IP/MPLS(TP)/SR (TE)
Time-Sensitive Application Support Private Line Services	No buffering for contention: low and fixed deterministic (native) latency Premium private line services	No buffering for contention: low and fixed latency and no packet loss, Premium private line services	Buffering for contention, Low and fixed latency using QoS, IHON. Bounded delay using IEEE TSN mechanisms.
Multiplexing Type, grooming technique	Static Multiplexing, lower bitrate channels into higher bitrate channels.	Static Multiplexing, grooming lower bitrate into higher bitrate	Efficient grooming of variable bitrate with static & statistical multiplexing
Switching capability	N/A, client port granularity.	Circuit switching, ODUk granularity.	Packet switching with packet granularity in the order of tens of Mb/s
Operation & Maintenance	End-to-end Path and 6 levels of TCM	End-to-end Path and 6 levels of TCM	End-to-end Service OAM, and 8 MEG levels for EVC monitoring
Parameters Monitored	Bit errors	Bit errors	Packet loss, Delay, Jitter, PDV
Fault management	Monitor mode TCM	Monitor mode TCM	CCM & LTM Messages
Error correction	Correction of bit errors using FEC	Correction of bit errors using FEC	FEC available for 100 Gb/s and beyond.

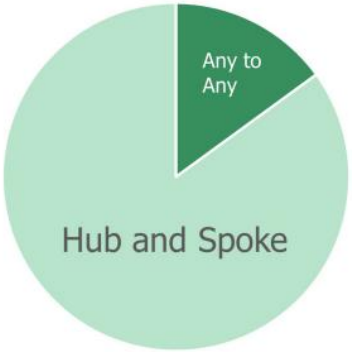
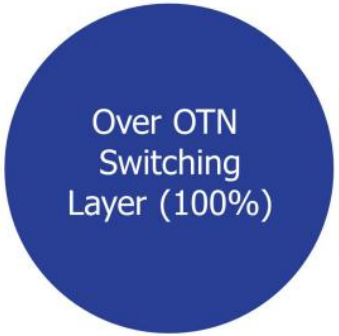
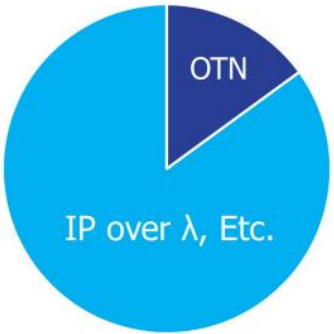
What are the main benefits of using OTN switching in your network? (Source: Heavy Reading, 2023)



Survey from 117 network operators

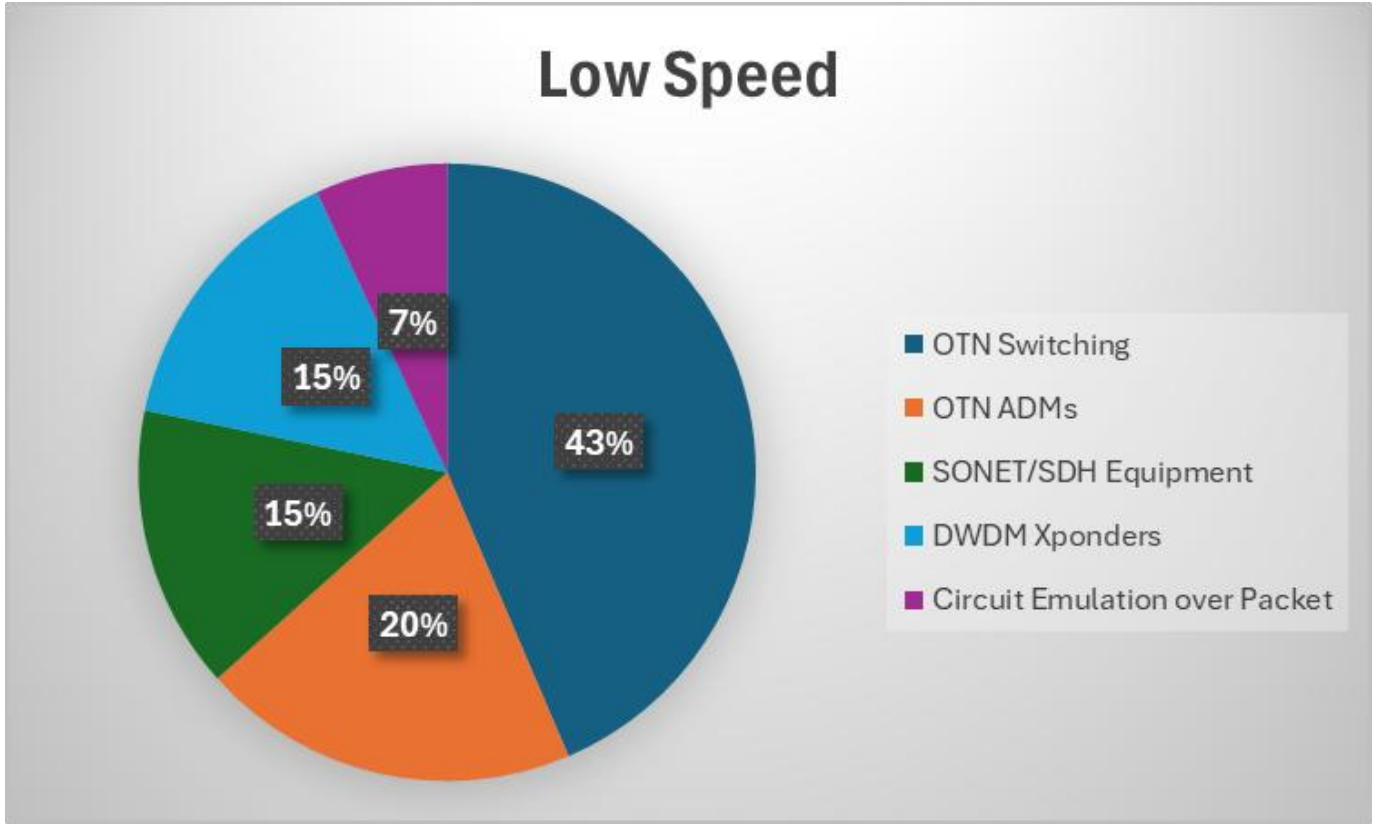
Transport Network Evolution Architecture based on Complementarity and CO-Operation.

CSP aggregation network traffic patterns (excludes DCI)

	Past	Present/Future
Traffic Patterns (All Traffic)		
% Traffic Over OTN Switching		

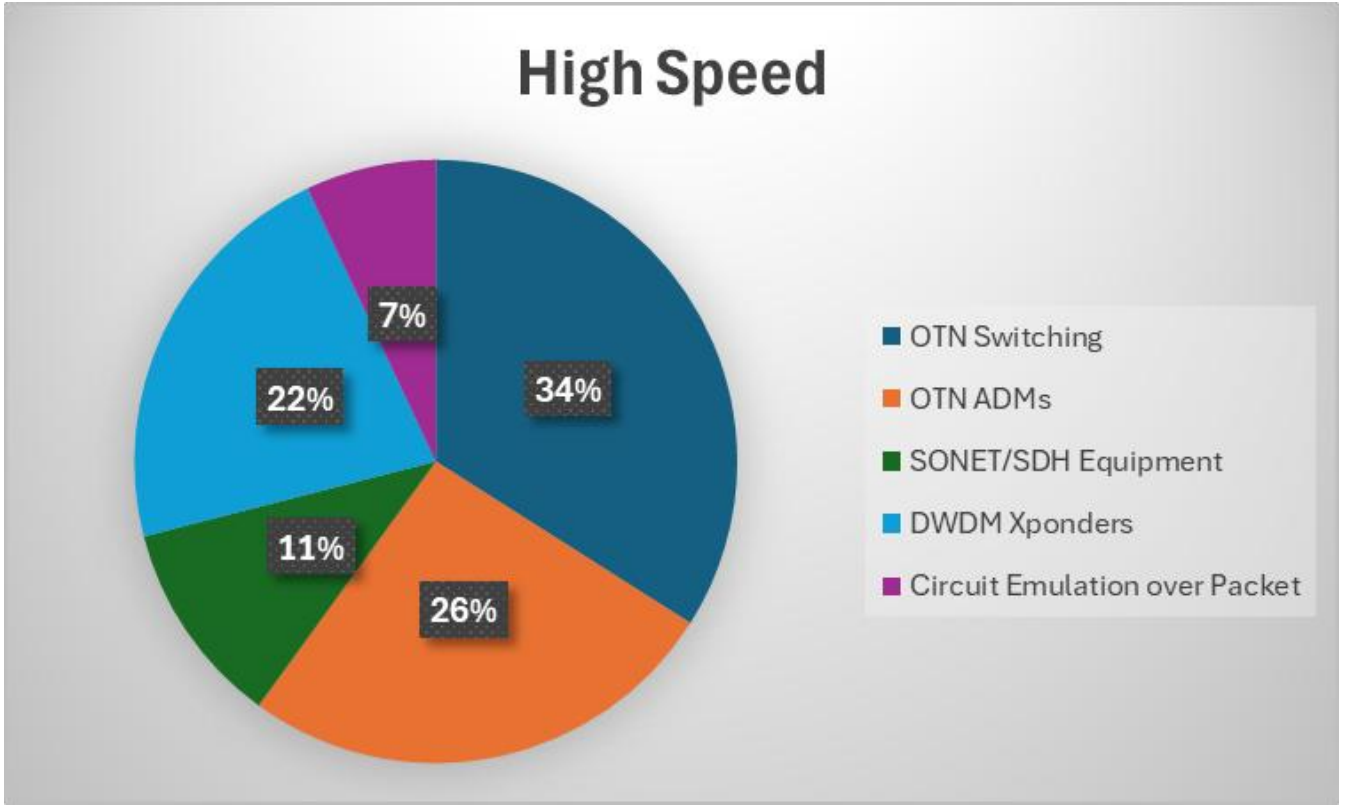
Primary mechanism for delivering low speed (i.e., < 10G) private line services

- OTN is a strong option for low speed services, as significant traffic grooming is needed to fill pipes and make transport efficient.

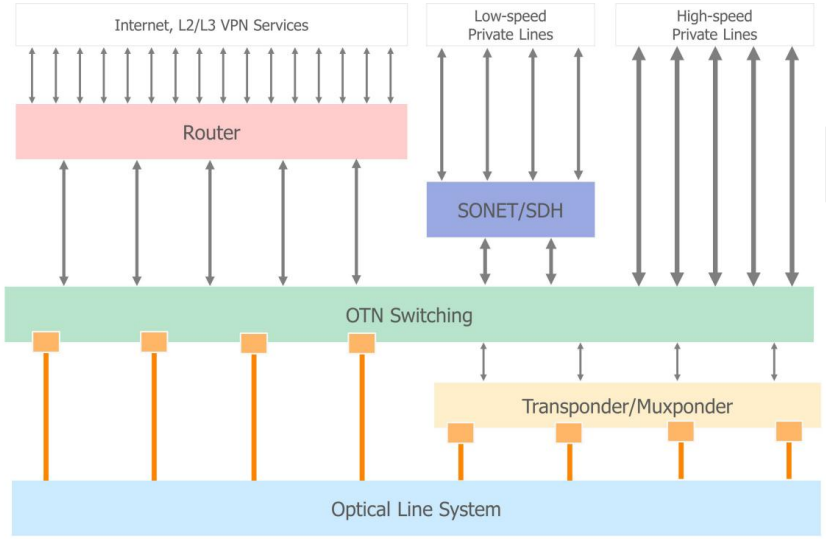


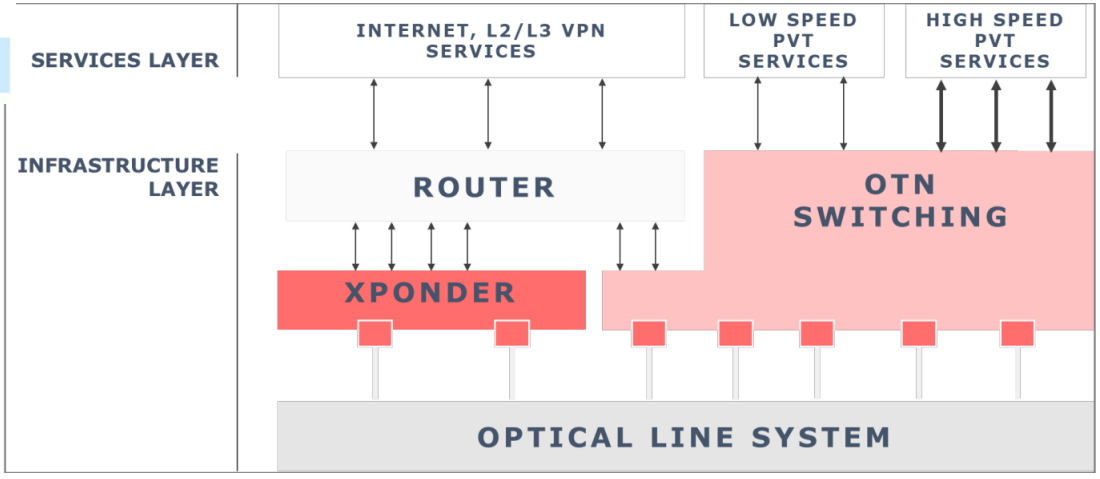
Primary mechanism for delivering high speed (i.e., > 10G & < 100G) private line services

- Greater use of OTN add/drop multiplexer equipment and DWDM Xponders that multiplex lower data rates for higher rate line-side transmission.

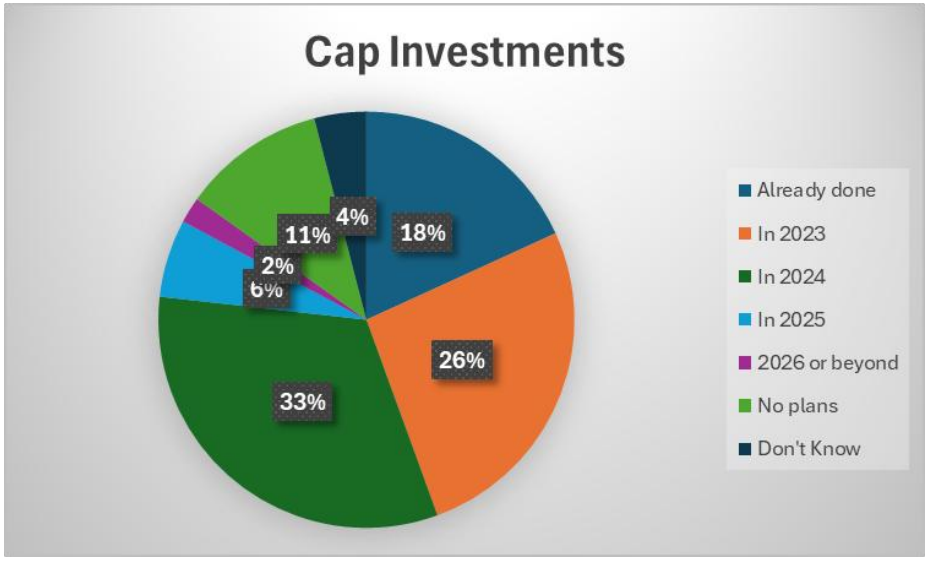


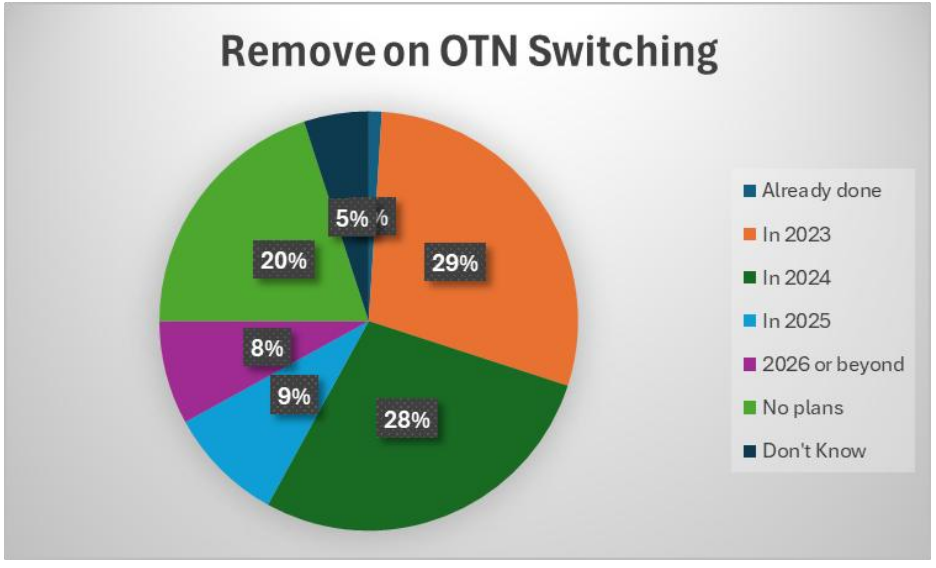
IP/Optical Transport Legacy mode of Architecture
CO-Operation and Complementary



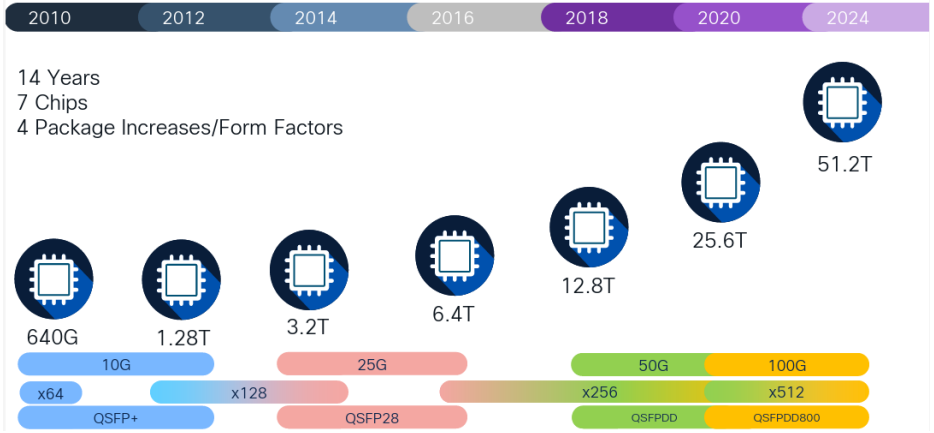


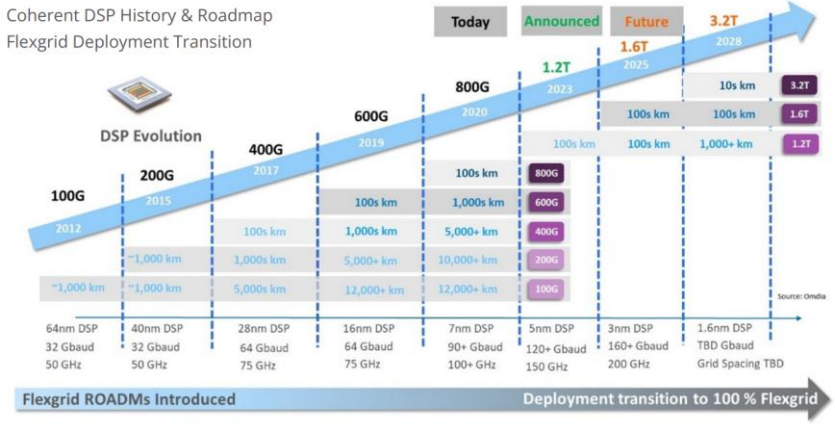
Cap/Remove OTN Switching (Survey from 117 network operators



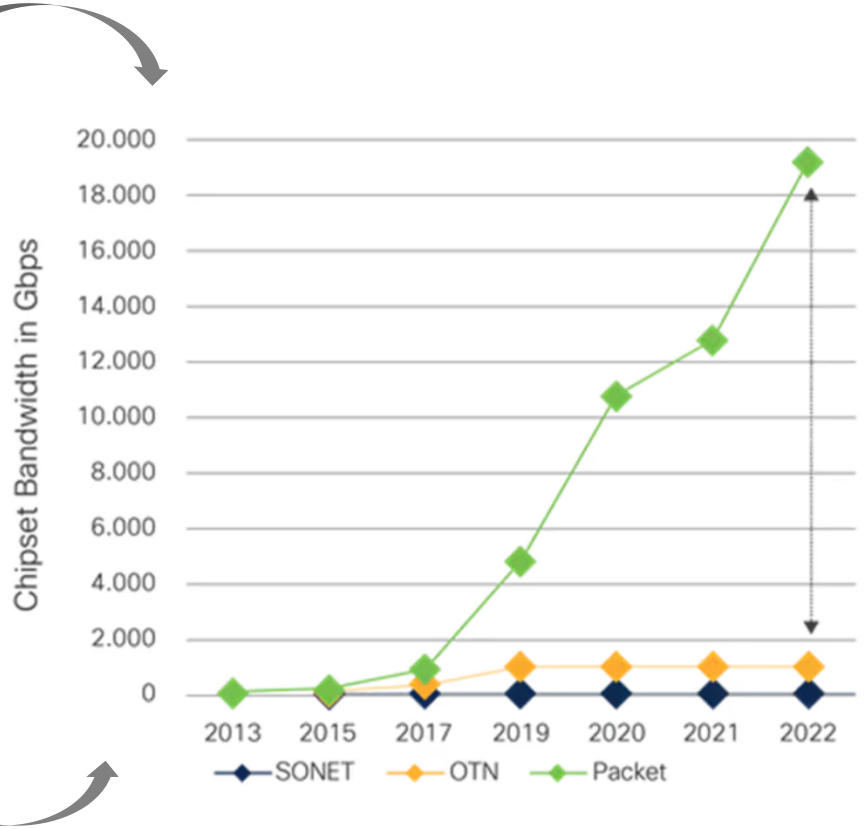


Innovation and Advancement in ASIC : The Limits of OTN Switching



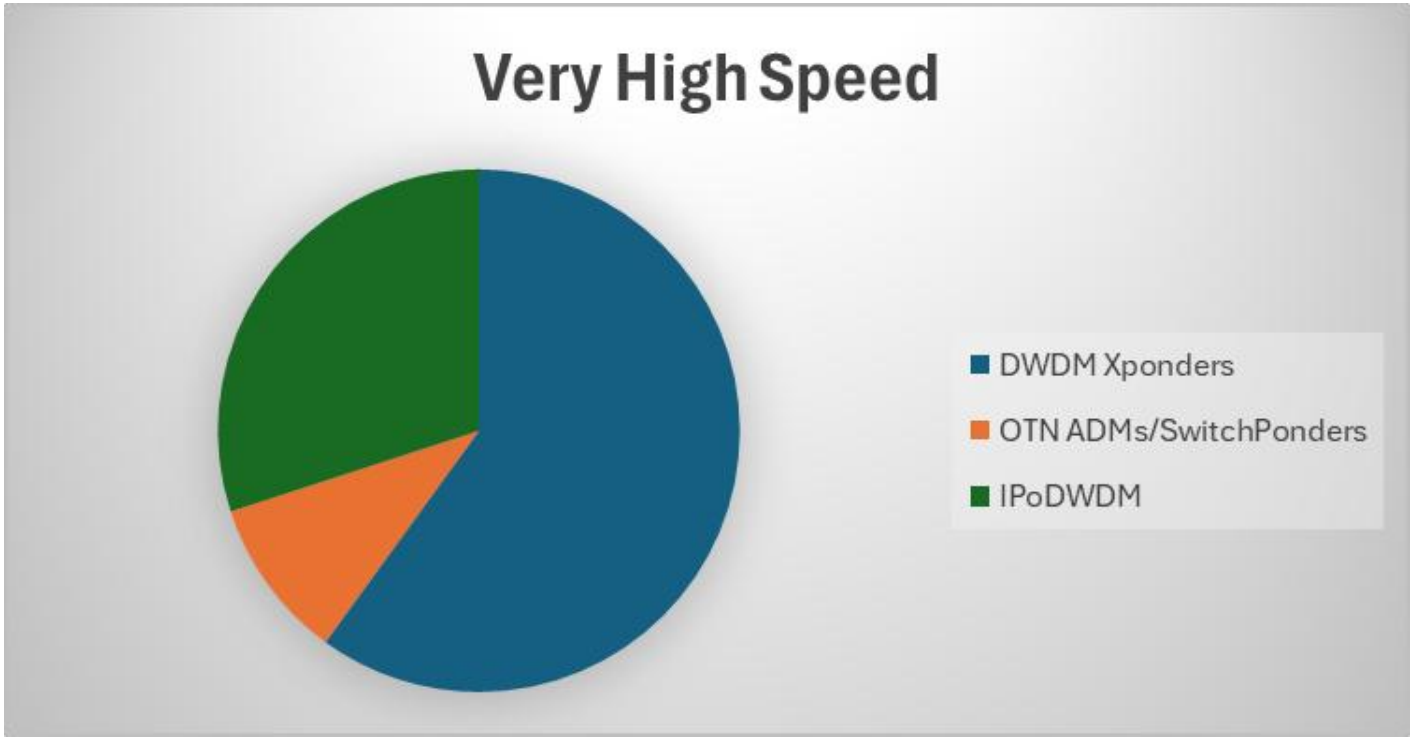


Source: Omdia



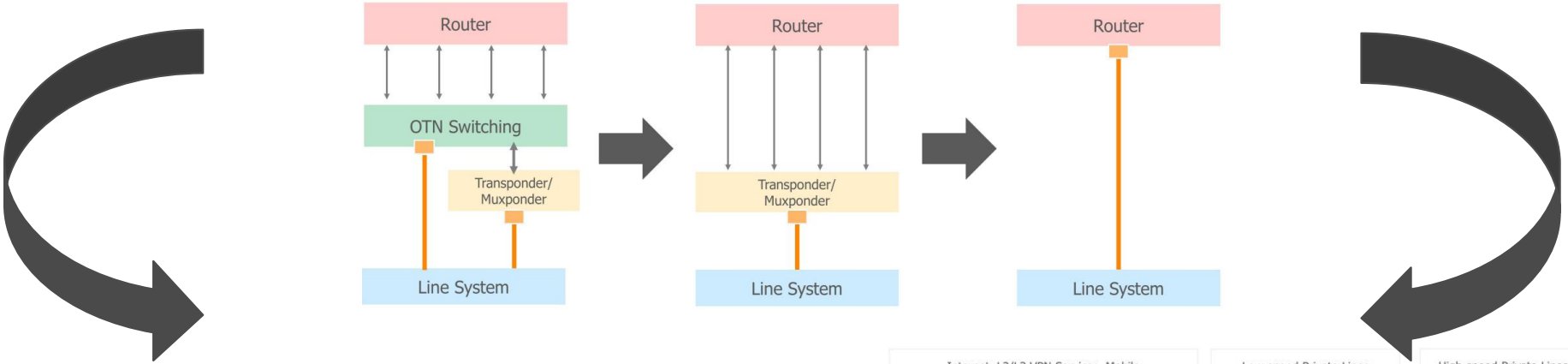
Primary mechanism for delivering Very High Speed (i.e., > 100G) private line services today and for the future.

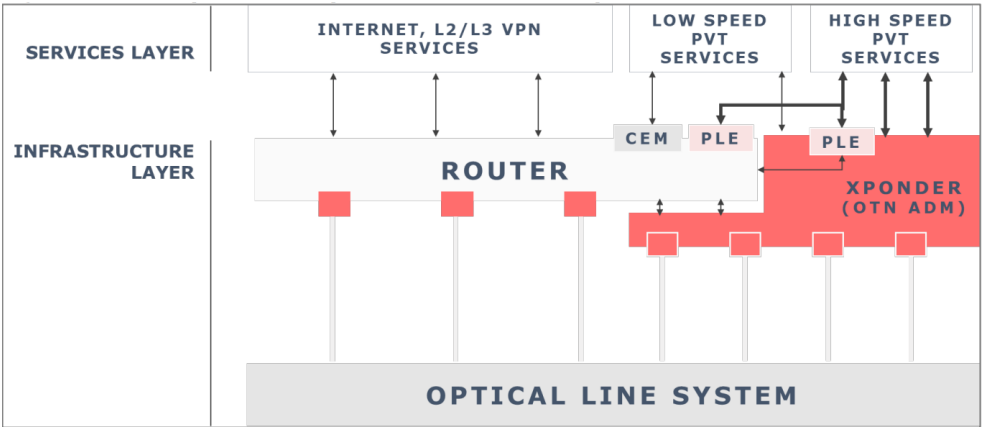
- Greater use of very high-speed DWDM Xponders and IPoDWDM for higher rate line-side transmission. Network traffic and the services that run over networks are based on coherent optical transmission and IP

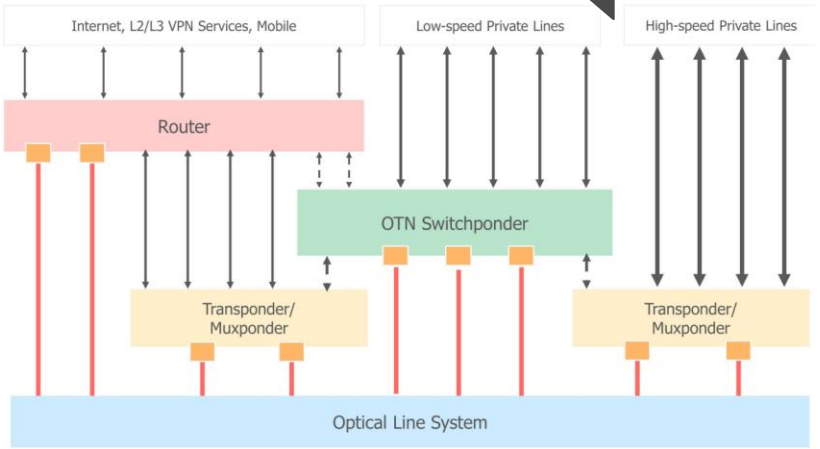


IP/Optical Transport Next Generation mode of Architecture

CO-Operation & Complementary



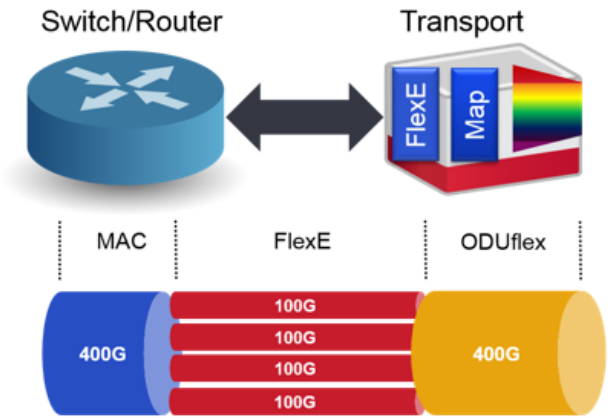




FlexE as a Bridge between OTN & MPLS

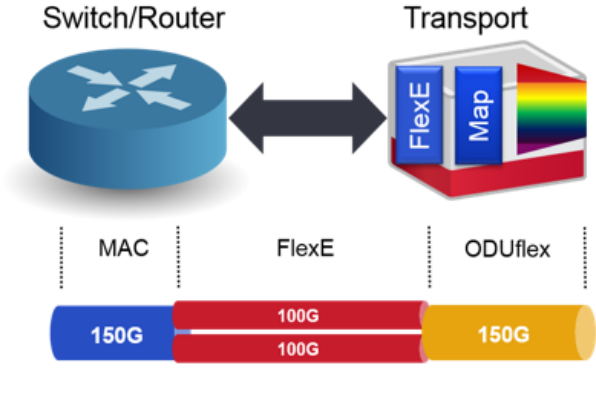
Bonding

- Group interfaces together to enable higher rate clients using existing technology/modules
- Alternative to LAG or ECMP without the inefficiencies associated with hashing algorithms



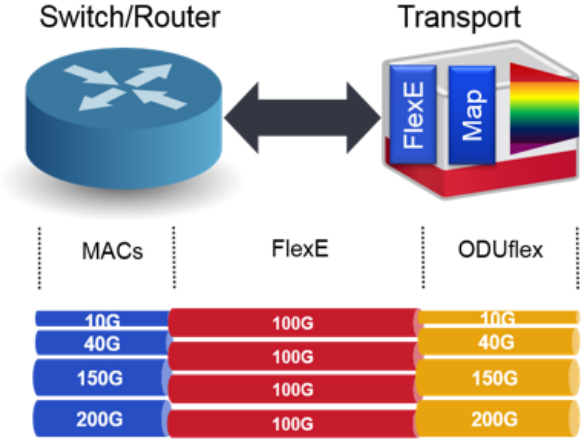
Sub-rating

- Match the client/service rate to a lower speed WDM line
- Provide a means of under-filling an interface without requiring flow control



Channelization

- Provide means of aggregating lower rate clients onto an interface
- More scalable alternative versus VLANs or LSPs

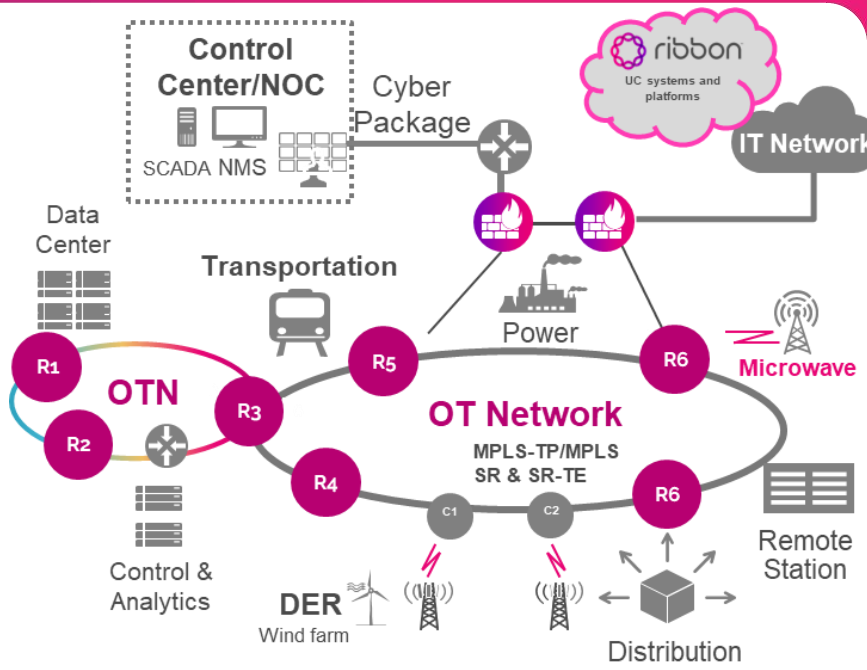


FRMCS Deployment

Use Case

REFERENCES

- **Risk-Free Modernization**
  - Switch fabric supporting Legacy (CES), Elastic MPLS (**TODAY**), SR, Flex-E and OTN
  - Advanced network Slicing support – hard vs soft – IT/OT convergence and 5G use cases readiness
  - Advanced tools for 3rd party integration into MUSE (HMDO)
  - Minimization of network complexity with planning, maintenance, automation and analytics tools
  - Advanced fiber health monitoring for E2E optical layer supervision and control
  - Long-term experience with C.I. projects
  - Future-proof Packet/Optical Domain orchestration
- **Secure OT**
  - Holistic cybersecurity solution – focus on SCADA and OT – energy and railway
  - Flexible Optical/Packet encryption – L1 to L3
  - Secure SW and HW platforms-Common Criteria and sSDLC
  - Compliance to regulations and standards (NERC-CIP, BSI, etc…)



- **Optimized for C.I. operators**
  - ✓ Hardened platforms (redundancy, DIN-rail, temp. range, protection, etc…)
  - ✓ Compliance with strict regulations and standards (IEC 61850, IEEE 1613, EN 50121, etc…)
  - ✓ One-stop-shop (site security, CCTV analytics, E2E project management, wireless, etc…)

REFERENCES

- https://ribboncommunications.com/
- https://www.cisco.com/site/us/en/solutions/routed-optical-networking/index.html
- https://www.lightreading.com/
- https://www.nokia.com/optical-networks/

Thank You