

# **EVPL Over Layer 1 Transport Technologies**

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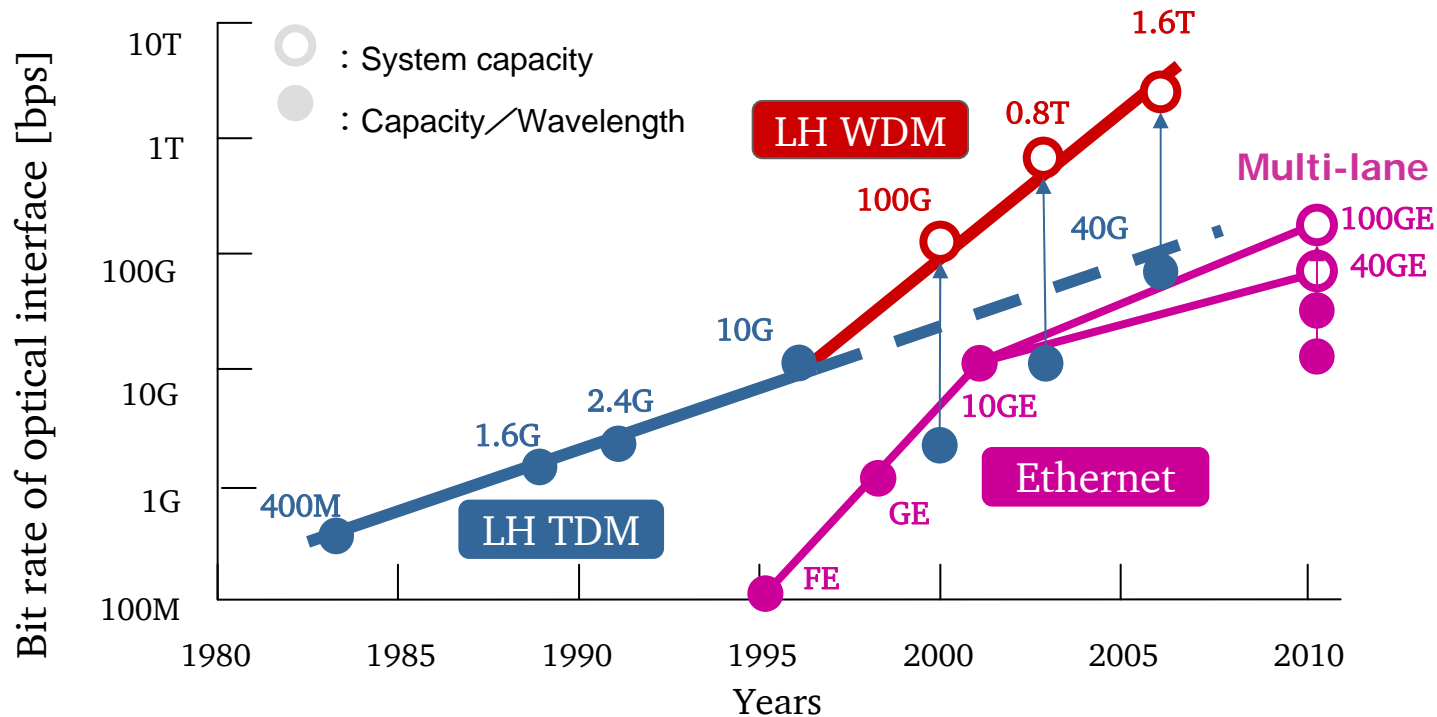
# Outline

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- Background environment
- Recent progress in Layer 1 networking technology (data plane & control plane)
- OIF world wide demonstration of EVPL over Layer 1 technologies
- Future direction of Layer 1 network

# Paradigm Shift in Optical Interface Development

Ethernet is now the driving force in the development in layer 1 technology



Considering EPL (Ethernet Private Line) and EVPL (Ethernet Virtual Private Line) is important to development of future L1 network

# Ethernet Virtual Private Line (EVPL) Over Layer 1

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Wide-area transport technologies are necessary to support long distance transport of Ethernet client

- Need for long distance Ethernet transport
  - ▶ Maximum transmission distance in Ethernet standardization is 40 km
- OTN (Optical Transport Network ) is ideal technology for Ethernet transport
  - ▶ Bandwidth guaranteed circuit
  - ▶ “Digital wrapper” structure is flexibly designed to support variety of service types at various data rates up to 100 Gbps
  - ▶ FEC (Forward Error Correction) enables reliable long distance transport in WDM network

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# Progress Overview of OTN Standardization

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Recent extensions additionally consider mapping of Ethernet clients signals as well as SONET/SDH clients signal

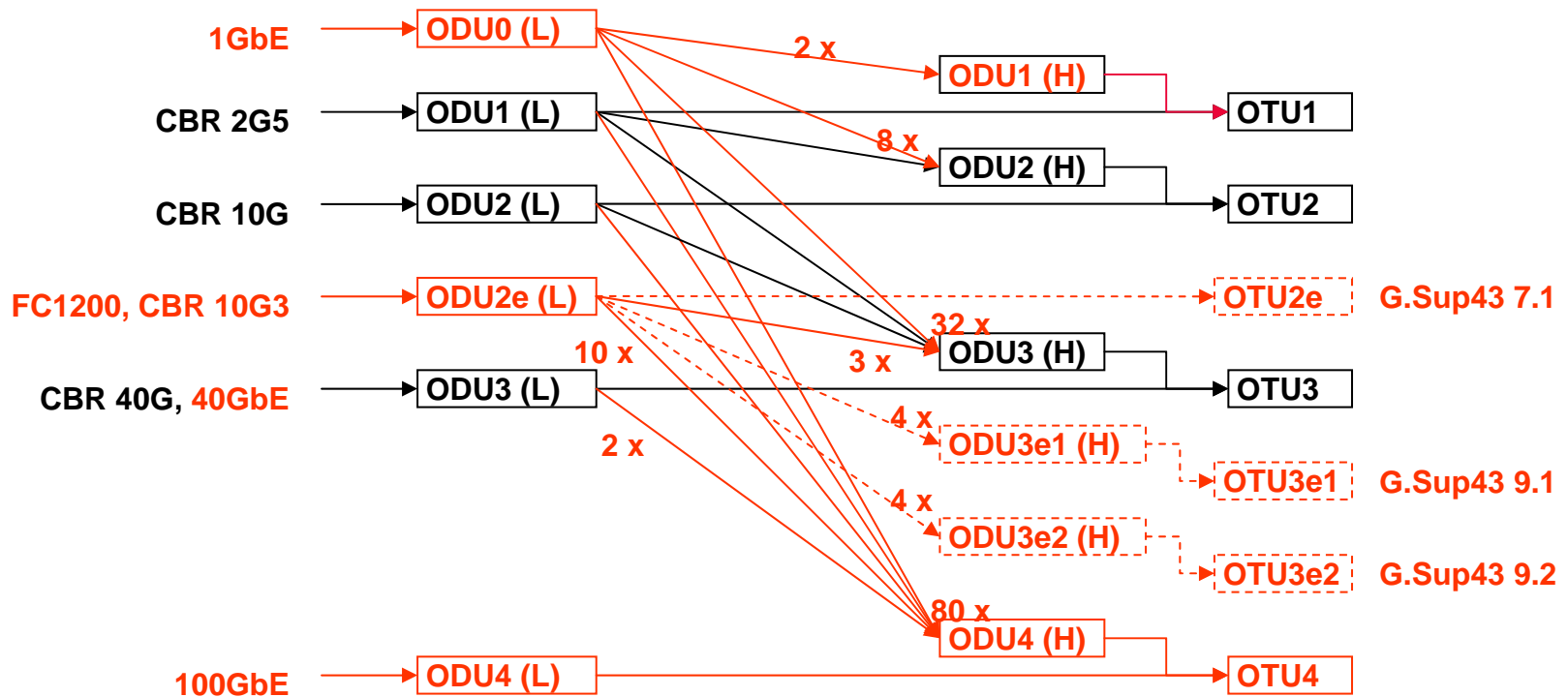
- OTN standardization in ITU-T SG 15
  - ▶ First version standardized in 2001 and discussion is continuing
  - ▶ Recommendation G.709 specifies frame structure and OAM capabilities

## Examples of recent topics

- ▶ Extension of OTN hierarchy
  - ✓ Extension considering Ethernet clients
- ▶ Transcoding for 40GE
  - ✓ Enables 40GE transport using OTU3
- ▶ Flexible ODU
  - ✓ ODU with flexible payload capacity for various client signals
- ▶ Generic Mapping Procedure (GMP)
  - ✓ Mapping of arbitrary rate client signal

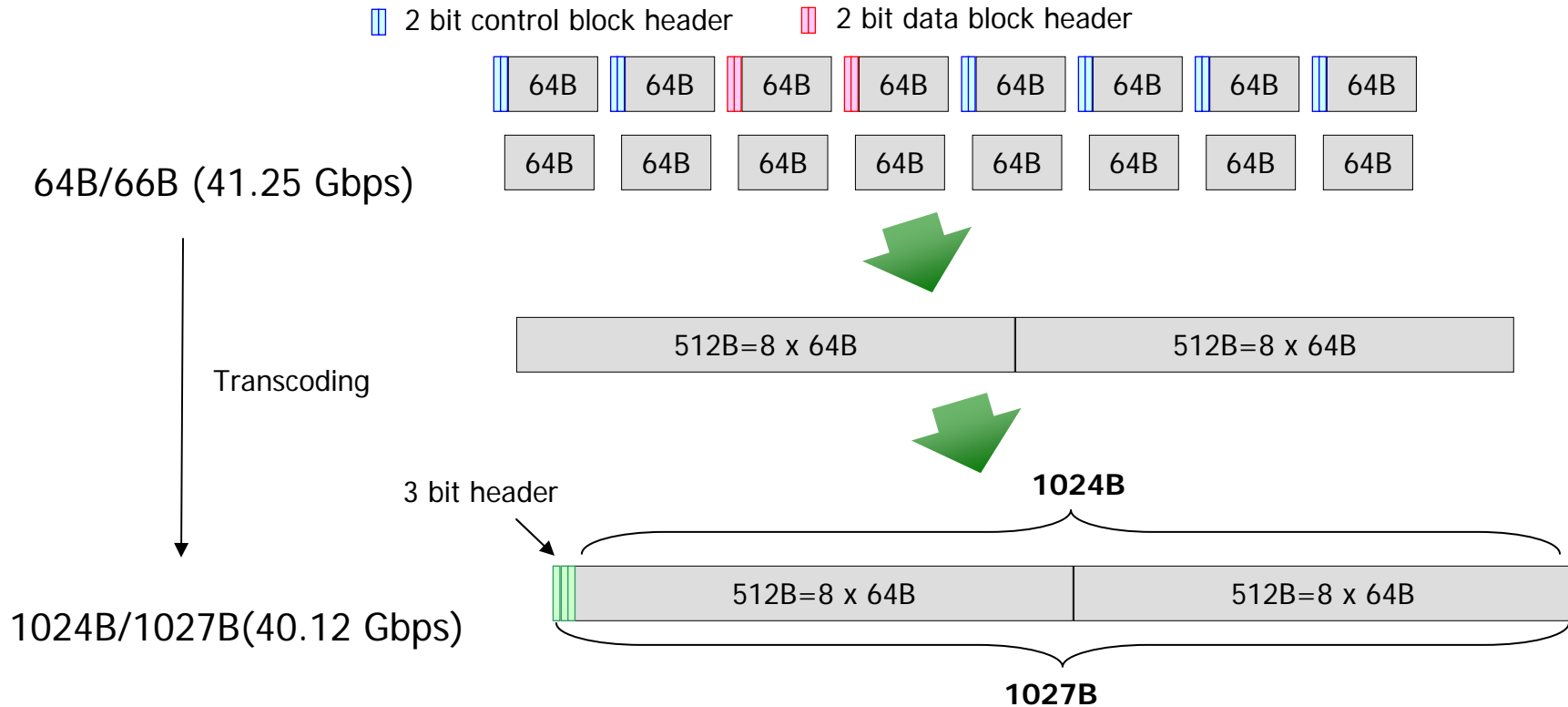
# Extension of OTN Hierarchy

- ITU-T SG15 agreed on G.709 Amendment 3 extending the existing OTN hierarchy
  - ▶ New ODU (container) for Ethernet client
    - ✓ ODU4(100GE), ODU0(1GE)
  - ▶ ODU2e was adopted into G.709 from G. sup43 for 10GE (BASE-R) transport
- ODU3e is newly defined for transport of 4 x 10GE in G.sup43



# Transcoding for 40GE

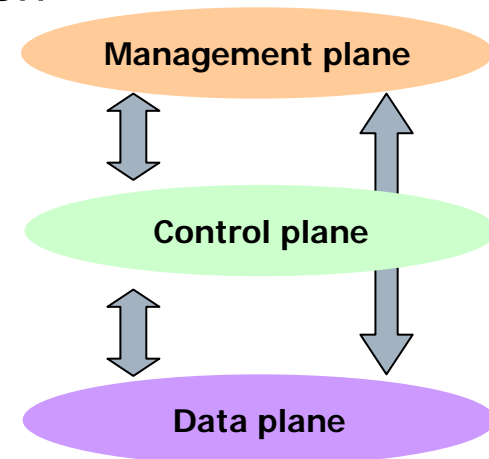
- Transcoding enables 40GE client (41.25 Gbit/s) transport using existing ODU3 (40.15 Gbit/s)
- 1024B/1027B achieves robust transport of 40G base-R signal by transcoding 64B/66B into 1024B/1026B for rate reduction



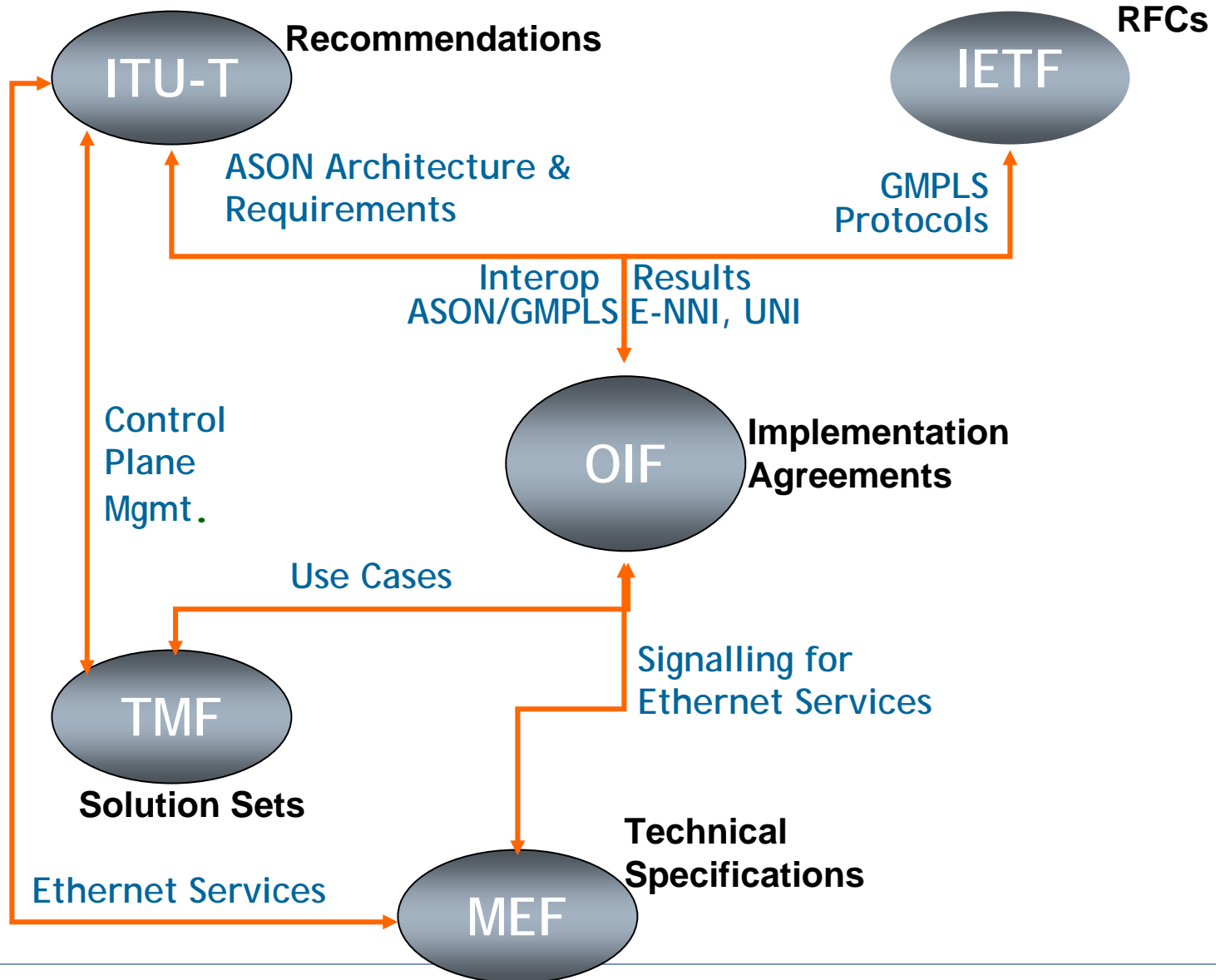
# “Control Plane”-Enabled Layer 1 Network

Standardized control plane achieves service enhancement and operational improvement with interoperable technology

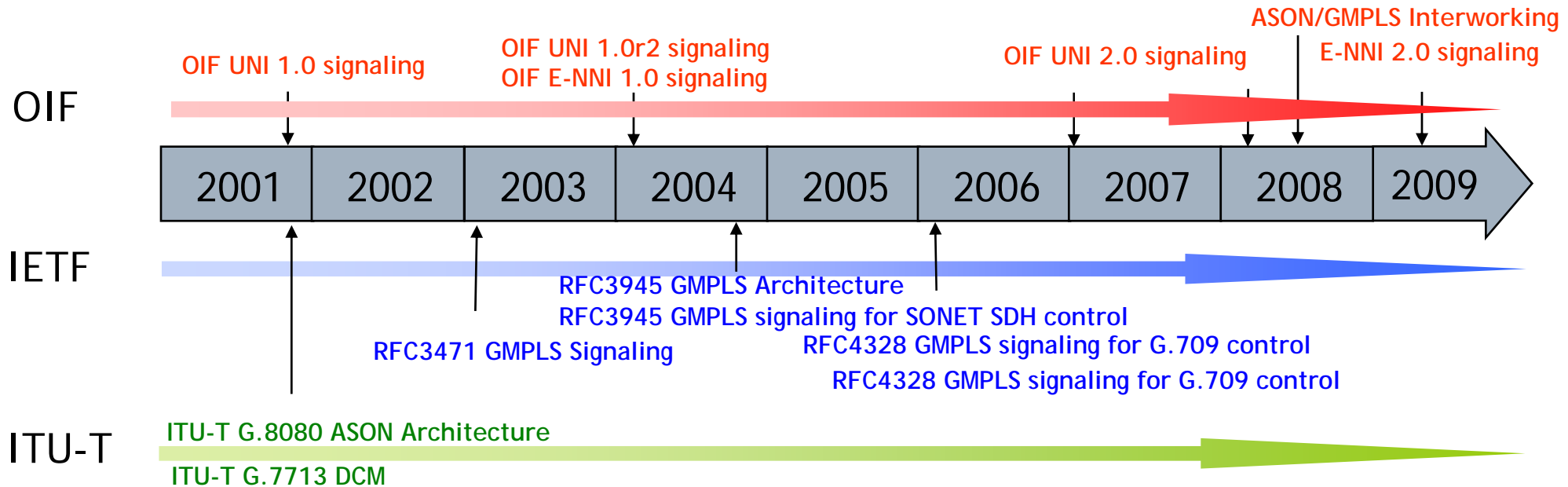
- Control plane provides intelligence to Layer 1 networks while maintaining transport nature of the data plane
  - ▶ Control plane / Data plane separation
    - ✓ Introduction of control plane does not affect functionality of transport network (data plane)
- Benefits of standardized control plane introduction
  - ▶ Service enhancement
    - ✓ On-demand bandwidth services
    - ✓ Faster service provisioning
    - ✓ Robust and cost-efficient restoration
  - ▶ Operational improvement
    - ✓ Auto discovery
    - ✓ Auto provisioning



# Control Plane Standardization



# Example of standards concerning signaling function



OIF UNI 2.0 enables control plane based EVPL over multiple transport technologies with the combination of other standardized components

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# OIF Conducted Interoperability Demonstration of EVPL Over OTN/SDH

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OIF pioneered interoperability tests of OTN supporting EPL and EVPL services

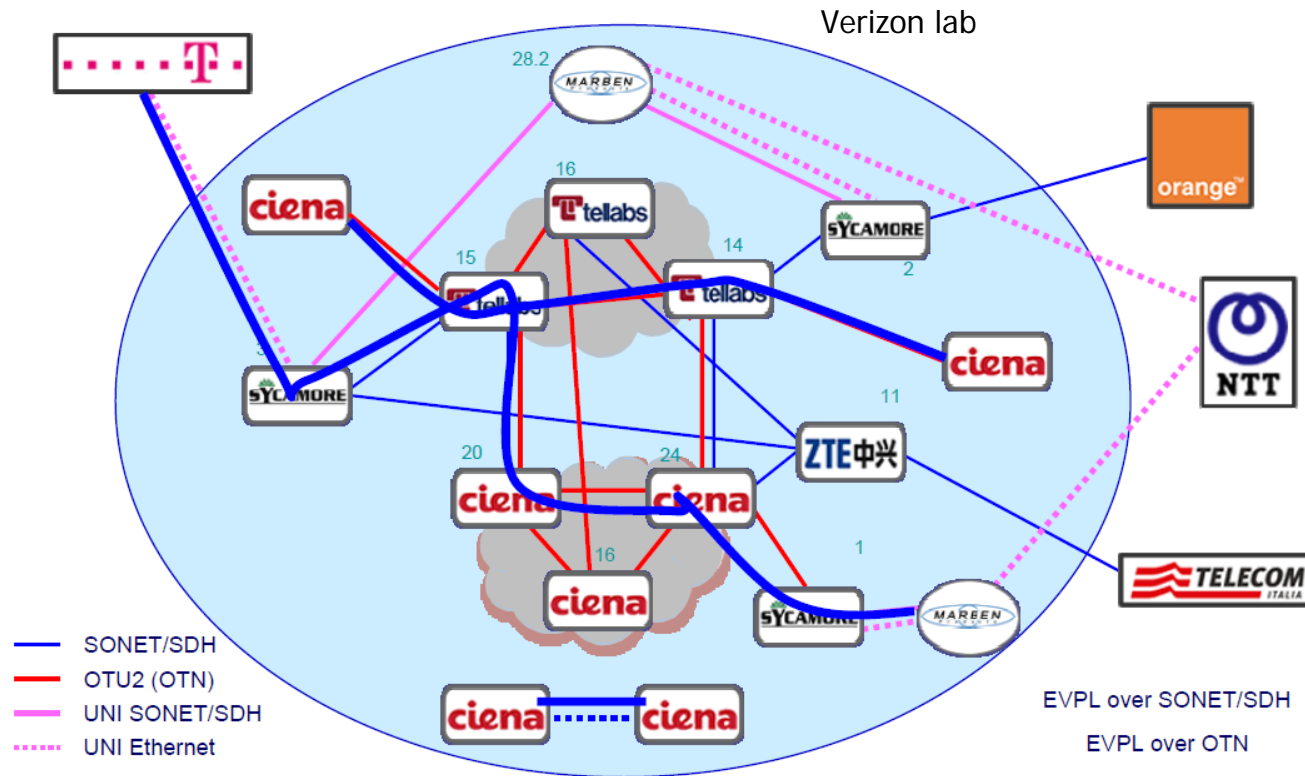
- 2009 OIF Worldwide Interoperability Demonstration
  - ▶ Broadband on-demand services in a multi-vendor multi-carrier environment
  - ▶ Conducted in carrier labs worldwide since March to June 2009,
- Tested OTN features include:
  - ▶ Mapping of EVPL services to OTN connections
  - ▶ Switching of OTN connections for EVPL across an OTN transport infrastructure
  - ▶ dynamic OTN connection provisioning and restoration

(using embedded SONET/SDH over OTN)

  - ▶ Mapping of embedded SONET/SDH OC48/STM16 links over OTN OTU2 links
  - ▶ Switching of OTN connections carrying embedded SONET/SDH
  - ▶ Support of SONET/SDH control plane E-NNI 2.0 for embedded SONET/SDH over OTN

# Example of Demonstration Topology for EVPL Over L1

- Topology of OIF Carrier Lab Day at Verizon Labs



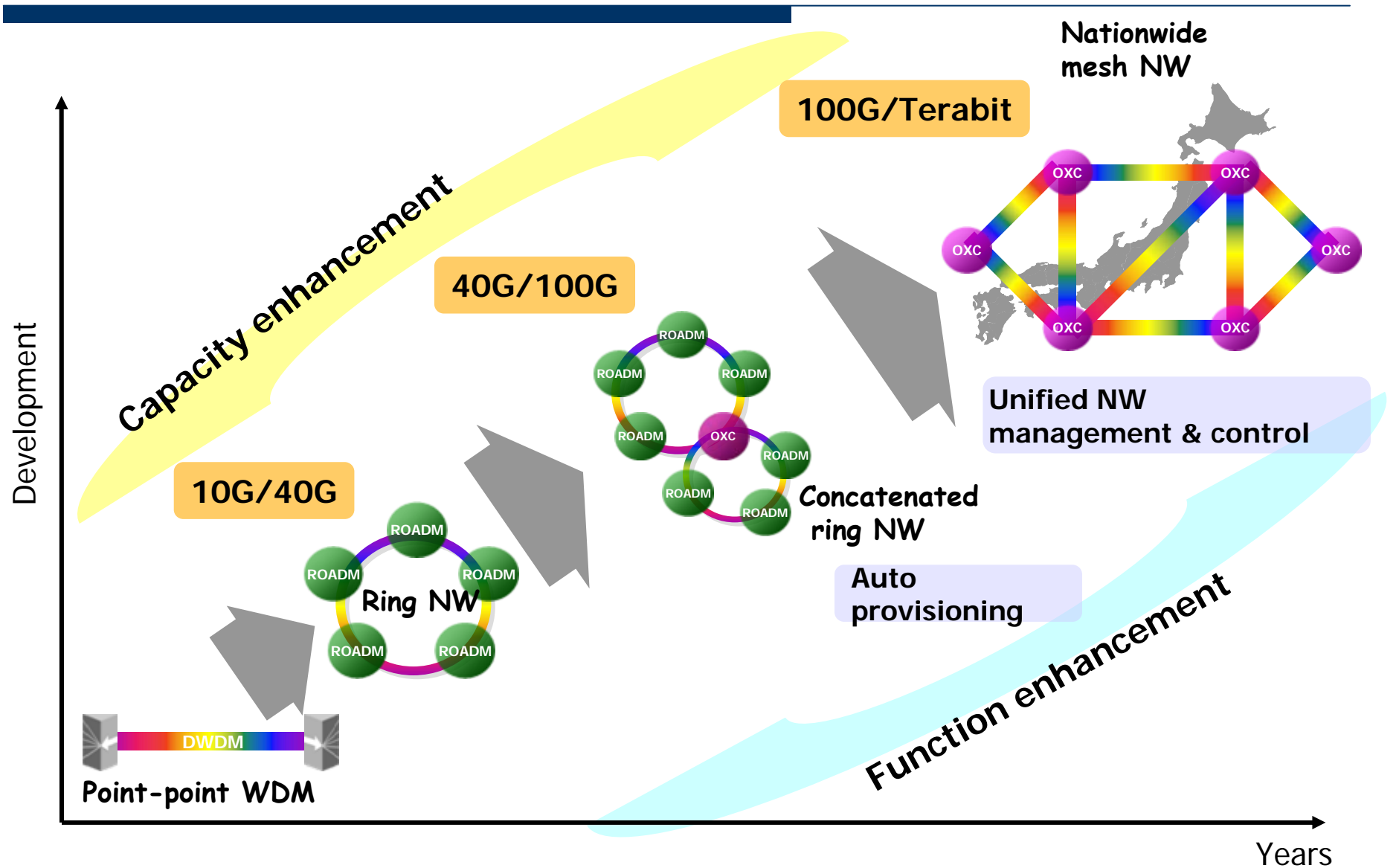
- Data plane connection for EVPL over OTN
- Dynamic connection setup for EVPL over SONET/SDH using UNI 2.0

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# Direction of Layer 1 Networking



# Control Plane Utilization in Future L1 Network

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## Key technology: Transparent optical network (a.k.a. all optical network)

- ▶ Provides end-to-end optical path without electrical signal regeneration.
  - Saves on CAPEX, power consumption, footprint.
- ▶ Eliminates need for on-site operation to provide OEO regeneration
  - Inevitable feature to take advantage of control plane-based auto provisioning

## ● Issue facing transparent optical network

- ▶ Limitation on optical transmission reachability due to accumulating signal impairment
  - Careful route selection is required

## ● Possible solution using control plane

- ▶ Path provisioning using impairment aware routing
- ▶ Information abstraction and visualization of the transmission guaranteed routes using signaling protocol

→ Please visit P5.14 Wed. Poster Session

# Summary

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- Ethernet clients drive Layer 1 technology development
- Recent progress in Layer 1 networking technology (data plane & control plane)
  - ▶ Extension of OTN
  - ▶ Control plane standardization
- OIF world wide demonstration of EVPL over Layer 1 technologies
  - ▶ Pioneered interoperability test of OTN supporting EPL and EVPL services
- Future direction of Layer 1 networking
  - ▶ Nationwide transparent optical network with unified network control and management