DetNet Control Plane – Possible Future

November 11, 2018
Bangkok, Thailand

DetNet and Control Plane

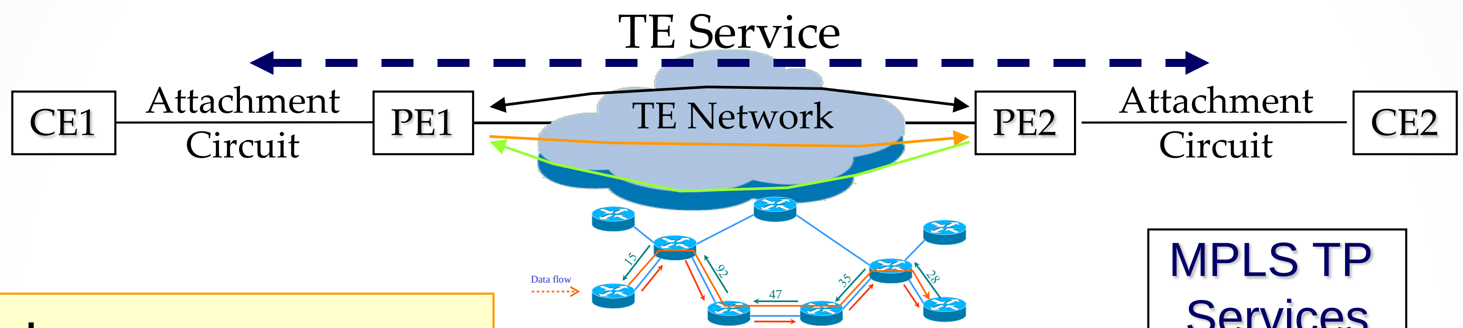
- Direct work on Control Plane functions is currently out of scope
  - This can be revisited once work deliverables are complete
- Indirect / supporting work, including implications and requirements, is in scope
  - Flow information model
  - Data plane solutions documents
  - YANG models
- Future work will leverage existing RFCs and drafts in development of other Working Groups
  - Some work likely to move to protocol owning WG, with DetNet WG defining requirements
  - Objective of this talk is identify those other WGs and their technologies
    - For more information see tutorial from IETF 103: An IETF Traffic Engineering Overview https://datatracker.ietf.org/meeting/103/materials/slides-103-edu-sessk-an-ietf-traffic-engineering-overview

Related IETF Technologies

- MPLS-TE: MPLS with traffic engineering
  - Includes: Data Plane, Routing (OSPF-TE, ISIS-TE), Signaling (RSVP-TE)
  - MPLS-SR (segment routing) with Traffic Engineering possible future
- GMPLS: Distributed Multi-layer transport network control
- PWs: Service adaptation via Pseudo Wires and EVPN control
- PCE: Centralized path computation and control
- ACTN/SDN-TE: An approach to delivering TE orchestration and control
- TE YANG Models: for monitoring and north/south control
  - Can be used with centralized, decentralized or hybrid control approaches

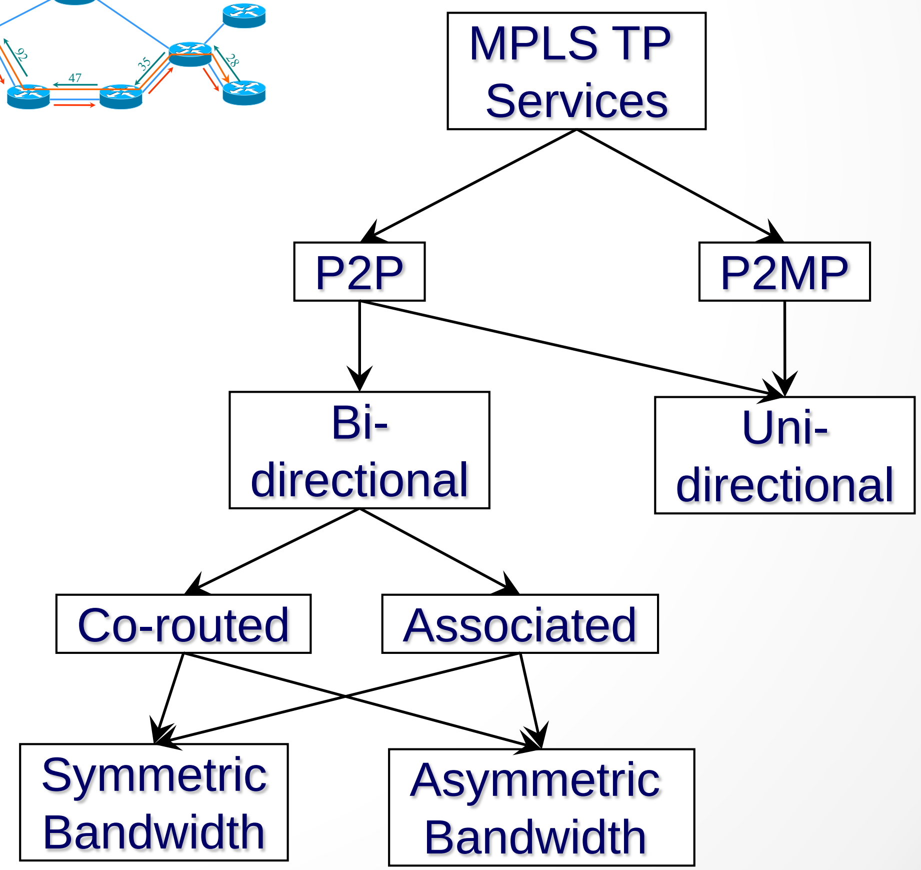
MPLS-TE Service

Traffic Engineered Tunnels Between Endpoints

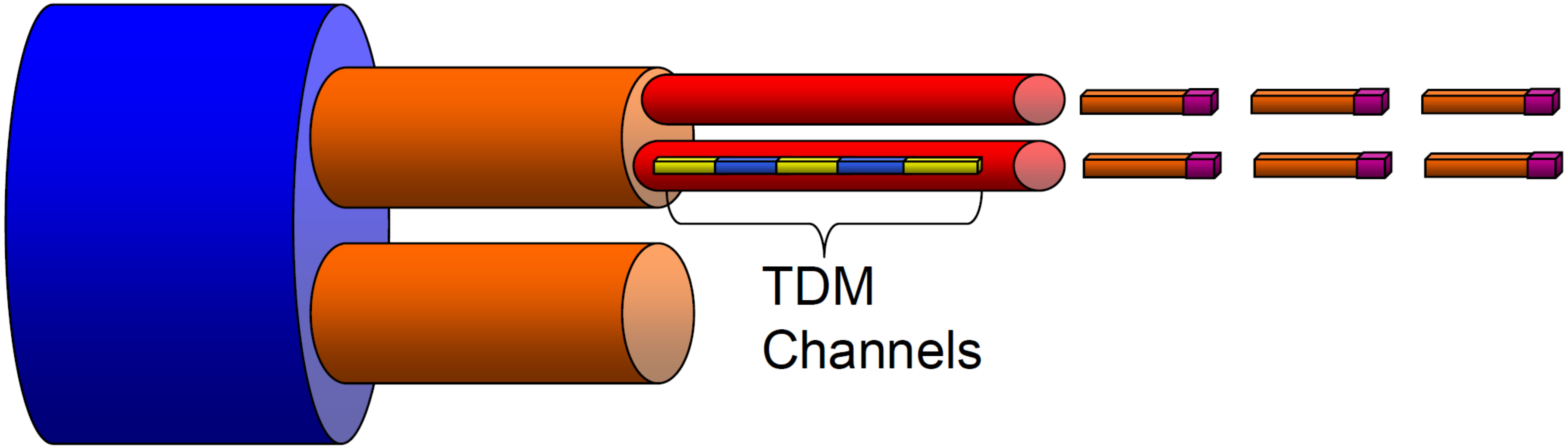


Service may be:

- Unidirectional Point-to-point (P2P) or Point-to-multipoint (P2MP)
- Bidirectional P2P
  - o Co-routed or associated
  - o Symmetric or asymmetric bandwidth
- Multiple recovery options



GMPLS : A Label Hierarchy



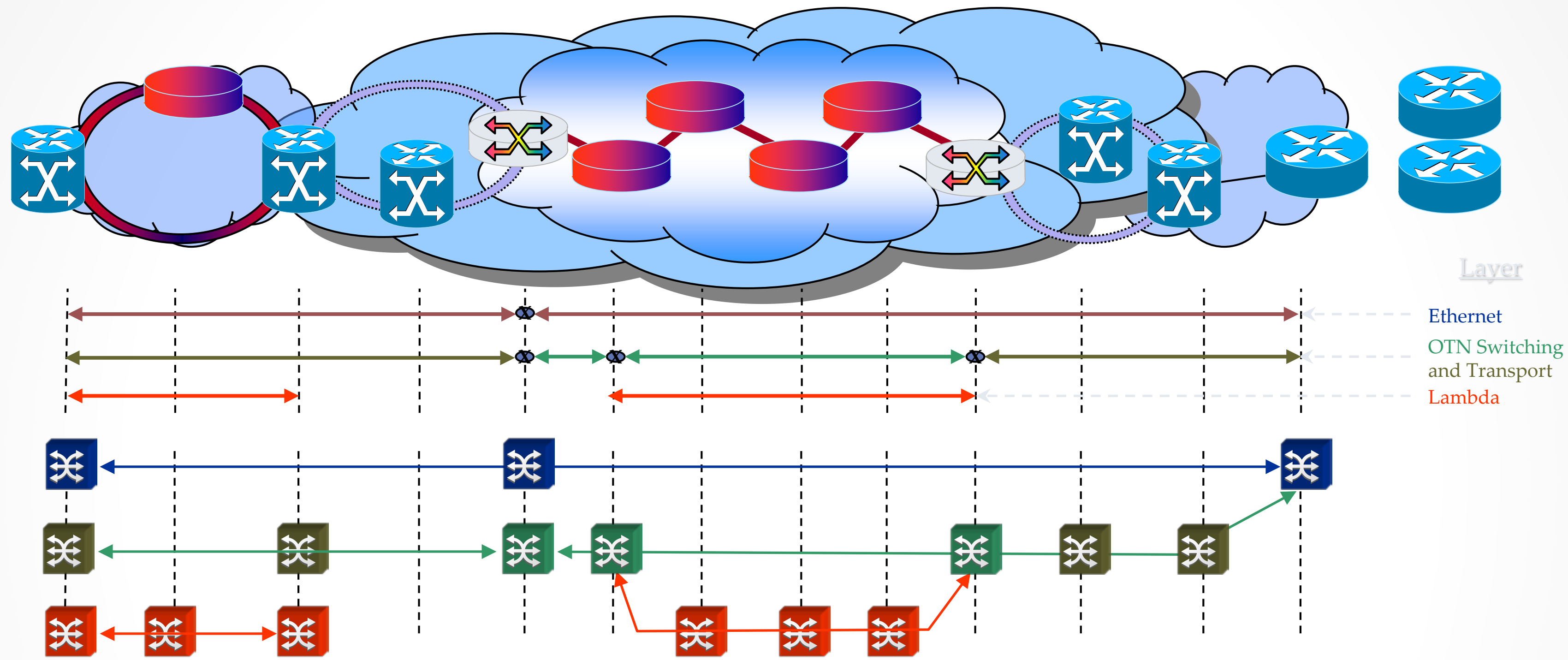
RFC 3945

- Observe that MPLS-TE is a circuit switching technology based on labels
  - We can generalize the concept to any switching technology
  - Labels move from additions to the packet (headers) to physical identifiers
- Generalized MPLS (GMPLS)
  - MPLS control plane extended for circuits, lambdas, fiber and ports
  - OSPF-TE (and ISIS-TE), RSVP-TE
  - New protocol
    - Link Management Protocol (LMP) to coordinate physical links

RFC 3473

Source: An IETF Traffic Engineering Overview

GMPLS: Example Multi-Layer Configuration



- Ethernet service: End to end with mid-stage grooming
- TDM - OTU/ODU services:
  Independent between Ethernet processing nodes
- Lambda services: Independent across WDM networks

MPLS-TE and GMPLS Control Protocols

MPLS Control Plane

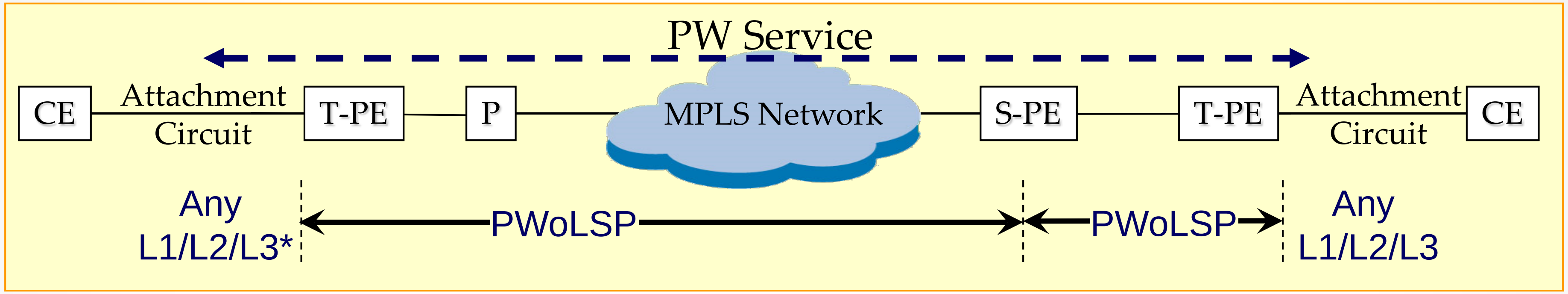
- Prefix LSP Signaling
  - LDP (and BGP)
- Tunnel LSP Signaling
  - RSVP-TE, CR-LDP
- TE-Routing
  - OSPF-TE, IS-IS-TE

GMPLS extensions

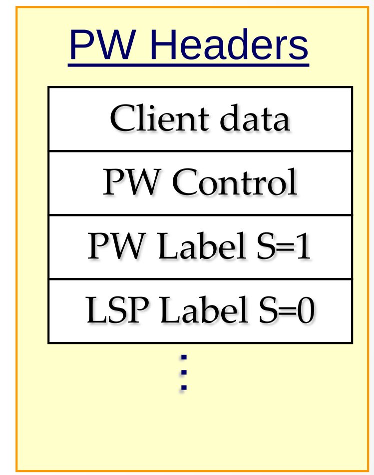
- GMPLS-Routing
  - OSPF-TE, IS-IS-TE
- GMPLS-Signaling
  - RSVP-TE, CR-LDP
- Link Management
  - LMP, LMP-WDM, LMP-SONET

- Some implementations use centralized control – more on this later

PseudoWires



- Transports layer 1, 2 or 3 data over packet networks
  - o For example TDM, Ethernet or ATM over MPLS
- PW Control Word used to
  - o Differentiate traffic types (IP vs PW)
  - o Enable PW client related processing
  - o Supports PW OAM
- BGP-Based EVPN is current preferred L2VPN control protocol



Path Computation Element (PCE)

RFC 4655

RFC 5152

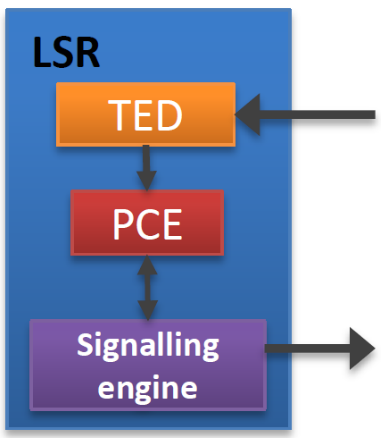
- *PCE: Path Computation Element. An entity (component, application, or network node) that is capable of computing a network path or route based on a network graph and applying computational constraints* – RFC 4655
  - This does not say it is a dedicated server
  - It can be embedded in a router
  - It can be embedded in ***every*** router
- For virtual PoP use case
  - PCE function in head-end LSR for local domain
  - PCE function in remote ASBR accessed through remote call

Source: An IETF Traffic Engineering Overview

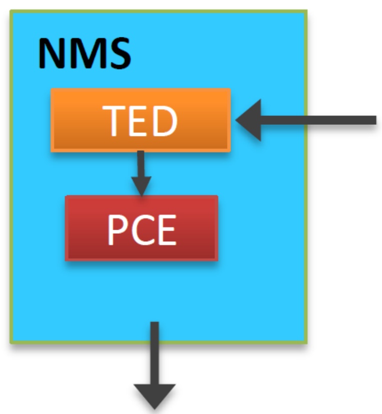
Realisations of the PCE Architecture

- Historically, head-end LSRs did path computation
  - They included a PCE component
- Historically , the NMS determined paths and instructed the network
  - It included a PCE component
- The PCE architecture recognises these and allows PCE to be externally visible perhaps on a dedicated server

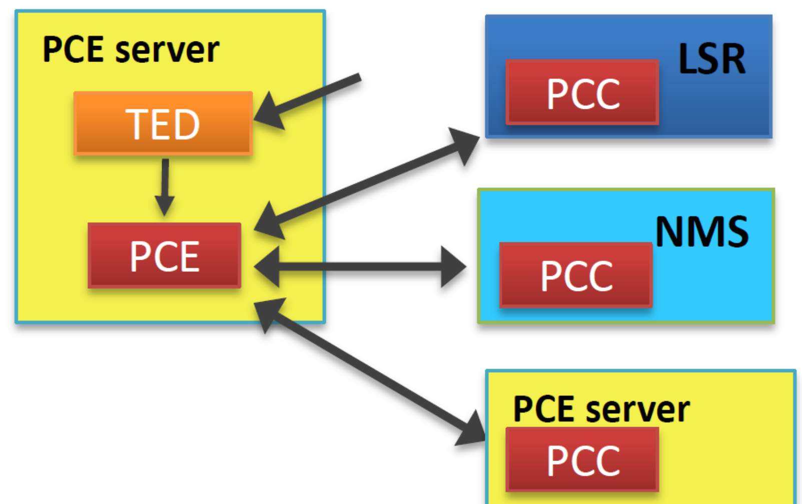
RFC 5440



PCE co-located in the LSR



PCE in the NMS



PCE in a dedicated server

Source: An IETF Traffic Engineering Overview

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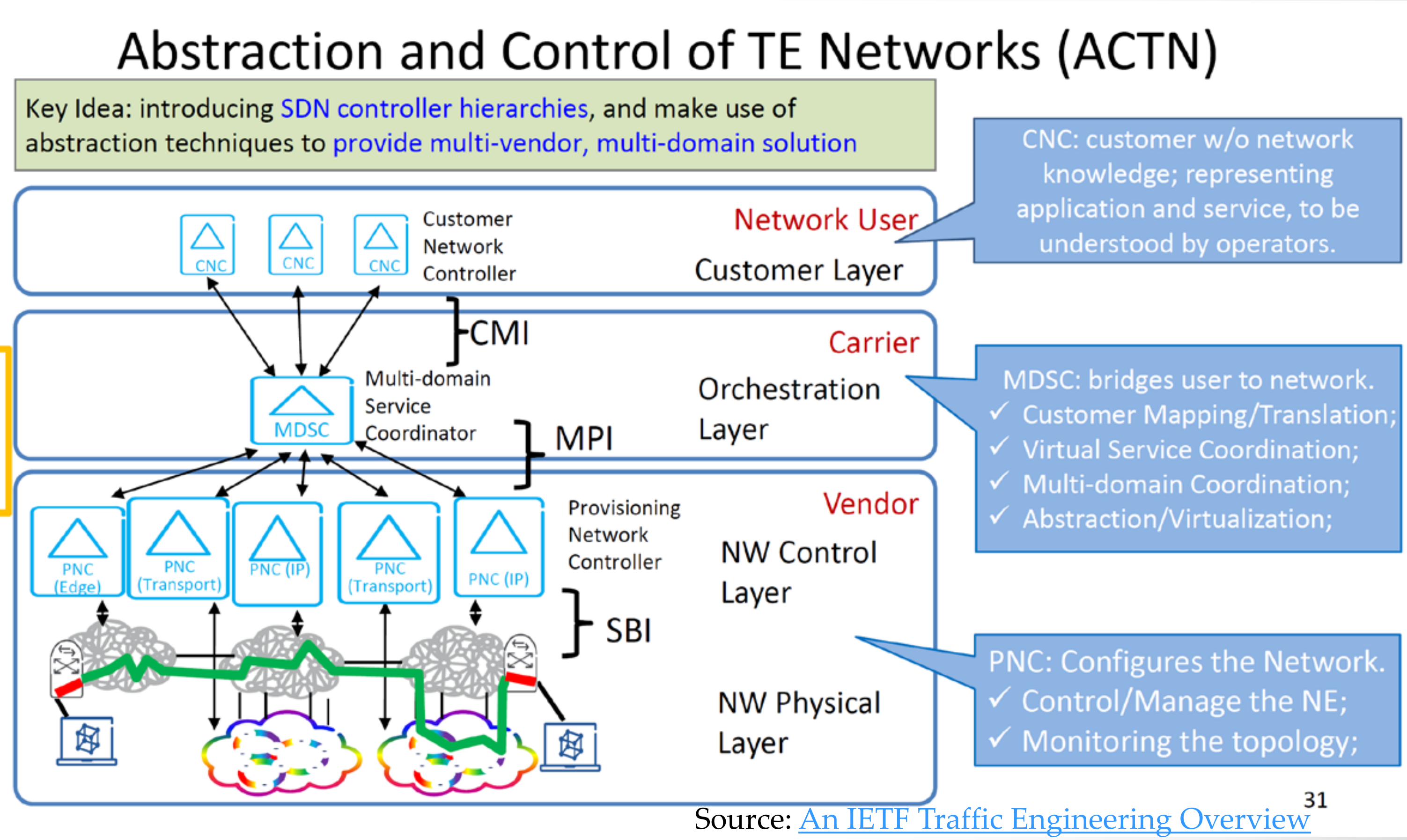
ACTN/SDN-TE

- TEAS WG ACTN provides a framework for SDN control of traffic engineered networks
- Useful reference architecture
  - o Controller-based solutions need not adhere to ACTN
- North-south interfaces are generally applicable
  - o To non-ACTN controllers and even distributed control planes
  - o Defined using YANG

RFC 8453



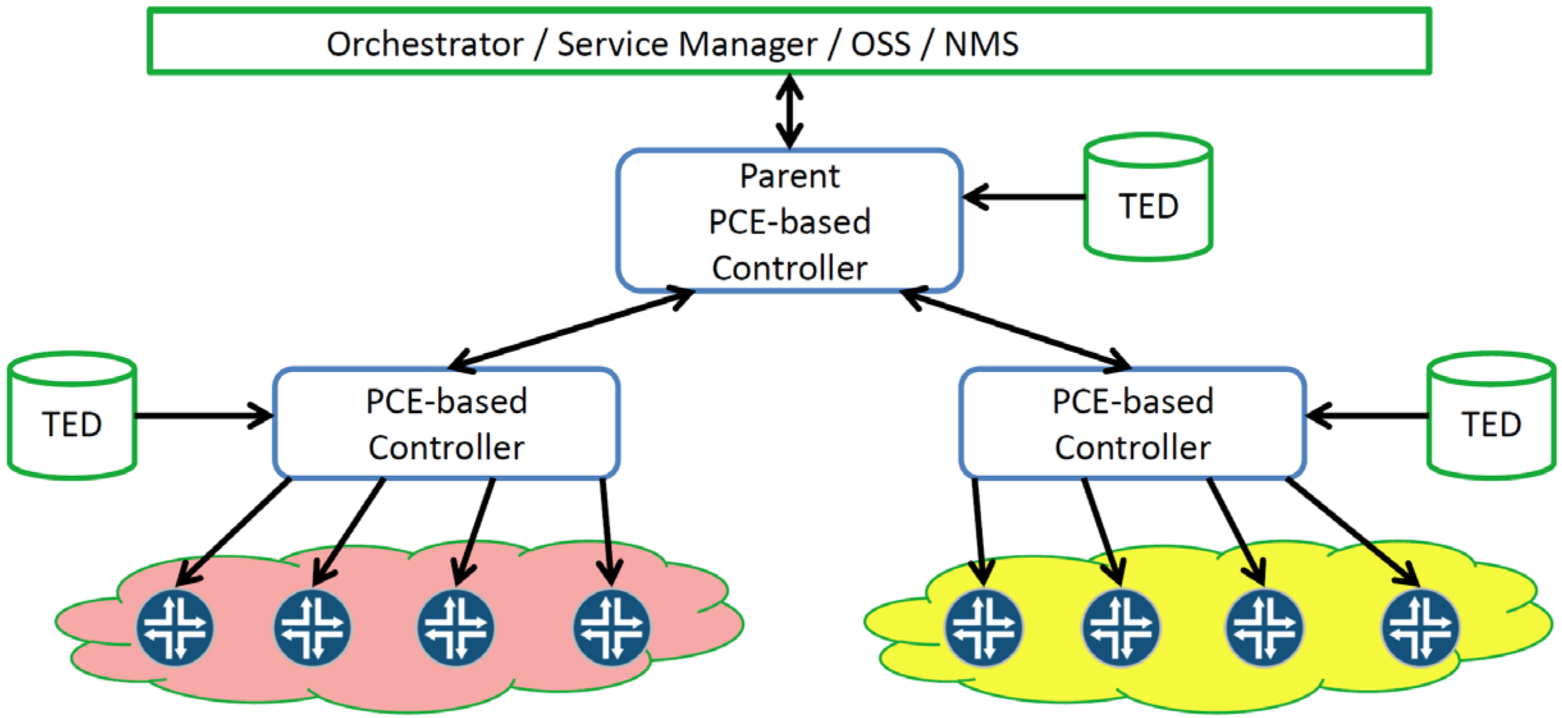
PCE as a Controller

- Non-ACTN SDN-TE Controller Example

PCE as a Central Controller (PCE-CC)

- Integrating PCE into an SDN architecture
  - All southbound exchanges use PCEP
  - Control may be single node
  - Applications proposed in MPLS, non-packet, and IP environments

RFC 8283



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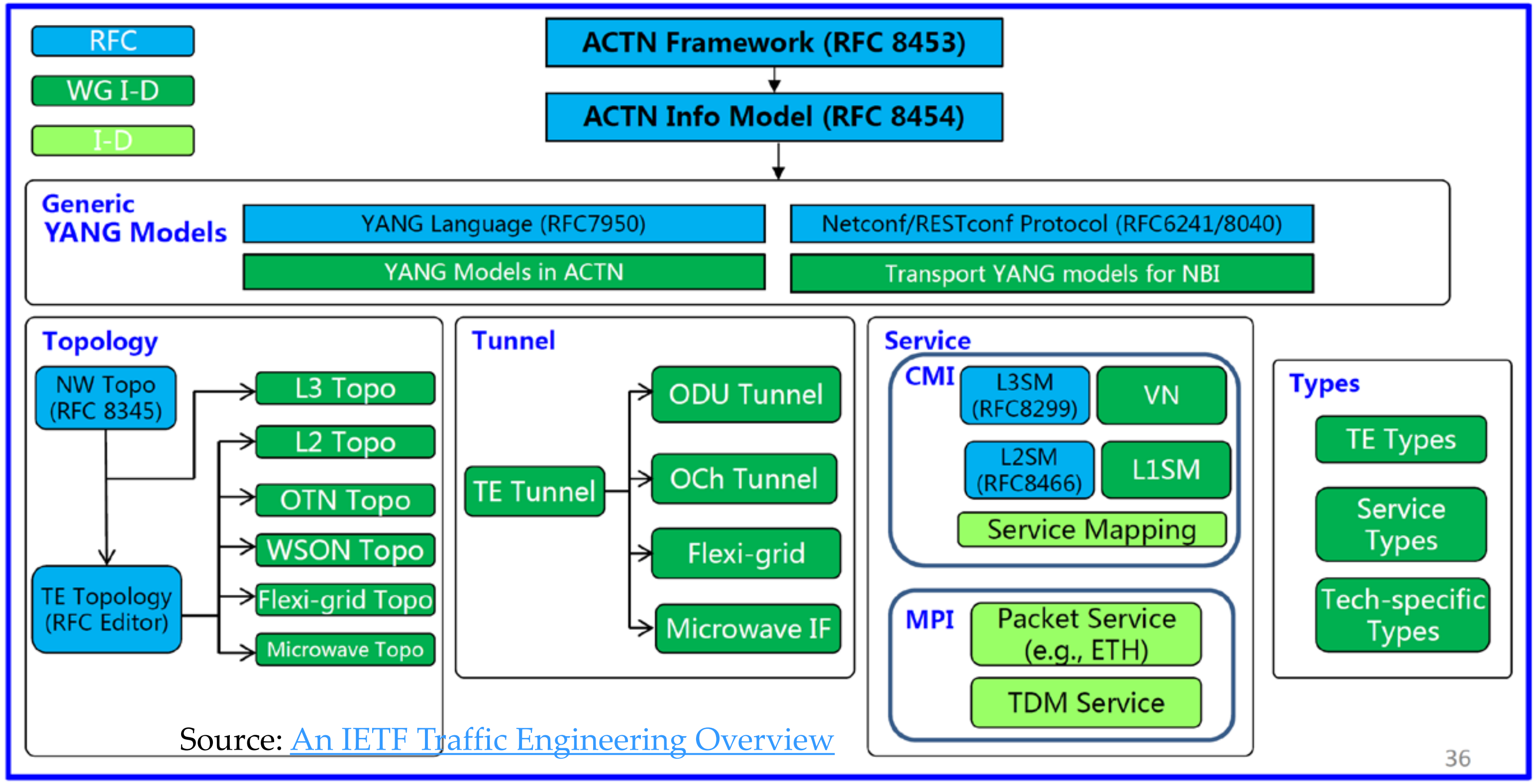
Source: An IETF Traffic Engineering Overview

TE-YANG

- Multiple YANG models supporting TE exist
  - o Defined in multiple WGs
  - o Different stages of process
- Reminder: ACTN is a reference model for SDN-TE, not a required implementation

YANG Models for ACTN and TE



Source: [An IETF Traffic Engineering Overview]()

Segment Routing (SR)

- A tunneling technology
  - Encapsulates a packet within a header
  - Forwards packet based upon encapsulating header
  - Compare and contrast with IP source routing
- A Traffic Engineering (TE) technology
  - Allows a router to steer traffic along an SR path
  - Path can be different from the least cost path
- Maybe more?
  - Innovative new applications to be discovered
- Control plane
  - Signaling removed from the network
  - Routing protocols augmented a little
- Forwarding planes
  - MPLS
  - IPv6
  - ***NOT*** IPv4

RFC 7855

Source: An IETF Traffic Engineering Overview

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- SR-TE work is on-going
  - o Currently path steering is defined via policy (Path Engineering only)
  - o Some individual proposals include resource control

Related IETF Working Groups

- TEAS: Traffic Engineering Architectures and GMPLS/RSVP-TE
- MPLS: MPLS data plane, LDP, MPLS specific control
- PCE: PCE protocol, servers
- LSR: Link state routing protocols (ISIS, OSPF)
- CCAMP: Non-Packet technology-specific control
- BESS: EVPN
- PALS: PWs
- SPRING: Segment Routing
- NetMod: YANG Language, core modules
- NetConf: YANG encoding and transport, some core modules