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
Service may be:
- Unidirectional Point-to-point (P2P) or Point-to-multipoint (P2MP)
- Bidirectional P2P
  - Co-routed or associated
  - Symmetric or asymmetric bandwidth
- Multiple recovery options
GMPLS: A Label Hierarchy

- 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
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
  - For example TDM, Ethernet or ATM over MPLS
- PW Control Word used to
  - Differentiate traffic types (IP vs PW)
  - Enable PW client related processing
  - Supports PW OAM
- BGP-Based EVPN is current preferred L2VPN control protocol
Path Computation Element (PCE)

- **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

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

Source: An IETF Traffic Engineering Overview
• 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
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

Source: An IETF Traffic Engineering Overview
Multiple YANG models supporting TE exist:
- Defined in multiple WGs
- Different stages of process

Reminder: ACTN is a reference model for SDN-TE, not a required implementation.
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

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

- **TEAS**: Traffic Engineering Architectures and GMPLS/RSPVP-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