SDN Architecture and Use Case for PCE-based Central Control

draft-zhao-teas-pce-control-function-01
draft-zhao-pce-central-controller-user-cases-01

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What is a 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"* from RFC 4655.
- That means that a PCE is a *functional component* in an abstract architecture.
  - It's purpose is to determine paths though a network
  - It operates on a topology map (the Traffic Engineering Database – TED)
  - It can be realised as a component of an existing device or as a dedicated server (or virtualised service)
- Benefits of the PCE
  - Offload CPU-heavy computations
    - Provide advanced and sophisticated algorithms
  - Coordinate computation across multiple paths
  - Operate on an enhance TED
- Primary initial purpose was for Traffic Engineered MPLS LSPs
  - Rapidly picked up for optical transport networks
- One of the earliest south-bound protocols – Path Computation Element Protocol – to be implemented in various Open Source Controller platforms

PCE Evolution and Deployment
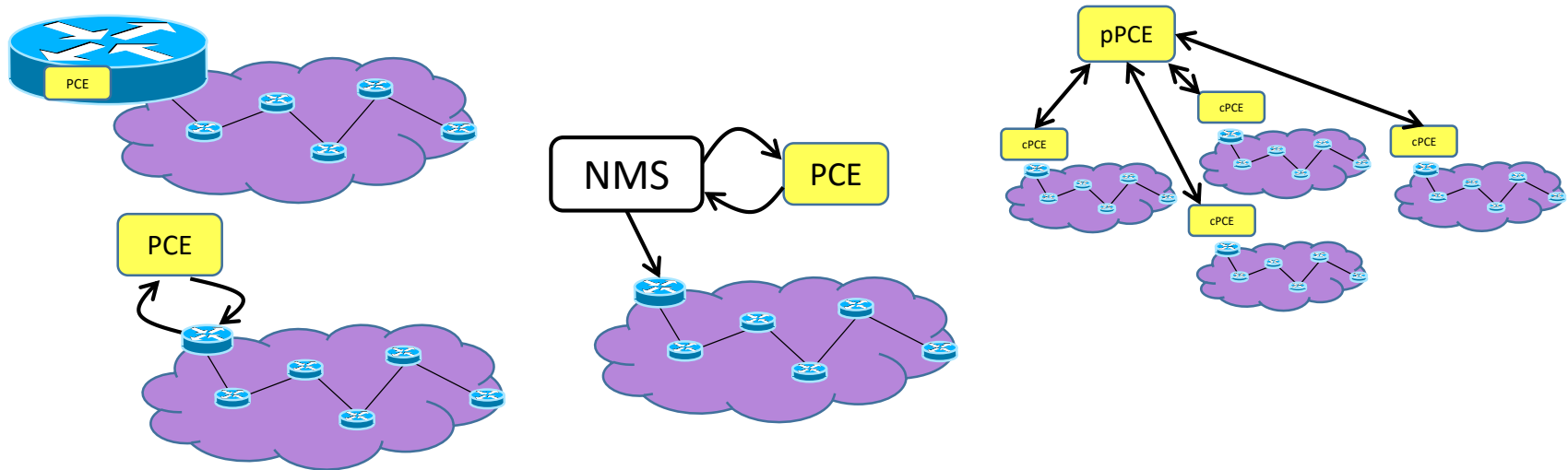
- The PCE evolved very quickly after it was invented
  - Advanced PCEP encodings for non-packet environments
- PCEP extensions for coordinated path computations
  - Path protection
  - Network re-optimisation
- Cooperating PCEs for multi-domain applications
- Applicability to sophisticated services such as point-to-multipoint
- Hierarchical PCE for selection of paths across multiple domains
- PCE Evolution continues today within the SDN Controller projects

What is the relationship with SDN?

- What is the relationship with SDN ?
  - PCEP can be considered the earliest SDN southbound protocol
    - PCE is an SDN controller plus the application logic for path computation
    - PCE provides end-to-end paths (when requested)
    - PCC installs a received path specification
  - An MPLS-TE network could be considered to be an SDN-based network if:
    - MPLS LSRs are built with full separation of control and forwarding planes
    - LSR performs exact match on a single field in the packet header
    - LSR processing is simple: stack operation and forward without routing protocols (e.g., MPLS-TP)
      - All paths are configured from a central platform via a control plane
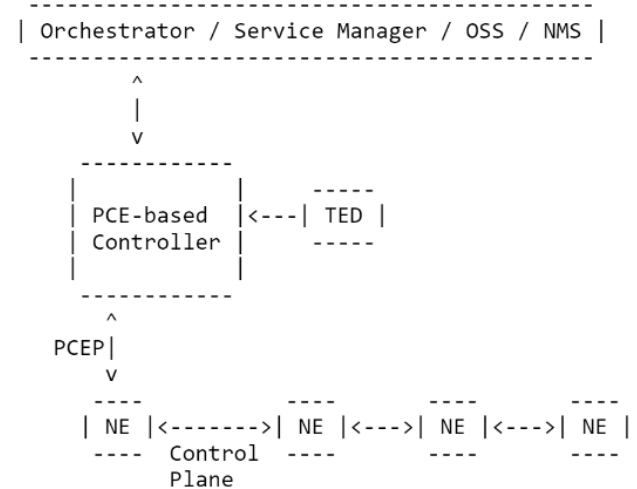
Controller PCE
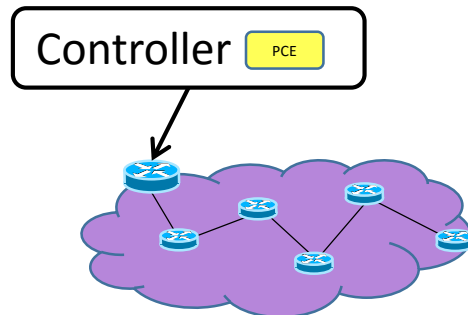
Stateful & Active PCE

- A Stateful PCE is aware of other LSPs in the network
  - A PCE could retain knowledge of paths it previously computed
  - Or it may gather information about LSPs as exported from the network
    - "Yes, I used that path you gave me"
    - "Here are some other LSPs I know about"
- An Active PCE is able to advise the network
  - About more optimal paths
  - When congestion is a problem
- As far as the protocol is concerned, it is only a small step
  - The PCC can say "Please worry about these LSPs for me."
    - Delegation of LSPs from the PCC to the PCE
  - The PCE can say "Here is a path you didn't ask for."
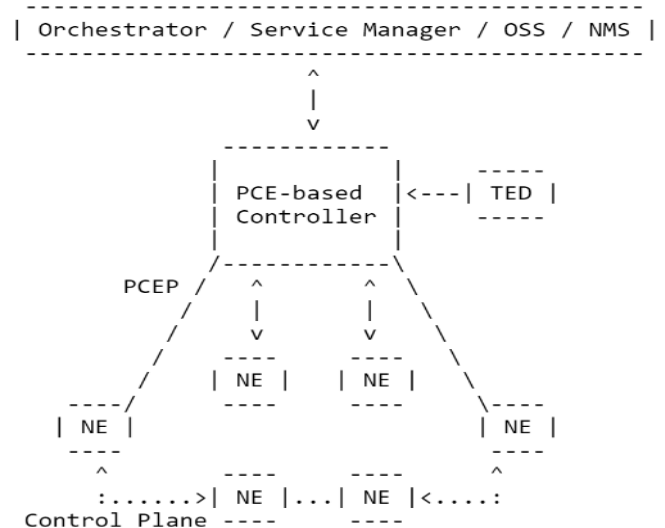   - For delegated LSPs or for new LSPs

Architectures for PCE as the Central Controller

- Using a PCECC to augment a distributed control plane

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-------------------------------------------
| Orchestrator / Service Manager / OSS / NMS |
-------------------------------------------
                    ^
                    |
                    v
         ------------
         |          |     -----
         | PCE-based |<---| TED |
         | Controller |    -----
         |          |
         ------------
              ^
         PCEP |
              v
         ----         ----         ----         ----
        | NE |<------->| NE |<--->| NE |<--->| NE |
         ----  Control  ----       ----         ----
               Plane
```

- Using PCE for Node-by-Node Central Control

```
-------------------------------------------
| Orchestrator / Service Manager / OSS / NMS |
-------------------------------------------
                    ^
                    |
                    v
         ------------
         |          |     -----
         | PCE-based |<---| TED |
         | Controller |    -----
         |          |
         /------------\
    PCEP /  ^      ^  \
        /   |      |   \
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 | NE |                   | NE |
  ----                     ----
    ^    ----   ----        ^
    :......>| NE |...| NE |<....:
Control Plane ----   ----
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Multiple PCECCs on a Partitioned Network

- Using cooperating PCECC-based controllers for horizontal control
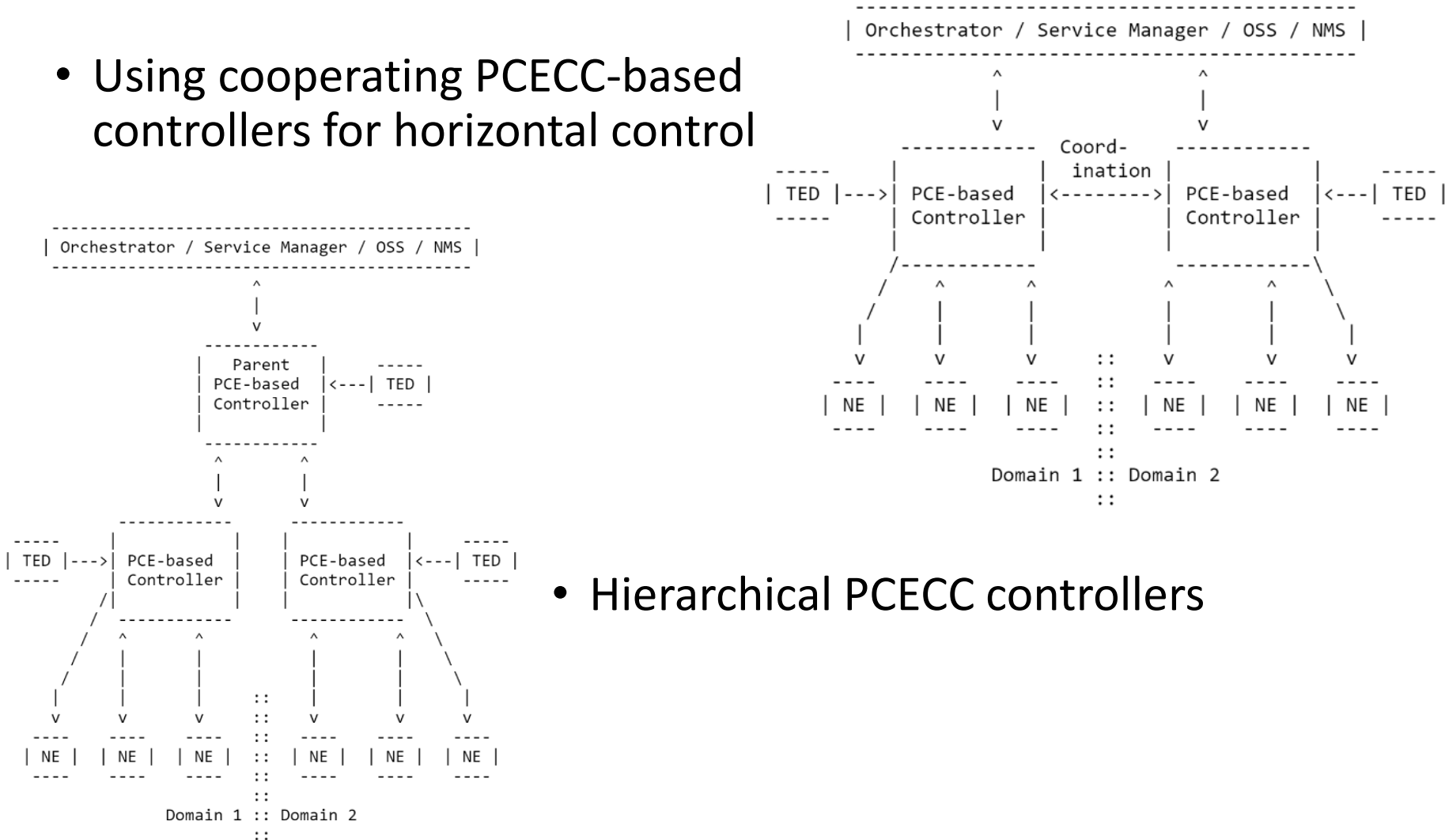
- Hierarchical PCECC controllers

PCECC Use Cases

- Control Plane Operated Networks
  - A common approach for an active, stateful PCE to control a traffic engineered MPLS or GMPLS network

- Static MPLS-based Label Switch Paths
  - Provisioned without the use of a control plane

- Transport SDN
  - MPLS-TP, TE-based Optical Networks

- Traffic Classification
  - What traffic to send on the LSP

- Detailed discussion on the Use Cases for Using PCE as the Central Controller(PCECC) may be found in:
  - https://tools.ietf.org/html/draft-zhao-pce-central-controller-user-cases-01

- Mobile backhaul example discussed this week in TEAS
  - https://www.ietf.org/proceedings/96/slides/slides-96-teas-9.pdf