

Introduction into the PCE Concept

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Agenda

- Definition of PCE
- Operation of a PCE
- Motivation for introducing PCE
- Different PCE architectures
- Computation Scenarios
- Summary

Path Computation Element (PCE)

Definition:

- A Path Computation Element (PCE) is an entity that is capable of computing a network path or route based on a network graph, and of applying computational constraints during the computation.

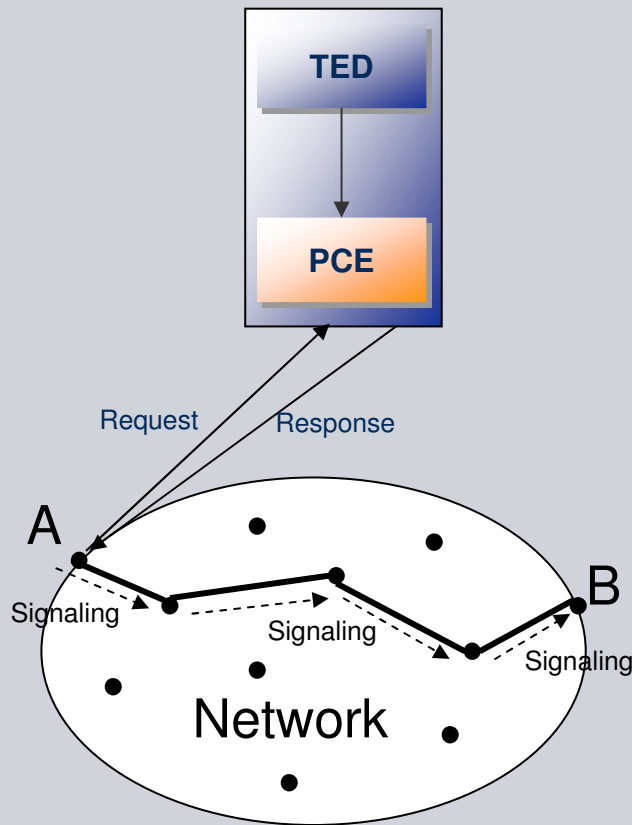
Function:

- Compute a network path

Location

- Within a network node or component, on an out-of-network server, etc.
- May or may not be located at the head-end of the path

Operation of a PCE



A PCE computes a requested path.

The procedure is the following:

1. A path computation client (PCC) sends a path computation request to the PCE
2. The PCE computes a path
3. The PCE sends the path to the PCC
4. The PCC starts signaling the path
5. The path is established

Motivation (1)

CPU-intensive path computation

- multi objective optimization for online routing
- shared backup path protection (SBPP)
- minimal cost online routing (point-to-multipoint)

Partial visibility

- ingress router and destination are located in separate domains (TE information is not exchanged across domain boundaries; use of loose routes does neither guarantee that the optimal path will be used, nor even that a viable path will be discovered)

Lack of control plane, routing or TE functionality

- Legacy equipment (e.g. interworking between GMPLS-capable and GMPLS-incapable networks)
- No local TE database; use of non-TE-enabled IGP

Motivation (2)

Backup path computation

- for “fast reroute” protection of TE LSPs
- shared backup path protection (SBPP)

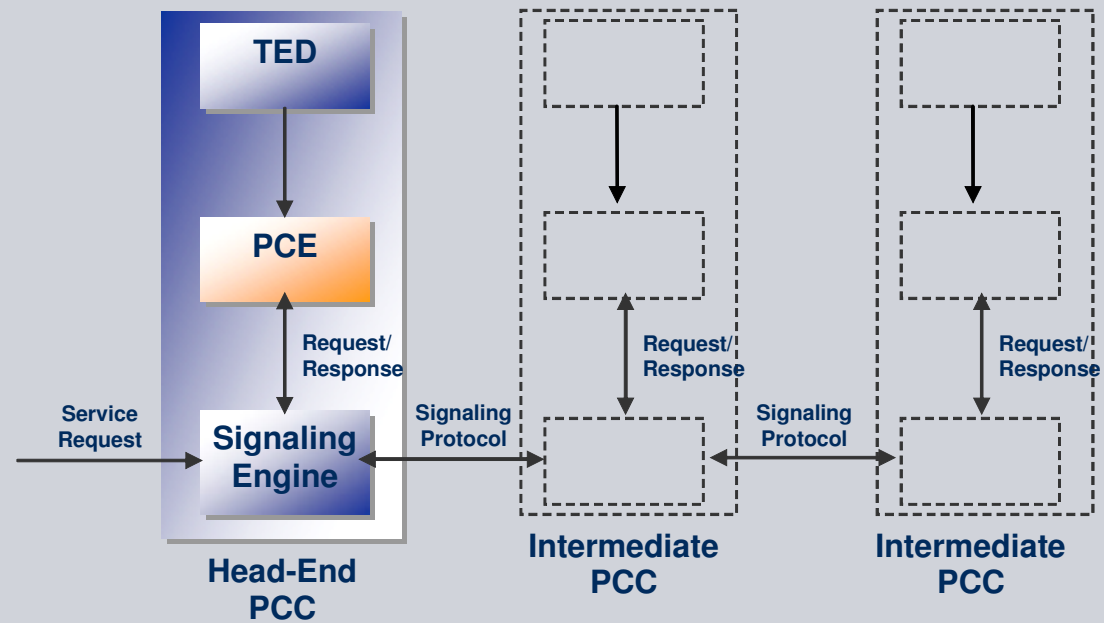
Multi-layer networks

- a server-layer network of one switching capability may support multiple networks of another (more fine-granular) switching capability
- connectivity across the server-layer network may be provided through virtual TE links or Forwarding Adjacencies

PCE Architecture

1. Composite PCE:
 - PCC and PCE are located in the same node

Composite PCE

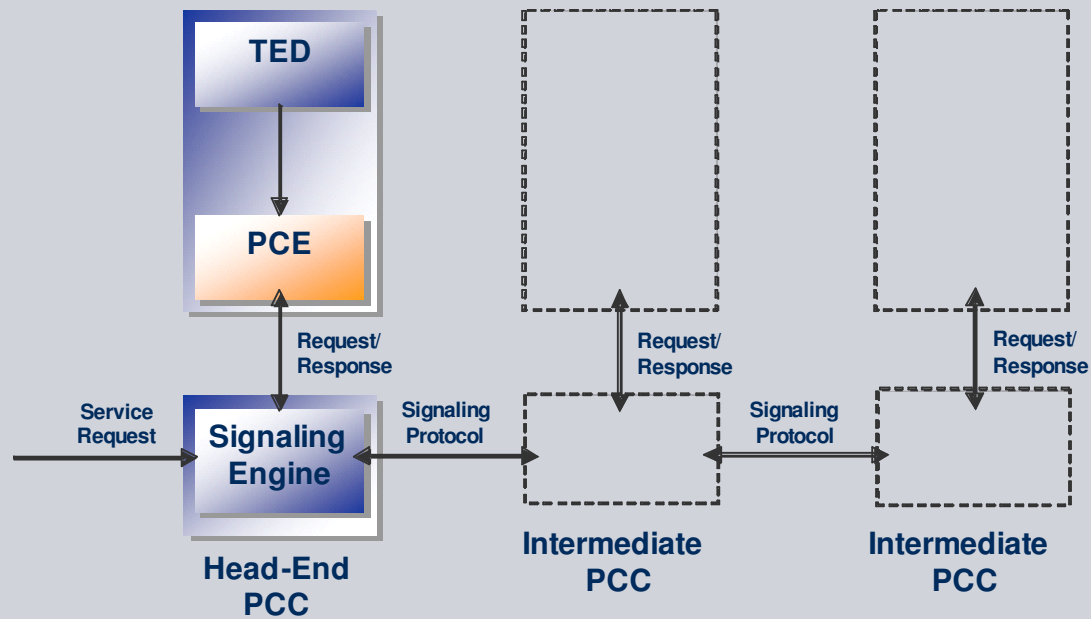


PCE Architecture

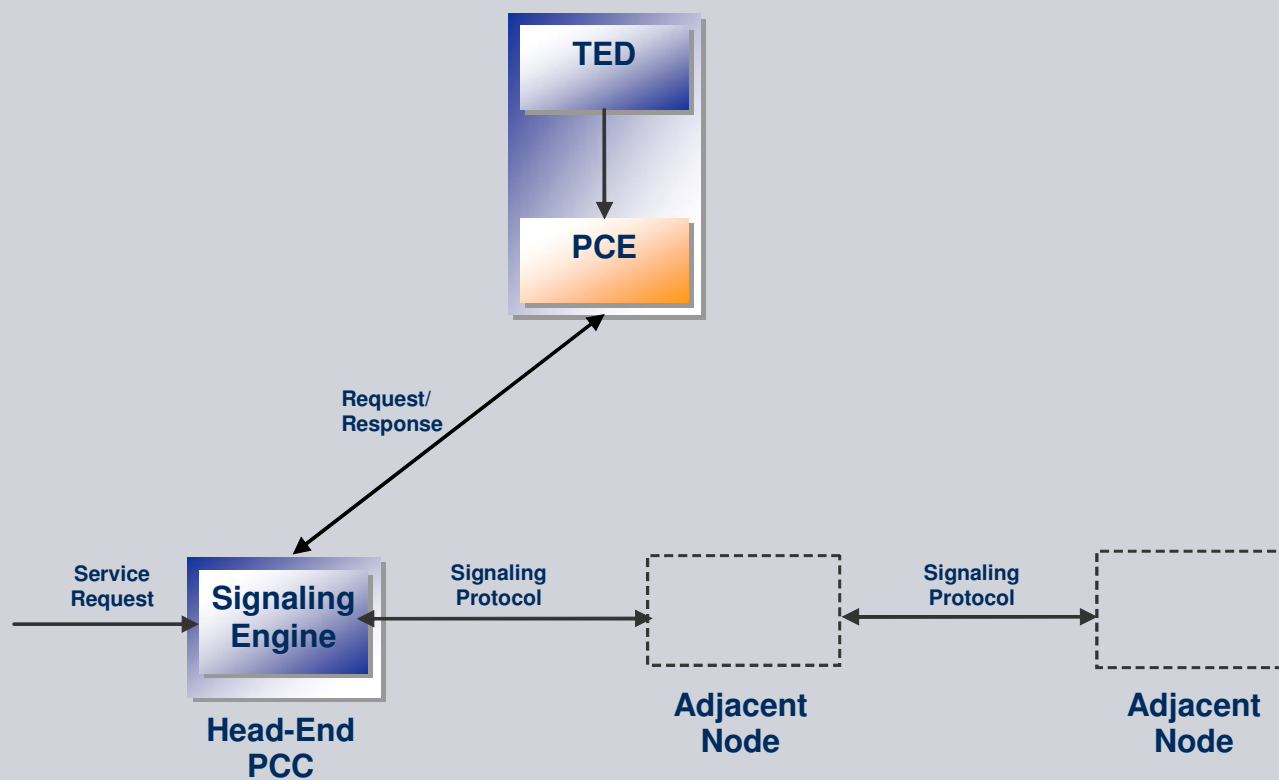
1. Composite PCE:
 - PCC and PCE are located in the same node

2. External PCE:
 - PCC and PCE are located in different nodes

External PCE



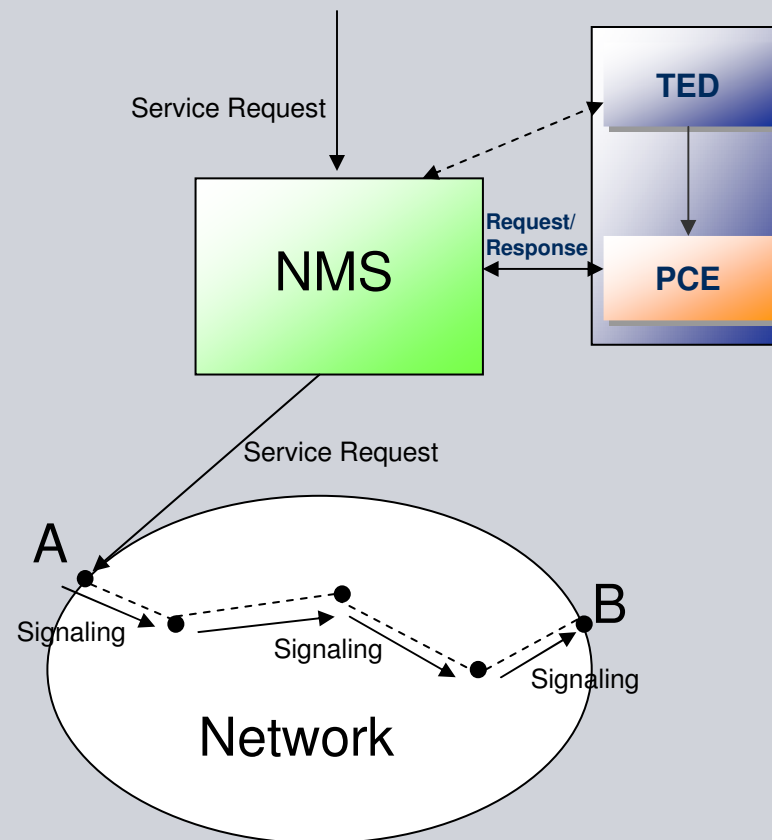
External PCE



PCE Architecture

1. Composite PCE:
 - PCC and PCE are located in the same node
2. External PCE:
 - PCC and PCE are located in different nodes
3. Management-based PCE:
 - PCC is a NMS

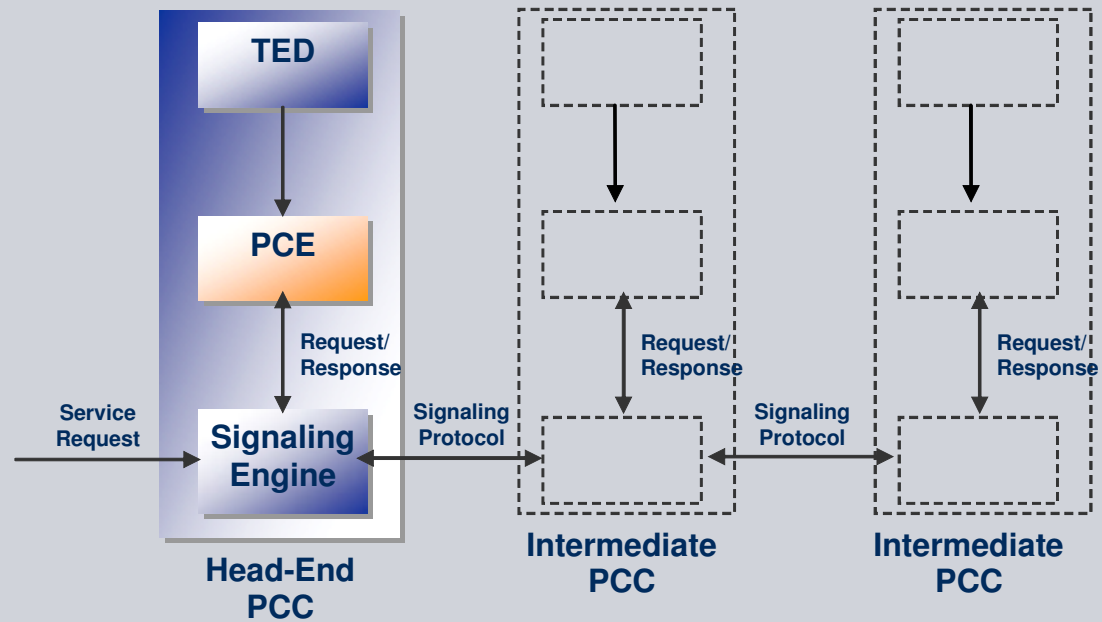
Management based PCE



PCE Architecture

1. Composite PCE:
 - PCC and PCE are located in the same node
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 - PCC and PCE are located in different nodes
3. Management-based PCE:
 - PCC is a NMS
4. Multiple PCE Path Computation:
 - Multiple PCEs are used to compute the path
 - No inter PCE communication

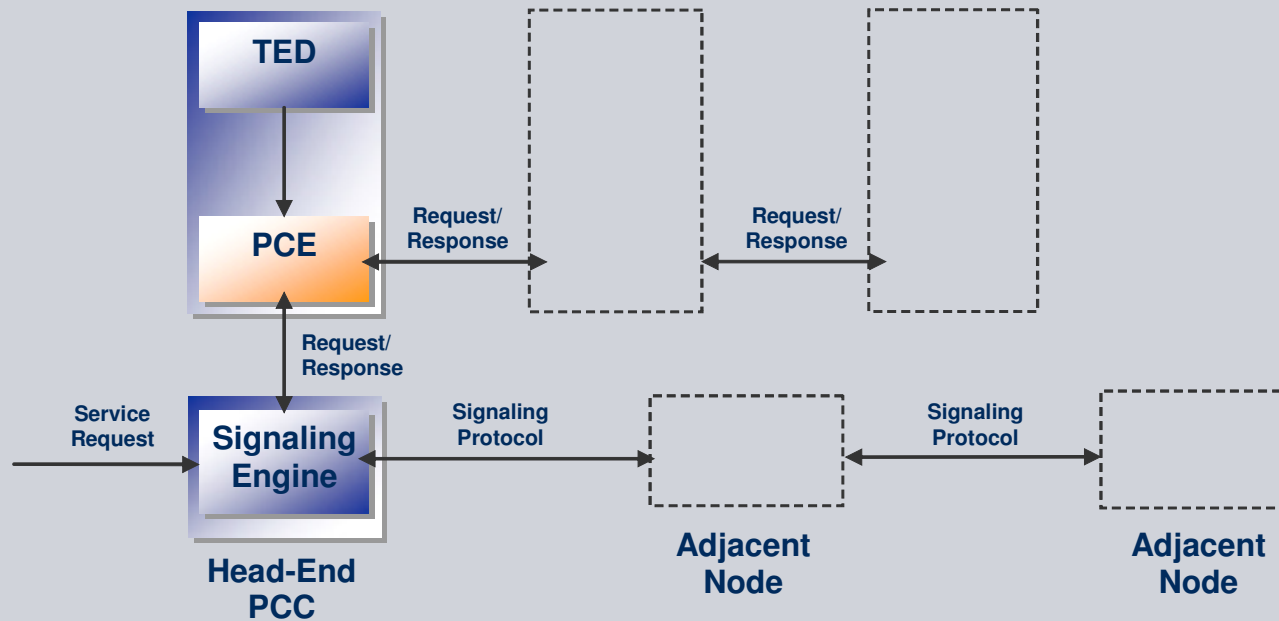
Multiple PCE Path Computation



PCE Architecture

1. Composite PCE:
 - PCC and PCE are located in the same node
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4. Multiple PCE Path Computation:
 - Multiple PCEs are used to compute the path
 - No inter PCE communication
5. Multiple PCE Path Computation with Inter-PCE communication:
 - Multiple PCEs collaborate to compute the path
 - Inter PCE communication

Multiple PCE Path Computation with Inter-PCE communication



Computation Scenarios

- PCE concept is applicable for **intra-domain**, **inter-domain**, and **inter-layer** path computation.
- Single PCE path computation:
A single PCE computes the requested path in a domain. There may be multiple PCEs in a domain.
- Multiple PCE path computation:
Multiple PCEs are used to compute the requested path in a domain.
- Centralized computation model:
All paths in a domain are computed by a single, centralized PCE.
- Distributed computation model:
Path request in a domain being shared among multiple PCEs.

Summary/Outlook

Function of PCE: Calculation of paths fulfilling required properties

Many different realizations are possible:

- Single PCE computation
- Centralized computation
- ...

Many different topics regarding PCE are currently in standardization:

- Path Computation Element Protocol (PCEP)
- PCE Discovery
- ...

References

- IETF Path Computation Element (PCE) Working Group:
<http://www3.ietf.org/html.charters/pce-charter.html>
- RFC 4655: A Path Computation Element (PCE)-Based Architecture

Other drafts and RFCs available:

- RFC 4657 (PCEP Generic Requirements)
- Draft: PCE communication Protocol (PCEP)
- Draft: OSPF protocol extensions for PCE Discovery
- ...

Thanks to the EU project Nobel 2 for supporting my work

An aerial night view of a city skyline, likely New York City, showing numerous illuminated skyscrapers and buildings. The lights create a vibrant, glowing effect against the dark night sky. The buildings are densely packed, and their windows are lit up, creating a grid of light. The overall scene is a high-angle, wide shot of a bustling urban environment at night.

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Thank you for your attention!