

# Path Computation Element in SURFnet6

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# Introduction

## Content

- Introduction
- Research Question
- Problem Description
- About PCE
  - Components
  - Features
- Usability in SURFnet6
- Future Work
- Conclusions

# Introduction

- SURFnet is a ISP for universities and research institutes.
- SURFnet6 contains over 6000km Dark Fiber throughout The Netherlands.
- SURFnet6 is a Hybrid network.
  - Traditional IP – Packet Switched.
  - Lightpaths – Circuit Switched.
- SURFnet gives the ability to request a dedicated lightpath.
- SURFnet's NOC @ SARA is responsible for handling these requests.

# Research Question

- Is the PCE-based architecture described in RFC4655 usable for SARA's planning tool?

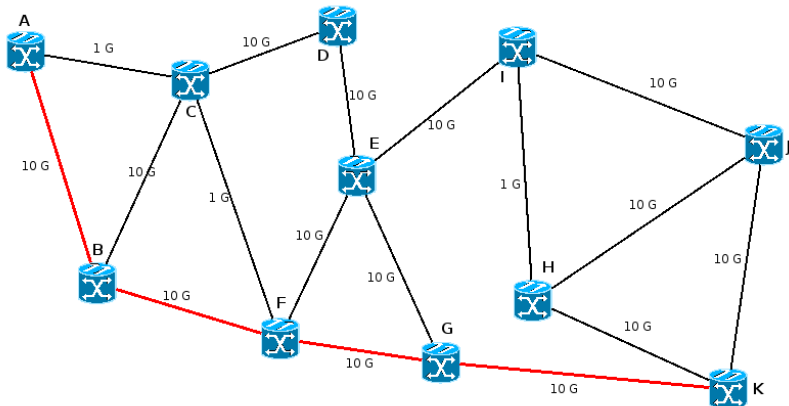
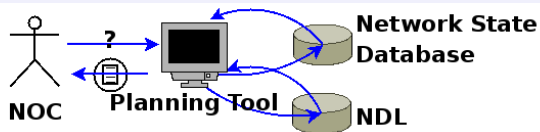
# SARA's planning tool

- R. v.d. Pol and A. Toonk created a planning tool to find a lightpath in the SURFnet6 network.
- The tool is used by SURFnet's NOC @ SARA to set up the lightpaths.

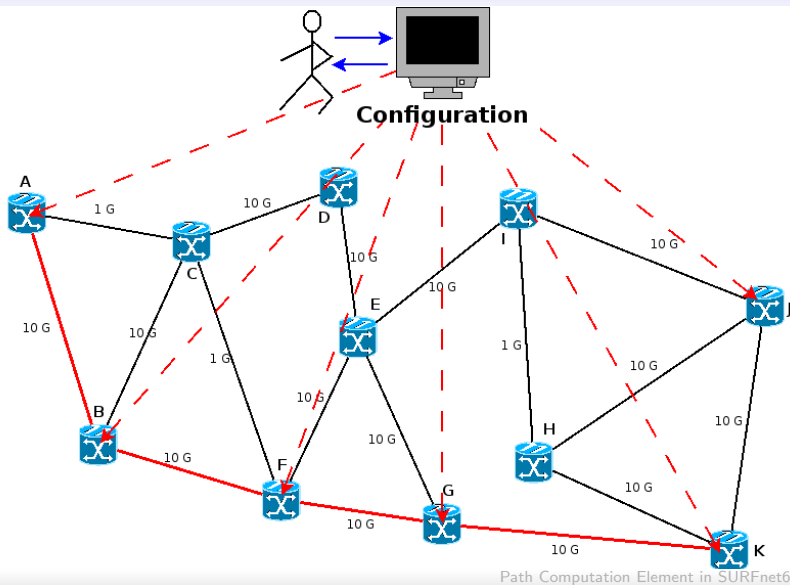
## Properties of the Planning Tool:

- Topology data in NDL (Network Description Language).
- Allocated equipment in Network State Database.
- Applies constraints (bandwidth, type of path).
- Calculates shortest path on remaining topology.

# SARA's planning tool – 1



## SARA's planning tool – 2



# About PCE

## PCE Definition

RFC4566 states:

*“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.”*



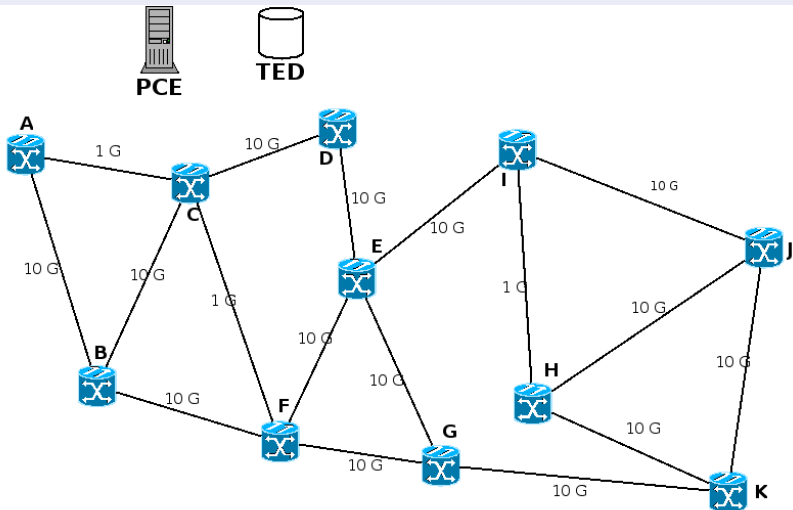
# About PCE

## PCE Properties

- One or more PCEs in a network.
- Application of constraints.
  - e.g. Bandwidth.
  - e.g. Type of path (Normal, Redundant, etc.).
- Application of policies.
- Communication with other PCEs.
- Computation of paths (using Traffic Engineering Database).
- Also possible to do inter-layer and inter-domain path computation.

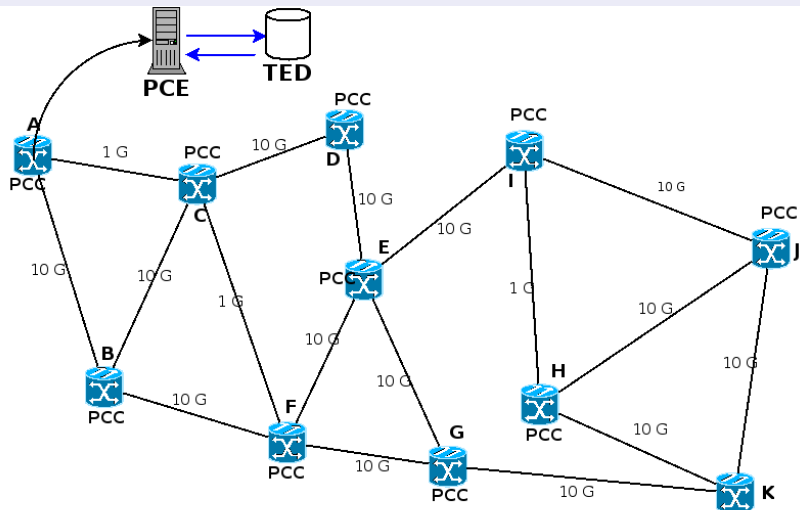
# Components

## PCE



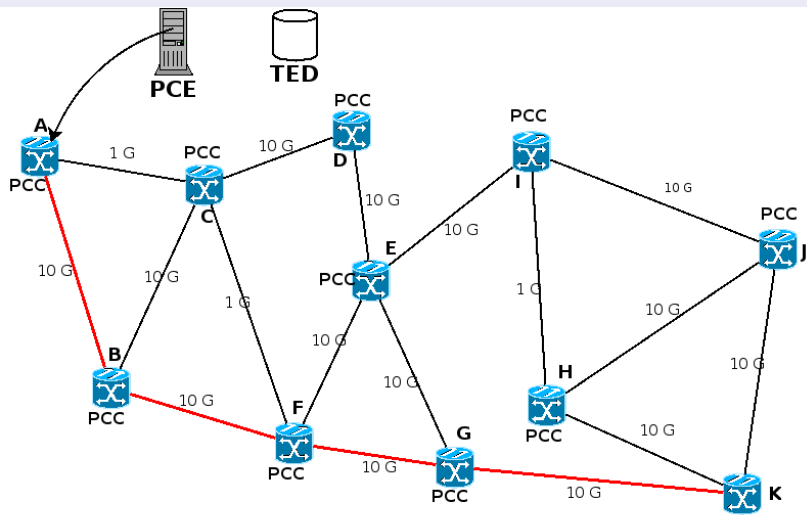
# Components

## Path request



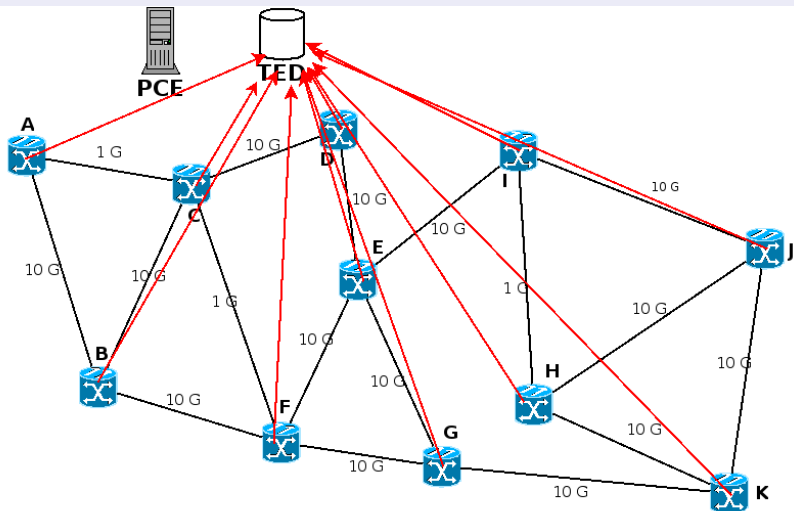
# Components

## Path Creation



# Components

## TED update



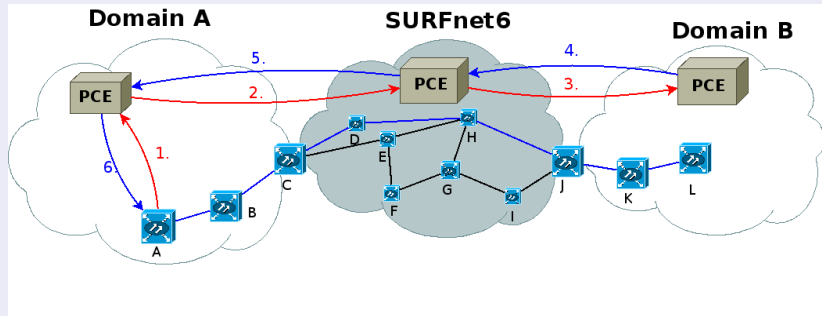
# Features

## Inter-domain and inter-layer path computation

- PCE is also able to do inter-domain and inter-layer path computations.
- The 'downside' is that these features is that they require an Interior Gateway Protocol with Traffic Engineering extensions like OSPF-TE and IS-IS-TE.
- Extra security is needed in these situations.

# Features

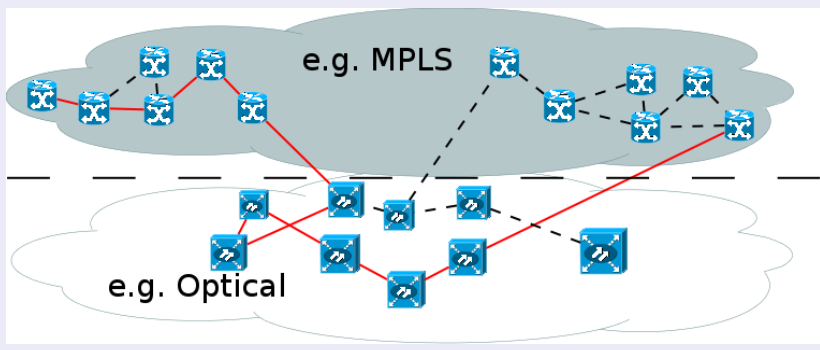
## Inter-domain path computation



1. Path request from A to L.
2. Path request from C to L.
3. Path request from J to L.
4. The path is: "J - K - L".
5. The path is: "C - D - H - J - K - L".
6. The path is: "B - C - D - H - J - K - L".

# Features

## Inter-layer path computation

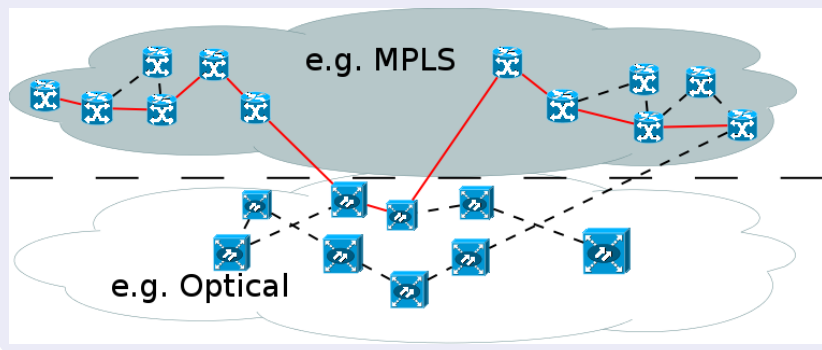


Without multi-layer PCE, SPF is done on each layer separately. The MPLS considers the optical layer as a single hop and counts 6 hops. Overall this results in a suboptimal path of 11 hops.



# Features

## Inter-layer path computation



With multi-layer PCE, SPF is done on all layers together. The PCE can now also see the Optical layer. It results in an optimal overall path of 10 hops.

# Usability in SURFnet6

- No support for future reservations
  - Normal reservation: needed next week; set up instantly;
  - Future reservation: needed next week; set up when needed;
- Mandatory implementations
  - The Path Computation Client
  - The PCEP protocol
  - The constraints
  - The policies (e.g. Restricting information for certain clients)

# Future Work

- How can Inter-domain and inter-layer PCE be implemented in SURFnet6?
- Some research could be done on algorithms the PCE should use.
- Research has to be done on proper policies.

# Conclusions

- PCE can certainly be an interesting extension for SARA's planning tool:
  - The dynamic approach of PCE adds significant complexity to the protocol.
  - A IETF standard will be used.
- PCE's inter-domain and inter-layer are certainly of interest for SURFnet6:
  - Standardized PCE protocol facilitates better communication between SURFnet6 and other research networks.
  - Less bureaucracy and formality.
  - For this feature, an IGP with TE extensions has to be implemented in SURFnet6 first.

# Questions?