Path Computation Element (PCEs): An Overview and Ongoing Work

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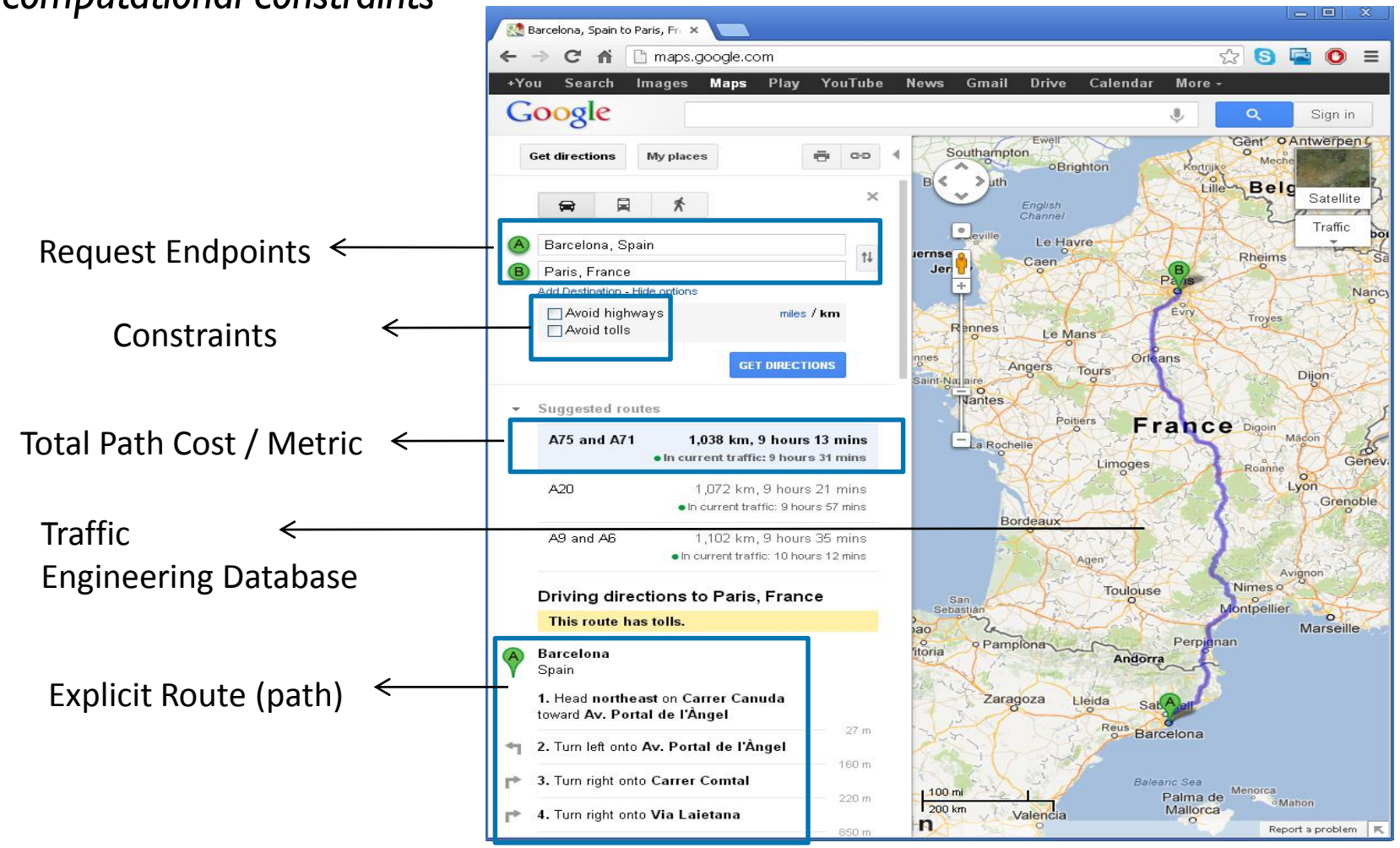
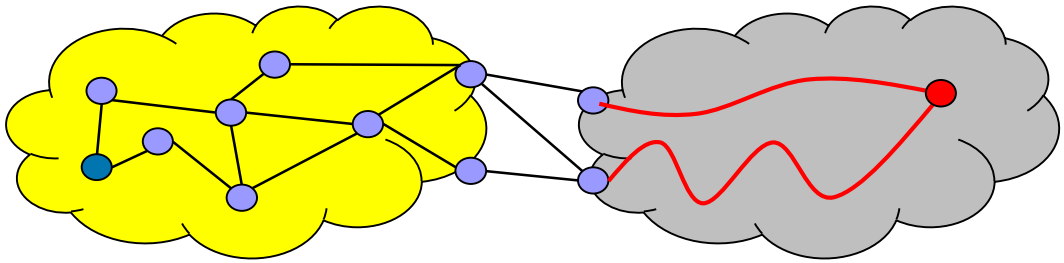
Path Computation Element / Function: what is it?

- *"An entity (component, application or network node) that is capable of computing a network path or route based on a network graph (TED) and applying computational constraints"*



Why Was PCE Invented?

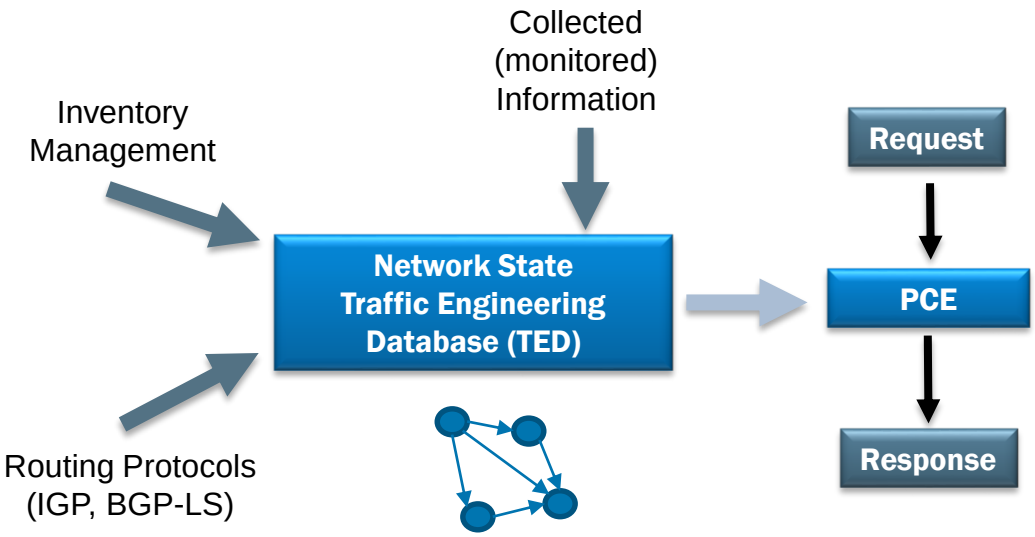
- The PCE was invented for a very specific reason
- Aimed to solve multi-domain computation
  - Find an a path across domains
  - I can see in my domain, but not into my peer's
  - Which exit-point should I choose?



- Centralized path computation
  - All path computations for a given domain are performed by a single, centralized PCE
- Distributed path computation
  - Multiple PCEs are deployed in a given domain
  - Computation of paths is shared among those PCEs

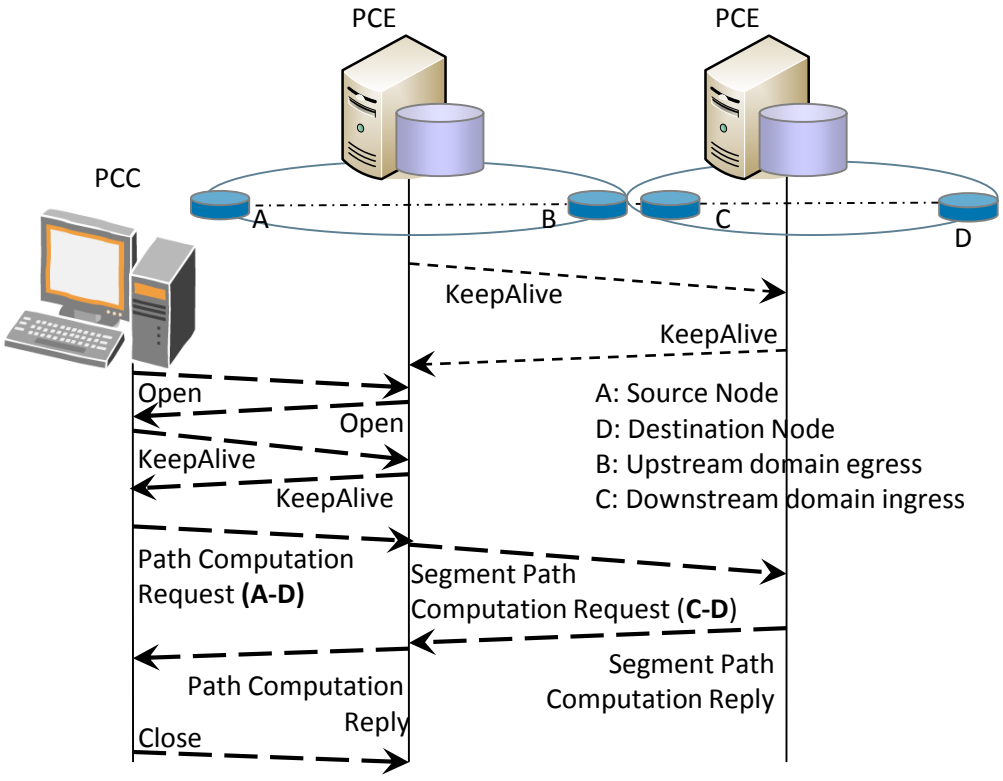
PCE Main Components

- The PCE architecture has two functional components
  - The PCE
    - The functional component that is able to perform complex path computations
  - The Path Computation Client (PCC)
    - Any client application or component requesting a path to be computed
- PCE depends on the Traffic Engineering Database (TED)
  - This is a collection of information about the nodes and links in the network



PCEP Protocol

- Put the function remotely accessible via an open, standard, feature complete interface and protocol (PCEP, TCP / message based, standard port 4189, keep-alive,…)
- After an initial handshake, a Path Computation Client (PCC) can request point-to-point or point-to-multipoint computations specifying the endpoints and constraints:
  - Switching layer, traffic parameters, attributes,…
  - Exclude/include network nodes, links or whole domains
- Re-optimize existing paths
  - avoiding resource double-booking
- Request synchronized/dependent computation
  - Inter-request constraints
- Perform Global Concurrent Optimization



A Variety of PCEP Extensions

- IGP Extensions
  - 5088, 5089: OSPF and IS-IS extensions for PCE discovery
- Path Confidentiality
  - 5520: Path key for inter-domain confidentiality
- DiffServ Support
  - 5455: Diffserv-Aware Class-Type Object
- GMPLS & WSON Support
  - Optical RWA (hardware restrictions, ROADMs, Wavelength Continuity…)
- Point-to-Multipoint Support
  - 6006: Point-to-Multipoint Traffic Engineering Label Switched Paths
- Global Concurrent Optimization
  - 5557: Requirements and Protocol Extensions in Support of Global Concurrent Optimization
- Vendor-specific constraints in PCEP
- Objective functions, including:
  - Minimum Cost Path (MCP)
  - Minimize the Load of the most loaded Link (MLL)
  - Minimize the Cumulative Cost of a set of paths (MCC)
  - Plus many more…

Stateful PCE & Active PCE

- A stateful PCE allows for efficient path computation considering both:
  - the network state (TED)
  - the LSP state (LSPDB) (i.e., set of computed paths and reserved resources in use in the network).
- An active PCE is able to recommend re-routing or instantiation of LSPs
  - May be stateless or stateful, but likely to hold state.
  - PCEP protocol extensions so the PCE can "Update" an existing LSP or "instantiate" a new one
- With Stateful and Active PCE, we can perform more "intelligent" path computation

Additional PCE Applicability

- Including, but not limited to:
  - Application Based Network Operations (ABNO)
  - PCE for Segment Routing
  - PCE for Service Function Chaining
  - PCE Centralized Controller
- Next Steps For the Path Computation (PACE) - FP7 Coordination and Support Action
  - Education and dissemination of PCE concepts
  - Tutorials, papers, knowledge base, outreach
  - Development and applicability of new uses of PCE
  - Including SDN and NFV through support of ABNO
- Consolidate and coordinate existing (OpenSource) PCE developments
- http://www.ict-pace.net/

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