



# A PCE-based approach for providing inter-AS MPLS-based QoS tunnels

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# Agenda



- ▶ Objectives and requirements
- ▶ Path Computation Service discovery
- ▶ Path Computation Procedure
- ▶ Inter PCE Communication Protocol

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# Objectives and requirements



## ▶ Provide hard guarantees for mission critical applications

- ▶ Traffic Isolation
- ▶ Bandwidth reservation
- ▶ Network Availability
- ▶ Resiliency

## ▶ For emerging applications

- ▶ Inter-provider VoIP services
  - Enterprise VoIP
  - PSTN migration to VoIP
- ▶ Inter-provider IP VPNs

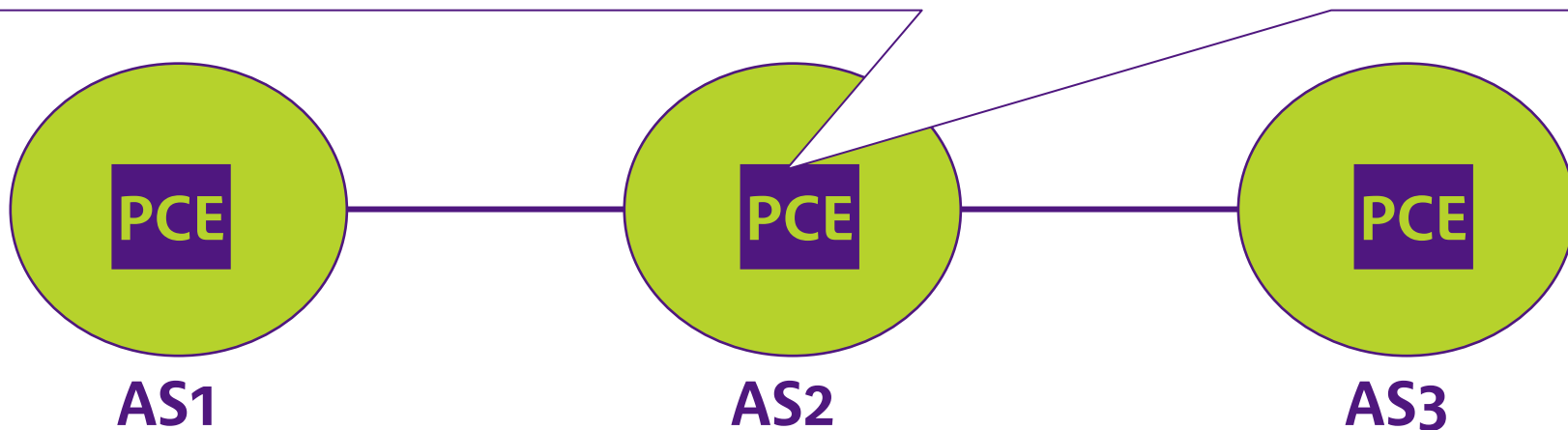
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# Solution overview (1)



- A PCE (Path Computation Element) is a network entity responsible for:
  - Computing inter-domain constrained paths
- A Path Computation System (PCS)
  - Implements a PCE
  - Negotiates inter-domain “sub-contracts” along AS-path for the computed TE LSP paths
  - Establishes inter-domain TE LSP when end-to-end agreement is reached



In the rest of this presentation  
PCE will be used to denote a PCS

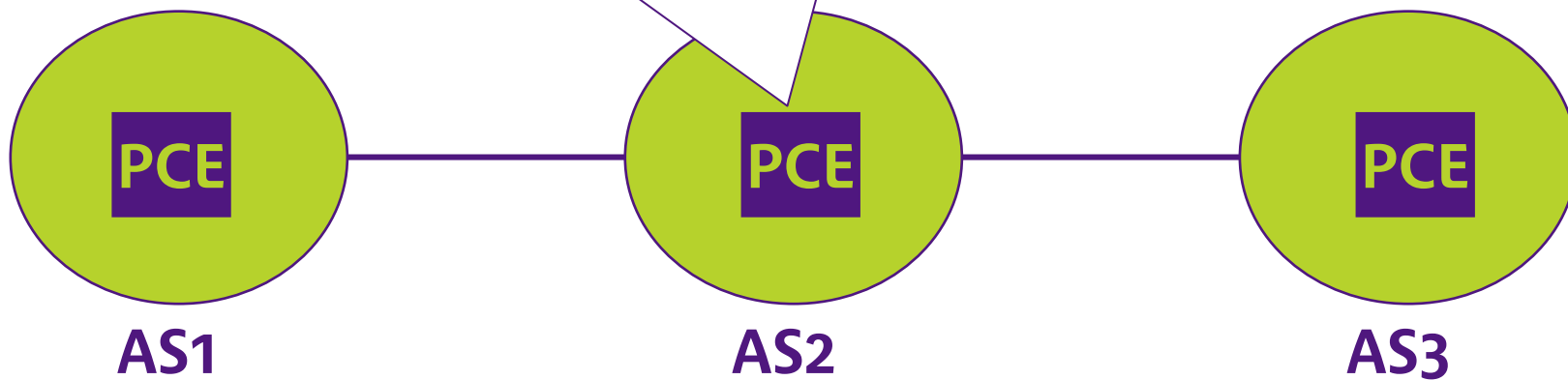
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# Solution overview (2)



Each provider deploys at least one PCE per AS



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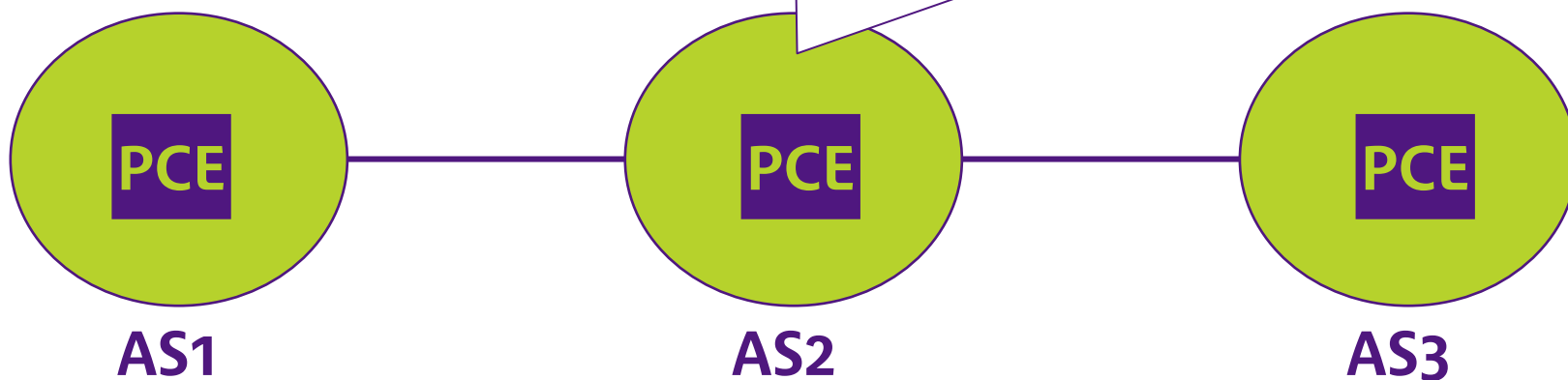


# Solution overview (3)



Each AS owns an identifier called Path Computation Service Identifier (PCSID).

PCSID can be represented by a routable IP address which can be different from the real IP address of the PCE



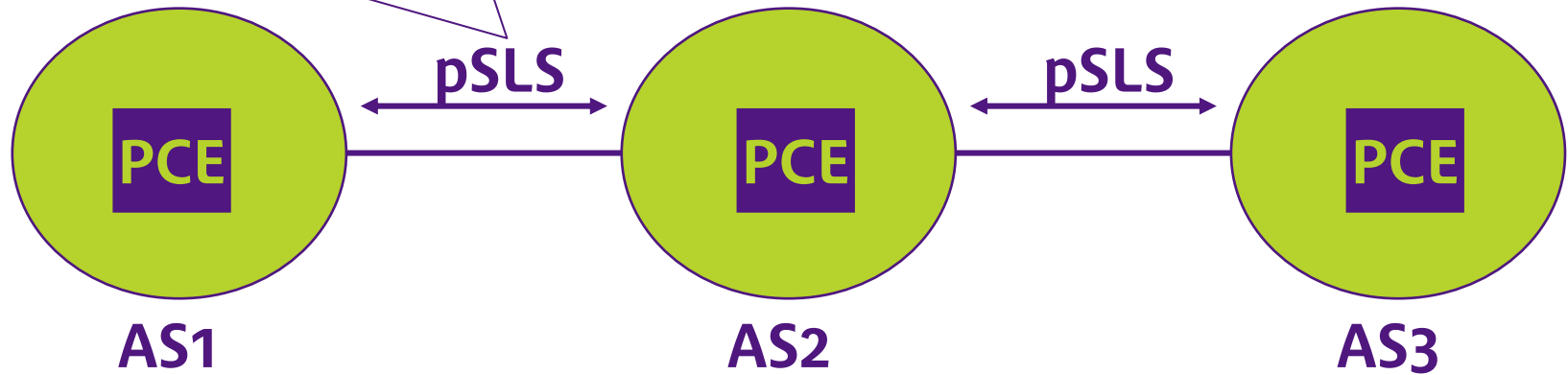
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# Solution overview (4)



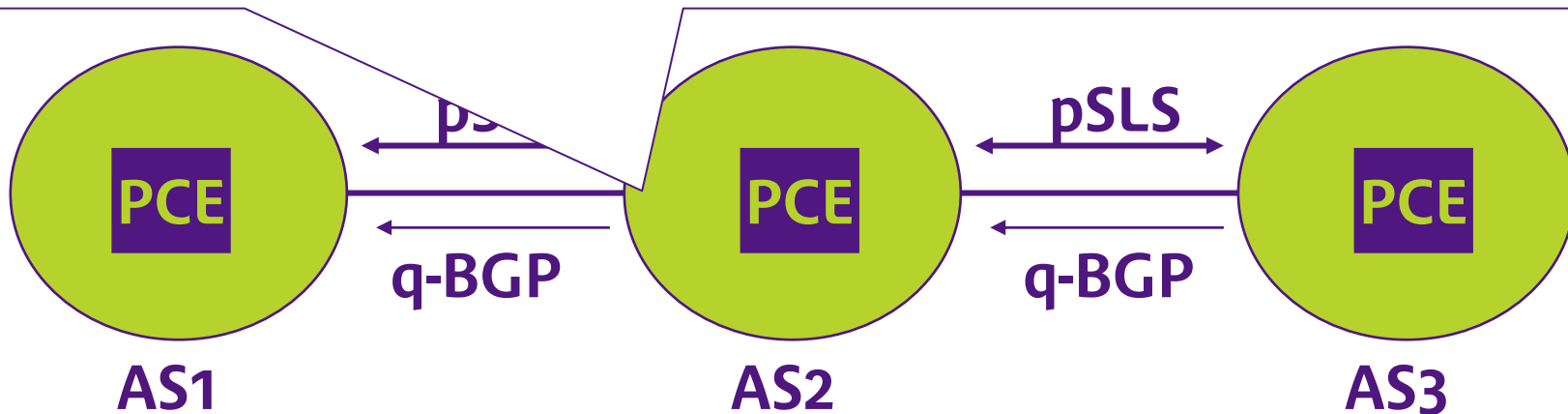
Neighboring SPs establish a pSLS: this pSLS is considered as a right to request inter-domain LSPs





# Solution overview (5)

- Each AS announces its PCSID in q-BGP:
  - This announcement is identified by a well-known community value
  - ..and is announced on a per DSCP plane basis together with its aggregated QoS values.
- LSP end points addresses are not advertised in q-BGP



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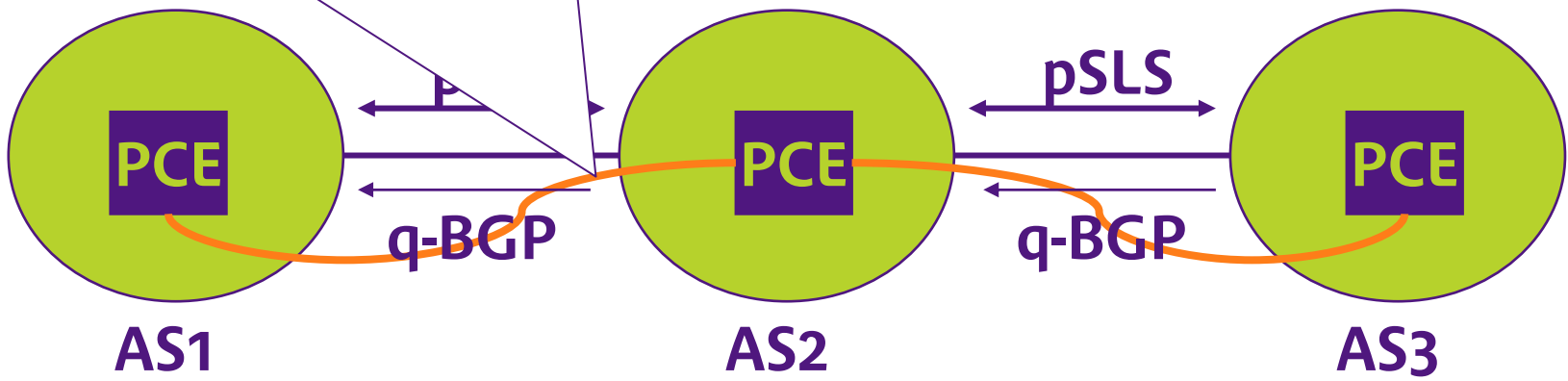




# Solution overview (6)



ASes exchange PCE related information including PCSID and IP @ of PCE.  
Adjacent PCEs open and maintain PCP sessions





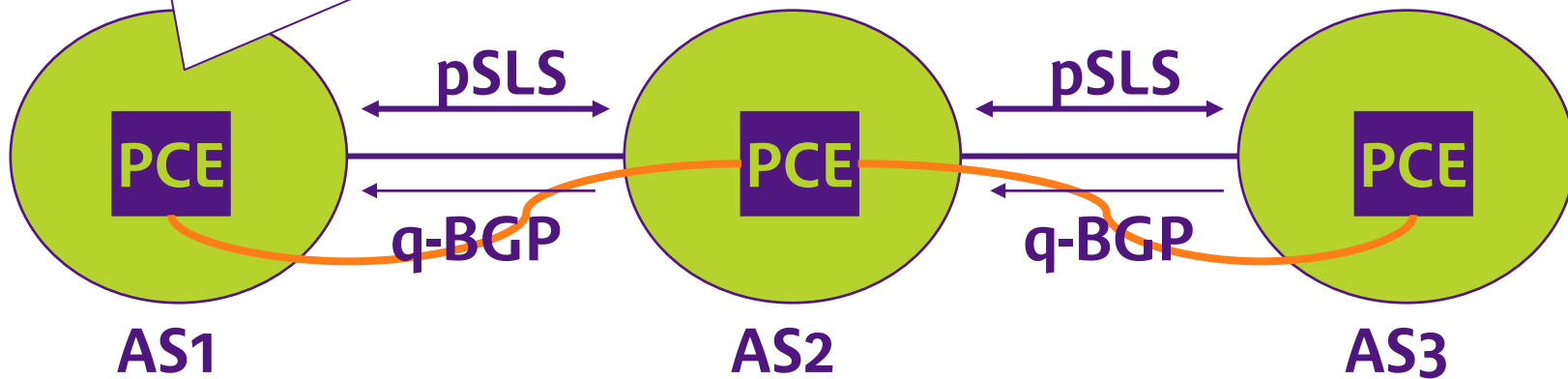
# Path Computation Procedure (1)



In order to compute an LSP path identified by:

- » a head end located in AS1, and tail end located in AS3
- » with QoS constraints
- » In a QC plan

AS1, must know the PCSID value of AS3

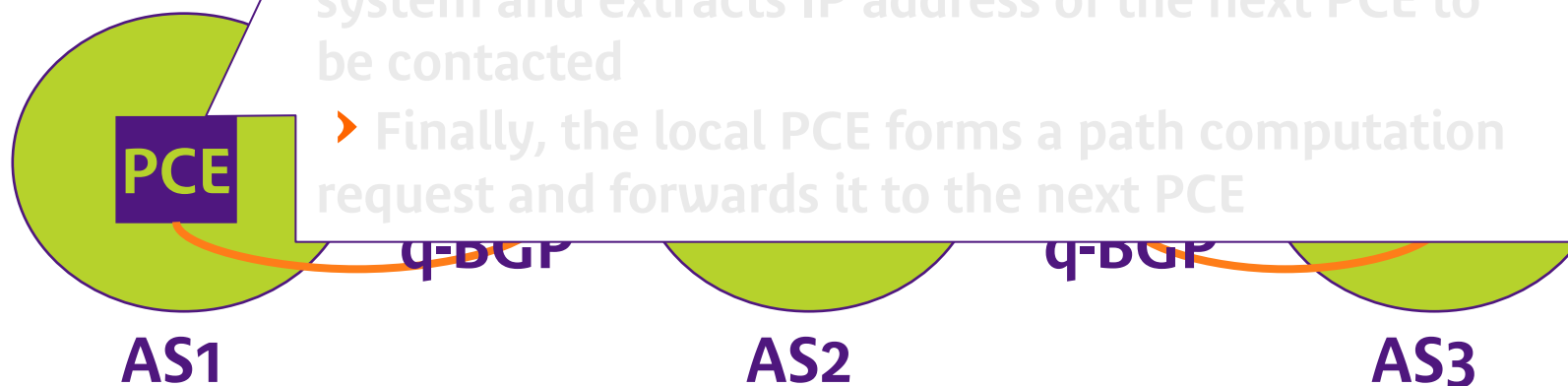


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# Path Computation Procedure (2)

- The PCE queries q-RIB of AS1 ASBRs and retrieves routes that serves the PCSID of AS3 in the requested QC plane
  - **These routes must satisfy requested QoS constraints**
- The PCE extracts from the AS\_PATH attribute associated with the returned route the AS number of the next hop ASBR
- Then, this PCE queries its SLS Management system and extracts IP address of the next PCE to be contacted
- Finally, the local PCE forms a path computation request and forwards it to the next PCE

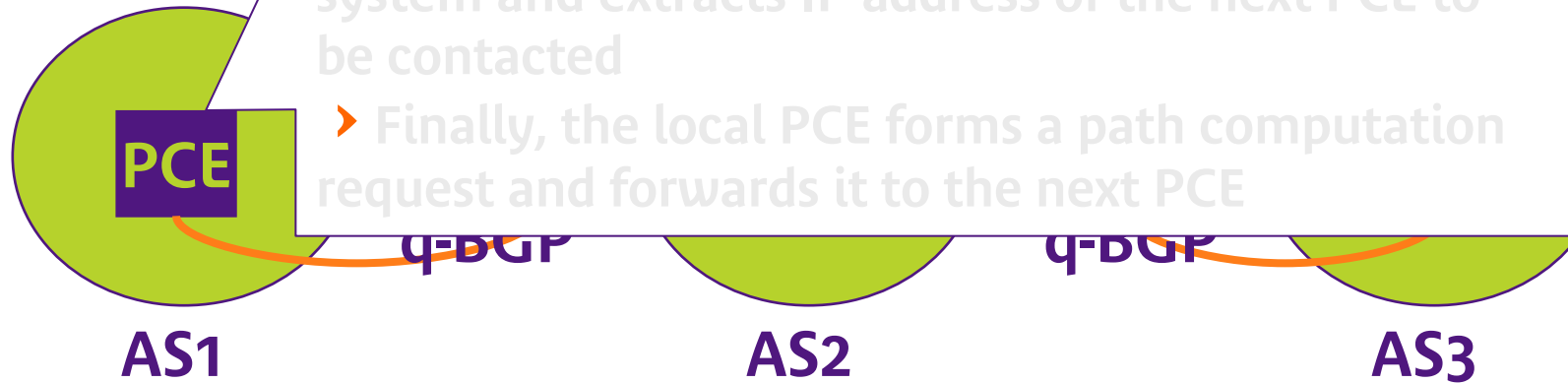


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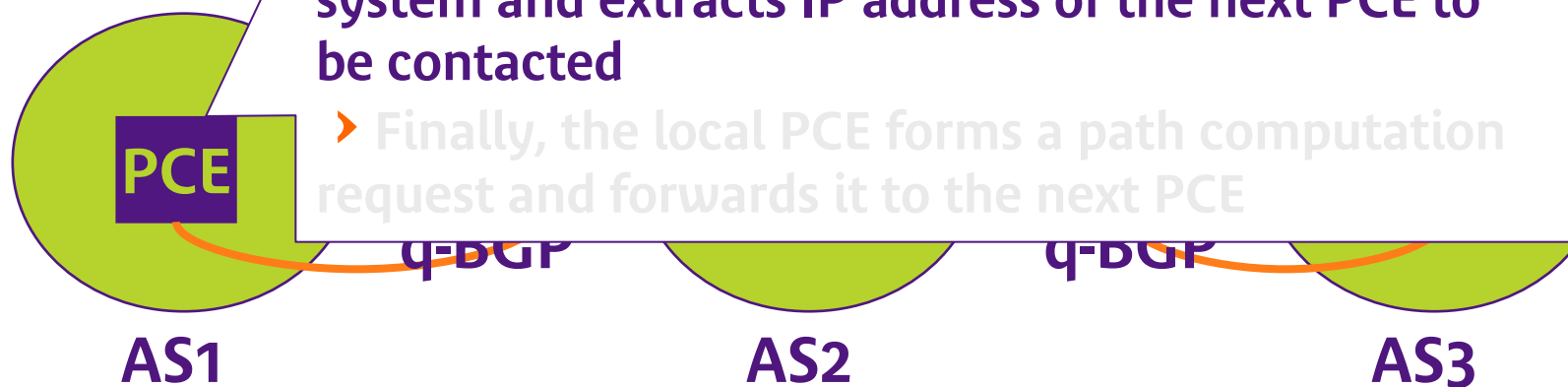


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# Path Computation Procedure (4)

- ▶ The PCE queries q-RIB of AS1 ASBRs and retrieves routes that serves the PCSID of AS3 in the requested QC plane
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  - ▶ The PCE extracts from the AS\_PATH attribute associated with the returned route the AS number of the next hop ASBR
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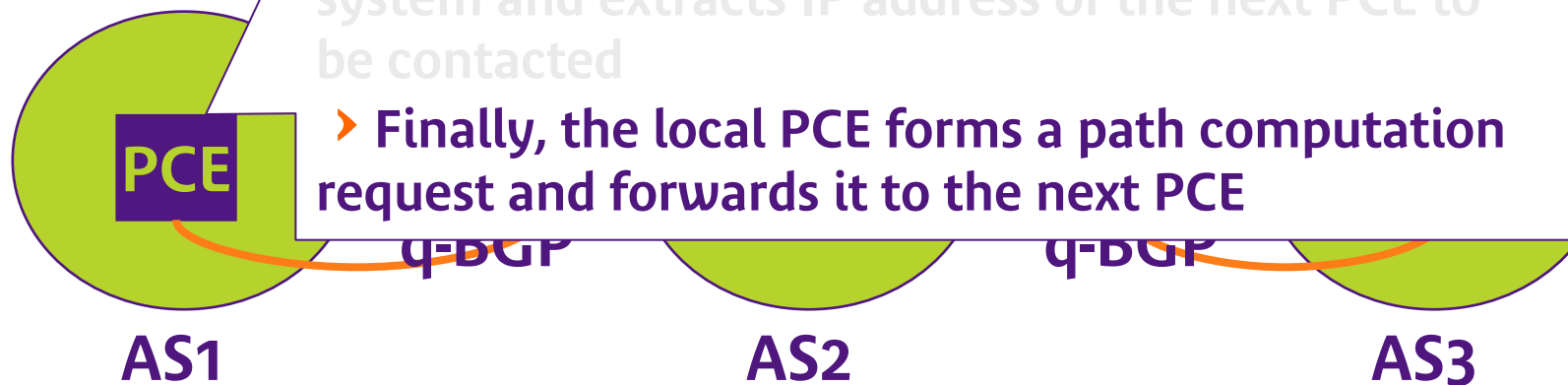


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# Path Computation Procedure (5)

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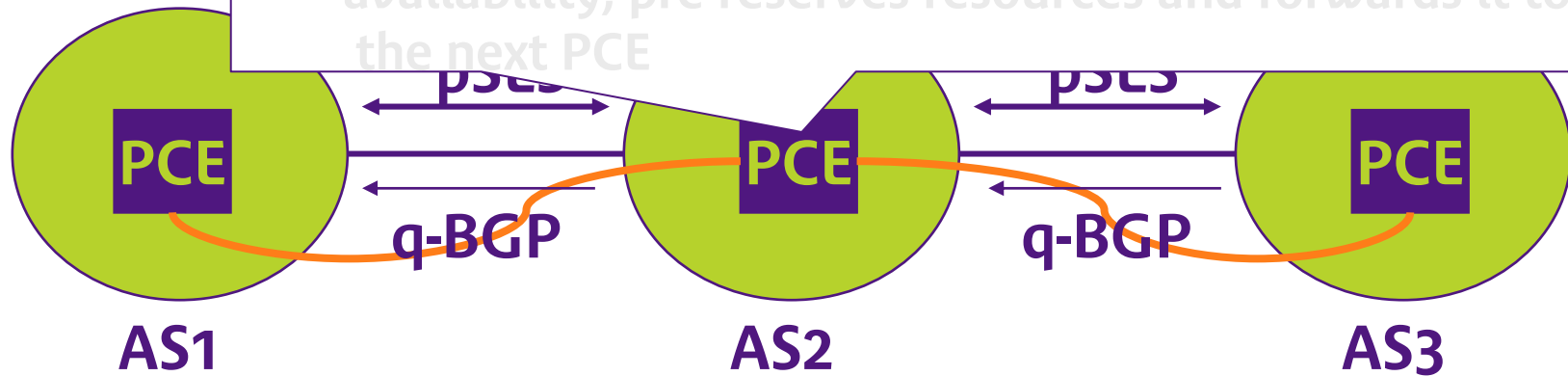
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# Path Computation Procedure (6)

When receiving the request, the PCE verifies:

- › If the requested BW don't exceed the resources negotiated in the pSLS
- › If the PCE is not the tail-end PCE
- › Then:
  - › it tries to find paths satisfying the constraints enclosed in the request and creates "child" orders.
  - › And it selects one of these orders, verifies resource availability, pre-reserves resources and forwards it to the next PCE



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# Path Computation Procedure (7)

When receiving the request, the PCE verifies:

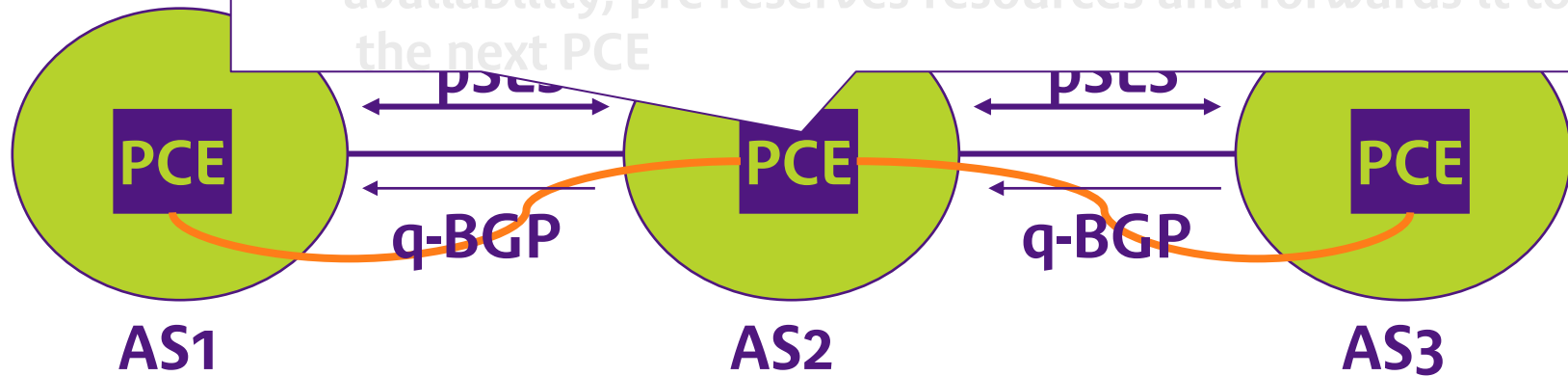
- › If the requested BW don't exceed the resources negotiated in the pSLS

- › If the PCE is not the tail-end PCE

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- › And it selects one of these orders, verifies resource availability, pre-reserves resources and forwards it to the next PCE



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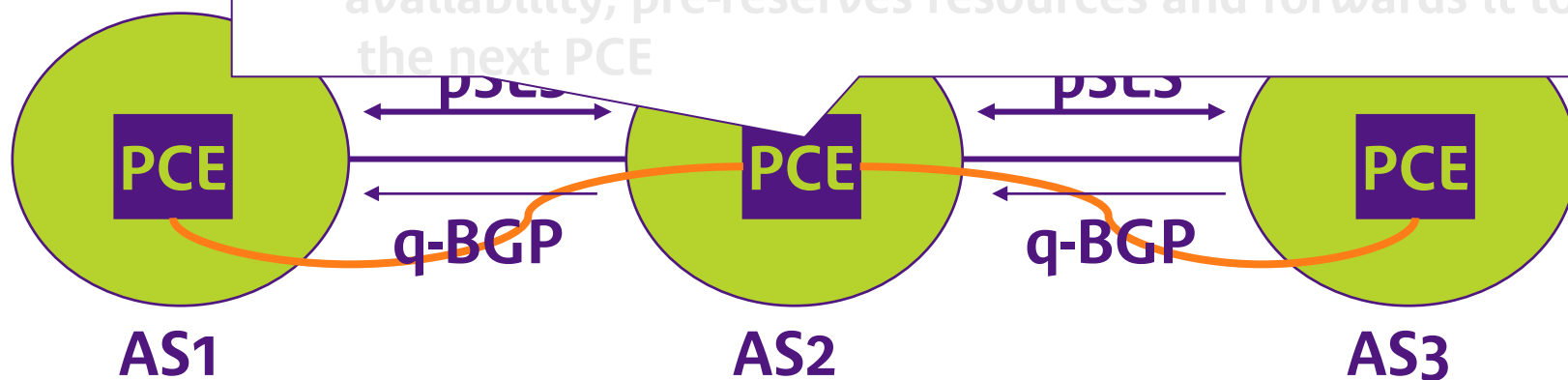




# Path Computation Procedure (8)

When receiving the request, the PCE verifies:

- › If the requested BW don't exceed the resources negotiated in the pSLS
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  - › And it selects one of these orders, verifies resource availability, pre-reserves resources and forwards it to the next PCE



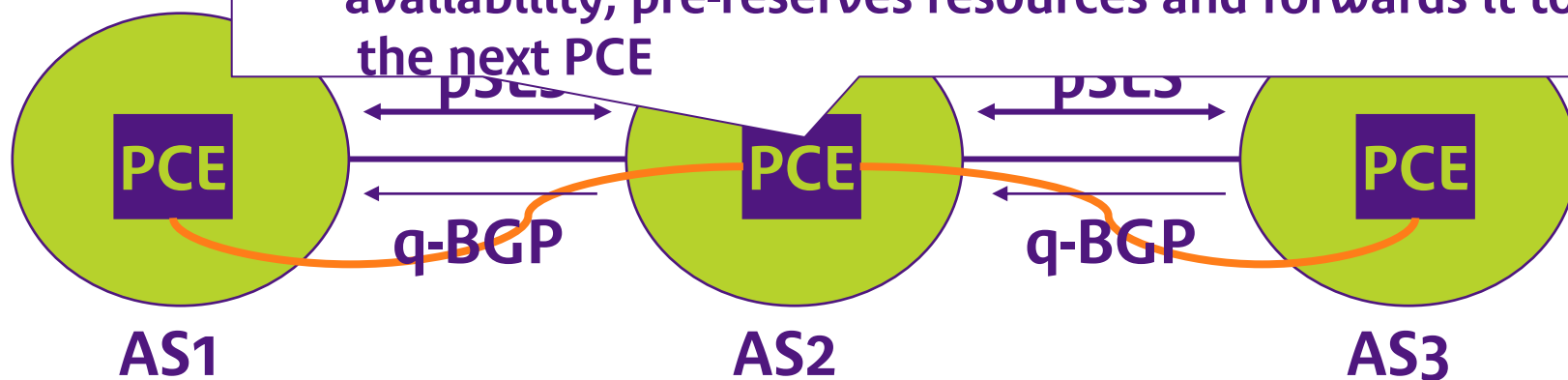
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# Path Computation Procedure (9)

When receiving the request, the PCE verifies:

- › If the requested BW don't exceed the resources negotiated in the pSLS
- › If the PCE is not the tail-end PCE
- › Then:
  - › it tries to find paths satisfying the constraints enclosed in the request and creates "child" orders.
  - › And it selects one of these orders, verifies resource availability, pre-reserves resources and forwards it to the next PCE



This process is iteratively repeated until the request reaches the PCE of the target AS identified by PCSID (AS3)

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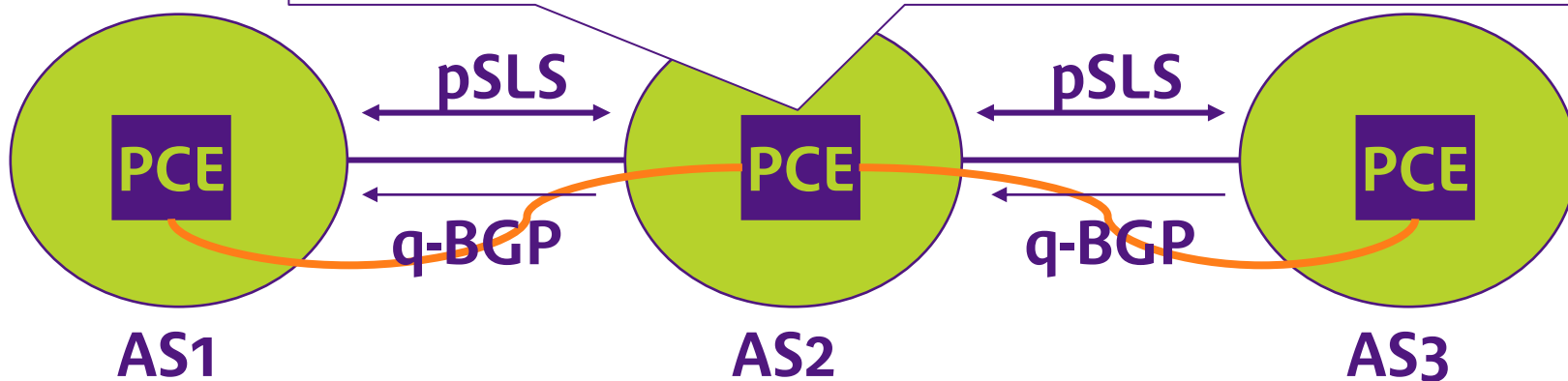


# Path Computation Procedure (10)



When receiving a response from AS3:

- › Resources are reserved and a validity date is set
- › The PCE prepends its own intra-domain sub-path to the received path and sends two responses:
  - One to AS3 to acknowledge the reservation
  - One to AS1 as an answer to the parent request



This process is iteratively repeated until the response reaches the PCE that initiates the parent request

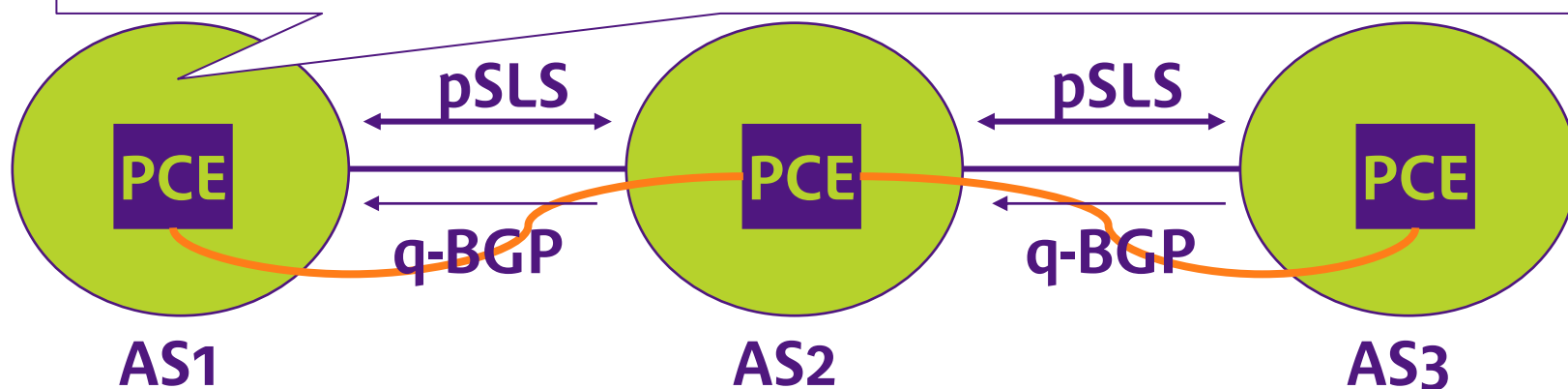




# Path Computation Procedure (11)

When receiving response from one of its adjacent PCEs with a computed path:

- The PCE acknowledges the response
- ...cancels all others requests which have been sent in order to satisfy this order
- ... and finally passes the returned path to the RSVP-TE/MPLS TE machinery to establish the inter-AS LSP



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# Inter PCE Communication Protocol



- ▶ Client/server protocol
- ▶ Uses TCP as transport protocol
- ▶ Supported messages are: open, close, request, response, path-error, ack, cancel
- ▶ Able to detect AS loops
- ▶ Able to detect request redundancy, requests that belongs to the same parent order, etc.
- ▶ Support only QoS constraints

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# For more information



▶ Mescal website ([www.mescal.org](http://www.mescal.org))

▶ IETF server:

- ▶ "*Inter PCE Communication protocol*", [draft-boucadair-pce-comm-proto-00.txt](#)
- ▶ "*A Solution for providing inter-AS MPLS-based QoS tunnels*", [draft-boucadair-pce-interas-01.txt](#)
- ▶ "*Path Computation Service discovery via Border Gateway Protocol*", [draft-boucadair-pce-discovery-01.txt](#)

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