MPLS Inter-domain Traffic Engineering

Matt Kolon

matt@juniper.net

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Agenda

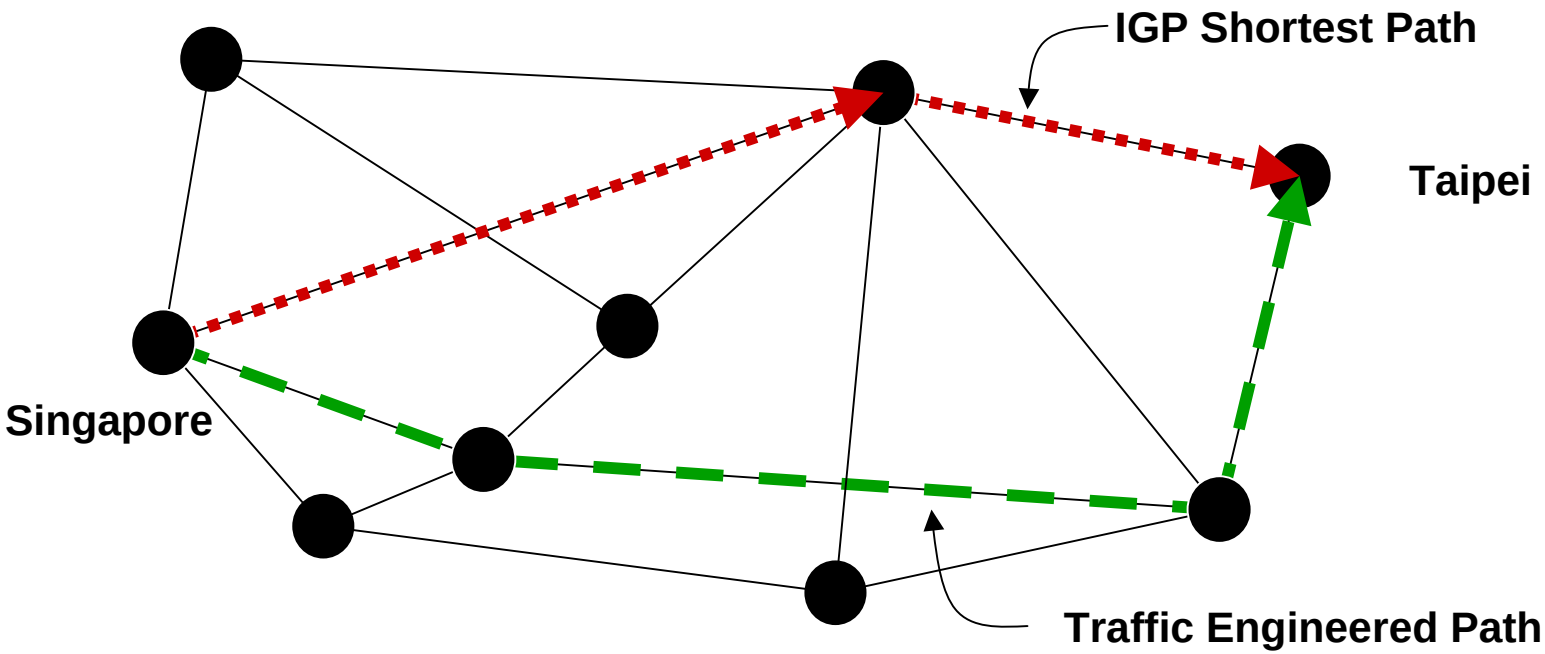
- MPLS TE Review
- Problems of Inter-domain TE
- Reachability and TE Info Distribution
- Signaling
- Path Computation
- Conclusion

Review: MPLS Traffic Engineering

- Eliminates overlay model of L2/IP Traffic Engineering
- TE available from router platforms and administration
- Allows intelligent use of available resources
- Brings benefits of MPLS to any traffic
  - Can carry non-IP traffic
  - Deterministic performance
  - Aids in obtaining QoS
  - Allows use of FRR and protection
- Is widely deployed and understood

Review: MPLS Traffic Engineering

Engineers unidirectional paths through provider network *without* using the IGP's shortest path calculation



Standard MPLS TE Mechanisms

- Extended IGP
  - Builds TED as well as LS database
  - Uses established extensions to ISIS and OSPF
- Traffic Engineering Database (TED)
  - Includes link attributes like BW, color, etc.
- Constrained SPF algorithm
  - Builds ERO according to link attributes
- RSVP for path signaling
  - Follows ERO with PATH and RESV messages

Applications for Inter-domain TE

- End-to-end inter-domain SLAs
- Carrier-of-carrier services (e.g. VPNs)
- Extended or virtual POP
- Extended or virtual trunk
- Inter-provider NNIs
- Inter-area intra-domain applications

Issues for Inter-domain TE

- Distributing TE information
  - Spreading topology and/or constraint information between domains
- Path computation
  - Determining a partial or complete path at ingress and perhaps in other places
- Signaling LSPs
  - Establishing LSPs using RSVP

Distributing TE Information

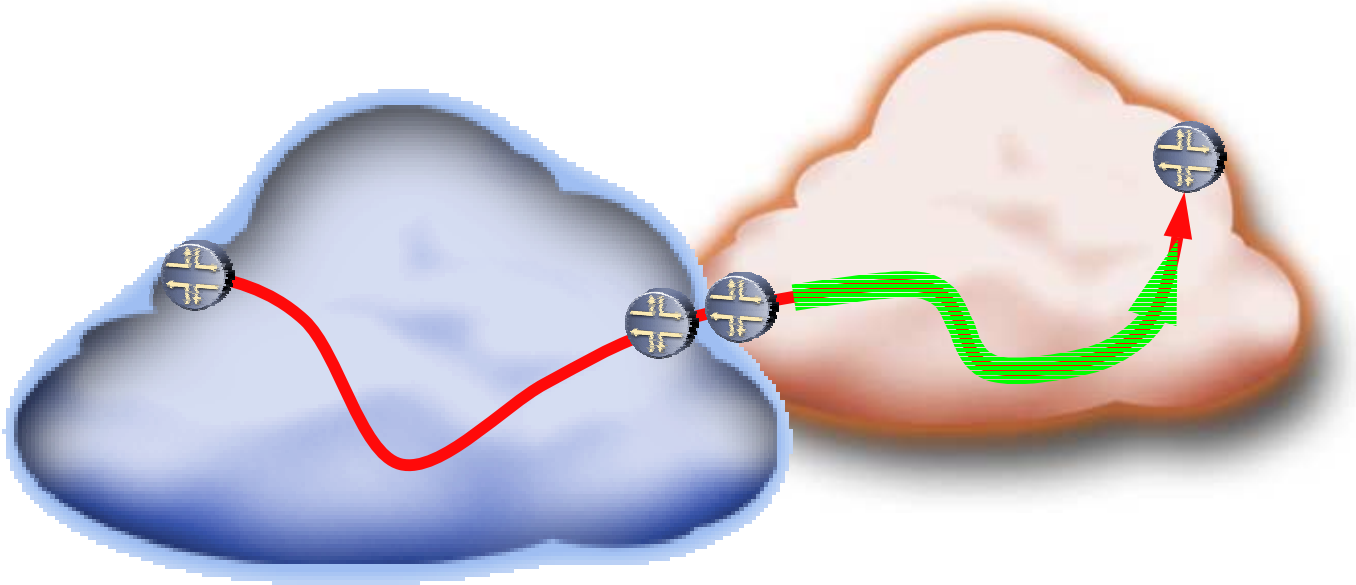
- TE information is currently distributed by IGPs
- Doesn’t help inter-domain application
- Inter-domain TE links
  - Require a TE distribution mechanism
  - This might be TE extensions to BGP
  - BGP TE info could then be fed to IGP
  - Processing and information scaling are concerns

Signaling Options

- Four Distinct Options
  - Nesting
  - Contiguous
  - Stitched
  - Hybrid
- Choice may be influenced by path computation techniques (see next section)
- May also depend on application, topology, capabilities of network

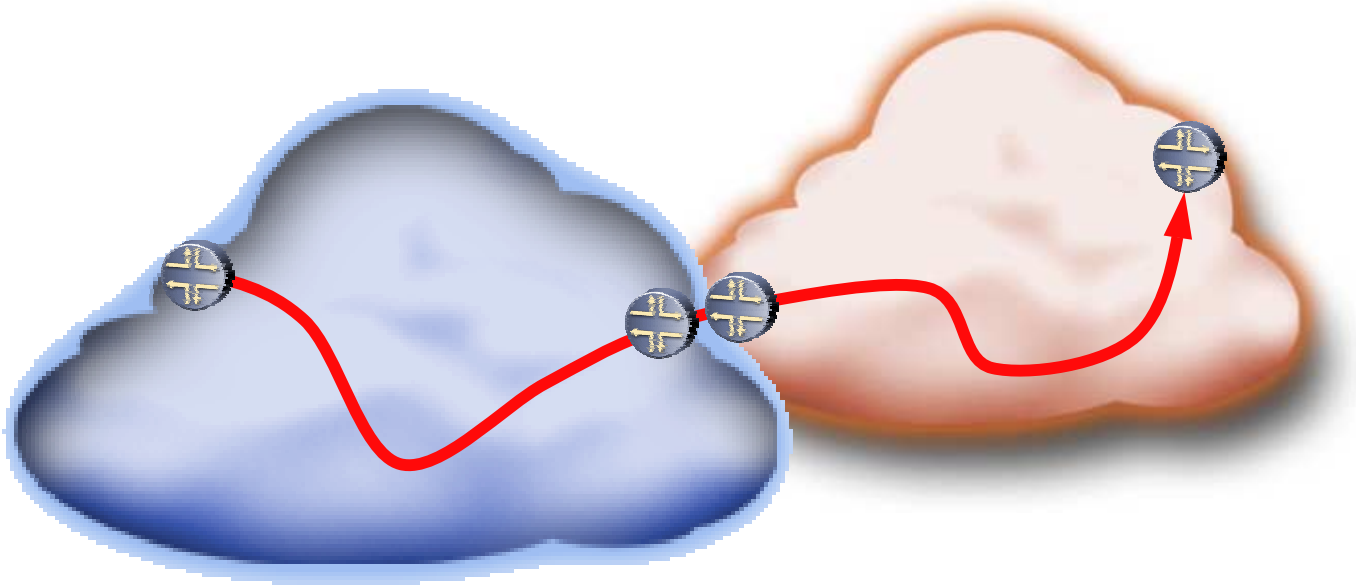
Signaling Options:Nesting

- One or more LSPs carried inside another
- FA LSP may be pre-provisioned or dynamic
- FA LSP controls path of first LSP in red network



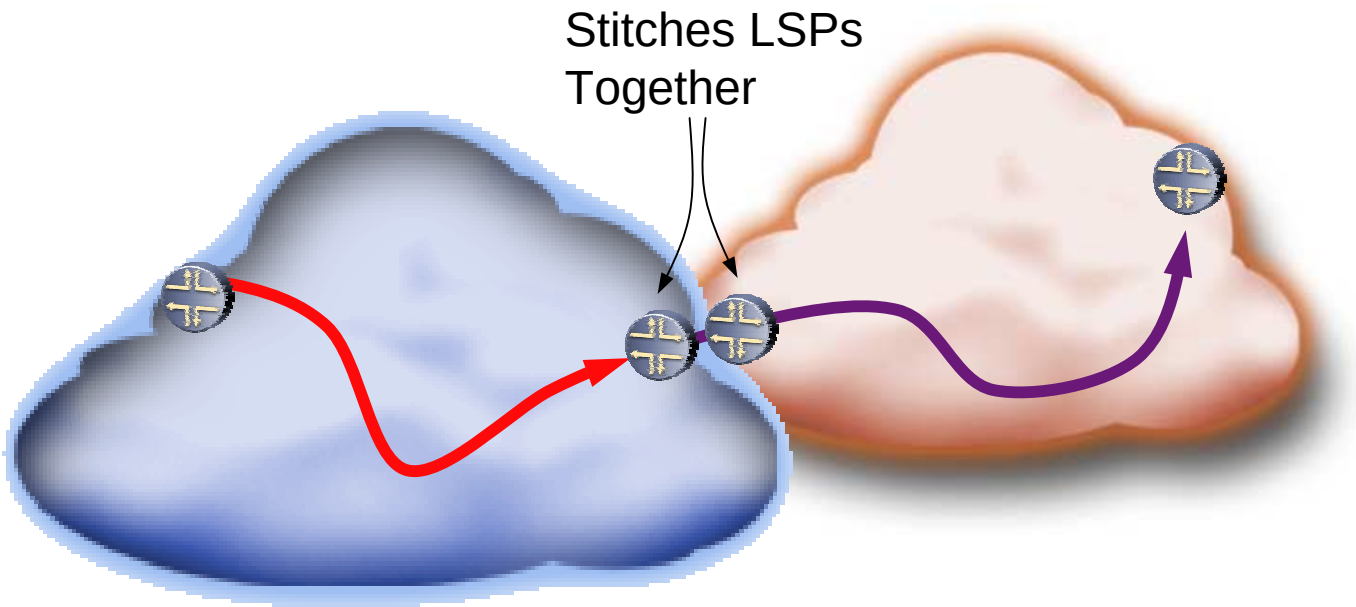
Signaling Options:Contiguous

- Single end-to-end LSP
- Hop-by-hop signaling used
- Requires some knowledge of red network by blue ingress router



Signaling Options: LSP Stitching

- 2 LSPs stitched to act as one
- Stitching may happen at single ASBR, or through a separate inter-domain LSP, or other tunnel mechanism



Signaling Options: Hybrid

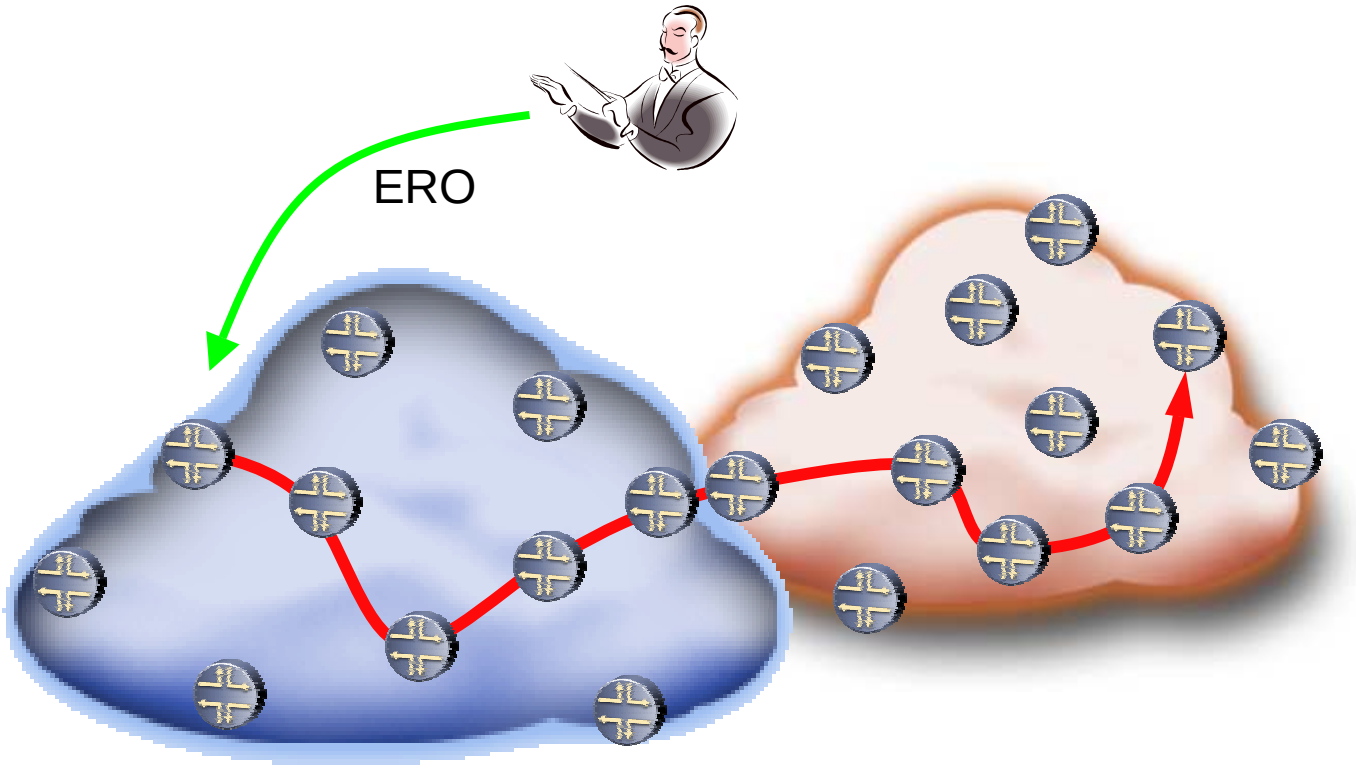
- Hybrid methods may be used
  - Combination of two or more signaling options
- Choice of downstream method(s) may be:
  - Requested by upstream
  - Restricted by attribute object
  - Imposed by downstream
  - Negotiated between domains

Path Computation

- Offline
- Ingress
- Domain Boundary
- Path Computation Element(s)

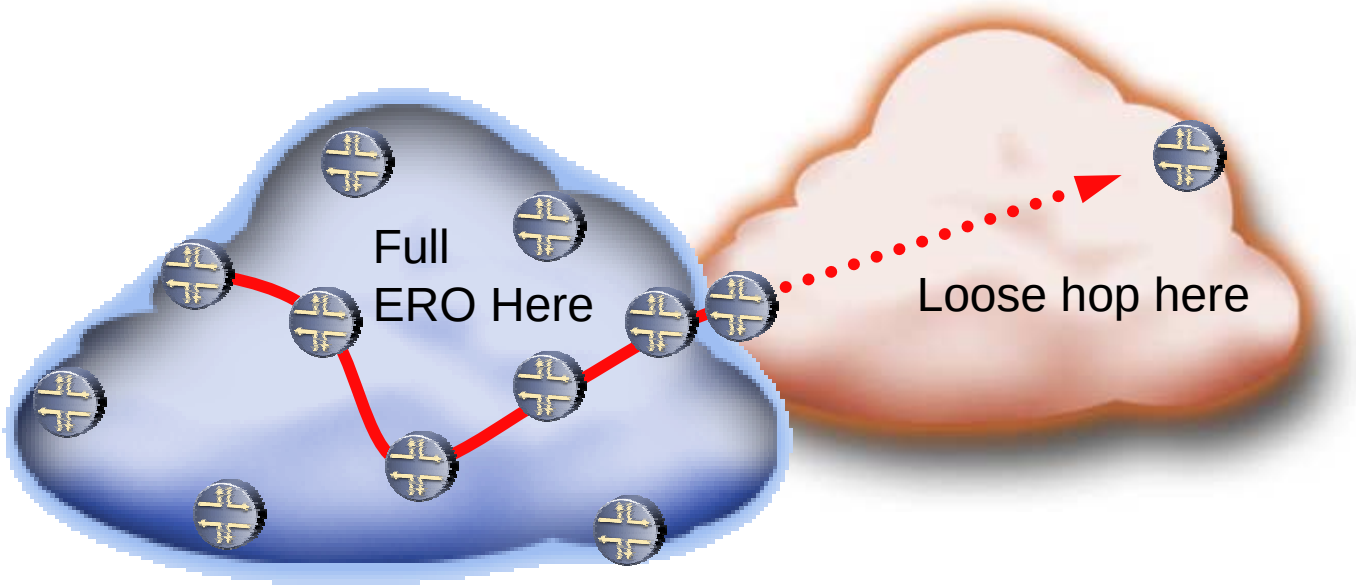
Path Computation: Offline

- Offline tools or planner
- Requires OOB sharing of TE information



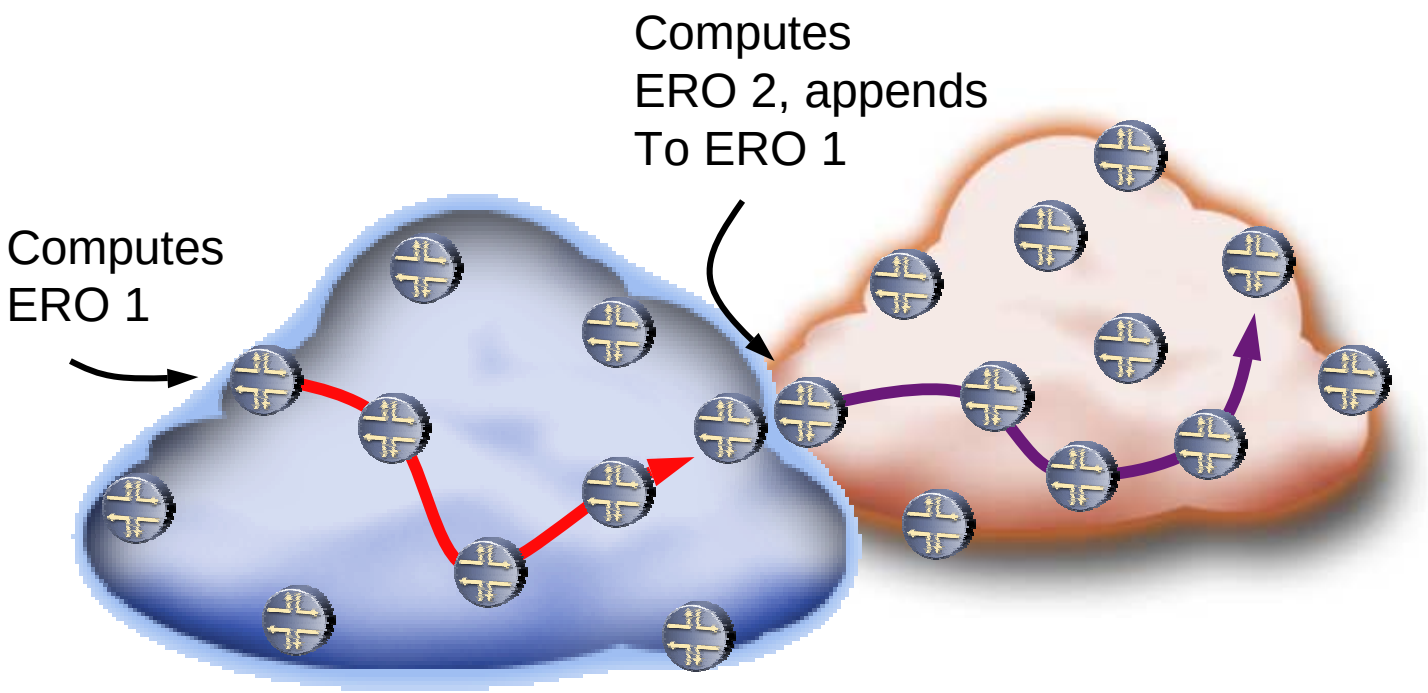
Path Computation: Ingress

- Head-end (ingress) router responsible for ERO
- Full, partial, or local-only info may be available



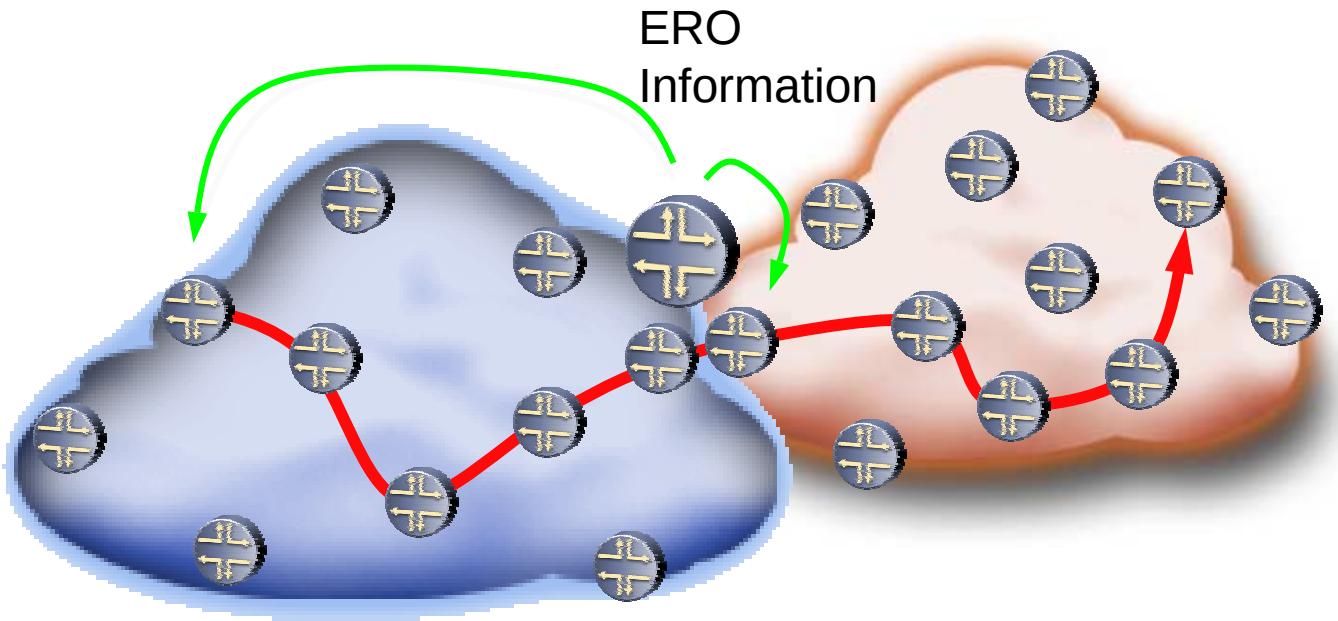
Path Computation: Domain Boundary

- LSR at each domain boundary adds to ERO
- Standard ERO processing rules still apply



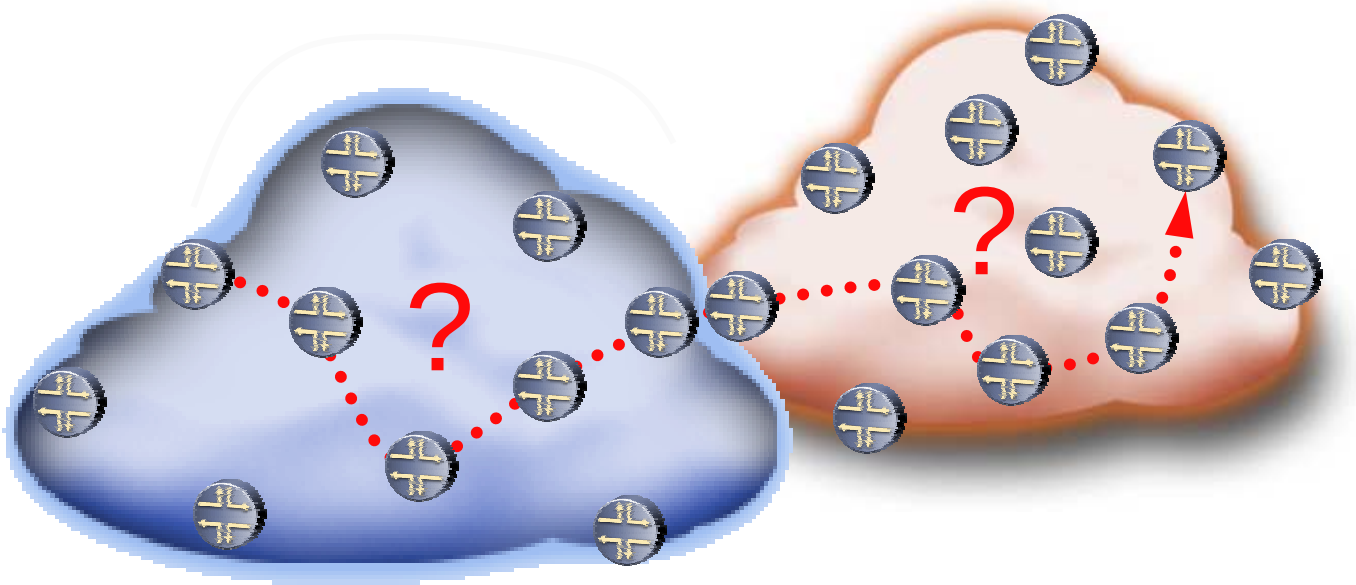
Path Computation: PCE

- PCE = Path Computation Element(s)
- PCEs may have full or partial visibility
- Can help preserve confidentiality



Optimal Inter-domain Paths

- Optimal = the path as if no domain boundaries existed
- Optimization and partitioning are always at odds



Other issues

- LSP Re-optimization
- LSP Setup Failure
- LSP Repair
- Fast Reroute
- Path Diversity
- Constraint Definitions
- Inter-domain OAM
- GMPLS

Conclusion

- End-to-end QoS, resource optimization, and recovery requires TE
- MPLS is the chosen TE method
- End-to-end means Inter-domain in the future
- A framework, and later mechanisms, for Inter-domain MPLS TE are required
  - Some mechanisms exist, some will have to be created or enhanced
- Work in this area is ongoing in ccamp, tewg, viz:

  draft-ietf-ccamp-inter-domain-framework-00.txt

Thank You

Matt Kolon

matt@juniper.net