Flexible Algorithms

Shraddha Hegde

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Nanog 81

What is Flex-algo?

- IGP traditionally computes best effort path
  - Based on IGP metric
- Flex-algo provides a way to compute TE paths in IGP
  - Based on various constraints
  - TE metric, latency metric
  - Admin color constraints
  - Avoid node constraints
- Backup paths also honor constraints
- Being standardized in IETF LSR WG draft-ietf-lsr-flex-algo

Why Flex-algo?

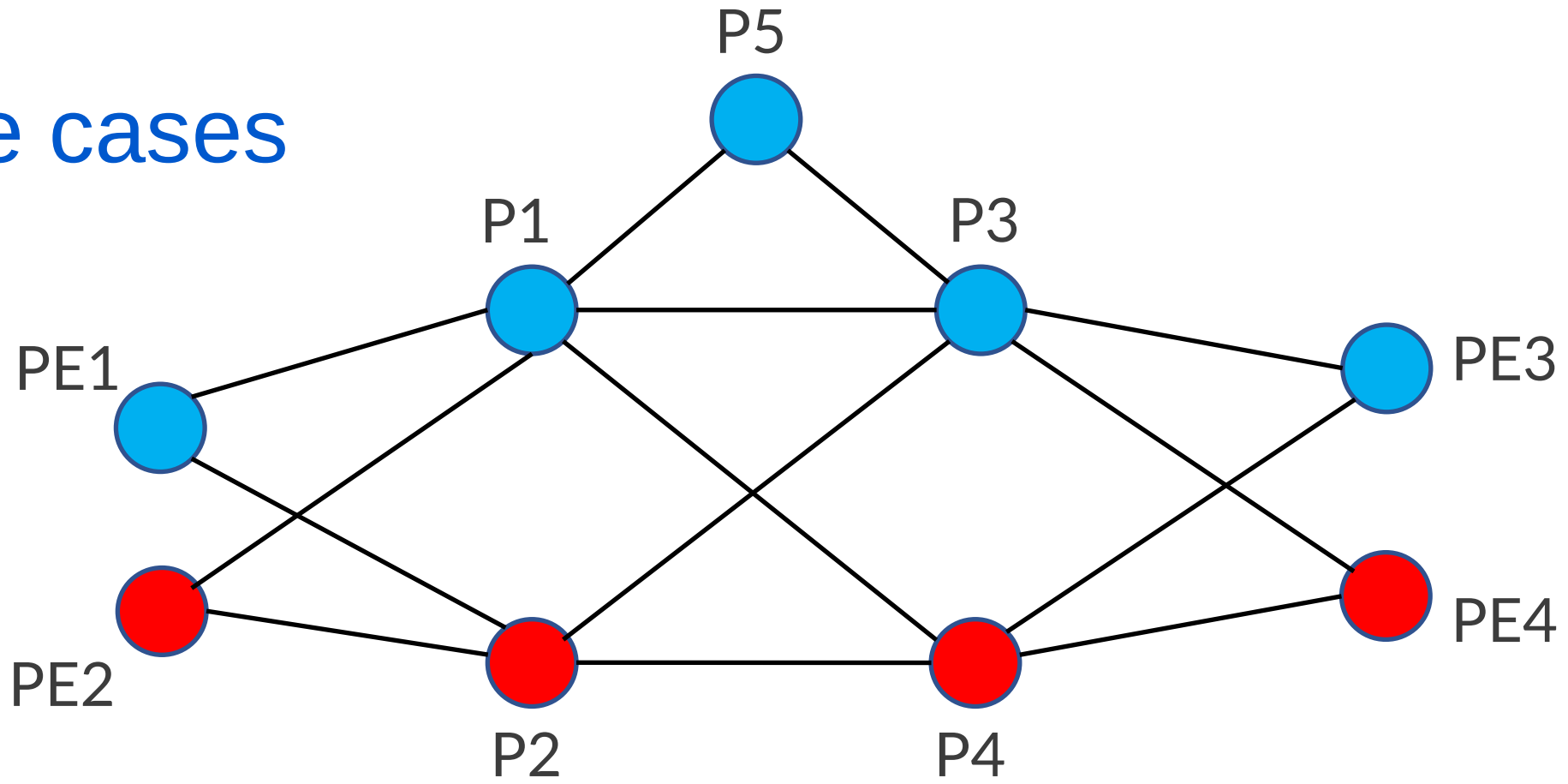
- **Requirements**
  - Strict TE constraints
    - Avoid nodes/links
    - Avoid traffic going in another plane
  - Honor the constraints for backup paths
    - TI-LFA backup paths to honor constraints
- **Possible Alternates**
  - SR-TE based solution
    - Compressed label stacks having Node-SIDs may not honor constraints during convergence
    - TI-LFA backup paths do not honor constraints

Flex-algo uses single label, satisfies strict TE constraints.

Use cases

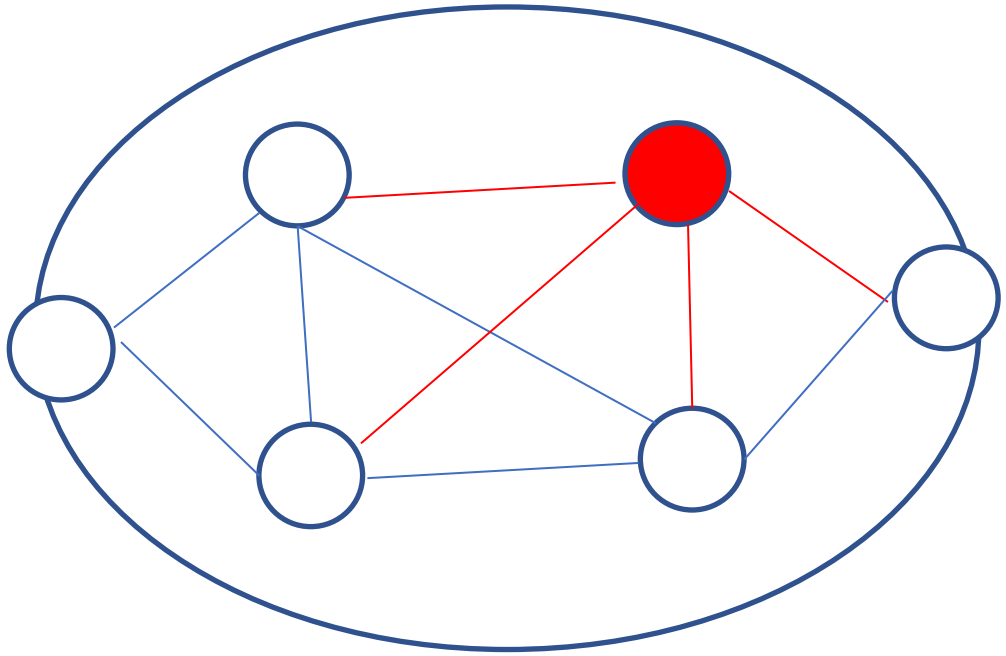
- Routing plane separation
  - Multiple routing planes with strict plane separation requirements
- Data Sovereignty
  - Strictly avoid nodes and links in certain geographical locations
- Merging two networks into one
  - Yet maintain the isolation for certain traffic
- Low latency routing

Use cases



- **Routing plane separation**
  - Strict traffic isolation between Red and Blue plane
  - If a plane is partitioned, traffic should drop and never switch to another plane

Use cases



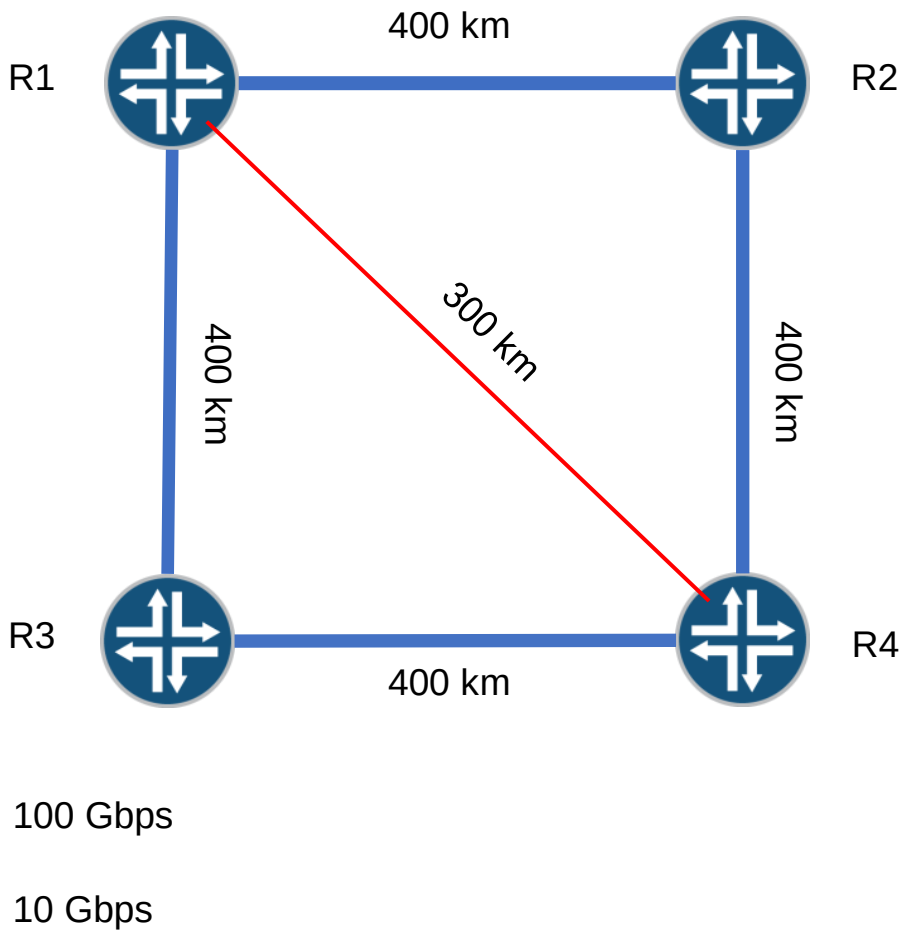
Avoid Red node and Exclude Red Links

- Data Sovereignty
  - Strictly avoid nodes and links in certain geographical locations

Low latency / high bandwidth paths

Policy

- All flows follow the lowest latency path available
  - In this network, latency is a function of circuit length
- However, high bandwidth flows must avoid 10G links



Link Advertisements

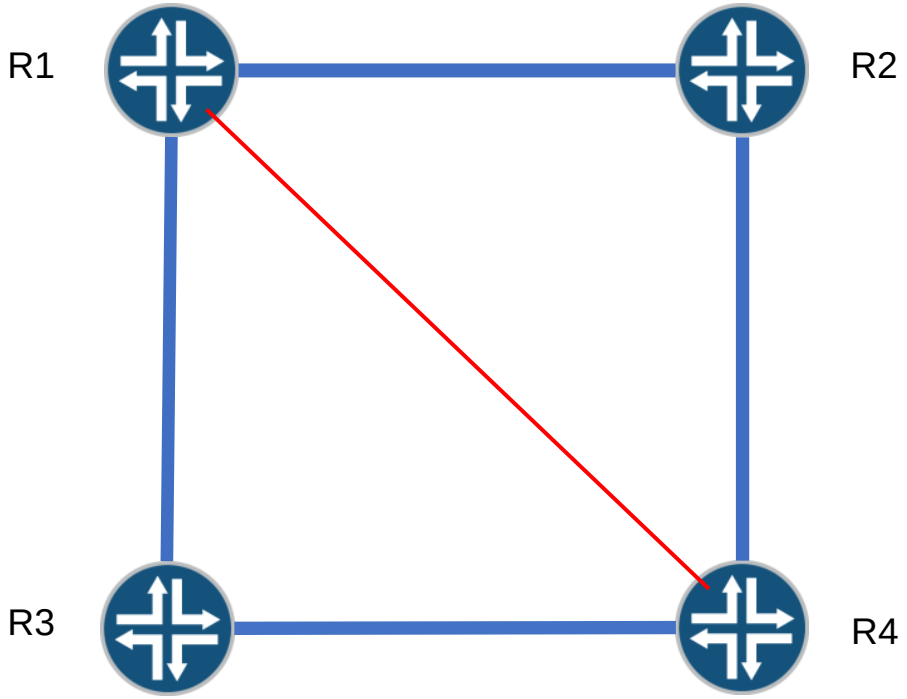
Link	IGP Metric	TE Metric	Administrative Group
R1-R2	400	400	Blue
R1-R3	400	400	Blue
R1-R4	300	300	Red
R2-R4	400	400	Blue
R3-R4	400	400	Blue

Flex-algo Definitions (FAD)

FAD	Metric Type	Calculation Type	Constraints
Low Latency	IGP	SPF	Include all
High bandwidth	IGP	SPF	Exclude red

Pulling it together

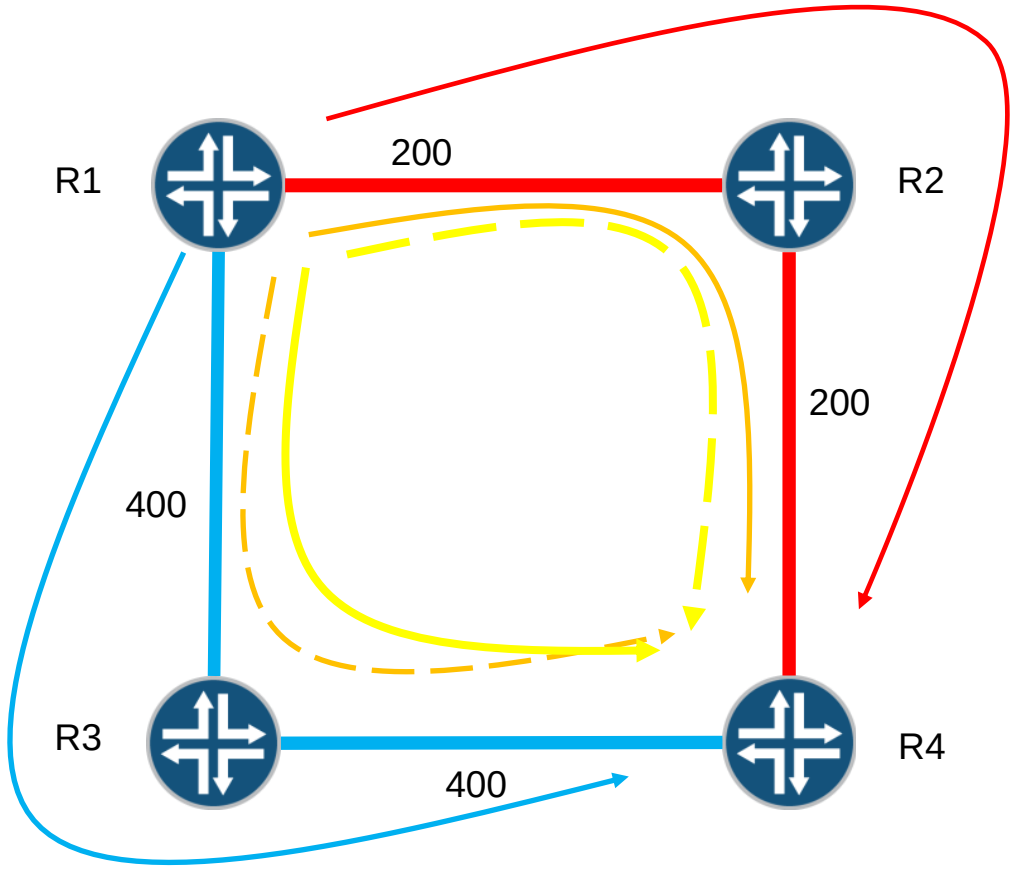
- R4 advertises Segment A
  - Associates it with the low latency FAD
- R4 advertises Segment B
  - Associates it with the high bandwidth FAD
- R1 calculates the least-cost path to Segment A
  - Next Hop is R4
  - Because low latency FAD includes all links
- R1 calculates the least-cost path to Segment B
  - Next Hop is ECMP (either R2 or R3)
  - Because high bandwidth FAD excludes red links



Path Diversity

Example Constraints

- Red flows traverse red links
  - And no others
- Orange flows prefer red links
  - But can fail over to blue links
- Blue flows traverse blue links
  - And no others
- Yellow flows prefer blue links
  - But can fail over to red links



Link Advertisements

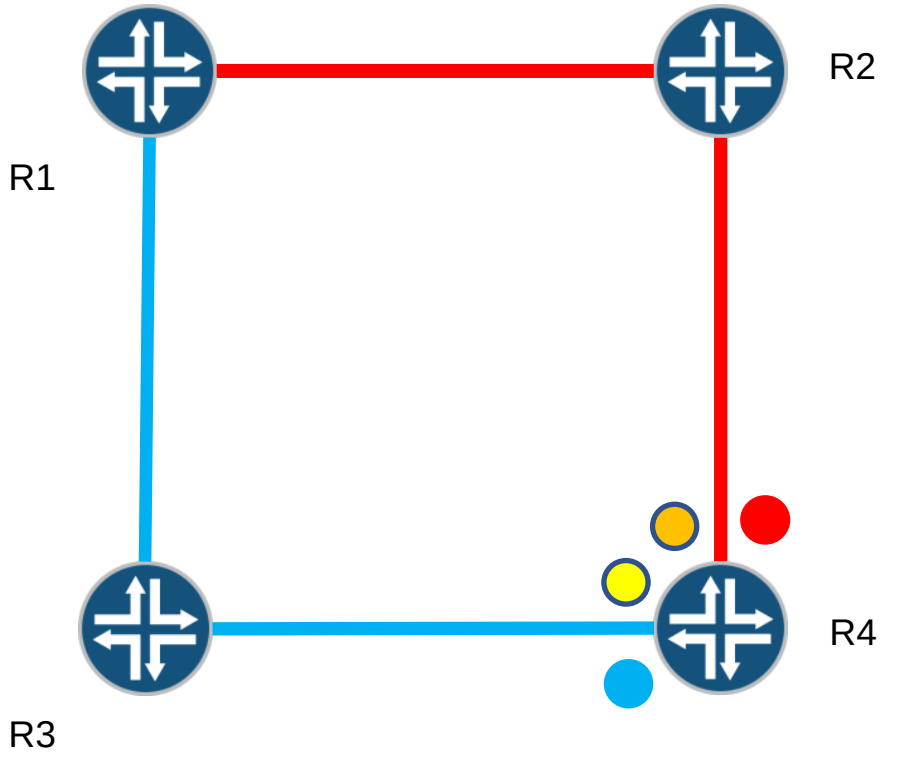
Link	IGP Metric	TE Metric	Administrative Group
R1-R2	200	400	Red
R1-R3	400	200	Blue
R2-R4	200	400	Red
R3-R4	400	200	Blue

Flex-algo Definitions (FAD)

FAD	Metric Type	Calculation Type	Constraints
Red	IGP	SPF	Exclude blue
Orange	IGP	SPF	Include all
Blue	TE	SPF	Exclude red
Yellow	TE	SPF	Include all

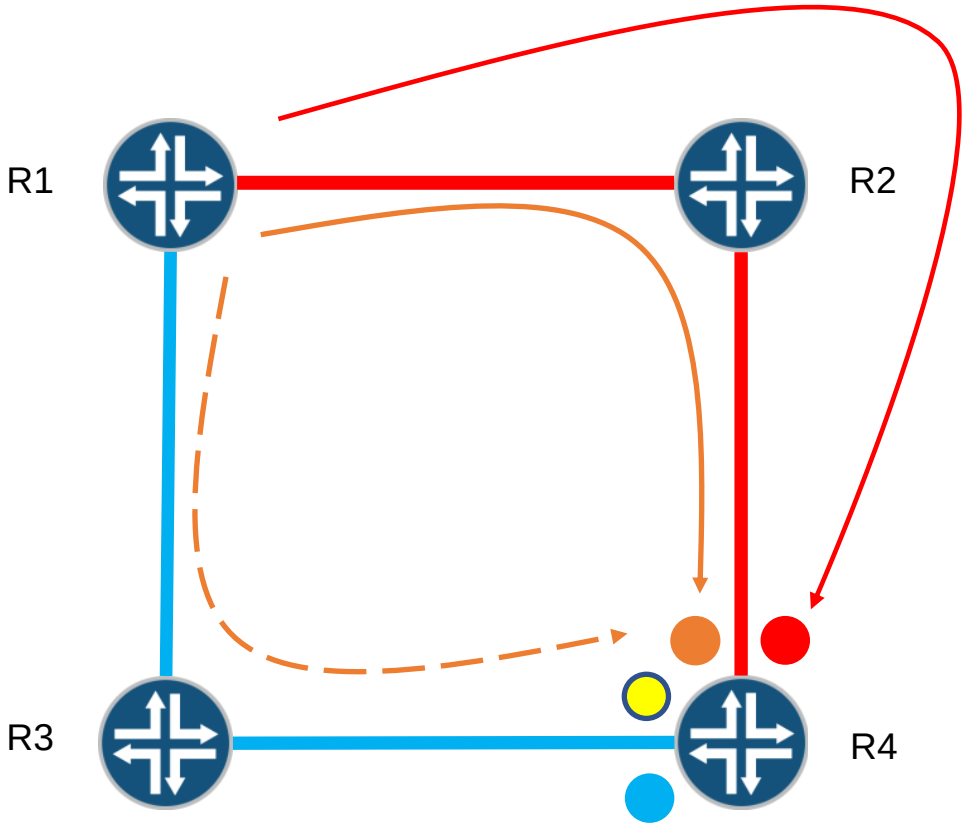
Pulling it together

- R4 advertises four prefix segments
  - Segment A associated with the red FAD
  - Segment B associated with the orange FAD
  - Segment C associated with the blue FAD
  - Segment D associated with the yellow FAD
- R1 calculates the least-cost path to R4 four times
  - Once for each FAD / prefix segment



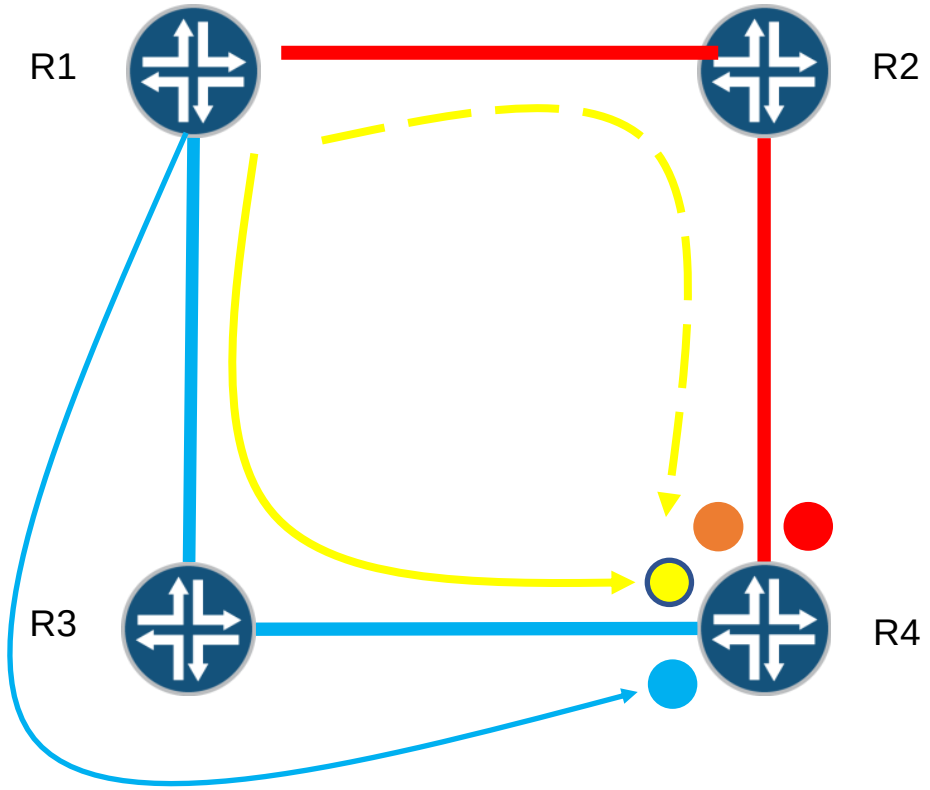
R1 Routes to R4

- Via Prefix A (red)
  - Next Hop is R2
  - No failover, because red FAD excludes blue links
- Via Prefix B (orange)
  - Next Hop is R2
    - Because orange FAD uses IGP metrics
    - Because IGP metrics are lower on red links
  - Failover is R3, because orange FAD includes all links



R1 Routes to R4 (Continued)

- Via Prefix Segment C (blue)
  - Next Hop is R3
  - No failover, because blue FAD excludes red links
- Via Prefix Segment D (yellow)
  - Next Hop is R3
    - Because yellow FAD uses TE metrics
    - Because TE metrics are lower on blue links
  - Failover is R2, because yellow FAD includes all links



IP Flex-algo

- Plain IPv4/IPv6 Network
  - No MPLS! No SRv6!

- Multiple Loopbacks
  - Associate each loopback with a Flex-algo
    - Reuse FAD procedures for draft-lsr-flex-algo
    - Reuse computation procedures from draft-lsr-flex-algo
  - Loopbacks corresponding to Flex-algo follow specific path
    - Next-hops for each loopback computed based on that flex-algo
  - Service prefixes carry different loopbacks as protocol next-hops
    - Ip-in-IP tunneling used to carry services
  - Being standardized in IETF draft-ietf-lsr-ip-flexalgo

Design Guidelines

- How many Flex-algos?
  - Total number of Flex-algos a router needs to participate should be in the order 2-16
  - 100s of flex-algos in the network is not advisable
- How often a Flex-algo definition needs to change?
  - The FAD definitions should not change very often and should be stable
    - Ex: Flex-algo 128 based on delay metric
    - Flex-algo 129 based on TE metric etc.
    - Flex-algo 130 exclude red links

      The FAD definition for flex-algo 130 will not change whereas the link colors can change more often

Design Guidelines

- Migrations
  - Every node that needs to be part of flex-algo need to support Flex-algo extensions
  - Legacy nodes that do not support Flex-algo to be not included as part of Flex-algo
  - Co-existence with LDP/RSVP

Flex-Algo Operational Requirements

- MPLS ping and traceroute on flex-algo labels
  - Control plane/Data plane synchronization and validation with MPLS ping and traceroute
- Ability to count traffic per Flex-algo SID
  - Build traffic matrix on a per Flex-algo basis
- Display of Flex-algo definitions, participation details, FAD winner, details of winning FAD
  - Debugging problems in Flex-algo participation

Flex-Algo Operational Requirements

- Display of Flex-algo topology
  - Debugging problems in topology derivation
- Display of Flex-algo SPF log details with reasons
  - Debugging problems with SPFs
- Display of Flex-algo routes
  - Debugging problems in downloading Flex-algo routes

Flex-algo is powerful

- Many networks require only course-grained TE
  - As in the use-cases described above
- Benefits of deploying Flex-algo into such networks
  - Each SR path is reduced to a single segment
  - No need to specify TE policy on a controller or on each segment egress node
  - Operational simplicity
- Benefits of deploying IP Flex-algo
  - No MPLS Required
  - No large address blocks per Flex-Algo required
  - No new protocols required, uses only IGP

References

- draft-ietf-lsr-flex-algo
- draft-ietf-lsr-ip-flex-algo

Thank you

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