Customized BGP Route Selection

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Customized BGP Route Selection

Introduction and motivation

Implementing CRS

Practical considerations and solutions

Conclusion

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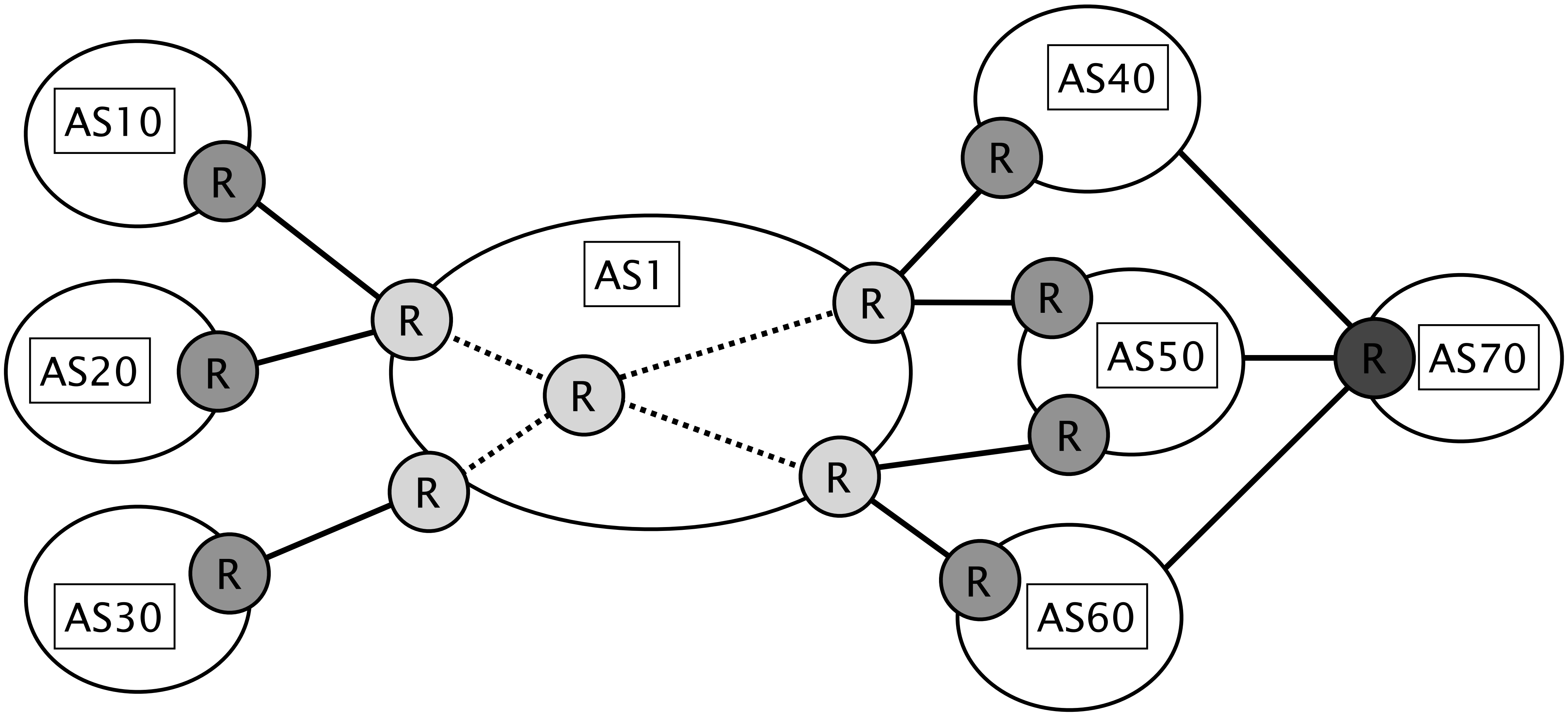
The Internet is a collection of Autonomous Systems (AS)



- An AS is a set of routers managed by a single administrative entity
  - Today, there are approximately 30.000 ASes

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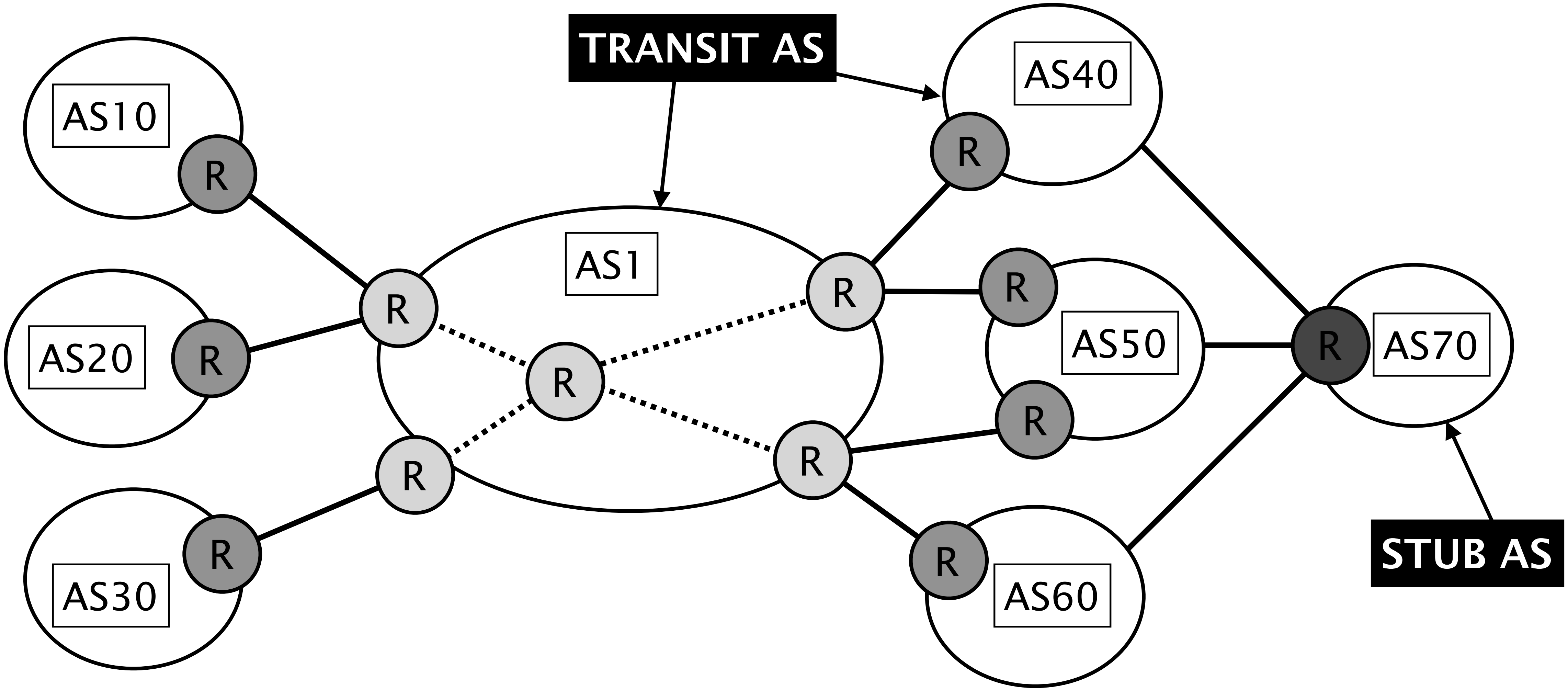

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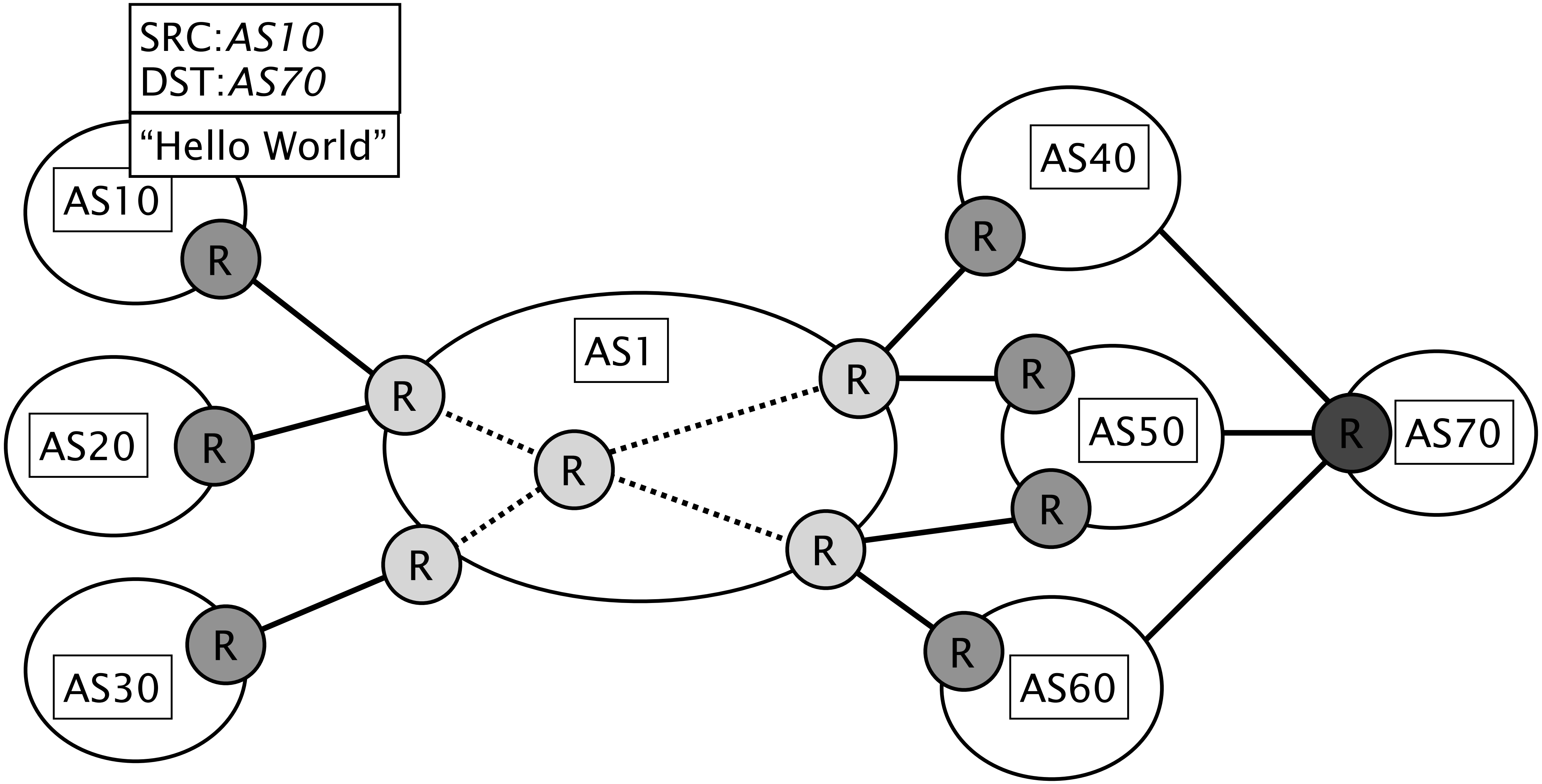

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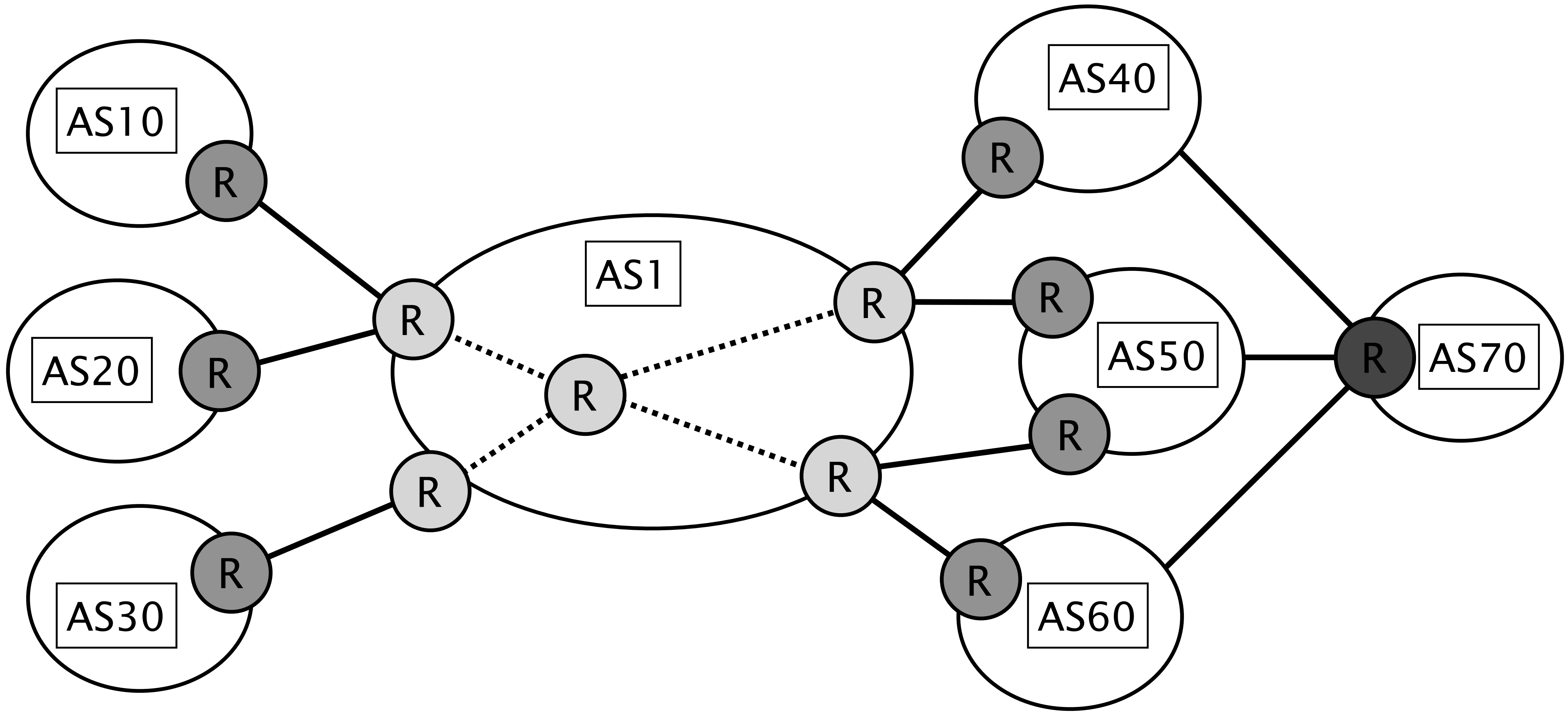

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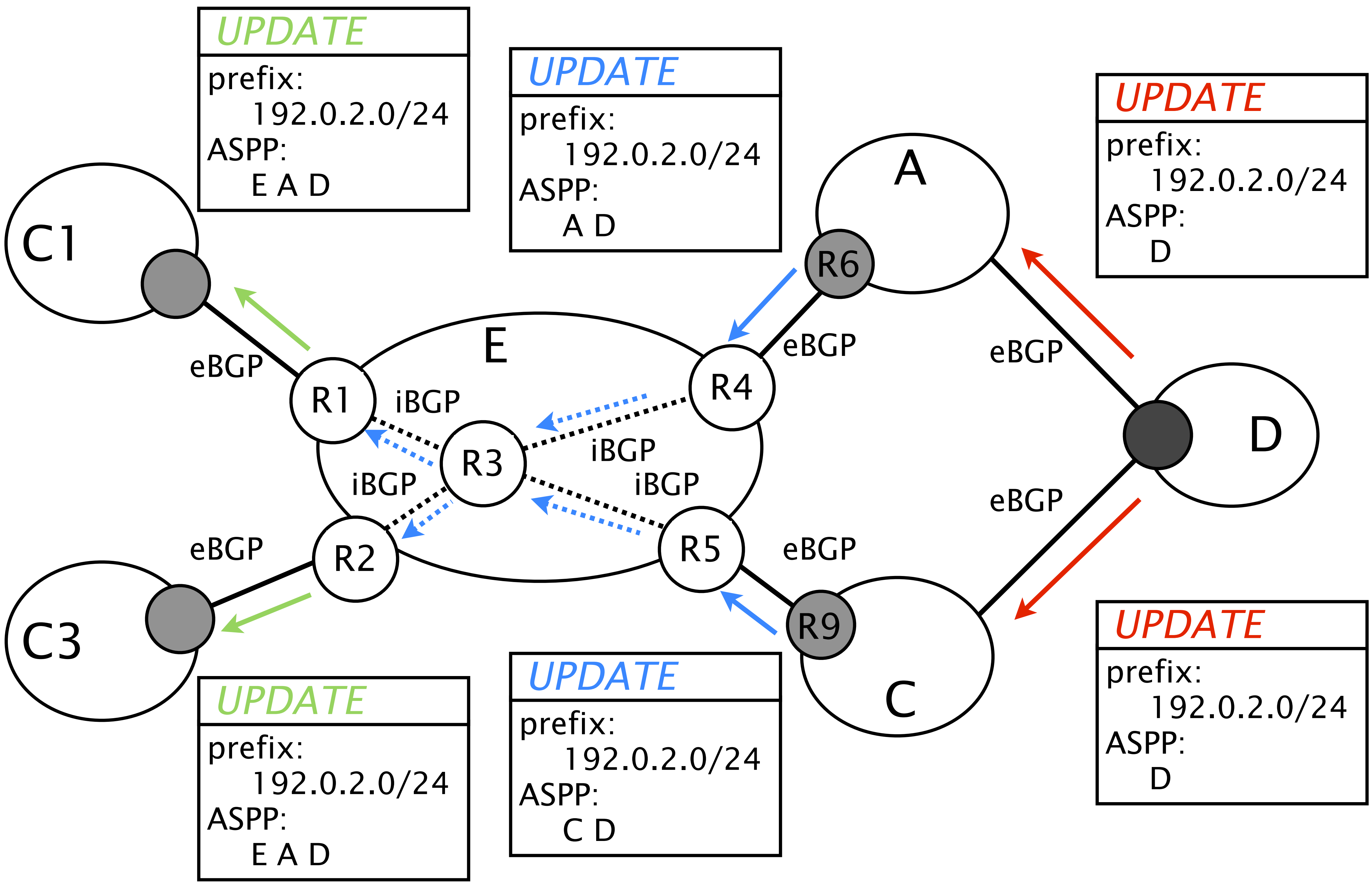
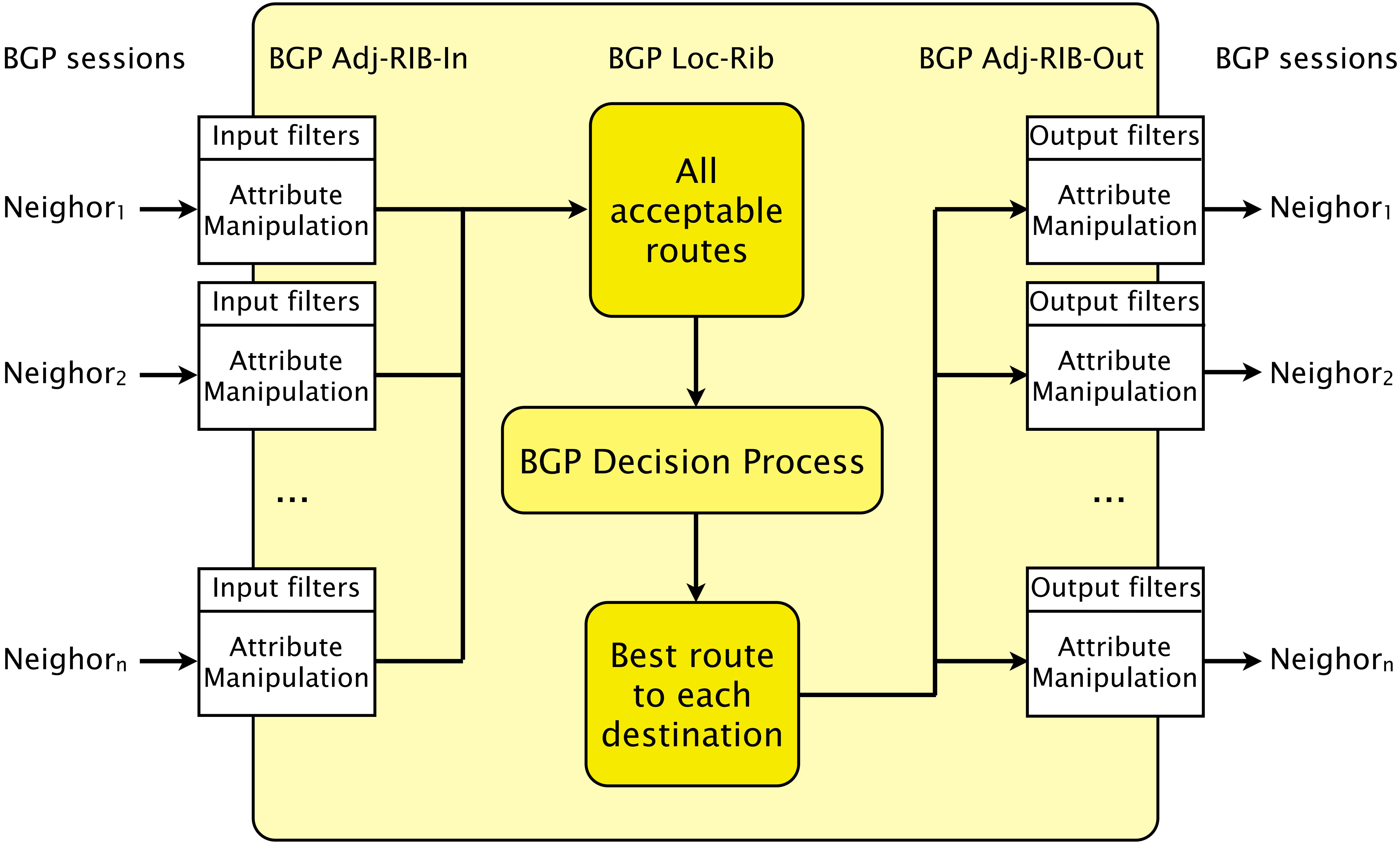
BGP is the *path-vector*, *policy-based* interdomain routing protocol

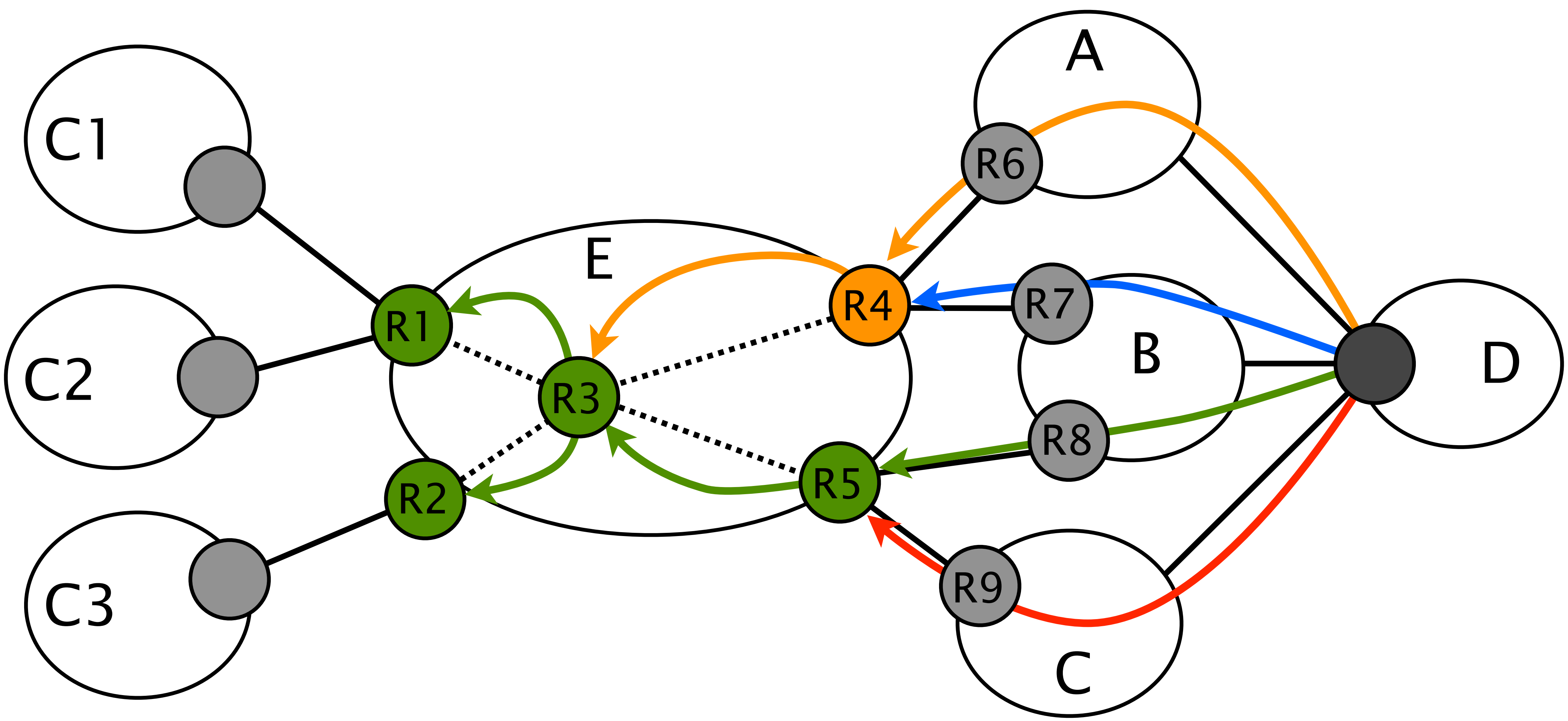


BGP is based on *sessions*, *policies* and a *decision process*



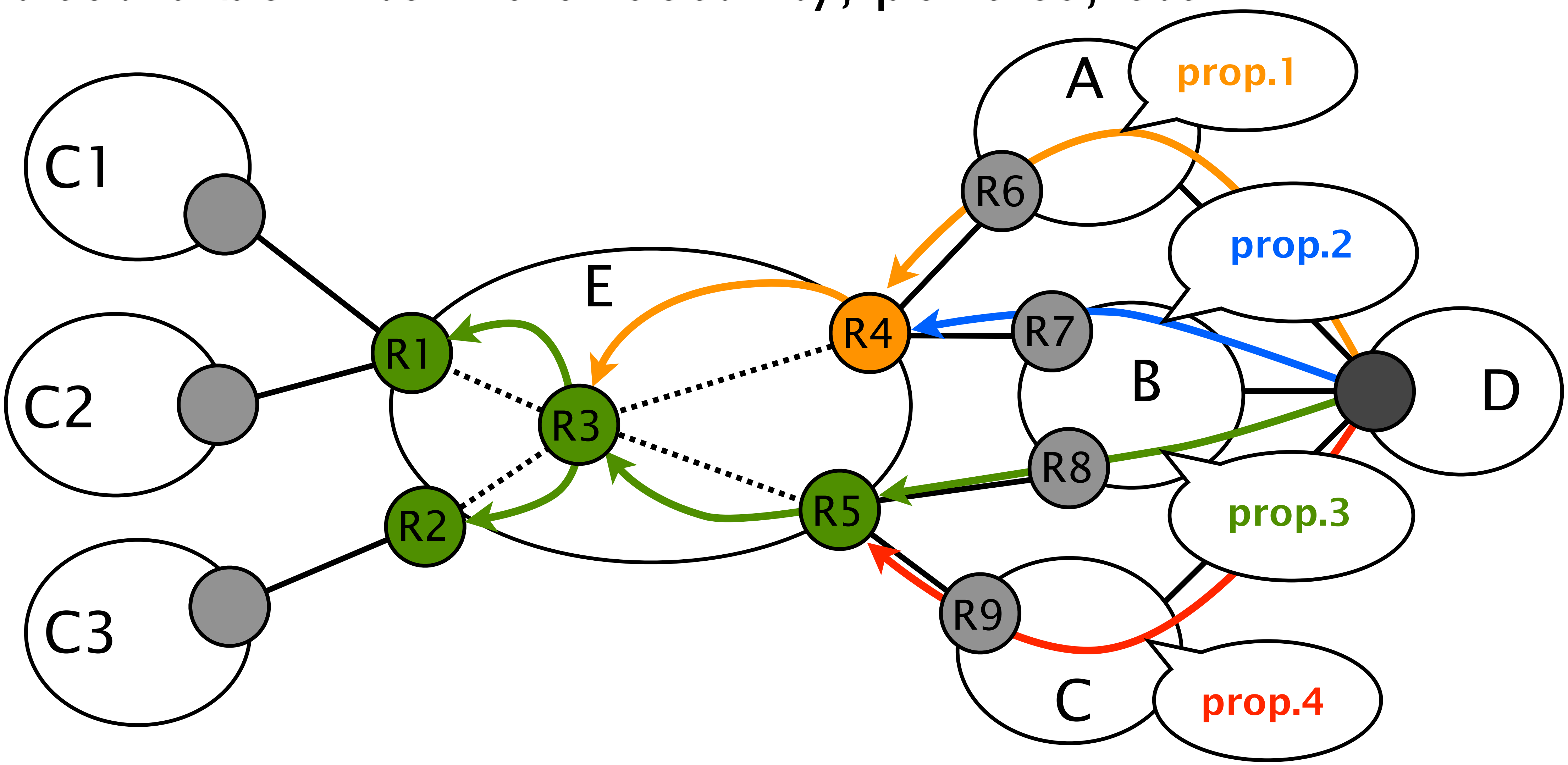
BGP Route Selection: *One-route-fits-all* model

- A BGP router selects **one** best route for each destination
- Globally, AS E knows 4 paths towards D
  - Locally, some routers only know one path (C1...C3, R1, R2)



BGP Route Selection: *One-route-fits-all* model

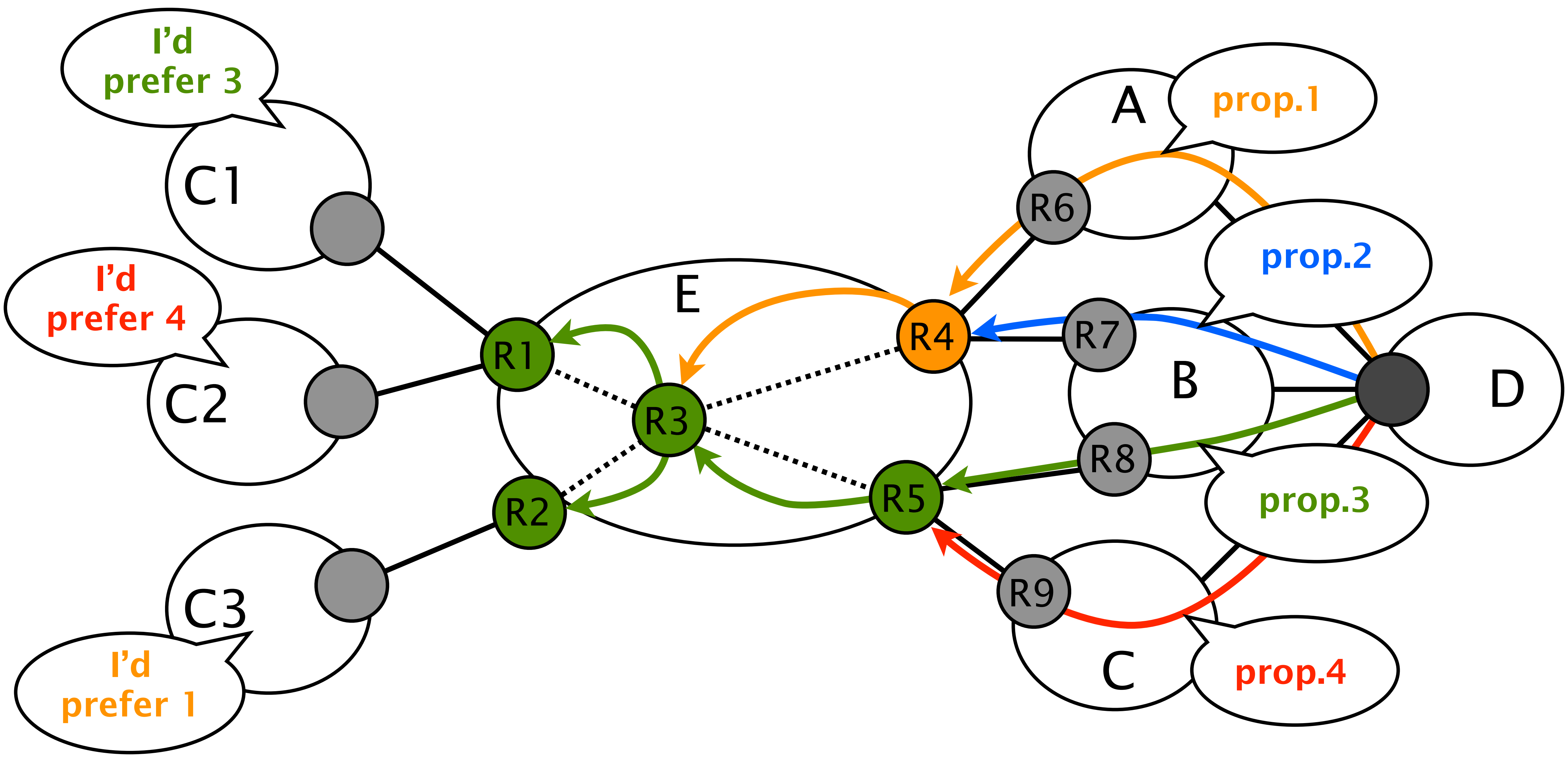
- Many ISPs have a rich path diversity
  - It is common to have 5-10 paths *per prefix*[1]
- Different paths have different properties
  - It could be in terms of security, policies, etc.



[1] W. Muhlbauer, A. Feldmann, O. Maennel, M. Roughan, and S. Uhlig. Building an AS-topology model that captures route diversity. *In Proc. ACM SIGCOMM*, 2006.

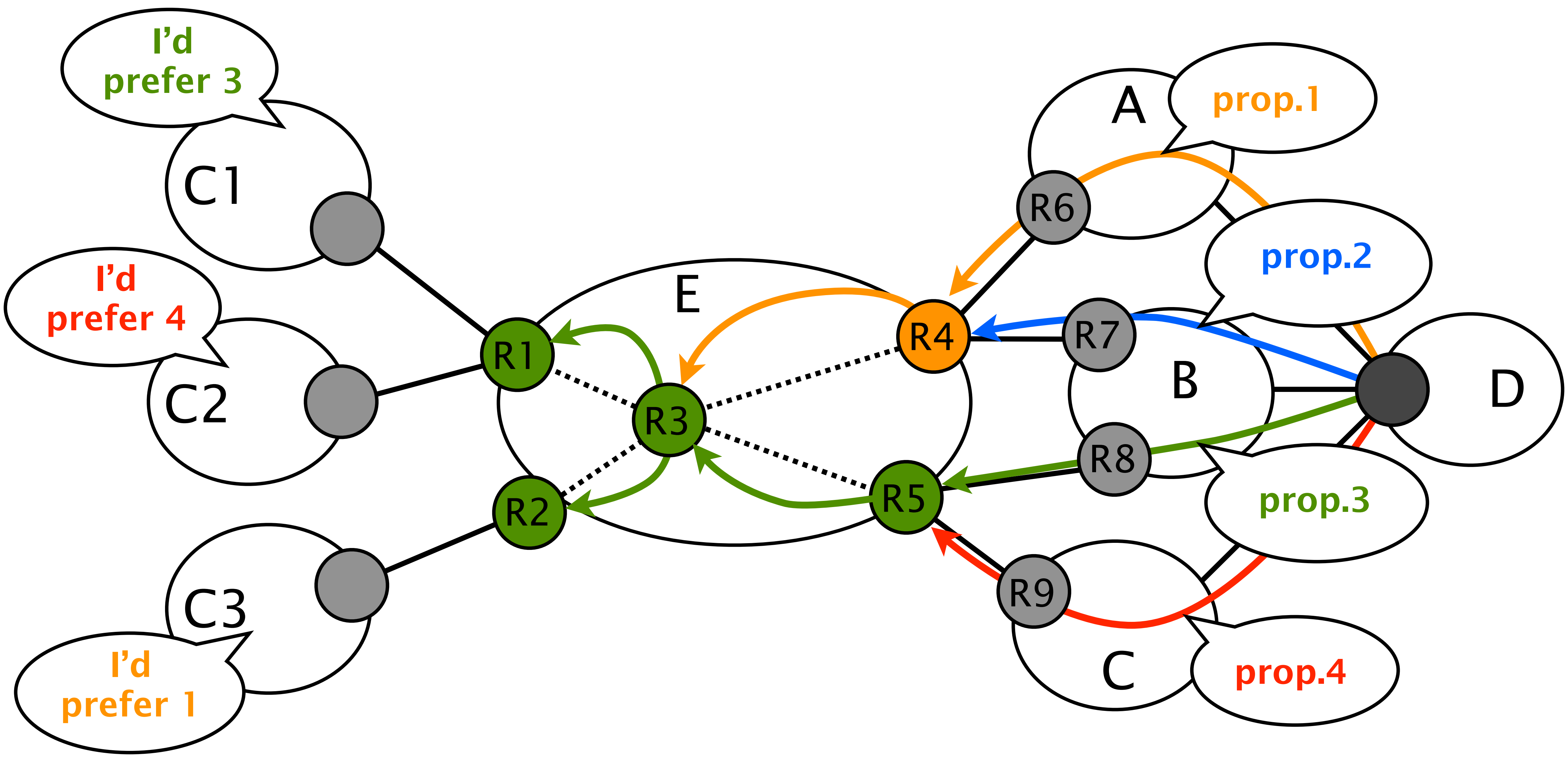
BGP Route Selection: *One-route-fits-all* model

- Clients may want different paths to the same prefix
  - If C1 is a competitor of C, he'd prefer to reach D via A or B
  - C1 may even want to pay an extra fee for that



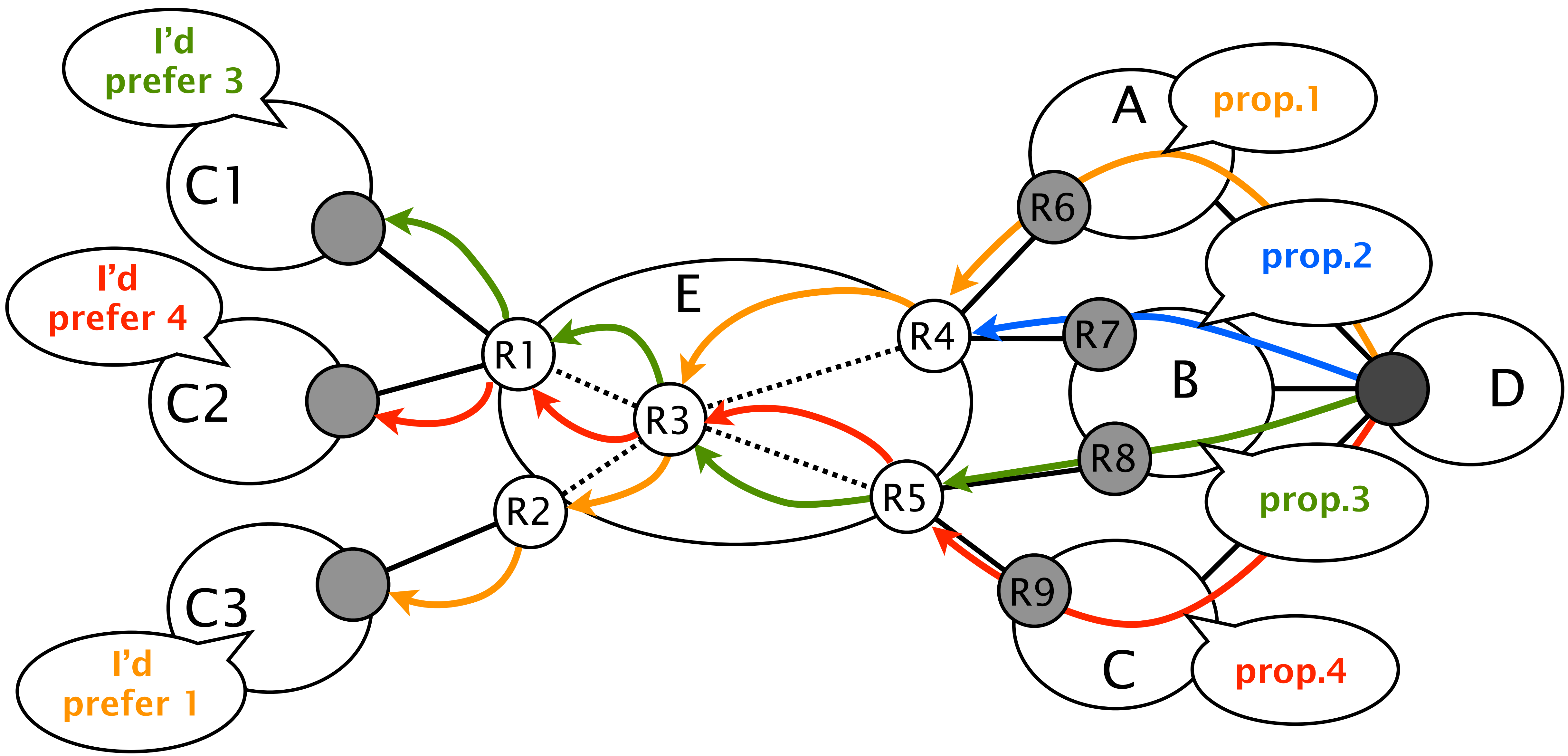
BGP Route Selection: *One-route-fits-all* model

- With vanilla BGP, you *can't* match customers' preferences to available paths
  - Customers of a given PE receive the same path



CRS: *Customized Route Selection*

- Under CRS, one router can offer *different* interdomain routes to *different* neighbors
  - C1 reaches D via B, C2 reaches D via C



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Implementing CRS

Potential issues and solutions

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Under CRS, routes are *colorized* based on their properties

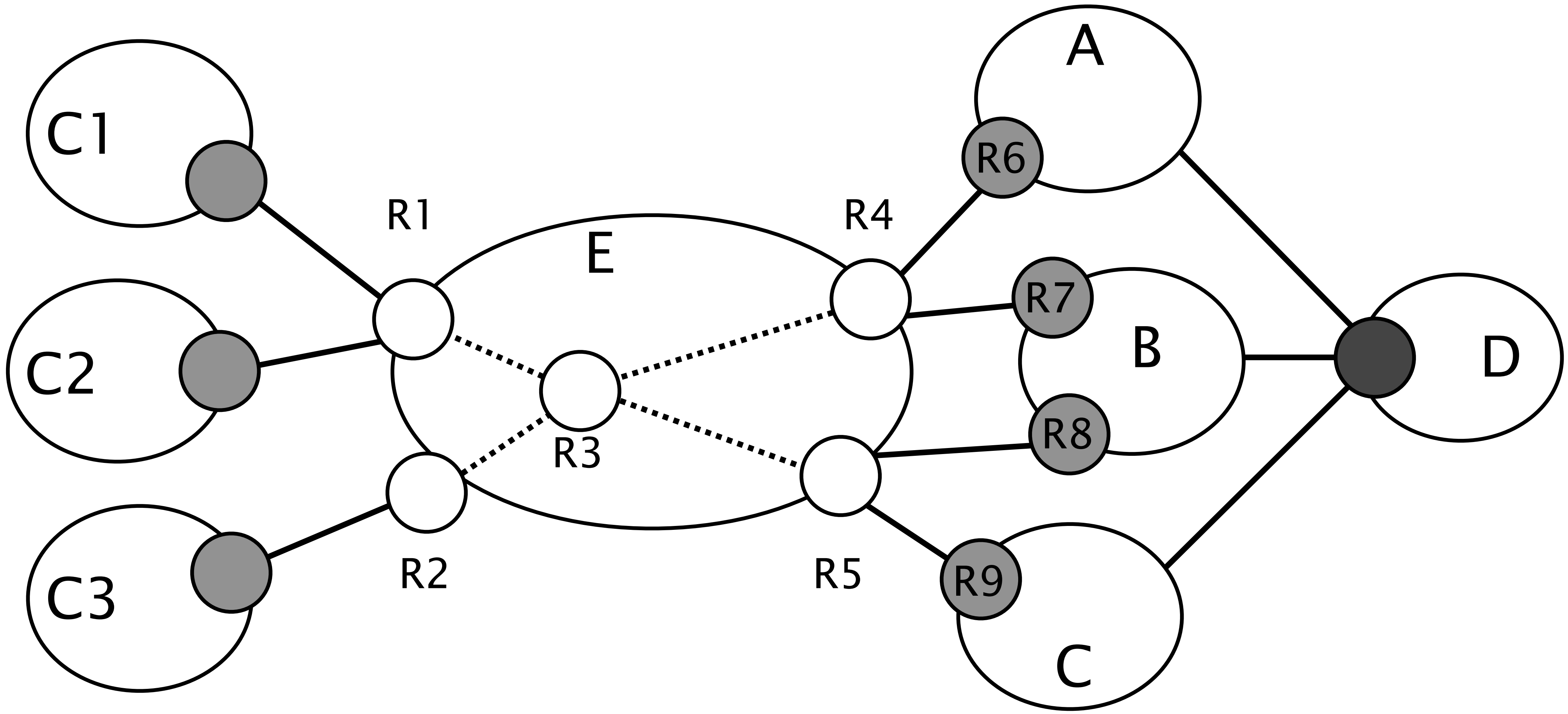
- A *color* denotes a set of routes sharing a property
  - *e.g.*, color *red* is associated to all *high-bandwidth* routes learned on *national* peerings
  - one route can have multiple colors

- Colors are “tags” associated to routes
  - we use the well-known BGP community field

What do we need to implement CRS with BGP MPLS VPNs ?

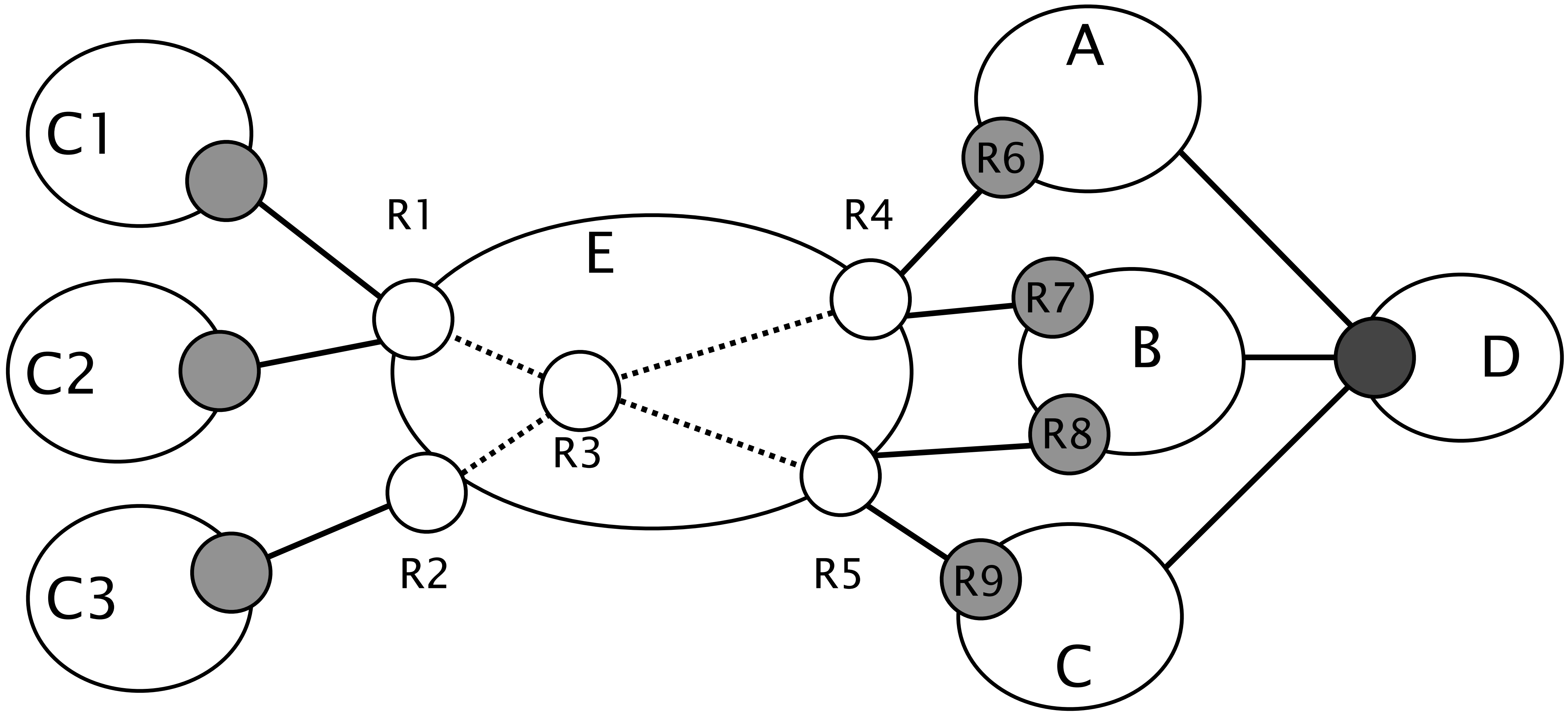
- Mechanisms to *disseminate* and *differentiate* paths
  - Multiprotocol BGP is used as dissemination protocol
  - Route Targets (RT) are used to identify colors
  - Route Distinguishers (RD) are used to ensure diversity
- *Customized* route selection mechanisms at ASBR
  - Use of Virtual Routing and Forwarding (VRF) instances
- Traffic forwarding on the chosen paths
  - MPLS tunneling

How do we implement CRS with BGP MPLS VPNs ?



- C1 wants to reach D via B, C2 via C
- Define 3 colors: routes learned via *A (green)*, *B (red)* and *C (blue)*
- Announce *red* routes to C1, *blue* routes to C2

How do we implement CRS with BGP MPLS VPNs ?



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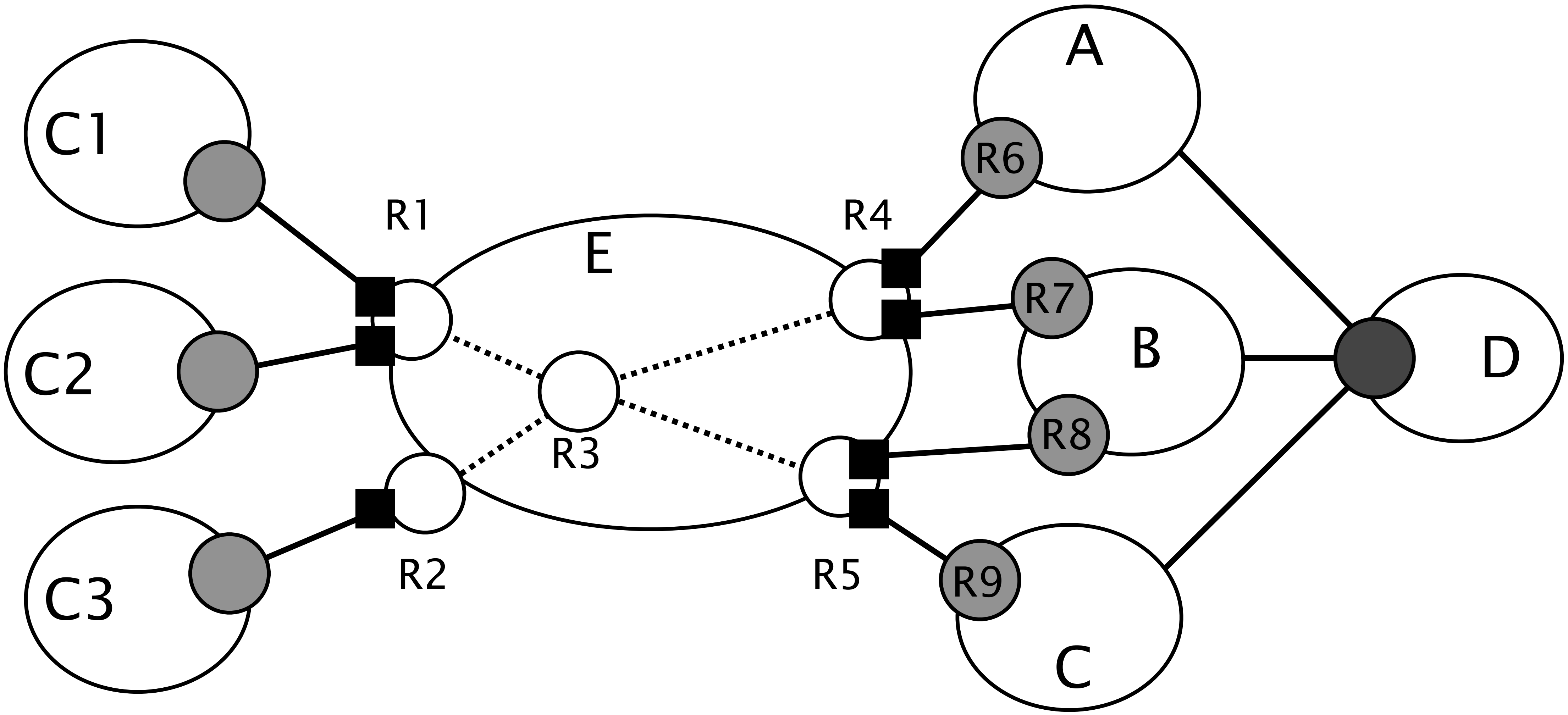
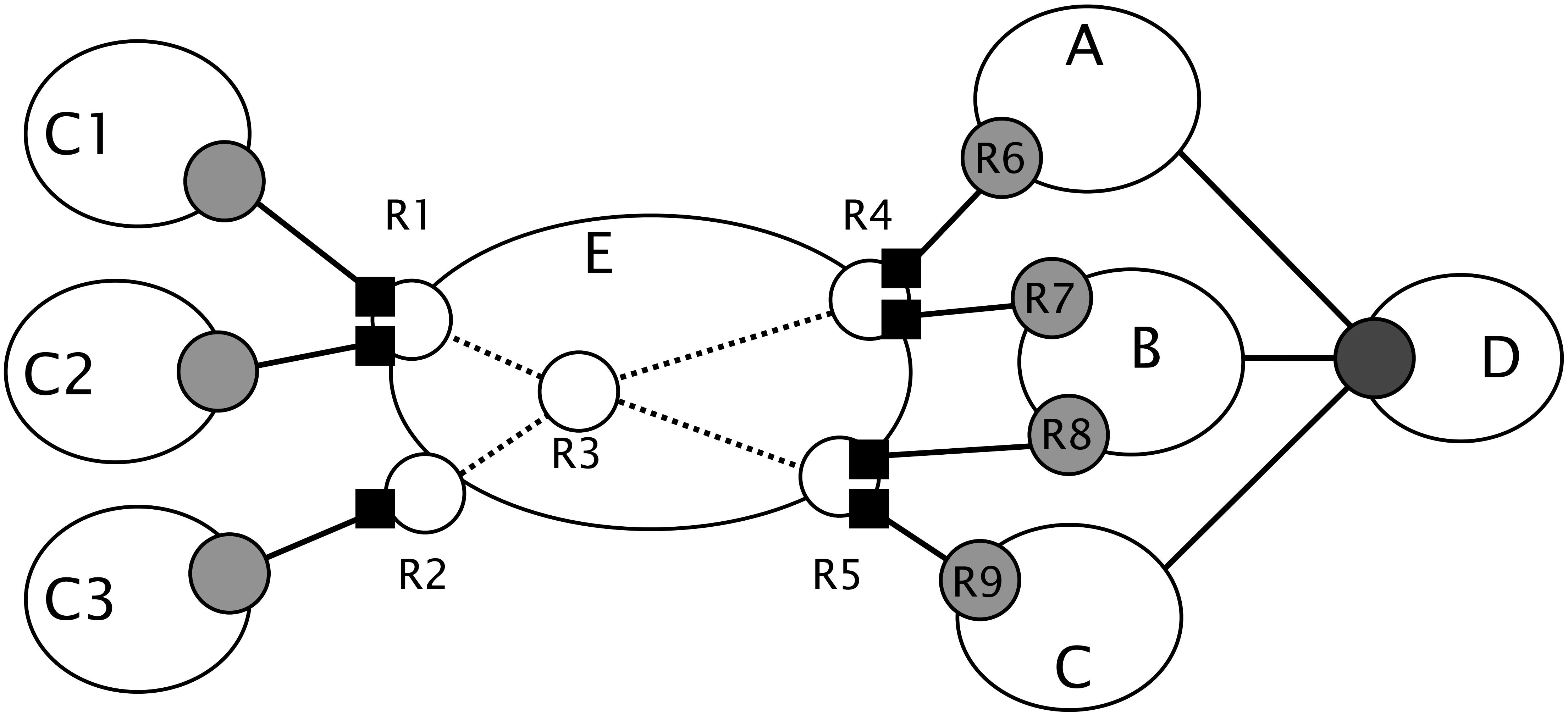


- Consider peers as VPNs and put them in VRFs

How do we implement CRS with BGP MPLS VPNs ?

Route Targets	
green	*learned via A*
red	*learned via B*
blue	*learned via C*



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- Use RT to identify *colors*

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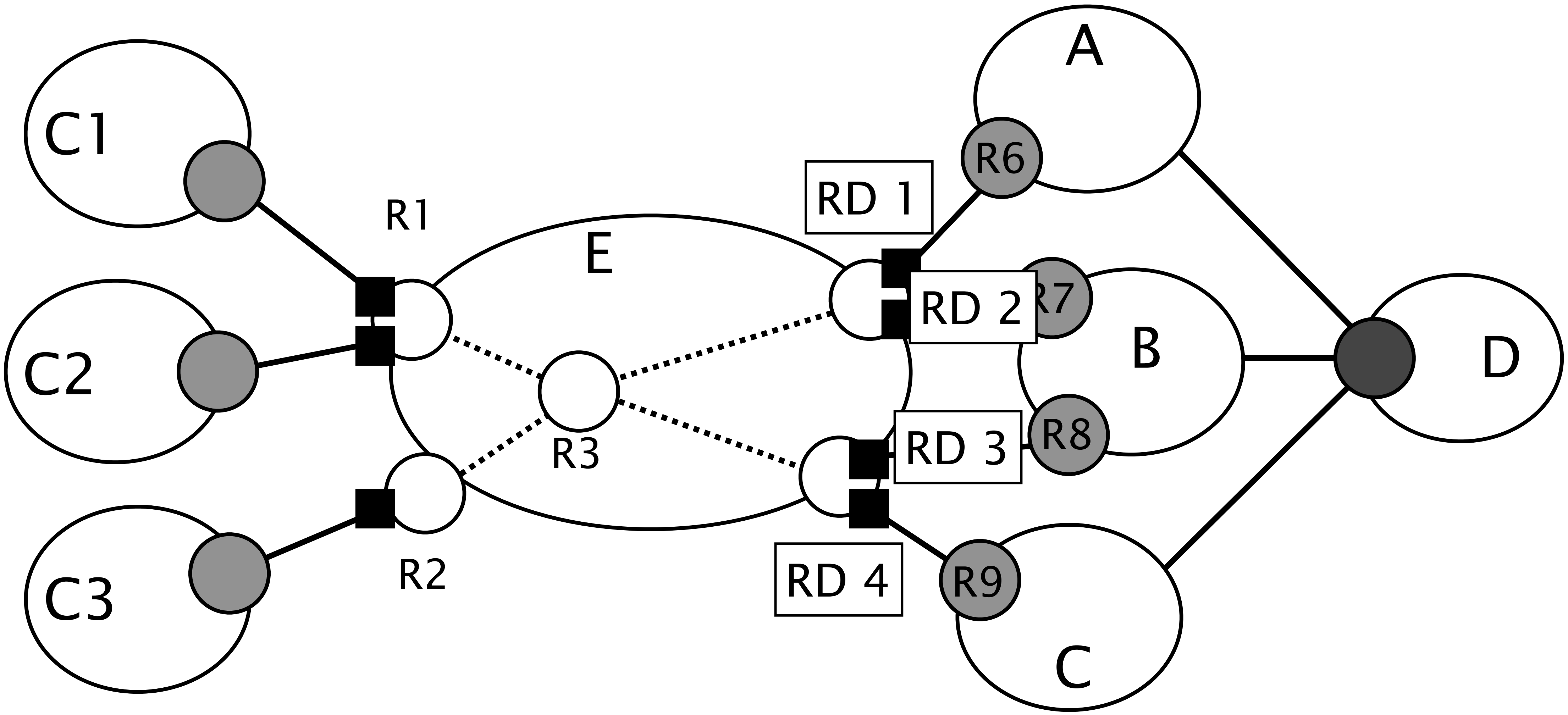
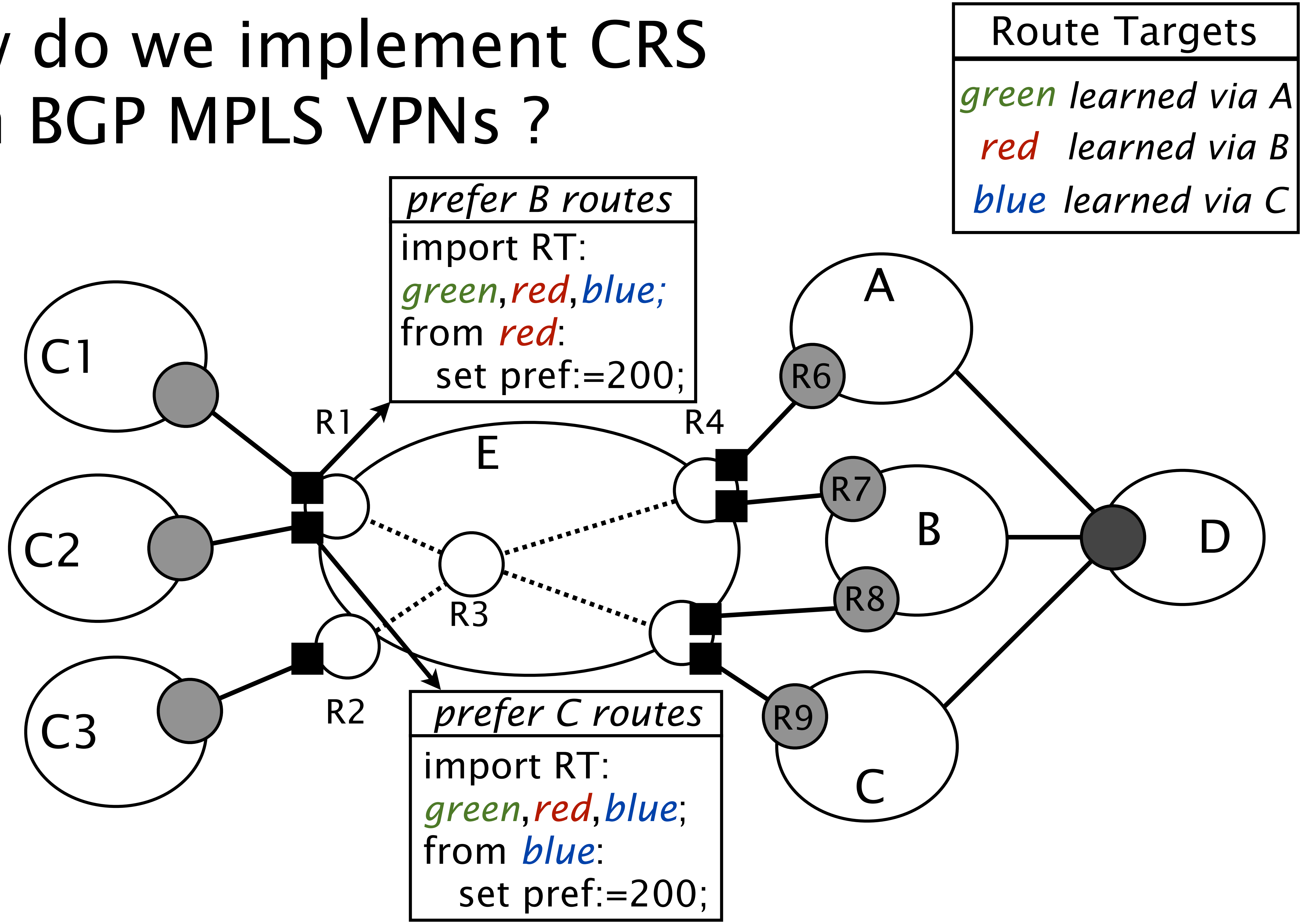


- Consider peers as VPNs and put them in VRFs
- Use RT to identify *colors*
- Use different RD to differentiate routes

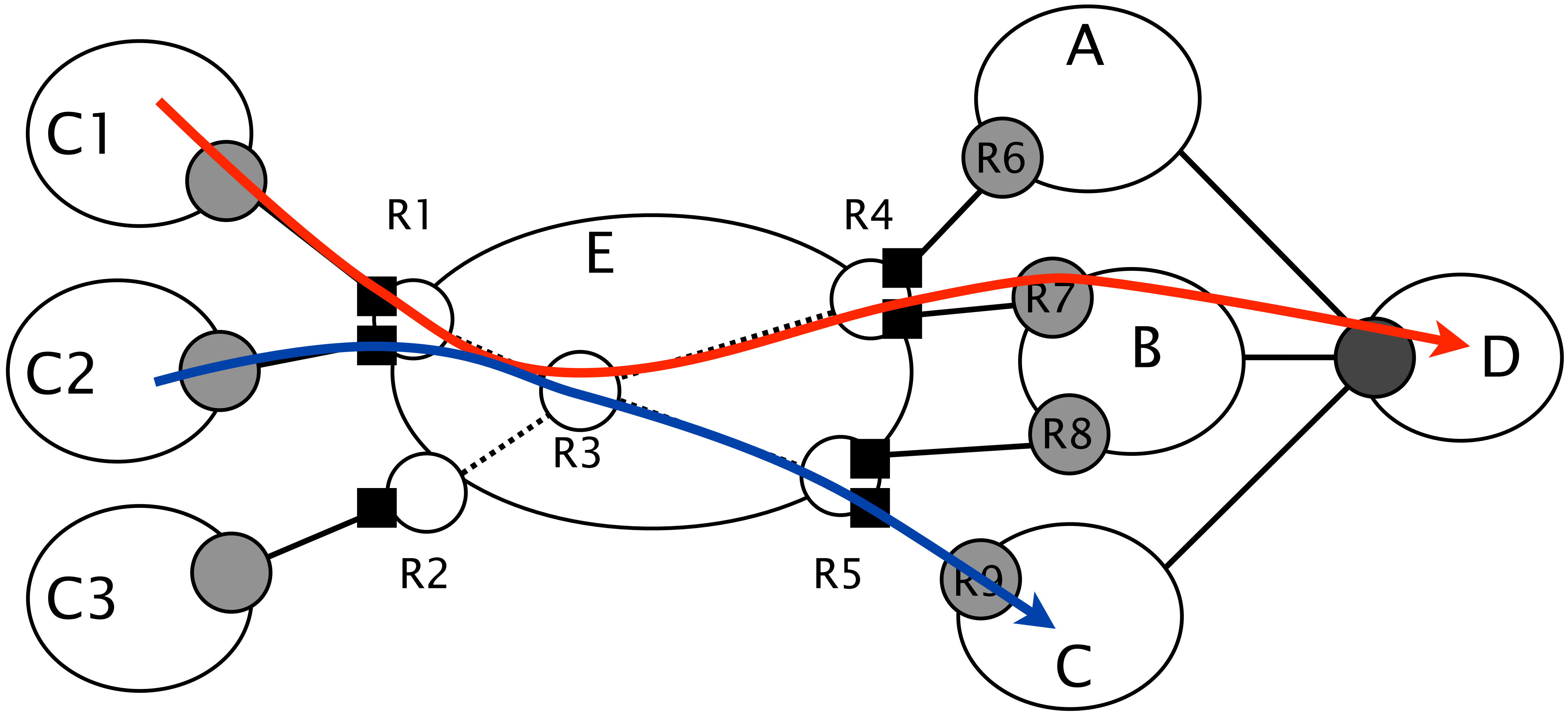
How do we implement CRS with BGP MPLS VPNs ?



- In each VRF, prefer certain routes via import filters

How do we implement CRS with BGP MPLS VPNs ?

Route Targets
green learned via A
red learned via B
blue learned via C



- MPLS is used for forwarding
  - Two levels label stack
  - R3 only knows label to reach the PEs

Customized BGP Route Selection Using BGP/MPLS VPNs

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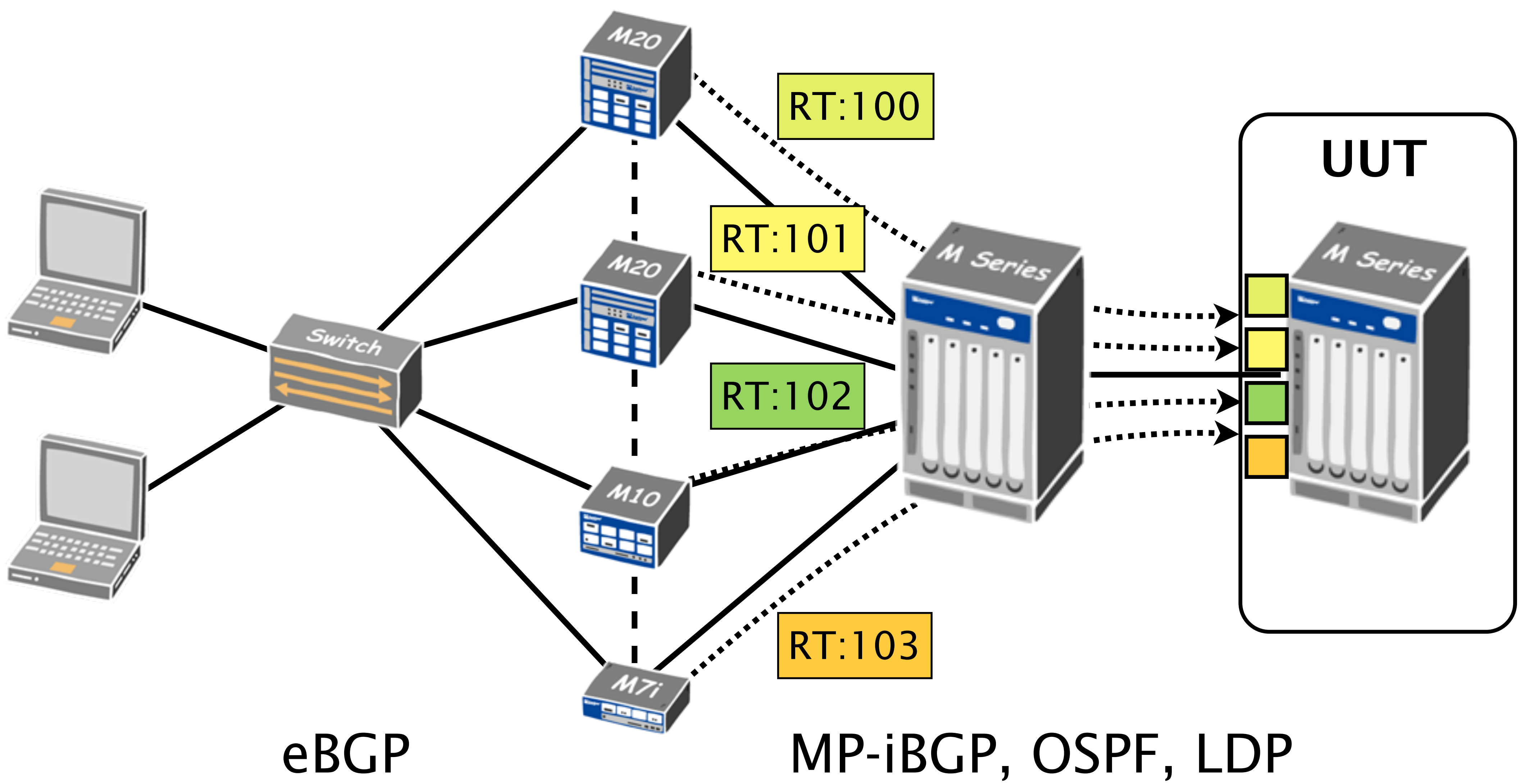
Is CRS pushing a M120 to the limit ?



Four tables are defined on the Unit Under Test (UUT)

- Each table is fed with one color (one RT)
- In each color, ~300k routes (1 path per route)
- In the end, 1.200.000 routes in **RIB** & **FIB**

Is CRS pushing a M120 to the limit ?

- UUT was a Juniper M120 [JunOS 9.3R2.8]
  - Routing Engine (RE) has 4 GB DRAM
  - Forwarding Engine Boards (FEB) have 512 MB DRAM

	RE	FEB
empty	*17%*	*9%*
fully-loaded (1.200.000 routes)	*38%*	*39%*

- FIB could handle more than 2.000.000 routes
  - Enough to support a few services *without* modifications

More services ?
scalability and...*scalability*

- Routes *dissemination* overhead
  - **All** PEs receive **all** VPN routes

- Routes *storage* overhead
  - RIB
    - Modest performance demand
    - Add more DRAM to support CRS ?
  - **FIB**
    - CRS's biggest challenge
    - Sharing between the VRFs in the FIB ?

How could we improve CRS FIB's scaling: *Selective VRF Download*

- By default, *all* VRFs are installed on *all* line cards

Slot	State	Temp (C)	CPU Utilization (%) Total	CPU Utilization (%) Interrupt	Memory DRAM (MB)	Utilization (%) Heap	Utilization (%) Buffer
2	Online	24	1	0	512	**39**	59
3	Online	28	1	0	512	**39**	59

- Customers ask for the same colors ?
  - Connect them on the same line card
  - Download VRFs only to line cards that need them
- It could be a management nightmare...

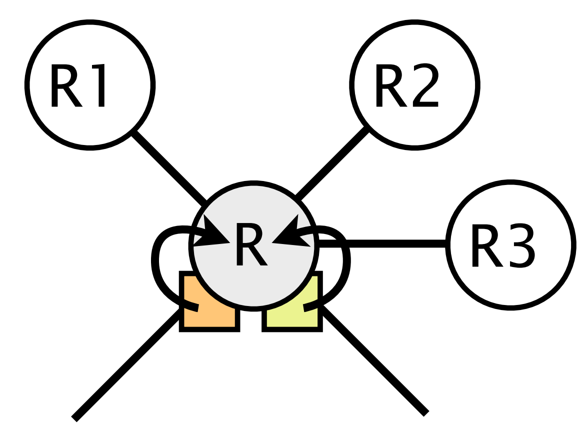
How could we improve CRS FIB's scaling: *Cross-VRF Lookup*

- Specific routing for a small set of prefixes ?
  - Create one small VRF *per color*
  - Add default entry towards a default VRF
- The price to pay is 2 IP lookups

VRF1
*>10/8 via *R1*
0/0 via *default*

VRF2
*>10/8 via *R2*
0/0 via *default*

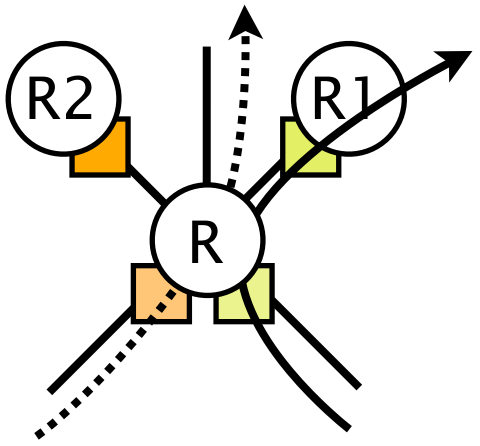
Default
…
*>10/8 via *R3*
…



How could we improve CRS FIB's scaling: *Distributed VRF*

- Distribute VRFs among routers which can afford extra load
  - PEs do not maintain complete VRFs anymore
  - PEs default route traffic towards these routers
- Increase in latency and load
- Distributed version of *Cross-VRF Lookup*

R maintain small VRFs
and default rest to R1 or R2
→ detour path
⋯→ direct path



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CRS is feasible

- *Implementable*
  - It can be realized on today's routers
  - It uses well known BGP MPLS/VPNs techniques
- *Scalable (for a few services*)
  - "Modest" message and storage overhead
  - Lab experiments tend to confirm that
  - Full BGP tables are needed to complete our evaluation
- *Guaranteed interdomain convergence*
  - Extra flexibility does not compromise global routing stability[1]

[1] Proof in SIGMETRICS'09 paper by Y. Wang, M. Schapira, and J. Rexford

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Questions ?

Please, come and see our poster !