Customized BGP Route Selection Using BGP/MPLS VPNs

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Customized BGP Route Selection Using BGP/MPLS VPNs

Introduction and motivation

Implementing CRS

Practical considerations and solutions

Conclusion

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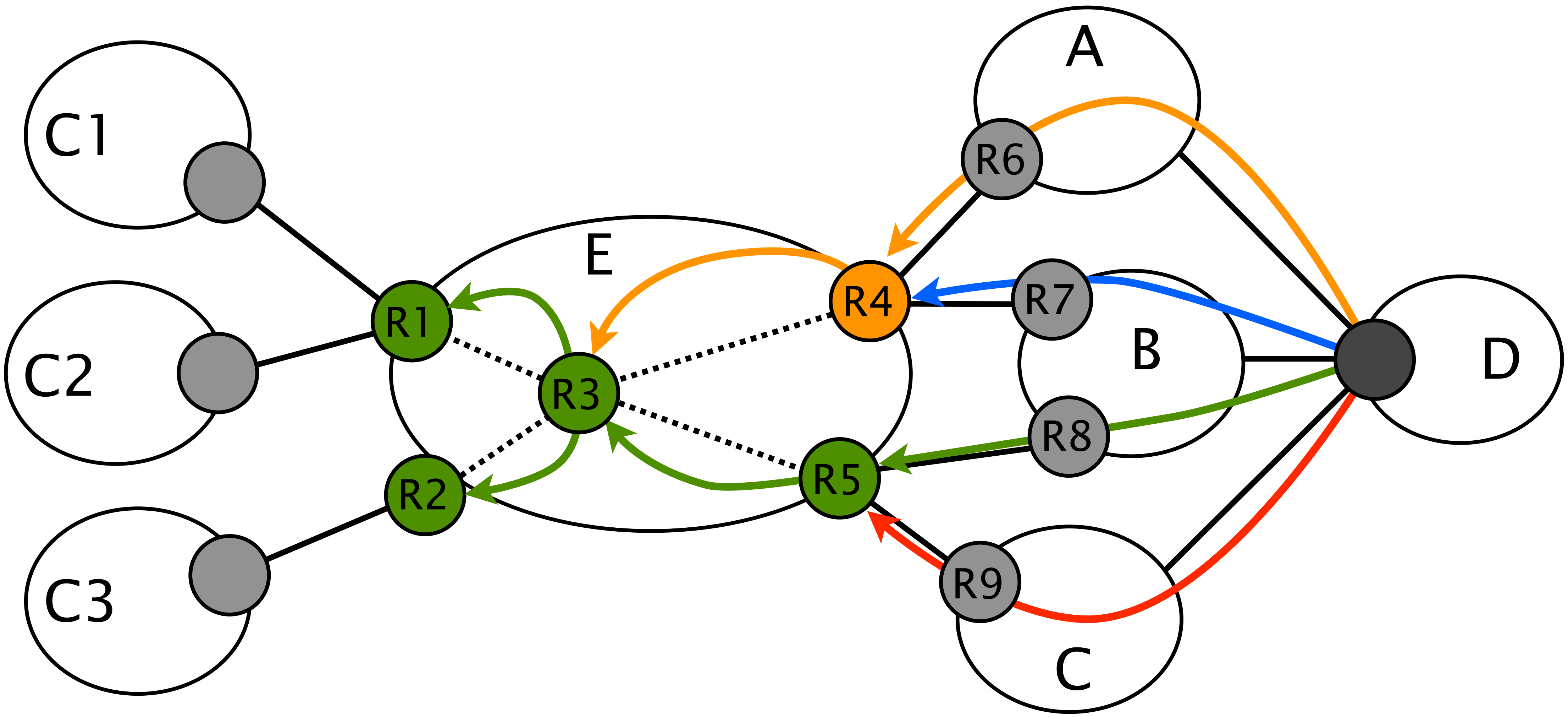
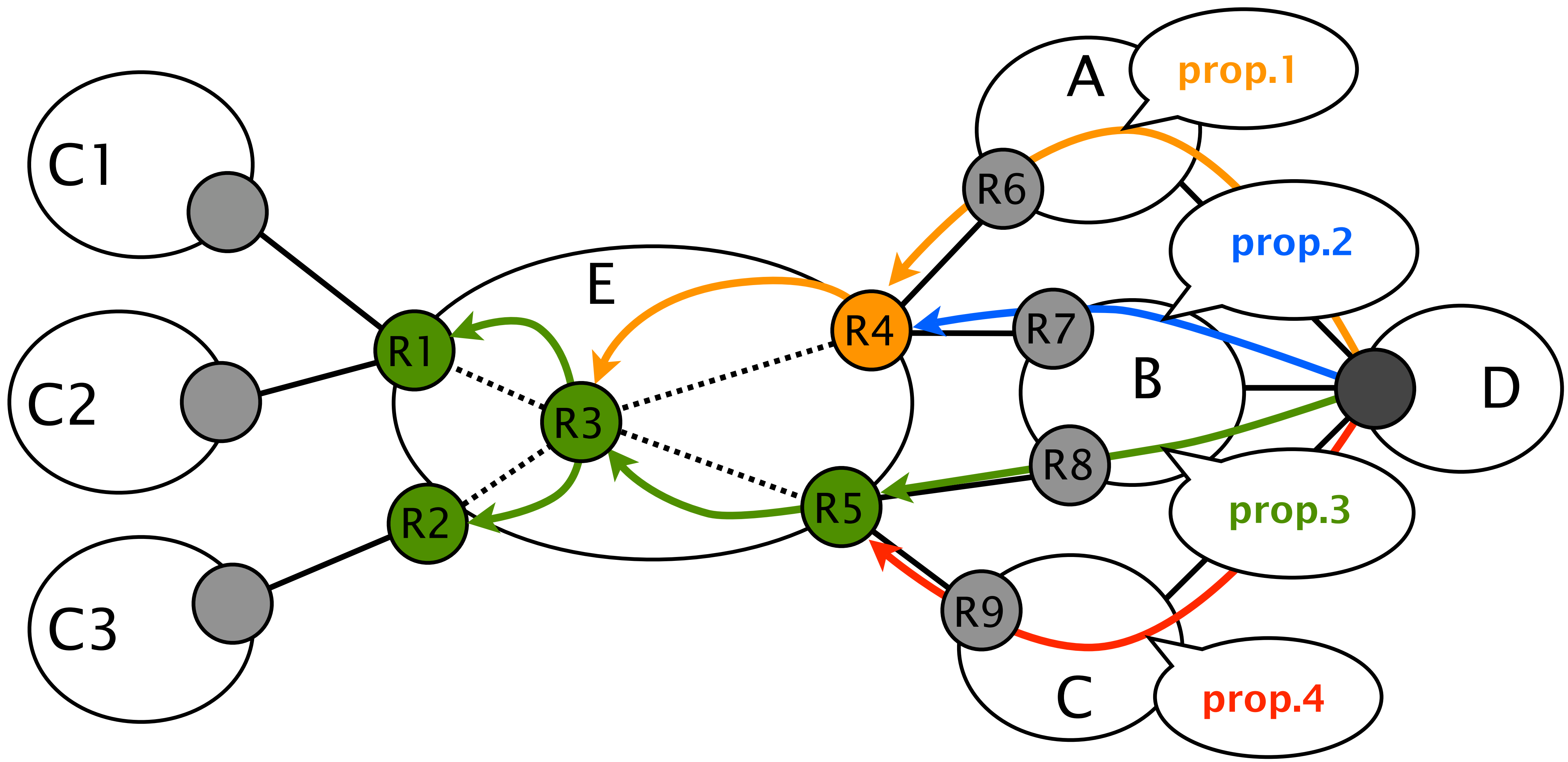
BGP Route Selection: *One-route-fits-all* model

- 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 (*e.g.*, C1...C3)



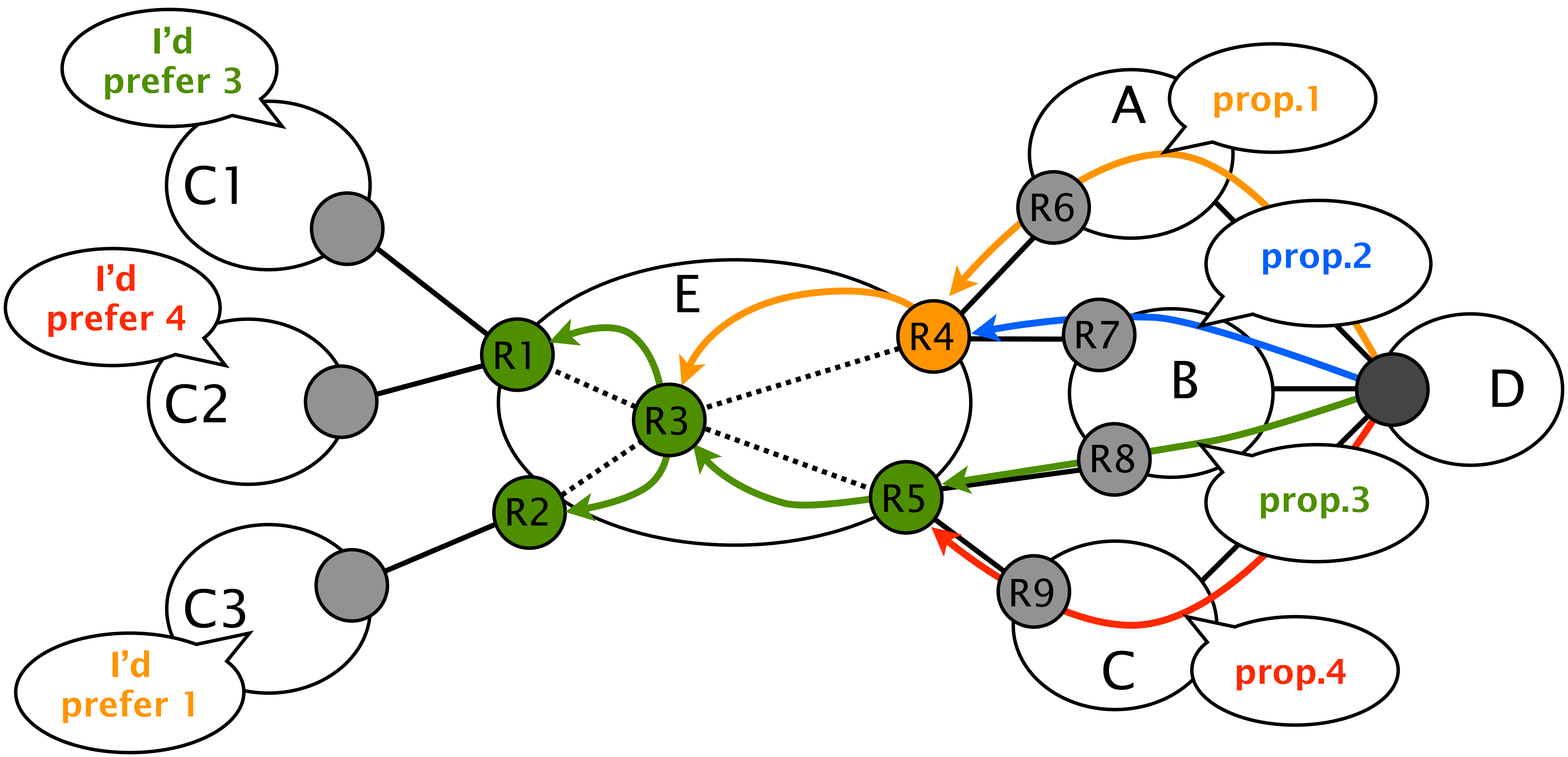
BGP Route Selection: *One-route-fits-all* model

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



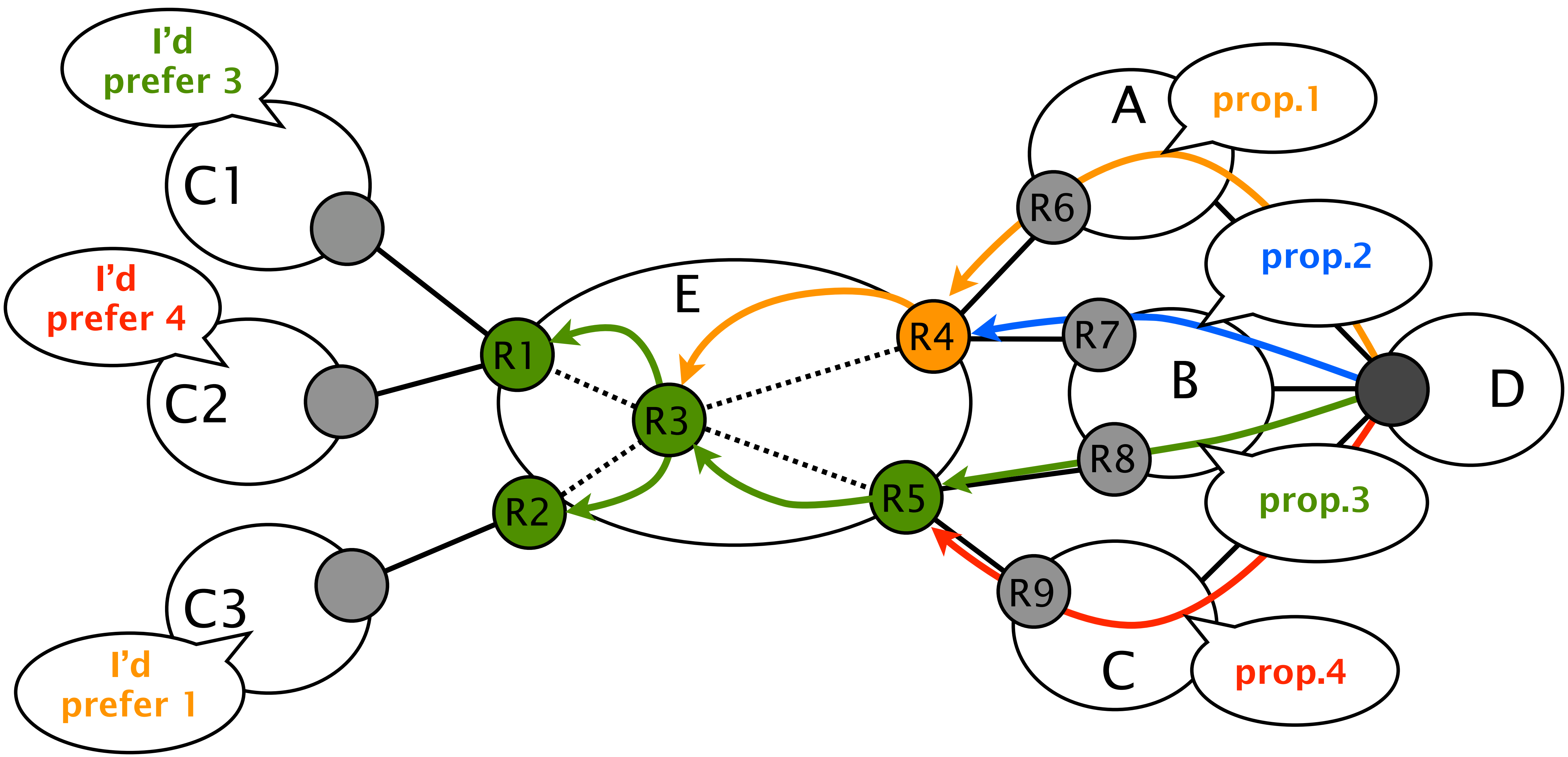
BGP Route Selection: *One-route-fits-all* model

- 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



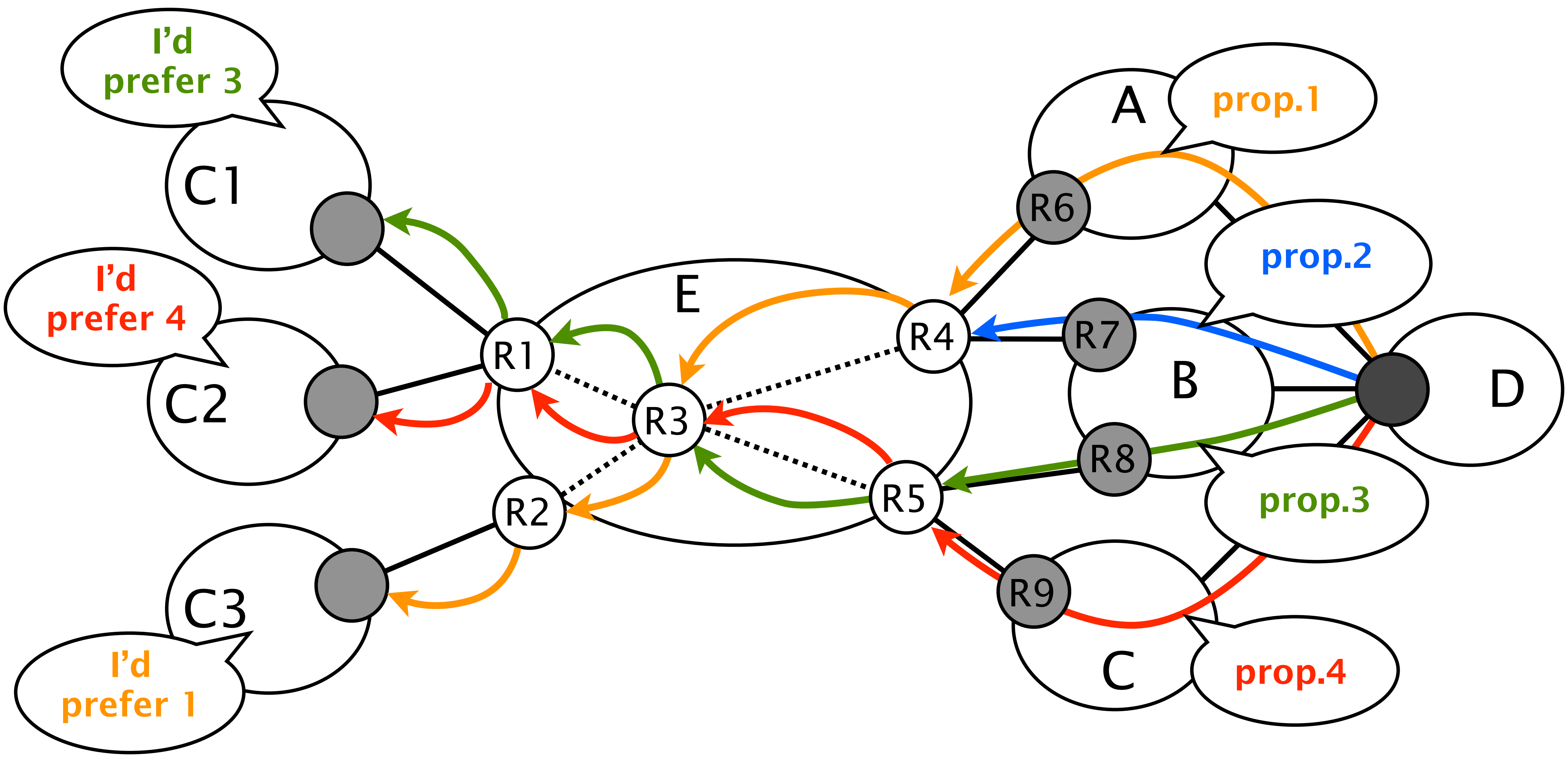
BGP Route Selection: *One-route-fits-all* model

- 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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- Introduction and motivation
- Implementing CRS
- Potential issues and solutions
- Conclusion

Two notions: *class* and *service*

- A *class* is a set of routes sharing a property
  - *e.g.*, all the routes learned via provider *X*
  - One route can belong to more than one class
- A *service* is the union of one or more classes
  - Some classes can be preferred over others
  - *e.g.*, service *Y* is the union of *class 1* and *class 2* where preference is given to *class 1*

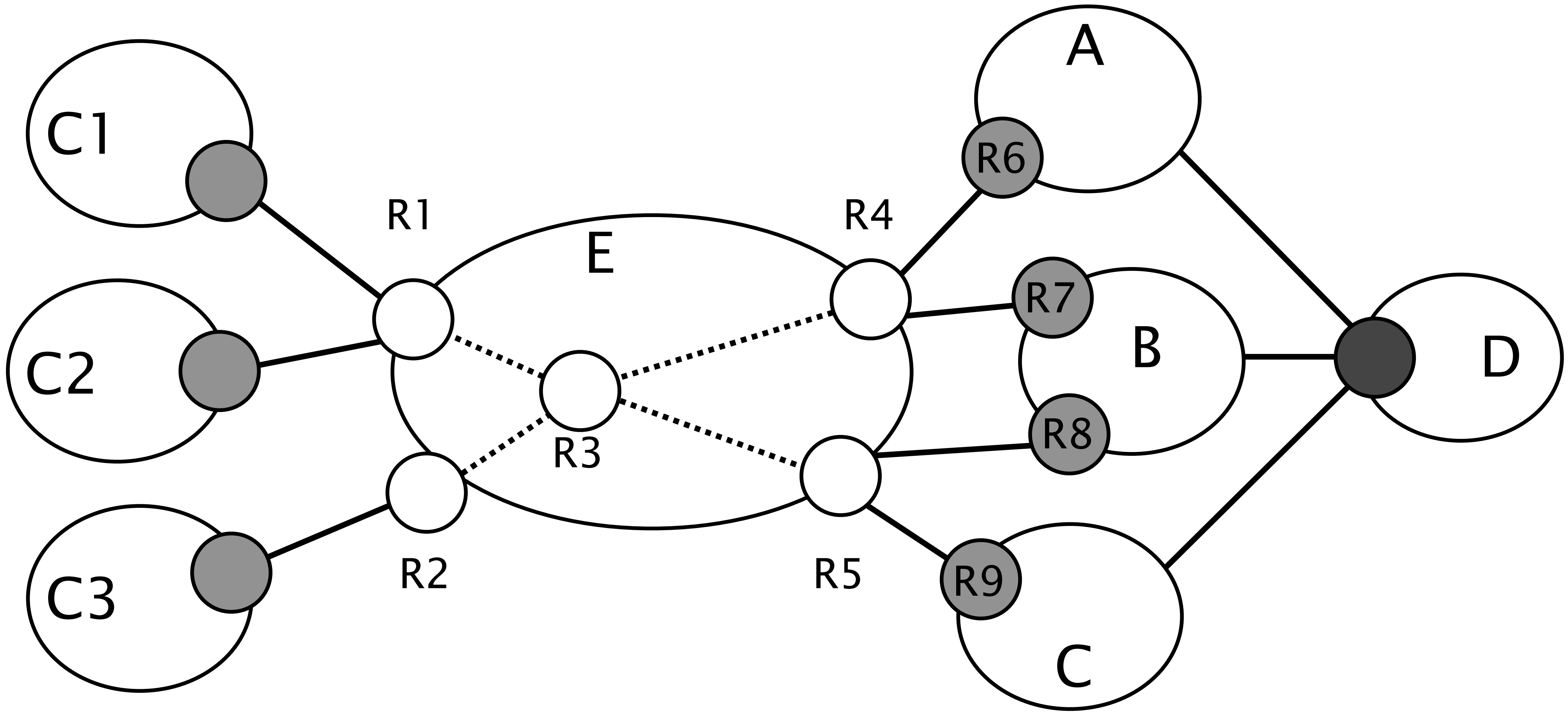
What do we need to implement CRS with BGP MPLS VPNs ?

- Mechanisms to *disseminate* and *differentiate* paths
  - Multiprotocol BGP is used as dissemination protocol
  - Route Targets (RT) are used to identify classes
  - Route Distinguishers (RD) are used to ensure diversity

- *Customized* route selection mechanisms at ASBR
  - Use Virtual Routing and Forwarding (VRF) instances to build services

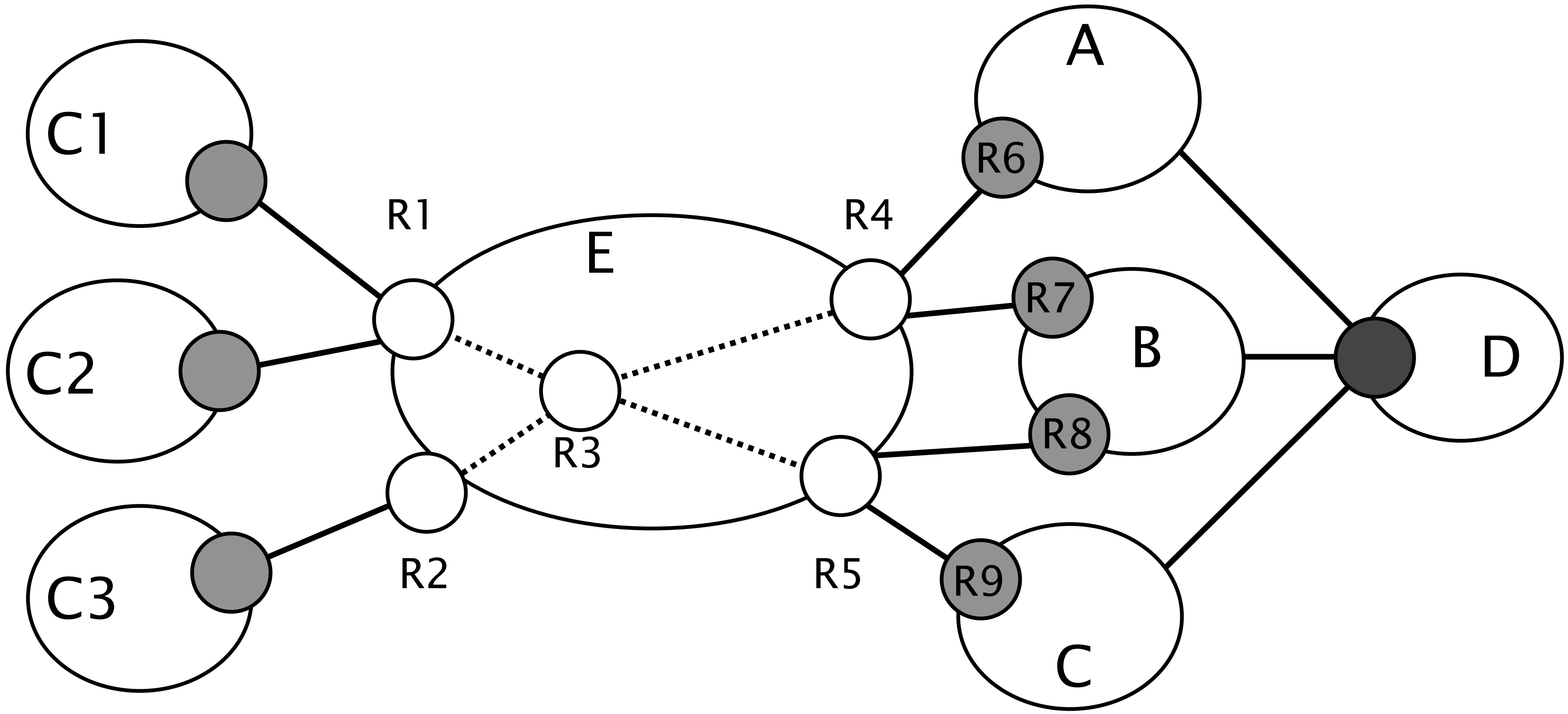
- Traffic forwarding on the chosen paths
  - MPLS tunneling

How do we implement CRS with BGP MPLS VPNs ?



- C1 wants to reach D via B, C2 via C
- Define two services on R1: *prefer B (resp. C) routes*
- Define three classes: *learned* via *A*, *B* or *C*

How do we implement CRS with BGP MPLS VPNs ?



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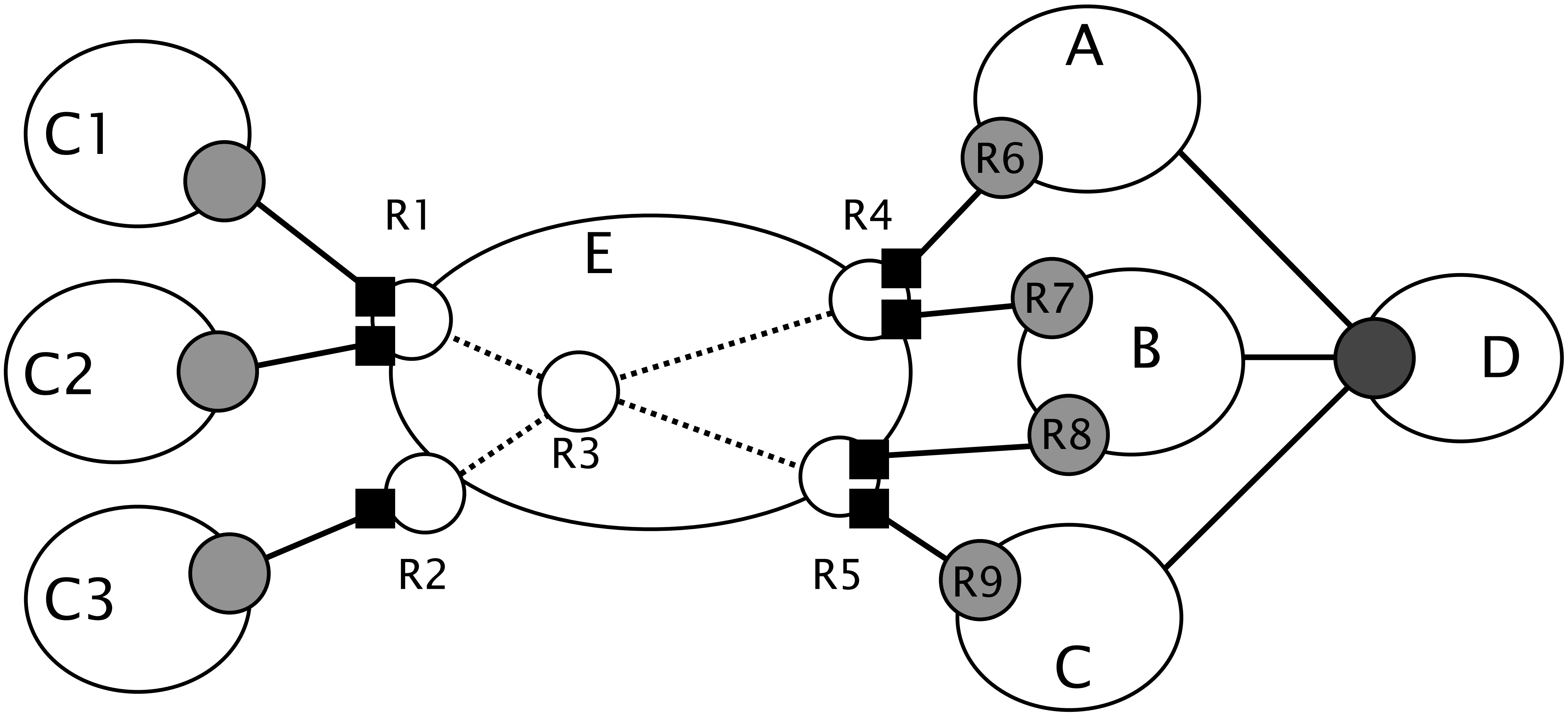
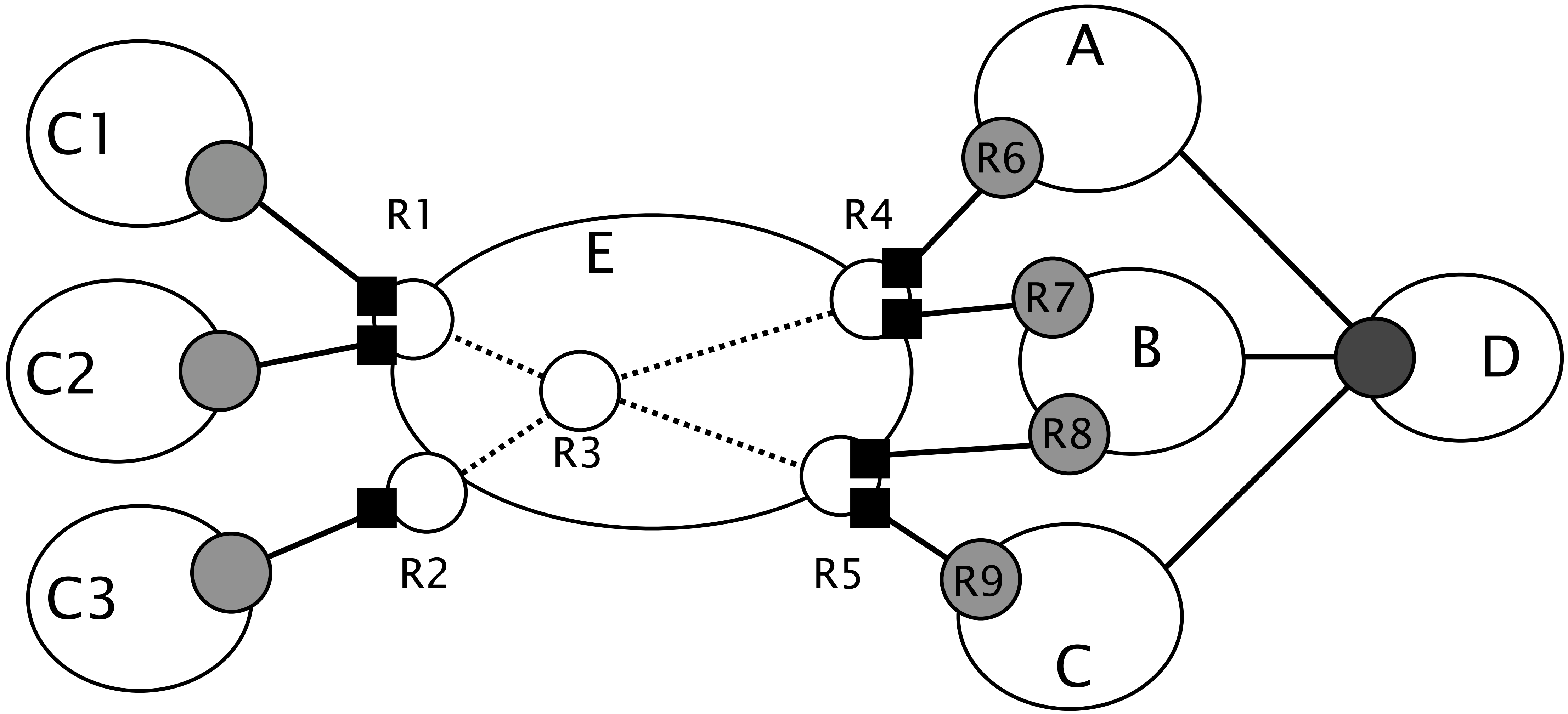


- Consider peers as VPNs and put them in VRFs

How do we implement CRS with BGP MPLS VPNs ?

Route Targets
101: *learned via A*
102: *learned via B*
103: *learned via C*



- Consider peers as VPNs and put them in VRFs
- Use RT to identify *classes*

How do we implement CRS with BGP MPLS VPNs ?

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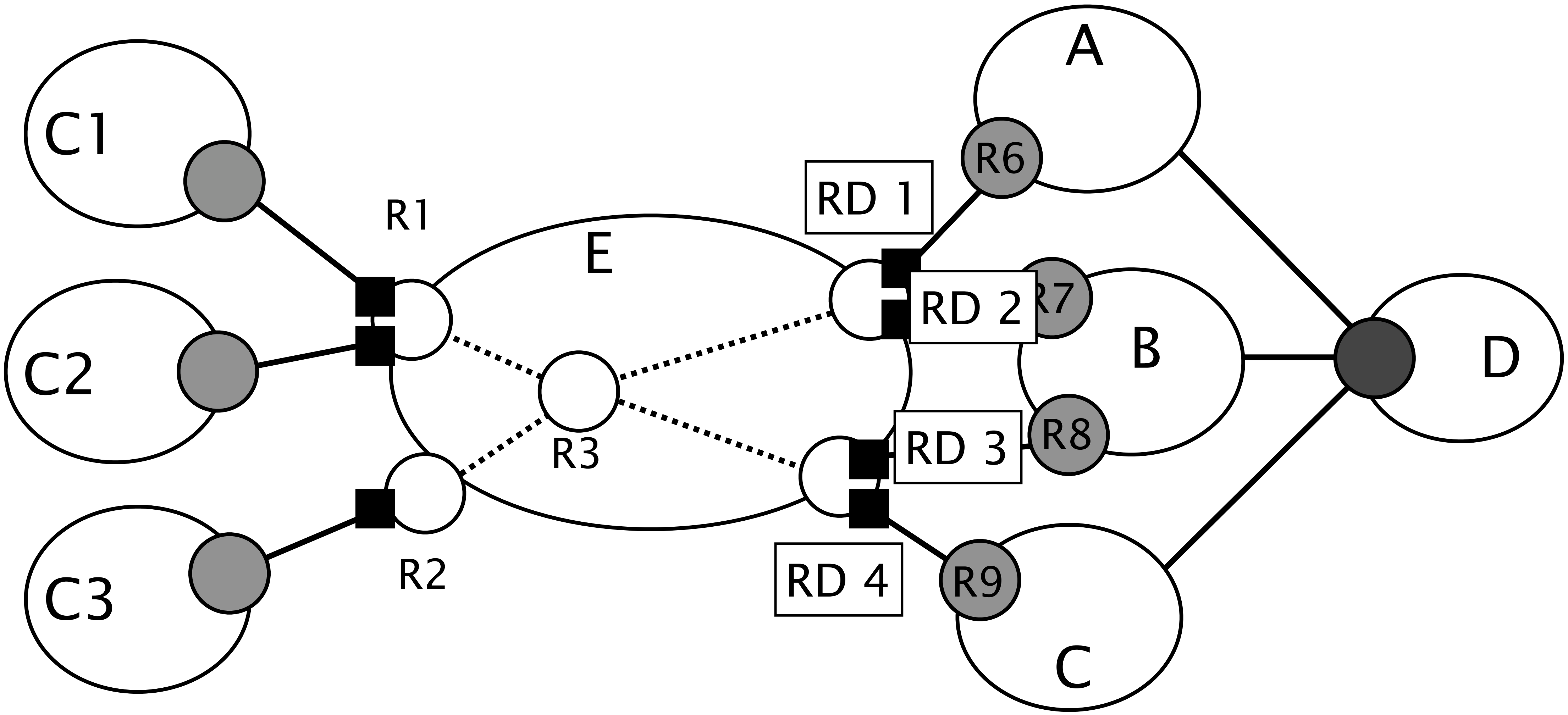
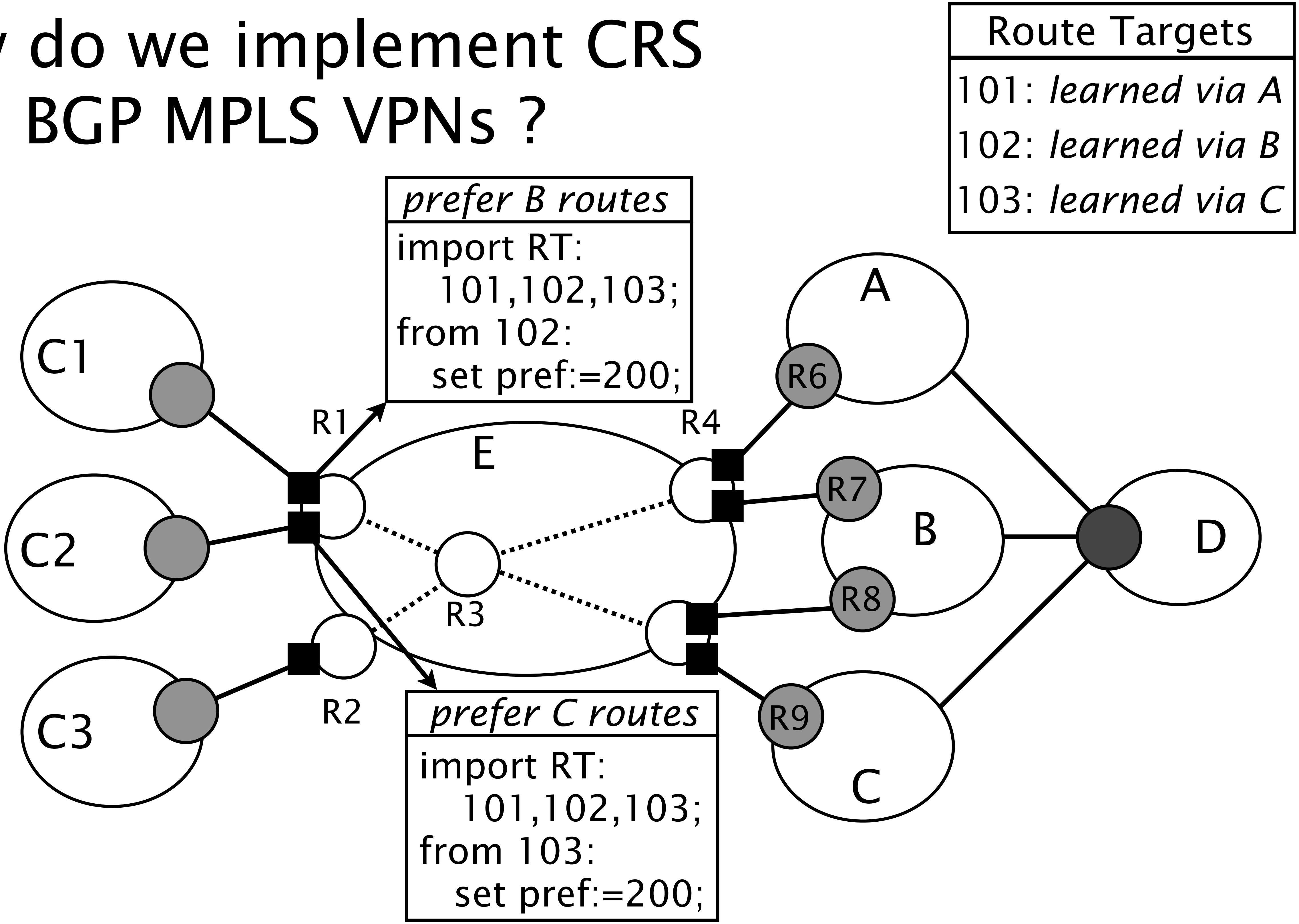


- Consider peers as VPNs and put them in VRFs
- Use RT to identify *classes*
- Use different RD to differentiate routes

How do we implement CRS with BGP MPLS VPNs ?



- Define *services* by using VRFs' import filters

How do we implement CRS with BGP MPLS VPNs ?

Route Targets
101: *learned via A*
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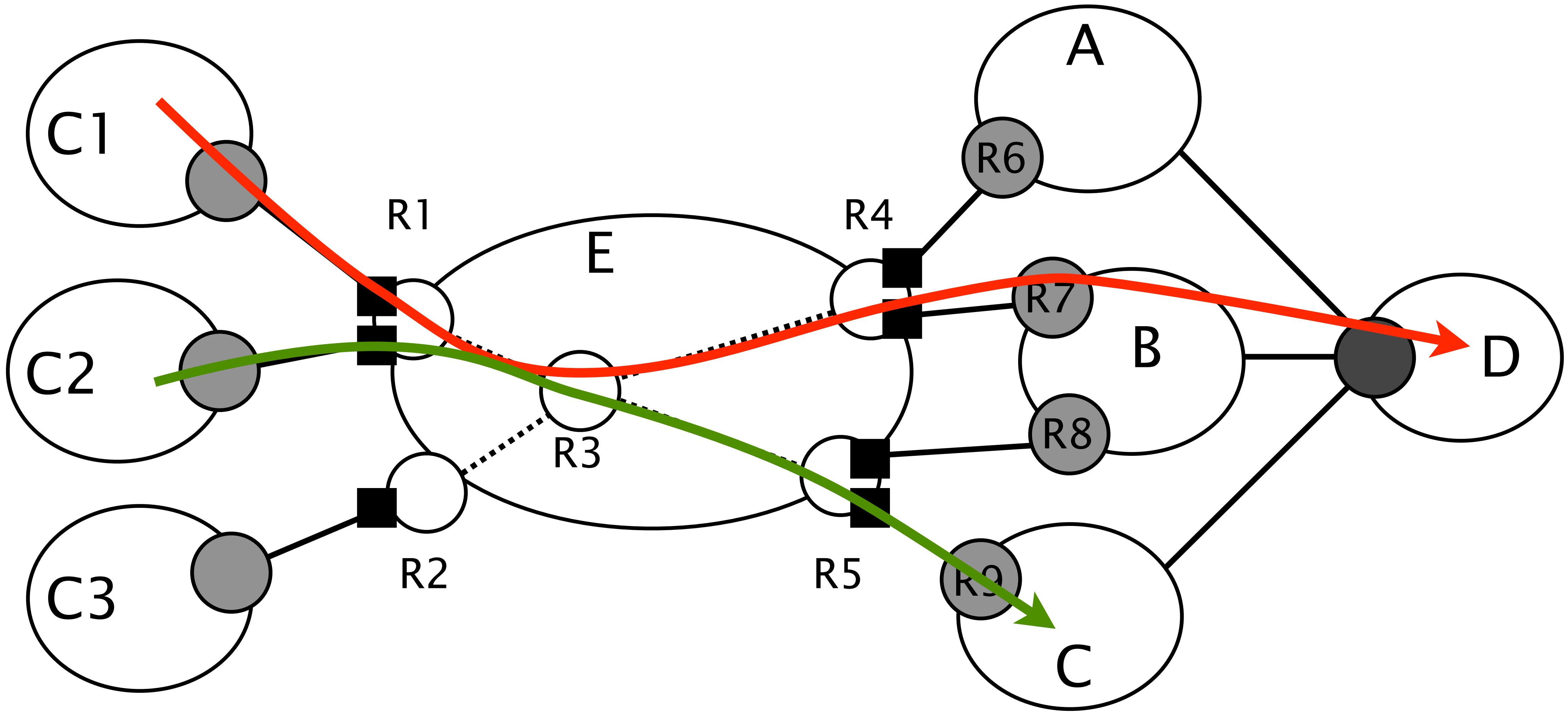


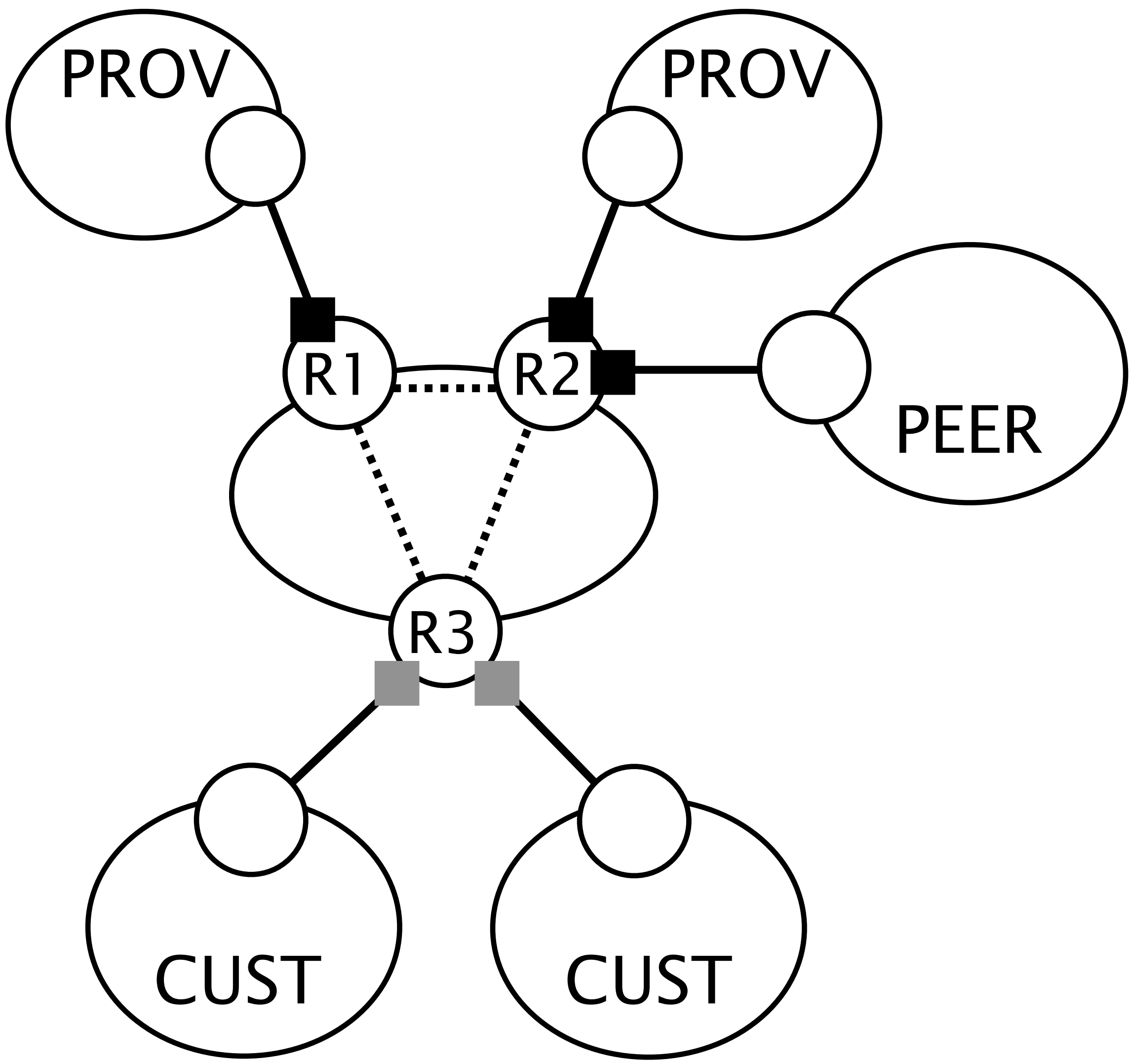
- MPLS is used for forwarding
  - Two levels label stack
  - R3 only knows label to reach the PEs

CRS applied to *classical* policies

- Define three classes
  - Providers (RT 100)
  - Peers (RT 101)
  - Customers (RT 102)

- Define two services
  - VRF Provider/Peer (■)
    - *import RT 102;*
  - VRF Customers (■)
    - *import RT 100,101,102;*

- Thanks to VRF isolation, policies violations vanish



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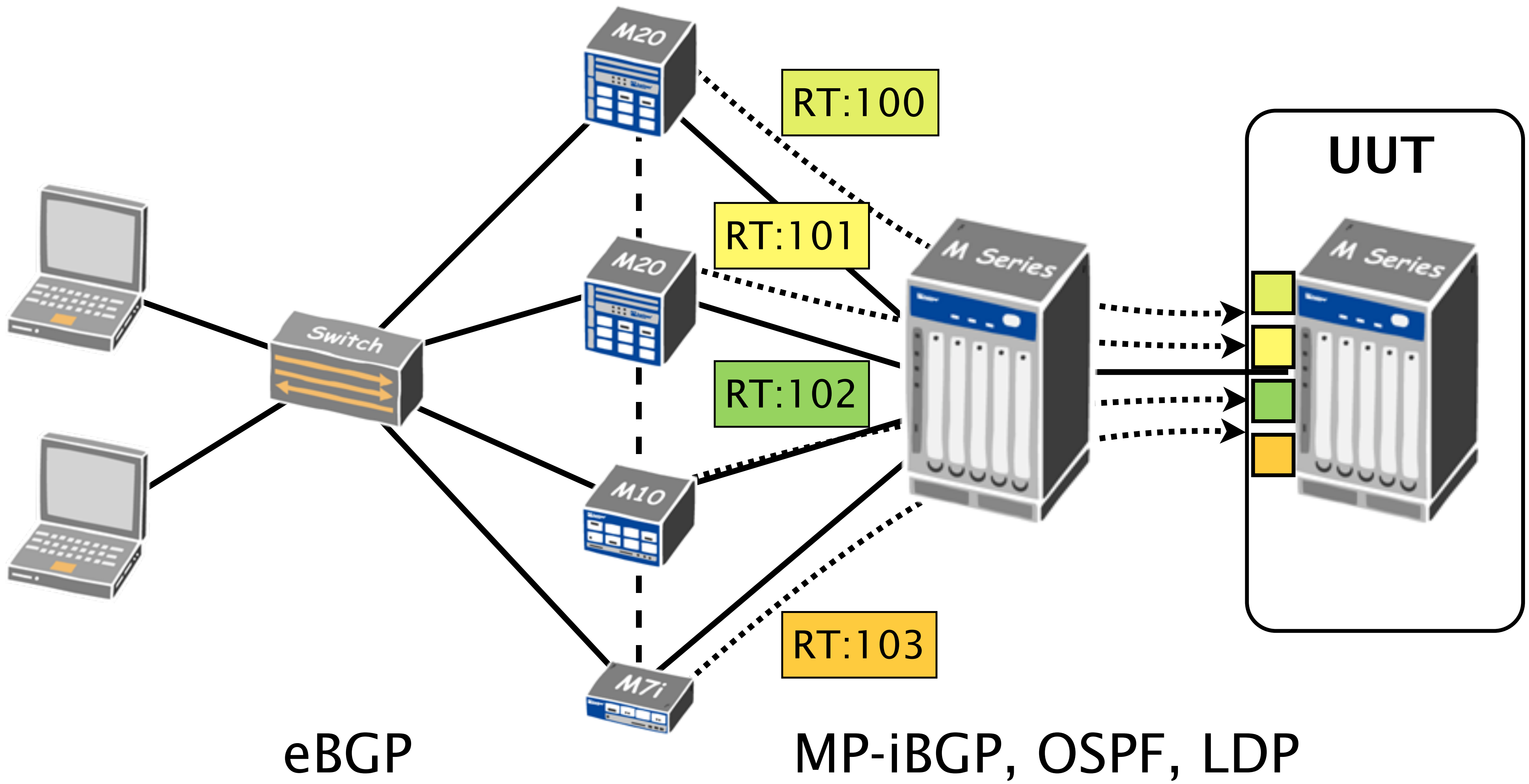
Is CRS pushing a M120 to the limit ?



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

- Each service is fed with one class (one RT)
- In each class, ~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

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

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

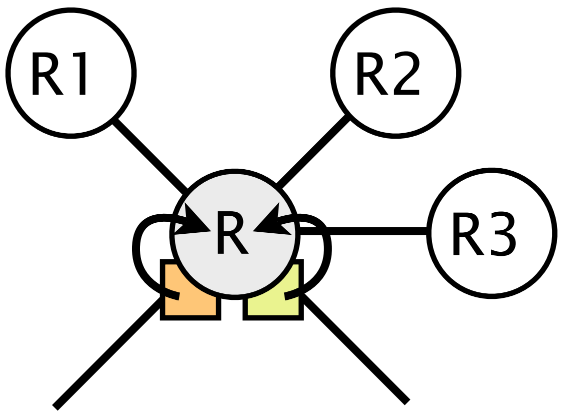
How could we improve CRS FIB's scaling: *Cross-VRF Lookup*

- Specific routing for a small set of prefixes ?
  - Create one small VRF *per service*
  - 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*

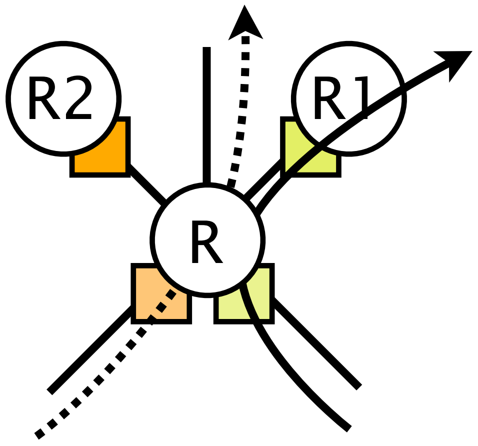
Default
...
*>10/8 via *R3*
...



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
- *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 ?