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)
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
With vanilla BGP, you *can’t* match customers’ preferences to available paths

- Customers of a given PE receive the same path

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

- I’d prefer 1
- I’d prefer 3
- I’d prefer 4
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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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?

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

<table>
<thead>
<tr>
<th>Route Targets</th>
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<tbody>
<tr>
<td>101: <em>learned via A</em></td>
</tr>
<tr>
<td>102: <em>learned via B</em></td>
</tr>
<tr>
<td>103: <em>learned via C</em></td>
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How do we implement CRS with BGP MPLS VPNs?

- 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

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<th>prefer B routes</th>
</tr>
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<tr>
<td>import RT: 101, 102, 103; from 102: set pref:=200;</td>
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<th>prefer C routes</th>
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<td>import RT: 101, 102, 103; from 103: set pref:=200;</td>
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How do we implement CRS with BGP MPLS VPNs?

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

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<td>103: learned via C</td>
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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

<table>
<thead>
<tr>
<th></th>
<th>RE</th>
<th>FEB</th>
</tr>
</thead>
<tbody>
<tr>
<td>empty</td>
<td>17%</td>
<td>9%</td>
</tr>
<tr>
<td>fully-loaded (1.200.000 routes)</td>
<td>38%</td>
<td>39%</td>
</tr>
</tbody>
</table>

- 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

<table>
<thead>
<tr>
<th>Slot</th>
<th>State</th>
<th>Temp (°C)</th>
<th>CPU Utilization (%)</th>
<th>Memory (MB)</th>
<th>Utilization (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Online</td>
<td>24</td>
<td>1</td>
<td>512</td>
<td>![39]</td>
</tr>
<tr>
<td>3</td>
<td>Online</td>
<td>28</td>
<td>1</td>
<td>512</td>
<td>![39]</td>
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- 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

**Diagram:**

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

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

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

**Network Diagram:**

- R1, R2, R3 interconnected.
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*

![Diagram showing detour and 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

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

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