

- # Modern BGP Design

## Simplify the BGP infrastructure

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## ● About me

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### Independent Network Architect

More than 25 years experience designing and implementing service provider and large enterprise networks.

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## ● Agenda

- Motivation
- Legacy/Traditional BGP design
- RR for Datacenter and POP
- One RR for ALL ?
- Platform selection
- Questions

- Motivation

- Most BGP design relay on classical behavior  
New feature are usually presented alone  
There is not a document like this  
It's based on my own original design  
Combine new feature to achieve a simple & modern solution
  - **bgp ADD-PATH** for Path Diversity
  - **bgp PIC** with FRR/xLFA to minimize fault restoration delay
  - **bgp ORR** Optimize Route Reflections

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# Legacy Route Reflector design

Traditional Route Reflector design, as we learn from books

## • Service Provider Backbone

### Sample Scenario

- Multiple POP
- Multiple Transit Site
- Multiple DC Sites

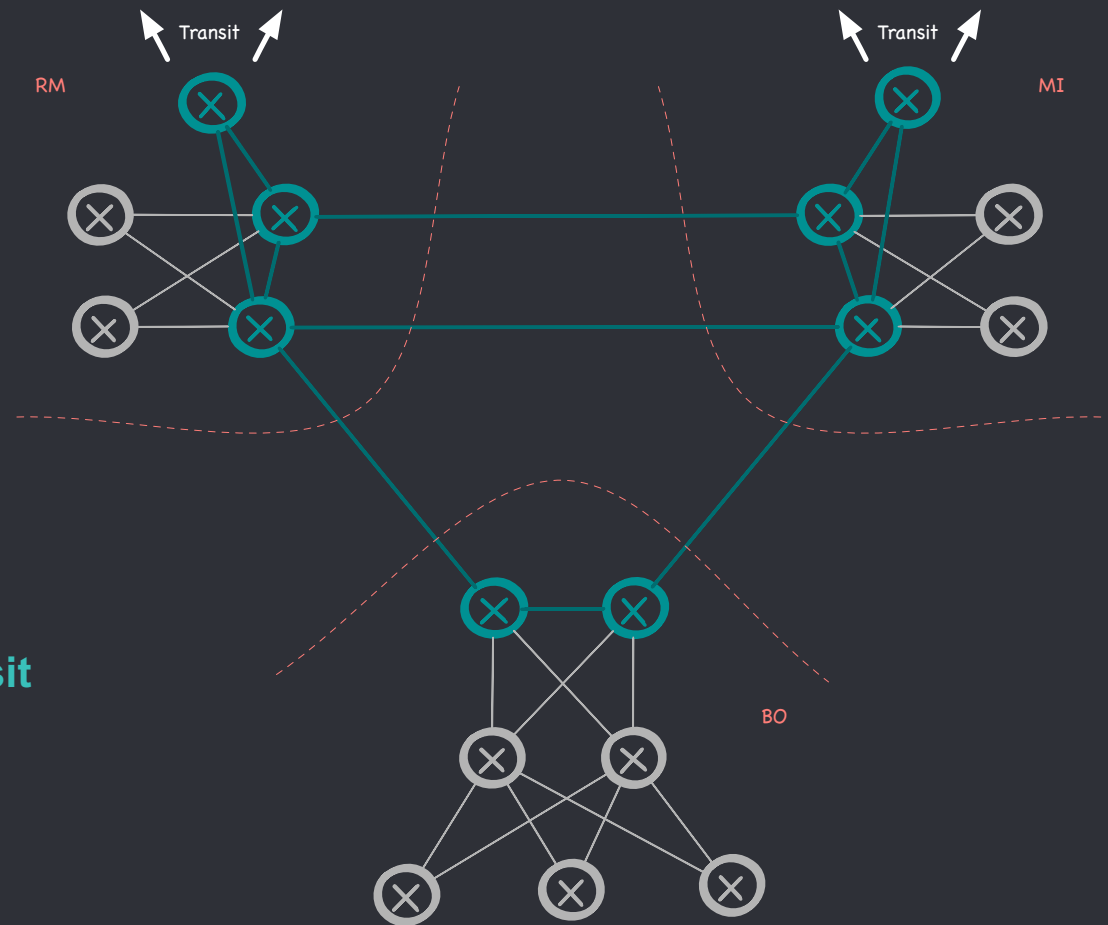
### Requirement

- Optimal routing
- Load Balancing
- FIRT(\*) confined in **CORE and Transit**
- default-route in POP/DC devices

### Goals

- Simplicity
- Scalability

\*) Full Internet Routing Table



## ● Core Full Mesh vs Route Reflections

**FIRT in all core routers for optimal routing**

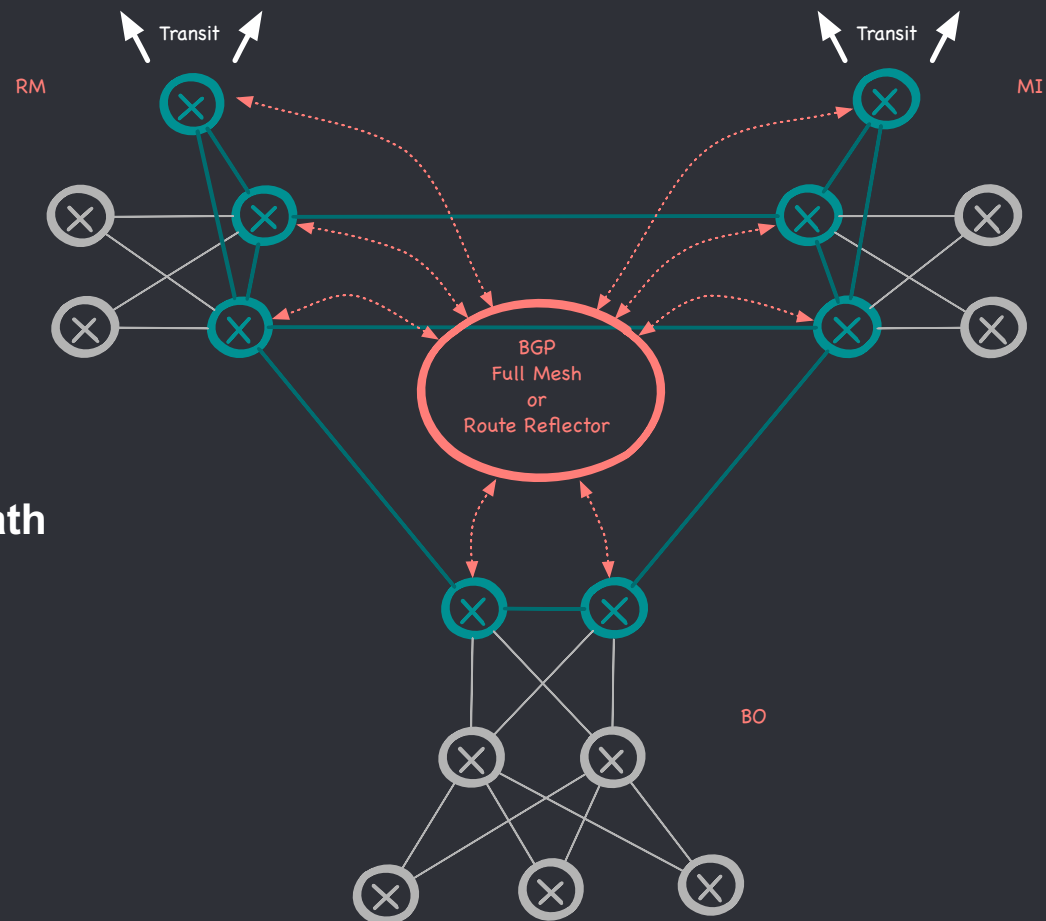
### **Full Mesh**

- all routers receive all neighbors best path
- multiple path are possible
- not scalable

### **Route Reflector:**

- Only Best Path it's reflected
- RR positioning it's important
- usually one RR per exit point

<https://blog.ipspace.net/2013/10/can-bgp-route-reflectors-really.html>



## ● Default route and RR hierarchy

**FIRT it's not required inside POP/DC**

default-route originated on:

- Transit : not optimal with MPLS
- Core : for LB and HA

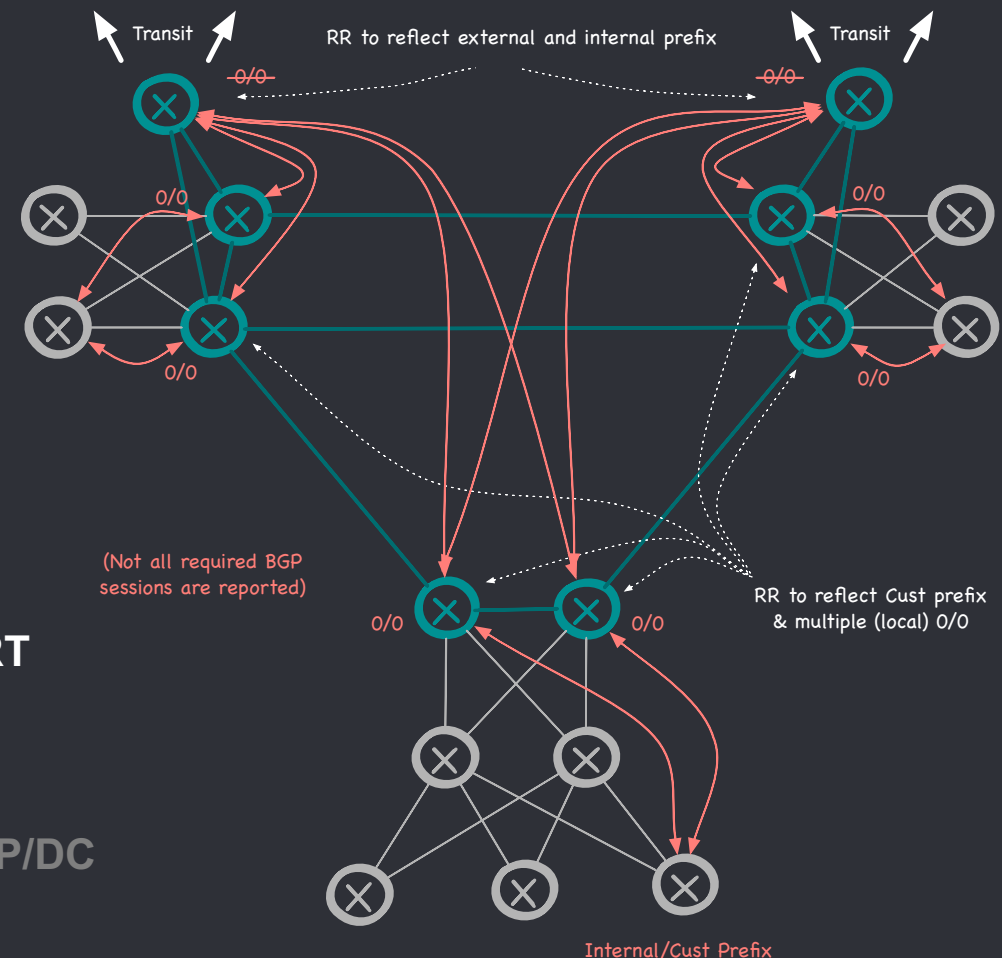
**MPLS forwarding with «two stage lookup»**

1. Using 0/0 from PE or DC to core
2. perform lookup and forward using FIRT

### **Hierarchical BGP design**

- Transit as route-reflectors for Core
- Core/Border as route-reflectors for POP/DC
- How many RR ?

**NOTE: if you are advertising cust prefix with IGP and then redistribute to BGP please don't!**





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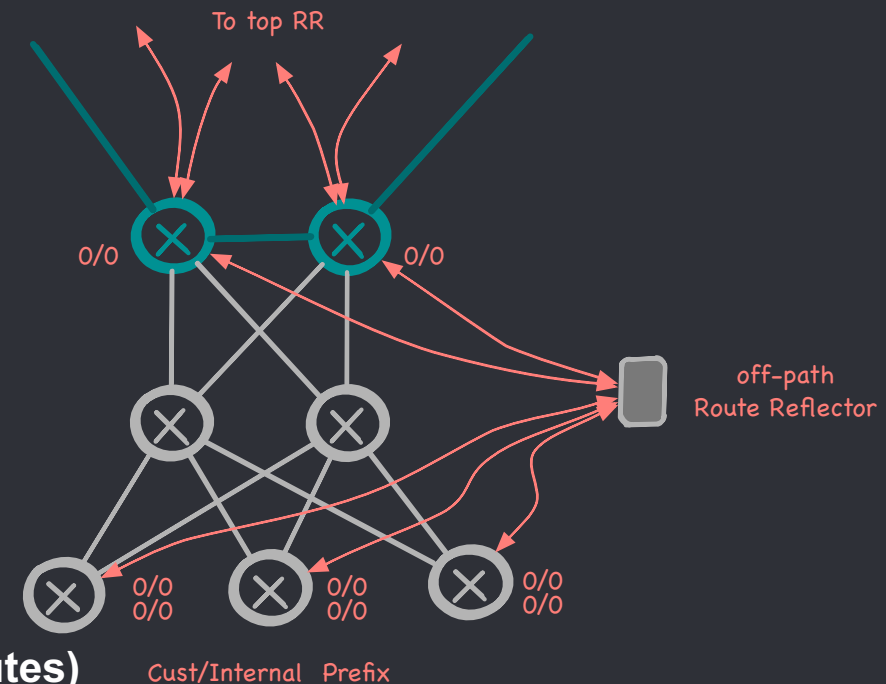
## DataCenter/Pop Route Reflector

Detach Route Reflector role from border routers

- Move RR role from Core Borders to dedicate RR

### Decoupling Control-Plane from Data-Plane:

- Redundant but also non optimal BGP prefix are useful to improve convergence time and achieve load-balancing
- ADD-PATH enable advertisement of multiple path with different next-hop (and attributes)  
-> rfc 7911 / Aug 2016
- BGP PIC CORE / EDGE can combine local information and next-hop tracking:  
move convergence time from BGP to IGP.



## ● ADD PATH Configuration example

**ADD-PATH** it's a negotiated capability must be supported & configured

- Session reset when enabled
- Independent Send and Receive capability
- Option to include max number of diverse path.

**In this simple design:**

- RR use only SEND
- Client use only RECEIVE

```
route-reflector:
protocols {
  bgp {
    group iBGP {
      cluster 192.0.0.0;
      ...
      family inet {
        unicast {
          add-path {
            send {
              path-count 2;
            }
          }
        }
      }
      neighbor 192.0.0.1;
      neighbor 192.0.0.2;
      [...]
    }
  }
}

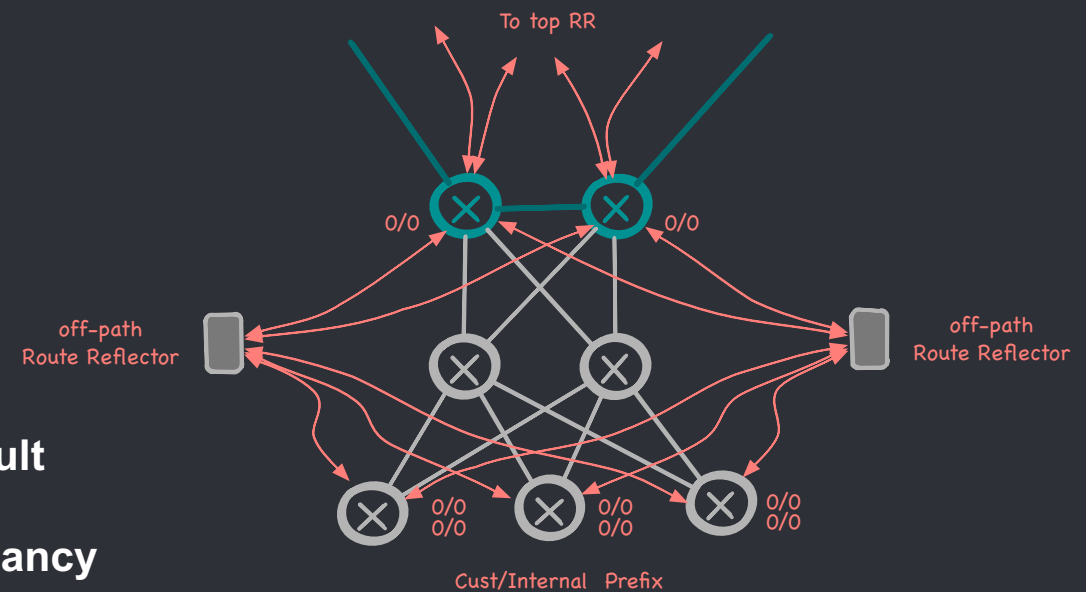
clients:
protocols {
  bgp {
    group RR {
      family inet {
        unicast {
          add-path receive;
        }
      }
      neighbor 192.0.0.254;
      neighbor 192.0.2.254;
    }
  }
}
```

- Route Reflector redundancy

- Redundancy must guarantee same functionality even in the event of a fault
- Do not abuse them, too much redundancy introduces complexity.

in this case:

- two path to cover LB and HA
- two copies to cover RR failure



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## Share Route Reflector

Share Route Reflectors between different Data-Center/Pop

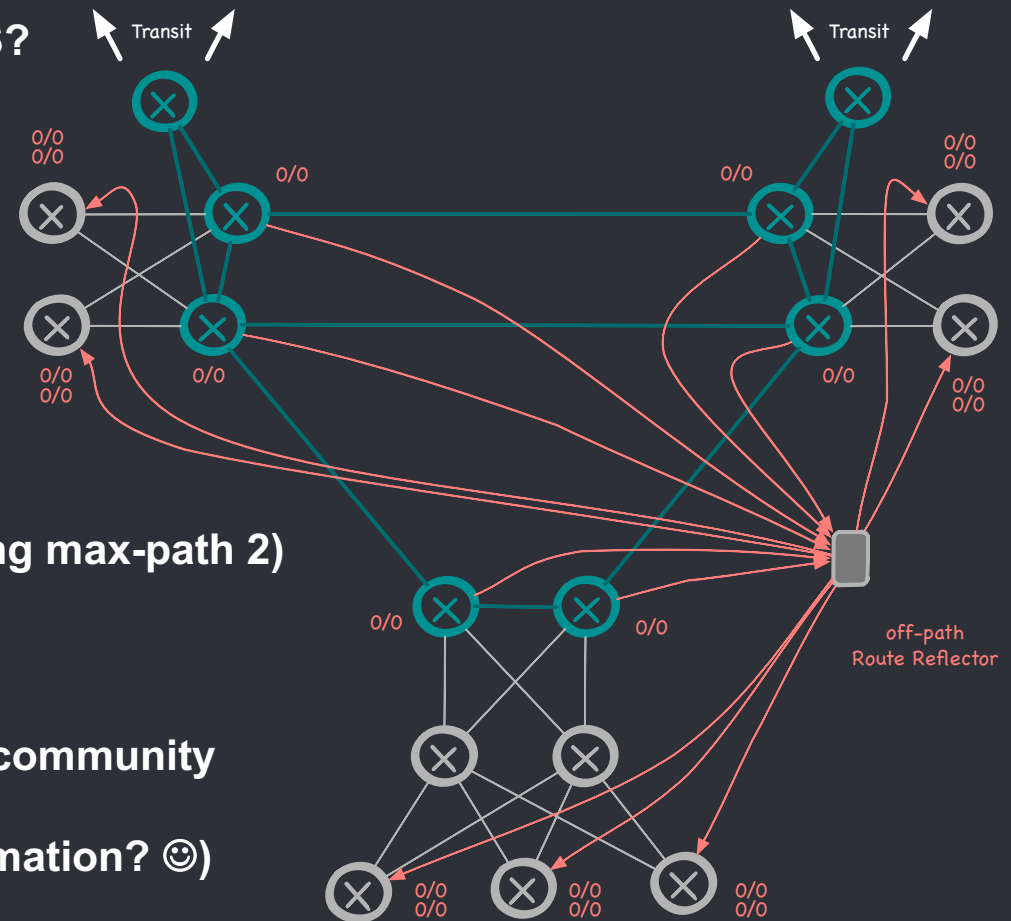
- Share same RR for all POP / DC

Can we use the same RR for all the SITES?

- Every site must receive local default-route. This prevent sub-optimal routing with MPLS

Options:

- Send ALL the [default-] route (removing max-path 2) and let's IGP select locally.  
Cons: Not scalable
- identify each site default route with a community and write a policy on RR for each site  
CONS: complex, not scalable (... automation? ☺)
- ORR (?) what it's this ?



## ● ORR Configuration

**Optimized Route Reflections**  
**RFC 9107 / Aug 2021**

**Route Selection from a different IGP Location**

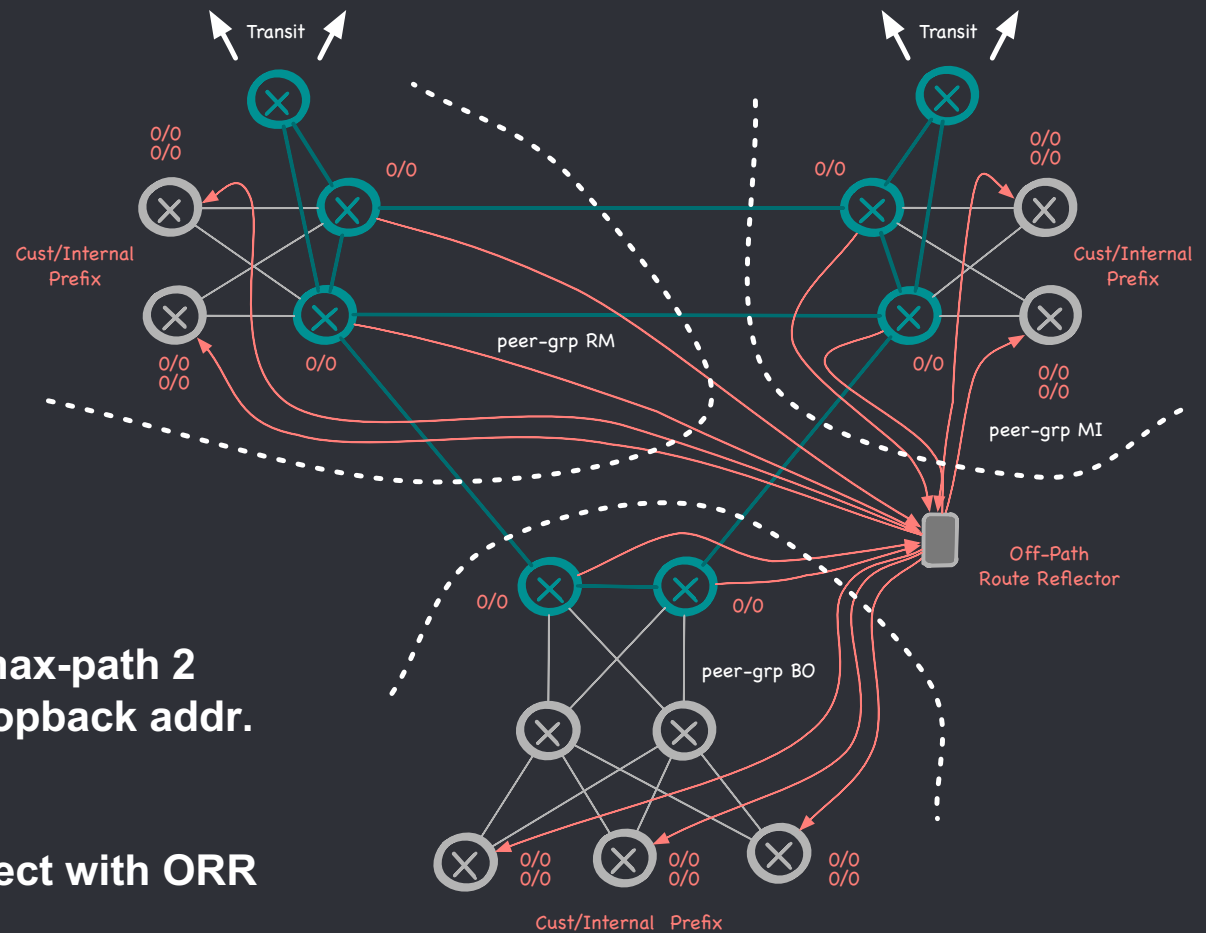
**leverage IGP running SPF based on client  
topoly and reflects best path(s) based  
on client position.**

**Configurable on a peer-group basis**

**example: reflection optimized for RM and MI**

```
protocols {
  bgp {
    group RM-NAMEX {
      type internal;
      cluster 192.0.0.0;
      ...
      optimal-route-reflection {
        igp-primary 192.0.0.1;
        igp-backup 192.0.0.2;
      }
      neighbor 192.0.0.1;
      neighbor 192.0.0.2;
      neighbor 192.0.0.3;
      neighbor 192.0.0.4;
    }
    group MI-MIX {
      type internal;
      cluster 192.0.0.0;
      ...
      optimal-route-reflection {
        igp-primary 192.0.2.1;
        igp-backup 192.0.2.2;
      }
      neighbor 192.0.2.1;
      neighbor 192.0.2.2;
      neighbor 192.0.2.3;
      neighbor 192.0.2.4;
    }
  }
}
```

## ● Optimize route distribution with ORR



### Solution:

- Create a peer-group per site
- Enable add-path send with max-path 2
- Enable ORR using border loopback addr.
- no community, no policy
- just enable add-path and select with ORR

**SIMPLE and AUTO-OPTIMIZED!**

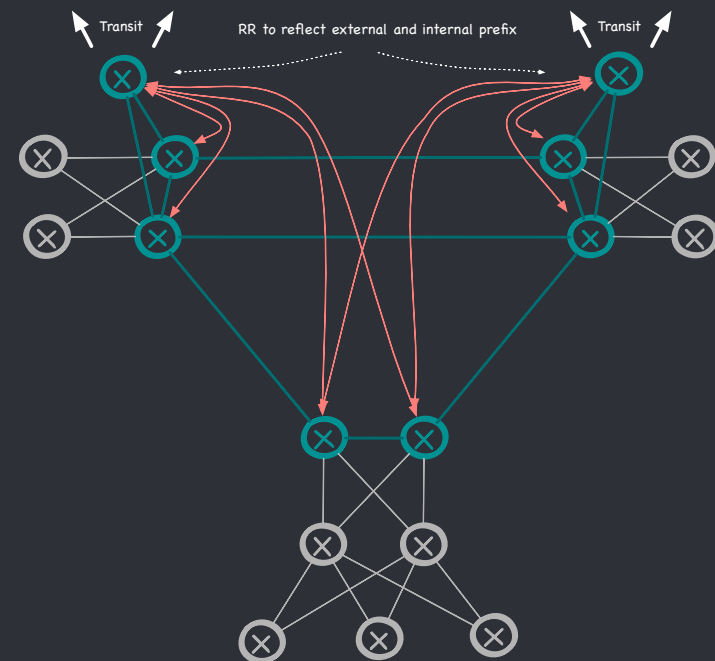
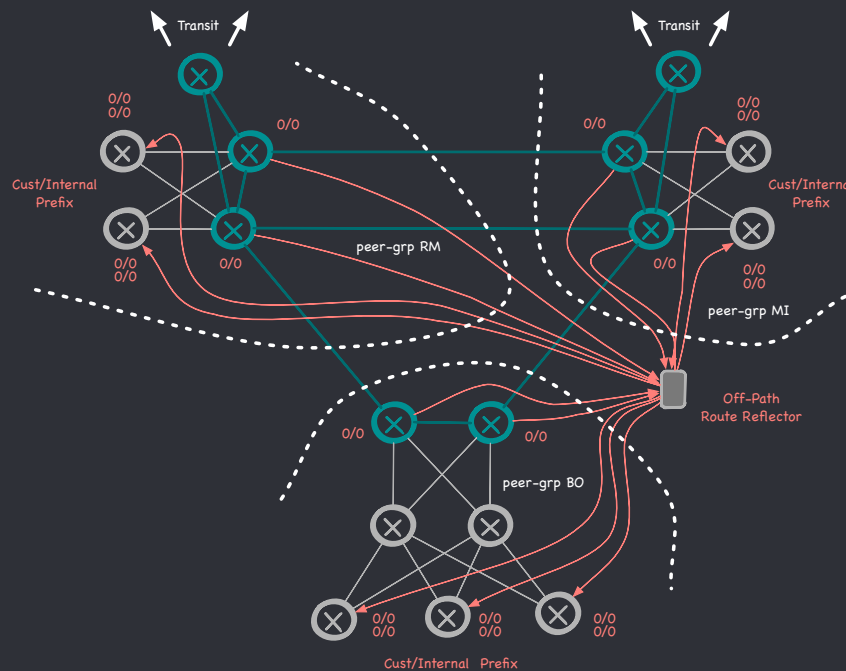


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## Combine Core and POP Route Reflectors

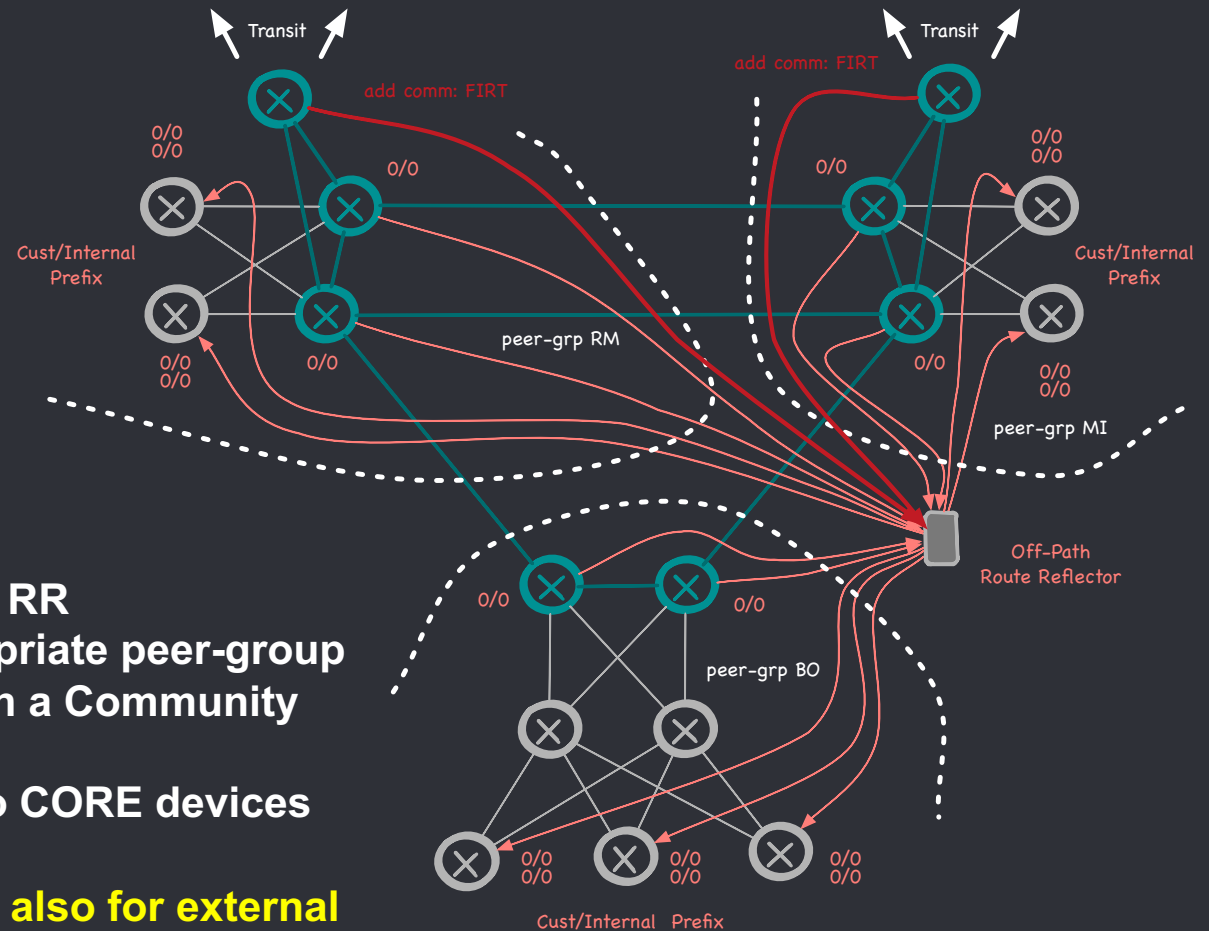
How combine DC/POP and Core RR

## ● Core vs POP/DC Route Reflectors : almost different informations



- DC/POP RR holds multiple default-routes and Customer/Internal prefix
- Core RR (Transit) holds the FIRT and Customer/Internal prefix
- It's possible to combine the two infrastructure ? how ?

- Share same RR for all the routing information



### Solution:

- Peer also Transit Routers with RR
- Configure Transit in the appropriate peer-group
- Mark all the external prefix with a Community
- Send EXTERNAL prefix only to CORE devices
- Leverage ADD-PATH and ORR also for external prefix and for all the sites -> HA (BGP PIC) and LB

## ● Complete RR Configuration

One peer-group per site

On Transit mark all received external prefix with a «FIRT» custom community

RR may use add-path to send multiple prefix/NH (when available) for both internal and external destinations

ORR will automatically select the two optimal prefix based on client IGP topology

prevent FIRT distribution on non-core device with a simple export policy

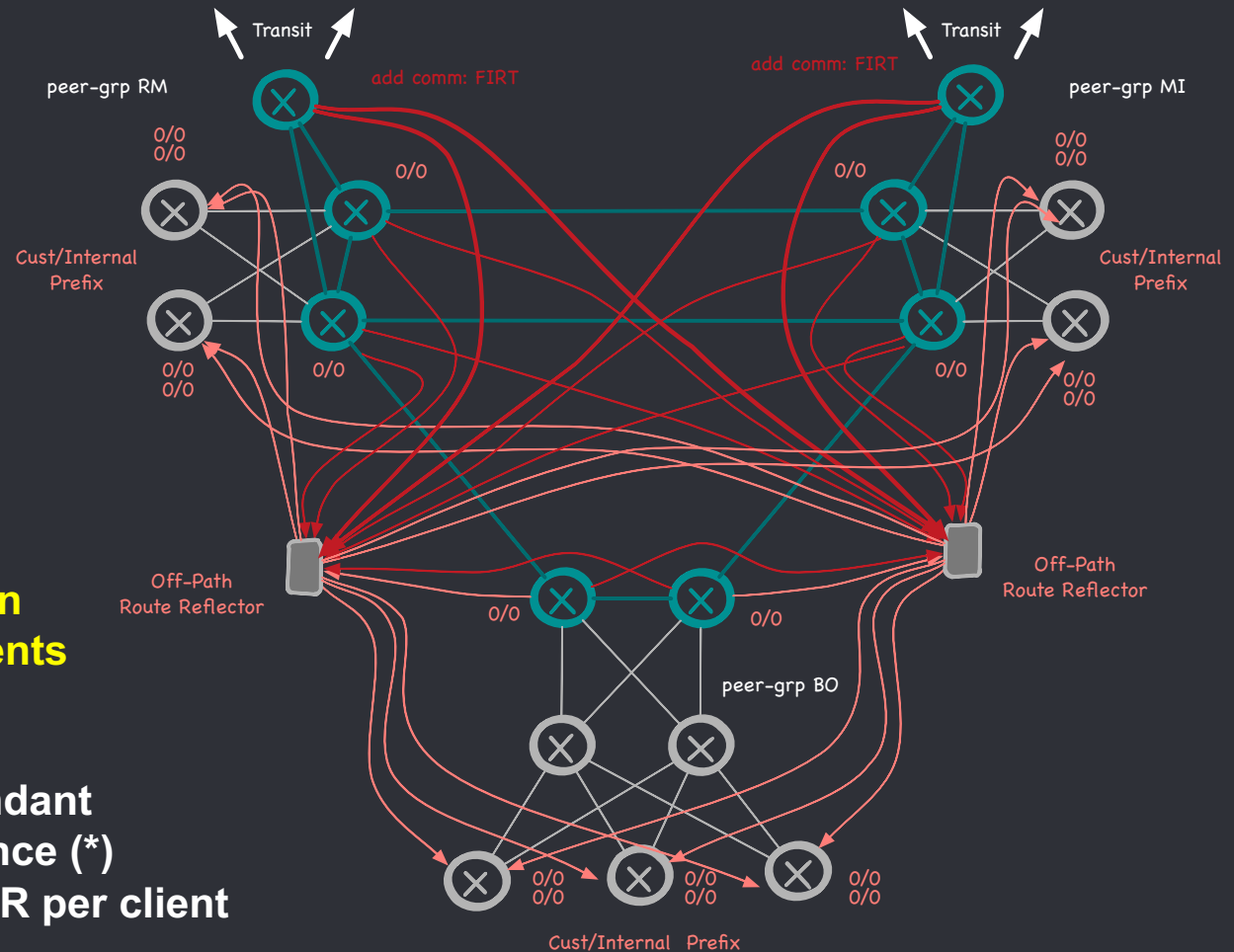
```
protocols {
  bgp {
    group RM-NAMEX {
      type internal;
      cluster 192.0.0.0;
      family inet {
        unicast {
          add-path {
            send {
              path-count 2;
            }
          }
        }
      }
      ...
      optimal-route-reflection {
        igp-primary 192.0.0.1;
        igp-backup 192.0.0.2;
      }
      neighbor 192.0.0.10;           // TRAN
      neighbor 192.0.0.1;           // CORE
      neighbor 192.0.0.2;           // CORE
      neighbor 192.0.0.3 export NO-FIRT; // PE
      neighbor 192.0.0.4 export NO-FIRT; // PE
    }
  }
}

policy-options {
  policy-statement NO-FIRT {
    term reject-external-prefix {
      from community FIRT;
      then reject;
    }
  }
}
```

- How Many Route Reflectors ??

- **It depends: number & location of RR driven by BC requirements**
- RR can be a VM in DC
- **Avoid circular dependency**
- Latency it's not critical: redundant information & local convergence (\*)
- in any case, no more than 2 RR per client

**\*) this is not true for all AFI/SAFI es: EVPN**



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## Summay

pros of modern bgp design

- Traditional vs Modern BGP design

key point of modern BGP design:

- All routing policy and optimization performed (almost automatically) on RR
- All client configuration are identical and without policy
- Path Diversity
- Load balancing with bgp multipath
- Reduced global BGP convergence time with Flat BGP infrastructure
- Reduced local BGP convergence time with BGP PIC (IGP driven)
- Simple and Scalable

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extra





# RR Platform

- Route Reflector it's not a router anymore
- Modern BGP implementations are optimized for multi-core and multi-thread
- Use VM with multiple core and high memory
- Server sizing based on nr. of client and nr. of prefixes
- More RR just to scale more clients and cover Business Continuity requirements
- ORR still not available in open/free implementations
- for IGP adjacency use a dedicated Interface/VLAN or a GRE Tunnel ( BGP-LS anyone? )

- Migration from Traditional Design

Q: This is beautiful but how to migrate from a traditional BGP design ?

A: Obviously depends on how many **customization/tricks** you have deployed in your backbone but:

**You can deploy the new infrastructure on top of the existing:**

- ✓ Add the new RR
- ✓ **On core device check RIB capacity for new FIRT copies**
- ✓ Peer all clients with the new RR
- ✓ use high AD/Preference on received prefix to prevent FIB install over existing
- ✓ compare old and new BGP prefixes to compare convergence

Use with route AD/Preference and progressively remove the old BGP cfg

- Key point in any design

*RFC1925 - The Twelve Networking Truths*

*rule 12 – "In protocol design, perfection has been reached not when there is nothing left to add, but when there is nothing left to take away"*

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Questions ?



# THANK YOU

disclaimer:

This is an original design performed during my consultancy activity  
you can share and use just citing the source

a special thanks to:

Ivan Pepelnjak & Tiziano Tofoni for the review

Check for latest version of this presentation at <https://github.com/nmodena/blog>