Modern BGP Design

Simplify the BGP infrastructure

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About me

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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**

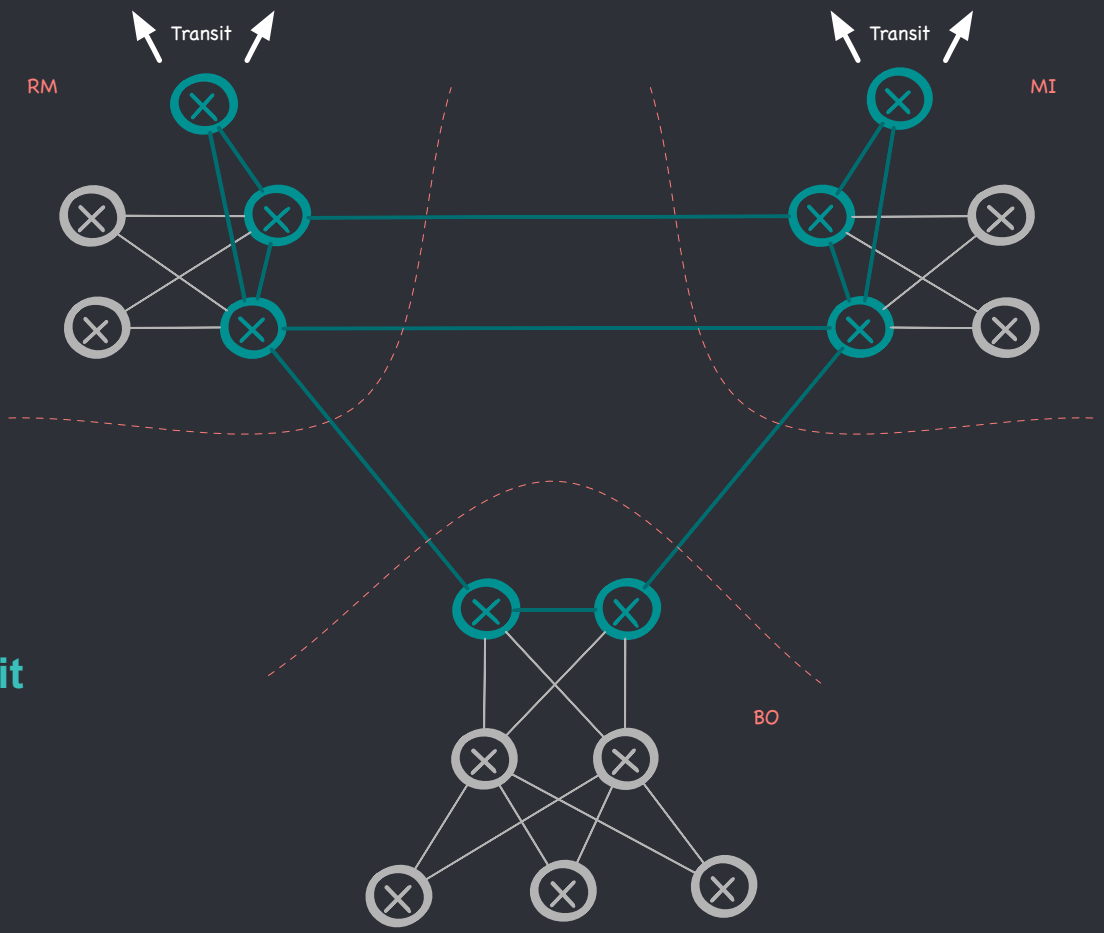
Requirement

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

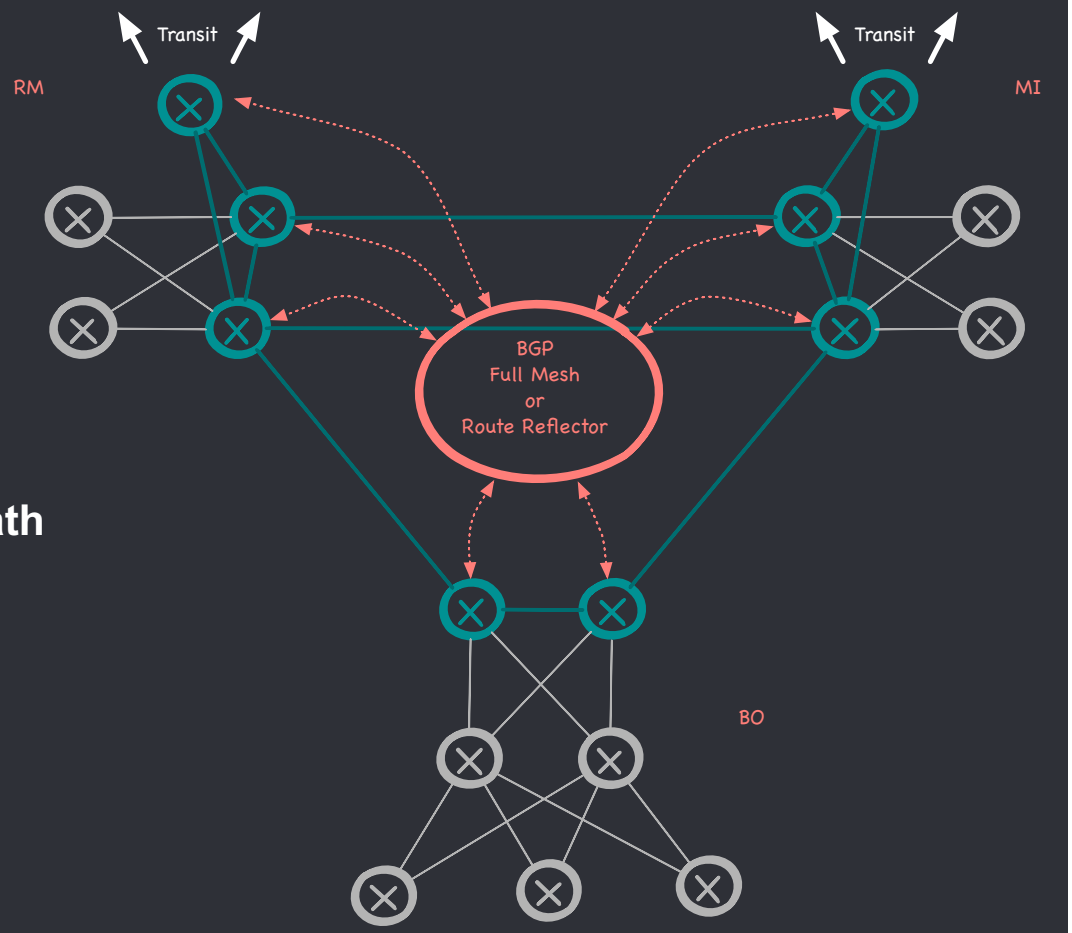
Goals

- **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 neigbhors 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

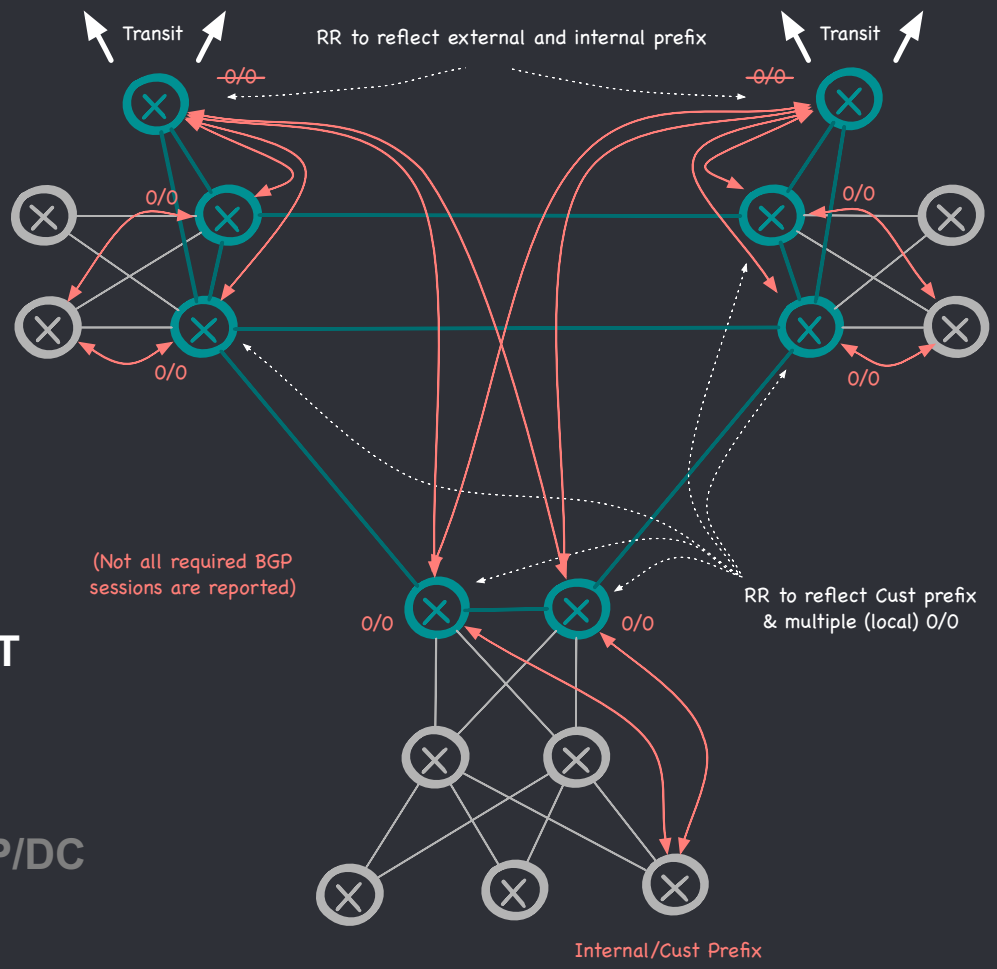
Default route and RR hierarchy

FIRT it's not required inside POP/DC

default-route originated on:
- ~~Transit~~ : not optimal with MPLS
- Core : for LB and HA

MPLS forwading 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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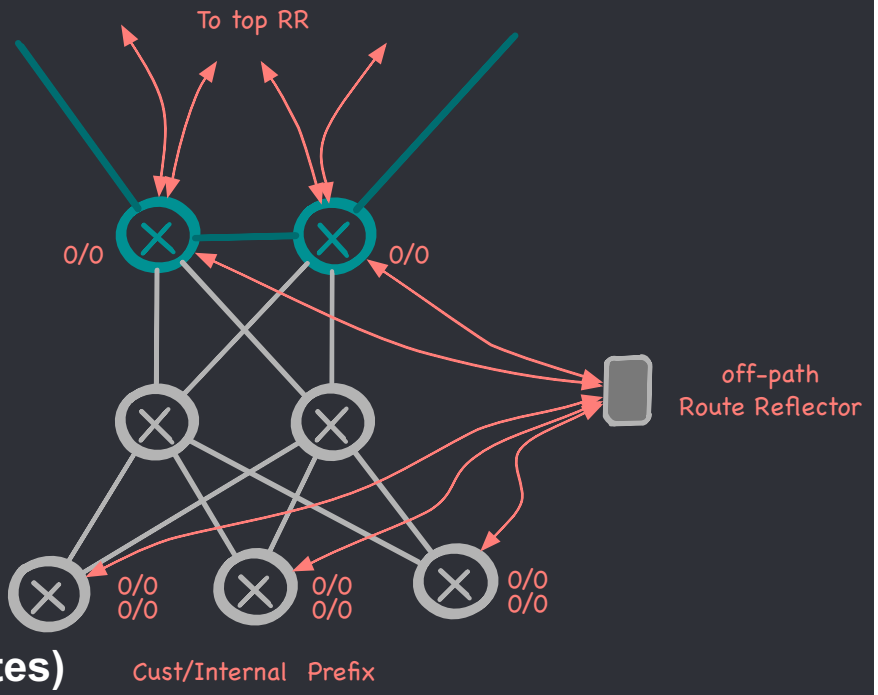
DataCenter/Pop Route Reflector

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 usefult 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 Receice capability**
- **Option to include max number of diverse path.**

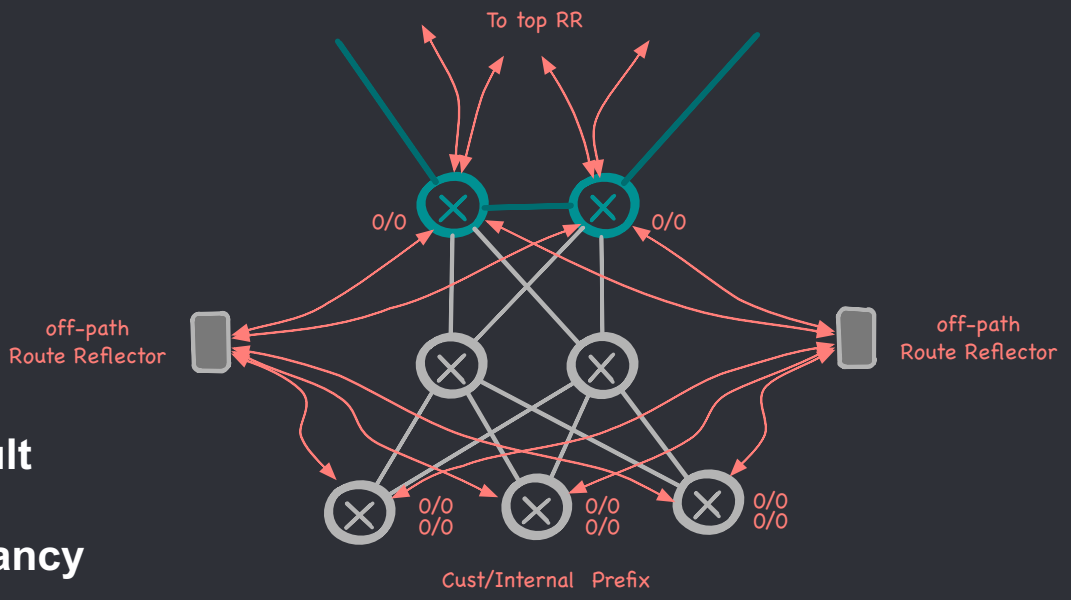
In this simple design:

- **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?

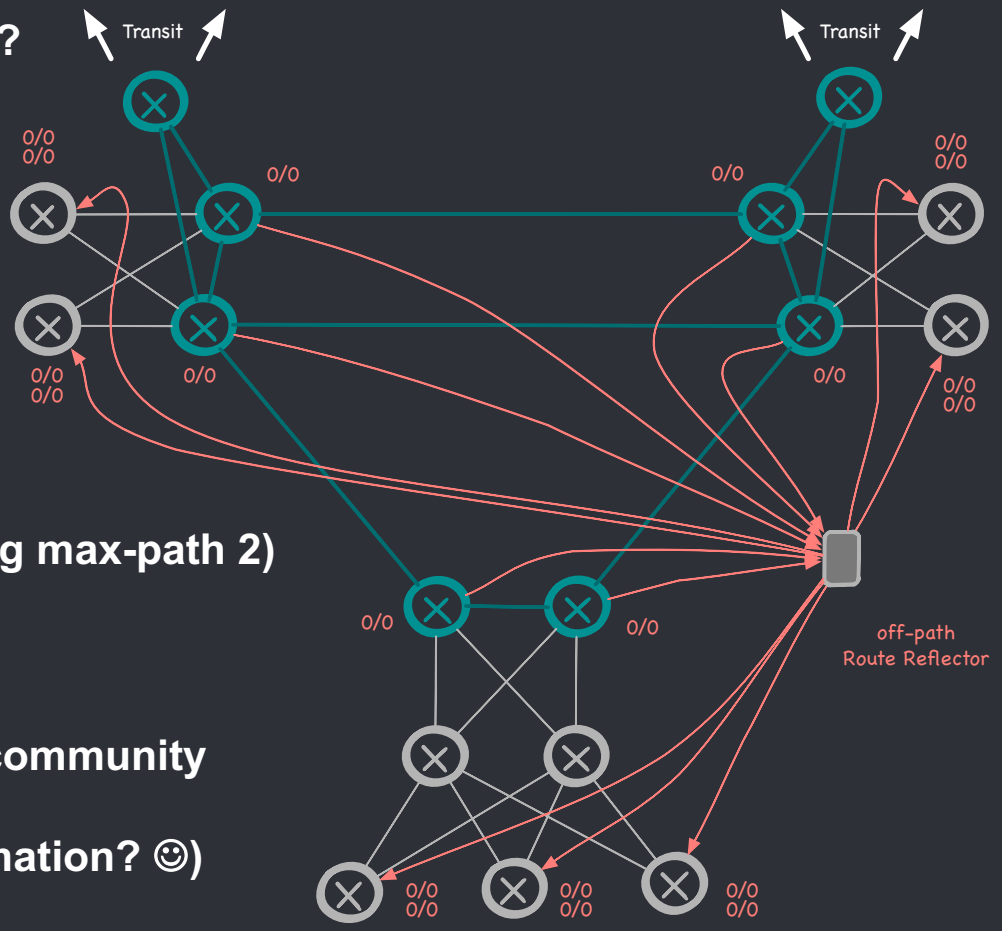
- **Every site must receive local default-route. This prevent sub-optimal routing with MPLS**

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

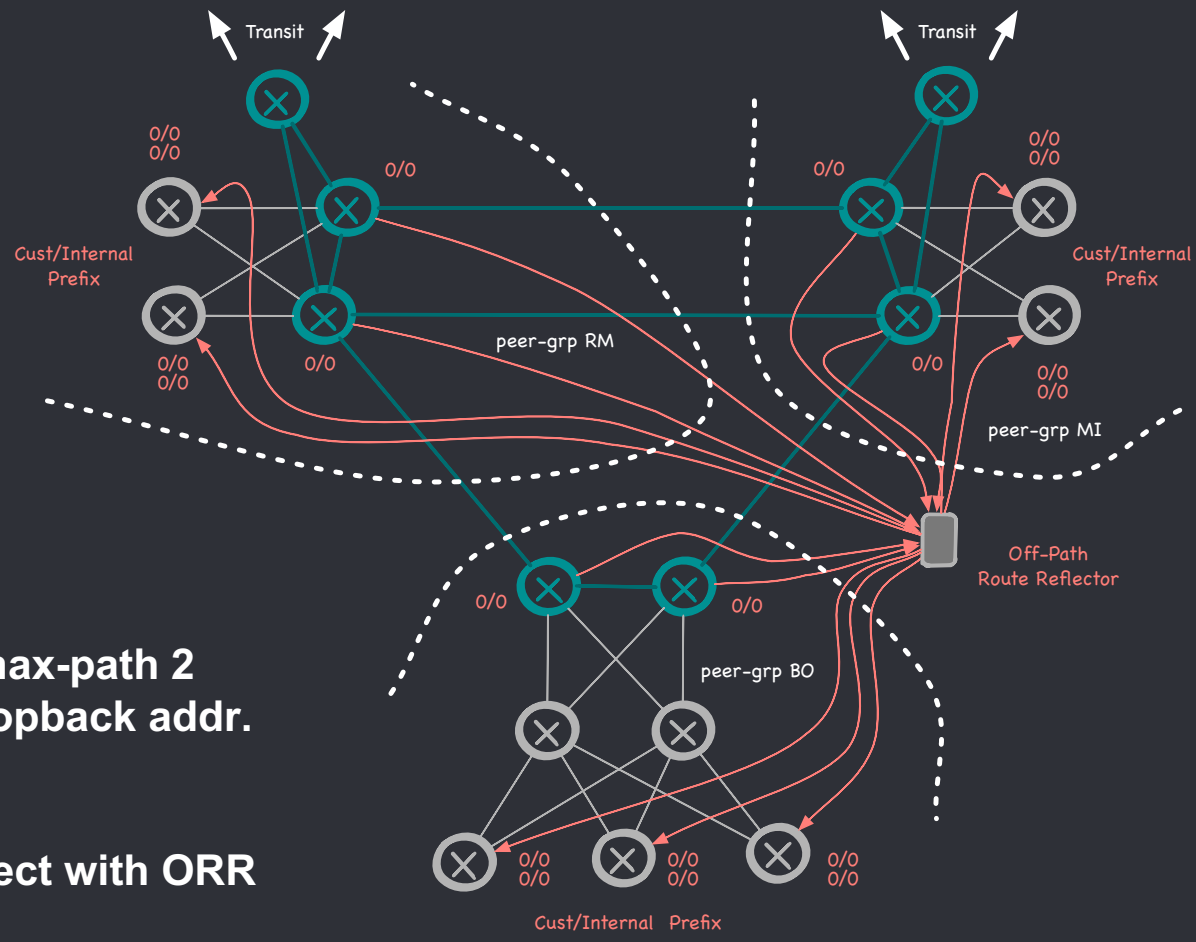
leverage IGP running SPF based on client topoly and reflects best path(s) based on client position.

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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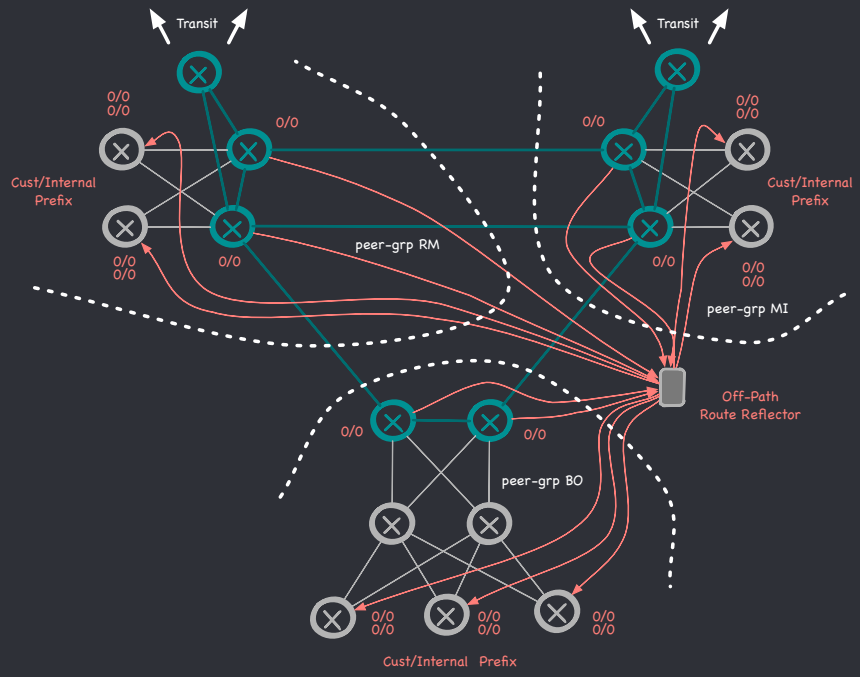
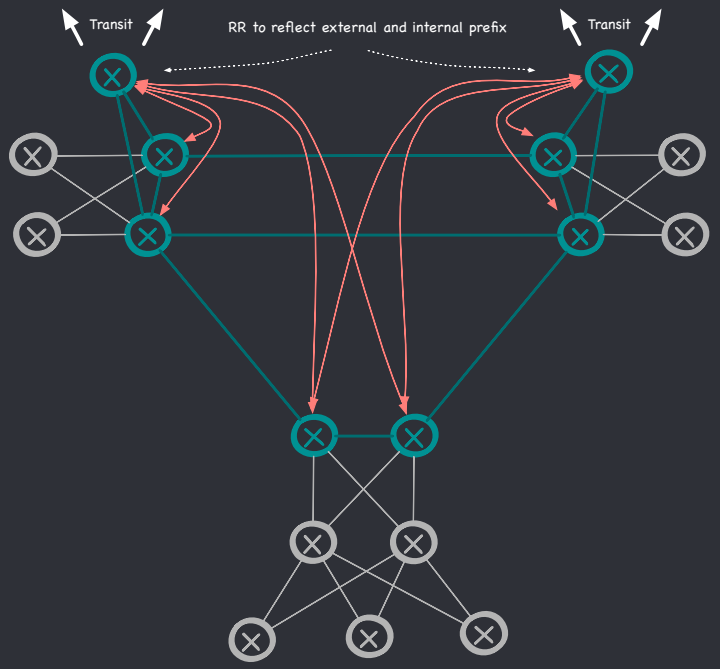
Combine Core and POP Route Reflectors

How combine DC/POP and Core RR

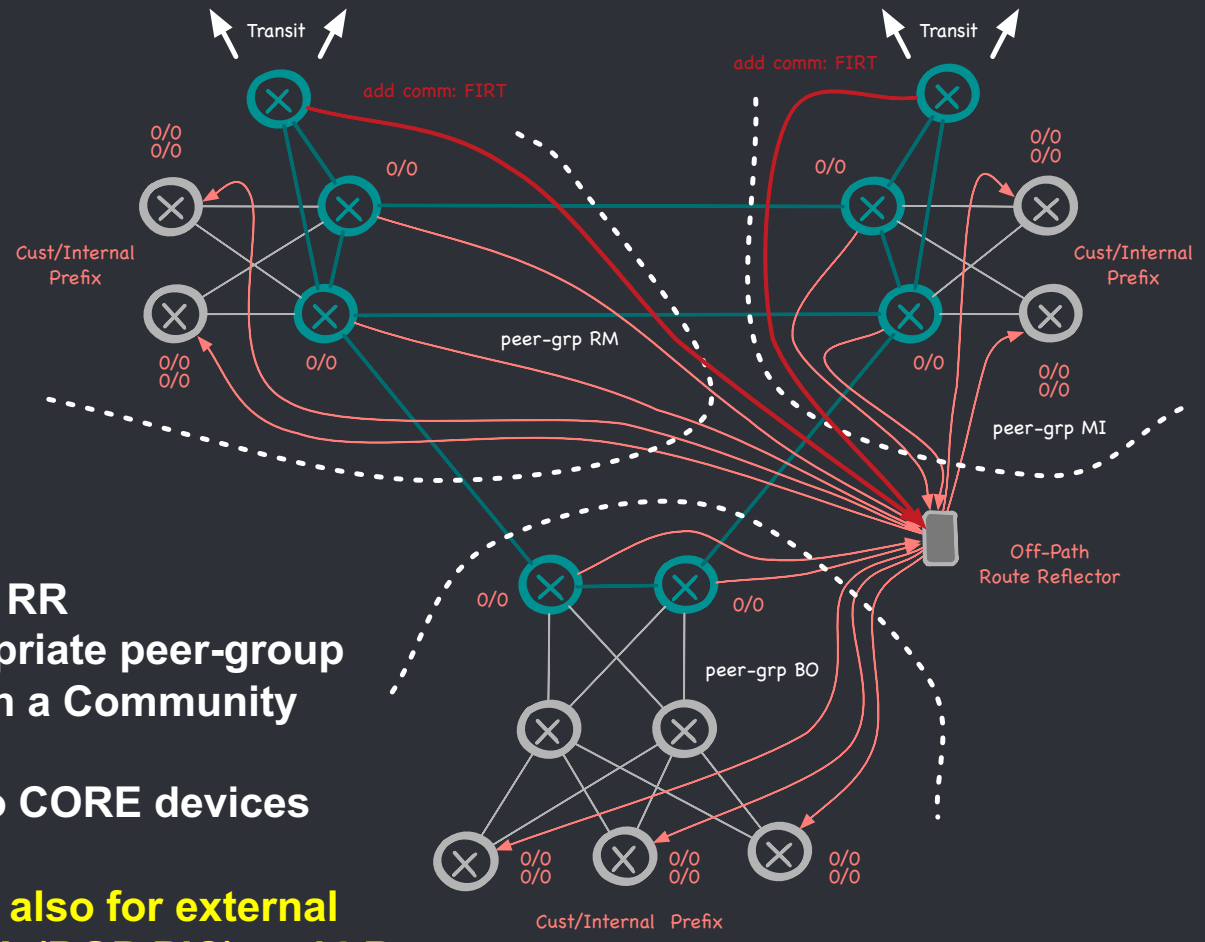
Core vs POP/DC Route Reflecotors : almost different informations





- **DC/POP RR holds multiple default-routes and Customer/Internal prefix**
- **Core RR (Transit) holds the FIRT and Customer/Internal prefix**
- **It’s possibile to combine the two infrastrucuture ? 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

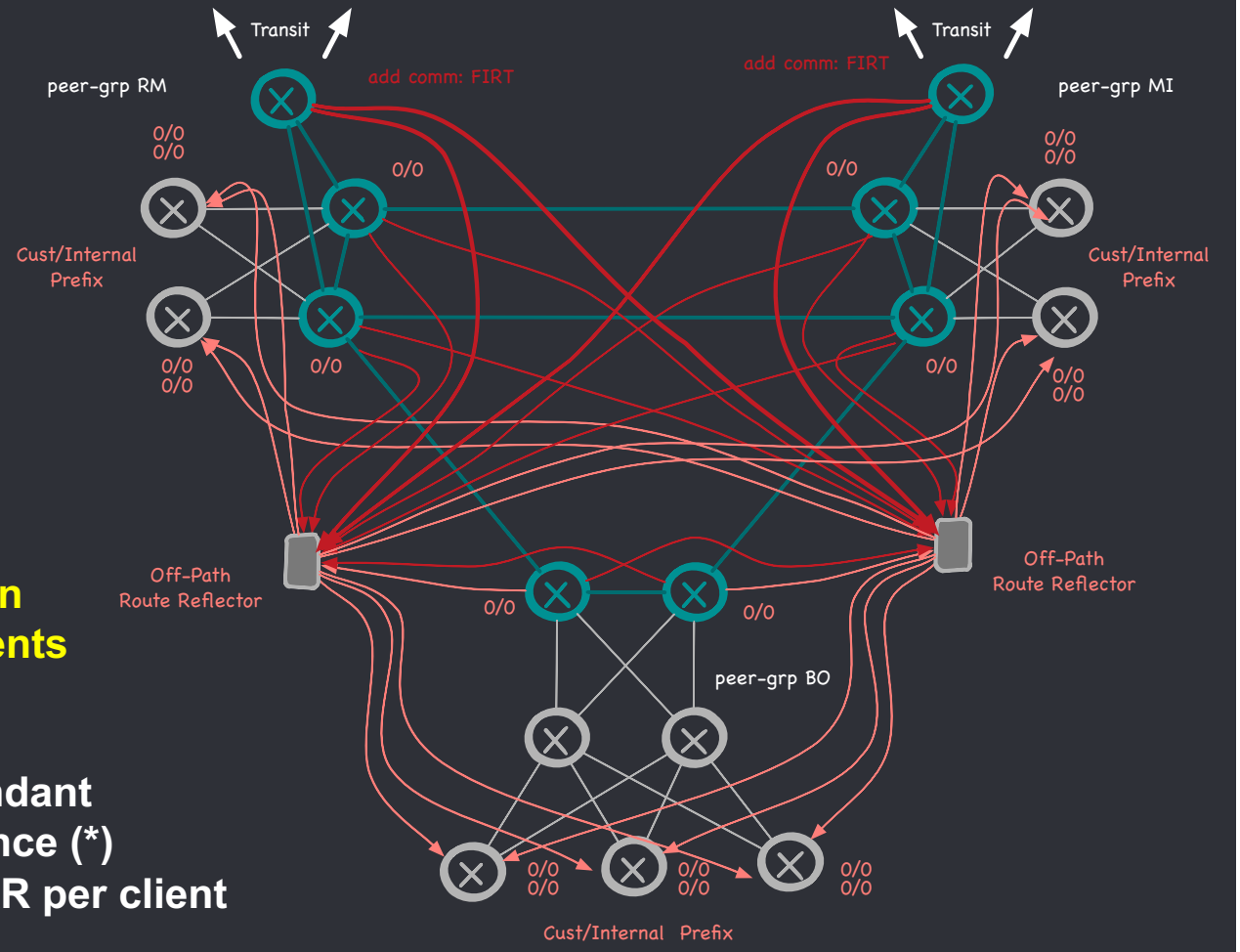
ORR will automatically select the two optimal prefix based on client IGP topology

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

6 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"

7 Questions ?

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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