Switch as Border Router

Small ISP without FIRT

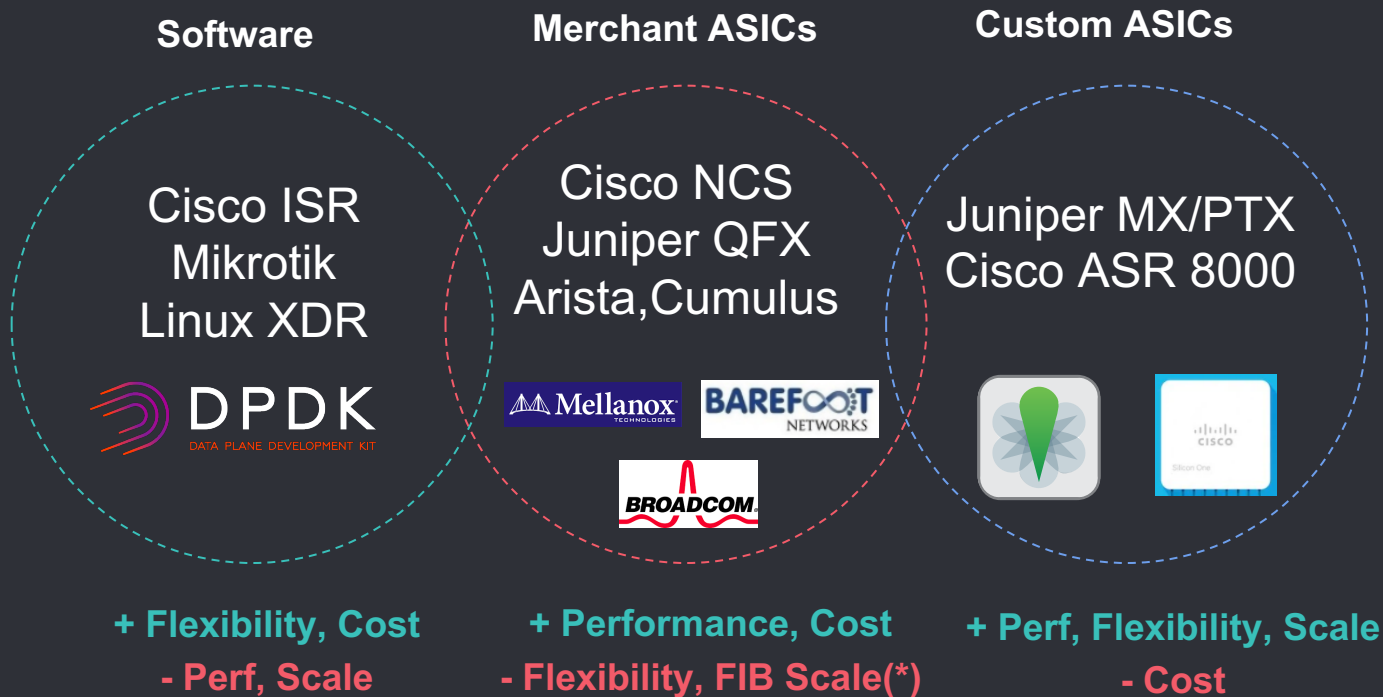ITNOG on the WEB 05/2020
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@nmodena

Agenda

- Motivation
- RIB vs FIB
- IXP and Transit
- Selective routing installation and propagation
- Route Selection for optimized routing
- Self assessment
- Summary

Software or Hardware based forwarding

Software

Merchant ASICs

Custom ASICs

Cisco ISR
Mikrotik
Linux XDR

Cisco NCS
Juniper QFX
Arista,Cumulus

Juniper MX/PTX
Cisco ASR 8000

+ Flexibility, Cost

- Perf, Scale

+ Performance, Cost

- Flexibility, FIB Scale(*)

+ Perf, Flexibility, Scale

- Cost

3

- Border router requirement

Border, Core & Aggregation routers for modern ISP must have:

- ◦ High Forwarding capacity
- ◦ High speed port density
- ◦ High RIB / FIB capacity
- ◦ Enhanced Load Balancing
- ◦ HW access lists (on the edge)
- ◦ Deep buffers (on link speed changes)

RIB vs FIB

Routing Information Base hold all the destination from the best path route selection

One or more entry for each destination are combined and installed in the forwarding table

FIB on ASICs uses fixed size TCAM for efficient lookup.

example: Broadcom Trident III: 128K FIB Entry

Routing Information Base

from Best Path Selection

```
SHOW IP ROUTE                    C
SHOW ROUTE                       J
```

DRAM

Forwarding Information Base

```
SHOW IP CEF                      C
SHOW ROUTE FORWARDING-TABLE J
```

TCAM

5

ISP Backbone without FIRT

use of just default-route to reach external destination (*)

PROS

Lower Resources (FIB)

Faster Convergence

Easier Management

Cheap devices

CONS

sub-optimal routing

No Transit Customers

Possible solution : Route selection & Selective FIB Download

(*) backbone with multiple and distributed exit points

1 A pratical example
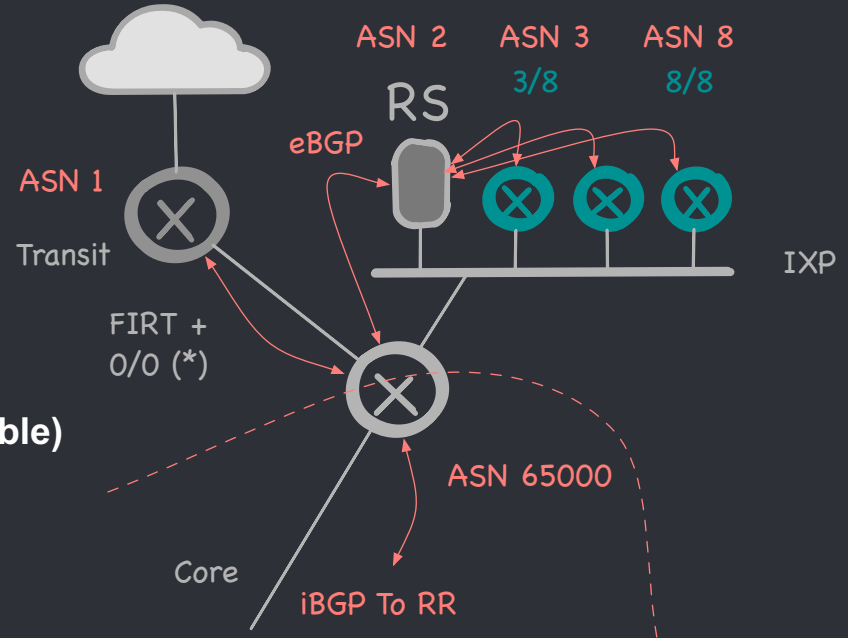
Border router with peers and transit

IXP Routing

IXP Peering
- **eBGP peering with Route Server**
- **no RS ASN in path**
- **next-hop unchaged**
- **BGP update of all members (customizable)**

Transit
- **FIRT Full Internet Routing Table**
- **and/or default-route**

Our goal is to optimize router resources for this scenario

ASN 2   ASN 3   ASN 8
         3/8   8/8

RS

eBGP

ASN 1

Transit

FIRT +
0/0 (*)

IXP

ASN 65000

Core

iBGP To RR

Border router with selective FIB install

IXP bgp configuration

```
protocols {
    bgp {
        group IXP {
            neighbor 172.16.0.1 {
                import from-IXP;
                export only-my-AS;
                peer-as 2;
}}}}

policy-options {
    policy-statement from-IXP {
        term accept-all {
            then {
                community add FIB;
            }
        }
    }
    community FIB members 65000:800;
}
```
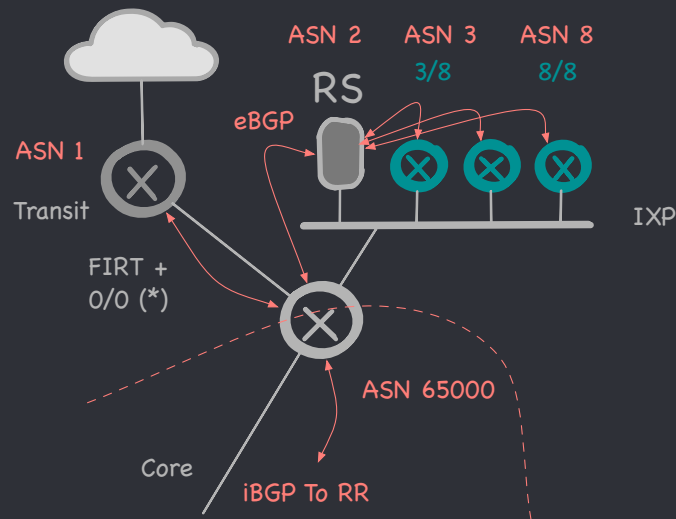

Tag all the relevant prefixes with a community

OPT: filter-out irrilevant destinations reached in other peering points or trough transits
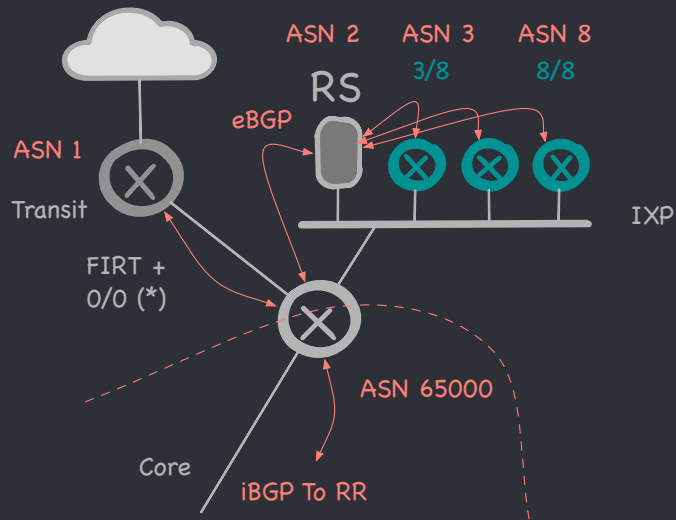
Border router with selective FIB install

Transit bgp import policy

```
policy-options {
    policy-statement from-TRANSIT {
        term default-route {
            from {
                route-filter 0.0.0.0/0 exact;
            }
            then {
                community add FIB;
                next policy;
            }
        }
        term default {
            then {
                community add RIB-ONLY;
            }
        }
    }
    community FIB members 65000:800;
    community RIB-ONLY members 65000:801;
}
```


Tag all transit routes with a different community except the default-route.

The FIRT is accepted and may be propagated internally for further usage

Border router with selective FIB install

Controlled FIB install

```
routing-options {
    forwarding-table {
        export selective-FIB-install;
    }
}

policy-options {
    policy-statement selective-FIB-install {
        term RIB-ONLY {
            from {
                protocol bgp;
                community RIB-ONLY;
            }
            then reject;
        }
    }
    community RIB-ONLY members 65000:801;
}
```
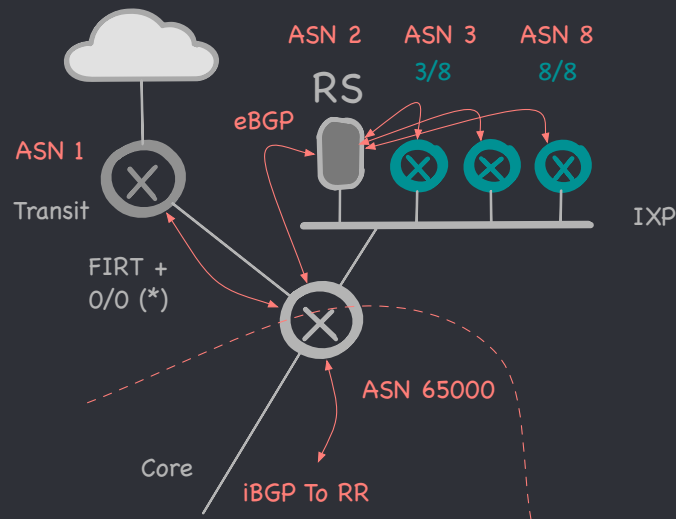

deploy a policy to control RIB to FIB download and reject RIB-ONLY tagged route

HINT: Almost every platform has this feature deployed for out-of-band route reflectors

Border router with selective FIB install

Checking for the RIB : all entries are present

```
nmodena@MX-05> show bgp summary
Table          Tot Paths  Act Paths Suppressed    History Damp State    Pending
inet.0
Peer               AS     InPkt     OutPkt      OutQ    Flaps Last Up/Dwn
172.16.0.1          2      1294       1304         0        0    9:39:54 Establ
  inet.0: 6/6/6/0
172.16.1.106        1    2073299        9         0        0      53:42 Establ
  inet.0: 42793/42793/42793/0
```

IXP
TRANSIT

```
nmodena@MX-05> show route
inet.0: 42822 destinations, 42823 routes (42822 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

0.0.0.0/0          *[BGP/170] 01:10:09, localpref 100
                      AS path: 1 I, validation-state: unverified
                    > to 172.16.1.106 via et-0/0/4.0
1.0.0.0/24         *[BGP/170] 01:10:09, localpref 100
                      AS path: 1 49673 24811 13335 I, validation-state: unverified
                    > to 172.16.1.106 via et-0/0/4.0
1.0.4.0/24         *[BGP/170] 01:10:09, localpref 100
                      AS path: 1 49673 6939 4826 38803 56203 I, validation-state: unverified
                    > to 172.16.1.106 via et-0/0/4.0
1.0.5.0/24         *[BGP/170] 01:10:09, localpref 100
                      AS path: 1 49673 6939 4826 38803 56203 I, validation-state: unverified
                    > to 172.16.1.106 via et-0/0/4.0
```

FIRT

Border router with selective FIB install
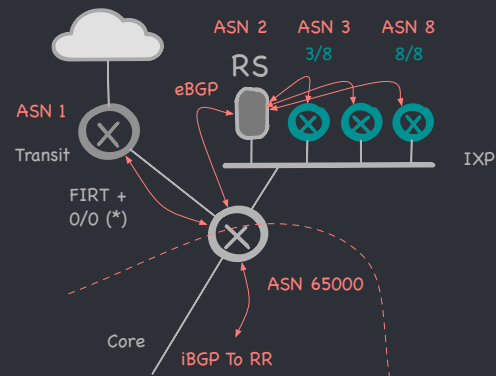
Checking for the FIB : only relevant entries are installed

```
nmodena@MX-05> show route forwarding-table
Routing table: default.inet
Internet:
Enabled protocols: Bridging,
Destination        Type RtRef Next hop           Type Index   NhRef Netif
default            user    0 50:0:0:b:0:0        ucst   596      4 et-0/0/4.0        Transit
default            perm    0                     rjct    36      1
0.0.0.0/32         perm    0                     dscd    34      3
3.0.0.0/8          user    0 172.16.0.3          ucst   599      5 et-0/0/5.0
3.0.1.0/24         user    0 172.16.0.3          ucst   599      5 et-0/0/5.0
3.0.2.0/24         user    0 172.16.0.3          ucst   599      5 et-0/0/5.0
8.0.0.0/8          user    0 172.16.0.8          ucst   598      5 et-0/0/5.0        Peers at IXP
8.0.1.0/24         user    0 172.16.0.8          ucst   598      5 et-0/0/5.0
8.0.2.0/24         user    0 172.16.0.8          ucst   598      5 et-0/0/5.0
10.0.0.0/8         user    0                     dscd    34      3
10.0.35.0/24       intf    0                     rslv   584      1 et-0/0/3.0
10.0.35.0/32       dest    0 10.0.35.0           recv   582      1 et-0/0/3.0        Internal Network
[…]
```
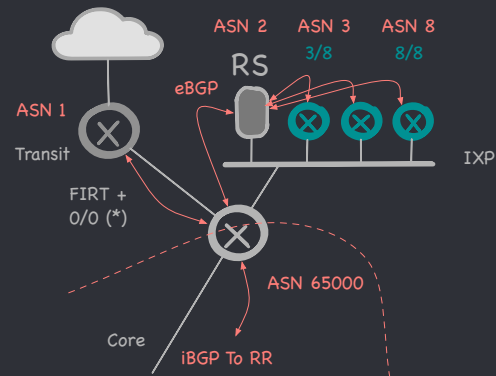
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Border router with selective FIB install

Compare RIB and FIB size

```
nmodena@MX-05> show route summary
inet.0: 42822 destinations, 42823 routes (42822 active, 0 holddown, 0 hidden)
              Direct:      5 routes,      5 active
               Local:      4 routes,      4 active
                OSPF:      9 routes,      9 active
                 BGP: 42802 routes, 42801 active
           Aggregate:      2 routes,      2 active
                 LDP:      1 routes,      1 active

inet.3: 8 destinations, 8 routes (8 active, 0 holddown, 0 hidden)
                 LDP:      8 routes,      8 active

nmodena@MX-05> show route forwarding-table summary
Routing table: default.inet
        user:         61 routes
        perm:          5 routes
        intf:          9 routes
        dest:         19 routes
```

Is it really THAT simple ?

yes, but only if you have a SINGLE TRANSIT provider and

all the remaining prefix fits into the FIB

…but this is not true in most cases…

Border router with multiple Transit

Multiple transit are used to get optimal paths like:
- **for ASN 20/30/40 use Transit 1**
- **for ASN 50/60/90 use Transit 2**
- **load balance the remainig traffic on both links**

this requires to
- **create policy to identify relevant prefixes**
- **check if the expected FIB size fit's in the TCAM**
- **mark this new prefixes for FIB download**

it is usually a procedure performed manually and if necessary

ASN 50/60/70

ASN 10

Transit 2

IXP

ASN 20/30/40

ASN 1

FIRT +
0/0 (*)

ASN 3   3/8

ASN 8   8/8

Transit 1

FIRT +
0/0 (*)

ASN 65000

Core

iBGP To RR
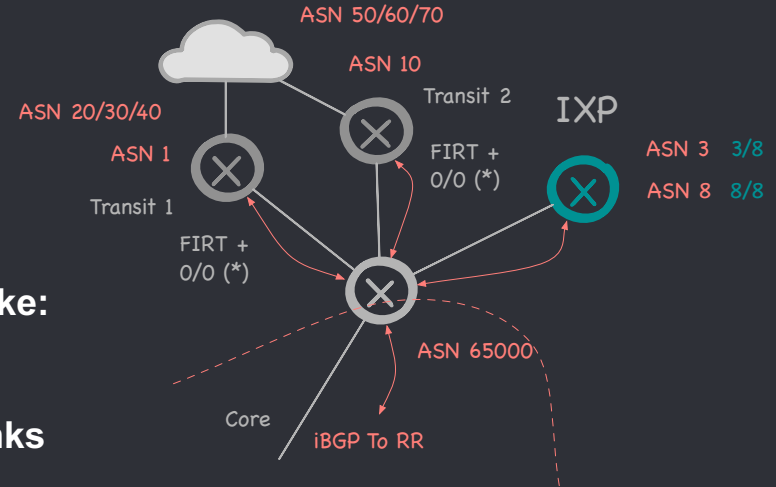
Border router and internal reachability

Also internal destination may be considered

and also can be reduced / summarized but depend on
- **addressing plan**
- **summarization strategy**
- **number of interfaces**
- **load balancing**
- **use of MPLS**

Hint: some modular devices has also FIB localization capability

ASN 10

Transit 2

IXP

FIRT +
0/0 (*)

ASN 3   3/8

ASN 1

ASN 8   8/8

Transit 1

FIRT +
0/0 (*)

IGP
+
MPLS

ASN 65000

iBGP

Backbone

RR
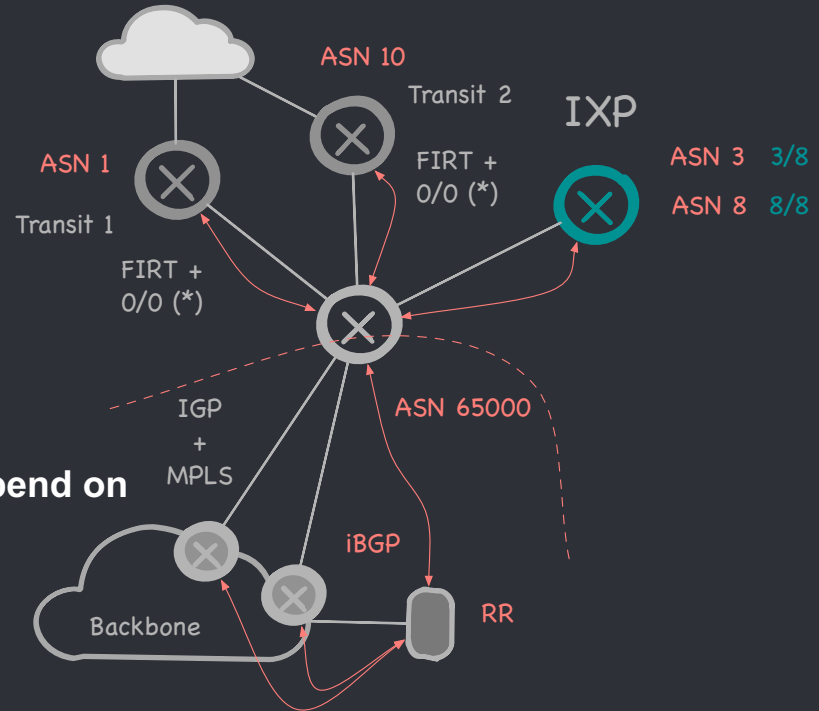
3 Evolution with optimized edge selection

distribution of selected external destinations

Layer-3 solution with optimized routing

ASN 20
ASN 30
ASN 40

ASN 50
ASN 60
ASN 70

P   T   T   P

1/8   FIRT   FIRT   3/8
             0/0   0/0   8/8
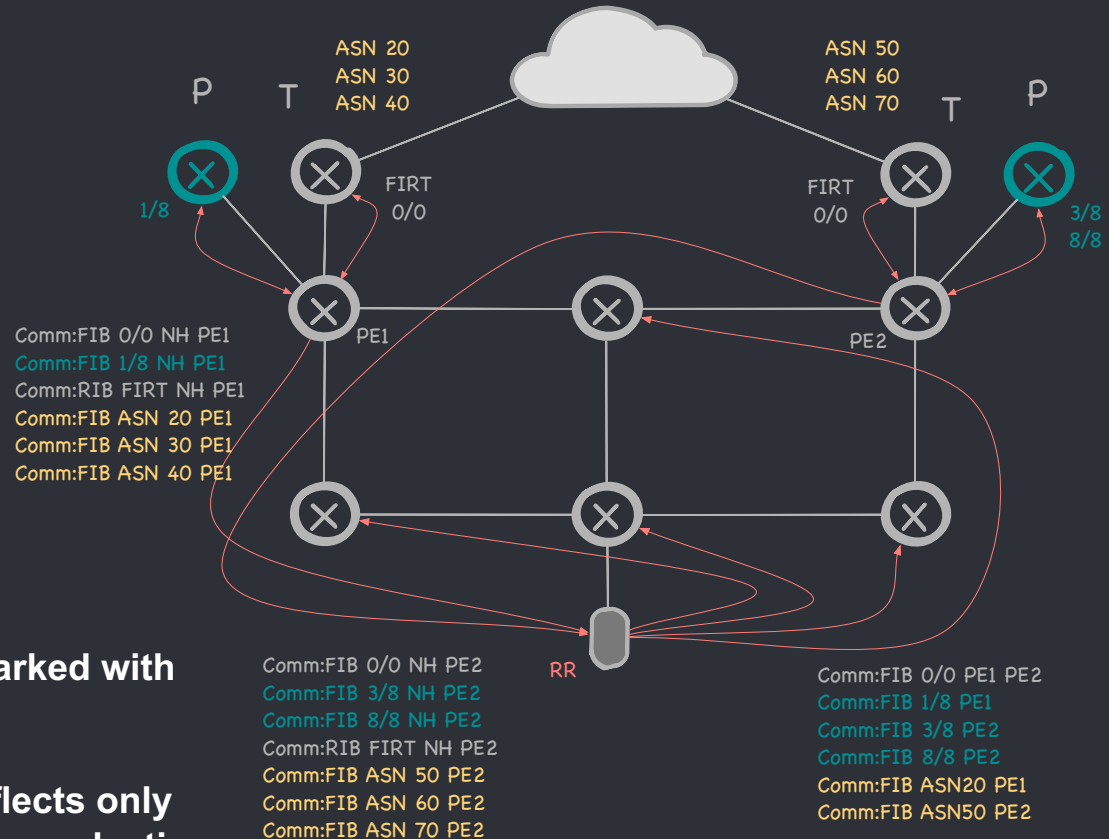
Comm:FIB 0/0 NH PE1
Comm:FIB 1/8 NH PE1
Comm:RIB FIRT NH PE1
Comm:FIB ASN 20 PE1
Comm:FIB ASN 30 PE1
Comm:FIB ASN 40 PE1

PE1   PE2

We can put all togheter:

**Border routers advertise
all external prefixes to RR marked with
FIB or RIB-ONLY community**

**RR can hold the FIRT and reflects only
relevant prefix to optimize peer selection**

RR

Comm:FIB 0/0 NH PE2
Comm:FIB 3/8 NH PE2
Comm:FIB 8/8 NH PE2
Comm:RIB FIRT NH PE2
Comm:FIB ASN 50 PE2
Comm:FIB ASN 60 PE2
Comm:FIB ASN 70 PE2

Comm:FIB 0/0 PE1 PE2
Comm:FIB 1/8 PE1
Comm:FIB 3/8 PE2
Comm:FIB 8/8 PE2
Comm:FIB ASN20 PE1
Comm:FIB ASN50 PE2

Layer-3 solution with optimized routing

ASN 20
ASN 30
ASN 40

ASN 50
ASN 60
ASN 70

P   T

T   P

FIRT
0/0

FIRT
0/0

1/8

3/8
8/8

Comm:FIB 0/0 NH PE1
Comm:FIB 1/8 NH PE1
Comm:RIB FIRT NH PE1
Comm:FIB ASN 20 PE1
Comm:FIB ASN 30 PE1
Comm:FIB ASN 40 PE1

PE1

PE2

RR

netflow

**why do not combine a netflow analysis
for an automatic edge selection ?**

What can go wrong ? ☺

Comm:FIB 0/0 NH PE2
Comm:FIB 3/8 NH PE2
Comm:FIB 8/8 NH PE2
Comm:RIB FIRT NH PE2
Comm:FIB ASN 50 PE2
Comm:FIB ASN 60 PE2
Comm:FIB ASN 70 PE2

Comm:FIB 0/0 PE1 PE2
Comm:FIB 1/8 PE1
Comm:FIB 3/8 PE2
Comm:FIB 8/8 PE2
Comm:FIB 31/8 PE1
Comm:FIB 27/16 PE2
Comm:FIB 61.8/16 PE2

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How to identify relevant destinations

Manually : become a regex ninja

Automatic: create an SDN Solution like David Barroso with Paolo Lucente

https://labs.spotify.com/2016/01/26/sdn-internet-router-part-1/

https://blog.ipspace.net/2015/01/sdn-router-spotify-on-software-gone-wild.html

https://github.com/dbarrosop/sir

4 Summary

Switch selection

Select Asic/Vendor based on your needs:
- FIB Size
- Filtering capability
- QOS with Filtering
- Load Balancing
- Buffers
- Netflow
- Telemetry
- Programmability
- CPU / RAM / Control Plane

Summary - Take Away

- on ASICS resources are fixed/limited
- We can operate with unsynchronized RIB and FIB
- Easier on border router with hot-potato and default-route
- it's possible to deploy on backbone but it's not simple
- Partial Routing distribution and/or different hasing can lead to traffic loops
- Troubleshooting requires new skills and updated procedure

- you can save a lot of money on high end device

5 Self Assessment

Is this solution good for me ?

- **Self Assesment**

- how many prefixes I currently have in my rib ?
- how many transit or peering-points I am connected to ?
- what distance (RTT,$) there is between them ?
- Sub-optimal routing or double transit it's an option ?
- I'm able to identify how many prefix I need to cover 90% of my destination ?
- How many time I spend troubleshooting transit issue ?
- how often I need to optimize transit traffic ?
- I have the knowledge to manage this system ?

-> balance between: TIME - KNOWLEDGE – COSTS - PERFORMANCE

0 THANK YOU

Questions ?

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