rare.freertr.net BIER implementation

P4 BMv2, TOFINO & DPDK dataplane

Csaba MATE

GÉANT/KIFU – RARE/freeRtr Lead core developer

Frederic LOUI

GÉANT/RENATER – RARE/Technical leader

IETF#110 Virtual meeting –BIER-WG

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Public

Agenda

- RARE/freeRtr in a nutshell
- BIER RFC’s/draft implementation
- RARE (2021) /freeRtr (2017) BIER implementation experiment
- BIER interworking with Junos
- “Loop unrolling” BIER replication
- Conclusion

RARE project : Group focus

- GEANT project sub-task: RARE
  - Control plane software
  - Multiple data planes
  - Interface them and the result is …

- Fully functional router
  - Running at hardware line rate
  - DIY “hackable/extensible” router
  - Control plane independence

One familiar platform

↓

Multiple solutions

↓

Each solution addresses

↓

R&E
use case

RARE latest news (M27/48)

- RARE p4 targets

P4 bmv2 software switch

BAREFOOT NETWORKS an intel company TOFINO intel Intel/barefoot Tofino on WEDGE-BF100-32X, APS-BF2556X-T1, others

FPGAs **under study**

- RARE “p4” emulation targets

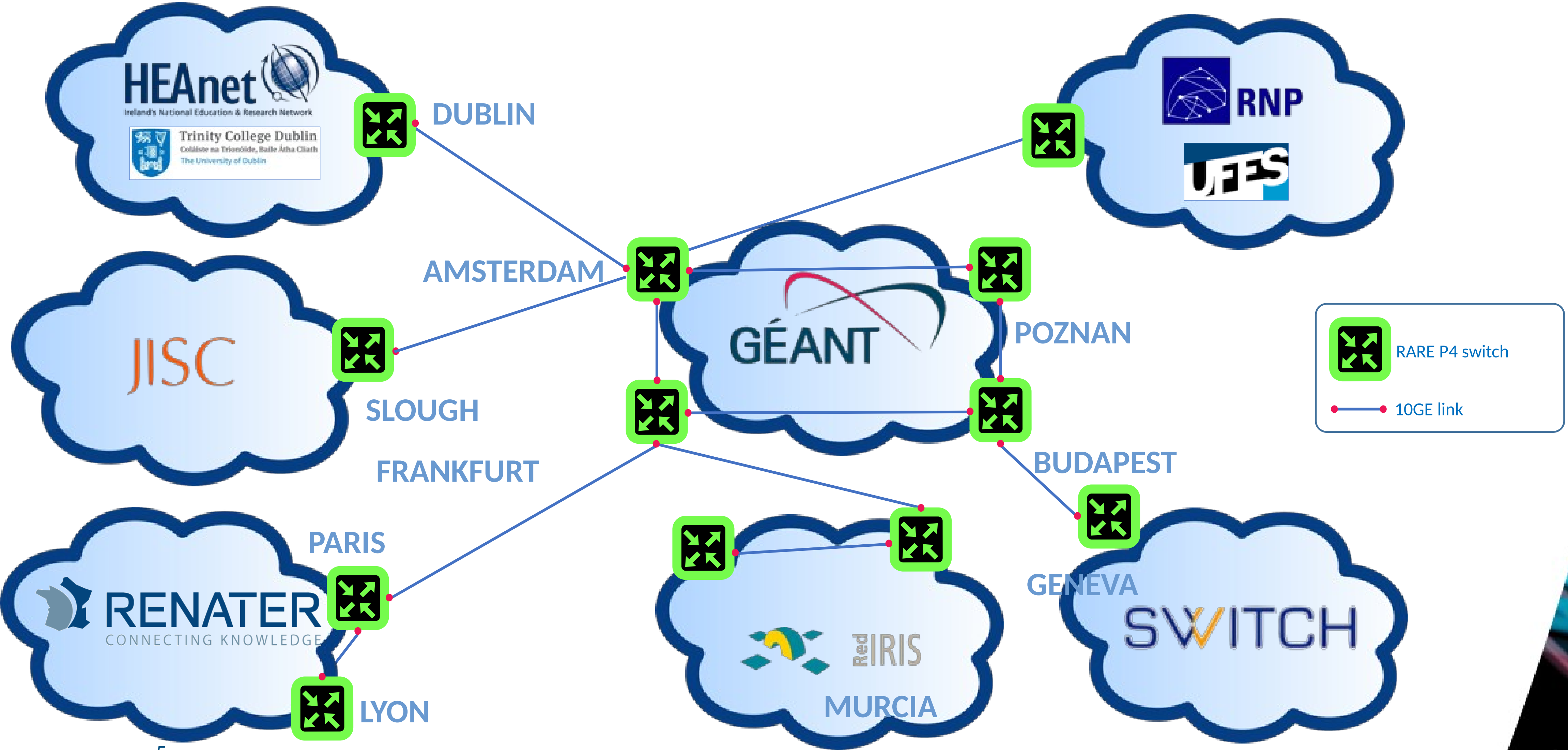
TCPDUMP & LIBPCAP

DPDK DATA PLANE DEVELOPMENT KIT

- RARE Network Programmable targets

NPL Broadcom **under study**

RARE P4 european testbed



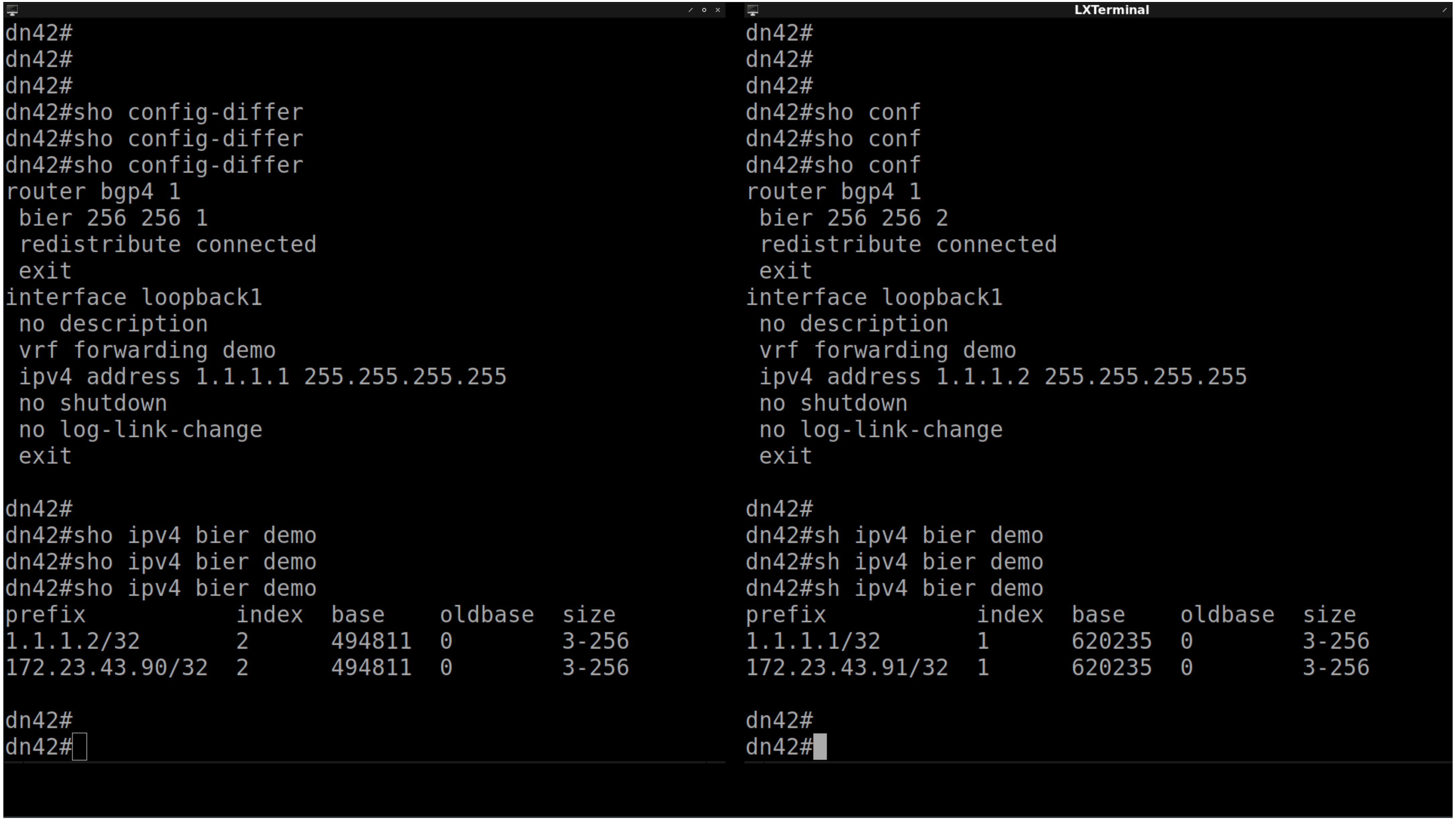
What we have

- BIER in MPLS - RFC8296
  - All the BitString lengths in software
  - 256bit mode in all the dataplanes
- BIER ISIS – RFC8401
- BIER OSPF – RFC8444
- BIER IDR draft
- BIER PIM draft

Experience

- wwwin.nop.hu/trackMap.tcl - a live network running dpdk dataplanes and sometimes a tofino node
- lg.nop.hu - an ISP like setup
- inf.nop.hu/mtrack.tcl - measured from multiple endpoints talking to each other 0-24
- Regular streaming to loudspeakers with vlc: demo
- All over BIER, initially in sw, nowadays in the dataplane
- We had a successful interop with Juniper! Someone else?
- Forwarding pitfall we’re doing

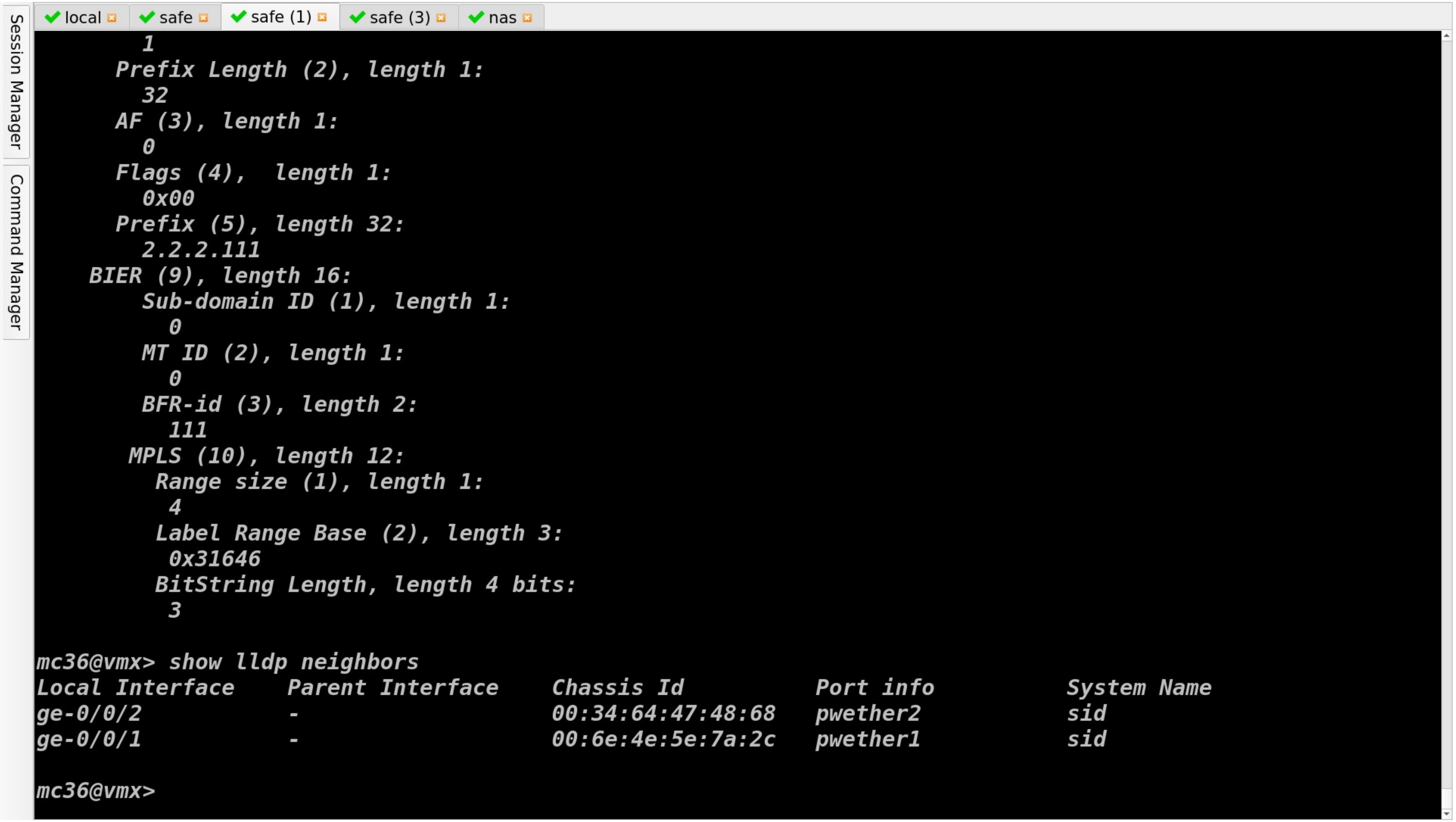
demo.freertr.net - an online BIER trial with draft-idr for 2+ years



```
dn42#
dn42#
dn42#
dn42#sho config-differ
dn42#sho config-differ
dn42#sho config-differ
router bgp4 1
 bier 256 256 1
 redistribute connected
 exit
interface loopback1
 no description
 vrf forwarding demo
 ipv4 address 1.1.1.1 255.255.255.255
 no shutdown
 no log-link-change
 exit

dn42#
dn42#sho ipv4 bier demo
dn42#sho ipv4 bier demo
dn42#sho ipv4 bier demo
prefix           index  base    oldbase  size
1.1.1.2/32       2      494811  0        3-256
172.23.43.90/32  2      494811  0        3-256

dn42#
dn42#
```

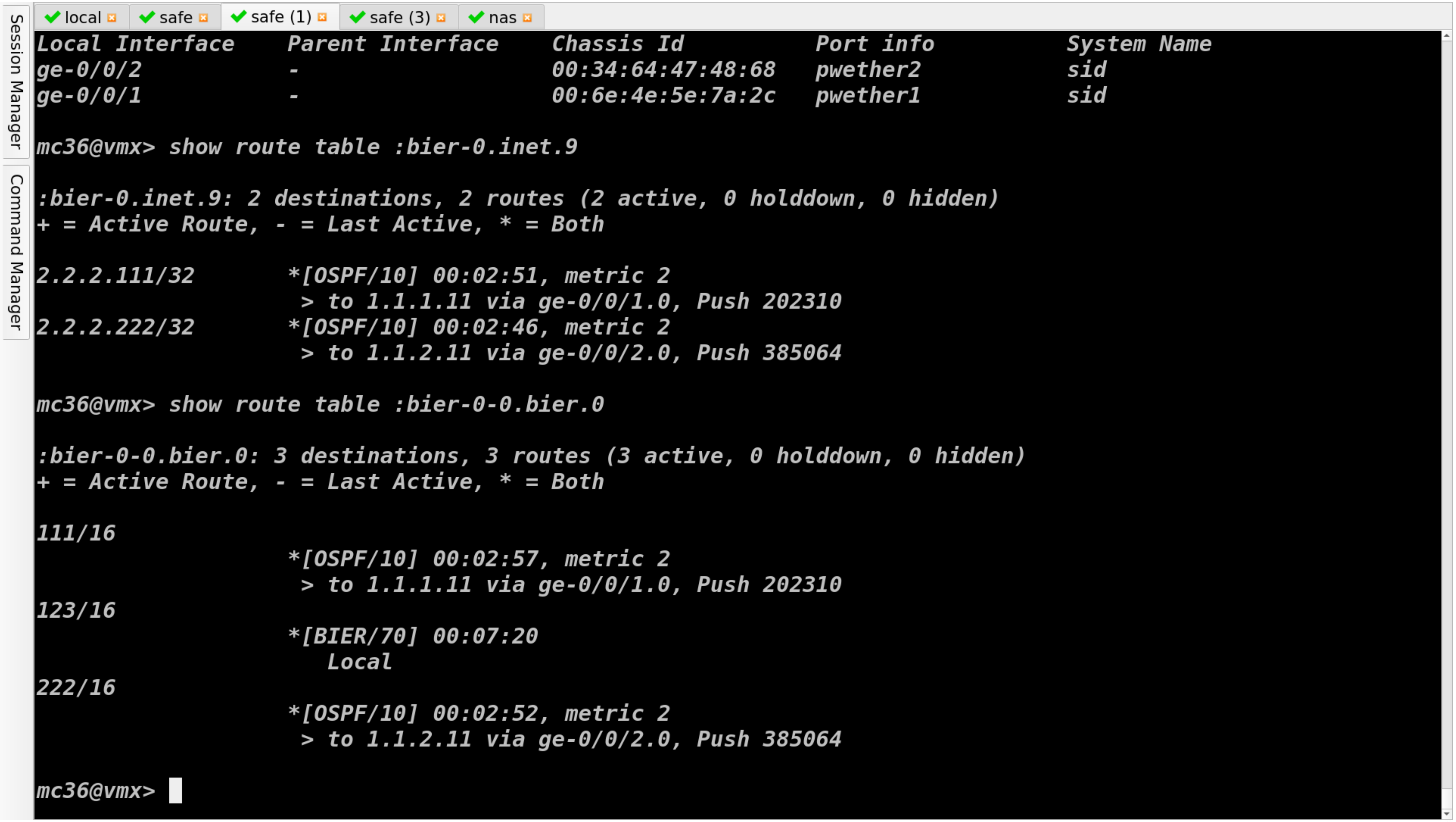
```
dn42#
dn42#
dn42#
dn42#sho conf
dn42#sho conf
dn42#sho conf
router bgp4 1
 bier 256 256 2
 redistribute connected
 exit
interface loopback1
 no description
 vrf forwarding demo
 ipv4 address 1.1.1.2 255.255.255.255
 no shutdown
 no log-link-change
 exit

dn42#
dn42#sh ipv4 bier demo
dn42#sh ipv4 bier demo
dn42#sh ipv4 bier demo
prefix           index  base    oldbase  size
1.1.1.1/32       1      620235  0        3-256
172.23.43.91/32  1      620235  0        3-256

dn42#
dn42#
```

Juniper’s vMX parsed the BIER info from OSPF



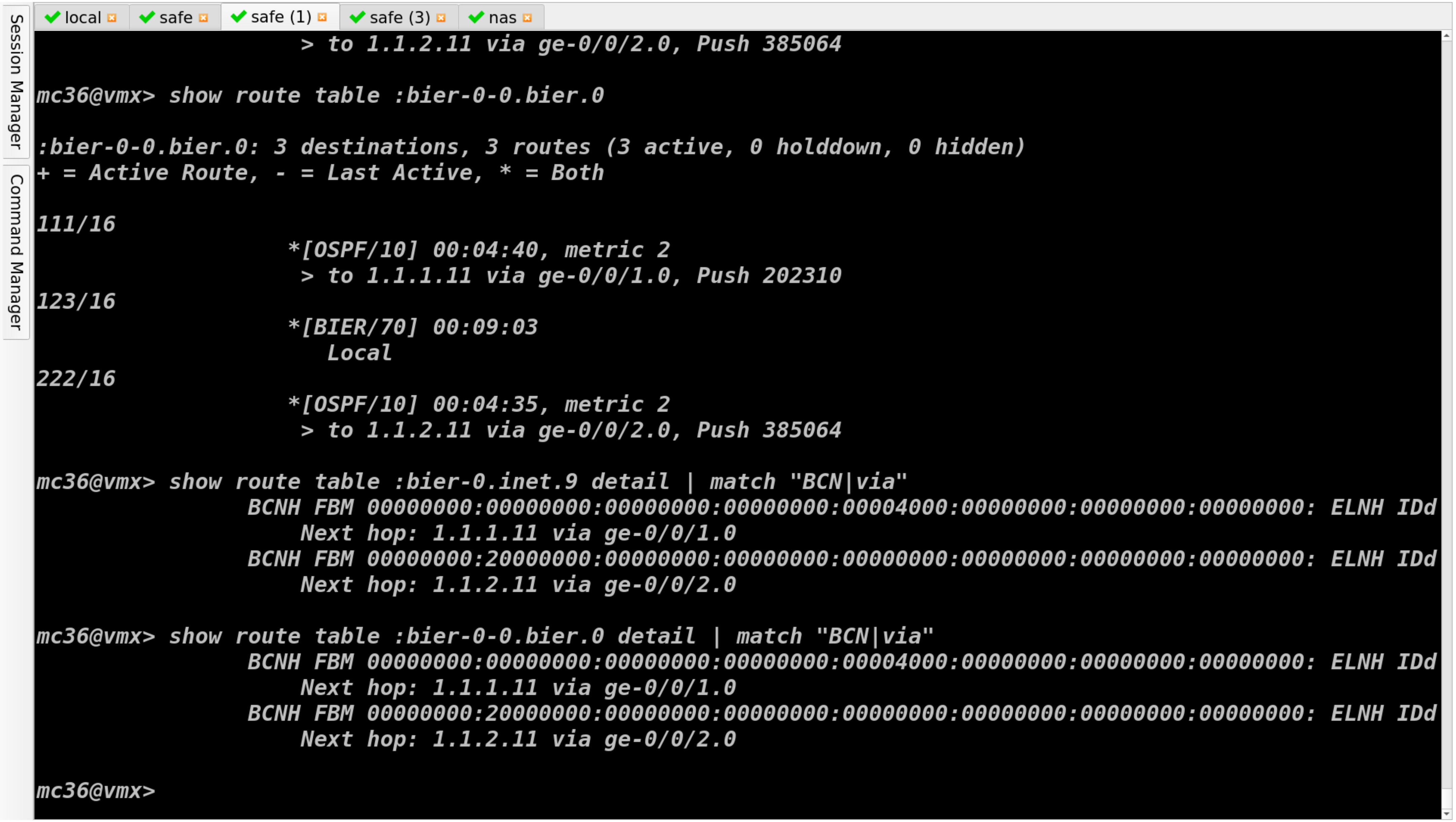
```
        1
      Prefix Length (2), length 1:
        32
      AF (3), length 1:
        0
      Flags (4),  length 1:
        0x00
      Prefix (5), length 32:
        2.2.2.111
    BIER (9), length 16:
        Sub-domain ID (1), length 1:
          0
        MT ID (2), length 1:
          0
        BFR-id (3), length 2:
          111
       MPLS (10), length 12:
         Range size (1), length 1:
          4
         Label Range Base (2), length 3:
          0x31646
         BitString Length, length 4 bits:
          3

mc36@vmx> show lldp neighbors
Local Interface    Parent Interface    Chassis Id          Port info          System Name
ge-0/0/2           -                   00:34:64:47:48:68   pwether2           sid
ge-0/0/1           -                   00:6e:4e:5e:7a:2c   pwether1           sid

mc36@vmx>
```

the vMX populated the forwarding tables correctly



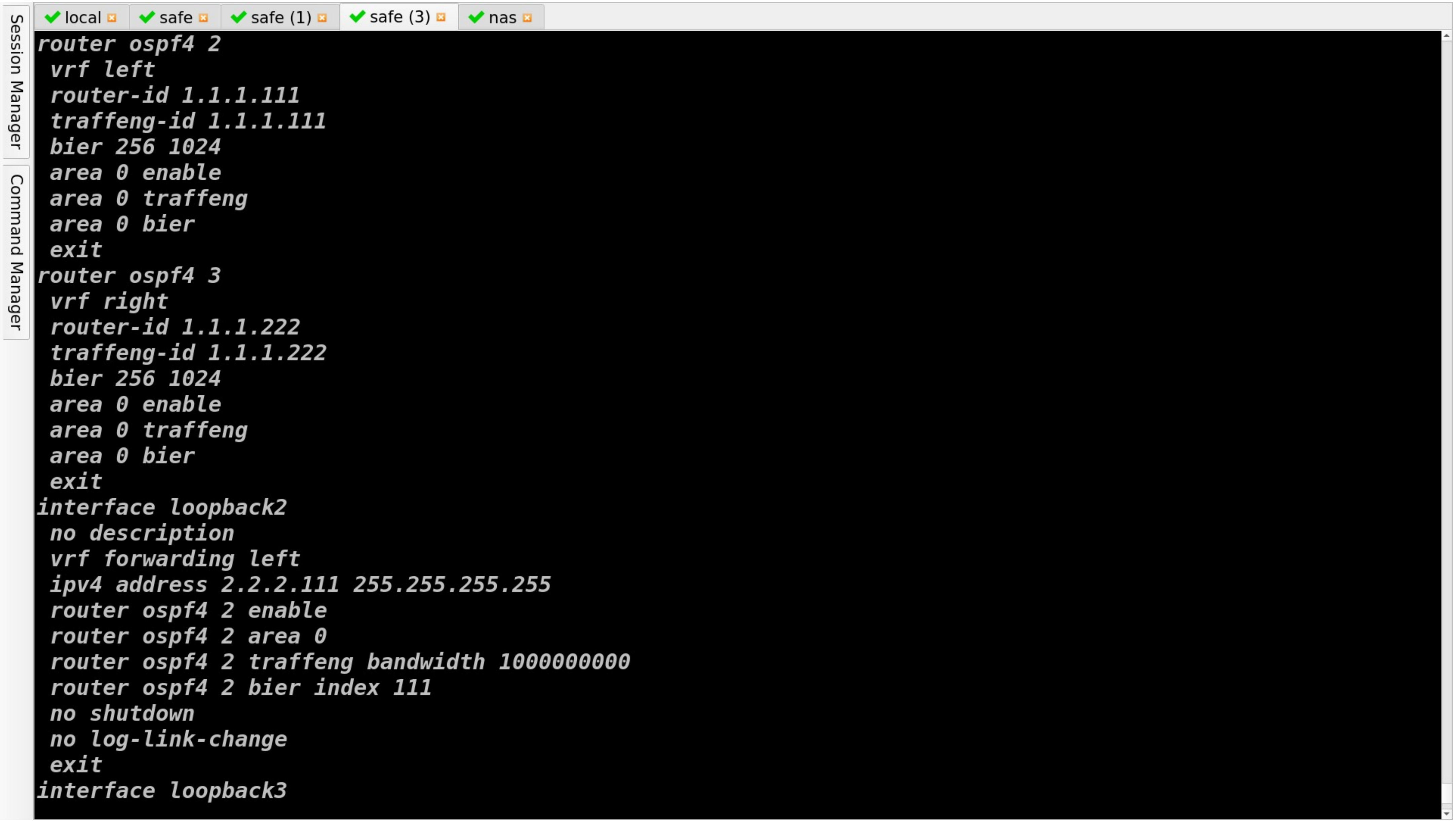
```
Local Interface    Parent Interface    Chassis Id         Port info         System Name
ge-0/0/2           -                   00:34:64:47:48:68  pwether2          sid
ge-0/0/1           -                   00:6e:4e:5e:7a:2c  pwether1          sid

mc36@vmx> show route table :bier-0.inet.9

:bier-0.inet.9: 2 destinations, 2 routes (2 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

2.2.2.111/32       *[OSPF/10] 00:02:51, metric 2
                    > to 1.1.1.11 via ge-0/0/1.0, Push 202310
2.2.2.222/32       *[OSPF/10] 00:02:46, metric 2
                    > to 1.1.2.11 via ge-0/0/2.0, Push 385064

mc36@vmx> show route table :bier-0-0.bier.0

:bier-0-0.bier.0: 3 destinations, 3 routes (3 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

111/16
                   *[OSPF/10] 00:02:57, metric 2
                    > to 1.1.1.11 via ge-0/0/1.0, Push 202310
123/16
                   *[BIER/70] 00:07:20
                      Local
222/16
                   *[OSPF/10] 00:02:52, metric 2
                    > to 1.1.2.11 via ge-0/0/2.0, Push 385064

mc36@vmx> 
```

some more forwarding info



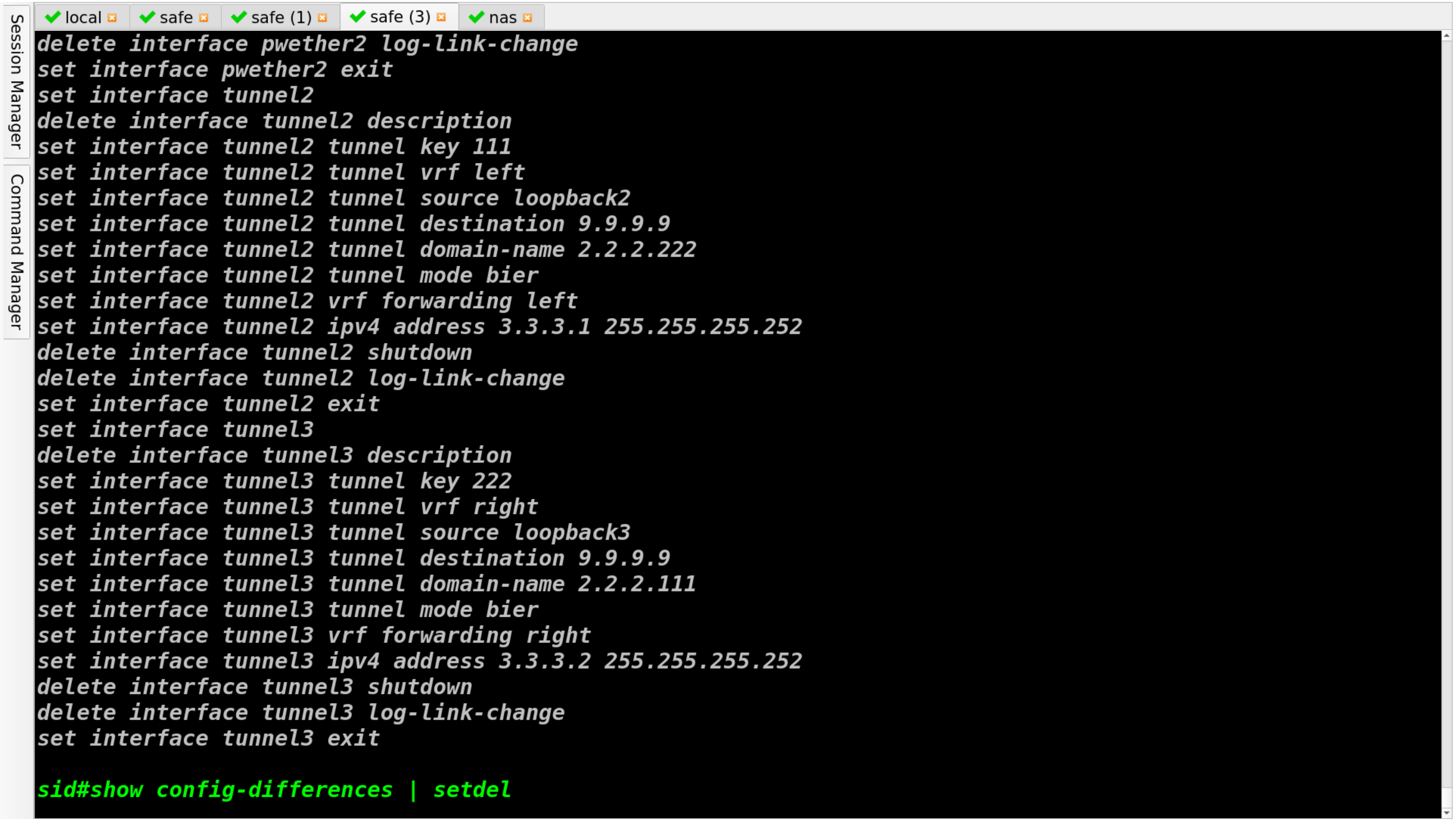
```
                    > to 1.1.2.11 via ge-0/0/2.0, Push 385064

mc36@vmx> show route table :bier-0-0.bier.0

:bier-0-0.bier.0: 3 destinations, 3 routes (3 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

111/16
                   *[OSPF/10] 00:04:40, metric 2
                    > to 1.1.1.11 via ge-0/0/1.0, Push 202310
123/16
                   *[BIER/70] 00:09:03
                      Local
222/16
                   *[OSPF/10] 00:04:35, metric 2
                    > to 1.1.2.11 via ge-0/0/2.0, Push 385064

mc36@vmx> show route table :bier-0.inet.9 detail | match "BCN|via"
                BCNH FBM 00000000:00000000:00000000:00000000:00004000:00000000:00000000:00000000: ELNH IDd
                    Next hop: 1.1.1.11 via ge-0/0/1.0
                BCNH FBM 00000000:20000000:00000000:00000000:00000000:00000000:00000000:00000000: ELNH IDd
                    Next hop: 1.1.2.11 via ge-0/0/2.0

mc36@vmx> show route table :bier-0-0.bier.0 detail | match "BCN|via"
                BCNH FBM 00000000:00000000:00000000:00000000:00004000:00000000:00000000:00000000: ELNH IDd
                    Next hop: 1.1.1.11 via ge-0/0/1.0
                BCNH FBM 00000000:20000000:00000000:00000000:00000000:00000000:00000000:00000000: ELNH IDd
                    Next hop: 1.1.2.11 via ge-0/0/2.0

mc36@vmx>
```

BFid set on the loopback on rare/freertr



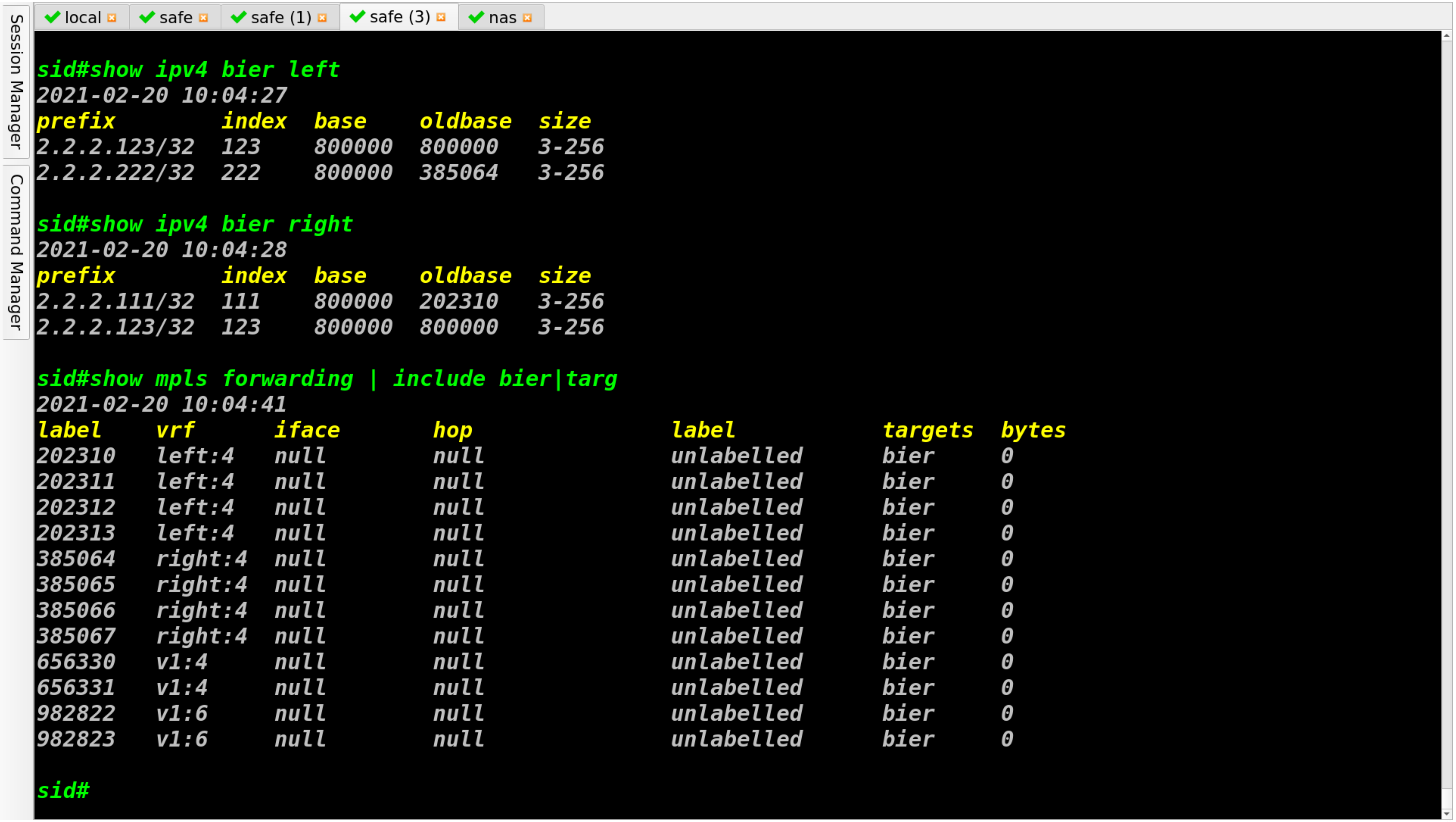
```
router ospf4 2
 vrf left
 router-id 1.1.1.111
 traffeng-id 1.1.1.111
 bier 256 1024
 area 0 enable
 area 0 traffeng
 area 0 bier
 exit
router ospf4 3
 vrf right
 router-id 1.1.1.222
 traffeng-id 1.1.1.222
 bier 256 1024
 area 0 enable
 area 0 traffeng
 area 0 bier
 exit
interface loopback2
 no description
 vrf forwarding left
 ipv4 address 2.2.2.111 255.255.255.255
 router ospf4 2 enable
 router ospf4 2 area 0
 router ospf4 2 traffeng bandwidth 1000000000
 router ospf4 2 bier index 111
 no shutdown
 no log-link-change
 exit
interface loopback3
```

the static BIER encap tunnels with the setdel filter :)



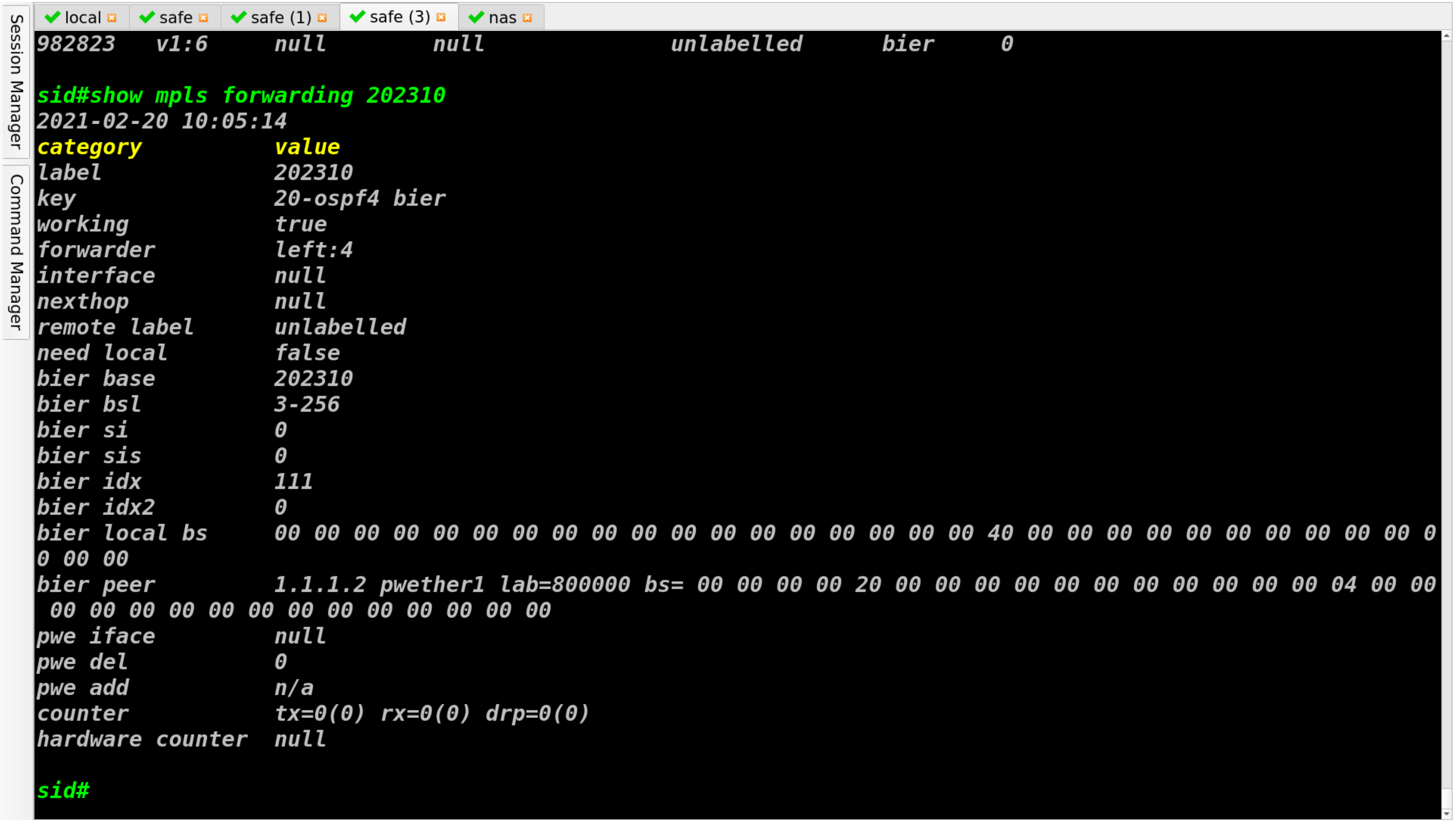
```
delete interface pwether2 log-link-change
set interface pwether2 exit
set interface tunnel2
delete interface tunnel2 description
set interface tunnel2 tunnel key 111
set interface tunnel2 tunnel vrf left
set interface tunnel2 tunnel source loopback2
set interface tunnel2 tunnel destination 9.9.9.9
set interface tunnel2 tunnel domain-name 2.2.2.222
set interface tunnel2 tunnel mode bier
set interface tunnel2 vrf forwarding left
set interface tunnel2 ipv4 address 3.3.3.1 255.255.255.252
delete interface tunnel2 shutdown
delete interface tunnel2 log-link-change
set interface tunnel2 exit
set interface tunnel3
delete interface tunnel3 description
set interface tunnel3 tunnel key 222
set interface tunnel3 tunnel vrf right
set interface tunnel3 tunnel source loopback3
set interface tunnel3 tunnel destination 9.9.9.9
set interface tunnel3 tunnel domain-name 2.2.2.111
set interface tunnel3 tunnel mode bier
set interface tunnel3 vrf forwarding right
set interface tunnel3 ipv4 address 3.3.3.2 255.255.255.252
delete interface tunnel3 shutdown
delete interface tunnel3 log-link-change
set interface tunnel3 exit

sid#show config-differences | setdel
```

BIER info from the vMX's left and right sides



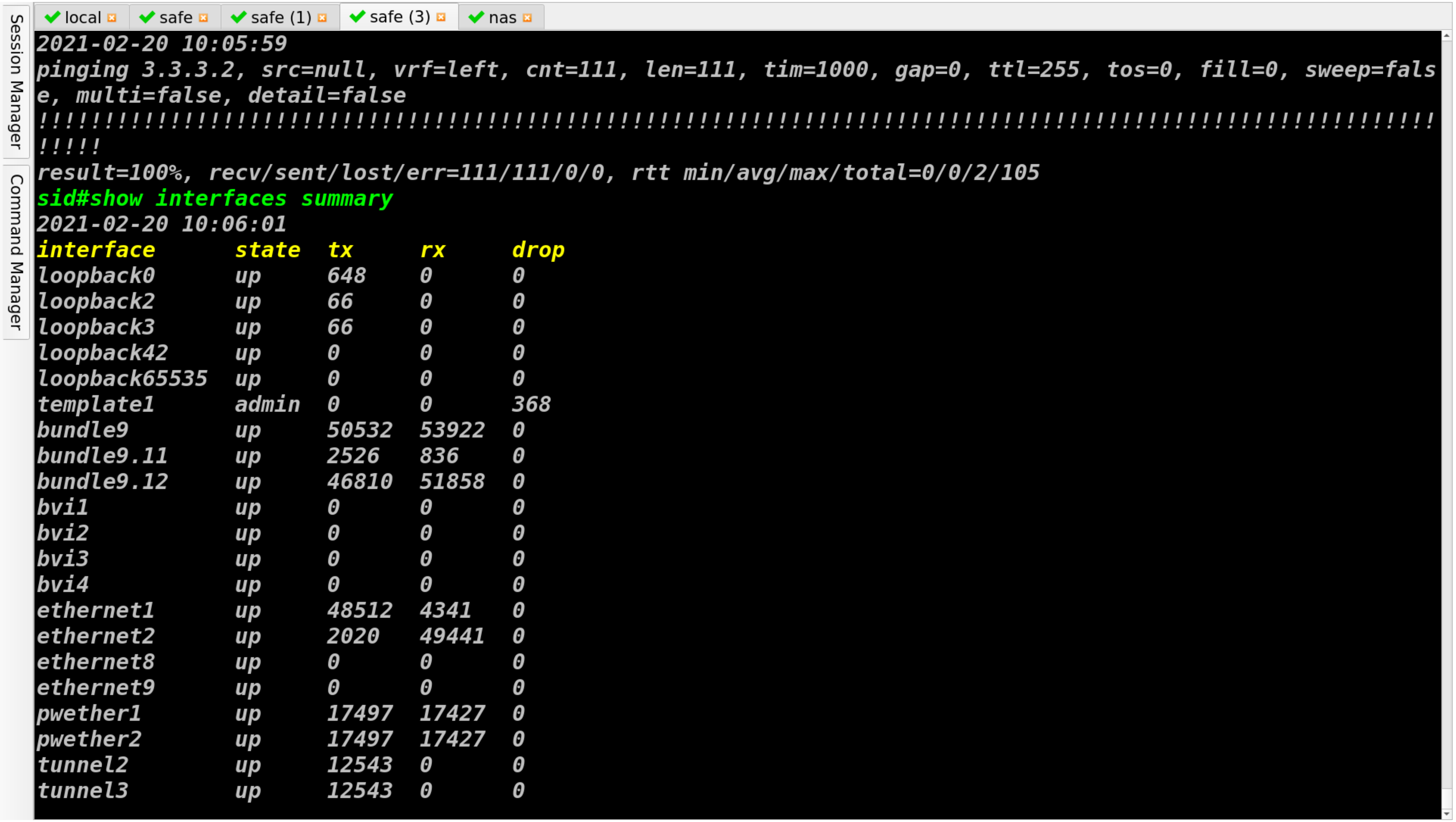
```
sid#show ipv4 bier left
2021-02-20 10:04:27
prefix        index  base    oldbase  size
2.2.2.123/32  123    800000  800000   3-256
2.2.2.222/32  222    800000  385064   3-256

sid#show ipv4 bier right
2021-02-20 10:04:28
prefix        index  base    oldbase  size
2.2.2.111/32  111    800000  202310   3-256
2.2.2.123/32  123    800000  800000   3-256

sid#show mpls forwarding | include bier|targ
2021-02-20 10:04:41
label    vrf      iface    hop                label           targets  bytes
202310   left:4   null     null               unlabelled      bier     0
202311   left:4   null     null               unlabelled      bier     0
202312   left:4   null     null               unlabelled      bier     0
202313   left:4   null     null               unlabelled      bier     0
385064   right:4  null     null               unlabelled      bier     0
385065   right:4  null     null               unlabelled      bier     0
385066   right:4  null     null               unlabelled      bier     0
385067   right:4  null     null               unlabelled      bier     0
656330   v1:4     null     null               unlabelled      bier     0
656331   v1:4     null     null               unlabelled      bier     0
982822   v1:6     null     null               unlabelled      bier     0
982823   v1:6     null     null               unlabelled      bier     0

sid#
```

rare/freertr’s forwarding info from the vMX’s left side



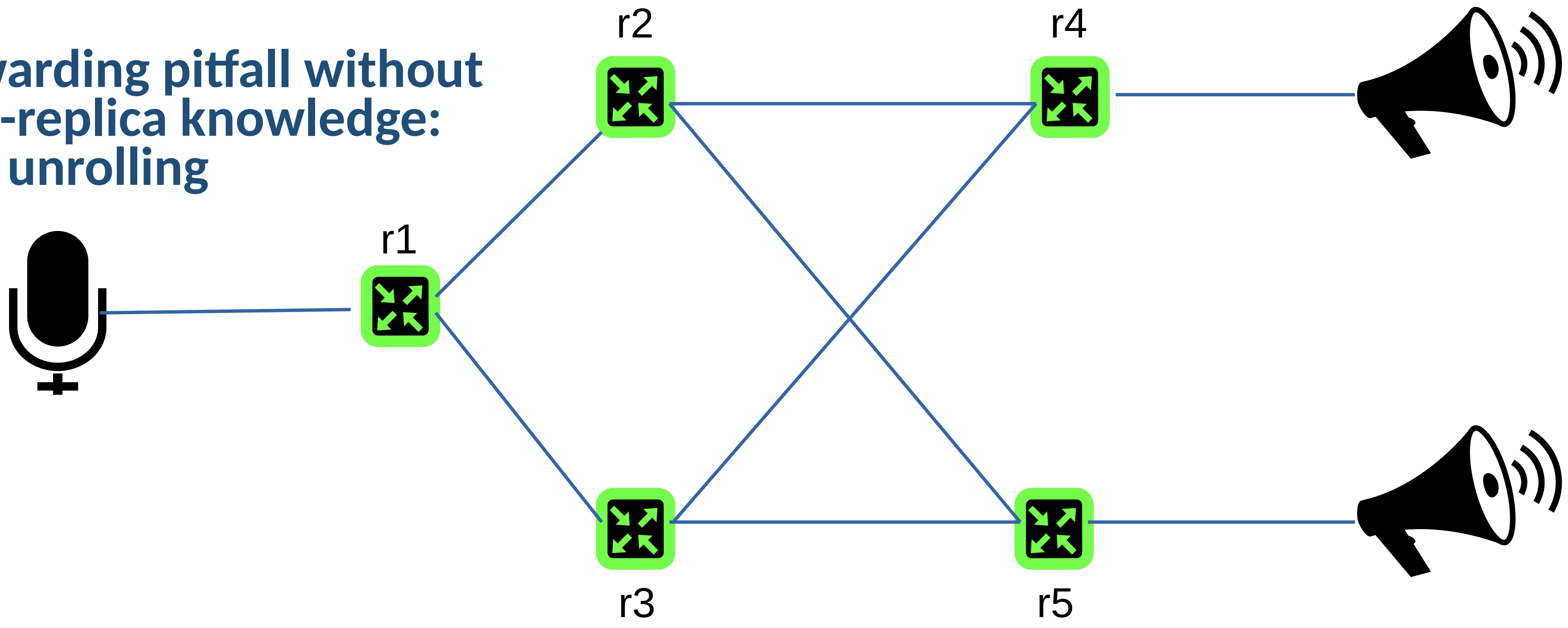
```
982823   v1:6     null        null                 unlabelled      bier     0

sid#show mpls forwarding 202310
2021-02-20 10:05:14
category          value
label             202310
key               20-ospf4 bier
working           true
forwarder         left:4
interface         null
nexthop           null
remote label      unlabelled
need local        false
bier base         202310
bier bsl          3-256
bier si           0
bier sis          0
bier idx          111
bier idx2         0
bier local bs     00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 40 00 00 00 00 00 00 00 00 00 00 0
0 00 00
bier peer         1.1.1.2 pwether1 lab=800000 bs= 00 00 00 00 20 00 00 00 00 00 00 00 00 00 00 00 04 00 00
 00 00 00 00 00 00 00 00 00 00 00 00 00
pwe iface         null
pwe del           0
pwe add           n/a
counter           tx=0(0) rx=0(0) drp=0(0)
hardware counter  null

sid#
```

first packets to the tunnel, the counters seems ok, so the vMX forwards perfectly!



```
2021-02-20 10:05:59
pinging 3.3.3.2, src=null, vrf=left, cnt=111, len=111, tim=1000, gap=0, ttl=255, tos=0, fill=0, sweep=fals
e, multi=false, detail=false
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!
result=100%, recv/sent/lost/err=111/111/0/0, rtt min/avg/max/total=0/0/2/105
sid#show interfaces summary
2021-02-20 10:06:01
interface      state  tx     rx     drop
loopback0      up     648    0      0
loopback2      up     66     0      0
loopback3      up     66     0      0
loopback42     up     0      0      0
loopback65535  up     0      0      0
template1      admin  0      0      368
bundle9        up     50532  53922  0
bundle9.11     up     2526   836    0
bundle9.12     up     46810  51858  0
bvi1           up     0      0      0
bvi2           up     0      0      0
bvi3           up     0      0      0
bvi4           up     0      0      0
ethernet1      up     48512  4341   0
ethernet2      up     2020   49441  0
ethernet8      up     0      0      0
ethernet9      up     0      0      0
pwether1       up     17497  17427  0
pwether2       up     17497  17427  0
tunnel2        up     12543  0      0
tunnel3        up     12543  0      0
```

Forwarding pitfall without inter-replica knowledge: loop unrolling



- r4 and r5 got the IGMP report from the connected VLCs
- both looked up the group’s source in mrib, both decided to send PIM in BIER to r1
- both looked up r1 loopback’s bfid from the rib and sent the PIM in BIER join
- first I tried the plain old PIM behavior: r1 sent the BIER encapped mcast on the same interface where it got the PIM in BIER join from, but r4 and r5 was able to hash to different incoming interfaces
- then I tried to do a rib lookup on r1 for r4 and r5’s loopbacks, but r1 was able to hash to different outgoing interfaces
- so for now, I use only the first path on r1 from the rib lookup and for now, duplication happens on the last possible hop
- RFC 6754 does not apply as r2 and r3 are unaware of the s,g. better idea?

Key take-away – We are ready to roll into production

- Automated testing: www.freertr.net/tests.html
- 3rd party testing via Spirent usage
  - (thanks PSNC@WB team)
- P4 profile calibration
- DPDK is in operation
- Production instance

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eman ta zabal zazu

Universidad del País Vasco Euskal Herriko Unibertsitatea

- Someone else? :)

Special thanks ...

And others ...
Who makes this possible !

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Networks • Services • People

Thank you

Any questions?

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