FreeRouter in a Nutshell: A "Protocoland" routing platform for Open and Portable Carrier-Class Testbeds

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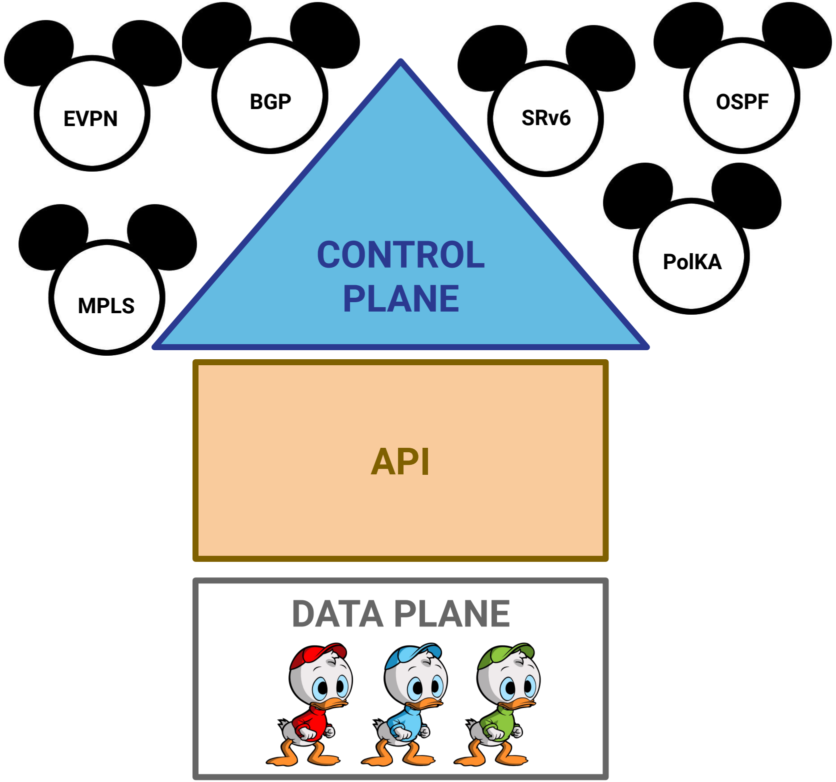
Nerds
Núcleo de Estudos em Redes
Definidas por Software

freerTr

INSTITUTO FEDERAL
Espírito Santo

UFES

PROTOCOLAND: PLAYGROUND OF PROTOCOLS



CARRIER-CLASS TESTBED: VALIDATED IMPLEMENTATIONS

POORLY TESTED LAB IMPLEMENTATIONS

VENDOR-LIKE IMPLEMENTATIONS

PORTABLE: DATA PLANE AGNOSTIC

EMULATION(NO DATA PLANE)

X86(XDP/DPDK)

ASIC(BAREFOOT/TOFINO)

AND OPEN SOURCE: FREEROUTER

"Genie, I wish for your freedom."

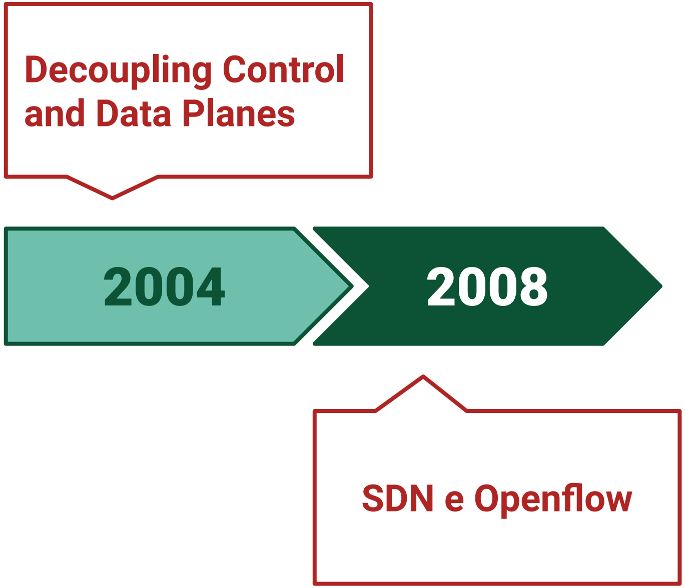
TIMELINE: PROGRAMMABLE NETWORKS…

Decoupling Control and Data Planes

2004

LIMITATIONS: But, the distributed architecture to control planes would potentially decrease the intrinsic reliability already achieved by the internet.

TIMELINE: PROGRAMMABLE NETWORKS



Decoupling Control and Data Planes

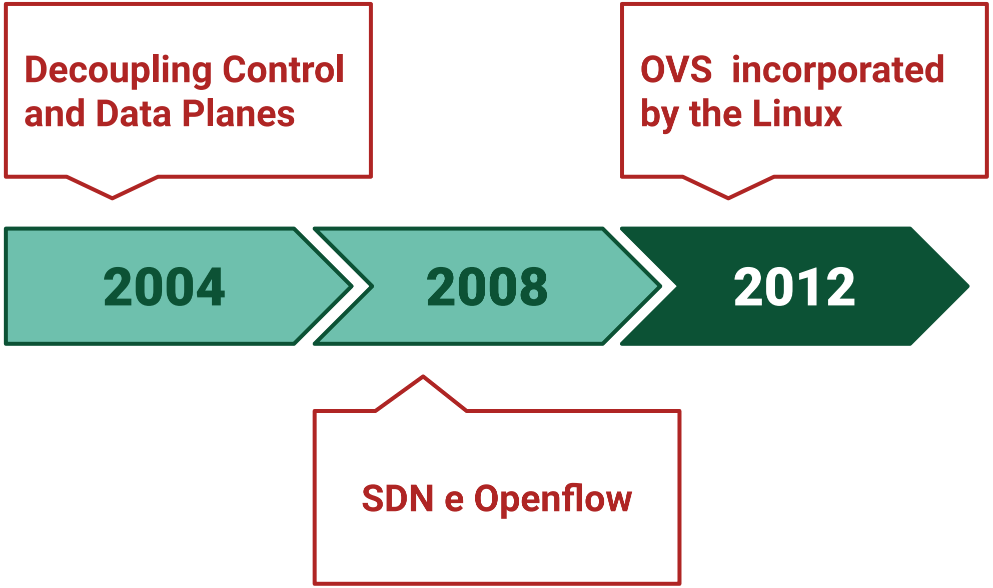
2004

2008

SDN e Openflow

LIMITATIONS: But innovations, real needs of carrier and enterprise mobile networks, lagged far behind the volumes of papers and prototype demonstrations.

TIMELINE: PROGRAMMABLE NETWORKS



2004

Decoupling Control and Data Planes

2008

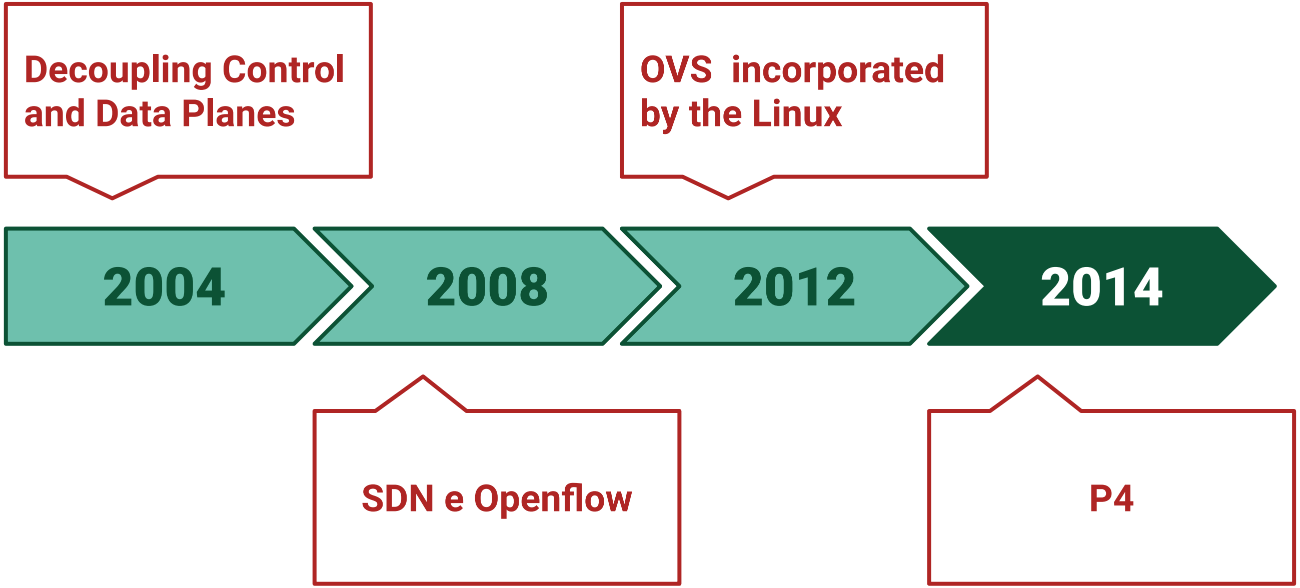
SDN e Openflow

2012

OVS incorporated by the Linux

LIMITATIONS: Their functionalities are under-explored by OpenFlow.

TIMELINE: PROGRAMMABLE NETWORKS



2004: Decoupling Control and Data Planes

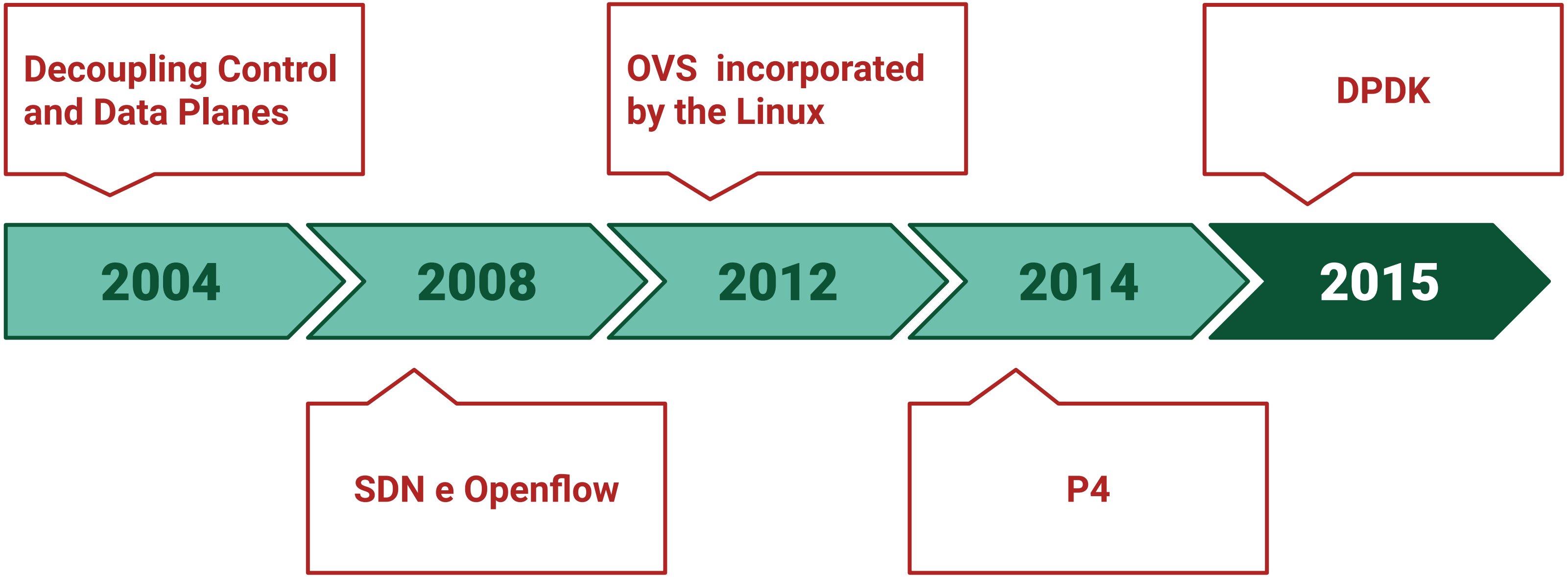
2008: SDN e Openflow

2012: OVS incorporated by the Linux

2014: P4

LIMITATIONS: Rewriting the whole set of legacy protocols of the internet?

TIMELINE: PROGRAMMABLE NETWORKS



2004

Decoupling Control and Data Planes

2008

SDN e Openflow

2012

OVS incorporated by the Linux

2014

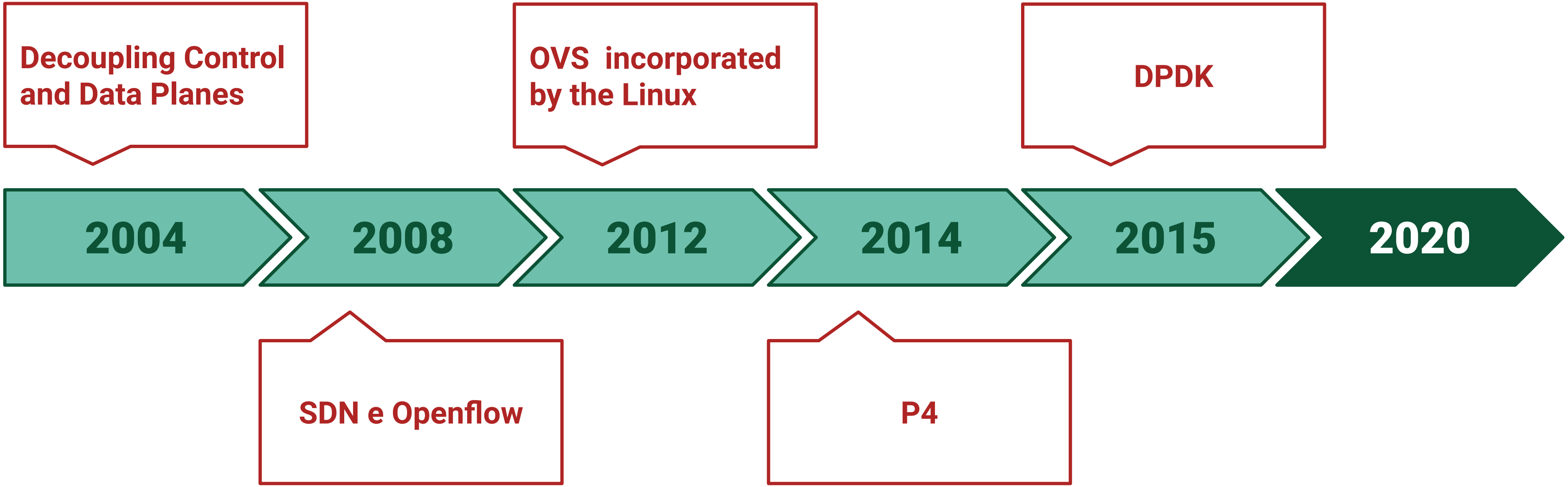
P4

2015

DPDK

LIMITATIONS: Proprietary architecture restricted hardware support.

TIMELINE: PROGRAMMABLE NETWORKS



Decoupling Control and Data Planes

2004

SDN e Openflow

2008

OVS incorporated by the Linux

2012

P4

2014

DPDK

2015

2020

LIMITATIONS: Clarification for the architecture elements/components.

TESTBED: CRUCIAL TOOL FOR EXPERIMENTATION

Open Source Routing

SONiC

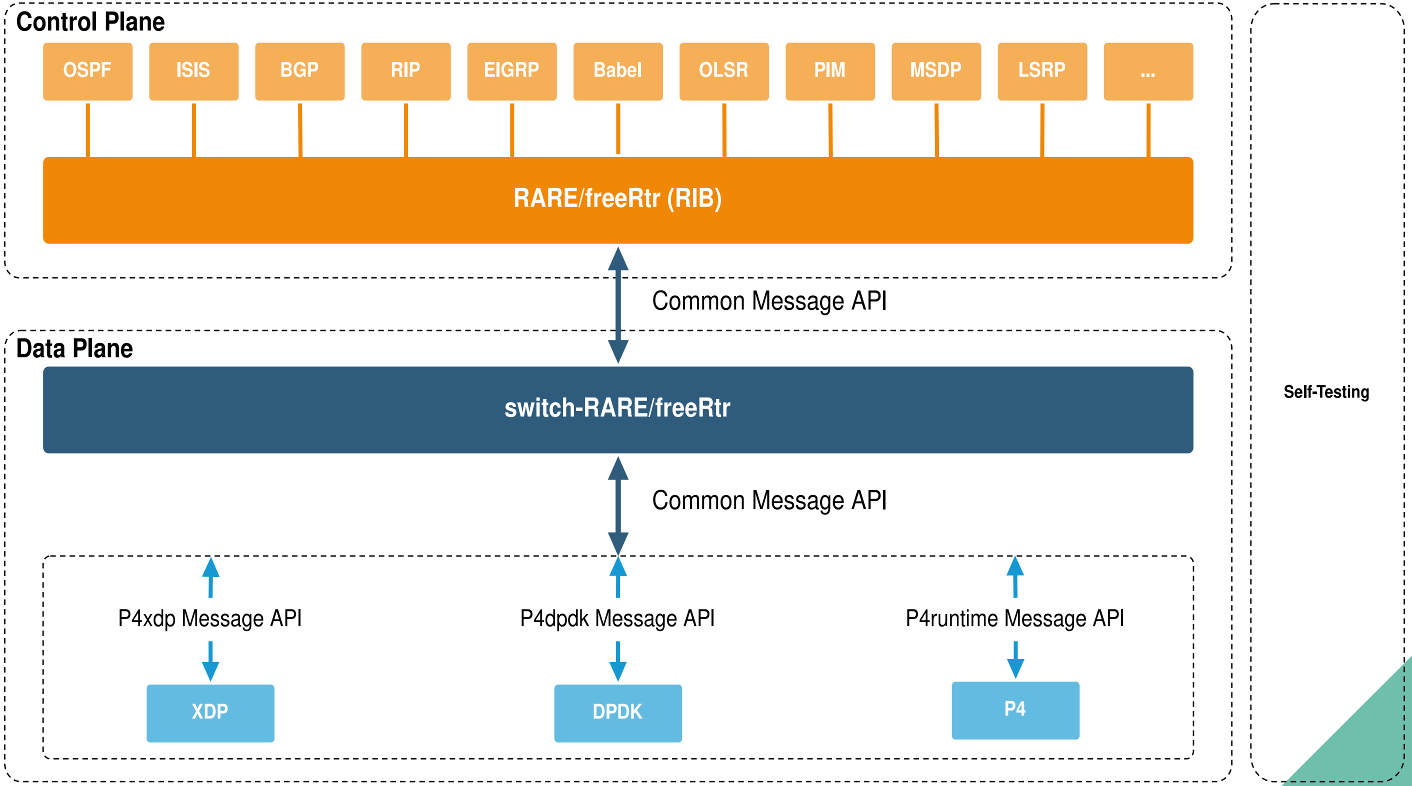
onos

Open Network Operating System

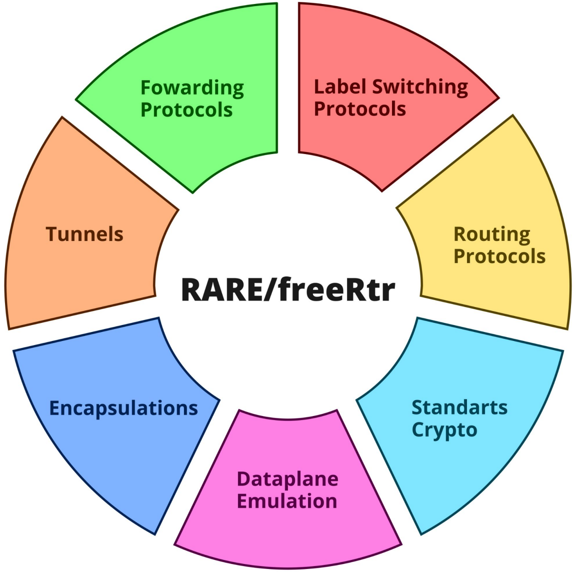
freeRtr

MININET

FREEROUTER: DECOUPLED ARCHITECTURE



FREEROUTER: “PROTOCOLAND”



Forwarding: IPv4, IPv6, IPx, MPL, NSH, Layer2, IRB, Atom, EoMPLS, VPLS, EVPN

Routing Protocols: OSPF, IS-IS, BGP, RIP, EIGRP, Babel, OLSR, PIM, MSDP

LSP Support: P2P, P2MP, MP2MP built by BGP, LDP, RSVP-TE, SR, SR-TE, BIER, PolKA

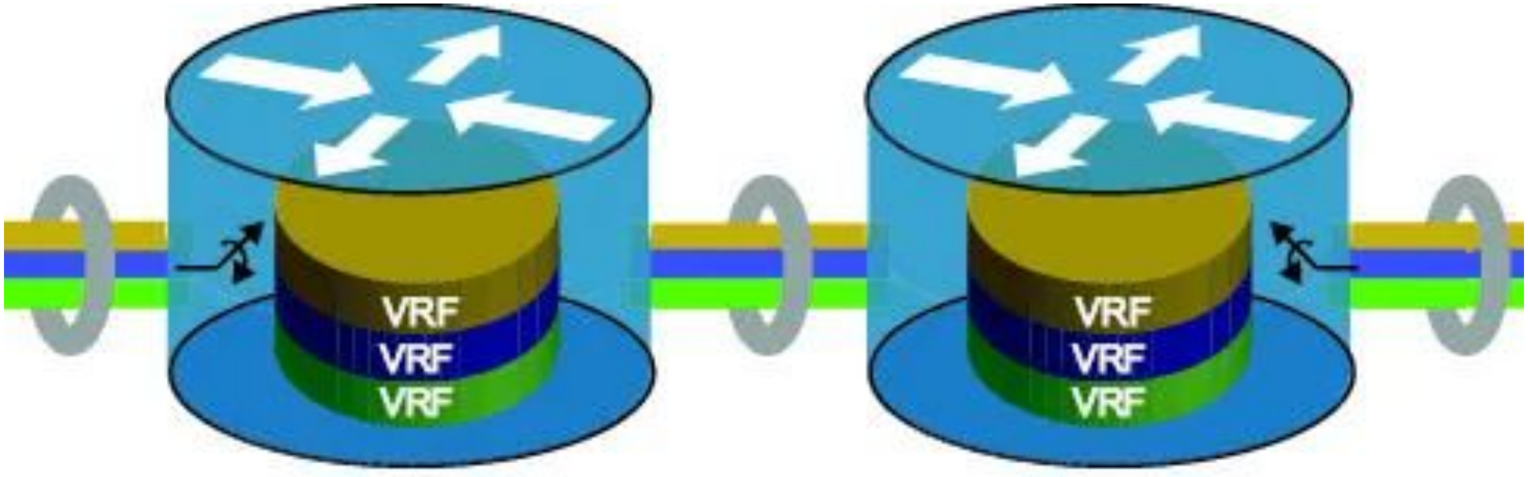
Crypto: MACsec, IPsec, IKEv1, IKEv2, TLS, DTLS, SSH, OpenVPN, Wireguard, SGT

Tunnel: GRE, GTP, IPIP, L2TP, PPTP, LISP, GENEVE, NVGRE, VXLAN, EtherIP, AMT

Encapsulation: Ethernet, VLAN, PPP, Frame Relay, PWEther, Virt-PPP, Hairpin

Misc: ACL, QoS, NAT, PBR, SRv6, VRRP, HSRP, Inspect, 6to4, RPL, tunnel, VPDN, PCEP

VRF: WHAT IS A VRF?



DEPENDENCE INSTALLATION

- **Linux**

  #sudo apt-get install default-jre-headless --no-install-recommends;

  just install jre for linux;

- **Windows**

  just install jre for windows;

- **MacOs**

  just install jre for windows Mac;

FREEROUTER INSTALLATION

- Emulated Version

```
#wget http://www.freertr.org/rtr.jar
```

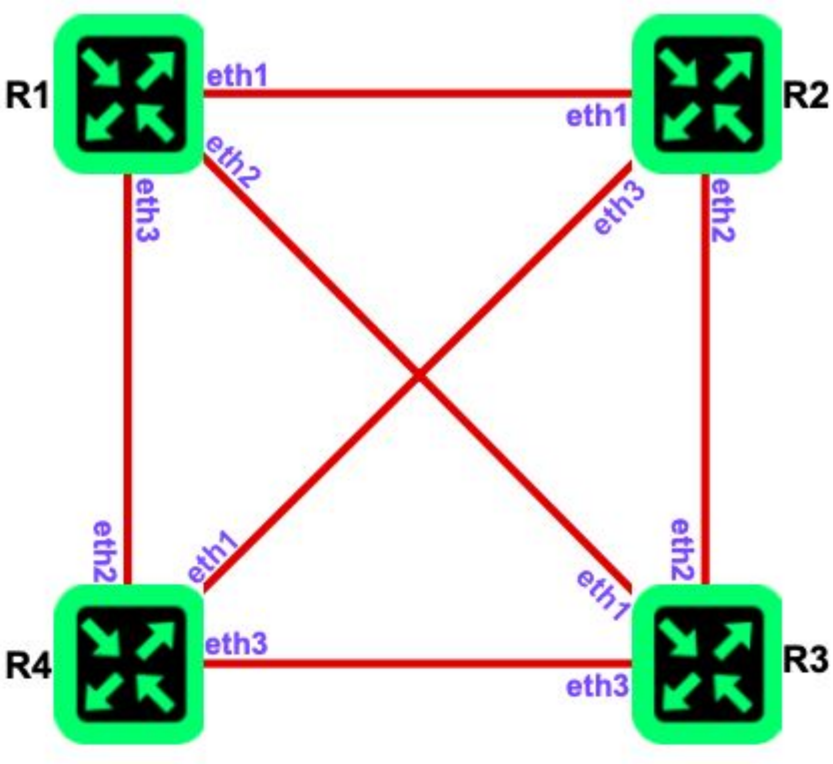
- Deploy on common devices

```
#wget freertr.org/install.sh ; sudo bash install.sh
```

- Deploy on switch tofino

EXPERIMENTATION

TOPOLOGY


R1
eth1
eth2
eth3
R2
eth1
eth3
eth2
R4
eth2
eth1
eth3
R3
eth2
eth1
eth3

HARDWARE FILE R1-HW.TXT

```
int eth1 eth 0000.1111.0001 127.0.0.1 26011 127.0.0.1 26021
int eth2 eth 0000.1111.0002 127.0.0.1 26012 127.0.0.1 26031
int eth3 eth 0000.1111.0003 127.0.0.1 26013 127.0.0.1 26042
tcp2vrf 1123 v1 23
```

SOFTWARE FILE R1-SW.TXT

```
hostname r1
!
vrf definition v1
 exit
!
router ospf4 1
 vrf v1
 router-id 10.1.1.1
 area 0 ena
 redistribute
connected
 exit
!
router ospf6 1
 vrf v1
 router-id 10.6.1.1
 area 0 ena
 redistribute
connected
 exit
!
```

```
interface template1
 no description
 lldp enable
 vrf forwarding v1
 ipv4 address dynamic
dynamic
 ipv6 address dynamic
dynamic
 router ospf4 1 enable
 router ospf6 1 enable
 shutdown
 no log-link-change
 exit
!
int lo0
 vrf for v1
 ipv4 addr 20.20.20.1 /32
 ipv6 addr 2020::1 /128
 exit
```

```
interface ethernet1
 description r1@eth1 ->
r2@eth1
 vrf forwarding v1
 ipv4 addr 1.1.1.1 /24
 ipv6 addr 1111::1 /64
 template template1
 no shutdown
 no log-link-change
 exit
!
interface ethernet2
 description r1@eth2 ->
r3@eth2
 vrf forwarding v1
 ipv4 addr 6.6.6.2 /24
 ipv6 addr 6666::2 /64
 template template1
 no shutdown
 no log-link-change
```

```
 exit
!
interface ethernet3
 description r1@eth3 ->
r3@eth1
 vrf forwarding v1
 ipv4 address 4.4.4.1 /24
 ipv6 address 4444::1 /64
 template template1
 router ospf6 1 enable
 no shutdown
 no log-link-change
 exit
!
```

LAUNCH ROUTER R1 & ACCESS R1

R1 launch r1-hw.txt and r1-sw.txt with a console prompt

```
#java -jar <path>/rtr.jar routersc <path>/r1-hw.txt <path>/r1-sw.txt
```

R1 telnet access from port 1123

```
#telnet localhost 1123
```

IMPORTANT TROUBLESHOOTING COMMANDS

```
router#sh run
router#sh ipv4 route v1
router#sh ipv6 route v1
router#sh int
router#ping
router#traceroute
router#ping 1.1.1.2 /vrf v1
```

CONCLUSION

- **Portable carrier-class testbed;**
- FreeRouter’s control and data plane unique separation strategy;
- FreeRouter to the research and education community;

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- Portable carrier-class testbed;
- **FreeRouter’s control and data plane unique separation strategy;**
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CONCLUSION

- Portable carrier-class testbed;
- FreeRouter’s control and data plane unique separation strategy;
- **FreeRouter to the research and education community;**

CONCLUSION

- FreeRouter has much to improve:
  - Networking programming/configuration by examples,
  - Strategies to make FreeRouter easy,
  - Formalization of protocol test for homologation processes,
  - Comparison to other solutions,
  - Data plane performance evaluation;

REFERENCES

http://www.freertr.org/

https://github.com/eversonscherrer/freertr

https://www.youtube.com/watch?v=yG6_HIRMXxE

https://www.youtube.com/channel/UCwCDxNqRMDUq9sGGL6BqMmQ