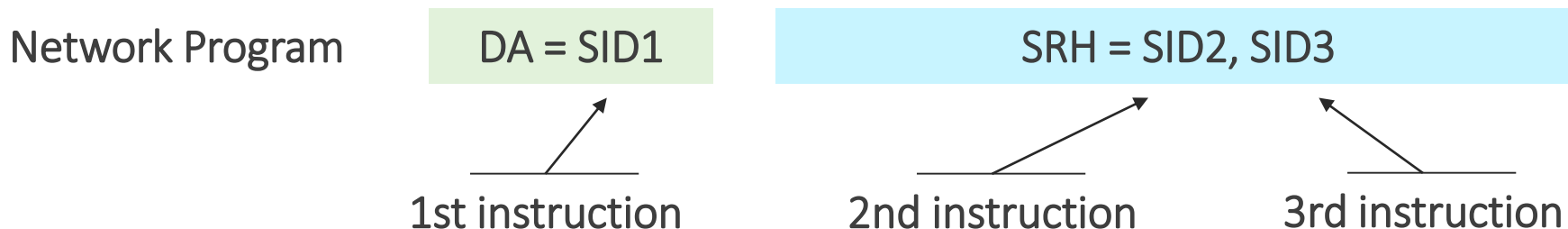# Micro-Program

A new set of (micro)-instructions

- Full leverage of SRH encapsulation
  - Zero extension

- Full leverage of SRv6 control-plane
  - Zero extension

Network Program

Network Program	DA = SID1	SRH = SID2, SID3

1st instruction   2nd instruction   3rd instruction

- A network program is a list of instructions (128-bit SRv6 SID)

- An instruction can be bound to any behavior
  - TE/FRR: END, END.X
  - VPN: END.DX, END.DT

Any instruction could hold a micro-program

Network Program

DA = SID1

SRH = SID2, SID3

1st instruction
carries a micro-program

2nd instruction
carries a micro-program

3rd instruction

Any instruction could hold a micro-program

Network Program
DA = SID1
SRH = SID2, SID3

1st instruction

2nd instruction carries a micro-program

3rd instruction carries a micro-program

Micro-Program in an SRv6 SID

SRv6 SID = 128 bits = 8 groups of 4 nibbles

Assuming an allocation block in /32 (B:B::/32)
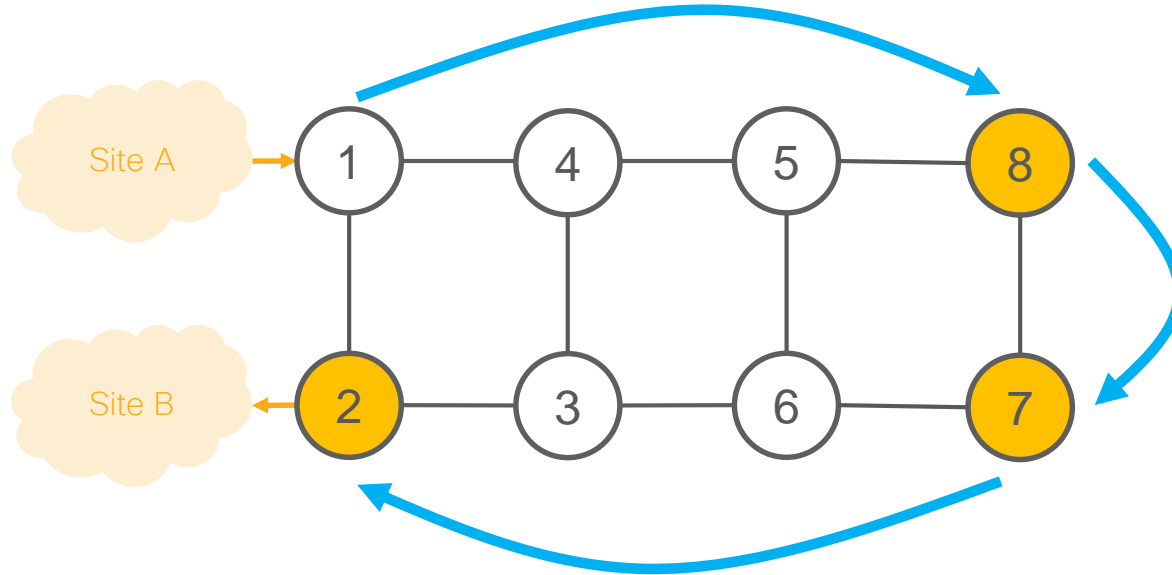
Assuming a micro-instruction ID in 4 nibbles

B:B:uID1:uID2:uID3:uID4:uID5:uID6

6 micro instructions per SRv6 Instruction

Illustration: go to 8 then 7 then 2 and decaps

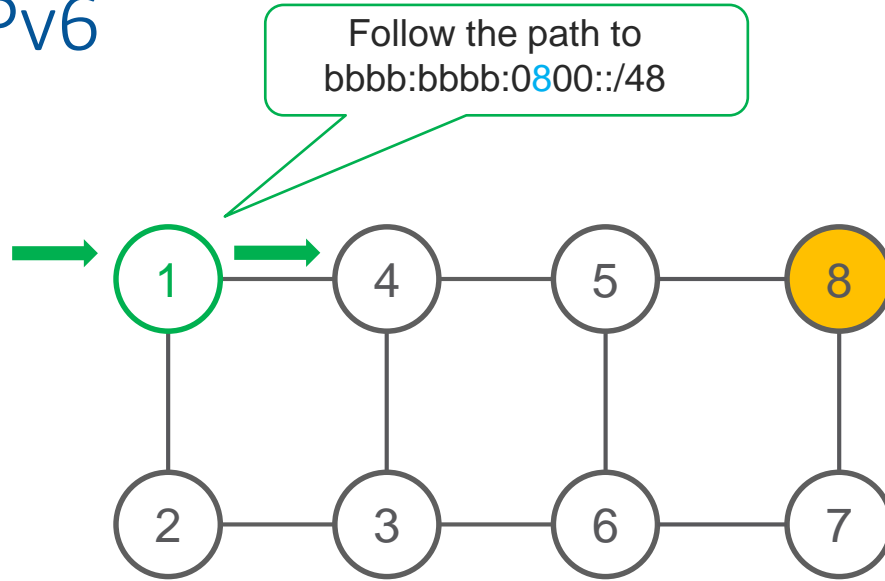One single micro-program in the DA is enough

DA = bbbb:bbbb:0800:0700:0200:0000:0000:0000

Basic IP Routing: no new extension
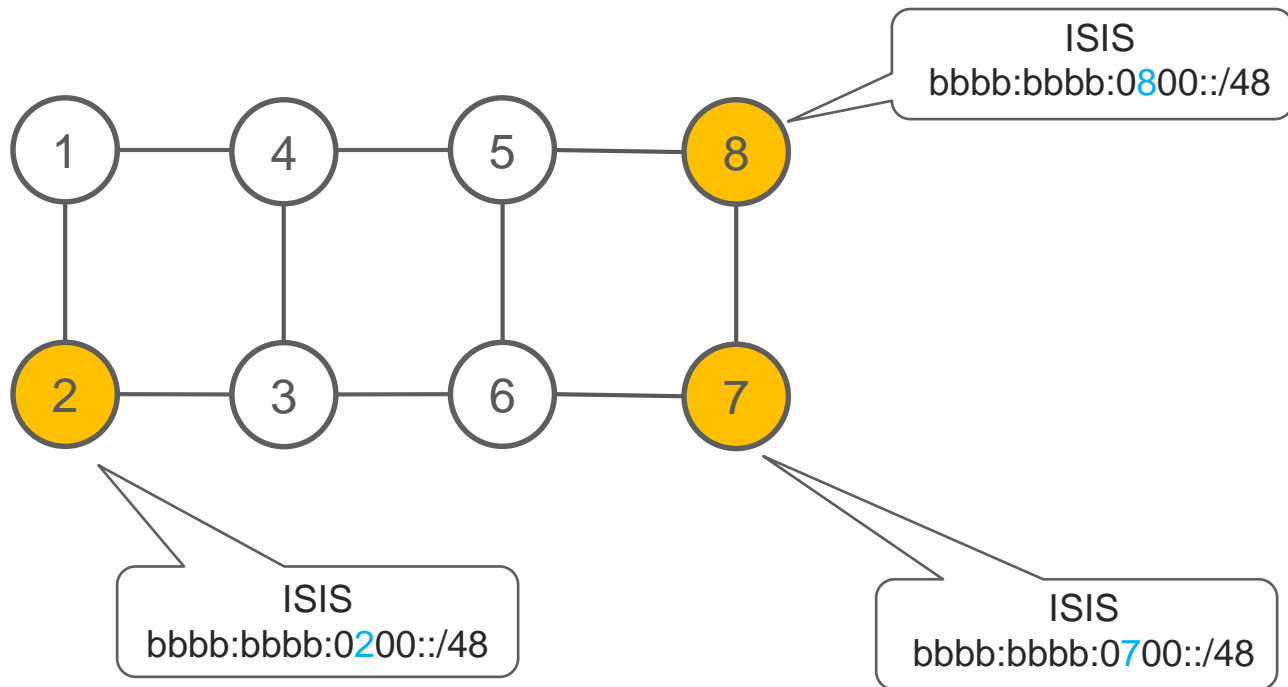
@1: basic IPv6

DA = bbbb:bbbb:0800:0700:0200:0000:0000:0000

@4: basic IPv6

Follow the path to
bbbb:bbbb:0800::/48
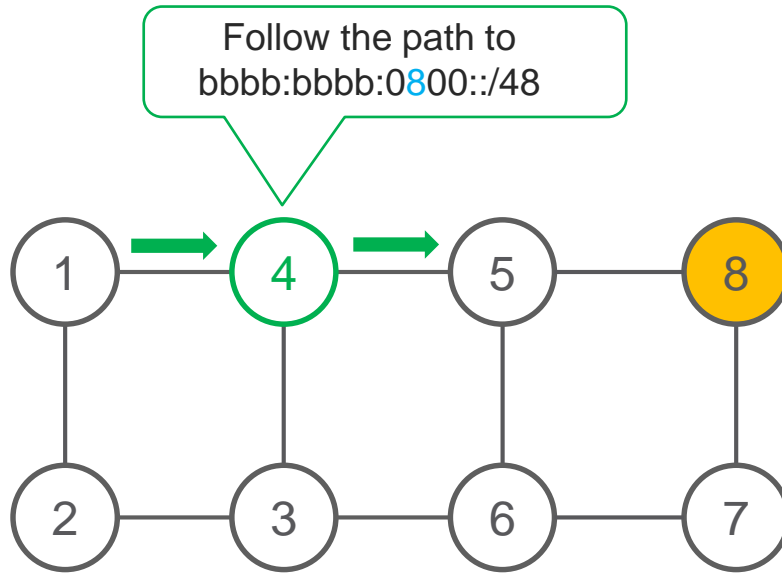
DA = bbbb:bbbb:0800:0700:0200:0000:0000:0000

@5: basic IPv6

Follow the path to
bbbb:bbbb:0800::/48
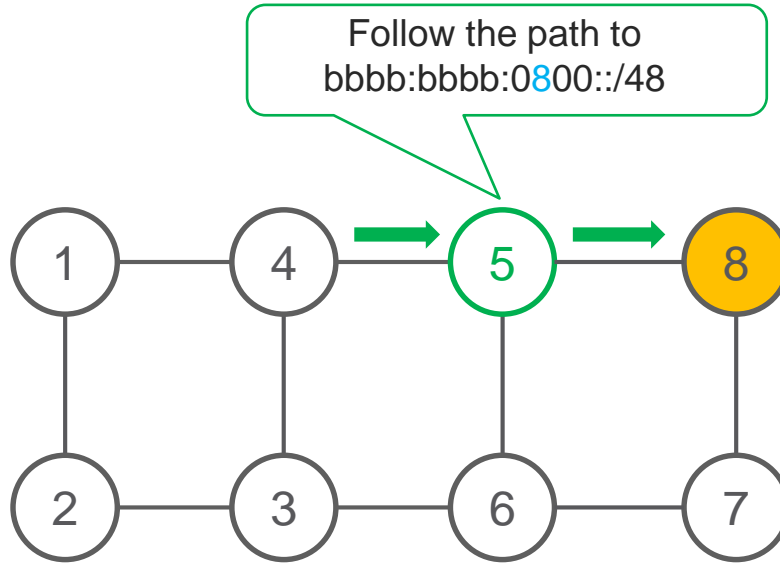
DA = bbbb:bbbb:0800:0700:0200:0000:0000:0000

@8: Shift and Forward
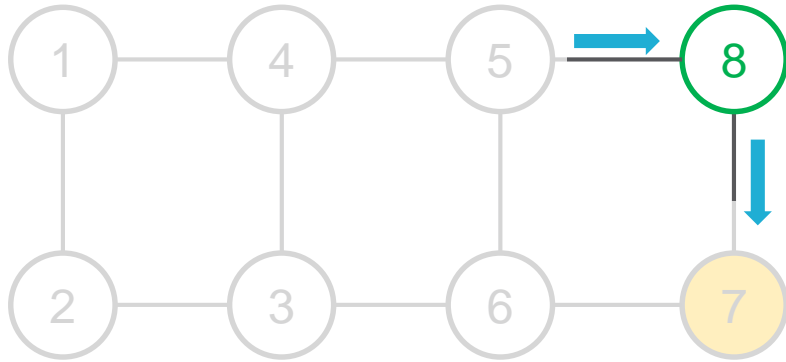
Rx'd DA: bbbb:bbbb:0800:0700:0200:0000:0000:0000

SHIFT << 16

Tx'd DA: bbbb:bbbb:0700:

bbbb:bbbb:0700::/48

```
FIB Longest-Match bbbb:bbbb:0800::/48 → SRv6 Instruction:

    Shift micro-Program by one micro-Instruction

    Set last micro-instruction to "end of micro-program"

    Lookup the updated DA and forward
```

@7: Shift and Forward

1 — 4 — 5 — 8

2 — 3 — 6 — 7

bbbb:bbbb:0200::/48

Rx'd DA: bbbb:bbbb:0700:0200:0000:0000:0000:0000
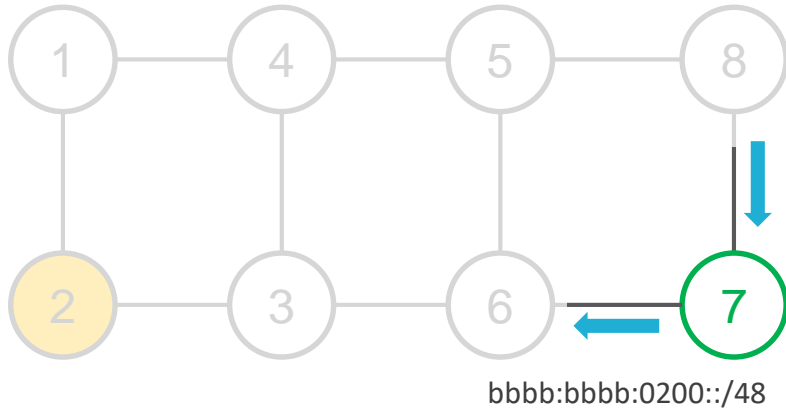
SHIFT << 16

Tx'd DA: bbbb:bbbb:0200:

FIB Longest-Match bbbb:bbbb:0700::/48 → SRv6 Instruction:

Shift micro-Program by one micro-Instruction

Set last micro-instruction to "end of micro-program"

Lookup the updated DA and forward

@6: basic IPv6

Follow the path to bbbb:bbbb:0200::/48
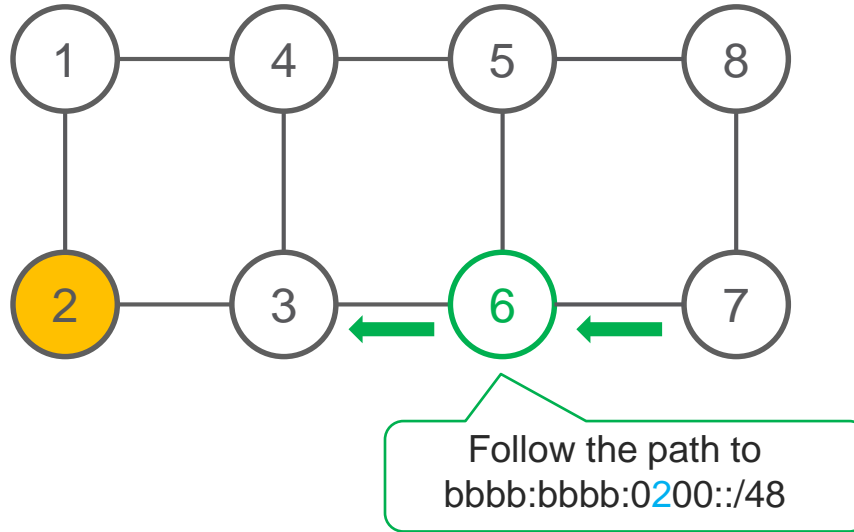
DA = bbbb:bbbb:0200:0000:0000:0000:0000:0000

@3: basic IPv6

Follow the path to
bbbb:bbbb:0200::/48
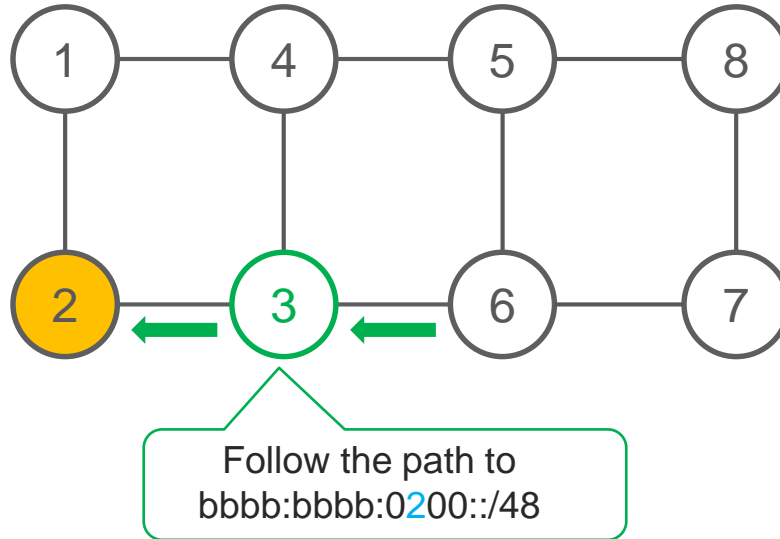
DA = bbbb:bbbb:0200:0000:0000:0000:0000:0000

@2: SRv6 End.DX4 behavior

Rx'd DA: bbbb:bbbb:0200:0000:0000:0000:0000:0000
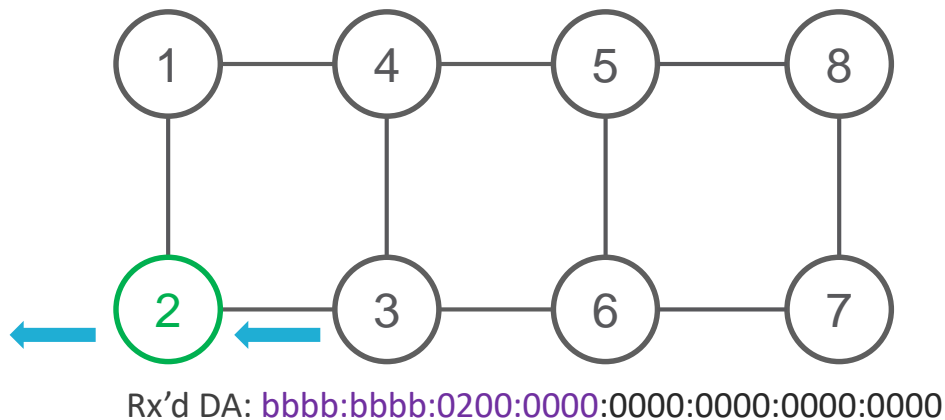
FIB Longest-Match bbbb:bbbb:0200:0000::/64 → SRv6 Instruction:

Decapsulate and cross-connect inner IPv4 packet to Site B

Benefits

- Ultra-scalable for 5G deployment
  - 18 FRR, TE, NFV and VPN micro-instructions in only 40 byte SRH overhead

- Mathematically the best SRv6 compression solution

- Linerate for multi-Tbps hardware
  - Shift is a basic hardware logic

- Friendly to merchant silicon
  - Proven by endorsement and interop

- Friendly to legacy equipment

No Cost

- Full leverage (zero change) to SRv6

  - Net PGM model

  - SRH encapsulation

  - Control Plane

- Seamless Deployment on IPv6 host

Alibaba

- Dennis Cai reports successful milestone in January 2020
  - SRv6 micro-program linerate hardware verification in Cisco lab
  - Cisco 8000 series (silicon one), NCS-5500, ASR9k

- Use-case
  - Applications are already IPv6 enabled
  - Network is already IPv6-enabled
  - Seamless end-to-end SDN control from Apps through DC, Metro, Backbone

Bell Canada

- Dan Voyer reports successful milestone in January 2020
  - SRv6 micro-program linerate hardware verification
  - Cisco 8000 series (silicon one), NCS-5500, ASR9k, CRS-X

- Use-case: 5G with
  - Ultra Scale
  - Protocol simplification and IPv6 convergence
  - Integrated TE, FRR, Slicing, VPN and NFV for end-to-end value-added service
  - Optimum Load-Balancing
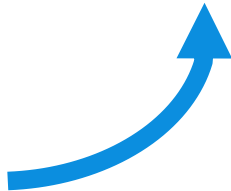 - Legacy reuse, CRS-X

Network Topology

Linux • Tofino • Jericho2 • Falcon • VPP

IPv6 Network

NCS5500 • 8000 • ASR9000 • XRv9k

Many thanks to Jakub Horn for staging the test and to all eco-system partners
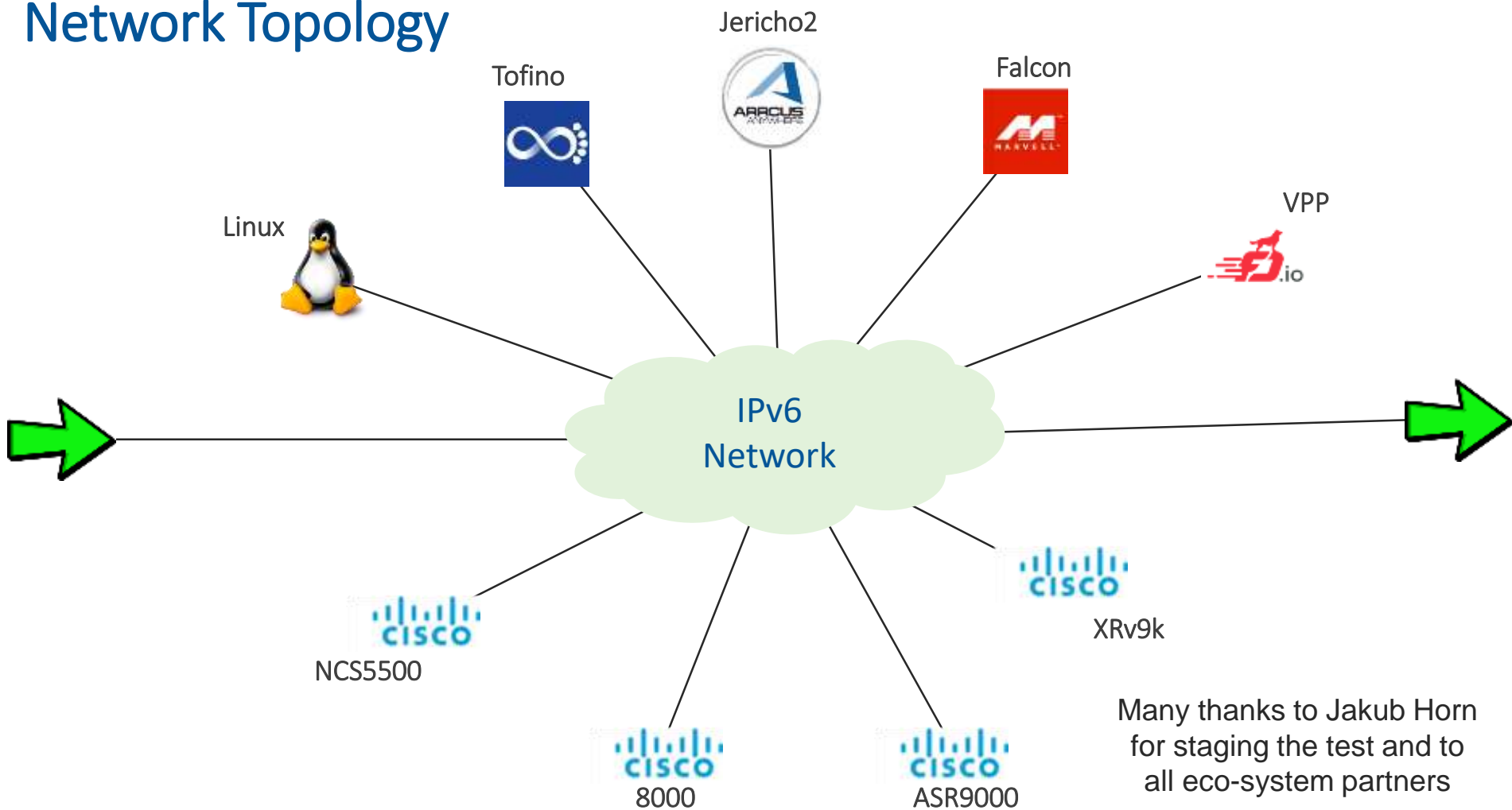
Conclusion

Simplicity Always Prevails

~~LDP~~

~~RSVP-TE~~

~~Inter-AS Option A/B/C~~

~~MPLS~~

~~UDP/VxLAN~~

~~NSH~~

Furthermore with more scale and functionality

At record speed

- In 2019: 8 large-scale commercial deployments
  - Softbank, Iliad, China Telecom, LINE corporation,
    China Unicom, CERNET2, China Bank and Uganda MTN.

- 18 HW linerate implementations
  - Cisco Systems, Huawei
  - Broadcom, Barefoot, Intel, Marvell, Mellanox
  - Multiple Interop Reports

- 11 open-source platforms/ Applications
  - Linux, FD.io VPP, P4, Wireshark, tcpdump, iptables, nftables, snort, ExaBGP, Contiv-VPP

Stay up-to-date
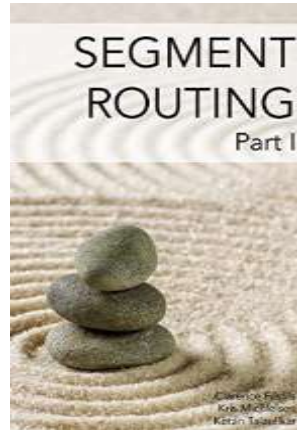
amzn.com/B01I58LSUO

amazon.com/dp/B07N13RDM9

twitter.com/SegmentRouting

segment-routing.net

facebook.com/SegmentRouting/

linkedin.com/groups/8266623

Thank you!