CO/DC
Network Transformation

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What is Bell Canada ?

Our Origins

- Oldest in World (1880)
  - We really did invent the phone
- Largest in Canada
- Public
- Multiple ventures
  - Wireline, Wireless, Media, Enterprise, etc.
  - Satellites, Sports teams,

Network 3.0

- SP Transformation
  - Culture
  - Processes
  - Technology
- New mode of operations (cloud)
- New competition (OTT)
- New services (NFV)
- Agility

Network 3.0 is a journey to…

Transform how Bell delivers the best customer experience with seamless access to a software-driven, cloud-based ecosystem

https://en.wikipedia.org/wiki/Bell_Canada

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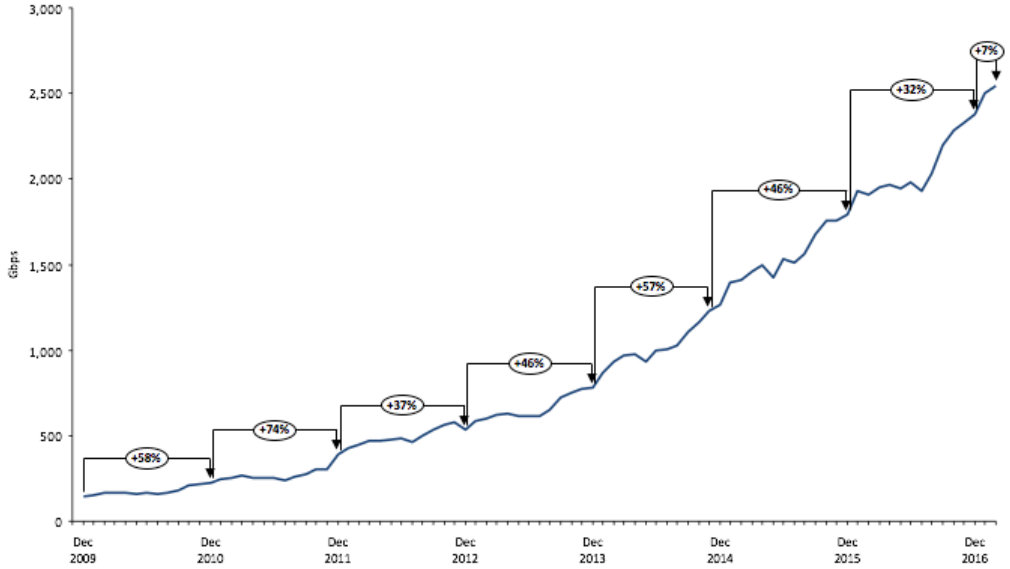
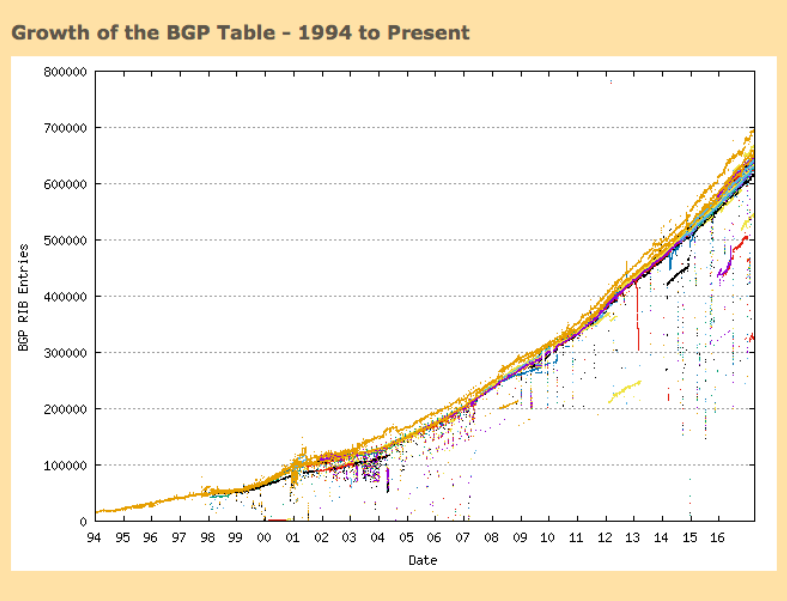
Challenges - Internet traffic is growing

- Internet grow exponentially
- Physical Networks are static and requires long cycle migration changes





Source https://bgp.potaroo.net

- Hit TCAM limits
  - August 2014 widespread outages
- Cost more money $$$

Growing faster than we can adapt – and pay for …

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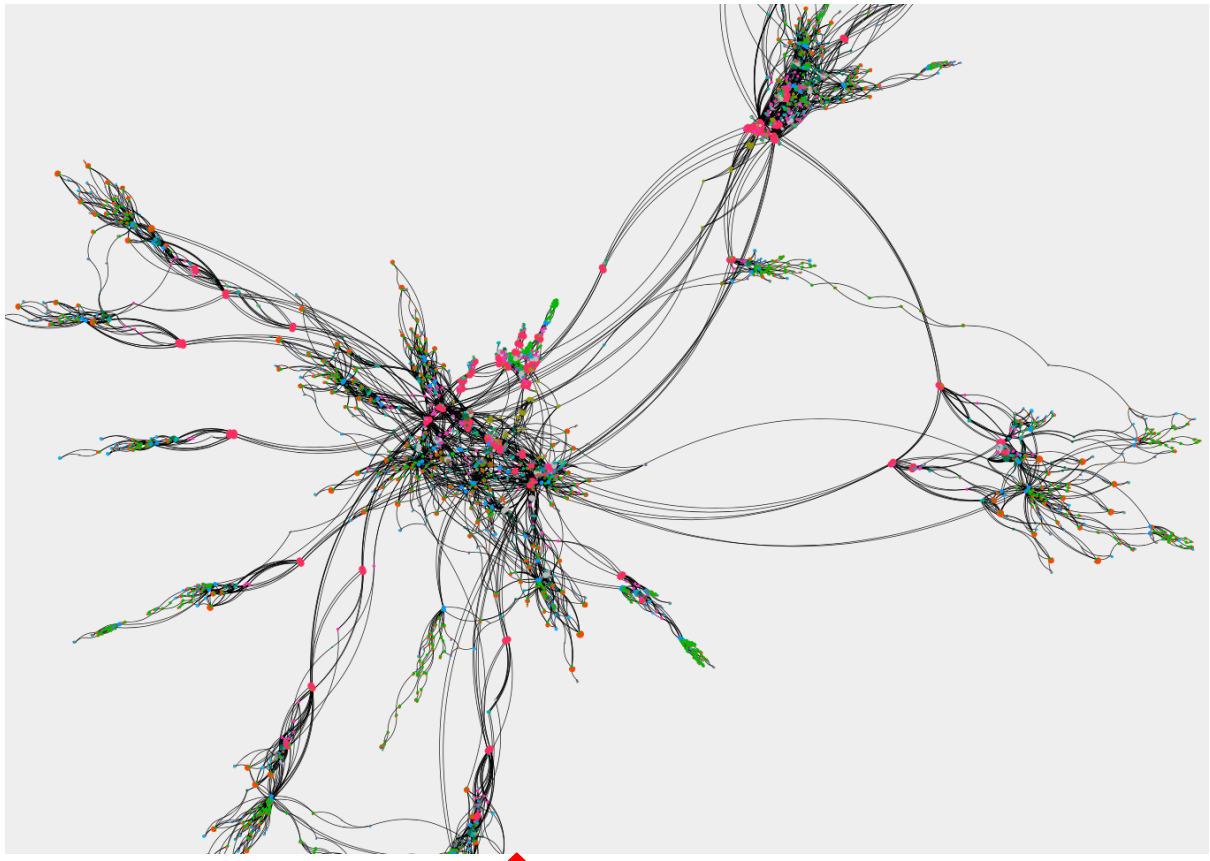
Challenges – Bell's Own Complexity

- Many independent MPLS domains today
  - Long provisioning cycles
    - Can take up to 3-4 weeks with tools (or longer) to engineer
  - No E2E Traffic Engineering
    - Complex with state in the network
    - Static and hardcoded, it's always on
  - No E2E OAM
    - Not always aware that tunnels are failing
    - Poor visibility of the state of the tunnels
    - hop by hop troubleshooting



Without simple and efficient traffic engineering, how do you manage this

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A Need for a New Architecture

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Next Generation Requirements

- Needs to be an industry standard ratified by global standards organizations
- Reusable in the core/WAN, possibly as the glue to bring all the networks together
- Software-programmable
- Leverage new CO/DC greenfield opportunity to try something new
- Provides solutions for both transition and end state
- Interoperability with the brownfield and greenfield
- Implicit ECMP handling

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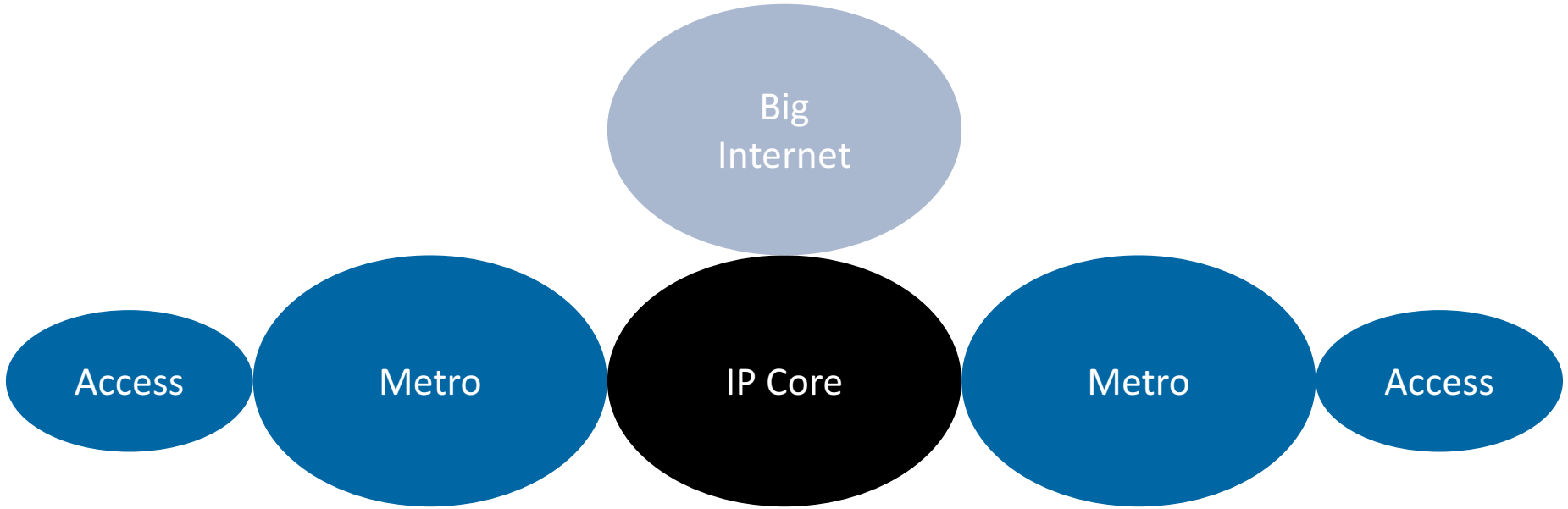
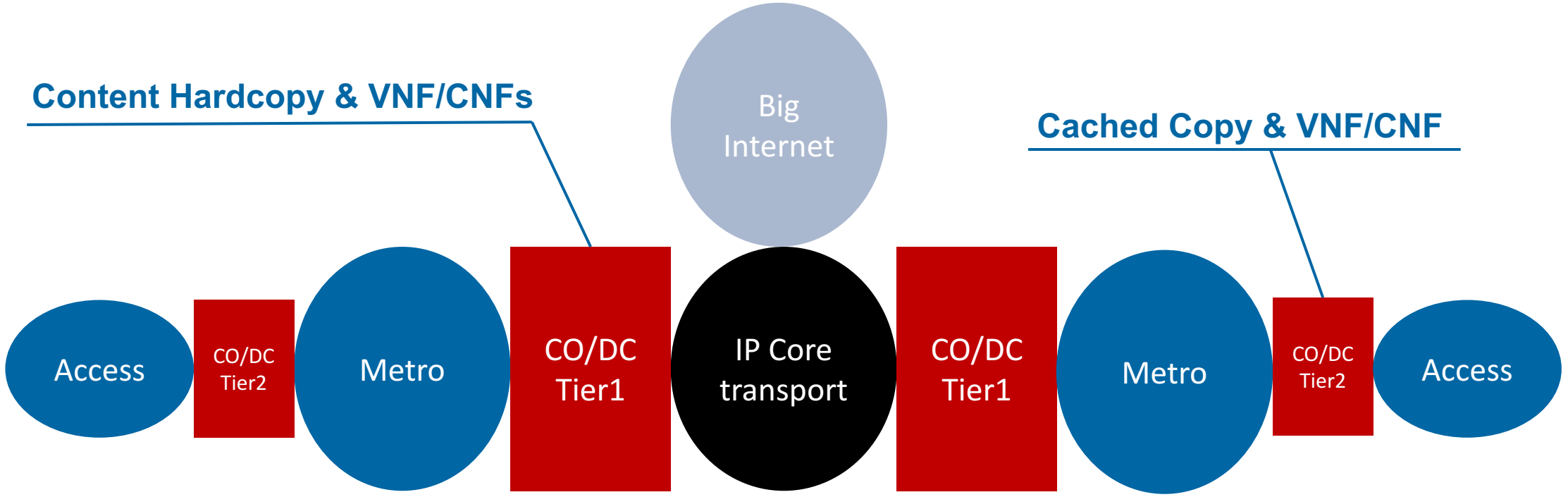
Before - Traditional View



After – Network Transformation



Architecture Central Offices Re-Design for network operators virtualization use cases

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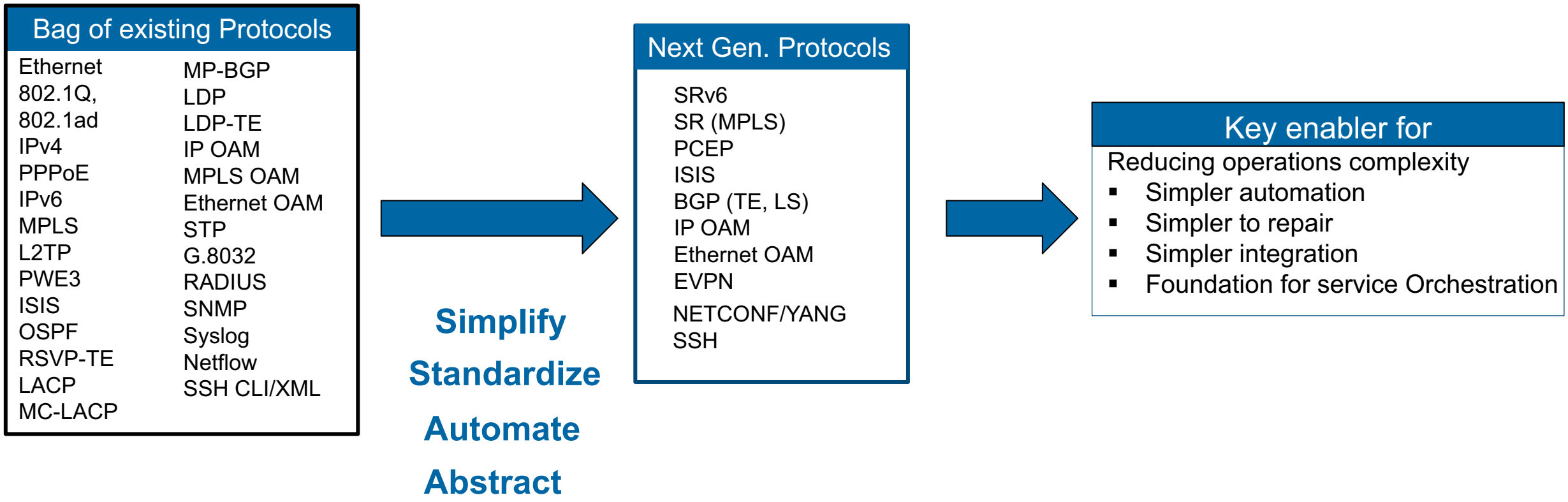
Architecture Change - Drastic Network Protocols Reduction @ Bell



Guiding principle required to accelerate execution and ensure evolution towards Agility

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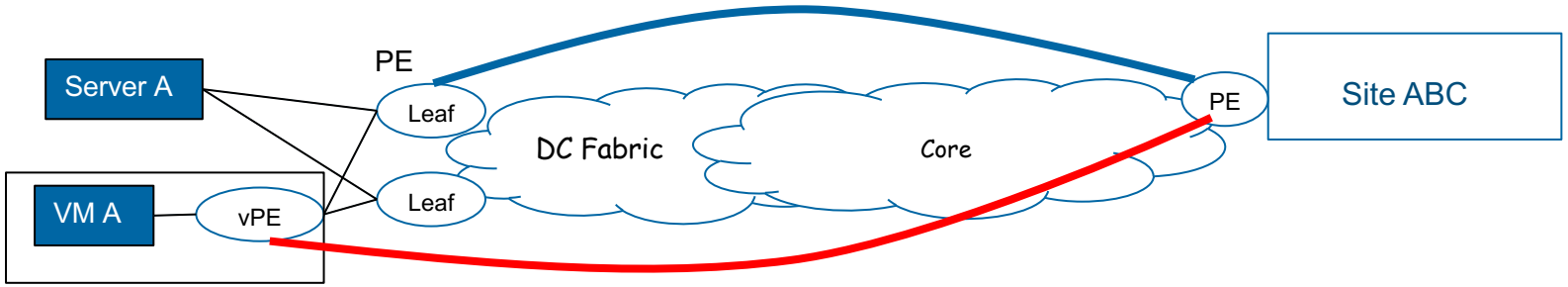
CO/DC – Fabric PE to Core PE – high level

The goal for network transformation is to move the complexity from core transport to the CO/DC and virtualize network components



Leverage existing Data Plane – MPLS E2E
Simplify Control Plane - SR fabric in DC - good starting point

The DC Fabric and Core Network seen as a common IP Network

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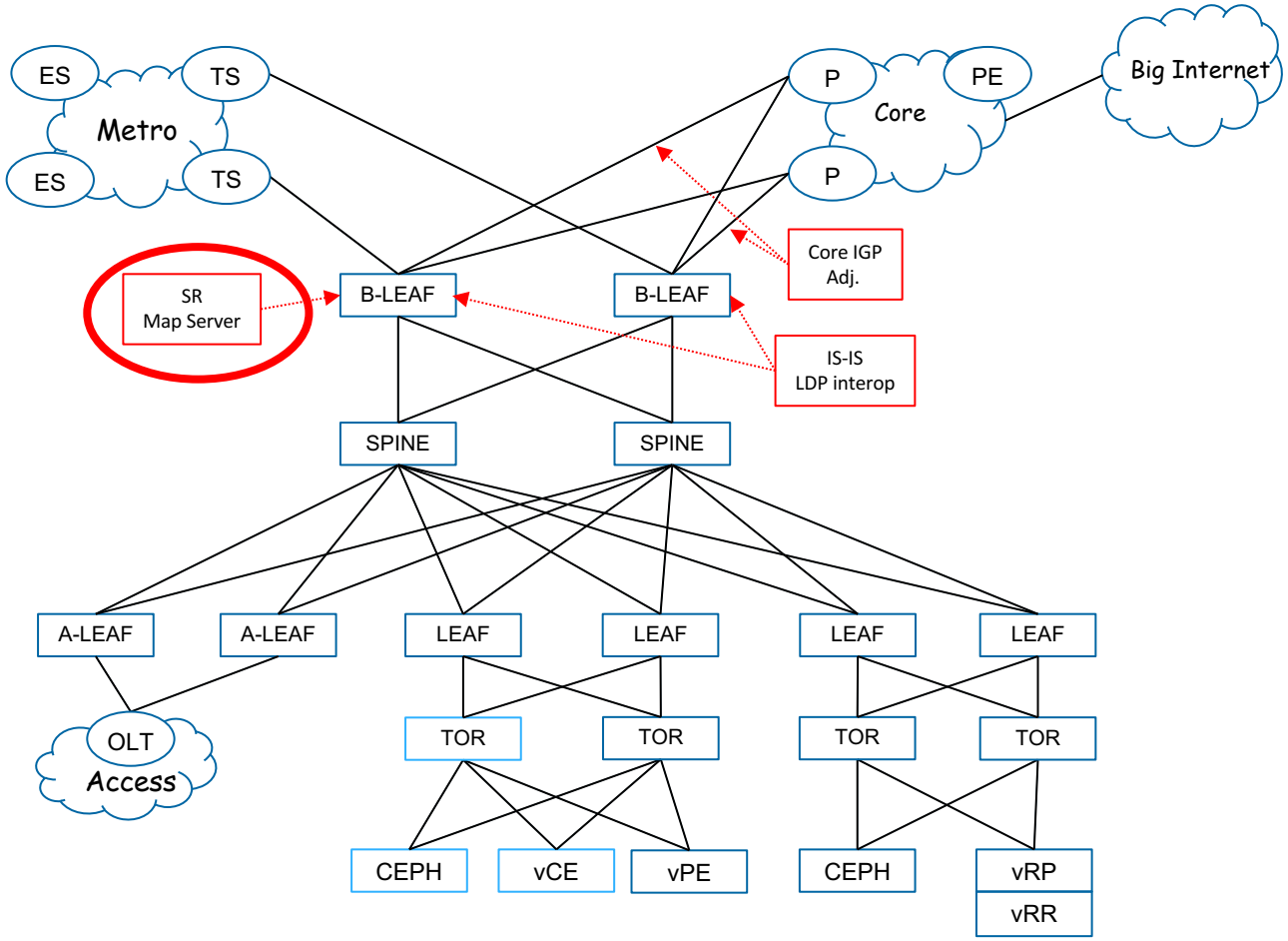
CO/DC – Architecture Overview

Key SR Points

- Fabric underlay is ISIS and SR = SIMPLE
- ECMP & SR for traffic engineering = FLEXIBLE
- SRTE with IP Core network = AGILE
- EVPN Overlay – L2/L3 services = AGILE & SIMPLE

CO/DC Challenges Solved by SR

- Classic DCI overlay is wrong for CO/DC, we need better integration to leverage network assets
- SR Solutions:
  - Map server for interop w/ brownfield LDP PE
  - Dual Stacking of LDP & SR



Segment Routing Mapping Server is important for brownfield interaction

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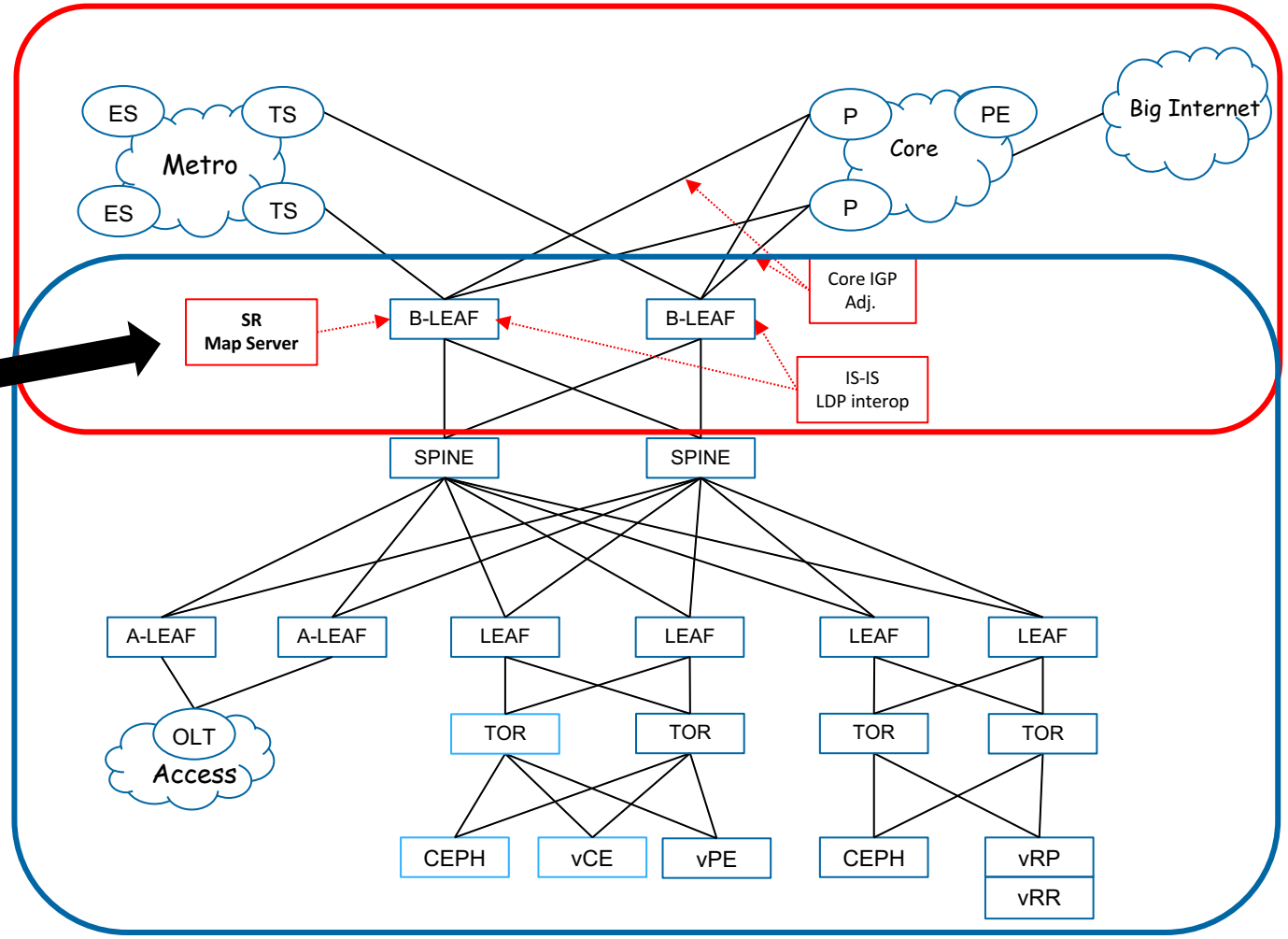
CO/DC – SR & LDP intermediate state

Classic MPLS Domain (LDP)

SR – LDP interop using SRMS

SR MPLS Domain



SR Absolute Label Algorithm

- Segment Routing Mapping Servers & SR Allocation
  - SRMS is critical to any SR deployment with brownfield interop
  - Reuse of the SRMS algorithm to assign Label in the SR Domain
  - SR Label are then assigned with the IP loopback processes

  - Plan the SR domains per label range
    - Use of full SRGB block: 65k
    - IP Core 8k block
    - CO/DC – Tier 1: 4k block
    - CO/DC – Tier 2: 2k Block

To ensure SR uniqueness across all domains, we came up with the following SR Absolute Label Algorithm

SRGB_Base* + (first-SID-Index [Infra_underlay|IPVPN|Internet] + loopback-last-octet) = SR absolute Label

*The SRGB_Base start at 16k

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Learnings – SR Allocation example with absolute label

For a given CO/DC_A with the following loopback address, 209.71.196.**15**/32

Absolute Label

SRGB_Base (**16000**) + first-SID-index (**10512**) + loopback-last-octet (**15**) = SR Absolute Label (**26527**)

```
RP/0/RSP0/CPU0:router#show mpls forwarding prefix 209.71.196.15/32
Local  Outgoing    Prefix             Outgoing     Next Hop        Bytes
Label  Label       or ID              Interface                    Switched
------ ----------- ------------------ ------------ --------------- ------------
26527  26527       SR Pfx (idx 10527) Hu0/3/0/2    10.55.65.41     0
26527              SR Pfx (idx 10527) Hu0/6/0/2    10.55.65.45     0
```

Prefix-SID only

first-SID-index (**10512**) + loopback-last-octet (**15**) = SR Prefix-SID Index (**10527**)

```
router isis CO/DC_A
 interface Loopback0
  address-family ipv4 unicast
   prefix-sid index 10527
```

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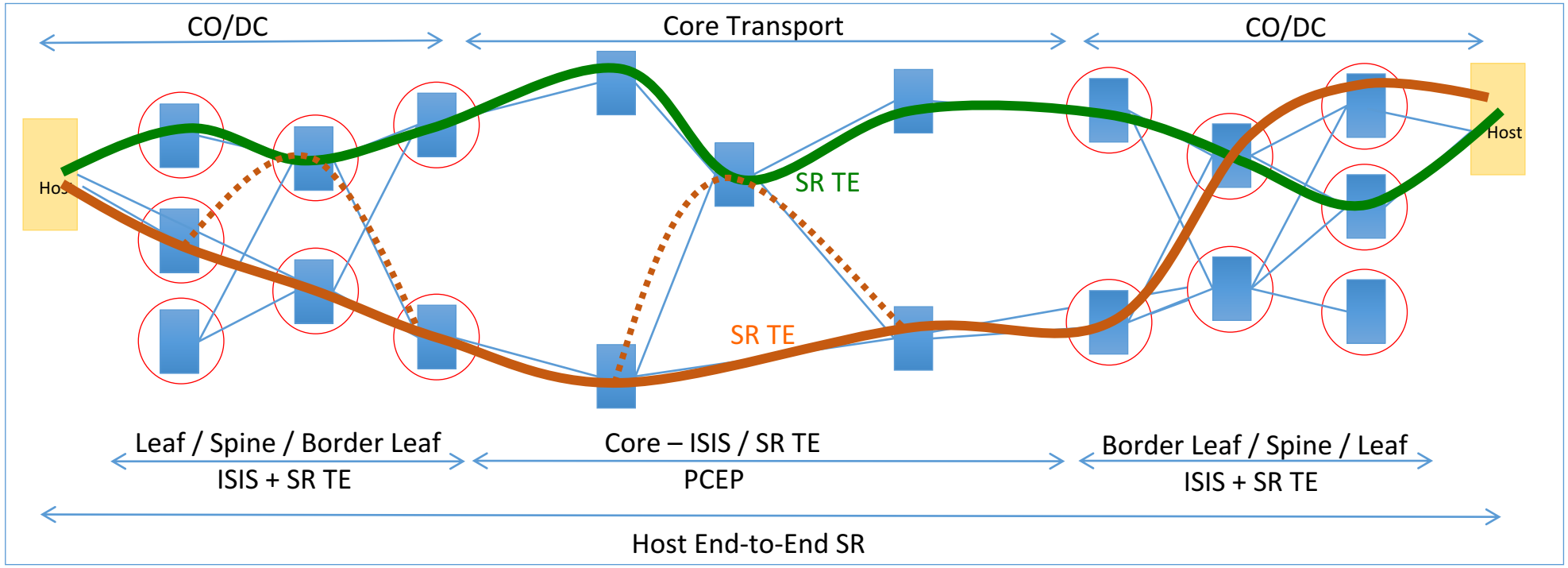
Next Steps

- Segment Routing from the host (HV, vPE, kernel, etc.)
  - Expand controller: SR-TE in DC, On-Demand Next-Hop
- SR _between_ DC's (core transformation to SR)



Application-responsive networking

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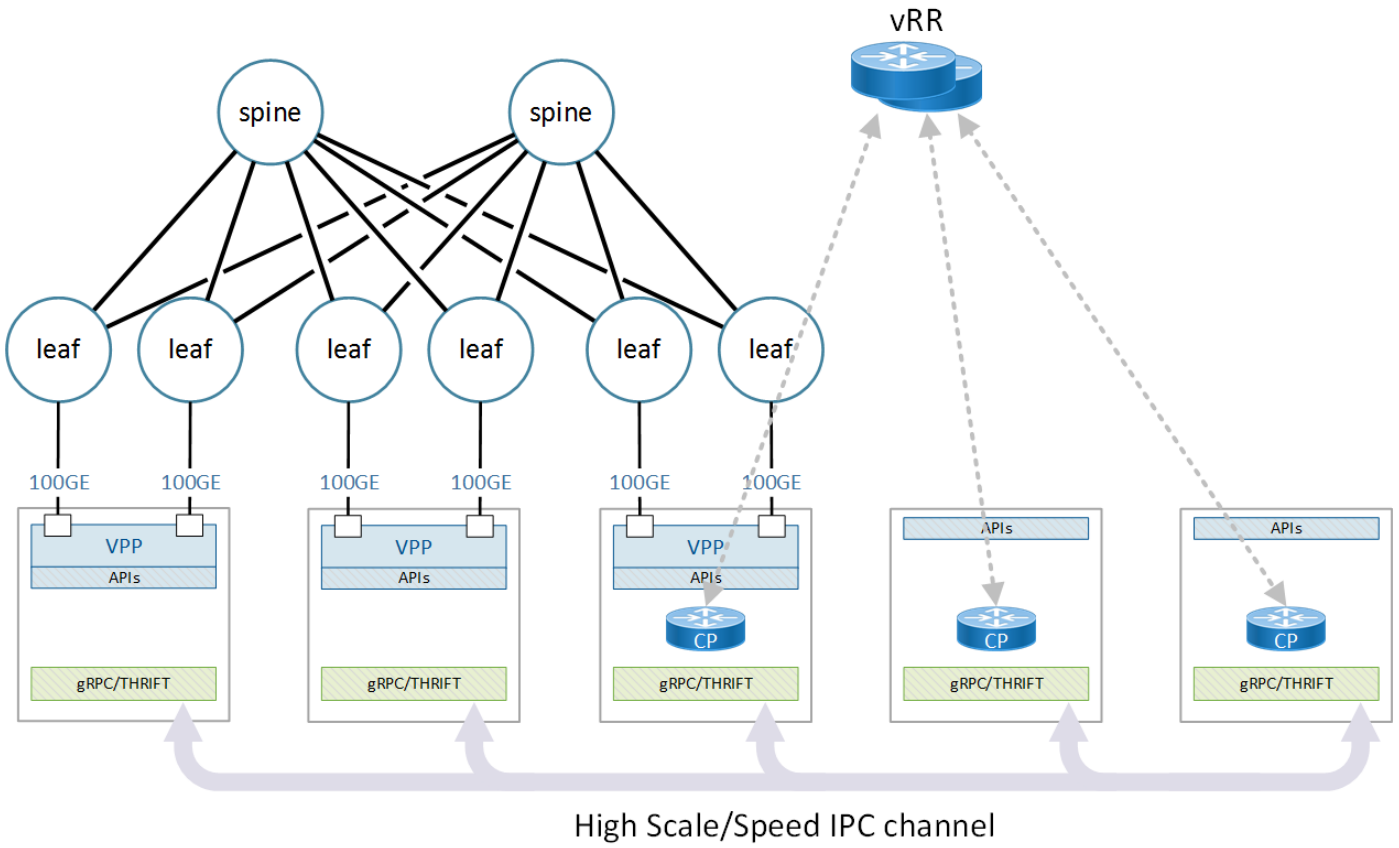
Use-Case: Scaled-Out vPE



Build a highly-distributed vPE function that scales linearly with the CO/DC fabric.

- Limited East-West Traffic
- Hypervisor is the new *edge*
- Same protocol stack
- Avoid the “Big Fat VNF”

- Follow *network disaggregation* principles and build using open, modular, replaceable components.

- Same design principles can be applied to other high-throughput VNFs

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Learnings

- Simplicity wins everywhere
  - Capture latent network value – leverage existing physical assets with efficient on-demand TE
  - Reduction CAPEX/OPEX and increase Agility
  - A lot of legacy protocols can be removed (LDP, RSVP-TE, etc.)
  - Make Engineering/Ops happy (deterministic labels, label reuse)
- Start small, find a greenfield island to introduce new technologies
- The hard part is the brownfield transition, be careful
  - SR vs Non-SR Nodes Interop/Integration
  - SR has lots of options!
- SRGB planning is important
  - In our case, we chose to allocate 64K labels to SR instead of default 8K (LOTS of VM's!)
- Work with industry standards
  - Keep the vendors honest

Do a lot more, with a lot less

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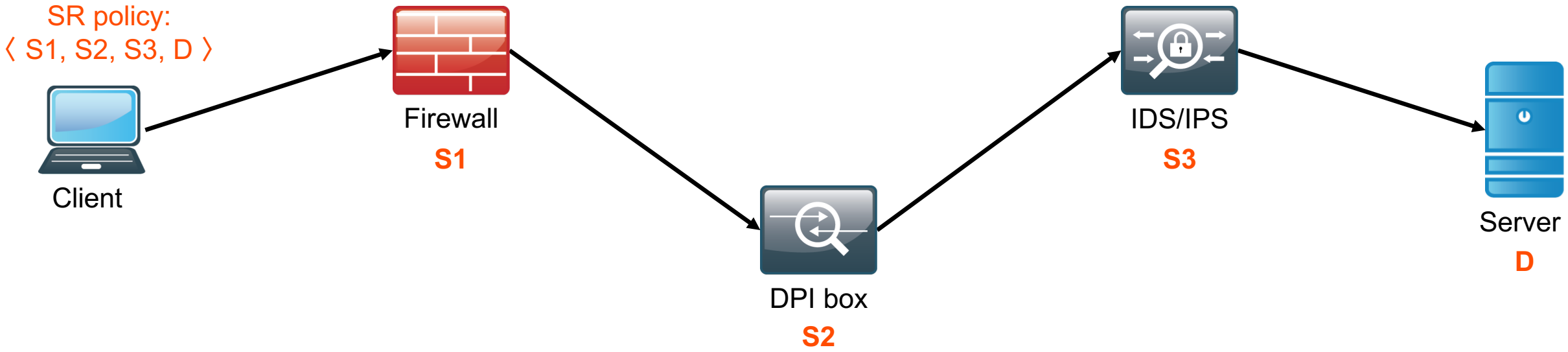
Use Cases – SRv6

SRv6 - NFV - Service Chaining

Packets from are steered through a sequence of services on their way to the server.



- **Segment Routing** service chaining: services are expressed with segments
  - Flexible
  - Scalable
  - Stateless

https://tools.ietf.org/html/draft-filsfils-spring-srv6-network-programming-00

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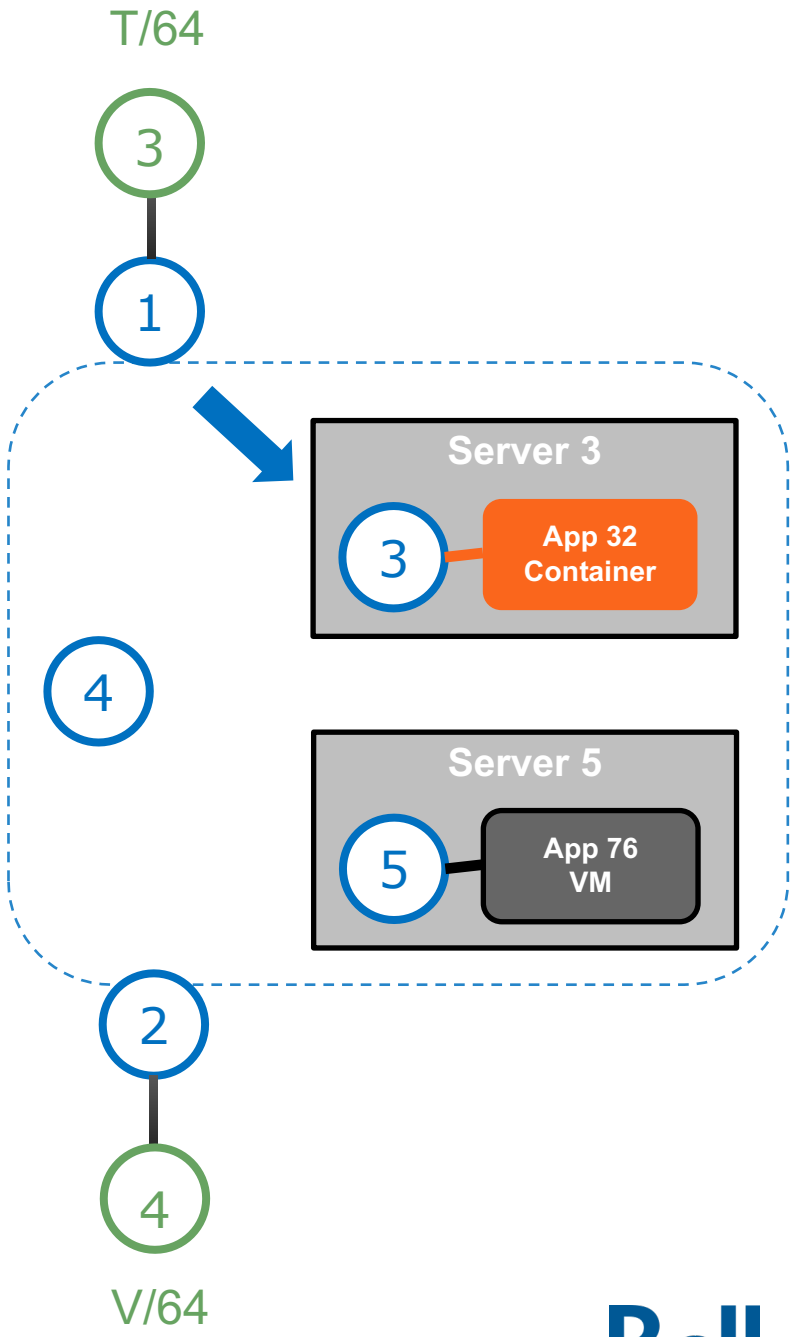
SRv6 - Integrated NFV

- A3::A32 means
  - App in Container 32
  - @ node A3::/64
- Stateless
  - NSH creates per-chain state in the fabric
  - SR does not
- App is SR aware or not

IPv6	(T1::0, V2::0)
payload	

IPv6	(A1::0, A3::A32)
SRH	{ A3::A32, A4::0, A5::A76, A2::C4 }
IPv6	(T1::0, V2::0)
payload	



Inner header could also be IPv4 instead of IPv6

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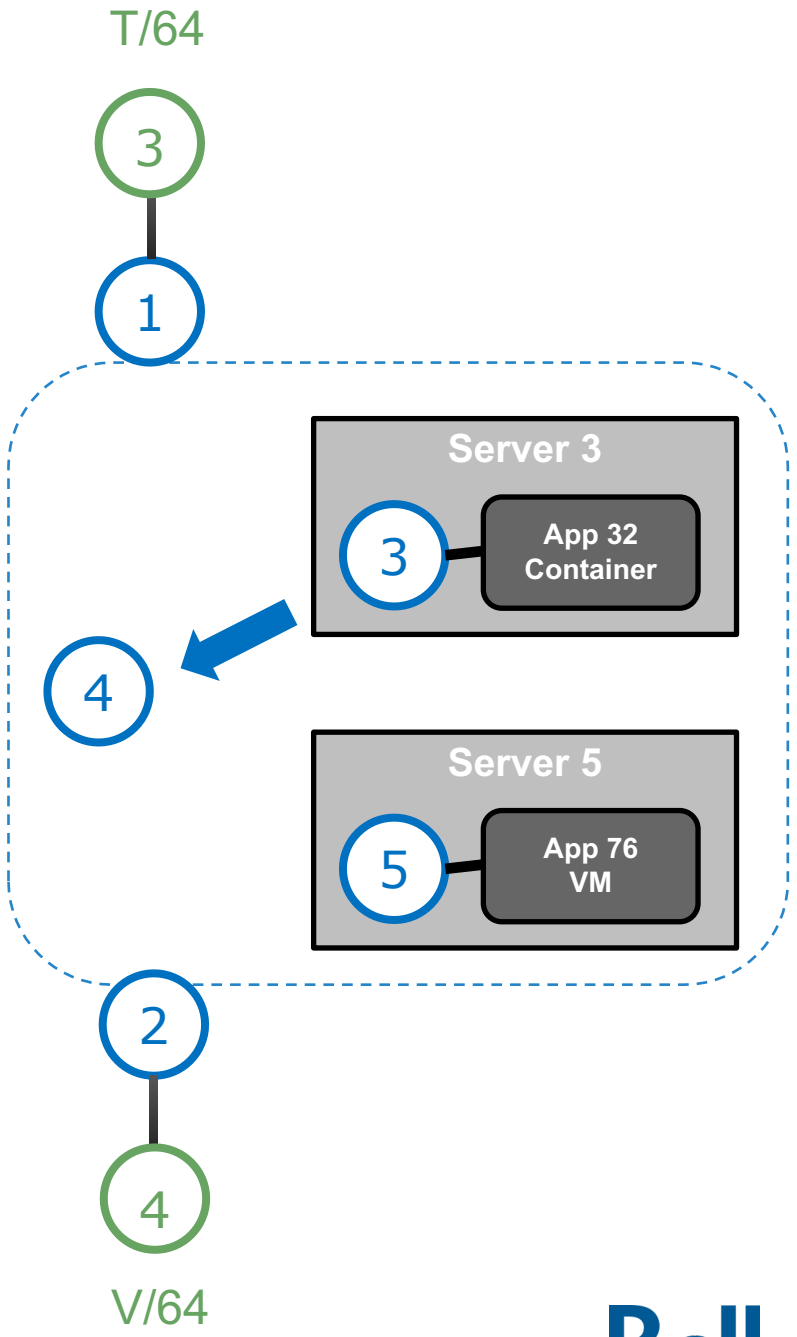
SRv6 - Integrated NFV

- Integrated with underlay SLA

IPv6	(A1::0, A4::0)
SRH	{ A3::A32, A4::0, A5::A76, A2::C4 }
IPv6	(T1::0, V2::0)
payload	



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SRv6 - Integrated NFV

- A5::A76 means
  - App in VM 76
  - @ node A5::/64
- Stateless
  - NSH creates per-chain state in the fabric
  - SR does not
- App is SR aware or not

IPv6	(A1::0, A5::A76)
SRH	{ A3::A32, A4::0, A5::A76, A2::C4 }
IPv6	(T1::0, V2::0)
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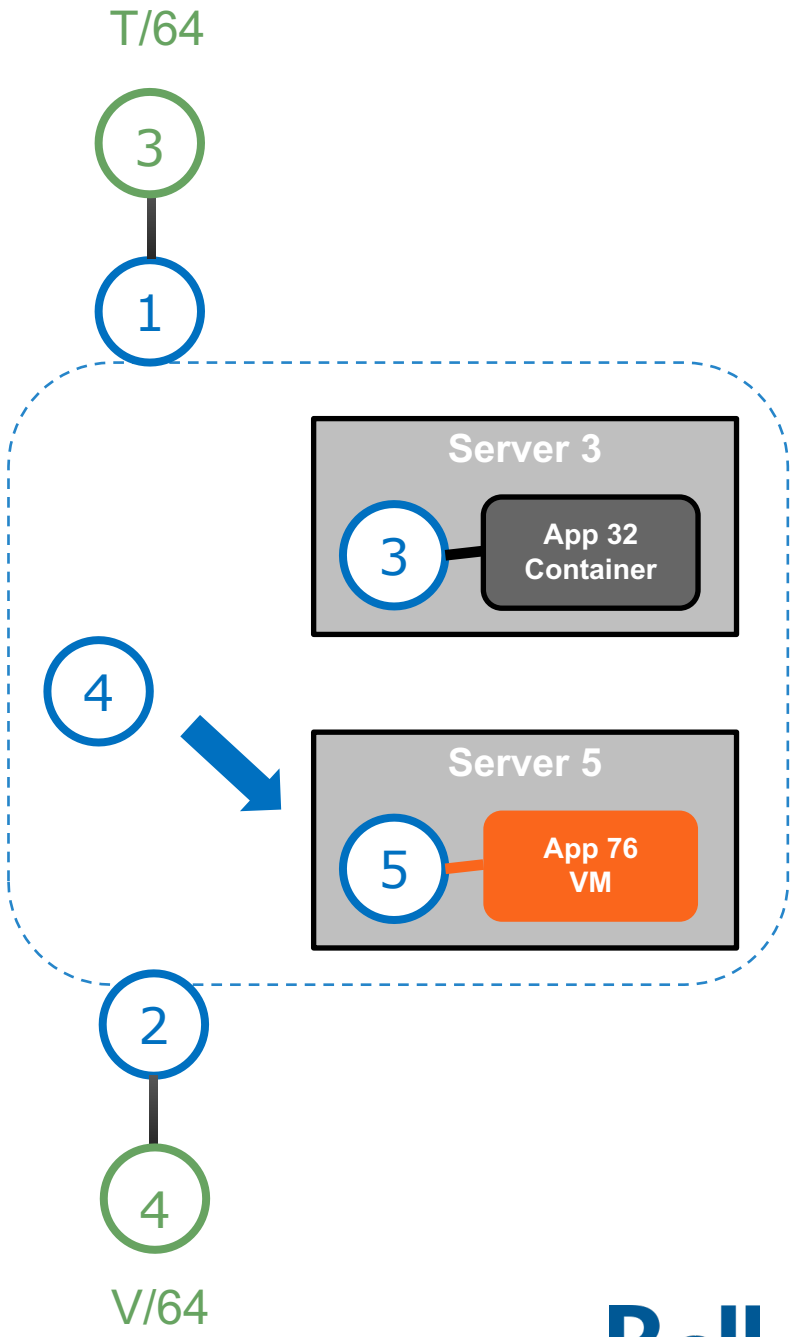

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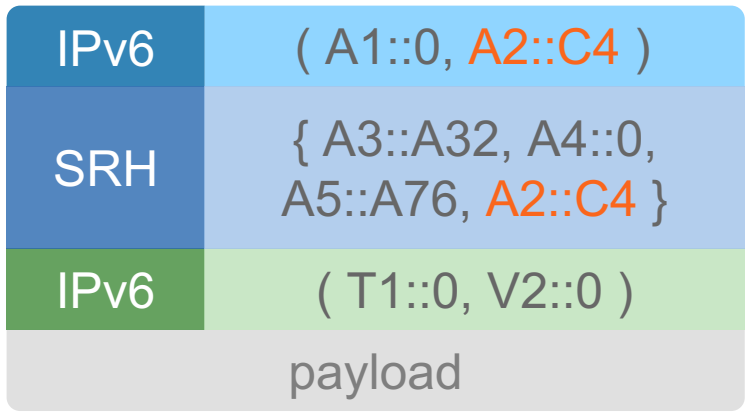
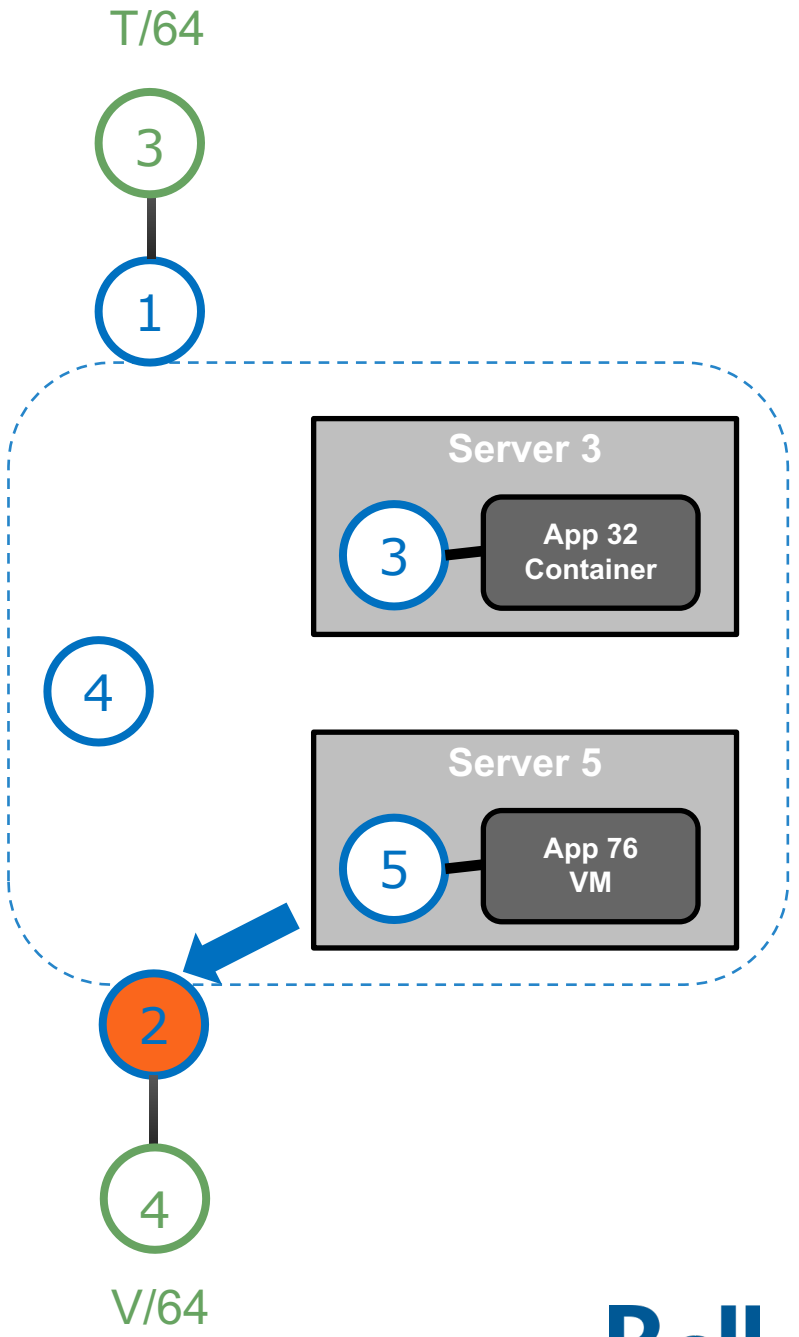
SRv6 - Integrated NFV

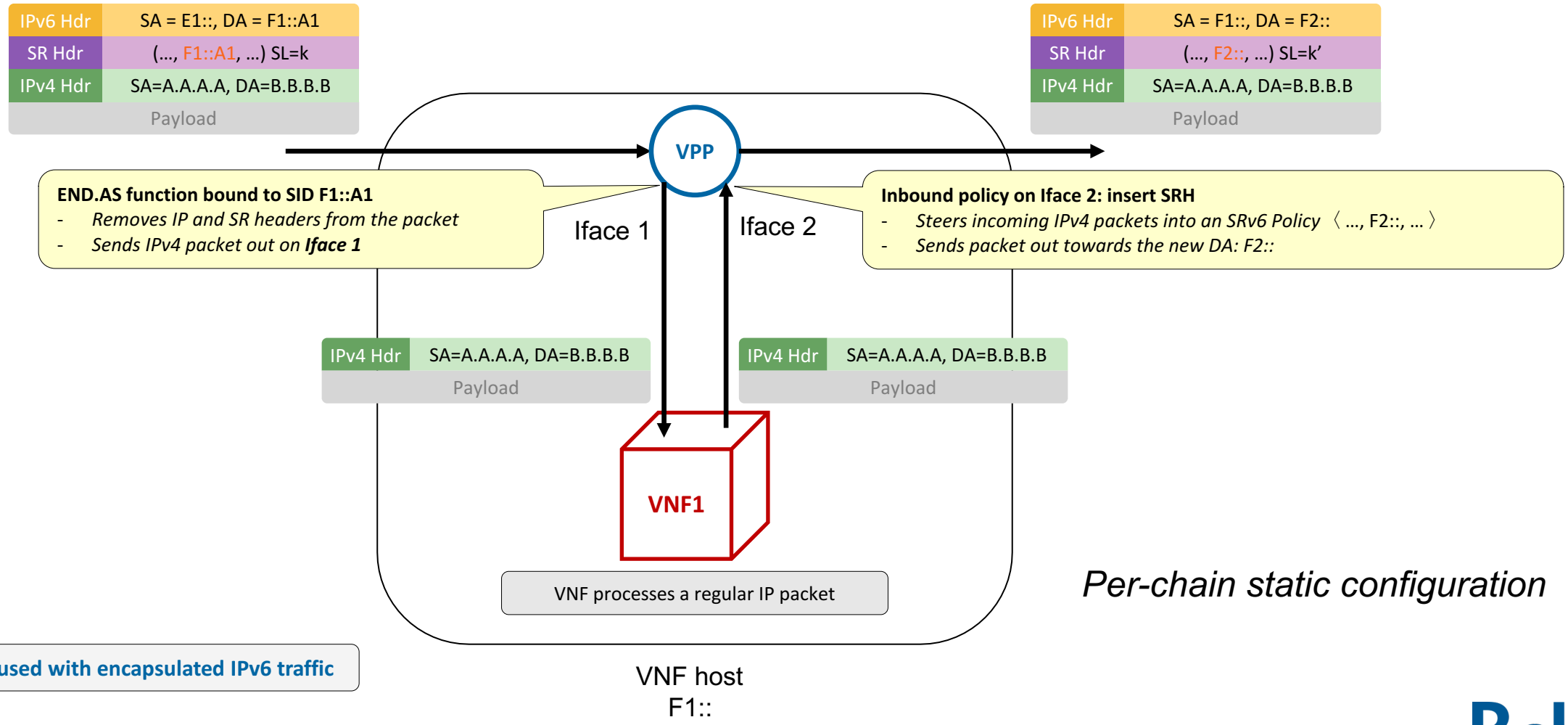
- Integrated with Overlay





NFV – SRv6 Function - END.AS – Static proxy

Endpoint to SR-unaware APP via static proxy

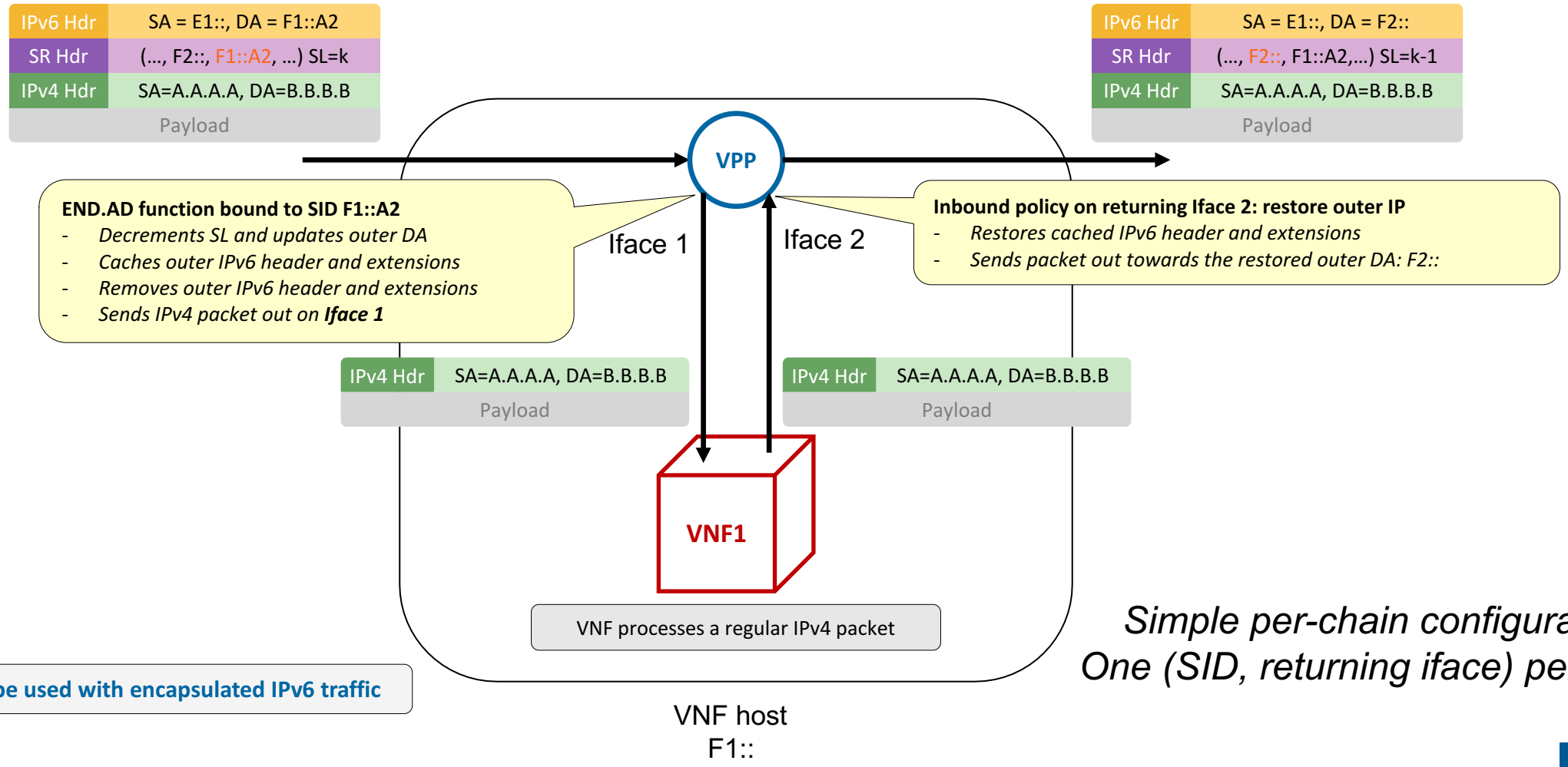


Per-chain static configuration

END.AS can also be used with encapsulated IPv6 traffic

NFV SRv6 Function - END.AD – Dynamic proxy

Endpoint to SR-unaware APP via dynamic proxy



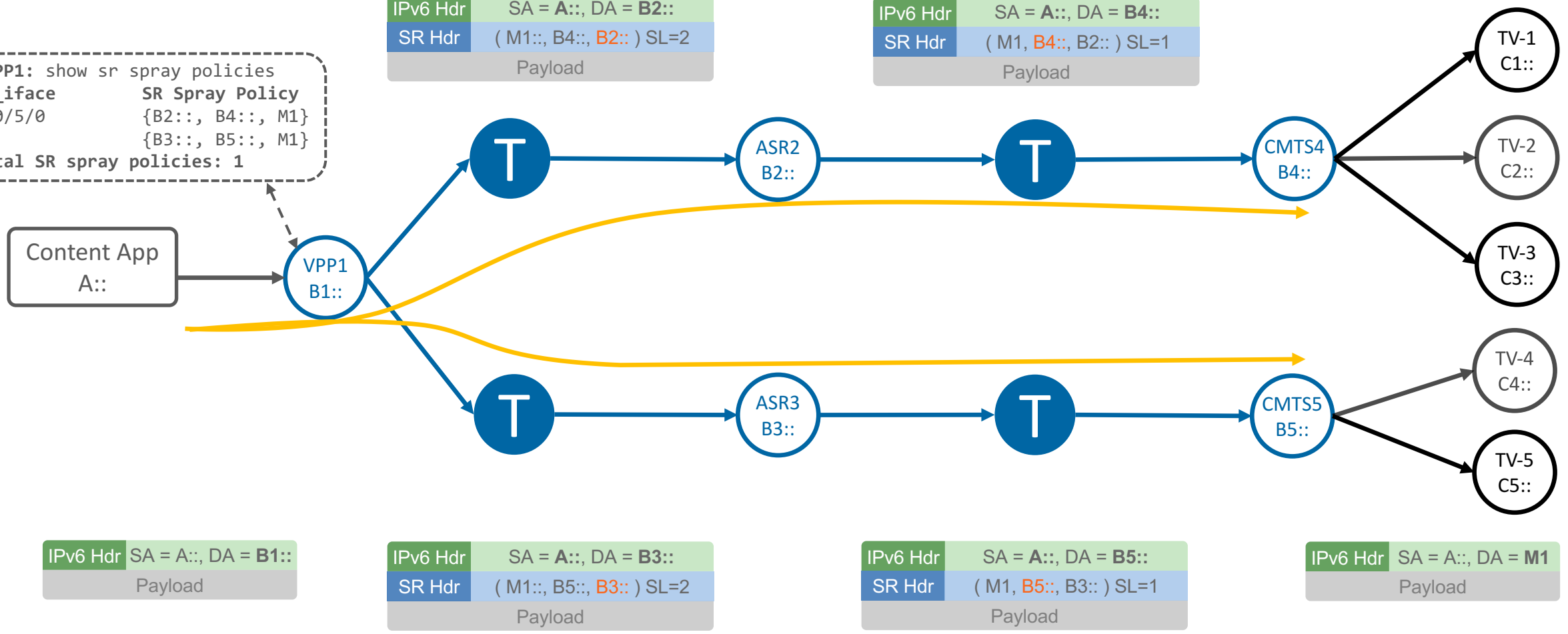
Simple per-chain configuration
One (SID, returning iface) per chain

END.AD can also be used with encapsulated IPv6 traffic

SRv6 - Spray use-case

TV2 and TV4 are **not** subscribed to this channel (M1) and do **not** recieve the content

```
>VPP1: show sr spray policies
In_iface          SR Spray Policy
GE0/5/0           {B2::, B4::, M1}
                  {B3::, B5::, M1}
Total SR spray policies: 1
```



Flexible, SLA-enabled and Efficient content injection without multicast core

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See the Demo

Thank You