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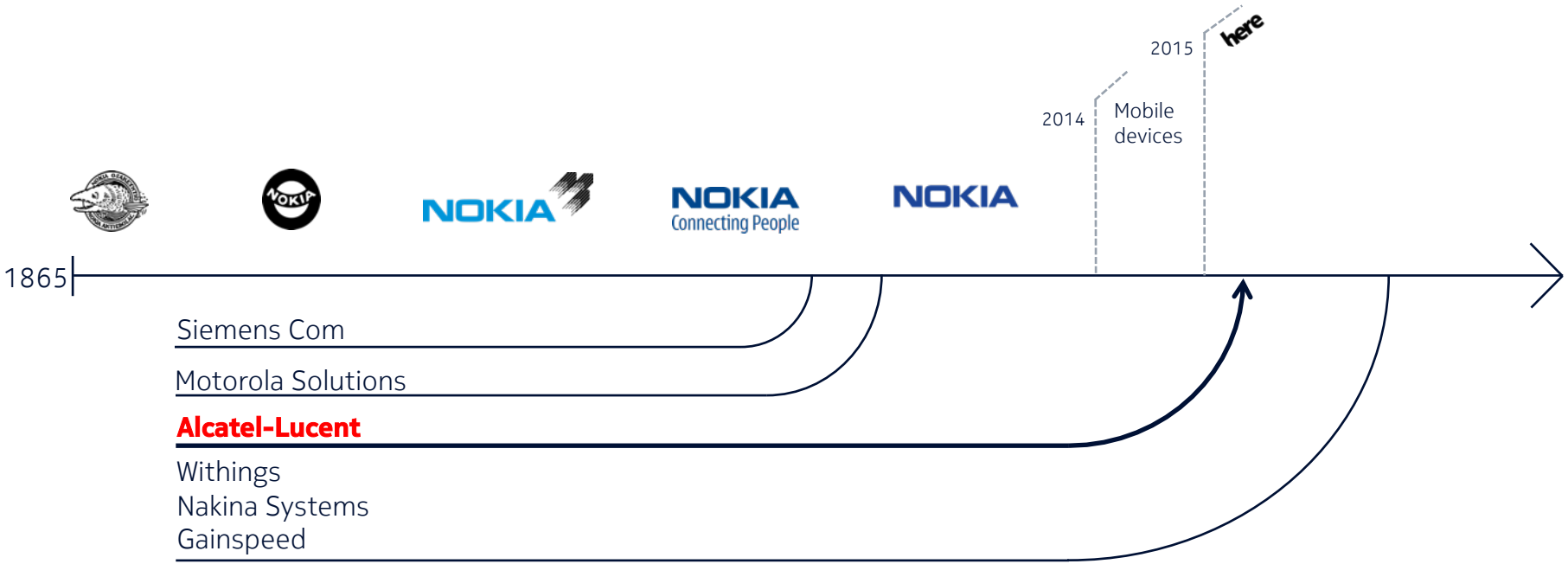
Network Automation through WAN SDN control

ES.NOG 2016

- Luis Miguel Díaz Vizcaíno

- 20/10/16

A long history of successful change



IP / Optical Networks
Optimizing network infrastructure for the Cloud

IP Routing & Packet Core

IP networking solutions for advanced residential, business and mobile services spanning the IP core, IP edge, Mobile Packet Core and IP/Ethernet metro and access.

Optical Transport

Scalable, versatile, dynamic packet-optical transport to maximize bandwidth, distance and resiliency.

Carrier SDN & NMS

Providing and optimizing network services and resources e2e over a programmable IP & optical fabric.

Nuage Networks

Making datacenter and branch network resources as readily consumable and efficient as cloud computing and storage.

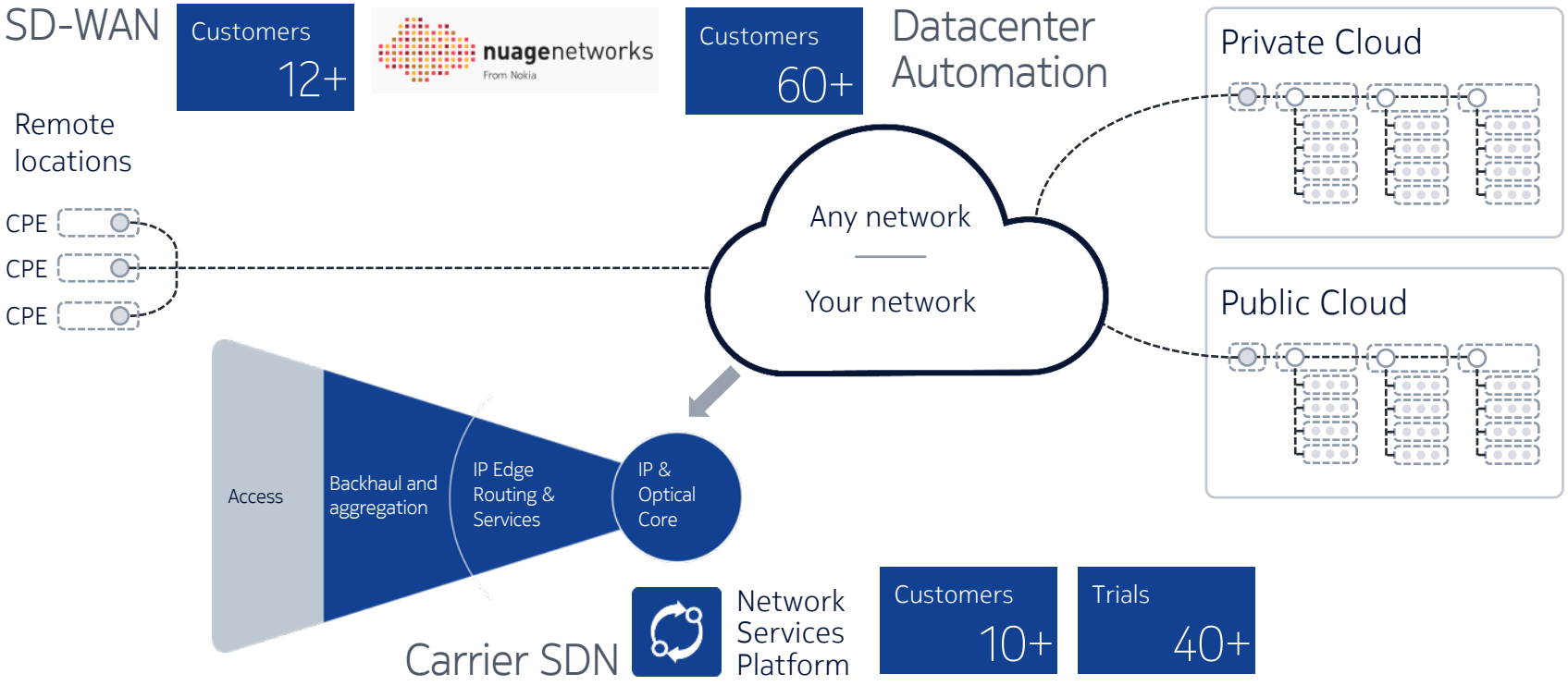
IP Video

Leveraging the latest
in cloud and streaming technologies to efficiently deliver an exceptional video experience.

Professional Services

Accelerating the benefits of new technologies including Software Defined Networks, Network Function Virtualization and programmable all-IP networks.

Software Defined Networks
Complete end-to-end SDN solution



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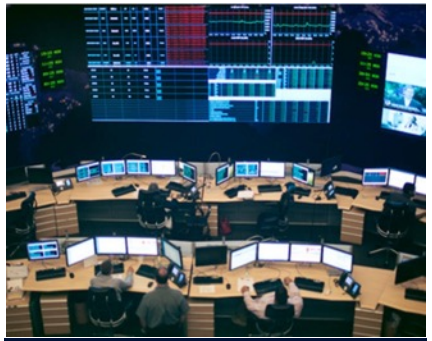
Problem Statement

Network challenges in the cloud/IT era

How do I innovate and turn-up new services at ‘cloud speed’?

How do I optimize the network in the face of rapidly changing traffic demand?

How do I integrate operations across multiple domains to boost efficiency?

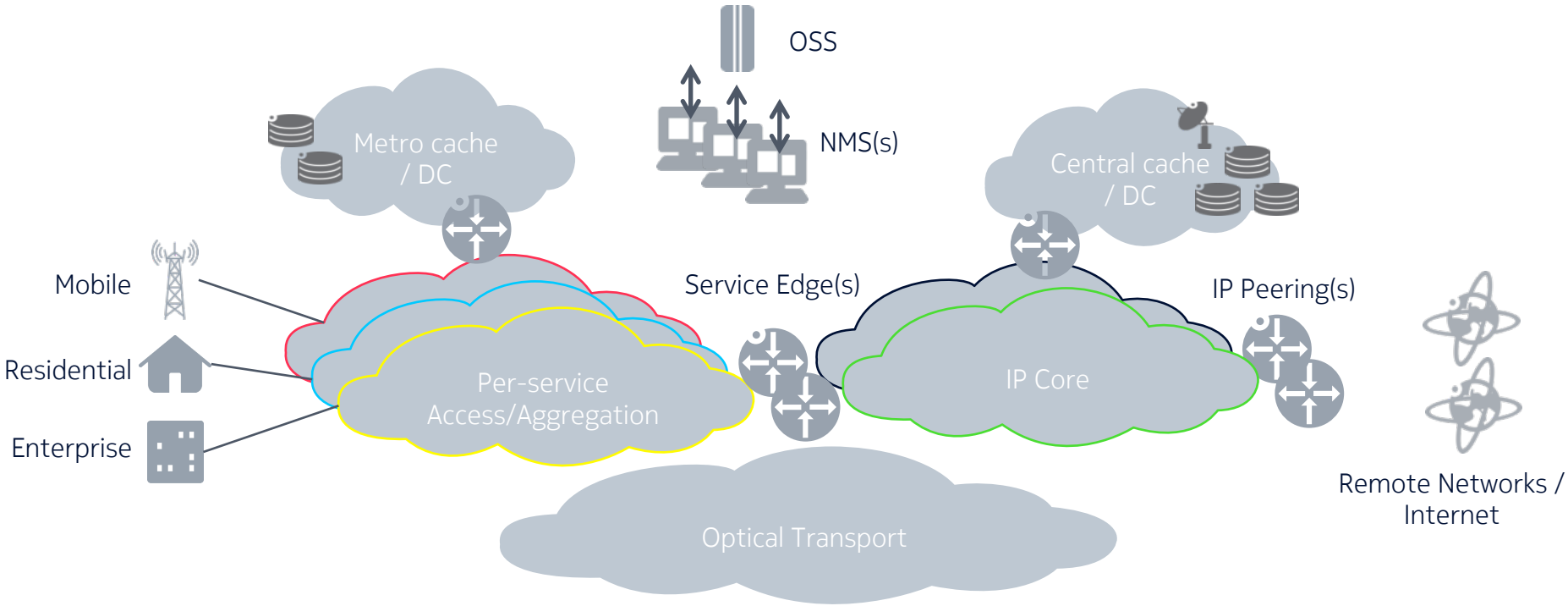


How do I assure my new, dynamic SDN services?

Challenge: deliver on-demand network services, cost effectively & at scale

Carrier SDN: Network Architecture Evolution

PMO: Historical network bottlenecks preventing future network growth (1/4)

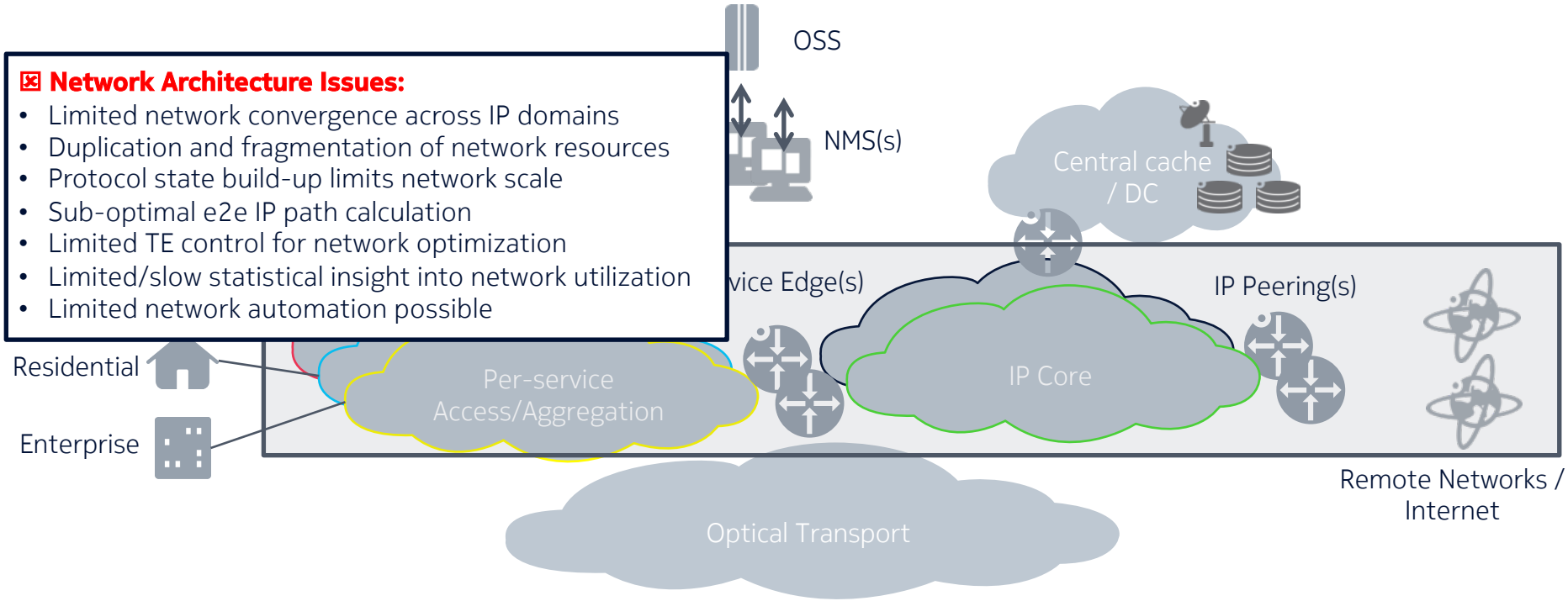


Carrier SDN: Network Architecture Evolution

PMO: Historical network bottlenecks preventing future network growth (2/4)

Network Architecture Issues:

- Limited network convergence across IP domains
- Duplication and fragmentation of network resources
- Protocol state build-up limits network scale
- Sub-optimal e2e IP path calculation
- Limited TE control for network optimization
- Limited/slow statistical insight into network utilization
- Limited network automation possible

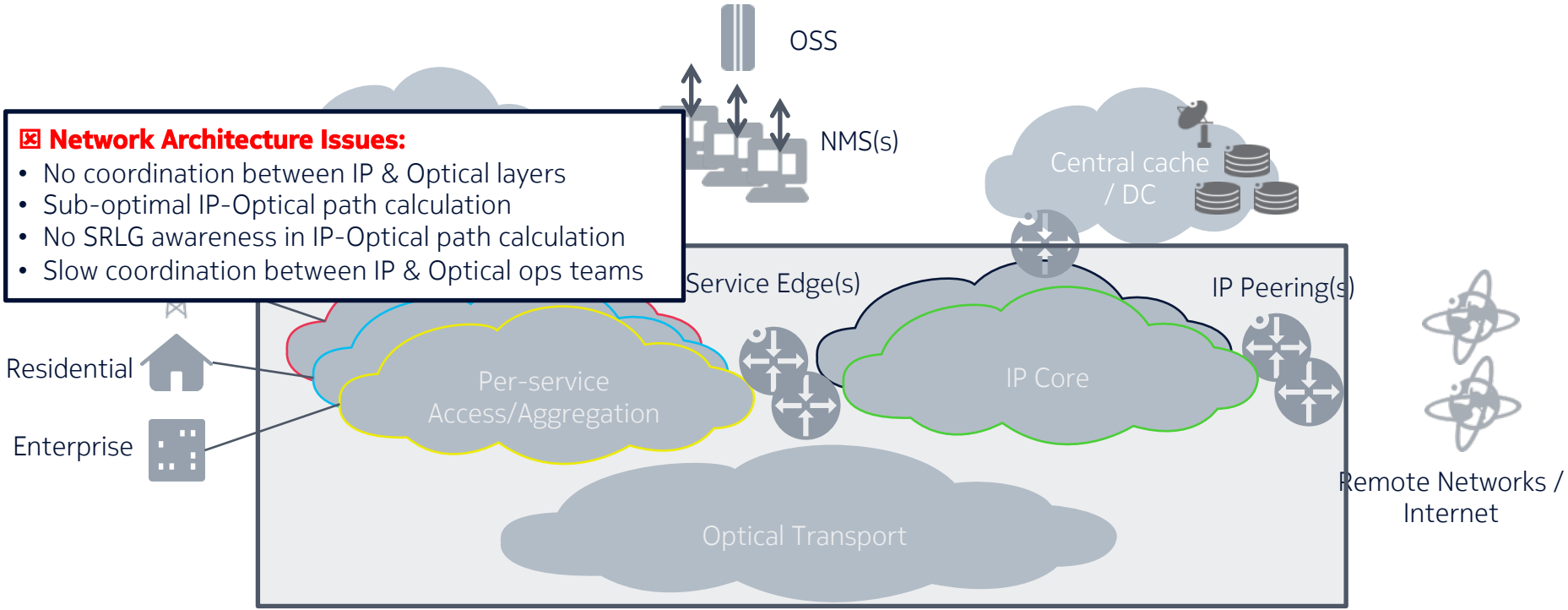


Carrier SDN: Network Architecture Evolution

PMO: Historical network bottlenecks preventing future network growth (3/4)

☒ Network Architecture Issues:

- No coordination between IP & Optical layers
- Sub-optimal IP-Optical path calculation
- No SRLG awareness in IP-Optical path calculation
- Slow coordination between IP & Optical ops teams

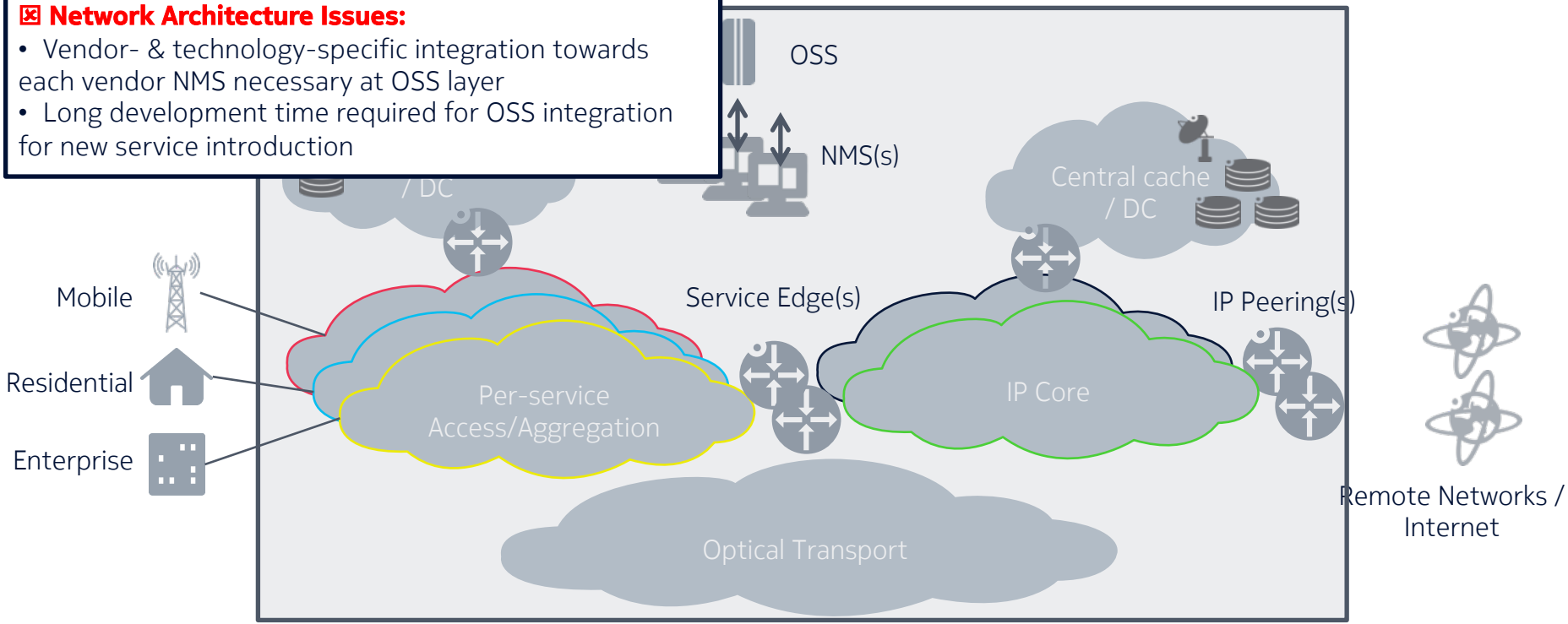


Carrier SDN: Network Architecture Evolution

PMO: Historical network bottlenecks preventing future network growth (4/4)

☒ Network Architecture Issues:

- Vendor- & technology-specific integration towards each vendor NMS necessary at OSS layer
- Long development time required for OSS integration for new service introduction



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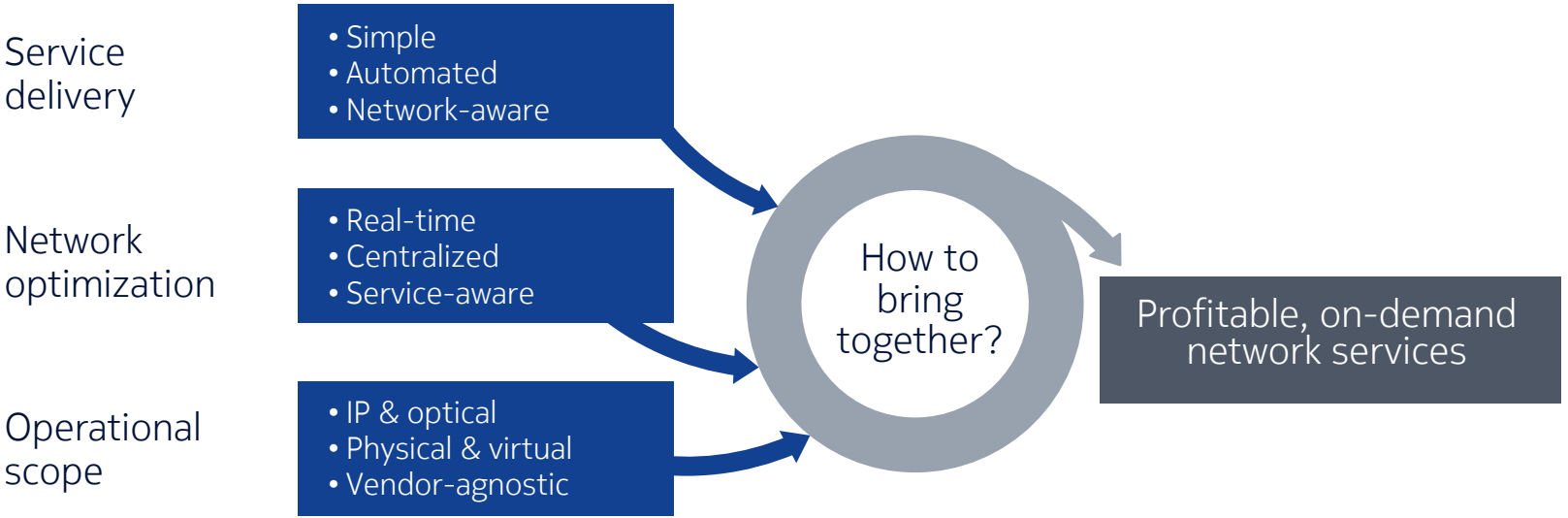
The Promise

Nokia Carrier SDN

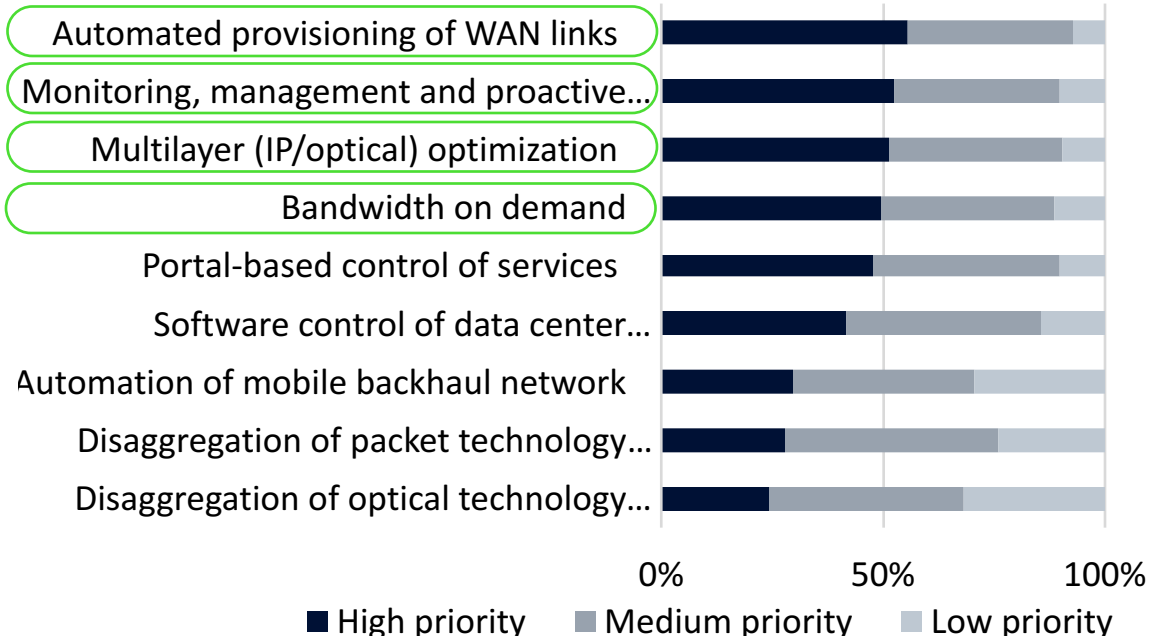
Network requirements for delivering profitable on-demand services



A new, more integrated approach required

Biggest Expected Benefits of carrier SDN over Next 3 Years

Heavy Reading, June 2016



Automate

Assure

Optimize

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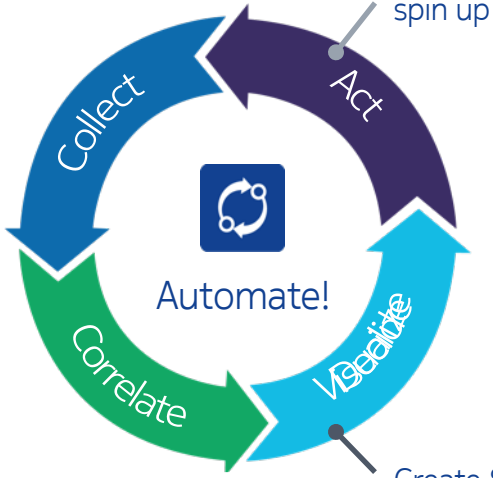
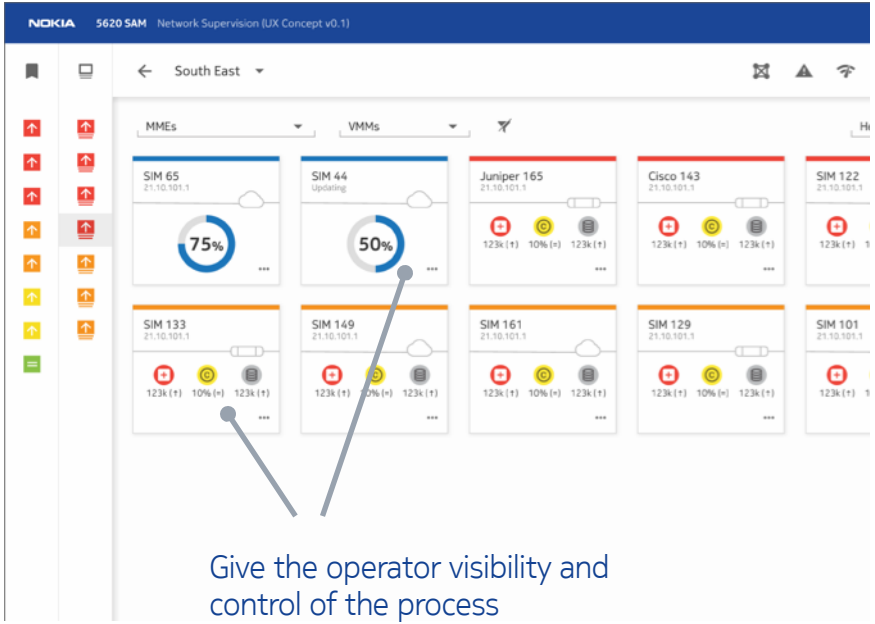
Taking network/service assurance into the carrier SDN era



Auto add bandwidth,
change path,
spin up a new VM

Create SDN/NFV
assurance policies
using data triggers



Give the operator visibility and
control of the process

The Tools

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Flow & Prefix Steering using BGP Segment Routing TE Policy
Overview

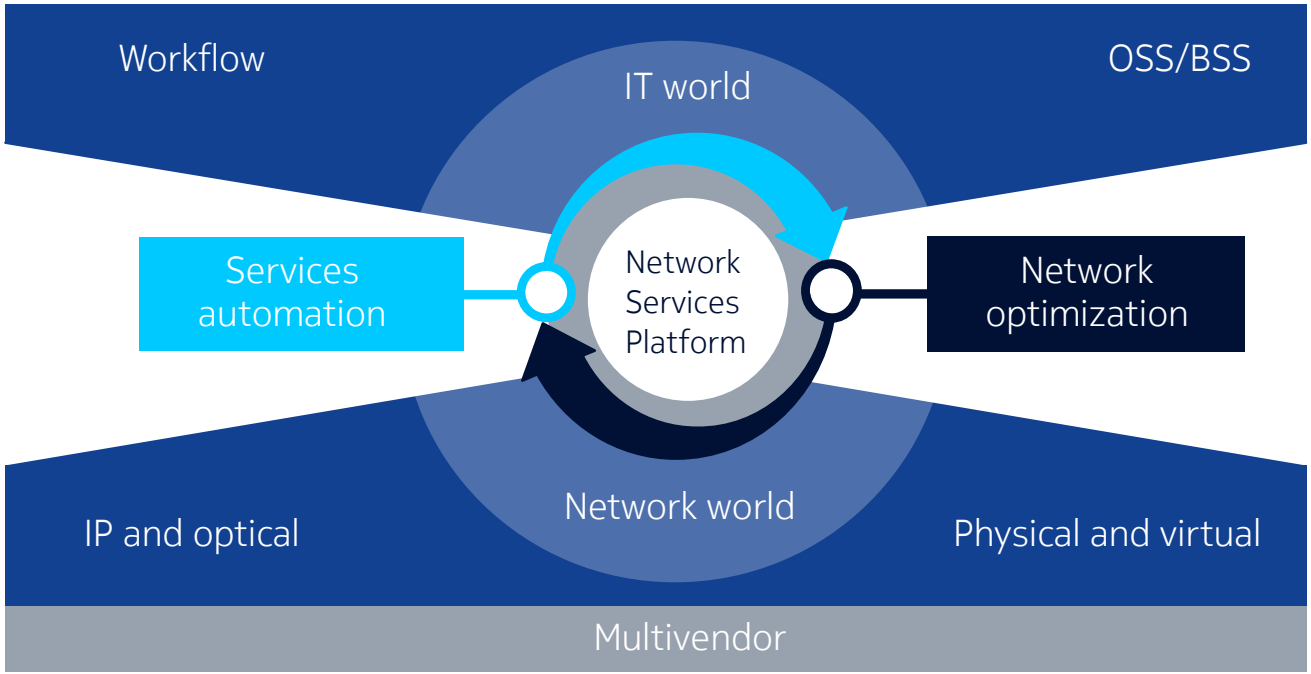
- Direct traffic towards a destination along a source routed path defined by one or more BGP next-hops
- Applicability in the DC, WAN
  - DC use case is motivated by Web-scale designs that replace IGP routing with BGP hop-by-hop paradigm
- Segment routing path can be intra-AS, intra-AS + egress peer link, or complete inter-AS path
  - Information about egress peer links and remote AS topology (if applicable) is learned by the local AS from BGP-LS
- Policy to steer traffic into the segment routing tunnel can be provided to the ingress node using PCEP or BGP (SR TE policy SAFI 73)
  - In the BGP case the BGP SR TE policy route can be originated by a controller (NSP) or an egress ASBR (the case of Egress peer engineering (EPE))
- Services/routing binding to the tunnel follows BGP-LU model

What is BGP SR TE Policy?

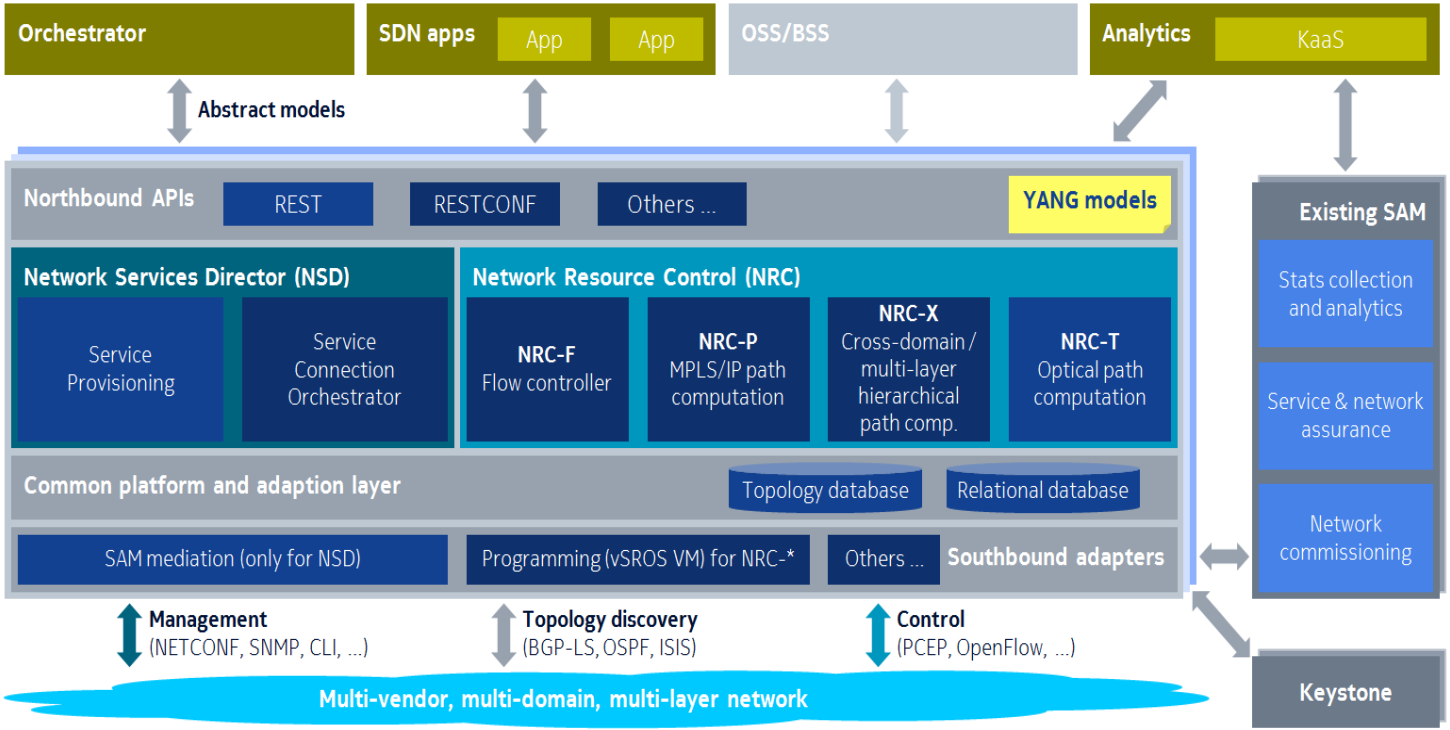
- SR TE Policy is a set of explicit paths represented by one or more segment lists.
- SR TE Policy can be distributed using a controller or any BGP speaker
- SR TE Policy represents a set of weighted equal cost multi path segment lists – representing explicit paths.
- Approach:
  - Typically a controller defines the set of SR TE Policies and advertise them to BGP routers.
  - The BGP router receiving the SR TE Policy will instantiate the policy in its routing and forwarding tables
  - And use this information to steer traffic per “prefix” to alternate path.
- A prefix or a flow requiring an SR TE policy to be applied will be colored according to the TE Policy.

Nokia Carrier SDN

Bridging IT and the multi-layer, multivendor network



NSP - Overall Architecture

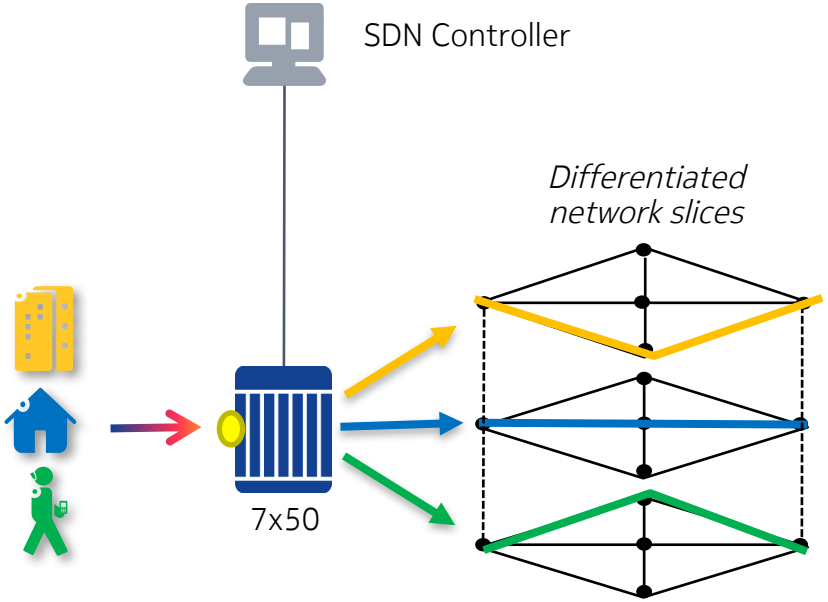


Carrier SDN Use Cases

Steering

SDN Traffic Steering
Problem Statement

- Operators want greater control over the traffic on their network to improve their ROI
  - Granular treatment of key customers/applications/large flows
  - Virtualization/slicing of network assets
  - Online optimization for congestion situations
  - Traffic steering/routing based on Business criteria
- Standardized programmable interfaces required to achieve these goals
- Target solutions must be simple for operations
  - Centralized network-wide control
  - Control decisions performed manually by Ops teams or automated based upon policy



Traffic Optimization: Congestion

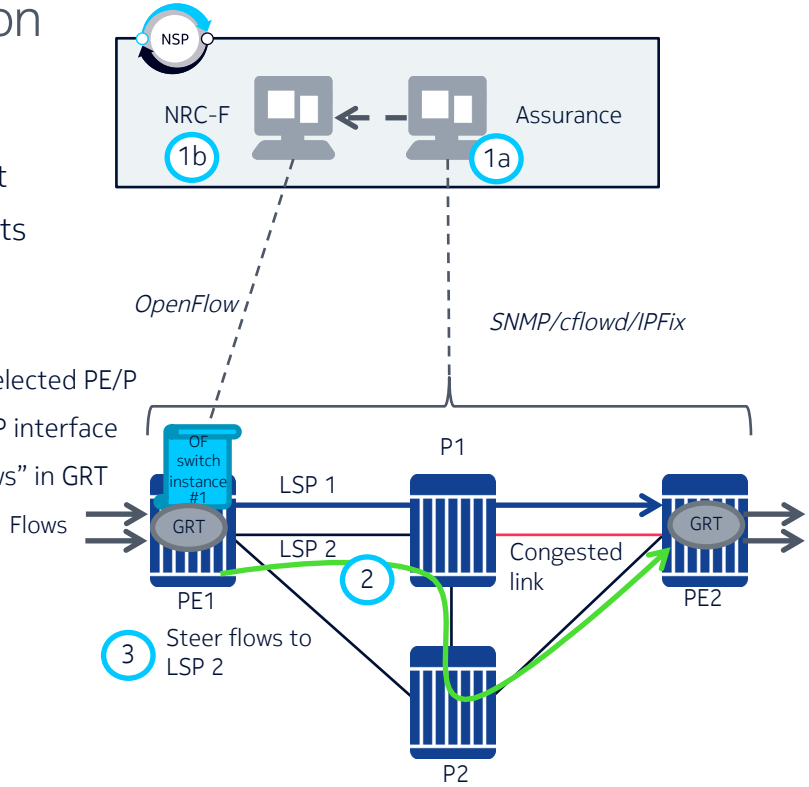
Optimize on “Top N Flows” during Congestion

SROS & NSP *Demo 2Q’16*

NSP 3.0c

SROS 14.0R1

- Use-case explanation:
  - Targeted for “hot” PE-PE / PE-IGW paths within GRT context
  - Start state: GRT on PE’s configured with IGP or BGP shortcuts
    - i.e. MPLS tunnels used to reach IGP prefixes or iBGP NH’s
  - 1a Assurance collects performance stats across network
    - Aggregate link utilization monitored via egress interface stats on selected PE/P
  - 1b TCA by Assurance alerts the NRC-F to imminent congestion on PE/P interface
    - Flow stats then collected from selected PE/P to identify “top N flows” in GRT
  - 2 LSP 2 is created with P1-PE2 link excluded (i.e. all busy links are excluded) – policy driven or using NRC-P/PCEP
  - 3 NRC-F redirects selected GRT traffic to LSP 2 at PE1
    - “top N flows” identified earlier are installed in OF table at PE1
  - After link utilization drops below threshold, revert back to standard traffic flow (i.e. LSP1) – policy driven



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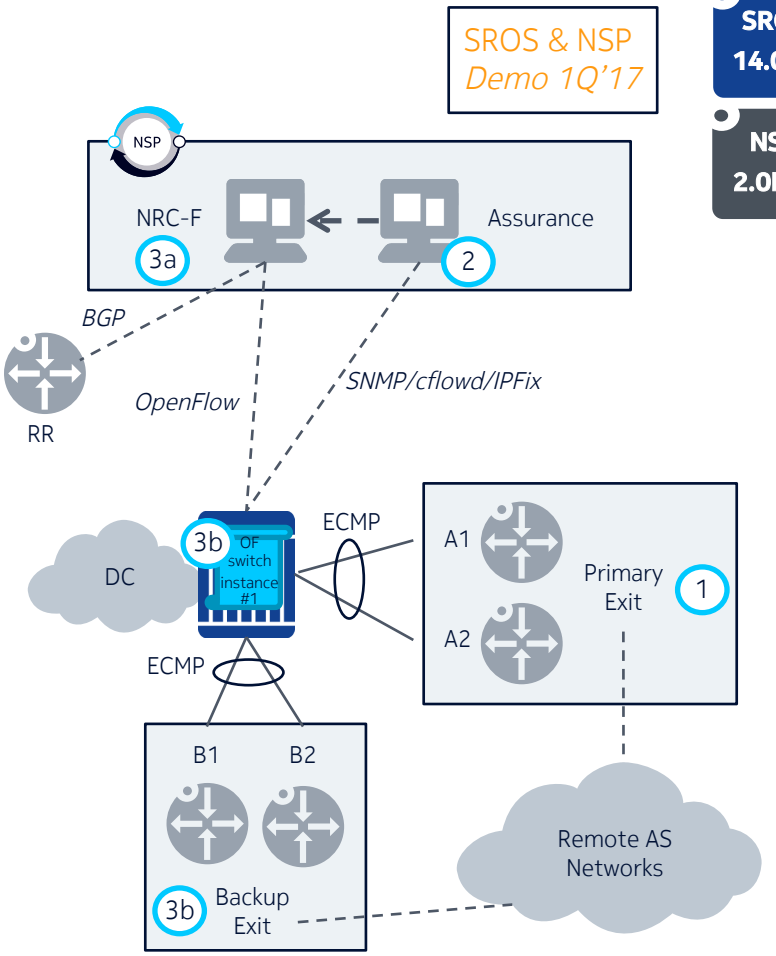
Per AS-based Traffic Optimization
Optimize on Destination AS

- Use-case explanation:
  - 1 By default, egress DC-GW traffic transits via primary exit (A1/A2)
    - Native IP forwarding w/ ECMP
  - 2 Assurance collects link utilization stats for A1/A2 and analyze the flows based on destination AS
    - 3a When link usage to A1/A2 exceeds a preset threshold, operator is alerted and can select a group of flows/subnets (belonging to same AS); and
    - 3b Redirect selected traffic to B1/B2 via OpenFlow upon operator action
- NSP/NRC-F details:
  - Calculates subnets corresponding to destination AS
    - Correlation between BGP RIB (subnet + dest AS) and flow stats collected via cflowd/IPFix
  - Populates OpenFlow match together with redirect to indirect next-hop action



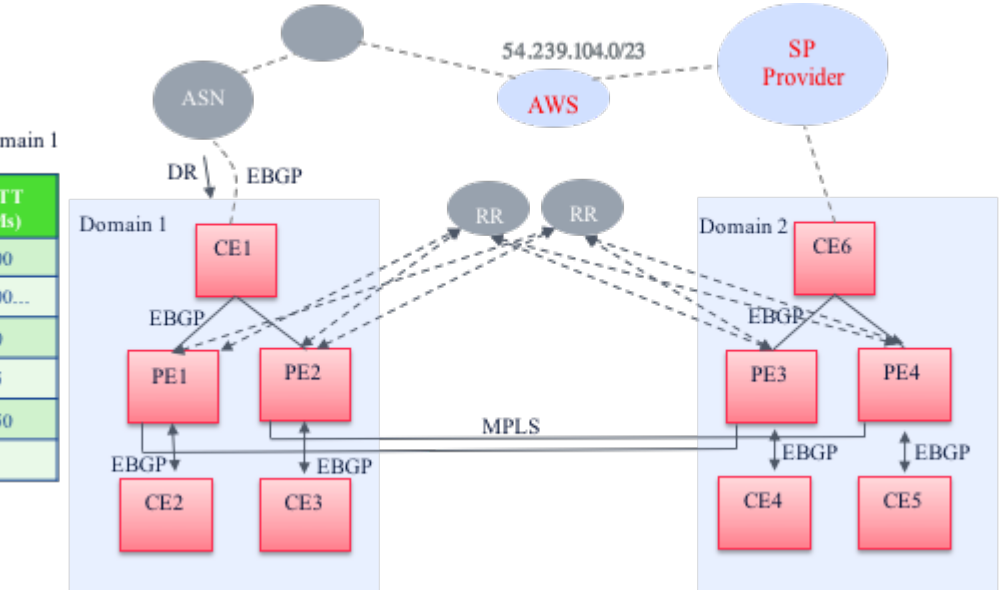
Latency-based Flow Optimization

Ability to steer traffic for specific destination VIP prefixes to alternate Domain according to the output of the comparison between measured round trip delay from <Default Domain, Destination Prefix> and <Alternate Domain, Destination Prefix>

VIP Route Metric Table

VIP RMT - Domain 1

Dest per Prefix	RTT (Ms)
AWS	100
Google…	200…
Twitter	70
Yahoo	75
Facebook	150
…	…

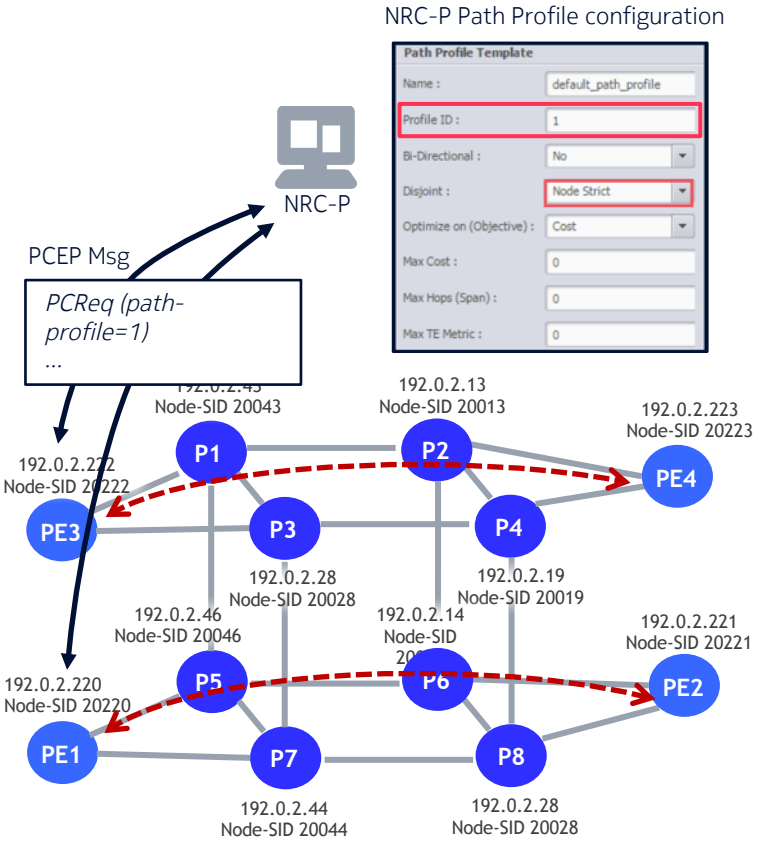


VIP RMT –Domain 2

Dest per Prefix	RTT (Ms)
AWS	50
Google…	100…
Twitter	50
Yahoo	100
Facebook	200
…	…

Disjoint Paths Traffic Engineering

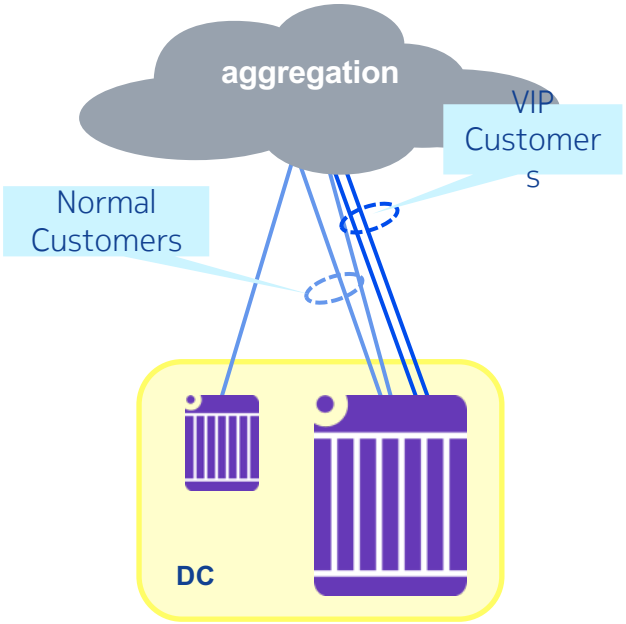
- Use-case: two services/LSPs need to be disjoint
  - Example: PE1-PE2 and PE3-PE4 (shown)
- NSP / 7x50 behavior
  - PCEP is extended to include a ‘path-profile’ object
  - A path-profile represents a policy (i.e. a list of path parameters) that a PCEP speaker (7x50) may present to NRC-P to influence path computation
  - A Profile/template is configured in NSP corresponding to a supported path-profile indicating how NRC-P should perform the path calculation



  Public

VIP-Source Subnet based Steering with VIP Link Management

- Public link group and dedicated link group
- Dedicated link group reserved for VIP customers
- Public link group is default exit
- Identify VIP traffic and redirect to dedicated links
- Bandwidth on Demand
  - Add or remove links to dedicated link group for VIP customers



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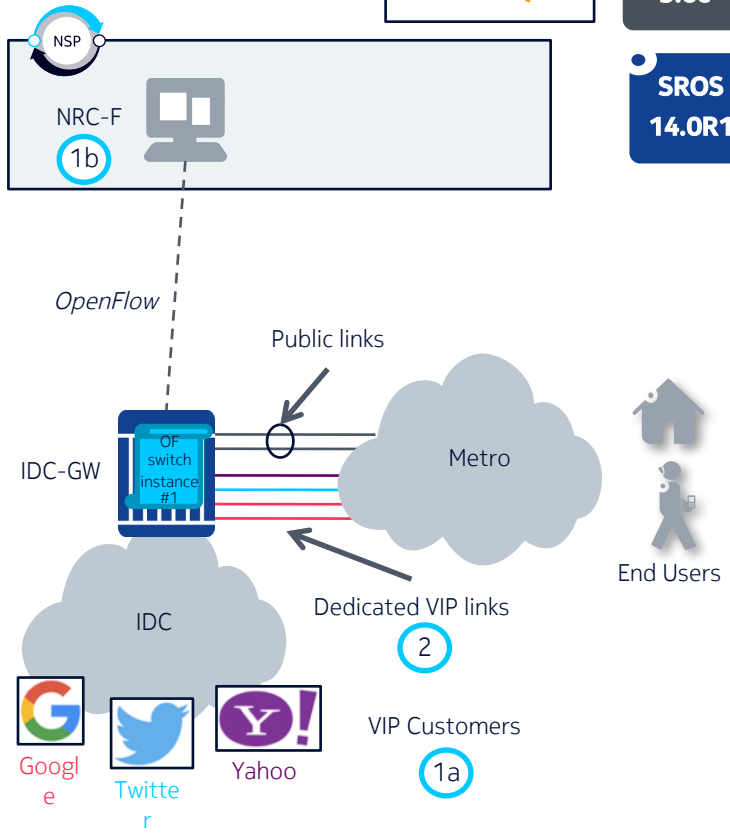
VIP-Source Subnet based Steering with VIP Link Management

SROS & NSP *Demo 4Q'16*

NSP 3.0c

SROS 14.0R1

- Use-case explanation:
  - Two sets of link groups exist: public and dedicated
    - Public link group is default exit
    - Dedicated link group is reserved for VIP customers only
  - 1a VIP customers sign-up for preferred treatment at IDC
    - Subnets used within DC are registered and fed into NRC-F
  - 1b NRC-F populates OpenFlow matches (source IP subnets of VIP customers) together with redirect to indirect next-hop action
  - 2 Traffic originated from VIP customers is redirected onto dedicated links via OpenFlow (rather than public links)
  - Bandwidth on Demand
    - Add or remove links to dedicated link group for VIP customers
    - Monitor per VIP-based source subnet



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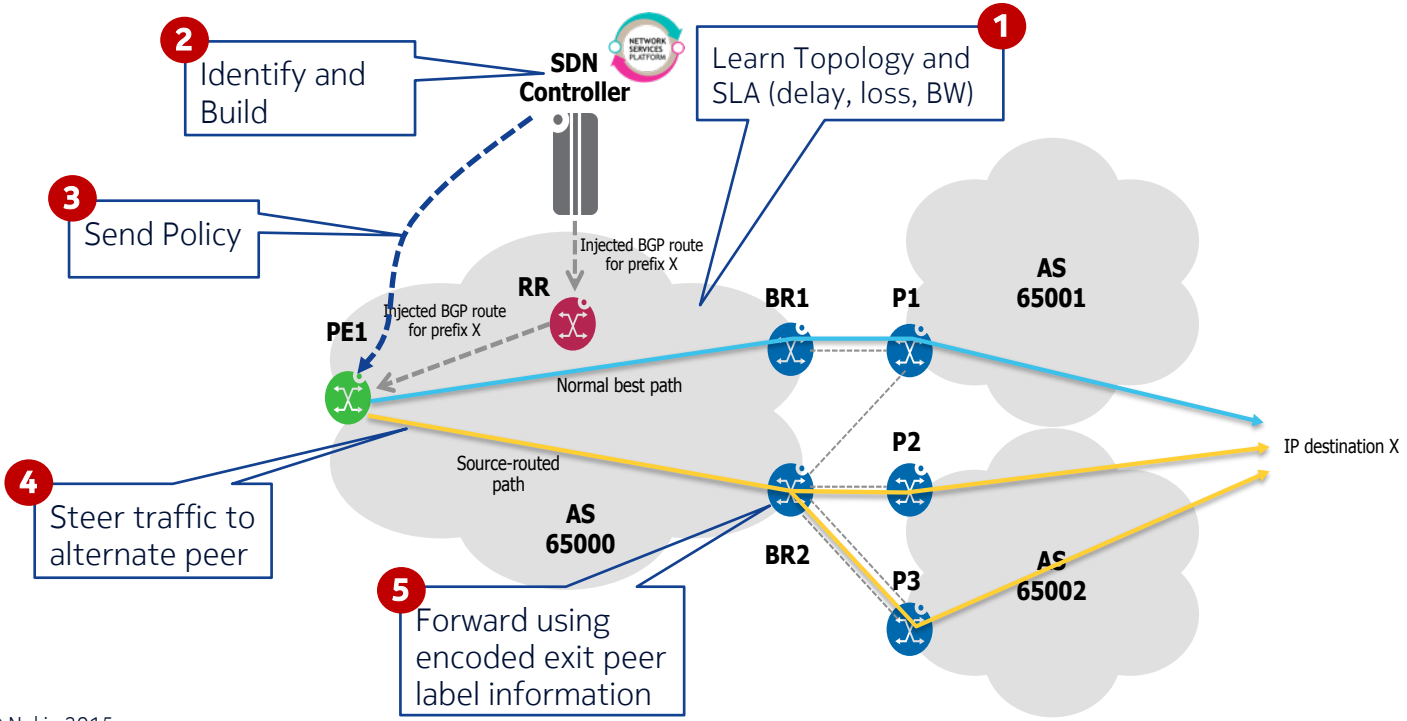
Egress Peer Engineering (EPE)

- Egress Peer Engineering (EPE) is a network use case where an ingress router (e.g., PE) or a source content is instructed to use a specific egress Peer router and a specific external interface to reach a particular destination.



VPN Flow Steering
Per-Flow TE Handing in IP-VPN

SROS & NSP *Demo 1Q'17*

NSP 3.0c

SROS 15.0R1

- Use-case explanation:
  - Targeted for PE-PE paths within VPRN context.
    - VPRN services which run "hot" or require added customer traffic control
    - DCI services w/ elephant flows
  - Start state: VPRN between two PE NH's resolves to a single LSP tunnel

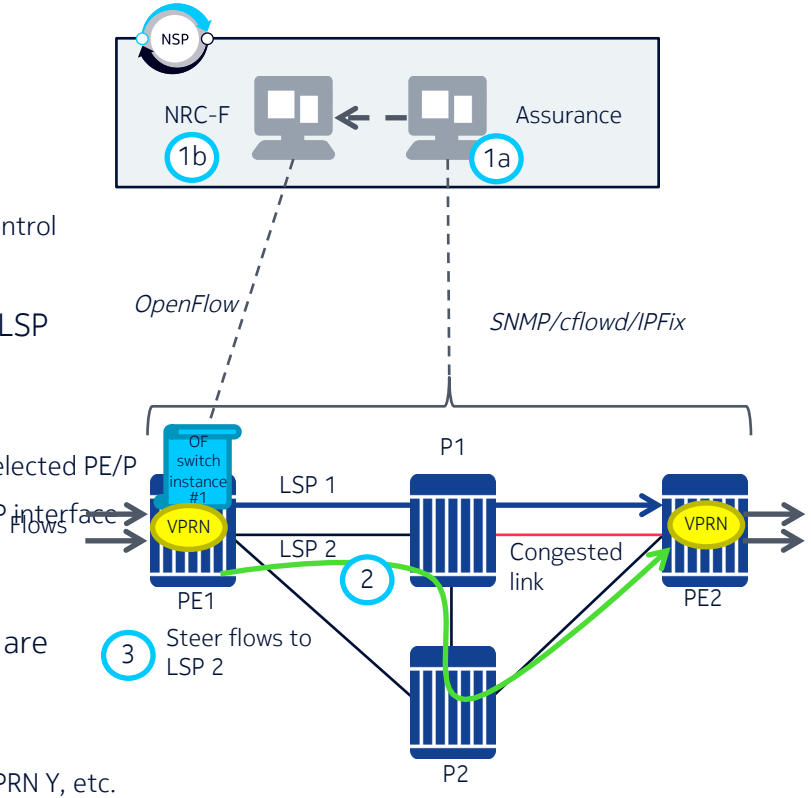
1a Assurance collects performance stats across network
- Aggregate link utilization monitored via egress interface stats on selected PE/P

1b TCA by Assurance alerts the NRC-F to imminent congestion on PE/P interface
- Flow stats then collected from selected PE and P to identify "top N flows" for selected VPRN's – policy driven

2 LSP 2 is created with P1-PE2 link excluded (i.e. all busy links are excluded) – policy driven

3 NRC-F redirects selected VPRN traffic to LSP 2 at PE1
- Various steering policy options: manual, "top-N flows" in VPRN X, VPRN Y, etc.

  - After link utilization drops below threshold, revert back to standard traffic flow (i.e. LSP1) – policy driven



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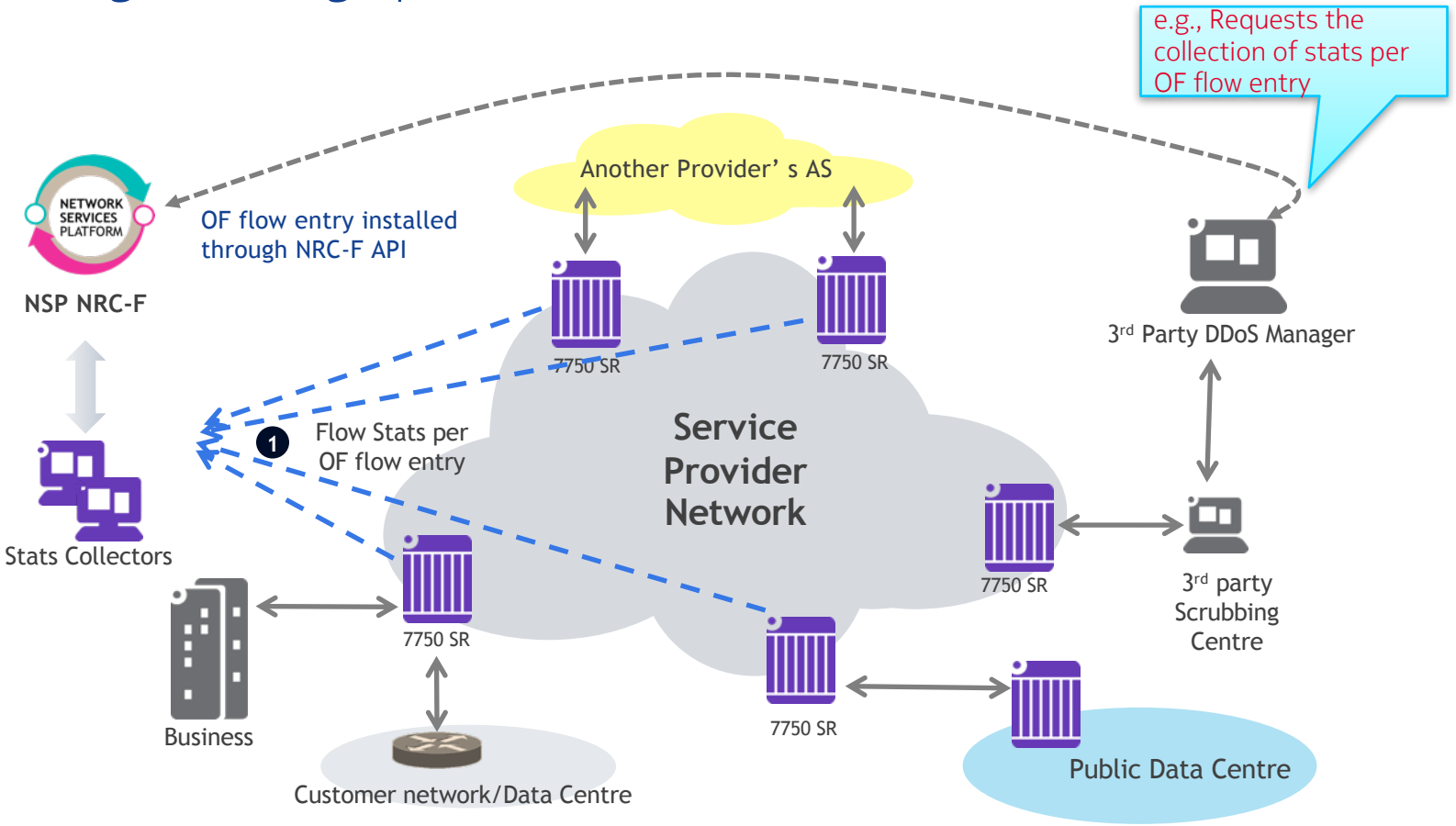
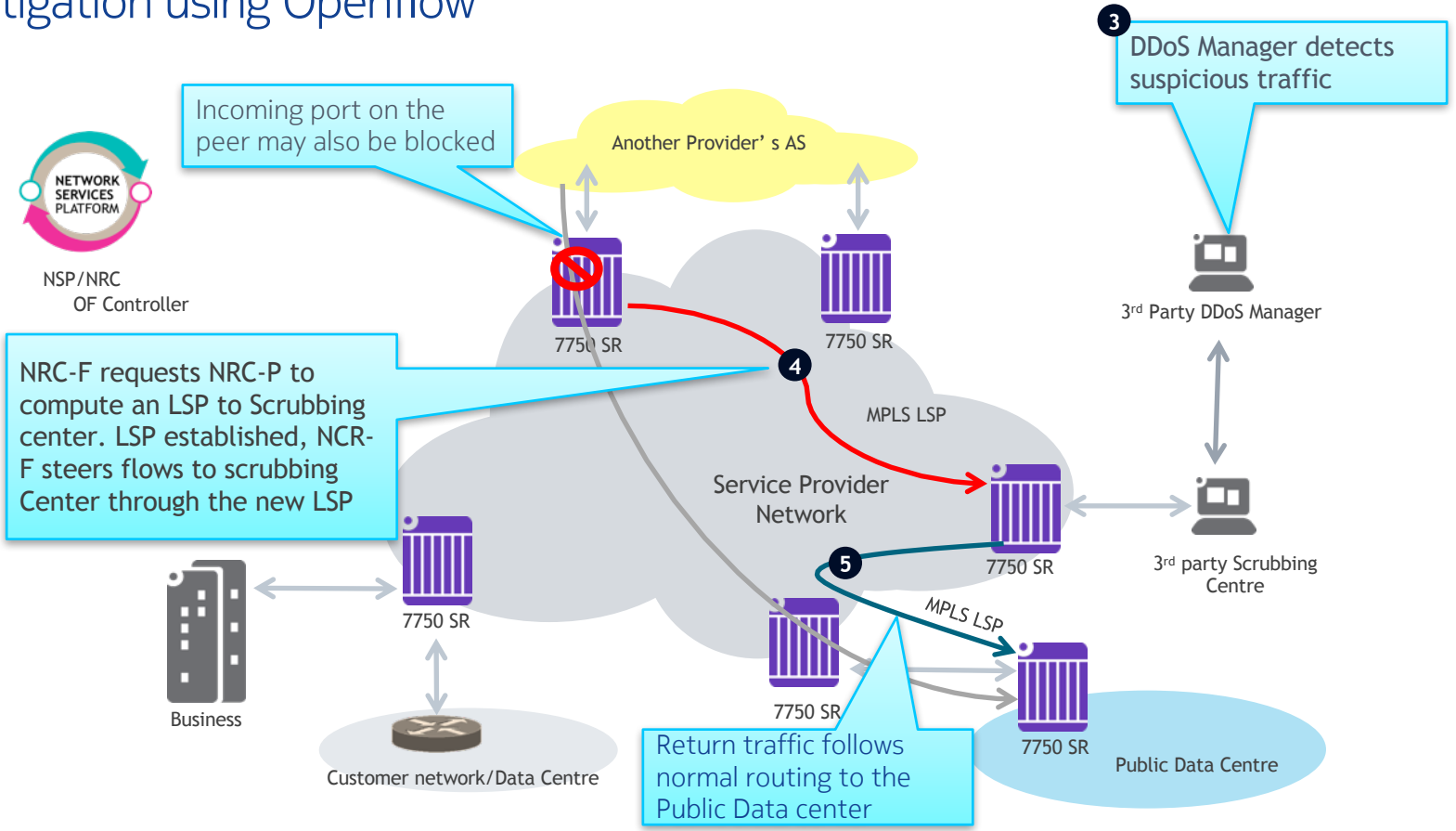
DDoS Mitigation using Openflow



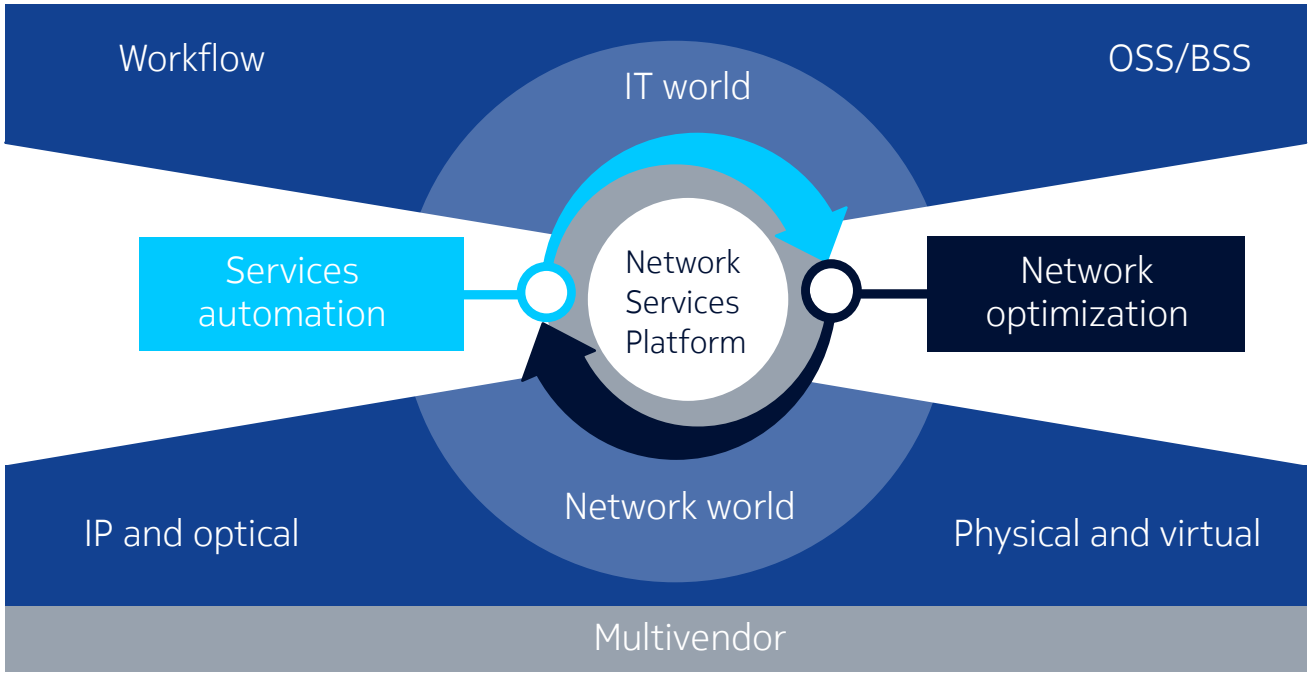
DDoS Mitigation using Openflow



Nokia Carrier SDN
Network Services Platform

Nokia Carrier SDN

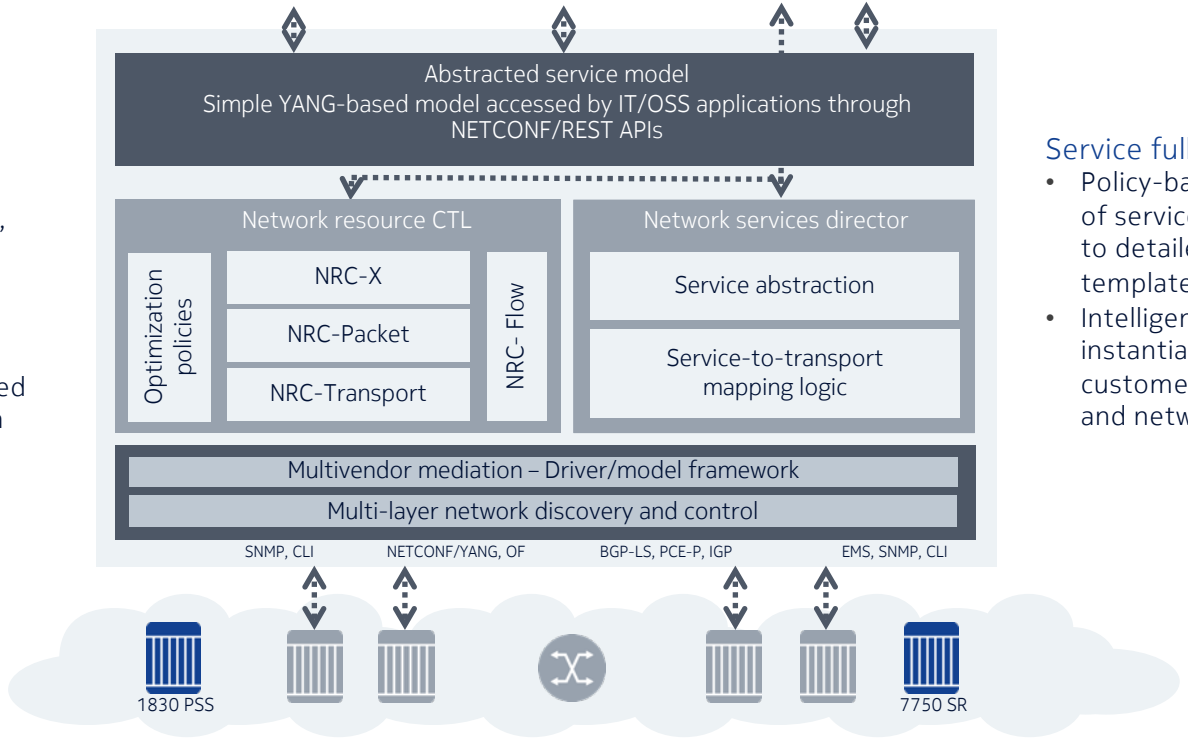
Bridging IT and the multi-layer, multivendor network



The NSP functional blocks - WAN automation and resource optimization

Path placement and optimization

- In-line, multi-domain, inter-layer path computation and creation
- Real-time topology and analytics-triggered network optimization
- Flow placement and control



Service fullfilment

- Policy-based mapping of service abstractions to detailed provisioning templates
- Intelligent service instantiation optimizes customer experience and network utilization

Global success: An award-winning, market-leading carrier SDN platform

"Most innovative SDN product strategy"[1]

ACG RESEARCH

"Global market share leader…"[2]

PT Expo (China)
"Best of show"

Current Analysis

"Strong" competitor tied for #1[3]

1. **Nokia NSP wins "2016 Leading Lights award for Most Innovative SDN Product Strategy"**
2. **Nokia NSP reported as "Global Market Share Leader in the following categories:Core Multi-layer SDN (IP + LH Optical), Multi-service Edge (MSER) SDN, Metro Optical SDN Control Software" -ACG Research; "Market Release: SP Multilayer Software Defined Network (SDN)", 4Q15**
3. **Nokia NSP ranked 'Strong' in WAN controller assessment Current Analysis; Krozier, David; "An Assessment of Commercial WAN SDN Controllers Against Customer Buying Criteria", July 14, 2016**

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