Segment Routing

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Agenda

- Objective
- Abstract Routing Model
- Use-cases
- Conclusion
- Q&A

SR Objectives

- Tackling issues reported by operators for years
  - IGP-based FRR for any topology
  - Simpler to operate, more scalable explicit routing
- Supporting “SDN”-based services
  - Provide a more responsive and scalable interaction between WAN orchestration, the applications and the network
- Evolution, no revolution
  - Must be simple to operate
  - Must support incremental deployment

Objective for this Nanog talk

- Informative
- Trigger your interest
  - A wealth of details in the upcoming drafts
- Seek your involvement
- Brief
  - We could speak for a full-day as we have much research and use-cases to share and discuss

Details

- draft-filsfils-rtgwg-segment-routing-00
- draft-filsfils-rtgwg-segment-routing-use-cases-00
- draft-previdi-isis-segment-routing-extensions-00
- draft-psenak-ospf-segment-routing-extensions-00
- draft-msiva-pce-pcep-segment-routing-extensions-00

Real

- Excellent endorsement and **leadership** from SP and Entreprise community
- Multi-vendor consensus and collaboration
- By mid June, we will submit detailed IETF drafts
  - Architecture
  - Use-cases
  - ISIS extensions
  - OSPF extensions
  - PCEP extensions
  - FRR
- SR EFT is available since Feb 28
  - 12k, ASR9k, CRS1, CRS3

S. Previdi, Ed.
C. Filsfils, Ed.
A. Bashandy
Cisco Systems, Inc.
M. Horneffer
Deutsche Telekom
B. Decraene
S. Litkowski
Orange
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R. Shakir
British Telecom
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TDC Oy
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Alcatel-Lucent
J. Tantsura
Ericsson
March 20, 2013

Abstract Routing Model

draft-filsfils-rtgwg-segment-routing-00

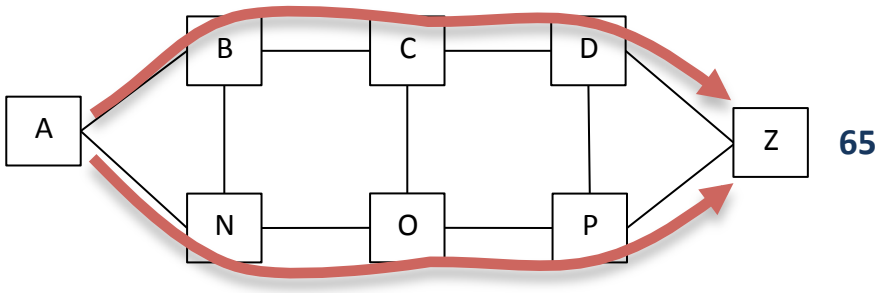
Segment Routing

- A 32-bit segment can represent any instruction
  - Service
  - Context
  - IGP-based forwarding construct
  - Locator
- Ordered list of segments
  - An ordered chain of topological and service instructions
- Per-flow state only at ingress SR edge node
  - Ingress edge node pushes the segment list on the packet

IGP Segments

- Prefix Segment
  - Steers traffic along ECMP-aware shortest-path to the related IGP Prefix
  - Global segment within the SR IGP domain
  - Node Segment: a prefix segment allocated to a prefix that identifies a specific node (e.g. the prefix is its loopback)
- Adjacency Segment
  - Steers traffic onto an adjacency or a set of adjacencies
  - Local segment related to a specific SR node
- SR Global Block
  - A subset of the Segment space
  - All the global segments must be allocated from SRGB
  - Operator manages SRGB like an IP address block: it ensures unique allocation of a global segment within the SR domain

IGP Prefix Segment

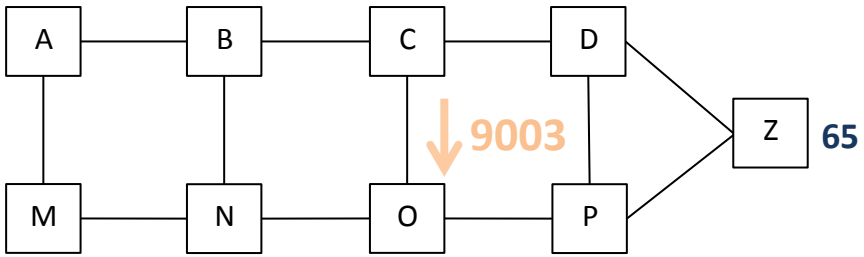


A packet injected anywhere with active segment 65 will reach Z via ecmp-aware shortest-path

- Z advertises its global prefix segment 65 with his loopback address Z/32
  - simple ISIS sub-TLV extension
  - simple OSPF Opaque sub-TLV extension
- All remote nodes install the prefix segment to Z in the SR dataplane along the shortest path to Z/32
- IPv4 and IPv6

draft-previdi-isis-segment-routing-extensions-00
draft-psenak-ospf-segment-routing-extensions-00

IGP Adjacency Segment



A packet injected at node C with active segment 9003 is forced through datalink CO

- C allocates a local segment 9003 for its adjacency CO
- C advertises the adjacency segment in the IGP
  - Simple ISIS sub-TLV extension
  - simple OSPF Opaque sub-TLV extension
- C is the only node to install the adjacency segment in SR dataplane
- IPv4 and IPv6

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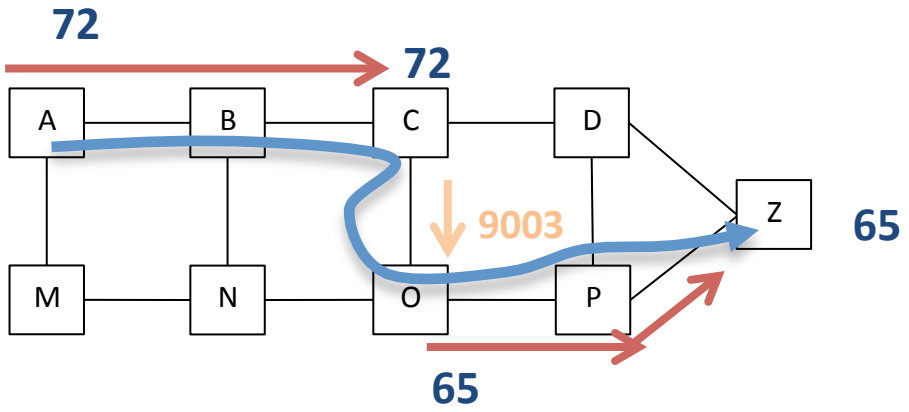
draft-psenak-ospf-segment-routing-extensions-00

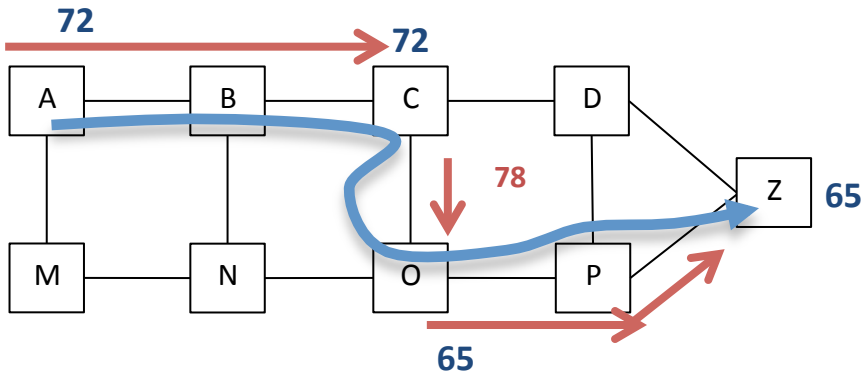
Combining Segments



- Source Routing
- ABCOPZ is expressed as {**72**, **9003**, **65**}

Combining Segments

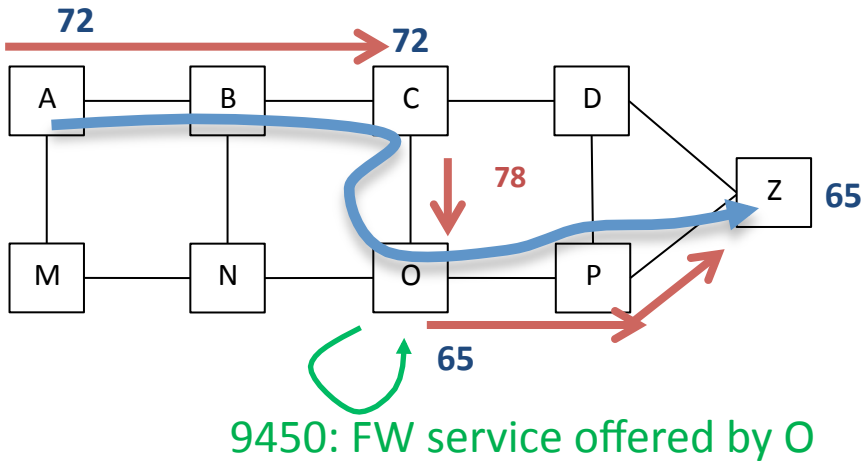
{72, 78, 65}



- Prefix Segment is at the heart of the proposal
  - ecmp multi-hop shortest-path
  - in most topologies, any path can be expressed as list of prefix segments

Combining Segments

{72, 78, 9450, 65}



- Service Segments can be part of the source route

SR Control-Plane

- Lightweight extension to ISIS/OSPF
- IPv4 and IPv6
- Agnostic to the dataplane
  - works with any dataplane that supports the encoding of a list of segments on the packet

MPLS dataplane

- The 20 right-most bits of the segment are encoded as a label
- A list of segments is represented as a stack of labels
- The active segment is the top label
- The IGP Prefix segment stays on the top of the stack thanks to a SWAP operation where the ingress and egress label values are the same
- Transports IPv4 and IPv6
- No changes in the operations of the MPLS dataplane
- SR can co-exist and interwork with other MPLS control-plane protocols (LDP, RSVP)

IPv6 dataplane

(without any MPLS dataplane)

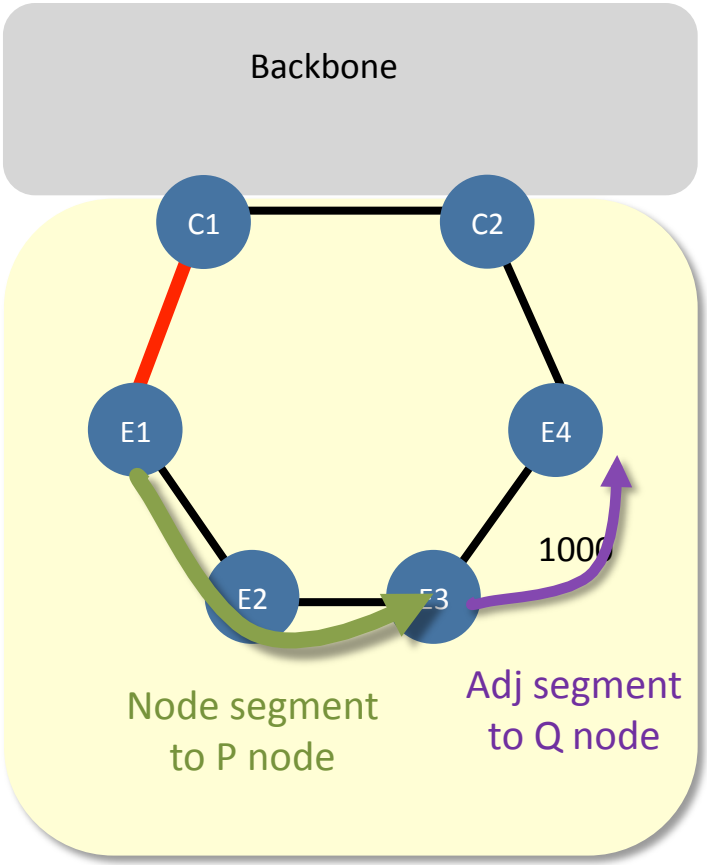
- All the SR ISIS/OSPF Control Plane is dataplane agnostic and hence applies directly to IPv6
- Remaining work: detailing the IPv6 tunneling and new Routing Extension type header
  - High-level description provided at March IPv6 Conference
  - Detailed Draft should be available soon
    - We are working on this in close collaboration with Comcast and other SP/Entreprise operators and academia
    - Any contribution is welcome

Use-Cases

draft-filsfils-rtgwg-segment-routing-use-cases-00

Automated & Guaranteed FRR

- Directed LFA FRR is guaranted in any symmetric topology
  - 2002, LFA FRR project at Cisco
  - draft-bryant-ipfrr-tunnels
- No extra computation (RLFA)
- Simple repair stack
  - node segment to P node
  - adjacency segment from P to Q



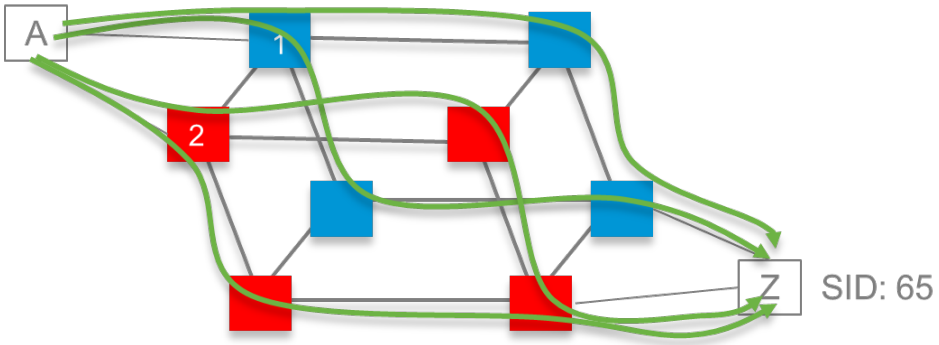
Default metric: 10

Disjointess in Dual-Plane

Anycast SID illustration

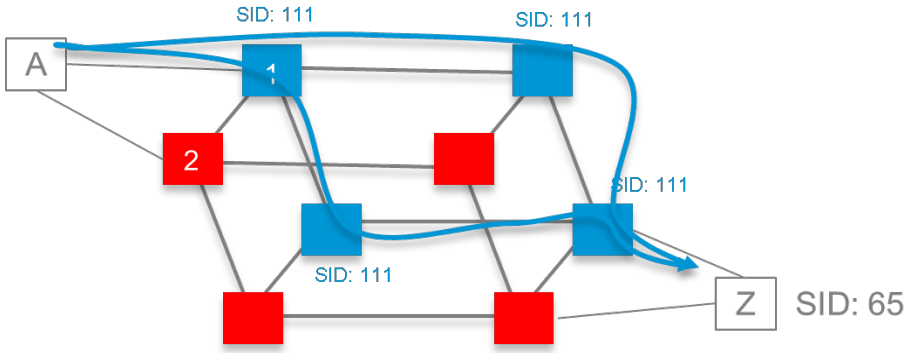
A sends traffic with [65]

Classic ecmp “a la IP”



A sends traffic with [111, 65]

Packet gets attracted in blue plane and then uses classic ecmp “a la IP”



CoS-based TE

Anycast SID illustration

- Tokyo to Brussels
  - data: via US: cheap capacity
  - voip: via russia: low latency
- CoS-based TE with SR
  - IGP metric set such as
    - Tokyo to Russia: via Russia
    - Tokyo to Brussels: via US
    - Russia to Brussels: via Europe
  - Anycast segment “Russia” advertised by Russia core routers
- Tokyo CoS-based policy
  - Data and Brussels: push the node segment to Brussels

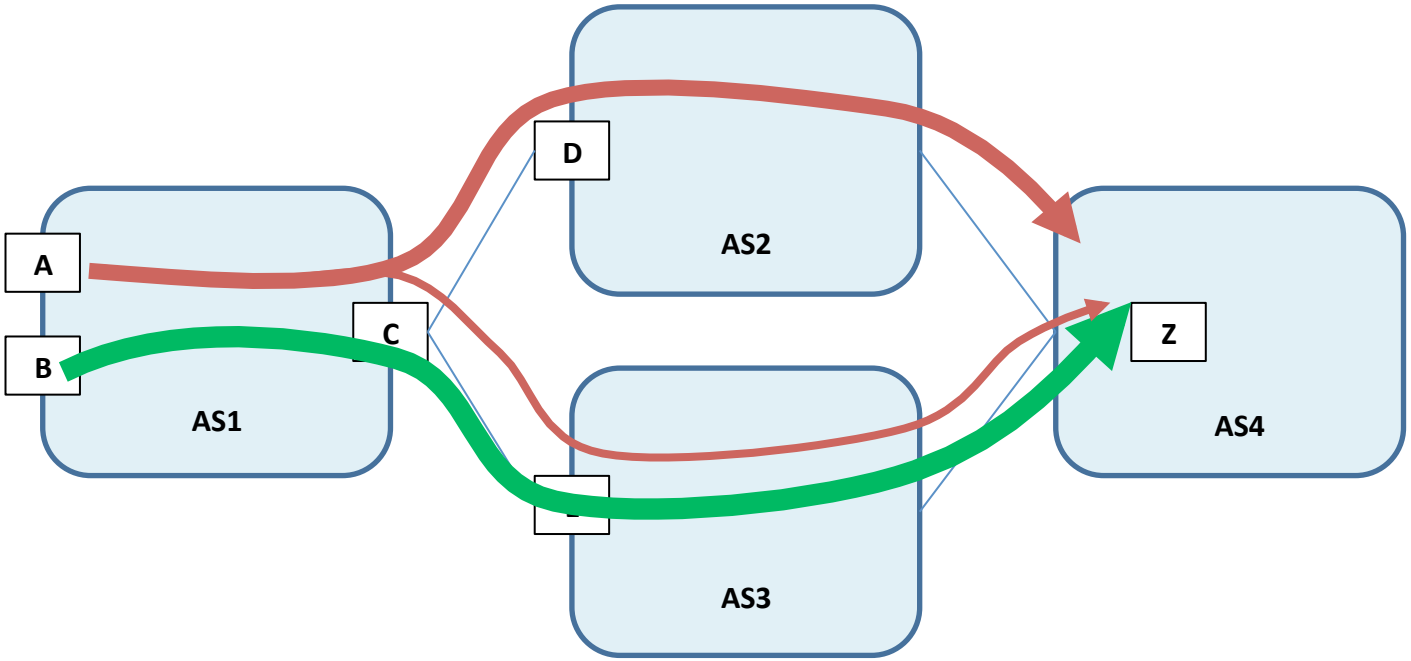
    ➔ ECMP-aware shortest-path to Brussels
  - VoIP and Brussels: push the anycast node to Russia, push Brussels

    ➔ ECMP-aware shortest-path to Russia, followed by
    ECMP-aware shortest-path to Brussels

Node segment to Brussels

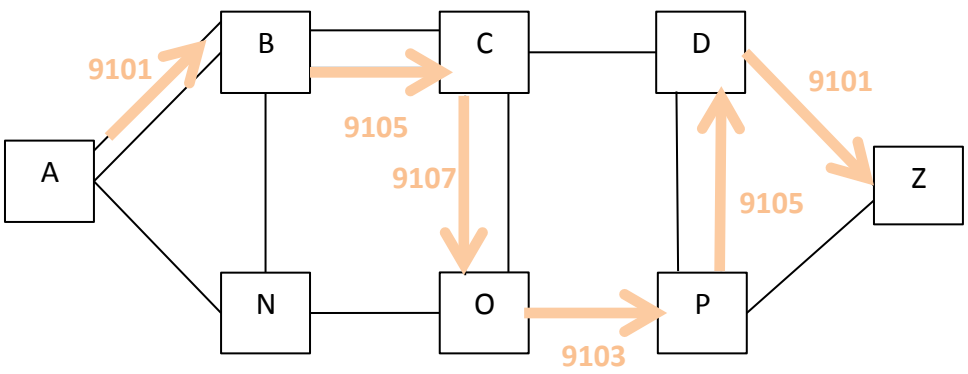
Node segment to Russia

Engineer traffic towards egress peers



- Ingress border routers control how their traffic is balanced between peers
  - Overriding BGP decision at egress border

Full control and OAM



9101
9105
9107
9103
9105
9101

- For Traffic Engineering
- or for OAM

Google

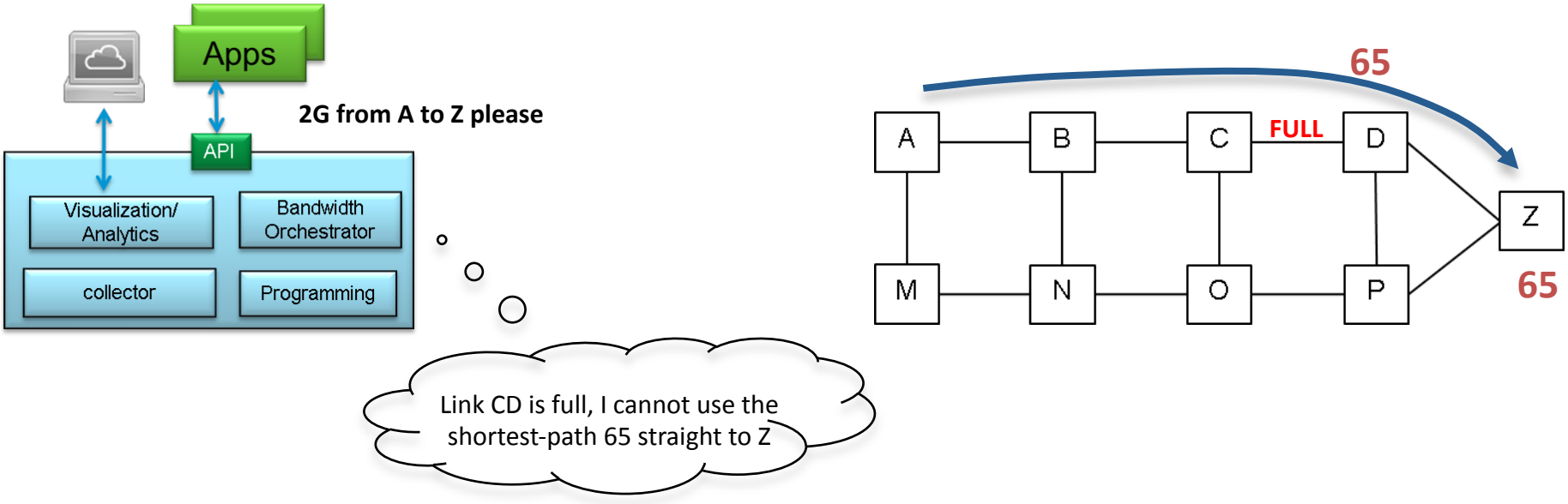
Localizing packet loss

In a large complex network

Nicolas Guilbaud nguilbaud@google.com
Ross Cartlidge rossc@google.com

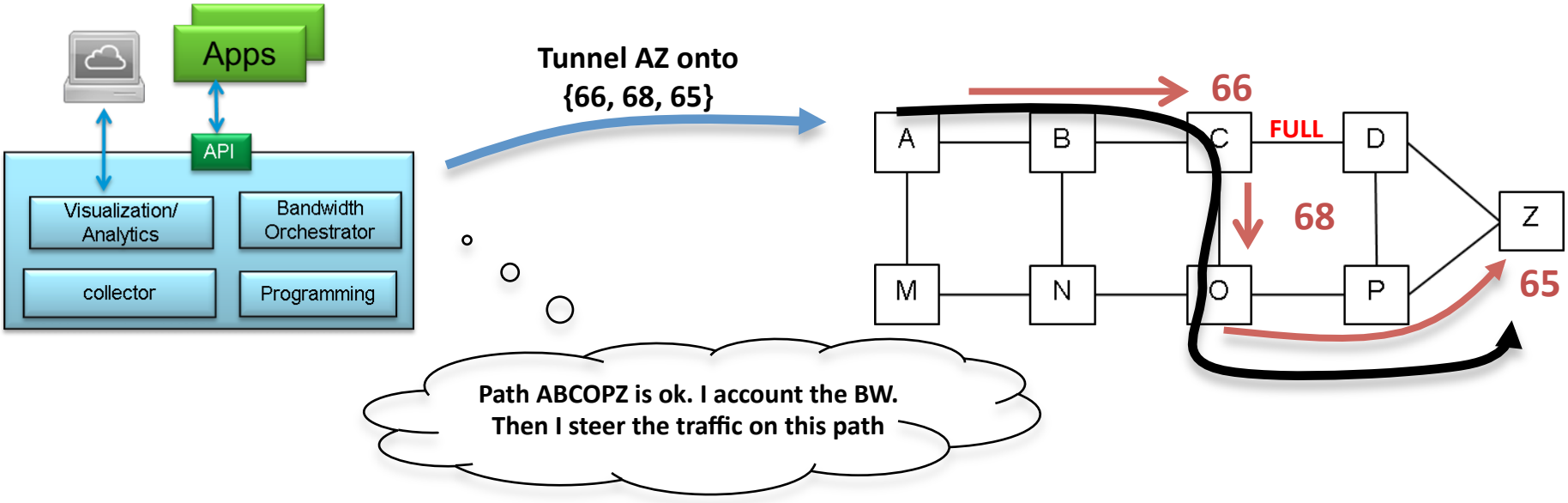
Nanog57, Feb 2013

SDN Orchestration



- The network is simple, highly programmable and responsive to changes instructed by stateful PCE

SDN Orchestration



- The network is simple, highly programmable and responsive to changes instructed by stateful PCE

Conclusion

- Technology is simple
  - Lightweight ISIS/OSPF extensions
  - Immediate applicability to MPLS dataplane
    - IPv4 and IPv6
  - A new type of Routing Extension header for IPv6 pure dataplane
- Numerous use cases
- Significant industry interest
- Multi-vendor/operator constructive collaboration
- Your feedback and contribution is welcome!