

Segment Routing !

- Path/Flow programmability 進化のかたち

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SDN Taxonomy

● SDN

広義のSDN

- Abstraction
- Virtualization
- Cloud Resource Orchestration
- Service control
- Workflow Automation
- ...

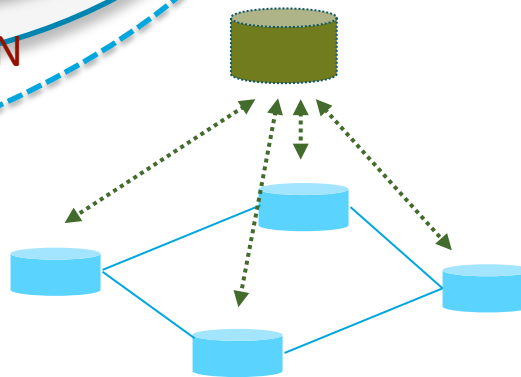
- Flow/Path programmability

狭義のSDN

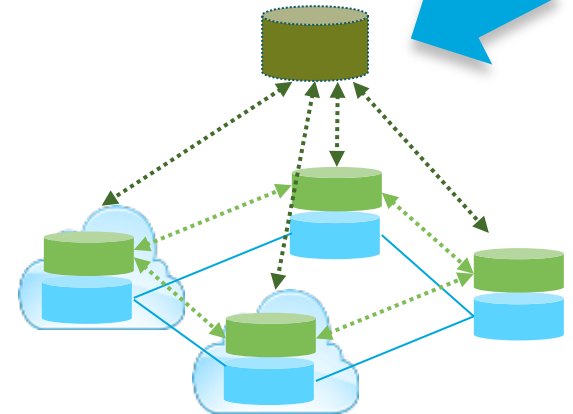
● Flow/Path Programmability

Hybrid Model (vs Controller/Agent Model)

- 自律分散コントロールプレーンが残す
 - Scaling, Robustness
 - Fault Detection, Protection, LAG..
- 集中型intelligenceが適する物は集中で
 - 可視化、分析、
 - 自動化、Traffic Engineering

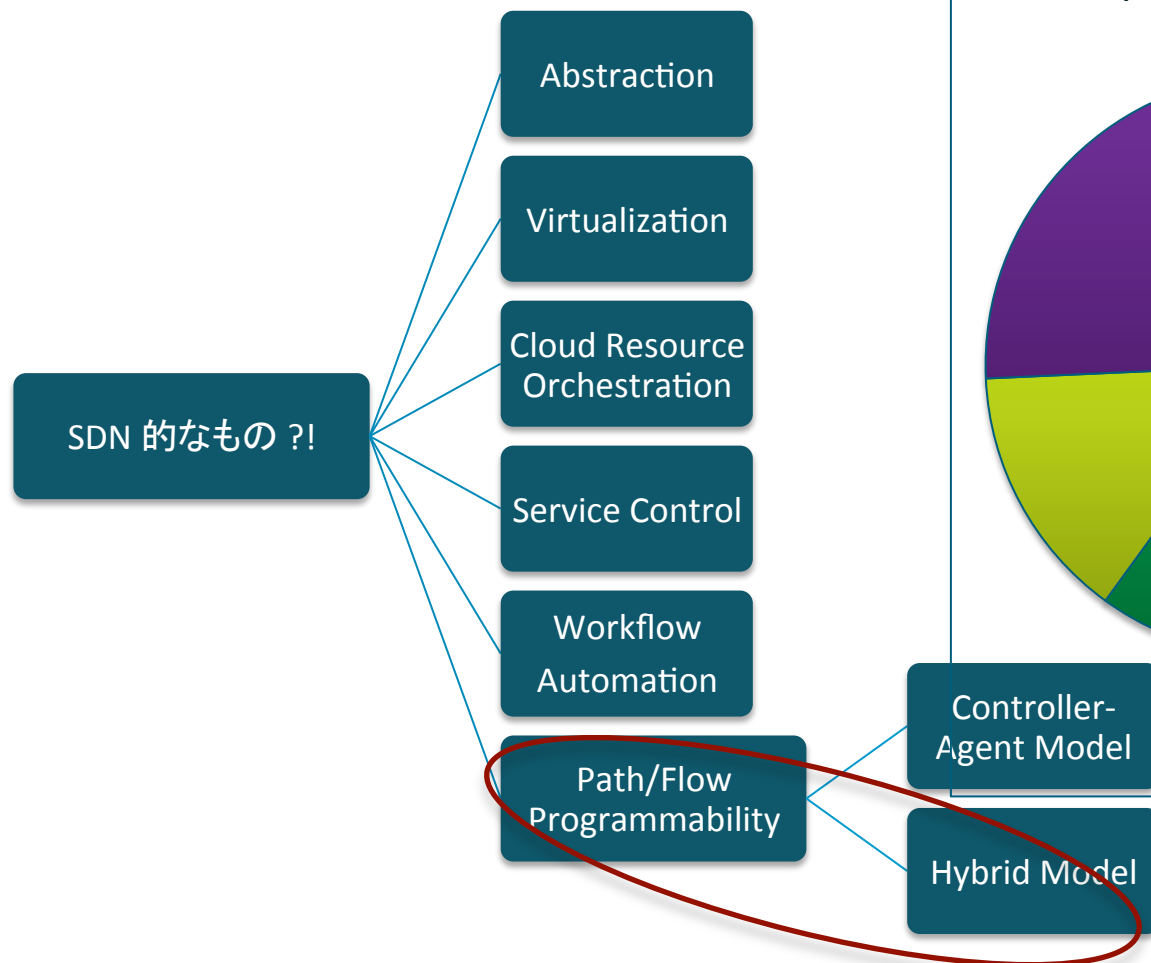


Controller/Agent Model

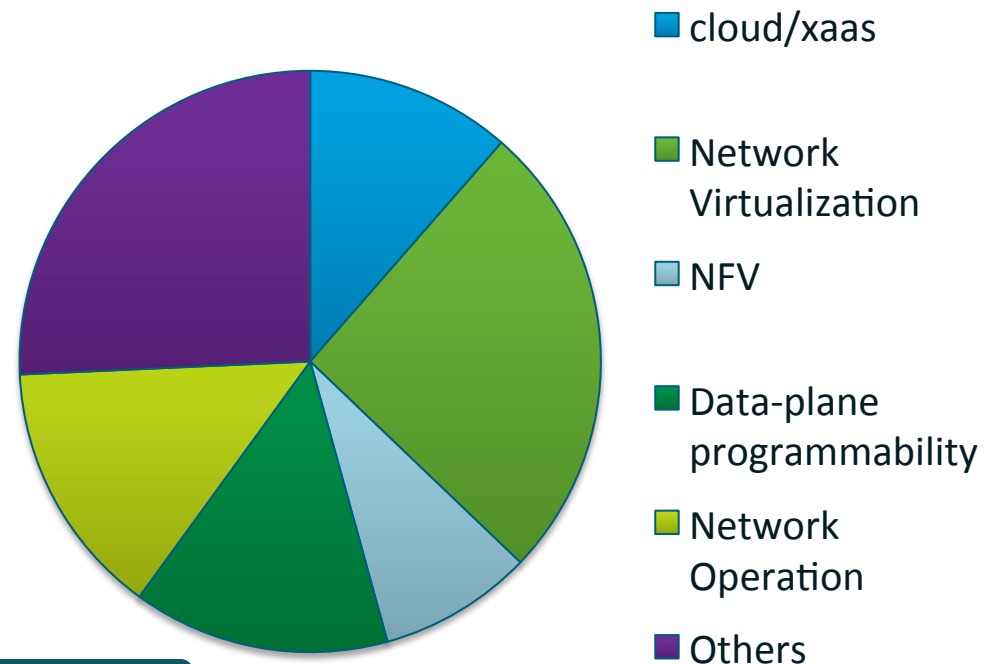


Hybrid Model

SDN Taxonomy ?!



SDN-Japan 2013 : 35 sessions

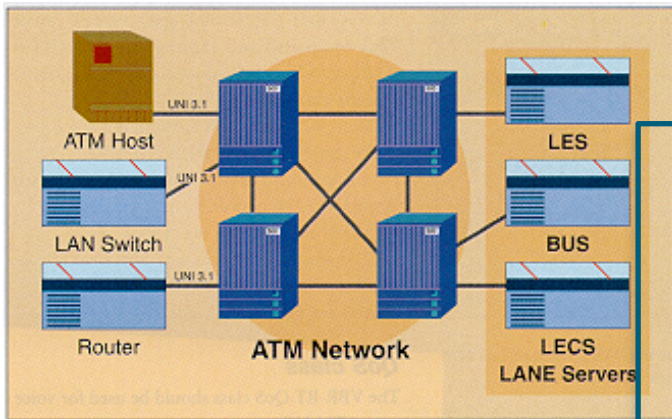


大多数が仮想化関連！

- “Virtualization Japan”に改名する? (冗談です)
- 「インフラのしくみそのものよりも、その上でどういう価値を出すか」が重要

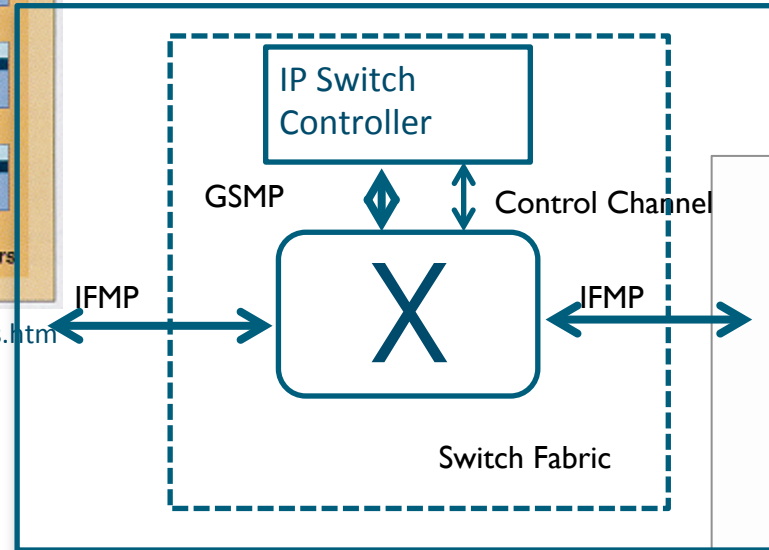
Flow/Path Programmability – lessons learnt

• LAN Emulation (LANE)



http://home.mira.net/~marcop/ATM_applications.htm

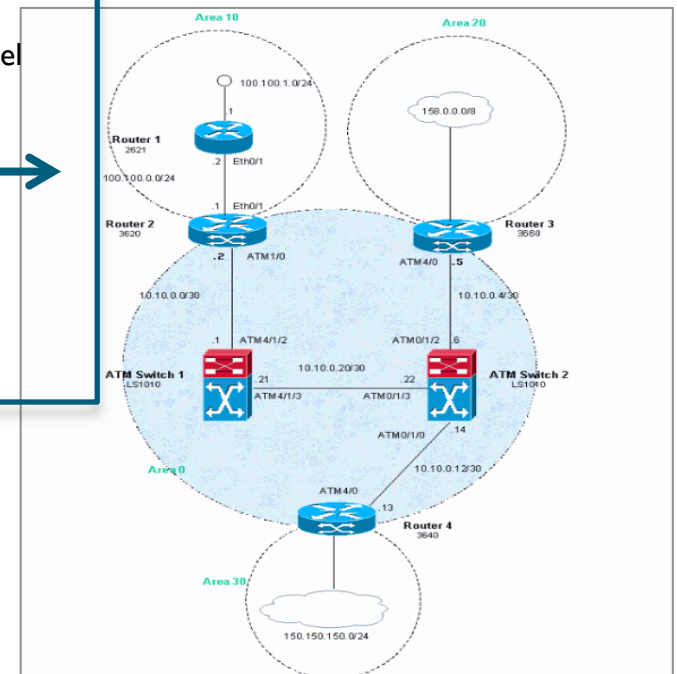
• IP Switching



http://www.cse.wustl.edu/~jain/cis788-97/ftp/ip_switching/index.htm を参考に作成

Innovative,
but just emulation is NOT good !!
既存機能のエミュレーションではだめ。

• MPLS - IP+ATM/VC merge

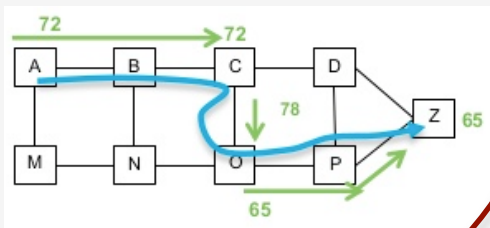


http://www.cisco.com/en/US/tech/tk436/tk798/technologies_configuration_example09186a00801c2d73.shtml

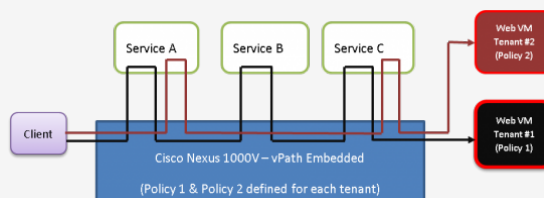
Flow/Path Programmability 進化のかたち

- Flow/Path それ自体が価値を提供することが求められる
- 「Applicationの要請にどれだけ答えられるか」

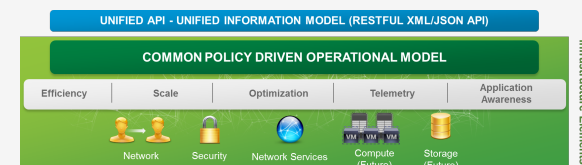
Segment Routing



Network Service Chaining

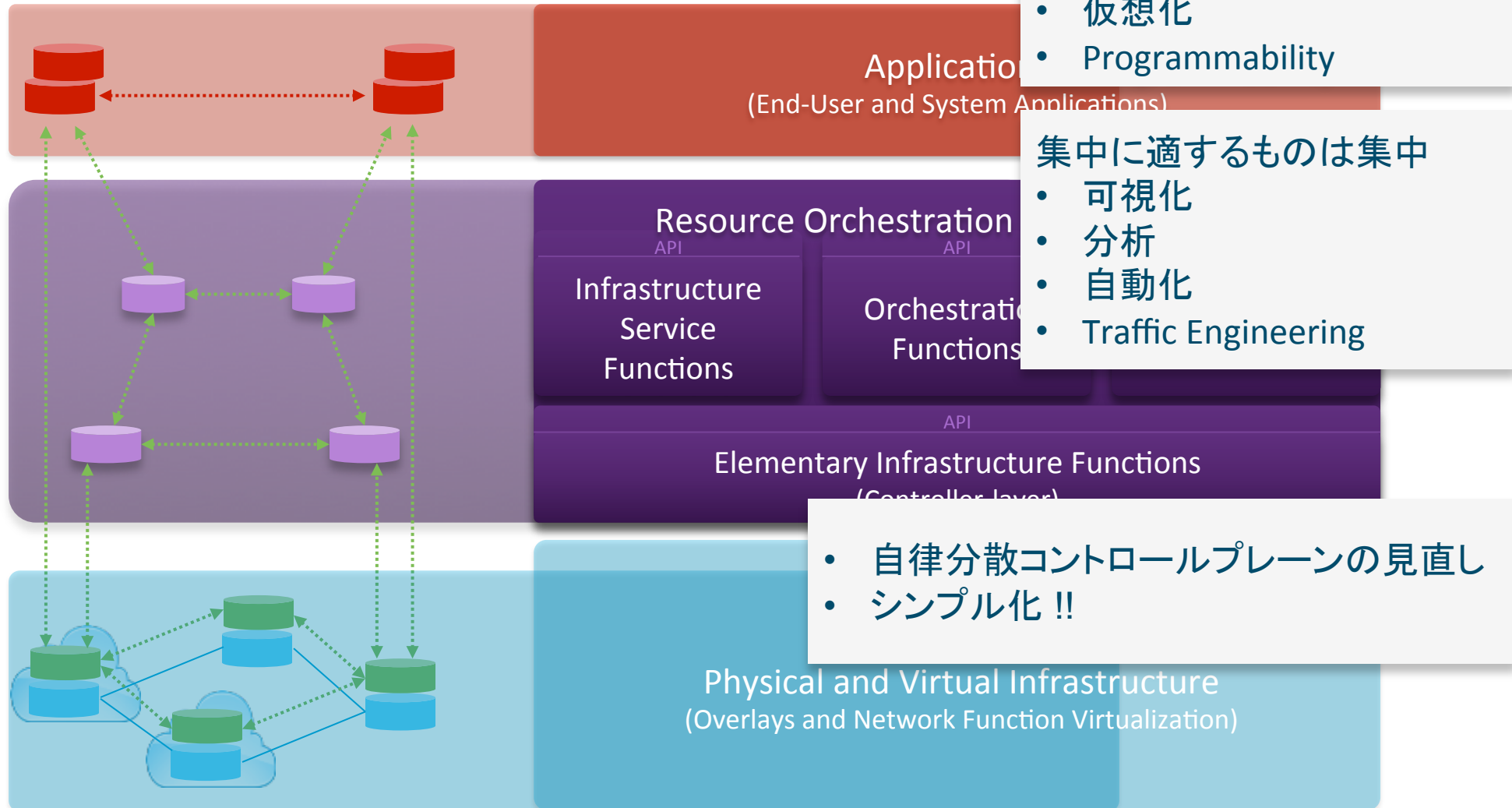


Policy-aware forwarding



仮想化も重要！、ハードウェアも重要！！

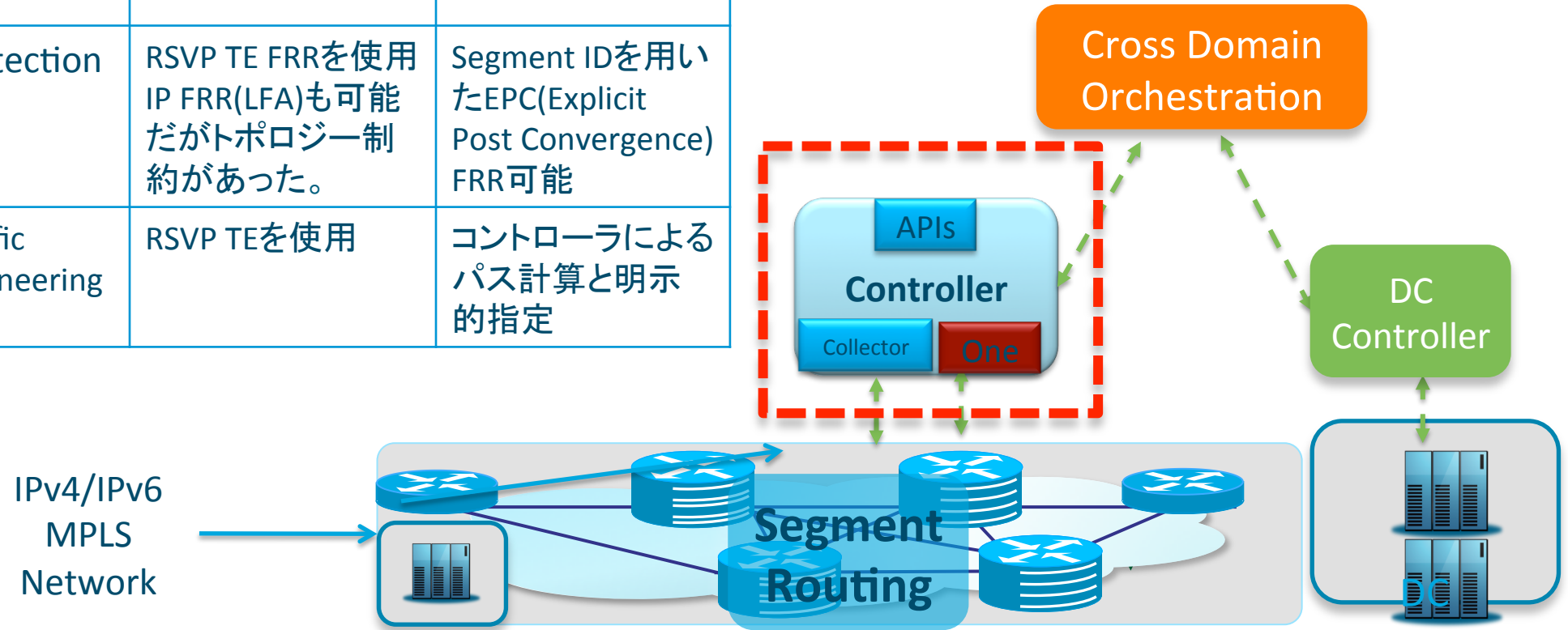
Segment Routing – Background SDN Architectural Model



Segment Routing^(*)によるNWのシンプル化

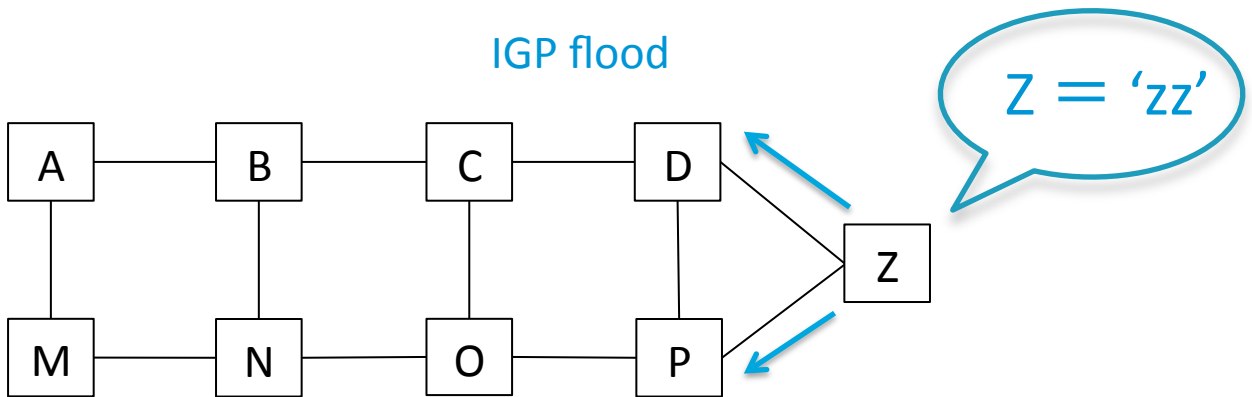
	MPLS	Segment Routing
転送ヘッダ	LDPやRSVPによりLabelを配布	IGPによりSegment IDを配布
Protection	RSVP TE FRRを使用 IP FRR(LFA)も可能 だがトポロジー制約があった。	Segment IDを用いたEPC(Explicit Post Convergence) FRR可能
Traffic Engineering	RSVP TEを使用	コントローラによるパス計算と明示的指定

- RSVP, LDPは不要
- ネットワーク内のステートが大幅に減少
- ApplicationやOrchestrationと容易に連携



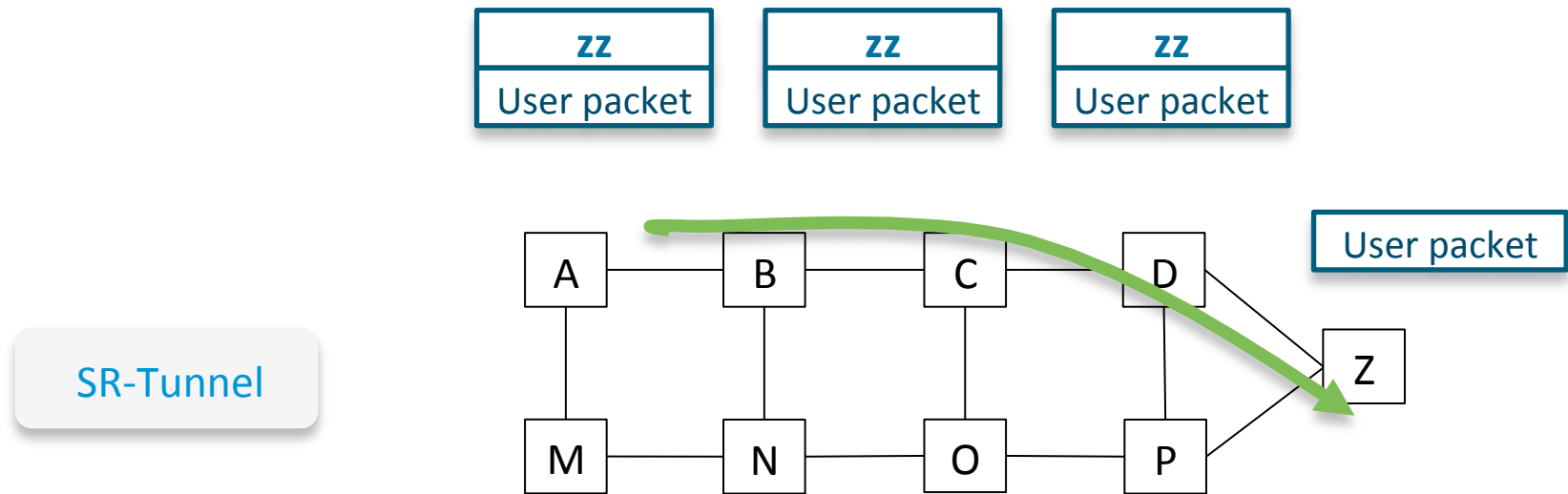
(*) draft-filsfils-rtgwg-segment-routing-00

Segment Routing – 基本動作



- 各ノードは自分のSegment IDを、IGPにより広報する
 - OSPFの場合、opaque LSAを使用 (draft-psenak-ospf-segment-routing-extensions)
 - 2種類のSegment ID
 - Node Segment ID (Node-SID) : ノードへのbest pathを表す
 - Adjacency Segment ID (Adj-SID) : インタフェースへのone hop path

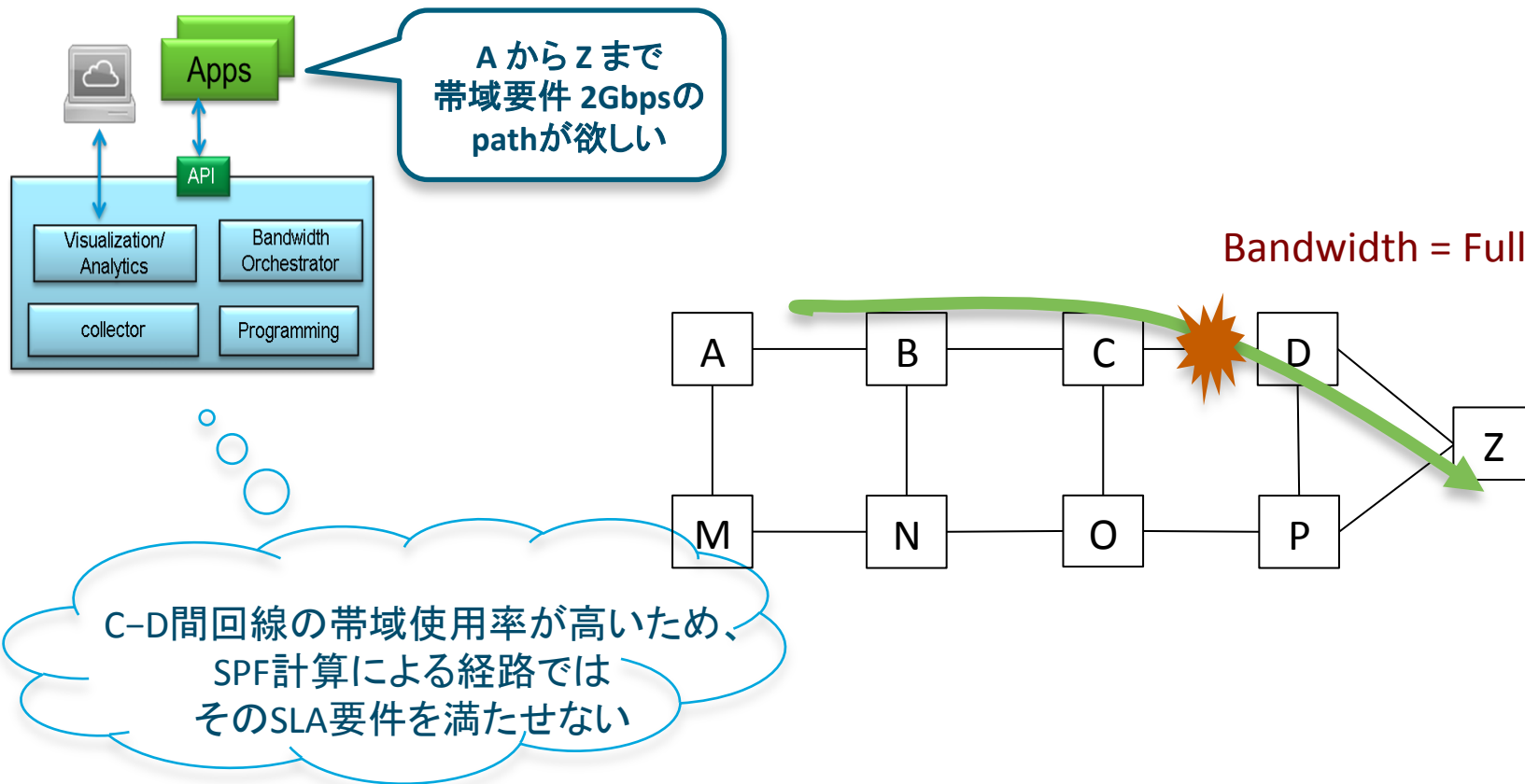
Segment Routing – 基本動作



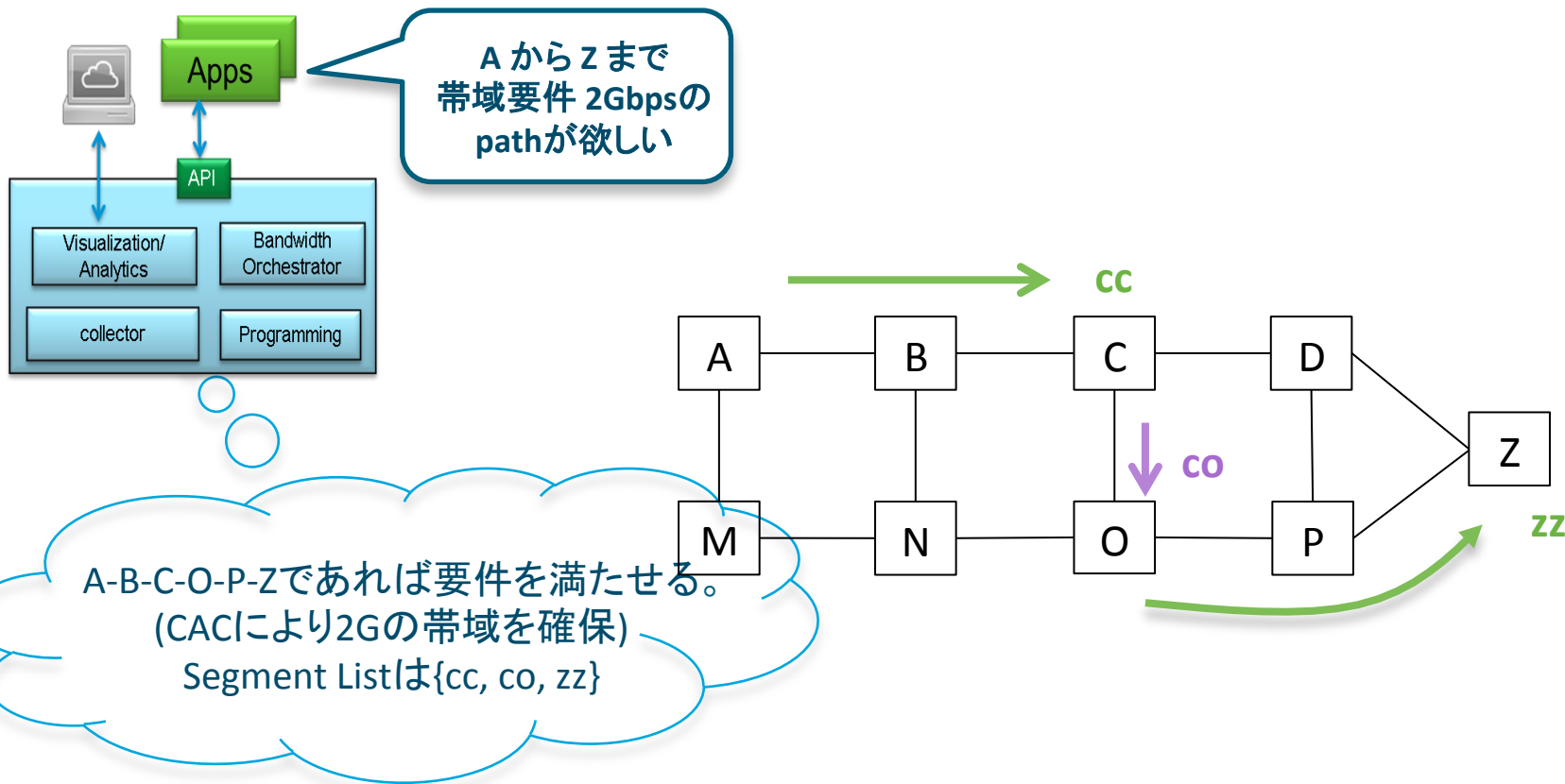
- ノードZを宛先とするパケットには、zzをつけて転送する

(Segment ID=global significant <-> c.f. MPLS Label = local significant)

Segment Routing – Controllerによる制御



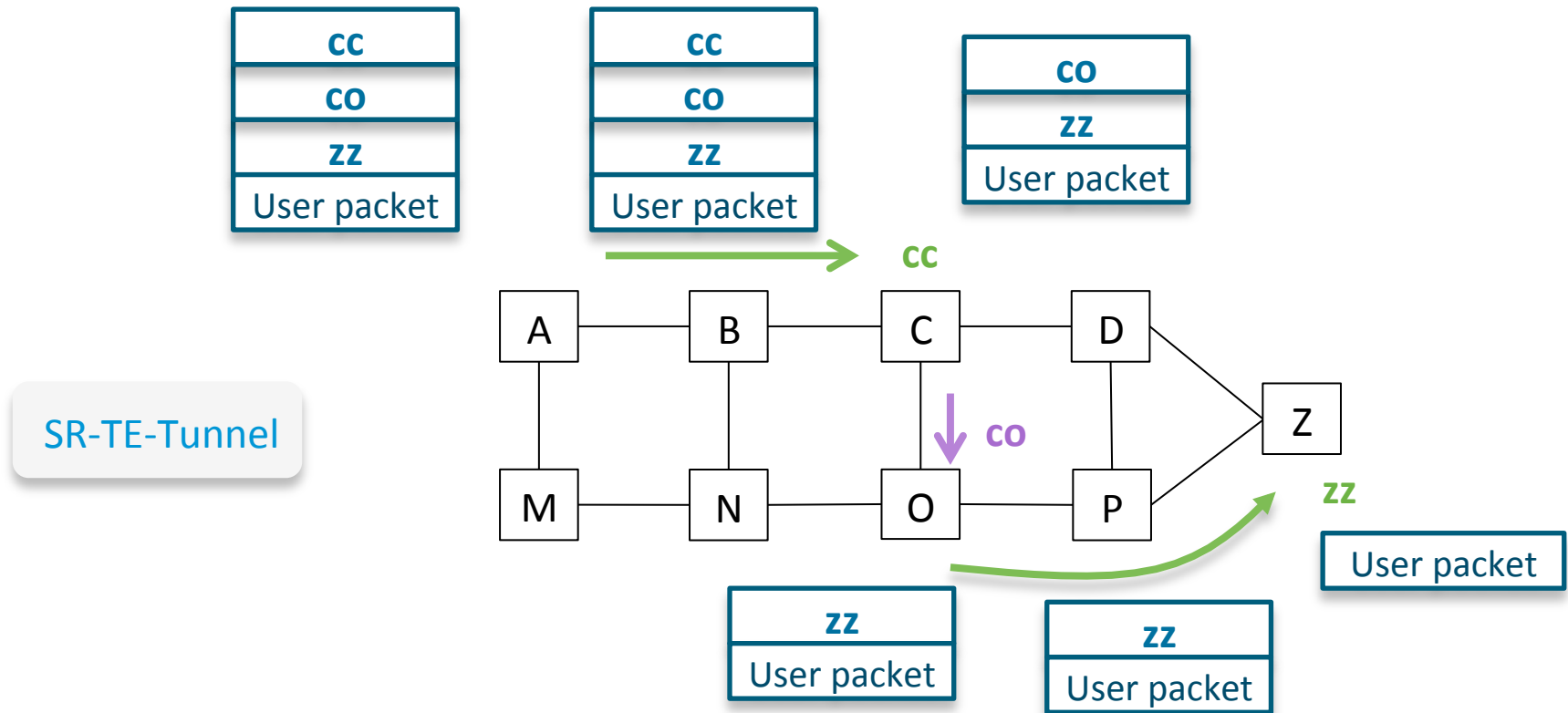
Segment Routing – Controllerによる制御



• Controller

- そのSLA要件を満たすパスを発見する
- NodeおよびAdjacency Segmentのリストをencodeする

Segment Routing - Source Routing



- SourceにてHeader Stackを生成し、パケットを送出する
Pathは、Segment idのStackとして表現される。(転送ヘッダ == Label, IPv6 data planeも可)
- 中継ノードはヘッダーに応じてforwarding、RSVP stateを持つ必要がない

Controller : PCEP Capability Negotiation

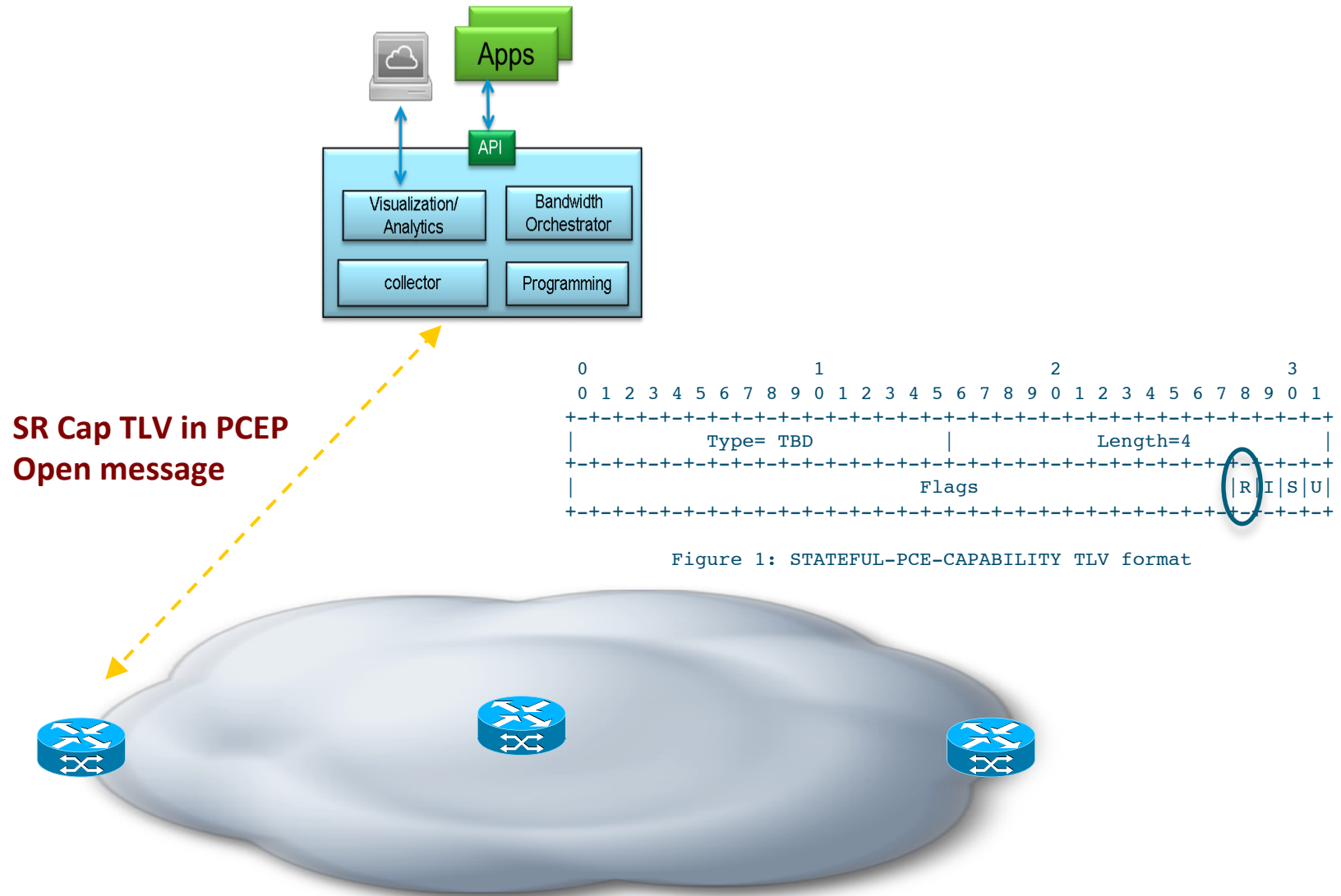
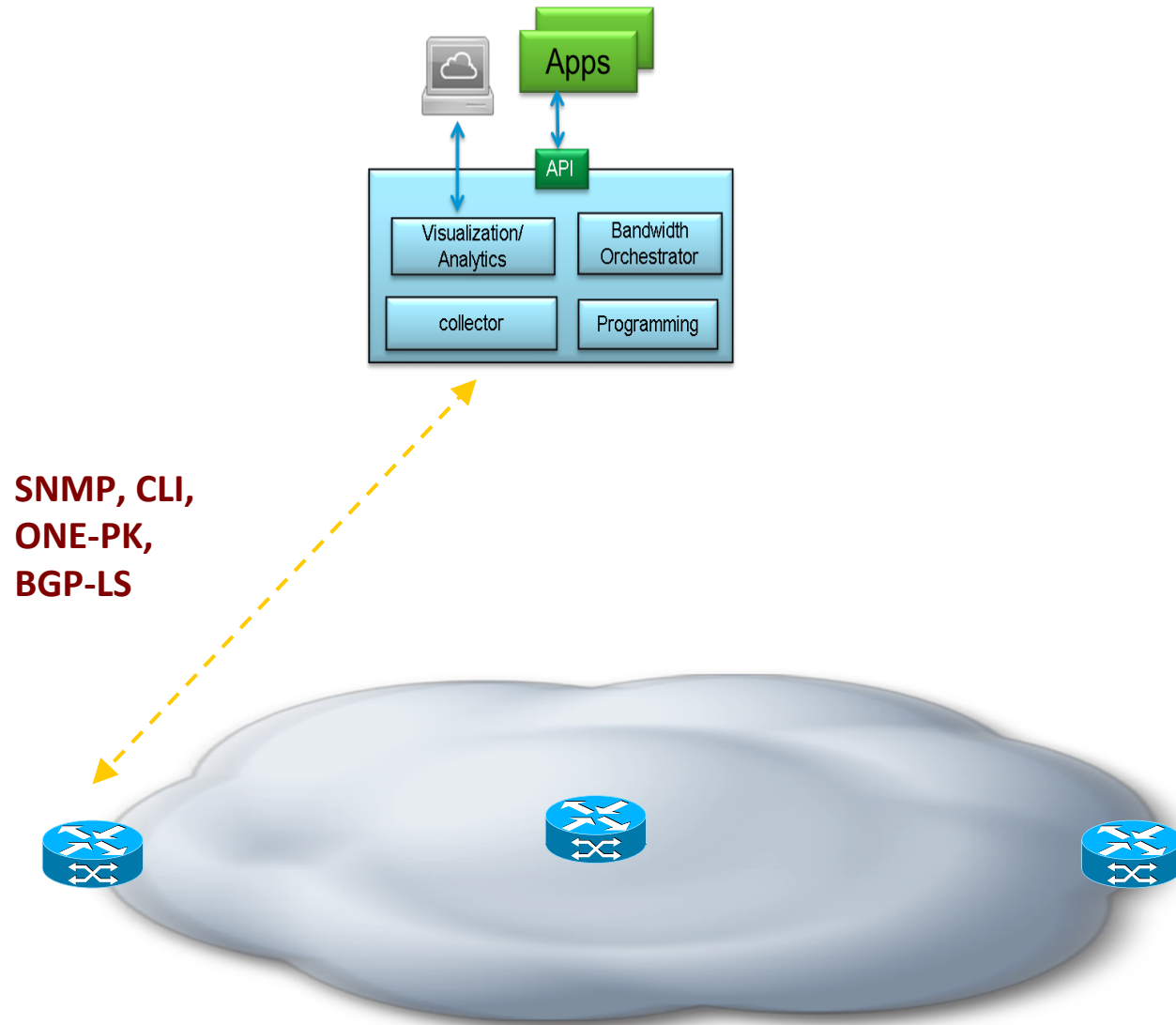


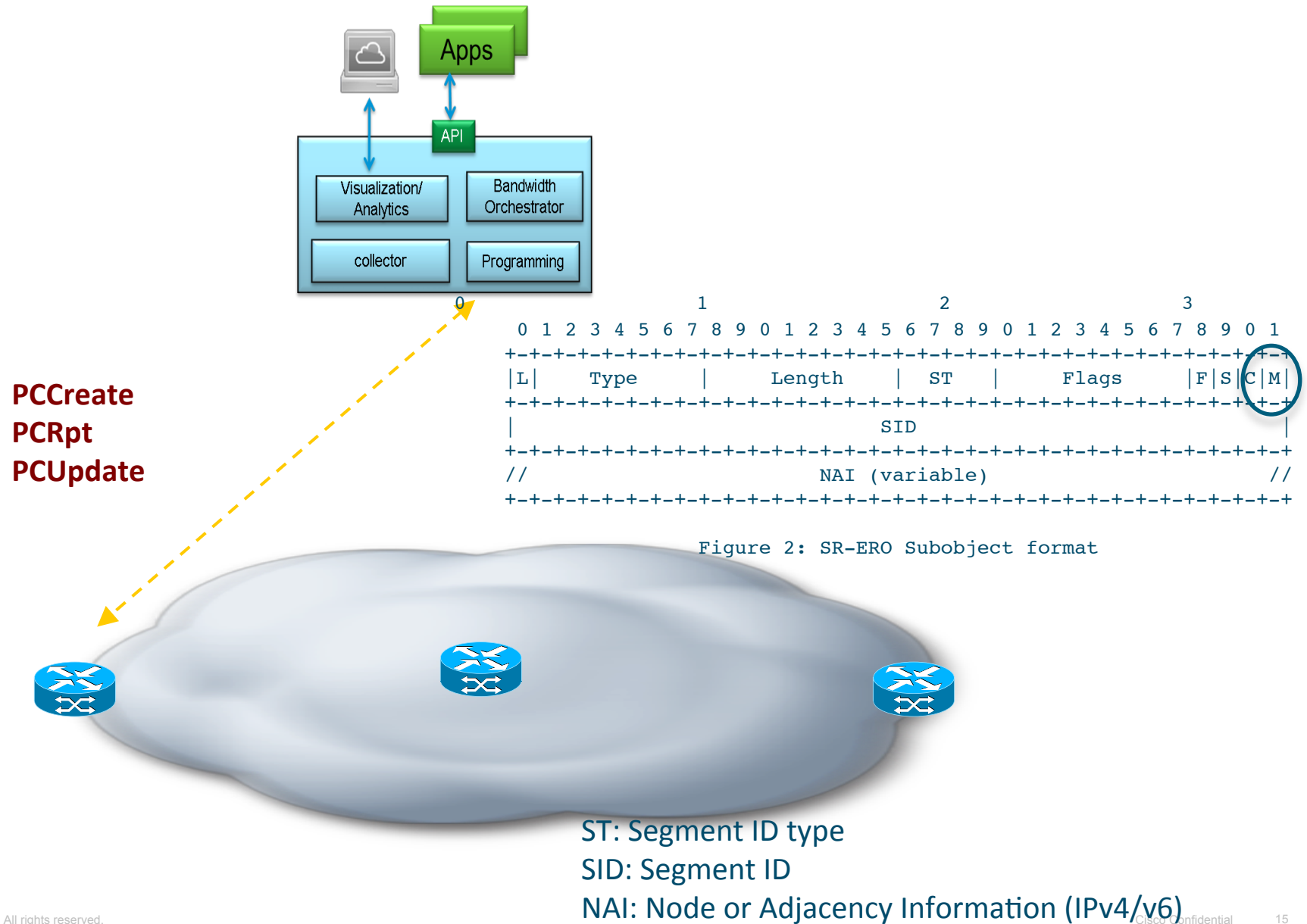
Figure 1: STATEFUL-PCE-CAPABILITY TLV format

Controller : Topology Information Gathering



BGP-LS : draft-ietf-idr-ls-distribution

Controller : Stateful PCEP



SR-TEの設定 – PCEP extension

- ❑ Stateful PCE:
 - Constraintに応じたpath computationを行う
 - SR TE tunnelの生成を行う (stateful PCE)

- ❑ PCEにより計算されたSR pathは、Segment ID (SID)のstackとして表現される
 - MPLS networkの場合
 - ✓ Segment = Label(20-bit)
 - ✓ TTL および TC bits (exp bits) はPCCによりセットされる

draft-sivabalan-pce-segment-routing

Segment Routing – Hybrid SDN

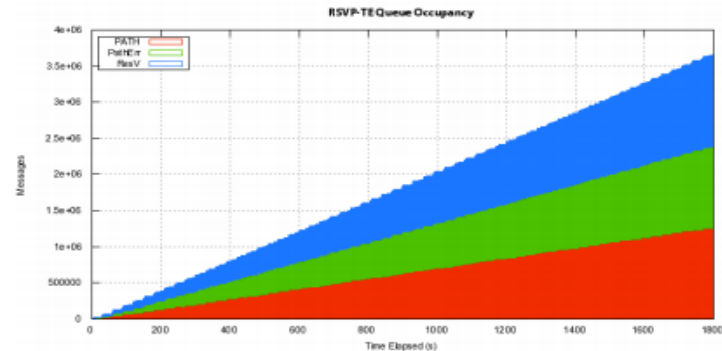
- SRは、自律分散コントロールプレーンとの共存が前提
 - 基本情報(Node/Adj Segment)はIGPで配布する
 - 明示的なTEが必要な部分のみ、add-on的にSR-TE pathをはる
 - 明示的Traffic Engineering
 - Controllerの障害時も、Forwardingは停止しない
 - 障害検出、OAM、protection(少なくとも一時的な)は、自律的に行う
 - EPC FRRにより、topology非依存のProtectionが可能
 - SR非対応ノード(LDP onlyなど)とも共存可能
 - Bidirectional Co-routed LSPのようなtransport的アプリケーションとも親和性が高い
 - Meta dataを運ぶことができる

Use case #1

BT: Performance Based LSPs

Path Constraints and Technology Options.

- **Requirement for a number of types of constrained service/flow routing:**
 - Co-routing.
 - Considering SRLG/Node/Link diversity or bi-directional paths.
 - Affinity-based routing.
 - Diverging from SPT based on constraining available paths by colour/admin-group.
 - Performance-managed services.
 - Latency, available bandwidth, etc.
- Clearly, a number of these constraints can be delivered by RSVP-TE today.
- **Per-service/flow routing requires a significant increase in the number of RSVP-TE LSPs when compared to current deployments:**
 - Number of LSPs is greater than full mesh (already not recommended).
 - Scale limit of mid-point signalling during large failures.
- **Limited additional functionality is offered by having mid-point state.**
 - Generally only admission control.
 - Required in a subset of path routing scenarios.



Mid-point Overloading – Post-Mortem Model

Unbounded RSVP-TE queue growth based on inability to process PATH messages within LSP retry time – LSPs never successfully re-signal.

Use case #2

DT: MPLS OAM

Segment Routing based OAM use case

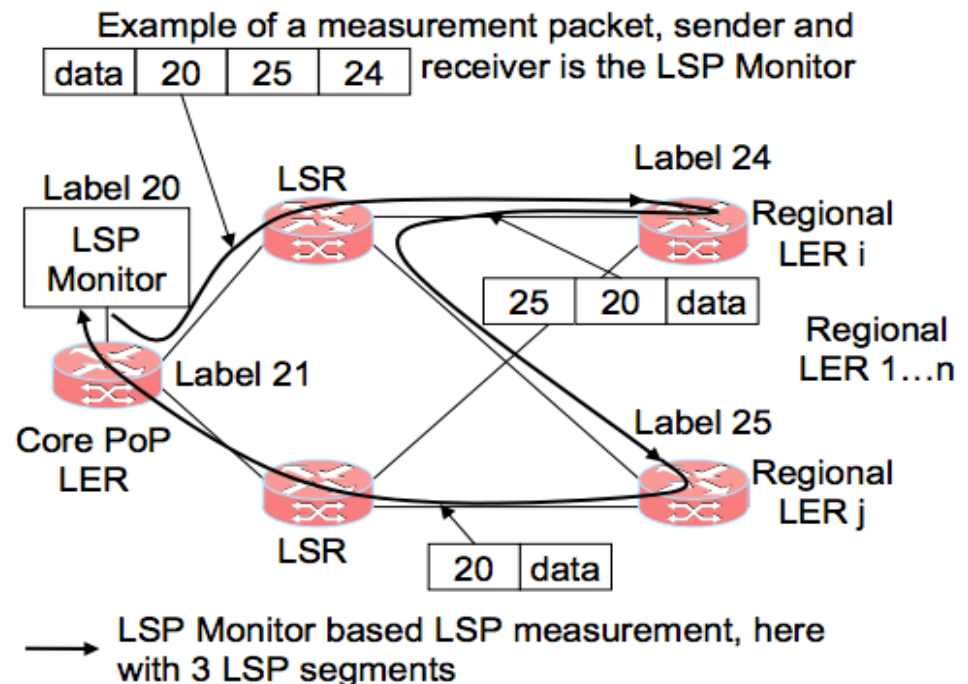
IETF 87, Berlin

Rüdiger Geib, Deutsche Telekom

Segment based Routing allows for scaleable LSP monitoring

Monitoring MPLS data plane liveliness

- source based routing allows execution of arbitrary LSP chains.
- then a ping with data plane loop can be built.
- by ISIS the LSP Monitor is aware of the network topology and its state.
- a single LSP monitor is able to address all LSPs of a domain. A redundant design is possible if desired.
- Example to the right: the LSP monitor checks data plane liveliness between LER i and LER j. In general, by the method shown all LSPs can be monitored.

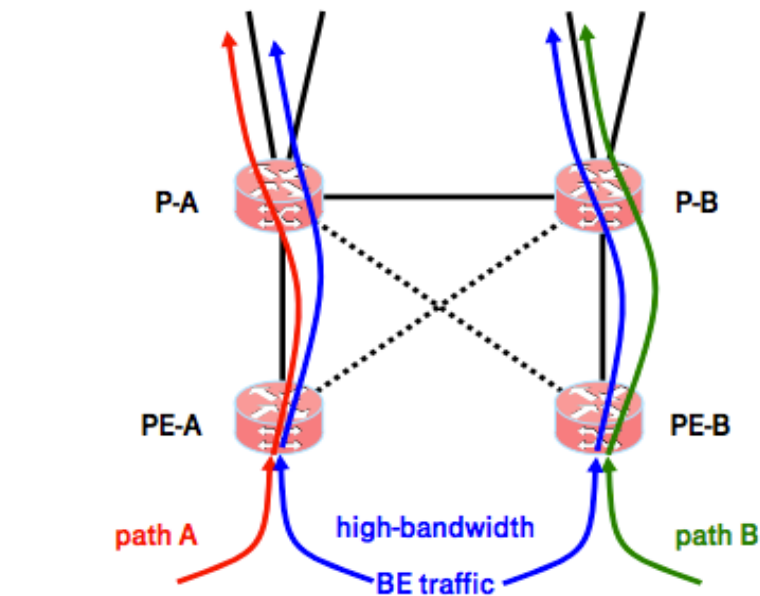


Use case #3

DT: Disjoint Path and QoS based routing

Merged network:

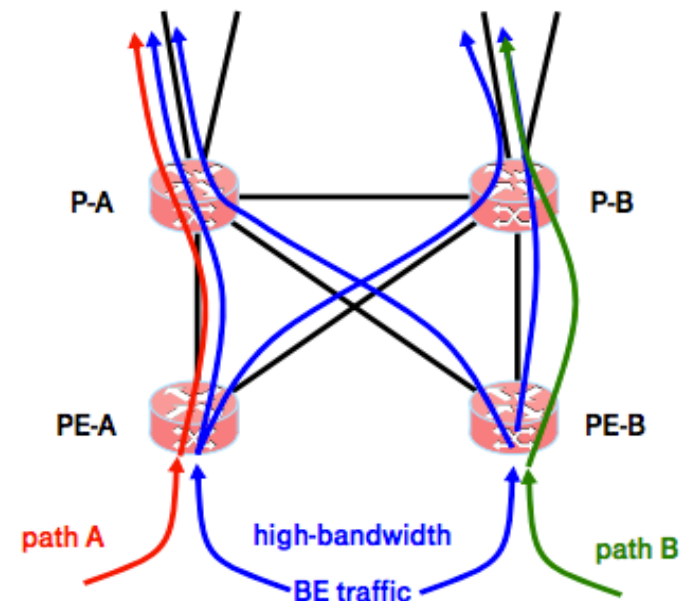
- Topology tailored for both disjoint paths and IP-FRR.
- Limited efficiency.



LIFE IS FOR SHARING.

Optimized future network with SR:

- Basic topology optimized for IP-FRR and efficiency.
- Sigtran traffic constrained with A/B anycast segment to provide disjoint paths.



Dr. Martin Homeffer / SR Use Cases @ DT

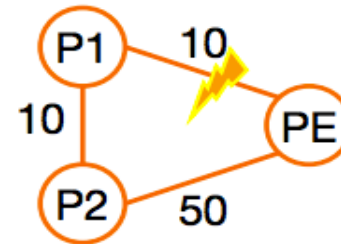
7/29/2013

Use case #4

Orange: FRR (Fast Reroute)

Incremental deployment in a LDP network

- As first step, Segment Routing use may be restricted to FRR backup path.
 - Keeping LDP for nominal traffic, like the way it currently is.
- If nodes are already SR capable, SR FRR can be deployed incrementally on a per PLR basis. (with incremental benefit).
 - i.e. enabling SR FRR on P1



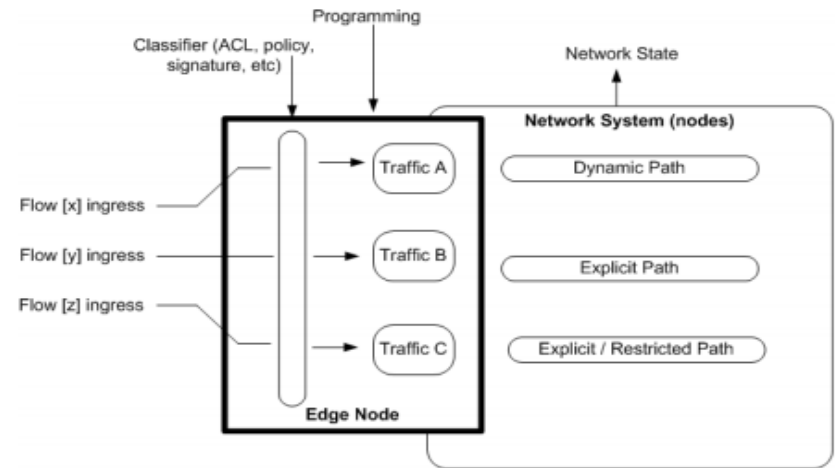
- In the absence of SR capable node in the network, SR FRR can be deployed incrementally on a per PLR + (last) P + (first) Q basis.
 - i.e. enabling SR FRR on P1 (PLR) & SR on P2 (P) and PE (Q)
 - Note that on the Q, SR may be replaced by a T-LDP session (which is natively the case in the above example)
- More details in [draft-filsfils-rtgwg-segment-routing-use-cases-01#section-6.4](https://www.ietf.org/proceedings/87/slides/slides-87-status-3.pdf)

Use case #5

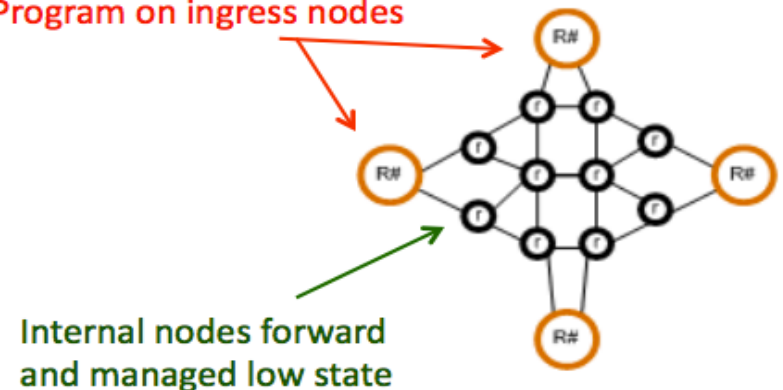
Rogers: Converged Multi-network operation

Programming and SDN Interaction

- Automation of the network is essential for future operation
 - Current operational modes not scalable
- SDN (path programming within this document's context) is desired, with per-flow/service network treatment
- Minimize the number of elements where programming must occur, and simplify configuration required



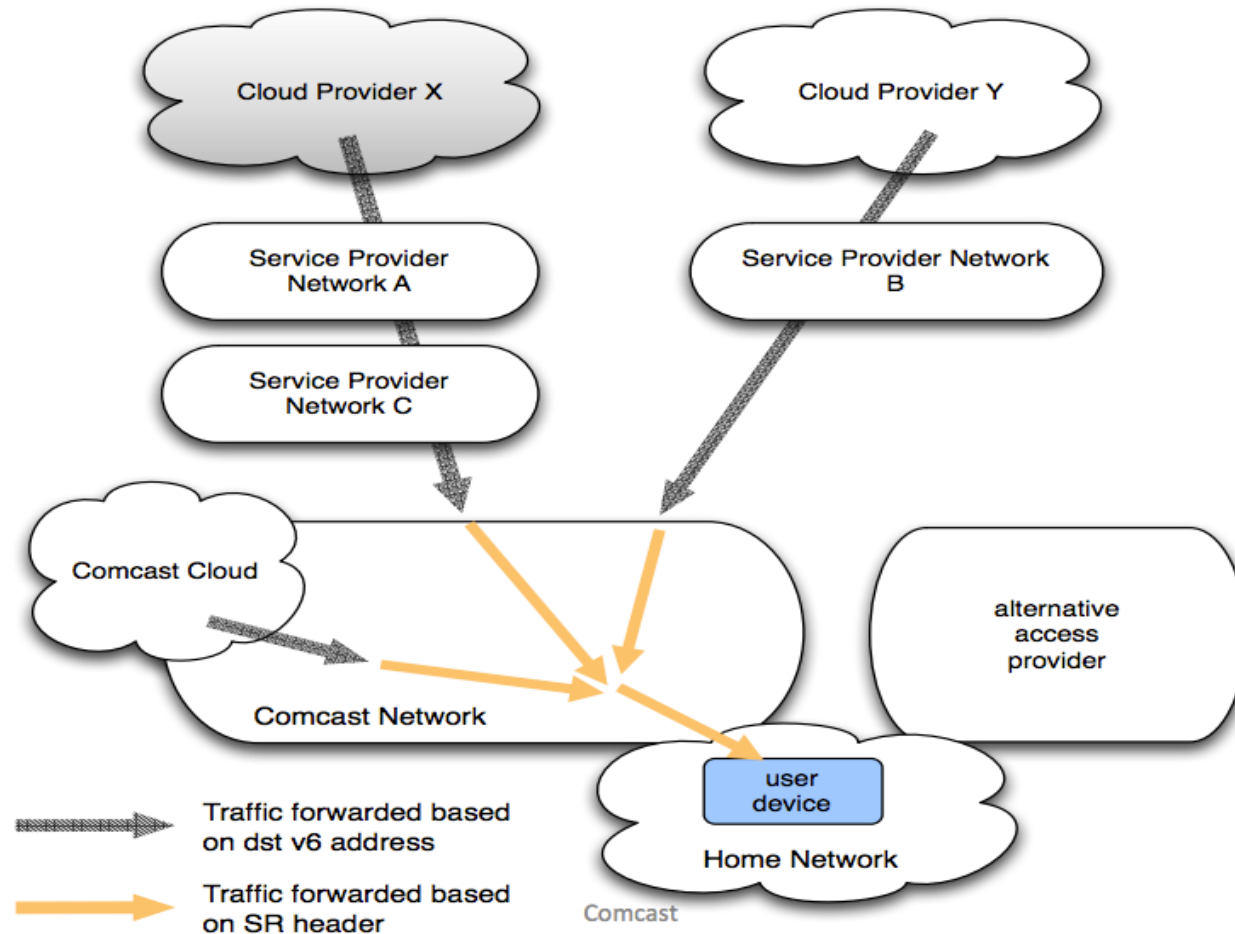
Program on ingress nodes



Use case #6

Comcast : IPv6 use case

Use Case Diagram



Segment Routingのメリット

1. Simple !!!

- 使用するControl PlaneはIGPだけ。LDP, RSVPは要らない。
 - LDP-IGP syncなどのstate syncも必要ない

2. 柔軟かつScalableなTraffic Engineering

- Service毎のdisjoint topology
- 帯域、latencyなどを加味したCSPF(Constraint SPF)
- Stateless !
 - RSVP stateを持つ必要が無い
 - 全てのstateはヘッダ(Label Stack)にある

3. Transport的pathの運用にも有用

- Controllerによる明示パス指定
- MPLS-TP OAM, Bi-directional Co-routed LSP, Path Protection

目的に合った、
程よい、
集中と分散の配分
↓
究極のHybrid SDN

Related I-Ds

- Architecture ([draft-filsfils-rtgwg-segment-routing](#))
- Use-Case ([draft-filsfils-rtgwg-segment-routing-use-cases](#))
- ISIS extension for SR ([draft-previdi-isis-segment-routing-extensions](#))
- OSPF extension for SR ([draft-psenak-ospf-segment-routing-extensions](#))
- FRR with SR ([draft-francois-sr-frr](#))
- PCEP extension for SR ([draft-sivabalan-pce-segment-routing](#))
- Performance Engineered LSP using SR ([draft-shakir-rtgwg-sr-performance-engineered-lsps](#))

<http://www.segment-routing.net/>

Thank you.

