JANOG50 あつまれSRv6の森
SRv6 最新機能 Path Tracing

Teppei Kamata
Cisco Systems G.K.

自己紹介

- 名前：鎌田徹平
- 所属：Cisco Systems
  (2009年新卒入社)
- Interop ShowNet NOC team member
- JANOGでの発表 3回目

  JANOG40: Segment Routing Tutorial
  JANOG43: SRv6最前線
  JANOG50: SRv6の森

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本日の発表内容:
SRv6の最新機能について

SRv6 - 標準化動向

- **RFC 8402** * – Proposed Standard
  - SR-MPLS with MPLS dataplane and Label SID’s
  - SRv6 with SRH and SRv6 SID’s
- **RFC 8754** – Proposed Standard
  - SRv6 DataPlane: SRH and SRv6 SID
- **RFC 8986** – Proposed Standard
  - Network Programming (END, END.X, END.DX/DT, H.Encap
- **RFC 9259** – Proposed Standard
  - OAM in SRv6
- **もう間も無くRFC**
  - SR Policy (draft-ietf-spring-segment-routing-policy-22) *
  - IS-IS extention (draft-ietf-lsr-isis-srv6-extensions-18)
  - BGP based overlay (draft-ietf-bess-srv6-services-15)
  - BGP-LS extension (draft-ietf-idr-bgpls-srv6-ext-09)

RFC 8986
SRv6 Network Programming

RFC 8754
IPv6 Segment Routing Header

100M *live subscribers* over SRv6

SIMPLICITY ALWAYS PREVAILS

* SR-MPLS/SRv6 共通

正直かなりこなれてきたと思います

- L2/L3 VPNはかなり実装が進んで来ています
- 次のStepとしてMPLSではできない“SRv6だからできること”に注目が集まり始めています

- 本日は(一部MPLSでもできるけど) SRv6の最新機能を紹介させていただきます
  - 特に3月のIETF113で発表されたばかりのPath tracingという機能について紹介させていただきたいと思っています

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SRv6最新機能紹介

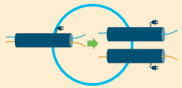
SR IGP Flexible Algorithms

Applicability Examples

Sensitive Data

Financial Transactions

Transport Redundancy



Different Fiber Conduits

Scalability

Low-End Platforms

Solution

オペレーターによりカスタマイズされたIGPアルゴリズムで、インテント(意図)ベースでTraffic Engineeringをインスタンス化できる

- メトリックの最小化: IGP, delay
- 制約条件を考慮した計算: link-affinity, SRLG

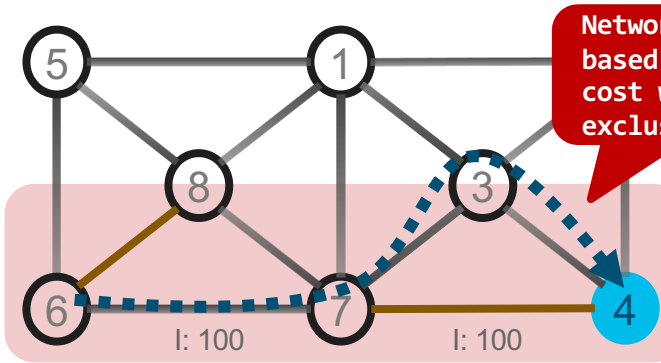
Benefits

Simplicity and Automation

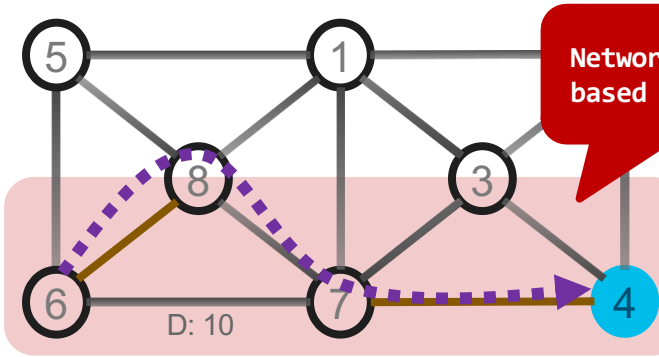
- IGPで計算されたTEパス(どこからどこへでも)
- Sub-50msec のプロテクション(TILFA)が可能で、Flex-Algorithmのプレーン内に閉じてバックアップパスが計算される

Scalability

- ラベル1つ(複数のラベルをスタックせずに)でTEパスを表現できる



Default IGP
link metric: I:10



Measured link
Delay: D:1

Interested? SR IGP Flexible Algorithm on segment-routing.net

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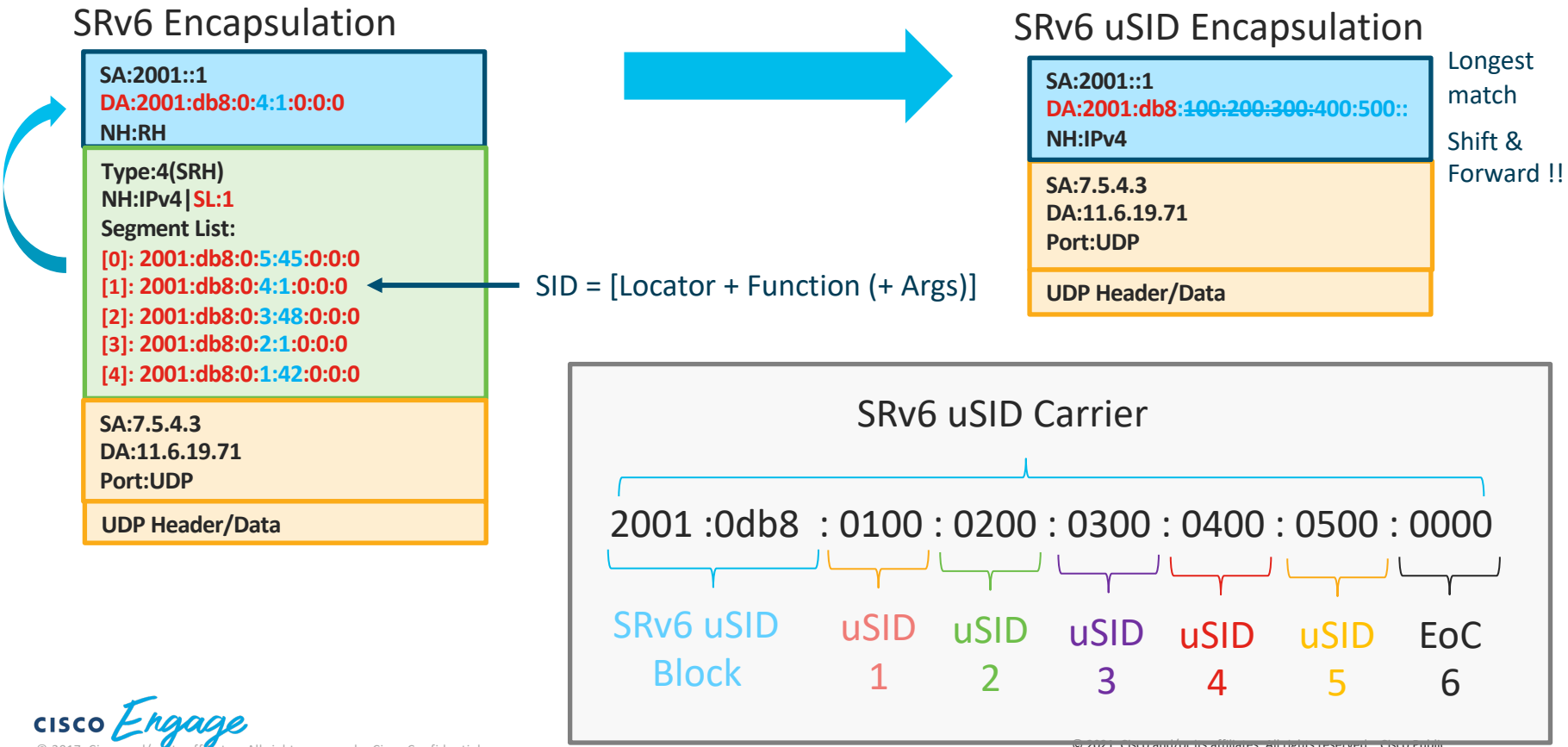
SRv6 Micro SID



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Innovation: Path Tracing

SRv6: Path Tracing

40-year-old unsolved IP problem

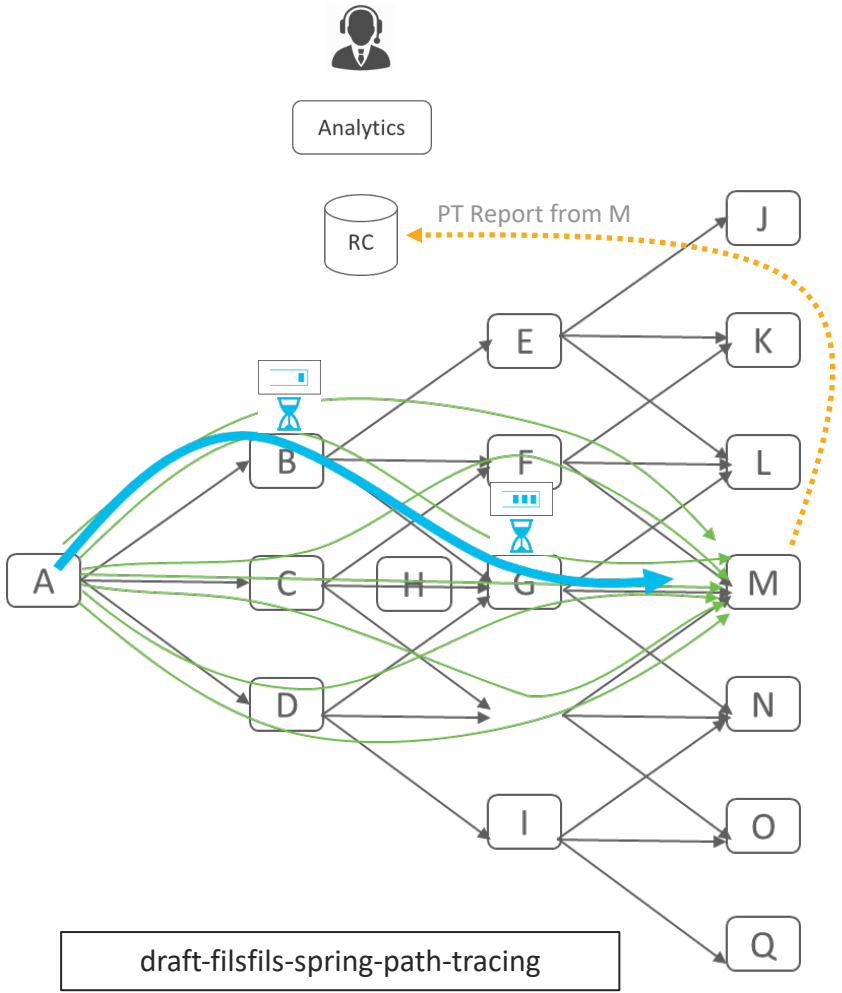
What is the Path from A to M?
ECMPのどこを通っているのかトラックすることは難しい
How is time spent from A to M?
それぞれのパスの遅延差はあるのか？
What is the load at each hop between A and M?
負荷や帯域はどれくらいですか？

Solution

Deterministic Per-Packet Tracing
Hop-by-HopのprobeでMidpoint Compressed Data (MCD)を収集する
Sink node (M) reports to a Regional Controller for Analytics

Benefits

Simplicity and Automation
Native interworking with SRv6
Linerate monitoring in base NPU HW pipeline
Seamless Deployment
Tight SLAs
Path, timing and load history at each hop is available



draft-filsfils-spring-path-tracing

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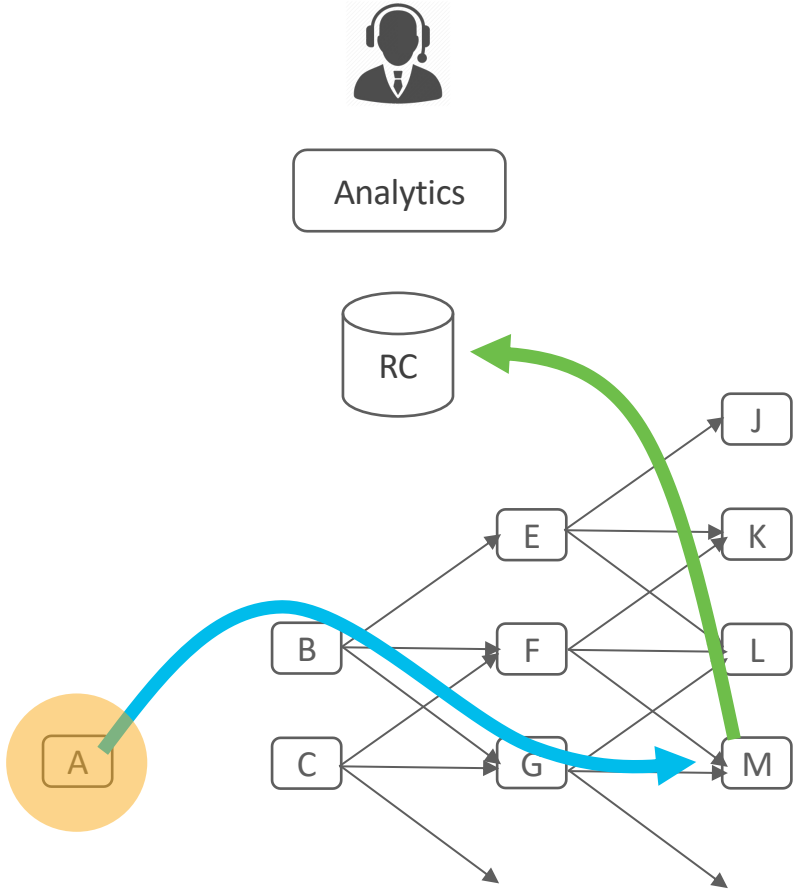
Roles and Data Model

Source

- Probeを生成するノード
  - SRC.T64: 64-bit PTP Tx Timestamp
  - SRC.OIL: 4-bit Outgoing Interface Load
  - SRC.OIF: 12-bit Outgoing Interface ID



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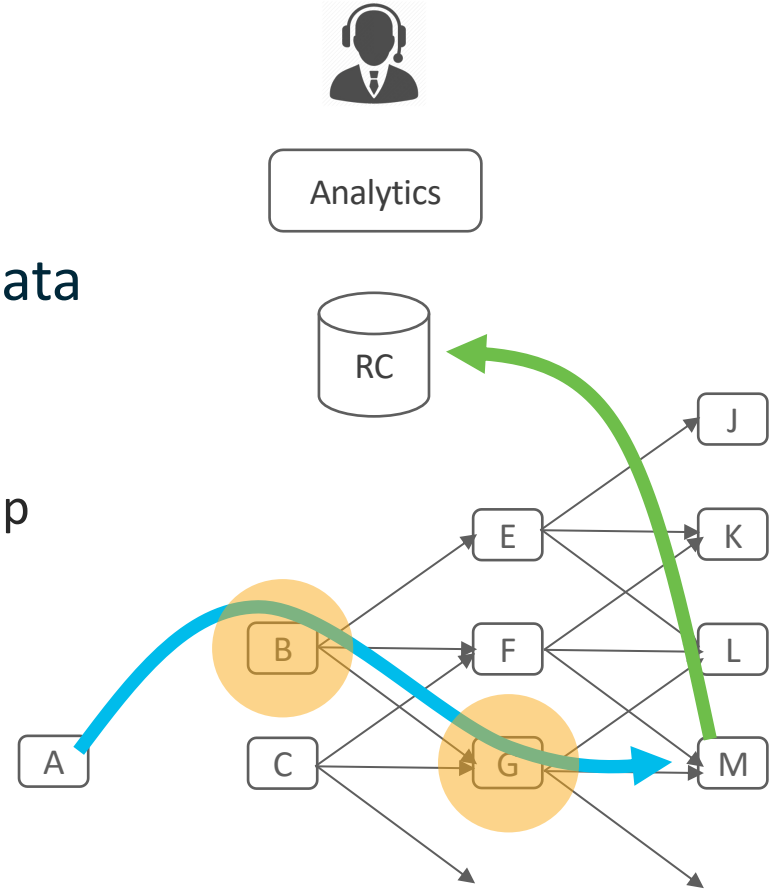
Midpoint

- MidPoint Compressed Data (MCD)を打ち込む
  MCD: 24-bit Midpoint Compressed Data
  - MCD.OIL: 4-bit Incoming Interface Load
  - MCD.OIF: 12-bit Incoming Interface ID
  - MCD.TTS: 8-bit Truncated PTP TimeStamp



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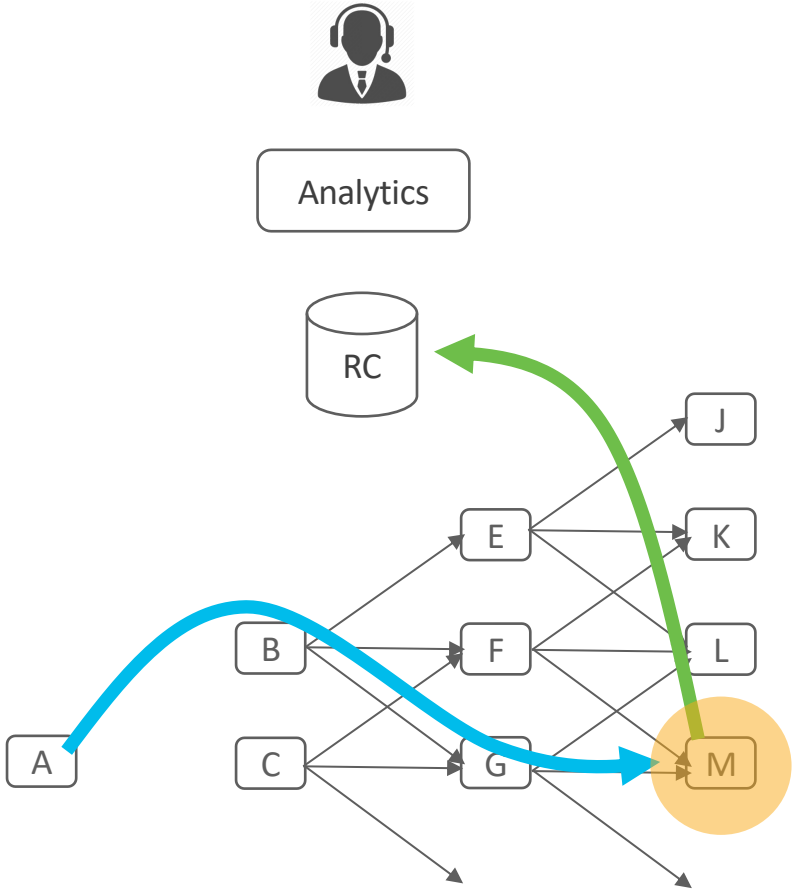
Sink

- Probeを終端してコレクタに送信
  - SNK.T64: 64-bit PTP Rx Timestamp
  - SNK.IIL: 4-bit Incoming Interface Load
  - SNK.IIF: 12-bit Incoming Interface ID



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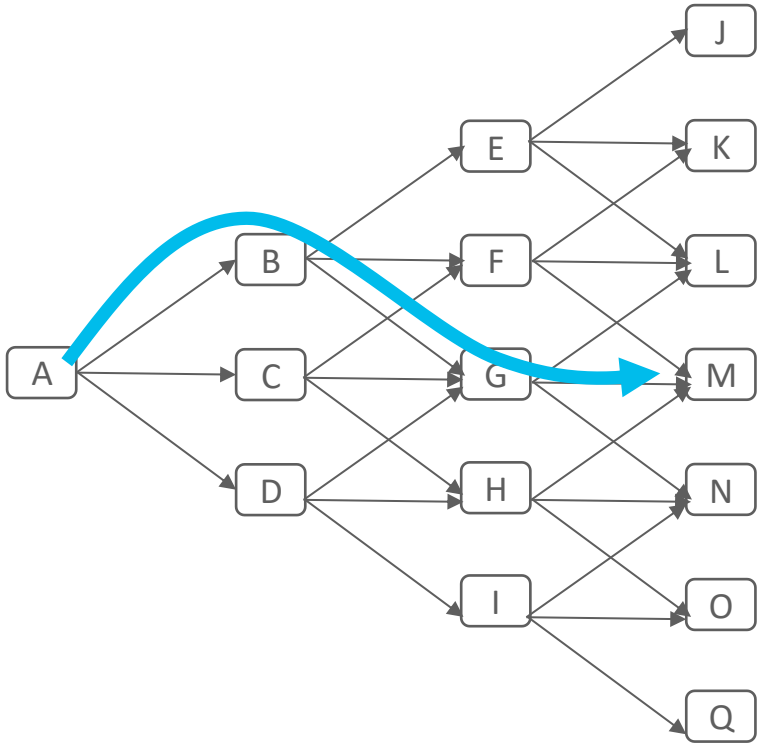
Collected Data

- Source
  - SRC.T64: 64-bit PTP Tx Timestamp
  - SRC.OIL: 4-bit Outgoing Interface Load
  - SRC.OIF: 12-bit Outgoing Interface ID
- Midpoint
  - MCD.OIL: 4-bit Incoming Interface Load
  - MCD.OIF: 12-bit Incoming Interface ID
  - MCD.TTS: 8-bit Truncated PTP TimeStamp
- Sink Node
  - SNK.T64: 64-bit PTP Rx Timestamp
  - SNK.IIL: 4-bit Incoming Interface Load
  - SNK.IIF: 12-bit Incoming Interface ID



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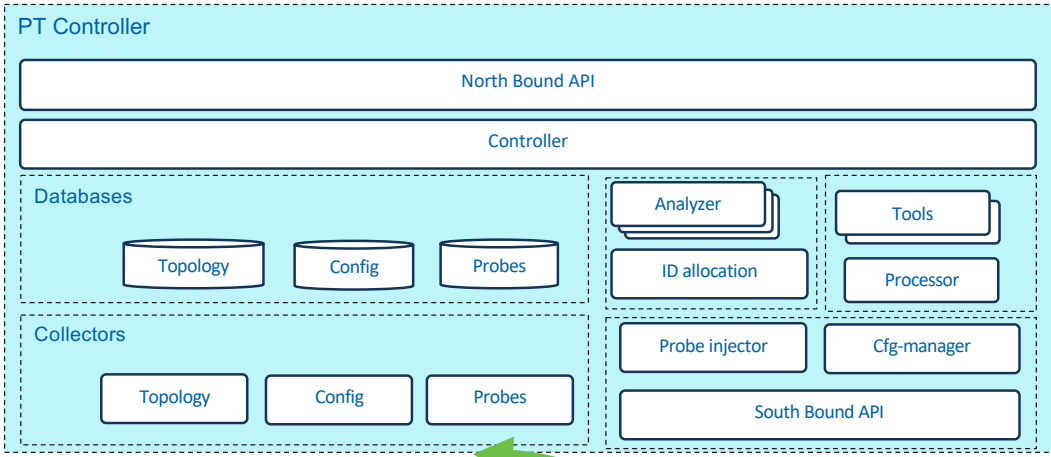
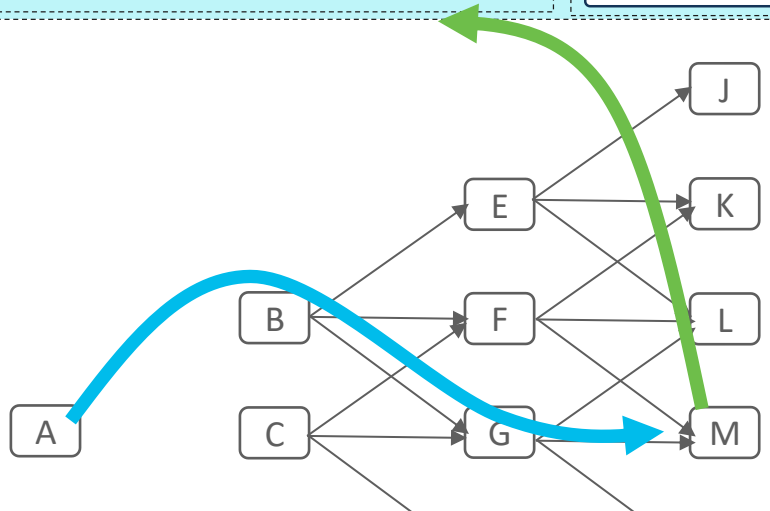
Controller (今回用意していません)

- **Controller:**
  すべてのコンポーネントの呼出しや連携を制御
- **Collectors:**
  トポロジー、ノードのコンフィグ、プローブデータを収集
- **Databases:**
  Graph DB, TS(Timestamp) DB, Key Value Store
- **ID allocation:**
  ID割り当てアルゴリズムの実装
- **Cfg-manager:**
  SB-APIを使用しPT(Path Trace) configのプッシュ
- **Probe-injector:**
  PT sessionの開始
- **Probe-processor:**
  収集したプローブから実データを構築
- **Analyzer:**
  ユースケースに応じて、収集したプローブの分析





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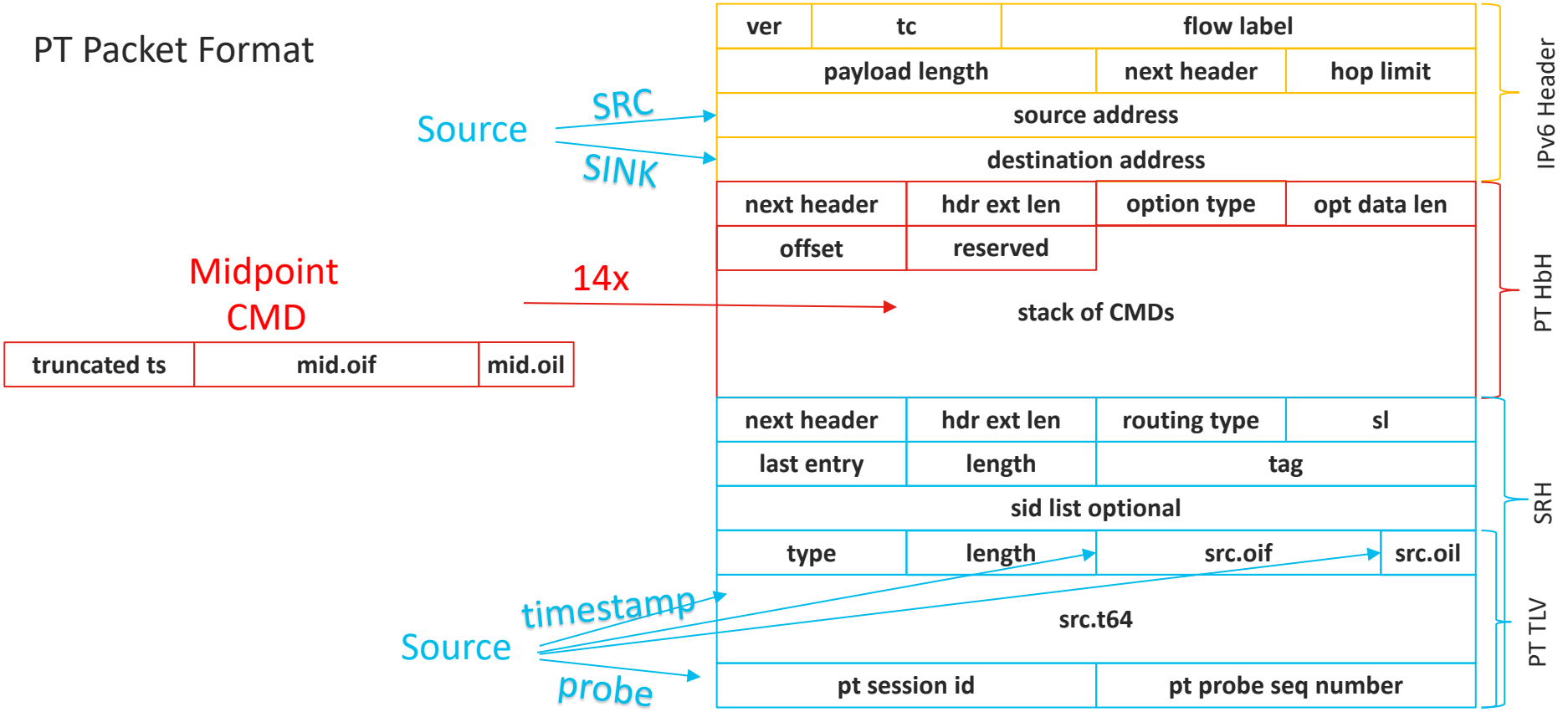
Demo: Path Tracing

PT Packet Format



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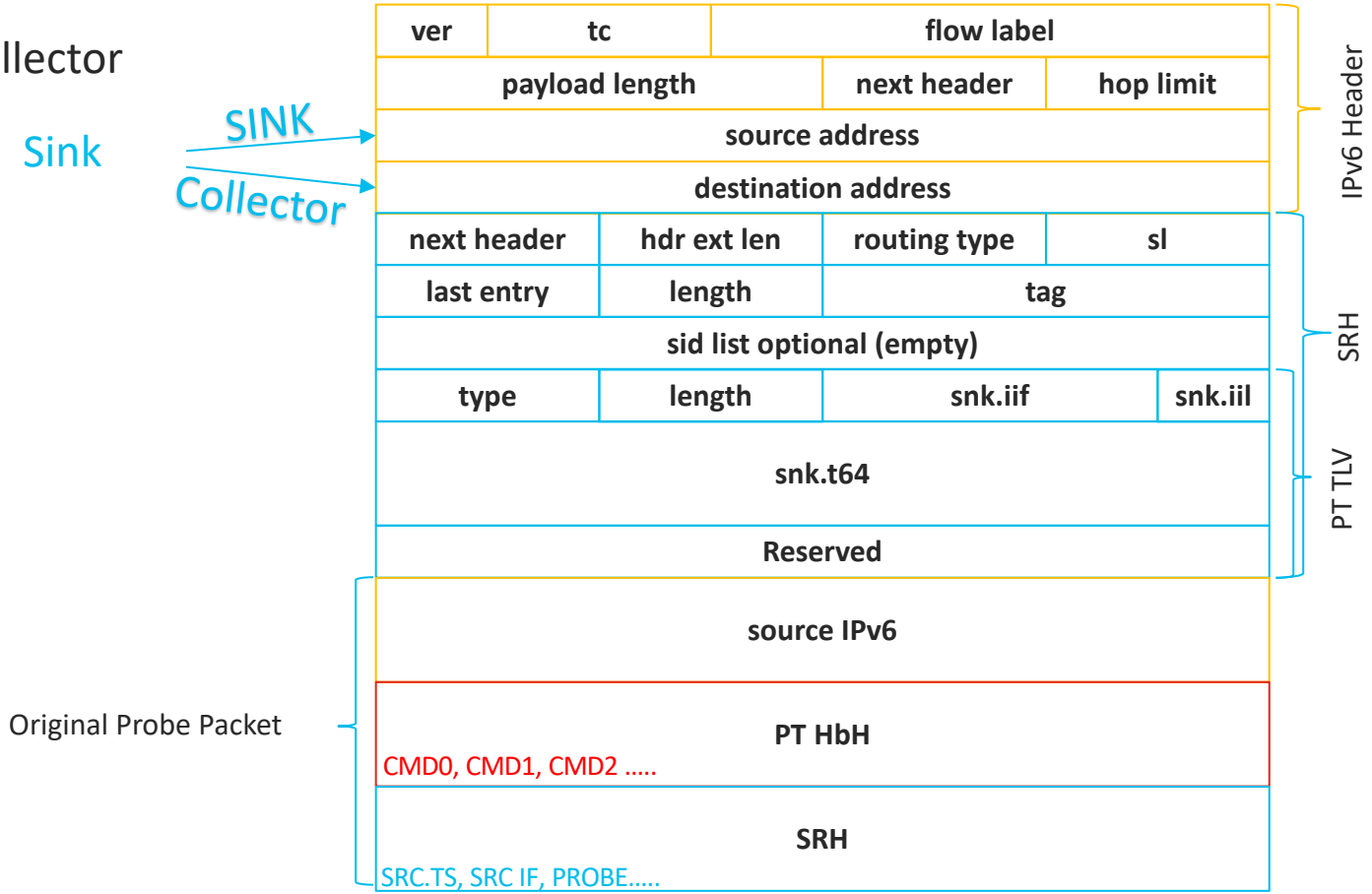
Packet from Sink to Collector



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Output Example

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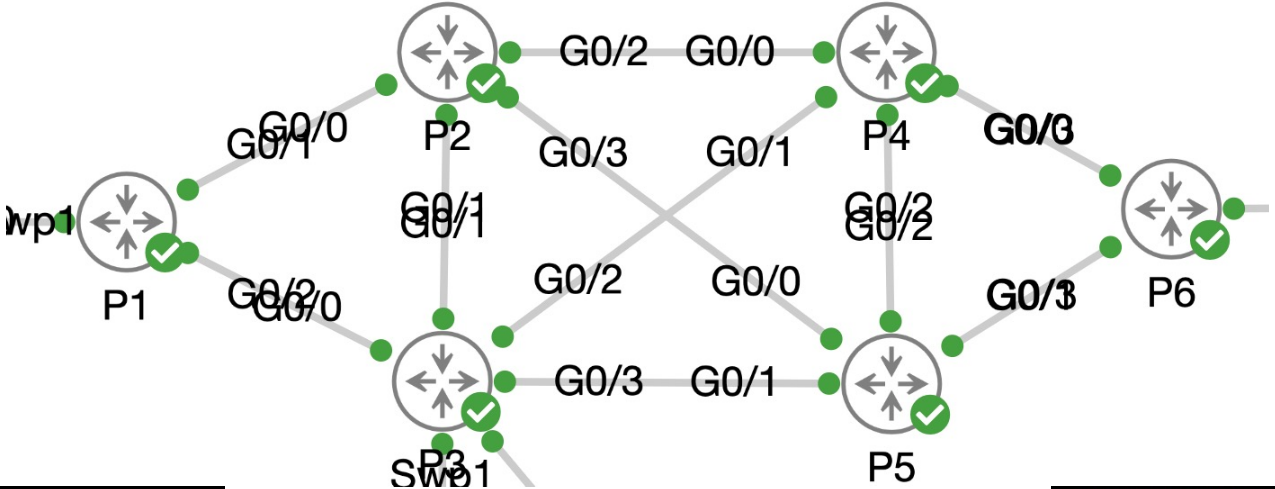
Packet Capture




```
IPv6 Hop-by-Hop Option
    Next Header: Routing Header for IPv6 (43)
    Length: 5
    [Length: 48 bytes]
    Path Tracing
        Type: Path Tracing (0x32)
            00.. .... = Action: Skip and continue (0)
            ..1. .... = May Change: Yes
            ...1 0010 = Low-Order Bits: 0x12
        Length: 44
        Offset: 14
        Reserved: 00
        CMD - Compressed Midpoint Data: 0x000000
            0000 .... .... .... = Incoming Interface Load: 0
            .... 0000 0000 0000 = Incoming Interface: 0 (0x000)
            Truncated Timestamp: 0x00 (0)
        CMD - Compressed Midpoint Data: 0x000000
            0000 .... .... .... = Incoming Interface Load: 0
            .... 0000 0000 0000 = Incoming Interface: 0 (0x000)
            Truncated Timestamp: 0x00 (0)
        CMD - Compressed Midpoint Data: 0x000000
            0000 .... .... .... = Incoming Interface Load: 0
            .... 0000 0000 0000 = Incoming Interface: 0 (0x000)
            Truncated Timestamp: 0x00 (0)
        CMD - Compressed Midpoint Data: 0x000000
            0000 .... .... .... = Incoming Interface Load: 0
            .... 0000 0000 0000 = Incoming Interface: 0 (0x000)
            Truncated Timestamp: 0x00 (0)
```

```
IPv6 Hop-by-Hop Option
    Next Header: Routing Header for IPv6 (43)
    Length: 5
    [Length: 48 bytes]
    Path Tracing
        Type: Path Tracing (0x32)
            00.. .... = Action: Skip and continue (0)
            ..1. .... = May Change: Yes
            ...1 0010 = Low-Order Bits: 0x12
        Length: 44
        Offset: 11
        Reserved: 00
        CMD - Compressed Midpoint Data: 0x0072cd
            0000 .... .... .... = Incoming Interface Load: 0
            .... 0000 0111 0010 = Incoming Interface: 114 (0x072)
            Truncated Timestamp: 0xcd (205)
        CMD - Compressed Midpoint Data: 0x0042ce
            0000 .... .... .... = Incoming Interface Load: 0
            .... 0000 0100 0010 = Incoming Interface: 66 (0x042)
            Truncated Timestamp: 0xce (206)
        CMD - Compressed Midpoint Data: 0x0031af
            0000 .... .... .... = Incoming Interface Load: 0
            .... 0000 0011 0001 = Incoming Interface: 49 (0x031)
            Truncated Timestamp: 0xaf (175)
        CMD - Compressed Midpoint Data: 0x000000
            0000 .... .... .... = Incoming Interface Load: 0
            .... 0000 0000 0000 = Incoming Interface: 0 (0x000)
            Truncated Timestamp: 0x00 (0)
```

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Conclusion

まとめ

- SRv6の最新機能について紹介しました
- SRv6 Path Tracingでは
  - ECMPのどこを通っているのかトラックすることができます
  - それぞれのパスの実際の遅延なども取得できます
  - 前回のJANOGでもIn-band Telemetryなどの発表がありましたが、OAMはどこまで取得する必要があるのか、議論できればと思います
- SRv6じゃないとできないことについても今後もご意見いただければ幸いです

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