IETF(と3GPP)でのモバイル・5G関連活動

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要約

- SRv6 (Segment Routing IPv6)をモバイルユーザープレーンに適用するアイディアをIETFへ提案、さらに良き協力者を得て3GPPにも提案

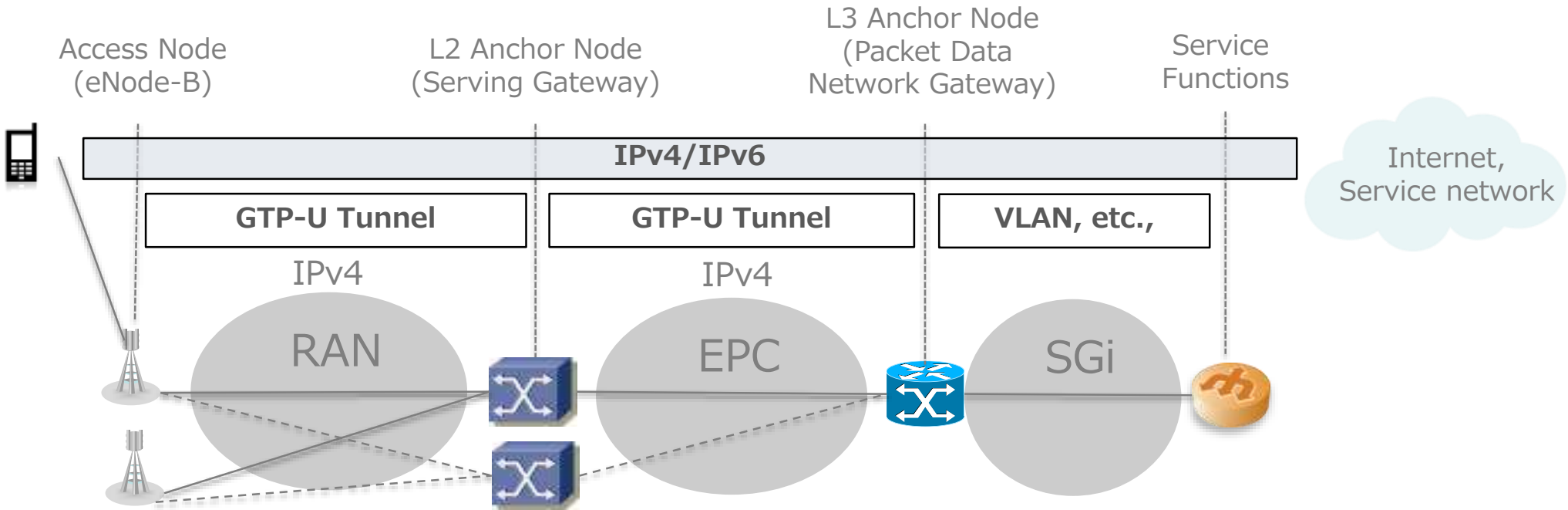
- 厳しい反論に遭いながらもステップバック、妥協点を見出し、ユーザープレーンプロトコル検討のスタディアイテム化を合意(3GPP CT4)

- 既存(GTP-U)含め、ユーザープレーン候補プロトコルのスタディを公式に開始する予定(IETF DMM WG, 3GPP CT4)

モバイルユーザープレーンとは何か

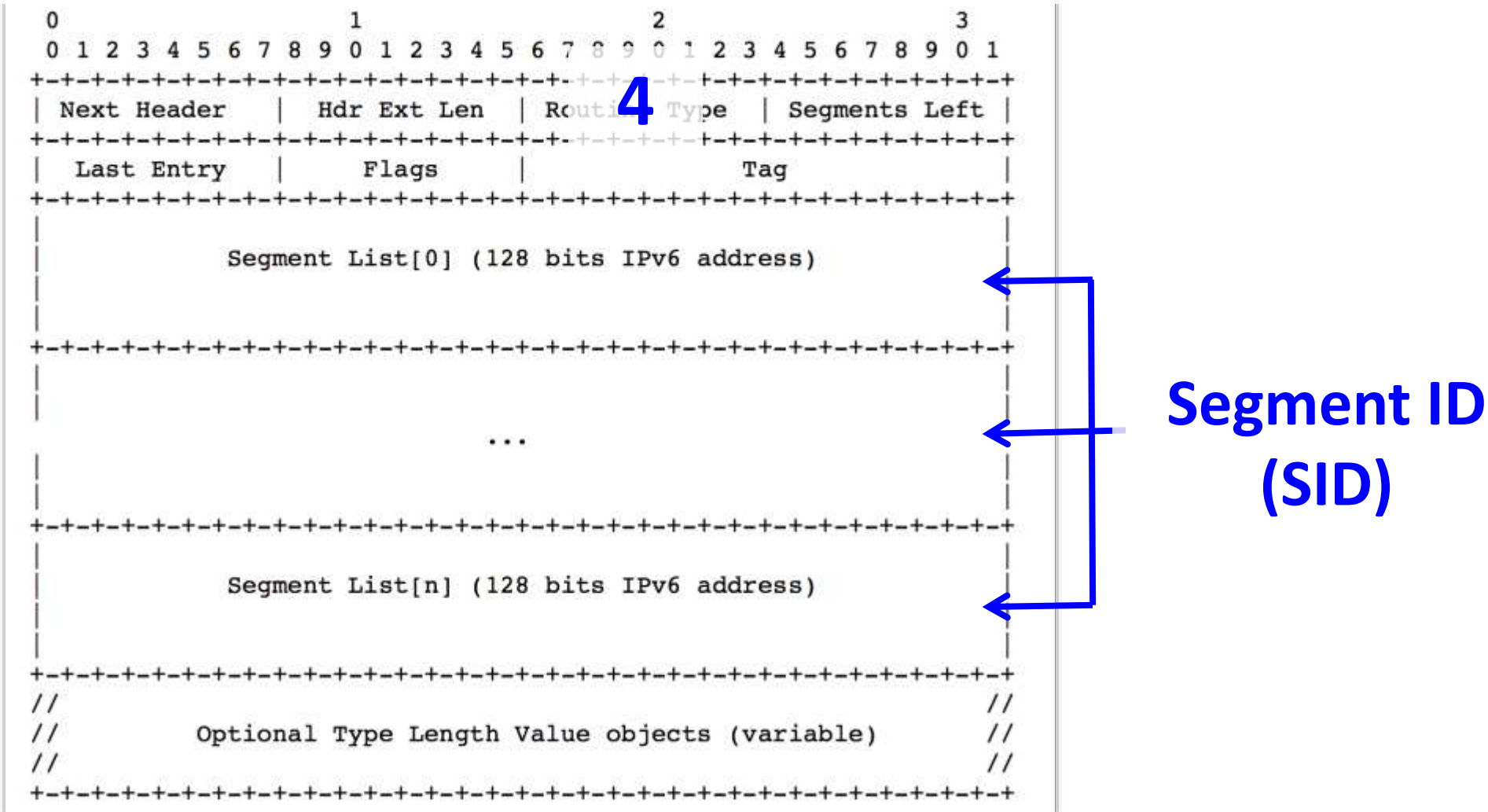
- GTP(GPRS Tunneling Protocol)で構成される、世界2大トンネルプロトコルの1つ
  - もう片方はL2TP

- 携帯ネットワーク(3G, LTE)経由のインターネットアクセスは、全てGTPトンネルを通る



SRv6とは何か

SRH (Segment Routing Header)を使います



SRv6とは何か

IPv6アドレスで色々な機能を表現できます

SRv6 Function* Name	Forwarding
END	Lookup SRH
END.X	L3 cross-connect to next-hop
END.T	L3 lookup IPv6 table
END.DT6	Decap outer IPv6 hdr and lookup IPv6 table
END.DT4	Decap outer IPv6 hdr and lookup IPv4 table
END.DX6	Decap outer IPv6 hdr and IPv6 cross-connect
END.DX4	Decap outer IPv6 hdr and IPv4 cross-connect
END.B6	Bound to an SRv6 policy(SID list)

SRv6 Function* Name	Forwarding
T	Pure IPv6 transit
T.Insert	Insert an SRv6 policy (SID list)
T.Encaps	Encap SRv6 policy (SID list) by outer IPv6 hdr

* SRv6 Network Programming

経緯(1)

- 7月
  - IETF99@プラハ
  - SRv6 Mobile User Plane (draft-matsushima-spring-dmm-srv6-mobile-uplane) を提案
    - DMM (Distributed Mobility Management) WGで発表
  - IETFコミュニティが関心を持つようになった

経緯(2)

- 8月
  - 3GPP CT4 WGへSRv6 UPを提案
    - CT4: Core and Terminal Working Group 4 (3GPPで用いるプロトコル設計の責任WG)
  - 激しい反論にあう
    - 5G Phase.1 (リリース15)の作業で手一杯
    - GTP-Uのなんの問題も指摘されていないし、GTP-Uで実現困難な要求もインプットされていない
    - SRv6がシステム全体に与えるインパクトが掴めない。でかすぎるのでは？
- 10月
  - モバイルにおけるIPv6普及を理由に、User Planeプロトコルのスタディするワークアイテムを提案 (3GPP CT4)
    - 8月と同じ理由（忙しい、インパクトでかそう）で合意に至らず

IPv6普及してるからユーザープレーン見直そう提案

3 Justification

CT4 has worked to study user-plane protocol on TR29.891 with some distilled requirements from TS23.501 for Rel-15. While existing user-plane protocol is expected for that release as same as previous generations, growth of IPv6 adoption as user packet data protocol has been observed. IAB consequently released a statement that recommends SDOs to review existing standards to ensure they will work with IPv6 and encourage the industry to develop strategies for IPv6-only operation. In the case of IPv6-only network, a standard and a work in progress are developed in IETF as the mobility solutions which do not require additional tunnelling that are Mobile IPv6 (RFC6275) and Segment Routing IPv6 for Mobile User-Plane (draft-matsushima-spring-dmm-srv6-mobile-uplane) with just IPv6 standard option headers as the user-plane.

http://portal.3gpp.org/ngppapp/CreateTdoc.aspx?mode=view&contributionId=835814

経緯(3)

- 11月
  - IETF100@シンガポール
  - 既存システム（C PlaneやRAN）にインパクトを与えないアイディアを盛り込んで、SRv6 Mobileドラフトをアップーデート (IETF100)
    - 更にIETFコミュニティの関心を引き、IETF DMMのWGドキュメントに
  - 3GPP CT#81@リノ
  - 既存プロトコルを含めて、広くUser Plane候補プロトコルをスタディする提案を再び3GPP CT4 WG へインプット
    - 再び反論される
    - しかしスタディ内容そのものより、スタディの開始時期をいつにするか、が焦点に
    - そこで、
      1）直近のRel-15作業が完了するまではCT4では作業せず
      IETFにスタディアイテムの通知と、簡易な質疑応答を行い、その間IETF側で作業を進める
      2) 今年7月以降に、Rel-16の要求をベースにUser Plane プロトコルのスタディを開始する
  - 合意にいたる

提案への反論、CTチェアの援護射撃

C4-176172 **Study on User-plane Protocol**
Source: SoftBank Corp.

(Replaces C4-175222)

Discussion:

Alternative solutions for User Plane has been taken account in this version.

Nokia still maintain their opinion that it's still too early to start this work since open issues. Also this may impact negatively to CT4 Rel-15 work. This is important work which should be targeted to reasonable dates. This work should be considered in the right timeframe. Also the proposed scope is too wide and goes beyond CT4 remits. Scope should be revisited to make it in remits of CT4. E.g. CT4 is responsible of N9 not N3 which is under RAN3. Coordination with other working groups are needed.

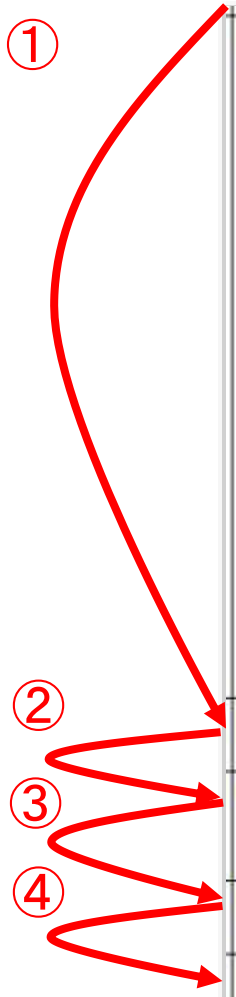
Ericsson agree with Nokia comments. Ericsson commented that this is in were early state in IEFT if there are any clear advantages are still unclear. There are lot of things which can be questioned and many open issues. Ericsson also believe June 2018 is reasonable time frame to start this proposed study.

CT4 discussed reasonable dates for this study and Nokia commented that in June 2018 CT4 could start to work on this topic. Most probably TR could be send for information in December 2018. Probably SA2 study will be finished in March 2019.

Proximus requested why study cannot start now since most probably it will not take too much meeting time in next few months. Nokia commented that we do not have Rel-16 requirements available and there is no reason to overload CT4 Rel-15 workload. Nokia commented that they do not have any problems related to proposed work but they have concerns for proposed timeframe.

CT Chairman commented that IETF have started to work in DMM. CT4 could provide input to IETF to ensure that our requirements would be covered by the solution. Also if there are issues which need early treatment CT4 should start related work already if possible - keeping in mind that the target date to finalise the study is in March 2019.

期間中、4回のリバイズを実施、粘り強く議論



6172	SID new Rel-15 Study on User-plane Protocol	SoftBank Corp.	Revised to C4-176235	Revision of C4-175222 Could be too early a SID is independent of any release Rel16 Stage 2: June 2019 Rel16 Stage 3: Dec 2019 So visibility on stg2 requirements for 5GS-ph2 Could be: Start July 2018, send for Information in Dec 2018 and complete the study in March 2019 Scope could be too broad. In 5GS, CT4 responsible of N9 not N3 for instance (RAN3) Link with IETF work. Ongoing work in DMM. We could provide input to IETF to ensure that our requirements would be covered by the solution. Some issues can be handled as soon as possible
6235	SID new Rel-15 Study on User-plane Protocol	SoftBank Corp.	Revised to C4-176366	
6366	SID new Rel-15 Study on User-plane Protocol	SoftBank Corp.	Revised to C4-176383	pragmatic approach, with a first phase focused on ongoing IETF work. could be triggered by LS to IETF.
6383	SID new Rel-15 Study on User-plane Protocol	SoftBank Corp.	Revised to C4-176400	limited time during the next 6 months.
6400	SID new Rel-15 Study on User-plane Protocol	SoftBank Corp.	Agreed	

今後の予定

- 3GPPでの公式なスタディアイテムの承認
  - 今月18日からの3GPP全体ミーティング
- 3GPPからIETFへのリエゾン作成、送付
  - User-Planeプロトコルのスタディ開始、候補プロトコルのインプット要請
- IETFでのSRv6 User Planeプロトコル 開発・標準化
  - オープンソース実装の存在が望ましい
- 3GPPでのUser Planeプロトコルのスタディ開始
  - 来年7月以降
  - IETFでの作業と、Release-16 Requirements の進捗がキー

補足資料

SRv6 for Mobile User-Plane

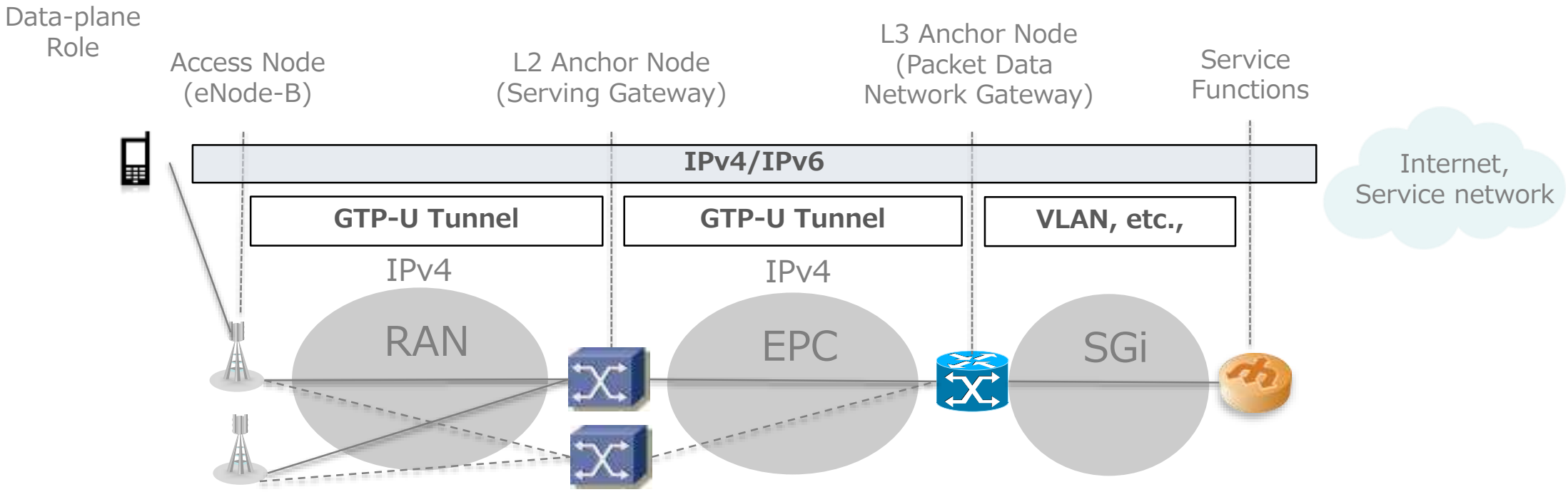
draft-matsushima-spring-dmm-srv6-mobile-uplane**-03**

IETF100

S.Matsushima, C.Filsfils, M.Kohno, D.Voyer

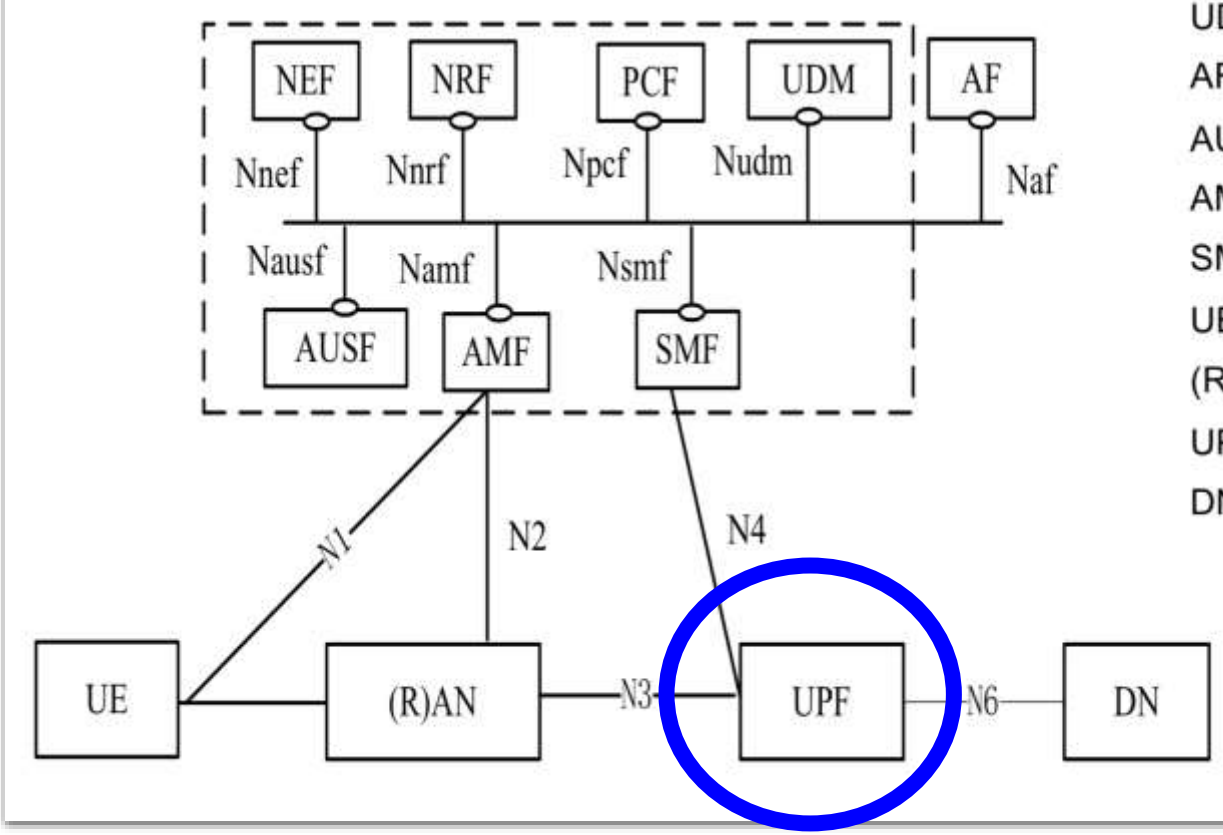
A Current Mobile Network Example

- **Well fragmented to RAN, EPC and SGi.** <- Redundancies lessen TCO
- **Per-session tunnel creation and handling.** <- Can be scaled up but costy
- **Non-optimum data-path.** <- Hard to meet Apps reqs



3GPP Rel-15 Architecture (5G Phase.1)

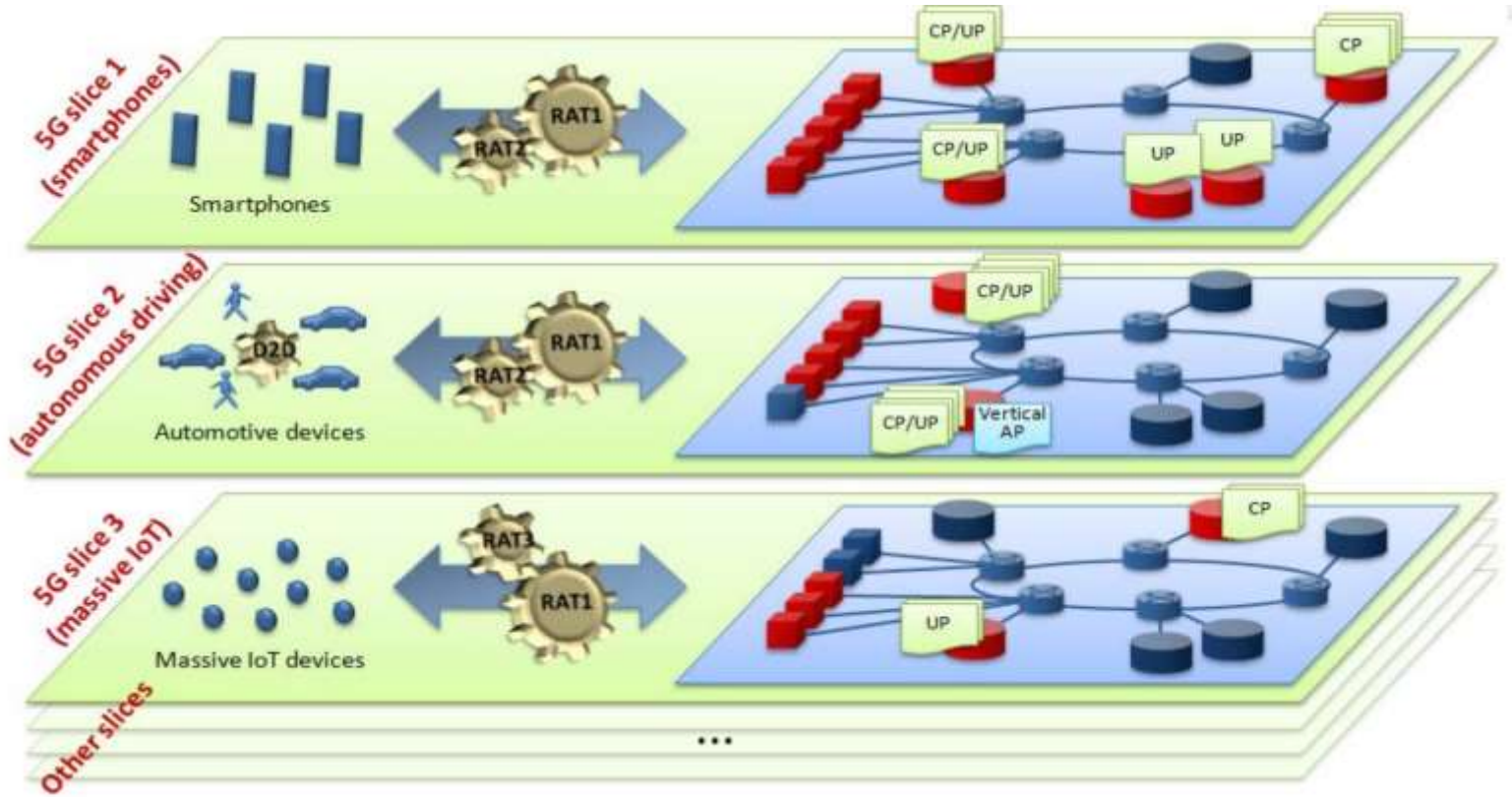
U-Plane Is Dramatically Simplified, Why?



NEF	Network Exposure Function
NRF	Network Repository Function
PCF	Policy Control Function
UDM	Unified Data Management
AF	Application Function
AUSF	Authentication Server Function
AMF	Access &Mobility Management Function
SMF	Session Management Function
UE	User Equipment
(R)AN	(Radio) Access Network
UPF	User Plane Function
DN	Data Network

Generic Expectations for 5G Networks

U-Plane must be simplified because to meet Complicated Optimizations



eMBB

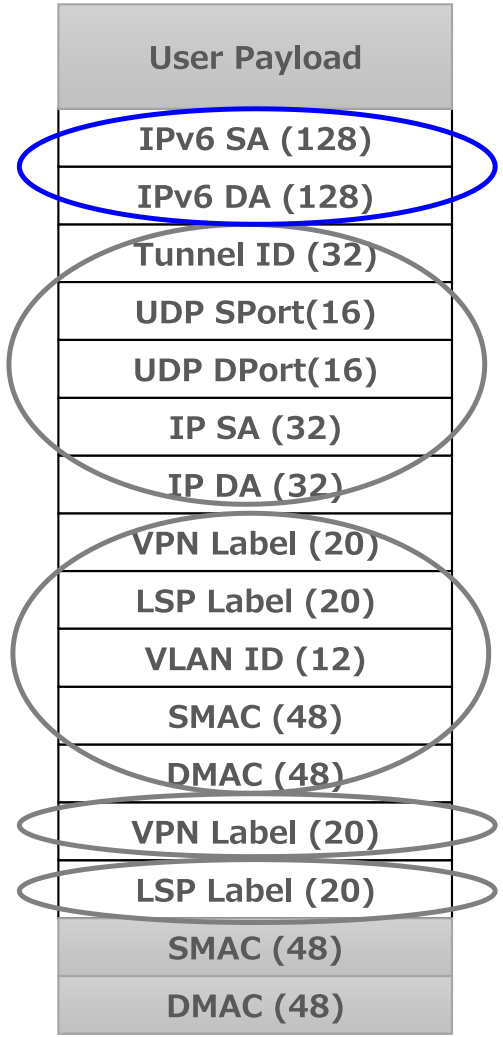
uRLLC

mMTC

Source: NGMN white-paper

But Today's U-plane Transports Are Well Complicated Already, Why?

Stacking Multiple Small ID Space Networks to Fulfill Requirements of Reliability, VPNs, etc.,



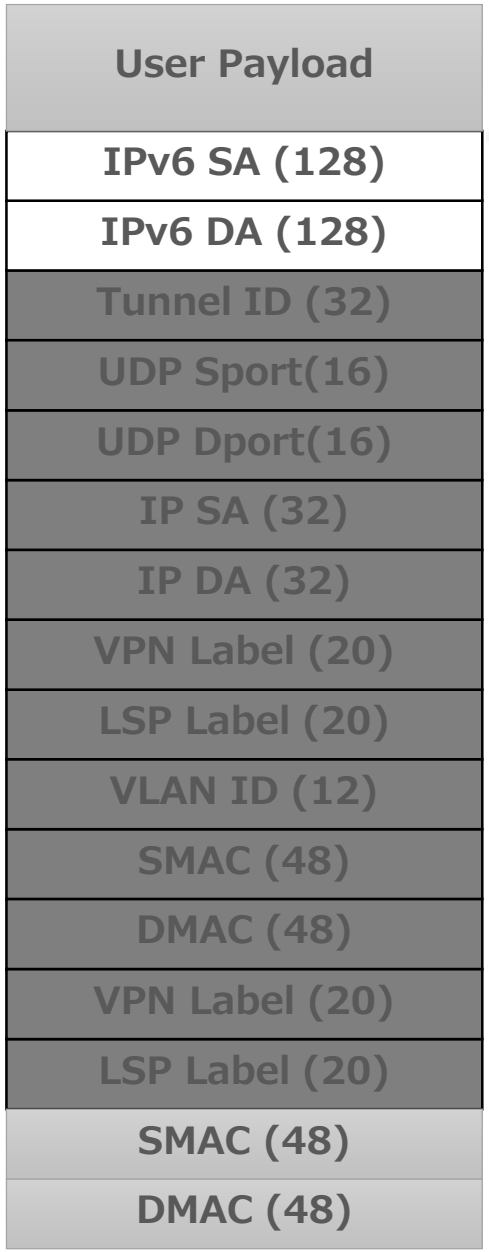
IPv6 as User PDN Protocol

GTPv1U as Mobile User-Plane Protocol
Multiplexes Sessions in A Tunnel Between Two Nodes

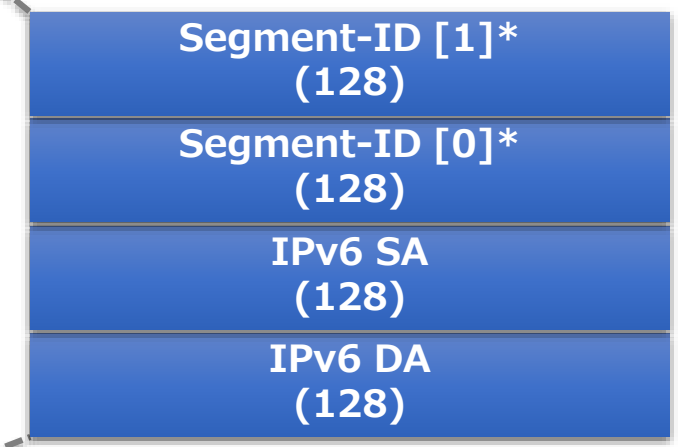
Deploys Mobile Back-haul and Core
w/ High Quality and Reliability
For C/U-Plane and O&M Networks

Multiple Virtual Networks Co-exist
Provides High Quality and Reliability

How We Can Simplify Complicating Stack?



Consolidates All Layers Role Into Single IPv6 Layer

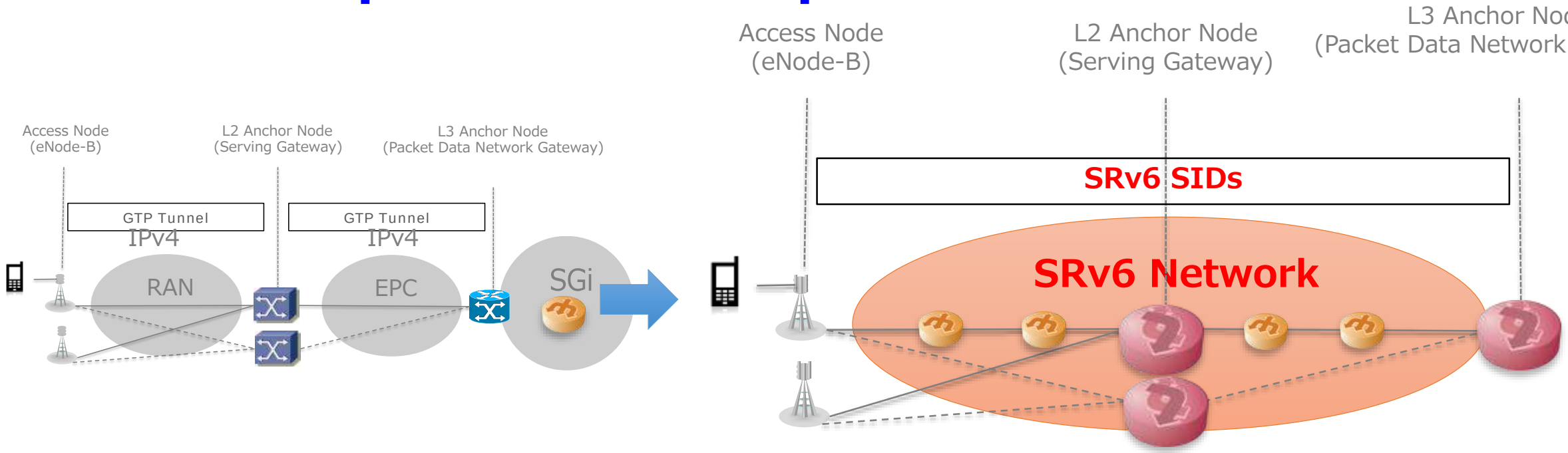


e.g;
TE-path,
VPN/APNs,
Service-chain,
etc.,

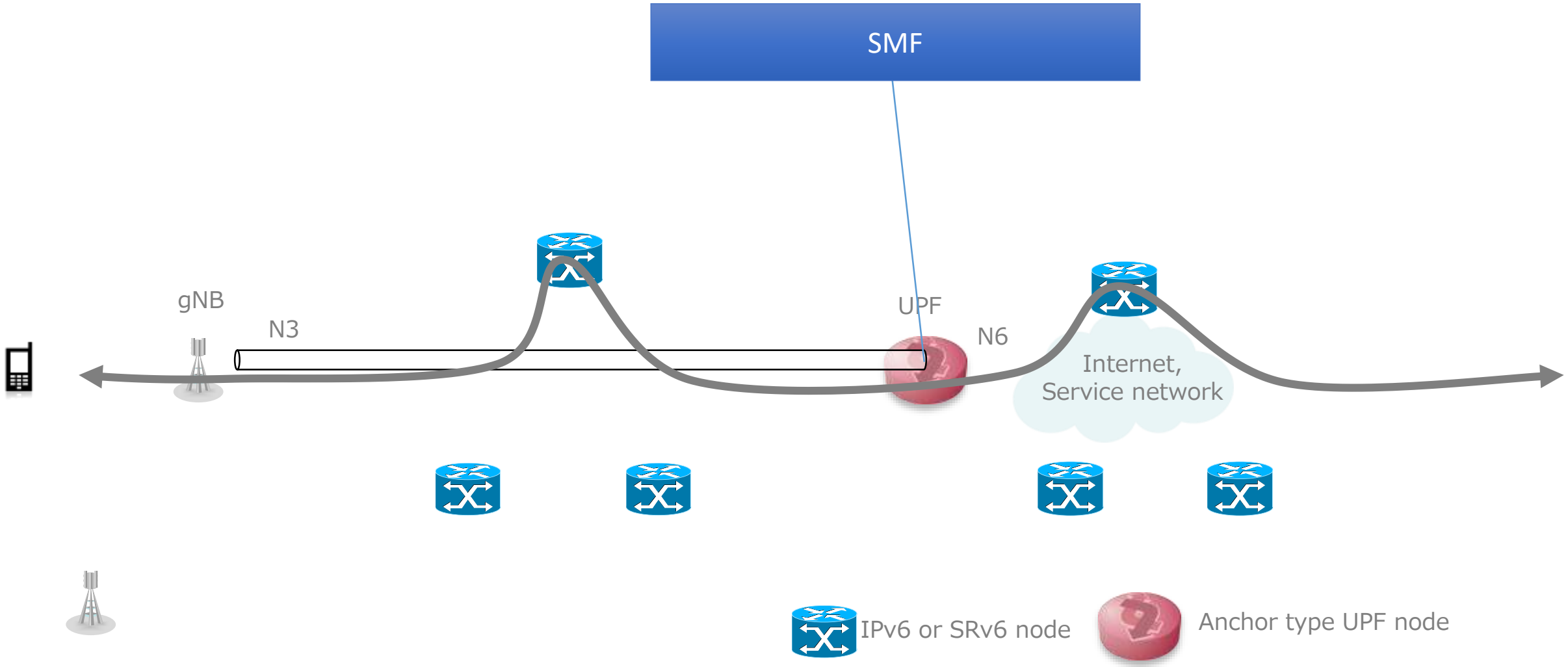
*Exist in Segment Routing Extension Header (SRH)

What if SRv6 Becomes An Alternative of GTP-U Tunnel?

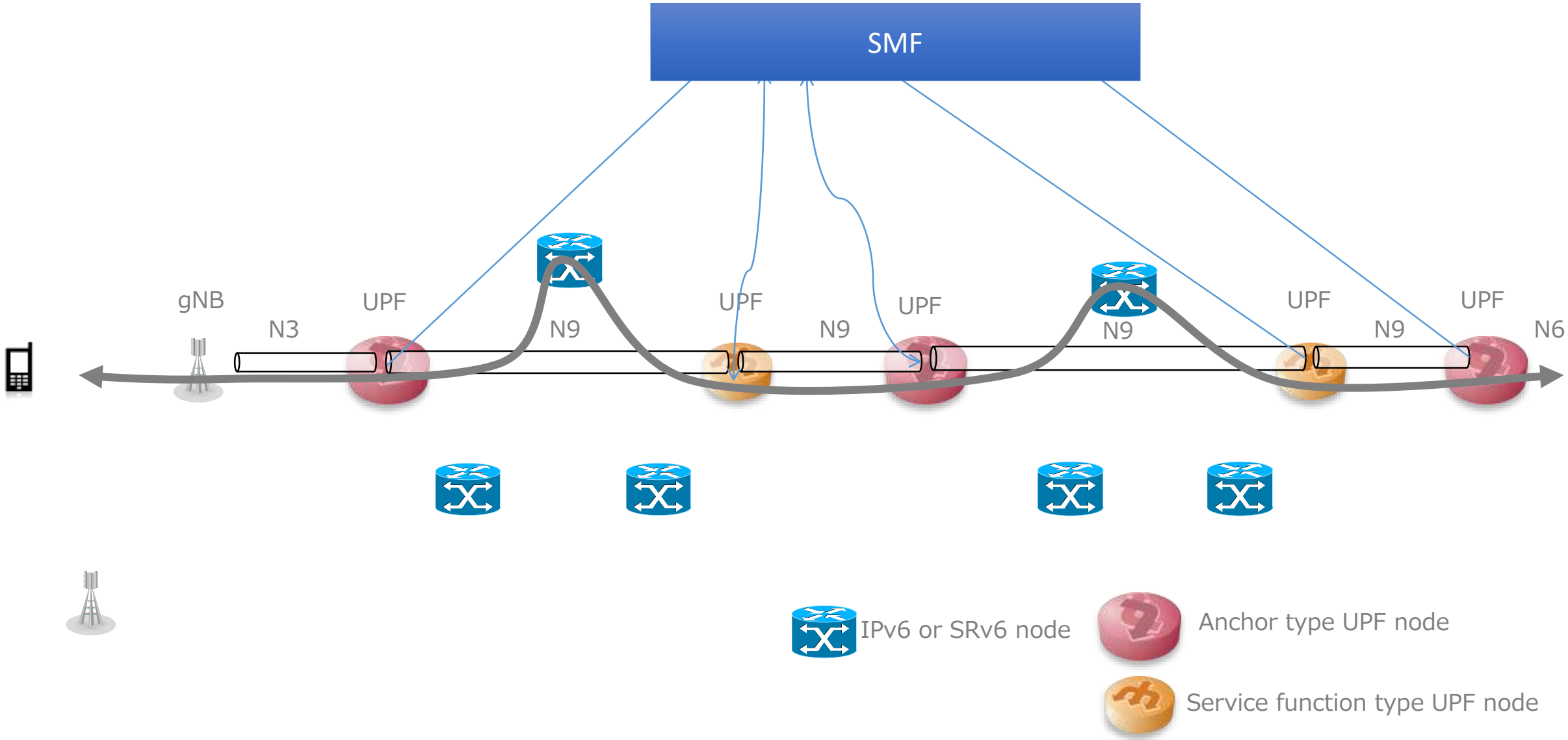
- ~~Well fragmented to RAN, EPC and SGi.~~
- ~~Per-session tunnel creation and handling.~~
- ~~Non-optimal data-path.~~
- **IPv6 integrates networks of the mobile and others.**
- **A SID represents data-plane role and function.**



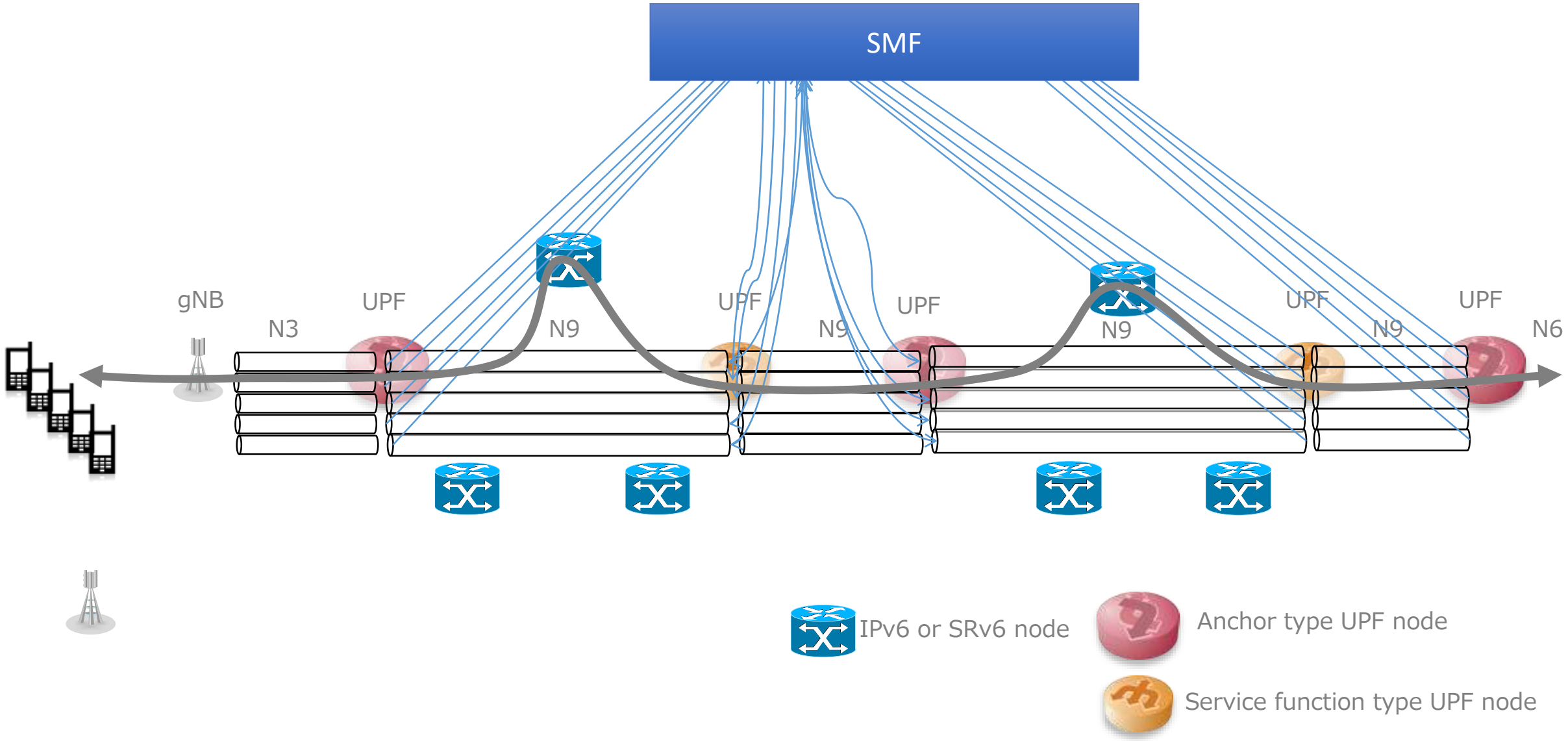
Single UPF in GTP-U Case



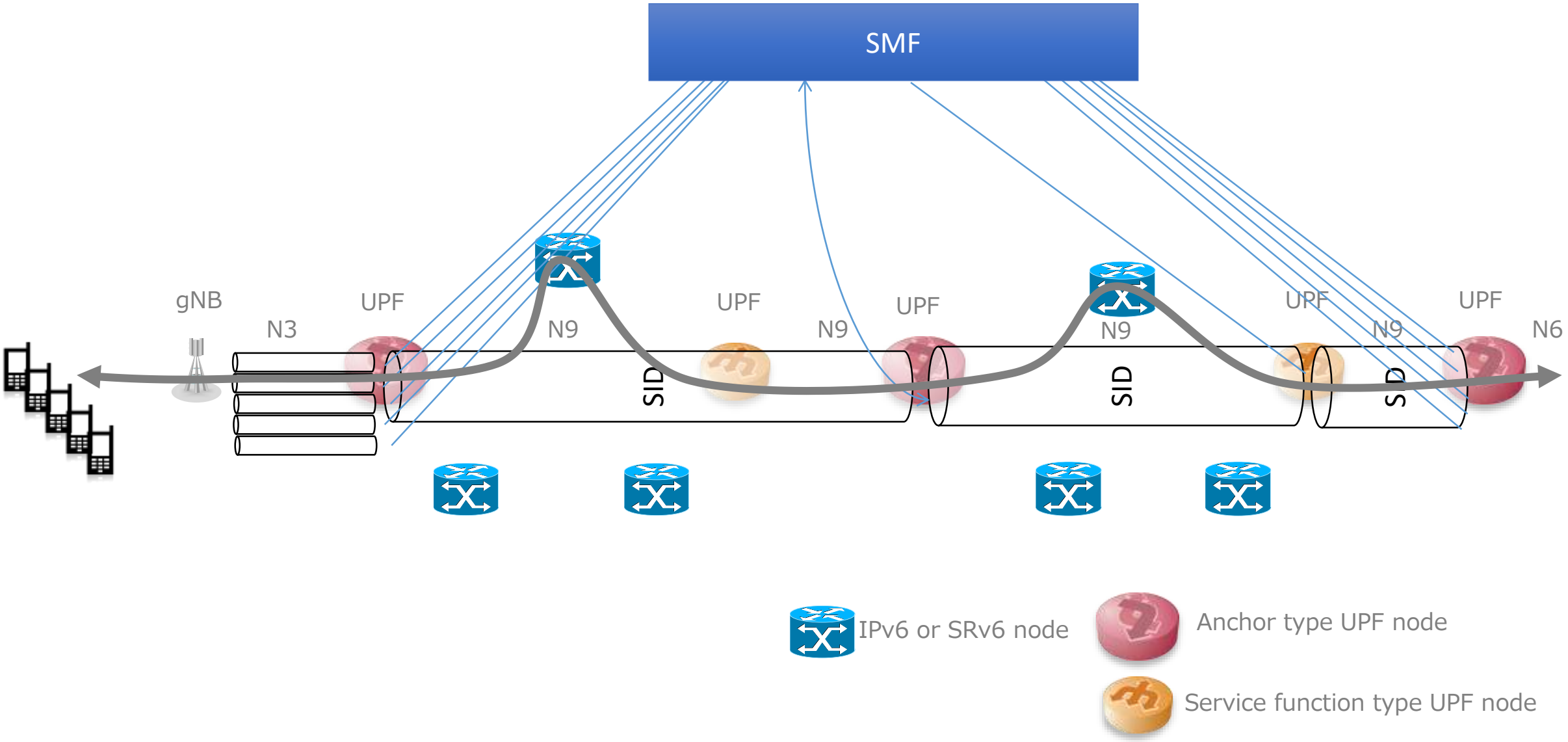
Multiple UPFs in GTP-U Case (1)



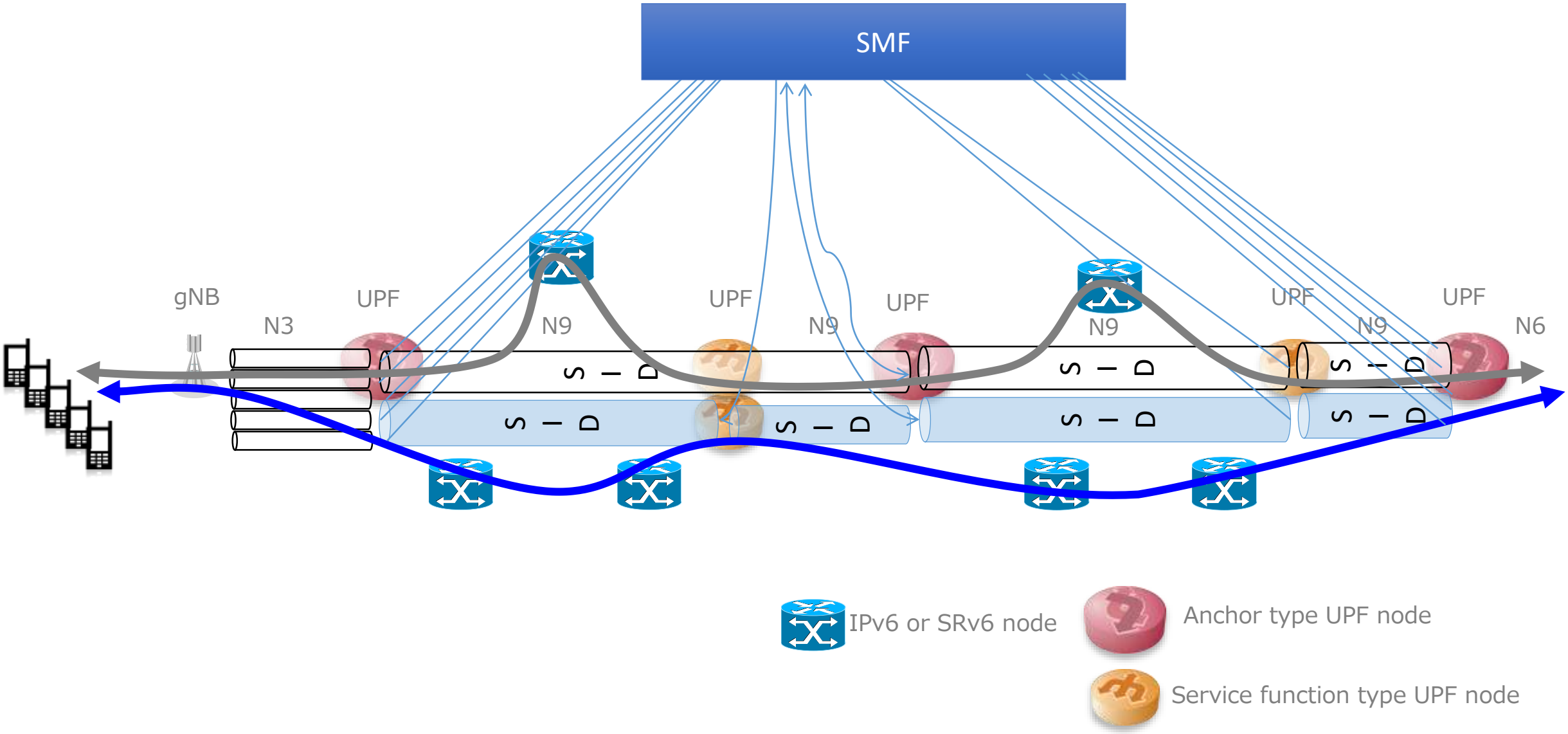
Multiple UPFs in GTP-U Case (2)



Multiple UPFs in An SRv6 Case (1)

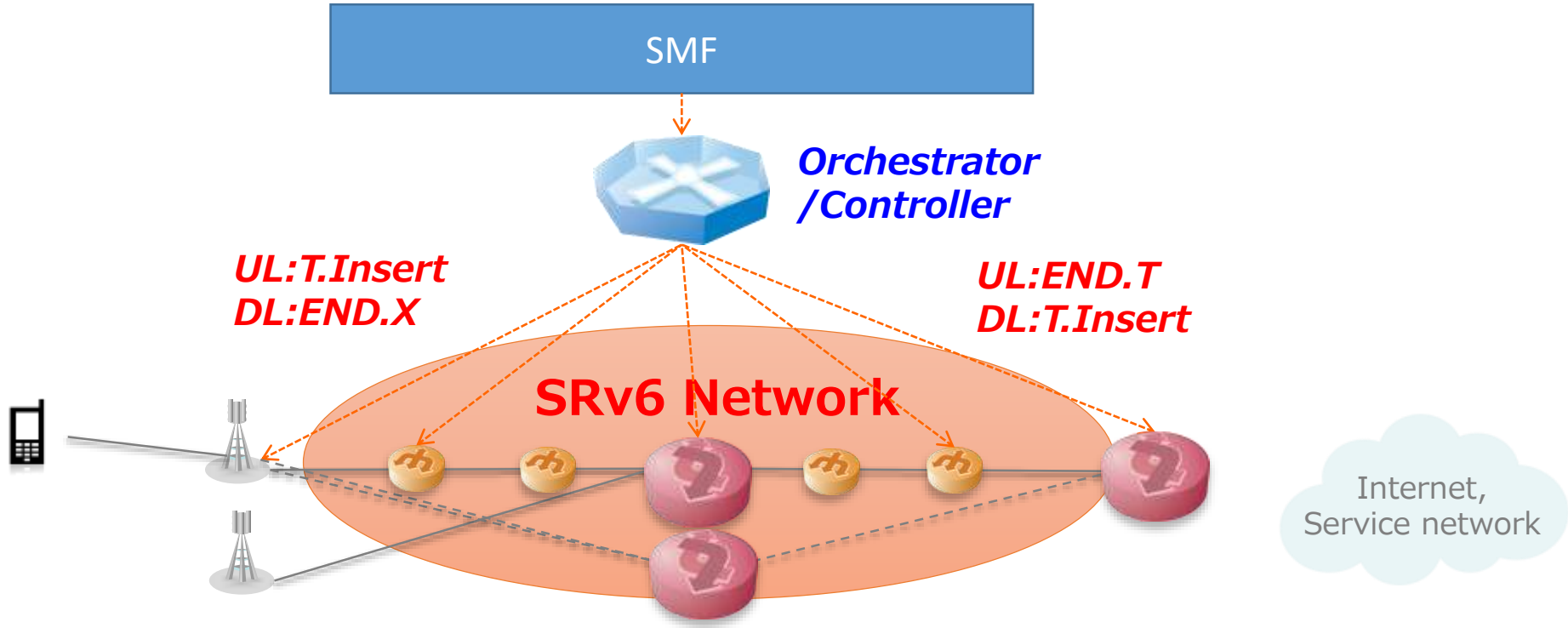


Multiple UPFs in An SRv6 Case (2)

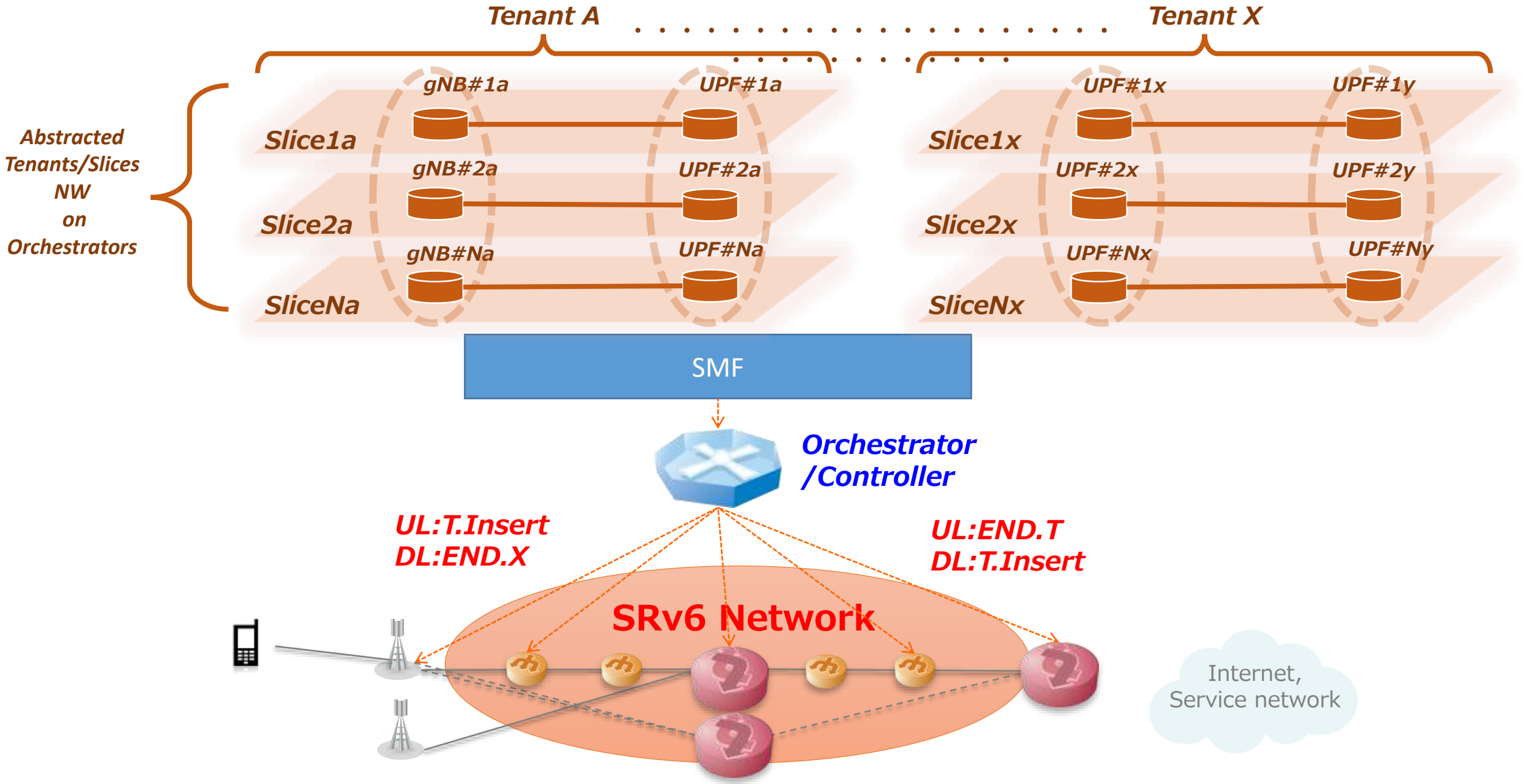


E2E Mobile Orchestration with SRv6

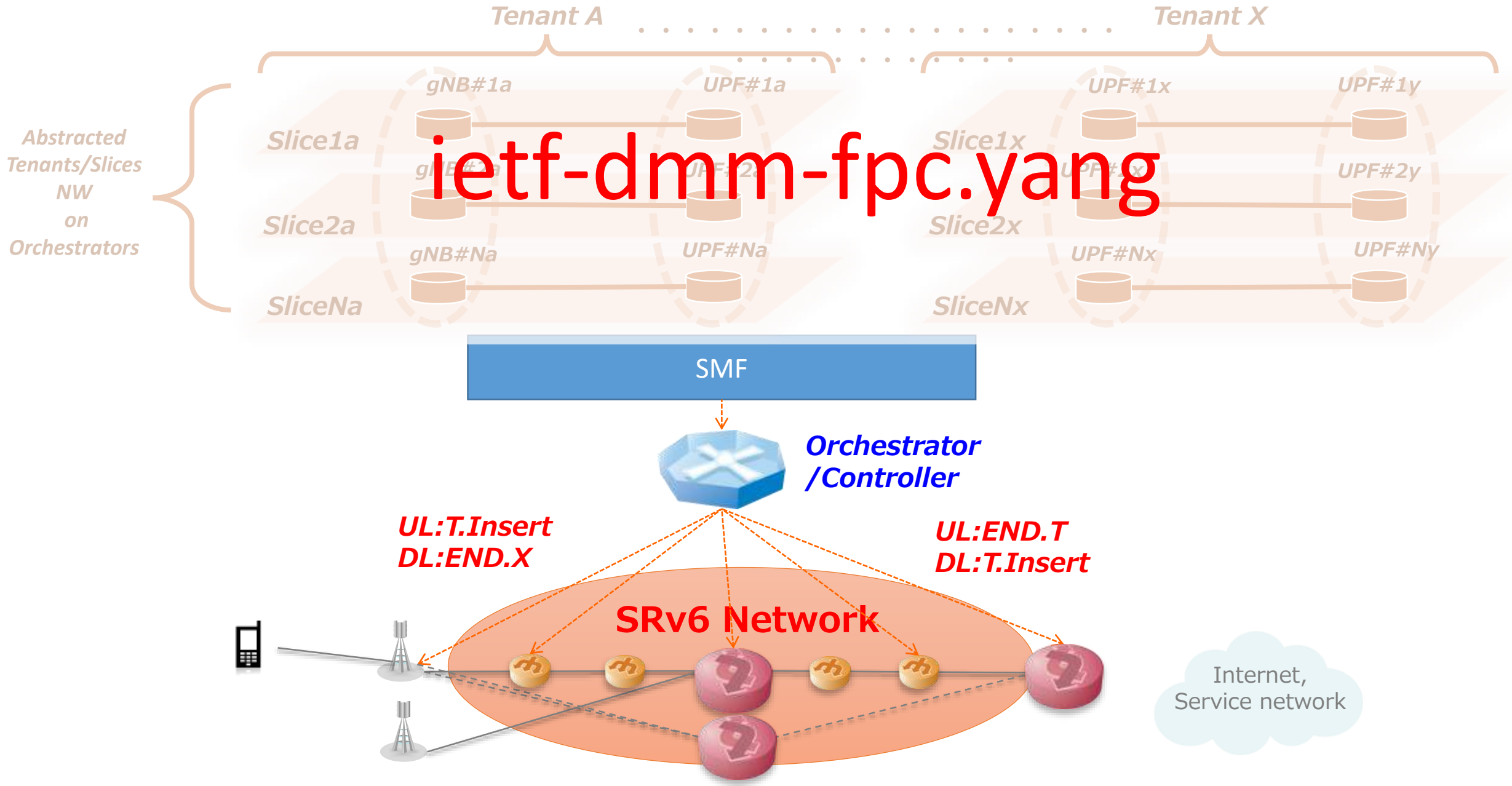
- **Data-plane nodes are NOT dedicated to specific roles.**
  -> SID represents each data-plane role.
- **Orchestrator puts SIDs to the nodes with its functions**
  -> It requires some data models to instantiate the data-plane



Data Model for Mobile Orchestration with SRv6



Data Model for Mobile Orchestration with SRv6



Summary

- **SRv6 is expected to make mobile network to be:**
  - Simple to operate in E2E basis.
  - Flexible where to deploy various functions.

- **SID Functions for mobile data-plane represent:**
  - Access point, L2 Anchor, and L3 Anchor node.
  - Interworking node in stateless manner with some new SRv6 function and parameters.

- **Basic Mode vs. Aggregate Mode**
  - Basic mode works with existing c-plane protocol with no impact.
  - **Stateless interwork function** enables interworking to existing RAN/EPC with no impact.
  - Aggregate mode introduces advanced features of SRv6 to seamless deployment which are service chain, VPNs, TE etc,. with mobility management.

Feedbacks after IETF99/CT4#79

- **Many people asked: System Impacts?**
  - To current control-plane protocol.
  - To current RAN.
  - People really care degree of system impact to change U-plane protocol from current one.

- **Benefits?**
  - What is able to do with SRv6?
  - Isn’t that possible with current u-plane protocol?
  - Isn’t SRv6 just another tunneling protocol?

Updates to v03: Answer to the Feedback

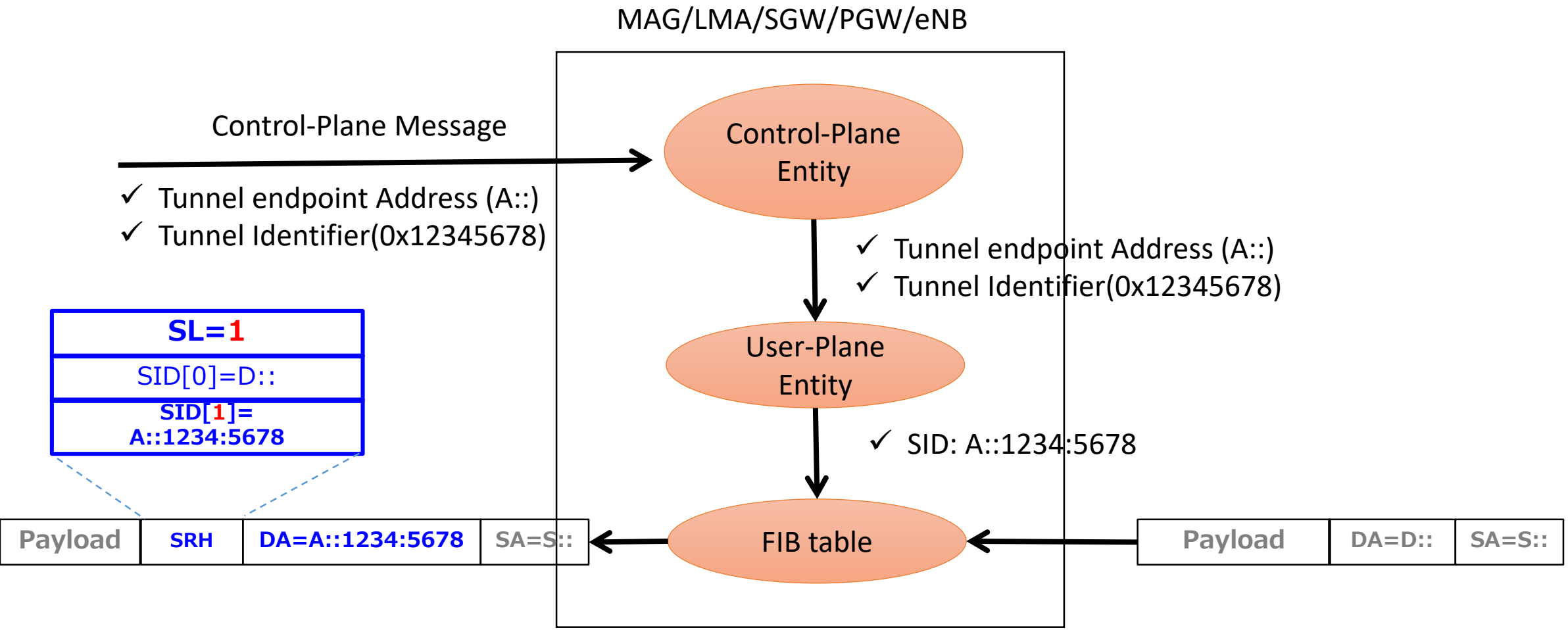
- **Introduces “Basic Mode” User-Plane**
  - (It is supposed) **No impact** to control-plane, but no advanced SRv6 features in there.
  - Operator is able to gradually migrate from basic to more advanced mode.

- **Introduces an Use Case “Stateless Interworking with Legacy Access”**
  - (It is supposed) **No impact** to current RAN in control-plane.

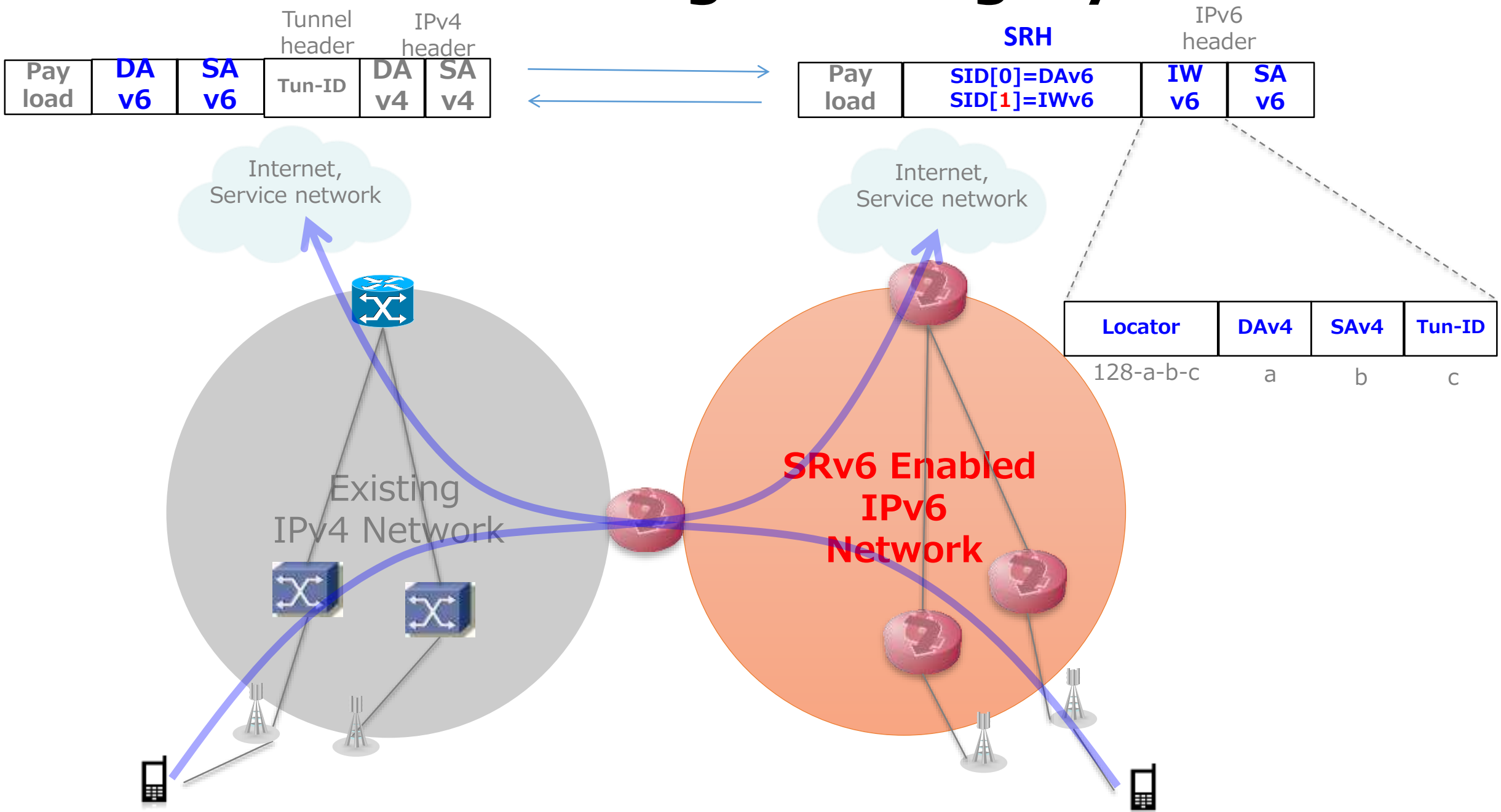
- **Introduces “Aggregate Mode” User-Plane**
  - Benefits **seamless deployment** of service-chain, VPNs and TE within the mobile user-plane
  - Complicated? Mobile control-plane can focus to only manage mobility and keep simple.
    - Implementing other service policies to the user-plane can be done by separate systems.
  - Complicate text? May need to find concise way to describe the procedures.

So please review

Leveraging Current Control-Plane



Stateless Interworking with Legacy Networks



Updates to v03: Technical Progress

- **Introduces New SRv6 Functions: “End.TM” and “T.Tmap”**
  - To support Stateless Interworking with legacy user-plane with some parameters.

End.TM
(Endpoint function with encaps for mapped tunnel)

SRv6 -> Legacy

```
1. IF NH=SRH & SL > 0 THEN
2.    decrement SL
3.    update the IPv6 DA with SRH[SL]
4.    push header of TUN-PROTO with tunnel ID from S          ;; Ref1
5.    push outer IPv4 header with SA, DA from S
6. ELSE
7.    Drop the packet

  Ref1: TUN-PROTO indicates target tunnel type.
```

T.Tmap
(Transit behavior with decaps tunnel and map SRv6 policy)

Legacy-> SRv6

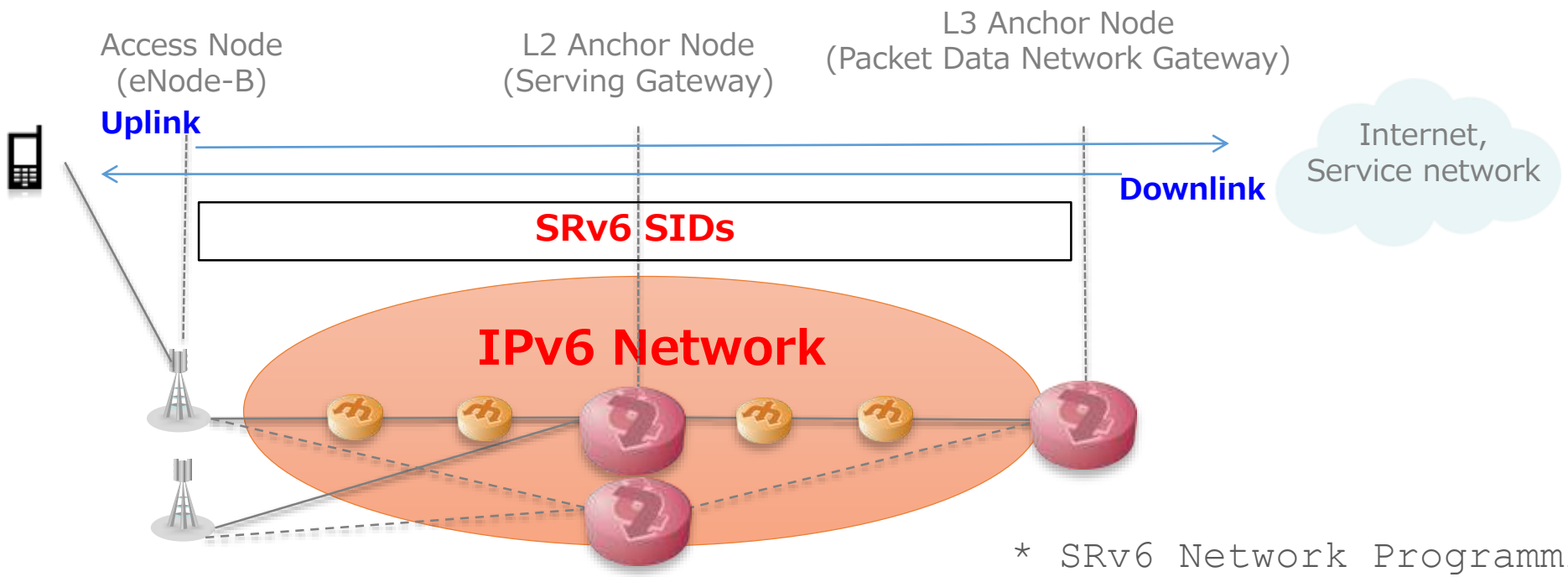
```
1.   IF P.PLOAD == TUN-PROTO & T.PLOAD == IPv6 THEN    ;; Ref1, Ref1bis
2.      pop the outer IPv4 header and tunnel headers
3.      copy IPv4 DA, SA, TUN-ID to form SID B with IW-IPv6-Prefix
4.      insert the SRH (D, B; SL=1)                    ;; Ref2, Ref2bis
5.      set the IPv6 DA = B
6.      forward along the shortest path to B
7.   ELSE
8.      Drop the packet

  Ref1: P.PLOAD and T.PLOAD represent payload protocol of the receiving
  packet, and payload protocol of the tunnel respectively.
```

Work in Progress

- **QoS and Accounting**
  - Enables SID to represent QoS and accounting policy.
- **E2E SR and Network Slicing**
  - Enables Apps running on MN be able to designate slices.
- **IPv4 Support**
  - Carries IPv4 user packets.
  - Many IPv6 transition solutions make it can be considered as an user application on IPv6.
    - MAP-E(RFC7597), MAP-T(RFC7599), 464XLAT(RFC6877) and DS-Lite(RFC6333).
- **Collaborations**
  - IETF DMM(Distributed Mobility Management) WG has issued an adoption call to the I-D.
  - 3GPP CT4 to initiate study work of user-plane protocol.

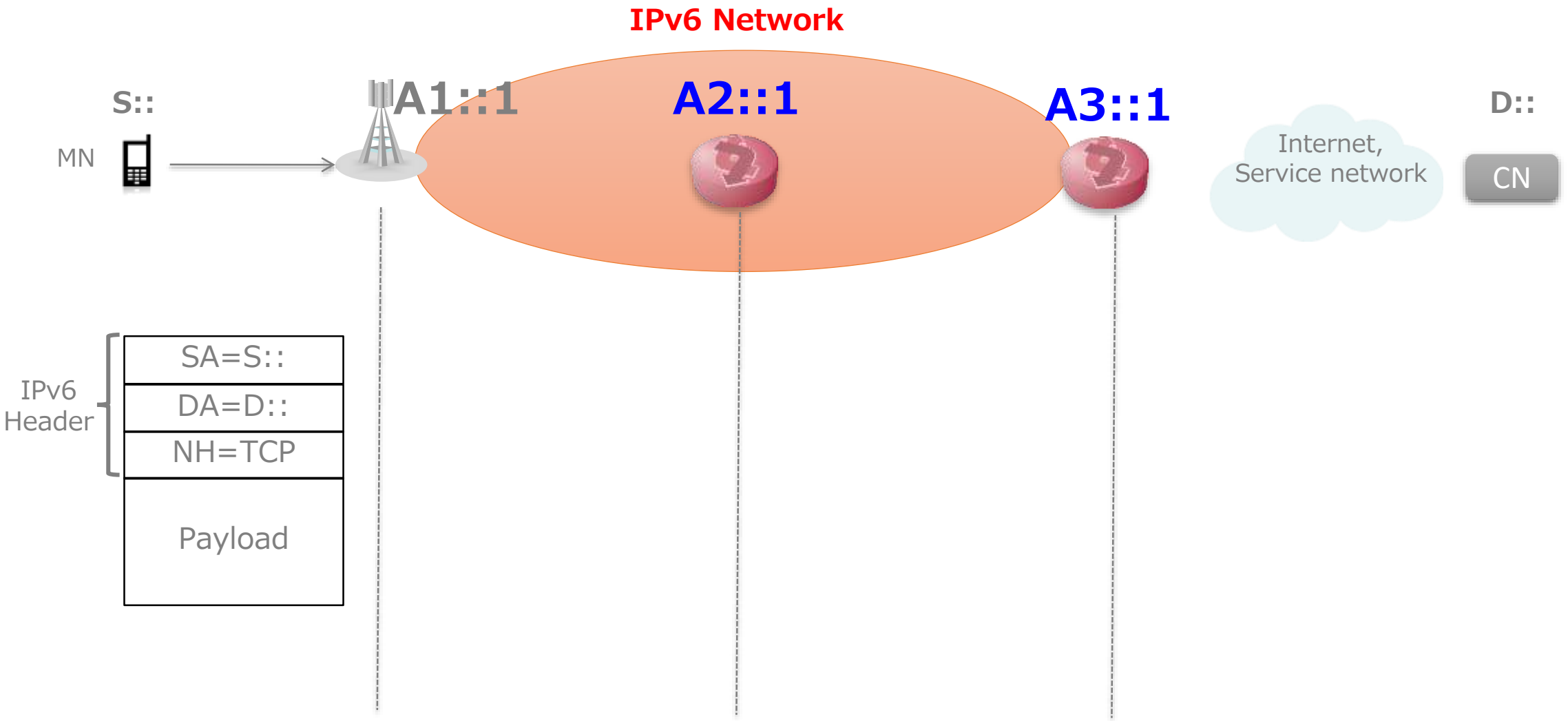
Basic Mode

	Uplink	Downlink
Access Point	T.Insert	End.X
L2 Anchor Node	End.B6	End.B6
L3 Anchor Node	End.T	T.Insert



* SRv6 Network Programming

Basic Mode User-Plane Flows (Uplink)



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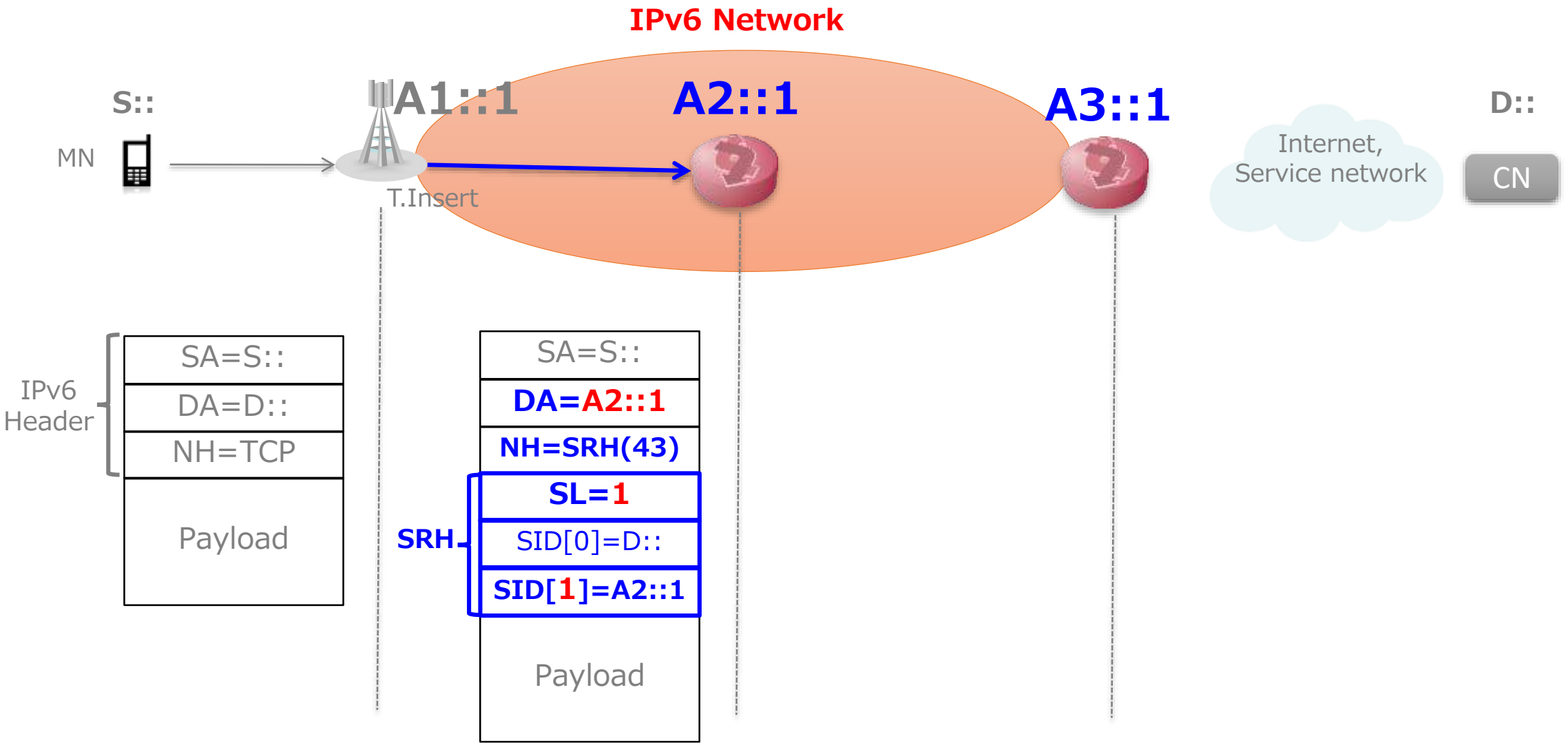

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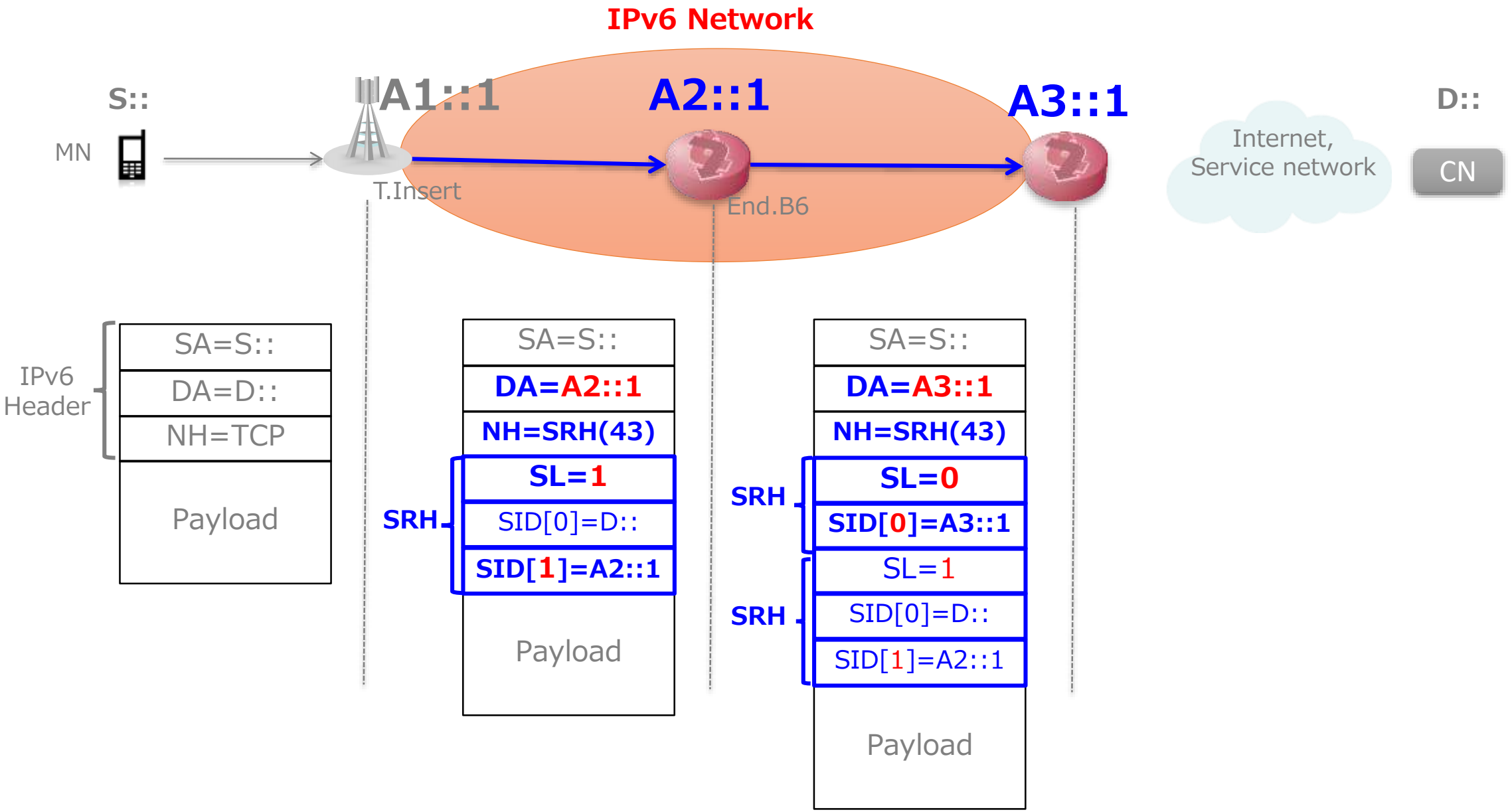

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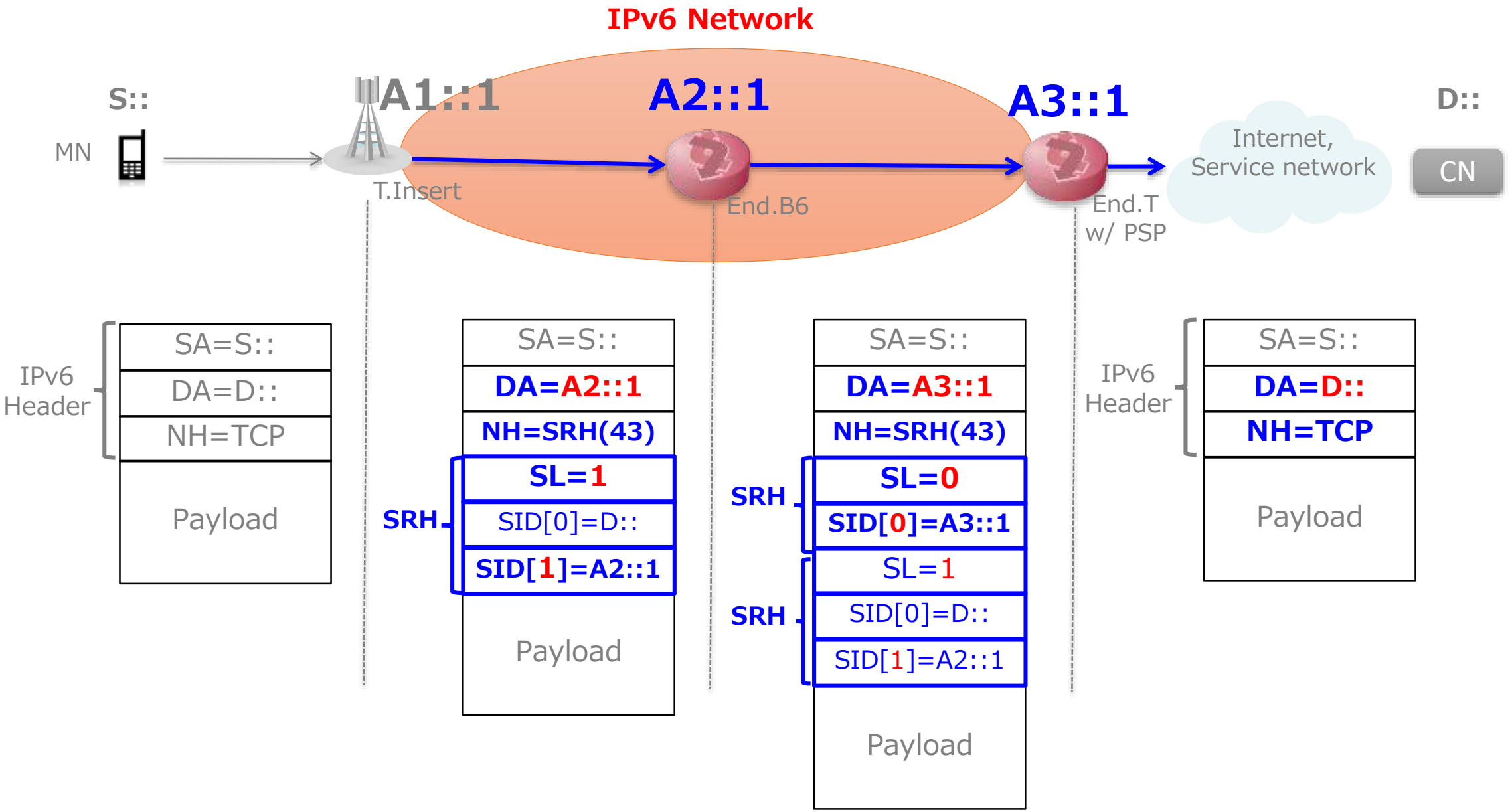
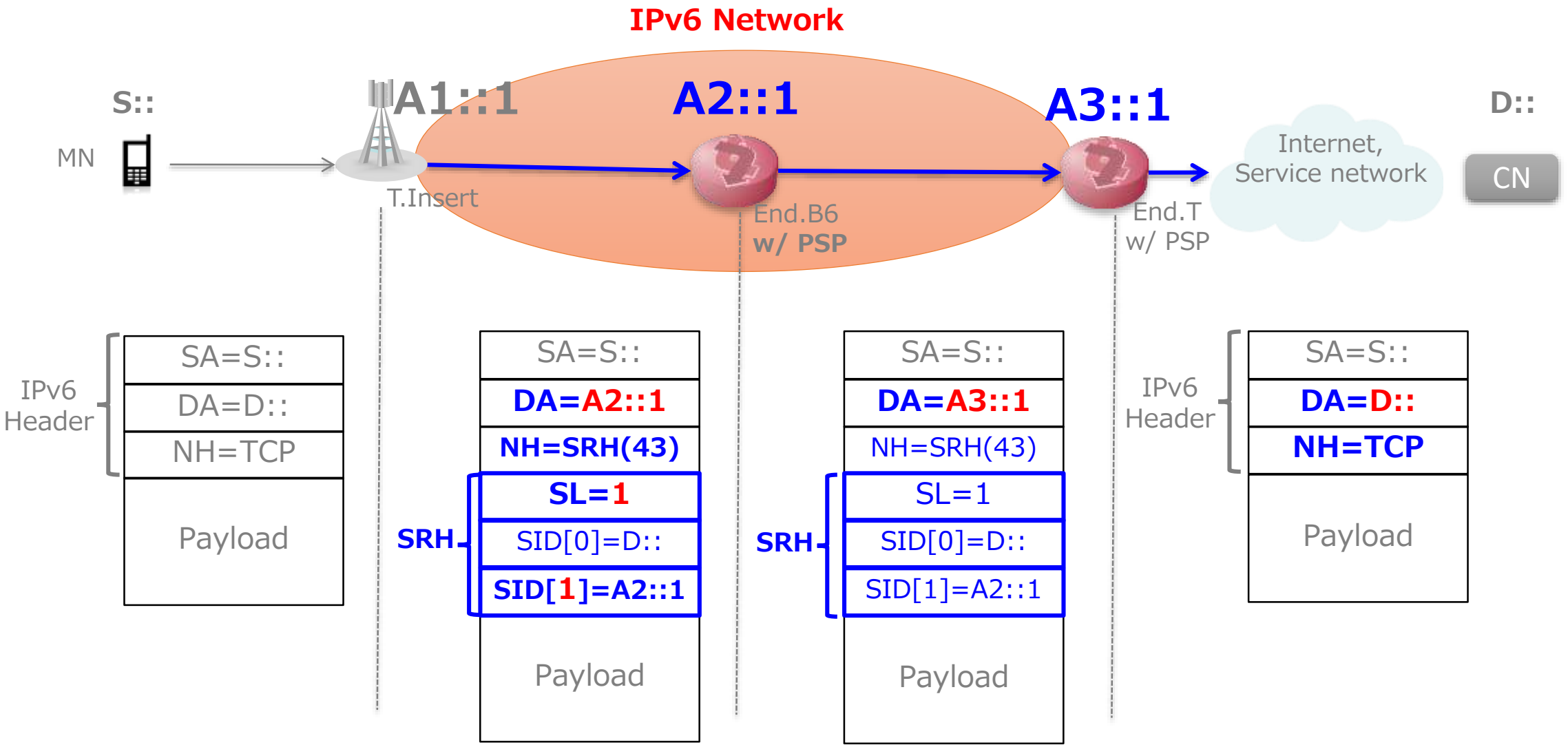
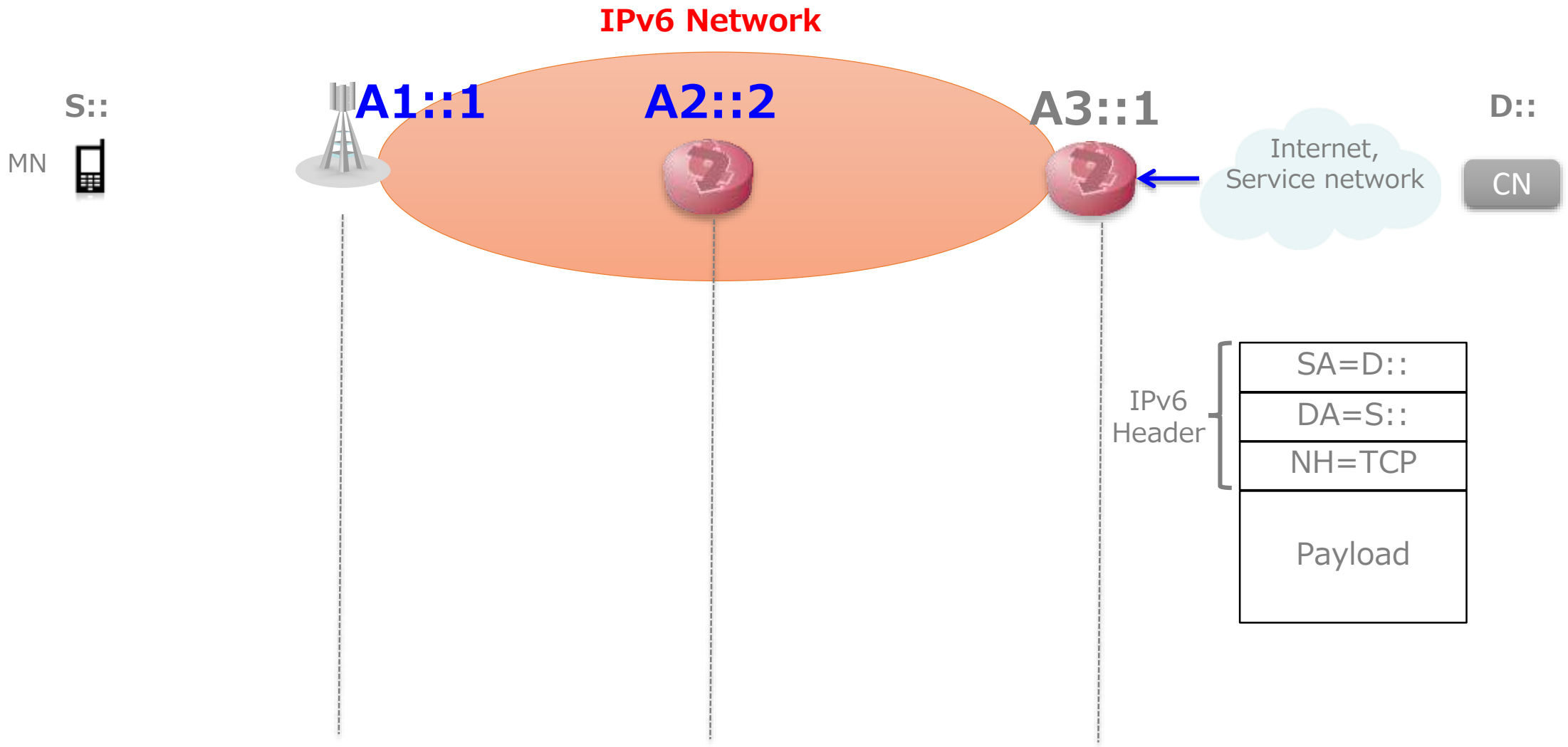


Basic Mode User-Plane Flows (Uplink)



Basic Mode User-Plane Flows (Downlink)



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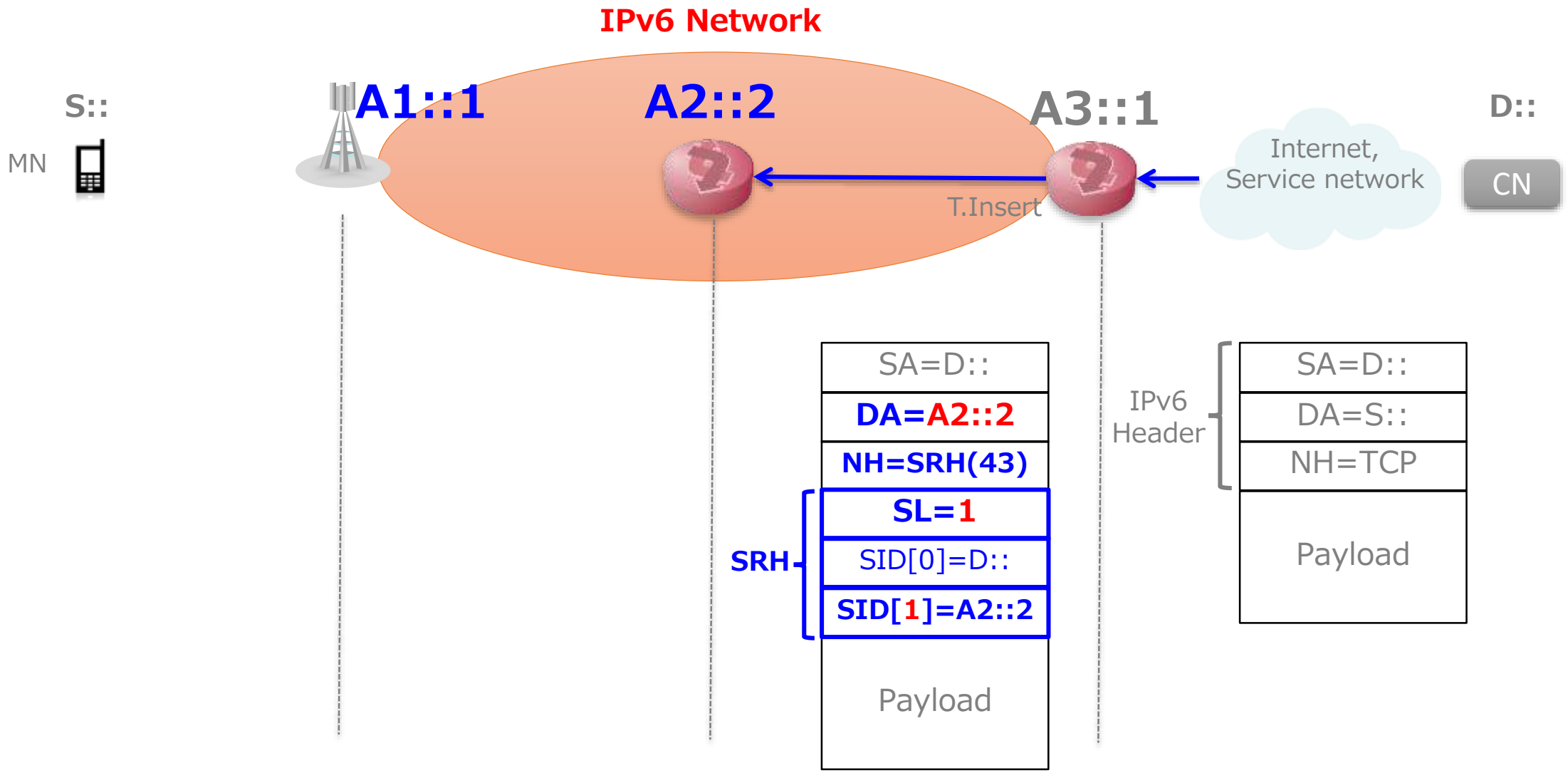
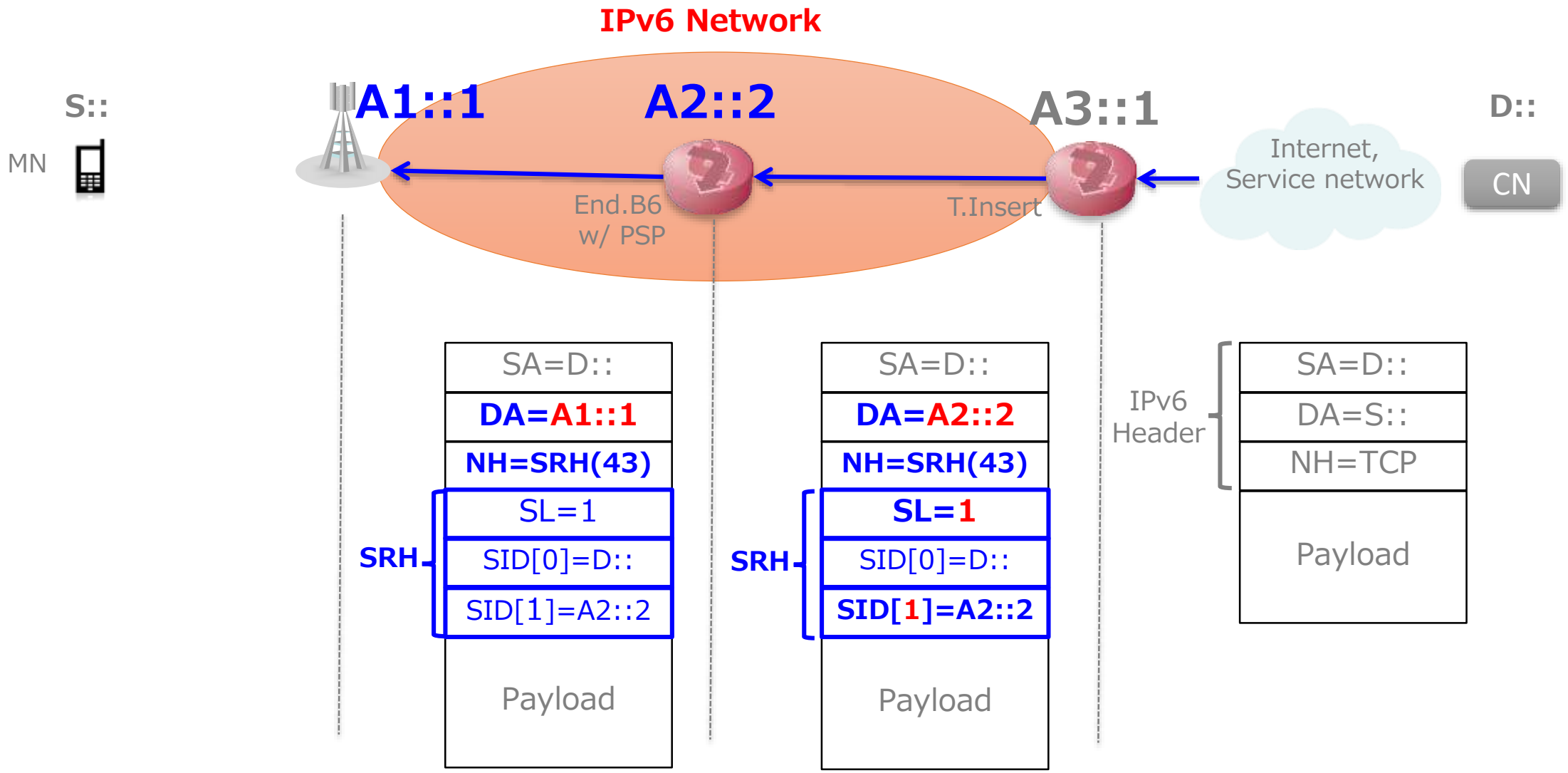


Basic Mode User-Plane Flows (Downlink)



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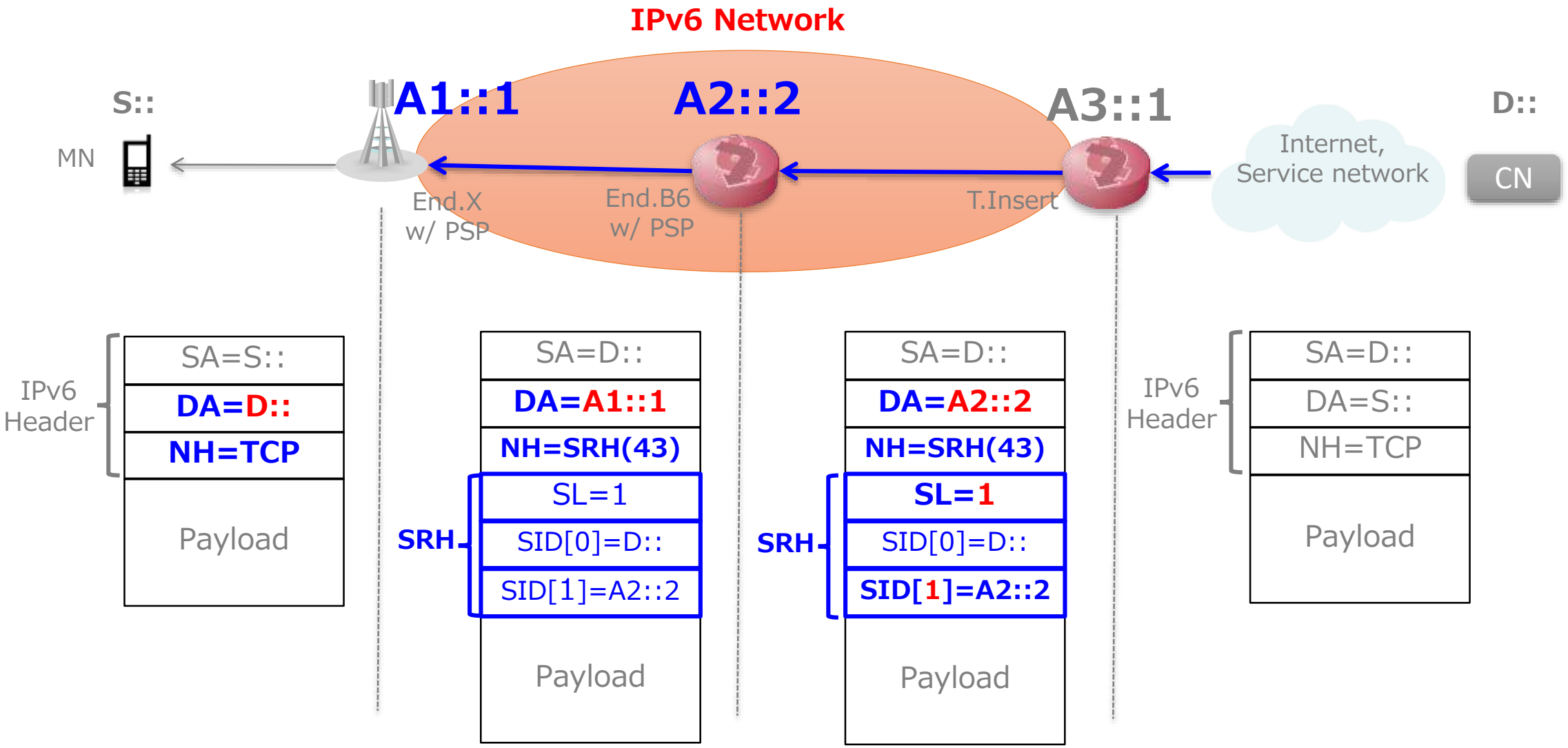
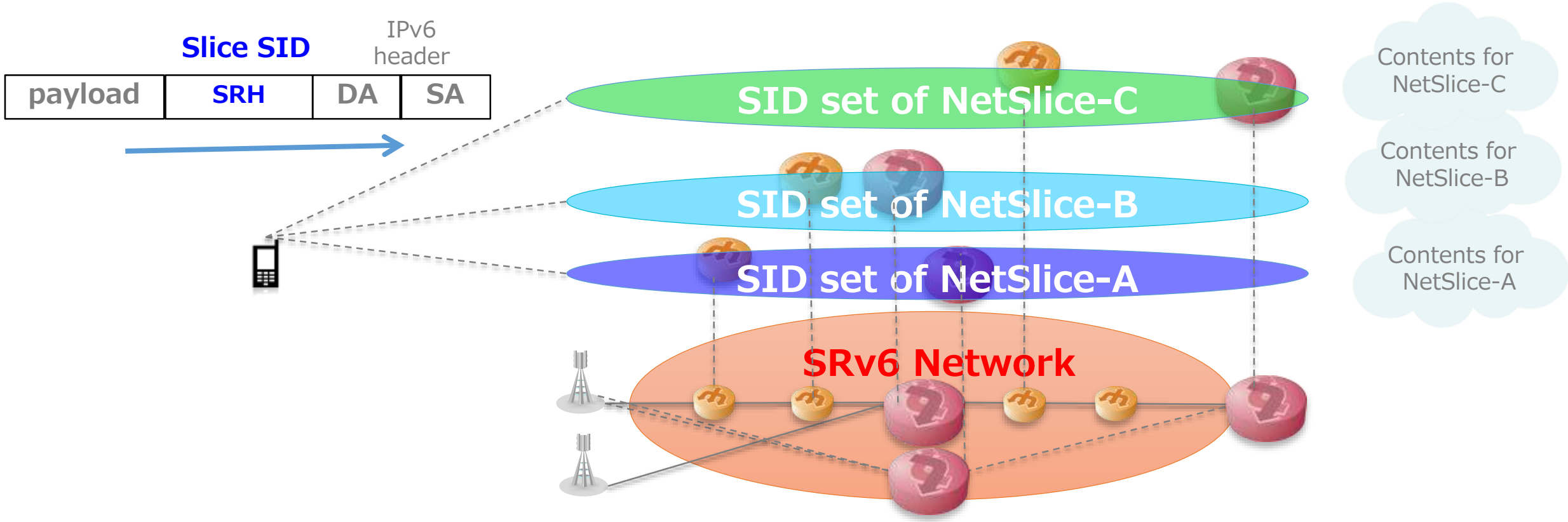


SRv6 for Network Slicing

- **A set of SIDs represents Network Slice.**
  -> Sharing same prefix among SIDs in a slice would work.
- **Then user packets could also indicate Slices by SID.**
  -> Applications in a MN could be able to use SID to do that.



References

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  - draft-ietf-6man-segment-routing-header
- SRv6 Network Programming
  - draft-filsfils-spring-srv6-network-programming
- ietf-dmm-fpc.yang
  - A SDO neutral mobile data-plane model as a part of the FPC work in IETF DMM working group.
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