P4 2022 Workshop
May 24-26th

Network Programmability "Squared"

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On behalf of:
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SRv6 Network Programming Model of SRv6 Mobile User Plane

6.6. End.M.GTP4.E

The "Endpoint behavior with encapsulation for IPv4/GTP tunnel" behavior (End.M.GTP4.E for short) is used in the downlink when doing interworking with legacy gNB using IPv4/GTP.

When the SR Gateway node N receives a packet destined to S and S is a local End.M.GTP4.E SID, N does:

```
S01. When an SRH is processed {
S02.   If (Segments Left != 0) {
S03.      Send an ICMP Parameter Problem to the Source Address,
             Code 0 (Erroneous header field encountered),
             Pointer set to the Segments Left field,
             interrupt packet processing, and discard the packet.
S04.   }
S05.   Proceed to process the next header in the packet
S06. }
```

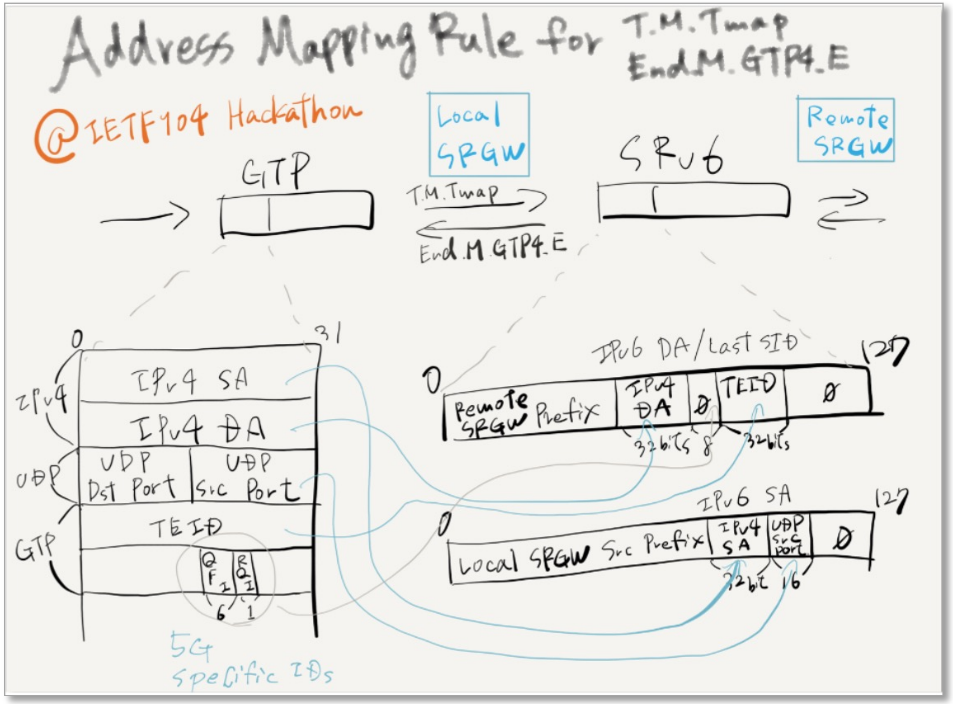
When processing the Upper-layer header of a packet matching a FIB entry locally instantiated as an End.M.GTP4.E SID, N does:

```
S01.    Store the IPv6 DA and SA in buffer memory
S02.    Pop the IPv6 header and all its extension headers
S03.    Push a new IPv4 header with a UDP/GTP Header
S04.    Set the outer IPv4 SA and DA (from buffer memory)
S05.    Set the outer Total Length, DSCP, Time To Live, and
           Next-Header fields
S06.    Set the GTP TEID (from buffer memory)
S07.    Submit the packet to the egress IPv6 FIB lookup and
           transmission to the new destination
```

Notes: The End.M.GTP4.E SID in S has the following format:

```
 0                                                        127
 +-----------------------+-------+----------------+---------+
 |  SRGW-IPv6-LOC-FUNC   |IPv4DA |Args.Mob.Session|0 Padded |
 +-----------------------+-------+----------------+---------+
        128-a-b-c            a            b           c
```

Figure 9: End.M.GTP4.E SID Encoding



https://www.ietf.org/archive/id/draft-ietf-dmm-srv6-mobile-uplane-21.html

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SRv6MUP Performance in P4 Was Measured (2019)

International Workshop on High-Precision Networks Operations and Control,
Segment Routing and Service Function Chaining (HiPNet+SR/SFC 2019)

Performance Evaluation of GTP-U and SRv6 Stateless Translation

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***Abstract*—The GPRS Tunneling Protocol User Plane (GTP-U) has long been deployed for GSM, UMTS and 4G LTE. Now for 5G, IPv6 Segment Routing (SRv6) has been proposed as an alternative user plane protocol to GTP-U in both 3GPP and IETF. SRv6 based on source routing has many advantages: stateless traffic steering, network programming and so on. Despite the advantages, it is hard to expect to replace GTP-U by SRv6 all at once, even in a 5G deployment because of a lot of dependencies between 3GPP nodes. Therefore, stateless translation and co-existence with GTP-U have been proposed in IETF. However there are no suitable measurement platform and performance evaluation results between GTP-U and SRv6. In particular, it is hard to measure latency on commercial traffic generators when a receiving packet type is different from a sending packet type. In this paper, we focus on the performance evaluation between GTP-U and SRv6 stateless translation. We designed an SRv6 measurement platform using a programmable switch, and measured GTP-U and SRv6 functions with pre-defined scenarios on a local environment. Well-known performance metrics, such as throughput and packets per second (PPS), are measured by the traffic generator while the latency at the functions was measured using telemetry on our SRv6 platform. In our evaluation, we cannot find the abrupt performance drop of well-known metrics at SRv6 stateless translation. Moreover, the latency of SRv6 stateless translation is similar to GTP-U and their performance degradation is negligible. Through the evaluation results, it is obvious that the SRv6 stateless translation is acceptable to the 5G user plane.**

***Index Terms*—SRv6, GTP-U, 5G, P4, Mobile user plane, Measurement**

I. Introduction

[5] for stateless translation between GTP-U and SRv6 has been proposed, and co-existence with GTP-U has been also discussed for the 5G user plane within IETF.

Unfortunately, there are no quantitative performance evaluation results between GTP-U and SRv6. Thus, it is hard to clarify the validity of SRv6 stateless translation method. Moreover, there is no suitable measurement platform although some GTP-U and SRv6 functions are supported by CPU-based and ASIC-based platforms. In CPU-based platform, it would be hard to achieve the pure performance evaluation for the 5G networks. Alternatively, ASIC-based platform as a commodity programmable switch, such as Barefoot Tofino [6], is reasonable for the evaluation.

Although several SRv6 functions are implemented on the programmable switch [7], there are problems with existing p4 code. The first problem is that there are no implementations of translation functions. The second one is that unnecessary switching and routing functions are involved to the SRv6 functions and they are widely spread out hardware resource. The last one is that we cannot measure the latency on a commercial traffic generator, such as IXIA, when packet types are changed by the translation functions on the programmable switch. In order to solve the problems, we should design and implement GTP-U and SRv6 translation functions with the latency measurement.

Our research goal of this paper is to evaluate the quantitative performance of stateless translation between GTP-U and

TABLE II
Average of well-known performance metrics (PPS and throughput).

	Light (short)		Light (long)		Heavy (short)		Heavy (long)	
	PPS	Throughput	PPS	Throughput	PPS	Throughput	PPS	Throughput
GTP-U functions (*GTP-U encap. and decap.*)	100,805	96.7 Mbps	8,127	99.7 Mbps	100,805,260	96.7 Gbps	8,127,358	99.7 Gbps
SRv6 functions (*SRv6 encap. and decap.*)	100,805	99.9 Mbps	8,127	99.9 Mbps	100,805,260	99.9 Gbps	8,127,358	99.9 Gbps
SRv6 translation functions (*T.M.Tmap* and *End.M.GTP4.E*)	100,805	99.9 Mbps	8,127	99.9 Mbps	100,805,260	99.9 Gbps	8,127,358	99.9 Gbps

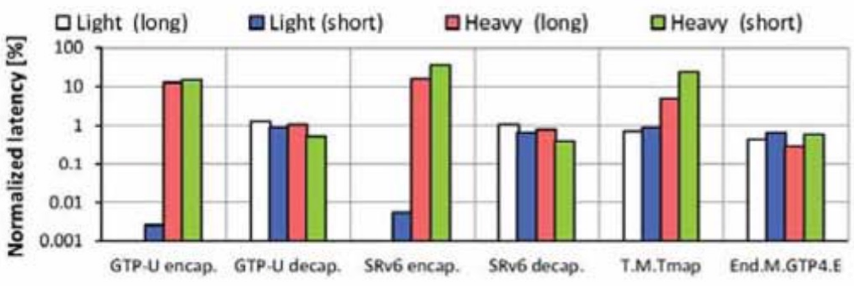
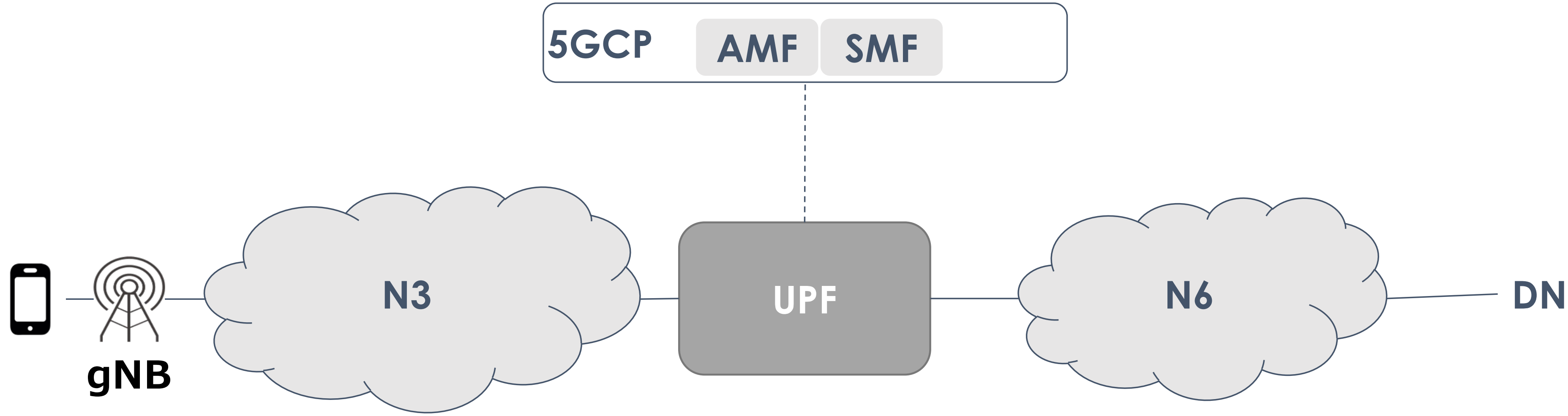


Fig. 5. Normalized latency on local environment.

https://ieeexplore.ieee.org/document/9012725

Now MNOs are building 5G Network..



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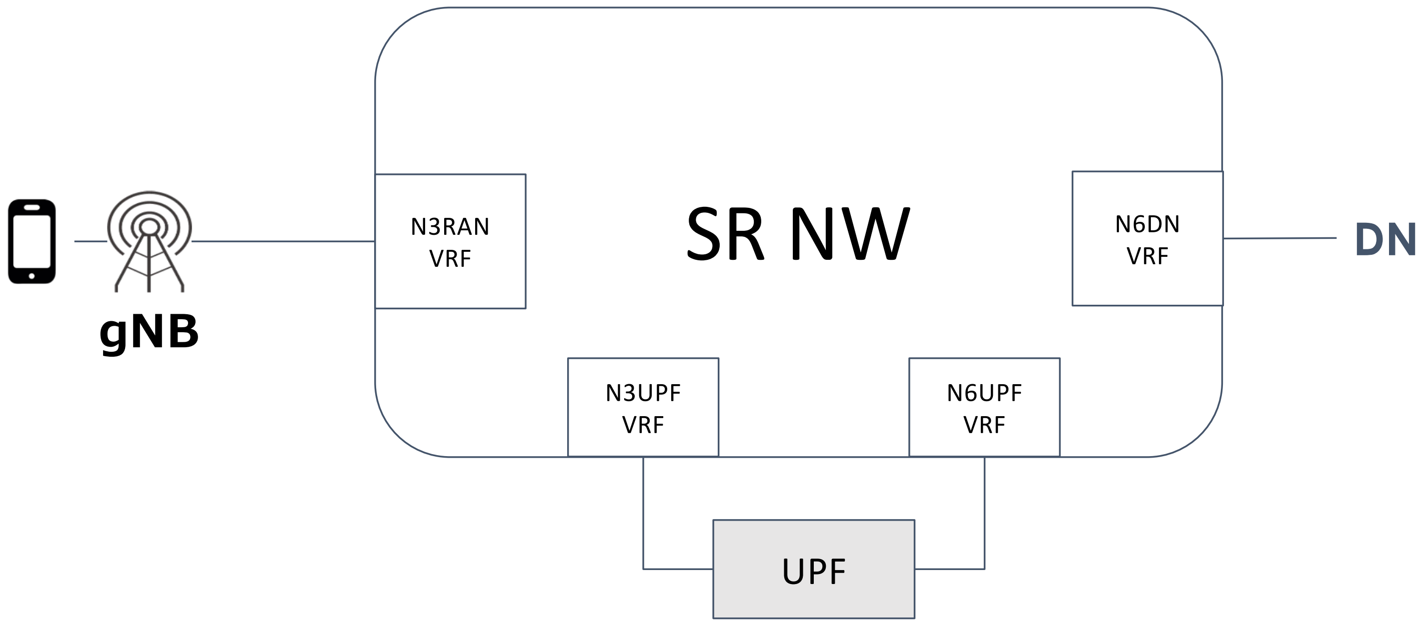
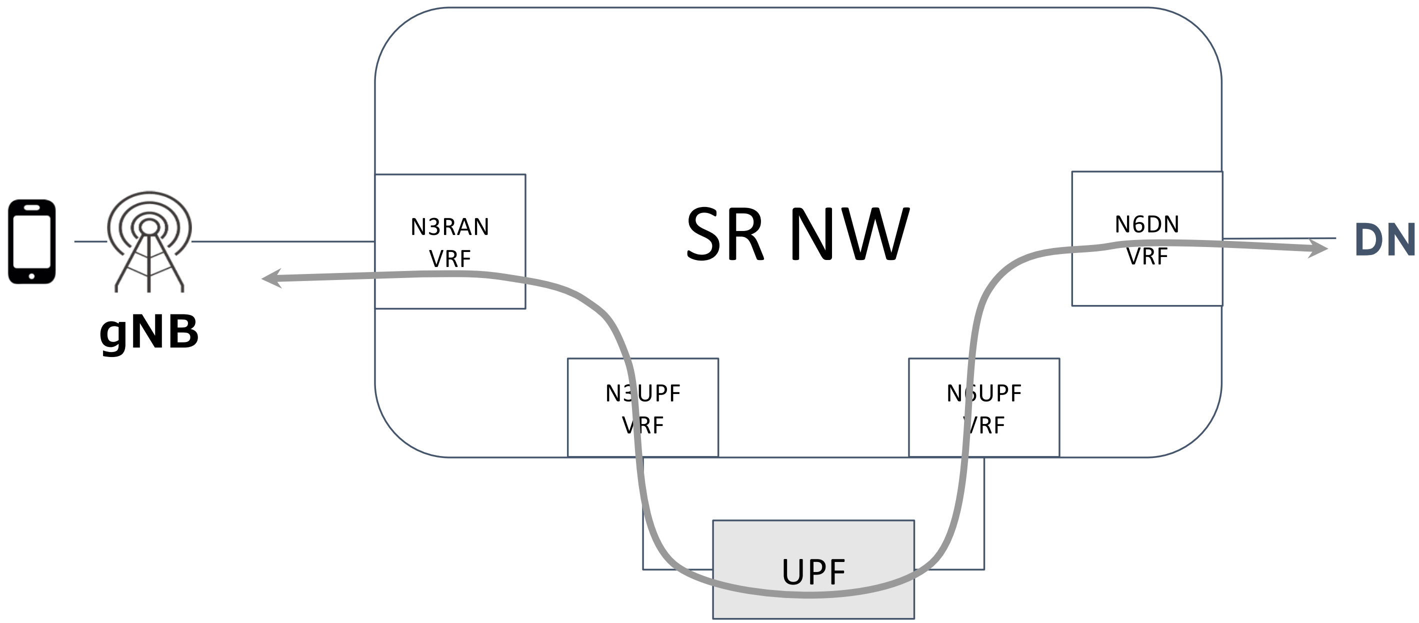
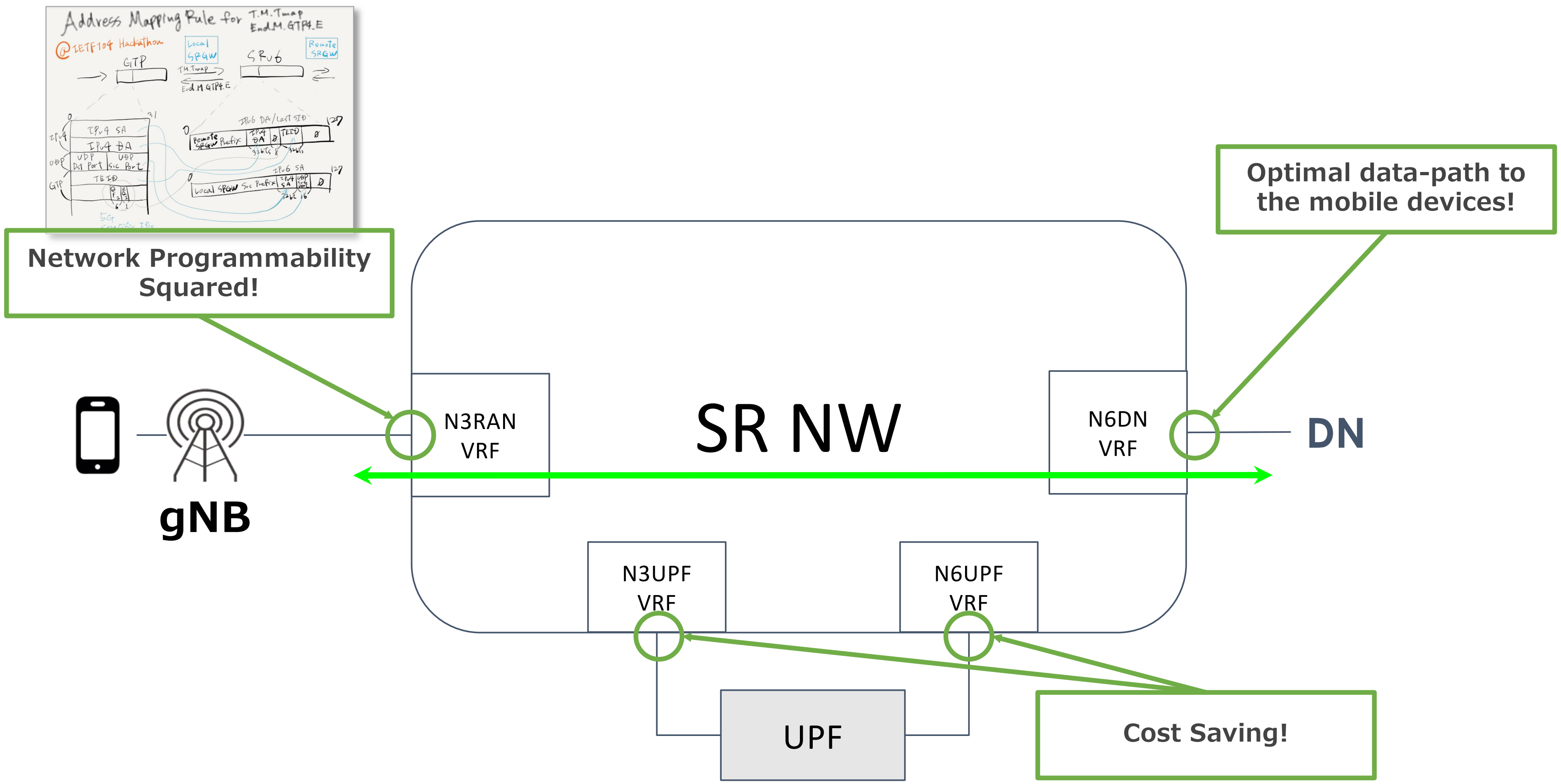
An MNO May Build 5G Network over SR Like This..



The User Plane Data-Path Does Not Look Optimal..



What if We Could Do This.. We Need Architecture!



Required Architecture Work, In Addition to the Data-Plane Implementation…

```
Internet Engineering Task Force                            S. Matsushima
Internet-Draft                                                K. Horiba
Intended status: Standards Track                                A. Khan
Expires: 20 September 2022                                  Y. Kawakami
                                                               SoftBank
                                                            T. Murakami
                                                               K. Patel
                                                            Arrcus, Inc
                                                               M. Kohno
                                                              T. Kamata
                                                           P. Camarillo
                                                    Cisco Systems, Inc.
                                                               D. Voyer
                                                            Bell Canada
                                                               S. Zadok
                                                              I. Meilik
                                                               Broadcom
                                                             A. Agrawal
                                                             K. Perumal
                                                                  Intel
                                                                J. Horn
                                                    Cisco Systems, Inc.
                                                          19 March 2022

  Segment Routing IPv6 Mobile User Plane Architecture for Distributed
                         Mobility Management
                 draft-mhkk-dmm-srv6mup-architecture-03

Abstract

   This document defines the Segment Routing IPv6 Mobile User Plane
   (SRv6 MUP) architecture for Distributed Mobility Management.  The
   requirements for Distributed Mobility Management described in
   [RFC7333] can be satisfied by routing fashion.
```

https://datatracker.ietf.org/doc/draft-mhkk-dmm-srv6mup-architecture/

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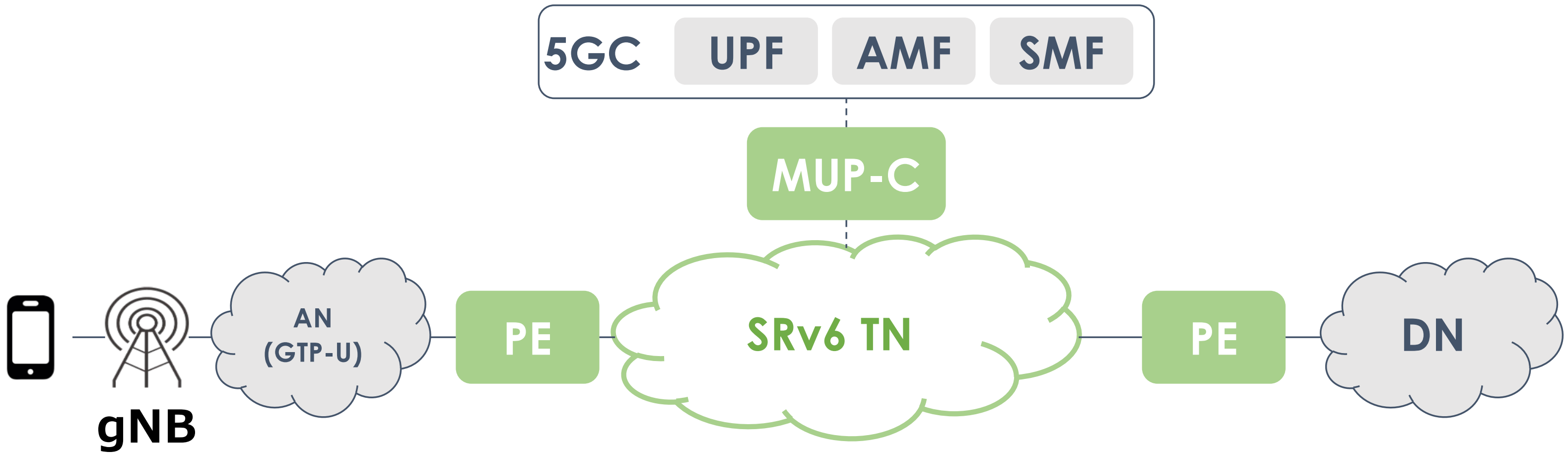
SRv6 MUP Architecture.. No Change to 5G, Just Plug-in



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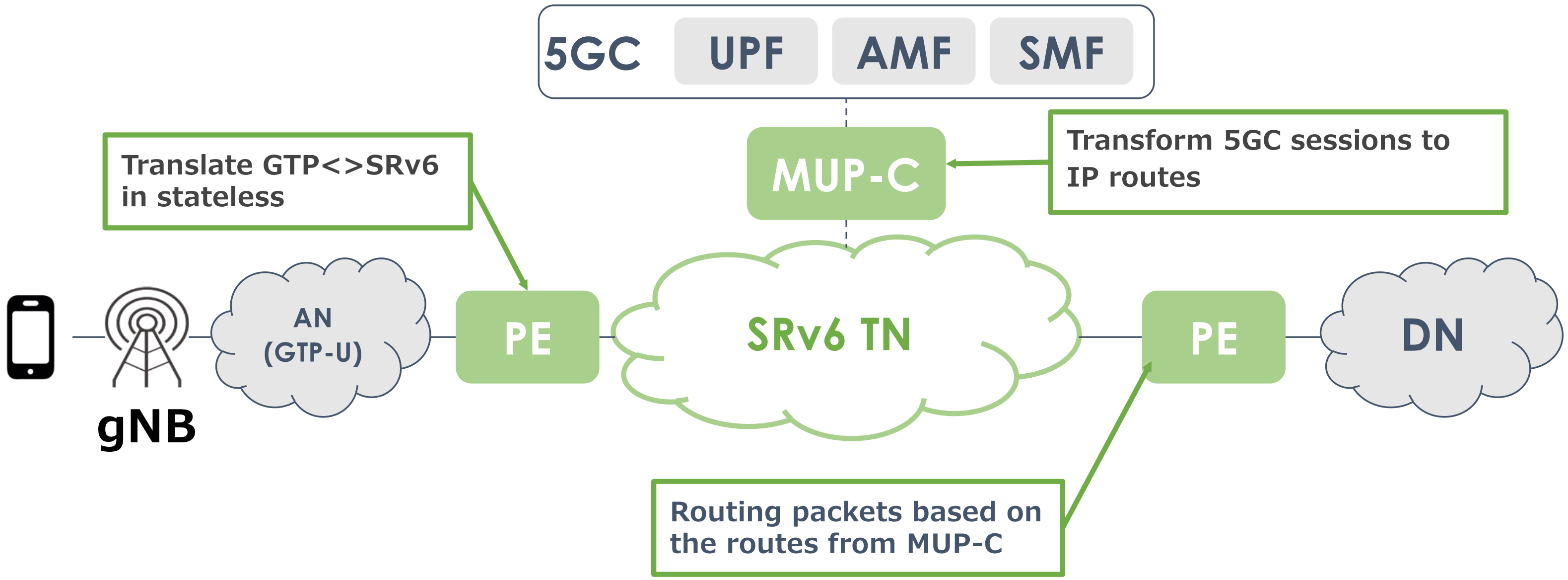
SRv6 MUP Architecture.. No Change to 5G, Just Plug-in



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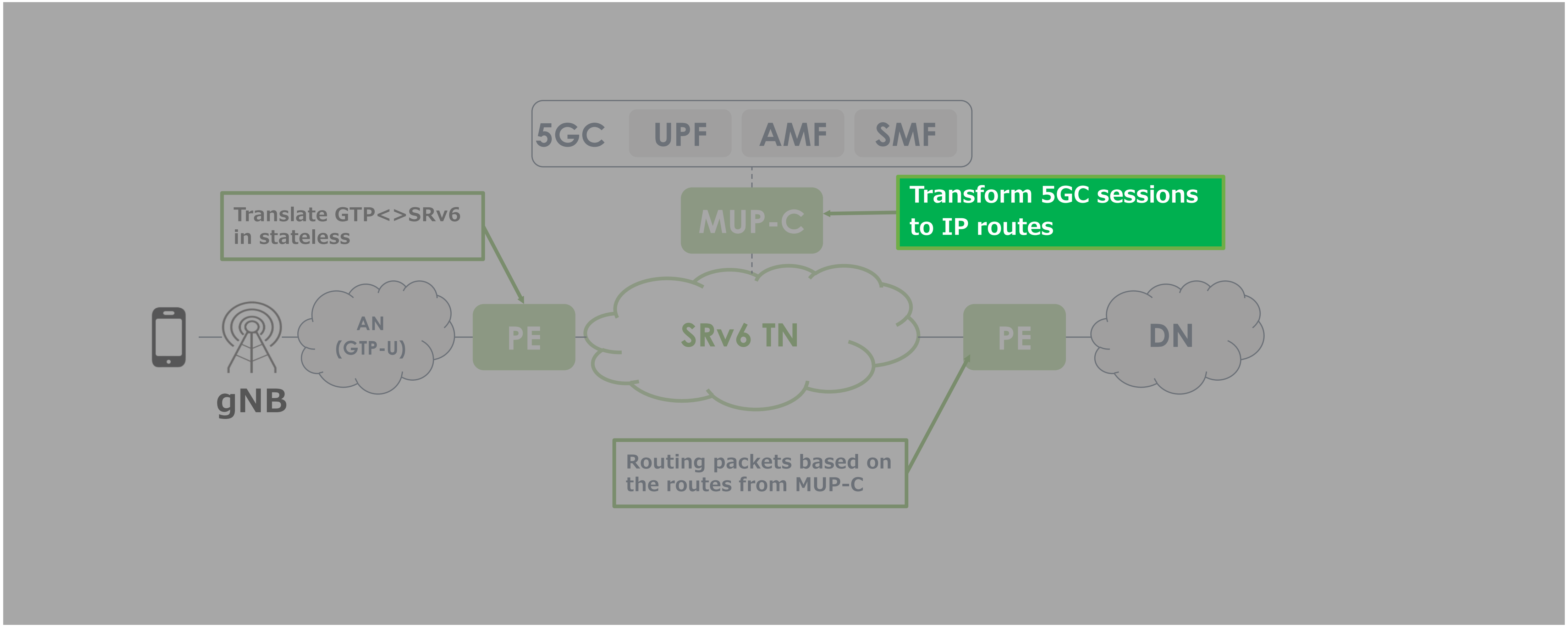
The Architecture Requires.. Control Plane Protocol!



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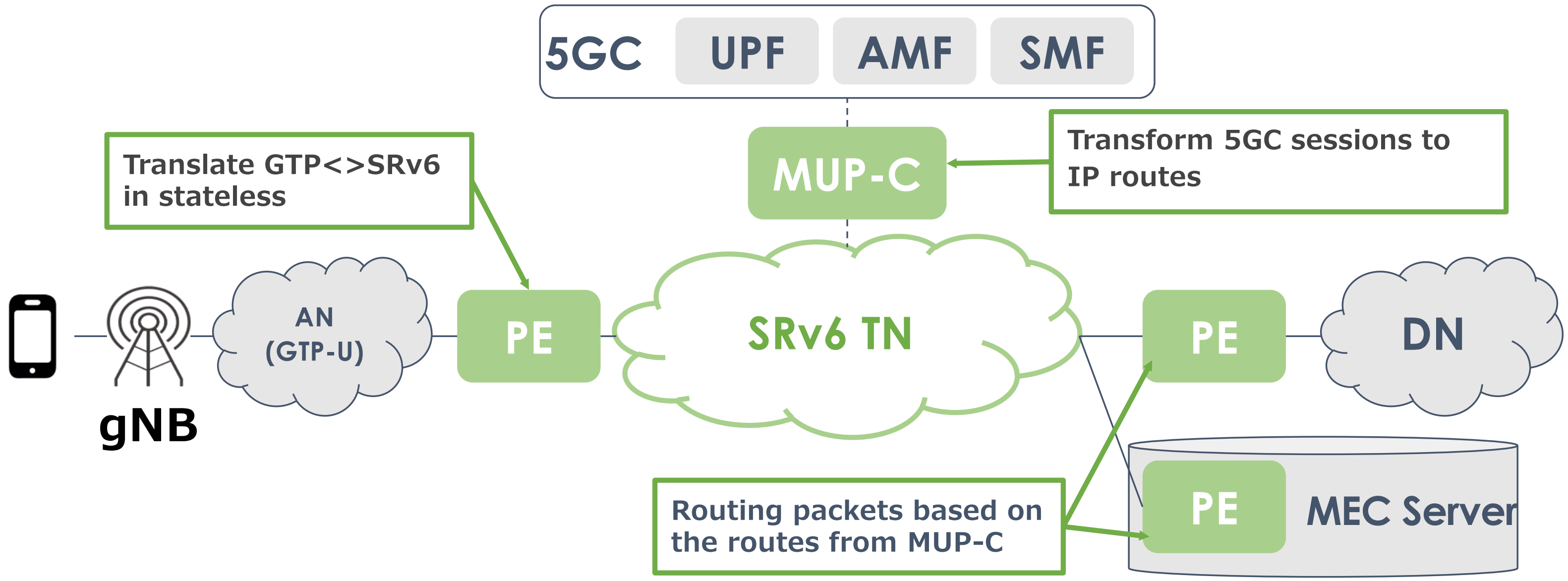
Required Control Plane Protocol Work, In Addition to the Data-Plane Implementation…

```
BESS                                                         T. Murakami
Internet-Draft                                                  K. Patel
Intended status: Standards Track                                  Arrcus
Expires: September 8, 2022                                 S. Matsushima
                                                                SoftBank
                                                                J. Zhang
                                                        Juniper Networks
                                                              S. Agrawal
                                                           Cisco Systems
                                                           March 7, 2022


          BGP Extensions for the Mobile User Plane (MUP) SAFI
                    draft-mpmz-bess-mup-safi-00.txt

Abstract

   This document defines a new SAFI known as a BGP Mobile User Plane
   (BGP-MUP) SAFI to support MUP Extensions and a extended community for
   BGP.  This document also provides BGP signaling and procedures for
   the new SAFI to convert mobile session information into appropriate
   IP forwarding information.  These extensions can be used by operators
   between MUP PE, MUP GW and MUP Controller for integrating mobile user
   plane into BGP MUP network using the IP based routing.

Status of This Memo
```

```
3.  BGP MUP Extensions

3.1.  BGP MUP SAFI

   This draft defines a new BGP SAFI known as a BGP-MUP SAFI.  The value
   of this SAFI is to be assigned by IANA from the Subsequent Address
   Family Identifiers (SAFI) registry.

   This document also defines a new BGP NLRI known as the BGP-MUP NLRI.
   The following is the format of the BGP-MUP NLRI:

               +-----------------------------------+
               |    Architecture Type (1 octet)    |
               +-----------------------------------+
               |       Route Type (2 octets)       |
               +-----------------------------------+
               |         Length (1 octet)          |
               +-----------------------------------+
               |  Route Type specific (variable)   |
               +-----------------------------------+
```

https://datatracker.ietf.org/doc/draft-mpmz-bess-mup-safi/

SRv6 MUP Architecture.. No Change to 5G, Just Plug-in



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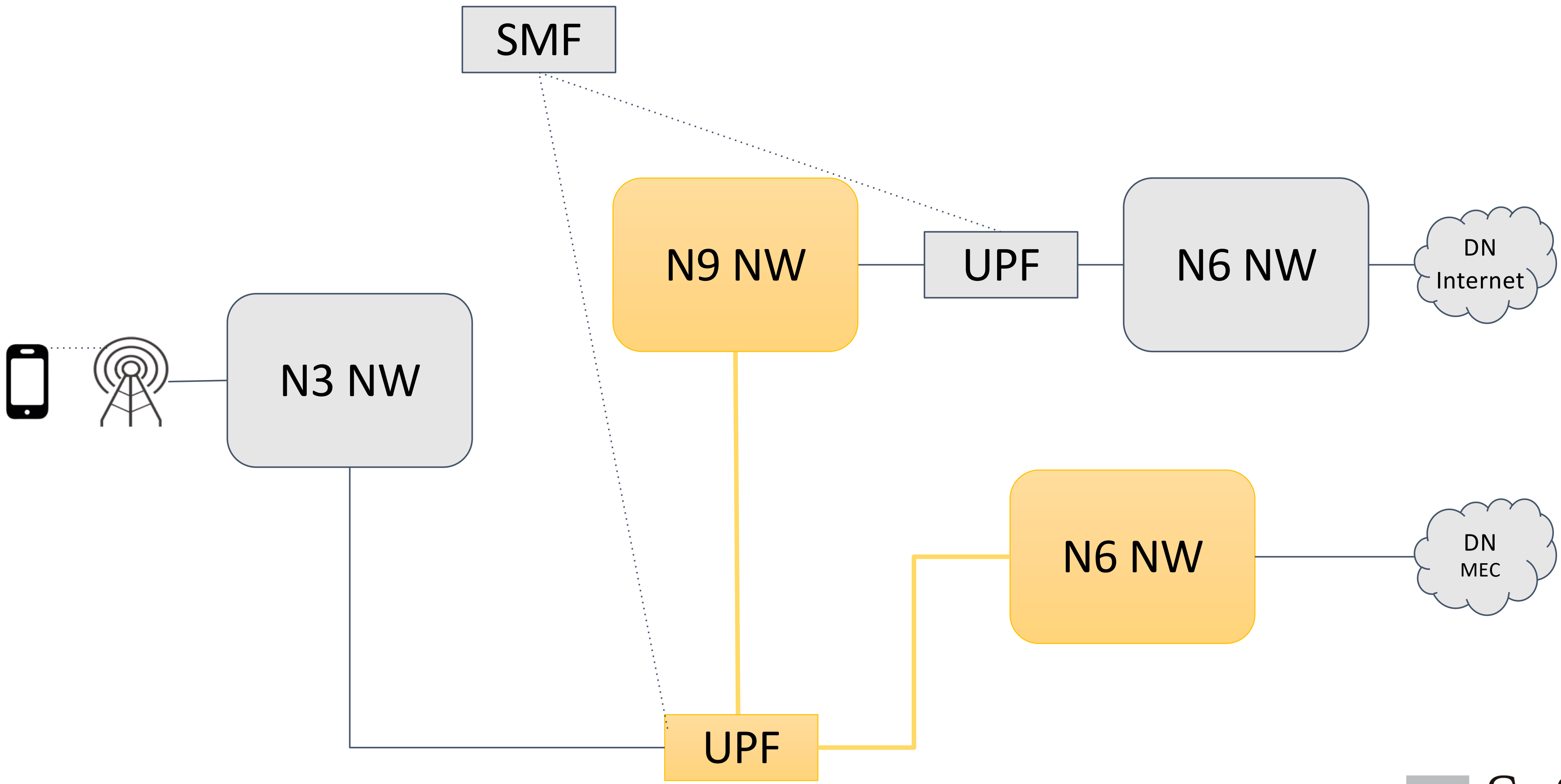
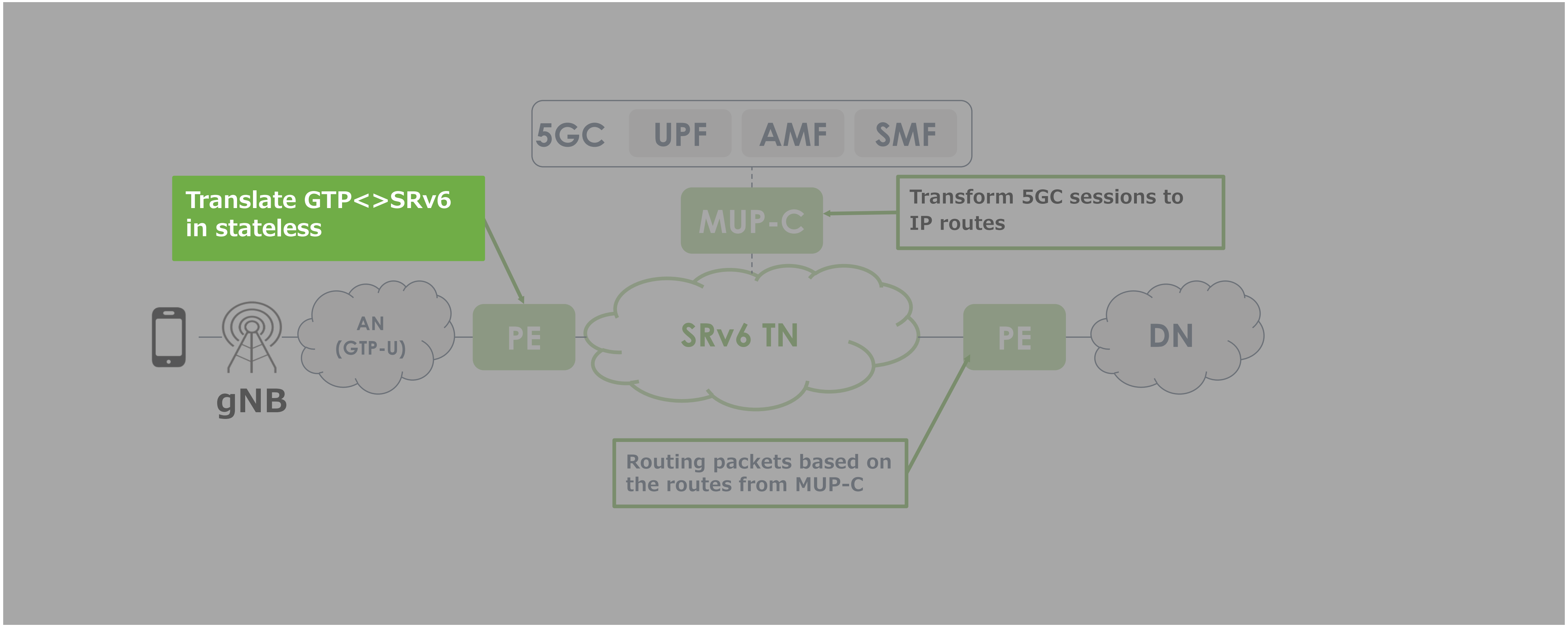
Additional UPFs and N6/N9 NWs for MEC w/o SRv6MUP..



So What the SRv6MUP P4 Development Looks Like?



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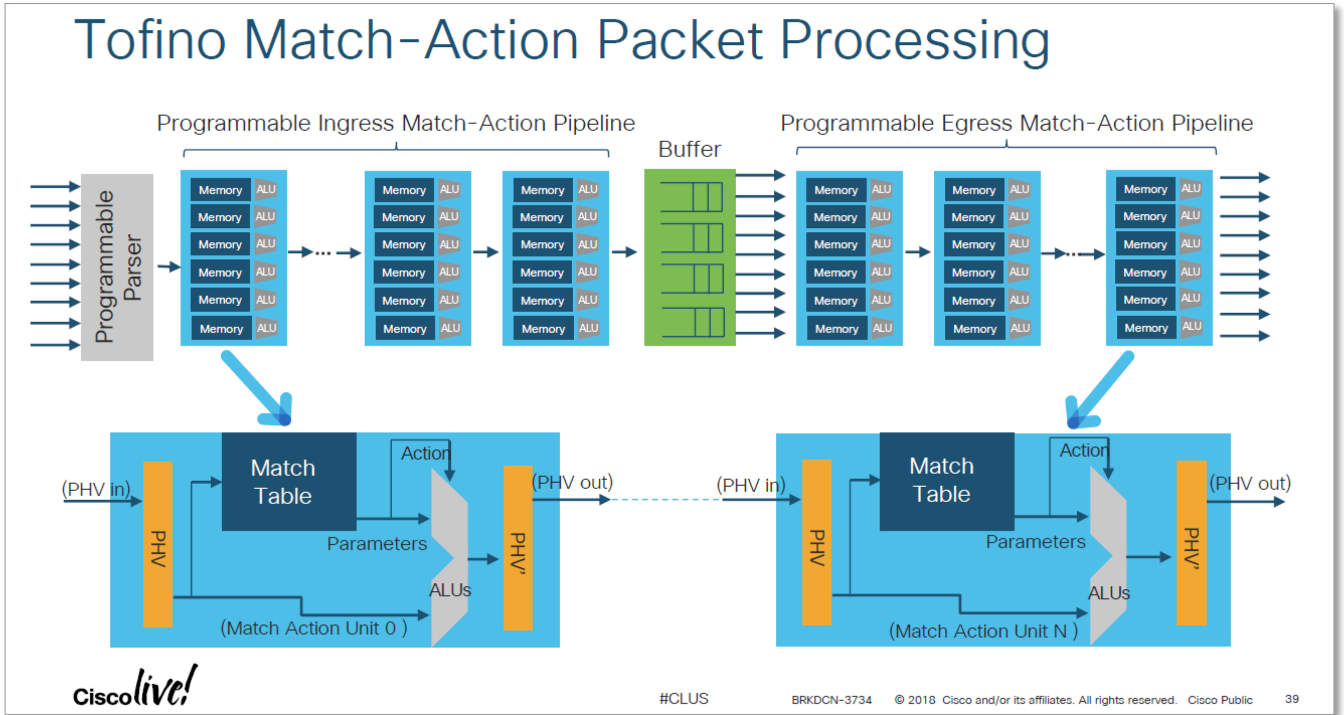
What the Data-Plane Implementation Work Requires the Operator to Do..

The operator needs to be aware, or manage the available ASIC resources:



https://people.ucsc.edu/~warner/Bufs/C34180.html

How much the resource consumed/remained?

- # of Pipeline stages;
- Table size on each stage;
- PHV;
- If any.

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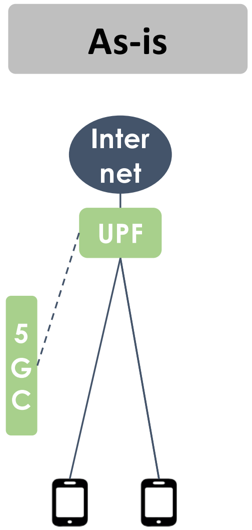
Toward the Future of Massive Distributed Computing



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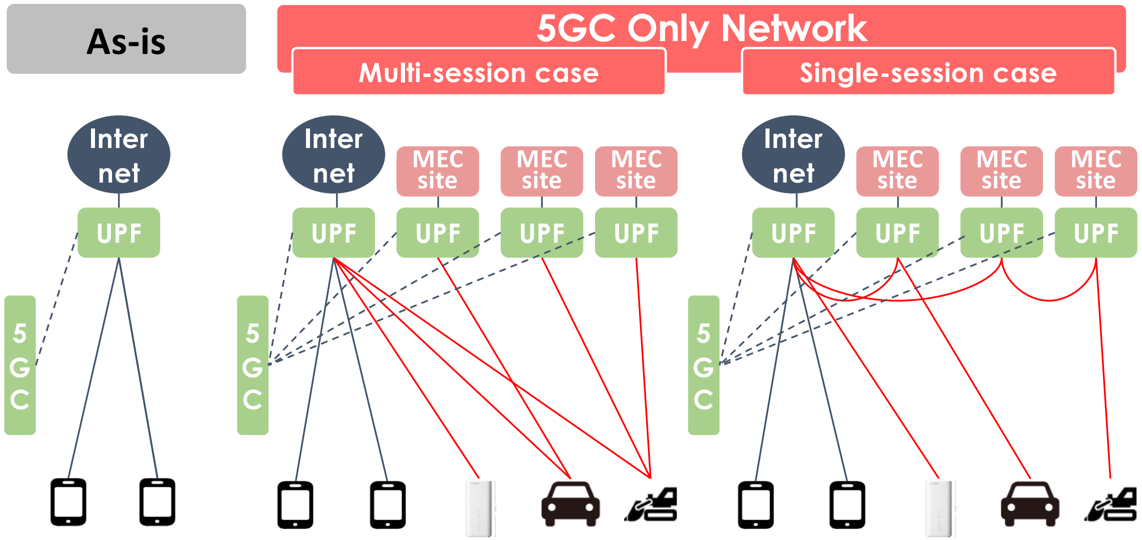
Toward the Future of Massive Distributed Computing



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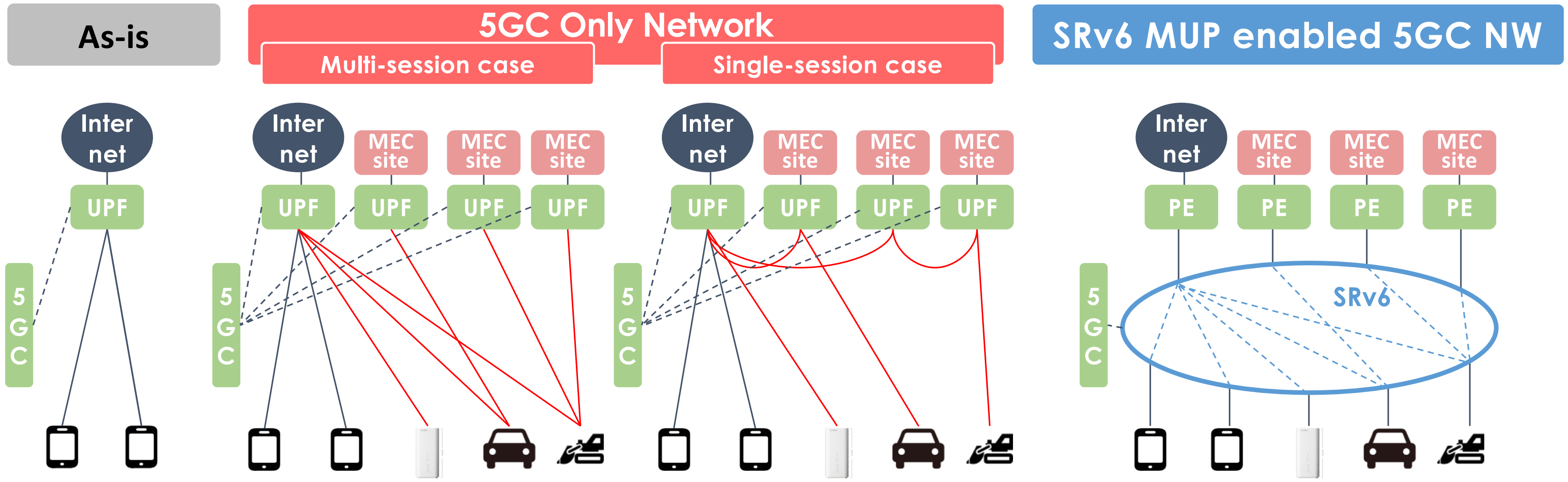
Toward the Future of Massive Distributed Computing



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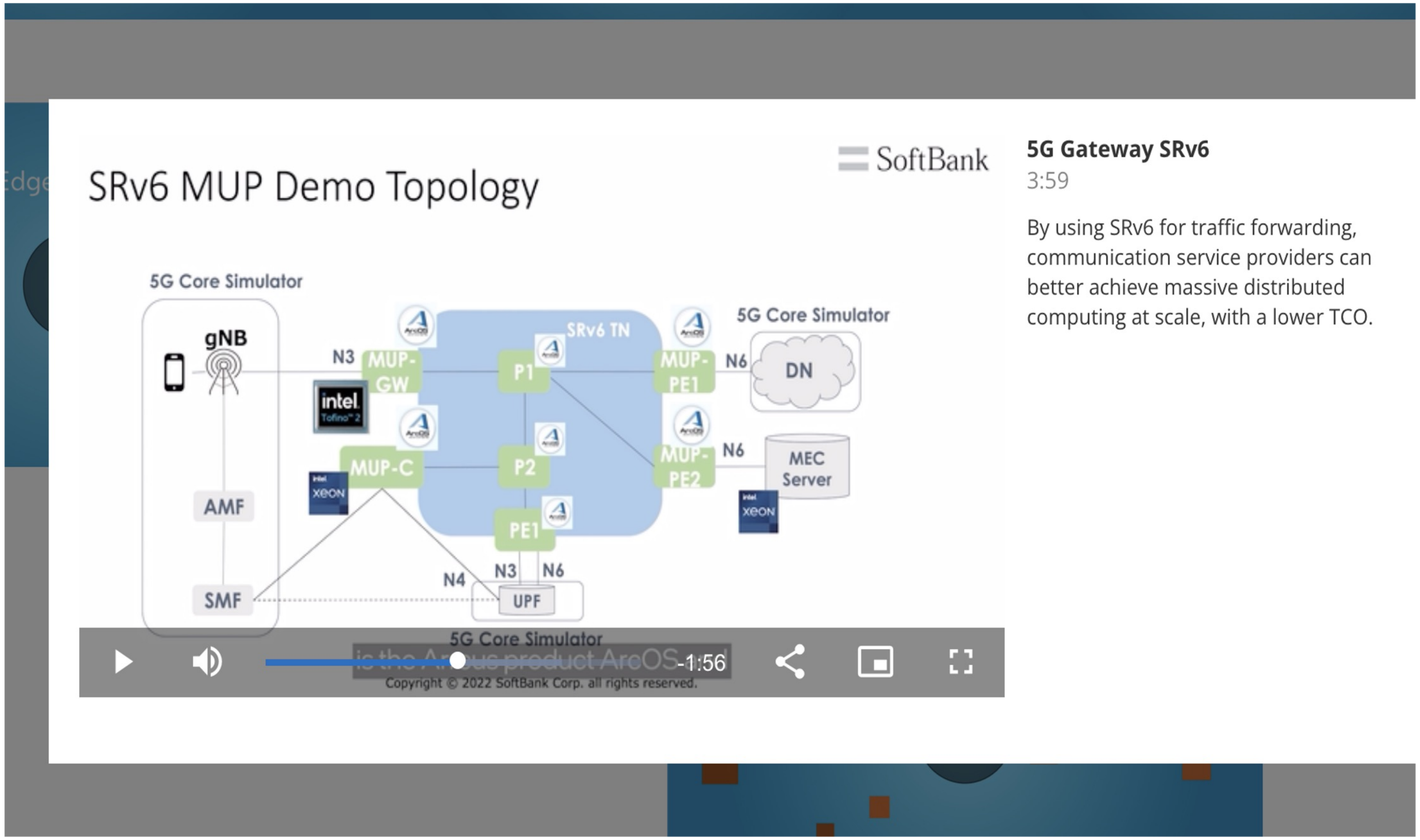
SRv6 MUP Demo Movie



https://www.intel.com/content/www/us/en/events/mobile-world-congress.html?videoId=6298415001001

Summary

- "Squared" Network Programmability by SRv6 and P4 enables Mobile Operators can get a chance to evolve 5G Mobile User Plane,
- As a takeaway, network architecture work and control plane protocol work will be required to fully leverage the programmability of the data plane,
- Operators need to be aware which ASIC resources available, and how much consumed/remained.

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Thank You

Acknowledge for:

Chunghan Lee,
Kentaro Ebisawa,
Hiroshi Kuwata,
Miya Kohno.

FAQ

<u>Q: Is SRv6MUP available over SR-MPLS?</u>

A: SRv6MUP is an application of IPv6. So SRv6MUP can run over any IPv6 VPN solutions, not only over SR-MPLS, but also legacy MPLS.

EoF