Generalized SRv6 for Compression

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Introduction
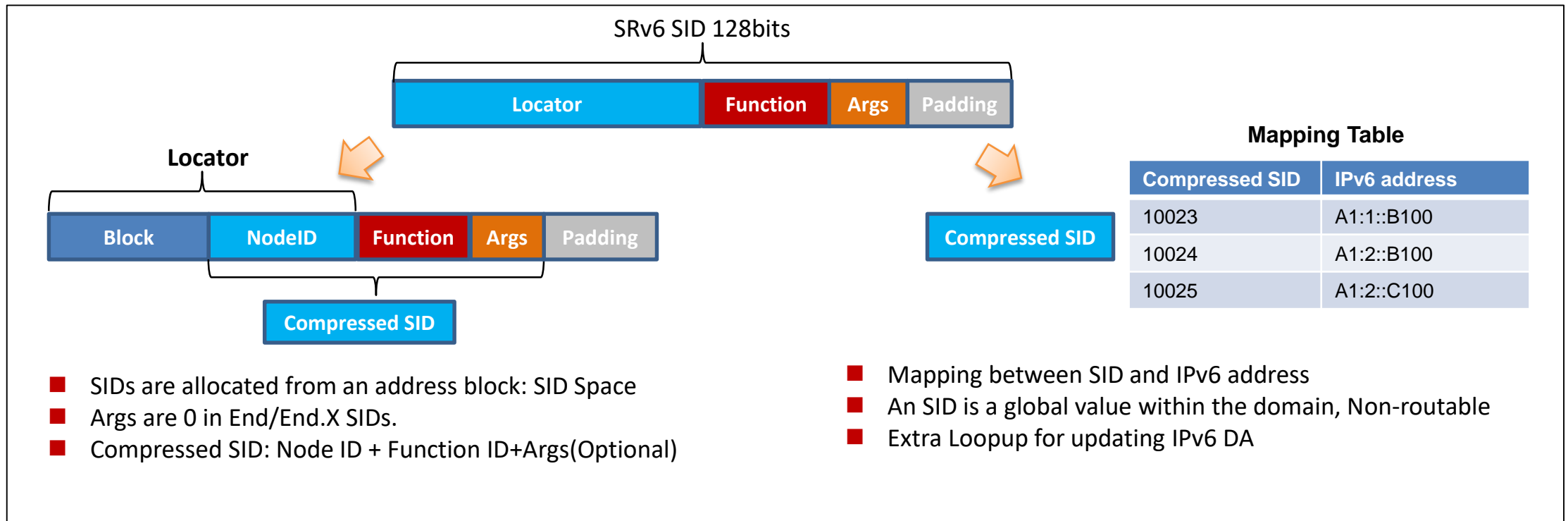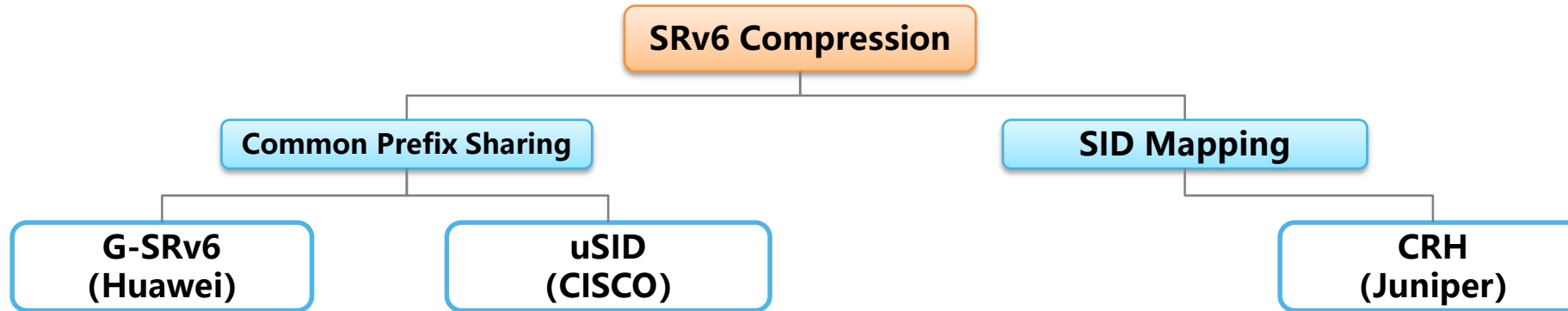
Cheng Li

Huawei IP Standard Representative

- 30+ IETF drafts，10 + WG drafts，1 RFC

- Currently focus on G-SRv6/SRv6，SFC，OAM

- Author of books

    – "SRv6 Network Programming - Ushering in a New Era of IP Networks"

    – "Refactoring Network: Architecture and Implementation of SDN"

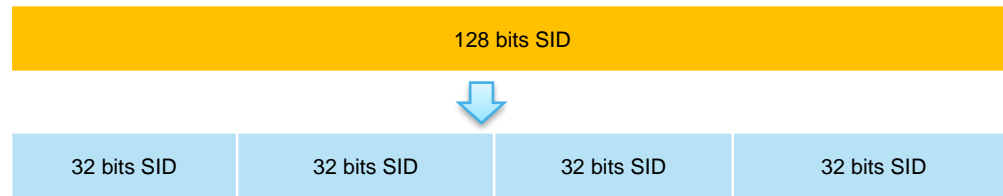- Paper："Application-aware G-SRv6 network enabling 5G services"，INFOCOM 2021

Overview of SRv6 Compression Solutions

- SIDs are allocated from an address block: SID Space
- Args are 0 in End/End.X SIDs.
- Compressed SID: Node ID + Function ID+Args(Optional)

- Mapping between SID and IPv6 address
- An SID is a global value within the domain, Non-routable
- Extra Loopup for updating IPv6 DA

Design considerations

Compression efficiency

128 bits SID

⬇

32 bits SID	32 bits SID	32 bits SID	32 bits SID

- Efficiency, Scalabilities, and Aligning should be considered.
- **32 bits is the ideal length**, 16 bits is not scalable

Native IPv6

Metro A   BackBone   Metro B   Failure domain

Agg route A1::/64   Agg route A0::/64   Agg route A2::/64

Routes — MPLS routes / SRv6 routes — Scalabilty
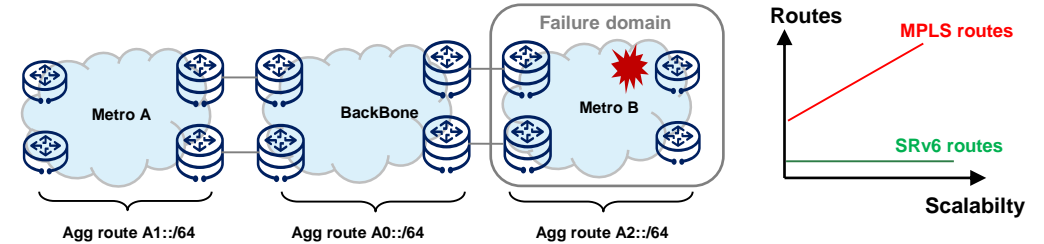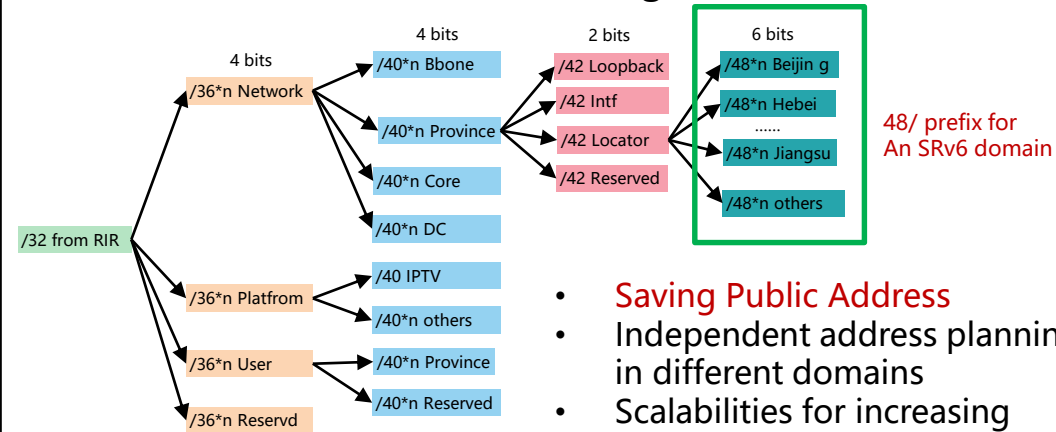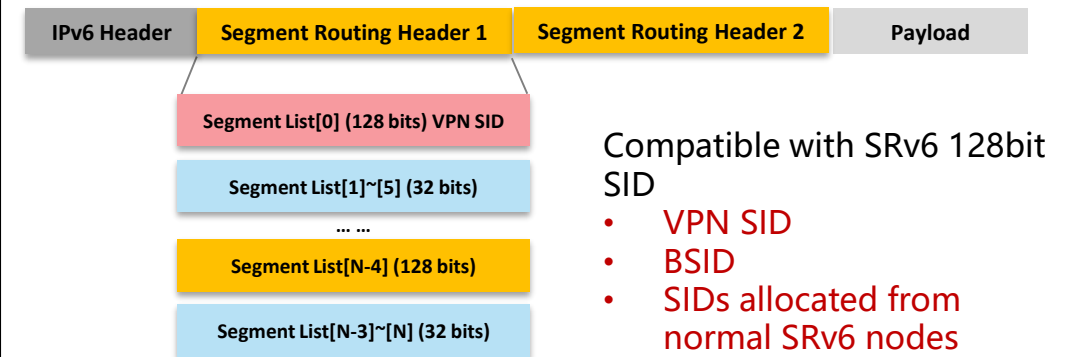
Native IPv6 Routing
- Based on IP reachability, overlay routing on **cmpr disable nodes**
- Route aggregation, support super scale networking
- Failure domain isolation

Address Planning

4 bits   4 bits   2 bits   6 bits

/32 from RIR

/36*n Network
- /40*n Bbone
- /40*n Province
  - /42 Loopback
  - /42 Intf
  - /42 Locator
    - /48*n Beijin g
    - /48*n Hebei
    - ......
    - /48*n Jiangsu
    - /48*n others
  - /42 Reserved
- /40*n Core
- /40*n DC

/36*n Platfrom
- /40 IPTV
- /40*n others

/36*n User
- /40*n Province
- /40*n Reserved

/36*n Reservd

48/ prefix for An SRv6 domain

- **Saving Public Address**
- **Independent address planning in different domains**
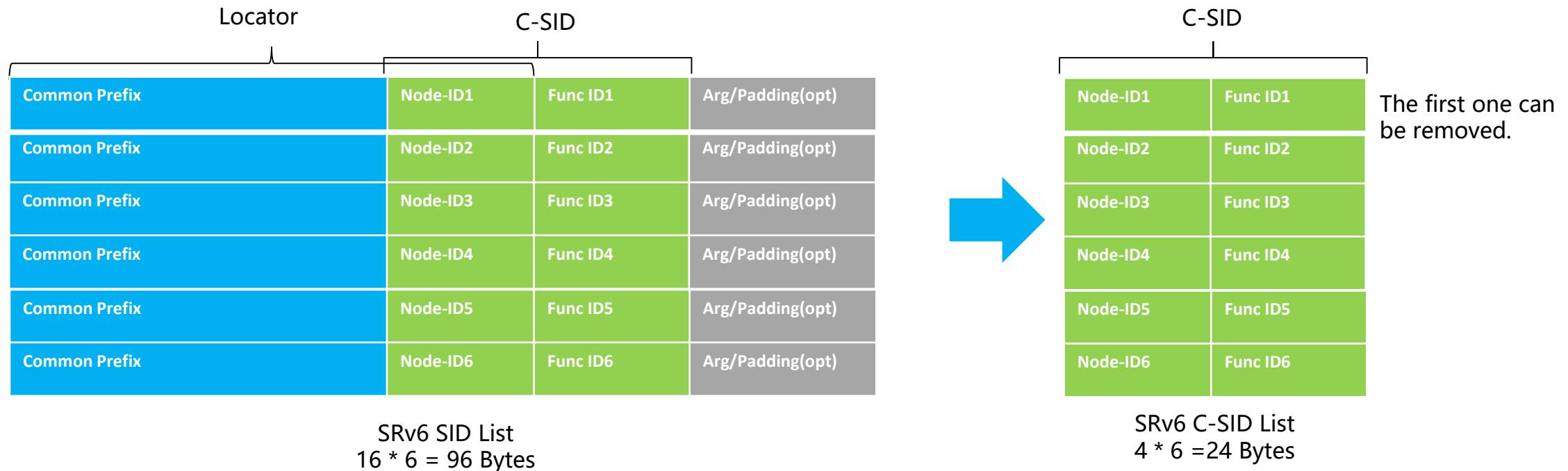- **Scalabilities for increasing Interfaces and nodes**

Compatible with SRv6

IPv6 Header	Segment Routing Header 1	Segment Routing Header 2	Payload

Segment List[0] (128 bits) VPN SID

Segment List[1]~[5] (32 bits)

… …

Segment List[N-4] (128 bits)

Segment List[N-3]~[N] (32 bits)

Compatible with SRv6 128bit SID
- **VPN SID**
- **BSID**
- **SIDs allocated from normal SRv6 nodes**

Generalized SRv6

Before G-SRv6： SRv6 Compressed SID

- A normal SRv6 SID is a 128 bits IPv6 address allocated from an address block, called SID Space.

- For the SIDs in the SID list within an SRH， they may share the common prefix, and the common prefix is redundant that can be deleted to reduce the overhead.

- Each SRv6 SID has the format shown below, we called the different part of the SRv6 SID is compressed SID(C-SID), and the SID is a Compressible SRv6 SID.

- The prefix can be managed according to the real network address planning.

- Common Prefix is included in the first SID in the IPv6 Destination address.

Locator   C-SID

Common Prefix	Node-ID1	Func ID1	Arg/Padding(opt)
Common Prefix	Node-ID2	Func ID2	Arg/Padding(opt)
Common Prefix	Node-ID3	Func ID3	Arg/Padding(opt)
Common Prefix	Node-ID4	Func ID4	Arg/Padding(opt)
Common Prefix	Node-ID5	Func ID5	Arg/Padding(opt)
Common Prefix	Node-ID6	Func ID6	Arg/Padding(opt)

SRv6 SID List
16 * 6 = 96 Bytes

C-SID

Node-ID1	Func ID1
Node-ID2	Func ID2
Node-ID3	Func ID3
Node-ID4	Func ID4
Node-ID5	Func ID5
Node-ID6	Func ID6

The first one can be removed.

SRv6 C-SID List
4 * 6 =24 Bytes

G-SRv6: Compatible and Scalable

■ Generalized SRv6 supports to encode multiple types of Segments in an enhanced SRH. G-SRv6 is compatible with SRv6 and uSID as well.

■ These Segments can be called Generalized Segment. G-SID(Generalized Segment Identifier) is a 128-bits value，and it may contain：

- an SRv6 SID(can be a Micro SID carrier)

- a compression G-SID(4 32 bits C-SIDs at most)
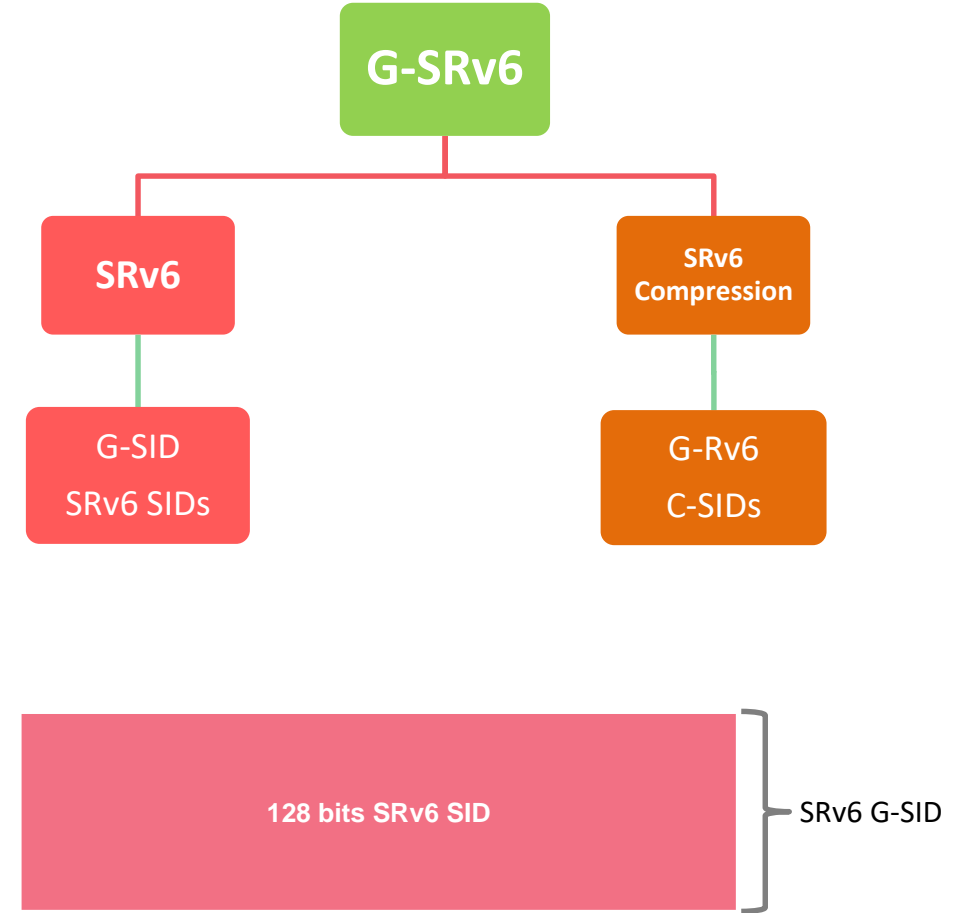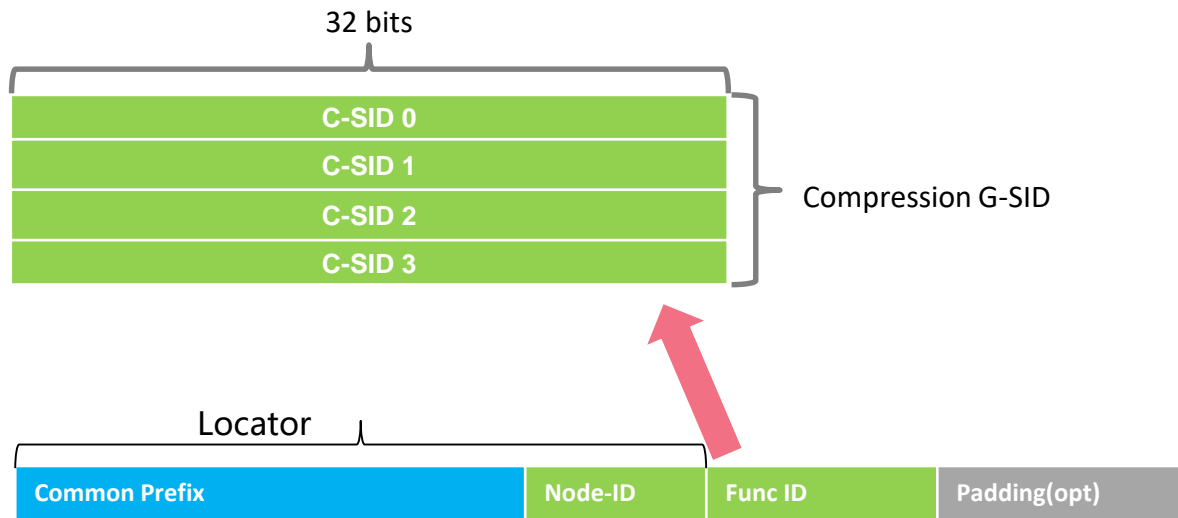
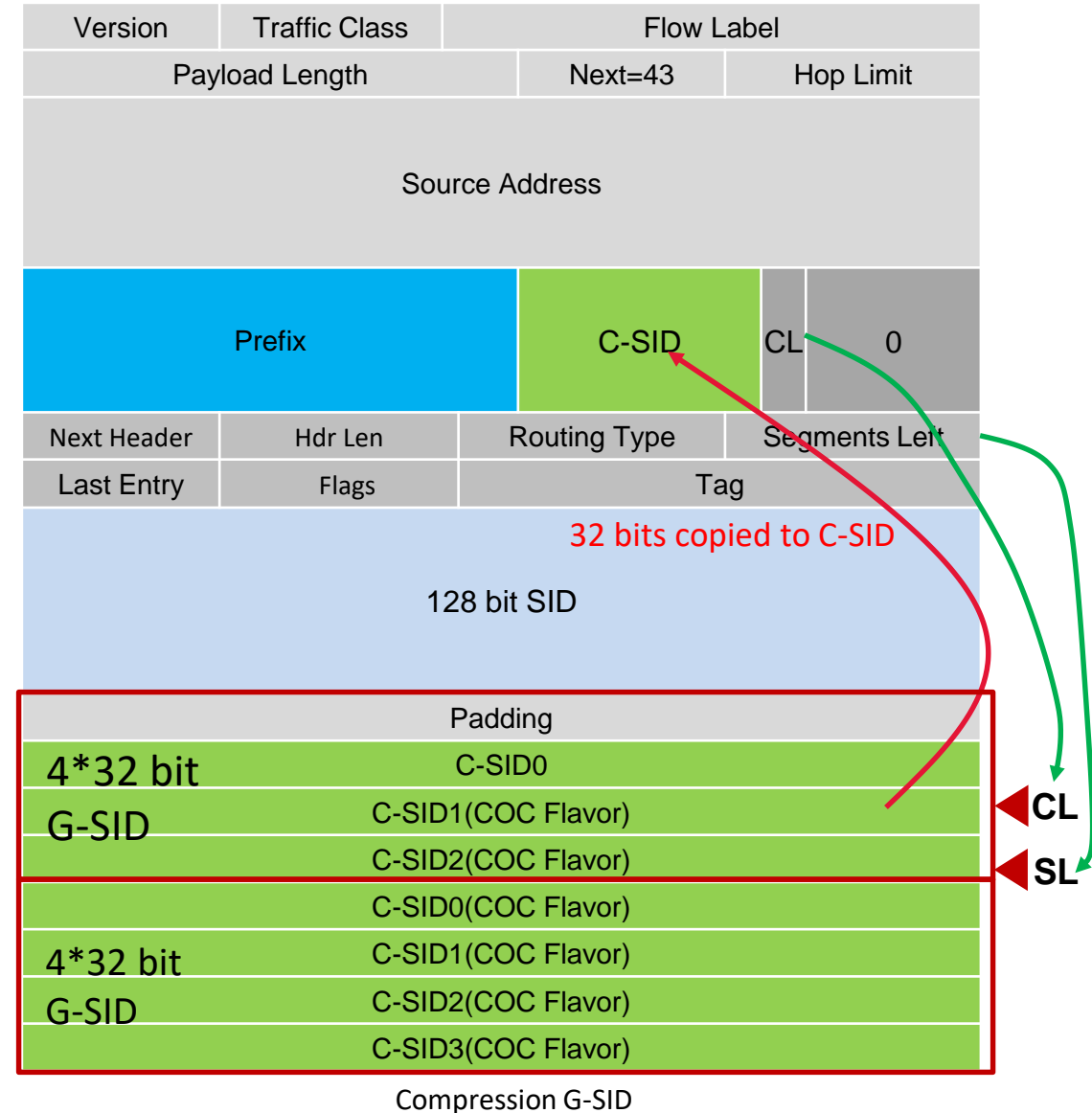# G-SRH: Compatible with SRv6, Incremental Deployment, Hardware Friendly

Solution: use SL to index a 128 bit G-SID, use CL to index C-SID inside this G-SID!

- C-flag in control plane: indicates the format of the SRv6 SID is compressible. The SID can be encoded as 128 or 32 bits in SRH
- COC(Continuation of Compression) flavor indicate the next SID is a 32-bits Compressed SID(C-SID)
- CL（Compressed SID left, the args of the compressible SRv6 SID）indicates the location of C-SID within the G-SID
  - Update C-SID from SRH[SL][CL] to IPv6 DA[CP: CP+31]

Common Prefix	C-SID	CL	Padding(Opt)

COC Flavor SRv6 SID in IPv6 DA

Pros

1. **Fully compatible with SRH，NO modification of SRH**
2. **Fully compatible with SRv6，add COC Flavor endpoint behaviors, no affect of existing SIDs**
3. **Fully compatible with SRv6 control plane: (Can be) No modification of Control Plane**
4. **Address saving & easy to deploy：**
   1. **Flexible address planning, does not require for a short common prefix**
   2. **No new address required when reusing the Locator**
   3. **No new route, no modification of routing scheme(can share the same locator with normal SRv6 SIDs)**
   4. Compressible SRv6 SID can be used as 128 bits or 32 bits. Reduce the number of SIDs.
5. **Less overhead**: A common prefix for a compressed sub-path instead of per 128 bits SID
6. **Smooth upgrade/Incremental deployment**: encode SRv6 SIDs and C-SIDs in a G-SRH
7. **Hardware Friendly**：No index mapping table
8. **Compatible with Micro SID**

Version	Traffic Class	Flow Label	
Payload Length		Next=43	Hop Limit
Source Address			
Prefix		C-SID	CL	0
Next Header	Hdr Len	Routing Type	Segments Left
Last Entry	Flags	Tag	

32 bits copied to C-SID

128 bit SID

Padding		
4*32 bit G-SID	C-SID0	
	C-SID1(COC Flavor)	← CL
	C-SID2(COC Flavor)	← SL
4*32 bit G-SID	C-SID0(COC Flavor)	
	C-SID1(COC Flavor)	
	C-SID2(COC Flavor)	
	C-SID3(COC Flavor)	

Compression G-SID

HUAWEI

Pseudo code: Only add code for COC Flavor SIDs, no Affection on Existing SIDs

Version	Traffic Class	Flow Label	
Payload Length		Next=43	Hop Limit
Source Address			
Prefix		C-SID	CL	0

Next Header	Hdr Len	Routing Type	Segments Left
Last Entry	Flags	Tag	
128 bit SID			

0	C-SID	C-SID(COC)	C-SID(COC)
Prefix		C-SID(COC)	0（Padding）
128 SID			
C-SID	C-SID(COC)	C-SID(COC)	C-SID(COC)
C-SID(COC)	C-SID(COC)	C-SID(COC)	C-SID(COC)

Payload

PS. For easy understanding，the length of a row in SID list is 128bit

if DA is a COC Flavor SID: 　　//update 32bits C-SID to DA

　　if DA.CL = 0:　　　　//first C-SID in next 128 bits

　　　　SL--

　　　　DA.CL = 3;

　　Else　　　　　　//next C-SID in current 128 bits

　　　　DA.CL--

　　DA[CP..CP+31] = SRH[SL][DA.CL]

　　Forward the packet based on new DA

Else　　　　//update 128 bits SID to DA, original SRv6 Processing

SRv6 processing

Common Prefix		C-SID	Args(other info)	CL
Common Prefix		C-SID	CL	Padding
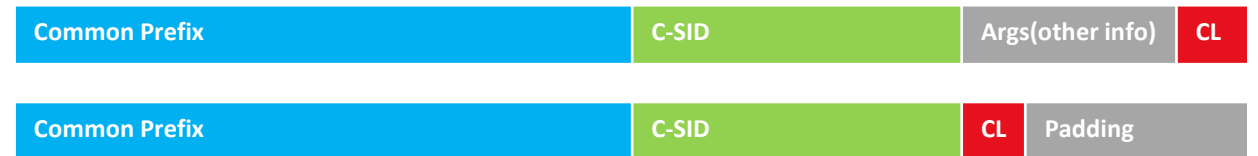
**CL is a location argument of the Compressible SID,
And it is the last 2 bits in Arguments**

C-SID List + 128 VPN SID，64 CP + 32 C-SID+32 Argument

SID List: 10 SIDs：

- A:1:1::, A:2:1::, A:3:1::, A:4:1::, A:5:1::, A:6:1:: , A:7:1::, A:8:1:: are End.X with COC Flavor SIDs

- A:9:2:: is an End.X SID(C-flag=1，Without COC flavor)

- A:10:10:: is an End.DT4 VPN SID

Initialization：SL=3，CL=0，**Reduced mode.**

10 * 128 bits to 3 * 128 bits including a 128bit VPN SID. 70% overhead off.

Compressible SRv6 SID and normal SRv6 SID use the same Locator, no new route is created!

A		1	1	000

Compressible SID: Locator A:1::/80   C-SID: 1:1 Argument 32bits 0

✓

A		1	1:1:1:1

Normal SID: Same Locator A:1::/80   Function 1:1:1:1
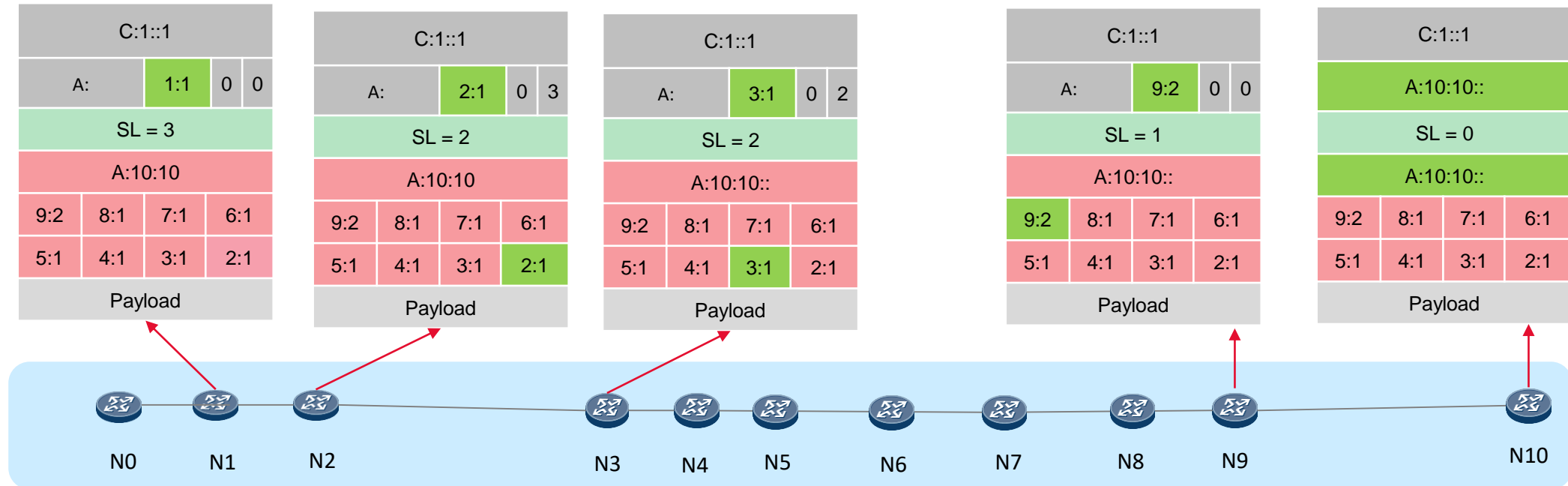
Mixed Encoding with SRv6 SID for incremental deployment

SID List: 10 SIDs：

- A:1:1::, A:2:1::, A:3:1::, B:6:1:: , B:7:1::, B:8:1:: are End.X with COC Flavor SIDs

- A1::5:1 End.X does not support SRv6 compression.

- A:4:2:: , B:9:2:: are End.X SID(Without COC flavor)

- B:10:10:: is an End.DT4 VPN SID
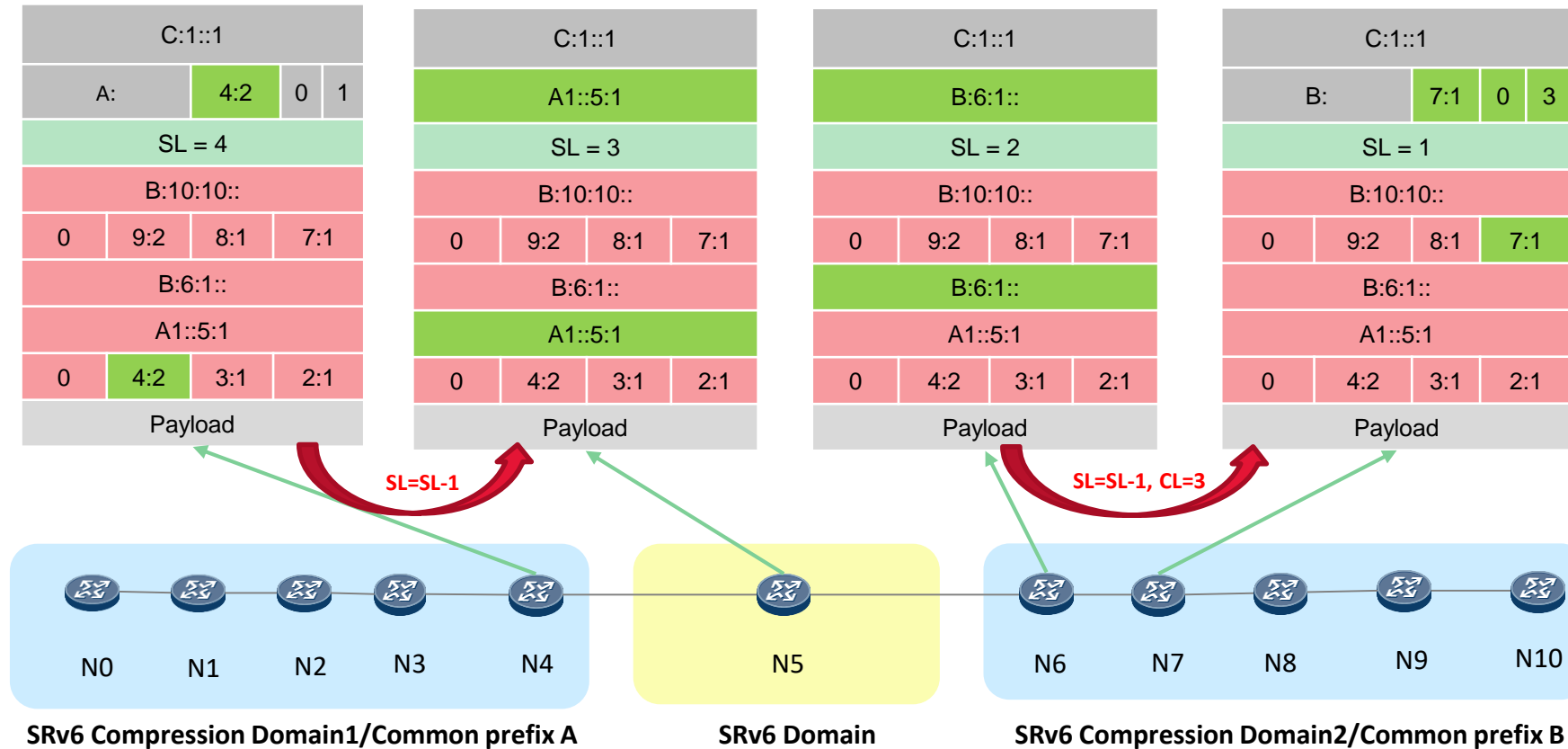
Mixed Encoding with uSID

SID List: 10 SIDs：

- A:1:1::, A:2:1::, A:3:1::, B:6:1:: , B:7:1::, B:8:1:: are End.X with COC Flavor SIDs
- **F::A:1:B:1:C:1 is an uSID carrier, F is a 32/ prefix, A:1, B:1, C:1 is the uSID allocated by Node A, B and C.**
- A:4:2:: , B:9:2:: are End.X SID(Without COC flavor)
- B:10:10:: is an End.DT4 VPN SID
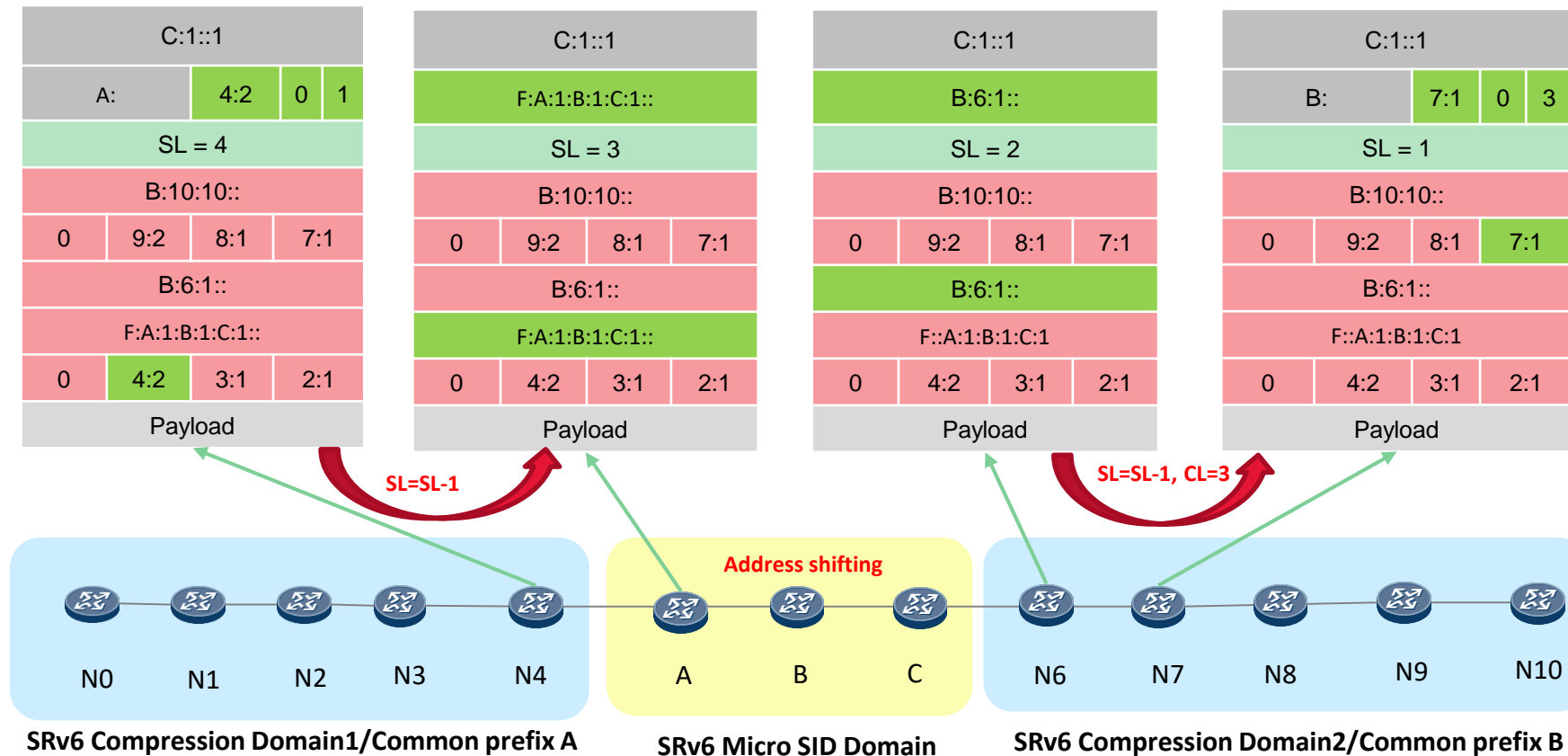
12 Vendors/10+ Customers support, CMCC Live Network trial done.

[Docs] [txt|pdf|xml|html] [Tracker] [Email] [Diff1] [Diff2] [Nits]

Versions: 00 01

```
SPRING Working Group                          Z. Li
Internet-Draft                                C. Li
Intended status: Standards Track    Huawei Technologies
Expires: February 15, 2021                W. Cheng
                                      China Mobile
                                           C. Xie
                                           C. Li
                                    China Telecom
                                         H. Tian
                                         F. Zhao
                                            CAICT
                                 August 14, 2020
```

Generalized Segment Routing Header
draft-lc-6man-generalized-srh-01

[Docs] [txt|pdf] [Tracker] [Email] [Diff1] [Diff2] [Nits]

```
SPRING Working Group                        W. Cheng
Internet-Draft                          China Mobile
Intended status: Standards Track            Z. Li
Expires: November 21, 2020                  C. Li
                                  Huawei Technologies
                                          F. Clad
                               Cisco Systems, Inc
                                          A. Liu
                                 ZTE Corporation
                                          C. Xie
                                  China Telecom
                                          Y. Liu
                                  China Mobile
                                        S. Zadok
                                        Broadcom
                                   May 20, 2020
```

Generalized SRv6 Network Programming for SRv6 Compression
draft-cl-spring-generalized-srv6-for-cmpr-01

12+ Vendors have PASSED Interop-test

Progress of G-SRv6：Interop-test and trial deployment plan

Phase 1

G-SRv6 Data plane Interop test

Phase 3

More Vendors

Phase 2

G-SRv6 Control Plane Test

Phase 4

Trial deployment

2020.Nov: Done trial deployment in CMCC Guangdong Province
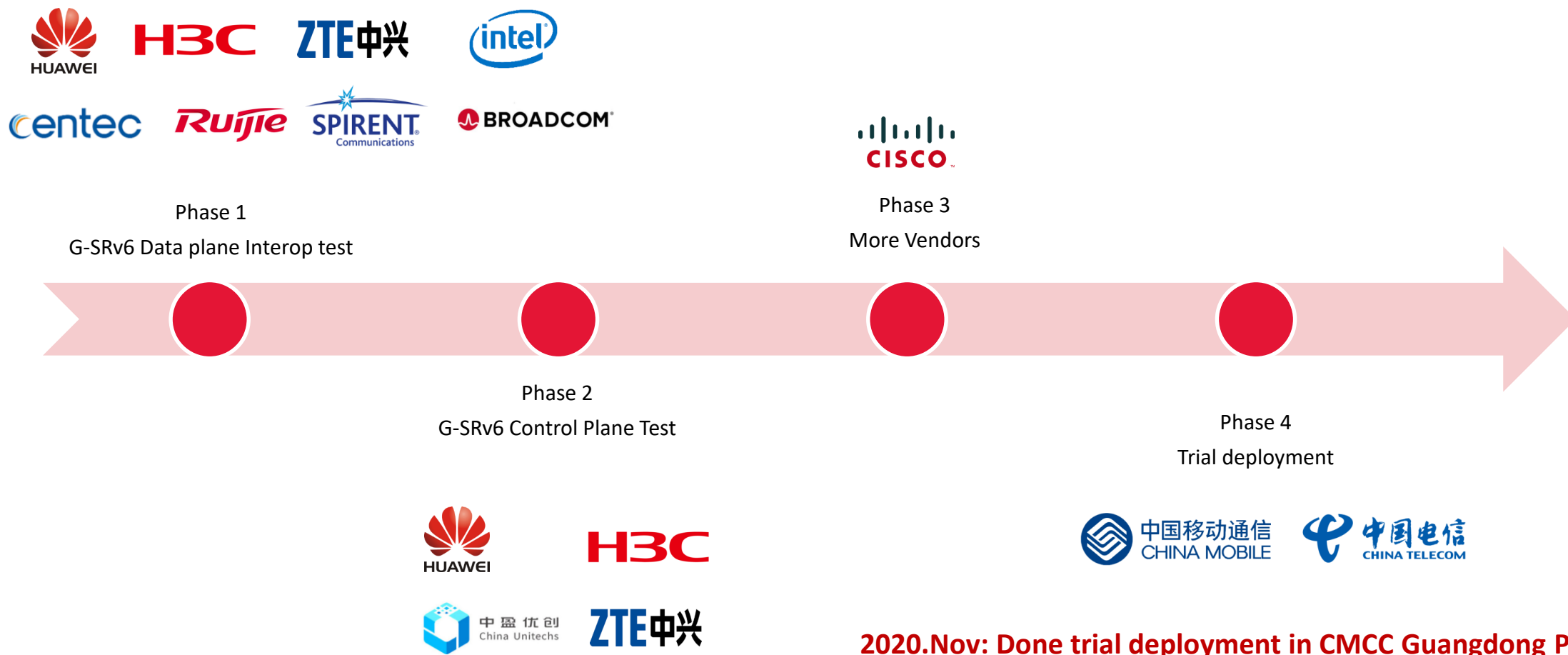
Conclusion

- **G-SRv6 is fully compatible with SRv6,**
  - No SRH encapsulation modification
  - **No new address consumption**: allocated SIDs from the Locator/ allocated to the node.
  - **No new route creation**: share the same locator with the normal SRv6 SID.
  - **No control plane modification**: Controller can install the SR policy with 128 bit G-SIDs, endpoint nodes understand the COC Flavor behaviors, Compression disable SRv6 nodes are unaware of Compression.
  - **No security policy modification.**
- **G-SRv6 has less overhead**
  - Each compression sub-path has only one common prefix, instead of for each 128 bits.
- **G-SRv6 has efficient address consumption**
  - It is **not** required to allocate a short common prefix for better compression.
- **G-SRv6 supports incremental deployments, which can be deployed on demand.**

G-SRv6 Info： INFOCOM2021 paper， SRv6 books, IPv6+ video, G-SRv6 Community

INFOCOM 2021: https://www.youtube.com/watch?v=Bl0r16XH4go
IETF Hackathon: https://www.youtube.com/watch?v=qbryDg8fXRM
CAICT IPv6plus: https://mp.weixin.qq.com/s/PIrJyiVEQu2qln6vIgY_Zw
Huawei Support： https://support.huawei.com/enterprise/zh/doc/EDOC1100183731
G-SRv6 Community: https://github.com/G-SRv6
More G-SRv6 Info: https://www.ipv6plus.net/Phase2/Generalized-SRv6/
Book： SRv6 Network Programming Ushering in a New Era of IP Networks Chapter 13
IPv6+ G-SRv6： https://www.ipv6plus.net/Phase2/Generalized-SRv6/

Thanks

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