SRv6 Compression Discussion

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Introduction

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IP Standard Representative.
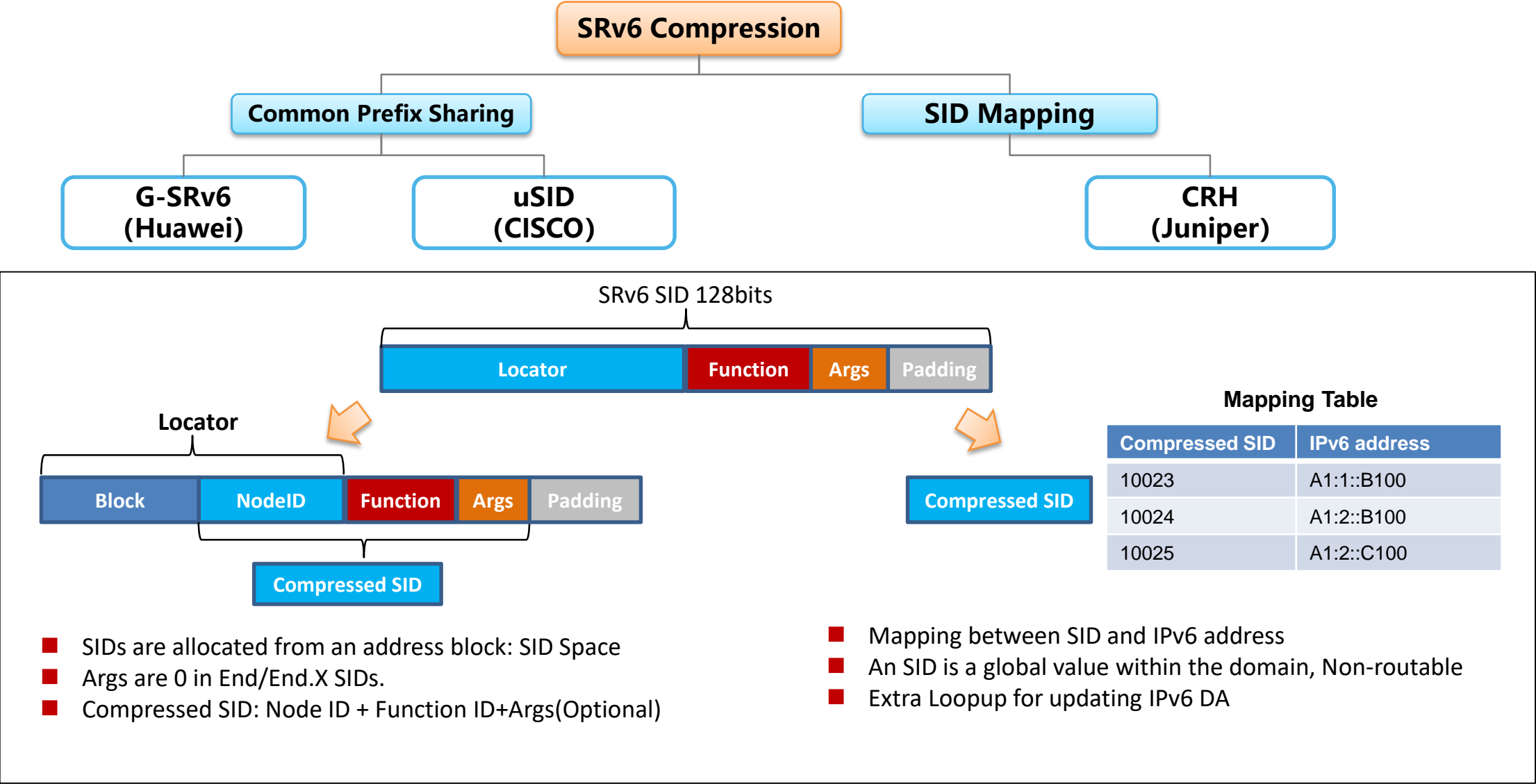
Huawei Technologies, Co., Ltd.

- 30+ IETF drafts， 9 WG drafts
- 15+ patents
- Currently focus on SRv6， SFC， OAM，Security

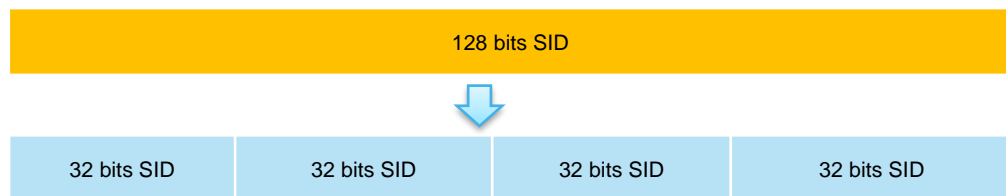# IETF drafts of SRv6 Compression

| Area	Topic	Drafts	Vendors	Operators
Compression Requirements	Shorter SRv6 SID Requirements	draft-cheng-spring-shorter-srv6-sid-requirement-01	Huawei/ZTE	China Mobile/China Telecom/ China Unicom/China Unionpay
Compression Solutions	Generalized SRv6 Network Programming	draft-cl-spring-generalized-srv6-np-01	Huawei	China Telecom/China Mobile/ CAICT
	Generalized Segment Routing Header	draft-lc-6man-generalized-srh-00	Huawei	China Telecom/China Mobile/ CAICT
	Generalized SRv6 Network Programming for Compression	draft-cl-spring-generalized-srv6-for-cmpr-01	Huawei/Cisco/ZTE/ Broadcom	China Mobile/China Telecom
	Compressed SRv6 Segment List Encoding in SRH	draft-filsfilscheng-spring-srv6-srh-comp-sl-enc-01	Cisco/Huawei/ZTE/ Broadcom	China Mobile/Alibaba/Bell Canada
	SRv6 vSID: Network Programming extension for variable length SIDs	draft-decraene-spring-srv6-vlsid-03	Huawei	Orange/Bloomberg/Bell Canada
	Micro SID	draft-filsfils-spring-net-pgm-extension-srv6-usid	Cisco/Nokia/Arccus/ Broadcom/Marvell	Bell Canada, Saudi Telecom, etc.
	Compressed Routing Header	draft-bonica-spring-srv6-plus	Juniper, Ericsson	NTT, Liquid Telecom

Overview of SRv6 Compression Solutions

SRv6 Compression

- **Common Prefix Sharing**
  - **G-SRv6 (Huawei)**
  - **uSID (CISCO)**
- **SID Mapping**
  - **CRH (Juniper)**

SRv6 SID 128bits

| Locator | Function | Args | Padding |

Locator

| Block | NodeID | Function | Args | Padding |

Compressed SID

Compressed SID

Mapping Table

Compressed SID	IPv6 address
10023	A1:1::B100
10024	A1:2::B100
10025	A1:2::C100

- 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.
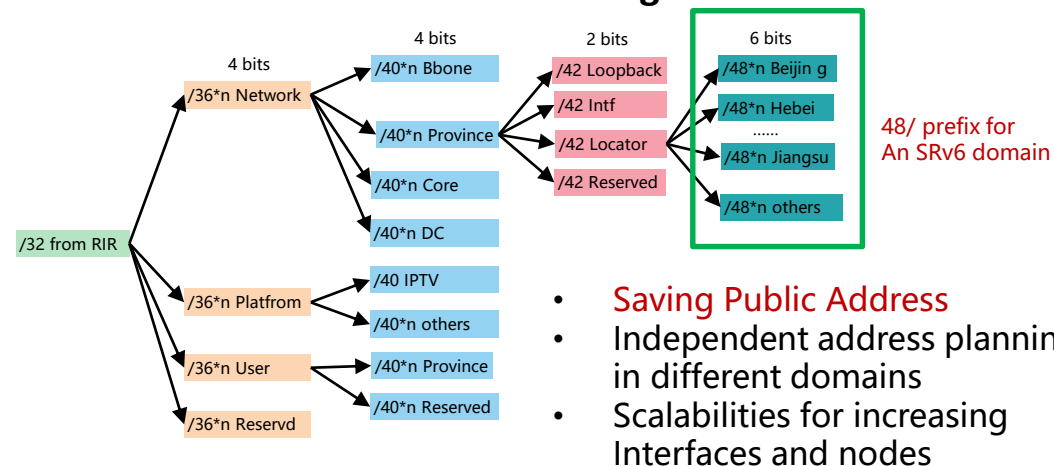- 32 bits is the ideal length, 16 bits is not scalable

Native IPv6
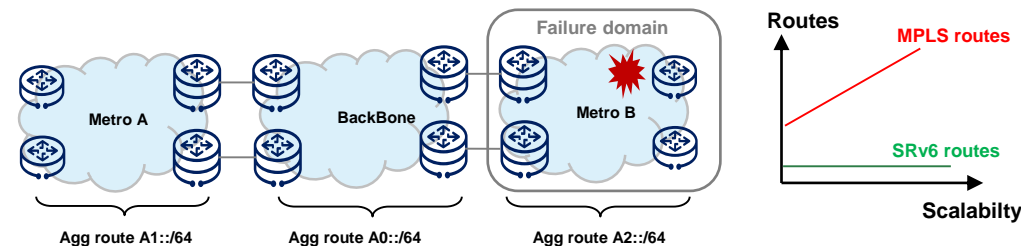
Native IPv6 Routing
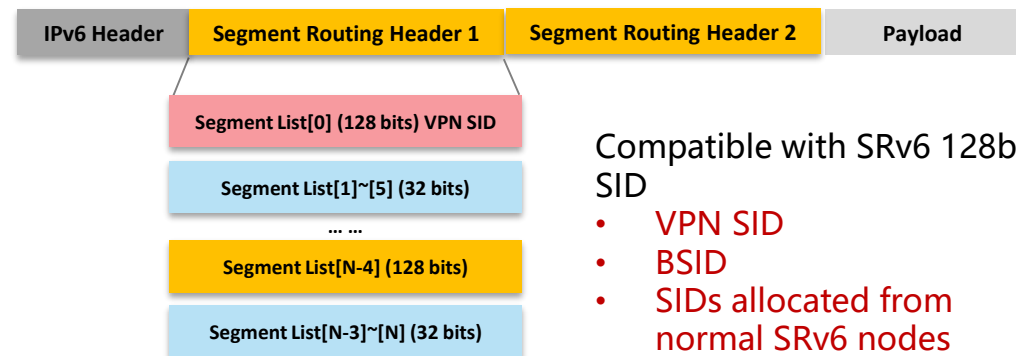- Based on IP reachability, overlay routing on cmpr disable nodes
- Route aggregation, support super scale networking
- Failure domain isolation

Address Planning

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.

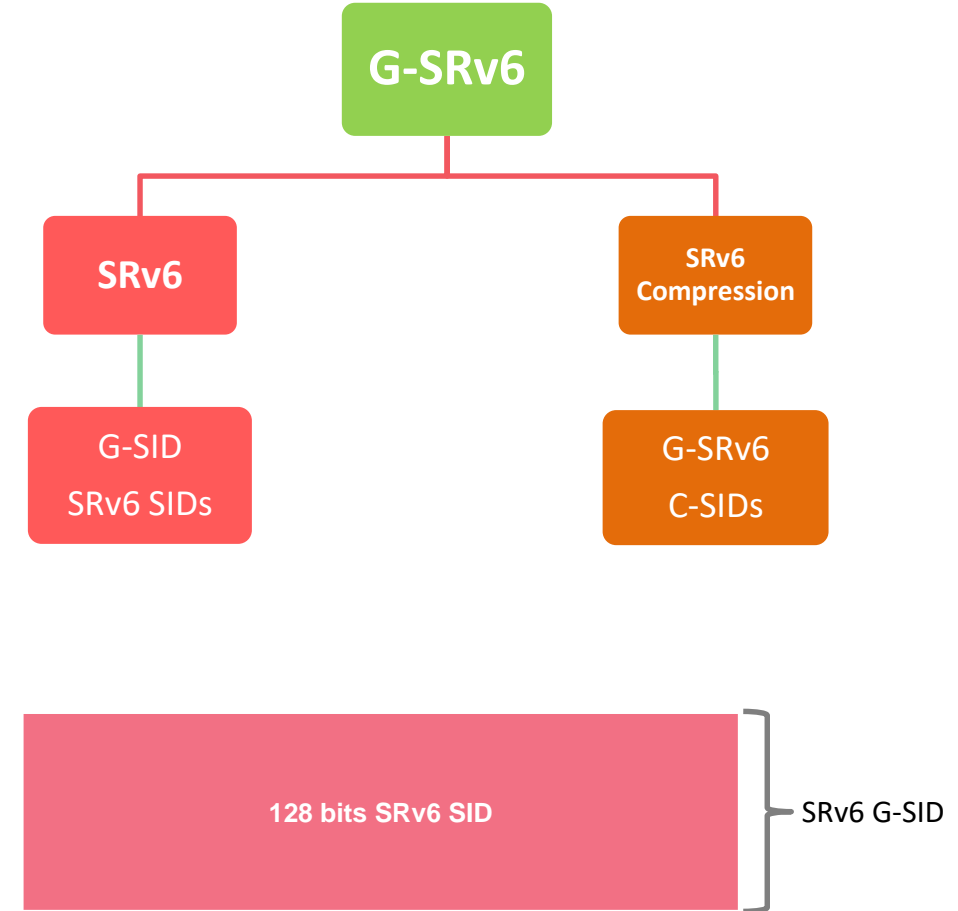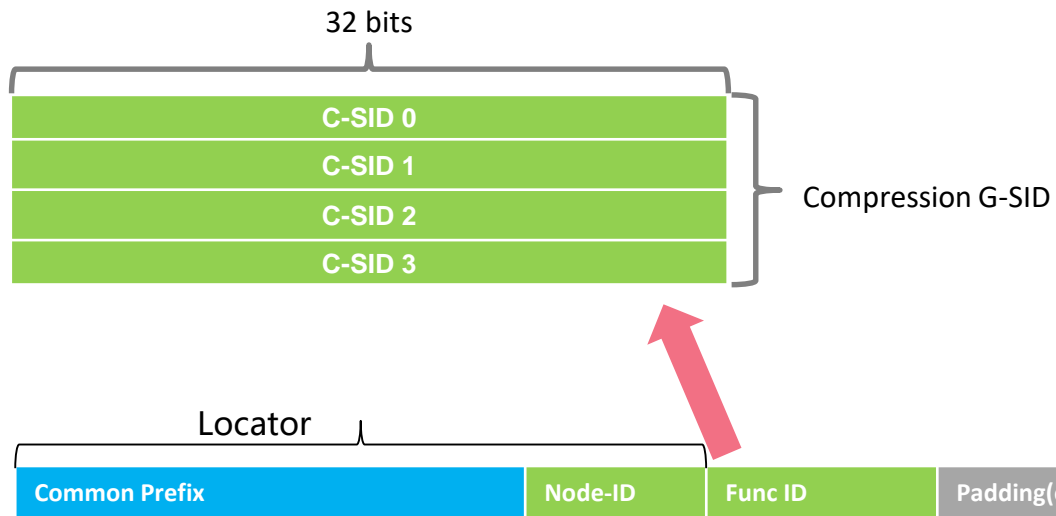| Locator	C-SID		
Common Prefix	Node-ID1	Func ID1	Padding(opt)
Common Prefix	Node-ID2	Func ID2	Padding(opt)
Common Prefix	Node-ID3	Func ID3	Padding(opt)
Common Prefix	Node-ID4	Func ID4	Padding(opt)
Common Prefix	Node-ID5	Func ID5	Padding(opt)
Common Prefix	Node-ID6	Func ID6	Padding(opt)

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)

32 bits

| C-SID 0 |
| C-SID 1 |
| C-SID 2 |
| C-SID 3 |

Compression G-SID

Locator

| Common Prefix | Node-ID | Func ID | Padding(opt) |

G-SRv6

SRv6

SRv6 Compression

G-SID
SRv6 SIDs

G-SRv6
C-SIDs

| 128 bits SRv6 SID |

SRv6 G-SID

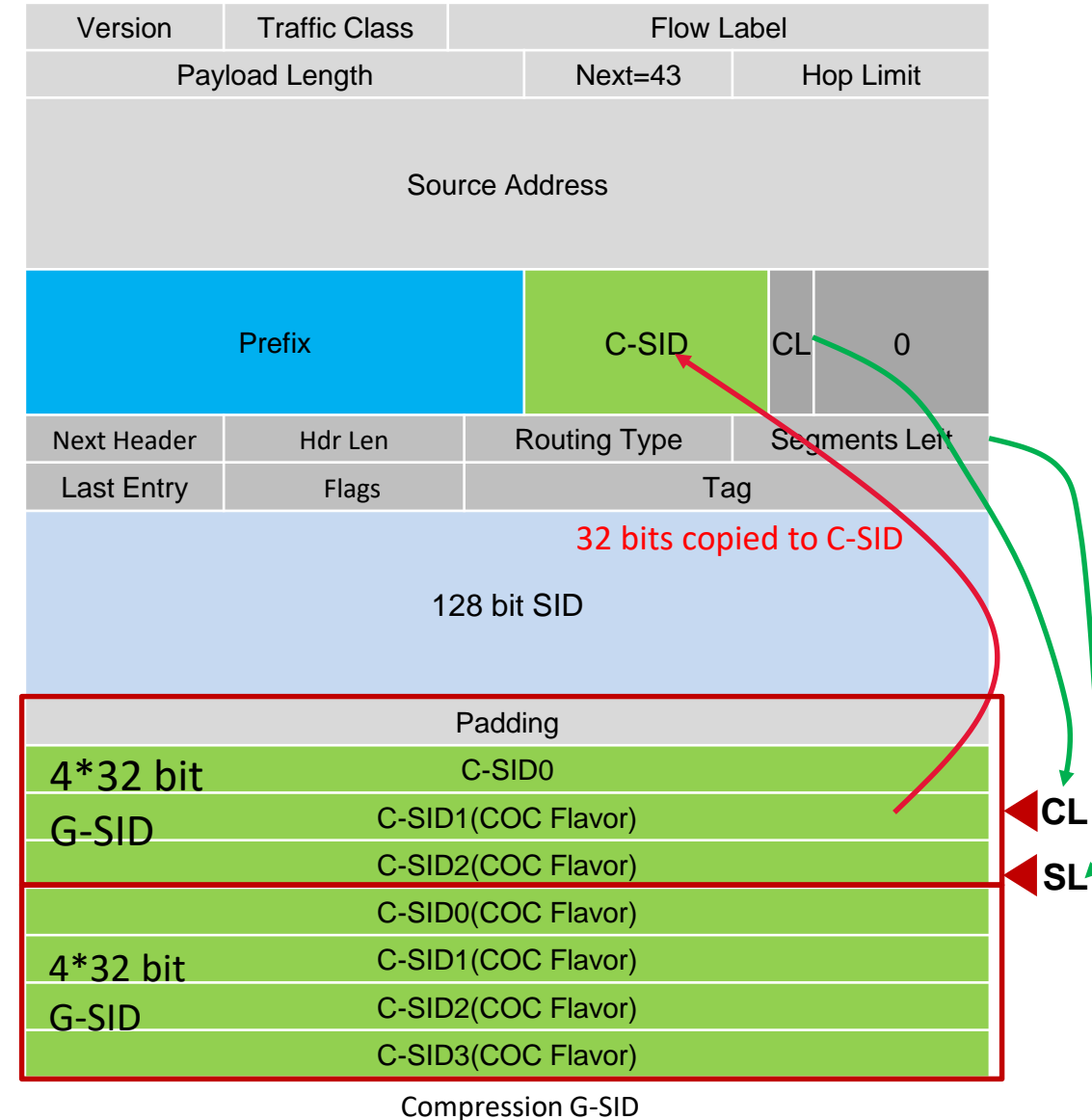# G-SRH: Compatible with SRv6, Incremental Deployment, Hardware Friendly

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(Continue 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**

https://tools.ietf.org/html/draft-lc-6man-generalized-srh-00

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

← CL

Compression G-SID

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 LOCAL SID 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.**

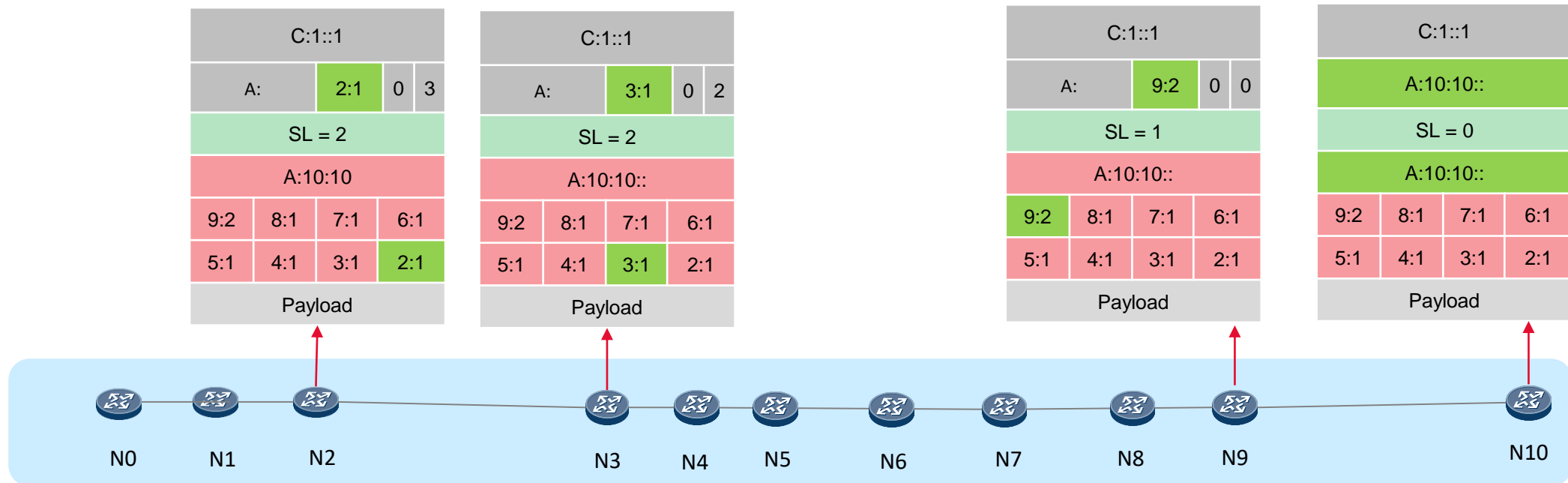10 * 128 bits to 3 * 128 bits including a 128bit VPN SID. 70% overhead off.

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

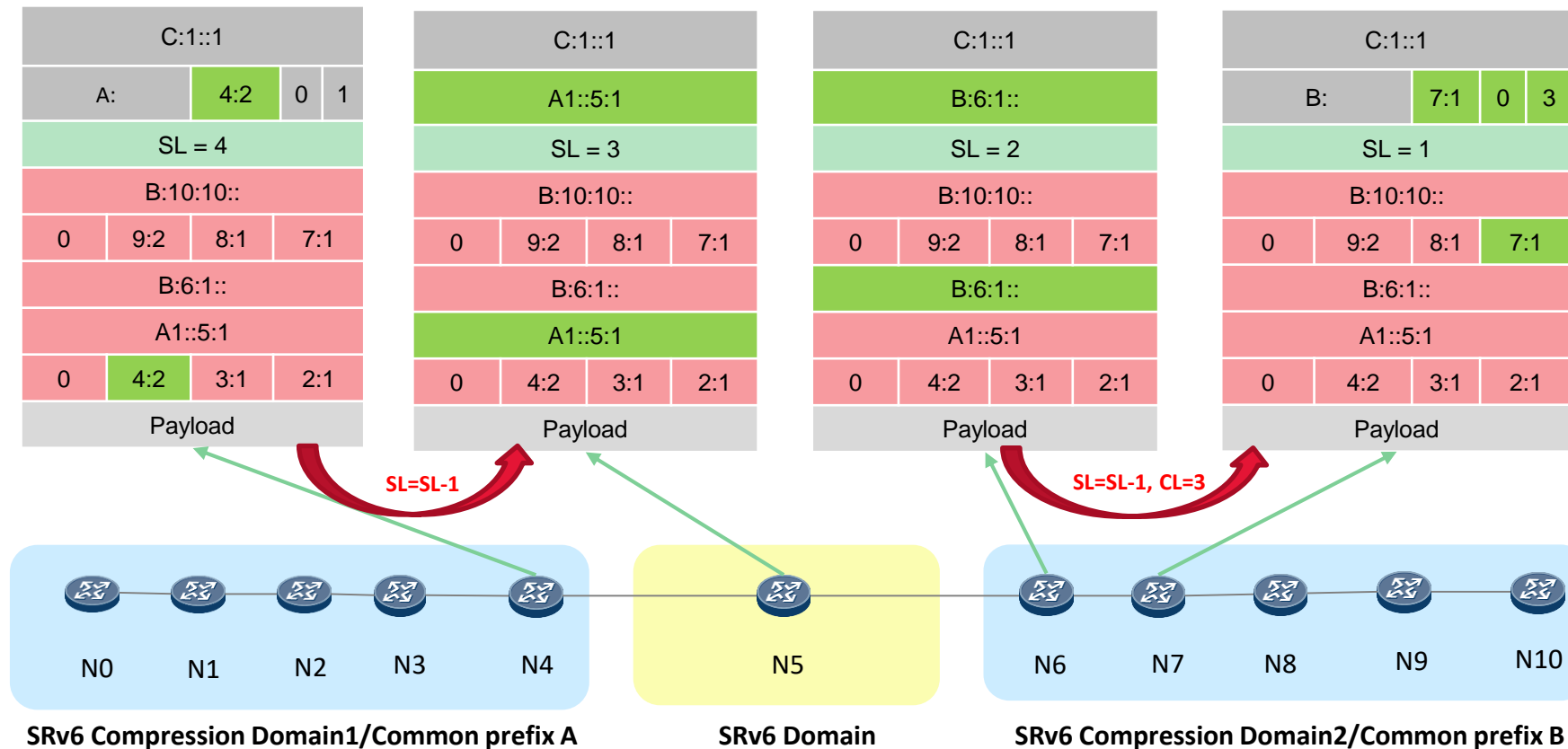| A		1	1:1:1:1

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
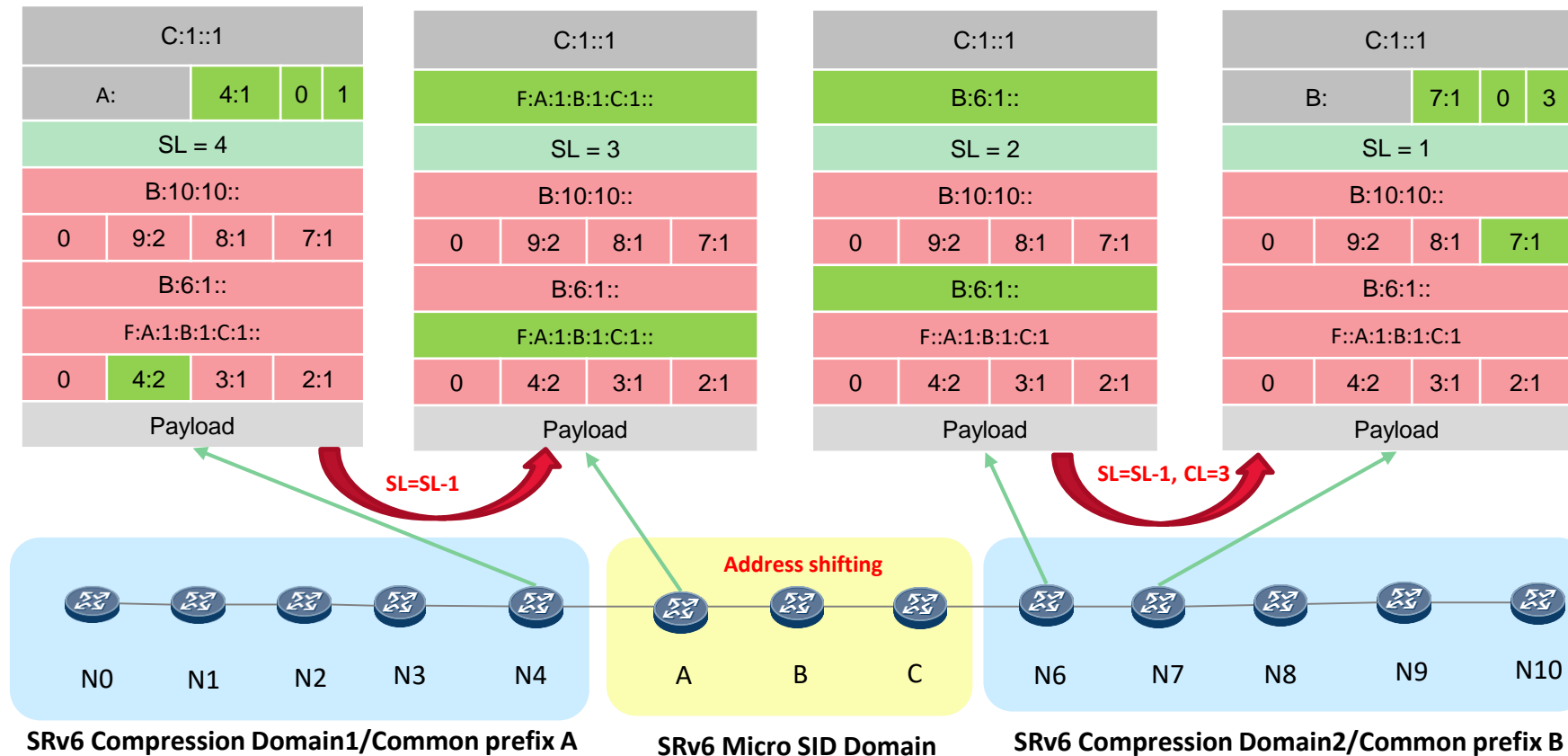
Comparison among Compression Solutions

Comparison	Details	uSID (Cisco)	G-SRv6 (CMCC/Huawei)
Compression efficiency	Compression efficiency	3 in 128bits (best case)	4 in 128bits
Address planning	Address consumption	Huge Address consumption **Shorter prefix, better compression.**	No new address(Same Locator) or Limited new address
	Deployment complexity	IPv6 address + New address planning in new address block	IPv6 address + addresses from current address space
	New Address Block	New	No. Can reuse the SID space.
Native IPv6 routing	Routable	Yes	Yes
	New Locator	Yes	Don't have to (can reuse the same Locator)
Compatible with SRv6	Compatible with SRv6	Yes	Yes
	Compatible with SRH	Yes	Yes
	Mixed 128bits/32bits SID encoding in an SRH	Yes	Yes

G-SRv6: No SRH modification, No new address consumption, No new route advertisements.(Can be)No modification of Control Plane

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.**

Thanks

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