HUAWEI

SRv6 Compression Technology and Standard Progress

Cheng Li

Senior IP Standard Representative

Huawei Technologies

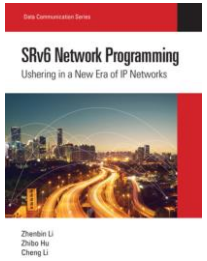
MPLS SD&AI NETWORLD23 ★18/20 APRIL | 24TH EDITION palais des congrès de paris

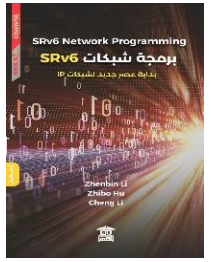
Introduction

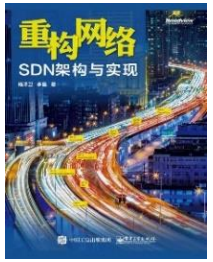
Cheng Li

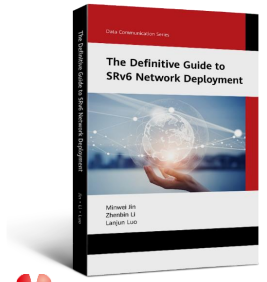
Huawei Senior IP Standard Representative

- **50+** IETF drafts，**16 +** WG drafts，**1** RFC
- Currently focus on **IPv6，SR, CATS, CUSP**
- **Author/Contributor of books**
  - **“SRv6 Network Programming-Ushering in a New Era of IP Networks” (Chinese/English/Arabic)**
  - “Refactoring Network: Architecture and Implementation of SDN” (Chinese)
  - Contributor of “The Definitive Guide to SRv6 Network Deployment” (Chinese/English)
- Recent Paper: “ Application-aware G-SRv6 network enabling 5G services ” , INFOCOM 2021







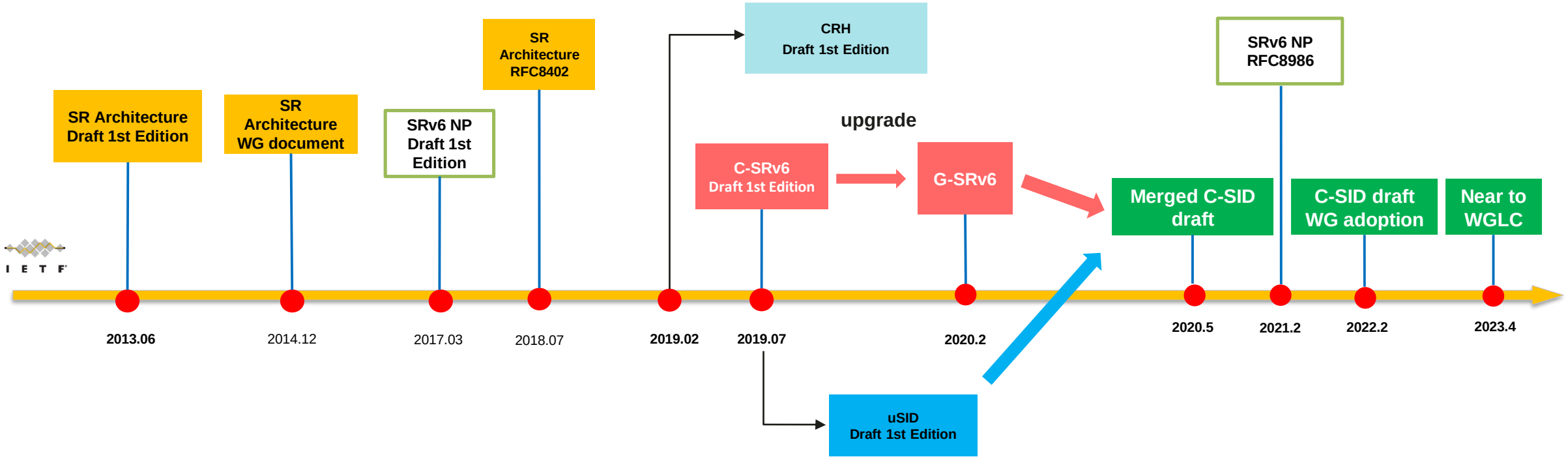


HUAWEI

Content

- History of SRv6 Compression
- Compressed-SID(C-SID) Introduction
- Status of Huawei Implementation
- Interop Test Report
- Summary of Rapid Worldwide Deployment of SRv6 and C-SID

History of SRv6 Compression



- 5 solutions were proposed, and finally merged into one single solution Compressed-SID (C-SID).
- C-SID draft[1] has been adopted as WG draft since Feb, 2022 and near to WGLC now.

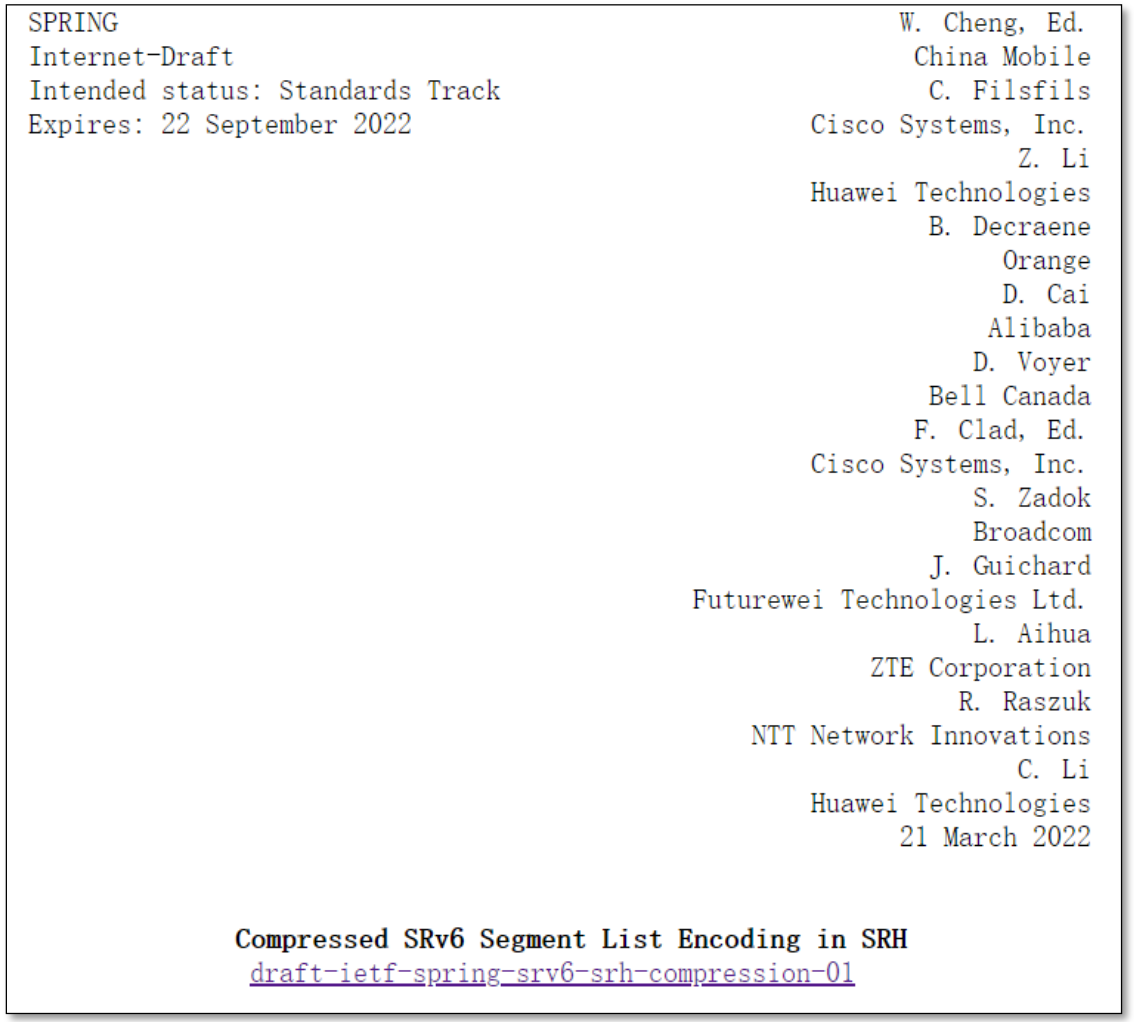
[1].https://datatracker.ietf.org/doc/draft-ietf-spring-srv6-srh-compression/

HUAWEI

SRv6 Compression: Converged and Adopted by WG

IETF SPRING WG

- draft-ietf-spring-srv6-srh-compression(C-SID) is accelerating to WGLC.
- C-SID draft defines flavors for the SR endpoint behaviors, which enables a compressed Segment-List encoding in the Segment Routing Header (SRH).
  - Replace-C-SID Flavor a.k.a G-SRv6
  - Next-C-SID Flavor a.k.a uSID
  - Combined Next-and-Replace-C-SID Flavor
- All flavors are defined under SRv6 network programming architecture, similar to PSP, USP and USD flavors defined in RFC8986.
- Replace-C-SID flavor SID and Next-C-SID can be encoded in a single SRH for better compression and interop, and the interop test had been done in 2020.



SPRING
Internet-Draft
Intended status: Standards Track
Expires: 22 September 2022

W. Cheng, Ed.
China Mobile
C. Filsfils
Cisco Systems, Inc.
Z. Li
Huawei Technologies
B. Decraene
Orange
D. Cai
Alibaba
D. Voyer
Bell Canada
F. Clad, Ed.
Cisco Systems, Inc.
S. Zadok
Broadcom
J. Guichard
Futurewei Technologies Ltd.
L. Aihua
ZTE Corporation
R. Raszuk
NTT Network Innovations
C. Li
Huawei Technologies

21 March 2022

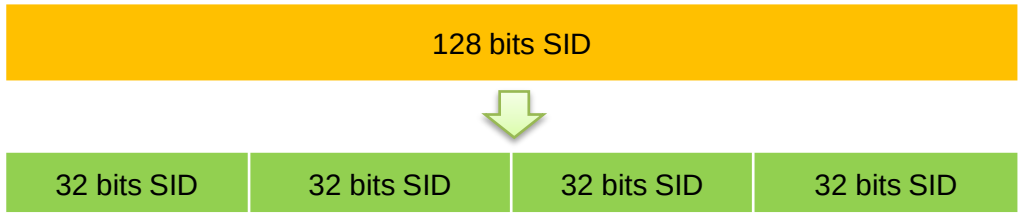
Compressed SRv6 Segment List Encoding in SRH
draft-ietf-spring-srv6-srh-compression-01

C-SID is the best solution according to Design Team's analysis result [1], which meets all the requirements of compression

[1]. https://datatracker.ietf.org/doc/draft-ietf-spring-compression-analysis/

Solution Design Principle: Efficient, Scalable, Compatible and Flexible

Efficient and Scalable



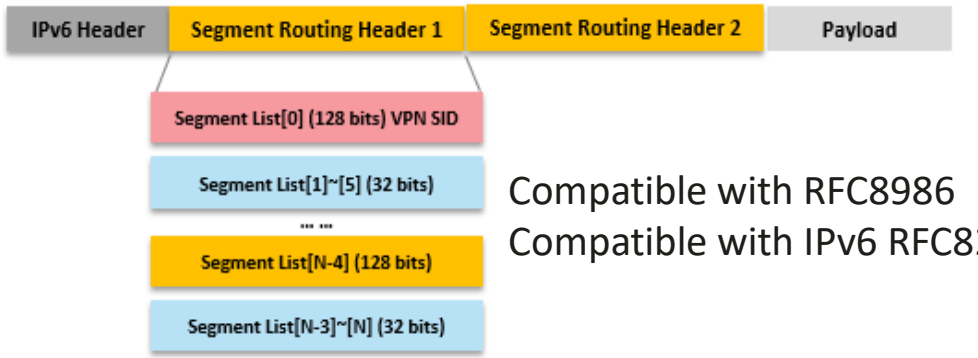
Trade-off between Efficiency and Scalability

32 bits has the best balance between efficiency and scalability

16 bits brings better compression with scalability issues

Compression rate is not the only goal

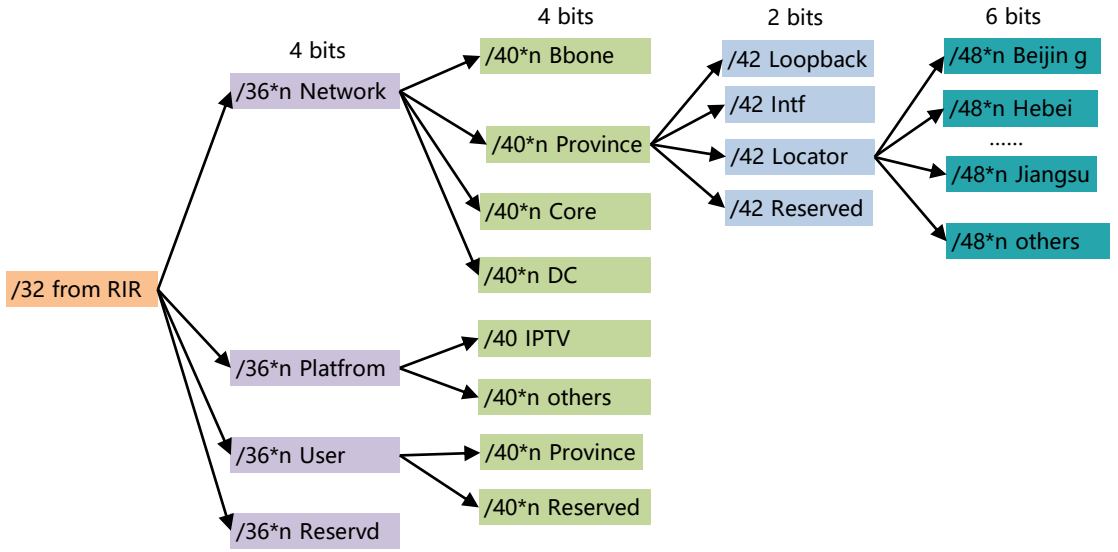
Compatible with IPv6/ SRv6



Compatible with RFC8986

Compatible with IPv6 RFC8200, etc.

Simple and Flexible



Simple and Flexible is REQUIRED

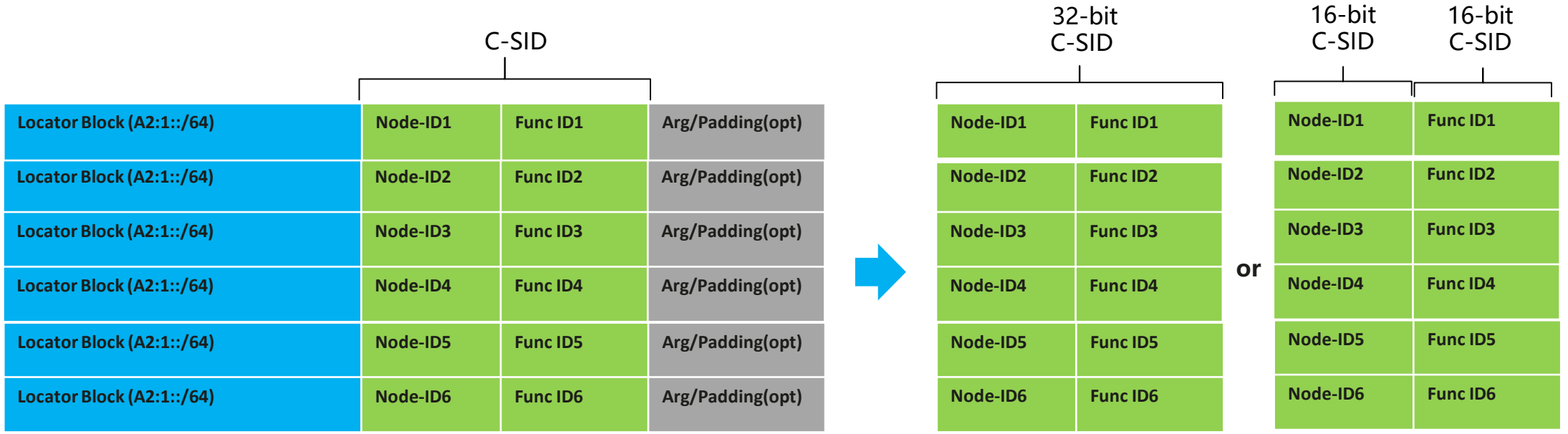
Simple deployment follows IPv6/SRv6

Flexible address planning for different scenarios

Compression MUST NOT affect other benefits brought by IPv6 and SRv6

SRv6 Compressed SID Introduction: Precondition

- **Assumption and precondition:**
  - 128-bit SRv6 SIDs are allocated from an address block, sharing the common prefix.
  - 128-bit SIDs follow the same format of **Locator-Block** : **Locator-NodeID** : **FunctionID** : **Argument/Padding**
- The redundant Locator-Block and Argument/Padding can be removed to reduce the size of SIDs.
- The different part of an SRv6 SID is the compressed SID(C-SID) of it.



HUAWEI

REPLACE-C-SID: Replace C-SID by C-SIDs in Containers

REPLACE-C-SID Flavored Behaviors:

- **Update 32/16-bit C-SID from SRH[SL][DA.Arg.Index] to DA**
- Note: DA.Arg.Index locates the C-SID in a C-SID container.

Benefits：

1. **Flexible Address Planning & Easy Deployment：**
    1. Flexible address planning, no need for a short address block.
    2. No need to readdress if SRv6 has been deployed.
2. **Best Balance between Compression and Scalability**
    1. **32-bit(Recommended)**
        1. Good Scalability for large networks. 16-20 bits Node ID, support up to 1M nodeID, support hierarchical address design.
        2. Good compression, similar to MPLS (32-bit Label). 75 % Size off.
    2. **16-bit**
        1. Only for small networks, support 4K*N NodeID, hard to use hierarchical address planning, hard to aggregate routes
        2. Outstanding compression, better than MPLS(32-bit label)
    3. **Longer the C-SID sequence, better the compression.**

Block	C-SID1	Argument
Block	C-SID2	Argument
Block	C-SID3	Argument
Block	C-SID4	Argument

4 SIDs

128-bit SIDs in SRH

Block		C-SID1	Argument
C-SID1	C-SID2	C-SID3	C-SID4
C-SID1	C-SID2	C-SID3	C-SID4
C-SID1	C-SID2	C-SID3	C-SID4

13 SIDs

32-bit REPLACE-C-SID Flavor C-SIDs in SRH

Block				C-SID1	Argument		
C-SID1	C-SID2	C-SID3	C-SID4	C-SID5	C-SID6	C-SID7	C-SID8
C-SID1	C-SID2	C-SID3	C-SID4	C-SID5	C-SID6	C-SID7	C-SID8
C-SID1	C-SID2	C-SID3	C-SID4	C-SID5	C-SID6	C-SID7	C-SID8

25 SIDs

16-bit REPLACE-C-SID Flavor C-SIDs in SRH

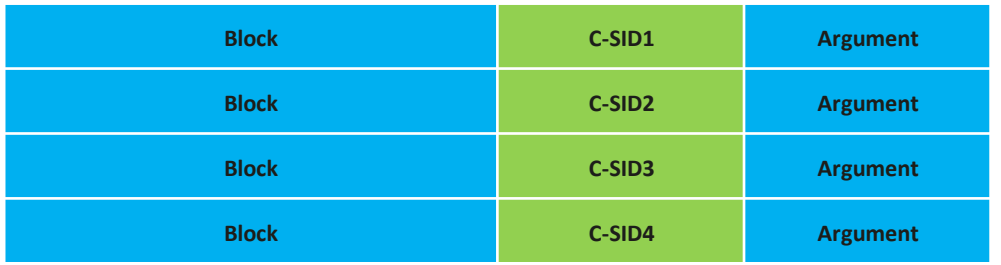
NEXT-C-SID: Update DA by shifting C-SIDs in DA

NEXT-C-SID flavored behaviors:

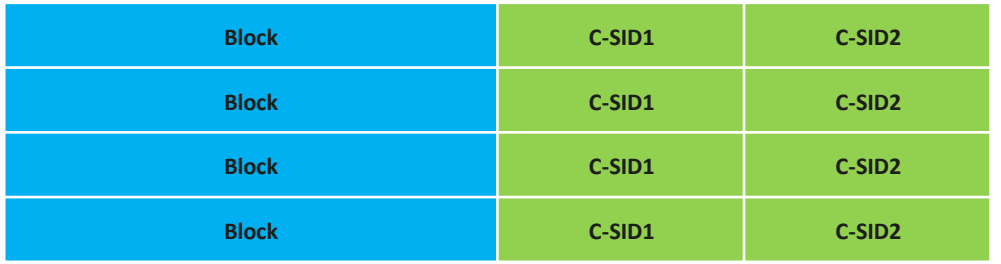
- **Pop the 32/16-bit C-SID in DA, and left shift the next C-SID**
- Note: Next C-SID is encoded in argument of the active SID in DA.

Benefits：

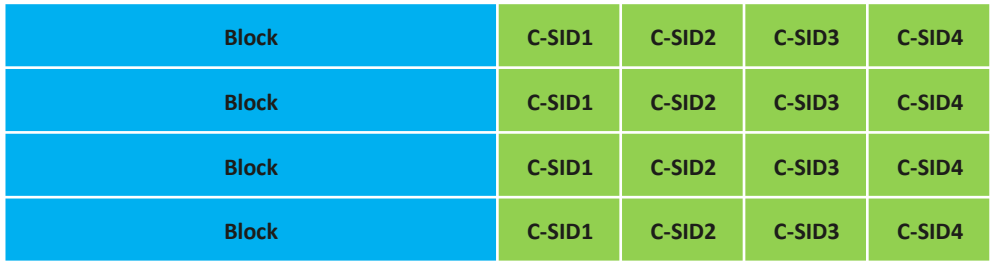
1. **Best Compression in 16-bit if SRH is not carried and Locator Block is very short.**
    1. **32-bit**
        1. Good Scalability for large networks, however,
        2. **No recommended** since very few C-SIDs can be carried in a container.
    2. **16-bit (Recommended)**
        1. Only for small networks, support 4K*N NodeID, hard to use hierarchical address planning, hard to aggregate routes
        2. Outstanding compression, better than MPLS(32-bit label)
    3. **Shorter the Locator Block, better the compression.**



128-bit SIDs in SRH



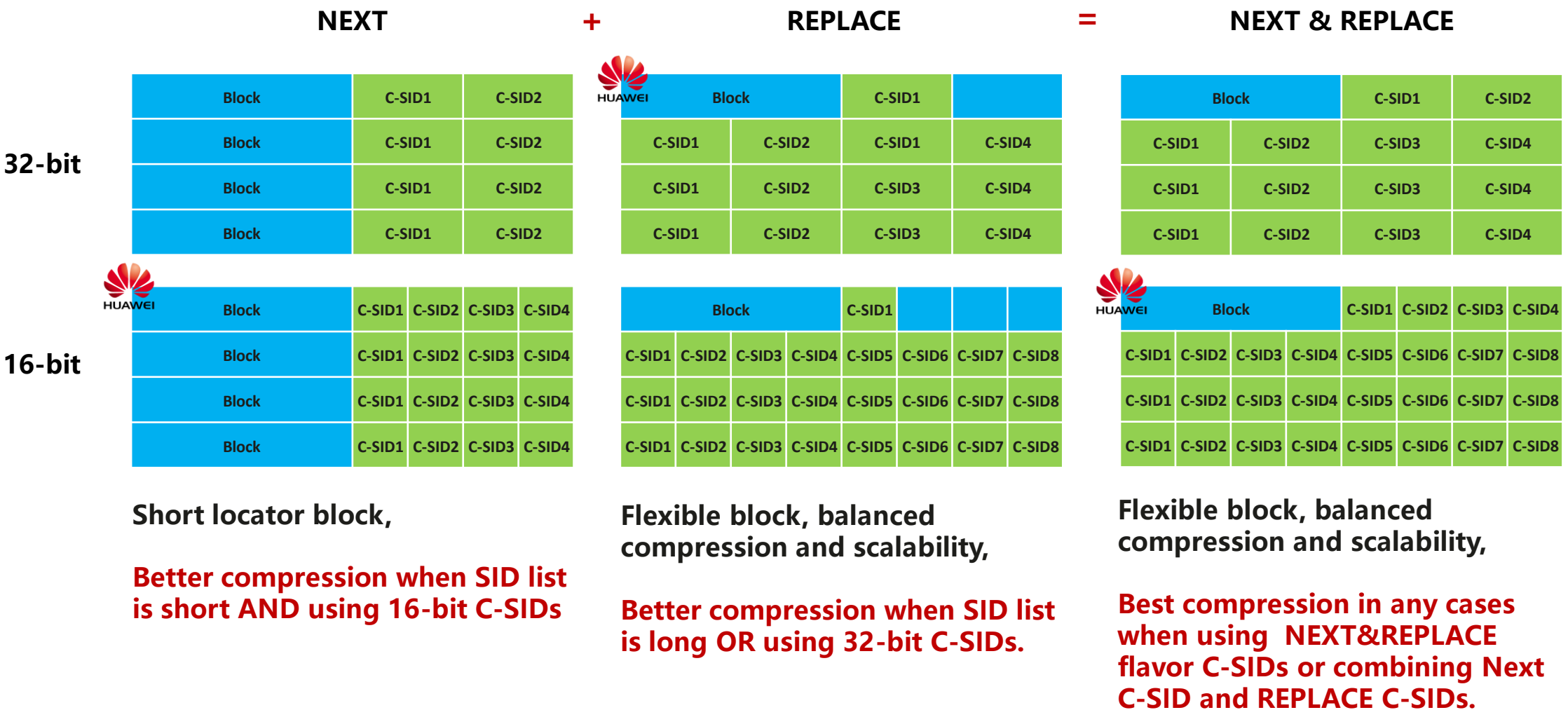
32-bit NEXT-C-SID Flavor C-SIDs in SRH



16-bit NEXT-C-SID Flavor C-SIDs in SRH

HUAWEI

Huawei Implementations on SRv6 C-SID



Short locator block,

Better compression when SID list is short AND using 16-bit C-SIDs

Flexible block, balanced compression and scalability,

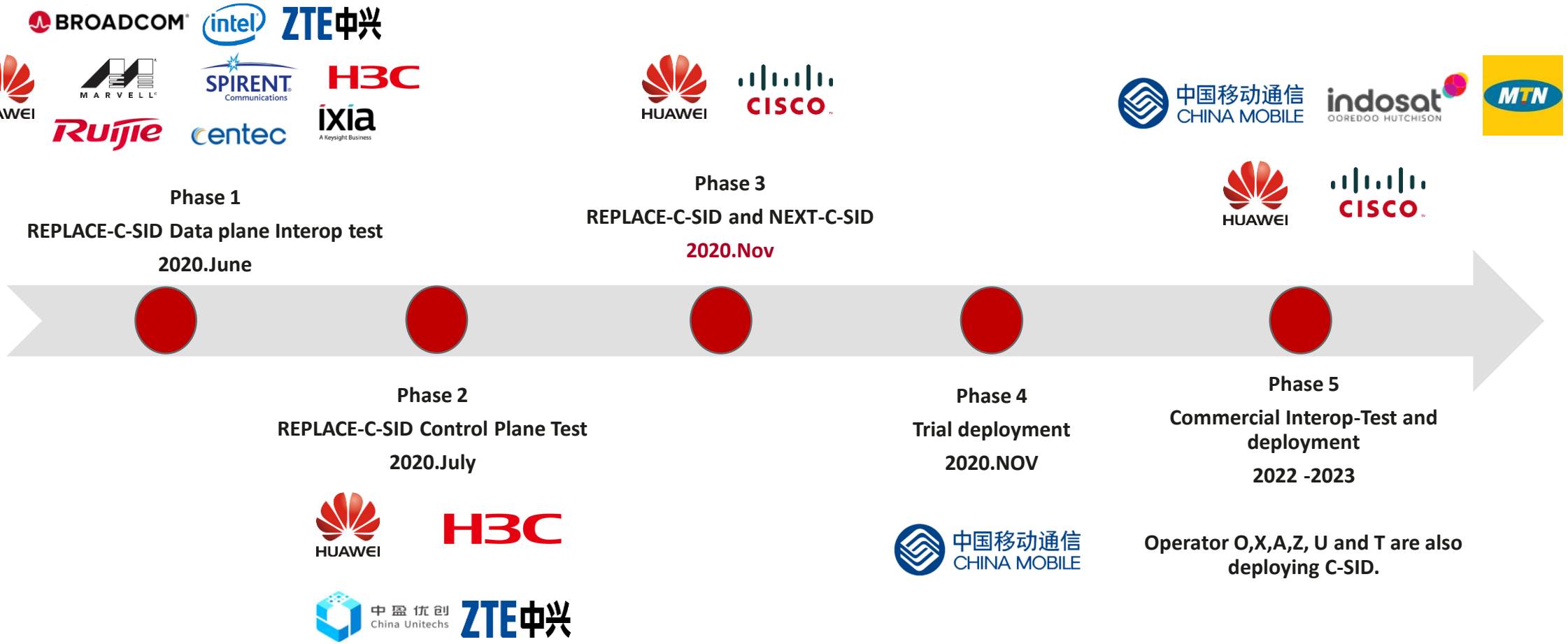
Better compression when SID list is long OR using 32-bit C-SIDs.

Flexible block, balanced compression and scalability,

Best compression in any cases when using NEXT&REPLACE flavor C-SIDs or combining Next C-SID and REPLACE C-SIDs.

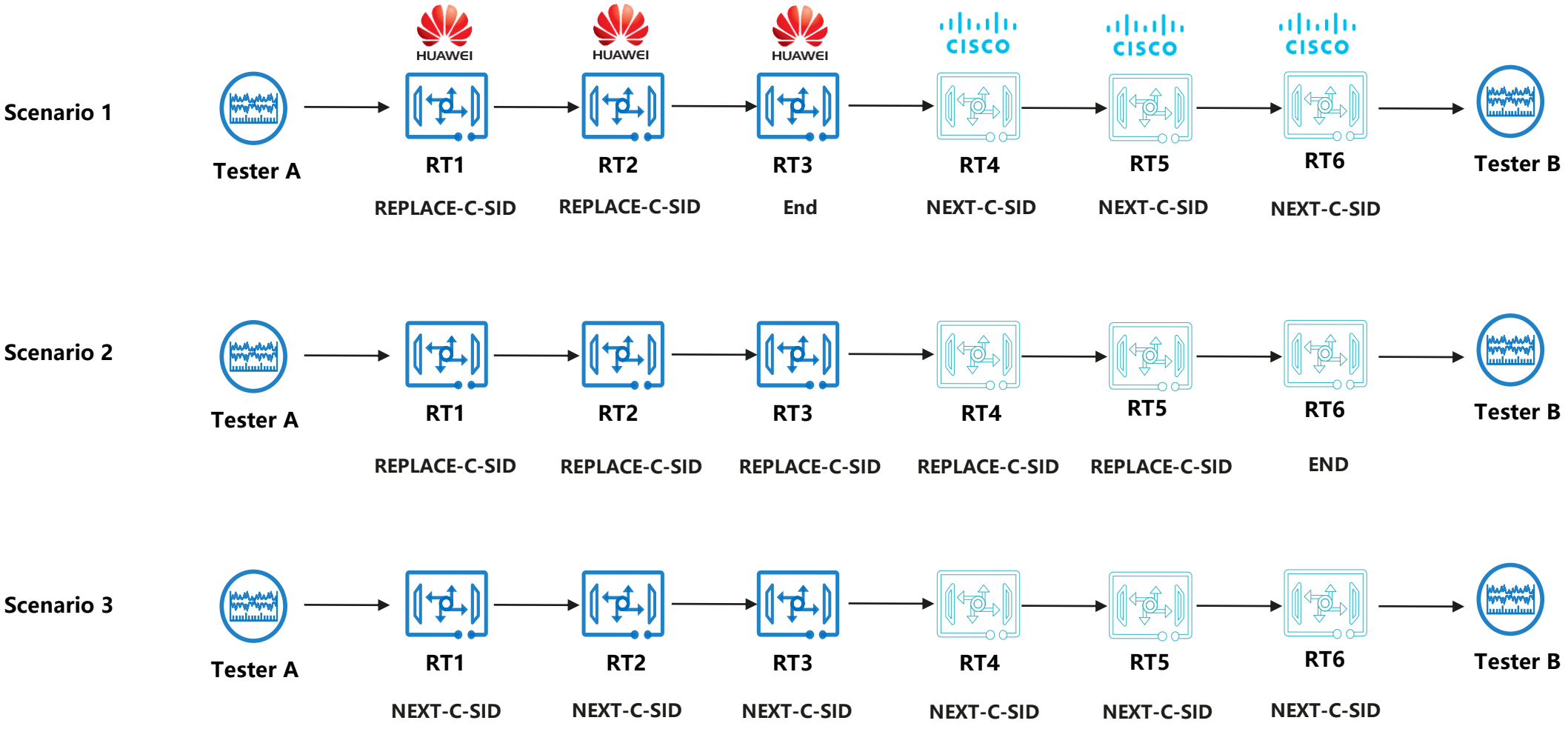
Huawei implementations can meet the compression requirements in any size (Large or small) networks

Overview of C-SID Interop Test and Rapid Worldwide Deployment



HUAWEI

C-SID Interoperability Test in CMCC in 2020



Huawei and Cisco completed the interop-test of C-SID in CMCC's LAB in 2020

[1].https://datatracker.ietf.org/doc/draft-ietf-spring-srv6-srh-compression/

2022 IOH Completed C-SID Interoperability Test

Huawei & Cisco IOH SRv6 Interoperability Test Success

15+	100%	Excellent
Complete cases	Pass rate	Test effect

SRv6 Brings Great Value to IOH Network

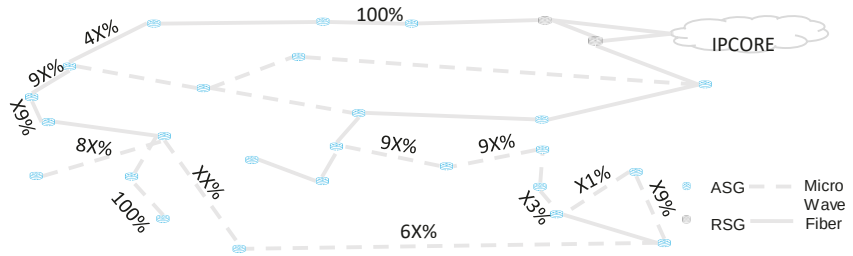
41% ↓	35% ↑
Transmission overhead reduce	Forwarding efficiency improve

Outstanding Contribution to Regional IPv6 Innovation

HUAWEI

Deploy C-SID and NCE to Promote Rapid Traffic Growth

High BW Usage and Insufficient Available Resources



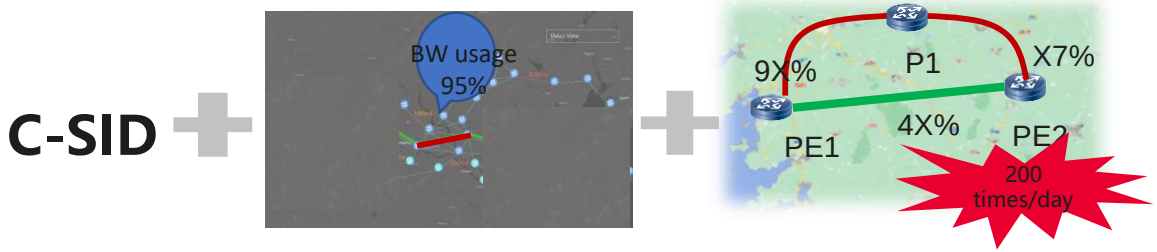
--Typical Aggregation Ring Topology of From Operator U

- Many microwave links
- Long path: **The forwarding path has 10+ hops on average.**
- High BW utilization: 70% on average and over 90% in some cases

Key Challenge: How to ensure smooth SRv6 upgrade without network-wide capacity expansion?

Many microwave links	Long path	High BW utilization
Insufficient bandwidth resources	SIDs bring more overhead	Unacceptable large investment in network expansion

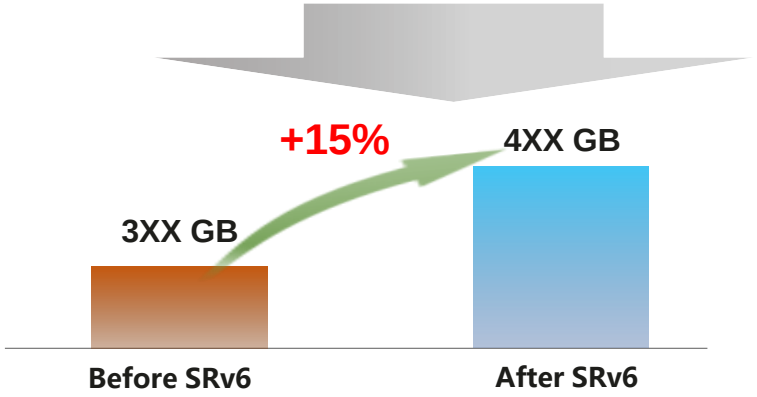
REPLACE-C-SID + SDN + Precise expansion supports SRv6 successfully deployed



Action 1: Reduce the SRv6 header size with REPLACE-C-SID

Action 2: Identify network bottlenecks and perform precise expansion.

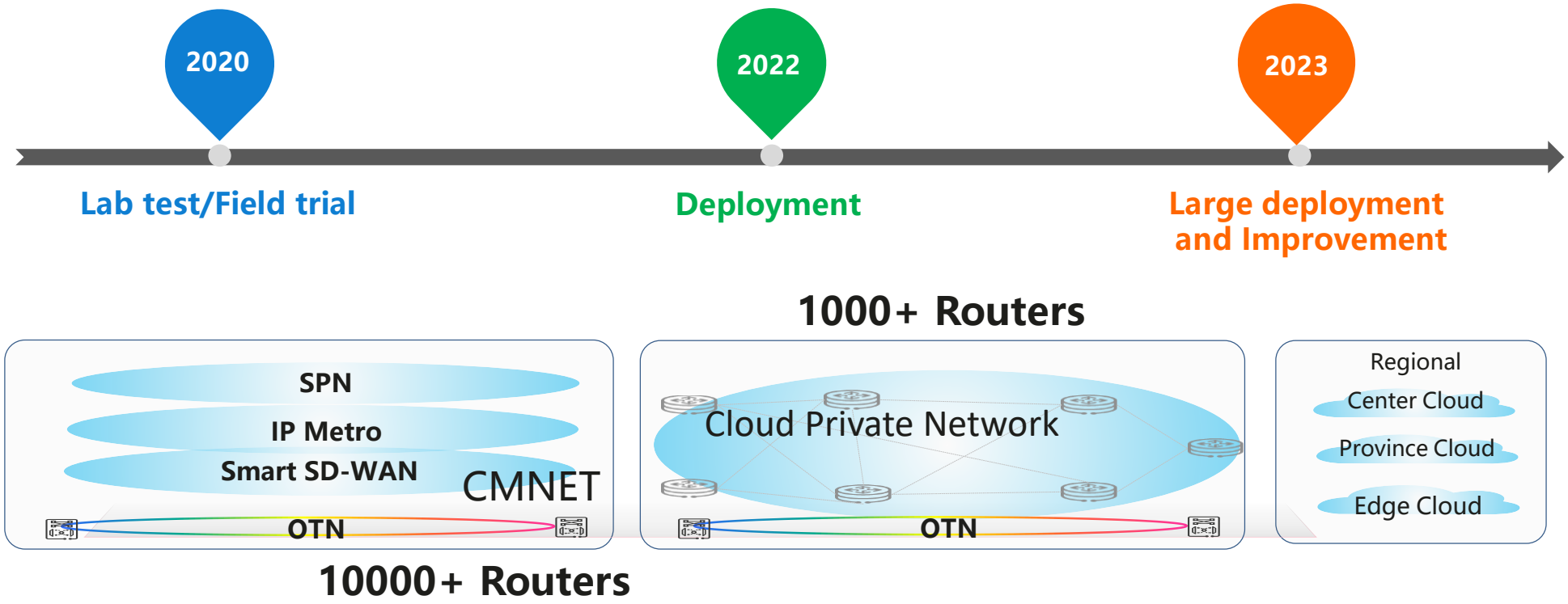
Action 3: Real-time automatic optimization ensuring optimal paths at any time.



After SRv6 is deployed in area N
Suppressed traffic is rapidly released

HUAWEI

CMCC: Leading the Deployments, Largest Deployment of C-SID



- CMCC led the interop test of C-SID between **10+** vendors in the past years, and had deployed G-SRv6/REPLACE-C-SID (Using Controller and SRv6 TE policy) on **1K+** (Multiple Vendors) routers in their Cloud Backbone network in 2022, reducing 50+% overhead of SRH.

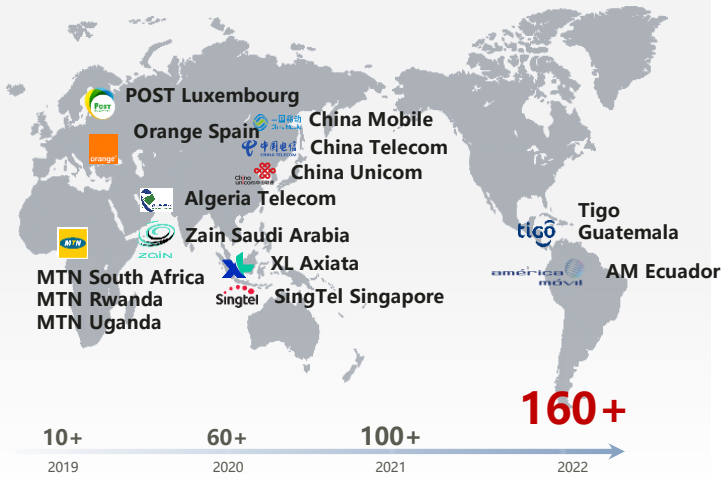
- CMCC is deploying G-SRv6/REPLACE-C-SID on **10K+** (Multiple Vendors) routers in CMNET, which is the largest network using C-SID. The news will be released soon and experience will be shared. **Larger deployment is on the way.**

SRv6 with compression is ready for multi-vendor large-scale deployment in multi-area networks

Review of SRv6 Industry Status: Fast Deployment around the World.

Reference: Global Carriers Consensus

orange	✓ Orange Spain Deployed
T	✓ Lean IP Architecture Released
Telefónica	✓ Brazil VIVO Field Trial
swisscom	✓ Swisscom IP Core Deployed
中国移动 China Mobile	✓ 24+ Provinces Deployed



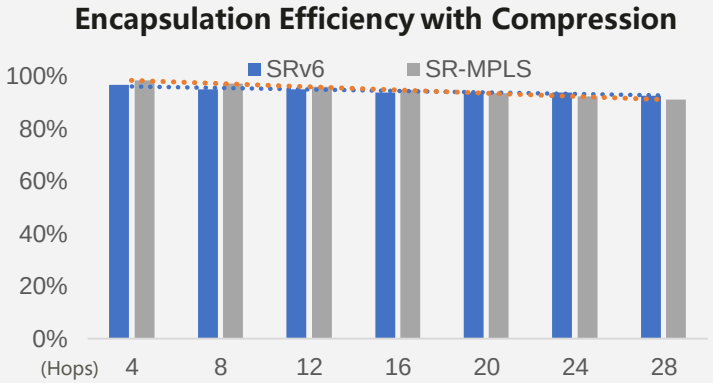
Interoperability: Proved Inter-op between Vendors

✓ **Interoperability:** Widely Tested in Organizations and Carriers

EANTC · vodafone · Ziggo · indosat OOREDOO HUTCHISON · swisscom · elisa

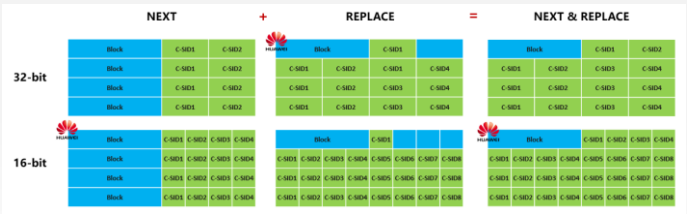
Category	Huawei	Vendor C
ISISv6/BGP	✓	✓
SRv6 EVPN	✓	✓
SRv6 L3VPN	✓	✓
SRv6 4PE/6PE	✓	✓
SRv6 Ti-LFA	✓	✓
SRv6 Ping/Trace	✓	✓
Header Compression	✓	✓
.....		

Efficiency: Similar/better with/than SR-MPLS



Calculation based on packet length of 1200 bytes

Huawei Implementation

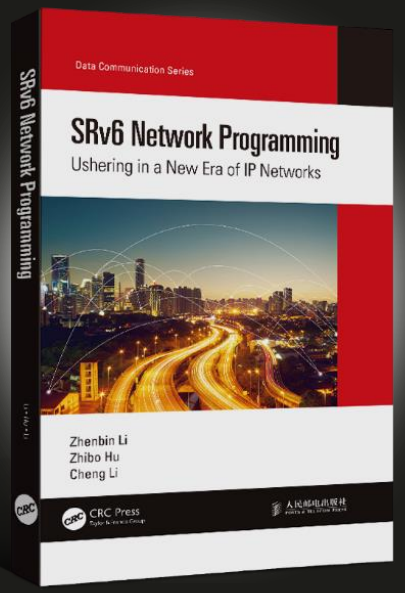


Huawei has implemented C-SID that can meet requirements of any networks

HUAWEI

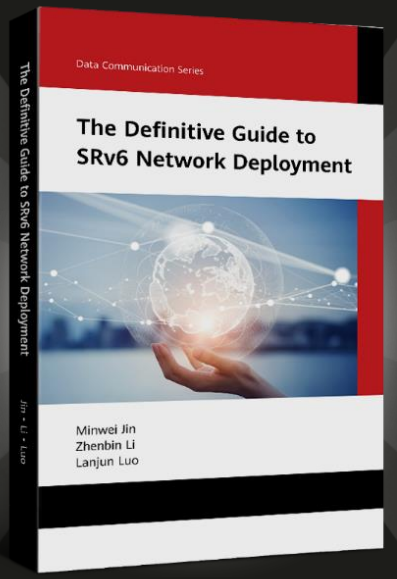
SRv6 Network Programming

Ushering in a New Era of IP Networks



The Definitive Guide to

SRv6 Network Deployment



Coming soon…

Compiled by Professional Teams

- Members of the IETF Internet Architecture Board (IAB)
- Huawei senior SR and IGP protocol experts
- Huawei senior pre-research engineers and IP standards representatives

Project Experience Sharing

- Complete collection of SRv6 theory and technologies
- Guide to SRv6 applications in innovative services
- Authentic stories about the SRv6 standardization process

Deployment Experience Disseminating

- Network planning, design and deployment
- Network O&M and application analysis

HUAWEI

HUAWEI

Thank You

MPLS SD&AI NET WORLD23