SRv6 based Network Slicing

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5G Emerging Services Leads to Network Slicing

**Diversified Services, Stringent Requirements**

- **xMBB**
  - Extreme mobile broadband
  - > 300 Mbps/user in very dense deployments, indoor and outdoor, humans and machines

- **Virtual reality office**
  - Indoor communications
  - > 1 Gbps/user
  - < 10 ms E2E latency

- **Connected cars**
  - < 5 ms E2E latency
  - > 100 Mbps/user

- **mMTC**
  - Massive machine-type communications
  - > 1 million devices / km²
  - > 10 years battery lifetime

- **uMTC**
  - Ultra-reliable machine-type communications
  - > 50 Mbps/user and < 10 ms E2E latency
  - also in rural areas

- **Broadband access everywhere**
  - > 50 Mbps/user and < 10 ms E2E latency also in rural areas

**Converged Network Infrastructure, Multiple Network Slices**

- **#1**
  - 8K/Holographic Video Network Slice
  - Large BW: 1G~10Gbps

- **#2**
  - Autonomous Driving Network Slice
  - Lower latency: 3~5ms Level

- **#n**
  - IOT Network Slice
  - Connections/km2: 106/km²

**Network Slicing is the KEY to meet diversified service requirement in one network**
Transport Network in End-to-End Network Slicing

E2E Orchestrator

RAN Slice Manager

Transport Slice Manager

Core Slice Manager

Transport network provides end-to-end network slice connectivity and SLA assurance
Transport Network Slicing Requirements

Level 3 – Independent Operation
- Independent management plane for on-demand provisioning of network slices
- For wholesale or self-operated vertical services

Level 2 – Resource Isolation
- Dedicated resource ensures no interference between network slices
- For 5G critical services with demanding performance assurance

Level 1 – Service Separation
- Isolation in service access & connectivity
- Possible interference between services
- For traditional enterprise services

Addressed by Existing VPNs

Addressed by Enhanced VPNs
Degree of Isolation: Depends on Service Requirement

- **Hard isolation**
  - Dedicated resource
  - Guaranteed performance
  - Limited multiplexing

- **Soft isolation**
  - Shared resource
  - Differentiated treatment
  - Statistical multiplexing

Network Slicing requires both hard and soft isolation to meet different level of SLA requirement
Transport Network Slicing Architecture

Network Slice Management
- Dynamic/automatic network slice life-cycle management
  - Creation, monitoring, adjustment, deletion
  - Network slice planning algorithms

Network Slice Instantiation
- Customize network slice topology and associated attributes
  - Integration between overlay connectivity and underlay resource

Network Resource Partitioning
- Flexible Ethernet (FlexE)
- Logical sub-interface
- Dedicated queues
- Time Sensitive Networking (TSN)

SRv6: End-to-End Unified Transport Network

- **Simplicity**: No extra signaling, less state maintained in network
- **Integration**: Underlay and overlay, network and application
- **End-to-End**: Unified mechanism across multiple network domains
- **DC Acceptance**: Based on IPv6 reachability, easier to be accepted in data center

Diagram showing network architecture with various controllers and services.
SRv6: Network Programming

SRv6 programmability is essential for 5G network slicing and service innovation.
SRv6 based Network Slicing: Data Plane

- SRv6 enhancement for network resource awareness
  - Different SRv6 SIDs represent network resource allocated on each segment for different network slices

- Network slice identification
  - Dedicated SRv6 Locator for each network slice
  - SRv6 SIDs inherit the slice identification from Locator

SRv6 SID (128bit)
Slice-Id embedded
Locator Function (ARG)
Slice-specific Functions/Args

A1:1::1
A1:2::1
A2:1::1
A2:2::1
A3:1::1
A3:2::1
A4:1::1
A4:2::1
A5:1::1
A5:2::1
A6:1::1
A6:2::1
A7:1::1
A7:2::1
A8:1::1
A8:2::1

Slice 1:
A1:1::1
A2:1::2
A3:1::1
A4:1::1
A5:1::1
A6:1::1
A7:1::1
A8:1::1

Slice 2:
A1:1::1
A2:1::2
A3:1::1
A4:1::1
A5:1::1
A6:1::1
A7:1::1
A8:1::1

tools.ietf.org/html/draft-dong-spring-sr-for-enhanced-vpn
SRv6 based Network Slicing: Control Plane

• Hybrid of centralized and distributed control
  • SDN with SR/SRv6

• Based on Multi-Topology concept
  • Provide basic functionality for network slicing
    • Create multiple virtual topologies in a physical network
    • Allow topology-specific attribute customization

• Extensions for SRv6 network slicing
  • Reuse Topology-ID as network slice identifier
  • Advertise slice-specific SRv6 Locators and SIDs
  • Advertise resource attributes associated with SRv6 SIDs of different network slices

Node C advertises:

**Network Slice Brown**
- Locator: A3:1::
- End SID: A3:1::1
- Link #1: End.X SID: A3:1::C1
  - Bandwidth: 2G
- Link #2: End.X SID: A3:1::C2
  - Bandwidth: 5G
- Link #3: End.X SID: A3:1::C3
  - Bandwidth: 3G

**Network Slice Blue**
- Locator: A3:2::
- End SID: A3:2::1
- Link #1: End.X SID: A3:2::C1
  - Bandwidth: 1G
- Link #2: End.X SID: A3:2::C3
  - Bandwidth: 2G

*tools.ietf.org/html/draft-dong-lsr-sr-enhanced-vpn*
Network Slicing Scalability Considerations

• Comply to SR/SRv6 principle
  • No per-flow state introduced in the network
  • Necessary per-hop states for guaranteed performance

• Shared control plane, isolated data plane
  • Multiple network slices over the same control session
  • Use slice-specific SIDs to steer traffic into different set of resources

• Further optimizations
  • Reduce control plane overhead
  • Improve resource utilization

A1:X::C1
A1:1::C1
A1:2::C1
A1:X::C1
Slice 1
Slice 2
Slice N

A2:1::C1
A2:2::C1
A2:X::C1

End SIDs
Slice 1: A1:1::1
Slice 2: A1:2::1
Slice N: A1:X::1

One Layer-3 Interface

End X SIDs
End X SIDs

Single IGP session
Network Slicing related Standards

RAN & Mobile Core
SA2: Network Slicing Architecture
- TS 23.501: System Architecture for the 5G System
- TS 23.502: Procedures for the 5G System (5GS)
SA5: Network Slicing Management
- TS 28.530: Management and orchestration, Concepts, use cases and requirements
- TS 28.531: Management and orchestration; Provisioning

Access & Transport Architecture
- SD-406: End-to-End Network Slicing
- Mobile Transport & Routing
  - SD.5GTransport / WT.5GTransport
- MTNSi: Mobile-Transport Network Slice instance Management Interface

Collaboration

Data, Control & Mgmt. plane
- Enhanced VPN Framework (VPN+)
  - draft-ietf-teas-enhanced-vpn (WG document)
- Service/Data Models
  - L3SM (RFC 8299) / L2SM (RFC 8466)
  - VN Model (WG document)
  - TE Service Mapping Model (WG document)
- SR for Enhanced VPN
  - draft-dong-spring-sr-for-enhanced-vpn
- Control Protocol Extensions
  - IGP: draft-dong-lsr-sr-enhanced-vpn
  - Other protocol extensions: in progress

IEEE
Ethernet Network
- Time Sensitive Network (TSN)
  - TSN Profile for service provider networks

ITU
SG-15
- GSTR-TN5G: Transport network support of IMT-2020/5G
- G.ctn5g: Characteristics of transport networks to support IMT-2020/5G
- G.mtn: Interfaces for a metro transport network

FlexE
- FlexE 1.0
- FlexE 2.0
Summary

• Transport network slicing is a key component in 5G end-to-end network slicing

• Architectural enhancements are needed to fully meet different levels of network slicing requirements

• SRv6 E2E and programmability make it suitable for network slicing
Thank you.

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