Carrying 5G Network Slice Identifiers in IP Headers Beyond the 3GPP-Managed Domain

draft-zdz-teas-5g-slice-ipextension-00

Authors: Cheng Zhou (China Mobile, **Presenter**)
Jie Dong (Huawei)
Guangyu Zhao (China Mobile)

July 22 , 2026

01 Problem Statement

5G E2E Slicing (3GPP Domain)

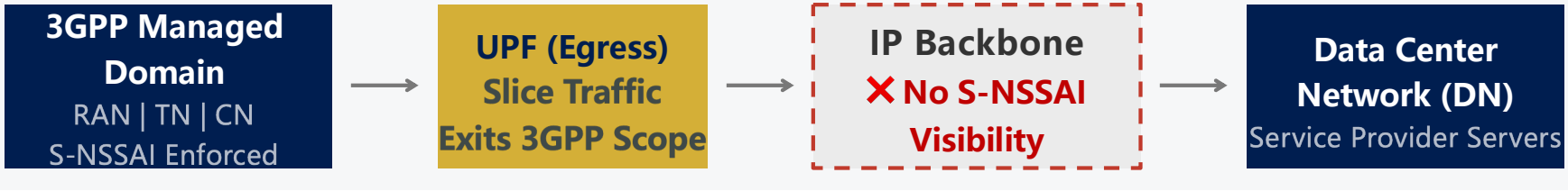
• Standardized by 3GPP across RAN, Transport (TN), and Core (CN), uniquely identified by **S-NSSAI** (8-bit SST + 24-bit SD).

• Mature slice-aware mechanisms exist within the 3GPP domain, supported by 3GPP and IETF standards (e.g., RFC 9543) for resource management.

The IP Backbone Visibility Gap

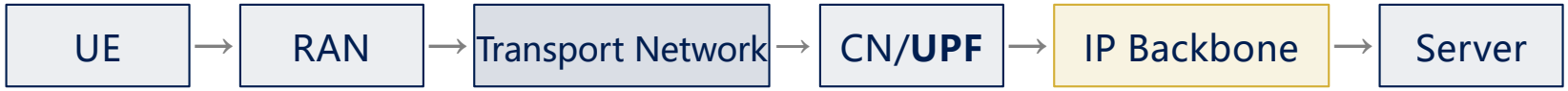
• Traffic exits the 3GPP domain via UPF and enters **IP backbones,** where S-NSSAI is **invisible** to standard routers.

• **Result:** The IP layer treats all 5G traffic uniformly, making per-slice QoS enforcement, bandwidth guarantees, and isolation impossible.



02 Relationship to Existing IETF Works

☐Complementary Network Segments



Existing IETF Scope: Transport network (RFC 9543, RFC 9889) using local identifiers.

This Draft's Scope: IP backbone network, extending slicing end-to-end with global S-NSSAI.

☐Key Distinctions: Scope & Identifier Models

Specification	Administrative Scope	Slice Identification Mechanism
RFC 9543	Provider-managed transport domain	Domain-local (VLAN, MPLS labels, SR SIDs)
TEAS 5G NS Drafts	3GPP-managed TN (network-local)	Network-local surrogates (PBR, VPNs)
This Draft	**IP Backbone (Inter-domain)**	**Global S-NSSAI in IP Header**

03 Solution - S-NSSAI in IP

1. Boundary Node Encoding

- **Uplink:** Ingress UPF embeds the session's S-NSSAI into IP headers before forwarding to the IP backbone.
- **Downlink:** Service Provider (SP) servers inject S-NSSAI (from subscription data) into downlink IP packets.

2. IPv6 Hop-by-Hop Format

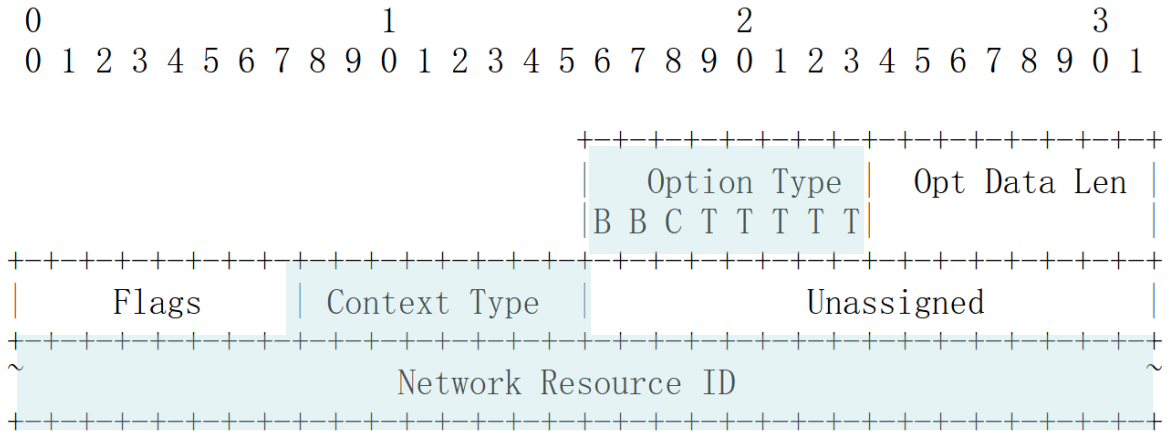
- **IPv6:** Uses the IPv6 Hop-by-Hop Options extension header to carry the full 32-bit S-NSSAI ("Slice ID Option");
- **Note:** IPv4 is explicitly out of scope since the IETF no longer develops new IPv4 extensions.

3. Slice-Aware QoS Assurance

- **IP backbone mgmt:** retrieves per-slice SLAs from the operator's BOSS/CSMF system.
- **Slice-aware nodes:** extract S-NSSAI to enforce policies (scheduling, shaping, TE), reusing mature IP QoS infrastructure.

04 Encoding in IPv6 Header

☐Leverage on-going works in IETF 6man WG



- *The encoding of the **Option Type** identifier follows the rules as specified in [RFC8200].*
- *The type of NR option is **TBA**.*

- Carried in the **IPv6 Hop-by-Hop Options header**
- Follow the format of Network Resource (NR) Option, defined in **draft-ietf-6man-enhanced-vpn-vtn-id**
- "**Context Type**" field to define a new type to indicate 5G Slice info
- " **Network Resource ID** " field **to carry detailed S-NSSAI ID**

05 Slice-Aware QoS Assurance Procedures

Control Plane Logic

1. SLA Parameter Ingestion
Retrieves per-slice SLAs (throughput, latency, jitter) from operator BOSS/CSMF.

2. Policy Compilation
Translates SLAs into actionable QoS policies indexed by S-NSSAI, defining forwarding classes and queue priorities.

3. Policy Distribution
Pushes policies to all Slice-Aware Nodes via NETCONF/YANG or RESTCONF interfaces for consistent enforcement.

Data Plane Operation

1. Packet Inspection
Checks for Slice ID Option in the IPv6 header to identify slice affiliation.

2. S-NSSAI Mapping
Extracts the 32-bit S-NSSAI value and performs a lookup in the local QoS policy table.

3. Forwarding Treatment
Applies queue selection, DSCP marking, and rate limiting. No match triggers default best-effort forwarding.

06 Deployment Considerations

- **Incremental Upgrade Feasibility:** Only backbone edge routers (UPF-facing & Service-facing border nodes) and interested intermediate nodes require upgrades to parse S-NSSAIs.
- **Leveraging DiffServ Infrastructure:** Slice-aware nodes can map S-NSSAI values directly to standard DSCP classes. Internal core nodes can then enforce QoS using standard DiffServ queues.
- **Extensibility to Enterprise and CDNs:** External networks like CDNs or enterprise data centers can inspect the IP header options to ensure internal end-to-end slice differentiation.

Summary & Next Steps

☐ Summary

- **Addressing the E2E Gap:** Proposes encoding 3GPP S-NSSAI directly into IPv6 extension headers to guarantee QoS over unmanaged IP backbones.
- **Seamless Interop:** Backward-compatible design that supports incremental deployment with minimal nodes configuration.

☐ Next Steps

- **WG Feedback:** Welcome review, comments, and discussion from the TEAS WG.
- **Cross-WG Collaboration:** Coordinate option specifications with **6man and v6ops** WGs to ensure alignment on IPv6 Hop-by-Hop options processing.