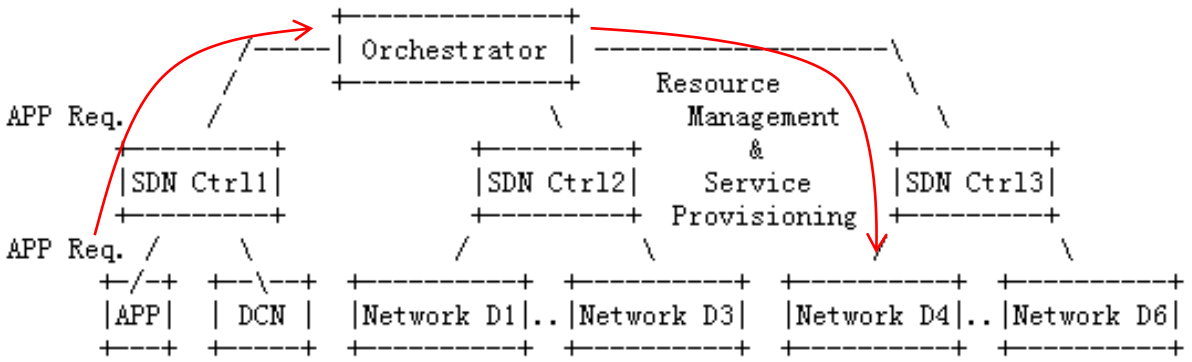
APN6: Application-aware IPv6 Networking

Motivations – Why APN6?

- The network operators need to be able to provide fine-granularity and even application-level SLA guarantee to achieve better Quality of Experience (QoE) for end users
  - 5G and verticals generates more and more applications with diverse network requirements
  - Revenue-producing apps: online gaming, live video streaming, enterprise video conferencing with much more demanding requirements
- Network operators are typically unaware of which applications are traversing their network, which is because network is decoupled from app
  - Not able to provide fine-granularity traffic operations for specific applications
  - Without corresponding revenue increases that might be enabled by differentiated service prov.
- **Adding application knowledge to the network layer** enables finer granularity requirements of applications to be specified to the network operator (even by app)
- As IPv6 is being widely deployed, the programmability provided by IPv6 encapsulations can be augmented by conveying app info

Challenges of Traditional Differentiated Service Provisioning

- The packets are not able to carry enough information for indicating applications and expressing their service/SLA requirements
- The network devices mainly rely on the 5-tuple of the packets or DPI
  - 5-tuples used for ACL/PBR matching of traffic
    - ✓ Indirect application information and not capable enough for new app identification
  - Deep Packet Inspection (DPI)
    - ✓ Introduces CAPEX and OPEX and Security/privacy issues
- SDN-based Solution
  - Orchestrator introduces application requirements so that the network is programmed accordingly
    - ✓ The loop is long not suitable for fast service provisioning for critical applications
    - ✓ Too many interfaces are involved in the loop introducing challenges of inter-operability



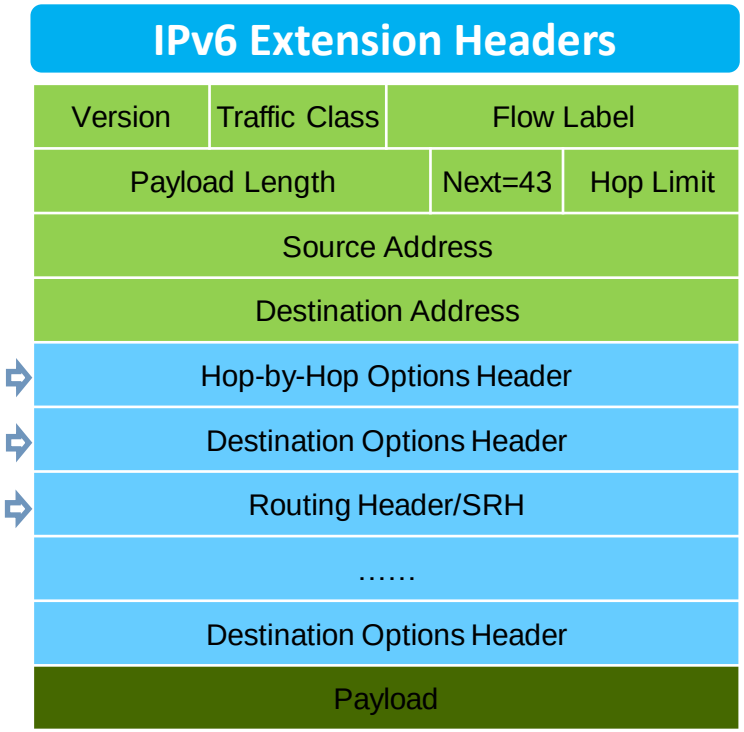
How APN can help?

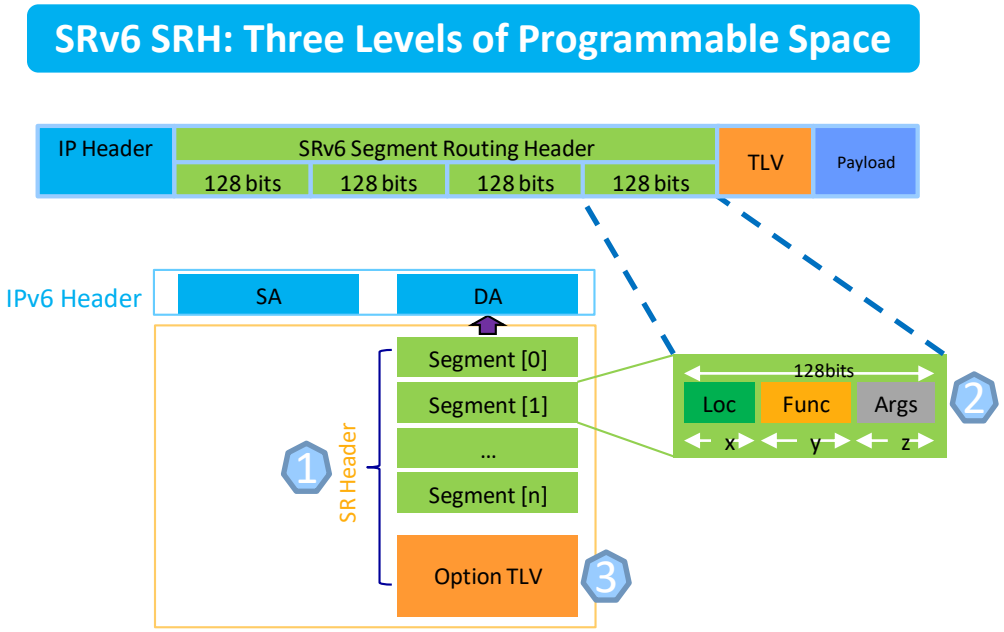
- APN6 aims to
  - satisfy the application-awareness/visibility requirements demanded by new services
  - provide differentiated service treatment and fine-grained traffic operations

- APN6 uses IPv6 network programmability to convey app info in the data plane allowing finer grained requirements from apps to be specified to the network

- APN6
  - conveys the application information into the network infrastructure
    - ✓ E.g. application identification, SLA/service requirements
  - allows the network to quickly adapt and perform the necessary actions for SLA guarantees
    - ✓ E.g. steer into an SRv6 path with SLA guarantee

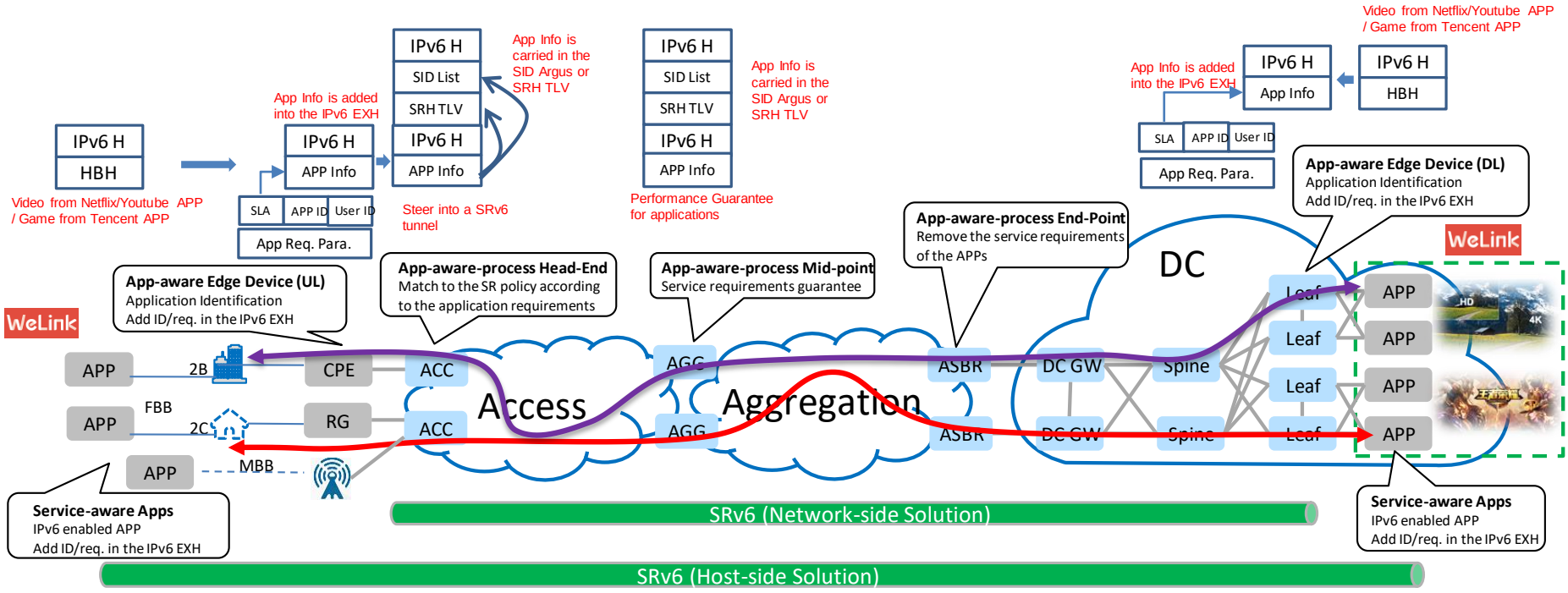
Foundations for APN6 - Future-proof Programmability





Application-aware IPv6 Networking (APN6)

- Make use of IPv6 extensions header to convey the service requirements along with the packet to the network
- To facilitate the service deployment and network resource adjustment to guarantee SLA for applications



App-aware IPv6 Networking (APN6) Framework

- APN6 is to make use of **IPv6 Extension Headers**
  - to convey the application related information including its requirements along with the packet to the network
  - to facilitate the service deployment and guarantee SLA

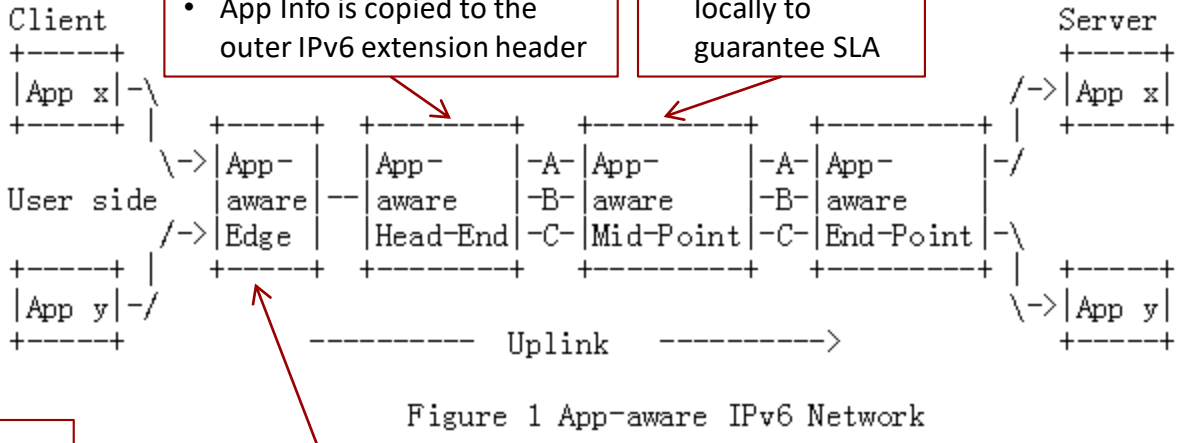


Figure 1 App-aware IPv6 Network

- According to the carried App Info, steer the packets into an existing path/policy, or trigger to set up new
- App Info is copied to the outer IPv6 extension header

- According to the carried App Info, adjust the resources locally to guarantee SLA

Optionally add the app information (ID, service requirements) in an IPv6 extension header

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- Derived from L2 QinQ Info

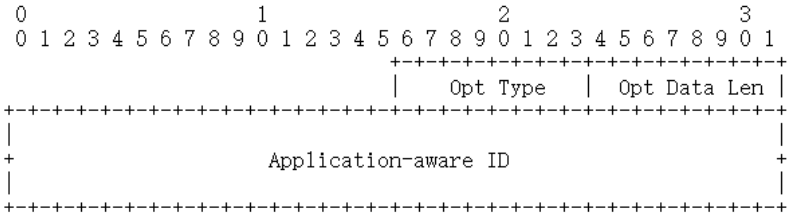
https://tools.ietf.org/html/draft-li-6man-app-aware-ipv6-network

Application-aware Options

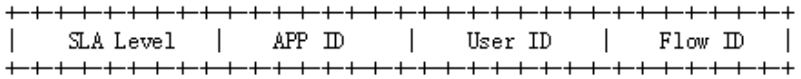
- **Application-aware ID option**
- **Service-Para Option**

Application-aware ID Option

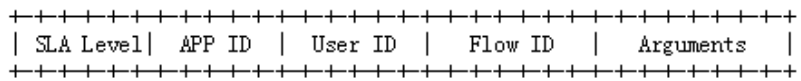
- **Carrying application ID, user ID, flow ID, and service requirements/SLAs**
- **The length of the APP-aware ID depends on the locations**
  - **128bits = IPv6 address = SRv6 SID = A address**



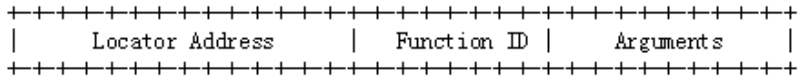
Structure I: Any combination of SLA level (e.g. Gold, Silver, Bronze), APP ID, and/or user ID, and/or Flow ID



Structure II: Any combination of SLA level (e.g. Gold, Silver, Bronze), APP ID, and/or user ID, and/or Flow ID, plus the arguments which indicating the service requirements of the identified application

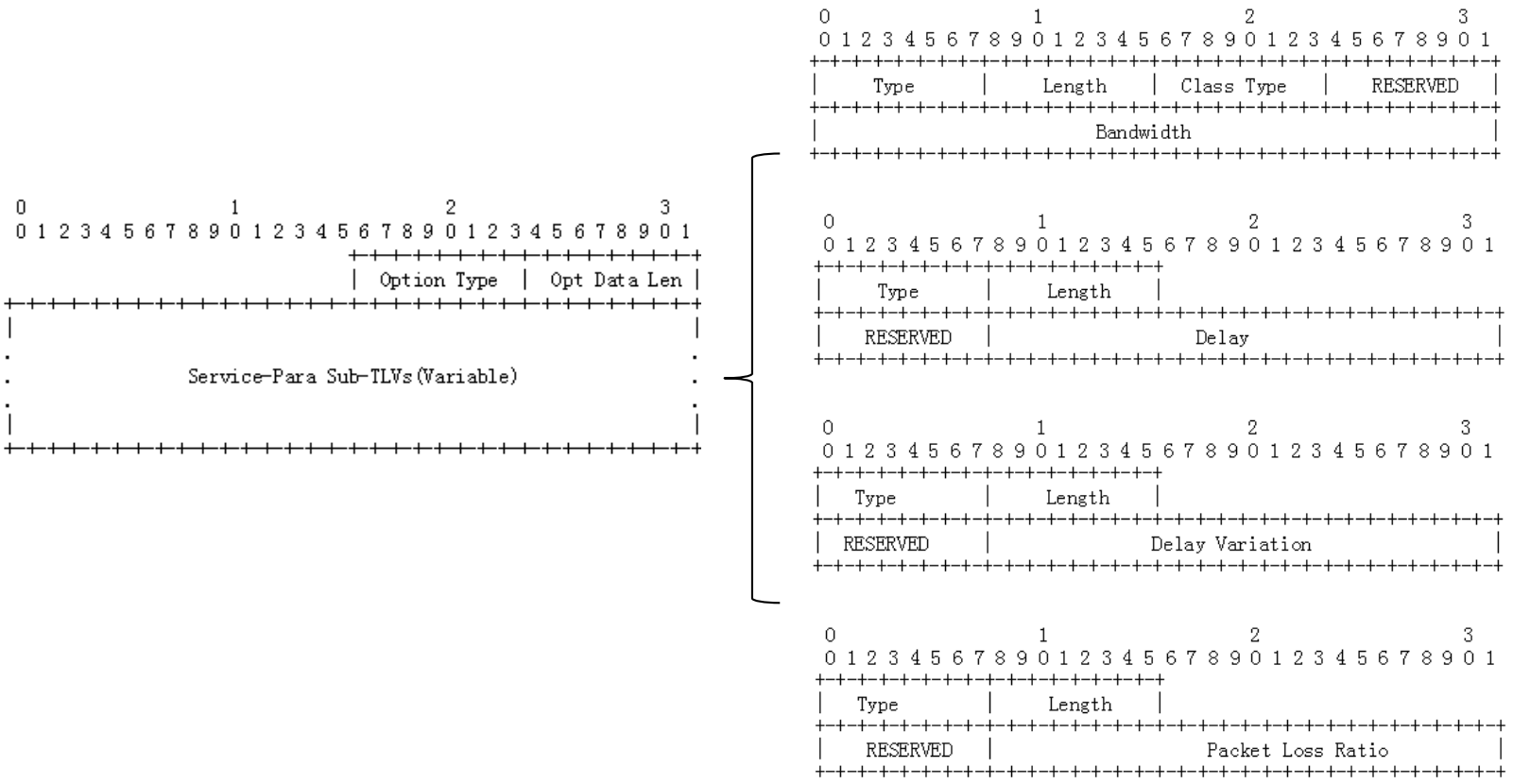


Structure III: An SRv6 SID, with its arguments as the information specified in Structure II

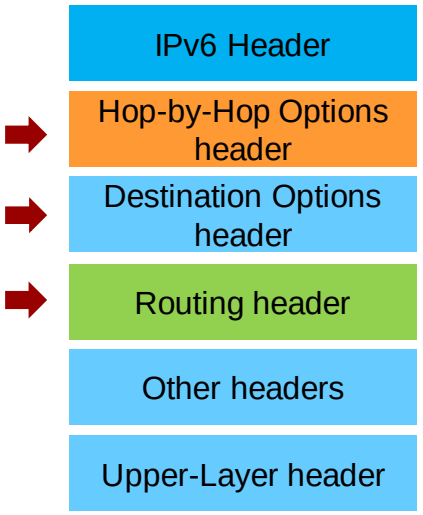


Service-Para Option

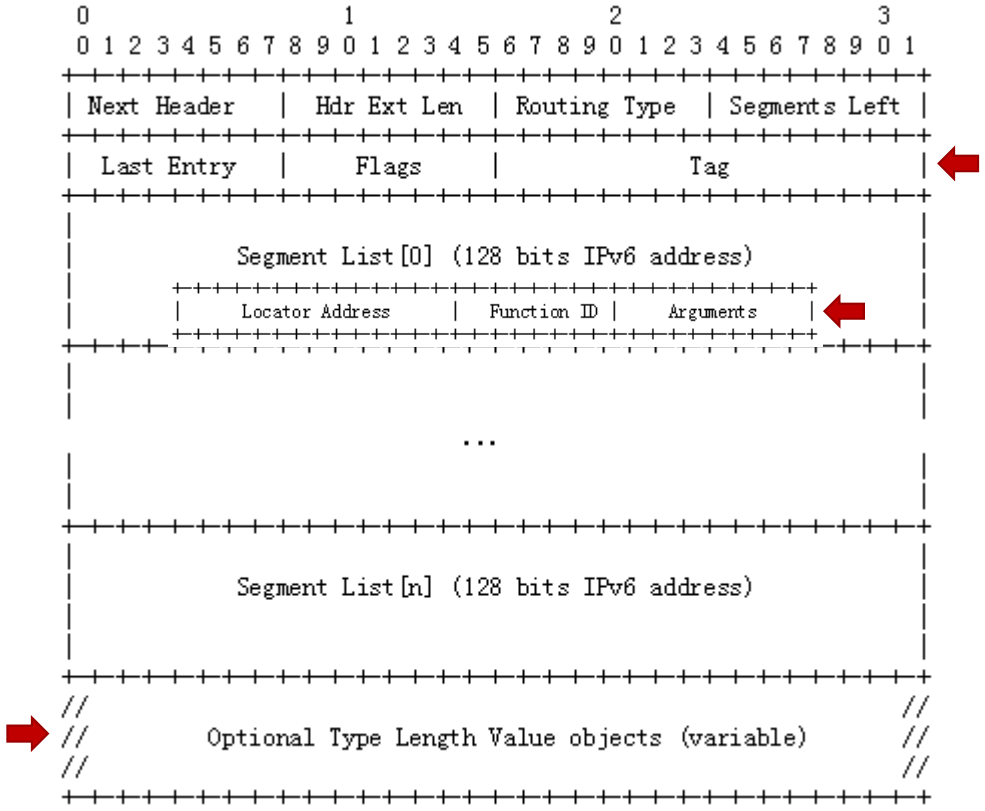
- **Carrying the service requirement parameter**



Locations for Application-aware Options

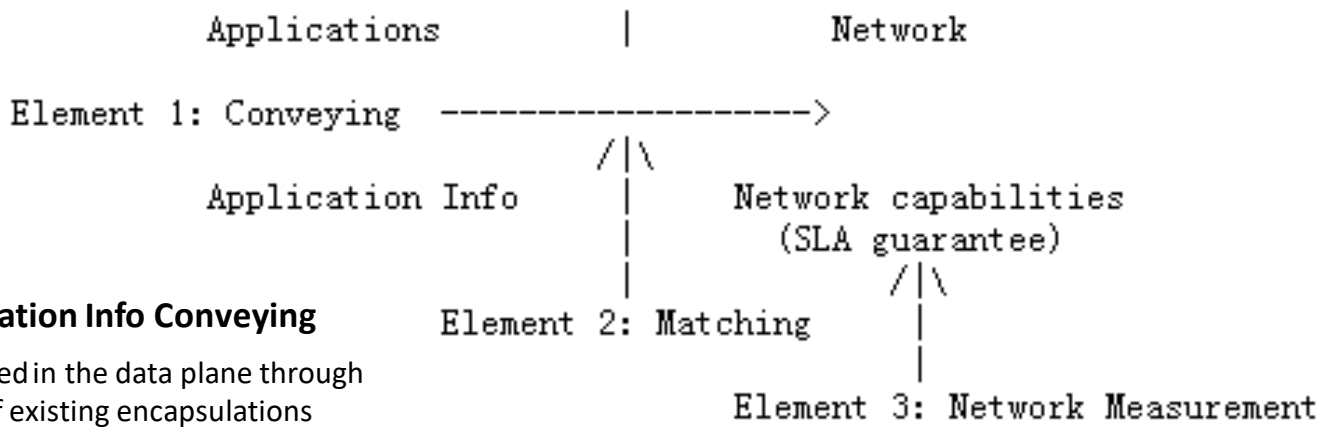


IPv6 Header [RFC8200]



draft-ietf-6man-segment-routing-header

APN6 Key Elements



Element 1: Application Info Conveying

- App info conveyed in the data plane through augmentation of existing encapsulations
- SHOULD NOT be enforced but provide an **open option** for app to decide whether to input this app info into its data stream

Element 2: App info and network capabilities matching

- Open the network capabilities to apps
- According to the app info, appropriate network services are selected, provisioned, and provided to the demanding applications to satisfy their performance requirements

Element 3: Network performance measurement

- According to the measurement to update the match between the app and corresponding network services for better fine-granularity SLA compliance

APN6 Use Cases

- The use cases that can benefit from the application awareness introduced by APN6
  - Application-aware SLA Guarantee
    - ✓ enable to provide differentiated services for various apps and increase revenue accordingly
    - ✓ enable network operators to provide fine-granularity SLA guarantees
  - Application-aware network slicing
    - ✓ have customized network transport to support some app's specific requirements, considering service and resource isolation
    - ✓ serve diverse services and fulfill various requirements of different apps at the same time, e.g. the mission critical app can be provisioned over a separate network slice
  - Application-aware Deterministic Networking
    - ✓ Match to a demanding app flow into a specific deterministic path
  - Application-aware Service Function Chaining
    - ✓ Match to an app flow into a specific SFC and subsequent steering without the need of DPIs
  - Application-aware Network Measurement

Security Considerations

- Since the application information is conveyed into the network, it does involve some security and privacy issues
- APN6 only provides the capability to the apps to provide their profiles and requirements to the network, but it leaves the apps to decide whether to put or not
  - If the applications decide not to provide any information, they will be treated in the same way as today's network and cannot get the benefits from APN6
- Once carried, the IPv6 extension headers, AH and ESP, can be used to guarantee the authenticity of the added application information
- An accurate valuation of security mechanism would be required in order to prevent any leak of critical information
  - Welcome to work together with us
- Some additional considerations may be required for multi-domain use cases.
  - For example, how to agree upon which application information/ID to use and guarantee authenticity for packets traveling through multiple domains (network operators)

The Value of APN6 are Widely Received by Industry

APN6 first presented @ IETF104

APN6 Side Meeting @ IETF105

- Attendee: 50+

Agenda

1. **Admin** (Chairs) [5 : 5/75]
2. **Problem Statement and Requirements** (Zhenbin Li) [10 : 15/75]
3. **Application-aware Information Conveying**
   a) Framework of App-aware IPv6 Networking (Shuping Peng) [10 : 25/75]
   b) Firewall and Service Tickets (Tom Herbert) [10 : 35/75]
   c) SRH Metadata for Simplified Firewall (Jim Guichard) [5 : 40/75]
4. **App-aware Services**
   a) IPv6-based DetNet (Yongqing Zhu) [5 : 45/75]
   b) SRv6 Path Segment (Fengwei Qin) [5 : 50/75]
   c) IPv6-based IFIT (In-situ Flow Information Telemetry) (Haoyu Song) [5 : 55/75]
5. **Shaping Our Discussion** (Chairs and Room) [15 : 70/75]
6. **Wrap Up** (Chairs) [5 : 75/75]

https://github.com/APN-Community

Next Step

- IETF BoF/Side Meeting

Gov	CAICT 中国信通院
Operators	Bell, Deutsche Telekom, SoftBank, KDDI, 中国移动 China Mobile, 中国电信 China Telecom
Vendors	CISCO, NOKIA, vmware
Research	The University of Auckland, 清華大學 Tsinghua University
OTT	Google, Tencent 腾讯
Verticals	CERNET, TOYOTA

Area	Topic	Draft	Authors
APN6	Problem statement and use cases	draft-li-apn6-problem-statement-usecases	HUAWEI, Bell, 中国电信 China Telecom, 中国移动 China Mobile, China unicom 中国联通, TOYOTA
	Application-aware IPv6 Networking	draft-li-apn6-app-aware-ipv6-network	
	APN use cases in EC	draft-liu-apn-edge-usecase	中国移动 China Mobile, HUAWEI
	APN use cases in Game Acceleration	draft-zhang-apn-game-acceleration-usecase	China unicom 中国联通, HUAWEI

Thank you!