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A Use Case for SCONE Implementation
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Abstract

This document describes 3GPP network elements that are capable of rate-limiting a UDP 4-tuple to communicate an upper bound on achievable bitrate termed "throughput advice" to implement SCONE protocol.

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Table of Contents

1. Introduction

This document describes utilizing the User Plane Function (UPF) in 5G networks and packet data network gateway in 4G networks (PDN-GW or P-GW and also referred as a PGW) to transport SCONE signal between the client-application endpoint on a User Equipment (UE) and the network element (UPF/PDN-GW) in the mobile networks. Specifically, this use case focuses on using UPF and PDN-GW to exchange bi-directional communications with client-application end-point on the UE. The mechanism described focuses on mobile networks including 4G and 5G but the mechanism is generic and applicable to other network architectures.

2. Conventions and Definitions

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

3. Overview of User Plane Network Element in Mobile Packet Core

This section describes 5G mobile packet core to explain the role of user-plane network element in mobile packet core and reasons why the 5G User Plane Function (UPF) and 4G P-GW as network elements can be considered candidates for signaling the "throughput advice" to client-application-endpoint. However, the applicability extends to network architectures beyond 4G/5G networks.

The user plane network element in the 5G packet core is the UPF, as shown in Figure 1. In the 4G packet core, the P-GW (as shown in Figure 2) performs the same role as the UPF does in the 5G mobile packet core.

The UPF is a fundamental component of the 3GPP’s 5G packet core network architecture. UPF is the data path between the end-user and the Internet, has access to subscriber policy via standard 3GPP interface and is responsible for routing and forwarding user data packets. UPF is the anchor point between the mobile infrastructure and the Packet Data Network. The UPF is responsible for functions such as:

* Packet routing, forwarding, and interconnection to the Data Network (Internet)

* Allocation of User Equipment (UE) IP Address/prefix, in conjunction with Session Management Function (SMF)

* Quality of Service policy enforcement

* Handling of traffic filtering, steering and application detection

* Traffic usage reporting

Note: This is not an exhaustive list of UPF functions. For details refer to [_5G-Arch].

To accomplish above mentioned functions, the UPF has four distinct reference points (interfaces) as defined by the 3GPP and as shown in the figure below:

```
               +-----+  Nudm/Nudr  +---------+
               | PCF +-------------+ UDM/UDR |
               +--+--+             +----+----+
                   |                    |
              Npcf |      +-----+       |Nudm
                   +------+ SMF +--------+
                          +--+--+      ___  __
                             | N4     (   )(  )
   +----+   +--------+    +--+--+    (         )    +------------------+
   | UE |---| gNodeB |----| UPF |----( Internet )---| Content Provider |
   +----+   +--------+ N3 +- -+-+ N6  (        )    +------------------+
                              | N9     (__(___)
                            +-+---+
                            | UPF |
                            +-----+
```

Figure 1: 5G Mobile Network Architecture

1. The N3 interface is between the UPF and the 5G Base station.

2. The N4 interface is a connection between the UPF and the Session Management Function (SMF).

3. The N6 interface is between the UPF and the public data network or the Internet.

4. The N9 interface is between instances of UPFs.

3.1. N3 Interface

The N3 interfaces transfers user plane traffic, that is, user data packets between the gNodeB and the UPF. It uses GPRS Tunneling Protocol - User Plane or GTP-U. It replaces the S1-U interfaces from the 4G mobile packet core.

3.2. N4 Interface

The N4 interface connects the UPF and the 5G Session Management Function (SMF). Through N4, the SMF informs the UPF about the subscriber policy and data plans. Additionally, this interface is used to manage session setup, modification, deletion, and for configuring forwarding rules for user data. The N4 interface among others uses Packet Forwarding Control Protocol (PFCP).

Note: SMF also interacts with Policy Control Function (PCF) for functions such as QoS and Charging policy rules, Unified Data Management (UDM) and Unified Data Repository (UDR) for functions such as subscription data and policy plans.

3.3. N6 Interface

The N6 interface connects the UPF to external Data Networks, similar to the SGi interface between the P-GW and the external Data Network for access to services and applications. The interface supports various trasnport protocols over IP.

3.4. N9 Interface

This interface interconnects two or more UPFs when used in a data path. The interface uses GTP-U protocol for user traffic tunneling including roaming.

Note: In the scenario of 2 or more UPFs in the data path, only one UPF that has access to subscriber policy would send "throughput advice" to the client-application-endpoint.

4. User Plane Interface Between UPF and UE

This section describes the N3 interface (between the UPF and gNodeB or gNB) and the air interface between the gNB and UE. For purposes of nomenclature, a Protocol Data Unit (PDU) session is a logical path between a UE and UPF to carry packets belonging to one or more IP flows between UE and DN. A PDU session within a 5G mobile network consists of an air-interface between UE and gNB and GTP-U tunnel between gNB and UPF (N3 interface). IP flows (aka service data flows or SDFs) may belong to one or more services. All the service data flows with the same QoS maps onto one PDU session. Below is an example of data flow to/from a UE to the UPF.

1. Uplink Data Flow

    * Apps that are hosted on UE that generate application packets for communication (e.g. web brownsing, video streaming).

    * These packets are transmitted to the gNB over the air interface.

    * N3 Encapsulation and Forwarding

        1. The gNB then encapsulates this user-plane data using GTP-U.

        2. It then forwards the encapsulated packets over the N3 interface to the UPF in the 5G mobile packet core.

    * UPF Routes Data to External Networks.

1. Within the UPF, UPF then removes the GTP-U header, processes the packet, and routes it over the N6 interface toward the destination (Internet, enterprise network, cloud services, etc.).

2. Downlink Data Flow

   * UPF receives incoming data in downlink direction at N6 interface (e.g. from the Internet).

   * The UPF encapsulates incoming data using GTP-U and sends it back over the N3 interface to the gNB.

   * The gNB forwards the packets to the UE over the air-interface. UE-side modem stack then transparently passes the application packets to the app hosted on the UE.

In summary, the UPF is responsible for packet routing and forwarding, packet inspection and filtering, subscriber policy enforcement, inline services (NAT, firewall, DNS etc) and QoS handling.

4.1. Significance of UPF from SCONE Perspective

The UPF is a data path mobile packet core network element that routes and forwards application packets between the gNodeB and the DN and it has access to subscriber policy via standard 3GPP N3 interface.

As a result, UPF is in the best position to send the throughput advice to client application over the data-path.

4.2. 4G Mobile Network Architecture

```
                    +-----+
                    | HSS |
                    +-----+
                       |
                    +-----+          +-------+
                    | MME |          | PCRF  |
                   /+-----+\         +-------+
                  /         \            |
                 /           \           |         ___  __
                /             \          |        /   )(  \
   +----+   +------+       +-------+  +-------+   (          )   +----------+
   | UE |---| eNB |--------| S-GW |--| P-GW |----( Internet )---| Content  |
   +----+   +------+   S1u +-------+  +-------+ SGi (        _)   | Provider |
                                                   (__(___)      +----------+
```

Figure 2: 4G Mobile Network Architecture

5. Implementing SCONE In the Mobile Network

As described in sections above, UPF is the 3GPP on-path "network element" that has access to subscriber policy and provides the data pipe connectivity between UE and the Internet. UPF is a network element that is capable of SCONE signaling over the data path.

Below is a high-level view of SCONE signal path in a 5G network. Please see [Mishra-2025] for a more complete version of this diagram.

```
                          +---------+
                          |   PCF   |
                          +---------+
                               | Subscriber
                               V Policy Rules
                          +---------+
                          |   SMF   |
                          +----+----+
                               | Subscriber
                               v Policy Rules
+--------+              + +---------+-+
| Client |/--------------\ |  SCONE  | |      __
|   App  |\--------------/ | Advisor | |    __(  )__
+--------+     SCONE      | +---------+ |   (        )   +----------+
|   OS   |  (advised bit |             +--( Internet )--+ Content  |
+--------+   rate and    |     UPF     |   (          )  | Provider |
|  Modem |   other IEs)  |             |    (__)(___)   +----------+
+----+---+               +------+------+
     |                          |
     |         +-----+          |
     +---------+ gNB +----------+
               +-----+
```

Figure 3: SCONE Integration with Video Policy in 5G SA N/W

Similarly, the SCONE signal for 4G network is shown below. Please see [Mishra-2025] for a more complete version of this diagram.

```
                             +---------+
                             |  PCRF   |
                             +----+----+
                                  | Subscriber
                                  v Policy Rules
   +--------+               + +---------+-+
   | Client |/--------------\ |  SCONE  | |       __
   |   App  |\--------------/ | Advisor | |    __(  )__
   +--------+     SCONE     | +---------+ |   (        )   +----------+
   |   OS   |  (advised bit |             +--( Internet )--+ Content  |
   +--------+   rate and    |     P-GW    |   (         )  | Provider |
   |  Modem |   other IEs)  |             |    (__)(___)   +----------+
   +----+---+               +------+------+
        |                          |
        |         +-----+       +--+---+
        +---------+ eNB +-------+ S-GW |
                  +-----+       +------+
```

Figure 4: SCONE Integration with Vido Policy in 4G N/W

6. SCONE Signal Requirements for the mobile networks

* SCONE protocol(s) MUST be client-application endpoint initiated to assist the network element with flow detection for any SCONE compliant

* application traffic.

* Client-application endpoint MAY send acknowledgement receipt of throughput advisory signal from the network element using the SCONE signal.

* SCONE signaling MUST NOT require changes to how a CSP determintes its video policy for a given flow. (No dependency between a CSP's video policy and the SCONE protocol).

* Dynamic update - "throughput advice" MAY change during the ongoing flow and UPF/PGW SHOULD be able to send "throughput advice" to client-application-endpoint as soon as possible.

* Applications MAY self-adapt the video flow max bit-rate to "throughput advice" value.

* SCONE signal MUST be extensible to networks beyond 4G/5G network.

7. Security Considerations

Security considerations are included separately in the SCONE protocol documents. Specific to the use case description in this document, there are no additional security considerations.

8. IANA Considerations

This document has no IANA actions.

9. References

9.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/rfc/rfc2119>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <https://www.rfc-editor.org/rfc/rfc8174>.

9.2. Informative References

[I-D.joras-scone-video-optimization-requirements]
Joras, M., Tomar, A., Tiwari, A., and A. Frindell, "SCONE Video Optimization Requirements", Work in Progress, Internet-Draft, draft-joras-scone-video-optimization-requirements-00, 4 November 2024, <https://datatracker.ietf.org/doc/html/draft-joras-scone-video-optimization-requirements-00>.

[Mishra-2025]
Mishra, S., "Leveraging the user plane function for network-side advisory signal", 6 February 2025, <https://datatracker.ietf.org/meeting/interim-2025-scone-01/materials/slides-interim-2025-scone-01-sessa-leveraging-the-user-plane-function-for-network-side-advisory-signal-00>.

[SCONE-Charter]
IETF, "SCONE Working Group Charter", 31 October 2024, <https://datatracker.ietf.org/wg/scone/about/>.

[_5G-Arch] 3GPP, "System architecture for the 5G System (5GS)", 7 January 2025, <https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3144>.

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