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Title: [FS\_AMD] WT#12: Candidate solutions for L4S-on-request

Agenda Item: 2.6

Source: Ericsson LM

Contact: Thorsten Lohmar

Abstract

Provide candidate solutions for L4S-on-request under WT#12.

Background and motivation

Working towards completion of the study item, two candidate solutions for L4S-on-request are provided.

Text proposal

The following text is proposed as a modification of TR 26.804 **CR0007**.

First change

#### 5.23.2.1 Collaboration scenarios for L4S ECN marking

Collaboration scenarios for L4S ECN marking are depicted below. Both the Media AS and the 5GMS Client make use of an L4S-enabled protocol stack. Figure 5.23.2.1-1 assumes that the Media AS resides within the external DN, while figure 5.23.2.1-2 assumes the Media AS within the Trusted DN.



Figure 5.23.2.1-1: Media AS in External DN



Figure 5.23.2.1-1: Media AS in Trusted DN

Next change

#### 5.23.4.3 L4S-on-request for downlink media streaming

An Application Function may request L4S support from the 5G Network for a certain QoS Flow, e.g. by invoking the Nnef\_AfsessionWithQoS service. The concept of this solution is that an application only requests L4S support from the network when the application layer provides support. The activation leverages the existing 5GMS Dynamic Policy invocation API, allowing the 5GMS-Aware Application to request L4S support as and when it is needed.

A high-level call flow for downlink media streaming is sketched in figure 5.23.4.3-1 below. The following is assumed:

- The service here is a unicast downlink media streaming service with dynamic policy support, as described in clause 5.7 of TS 26.501 [15].

- The Layer 4 protocol used for application flows is TCP and the TCP stack used supports L4S.

- The network supports L4S packet marking.

- The application has specifically requested ECN marking for its media delivery session.

- NG-RAN manipulaties the ECN bits (per clause 5.37.3.2 of TS 23.501 [23]). It is equally possible that the PSA-UPF manipulates the ECN bits (per clause 5.37.3.3 of [23]).

Figure 5.23.4.3-1: Downlink media streaming call flow for L4S on request

The steps are as follows:

0: *Policy Template Provisioning.* A Policy Template is provisioned **with the requirement for L4S capability indicated by setting a flag**.

1: *Dynamic Policy activation.* The Media Session Handler within the 5GMSd Client obtains Service Access Information and triggers a dynamic policy activation. A Policy Template Binding is present within the Service Access Information for each provisioned Policy Template. **Policy Template Bindings suitable for L4S are indicated by an L4S capability requirement flag being set. The 5GMSd Client detects that an L4S-capable media transport stack is present and in use. The selected Policy Template is one configured with L4S capability.**

2: *QoS request.* The 5GMSd AF requests QoS handling using e.g. the Nnef\_AfSessionWithQoS service or the Npcf\_PolicyAuthorization service. **If the L4S capability requirement flag is set in the selected Policy Template, this indicates that the new QoS flow is required to be L4S-enabled.** The new QoS flow with the L4S indication setting propagates through the 5G System.

3: **If the L4S capability requirement flag is set in the Policy Template Binding for the selected Policy Template, the 5GMSd Client selects/enables the L4S capability of the used transport protocol.**

NOTE: This step may happen implicitly by selecting an L4S-supporting transport protocol stack.

4: The Media Player within the 5GMSd Client triggeres the establishment of a TCP connection. The ECT(1) codepoint is set in the IP header, indicating an L4S-Capable Transport, and the SDAP entity ensures that the packet is forwarded via the matching QoS flow.

5: The 5GMSd AS responds to the TCP connection establishment request. The 5GMSd AS sets ECT(1) in the IP headers, indicating an L4S-Capable Transport.

6: The UPF finds the matching QoS flow identifier for the downlink packet and sends the packet via the according QoS flow to the UE. TCP Connection setup continues, with one ECT bit set in all packets.

7. When the RAN detects an upcoming congestion (based on continuous congestion monitoring), the 5G System sets the CE (Congestion Experienced) codepoint in the IP header of the downlink packet.

8. The TCP protocol stack used by the Media Player in the 5GMSd Client reflects the Early Congestion Notification to the TCP sender by setting the ECN-Echo (ECE) flag in the TCP header of an uplink PDU of the same TCP connnection. The TCP sender reacts to the ECN-Echo accordingly (i.e., by reducing its sending congestion window).

NOTE 1: The ECN-Echo flag is also acknowledged by the TCP sender setting the Congestion Window Reduced (CWR) flag in an outgong TCP frame, but this acknowledgement is not illustrated in this call flow.

NOTE 2: Classic ECN [X6] requires an ECN signal to be treated as equivalent to a packet drop. L4S [X1] specifies a more fine-grained response and an early congestion signal triggers a less severe reaction. How a TCP sender behaves “accordingly” is not in scope of the specification.

9. Based on the CE indication received in step 7, or by detecting a reduced bit rate in the downlink application flow, the Media Player in the 5GMSd Client reacts by, for example, changing the requested representation.

#### 5.23.4.4 L4S-on-request for uplink media streaming

Support for uplink media streaming is very similar to that for downlink media streaming.

A high-level call flow for uplink media streaming is sketched in figure 5.23.4.3-1 below. The following is assumed:

- The service here is a unicast uplink media streaming service with dynamic policy support, as described in clause 6.9 of TS 26.501 [15].

- The Layer 4 protocol used for application flows is TCP and the TCP stack used supports L4S.

- The network supports L4S packet marking.

- The application has specifically requested ECN marking for its media delivery session.

- NG-RAN manipulaties the ECN bits (per clause 5.37.3.2 of TS 23.501 [23]). It is equally possible that the PSA-UPF manipulates the ECN bits (per clause 5.37.3.3 of [23]).



Figure 5.23.4.4-1: Uplink media streaming call flow for L4S on request

The steps are as follows:

0: *Policy Template Provisioning.* A Policy Template is provisioned **with the requirement for L4S capability indicated by setting a flag**.

1: *Dynamic Policy activation.* The Media Session Handler within the 5GMSu Client obtains Service Access Information and triggers a dynamic policy activation. A Policy Template Binding is present within the Service Access Information for each provisioned Policy Template. **Policy Template Bindings suitable for L4S are indicated by an L4S capability requirement flag being set. The 5GMSu Client detects that an L4S-capable media transport stack is present and in use. The selected Policy Template is one configured with L4S capability.**

2: *QoS request.* The 5GMSu AF requests QoS handling using e.g. the Nnef\_AfSessionWithQoS service or the Npcf\_PolicyAuthorization service. **If the L4S capability requirement flag is set in the selected Policy Template, this indicates that the new QoS flow is required to be L4S-enabled.** The new QoS flow with the L4S indication setting propagates through the 5G System.

3: **If the L4S capability requirement flag is set in the Policy Template Binding for the selected Policy Template, the 5GMSu Client selects/enables the L4S capability of the used transport protocol.**

NOTE: This step may happen implicitly by selecting an L4S-supporting transport protocol stack.

4: The Media Streamer within the 5GMSu Client triggeres the establishment of a TCP connection. The ECT(1) codepoint is set in the IP header, indicating an L4S-Capable Transport, and the SDAP entity ensures that the packet is forwarded via the matching QoS flow.

5: The 5GMSu AS responds to the TCP connection establishment request. The 5GMSu AS sets ECT(1) in the IP headers, indicating an L4S-Capable Transport.

6: The UPF finds the matching QoS flow identifier for the downlink packet and sends the packet via the according QoS flow to the UE. TCP Connection setup continues, with one ECT bit set in all packets.

7. When the RAN detects an upcoming congestion (based on continuous congestion monitoring), the 5G System sets the CE (Congestion Experienced) codepoint in the IP header of the uplink packet.

8. The TCP protocol stack used by the 5GMSu AS reflects the Early Congestion Notification to the TCP sender by setting the ECN-Echo (ECE) flag in the TCP header of a downlink PDU of the same TCP connnection. The TCP sender reacts to the ECN-Echo accordingly (i.e., by reducing its sending congestion window).

NOTE 1: The ECN-Echo flag is also acknowledged by the TCP sender setting the Congestion Window Reduced (CWR) flag in an outgong TCP frame, but this acknowledgement is not illustrated in this call flow.

NOTE 2: Classic ECN [X6] requires an ECN signal to be treated as equivalent to a packet drop. L4S [X1] specifies a more fine-grained response and an early congestion signal triggers a less severe reaction. How a TCP sender behaves “accordingly” is not in scope of the specification.

9. Based on the CE indication received in step 7, or by detecting a reduced bit rate in the uplink application flow, the Media Streamer in the 5GMSu Client reacts by, for example, changing the requested representation.

Next change

#### 5.23.5.3 L4S-on-request for downlink and uplink media streaming

Based on the call flow in clause 5.23.4.3, the following observations are made:

- L4S/ECN does not require modifications to the Media Player or a TCP based Media Streamer.

- The 5GMS AF needs to explicitly request L4S handling of packets by the 5G System by interacting with the PCF at reference point N5 (or else via the NEF at reference poiont N33).

- The Policy Template resource structure at reference point M1 needs to be extended to include an L4S capability requirement flag.

- The Policy Template Binding data structure carried in the Service Access Information resource at reference point M5 needs to be extended to reflect the value of the L4S capability requirement flag in the corresponding Policy Template.

- An L4S-capable transport protocol stack is required in both the 5GMS Client and at the 5GMS AS.

NOTE: When the transport protocol stack used on the UE or the Application Server does not support ECN marking, the ECT flags are set accordingly to explicitly indicate lack of support.

- Depending on the transport stack implementation, an explicit L4S activation is required at session start.

Next change

#### 5.23.6.3 L4S-on-request for downlink and uplink media streaming

Provisioning information is provided by the 5GMS Application Provider at reference point M1 to declare that a Policy Template requires L4S support. The Policy Template structure is enhanced to offer a L4S enablement flag. This flag is also exposed to the Media Session Handler in the Policy Template binding exposed in Service Access Information.

In this candidate solution, two Policy Templates may be provisioned by the 5GMS Application Provider, one with L4S enabled and one without. The Media Session Handler in the 5GMS Client then instantiates the appropriate Policy Template depending on its requirements.

When the L4S flag is set in the instantiated Policy Template, the 5GMS AF requests L4S handling by the 5G System and the 5G System assumes that the traffic is L4S enabled.

End of changes