**3GPP TSG-SA WG4 Meeting #130 S4-242120**

**Orlando, USA, 18th – 22nd Nov 2024**

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| *CR-Form-v12.0* | | | | | | | | |
| **TEXT PROPOSAL** | | | | | | | | |
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|  | **CR0007** | **CR** |  | **rev** |  | **Current version:** | **18.1.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network |  | Core Network | **X** |

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| ***Title:*** | **[FS\_AMD] WT#12 pCR on M11 API extensions to signal L4S usage** | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Qualcomm | | | | | | | | | |
| ***Source to TSG:*** | S4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | FS\_AMD | | | | |  | ***Date:*** | | | 2024-09-25 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-19 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-10 (Release 10) Rel-11 (Release 11) Rel-12 (Release 12)* *Rel-13 (Release 13) Rel-14 (Release 14) Rel-15 (Release 15) Rel-16 (Release 16)*  *Rel-17 (Release 17)*  *Rel-18 (Release 18)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | As agreed in SP-240514, how to improve the QoS support for Media Streaming services based on the QoS enhancements and the network information exposure is to be studied. Therefore, this paper proposes the Key Issue of "Improved QoS support for Media Streaming services". | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Proposal of KI#X: Improved QoS support for Media Streaming services. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | SI cannot be completed. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 2, 3.3, 5.23(new) | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | | S4-240638, S4-240806, S4-240971, S4-241229, S4-241521  SA4#129e: S4-241748 merges S4-241746.  SA4-e (AH) MBS SWG post 129e: Provide a clean version of new clauses as basis for future work.  Merge S4aI240187.  Merge S4aI240200. | | | | | | | | |

QoS enhancements and network information exposure in 5GS

#### 5.23.1.2.4 Existing APIs for Application Access to L4S

Currently, only Apple platforms have functionality that allows access to ECN status through IP packet metadata [4]. With the proliferation of L4S, it is expected that more APIs will be introduced to enable this access.

The following example shows how this access can be achieved:

|  |
| --- |
| import Network  class ECNMonitor {      var connection: NWConnection?        func setupConnection(to endpoint: NWEndpoint) {          // Create connection parameters          let parameters = NWParameters()          parameters.allowLocalEndpointReuse = true            // Enable IP metadata for ECN access          parameters.requireIPMetadata = true            // Create the connection          connection = NWConnection(to: endpoint, using: parameters)            // Set up receive handler          connection?.receiveMessage { [weak self] content, context, isComplete, error in              if let context = context {                  // Get IP metadata from context                  let metadata = context.protocolMetadata.first { $0 is NWProtocolIP.Metadata } as? NWProtocolIP.Metadata                    if let metadata = metadata {                      // Access ECN flags using nw\_ip\_metadata\_get\_ecn\_flag                      let ecnFlag = nw\_ip\_metadata\_get\_ecn\_flag(metadata)                        // Interpret ECN flags                      switch ecnFlag {                      case 0:  // Non-ECT                          print("Packet is Not-ECN-Capable Transport (Non-ECT)")                      case 1:  // ECT(1)                          print("Packet is ECN Capable Transport (1)")                      case 2:  // ECT(0)                          print("Packet is ECN Capable Transport (0)")                      case 3:  // CE                          print("Packet has Congestion Experienced (CE)")                      default:                          print("Unknown ECN flag value")                      }                  }              }                // Continue receiving              …          }            // Start the connection          connection?.start(queue: .main)      }  …  } |

This API allows applications to:

1. Enable ECN metadata access through connection parameters.
2. Access raw ECN flags from each received packet.
3. Distinguish between all ECN codepoints (Non-ECT, ECT(0), ECT(1), and CE).

The ECN flags follow the standard encoding defined in RFC 3168:

- 00: Not-ECN-Capable Transport (Non-ECT)

- 10: ECN Capable Transport (0)

- 01: ECN Capable Transport (1)

- 11: Congestion Experienced (CE)

For L4S deployment in media delivery, applications can use this API to implement appropriate congestion control responses to ECN marks.

Call flows

#### 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. The Media Session Handler may inform the 5GMSd-Aware Application about the activation of L4S via the media session handling client API at reference point M11.**

4. **Subject to availability of API access**, the Media Player may use congestion notifications to perform early adaptation.

5: **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.

6: 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.

7: 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.

8: 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.

9. 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.

10. 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.

11. 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.

Gap analysis and requirements

#### 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.

- A new or modified notification is required at reference point M11 to enable the Media Session Handler to announce the value of the L4S capability requirement flag to the Media Player when a Dynamic Policy is instantiated.

- 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.

Candidate solutions

#### 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.

The Media Session Handler announces to the Media Player the use of L4S in the Dynamic Policy by means of a new asynchronous notification at reference point M11.

Sumary and conclusions

### 5.23.7 Summary and conclusions

Editor’s Note: Imed or Qi to add some bullets covering the additional M11 notification.

\* \* \* \* End of changes \* \* \* \*