**3GPP SA WG2 Meeting #164 *S2-240xxxx***

**Hyderabad, IN, 14-18 October 2024 *(was S2-2409165 was S2-2408824 was S2-2407563)***

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| *CR-Form-v12.3* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **501** | **CR** | **5422** | **rev** | **3** | **Current version:** |  |  |
|  | | | | | | | | |
| *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 | **x** | Radio Access Network | **X** | Core Network | **x** |

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|  | | | | | | | | | | |
| ***Title:*** | XRM\_Ph2 KI#6 L4S support in non-3GPP access | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Charter Communications, CableLabs, Tencent?, Tencent Cloud?, Nokia?, Samsung? | | | | | | | | | |
| ***Source to TSG:*** | SA2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | XRM\_Ph2 | | | | |  | ***Date:*** | | | 2024-08-23 |
|  |  | | | |  | |  | | |  |
| ***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-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)  Rel-20 (Release 20)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | The following R19 TR23700-70 conclusions for Key Issue #6 (i.e., clause 8.6) were agreed as principles for normative work:   1. Dedicated 5G QoS Flow(s) and non-3GPP access resources (e.g. IPsec Child SAs) are used for carrying L4S enabled IP traffic. 2. For wireline access:    1. ECN marking for L4S is supported in W-AGF. It is controlled via N2 signalling (Indication of ECN marking for L4S for a corresponding QoS Flow(s)) and applies to proper mapping between L4S-enabled QoS profile(s) and L4S-enabled W-UP resource(s).    2. ECN marking for L4S is supported in 5G-RG in UL. It is controlled via N1 signalling (Indication of ECN marking for L4S for a corresponding QoS Flow(s)) and applies to proper mapping between L4S-enabled QoS rule(s) and L4S-enabled W-UP resource(s). 3. For untrusted/trusted access:    1. ECN marking for L4S is supported in N3IWF/TNGF. It is controlled via N2 signalling (Indication of ECN marking for L4S for a corresponding QoS Flow(s)) and applies to proper mapping between L4S-enabled QoS profile(s) and L4S-enabled IPsec Child SAs.    2. N3IWF/TNGF in UL shall support and UE in DL can support the IP-in-IP tunnel behaviour of copying ECN bits between outer and inner headers as per IETF RFC 6040 [47].   NOTE: To support this functionality, the UE needs to support UL L4S feedback as described in IETF RFC 9330 [14] which is not in the scope of 3GPP. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Introduction of L4S functionality on non-3GPP access resources, according to KI#6 conclusion in TR23.700-70 clause 8.6 | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | New feature not implemented in the specification. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 2, 5.8.2.7, 5.8.5.4, 5.37.3.1, 5.37.3.x, 6.2.9, and 6.2.9A | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **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:*** | |  | | | | | | | | |

\* \* \* \* First change \* \* \* \*

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 22.261: "Service requirements for next generation new services and markets; Stage 1".

[3] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[4] 3GPP TS 23.203: "Policies and Charging control architecture; Stage 2".

[5] 3GPP TS 23.040: "Technical realization of the Short Message Service (SMS); Stage 2".

[6] 3GPP TS 24.011: "Point-to-Point (PP) Short Message Service (SMS) support on mobile radio interface: Stage 3".

[7] IETF RFC 7157: "IPv6 Multihoming without Network Address Translation".

[8] IETF RFC 4191: "Default Router Preferences and More-Specific Routes".

[9] IETF RFC 2131: "Dynamic Host Configuration Protocol".

[10] IETF RFC 4862: "IPv6 Stateless Address Autoconfiguration".

[11] ITU‑T Recommendation I.130: "Method for the characterization of telecommunication services supported by an ISDN and network capabilities of an ISDN".

[12] ITU‑T Recommendation Q.65: "The unified functional methodology for the characterization of services and network capabilities".

[13] 3GPP TS 24.301: "Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS): Stage 3".

[14] Void.

[15] 3GPP TS 23.228: "IP Multimedia Subsystem (IMS); Stage 2".

[16] 3GPP TS 22.173: "IMS Multimedia Telephony Service and supplementary services; Stage 1".

[17] 3GPP TS 23.122: "Non-Access-Stratum (NAS) functions related to Mobile Station in idle mode".

[18] 3GPP TS 23.167: "3rd Generation Partnership Project; Technical Specification Group Services and Systems Aspects; IP Multimedia Subsystem (IMS) emergency sessions".

[19] 3GPP TS 23.003: "Numbering, Addressing and Identification".

[20] IETF RFC 7542: "The Network Access Identifier".

[21] 3GPP TS 23.002: "Network Architecture".

[22] 3GPP TS 23.335: "User Data Convergence (UDC); Technical realization and information flows; Stage 2".

[23] 3GPP TS 23.221: "Architectural requirements".

[24] 3GPP TS 22.153: "Multimedia priority service".

[25] 3GPP TS 22.011: "Service Accessibility".

[26] 3GPP TS 23.401: "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".

[27] 3GPP TS 38.300: "NR; NR and NG-RAN Overall Description".

[28] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol Specification".

[29] 3GPP TS 33.501: "Security architecture and procedures for 5G system".

[30] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".

[31] 3GPP TS 37.340: "Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multi-connectivity; Stage 2".

[32] 3GPP TS 23.214: "Architecture enhancements for control and user plane separation of EPC nodes; Stage 2".

[33] 3GPP TS 22.101: "3rd Generation Partnership Project; Technical Specification Group Services and Systems Aspects; Service aspects; Service principles".

[34] 3GPP TS 38.413: "NG-RAN; NG Application Protocol (NGAP)".

[35] 3GPP TS 33.126: "Lawful Interception Requirements".

[36] 3GPP TS 23.682: "Architecture enhancements to facilitate communications with packet data networks and applications".

[37] 3GPP TS 22.280: "Mission Critical Services Common Requirements (MCCoRe); Stage 1".

[38] 3GPP TS 23.379: "Functional architecture and information flows to support Mission Critical Push To Talk (MCPTT); Stage 2".

[39] 3GPP TS 23.281: "Functional architecture and information flows to support Mission Critical Video (MCVideo); Stage 2".

[40] 3GPP TS 23.282: "Functional architecture and information flows to support Mission Critical Data (MCData); Stage 2".

[41] 3GPP TS 32.240: "Charging management; Charging architecture and principles".

[42] 3GPP TS 38.401: "NG-RAN Architecture description".

[43] 3GPP TS 23.402: "Architecture enhancements for non-3GPP accesses".

[44] IETF RFC 4960: "Stream Control Transmission Protocol".

[45] 3GPP TS 23.503: "Policy and Charging Control Framework for the 5G System".

[46] 3GPP TS 23.041: "Public Warning System".

[47] 3GPP TS 24.501: "Non-Access-Stratum (NAS) protocol for 5G System (5GS); Stage 3".

[48] 3GPP TS 24.502: "Access to the 5G System (5GS) via non-3GPP access networks; Stage 3".

[49] 3GPP TS 29.500: "5G System; Technical Realization of Service Based Architecture; Stage 3".

[50] 3GPP TS 38.304: "NR; User Equipment (UE) procedures in idle mode".

[51] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[52] 3GPP TS 36.304: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode".

[53] Void.

[54] IETF RFC 4861: "Neighbor Discovery for IP version 6 (IPv6)".

[55] 3GPP TS 23.271: "Functional stage 2 description of Location Services (LCS)".

[56] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".

[57] IETF RFC 4555: "IKEv2 Mobility and Multihoming Protocol (MOBIKE)".

[58] 3GPP TS 29.510: "5G System: Network function repository services; Stage 3".

[59] 3GPP TS 29.502: "5G System: Session Management Services: Stage 3".

[60] IETF RFC 7296: "Internet Key Exchange Protocol Version 2 (IKEv2) ".

[61] 3GPP TS 23.380: "IMS Restoration Procedures".

[62] 3GPP TS 24.229: "IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3".

[63] 3GPP TS 23.292: "IP Multimedia Subsystem (IMS) centralized services; Stage 2".

[64] 3GPP TS 23.222: "Functional architecture and information flows to support Common API Framework for 3GPP Northbound APIs".

[65] 3GPP TS 29.244: "Interface between the Control Plane and the User Plane Nodes; Stage 3".

[66] 3GPP TS 32.421: "Telecommunication management; Subscriber and equipment trace; Trace concepts and requirements".

[67] 3GPP TS 32.290: "5G system; Services, operations and procedures of charging using Service Based Interface (SBI)".

[68] 3GPP TS 32.255: "5G Data connectivity domain charging; Stage 2".

[69] 3GPP TS 38.306: "NR; User Equipment -UE) radio access capabilities".

[70] 3GPP TS 36.306: "Evolved Universal Terrestrial Radio Access -E-UTRA); User Equipment -UE) radio access capabilities".

[71] 3GPP TS 29.518: "5G System; Access and Mobility Management Services; Stage 3".

[72] Void.

[73] IETF RFC 2865: "Remote Authentication Dial In User Service (RADIUS)".

[74] IETF RFC 3162: "RADIUS and IPv6".

[75] 3GPP TS 29.281: "General Packet Radio System (GPRS) Tunnelling Protocol User Plane (GTPv1-U)".

[76] 3GPP TS 26.238: "Uplink streaming".

[77] 3GPP TR 26.939: "Guidelines on the Framework for Live Uplink Streaming (FLUS)".

[78] International Telecommunication Union (ITU), Standardization Bureau (TSB): "Operational Bulletin No. 1156"; http://handle.itu.int/11.1002/pub/810cad63-en (retrieved October 5, 2018).

[79] 3GPP TS 28.533: "Management and orchestration; Architecture framework".

[80] 3GPP TS 24.250: "Protocol for Reliable Data Service; Stage 3".

[81] IETF RFC 8684: "TCP Extensions for Multipath Operation with Multiple Addresses".

[82] IETF RFC 8803: "0-RTT TCP Convert Protocol".

[83] IEEE Std 802.1CB-2017: "IEEE Standard for Local and metropolitan area networks-Frame Replication and Elimination for Reliability".

[84] 3GPP TS 23.316: "Wireless and wireline convergence access support for the 5G System (5GS)".

[85] WiFi Alliance Technical Committee, Hotspot 2.0 Technical Task Group: "Hotspot 2.0 (Release 2) Technical Specification".

[86] 3GPP TS 23.288: "Architecture enhancements for 5G System (5GS) to support network data analytics services".

[87] 3GPP TS 23.273: "5G System (5GS) Location Services (LCS); Stage 2".

[88] 3GPP TS 23.216: "Single Radio Voice Call Continuity (SRVCC); Stage 2".

[89] CableLabs DOCSIS MULPI: "Data-Over-Cable Service Interface Specifications DOCSIS 3.1, MAC and Upper Layer Protocols Interface Specification".

[90] BBF TR-124 issue 5: "Functional Requirements for Broadband Residential Gateway Devices".

[91] BBF TR-101 issue 2: "Migration to Ethernet-Based Broadband Aggregation".

[92] BBF TR-178 issue 1: "Multi-service Broadband Network Architecture and Nodal Requirements".

[93] BBF TR-456 issue 2: "AGF Functional Requirements".

[94] BBF WT-457: "FMIF Functional Requirements".

Editor's note: The reference to BBF WT-457 will be revised when finalized by BBF.

[95] Void.

[96] Void.

[97] IEEE Std 802.1AB-2016: "IEEE Standard for Local and metropolitan area networks -- Station and Media Access Control Connectivity Discovery".

[98] IEEE Std 802.1Q-2022: "IEEE Standard for Local and metropolitan area networks--Bridges and Bridged Networks".

[99] 3GPP TS 38.423: "NG-RAN; Xn Application Protocol (XnAP)".

[100] 3GPP TS 36.413: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP)".

[101] 3GPP TS 29.274: "Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C); Stage 3".

[102] 3GPP TS 23.632: "User Data Interworking, Coexistence and Migration; stage 2".

[103] 3GPP TS 29.563: "5G System (5GS); HSS services for interworking with UDM; Stage 3".

[104] IEEE Std 802.1AS-2020: "IEEE Standard for Local and metropolitan area networks--Timing and Synchronization for Time-Sensitive Applications".

[105] 3GPP TS 22.104: "Service requirements for cyber-physical control applications in vertical domains".

[106] IEEE Std 802.11-2012: "IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

[107] IEEE Std 1588-2008: "IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems".

[108] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".

[109] 3GPP TS 24.193: "Access Traffic Steering, Switching and Splitting; Stage 3".

[110] 3GPP TS 24.526: "User Equipment (UE) policies for 5G System (5GS); Stage 3".

[111] 3GPP TS 22.186: "Enhancement of 3GPP support for V2X scenarios; Stage 1".

[112] 3GPP TR 38.824: "Study on physical layer enhancements for NR ultra-reliable and low latency case (URLLC)".

[113] IEEE: "Guidelines for Use of Extended Unique Identifier (EUI), Organizationally Unique Identifier (OUI), and Company ID (CID)", https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/tutorials/eui.pdf.

[114] 3GPP TS 32.256: "Charging Management; 5G connection and mobility domain charging; Stage 2".

[115] 3GPP TS 33.210: "Network Domain Security (NDS); IP network layer security".

[116] 3GPP TS 38.415: "PDU Session User Plane Protocol".

[117] 3GPP TS 24.535: "Device-side Time-Sensitive Networking (TSN) Translator (DS-TT) to network-side TSN Translator (NW-TT) protocol aspects; Stage 3".

[118] 3GPP TS 32.274: "Charging Management; Short Message Service (SMS) charging".

[119] 3GPP TS 23.008: "Organization of subscriber data".

[120] 3GPP TS 38.314: "NR; Layer 2 measurements".

[121] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

[122] 3GPP TS 29.503: "5G System; Unified Data Management Services; Stage 3".

[123] 3GPP TS 32.254: "Charging management; Exposure function Northbound Application Program Interfaces (APIs) charging".

[124] 3GPP TS 33.535: "Authentication and Key Management for Applications based on 3GPP credentials in the 5G System (5GS)".

[125] 3GPP TS 38.410: "NG-RAN; NG general aspects and principles".

[126] IEEE Std 1588: "IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems", Edition 2019.

[127] ST 2059-2:2015: "SMPTE Standard - SMPTE Profile for Use of IEEE-1588 Precision Time Protocol in Professional Broadcast Applications".

[128] 3GPP TS 23.304: "Proximity based Services (ProSe) in the 5G System (5GS)".

[129] 3GPP TS 23.247: "Architectural enhancements for 5G multicast-broadcast services".

[130] 3GPP TS 23.548: "5G System Enhancements for Edge Computing; Stage 2".

[131] IEEE Std 802.3: "Ethernet".

[132] 3GPP TS 29.561: "5G System; Interworking between 5G Network and external Data Networks; Stage 3".

[133] 3GPP TS 29.513: "Policy and Charging Control signalling flows and QoS parameter mapping; Stage 3".

[134] 3GPP TS 23.558: "Architecture for enabling Edge Applications (EA)".

[135] 3GPP TS 26.501: "5G Media Streaming (5GMS); General description and architecture".

[136] 3GPP TS 23.256: "Support of Uncrewed Aerial Systems (UAS) connectivity, identification and tracking; Stage 2".

[137] GSMA NG.116: "Generic Network Slice Template".

[138] IETF RFC 3948: "UDP Encapsulation of IPsec ESP Packets".

[139] 3GPP TS 24.539: "5G System (5GS); Network to TSN translator (TT) protocol aspects; Stage 3".

[140] 3GPP TS 33.220: "Generic Authentication Architecture (GAA); Generic bootstrapping architecture".

[141] 3GPP TS 33.223: "Generic Authentication Architecture (GAA); Generic Bootstrapping Architecture (GBA) Push function".

[142] 3GPP TS 23.540: "Technical realization of Service Based Short Message Service; Stage 2".

[143] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".

[144] 3GPP TS 29.525: "5G System; UE Policy Control Service; Stage 3".

[145] 3GPP TS 29.505: "5G System; Usage of the Unified Data Repository Services for Subscription Data; Stage 3".

[146] IEEE Std 802.1Qdj-2024: "IEEE Draft Standard for Local and metropolitan area networks - Bridges and Bridged Networks - Amendment XX: Configuration Enhancements for Time-Sensitive Networking".

[147] Void.

[148] 3GPP TS 28.557: "Management and orchestration; Management of Non-Public Networks (NPN)".

[149] 3GPP TS 28.541: "Management and orchestration; 5G Network Resource Model (NRM)".

[150] IETF RFC 8655: "Deterministic Networking Architecture".

[151] IETF RFC 8343: "A YANG Data Model for Interface Management".

[152] IETF RFC 8344: "A YANG Data Model for IP Management".

[153] IETF RFC 7224: " IANA Interface Type YANG Module".

[154] IETF draft-ietf-detnet-yang: "Deterministic Networking (DetNet) YANG Model".

Editor's note: The reference to draft-ietf-detnet-yang will be revised to RFC when finalized by IETF.

[155] IETF RFC 6241: "Network Configuration Protocol (NETCONF)".

[156] IETF RFC 8040: "RESTCONF Protocol".

[157] IETF RFC 8939: "Deterministic Networking (DetNet) Data Plane: IP".

[158] IETF RFC 5279: "A Uniform Resource Name (URN) Namespace for the 3rd Generation Partnership Project (3GPP)".

[159] IETF RFC 9330:"Low Latency, Low Loss, Scalable Throughput (L4S) Internet Service: Architecture".

[160] IETF RFC 9331: "Explicit Congestion Notification (ECN) Protocol for Very Low Queuing Delay (L4S)".

[161] IETF RFC 9332: "Dual-Queue Coupled Active Queue Management (AQM) for Low Latency, Low Loss, and Scalable Throughput (L4S)".

[162] IETF RFC 6603: "Prefix Exclude Option for DHCPv6-based Prefix Delegation".

[163] IETF RFC 8415: "Dynamic Host Configuration Protocol for IPv6 (DHCPv6)".

[164] ITU‑T Recommendation G.810: "Definitions and terminology for synchronization networks".

[165] 3GPP TS 38.470: "NG-RAN; F1 general aspects and principles".

[166] IETF RFC 9000: "QUIC: A UDP-Based Multiplexed and Secure Transport".

[167] IETF RFC 9001: "Using TLS to Secure QUIC".

[168] IETF RFC 9002: "QUIC Loss Detection and Congestion Control".

[169] IETF RFC 9221: "An Unreliable Datagram Extension to QUIC".

[170] IETF RFC 9298: "Proxying UDP in HTTP".

[171] IETF RFC 9114: "Hypertext Transfer Protocol Version 3 (HTTP/3)".

[172] IETF RFC 9297: "HTTP Datagrams and the Capsule Protocol".

[173] IETF RFC 9220: "Bootstrapping WebSockets with HTTP/3".

[174] draft-ietf-quic-multipath: "Multipath Extension for QUIC".

Editor's note: The above document cannot be formally referenced until it is published as an RFC.

[175] 3GPP TS 28.530: "Management and orchestration; Concepts, use cases and requirements".

[176] 3GPP TS 28.531: "Management and orchestration; Provisioning".

[177] 3GPP TS 23.434: "Service Enabler Architecture Layer for Verticals (SEAL); Functional architecture and information flows".

[178] IEEE Std 802.1CBdb-2021: "Amendment 2: Extend Stream Identification Functions".

[179] 3GPP TS 26.522: "5G Real-time Media Transport Protocol Configurations".

[180] 3GPP TS 23.586: "Architectural Enhancements to support Ranging based services and Sidelink Positioning".

[181] 3GPP TS 23.542: "Application layer support for Personal IoT Network".

[182] IETF RFC 8415: "Dynamic Host Configuration Protocol for IPv6 (DHCPv6)".

[183] 3GPP TS 29.571: "5G System; Common Data Types for Service Based Interfaces; Stage 3".

[184] 3GPP TS 23.289: "Mission Critical services over 5G System; Stage 2".

[185] IETF RFC 3550: "RTP: A Transport Protocol for Real-Time Applications".

[186] IETF RFC 3711: "The Secure Real-time Transport Protocol (SRTP)".

[187] IETF RFC 6184: "RTP Payload Format for H.264 Video".

[188] IETF RFC 7798: "RTP Payload Format for High Efficiency Video Coding (HEVC) ".

[189] IETF RFC 8285: "A General Mechanism for RTP Header Extensions".

[190] 3GPP TS 28.405: "Quality of Experience (QoE) measurement collection; Control and configuration".

[191] 3GPP TS 37.355: " LTE Positioning Protocol (LPP)".

[192] 3GPP TS 32.422: "Telecommunication management; Subscriber and equipment trace; Trace control and configuration management".

[193] IETF RFC 3168: "The Addition of Explicit Congestion Notification (ECN) to IP".

[194] 3GPP TS 33.503: "Security Aspects of Proximity based Services (ProSe) in the 5G System (5GS)".

[195] 3GPP TS 38.414: "NG-RAN; NG data transport".

[196] 3GPP TS 38.799: "Study on Additional Topological Enhancements for NR".

[x1] IETF RFC 6040: " Tunnelling of Explicit Congestion Notification".

\* \* \* \* Second change \* \* \* \*

5.8.2.7 PDU Session and QoS Flow Policing

ARP is used for admission control (i.e. retention and pre-emption of the new QoS Flow). The value of ARP is not required to be provided to the UPF.

For every QoS Flow, the SMF shall determine the transport level packet marking value (e.g. the DSCP in the outer IP header) based on the 5QI, the Priority Level (if explicitly signalled) and optionally, the ARP priority level and provide the transport level packet marking value to the UPF.

The SMF shall provide the Session-AMBR values of the PDU Session to the UPF so that the UPF can enforce the Session-AMBR of the PDU Session across all Non-GBR QoS Flows of the PDU Session.

SMF shall provide the GFBR and MFBR value for each GBR QoS Flow of the PDU Session to the UPF. SMF may also provide the Averaging window to the UPF, if Averaging window is not configured at the UPF or if it is different from the default value configured at the UPF.

In the case of 3GPP access, the SMF may decide to activate ECN marking for L4S by PSA UPF for the QoS Flow (see clause 5.37). In this case, the SMF shall send an ECN marking for L4S indicator to PSA UPF.

\* \* \* \* Third change \* \* \* \*

5.8.5.4 QoS Enforcement Rule

The following table describes the QoS Enforcement Rule (QER) that defines how a packet shall be treated in terms of bit rate limitation and packet marking for QoS purposes. All Packet Detection Rules that refer to the same QER share the same QoS resources, e.g. MFBR.

**Table 5.8.5.4-1: Attributes within QoS Enforcement Rule**

|  |  |  |
| --- | --- | --- |
| **Attribute** | **Description** | **Comment** |
| N4 Session ID | Identifies the N4 session associated to this QER |  |
| Rule ID | Unique identifier to identify this information. |  |
| QoS Enforcement Rule correlation ID (NOTE 1) | An identity allowing the UP function to correlate multiple Sessions for the same UE and APN. | Is used to correlate QoS Enforcement Rules for APN-AMBR enforcement. |
| Gate status UL/DL | Instructs the UP function to let the flow pass or to block the flow. | Values are: open, close, close after measurement report (for termination action "discard"). |
| Maximum bitrate | The uplink/downlink maximum bitrate to be enforced for the packets. | This field may e.g. contain any one of:  - APN-AMBR (for a QER that is referenced by all relevant Packet Detection Rules of all PDN Connections to an APN) (NOTE 1).  - Session-AMBR (for a QER that is referenced by all relevant Packet Detection Rules of the PDU Session)  - QoS Flow MBR (for a QER that is referenced by all Packet Detection Rules of a QoS Flow)  - SDF MBR (for a QER that is referenced by the uplink/downlink Packet Detection Rule of a SDF)  - Bearer MBR (for a QER that is referenced by all relevant Packet Detection Rules of a bearer) (NOTE 1). |
| Guaranteed bitrate | The uplink/downlink guaranteed bitrate authorized for the packets. | This field contains:  - QoS Flow GBR (for a QER that is referenced by all Packet Detection Rules of a QoS Flow)  - Bearer GBR (for a QER that is referenced by all relevant Packet Detection Rules of a bearer) (NOTE 1). |
| Averaging window | The time duration over which the Maximum and Guaranteed bitrate shall be calculated. | This is for counting the packets received during the time duration. |
| Down-link flow level marking | Flow level packet marking in the downlink. | For UPF, this is for controlling the setting of the RQI in the encapsulation header as described in clause 5.7.5.3. |
| QoS Flow ID | QoS Flow ID to be inserted by the UPF. | The UPF inserts the QFI value in the tunnel header of outgoing packets. |
| Paging Policy Indicator | Indicates the PPI value the UPF is required to insert in outgoing packets (see clause 5.4.3.2). | PPI applies only for DL traffic. The UPF inserts the PPI in the outer header of outgoing PDU. |
| Packet rate (NOTE 1) | Number of packets per time interval to be enforced. | This field contains any one of:  - downlink packet rate for Serving PLMN Rate Control (the QER is referenced by all PDRs of the UE belonging to PDN connections using CIoT EPS Optimisations as described in TS 23.401 [26]).  - uplink/downlink packet rate for APN Rate Control (the QER is referenced by all PDRs of the UE belonging to PDN connections to the same APN using CIoT EPS Optimisations as described in TS 23.401 [26]). |
| End of Data Burst Marking Indication | Indicates to the UPF to provide an End of Data Burst indication of the last PDU of a Data burst to the NG-RAN over GTP-U | NG-RAN can configure UE power management schemes like connected mode DRX when UPF provides an indication of the End of Data Burst, see clause 5.37.8.3. |
| PDU Set Information marking Indicator | Indicates the UPF to insert PDU Set Information related to packets belonging to a PDU Set into GTP-U header. | UPF identifies PDU Sets in DL traffic and forwards PDU Set related information of each PDU to the NG-RAN over GTP-U, as described in clause 5.37.5. |
| ECN marking for L4S indicator (NOTE X) | Indicates the UPF to perform ECN marking for L4S for the corresponding QoS Flow. | UPF uses information sent by NG-RAN in GTP-U header extension to perform ECN marking for L4S for the corresponding direction. |
| NOTE 1: This parameter is only used for interworking with EPC. | | |
| NOTE X: This parameter is only used for 3GPP access and is not applicable for non-3GPP access. | | |

\* \* \* \* Fourth change \* \* \* \*

5.37.3 Support of ECN marking for L4S to expose the congestion information

5.37.3.1 General

L4S (Low Latency, Low Loss and Scalable Throughput) is described in IETF RFC 9330 [159], IETF RFC 9331 [160] and IETF RFC 9332 [161]. It exposes congestion information by marking ECN bits in the IP header of the user IP packets between the UE and the application server to trigger application layer rate adaptation.

In 5G System, ECN marking for L4S may be supported. ECN marking for L4S is enabled on a per QoS Flow basis in the uplink and/or downlink direction and may be used for GBR and non-GBR QoS Flows. In the case of 3GPP access, ECN marking for the L4S in the IP header is supported in either the NG-RAN (see clause 5.37.3.2 and TS 38.300 [27]), or in the PSA UPF (see clause 5.37.3.3). In the case of untrusted/trusted non-3GPP access , ECN marking for L4S in the IP header is supported in the N3IWF/TNGF (see clause 5.37.3.x, clause 6.2.9, and clause 6.2.9A).

NOTE 1: Based on operator's network configuration and policies, SMF decides whether NG-RAN or PSA UPF based ECN marking for L4S is used.

In the case of ECN marking for L4S by PSA UPF, the NG-RAN is instructed to perform congestion information monitoring and report to the PSA UPF the congestion information (i.e. a percentage of packets that UPF uses for ECN marking for L4S) of the QoS Flow on UL and/or DL directions via GTP-U header extension to PSA UPF and accordingly, the PSA UPF may mark the UL and/or DL direction packets of the QoS Flow.

NOTE 2: As for any QoS Flow, QoS rules in the UE and PDRs in the PSA UPF control which packets are bound to the L4S enabled QoS flow. The Packet Filter Set in the QoS rule or PDR can use packet filter(s) in clause 5.7.6.2 (e.g. match packets with ECT(1) or CE (See RFC 9331 [160]) together with IP 5 tuple) to steer traffic to an L4S enabled QoS Flow.

NOTE 3: A QoS Flow may be enabled with ECN marking for L4S requirement e.g. statically when a PDU session is established based on configuration in SMF or PCF, or dynamically based on detection of the L4S traffic (e.g. match packets with ECT(1) or CE (See RFC 9331 [160]) together with IP 5 tuple) in the IP header whereby SMF or PCF triggers a setup of a QoS Flow enabled for L4S, or by requests by an AF.

NOTE 4: To support this functionality, the UE needs to support L4S feedback as described in IETF RFC 9330 [159], which is not in the scope of 3GPP.

When serving PSA UPF or NG-RAN is changed e.g. due to inter-NG-RAN handover or PSA UPF relocation, target NG-RAN and target PSA UPF, if supported, should continue to perform ECN marking for L4S for the QoS Flow. However, if not available (i.e. ECN marking for L4S is not supported in both, target NG-RAN and target PSA UPF), AF should be notified that ECN marking for L4S can no longer be performed if ECN marking for L4S had been enabled for the QoS Flow based on AF request. When ECN marking for L4S is supported again either in target NG-RAN or in target PSA UPF, AF should be notified that ECN marking for L4S can be performed again if ECN marking for L4S had been enabled for the QoS Flow based on AF request.

5.37.3.2 Support of ECN marking for L4S in NG-RAN

ECN marking for L4S may be supported in NG-RAN as specified in TS 38.300 [27].

To enable ECN marking for L4S in NG-RAN, dedicated QoS Flow(s) are used for carrying L4S enabled IP traffic. The SMF may be instructed, based on either dynamic or predefined PCC rule, to provide an indication for ECN marking for L4S to NG-RAN for a corresponding QoS Flow(s) in UL and/or DL directions. In the absence of such PCC rule, the use of ECN marking for L4S in NG-RAN on a QoS Flow is controlled by a coordinated configuration in NG-RAN and 5GC.

The criteria based on which NG-RAN decides to mark ECN bits for L4S is NG-RAN implementation specific.

In the case of inter NG-RAN UE mobility, if the ECN marking for L4S has been enabled on source NG-RAN, but the target NG-RAN does not support ECN marking for L4S, then the SMF may, if supported, enable ECN marking for L4S in PSA UPF as defined in clause 5.37.3.3.

5.37.3.3 Support of ECN marking for L4S in PSA UPF

To enable ECN marking for L4S by a PSA UPF, a QoS Flow level ECN marking for L4S indicator may be sent by SMF to PSA UPF over N4. SMF also indicates to NG-RAN to report the congestion information (i.e. a percentage of packets that UPF uses for ECN marking for L4S) of the QoS Flow on UL and/or DL directions via GTP-U header extension to PSA UPF and accordingly, the PSA UPF may mark the UL and/or DL direction packets of the QoS Flow. If there is no UL packet when report for DL and/or UL needs to be provided, NG-RAN may generate an UL Dummy GTP-U Packet for such a reporting.

The SMF may be instructed, based on either dynamic or predefined PCC rule, to provide an indication for ECN marking for L4S to PSA UPF for a corresponding QoS Flow(s) in UL and/or DL directions.

Upon successful activation of congestion information reporting for UL and/or DL directions, PSA UPF uses information sent by NG-RAN in GTP-U header extension (see TS 38.415 [116] and TS 38.300 [27]) to perform ECN bits marking for L4S for the corresponding direction.

NOTE: How the congestion information is converted to ECN markings is UPF implementation specific.

The criteria based on which NG-RAN decides to provide the congestion information is up to NG-RAN implementation.

In the case of PSA UPF relocation, if the ECN marking for L4S has been enabled on source PSA UPF, SMF should select a target PSA UPF supporting ECN marking for L4S. If the target PSA UPF does not support ECN marking for L4S, then SMF may, if supported, switch to ECN marking for L4S in target NG-RAN by following clause 5.37.3.2. In such case, the target NG-RAN stops sending congestion information to the target PSA UPF.

In the case of inter NG-RAN UE mobility, if the congestion information reporting has been enabled on source NG-RAN while the target NG-RAN does not support congestion information reporting, then the SMF shall inform PSA UPF to stop ECN marking for L4S. If ECN marking for L4S is supported by the target NG-RAN, the SMF may instruct the target NG-RAN to perform ECN marking for L4S in NG-RAN by following clause 5.37.3.2. For a given QoS Flow, if the target NG-RAN supports congestion information reporting, the target NG-RAN shall report congestion information to UPF once it is available.

5.37.3.x Support of ECN marking for L4S in N3IWF and TNGF

ECN marking for L4S may be supported in N3IWF and TNGF, as specified in clause 6.2.9, 6.2.9A, respectively.

To enable ECN marking for L4S in N3IWF and TNGF, dedicated QoS Flow(s) and non-3GPP access resources (i.e., IPsec Child SAs) are used for carrying L4S enabled IP traffic. The SMF may be instructed, based on either dynamic or predefined PCC rule, to provide an indication for ECN marking for L4S to N3IWF and TNGF for a L4S enabled QoS Flow(s) in UL and/or DL directions. In the absence of such PCC rule, the use of ECN marking for L4S in N3IWF and TNGF, on a QoS Flow is controlled by a coordinated configuration in N3IWF and TNGF, and 5GC.

For DL, intermediate non-3GPP access nodes (i.e., N3IWF and TNGF) map the L4S-enabled QoS Flows to L4S enabled non-3GPP access resources.

NOTE: Any non-3GPP access node (i.e., N3IWF and TNGF) supporting L4S and acting as an IP-in-IP tunnel endpoint between the XR application client and server is assumed to implement encapsulation and decapsulation as specified in IETF RFC 6040 [x1].

The criteria based on which N3IWF and TNGF decide to mark ECN bits for L4S is implementation specific.

ECN marking for L4S in W-AGF and 5G-RG is specified in TS 23.316 [84] clause 4.x.2.

\* \* \* \* Fifth change \* \* \* \*

6.2.9 N3IWF

The functionality of N3IWF in the case of untrusted non-3GPP access includes the following:

- Support of IPsec tunnel establishment with the UE: The N3IWF terminates the IKEv2/IPsec protocols with the UE over NWu and relays over N2 the information needed to authenticate the UE and authorize its access to the 5G Core Network.

- Termination of N2 and N3 interfaces to 5G Core Network for control - plane and user-plane respectively.

- Relaying uplink and downlink control-plane NAS (N1) signalling between the UE and AMF.

- Handling of N2 signalling from SMF (relayed by AMF) related to PDU Sessions and QoS.

- Establishment of IPsec Security Association (IPsec SA) to support PDU Session traffic.

- Relaying uplink and downlink user-plane packets between the UE and UPF. This involves:

- De-capsulation/ encapsulation of packets for IPSec and N3 tunnelling.

- Enforcing QoS corresponding to N3 packet marking (e.g. DSCP), taking into account QoS requirements associated to such marking received over N2. QoS includes 5QI, the Priority Level (if explicitly signalled) and optionally, the ARP priority level.

NOTE: Based on operator policy and/or regional/national regulations, the N3IWF can apply a different DSCP value to the outer ESP tunnel packet than the DSCP value of the inner IP packet.

- Packet marking, e.g. setting the DSCP value based on the Establishment cause on N2, and based on 5QI, the Priority Level (if explicitly signalled) and optionally, the ARP priority level on N3.

- Local mobility anchor within untrusted non-3GPP access networks using MOBIKE per IETF RFC 4555 [57].

- Supporting AMF selection.

- Support of ECN marking for L4S: The SMF, if applicable, provides ECN marking request per QoS flow level to the N3IWF as part of PDU session management procedures.

- When ECN marking for L4S at N3IWF is enabled for downlink or uplink, the N3IWF should set the Congestion Experienced (CE) codepoint in downlink or uplink as per the recommendations in IETF RFC 9330 [159], IETF RFC 9331 [160], IETF RFC 9332 [161], IETF RFC 6040 [x1].

\* \* \* \* Sixth change \* \* \* \*

6.2.9A TNGF

The functionality of TNGF in the case of trusted non-3GPP access includes the following:

- Terminates the N2 and N3 interfaces.

- Terminates the EAP-5G signalling and behaves as authenticator when the UE attempts to register to 5GC via the TNAN.

- Implements the AMF selection procedure.

- Transparently relays NAS messages between the UE and the AMF, via NWt.

- Handles N2 signalling with SMF (relayed by AMF) for supporting PDU sessions and QoS.

- Transparently relays PDU data units between the UE and UPF(s).

- Implements a local mobility anchor within the TNAN.

- Packet marking in the downlink, and the uplink on N2 and N3, as for the N3IWF (clause 6.2.9).

- ECN marking for L4S, as for N3IWF (clause 6.2.9)

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