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Tunnelling Protocol User Plane (GTPv1-U)
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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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1 Scope

The present document defines the user plane of GTP used on:

- the Gn and Gp interfaces of the General Packet Radio Service (GPRS);
- the Iu, Gn and Gp interfaces of the UMTS system;
- the S1-U, S11-U, S2a, S2b, X2, S4, S5, S8, S12, M1 and Sn interfaces of the Evolved Packet System (EPS);
- the F1-U, Xn, N3 and N9 interfaces of the 5G System (5GS);

This definition ensures full backwards compatibility with RNC, SGSN and GGSN implementations according to release 7 of 3GPP TS 29.060 [6].

NOTE: Releases previous to Release-8 have used 3GPP TS 29.060 [6] as normative definition of the user plane of GTP. This shall be considered when essential corrections are included in the present document or in pre-release-8 version of 3GPP TS 29.060 [6].

Fallback from GTPv1-U to GTPv0-U shall not be supported. Therefore, 3GPP Rel-8 and onwards GTPv1-U entity should not listen to the well-known GTPv0 port 3386. If GTPv1 entity listens to the GTPv0 port, the entity shall silently discard any received GTPv0-U message.

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 23.003: "Numbering, addressing and identification".

[3] 3GPP TS 23.007: "Restoration procedures".

[4] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".

[5] 3GPP TS 23.401: "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".

[6] 3GPP TS 29.060: "General Packet Radio Service (GPRS); GPRS Tunnelling Protocol (GTP) across the Gn and Gp interface".

[7] 3GPP TS 29.274: "3GPP Evolved Packet System; Evolved GPRS Tunnelling Protocol for EPS (GTPv2)".

[8] 3GPP TS 32.295: "Telecommunication management; Charging management; Charging Data Record (CDR) transfer".

[9] IETF RFC 768 (STD 0006): "User Datagram Protocol", J. Postel.

[10] IETF RFC 791 (STD 0005): "Internet Protocol", J. Postel.

[11] IETF RFC 4291: "IP Version 6 Addressing Architecture".

[12] 3GPP TS 33.210: "3G security; Network Domain Security (NDS); IP network layer security".

[13] 3GPP TS 23.121: "Architectural requirements for Release 1999".

[14] 3GPP TS 43.129: "Packet-switched handover for GERAN A/Gb mode; Stage 2".

[15] IETF RFC 2460: "Internet Protocol, Version 6 (IPv6) Specification", Standards Track

[16] 3GPP TS 25.413: "UTRAN Iu interface RANAP signalling".

[17] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".

[18] 3GPP TS 23.246: "Multimedia Broadcast/Multicast Service (MBMS); Architecture and functional description; Stage 2".

[19] IETF RFC 4604 (2006): "Using Internet Group Management Protocol Version 3 (IGMPv3) and Multicast Listener Discovery Protocol Version 2 (MLDv2) for Source-Specific Multicast".

[20] IETF RFC 4607 (2006): "Source-Specific Multicast for IP".

[21] 3GPP TS 33.102: "3G Security; Security architecture".

[22] 3GPP TS 33.401: "3GPP System Architecture Evolution (SAE): Security architecture ".

[23] 3GPP TS 23.402: "Architecture enhancements for non-3GPP accesses".

[24] 3GPP TS 36.323: "Evolved Universal Terrestrial Radio Access (E-UTRA); Packet Data Convergence Protocol (PDCP) specification".

[25] 3GPP TS 36.425: "E-UTRAN X2 interface user plane protocol".

[26] IETF RFC 2474, "Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers".

[27] 3GPP TS 36.465: "Evolved Universal Terrestrial Radio Access (E-UTRAN) and Wireless LAN (WLAN) Xw interface user plane protocol".

[28] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[29] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[30] 3GPP TS 38.425: "NG-RAN; NR user plane protocol".

[31] 3GPP TS 38.415: "NG-RAN; PDU Session User Plane Protocol".

[32] 3GPP TS 33.250: "Security assurance specification for the PGW network product class".

[33] 3GPP TS 23.527: "5G System; Restoration Procedures".

[34] 3GPP TS 38.300: "NR; NR and NG-RAN Overall Description; Stage 2".

[35] 3GPP TS 38.323: "NR; Packet Data Convergence Protocol (PDCP) specification".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

Common Tunnel Endpoint Identifier (C-TEID): Unambiguously identifies a tunnel endpoint in the receiving GTP-U protocol entity for a given UDP/IP endpoint. The sending end side of a GTP tunnel locally assigns the C-TEID value used in the TEID field and signals it to the destination Tunnel Endpoint using a control plane message.

GTP-U Message: GTP-U (user plane) messages are either user plane messages or signalling messages. User plane messages are used to carry user data packets between GTP-U entities. Signalling messages are sent between network nodes for path management and tunnel management.**GTP-U peer:** node implementing at least one side of any of the GTP user plane based protocols. RNC, SGSN, GGSN, eNodeB, SGW, ePDG, gNB, N3IWF, UPF, PGW or TWAN or MME.

GTP-U Tunnel: A GTP-U tunnel is identified in each node with a TEID, an IP address and a UDP port number. A GTP-U tunnel is necessary to enable forwarding packets between GTP-U entities.

GTP-U Tunnel Endpoint: A GTP-U tunnel endpoint identifies a user plane context (e.g EPS bearer, PDU session or a RAB) for which a received GTP-U packet is intended. A given GTP-U tunnel endpoint may receive GTP-U packets from more than one source GTP-U peer (See clause 4.3.0).**UDP/IP Path:** Connection-less unidirectional or bidirectional path defined by two end-points. An IP address and a UDP port number define an end-point. A UDP/IP path carries GTP messages between network nodes related to one or more GTP tunnels.

GTP-PDU: GTP Protocol Data Unit (PDU) is a GTP-U message, which may be either a G-PDU or a signalling message.

G-PDU: User data packet (T-PDU) plus GTP-U header, sent between GTP network nodes.

Signalling Message: A GTP-U message (GTP-PDU that is not a G-PDU) sent between GTP network nodes. These may be Path Management messages or Tunnel Management messages.

T-PDU: A user data packet, for example an IP datagram, sent between a UE and a network entity in an external packet data network. A T-PDU is the payload that is tunnelled in the GTP-U tunnel.

Tunnel Endpoint Identifier (TEID): Unambiguously identifies a tunnel endpoint in the receiving GTP-U protocol entity for a given UDP/IP endpoint. The receiving end side of a GTP tunnel locally assigns the TEID value the transmitting side has to use. The TEID values are exchanged between tunnel endpoints using control plane message.

Trusted WLAN Access Network: see 3GPP TS 23.402 [23].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

C-TEID	Common Tunnel Endpoint IDentifier
EN-DC	E-UTRA-NR Dual Connectivity
ePDG	Evolved Packet Data Gateway
GSN	GPRS Support Node
GGSN	Gateway GPRS Support Node
G-PDU	GTP encapsulated user Plane Data Unit
GTP	GPRS Tunnelling Protocol
GTP-C	GTP Control
GTP-U	GTP User
IE	Information Element
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
MME	Mobility Management Entity
PDU	Packet Data Unit
PGW	PDN Gateway
QoS	Quality of Service
RANAP	Radio Access Network Application Part
RNC	Radio Network Controller
SGSN	Serving GPRS Support Node
SGW	Serving Gateway
TEID	Tunnel Endpoint IDentifier

T-PDU	Transport PDU
TWAN	Trusted WLAN Access Network
UDP	User Datagram Protocol
UTRAN	UMTS Terrestrial Radio Access Network

4 General

4.1 GTP Path

For the definition of UDP/IP Path and GTP Endpoint, see 3GPP TS 29.060 [6].

4.2 GTP-U Tunnels

4.2.1 GTP-U Tunnel description

GTP-U Tunnels are used to carry encapsulated T-PDUs and signalling messages between a given pair of GTP-U Tunnel Endpoints. The Tunnel Endpoint ID (TEID) which is present in the GTP header shall indicate which tunnel a particular T-PDU belongs to. In this manner, packets are multiplexed and de-multiplexed by GTP-U between a given pair of Tunnel Endpoints. The TEID value to be used in the TEID field shall be signalled to the peer GTP-U entity using a control plane protocol like GTPv1-C, GTPv2-C, RANAP or S1-AP.

In what follows we refer to the outer GTPv1-U IP packet as the IP packet that carries a GTPv1-U packet. The inner IP packet in a GTPv1-U packet (T-PDU) is either

- An IP packet sent to the UE/MS in the downlink direction over one or more tunnels from the external network identified by the APN.
- An IP packet sent from a UE/MS in the uplink direction over one or more tunnels to the external network identified by the APN.

NOTE 1: Not all tunnels in 3GPP networks will necessarily be GTPv1-U,

NOTE 2: The inner MTU size of the GTPv1-U tunnel is typically not the same as the outer MTU size of the IP path carrying the outer IP packets.

The maximum size of a T-PDU that may be transmitted without fragmentation by GGSN or the MS is defined in 3GPP TS 23.060 [4].

4.2.2 IP transport

According to IETF RFC 791 [10], any IPv4 router in the backbone may fragment the outer IPv4 GTPv1-U packet with a flag of DF=0.

Unnecessary fragmentation should be avoided when possible due to the following;

- Fragmentation is bandwidth inefficient, since the complete IP header is duplicated in each fragment.
- Fragmentation is CPU intensive since more fragments require more processing at both GTPv1-U endpoints and IP routers. It also requires additional memory at the receiver.
- If one fragment is lost, the complete packet has to be discarded. The reason is there is no selective retransmission of IP fragments provided in IPv4 or IPv6.

Recommendations on how to set the default inner MTU size at the PDN GW and UE/MS to avoid IP fragmentation of both inner IP packets (in the PDN GW or UE/MS) and outer IP packets in the backbone are specified in clause 9.3 of 3GPP TS 23.060 [4].

4.2.3 GTP-U Tunnel IP transport

Functionality for IP transport and IP fragmentation at a RAN node on the Iu interface or S12 is defined in 3GPP TS 25.414 [16].

Functionality for IP transport and IP fragmentation at an eNodeB on the S1-U and X2 interface is defined in 3GPP TS 36.300 [17].

Functionality for IP transport and IP fragmentation at an NG-RAN on the N3 and Xn interface is defined in 3GPP TS 38.300 [34].

The outer GTPv1-U packet layer shall support IPv4 as defined by IETF RFC 791 [10] and should support IPv6 as defined by IETF RFC 2460 [15].

The following text as well as clauses 4.2.4 and 4.2.5 apply only to core network GTPv1-U endpoints.

GTPv1-U tunnel endpoints do not need to change the hopcount/TTL or to perform any IP routing functions in respect to inner IP packet other than the functions explicitly stated here. However, other co-located functions may do so. For example, the GGSN/PGW/UPF may change the hopcount/TTL as the IP datagram enters/leaves the Gi/SGi/N6 interface from/to the GTPv1-U tunnel interface and IP packets may be discarded or rejected at any point by a co-located function due to local policy and/or QoS (the policy enforcement point).

4.2.4 Ingress GTP tunnel (GTPv1-U sending endpoint)

An inner IP packet shall be encapsulated at the GTPv1-U sender with a GTP header, UDP and IP header. If the resulting outer IP packet is larger than the MTU of the first link towards the destination GTPv1-U endpoint, fragmentation of the IP packet shall be performed by the sender as per IETF RFC 791 [10] for an outer layer of IPv4 and IETF RFC 2460 [15] for an outer layer of IPv6. The GTPv1-U sender should preferably fragment the IP packet to the smallest MTU of any link between GTPv1-U sender and GTPv1-U receiver.

Fragmentation policy of the inner datagram is implementation dependent but shall interwork with IETF RFC 791 [10] for inner IPv4 datagrams and IETF RFC 2460 [15] for inner IPv6 packets.

4.2.5 Egress GTP tunnel (GTPv1-U receiving endpoint)

The GTPv1-U receiving endpoint packets shall reassemble any IP fragments in datagrams received from the GTPv1-U sending endpoint as per IETF RFC 791 [10] for outer IPv4 datagrams and as per IETF RFC 2460 [15] for outer IPv6 datagrams. The IP reassembly buffer in the receiving endpoint shall be at least the inner MTU size plus the size of the tunnel headers (outer IP header, outer UDP header, and GTP header, including any GTP extension headers).

The completely reassembled IP packet shall then be passed to the IP/UDP/GTPv1-U layers to extract the inner IP packet which is then processed further according to the receiving node's functionality.

4.2.6 MBMS IP Multicast Distribution of the User Plane Data

GTP-U Multicast Tunnels are used for unidirectional transfer of the encapsulated T-PDUs from one GTP-U Tunnel Endpoint acting as an IP multicast source to multiple GTP-U Tunnel Endpoints acting as IP multicast listeners, as specified in TS 23.246 [18]. The Common Tunnel Endpoint ID (C-TEID) which is present in the GTP header shall indicate which tunnel a particular T-PDU belongs to. The C-TEID value to be used in the TEID field is allocated at the source Tunnel Endpoint and signalled to the destination Tunnel Endpoint using a control plane protocol i.e. GTPv1-C, and RANAP, GTPv2-C and S1-AP. There is one C-TEID allocated per MBMS bearer service.

The destination IP address in the outer GTPv1-U IP header is an address in the multicast address range as specified in IETF RFC 4607 [20].

If the RNC decides to receive IP multicast packets, then the RNC shall join the IP multicast group as specified by IETF RFC 4604 [19] and IETF RFC 4607 [20].

If the eNodeB supports MBMS as specified in TS 23.246 [18], it shall join the IP multicast group as specified in IETF RFC 4604 [19] and IETF RFC 4607 [20].