Operations
Internet-Draft
Intended status: Standards Track
Expires: 30 May 2026

D. Voyer
S. Gopalakrishnan
Cisco Systems
T. Graf
Swisscom
V. Satyanarayana
Juniper Networks
C. Staicu
Bell Canada

26 November 2025

Export of GTP-U Information in IP Flow Information Export (IPFIX)
draft-ietf-opsawg-ipfix-gtpu-07

Abstract

This document introduces IP Flow Information Export (IPFIX) Information Elements to report information contained in the Generic Packet Radio Service Tunneling Protocol(GTP) User Plane header such as Tunnel Endpoint Identifier, and data contained in its session container extension header.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at https://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on 30 May 2026.

Table of Contents

1. Introduction

A dedicated header, called GPRS Tunneling Protocol (GTP) Header, is defined by the 3GPP for use of user Plane (GTP User (GTP-U)) [TS.29281] (latest reference being Release 19) traffic of mobile subscribers.

This document specifies six IPFIX Information Elements (IEs) [RFC7012] to export GTP-U information.

Specifically, these IEs are used to export the GTP-U Tunnel Endpoint Identifier (TEID), QoS Flow Identifier (QFI), and PDU Type from the PDU Session Container extension header.

Some examples are provided in Appendix A.

2. Terminology

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 [RFC8174] when, and only when, they appear in all capitals, as shown here.

This document makes use of the terms defined in [RFC7011]

* IPFIX
* IPFIX Information Element
* Template
* Template Record
* Options Template
* Options Template Record
* Data Record
* Data Set

This document makes use of following terms from [RFC6459]:

* User Plane

The document uses the following abbreviations:

* IE: Information Element
* GTP: GPRS Tunneling Protocol
* GTP-U: GTP User
* GTP-C: GTP Control
* PDU: Protocol Data Unit
* TEID: Tunnel Endpoint Identifier
* UPF: User Plane Function

* QFI: QoS Flow Identifier

3. IPFIX GTP-U Information Elements

This section defines IPFIX IEs corresponding to various fields in the GTP-U header.

gtpuFlags
: 8-bit flags field indicating the version of GTP-U header, protocol type, and presence of extension header, sequence number and N-PDU number defined in Section 5.1 of the 3GPP specification [TS.29281]. The bits are exported as observed.

gtpuMsgType
: 8-bit field which indicates the type of the GTP-U message as mentioned in section 6.1 of 3GPP specification [TS.29281].

gtpuTEid
: 32-bit tunnel endpoint identifier field unambiguously identifies a tunnel endpoint in the receiving GTP-U protocol entity for a given UDP/IP endpoint.

gtpuSequenceNum
: 16-bit sequence number field defined in the GTP-U. This field is interpreted based on the sequence number flag value from gtpuFlags.

gtpuQFI
: 6-bit QoS flow identifier field defined in PDU Session Container extension header of GTP-U. This may be used to determine the QoS flow and QoS profile which are associated with the received packet. The presence of this extension header is interpreted based on the extension header flag value from gtpuFlags.

gtpuPduType
: 4-bit PDU type field defined in PDU Session Container extension header of GTP-U. This field indicates the structure of the PDU session user plane frame. The presence of this extension header is interpreted based on the extension header flag value from gtpuFlags.

gtpuTotalHdrLength
: 8-bit field indicating the total length of the GTP-U header which includes mandatory fields and all the optional headers as defined in Section 5 of the 3GPP specification [TS.29281].

gtpuHeaderSection
This Information Element carries a series of n octets from the GTP-U header mandatory fields and all the following optional headers if any, defined in Section 5 of the 3GPP specification [TS.29281] as a series of octets in IPFIX.

4. Sample Use Cases

The GTP-U related IPFIX IEs are helpful in order to identify the transport performance of PDU Sessions, e.g., with specific QoS class within a network slice (refer to [I-D.ietf-teas-5g-ns-ip-mpls]) or within a group of network slices hosted on the same User Plane Function (UPF).

For example, when a set of UPFs are deployed per 5G slice, the slice is identified first using a list of gNodeB IP addresses composing the slice and a list of IP addresses of UPFs dedicated for the slice. The gNodeB and the UPF form the tunnel endpoints. The traffic for each individual PDU Session per direction is identified using the GTP-U TEID, GTP-U PDU Type together with the above mentioned IP tunnel endpoints. Furthermore, the traffic for a specific QoS class within a PDU Session per traffic direction is identified using the combination of GTP-U TEID, GTP-U PDU Type, and GTP-U QFI attributes. It is possible that for a single PDU session there might be multiple IP flows with different GTP-U QFI but with same GTP-U TEID.

In another scenario when multiple 5G slices share the same UPF, each slice is identified using a separated list of gNodeB IPv4 or IPv6 addresses per slice. If an Uplink Classifier (refer to section 3.1 of [TS.23501]) is deployed there is an addition of a GTP-U tunnel between the Intermediate/Uplink-Classifier UPF and the final UPF. This brings a challenge for identifying the end-to-end path for a certain PDU Session - the GTP-U PDU Type and GTP-U QFI attributes from the gNodeB and Intermediate/Uplink-Classifier UPF tunnel will be the same on the Intermediate/Uplink-Classifier and final UPF tunnels, however the GTP-U TEIDs will be different since on each tunnel.

The use of the IPFIX GTP-U IEs is to identify either a particular PDU Session on a particular slice (using GTP-U TEID in combination with the gNodeB and the UPF IP addresses) or all the IP traffic flows for a 3GPP QoS flow on a slice (using GTP-U QFI in combination with the gNodeB and the UPF IP addresses) or a 3GPP QoS flow for a particular PDU Session on a slice (using both GTP-U TEID and GTP-U QFI in combination with the gNodeB and UPF IP addresses).

Additionally, exporting GTP-U IEs together with transportChecksum IE would help detect misbehaving nodes particularly when using GTP-U over IPv6.

5. IANA Considerations

IANA has registered the following IEs in the "IPFIX Information Elements" registry available at [IANA-IPFIX].

Table 1 lists the GTP-U IEs:

Element ID	Name
505	gtpuFlags
506	gtpuMsgType
507	gtpuTEid
508	gtpuSequenceNum
509	gtpuQFI
510	gtpuPduType
TBD1	gtpuTotalHdrLength
TBD2	gtpuHeaderSection

Table 1: GTP-U IEs in the "IPFIX Information Elements" Registry

IANA is requested to update these entries as indicated in the following subsections.

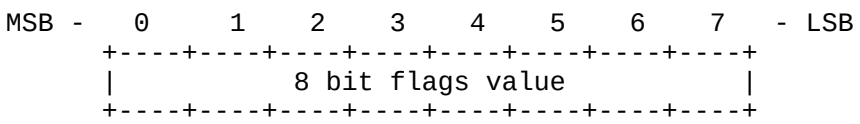
5.1. gtpuFlags

Name: gtpuFlags

ElementID: 505

Description: 8-bit flags field indicating the version of GTP-U header, protocol type, and presence of extension header, sequence number and N-PDU number defined in Section 5.1 of the 3GPP specification [TS.29281]. The bits are exported as observed.

The basic encoding is 8 bits. The layout of basic encoding is as follows:



Examples:

value : 0x34

binary: 00110100

decode: 00110100 - Flags value

value : 0x30

binary: 00110000

decode: 00110000 - Flags value

Abstract Data Type: unsigned8

Data Type Semantics: flags

Additional Information: Refer to Section 5.1 of [TS.29281].

Reference: [RFC-to-be]

5.2. gtpuMsgType

Name: gtpuMsgType

ElementID: 506

Description: 8-bit field which indicates the type of the GTP-U message as mentioned in section 6.1 of 3GPP specification [TS.29281].

Abstract Data Type: unsigned8

Data Type Semantics: identifier

Additional Information: Refer to Section 5.1 of the 3GPP specification [TS.29281].

Reference: [RFC-to-be]

5.3. gtpuTEid

Name: gtpuTEid

ElementID: 507

Description: 32-bit tunnel endpoint identifier field unambiguously identifies a tunnel endpoint in the receiving GTP-U protocol entity for a given UDP/IP endpoint.

Abstract Data Type: unsigned32

Data Type Semantics: identifier

Additional Information: Refer to Section 5.1 of the 3GPP specification [TS.29281].

Reference: [RFC-to-be]

5.4. gtpuSequenceNum

Name: gtpuSequenceNum

ElementID: 508

Description: 16-bit sequence number field defined in the GTP-U. This field is interpreted based on the sequence number flag value from gtpuFlags.

Abstract Data Type: unsigned16

Data Type Semantics: identifier

Additional Information: Refer to Section 5.1 of the 3GPP specification [TS.29281].

Reference: [RFC-to-be]

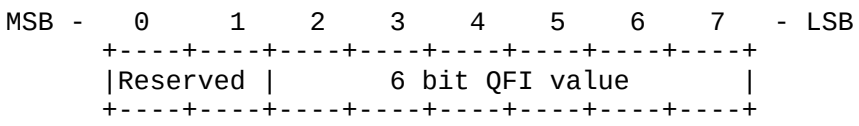
5.5. gtpuQFI

Name: gtpuQFI

ElementID: 509

Description: 6-bit QoS flow identifier field defined in PDU Session Container extension header of GTP-U. This may be used to determine the QoS flow and QoS profile which are associated with the received packet. The presence of this extension header is interpreted based on the extension header flag value from gtpuFlags.

The basic encoding is 8 bits. The layout of basic encoding is as follows:



Examples:

value : 0x08

binary: 00001000

decode: 001000 - QFI value

value : 0x3e

binary: 00111110

decode: 111110 - QFI value

Abstract Data Type: unsigned8

Data Type Semantics: identifier

Additional Information: Refer to Section 5.5.3.3 of the 3GPP specification [TS.38415] and Section 5.7.1.1 of the 3GPP specification [TS.23501].

Reference: [RFC-to-be]

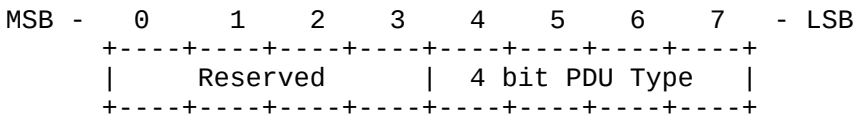
5.6. gtpuPduType

Name: gtpuPduType

ElementID: 510

Description: 4-bit PDU type field defined in PDU Session Container extension header of GTP-U. This field indicates the structure of the PDU session user plane frame. The presence of this extension header is interpreted based on the extension header flag value from gtpuFlags.

The basic encoding is 8 bits. The layout of basic encoding is as follows:



Examples:

value : 0x01

binary: 00000001

decode: 0001 - PDU Type value

Abstract Data Type: unsigned8

Data Type Semantics: identifier

Additional Information: Refer to Section 5.5.3 of the 3GPP specification [TS.38415].

Reference: [RFC-to-be]

5.7. gtpuTotalHdrLength

Name: gtpuHeaderLength

ElementID: TBD1

Description: 8-bit field indicating the total header length of the GTP-U which includes mandatory fields and all the optional headers as defined in Section 5 of the 3GPP specification [TS.29281].

Abstract Data Type: unsigned8

Data Type Semantics: identifier

Additional Information: Refer to Section 5 of [TS.29281].

Reference: [RFC-to-be]

5.8. gtpuHeaderSection

Name: gtpuHeaderSection

ElementID: TBD2

Description: This Information Element carries a series of n octets from the GTP-U header mandatory fields and all the following optional headers if any, defined in Section 5 of the 3GPP specification [TS.29281] as a series of octets in IPFIX

Abstract Data Type: octetArray

Data Type Semantics: default

Additional Information: Refer to Section 5 of [TS.29281].

Reference: [RFC-to-be]

6. Acknowledgements

The authors would like to thank Benoit Claise, Ketan Talaulikar, Dhananjay Patki, Paul Aitken and Shraddha Hegde for their reviews and valuable comments.

7. Contributors

Kandhla Chandi
Bell Canada
Email: kandhla.chandi@bell.ca

Ralu Johny
Cisco
Email: rjohny@cisco.com

8. Implementation Status

Note to the RFC-Editor: Please remove this section before publishing.

8.1. Cisco IOS XR

Cisco implemented the following IEs as part of a test implementation in the IOS XR platform:

* gtpuFlags
* gtpuMsgType
* gtpuTEid
* gtpuSequenceNum
* gtpuQFI
* gtpuPduType

9. Security Considerations

There exist no extra security considerations regarding allocation of these IPFIX IEs compared to [RFC7012].

The IEs described in this document export GTP user plane data information on how packets are being forwarded in a 3GPP network. Applications and operators using the IEs described in this document must evaluate the sensitivity of this information in their implementation context, and apply the data-at-rest storage guidance in Section 11.8 of [RFC7011] as appropriate.

10. Operational Considerations

The IPFIX IEs defined in this document require extraction of fields from packets. There may exist older devices in the network that do not support extensions defined in this document. For those devices [RFC7133] defines dataLinkFrameSection which is a useful mechanism to export the packet header as a fallback scenario. However, when dataLinkFrameSection is used, Flow aggregation as per [RFC7015] can’t be applied. This document will serve as a guideline to extract the necessary fields from the GTP-U header for the above scenarios.

11. References

11.1. Normative References

[RFC7011] Claise, B., Ed., Trammell, B., Ed., and P. Aitken, "Specification of the IP Flow Information Export (IPFIX) Protocol for the Exchange of Flow Information", STD 77, RFC 7011, DOI 10.17487/RFC7011, September 2013, <https://www.rfc-editor.org/info/rfc7011>.

[RFC7012] Claise, B., Ed. and B. Trammell, Ed., "Information Model for IP Flow Information Export (IPFIX)", RFC 7012, DOI 10.17487/RFC7012, September 2013, <https://www.rfc-editor.org/info/rfc7012>.

[RFC7015] Trammell, B., Wagner, A., and B. Claise, "Flow Aggregation for the IP Flow Information Export (IPFIX) Protocol", RFC 7015, DOI 10.17487/RFC7015, September 2013, <https://www.rfc-editor.org/info/rfc7015>.

[RFC7133] Kashima, S., Kobayashi, A., Ed., and P. Aitken, "Information Elements for Data Link Layer Traffic Measurement", RFC 7133, DOI 10.17487/RFC7133, May 2014, <https://www.rfc-editor.org/info/rfc7133>.

[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/info/rfc8174>.

[TS.23501] 3GPP, "5G; System architecture for the 5G System (5GS)", Version 17.11.0, 3GPP TS 23.501, January 2024.

[TS.29281] 3GPP, "General Packet Radio System (GPRS) Tunnelling Protocol User Plane (GTPv1-U)", Version 17.4.0, 3GPP TS 29.281, October 2022.

[TS.38415] 3GPP, "NG-RAN; PDU Session User Plane Protocol)", Version 17.1.0, 3GPP TS 38.415, February 2024.

11.2. Informative References

[I-D.ietf-teas-5g-ns-ip-mpls] Szarkowicz, K. G., Ed., Roberts, R., Ed., Lucek, J., Boucadair, M., Ed., and L. M. Contreras, "A Realization of Network Slices for 5G Networks Using Current IP/MPLS Technologies", Work in Progress, Internet-Draft, draft-ietf-teas-5g-ns-ip-mpls-18, 5 December 2024, <https://datatracker.ietf.org/doc/html/draft-ietf-teas-5g-ns-ip-mpls-18>.

[IANA-IPFIX]
"IANA, "IP Flow Information Export (IPFIX) Entities"",
<https://www.iana.org/assignments/ipfix/ipfix.xhtml>.

[RFC6459] Korhonen, J., Ed., Soininen, J., Patil, B., Savolainen, T., Bajko, G., and K. Iisakkila, "IPv6 in 3rd Generation Partnership Project (3GPP) Evolved Packet System (EPS)", RFC 6459, DOI 10.17487/RFC6459, January 2012, <https://www.rfc-editor.org/info/rfc6459>.

Appendix A. IPFIX Encoding Examples

In this section, an example is provided to show IPFIX encoding format for the GTP-U introduced IEs. Template definition and data set corresponding to an observed GTP-U header is illustrated below.

```
Observed GTP-U Header:
Flags = 0x36, Message Type = 0xff, TEID = 0x01,
Sequence number = 0x0000,
Next extension header type = 0x85 (PDU Session container),
PDU Type = 0, QFI = 8
```

A.1. Template Record

A.1.1. Template Record and Data Set

Sample template consisting of the GTP-U IEs:

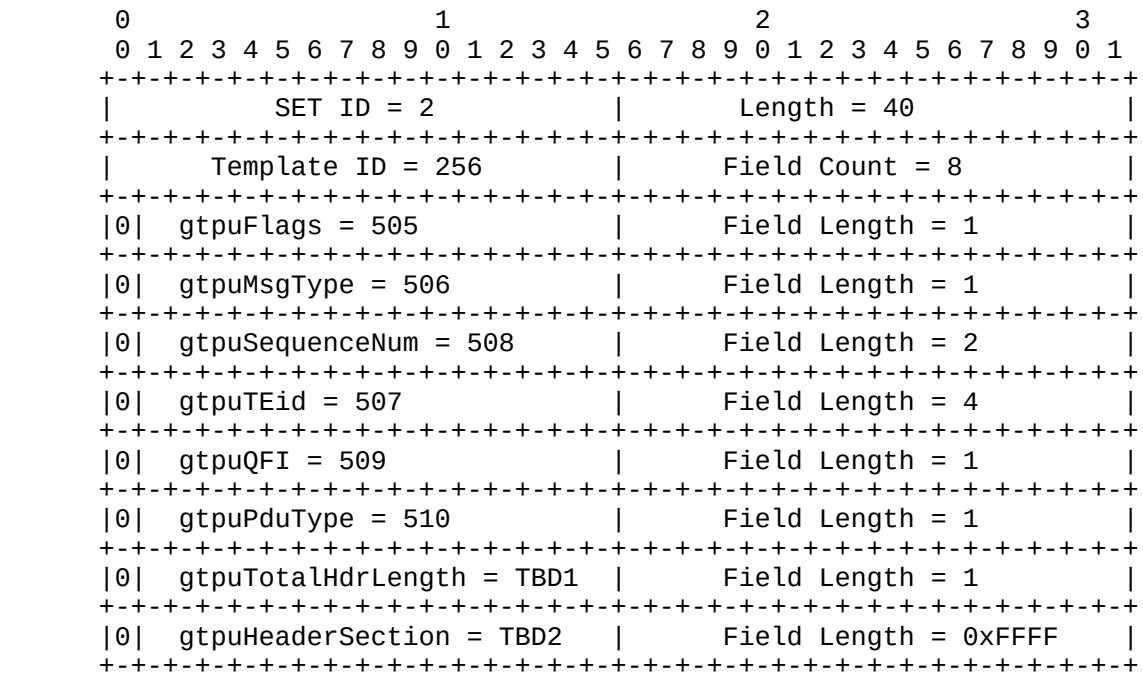


Figure 1: Sample Template Record

In this example, the Template ID is 256, which will be used in the Data Record.

The data set is represented as follows:

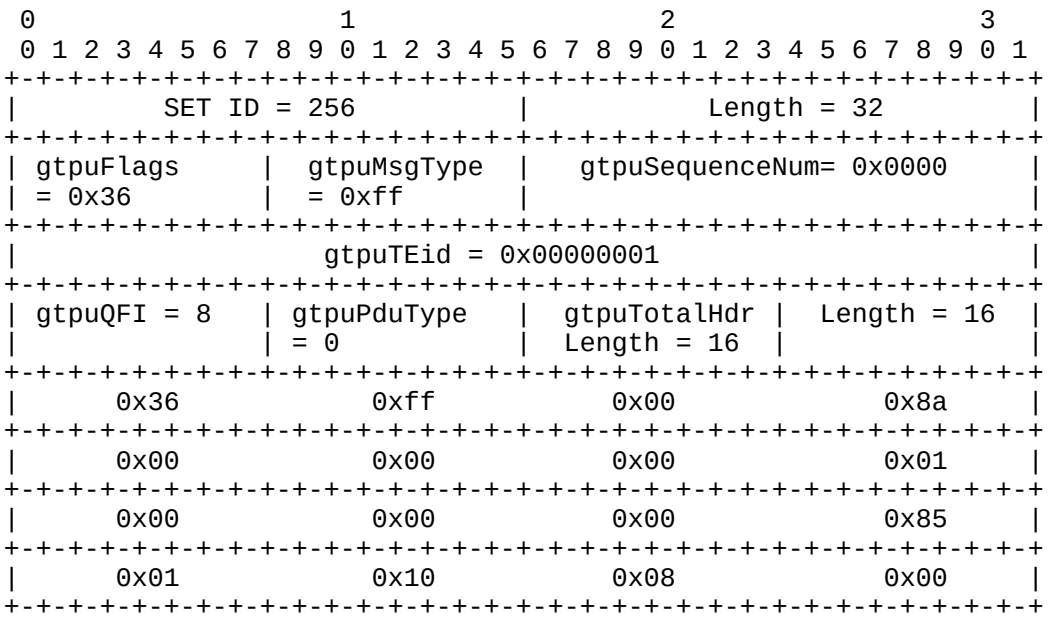


Figure 2: Data Set Encoding Format

Authors' Addresses

Daniel Voyer
Cisco Systems
Email: danvoyerwork@gmail.com

Sriram Gopalakrishnan
Cisco Systems
India
Email: sriragop@cisco.com

Thomas Graf
Swisscom
Email: thomas.graf@swisscom.com

Vyasraj Satyanarayana
Juniper Networks
Email: vyasraj@juniper.net

Cristian Staicu
Bell Canada
Email: cristian.staicu@bell.ca