Operations
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Export of GTP-U Information in IP Flow Information Export (IPFIX)
draft-ietf-opsawg-ipfix-gtpu-00

Abstract

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

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1. Introduction

A dedicated header, called GPRS Tunneling Protocol Header (GTP), is defined by the 3GPP for use of ~~GTP-C Control~~ control plane (GTP Control (GTP-C)) and ~~GTP-Uuser~~ ~~User P~~ plane a(GTP-U) [TS.29281] traffic of mobile subscribers.

This document specifies six IPFIX Information Elements (IEs) [RFC7012] ~~for fields within a~~to export GTP-U ~~header~~information.

Specifically, ~~These~~ 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 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

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

Commenté [BMI1]: Add a statement about the base 3GPP release used to define the IEs.

Commenté [BMI2]: This is true but not sure this adds much to readers of this document. No need IMHO to mention GTP-C explicitly.

Commenté [MB3]: Updated terminology to clarify user plane.

* IPFIX

* IPFIX Information Element~~Elements~~

* Template

* Template Record

* Options Template

* Options Template Record

* Data Record

* Data Set

The document makes use of the 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

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 defined in the GTP-U.

gtpuMsgType
8-bit message type field defined in the GTP-U.

gtpuTEid
32-bit tunnel endpoint identifier field defined in GTP-U which 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 corresponding flag value from gtpuFlags.

gtpuQFI
6-bit QoS flow identifier field defined in PDU Session Container extension header of GTP-U.

gtpuPduType
4-bit PDU Type field defined in PDU Session Container extension header of GTP-U.

Commenté [BMI4]: Is it worth to also report the extension header chain? Also, the peer tunnel endpoint?

Commenté [BMI5]: This covers the version. Not sure «flags» is accurate here.

Commenté [BMI6]: As the header length is variable, is it worth to also export the length as a separate IE?

Commenté [BMI7]: I would mirror this part from the 3GPP spec:

Octets 8 7 6 5 4 3 2 1 1
Version (3bits) PT (*) E S PN

+ some narrative text.

Commenté [BMI8]: At the collector side, the presence of this IE when the S bit is unset should be handled as an anomaly. I wonder some text to cover this is needed.

Commenté [BMI9]: I guess more details are needed to indicate where this information is extracted from.

Commenté [BMI10]: Should a check based on the E bit be done?

dd

4. Sample Use Cases

In order to identify the transport performance of PDU Sessions, e.g., with specific QoS class within a network slice or within a group of network slices hosted on the same User Plane Function (UPF), ~~the GTP User Plane~~ GTP-U related IPRIX IEs would be ~~much~~ helpful.

For example, when ~~in case of one or a couple of dedicated~~a set of UPFs are deployed per 5G slice, the slice is identified first using list of gNodeB IPs composing the slice and list of IPs of UPF ~~User Plane Function~~ dedicated for the slice. The gNodeB and the ~~User Plane Function~~UPF form the tunnel endpoints. Also, the traffic for individual PDU ~~session~~Session per traffic direction is identified using the GTP-U TEID, GTP-U PDU Type together with above mentioned tunnel endpoints. Furthermore, the traffic for specific QoS class within a PDU ~~session~~ 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 there ~~may~~ might be multiple IP flows having the same attributes.

In another scenario when multiple 5G slices ~~are served by~~share the same ~~User Plane Function~~UPF, the slice is identified using a separated list of gNodeB IPv6 addresses per slice. If ~~Intermediate~~ intermediate ~~User Plane Function~~UPF or Uplink Classifier is deployed there is an addition of a GTP-U tunnel between the Intermediate/Uplink-Classifier UPF and the final UPF. These brings a challenge for identifying the ~~end~~ end-~~to~~ to-end path for a certain PDU S~~s~~ession - where 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 tunnel, however the GTP-U TEIDs will be different since this is a different tunnel.

5. IANA Considerations

IANA has ~~added~~ registered the following ~~new~~ IEs ~~to~~ in the "IPFIX Information Elements" registry ~~[RFC7012]~~group available at [IANA-IPFIX].

Table 1 lists the GTP-U IEs:

Element ID	Name

Commenté [BMI11]: Can we cover how IPFIX can help to cover:

«When using GTP-U over IPv6 (see IETF RFC 8200 [36]), the UDP checksum shall not be set to zero by the sending GTP-U entity unless it is ensured that the peer GTP-U entity and the path in-between supports UDP zero checksum. NOTE 1: GTP-U entities complying with an earlier version of the specification or on path IPv6 middleboxes can implement IPv6 as specified in IETF RFC 2460 [15] and discard UDP packets containing a zero checksum. »

Commenté [BMI12]: Given that you use the slice case, can we consider an elaboration based on draft-ietf-dmm-tn-aware-mobility-11 - Mobility aware Transport Network Slicing for 5G , which uses the GTP-U as a means to stitch 5G slice/transport slices?

Commenté [BMI13]: May be add a pointer to https://datatracker.ietf.org/doc/html/draft-ietf-teas-5g-ns-ip-mpls-13#name-5g-network-slicing

Commenté [BMI14]: To avoid confusing them with GTP IEs

Commenté [BMI15]: I guess you meant «IP addresses»?

Commenté [BMI16]: Idem

Commenté [BMI17]: Can we have a reference to back this option?

Commenté [BMI18]: So?

Commenté [BMI19]: Refer to the TEAS document cited above for an example of this option: https://datatracker.ietf.org/doc/html/draft-ietf-teas-5g-ns-ip-mpls-13#name-first-5g-slice-versus-subse

Commenté [BMI20]: Glad to see IPv6 mentioned here, but this is applicable independent of the address family. Right?

Commenté [BMI21]: What's an «intermediate UPF»?

Commenté [BMI22]: This corresponds to which entity in the architecture?

505	gtpuFlags	
506	gtpuMsgType	
507	gtpuTEid	
508	gtpuSequenceNum	
509	gtpuQFI	
510	gtpuPduType	

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

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

5.1. gtpuFlags

Name: gtpuFlags

ElementID: 505

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

Abstract Data Type: unsigned8

Data Type Semantics: flags

Additional Information: Refer to S~~s~~ection 5.1 of ~~the 3GPP specification~~ [TS.29281].

Reference: [RFC-to-be]

5.2. gtpuMsgType

Name: gtpuMsgType

ElementID: 506

Commenté [BMI23]: I would insist that the bits are exported as observed. This allows for example to export the current unassigned bit even if no meaning is associated with it yet.

Commenté [BMI24]: I would say this corresponds to the first byte of the header. The internal structure may change in the future (associate a meaning with the remaining bit).

Commenté [BMI25]: I would delete as this is redundant with the Additional info.

Description: ~~8-bit Message type field indicating~~Indicates ~~-~~the type of the GTP-U Message. ~~-defined in section 5.1 of the 3GPP specification [TS.29281].~~

Commenté [BMI26]: Redundant with the data type

Commenté [BMI27]: I would delete this mention

Abstract Data Type: unsigned8

Data Type Semantics: identifier

Additional Information: Refer to ~~section~~ 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 defined in section 5.1 of the 3GPP specification [TS.29281].~~ This field unambiguously identifies a tunnel endpoint in the receiving GTP-U protocol entity for a given UDP/IP endpoint. The receiving 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 messages.

Commenté [BMI28]: Redundant with the data type

Abstract Data Type: unsigned32

Data Type Semantics: identifier

Additional Information: Refer to S~~s~~ection 5.1 of the 3GPP specification [TS.29281].

Reference: [RFC-to-be]

5.4. gtpuSequenceNum

Name: gtpuSequenceNum

ElementID: 508

Description: ~~16-bit~~ Export the content of the S~~s~~equence ~~number~~ Number ~~f~~Field ~~defined in section 5.1 (Optional Fields) of the 3GPP specification [TS.29281]~~.

Commenté [BMI29]: To match the use on the 3GPP spec.

Abstract Data Type: unsigned16

Data Type Semantics: identifier

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

Reference: [RFC-to-be]

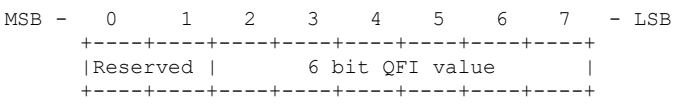
5.5. gtpuQFI

Name: gtpuQFI

ElementID: 509

Description: 6-bit QoS flow identifier field defined in PDU Session Container extension header of GTP-U. ~~This is defined in section 5.5.3.3 of the 3GPP specification [TS.38415].~~ This is used to determine the QoS flow and QoS profile which are associated with the received packet.

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 S~~s~~ection 5.5.3.3 of the 3GPP specification [TS.38415] and S~~s~~ection 5.7.1.1 ~~from~~ of the 3GPP specification [TS.23501] for additional details.

Commenté [BMI30]: Explicit which details

Reference: [RFC-to-be]

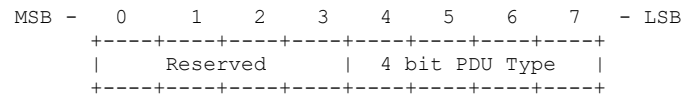
5.6. gtpuPduType

Name: gtpuPduType

ElementID: 510

Description: 4-bit PDU type field defined in PDU Session Container extension header of GTP-U. ~~This is defined in section 5.5.3 of the 3GPP specification [TS.38415].~~ This field indicates the structure of the PDU session user plane frame.

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~~ Section 5.5.3 of the 3GPP specification [TS.38415].

Reference: [RFC-to-be]

6. Acknowledgements

The authors would like to thank Ketan Talaulikar and Dhananjay Patki for their reviews and valuable comments.

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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 ~~exists~~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 ~~metrics~~information on how packets are being forwarded in a ~~5G~~ 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 ~~extensions~~ IEs defined in this ~~draft~~ document require~~s~~ ~~deep parsing and~~ extraction of fields from ~~the~~ packet~~s~~. 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

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

[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>.

[RFC8126] Cotton, M., Leiba, B., and T. Narten, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 8126, DOI 10.17487/RFC8126, June 2017, <https://www.rfc-editor.org/info/rfc8126>.

[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

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

Appendix A. IPFIX Encoding Examples

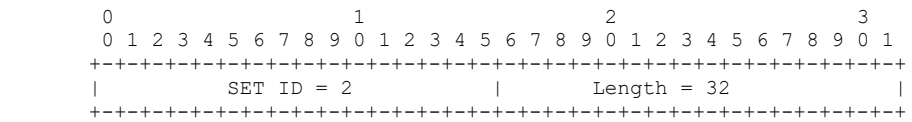
In this section, an example is provided to show IPFIX encoding format for the GTP-U introduced IEs. Template definition and data set corresponding to an observed GTP-U header is illustrated below.

Observed GTP-U Header:
Flags = 0x36, Message Type = 0xff, TEID = 0x1,
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:



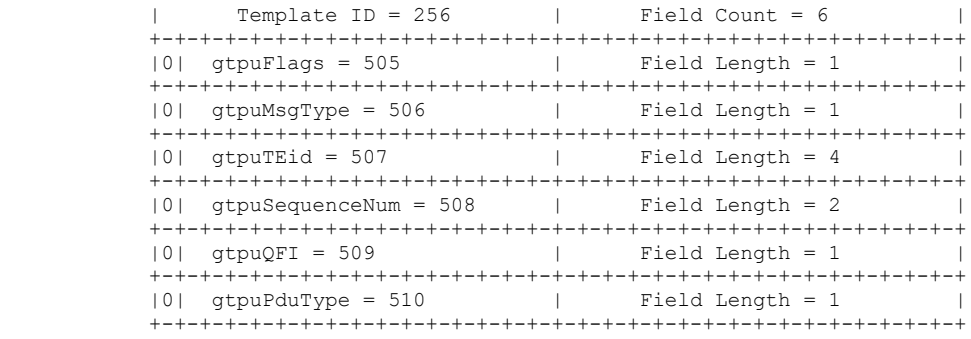


Figure 1: Sample Template Record

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

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