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Export of Gigabit Passive Optical Network Encapsulation Mode in IP Flow Information Export (IPFIX)

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Abstract

This document introduces new IP Flow Information Export (IPFIX) Information Elements to identify a set of G-PON Encapsulation Method entities in the Passive Optical Transport of the Optical Distribution Network.

Status of This Memo

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

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This Internet-Draft will expire on 17 November 2026.

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1. Introduction

The G-PON Encapsulation Method (GEM) data plane header defined in Section 8.3.1 of [itu-g984-3] and XG-PON Encapsulation Method (XGEM) data plane header defined in Section 9.1.2 of [itu-g9804-2] facilitates the framing, error control, encryption keying, payload type identification and payload separation in the Optical Distribution Network. It is being used in the Optical Distribution Network between the Optical Line Termination (OLT) at the network operator and the Optical Network Unit (ONU), Optical Network Terminal (ONT) at the end user in the passive optical transport within the broadband access domain.

IPFIX is widely applied in the broadband access domain to gain visibility into the forwarding and data plane. However, that visibility is today constraint to the ethernet, IP and application transport properties of the data plane.

This document specifies two IPFIX Information Elements (IEs) to facilitate visibility in the GEM and XGEM data plane.

Figure 1 shows the GEM frame, the GEM header and its properties.

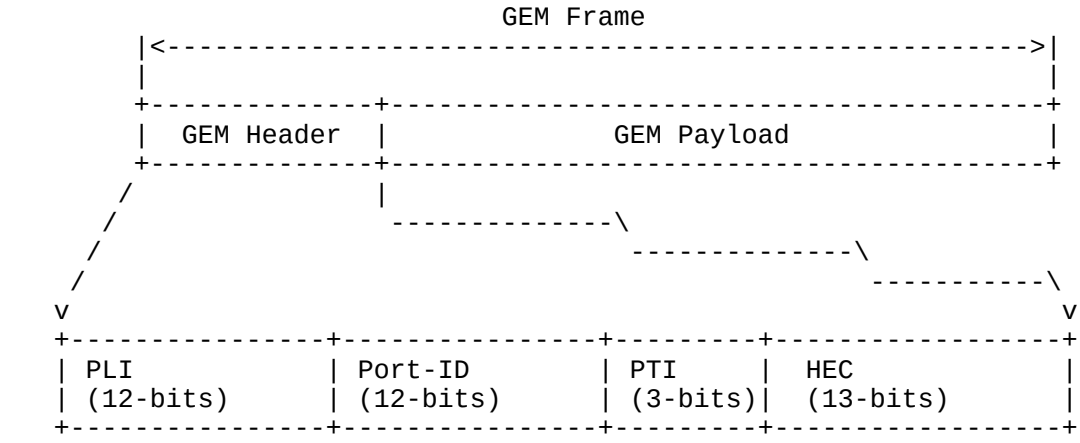

Figure 1: G.984.3 GEM header and frame structure

Figure 2 shows the XGEM frame, the XGEM header and its properties.

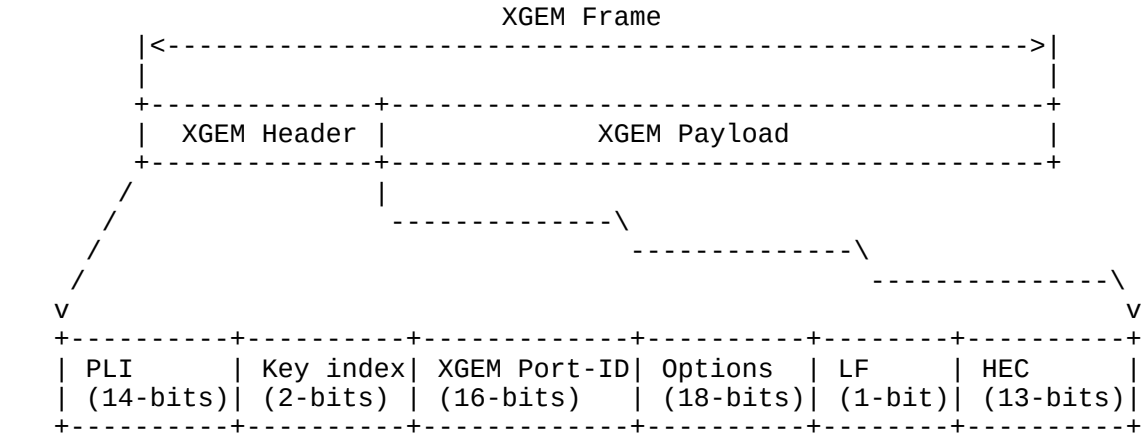

Figure 2: G.9804.2 XGEM header and frame structure

These IEs are used to export the GEM resp. XGEM Port-ID and PTI to enable the distinction between user service and user and OAM application frames.

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], [itu-g984-3], and [itu-g9804-1].

The following terms are used as defined in [RFC7011]:

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

The following terms are used as defined in [itu-g9804-1]:

* Optical Access Network (OAN)
* Optical Distribution Network (ODN)
* Optical Line Termination (OLT)
* Optical Network Termination (ONT)
* Optical Network Unit (ONU)
* Gigabit-capable Passive Optical Network (G-PON)
* 10-Gigabit Passive Optical Network (XG-PON)
* 10-Gigabit-capable PON encapsulation method (XGEM) port

The following terms are used as defined in [itu-g984-3]:

* G-PON Encapsulation Method (GEM)

* GEM Port

3. New IPFIX G-PON GEM Elements

This section specifies the new IPFIX G-PON GEM IEs.

ingressGponGemPti
: 3-bit GEM PTI content type field defined in Section 8.3.1 of [itu-g984-3] associated with ingress interface. The values are encoded in the 3 least significant bits of the IE.

egressGponGemPti
: 3-bit GEM PTI content type field defined in Section 8.3.1 of [itu-g984-3] associated with egress interface. The values are encoded in the 3 least significant bits of the IE.

ingressGponGemPortId
: 12-bit GEM Port-ID field defined in Section 8.3.1 of [itu-g984-3] and XGEM Port-ID field in Section 9.1.2 of [itu-g9804-2] associated with ingress interface. The values are encoded in the 12 least significant bits of the IE.

egressGponGemPortId
: 12-bit GEM Port-ID field defined in Section 8.3.1 of [itu-g984-3] and XGEM Port-ID field in Section 9.1.2 of [itu-g9804-2] associated with egress interface. The values are encoded in the 12 least significant bits of the IE.

4. Sample Use Cases

The IPFIX IEs ingressGponGemPti (TBD1), egressGponGemPti (TBD2), ingressGponGemPortId (TBD3), egressGponGemPortId (TBD4), sourceMacAddress (56), destinationMacAddress (80), ingressInterface (10), egressInterface (14) and forwardingStatus (89)[RFC5102] [RFC7270] [IANA-IPFIX], and some existing counter information [IANA-IPFIX] providing answers to the following questions (among others):

* How many user or OAM data fragments are forwarded or dropped to which ONU on which egress interface and GEM Port-ID?

* If dropped, for which reasons?

The received ONU frames on an OLT are mapped and forwarded depending on GEM Port-ID to a dot1qVlanId (243) and dot1qPriority (244) upstream to the provider network.

5. IANA Considerations

Note to the RFC-Editor:

* Please replace TBD1 - TBD4 with the values allocated by IANA

* Please replace the [RFC-to-be] with the RFC number assigned to this document

5.1. New IPFIX G-PON GEM Information Elements

This document requests IANA to add new IEs (Section 5.1) to the "IPFIX Information Elements" registry [RFC7012] available at [IANA-IPFIX].

Table 1 lists the new G-PON GEM IEs:

Element ID	Name
TBD1	ingressGponGemPti
TBD2	egressGponGemPti
TBD3	ingressGponGemPortId
TBD4	egressGponGemPortId

Table 1: New G-PON GEM IEs in the "IPFIX Information Elements" Registry

5.1.1. ingressGponGemPti

Name: ingressGponGemPti

ElementID: TBD1

Description: Values for this Information Element are listed in the "G-PON Encapsulation Method PTI" subregistry, see [IANA-IPFIX].

Abstract Data Type: unsigned8

Data Type Semantics: flags

Range: The valid range is 0-7.

Additional Information: See the assigned types in [IPFIX G-PON Encapsulation Method PTI Subregistry] associated with ingress interface. The values are encoded in the 3 least significant bits of the IE.

Note to IANA: Please replace [IPFIX G-PON Encapsulation Method PTI Subregistry] with the URL of the IANA subregistry.

Reference: [RFC-to-be]

5.1.2. egressGponGemPti

Name: ingressGponGemPti

ElementID: TBD1

Description: Values for this Information Element are listed in the "G-PON Encapsulation Method PTI" subregistry, see [IANA-IPFIX].

Abstract Data Type: unsigned8

Data Type Semantics: flags

Range: The valid range is 0-7.

Additional Information: See the assigned types in [IPFIX G-PON Encapsulation Method PTI Subregistry] associated with egress interface. The values are encoded in the 3 least significant bits of the IE.

Note to IANA: Please replace [IPFIX G-PON Encapsulation Method PTI Subregistry] with the URL of the IANA subregistry.

Reference: [RFC-to-be]

5.1.3. ingressGponGemPortId

Name: ingressGponGemPortId

ElementID: TBD2

Description: The 12-bit GEM Port-ID field defined in Section 8.3.1 of [itu-g984-3] and XGEM Port-ID field in Section 9.1.2 [itu-g9804-2] associated with an ingress interface.

Abstract Data Type: unsigned16

Data Type Semantics: identifier

Additional Information: The values are encoded in the 12 least significant bits of the IE.

Reference: [RFC-to-be]

5.1.4. egressGponGemPortId

Name: ingressGponGemPortId

ElementID: TBD2

Description: The 12-bit GEM Port-ID field defined in Section 8.3.1 of [itu-g984-3] and XGEM Port-ID field in Section 9.1.2 [itu-g9804-2] associated with an egress interface.

Abstract Data Type: unsigned16

Data Type Semantics: identifier

Additional Information: The values are encoded in the 12 least significant bits of the IE.

Reference: [RFC-to-be]

5.1.5. G-PON Encapsulation Method PTI Subregistry

This document requests IANA to create a new subregistry called "IPFIX G-PON Encapsulation Method PTI" under the "IPFIX Information Elements" registry [RFC7012] available at [IANA-IPFIX].

The allocation policy of this new subregistry is Expert Review (Section 4.5 of [RFC8126]).

The designated experts for this registry should be familiar with the G-PON Encapsulation Method. The guidelines that are being followed by the designated experts for the IPFIX registry should be followed for this subregistry. In particular, criteria that should be applied by the designated experts include to monitor the G-PON Encapsulation Method related activities at ITU-T and mirror the GEM PTI content type fields into this registry. Hence, keeping both registries in sync.

Initial values in the registry are defined in Table 2 and reflect the 3-bit GEM PTI content type field defined in Section 8.3.1 of [itu-g984-3].

Value	GEM PTI Content Type Meaning	Additional Information
000	User data fragment, not the end of a frame	[RFC-to-be]
001	User data fragment, end of a frame	[RFC-to-be]
010	Reserved	[RFC-to-be]
011	Reserved	[RFC-to-be]
100	GEM OAM, not the end of a frame	[RFC-to-be]
101	GEM OAM, end of a frame	[RFC-to-be]
110	Reserved	[RFC-to-be]
111	Reserved	[RFC-to-be]

Table 2: "IPFIX G-PON Encapsulation Method PTI" Subregistry

6. Acknowledgements

The authors would like to thank Paul Aitken and Nuno Andr迪 for their review and valuable comments, and Xiao Chen, Jian Ping Zhang, Jiale Li and Chongfeng Xie for the implementation and validation.

7. Implementation Status

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

7.1. Huawei MA5800T-X17

Huawei plans to implement the following IEs as part of a production implementation in the VRP based MA5800T-X17 OLT platform:

* ingressGponGemPortId

* egressGponGemPortId

The implementation has been validated at IETF 125 hackathon.

8. Security Considerations

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

The IEs described in this document export provider plane data metrics on how frames are being forwarded within an Optical Access 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.

9. References

9.1. Normative References

[itu-g9804-1]
"G.9804.1", ITU-T, International Telecommunication Union, November 2019, <https://www.itu.int/rec/T-REC-G.9804.1>.

[itu-g9804-2]
"G.9804.2", ITU-T, International Telecommunication Union, September 2021, <https://www.itu.int/rec/T-REC-G.9804.2>.

[itu-g984-3]
"G.984.3", ITU-T, International Telecommunication Union, January 2014, <https://www.itu.int/rec/T-REC-G.984.3>.

[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>.

[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>.

9.2. Informative References

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

[RFC5102] Quittek, J., Bryant, S., Claise, B., Aitken, P., and J. Meyer, "Information Model for IP Flow Information Export", RFC 5102, DOI 10.17487/RFC5102, January 2008, <https://www.rfc-editor.org/info/rfc5102>.

[RFC7270] Yourtchenko, A., Aitken, P., and B. Claise, "Cisco-Specific Information Elements Reused in IP Flow Information Export (IPFIX)", RFC 7270, DOI 10.17487/RFC7270, June 2014, <https://www.rfc-editor.org/info/rfc7270>.

Appendix A. IPFIX Encoding Examples

This appendix represents an encoding for the newly introduced IEs, for the example values in Table 3. The encoding uses the following IEs, respectively: ingressGponGemPti, egressGponGemPti, ingressGponGemPortId, egressGponGemPortId, sourceMacAddress, and destinationMacAddress.

Ingress GEM Port	Egress GEM Port	Ingress GEM PTI	Egress GEM PTI	Source Mac Address	Destination Mac Address
10	0	0	0	00:00:5E:00:53:01	00:00:5E:00:53:02
0	10	0	0	00:00:5E:00:53:02	00:00:5E:00:53:01
20	0	100	0	00:00:5E:00:53:01	00:00:5E:00:53:02
0	20	0	100	00:00:5E:00:53:02	00:00:5E:00:53:01

Table 3: Two Ingress or Egress Observed GEM headers and Their Associated MAC Adresses

With encoding in Figure 3, the examples in Table 3 are represented with the following IEs: “=>” is used to indicate which IE is mapped to a given information.

* Ingress GEM PTI => ingressGponGemPti (TBD1)

* Egress GEM PTI => egressGponGemPti (TBD2)

* Ingress GEM Port => ingressGponGemPortId (TBD3)

* Egress GEM Port => egressGponGemPortId (TBD4)

* Source Mac Address => sourceMacAddress (56)

* Destination Mac Address => destinationMacAddress (80)

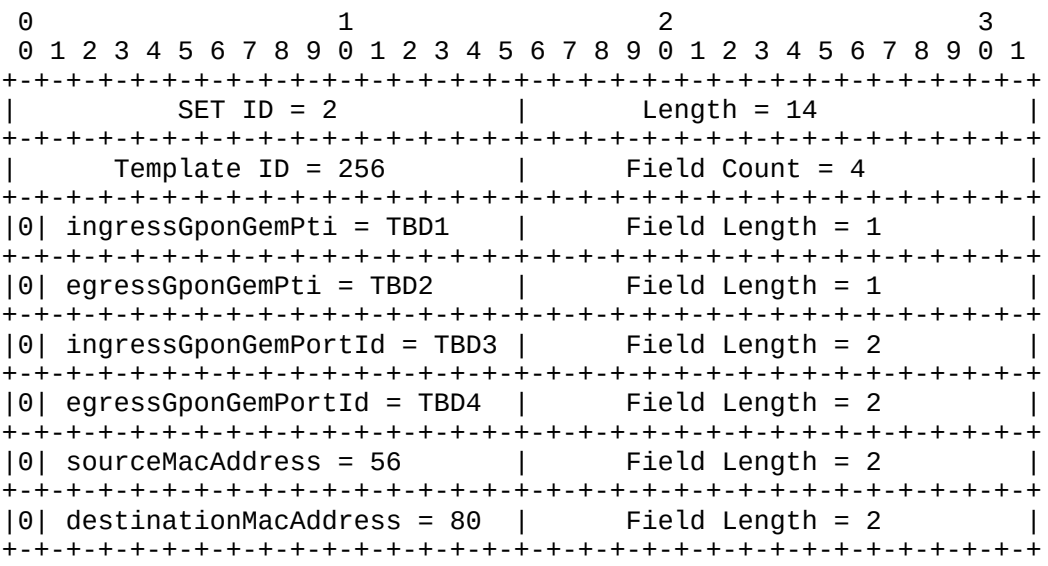

Figure 3: Template Record with Ingress and Egress GEM Port IDs and GEM PTIs and Source and Destination MAC Addresses

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

The data set is represented as follows:

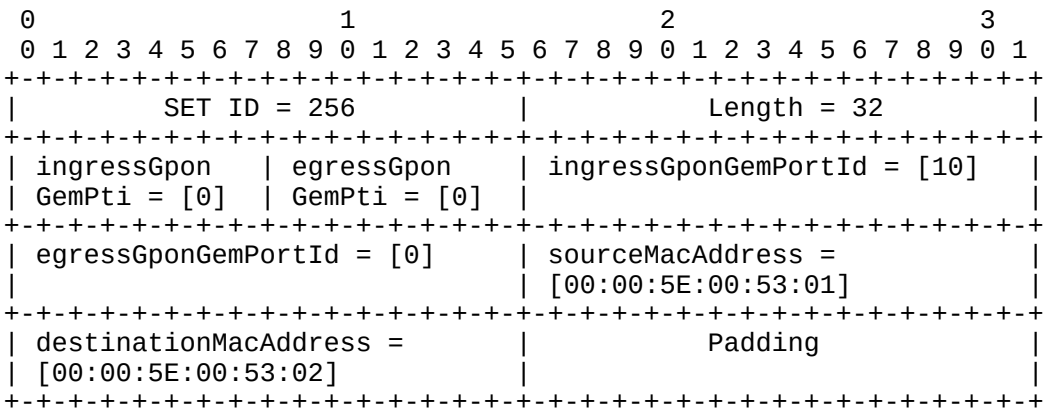

Figure 3: Data Record with Ingress and Egress GEM Port IDs and GEM PTIs and Source and Destination MAC Addresses

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