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5G Wireless Wireline Convergence User Plane Encapsulation (5WE)

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Abstract

As part of providing wireline access to the 5G Core (5GC), deployed wireline networks carry user data between 5G residential gateways and the 5G Access Gateway Function (AGF). The encapsulation method specified in this document supports the multiplexing of traffic for multiple PDU sessions within a VLAN delineated access circuit, permits legacy equipment in the data path to inspect certain packet fields, carries 5G QoS information associated with the packet data, and provides efficient encoding. It achieves this by specific points of similarity with the RFC 2516 PPPoE data packet encapsulation.

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1. Introduction

Converged 5G ("fifth generation") wireline networks carry user data between 5G residential gateways (5G-RG) and the 5G Access Gateway Function (identified as a Wireline-AGF (W-AGF) by 3GPP in [TS23316]) across deployed access networks based on Broadband Forum [TR101] and [TR178]. This form of wireline access is considered to be trusted non-3GPP access by the 5G system.

The transport encapsulation used needs to meet a variety of requirements including the following:

- The ability to multiplex multiple logical connections (Protocol Data Unit (PDU) Sessions as defined by 3GPP) within a VLAN identified point to point logical circuit between a 5G-RG and a W-AGF.

- To allow unmodified legacy equipment in the data path to identify the encapsulation and inspect specific fields in the payload. Some access nodes in the data path between the 5G-RG and the W-AGF (Such as digital subscriber loop access multiplexers (DSLAMs) and optical line terminations (OLTs)) currently inspect packets identified by specific Ethertypes to identify protocols such as

the point to point protocol over ethernet (PPPoE), IP, ARP, and IGMP. This may be for the purpose of enhanced QoS, policing of identifiers and other applications. Some deployments are dependent upon this inspection. Such devices are able to do this for PPPoE or IP over ethernet (IPoE) packet encodings but would be unable to do so if a completely new encapsulation, or an existing encapsulation using a new Ethertype, were used.

- To carry per packet 5G QoS information.

- Fixed access residential gateways are sensitive to the complexity of packet processing, therefore an encapsulation that minimizes processing is an important consideration.

A data encapsulation that uses a common Ethertype and has certain fields appearing at the same offset as the PPPoE [RFC2516] data encapsulation can address these requirements. This data encapsulation is referred to as the 5G WWC user plane Encapsulation or 5WE. Currently deployed access nodes do not police the VER, TYPE and CODE fields of an RFC 2516 header, and only perform limited policing of stateful functions with respect to the procedures documented in RFC 2516. Therefore, these fields have a different definition for 5WE and are used to:

- Identify that the mode of operation for packets encapsulated in such a fashion uses non-access stratum (NAS, a logical control interface between user equipment (UE) and 5GC as specified by 3GPP) based 5G WWC session establishment and life cycle maintenance procedures as documented in [TS23502][TS23316] instead of legacy PPP/PPPoE session establishment procedures (i.e. PADI discipline, LCP, NCP etc.). In this scenario "discovery" is performed by means outside the scope of this document.

- Permit the session ID field to be used to identify the 5G PDU session the encapsulated packet is part of.

- Communicate per-packet 5G QoS Flow Identifier (QFI) and Reflective QoS Indication (RQI) information from the 5GC to the 5G-RG.

This 5G specific redesign of fields not inspected by deployed equipment results in an encapsulation uniquely applicable to the requirements for the communication of PDU session traffic between the subscriber premises and the 5G system over wireline networks. The 6 byte RFC 2516 data packet header followed by a 2 byte PPP protocol ID is also the most frugal of the encapsulations that are

currently supported by legacy access equipment that could be adapted to meet these requirements.

This encapsulation is expected to be used in environments where RFC 2516 is deployed. Therefore, implementations MUST examine the version number:

- if the version number is 1, and PPPoE [RFC2516] is supported, process the frame further, else silently discard it.

- if the version number is 2 and 5WE is supported, process the frame further, else silently discard it.

In both cases frames for the supported version number should have session IDs corresponding to established sessions for the respective protocol models. A 5WE frame with an unrecognized session ID MUST be silently discarded.

This encapsulation may have MTU issues when used for Ethernet multiplexing in networks where the underlying Ethernet payload is limited to 1500 bytes.

This encapsulation is not suitable for other network environments, e.g., general use over the public Internet.

1.1. Requirements Language

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.

1.2. Acronyms

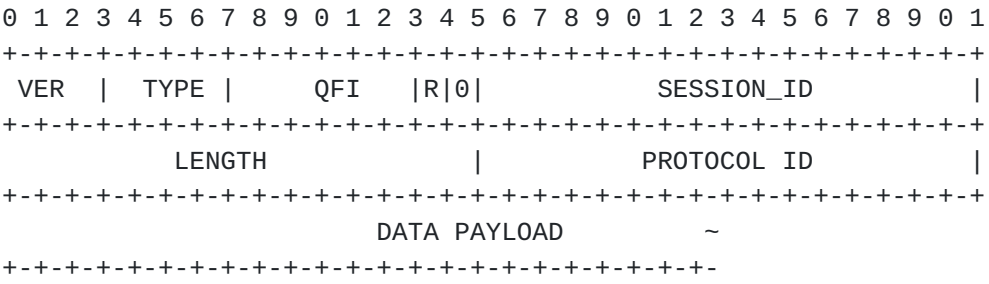
This document uses the following acronyms:

3GPP	3rd Generation Partnership Project
5WE	5G WWC Encapsulation
5GC	5th Generation Core (network)
DSLAM	Digital Subscriber Loop Access Multiplexer
W-AGF	Wireline Access Gateway Function
IPoE	IP over Ethernet
NAS	Non-Access Stratum
OLT	Optical Line Termination
PDU	Protocol Data Unit

PPPoE PPP over Ethernet
QFI QoS Flow Identifier
QoS Quality of Service
RG Residential Gateway
RQI Reflective QoS Indicator
WWC Wireless Wireline Convergence

2. Data Encapsulation Format

The Ethernet payload [IEEE802] for PPPoE [RFC2516] is indicated by an Ethertype of 0x8864. The information following that Ethertype uses a value of 2 in the VER field for the repurposing of the PPPoE data encapsulation as the 5G WWC user plane encapsulation (5WE). The 5G WWC User Plane encapsulation is structured as follows:



The description of each field is as follows:

VER is the version. It MUST be set to 0x02.

TYPE is the message type. It MUST be set to 0x01.

QFI encodes the 3GPP 5G QoS Flow Identifier [TS38415] to be used for mapping 5G QoS to IP DSCP/802.1 P-bits [IEEE802].

R (short for Reflective QoS Indication [TS38415]) encodes the one bit RQI. It is set by the network side 5WE termination for downstream traffic and ignored by the network for upstream traffic.

0 indicates the bit(s) MUST be sent as zero and ignored on receipt.

SESSION_ID is a 16-bit unsigned integer in network byte order. It is used to distinguish different PDU sessions that are in the VLAN delineated multiplex. A value of 0xffff is reserved for future use and MUST NOT be used.

LENGTH is the length in bytes of the data payload including

the initial Protocol ID. It is 16 bits in network byte order.

PROTOCOL ID is the 16 bit identifier of the data payload type encoded using values from the IANA PPP DLL protocol numbers registry. (https://www.iana.org/assignments/ppp-numbers/ppp-numbers.xhtml#ppp-numbers-2)

The following values are valid in this field for 5G WWC use:

0x0021: IPv4

0x0031: Ethernet (referred to in PPP as "bridging")

0x0057: IPv6

Packets received that do not contain one of the above protocol IDs are silently discarded.

DATA PAYLOAD is encoded as per the protocol ID.

3. Acknowledgements

This memo is a result of comprehensive discussions by the Broadband Forum's Wireline Wireless Convergence Work Area.
The authors would also like to thank Joel Halpern and Dirk Von Hugo for their detailed review of this draft.

4. Security Considerations

5G NAS procedures used for session life cycle maintenance employ ciphering and integrity protection [TS23502]. They can be considered to be a more secure session establishment discipline than existing RFC 2516 procedures, at least against on path attackers.
The design of the 5WE encapsulation will not circumvent existing anti-spoofing and other security procedures in deployed equipment. The existing access equipment will be able to identify fields that they normally process and policed as per existing RFC 2516 traffic.

Therefore, the security of a fixed access network using 5WE will be equivalent or superior to current practice.

5WE encapsulated traffic is used on what the 5GC considers to be trusted non-3GPP interfaces, therefore is not ciphered. 5WE is not suitable for use over an untrusted non-3GPP interface.

The security requirements of the 5G system are documented in [TS33501]

5. IANA Considerations

IANA is requested to create a registry on the Point-to-Point (PPP) Protocol Field Assignments IANA Web page as follows:

Registry Name: PPP Over Ethernet Versions
Registration Procedure: Specification Required
References: [RFC2516] [this document]

VER	Description	Reference
0	reserved	[this document]
1	PPPoE	[RFC2516]
2	5G WWC User Plane Encapsulation	[this document]
3-15	unassigned	[this document]

IANA is requested to add [this document] as an additional reference for Ethertype 0x8864 in the Ethertypes table on the IANA "IEEE 802 Numbers" web page.(https://www.iana.org/assignments/ieee-802-numbers/ieee-802-numbers.xhtml#ieee-802-numbers-1)

6. References

6.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[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>.

[RFC2516] "A Method for Transmitting PPP Over Ethernet (PPPoE)", IETF RFC 2516, February 1999

[TS38415] 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NG-RAN; PDU Session User Plane Protocol (Release 15), 3GPP TS38.415

[TS23502] 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Procedures for the 5G System (Release 16), 3GPP TS23.502

[TS23316] 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Wireless and wireline convergence access support for the 5G System (5GS) (Release 16), 3GPP TS23.316, November 2018

6.2. Informative References

[TR101] "Migration to Ethernet Based Broadband Aggregation", Broadband Forum Technical Report: TR-101 issue 2, July 2011

[TR178] "Multi-service Broadband Network Architecture and Nodal Requirements", Broadband Forum Technical Report: TR-178, September 2014

[IEEE802] 802, IEEE, "IEEE Standard for Local and Metropolitan Networks: Overview and Architecture", IEEE Std 802-2014.

[TS33501] 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Security Architecture and Procedures for 5G System (Release 16), 3GPP TS33.501, December 2019

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