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5G Fixed Mobile Convergence User Plane Encapsulation

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Abstract

As part of providing wireline access to the 5G core, deployed wireline networks carry user data between 5G residential gateways and the 5G Access Gateway Function (AGF). The encapsulation used needs to meet a variety of requirements including being able to multiplex the traffic of multiple PDU sessions within a VLAN delineated access circuit, to permit legacy equipment in the data path to snoop certain packet fields, to carry 5G QoS information associated with the data, and to be efficiently encoded. This memo specifies an encapsulation that meets these requirements.

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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 an F-AGF in [5]) across deployed TR-101[6] and TR-178[7] access networks.

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

- The ability to multiplex multiple logical connections (PDU sessions) within a VLAN identified p2p logical circuit between a 5G-RG and an F-AGF.

- To allow unmodified legacy equipment in the datapath to identify the encapsulation and snoop specific fields in the payload. Some access nodes in the data path between the 5G-RG and the F-AGF (Such as DSLAMs and OLTs) currently snoop into packets identified by specific ethertypes to identify protocols such as PPPoE, IP, ARP and IGMP. This may be for the purpose of enhanced QoS, policing of identifiers and other applications. Some deployments are depended upon this snooping. Such devices are currently able to do so for PPPoE or IPoE packet encodings but would be unable to do so if a new encapsulation, or an existing encapsulation using a new ethertype, were used.

- To carry per packet 5G QoS information.

- Fixed access is very sensitive to the complexity of residential gateways, therefore encapsulation overhead and efficiency is an important consideration.

A modified RFC 2516[3] PPPoE data encapsulation can address these requirements. 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 may be repurposed to:

- Identify that the mode of operation for packets encapsulated in such a fashion uses control plane (NAS) based 5G FMC session establishment and life cycle maintenance procedures as documented in [4][5] instead of legacy PPP/PPPoE session establishment procedures (i.e. PADI discipline, LCP, NCP etc.).

- 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 Reverse QoS Indication (RQI) information from the 5GC core to the 5G-RG.

The 8 byte RFC 2516 data packet header is the most frugal of the encapsulations that are currently supported by legacy access equipment that can also meet all the requirements.

1.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

1.2. Acronyms

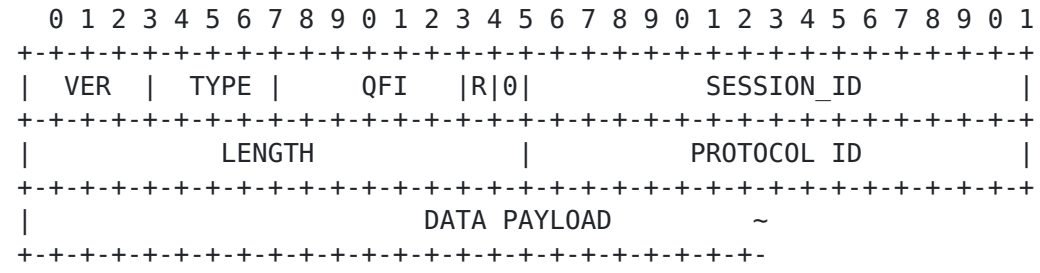
This document uses the following acronyms:

DSLAM Digital Subscriber Loop Access Multiplexer
F-AGF Fixed Network Access Gateway Function
FMC Fixed Mobile Convergence
IPoE IP over Ethernet
NAS Non-Access Stratum
OLT Optical Line Termination

PPPoE PPP over Ethernet
QFI QoS Flow Identifier
RG Residential Gateway
RQI Reverse QoS Indicator

2. Data Encapsulation Format

PPPoE data packet encapsulation is indicated in an IEEE 802[8] Ethernet frame by an ethertype of 0x8864. The information following that ethertype for the repurposing of the PPPoE data encapsulation as the 5G FMC user plane encapsulation uses a value of 2 in the VER field. The 5G FMC User Plane encapsulation is structured as follows:



The description of each field is as follows:

VER is the version. It MUST be set to 2.

TYPE is the message type. It MUST be set to 1.

QFI encodes the 3GPP 5G QoS Flow Identifier to be used for mapping
5G QoS to IP DSCP/802.1 P-bits[9].

R (short for RQI) encodes the one bit Reflective QoS Indicator

0 indicates the bit(s) MUST be set to zero

SESSION_ID is a 16-bit unsigned integer. It is used to distinguish different PDU sessions that are in the VLAN delineated multiplex.

LENGTH is the length in bytes of the data payload including the initial Protocol ID.

PROTOCOL ID is the 16 bit identifier of the data payload type encoded as per RFC 2516. The following values are valid in

this field for 5G FMC use:

0x0021: IPv4

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

0x0057: IPv6

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 for his detailed review of this draft.

4. Security Considerations

5G NAS procedures used for session life cycle maintenance employ ciphering and integrity protection therefore can be considered to be a more secure session establishment discipline than existing RFC 2516 procedures, at least against man in the middle attacks.

The re-purposing of the RFC 2516 data 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 police as per existing RFC 2516 traffic.

Therefore the security of an access network will be equivalent or superior to current practice.

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: Expert Review
References: [RFC2516] [this document]

VER	Description	Reference
0	reserved	[this document]
1	Classic PPPoE	[RFC2516]

2	5G FMC 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.

6. References

6.1. Normative References

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

[2] 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>.

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

6.2. Informative References

[4] 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Procedures for the 5G System (Release 16), 3GPP TS23.502

[5] 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Study on the Wireless and Wireline Convergence for the 5G system architecture (Release 16), 3GPP TR23.716, November 2018

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

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

[8] 802, IEEE, "IEEE Standard for Local and Metropolitan Networks: Overview and Architecture", IEEE Std 802-2014.

[9] 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NG-RAN; PDU Session User Plane Protocol (Release 15), 3GPP TS38.415

[10] "IANA Considerations for PPPoE", IETF RFC 4937, June 2007

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