5G Fixed Mobile Convergence User Plane Encapsulation
                draft-allan-5g-fmc-encapsulation-01

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 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](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 Fixed-AGF (FAGF) by 3GPP 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 (Protocol
   Data Unit (PDU) Sessions as defined by 3GPP) 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 non-access stratum(NAS, a logical control
  interface between UE and 5GC as specified by 3GPP) 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
  Reflective QoS Indication (RQI) information from the 5GC 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   Reflective 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:

```
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |  VER  | TYPE  |    QFI    |R|0|           SESSION_ID          |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |            LENGTH             |           PROTOCOL ID         |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                       DATA PAYLOAD         ~
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
```

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 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 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 a fixed 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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