**3GPP SA WG2 Meeting #154 S2-2210222**

**14 - 18 November, 2022, Toulouse, France (revision of S2-221xxxx)**

**Source: Intel**

**Title: KI#4, KI#5: Additional conclusion on PDU Set Information identification**

**Document for: Approval**

**Agenda Item: 9.19.1**

**Work Item / Release: FS\_XRM / Rel-18**

*Abstract of the contribution: This paper proposes additional conclusions for KI#4 and KI#5 related to support of GTP-U encapsulation on N6 for carrying PDU Set Identification information.*

# 1 Discussion on PDU Set Information identification

SA2#153e agreed to support the option where the PDU Set Information is derived at the PSA UPF based on Deep Packet Inspection (DPI) of the RTP/SRTP header and payload based on “instruction from SMF”:

*The detection and marking of the DL PDU Sets sent to the NG-RAN shall be done by the PSA UPF.*

*PSA UPF may identify the PDU Set based on instruction from SMF and packet header of N6 protocols:*

*- by matching RTP/SRTP header and payload (RFC 3550/3711/6184/7798/draft-ietf-avtcore-rtp-vvc/draft-ietf-avtext-framemarking are supported).*

*Editor's note: Whether support PDU Set identification information in new RTP is pending to SA WG4 5G\_RTP WI.*

*NOTE: In above cases, it is assumed that the RTP/SRTP header and/or payload necessary for the identification of PDU Set Information is not encrypted.*

The door is still open for support of additional options, as indicated in the following Editor’ note:

*Editor's note:* *Other N6 protocols, i.e. HTTP/MASQUE, GTP-U, IP/TCP/UDP/QUIC options, carrying PDU Set information are FFS. (Potential SoH).*

While we accept the majority’s view to progress solutions based on “matching RTP/SRTP header and payload” to normative stage, we argue that these solutions are quite complex in that they need to provide “PDU Set Identification” rules to the UPF that are: a) protocol-specific and b) require UPF to perform Deep Packet Inspection (DPI) that goes far beyond the traditional 5-tuple. The processing itself is much more than “pattern matching”, because the UPF needs to keep track of PDU Sequence Numbers and/or start/stop markers, and insert them in the GTP-U header on N3.

Consider for instance the PDU Set identification based on RTP header extension described in TR 23.700-60 Figure 6.24.3.2.1-1 (Solution #24):



Figure 6.24.3.2.1-1: Frame Marking RTP header extension for non-scalable streams

The “S” and “E” bits in the RTP header extension (as per draft-ietf-avtext-framemarking) are used to indicate the first and last packet in the “frame” (i.e. in the media unit). These two bits would be used by the PSA UPF to determine the first and last PDU in the PDU Set.

The “I” and “D” bits in the RTP header extension are used to identify “Independent” and “Discardable” frames. These two bits together would be used by the PSA UPF to determine the “PDU Set Importance” parameter.

It should be noted that:

- The RTP header extension containing the “S”, “E, “I” and “D” bits is embedded deep inside the RTP packet (at least 20 bytes away from the UDP header of the traditional IP 5-tuple).

- The RTP header extension containing the “S”, “E, “I” and “D” bits is embedded at a variable depth (e.g. it depends on the number of contributing sources indicated by the “CC” field).

Consider next the PDU Set identification based on NAL unit header described in TR 23.700-60 Figure 6.12.3.2-3 (Solution #12):



Figure 6.12.3.2-3: NAL unit header format for H.264

When NAL unit header is used, the PSA UPF is again assumed to rely on the “S” and “E” bit inside the Fragmentation Unit (FU) header for deriving the first and last PDU of a PDU Set, while the “NRI” field could be used for deriving the “PDU Set Importance”. The same observations apply as for the use of RTP extension header i.e. the relevant bits of information are embedded deep inside the RTP packet and at variable depth. It should also be noted that the NAL unit header for H.265 and H.266 are different from the NAL unit header for H.264 depicted in Figure 6.12.3.2-3. Also, video codec such as AV1 are using OBU (open bitstream unit), which is different from NALU-based video codecs.

**Observation 1: Solutions based on RTP header extension and NAL unit header inspection are complex. They require DPI far beyond the traditional 5-tuple and the processing itself is not a simple pattern matching.**

One important difference between RTP header extension and NAL unit header is that the RTP header extension is part of the RTP packet header (as suggested by the name), whereas the NAL unit header is part of the RTP packet payload. Therefore, when payload encryption is used with SRTP, the NAL unit header information is not available to the PSA UPF.

This is explicitly acknowledged in Sol #12 and Sol #24, as follows:

Clause 6.12.3.2.2

*NOTE 1: The mechanism described in this clause* ***does not work with SRTP****-based payload encryption.*

Clause 6.12.3.2.4

*NOTE 1: The mechanism described in this clause* ***does not work with SRTP****-based payload encryption.*

Clause 6.12.3.2.5

*NOTE 1: The mechanism described in this clause* ***does not work with SRTP****-based payload encryption.*

Clause 6.24.3.2.1 (three times, Option 2, 5 and 6):

*NOTE 1: Option 2 depends on the readability of NALU header in RTP payload. If RTP payload is encrypted, e.g.* ***SRTP is used****, option 2* ***will not applicable****.*

*NOTE 3:* *Option#X depends on the readability of NALU header in RTP payload. If RTP payload is encrypted, e.g.* ***SRTP is used****, option#X* ***will not be applicable****.*

*NOTE: Option#6 depends on the readability of NALU header in RTP payload. If RTP payload is encrypted, e.g.* ***SRTP is used****, option#6* ***will not be applicable****.*

**Observation 2: Solutions based on NAL unit header inspection do not solve the problem of PDU Set Identification in presence of SRTP encryption.**

In our view most of the XRM traffic will be encrypted e2e. Therefore, the 3GPP system should provide system support for all cases, including the case where the NAL Unit header is encrypted.

**Observation 3: 3GPP should provide a solution for all scenarios, including the case where the NAL Unit header is encrypted.**

While the solution based on RTP extension header, even though processing-intensive, can be used in case of encrypted traffic, it should be noted that it is based on an Internet Draft (draft-ietf-avtext-framemarking) whose intended status is Experimental and which has expired on 15 May 2022 without having been renewed. Moreover, the video codecs support by draft-ietf-avtext-framemarking is limited to H264, H265, H.266, VP8 and VP9.

**Observation 4: Solutions based on RTP header extension depend on an expired Internet Draft whose intended status is Experimental.**

SA2#153e sent an LS OUT to SA4 (S2-2209905) asking them if they plan to work on RTP protocol extensions in Rel-18 timeframe that would allow the transport of additional information like “PDU Set size in bites” or “PDU Set length in number of PDUs”, for the purpose of simplifying extraction of PDU Set related information:

***Option 2.*** *Define new protocol (e.g., RTP/SRTP) header extensions by taking into account Network Abstraction Layer (NAL) units, RTP Payload type (e.g., H.264/5/6 and VP9/AV1), etc., to identify PDU Sets in DL, including, e.g., PDU set sequence number, PDU Set size in bits, PDU Set length in number of PDUs, PDU sequence number within the PDU set.*

*The purpose of option 2 is to simplify the extraction of PDU Set related information. SA2 believes that option 2 falls under SA4’s responsibility and kindly ask them to investigate and, if necessary, define new mechanisms to identify PDU Sets between the AS and the UPF and also provide a timeline information so that SA2 can decide whether Option 2 can be considered within SA2 Rel-18 normative work (e.g., within Q1/Q2 2023).*

It should be noted that the PDU Set Size information (either in bits or in number of PDUs) is considered to be a useful piece of information, as per the following conclusion in TR 23.700-60 clause 8.4.2.1:

*- Optional, PDU Set Size.*

*NOTE 2: Either PDU Set Size expressed in bytes or PDU Set Size expressed as number of PDUs, needs further determined.*

However, the PDU Set Size is not possible to be deduced by inspection of the existing RTP (or NAL unit) header. So, in absence of any solution for new RTP header extensions defined by SA4 in Rel-18 timeframe, it is impossible for 5GS to derive the PDU Set Size based on DPI.

**Observation 5: Certain pieces of PDU Set Information (like PDU Set Size) are impossible to derive based on DPI of existing RTP or NAL unit protocols.**

Even if SA4 are willing to work on new RTP extensions for conveyance of PDU Set information (including PDU Set Size), it should be noted that the new RTP extensions will be conveyed all the way down to the XR client in the UE and may cause backwards compatibility issues. Resolving such issues may require interaction with the IETF, which in turn may delay the availability of such extensions beyond Rel-18.

**Observation 6: 3GPP-specific RTP extensions for PDU Set identification may not be available in Rel-18 timeframe.**

In contrast to RTP packet inspection, solutions relying on N6 encapsulation header for carrying PDU Set information are far less processing-intensive because they push the burden of PDU Set identification to the XRM Application Server (XRM AS). The processing in the UPF then becomes a simple copy/paste of meta-information that is provided on N6 into the extended GTP-U header on N3.

**Observation 7: Solutions relying on N6 encapsulation header are far less processing-intensive than solutions relying on RTP packet inspection, because they push the PDU Set identification burden towards the XRM AS.**

Among all the solutions relying on N6 encapsulation on the table, there is one that comes for free: that is the solution relying on GTP-U encapsulation on N6. It comes for free because there seems to be a consensus that the conveyance of PDU Set information from the UPF to NG-RAN will require new GTP-U extensions. This means that a similar (and possibly identical) GTP-U extensions could be used on both sides of the UPF (i.e. on both N6 and N3).

**Observation 8: The solution based on GTP-U encapsulation on N6 comes “for free” because a similar (or identical) GTP-U header is used on both sides of the UPF (N3 and N6).**

As described in clause 6.22.2 (Solution #22) the use of GTP-U on N6 is already supported in the specification.

*NOTE 2: The use of GTP-U on N6 is already supported using the Traffic Steering functionality described in clause 5.4.8 of TS 29.244 [49]. Specifically, the Outer Header Creation IE (clause 8.2.56 of TS 29.244 [49]) and Outer Header Removal IE (clause 8.2.64 of TS 29.244 [49]) support the use of GTP-U.*

**Observation 9: The use of GTP-U on N6 is already supported in the specification. The only thing that is needed is the definition of the new extended GTP-U header (which is needed anyway to support meta-information on the N3 side).**

The definition of GTP-U extensions being fully under 3GPP control, it is obvious that 3GPP can define GTP-U extension for any type of PDU Set Identification information that can be produced by the XRM AS, including information that is today impossible to derive based on DPI of RTP packets (e.g. PDU Set Size, Burst size, etc.).

**Observation 10: GTP-U extensions can carry any type of PDU Set Information that can be generated by the XRM AS.**

As a final remark, the GTP-U extensions are consumed within the 5GS network and have no impact on the XRM client in the UE.

**Observation 11: GTP-U extensions are consumed within the 5GS network and have no impact on the XRM client in the UE.**

**Proposal: Based on the discussion above it is proposed to conclude that 5GS shall support the option relying on GTP-U encapsulation header on N6 (i.e. between the PSA and the XRM AS).**

The exact information contained in the GTP-U header is out of the scope of this contribution.

# 2 Proposal

**Observation 1: Solutions based on RTP header extension and NAL unit header inspection are complex. They require DPI far beyond the traditional 5-tuple and the processing itself is not a simple pattern matching.**

**Observation 2: Solutions based on NAL unit header inspection do not solve the problem of PDU Set Identification in presence of SRTP encryption.**

**Observation 3: 3GPP should provide a solution for all scenarios, including the case where the NAL Unit header is encrypted.**

**Observation 4: Solutions based on RTP header extension depend on an expired Internet Draft whose intended status is Experimental.**

**Observation 5: Certain pieces of PDU Set Information (like PDU Set Size) are impossible to derive based on DPI of existing RTP or NAL unit protocols.**

**Observation 6: 3GPP-specific RTP extensions for PDU Set identification may not be available in Rel-18 timeframe.**

**Observation 7: Solutions relying on N6 encapsulation header are far less processing-intensive than solutions relying on RTP packet inspection, because they push the PDU Set identification burden towards the XRM AS.**

**Observation 8: The solution based on GTP-U encapsulation on N6 comes “for free” because a similar (or identical) GTP-U header is used on both sides of the UPF (N3 and N6).**

**Observation 9: The use of GTP-U on N6 is already supported in the specification. The only thing that is needed is the definition of the new extended GTP-U header (which is needed anyway to support meta-information on the N3 side).**

**Observation 10: GTP-U extensions can carry any type of PDU Set Information that can be generated by the XRM AS.**

**Observation 11: GTP-U extensions are consumed within the 5GS network and have no impact on the XRM client in the UE.**

**Proposal: Based on the discussion above it is proposed to conclude that 5GS shall support the use of GTP-U encapsulated N6 tunnels between the PSA and the XRM AS.**

It is proposed to agree the proposed text for inclusion in TR 23.700-60.

\*\*\* BEGIN CHANGES \*\*\*

# 8 Conclusions

#### 8.4.2.2 PDU Set Information identification on UPF and supported N6 protocols

The detection and marking of the DL PDU Sets sent to the NG-RAN shall be done by the PSA UPF.

PSA UPF may identify the PDU Set based on instruction from SMF and packet header of N6 protocols:

- by matching RTP/SRTP header and payload (RFC 3550/3711/6184/7798/draft-ietf-avtcore-rtp-vvc/draft-ietf-avtext-framemarking are supported).

Editor's note: Whether support PDU Set identification information in new RTP is pending to SA WG4 5G\_RTP WI.

NOTE: In above cases, it is assumed that the RTP/SRTP header and/or payload necessary for the identification of PDU Set Information is not encrypted.

- by reading the PDU Set Identification information included in the GTP-U header of DL packets arriving on N6.

NOTE: The exact information contained in the GTP-U extension headers on N6 needs to be aligned with the information contained in the GTP-U extension headers on N3 (refer to clause 8.4.2.2 Delivering PDU Set Information to RAN).

- by UPF implementation, e.g. PDU Set detection based on traffic characteristics. IP header parameters DSCP/TOS, IP port, IPv6 flow label may be used to detect PDU set, however detailed mechanisms in UPF for PDU Set information identification will not be standardized.

\*\*\* END CHANGES \*\*\*