**3GPP TSG-WG SA4 Meeting #118E e-meeting *S4-220*492**

**Elbonia, April 6th – 14th, 2022**

Title: [DRAFT] LS Reply on QoS support with PDU Set granularity

Response to: LS (S2-2201803/S4-220XXX)

Release: Rel-18

Work Item: FS\_XRM

Source: SA4

To: SA2

Cc: RAN1, RAN2, RAN3

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**1. Overall Description:**

3GPP TSG SA WG4 (SA4) would like to thank 3GPP TSG SA WG2 (SA2) on the LS on QoS support with PDU Set granularity. We believe this is an important topic and we are generally very interested in exchanging information with SA2 on this matter.

3GPP SA4 is continuously working on issues related to the LS. In particular, the Rel-17 study on XR Traffic, documented in TR26.926, is addressing some concrete aspects mentioned in the below questions. Unfortunately, the XR Traffic work has been down-prioritized due to some urgent work item completion in SA4. Nevertheless, we expect that the information on TR26.926 v1.1.0 and the accompanied permanent document supports some of the answers below, and more comprehensive information will be available later this year. However, we also note that TR 26.926 was primarily generated to develop typical traffic patterns for RAN1 simulations but may not serve as a universally applicable framework. As an example, TR 26.926 assumes a specific video codec, assumes a subset of applications, and defines trace formats, that includes advanced metadata that may not be available on system interfaces. In particular, the concept of *slices* was introduced as it is the way how H.265/HEVC provides video data in NAL units to the network. [A more generic term is media data unit, also introduced in TR26.926 which is independent of the specific codec and media type. <add definition from TR 26.926, provide context>]

For your questions, SA4 would like to provide the answers as following.

1. *Any feedback/guidance on the definition of PDU Sets and video slices in the attached document S2-2201851.*

**Answer#1:**

For definition of PDU Set, SA4 understands the PDU Set represents the set of packets transmitted within the 5G system and defined to facilitate SA2 study on QoS enhancement. Primarily, we view the definition an SA2 concept and SA4 can only comment to the extent if we can possibly map media data to the PDU Set concept.

As one example, SA4 has analyzed to what extent RTP packetized H.265/HEVC video as defined in IETF RFC 7798 may be mapped to the PDU Set concept. RFC7798 provides detailed information on how to map video frames and their corresponding NAL units (the data unit in H.265/HEVC interfacing with the network) to a PDU Set concept. We believe for example, that Fragmentation Unit Packets (defined as a fragment of a NAL unit consisting of an integer number of consecutive octets of that NAL unit, for example a video slice) may be considered as a PDU Set according to the first part of the definition (*A PDU Set is composed of one or more PDUs carrying the payload of one unit of information generated at the application level (e.g., a frame or video slice for XRM Services)*, …). In some implementations (note that neither the video codec specifications, nor the IETF RFC, nor 3GPP specifications up to today provide any requirements or recommendation on implementations), the loss of one fragmentation packet of the NAL Unit may result in discarding the entire NAL unit and hence the second part of the PDU definition (*which are of same importance requirement at application layer. All PDUs in a PDU Set are needed by the application layer to use the corresponding unit of information.*) applies. In other implementations, receivers may use the data up to the first lost fragmentation unit to recover at least parts of the video data included in the NAL unit and apply error concealment afterwards. In this case, the third part of the PDU Set definition (*the application layer can still recover parts of the information unit, when some PDUs are missing*) applies, but in this case the equal importance part of the PDU Set definition (*which are of same importance requirement at application layer*) may be misleading (Note that in this operation mode, as an example if the first packet of the PDU Set is lost, all other packets of the fragmentation units are useless, whereas of the last packet is lost, all packets except the last one can be used by the decoder). In addition, for video, data included NAL Unit is typically spatially and/or temporarily predicted from video data in other NAL Units, so some sort of cross-dependency of NAL units exists. Based on this and other potential scenarios, even mapping multiple NAL units to a single PDU Set may be considered as a viable setup. Generally speaking, packet losses in video applications typically result in some sort of impacted video quality.

Note that H.264/AVC has similar interfaces as H.265/HEVC based on NAL Units and based on IETF RFC6184, the same principles explained above for H.265/HEVC likely also apply for H.264/AVC.

<Application Layer FEC – generic, Thomas>

SA4 is also considering how other examples such as Audio data units, Video beyond H.265/HEVC, etc. may map to the PDU concept, but has not yet completed a full analysis. Third-party services and receiver implementations may not exactly follow the specifications in IETF or SA4, and hence, a comprehensive analysis of the SA2 PDU Set concept may be difficult to achieve.

Based on this analysis, we believe that the current PDU Set definition and the anticipated use for an application may map to and benefit some cases and operation modes for media delivery. In particular, it should be the media application layer that can make use of the PDU Set definition and define the appropriate information unit that are mapped to a PDU set. Detailed implementation of such mapping, e.g. signalling of information units to be mapped to PDU Sets from the application to the 5G Systems, is for further study. For other cases, the current definition and concept around PDU Sets may not fully apply and other QoS frameworks may be consider. In general, SA4 is willing to continuously work with SA2 on this matter.

A PDU Set is composed of one or more PDUs carrying the payload of one unit of information generated at the application level (e.g., a frame or video slice for XRM Services), which are of same importance requirement at application layer. All PDUs in a PDU Set are needed by the application layer to use the corresponding unit of information. In some cases, the application layer can still recover parts of the information unit, when some PDUs are missing.

However,

It is mainly a SA2 concept and SA4 is wondering, why the number of “information unit” (like NAL Units) is restricted to one. An application should be allowed to place multiple information units within one PDU Set, such as Parameter Sets (like Sequence or Picture Parameter Sets) together with an IDR frame.

About the video slice, there exists no absolute definition of it but each video coding specification has a specific definition such as in the H.264/AVC and H.265/HEVC specs. However, it is not necessary to understand the media codec specific details of a video slices from SA2 perspective. SA2 should not define video slices as it is not a network concept. In addition, the definition in itself is misleading.

Refer to media unit.

* 1. On the PDU set definition, we believe we can identify cases in SA4 specs that may map to PDU sets. However, there are more questions in 372 that need answer to understand better in particular on timing, bitrates, sequences and so on.

Get some examples from 372

1. The definition of a slice form SA2 “a “slice” represents a sequence of packets that includes, e.g., all the necessary information to reconstruct a video frame and is useful only if all its packets have been received by the receiver” is wrong in the following sense:
   1. a slice is mapped to an NAL unit and then based on the protocol in use, this is mapped to 1 or multiple IP packets. WE have provided an example in doc S4-220372 how to this for the RTP payload format.
   2. It does not include all necessary information, because if you do predictive coding in video, you also need the frame that you reference.
   3. There are cases when only partial data of the slice can still be useful. See also 372 for this. So this not correct as a bold statement.
   4. Generally, SA2 should not deal with video slice definition at all. SA2 should define abstract concepts that SA4 can use for specific use cases.
2. It is correct that an application provider may map a slice to a PDU set (at least conceptually, details on signaling and implementation very unclear). However, by no means one can imply that in a deployment, a slice can automatically map to a PDU set. So the application can make use of the PDU set concept if it is aware what it gets. Blind application of PDU set concepts to video traffic flows may be much more harmful than helpful.
3. *Any input on traffic characteristics of typical media services that rely on e.g. PDU Sets, as necessary.*

**Answer#2:**  It is very difficult to identify a common “traffic characteristic”, since it often depends on the application choices. In particular individualized video services such as XR, Split-Rendering or Cloud Gaming do not use the traditional coding structure with a fixed IDR-Frame interval. Such structures are typically only used, when multiple receivers consume the same video.

Further, the traffic characteristic such as burstiness of the traffic can be influenced by network element such as traffic shapers. It is expected, that the XR Application Servers are deployed in a different domain and traffic conditioning may be applied at domain boundaries. <Maybe some hints to TR 26.926>

1. *Clarify what, if any, dependency there is between the IP packets that make up PDU Sets, e.g. a frame/”slice”.*

**Answer#3:** As stated in TR 26.926, when one IP Packet of a PDU set is missing, the potentially the entire PDU Set is discarded. However, modern error concealment methods may still recover parts of the content. From the transmission requirement perspective, there is dependency between the IP packets carrying a video slice/frame .

1. *Clarify what, if any, dependency there is between PDU Sets that may carry, e.g. different frames/”slices”.*

**Answer#4:** In the video decoding phase, some frames/slices need to refer to other frames/slices based on the video coding configuration. From network transmission perspective, the PDU Sets carrying different frames/slices with reference relationship shall have dependency. As consequence, a PDU Set may depend on previously received PDU Sets.

1. *Provide feedback about the detailed traffic characteristics of XR media services in “Annex X (informative): Traffic characteristics of XR and media services” in the attached document S2-2201807.*

**Answer#5:** SA4 has reviewed the Annex and has some comments on the description about the periodicity, jitter, frame importance, PDU Set granularity and traffic correlation. SA4 will keep SA2 informed if any issue identified in the future SA4 study. Findings will be documented in TR 26.926.

**2. Actions:**

**To SA2 group.**

**ACTION:** SA4 asks SA2 group to take the above reply into account and provide feedback if any.

**3. Date of Next TSG SA WG4 Meetings:**

SA4#119-e 11 – 20 May 2022 E-Meeting

SA4#120 22 – 26 August 2022 Malaga