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**RTP Control Protocol (RTCP) Extended Report (XR) Blocks for QoE Metric
Reporting
draft-ietf-xrblock-rtcp-xr-qoe-05**

Abstract

This document defines an RTP Control Protocol (RTCP) Extended Report (XR) Block including two new segment types and associated SDP parameters that allow the reporting of QoE metrics for use in a range of RTP applications.

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Table of Contents

1.	Introduction	3
1.1.	QoE Metrics Report Block	3
1.2.	RTCP and RTCP XR Reports	3
1.3.	Performance Metrics Framework	3
1.4.	Applicability	3
2.	Terminology	4
2.1.	Standards Language	4
3.	QoE Metrics Block	5
3.1.	Metric Block Structure	5
3.2.	Definition of Fields in QoE Metrics Block	6
3.2.1.	Single Stream per SSRC Segment	7
3.2.2.	Multi-Channel audio per SSRC Segment	8
4.	SDP Signaling	9
4.1.	SDP rtcp-xr-attrib Attribute Extension	9
4.2.	Offer/Answer Usage	11
5.	IANA Considerations	12
5.1.	New RTCP XR Block Type value	12
5.2.	New RTCP XR SDP Parameter	13
5.3.	Contact information for registrations	13
5.4.	New registry of calculation algorithms	13
6.	Security Considerations	14
7.	Authors	14
8.	Acknowledgements	14
9.	References	15
9.1.	Normative References	15
9.2.	Informative References	15
Appendix A.	Evaluation Example of User Quality of Experience for video stream	16
Appendix B.	Change Log	17
B.1.	draft-ietf-xrblock-rtcp-xr-qoe-05	17
B.2.	draft-ietf-xrblock-rtcp-xr-qoe-04	17
B.3.	draft-ietf-xrblock-rtcp-xr-qoe-03	17
B.4.	draft-ietf-xrblock-rtcp-xr-qoe-02	17
B.5.	draft-ietf-xrblock-rtcp-xr-qoe-01	18
B.6.	draft-ietf-xrblock-rtcp-xr-qoe-00	18
	Authors' Addresses	18

1. Introduction

1.1. QoE Metrics Report Block

This document defines a new block type to augment those defined in [\[RFC3611\]](#), for use in a range of RTP applications.

The new block type provides information on multimedia quality using one of several standard metrics.

The metrics belong to the class of application level metrics defined in [\[RFC6792\]](#).

1.2. RTCP and RTCP XR Reports

The use of RTCP for reporting is defined in [\[RFC3550\]](#). [\[RFC3611\]](#) defined an extensible structure for reporting using an RTCP Extended Report (XR). This draft defines a new Extended Report block for use with [\[RFC3550\]](#) and [\[RFC3611\]](#).

1.3. Performance Metrics Framework

The Performance Metrics Framework [\[RFC6390\]](#) provides guidance on the definition and specification of performance metrics. The RTP Monitoring Architectures [\[RFC6792\]](#) provides guideline for reporting block format using RTCP XR. The XR Block described in this document are in accordance with the guidelines in [\[RFC6390\]](#) and [\[RFC6792\]](#).

1.4. Applicability

The QoE Metrics Report Block can be used in any application of RTP for which QoE measurement algorithms are defined.

The factors that affect real-time AV application quality can be split into two categories. The first category consists of transport-dependent factors such as packet loss, delay and jitter (which also translates into losses in the playback buffer). The factors in the second category are application-specific factors that affect real time application (e.g., video) quality and are sensitivity to network errors. These factors can be but not limited to video codec and loss recovery technique, coding bit rate, packetization scheme, and content characteristics.

Compared with application-specific factors, the transport-dependent factors sometimes are not sufficient to measure real time data quality, since the ability to analyze the real time data in the application layer provides quantifiable measurements for subscriber Quality of Experience (QoE) that may not be captured in the

transmission layers or from the RTP layer down. In a typical scenario, monitoring of the transmission layers can produce statistics suggesting that quality is not an issue, such as the fact that network jitter is not excessive. However, problems may occur in the service layers leading to poor subscriber QoE. Therefore monitoring using only network-level measurements may be insufficient when application layer content quality is required.

In order to provide accurate measures of real time application quality when transporting real time contents across a network, the synthetical multimedia quality Metrics is highly required which can be conveyed in the RTCP XR packets[RFC3611] and may have the following three benefits:

- o Tuning the content encoder algorithm to satisfy real time data quality requirements.
- o Determining which system techniques to use in a given situation and when to switch from one technique to another as system parameters change.
- o Verifying the continued correct operation of an existing system.

2. Terminology

2.1. Standards 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](#)].

The terminology used is

Numeric formats S X:Y

where S indicates a two's complement signed representation, X the number of bits prior to the decimal place and Y the number of bits after the decimal place.

Hence 8:8 represents an unsigned number in the range 0.0 to 255.996 with a granularity of 0.0039. S7:8 would represent the range -127.996 to +127.996. 0:16 represents a proper binary fraction with range

0.0 to $1 - 1/65536 = 0.9999847$

though note that use of flag values at the top of the numeric range slightly reduces this upper limit. For example, if the 16-bit values 0xffffe and 0xffff are used as flags for "over-range" and "unavailable" conditions, a 0:16 quantity has range

0.0 to 1 - 3/65536 = 0.9999542

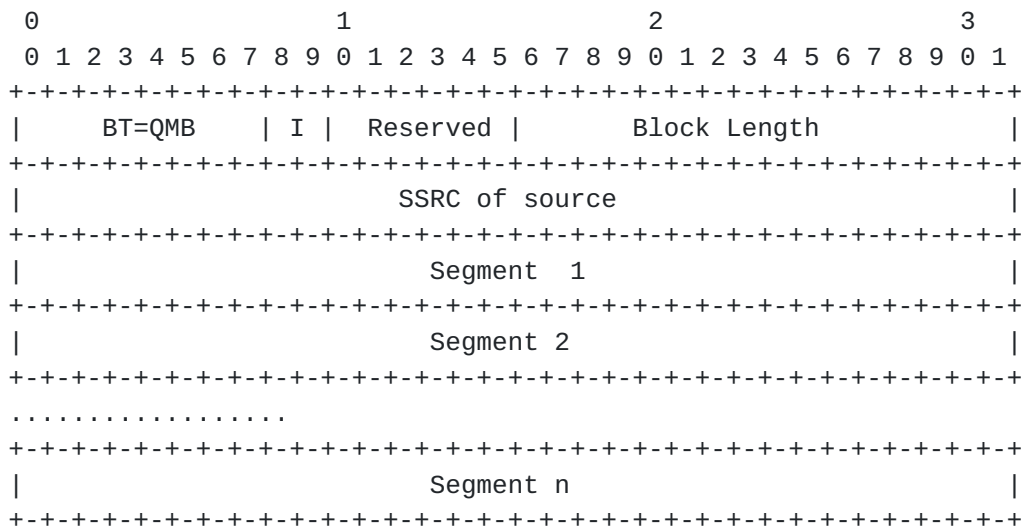
3. QoE Metrics Block

This block reports the multimedia application performance or quality beyond the information carried in the standard RTCP packet format. Information is recorded about multimedia application QoE metric which provides a measure that is indicative of the user's view of a service. Multimedia application QoE metric is commonly expressed as a MOS ("Mean Opinion Score"), MOS is on a scale from 1 to 5, in which 5 represents excellent and 1 represents unacceptable. MOS scores are usually obtained using subjective testing or using objective algorithm. However Subjective testing to estimate the multimedia quality may be not suitable for measuring the multimedia quality since the results may vary from test to test. Therefore using objective algorithm to calculate MOS scores is recommended. ITU-T recommendations define the methodologies for assessment of the performance of multimedia stream [\[G.107\]](#) [\[P.564\]](#) [\[G.1082\]](#) [\[P.1201.1\]](#) [\[P.1201.2\]](#) [\[P.1202.1\]](#) [\[P.NBAMS-HR\]](#) and provides a method to evaluate QoE estimation algorithms and objective model for video and audio. Hence this document recommends vendors and implementers to use these International Telecommunication Union (ITU)-specified methodologies to measure parameters when possible.

3.1. Metric Block Structure

The report block contents are dependent upon a series of flag bits carried in the first part of the header. Not all parameters need to be reported in each block. Flags indicate which are and which are not reported. The fields corresponding to unreported parameters MUST be present, but are set to zero. The receiver MUST ignore any QoE Metrics Block with a non-zero value in any field flagged as unreported. The encoding of QoE metrics block payload consists of a series of 32 bit units called segments that describe MOS Type, MoS algorithm and MoS value.

The QoE Metrics Block has the following format:



3.2. Definition of Fields in QoE Metrics Block

Block type (BT): 8 bits

The QoE Metrics Block is identified by the constant <QMB>.

Interval Metric flag (I): 2 bits

This field is used to indicate whether the QoE metrics are Interval or Cumulative metrics, that is, whether the reported values applies to the most recent measurement interval duration between successive metrics reports (I=10) (the Interval Duration) or to the accumulation period characteristic of cumulative measurements (I=11) (the Cumulative Duration) or is a sampled instantaneous value (I=01) (Sampled Value).

Reserved.: 6 bits

This field is reserved for future definition. In the absence of such a definition, the bits in this field MUST be set to zero and MUST be ignored by the receiver.

Block Length: 16 bits

The length of this report block in 32-bit words, minus one. For the QoE Metrics Block, the block length is variable length.

SSRC of source: 32 bits

As defined in [Section 4.1 of \[RFC3611\]](#).

Segment i: 32 bits

There are two segment types defined in this document: single stream per SSRC segment, multi-channel audio per SSRC segment. Multi-channel audio per SSRC segment is used to deal with the case where Multi-channel audios are carried in one RTP stream while single stream per SSRC segment is used to deal with the case where each media stream is identified by SSRC and sent in separate RTP stream. The leftmost bit of the segment determines its type. If the leftmost bit of the segment is zero, then it is single stream segment. If the leftmost bit is one, then it is multi-channel audio segment. Note that two segment types can not be present in the same metric block.

3.2.1. Single Stream per SSRC Segment

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|S|      CAID      |      PT      |      MOS Value      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Segment Type (S): 1 bit

This field is used to identify the segment type used in this report block. A zero identifies this as a single stream segment. Single stream means there is only one media stream carried in one RTP stream. The single stream segment can be used to report the MoS value associated with the media stream identified by SSRC. If there are multiple media streams and they want to use the single stream per SSRC segment to report the MOS value, they should be carried in the separate RTP streams with each identified by different SSRC. In this case, multiple QoE Metrics Blocks are required to report the MOS value corresponding to each media stream using single stream segment in the same RTCP XR packet.

Calc Algorithm ID (CAID) : 8bits

The 8-bit CAID is the local identifier of calculation algorithm associated with this segment in the range 1-255 inclusive.

Payload Type (PT): 7 bits

QoE metrics reporting depends on the payload format in use. This field identifies the format of the RTP payload. For RTP sessions where multiple payload formats can be negotiated or the payload format changes during the mid-session), the value of this field will be used to indicate what payload format was in use for the reporting interval.

MOS Value: 16 bits

The estimated mean opinion score for multimedia application quality is defined as including the effects of delay, loss, discard, jitter and other effects that would affect multimedia quality . It is expressed in numeric format 8:8 with the value in the range 0.0 to 255.996. The valid the measured value ranges from 0.0 to 50.0, corresponding to MoS x 10 as for MoS. If the measured value is over ranged, the value 0xFFFE MUST be reported to indicate an over-range measurement. If the measurement is unavailable, the value 0xFFFF MUST be reported. Values other than 0xFFFE, 0xFFFF and the valid range defined above MUST NOT be sent and MUST be ignored by the receiving system.

3.2.2. Multi-Channel audio per SSRC Segment

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|S|      CAID      |      PT      |CHID |      MOS Value      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Segment Type (S): 1 bit

This field is used to identify the segment type used in this report block. A one identifies this as a multi-channel audio segment.

CAlg Algorithm ID (CAID) : 8bits

The 8-bit ID is the local identifier of this segment in the range 1-255 inclusive.

Payload Type (PT): 7 bits

As defined in [Section 3.2.1](#) of this document.

Channel Identifier (CHID): 3 bits

If multiple channels of audio are carried in one RTP stream, each channel of audio will be viewed as a independent channel(e.g., left channel audio, right channel audio). This field is used to identify each channel carried in the same media stream. The default Channel mapping follows static ordering rule described in the [section 4.1 of \[RFC3551\]](#). However there are some payload formats that use different channel mappings, e.g., AC-3 audio over RTP [\[RFC4184\]](#) only follow AC-3 channel order scheme defined in [\[ATSC\]](#). Enhanced AC-3 Audio over RTP [\[RFC4598\]](#) uses dynamic channel transform mechanism. In order that the appropriate

channel mapping can be determined, QoE reports need to be tied to an RTP payload format, i.e., including the payload type of the reported media according to [\[RFC6792\]](#) and using Payload Type to determine the appropriate channel mapping.

MOS Value: 13 bits

The estimated mean opinion score for multimedia application quality is defined as including the effects of delay, loss, discard, jitter and other effects that would affect multimedia quality. It is expressed in numeric format 6:7 with the value in the range 0.0 to 63.992. The valid the measured value ranges from 0.0 to 50.0, corresponding to MoS x 10 as for MoS. If the measured value is over ranged, the value 0x1FFE MUST be reported to indicate an over-range measurement. If the measurement is unavailable, the value 0x1FFF MUST be reported. Values other than 0x1FFE, 0x1FFF and the valid range defined above MUST NOT be sent and MUST be ignored by the receiving system.

4. SDP Signaling

[RFC3611] defines the use of SDP (Session Description Protocol) [\[RFC4566\]](#) for signaling the use of XR blocks. However XR blocks MAY be used without prior signaling (see [section 5 of RFC3611](#)).

4.1. SDP rtcp-xr-attr Attribute Extension

This section augments the SDP [\[RFC4566\]](#) attribute "rtcp-xr" defined in [\[RFC3611\]](#) by providing an additional value of "xr-format" to signal the use of the report block defined in this document. Within the "xr-format", the syntax element "extmap" is an attribute as defined in [\[RFC4566\]](#) and used to signal the mapping of the local identifier (CAID) in the segment extension defined in [section 3.2](#) to the calculation algorithm. Specific extension attributes are defined by the specification that defines a specific extension name; there may be several.


```

xr-format =/ xr-qoe-block
xr-qoe-block = "qoe-metrics" ["=" extmap *("," extmap)]
extmap = mapentry "=" extensionname [SP extentionattributes]
direction = "sendonly" / "recvonly" / "sendrecv" / "inactive"
mapentry = "calg:" 1*5 DIGIT ["/" direction]
extensionname = "P564";ITU-T P.564 Compliant Algorithm [P.564]
               / "G107";ITU-T G.107 [G.107]
               / "TS101_329";ETSI TS 101 329-5 Annex E [ETSI]
               / "JJ201_01 ";TTC JJ201.01 [TTC]
               / "P1201_01";ITU-T P.1201.2 [P.1201.1]
               / "P1201_02";ITU-T P.1201.2 [P.1201.2]
               / "P1202_01";ITU-T P.1202.1 [P.1202.1]
               / "P1202_02";ITU-T P. NBAMS-HR [P.NBAMS-HR]
               / non-ws-string
extentionattributes = mediatype
                    /mosreference
                    /attributes-ext
mediatype = "a" ;voice
           / "v" ;video
           / "m" ;multimedia
mosreference = "mosref=" ("0"; lower resolution
                    / "1";higher resolution
                    / 1*2DIGIT ) ;Value 2~15 are valid and
                    ;reserved for future use
attributes-ext = non-ws-string
SP = <Define in RFC5234>
DIGIT = <as defined in Section 3.4 of \[RFC5234\]>
non-ws-string = 1*(%x21-FF)

```

Each local identifier (CAID) of calculation algorithm used in the segment defined in the [section 3.2](#) is mapped to a string using an attribute of the form:

```
a=extmap:<value> ["/"<direction>] <name> <extensionattributes>
```

where <name> is a calculation algorithm name, as above, <value> is the local identifier (CAID) of the calculation algorithm associated with the segment defined in this document and is an integer in the valid range inclusive.

Example:

```
a = calg:1=G107,calg:2=P1202.1
```

A usable mapping MUST use IDs in the valid range, and each ID in this range MUST be unique and used only once for each stream or each channel in the stream.

The mapping MUST be provided per media stream (in the media-level

section(s) of SDP, i.e., after an "m=" line).

Note that the syntax element "mosreference" is referred to the media resolution (e.g., Narrowband (3.4kHz) Speech and Standard Definition (SD) Resolution Video with lower resolution, Wideband (7kHz) Speech and High Definition (HD) Resolution Video with higher resolution). MOS scores reported in the QoE block may vary with the Mos reference; For example MOS values for narrowband, wideband codecs occupy the same range but should be reported in different value. For video application, MoS scores for SD resolution, HD resolution video also occupy the same ranges and should be reported in different value.

4.2. Offer/Answer Usage

When SDP is used in offer-answer context, the SDP Offer/Answer usage defined in [\[RFC3611\]](#) applies. In the offer answer context, the signaling described above may be used in three ways:

- o asymmetric behavior (segment extensions sent in only one direction),
- o the offer of mutually exclusive alternatives, or
- o the offer of more segments than can be sent in a single session.

A direction attribute MAY be included in an extmap; without it, the direction implicitly inherits, of course, from the stream direction.

Segment extension, with their directions, may be signaled for an "inactive" stream. It is an error to use an extension direction incompatible with the stream direction (e.g., a "sendonly" attribute for a "recvonly" stream).

If an segment extension map is offered as "sendrecv", explicitly or implicitly, and asymmetric behavior is desired, the SDP may be modified to modify or add direction qualifiers for that segment extension.

Local identifiers in the valid range inclusive in an offer or answer must not be used more than once per media section. A session update MAY change the direction qualifiers of segment extensions under use. A session update MAY add or remove segment extension(s). Identifiers values in the valid range MUST NOT be altered (remapped).

If a party wishes to offer mutually exclusive alternatives, then multiple segment extensions with the same identifier in the (unusable) range 4096-4351 may be offered; the answerer should select at most one of the offered extensions with the same identifier, and remap it to a free identifier in the valid range, for that extension to be usable. Note that two segment types defined in [section 3](#) are

also two exclusive alternatives.

If more segment extensions are offered in the valid range, the answerer should choose those that are desired, and place the offered identifier value "as is" in the SDP answer.

Similarly, if more segment extensions are offered than can be fit in the valid range, identifiers in the range 4096-4351 may be offered; the answerer should choose those that are desired, and remap them to a free identifier in the valid range.

Note that the range 4096-4351 for these negotiation identifiers is deliberately restricted to allow expansion of the range of valid identifiers in future. segment extensions with an identifier outside the valid range cannot, of course, be used.

Example (port numbers, RTP profiles, payload IDs and rtpmaps, etc. all omitted for brevity):

The offer:

```
a=rtcp-xr:qoe-  
metrics=calg:4906=P1201.1m,calg:4906=P1202.1v,calg:4907=G107a
```

The answerer is interested in transmission P.1202.1 only on video, but doesn't understand P.1202.1 at all. It is interested in transmission G.107 on audio. It therefore adjusts the declarations:

```
a=rtcp-xr:qoe-metrics=calg:1=P1202.1v, calg:2=G107a
```

5. IANA Considerations

New block types for RTCP XR are subject to IANA registration. For general guidelines on IANA considerations for RTCP XR, refer to [\[RFC3611\]](#).

5.1. New RTCP XR Block Type value

This document assigns the block type value MMQ in the IANA "RTCP XR Block Type Registry" to the "QoE Metrics Block".

[Note to RFC Editor: please replace MMQ with the IANA provided RTCP XR block type for this block.]

5.2. New RTCP XR SDP Parameter

This document also registers a new parameter "qoe-metrics" in the "RTCP XR SDP Parameters Registry".

5.3. Contact information for registrations

The contact information for the registrations is:

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5.4. New registry of calculation algorithms

This document creates a new registry to be called "RTCP XR QoE metric block - multimedia application Calculation Algorithm" as a sub-registry of the "RTP Control Protocol Extended Reports (RTCP XR) Block Type Registry". This registry applies to the multimedia session where each type of media are sent in a separate RTP stream and also applies to the session where Multi-channel audios are carried in one RTP stream. Policies for this new registry are as follows:

- o The information required to support this assignment is an unambiguous definition of the new metric, covering the base measurements and how they are processed to generate the reported metric. This should include the units of measurement, how values of the metric are reported in the one 16-bit fields or 13-bit fields "MoS Value".
- o The review process for the registry is "Specification Required" as described in [Section 4.1 of \[RFC5226\]](#).
- o Entries in the registry are identified by entry name and mapped to the local identifier (CAID) in the segment extension defined in [section 3.2](#).
- o Registration Template

The following information must be provided with each registration:

- * Name: A string uniquely and unambiguously identifying the Calculation algorithm for use in protocols.
- * Name Description: A valid Description of the Calculation algorithm name.

- * Reference: The reference which defines the calculation algorithm corresponding to the Name and Name Description.
- * Type: The media type to which the calculation algorithm is applied

o Initial assignments are as follows:

Name	Name Description	Reference	Type
=====	=====	=====	=====
P564	ITU-T P.564 Compliant Algorithm	[P.564]	Voice
G107	ITU-T G.107	[G.107]	Voice
TS101_329	ETSI TS 101 329-5 Annex E	[ETSI]	Voice
JJ201_01	TTC JJ201.01	[TTC]	Voice
P1201_01	ITU-T P.1201.01	[P.1201.1]	Multimedia
P1201_02	ITU-T P.1201.02	[P.1201.2]	Multimedia
P1202_01	ITU-T P.1202.01	[P.1202.01]	Video
P1202_02	ITU-T P. NBAMS-HR	[P. NBAMS-HR]	Video

6. Security Considerations

The new RTCP XR report blocks proposed in this document introduces no new security considerations beyond those described in [[RFC3611](#)].

7. Authors

This draft merges ideas from two drafts addressing the QoE metric Reporting issue. The authors of these drafts are listed below (in alphabetical order):

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[P.1201.2]

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[Appendix A.](#) Evaluation Example of User Quality of Experience for video stream

To evaluate user quality of experience levels using objective test data. MoS Scores provide a familiar, easily understood numeric representation of video, audio, and overall audiovisual quality. Unlike audio, video is even more sensitive to transport impairments than voice, and even low rates of packet loss can cause severe degradation in perceived quality. However, all occurrences of packet loss do not have an equal impact on perceptual quality, in part

because of the way video frames are structured during the encoding process - such as frame properties including frame type and quantization parameter (QP), frame structure, and in part due to subjective factors - such as the degree to which perception is affected by the levels of motion and detail in the video sequence, demux/decoder statistics characteristic parameters including packet loss concealment metrics, jitter buffer metrics and/or Frame loss rate parameter. Note that Frame loss rate can be derived When a video stream is sent from the media source to RTP receiving end and get monitored, in order to provide accurate evaluation of video quality, One possible evaluation method of QoE is the network nodes that implement network management tools may get frame properties, perception degree as MoS calculation input parameters from media source, and demux/decoder statistics characteristic parameters and transport impairment as other MoS calculation input parameters from the RTP receiving end and use appropriate MoS calculation algorithm to calculate MoS scores. Such MoS Scores value can be useful for troubleshooting or comparing video quality across different service types.

Appendix B. Change Log

B.1. [draft-ietf-xrblock-rtcp-xr-qoe-05](#)

The following are the major changes compared to previous version:

- o A few Contact information update.
- o A few Acknowledgement section update.

B.2. [draft-ietf-xrblock-rtcp-xr-qoe-04](#)

The following are the major changes compared to previous version:

- o Split two references P.NAMS and P.NBAMS into four references.
- o SDP signaling update.
- o Add one example to explain User QoE evaluation for video stream

B.3. [draft-ietf-xrblock-rtcp-xr-qoe-03](#)

The following are the major changes compared to previous version:

- o Add one new reference to support TTC JJ201.01.
- o Update two references P.NAMS and P.NBAMS.
- o Other Editorial changes based on comments applied to PDV and Delay drafts.

B.4. [draft-ietf-xrblock-rtcp-xr-qoe-02](#)

The following are the major changes compared to previous version:

- o Remove leftmost second bit since it is useless.
- o Change 13bits MoS value field into 14 bits to increase MoS precision.
- o Fix some typo and make some editorial changes.

B.5. draft-ietf-xrblock-rtcp-xr-qoe-01

The following are the major changes compared to previous version:

- o Remove layered support from the QoE metric draft.
- o Allocate 7 bits in the block header for payload type to indicate what type of payload format is in use and add associated definition of payload type.
- o Clarify using Payload Type to determine the appropriate channel mapping in the definition of Channel Identifier.

B.6. draft-ietf-xrblock-rtcp-xr-qoe-00

The following are the major changes compared to previous version:

- o Allocate one more bit in the single stream per SSC segment to get alignment with the other two segment type.

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