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RTP Control Protocol (RTCP) Extended Report (XR) Block for Jitter Buffer Metric Reporting

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Abstract

This document defines an RTP Control Protocol (RTCP) Extended Report (XR) Block that allows the reporting of Jitter Buffer metrics for a range of RTP applications.

Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

1.1. Jitter Buffer Metrics 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 jitter buffer configuration and performance.

The metric belongs to the class of transport-related end system metrics defined in [RFC6792].

Instances of this metrics block refer by Synchronization source (SSRC) to the separate auxiliary Measurement Information block [RFC6776] which contains information such as the SSRC of the measured stream, and RTP sequence numbers and time intervals indicating the span of the report.

1.2. RTCP and RTCP XR Reports

The use of RTCP for reporting is defined in [RFC3550]. [RFC3611] defines an extensible structure for reporting using an RTCP Extended Report (XR). This document 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. Metrics described in this draft are in accordance with the guidelines in [RFC6390]and [RFC6792].

1.4. Applicability

Real-time applications employ a de-jitter buffer [RFC5481] to absorb jitter introduced on the path from source to destination. These metrics are used to report how the jitter buffer at the receiving end of RTP stream behaves as a result of jitter in the network; and they are applicable to a range of RTP applications.

These metrics are corresponding to terminal related factors that affect real-time application quality and are useful to provide better end-user quality of experience (QoE) when these terminal-related factors are used as inputs to calculate QoE metrics [QMB].

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].

3. Jitter Buffer Operation

A jitter buffer is required to absorb delay variation in network delivery of media packets. A jitter buffer works by holding media data for a period of time after it is received and before it is played out. Packets that arrive early are held in the jitter buffer longer. If packets arrive too early they may be discarded if there is no available jitter buffer space. If packets are delayed excessively by the network they may be discarded if they miss their playout time.

Overall user perceived delay = network round trip delay + local (jitter buffer (nominal) delay + encoder serialization delay) + remote (jitter buffer (nominal) delay + encoder serialization delay)

The jitter buffer can be considered as a time window with early edge aligned with the delay corresponding to the earliest arriving packet and late edge representing the maximum permissible delay before a late arriving packet would be discarded. The delay applied to packets that arrive on time or at their expected arrival time is known as the Nominal Delay and this is equivalent to the time difference/ buffer size difference between the on-time packets insertion point and the point at which packets are read out.

The reference for the expected arrival time may, for example, be the first packet in the session or the running average delay. If all packets arrived at their expected arrival time, then every packet would be held in the jitter buffer exactly the Nominal Delay.

The jitter buffer maximum delay is the delay that is applied to an earliest arriving packet that is not discarded and corresponds to the early edge of the jitter buffer time window.

3.1. Idealized Jitter Buffer

In practice jitter buffer implementations vary considerably however they should behave in a manner conceptually consistent with an idealized jitter buffer described as follows:

(i). Receive the first packet and delay playout by D ms. Keep the RTP timestamp and receive time as a reference.

RTP TS[1]

receive time[1]

Assume that both are normalized in ticks (there are 10 000 ticks in a millisecond).

(ii). Receive the next packet

(iii). Calculate r = RTP TS[n] - RTP TS[1] and t = receive time[n] - receive time[1]. If r == t then the packet arrived on time. If r < t then the packet arrived late and if r > t then the packet arrived early.

(iv). Delay playout of packet by D + (r-t)

(v). Go back to (ii)

Note that this idealized implementation assumes that the sender's RTP clock is synchronized to the clock in the receiver which is used to timestamp packet arrivals. If there is no such inherent synchronization, the system may need to use an adaptive jitter buffer or other techniques to ensure reliable reception.

3.2. Fixed Jitter Buffer

A fixed jitter buffer lacks provision to track network condition and has a fixed size and packets leaving the jitter buffer have a constant delay. For fixed jitter buffer implementation, the nominal delay is set to a constant value corresponding to the packets that arrive at their expected arrival time while the maximum delay is set to a constant value corresponding to the fixed size of the jitter buffer.

3.3. Adaptive Jitter Buffer

An adaptive jitter buffer can adapt to the change in the network's delay and has variable size or variable delay. It allows the nominal delay to be set to a low value initially, to minimize user perceived delay, however can automatically extend the late edge (and possibly also retract the early edge) of buffer window if a significant proportion of packets are arriving late (and hence being discarded).

4. Jitter Buffer Metrics Block

This block describes the configuration and operating parameters of the jitter buffer in the receiver of the RTP end system or RTP mixer which sends the report. Instances of this metrics block refer by SSRC to the separate auxiliary Measurement Information Block [RFC6776] which describes the measurement interval in use. This metrics block relies on the measurement interval in the Measurement Information Block indicating the span of the report and MUST be sent in the same compound RTCP packet as the Measurement Information Block. If the measurement interval is not received in the same compound RTCP packet as this metrics block, this metrics block MUST be discarded.

4.1. Report Block Structure

Jitter Buffer (JB) Metrics Block

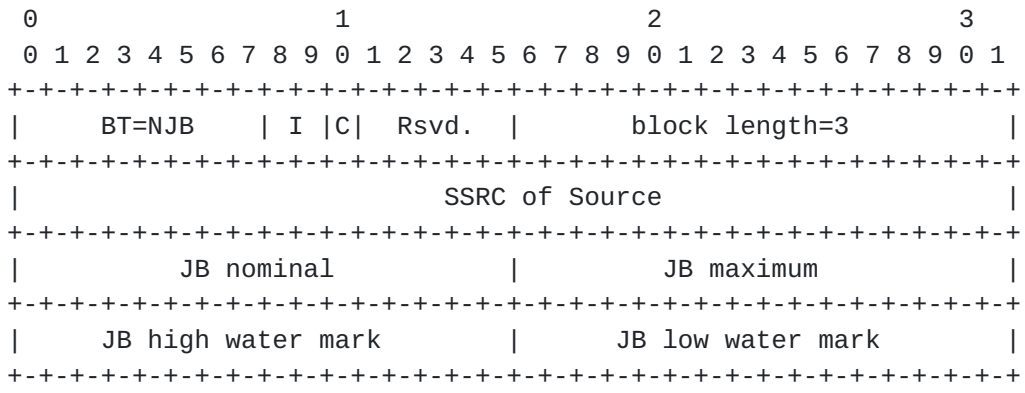

Figure 1: Report Block Structure

4.2. Definition of Fields in Jitter Buffer Metrics Block

Block type (BT): 8 bits

A Jitter Buffer Metrics Report Block is identified by the constant NJB.

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

Interval Metric flag (I): 2 bits

This field is used to indicate whether the Jitter Buffer metrics are Sampled, Interval or Cumulative metrics:

I=01: Sampled Value - the reported value is a sampled instantaneous value.

I=10: Interval Duration - the reported value applies to the most recent measurement interval duration between successive metrics reports.

I=11: Cumulative Duration - the reported value applies to the accumulation period characteristic of cumulative measurements.

In this document, Jitter Buffer Metrics can only be sampled , and cannot be measured over definite intervals. Also, the value I=00 is reserved for future use. Senders MUST NOT use the values I=00 or I=10 or I=11. If a block is received with I=00 or I=10 or I=11, the receiver MUST discard the block.

Jitter Buffer Configuration (C): 1 bit

This field is used to identify the jitter buffer method in use at the receiver, according to the following code:

0 = Fixed jitter buffer

1 = Adaptive jitter buffer

Reserved (Rsvd.): 5 bits

These bits are reserved. They MUST be set to zero by senders ignored by receivers (See [RFC6709] section 4.2).

Block Length: 16 bits

The length of this report block in 32-bit words, minus one, in accordance with the definition in [RFC3611]. This field MUST be set to 3 to match the fixed length of the report block.

jitter buffer nominal delay (JB nominal): 16 bits

This is the current nominal jitter buffer delay in milliseconds, which corresponds to the nominal jitter buffer delay for packets that arrive exactly on time. It is calculated based on the time spent in the jitter buffer for the packet that arrives exactly on time. This parameter MUST be provided for both fixed and adaptive jitter buffer implementations.

The measured value is unsigned value. If the measured value exceeds 0xFFFD, the value 0xFFFE MUST be reported to indicate an over-range measurement. If the measurement is unavailable, the value 0xFFFF MUST be reported.

jitter buffer maximum delay (JB maximum): 16 bits

This is the current maximum jitter buffer delay in milliseconds which corresponds to the earliest arriving packet that would not be discarded. It is calculated based on the time spent in the jitter buffer for the earliest arriving packet In simple queue implementations this may correspond to the size of the jitter buffer. In adaptive jitter buffer implementations, this value may vary dynamically. This parameter MUST be provided for both fixed and adaptive jitter buffer implementations.

The measured value is unsigned value. If the measured value exceeds 0xFFFD, the value 0xFFFE MUST be reported to indicate an over-range measurement. If the measurement is unavailable, the value 0xFFFF MUST be reported.

jitter buffer high water mark (JB high water mark): 16 bits

This is the highest value of the jitter buffer nominal delay in milliseconds which occurred at any time during the reporting interval. This parameter MUST be provided for adaptive jitter buffer implementations and its value MUST be set to JB maximum for fixed jitter buffer implementations.

The measured value is unsigned value. If the measured value exceeds 0xFFFD, the value 0xFFFE MUST be reported to indicate an over-range measurement. If the measurement is unavailable, the value 0xFFFF MUST be reported.

jitter buffer low water mark (JB low water mark): 16 bits

This is the lowest value of the jitter buffer nominal delay in milliseconds which occurred at any time during the reporting interval. This parameter MUST be provided for adaptive jitter buffer implementations and its value MUST be set to JB maximum for fixed jitter buffer implementations.

The measured value is unsigned value. If the measured value exceeds 0xFFFD, the value 0xFFFE MUST be reported to indicate an over-range measurement. If the measurement is unavailable, the

value 0xFFFF MUST be reported.

5. 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).

5.1. SDP rtcp-xr-attrib 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.

```
xr-format =/ xr-jb-block

xr-jb-block = "jitter-buffer"
```

5.2. Offer/Answer Usage

When SDP is used in offer-answer context [RFC3264], the SDP Offer/Answer usage defined in [RFC3611] for unilateral "rtcp-xr" attribute parameters applies. For detailed usage of Offer/Answer for unilateral parameter, refer to section 5.2 of [RFC3611].

6. 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].

6.1. New RTCP XR Block Type value

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

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

6.2. New RTCP XR SDP Parameter

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

6.3. Contact information for registrations

The contact information for the registrations is:

Qin Wu (sunseawq@huawei.com)
101 Software Avenue, Yuhua District
Nanjing, Jiangsu 210012
China

7. Security Considerations

It is believed that this proposed RTCP XR report block introduces no new security considerations beyond those described in [RFC3611]. This block does not provide per-packet statistics so the risk to confidentiality documented in Section 7, paragraph 3 of [RFC3611] does not apply.

8. Contributors

Geoff Hunt wrote the initial draft of this document.

9. Acknowledgments

The authors gratefully acknowledge reviews and feedback provided by Bruce Adams, Philip Arden, Amit Arora, Bob Biskner, Kevin Connor, Claus Dahm, Randy Ethier, Roni Even, Jim Frauenthal, Albert Higashi, Tom Hock, Shane Holthaus, Paul Jones, Rajesh Kumar, Keith Lantz, Mohamed Mostafa, Amy Pendleton, Colin Perkins, Mike Ramalho, Ravi Raviraj, Albrecht Schwarz, Tom Taylor, Hideaki Yamada,Claire Bi,Colin Perkin, Dan Romascanu, Kevin Gross and Glen Zorn.

10. References

10.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", March 1997.

[RFC3264] Rosenberg, J. and H. Schulzrinne, "An Offer/Answer Model with the Session Description Protocol (SDP)", RFC 3264, June 2002.

[RFC3550] Schulzrinne, H., "RTP: A Transport Protocol for Real-Time Applications", RFC 3550, July 2003.

[RFC3611] Friedman, T., Caceres, R., and A. Clark, "RTP Control Protocol Extended Reports (RTCP XR)", November 2003.

[RFC4566] Handley, M., Jacobson, V., and C. Perkins, "SDP: Session Description Protocol", July 2006.

[RFC6776] Wu, Q., "Measurement Identity and information Reporting using SDES item and XR Block", RFC 6776, August 2012.

10.2. Informative References

[QMB] Clark, A., "RTP Control Protocol (RTCP) Extended Report (XR) Blocks for QoE Metric Reporting", ID draft-ietf-xrblock-rtcp-xr-qoe-08, May 2013.

[RFC5481] Morton, A. and B. Claise, "Packet Delay Variation Applicability Statement", RFC 5481, March 2009.

[RFC6390] Clark, A. and B. Claise, "Framework for Performance Metric Development", RFC 6390, October 2011.

[RFC6709] Carpenter, B., Aboba, B., and S. Cheshire, "Design Considerations for Protocol Extensions", RFC 6709, September 2012.

[RFC6792] Hunt, G., Wu, Q., and P. Arden, "Monitoring Architectures for RTP", RFC 6792, November 2012.

Appendix A. Metrics represented using RFC6390 Template

RFC EDITOR NOTE: please change XXXX in [RFCXXXX] by the new RFC number, when assigned.

a. jitter buffer nominal delay Metric

* Metric Name: jitter buffer nominal delay in RTP

* Metric Description: The "expected arrival time" is the time that a RTP packet would arrive if there was no delay variation. The delay applied to packets that arrive at their expected time is known as the Nominal Delay.

* Method of Measurement or Calculation: See section 4.2, jitter buffer nominal delay definition [RFCXXXX].

* Units of Measurement: See section 4.2, jitter buffer nominal delay definition [RFCXXXX].

* Measurement Point(s) with Potential Measurement Domain: See section 4, 1st paragraph [RFCXXXX].

* Measurement Timing: See section 4, 1st paragraph [RFCXXXX] for measurement timing and section 4.2 paragraph [RFCXXXX] for Interval Metric flag.

* Use and applications: See section 1.4 [RFCXXXX].

* Reporting model: See RFC3611.

b. jitter buffer maximum delay Metric

* Metric Name: jitter buffer maximum delay in RTP

* Metric Description: It is the current maximum jitter buffer delay for RTP traffic which corresponds to the earliest

arriving packet that would not be discarded.

* Method of Measurement or Calculation: See section 4.2, jitter buffer maximum delay definition and section 3, the last paragraph [RFCXXXX].

* Units of Measurement: See section 4.2, jitter buffer maximum delay definition [RFCXXXX].

* Measurement Point(s) with Potential Measurement Domain: See section 4, 1st paragraph [RFCXXXX].

* Measurement Timing: See section 4, 1st paragraph [RFCXXXX] for measurement timing and section 4.2 paragraph [RFCXXXX] for Interval Metric flag.

* Use and applications: See section 1.4 [RFCXXXX].

* Reporting model: See RFC3611.

c. jitter buffer high water mark Metric

* Metric Name: jitter buffer high water mark in RTP

* Metric Description: It is the highest value of the jitter buffer nominal delay for RTP traffic which occurred at any time during the reporting interval.

* Method of Measurement or Calculation: See section 4.2, jitter buffer high water mark definition [RFCXXXX].

* Units of Measurement: See section 4.2, jitter buffer nominal delay definition [RFCXXXX].

* Measurement Point(s) with Potential Measurement Domain: See section 4, 1st paragraph [RFCXXXX].

* Measurement Timing: See section 4, 1st paragraph [RFCXXXX] for measurement timing and section 4.2 paragraph [RFCXXXX] for Interval Metric flag.

* Use and applications: See section 1.4 [RFCXXXX].

* Reporting model: See RFC3611.

d. jitter buffer low water mark Metric

* Metric Name: jitter buffer low water mark in RTP

* Metric Description: It is the lowest value of the jitter buffer nominal delay for RTP traffic which occurred at any time during the reporting interval.

* Method of Measurement or Calculation: See section 4.2, jitter buffer low water mark definition [RFCXXXX].

* Units of Measurement: See section 4.2, jitter buffer low water mark definition [RFCXXXX].

* Measurement Point(s) with Potential Measurement Domain: See section 4, 1st paragraph [RFCXXXX].

* Measurement Timing: See section 4, 1st paragraph [RFCXXXX] for measurement timing and section 4.2 paragraph [RFCXXXX] for Interval Metric flag.

* Use and applications: See section 1.4 [RFCXXXX].

* Reporting model: See RFC3611.

Appendix B. Change Log

Note to the RFC-Editor: please remove this section prior to publication as an RFC.

B.1. draft-ietf-xrblock-rtcp-xr-jb-12

The following are the major changes to previous version :

- Editorial changes based on recieved comments.

B.2. draft-ietf-xrblock-rtcp-xr-jb-11

The following are the major changes to previous version :

- Comments in WGLC and from PM-DIR review are addressed in this version.

B.3. draft-ietf-xrblock-rtcp-xr-jb-10

The following are the major changes to previous version :

- Add some text to section 3.2 to clarify how fixed jitter buffer is used.

- Other Editorial changes.

B.4. draft-ietf-xrblock-rtcp-xr-jb-09

The following are the major changes to previous version :

- Incorporate proposed changes by Kevin and proposed text by Alan to address interoperability report issue.

- Add new appendix to format metrics using RFC6390 template.

B.5. draft-ietf-xrblock-rtcp-xr-jb-08

The following are the major changes to previous version :

- Rewrote descriptive text and definitions for clarification.

B.6. draft-ietf-xrblock-rtcp-xr-jb-07

The following are the major changes to previous version :

- Add one new section to discuss jitter buffer operation.

B.7. draft-ietf-xrblock-rtcp-xr-jb-05

The following are the major changes to previous version :

- Some editorial change changes based on the discussion with Glen and Kevin on the list.

B.8. draft-ietf-xrblock-rtcp-xr-jb-03

The following are the major changes to previous version :

- Reduce the "jb cfg" to 1-bit based on discussion in the WGLC.
- Other editorial change changes aligning with PDV,Delay draft.

B.9. draft-ietf-xrblock-rtcp-xr-jb-02

The following are the major changes to previous version :

- Add some explanation text in the SDP offer/answer section.
- Add some text in applicability section to explain the use to report jitter buffer metrics.
- Other editorial change changes aligning with PDV,Delay draft.

B.10. draft-ietf-xrblock-rtcp-xr-jb-01

The following are the major changes to previous version :

- Outdated reference update
- Add one Editor notes to ask clarification on the use of reporting jitter buffer metrics.
- Other Editorial changes.

B.11. draft-ietf-xrblock-rtcp-xr-jb-00

The following are the major changes to previous version :

- Boilerplate updates.
- references updates
- allocate 32 bit field in report block for SSRC

- Other editorial changes to get alignment with MONARCH draft.

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