Internet Engineering Task Force (IETF)
Request for Comments: 6798
Category: Standards Track
ISSN: 2070-1721
November 2012

A. Clark
Telchemy
Q. Wu
Huawei

RTP Control Protocol (RTCP) Extended Report (XR) Block for Packet Delay Variation Metric Reporting

Abstract

This document defines an RTP Control Protocol (RTCP) Extended Report (XR) block that allows the reporting of packet delay variation metrics for a range of RTP applications.

Status of This Memo

Copyright Notice

Table of Contents

1. Introduction

1.1. Packet Delay Variation 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 Packet Delay Variation (PDV) using one of several standard metrics, for example, Mean Absolute Packet Delay Variation 2 (MAPDV2) (Clause 6.2.3.2 of [G.1020]) or 2-point PDV (Clause 6.2.4 of [Y.1540]).

The metrics belong to the class of transport metrics defined in [MONARCH].

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 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 [MONARCH] provides guidelines for reporting block format using RTCP XR. The XR block described in this document is in accordance with the guidelines in [RFC6390] and [MONARCH].

1.4. Applicability

These metrics are applicable to a wide range of RTP applications in which the application streams are sensitive to delay variation [RFC5481]. For example, applications could use the measurements of these metrics to help adjust the size of adaptive jitter buffers to improve performance. Network managers can use these metrics to compare actual delay variation to targets (i.e., a numerical objective or Service Level Agreement) to help ensure the quality of real-time application performance.

2. Terminology

2.1. 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].

2.2. Notations

This report block makes use of binary fractions. 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 represents the range -127.996 to +127.996. 0:16 represents a proper binary fraction with range as follows:

0.0 to 1 - 1/65536 = 0.9999847

however, 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 0xfffe and 0xffff are used as flags for "over-range" and "unavailable" conditions, a 0:16 quantity has a range as follows:

0.0 to 1 - 3/65536 = 0.9999542

3. Packet Delay Variation Metrics Block

Metrics in this block report on packet delay variation in the stream arriving at the RTP system. The measurement of these metrics is made at the receiving end of the RTP stream. Instances of this metric block refer by synchronization source (SSRC) to the separate auxiliary Measurement Information Block [RFC6776], which contains measurement intervals. This metric block relies on the measurement interval given by the value of the "Measurement Duration (Interval)" field in the Measurement Information Block to indicate 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 for this metric block, this metric block MUST be discarded.

3.1. Report Block Structure

PDV metrics block:

```
 0                   1                   2                   3
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     BT=15     | I |pdvtyp |Rsv|       block length=4          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        SSRC of Source                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Pos PDV Threshold/Peak     |      Pos PDV Percentile       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Neg PDV Threshold/Peak     |      Neg PDV Percentile       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Mean PDV             |            Reserved           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 1: Report Block Structure

3.2. Definition of Fields in PDV Metrics Block

Block type (BT): 8 bits

A Packet Delay Variation Metrics Block is identified by the constant 15.

Interval Metric flag (I): 2 bit

This field is used to indicate whether the Packet Delay Variation metrics are Sampled, Interval, or Cumulative metrics [MONARCH], that is, whether the reported values apply to the most recent measurement interval duration between successive metrics reports (I=10) (the Interval Duration), or they apply to the accumulation period characteristic of cumulative measurements (I=11) (the Cumulative Duration), or they are a sampled instantaneous value (I=01) (Sampled Value). The value I=00 is reserved and MUST NOT be used. If the value I=00 is received, then the XR block MUST be ignored by the receiver.

Packet Delay Variation Metric Type (pdvtyp): 4 bits

Packet Delay Variation Metric Type is of type enumerated and is interpreted as an unsigned, 4-bit integer. This field is used to identify the Packet Delay Variation Metric Type used in this report block, according to the following code:

bits 014-011

0: MAPDV2, Clause 6.2.3.2 of [G.1020],

1: 2-point PDV, Clause 6.2.4 of [Y.1540].

Rsv: 2 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 ignored by the receiver.

block length: 16 bits

The length of this report block is in 32-bit words, minus one. For the Packet Delay Variation Metrics Block, the block length is equal to 4.

SSRC of source: 32 bits

This field is as defined in Section 4.1 of [RFC3611].

Positive PDV Threshold/Peak: 16 bits

This field is associated with the Positive PDV percentile and expressed in milliseconds with numeric format S11:4. The term "Positive" represents that the packets are arriving later than the expected time.

If the measured value is less than -2047.9375 (the value that would be coded as 0x8001), the value 0x8000 SHOULD be reported to indicate an over-range negative measurement. If the measured value is greater than +2047.8125 (the value that would be coded as 0x7FFD), the value 0x7FFE SHOULD be reported to indicate an over-range positive measurement. If the measurement is unavailable, the value 0x7FFF MUST be reported.

Positive PDV Percentile: 16 bits

This field indicates the percentages of packets in the RTP stream for which individual packet delays were less than the Positive PDV Threshold. It is expressed in numeric format 8:8 with values from 0 to 100th percentile.

If the measurement is unavailable, the value 0xFFFF MUST be reported.

Negative PDV Threshold/Peak: 16 bits

This field is associated with the Negative PDV percentile and expressed in milliseconds with numeric format S11:4. The term "Negative" represents that the packets are arriving earlier than the expected time.

If the measured value is more negative than -2047.9375 (the value that would be coded as 0x8001), the value 0x8000 SHOULD be reported to indicate an over-range negative measurement. If the measured value is more positive than +2047.8125 (the value that would be coded as 0x7FFD), the value 0x7FFE SHOULD be reported to indicate an over-range positive measurement. If the measurement is unavailable, the value 0x7FFF MUST be reported.

Negative PDV Percentile: 16 bits

This field indicates the percentages of packets in the RTP stream for which individual packet delays were more than the Negative PDV Threshold. It is expressed in numeric format 8:8 with values from 0 to 100th percentile.

If the measurement is unavailable, the value 0xFFFF MUST be reported.

If the PDV Type indicated is 2-point PDV and the Positive and Negative PDV percentiles are set to 100.0, then the Positive and Negative Threshold/Peak PDV values are the peak values measured during the reporting interval (which may be from the start of the call for cumulative reports). In this case, the difference between the Positive and Negative Threshold/Peak values defines the range of 2-point PDV.

Mean PDV: 16 bits

The mean PDV value of data packets is expressed in milliseconds with Numeric format S11:4 format.

For MAPDV2, this value is generated according to Clause 6.2.3.2 of [G.1020]. For interval reports, the MAPDV2 value is reset at the start of the interval.

For 2-point PDV, the value reported is the mean of per-packet 2-point PDV values. This metric indicates the arrival time of the first media packet of the session with respect to the mean of the arrival times of every packet of the session. A single value of the metric (for a single session) may not be useful by itself, but its average over a number of sessions may be useful in diagnosing media delay at session startup. For example, this might occur if media packets are often delayed behind signaling packets due to head-of-line blocking.

If the measured value is more negative than -2047.9375 (the value that would be coded as 0x8001), the value 0x8000 SHOULD be reported to indicate an over-range negative measurement. If the measured value is more positive than +2047.8125 (the value that would be coded as 0x7FFD), the value 0x7FFE SHOULD be reported to indicate an over-range positive measurement. If the measurement is unavailable, the value 0x7FFF MUST be reported.

Reserved: 16 bits

These bits are reserved for future definition. They MUST be set to zero by the sender and ignored by the receiver.

3.3. Guidance on Use of PDV Metrics

This subsection provides informative guidance on when it might be appropriate to use each of the PDV metric types.

MAPDV2 (Clause 6.2.3.2 of [G.1020]) is the envelope of instantaneous (per-packet) delay when compared to the short-term moving average delay. This metric could be useful in determining residual impairment when an RTP end system uses an adaptive de-jitter buffer that tracks the average delay variation, provided that the averaging behavior of the adaptive algorithm is similar to that of the MAPDV2 algorithm.

2-point PDV (Clause 6.2.4 of [Y.1540]) reports absolute packet delay variation with respect to a defined reference packet transfer delay. Note that the reference packet is generally selected as the packet with minimum delay based on the most common criterion (see Sections 1 and 5.1 of [RFC5481]). In an RTP context, the two "points" are at the sender (the synchronization source that applies RTP timestamps) and at the receiver. The value of this metric for the packet with index j is identical to the quantity D(i,j) defined in Section 6.4.1 of [RFC3550], and the packet index i should be set equal to the index of the reference packet for the metric in practice. The metric includes the effect of the frequency offsets of clocks in both the sender and receiver end systems, so it is useful mainly in networks where synchronization is distributed. As well as measuring packet delay variation in such networks, it may be used to ensure that synchronization is effective, for example, where the network carries ISDN data traffic over RTP [RFC4040]. The metric is likely to be useful in networks that use fixed de-jitter buffering, because it may be used to determine the length of the required de-jitter buffer, or to determine if network performance has deteriorated such that existing de-jitter buffers are too small to accommodate the observed delay variation.

3.4. Examples of Use

(a) To report MAPDV2 [G.1020]:

Pos PDV Threshold = 50.0; Pos PDV Percentile = 95.3; Neg PDV Threshold = 50.0 (note this implies -50 ms); Neg PDV Percentile = 98.4; PDV type = 0 (MAPDV2)

causes average MAPDV2 to be reported in the Mean PDV field.

Note that implementations either may fix the reported percentile and calculate the associated PDV level or may fix a threshold PDV level and calculate the associated percentile. From a practical implementation perspective, it is simpler to use the second of these approaches (except of course in the extreme case of the 100th percentile).

(b) To report 2-point PDV [Y.1540]:

Pos PDV Threshold = 60 (note this implies +60 ms); Pos PDV Percentile = 96.3; Neg PDV Threshold = 0; Neg PDV Percentile = 0; PDV type = 1 (2-point PDV)

causes 2-point PDV to be reported in the Mean PDV field.

2-point PDV, according to [Y.1540] is the difference in delay between the current packet and the referenced packet of the stream. If the sending and receiving clocks are not synchronized, this metric includes the effect of relative timing drift.

4. SDP Signaling

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

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-pdv-block

xr-pdv-block  = "pkt-dly-var" [ "," pdvtype ] [ "," nspec "," pspec ]

     pdvtype  = "pdv="  ( "0"          ; MAPDV2 ITU-T G.1020
                        / "1"          ; 2-point PDV ITU-T Y.1540
                        / 1*2DIGIT )  ;Value 2~15 are valid and
                                       ;reserved for future use
     nspec    = ("nthr=" fixpoint)      ; negative PDV threshold (ms)
                / ("npc=" fixpoint )  ; negative PDV percentile
     pspec    = ("pthr=" fixpoint)      ; positive PDV threshold (ms)
                / ("ppc=" fixpoint)   ; positive PDV percentile

     fixpoint       = 1*DIGIT "." 1*DIGIT  ; fixed point decimal
     DIGIT          = <as defined in Section 3.4 of [RFC5234]>
```

When SDP is used in offer/answer, a system sending SDP may request a specific type of PDV measurement. In addition, they may state a specific percentile or threshold value and expect to receive the corresponding threshold or percentile metric, respectively. The system receiving the SDP SHOULD send the PDV metrics requested, but if the metric is not available, the system receiving the SDP MUST send the metric block with the flag value indicating that the metric is unavailable.

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 15 in the IANA "RTCP XR Block Type" registry to the "Packet Delay Variation Metrics Block".

5.2. New RTCP XR SDP Parameter

This document also registers a new parameter "pkt-dly-var" in the "RTCP XR SDP Parameters" registry.

5.3. 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

5.4. New Registry of PDV Types

This document creates a new registry to be called "RTCP XR PDV block - PDV type" as a sub-registry of the "RTP Control Protocol Extended Reports (RTCP XR) Block Type Registry". Policies for this new registry are as follows:

- The information required to support an 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 three 16-bit fields "Pos PDV Threshold/Peak", "Neg PDV Threshold/Peak", and "Mean PDV" within the report block, and how the metric uses the two 16-bit fields "Pos PDV Percentile" and "Neg PDV Percentile".

- The review process for the registry is "Specification Required" as described in Section 4.1 of [RFC5226].

- Entries in the registry are unsigned 4-bit integers. The valid range is 0 to 15 corresponding to the 4-bit field "pdvtyp" in the block. Values are to be recorded in decimal.

- Initial assignments are as follows:

  * 0: MAPDV2, Clause 6.2.3.2 of [G.1020],

  * 1: 2-point PDV, Clause 6.2.4 of [Y.1540],

  * 2-15: Reserved for future use.

6. Security Considerations

It is believed that this proposed RTCP XR 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.

7. Contributors

Geoff Hunt wrote the initial version of this document.

8. 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, Jing Zhao, Kevin Gross, Colin Perkins, Charles Eckel, Glen Zorn, Shida Schubert, Benoit Claise, Adrian Farrel, and Pete Resnick.

9. References

9.1. Normative References

[G.1020] ITU-T Rec. G. 1020, "Performance parameter definitions for quality of speech and other voiceband applications utilizing IP networks", July 2006.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC3550] Schulzrinne, H., Casner, S., Frederick, R., and V. Jacobson, "RTP: A Transport Protocol for Real-Time Applications", STD 64, RFC 3550, July 2003.

[RFC3611] Friedman, T., Caceres, R., and A. Clark, "RTP Control Protocol Extended Reports (RTCP XR)", RFC 3611, November 2003.

[RFC4040] Kreuter, R., "RTP Payload Format for a 64 kbit/s Transparent Call", RFC 4040, April 2005.

[RFC4566] Handley, M., Jacobson, V., and C. Perkins, "SDP: Session Description Protocol", RFC 4566, July 2006.

[RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 5226, May 2008.

[RFC5234] Crocker, D. and P. Overell, "Augmented BNF for Syntax Specifications: ABNF", STD 68, RFC 5234, January 2008.

[RFC6776] Clark, A. and Q. Wu, "Measurement Identity and Information Reporting Using a Source Description (SDES) Item and an RTCP Extended Report (XR) Block", RFC 6776, October 2012.

[Y.1540] ITU-T Rec. Y.1540, "IP packet transfer and availability performance parameters", November 2007.

9.2. Informative References

[MONARCH] Wu, W., Hunt, G., and P. Arden, "Guidelines for Use of the RTP Monitoring Framework", Work in Progress, September 2012.

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

[RFC6390] Clark, A. and B. Claise, "Guidelines for Considering New Performance Metric Development", BCP 170, RFC 6390, October 2011.

Authors' Addresses

Alan Clark
Telchemy Incorporated
2905 Premiere Parkway, Suite 280
Duluth, GA 30097
USA

EMail: alan.d.clark@telchemy.com

Qin Wu
Huawei
101 Software Avenue, Yuhua District
Nanjing, Jiangsu 210012
China

EMail: sunseawq@huawei.com