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Multicast Acquisition Report Block Type for RTP Control Protocol (RTCP) Extended Reports (XRs)

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Abstract

In most RTP-based multicast applications, the RTP source sends inter-related data. Due to this interdependency, randomly joining RTP receivers usually cannot start consuming the multicast data right after they join the session. Thus, they often experience a random acquisition delay. An RTP receiver can use one or more different approaches to achieve rapid acquisition. Yet, due to various factors, performance of the rapid acquisition methods usually varies. Furthermore, in some cases the RTP receiver can do a simple multicast join (in other cases it is compelled to do so). For quality reporting, monitoring and diagnostics purposes, it is important to collect detailed information from the RTP receivers about their acquisition and presentation experiences. This document addresses this issue by defining a new report block type, called Multicast Acquisition (MA) Report Block, within the framework of RTP Control Protocol (RTCP) Extended Reports (XR) (RFC 3611). This document also defines the necessary signaling of the new MA report block type in the Session Description Protocol (SDP).

Status of this Memo

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1. Introduction

RTP Control Protocol (RTCP) is the out-of-band control protocol for the applications that are using the Real-time Transport Protocol (RTP) for media transport [RFC3550]. In addition to providing minimal control functionality to RTP entities, RTCP also enables a basic level monitoring of RTP sessions via sender and receiver reports. More statistically detailed monitoring as well as application-specific monitoring is usually achieved through the RTCP Extended Reports (XRs) [RFC3611].

In most RTP-based multicast applications such as the ones carrying video content, the RTP source sends inter-related data. Consequently, the RTP application may not be able to decode and present the data in an RTP packet before decoding one or more earlier RTP packets and/or before acquiring some Reference Information about the content itself. Thus, RTP receivers that are randomly joining a multicast session often experience a random acquisition delay. In order to reduce this delay, [I-D.ietf-avt-rapid-acquisition-for-rtp] proposes an approach where an auxiliary unicast RTP session is established between a retransmission server and the joining RTP receiver. Over this unicast RTP session, the retransmission server provides the Reference Information, which is all the information the RTP receiver needs to rapidly acquire the multicast stream. This method is referred to as the Rapid Acquisition of Multicast Sessions (RAMS). However, depending on the variability in the Source Filtering Group Management Protocol (SFGMP) processing times, availability of network resources for rapid acquisition and nature of the RTP data, not all RTP receivers can acquire the multicast stream in the same amount of time. The performance of rapid acquisition may vary not only for different RTP receivers but also over time.

To increase the visibility of the multicast service provider into its network, to diagnose slow multicast acquisition issues and to collect the acquisition experiences of the RTP receivers, this document defines a new report block type, which is called Multicast Acquisition (MA) Report Block, within the framework of RTCP XR. RTP receivers that are using the method described in [I-D.ietf-avt-rapid-acquisition-for-rtp] may use this report every time they join a new multicast RTP session. RTP receivers that use a different method for rapid acquisition or those do not use any method but rather do a simple multicast join may also use this report to collect information. This way, the multicast service provider can quantitatively compare the improvements achieved by different methods.

2. Requirements Notation

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

3. Definitions

This document uses the acronyms and definitions from Section 3 of [I-D.ietf-avt-rapid-acquisition-for-rtp].

4. Multicast Acquisition (MA) Report Block

This section defines the format of the MA report block. The base report is payload-independent. An extension mechanism is provided where further optional payload-independent and payload-specific information can be included in the report as desired.

The OPTIONAL extensions that are defined in this document are primarily developed for the method presented in [I-D.ietf-avt-rapid-acquisition-for-rtp]. Other methods that provide rapid acquisition can define their own extensions to be used in the MA report block.

The packet format for the RTCP XR is defined in Section 2 of [RFC3611]. Each XR packet has a fixed-length field for version, padding, reserved bits, payload type (PT), length, SSRC of packet sender as well as a variable-length field for report blocks. In the XR packets, the PT field is set to XR (207).

It is better to send the MA report block after all the necessary information is collected and computed. Partial reporting is generally not useful as it cannot give the full picture of the multicast acquisition, and causes additional complexity in terms of report block matching and correlation. The MA report block is only sent as a part of an RTCP compound packet, and it is sent in the primary multicast session.

The need for reliability of the MA report block is not any greater than other report blocks or types. If desired, the report block could be repeated for redundancy purposes while respecting to the RTCP scheduling algorithms.

Following the rules specified in [RFC3550], all integer fields in the base report and extensions defined below are carried in network-byte order, that is, most significant byte (octet) first, also known as big-endian. Unless otherwise stated, numeric constants are in decimal (base 10).

4.1. Base Report

The base report format is shown in Figure 1.

```
     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=11     |   MA Method   |         Block Length          |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |              SSRC of the Primary Multicast Stream             |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |             Status            |             Rsvd.             |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 1: Base report format for the MA report block

- BT (8 bits): Field that denotes the type for this block format. The MA report block is identified by the constant 11.

- MA Method (8 bits): Field that denotes the type of the MA method (e.g., simple join, RAMS, etc.). See Section 7.3 for the values registered with IANA.

- Block Length (16 bits): The length of this report block, including the header, in 32-bit words minus one.

- SSRC of the Primary Multicast Stream (32 bits): Field that denotes the SSRC of the primary multicast stream.

- Status (16 bits): Field that denotes the status code for the MA operation.

  This document defines several status codes and registers them with IANA in Section 7.5. If a new vendor-neutral status code will be defined, it MUST be registered with IANA through the guidelines specified in Section 7.5. If the new status code is intended to be used privately by a vendor, there is no need for IANA management. Section 4.2.2 defines how a vendor defines and uses private extensions to convey its messages.

  To indicate use of a private extension, the RTP receiver MUST set the Status field to zero. A private extension MUST NOT be used in an XR report unless the RTP receiver knows from out-of-band methods that the entity that will receive and process the XR report understands the private extension.

- Rsvd. (16 bits): The RTP receiver MUST set this field to zero. The recipient MUST ignore this field when received.

If the multicast join was successful meaning that at least one multicast packet has been received, some additional information MUST be appended to the base report as will be described in Section 4.2.1.

4.1.1. Status Code Rules for New MA Methods

Different MA methods usually use different status codes, although some status codes (e.g., a code indicating that multicast join has failed) can be common among multiple MA methods. The status code reported in the base report MUST always be within the scope of the particular MA method specified in the MA Method field.

In certain MA methods, the RTP receiver can generate a status code for its multicast acquisition attempt, or can be told by another network element or RTP endpoint what the current status is via a response code. In such cases, the RTP receiver MAY report the value of the received response code as its status code if the response code has a higher priority. Each MA method needs to outline the rules pertaining to its response and status codes so that RTP receiver implementations can determine what to report in any given scenario.

4.1.2. Status Code Rules for the RAMS Method

In this section, we provide the status code rules for the RAMS method described in [I-D.ietf-avt-rapid-acquisition-for-rtp].

Section 11.6 of [I-D.ietf-avt-rapid-acquisition-for-rtp] defines several response codes. The 1xx and 2xx-level response codes are informational and success response codes, respectively. If the RTP receiver receives a 1xx or 2xx-level response code, then the RTP receiver MUST use one of the 1xxx-level status codes defined in Section 7.5 of this document. If the RTP receiver receives a 4xx or 5xx-level response code (indicating receiver-side and server-side errors, respectively), then the RTP receiver MUST use the response code as its status code. In other words, the 4xx and 5xx-level response codes have a higher priority than the 1xxx-level status codes.

4.2. Extensions

To improve the reporting scope, it might be desirable to define new fields in the MA report block. Such fields are to be encoded as TLV elements as described below and sketched in Figure 2:

- o Type: A single-octet identifier that defines the type of the parameter represented in this TLV element.

- o Length: A two-octet field that indicates the length (in octets) of the TLV element excluding the Type and Length fields, and the 8-bit Reserved field between them. Note that this length does not include any padding that is needed for alignment.

o Value: Variable-size set of octets that contains the specific value for the parameter.

In the extensions, the Reserved field MUST be set to zero and ignored on reception. If a TLV element does not fall on a 32-bit boundary, the last word MUST be padded to the boundary using further bits set to zero.

In the MA report block, the RTP receiver MUST place any vendor-neutral or private extension after the base report.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |   Reserved    |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
:                             Value                             :
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2: Structure of a TLV element

4.2.1. Vendor-Neutral Extensions

If the goal in defining new TLV elements is to extend the report block in a vendor-neutral manner, they need to be registered with IANA through the guidelines provided in Section 7.4.

The current document defines several vendor-neutral extensions. First, we present the TLV elements that can be used by any RTP-based multicast application.

o RTP Seqnum of the First Multicast Packet (16 bits): TLV element that specifies the RTP sequence number of the first multicast packet received for the primary multicast stream. If the multicast join was successful, this element MUST be included. If no multicast packet has been received, this element MUST NOT exist in the report block.

   Type: 1

o SFGMP Join Time (32 bits): TLV element that denotes the greater of zero or the time difference (in ms) between the instant SFGMP Join message has been sent and the instant the first packet was received in the multicast session. If the multicast join was successful, this element MUST be included. If no multicast packet has been received, this element MUST NOT exist in the report block.

Type: 2

o Application Request-to-Multicast Delta Time (32 bits): OPTIONAL TLV element that denotes the time difference (in ms) between the instant the application became aware it would join a new multicast session and the instant the first RTP packet was received from the primary multicast stream. If no such packet has been received, this element MUST NOT exist in the report block.

Type: 3

o Application Request-to-Presentation Delta Time (32 bits): OPTIONAL TLV element that denotes the time difference (in ms) between the instant the application became aware it would join a new multicast session and the instant the media is first presented. If the RTP receiver cannot successfully present the media, this element MUST NOT exist in the report block.

Type: 4

We next present the TLV elements that can be used when the RTP receiver supports and uses the RAMS method described in [I-D.ietf-avt-rapid-acquisition-for-rtp]. However, if the RTP receiver does not send a rapid acquisition request, the following TLV elements MUST NOT exist in the MA report block. Some elements may or may not exist depending on whether the RTP receiver receives any packet from the unicast burst and/or the primary multicast stream or not. These are explained below.

o Application Request-to-RAMS Request Delta Time (32 bits): OPTIONAL TLV element that denotes the time difference (in ms) between the instant the application became aware it would request a rapid acquisition and the instant the rapid acquisition request was actually sent by the application.

Type: 11

o RAMS Request-to-RAMS Information Delta Time (32 bits): OPTIONAL TLV element that denotes the time difference (in ms) between the instant the rapid acquisition request has been sent and the instant the first RAMS Information message was received in the unicast session. If no such message has been received, this element MUST NOT exist in the report block.

Type: 12

o RAMS Request-to-Burst Delta Time (32 bits): OPTIONAL TLV element that denotes the time difference (in ms) between the instant the

rapid acquisition request has been sent and the instant the first burst packet was received in the unicast session. If no burst packet has been received, this element MUST NOT exist in the report block.

Type: 13

- RAMS Request-to-Multicast Delta Time (32 bits): OPTIONAL TLV element that denotes the time difference (in ms) between the instant the rapid acquisition request has been sent and the instant the first RTP packet was received from the primary multicast stream. If no such packet has been received, this element MUST NOT exist in the report block.

  Type: 14

- RAMS Request-to-Burst-Completion Delta Time (32 bits): OPTIONAL TLV element that denotes the time difference (in ms) between the instant the rapid acquisition request has been sent and the instant the last burst packet was received in the unicast session. If no burst packet has been received, this element MUST NOT exist in the report block.

  Type: 15

- Number of Duplicate Packets (32 bits): OPTIONAL TLV element that denotes the number of duplicate packets due to receiving the same packet in both unicast and primary multicast RTP sessions. If no RTP packet has been received from the primary multicast stream, this element MUST NOT exist. If no burst packet has been received in the unicast session, the value of this element MUST be set to zero.

  Type: 16

- Size of Burst-to-Multicast Gap (32 bits): OPTIONAL TLV element that denotes the greater of zero or the difference between the sequence number of the first multicast packet (received from the primary multicast stream) and the sequence number of the last burst packet minus 1 (considering the wrapping of the sequence numbers). If no burst packet has been received in the unicast session or no RTP packet has been received from the primary multicast stream, this element MUST NOT exist in the report block.

  Type: 17

4.2.2. Private Extensions

It is desirable to allow vendors to use private extensions in TLV format. The range of [128-254] of TLV Types is reserved for private extensions. IANA management for these extensions is unnecessary and they are the responsibility of individual vendors.

Implementations use the structure depicted in Figure 3 for the private extensions. Here, the private enterprise numbers are used from http://www.iana.org/assignments/enterprise-numbers. This will ensure the uniqueness of the private extensions and avoid any collision.

```
  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
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |      Type     |   Reserved    |            Length             |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                       Enterprise Number                       |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 :                             Value                             :
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 3: Structure of a private extension

5. Session Description Protocol Signaling

A new unilateral parameter is defined for the MA report block to be used with the Session Description Protocol (SDP) [RFC4566] using the Augmented Backus-Naur Form (ABNF) [RFC5234]. It has the following syntax within the 'rtcp-xr' attribute [RFC3611]:

```
xr-format = <See RFC 3611>
xr-format /= multicast-acq-ext

multicast-acq-ext = "multicast-acq"
```

Refer to Section 5.1 of [RFC3611] for a detailed description and the full syntax of the "rtcp-xr" attribute. The "multicast-acq-ext" parameter is compatible with the definition of "format-ext" in the "rtcp-xr" attribute.

6. Security Considerations

The security considerations of [RFC3611] apply in this document as well.

The information contained in MA reports could be stolen as any other RTCP reports if proper protection mechanism(s) are not in place. If desired, similar to other RTCP XR reports, the MA reports MAY be protected by using Secure RTP (SRTP) and Secure RTP Control Protocol (SRTCP) [RFC3711].

Malicious sniffing or otherwise obtaining MA report blocks can reveal performance characteristics of the RTP service and underlying network. This information is mostly available to an observer with the ability to capture RTP and RTCP session traffic. The contents and value of any private extensions need to be studied when considering the necessity to secure the MA reports since application-level performance data might be present that is not otherwise available to an attacker as with the required fields and vendor-neutral extensions.

Using the MA reports to provide feedback into the acquisition of the multicast streams can introduce possible additional security implications. If a forged or otherwise modified MA report is received for an earlier acquisition attempt, invalid data can be used as input in later rapid acquisition attempts. For example, incorrectly small SFGMP join times could cause the unicast burst to be too short, leading to gaps in sequence numbers in the approach discussed in [I-D.ietf-avt-rapid-acquisition-for-rtp]. Additionally, forged reports could give the appearance that rapid acquisition is performing correctly, when it is in fact failing, or vice versa. While integrity protection can be achieved through different ways, we RECOMMEND the use of SRTCP [RFC3711].

7. IANA Considerations

The following contact information is provided for all registrations in this document:

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Note to the RFC Editor: In the following, please replace "XXXX" with the number of this document prior to publication as an RFC.

7.1. RTCP XR Block Type

Note to IANA: Type value 11 has been pre-registered with IANA for the "Multicast Acquisition Report Block" in the RTCP XR Block Type Registry. Please replace the existing reference with the RFC number of this document.

7.2. RTCP XR SDP Parameter

This document registers the SDP [RFC4566] parameter 'multicast-acq' for the 'rtcp-xr' attribute in the RTCP XR SDP Parameters Registry.

7.3. Multicast Acquisition Method Registry

This document creates a new IANA registry for the MA methods. The registry is called the Multicast Acquisition Method Registry. This registry is to be managed by the IANA according to the Specification Required policy of [RFC5226].

The length of the MA Method field is a single octet, allowing 256 values. The registry is initialized with the following entries:

MA Method	Description	Reference
0	Reserved	[RFCXXXX]
1	Simple join (No explicit method)	[RFCXXXX]
2	RAMS	[I-D.ietf-avt-rapid-acquisition-for-rtp]
3-254		Specification Required
255	Reserved	[RFCXXXX]

The MA Method values 0 and 255 are reserved for future use.

Any registration for an unassigned value needs to contain the following information:

- o Contact information of the one doing the registration, including at least name, address, and email.

- o A detailed description of how the MA method works.

7.4. Multicast Acquisition Report Block TLV Space Registry

This document creates a new IANA TLV space registry for the MA report block extensions. The registry is called the Multicast Acquisition Report Block TLV Space Registry. This registry is to be managed by the IANA according to the Specification Required policy of [RFC5226].

The length of the Type field in the TLV elements is a single octet, allowing 256 values. The registry is initialized with the following entries:

Type	Description	Reference
0	Reserved	[RFCXXXX]
1	RTP Seqnum of the First Multicast Packet	[RFCXXXX]
2	SFGMP Join Time	[RFCXXXX]
3	Application Request-to-Multicast Delta Time	[RFCXXXX]
4	Application Request-to-Presentation Delta Time	[RFCXXXX]
11	Application Request-to-RAMS Request Delta Time	[RFCXXXX]
12	RAMS Request-to-RAMS Information Delta Time	[RFCXXXX]
13	RAMS Request-to-Burst Delta Time	[RFCXXXX]
14	RAMS Request-to-Multicast Delta Time	[RFCXXXX]
15	RAMS Request-to-Burst-Completion Delta Time	[RFCXXXX]
16	Number of Duplicate Packets	[RFCXXXX]
17	Size of Burst-to-Multicast Gap	[RFCXXXX]
18-127		Specification Required
128-254	Reserved for private extensions	[RFCXXXX]
255	Reserved	[RFCXXXX]

The Type values 0 and 255 are reserved for future use. The Type values between (and including) 128 and 254 are reserved for private extensions.

Any registration for an unassigned Type value needs to contain the following information:

- o Contact information of the one doing the registration, including at least name, address, and email.

- o A detailed description of what the new TLV element represents and how it is interpreted.

7.5. Multicast Acquisition Status Code Space Registry

This document creates a new IANA TLV space registry for the status codes. The registry is called the Multicast Acquisition Status Code Space Registry. This registry is to be managed by the IANA according to the Specification Required policy of [RFC5226].

The length of the Status field is two octets, allowing 65536 codes. However, the status codes have been registered to allow for an easier classification. For example, the values between (and including) 1 and 1000 are primarily used by the MA method of simple join. The values between (and including) 1001 and 2000 are used by the MA method described in [I-D.ietf-avt-rapid-acquisition-for-rtp]. When registering new status codes for the existing MA methods or newly defined MA methods, registrants are encouraged to allocate sufficient continuous space. Note that because of the limited space, not every MA method can be assigned 1000 different values for its Status codes.

The Status code 65535 is reserved for future use. The registry is initialized with the following entries:

Code	Description	Reference
0	A private status code is included in the message	[RFCXXXX]
1	Multicast join was successful	[RFCXXXX]
2	Multicast join has failed	[RFCXXXX]
3	A presentation error has occurred	[RFCXXXX]
4	An unspecified RR internal error has occurred	[RFCXXXX]
1001	RAMS has been successfully completed	[RFCXXXX]
1002	No RAMS-R message has been sent	[RFCXXXX]
1003	Invalid RAMS-I message syntax	[RFCXXXX]
1004	RAMS-I message has timed out	[RFCXXXX]
1005	RAMS unicast burst has timed out	[RFCXXXX]
1006	An unspecified RR internal error has occurred during RAMS	[RFCXXXX]
1007	A presentation error has occurred during RAMS	[RFCXXXX]
65535	Reserved	[RFCXXXX]

Any registration for an unassigned Status code needs to contain the following information:

o Contact information of the one doing the registration, including at least name, address, and email.

- A detailed description of what the new Status code describes and how it is interpreted.

8. Acknowledgments

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9. References

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