Multicast Acquisition Report Block Type for RTP Control Protocol (RTCP)
                     Extended Reports (XRs)
              draft-ietf-avt-multicast-acq-rtcp-xr-01

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. One approach to reduce this delay is to use an
   auxiliary unicast RTP session with a retransmission server to receive
   a burst stream that facilitates rapid acquisition of the multicast
   stream. An RTP receiver may use this approach (or any other
   approach) to achieve rapid acquisition. Yet, due to various factors,
   performance of the rapid acquisition methods usually varies.
   Furthermore, in some cases the RTP receiver may (or may have to) do a
   simple multicast join. 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). This document also defines the necessary signaling of the new
   MA report block type in the Session Description Protocol (SDP).

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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. 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", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

3. Definitions

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

   (Primary) Multicast Session: The multicast session to which RTP
   receivers can join at a random point in time.

   Primary Multicast RTP Session: The multicast RTP session an RTP
   receiver is interested in acquiring.

   Primary Multicast (RTP) Streams: The RTP stream(s) carried in the
   primary multicast RTP session.

   Source Filtering Group Management Protocol (SFGMP): Following the
   definition in [RFC4604], SFGMP refers to the Internet Group
   Management Protocol (IGMP) version 3 [RFC3376] and the Multicast
   Listener Discovery Protocol (MLD) version 2 [RFC3810] in the IPv4 and
   IPv6 networks, respectively. However, the report block type
   introduced in this document does not depend on a specific version of
   either of these group management protocols. In the remainder of this
   document, SFGMP will refer to any group management protocol that has
   Join and Leave functionalities.

   Retransmission (Burst) Packet: An RTP packet that is formatted as
   defined in [RFC4588].

   Reference Information: The set of certain media content and metadata
   information that is sufficient for an RTP receiver to start usefully
   consuming a media stream. The meaning, format and size of this
   information are specific to the application and are out of scope of
   this document.

   (Unicast) Burst (Stream): A unicast stream of RTP retransmission
   packets that enable an RTP receiver to rapidly acquire the Reference
   Information associated with a primary multicast stream. Each burst
   stream is identified by its SSRC identifier that is unique in the
   primary multicast RTP session. The burst streams are typically
   transmitted at an accelerated rate.

   Retransmission Server (RS): The RTP/RTCP endpoint that can generate
   the retransmission packets and the burst streams. RS may also
   generate other non-retransmission packets to aid the rapid
   acquisition process.

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 MAY 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).

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.             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
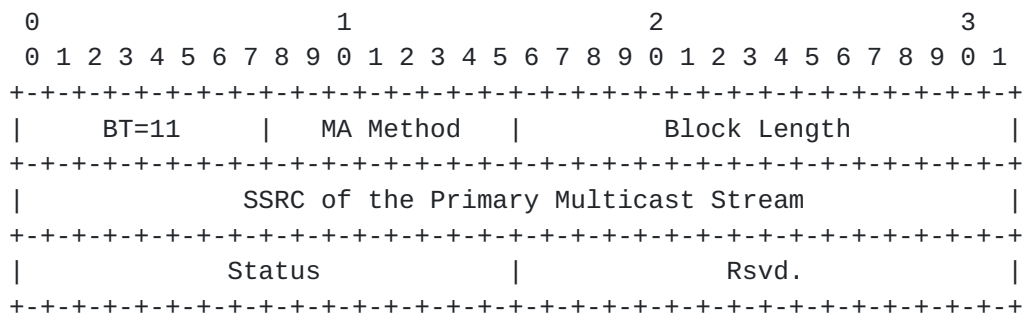
           Figure 1: Base report format for the MA report block

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

   o MA Method (8 bits): Mandatory 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.

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

   o SSRC of the Primary Multicast Stream (32 bits): Mandatory field
      that denotes the SSRC of the primary multicast stream.

o Status (16 bits): Mandatory field that denotes the status code
   for the MA operation.

   This document defines several status codes and registers them with
   IANA. 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.
   Instead, the vendor MUST use the private extension mechanism
   (Section 4.2.2) to convey its message and MUST indicate this by
   putting zero in the Status field.

o Rsvd. (16 bits): This field SHALL be set to 0 and ignored.

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

Different MA methods usually use different status codes, although
some status codes (e.g., a code indicating that multicast join has
failed) may apply to more than one MA method. However, 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 may generate a status code
for its multicast acquisition attempt, or may 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. It is RECOMMENDED that each MA method
outlines the rules pertaining to its response and status codes so
that RTP receiver implementations can determine what to report in any
given scenario. Below, we provide these rules for the RAMS method
described in [I-D.ietf-avt-rapid-acquisition-for-rtp].

Section 12.6 of [I-D.ietf-avt-rapid-acquisition-for-rtp] defines
several response codes for its MA method. 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, it MUST use one of the 1xxx-level status codes defined
in Section 7.5 of this document. The RTP receiver may also receive a
4xx or 5xx-level response code (indicating receiver-side and server-
side errors, respectively). In that case, 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. The 5xx-level response codes have a higher priority

than the 4xx-level response codes and MUST be reported in the base
report in case the RTP receiver receives both 4xx and 5xx-level
response codes (in different RAMS-I messages) during the same RAMS
session.

4.2. Extensions

To improve the reporting scope, it may be desirable to define new
fields in the MA report block. Such fields MUST 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 required for alignment.

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

In the extensions, the Reserved field SHALL be set to zero and
ignored. 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, any vendor-neutral or private extension MUST
be placed after the base report. The support for extensions is
OPTIONAL.

```
 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                             :
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
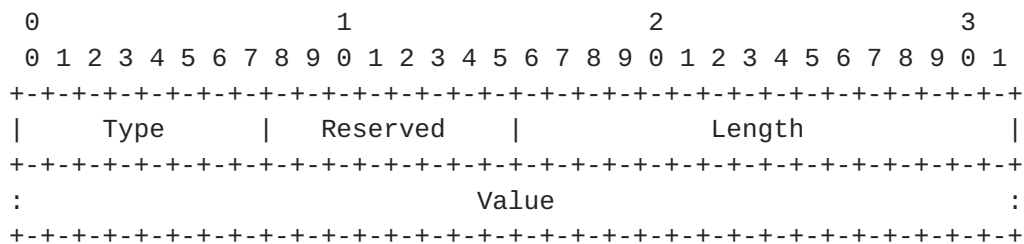
Figure 2: Structure of a TLV element

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 MUST 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 exist. If no
   multicast packet has been received, this element SHALL NOT exist.

   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 exist. If no multicast packet has
   been received, this element SHALL NOT exist.

   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 SHALL NOT exist.

   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 SHALL NOT exist.

   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 SHALL NOT exist.

      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 SHALL NOT exist.

      Type: 13

o 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 SHALL NOT exist.

      Type: 14

o 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 SHALL NOT
   exist.

      Type: 15

o 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 SHALL NOT exist. If no burst packet has been

received in the unicast session, the value of this element SHALL
be set to zero.

Type: 16

o 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 SHALL NOT exist.

Type: 17

4.2.2. Private Extensions

It is desirable to allow vendors to use private extensions in TLV
format. For interoperability, such extensions MUST NOT collide with
each other.

A certain range of TLV Types is reserved for private extensions
(Refer to Section 7.4). IANA management for these extensions is
unnecessary and they are the responsibility of individual vendors.

The structure that MUST be used for the private extensions is
depicted in Figure 3. Here, the 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                               :
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
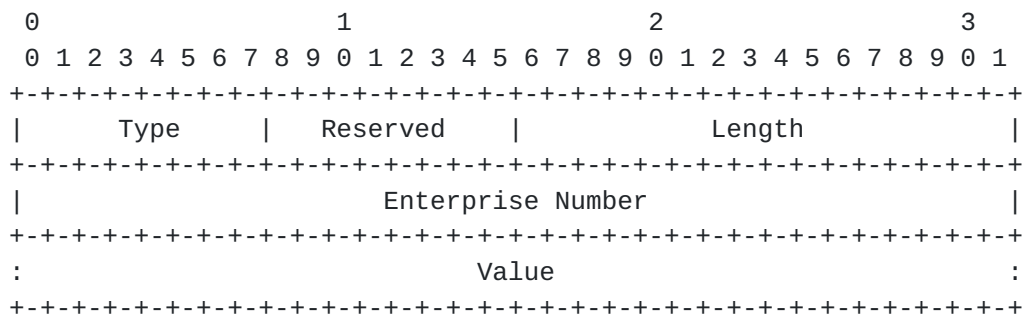
Figure 3: Structure of a private extension

5. **Session Description Protocol Signaling**

   A new 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]:

                    multicast-acq-ext = "multicast-acq"

                               Figure 4

   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. 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].

   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 may be used
   as input in later rapid acquisition attempts. For example,
   incorrectly small SFGMP join times may 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 may give the appearance that rapid acquisition is
   performing correctly, when it is in fact failing, or vice versa.

7. IANA Considerations

   The following contact information shall be used for all registrations
   in this document:

   Ali Begen
   abegen@cisco.com

   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

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

   This document assigns the block type value 11 in the RTCP XR Block
   Type Registry to "Multicast Acquisition Report Block."

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 MUST 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
---- -------------------------------------------------- -------------
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]
```

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 MUST 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 shall be 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, a similar classification scheme SHOULD be
   followed.

   The Status code 65536 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]

   Any registration for an unassigned Status code MUST 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 Status code describes and
      how it shall be interpreted.

8. Acknowledgments

9. References

9.1. Normative References

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