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Monitoring Architecture for RTP
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Abstract

   This memo proposes an architecture for extending RTP Control Protocol
   (RTCP) with a new RTCP Extended Reports (XR) (RFC3611) block type to
   report new metrics regarding media transmission or reception quality,
   following RTCP guideline established in RFC5968. This memo suggests
   that a new block should contain a single metric or a small number of
   metrics relevant to a single parameter of interest or concern, rather
   than containing a number of metrics which attempt to provide full
   coverage of all those parameters of concern to a specific
   application. Applications may then "mix and match" to create a set
   of blocks which covers their set of concerns. Where possible, a
   specific block should be designed to be re-usable across more than
   one application, for example, for all of voice, streaming audio and
   video.

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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   material or to cite them other than as "work in progress."

   This Internet-Draft will expire on September 3, 2012.

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[1](#). Introduction

As the delivery of multimedia services using the Real-Time Transport
Protocol (RTP) over IP network is gaining an increasing popularity,
uncertainties in the performance and availability of these services
are driving the need to support new standard methods for gathering
performance metrics from RTP applications. These rapidly emerging
standards, such as RTP Control Protocol Extended Reports (RTCP
XR)[RFC3611] and other RTCP extension to Sender Reports (SR),
Receiver Reports (RR) [RFC3550] are being developed for the purpose
of collecting and reporting performance metrics from endpoint devices
that can be used to correlate the metrics, provide end to end service
visibility and measure and monitor Quality of Experience (QoE)
[RFC6390].

However the proliferation of RTP/RTCP specific metrics for transport
and application quality monitoring has been identified as a potential
problem for RTP/RTCP interoperability, which attempt to provide full
coverage of all those parameters of concern to a specific
application. Given that different applications layered on RTP may
have some monitoring requirements in common, these metrics should be
satisfied by a common design.

The objective of this document is to define an extensible RTP
monitoring framework to provide a small number of re-usable Quality
of Service (QoS)/QoE metrics which facilitate reduced implementation
costs and help maximize inter-operability. RTCP Guideline [RFC5968]
has stated that, where RTCP is to be extended with a new metric, the
preferred mechanism is by the addition of a new RTCP XR [RFC3611]
block. This memo assumes that any requirement for a new metric to be
transported in RTCP will use a new RTCP XR block.

2. **Terminology**

   This memo is informative and as such contains no normative
   requirements.

   In addition, the following terms are defined:

   Transport level metrics

      A set of metrics which characterise the three transport
      impairments of packet loss, packet delay, and packet delay
      variation. These metrics should be usable by any application
      which uses RTP transport.

   Application level metrics

      Metrics relating to application specific parameters or QoE related
      parameters. Application specific parameters are measured at the
      application level and focus on quality of content rather than
      network performance. QoE related parameters reflect the end-to-
      end performance at the services level and is ususally measured at
      the user endpoint. One example of such metrics is the QoE Metric
      specified in QoE metric reporting Block [QOE].

   End System metrics

      Metrics relating to the way a terminal deals with transport
      impairments affecting the incident RTP stream. These may include
      de-jitter buffering, packet loss concealment, and the use of
      redundant streams (if any) for correction of error or loss.

   Direct metrics

      Metrics that can be directly measured or calculated and are not
      dependent on other metric.

   Composed metrics

      Metrics that are not directly measured and derived from other
      metrics. One example of such metrics is the ones calculated based
      on Direct metric that have been measured.

Interval metrics

   It is referred to as the metrics of which the reported values
   apply to the most recent measurement interval duration between
   successive metrics reports.

Cumulative metrics

   It is referred to as the metrics of which the reported values
   apply to the accumulation period characteristic of cumulative
   measurements.

Sampled metrics

   It is referred to as the metrics of which the reported values only
   apply to the value of a continuously measured or calculated that
   has been sampled at any given instance of the interval.

3. **RTP monitoring architecture**

   There are many ways in which the performance of an RTP session can be
   monitored. These include RTP-based mechanisms such as the RTP SNMP
   MIB [RFC2959], or the SIP event package for RTCP summary reports
   [RFC6035], or non-RTP mechanisms such as generic MIBs, NetFlow,
   IPFix, and so on. Together, these provide useful mechanisms for
   exporting data on the performance of an RTP session to non-RTP
   network management systems. It is desirable to also perform in-
   session monitoring of RTP performance. RTCP provides the means to do
   this. In the following, we specify an architecture for using and
   extending RTCP for monitoring RTP sessions. One major benefit of
   such architecture is ease of integration with other RTP/RTCP
   mechanism.

3.1. **Overview**

   The RTP monitoring architecture comprises the following two key
   functional components shown below:

   o RTP Monitor

   o RTP Metric Block Structure

   RTP Monitor is the functional component defined in the Real-time
   Transport Protocol [RFC3550] that acts as a source of information
   gathered for monitoring purposes. It may gather such information
   reported by RTCP XR or other RTCP extension and calculate statistics
   from multiple source. According to the definition of monitor in the
   RTP Protocol [RFC3550], the end system that runs an application
   program that sends or receives RTP data packets, an intermediate-
   system that forwards RTP packets to End-devices or a third party that
   observes the RTP and RTCP traffic but does not make itself visible to
   the RTP Session participants (i.e., the third party monitor depicted
   in figure 1) can be envisioned to act as the monitor within the RTP
   monitoring architecture. Note that the third party monitor should be
   placed on the RTP/RTCP paths between the sender, intermediate and the
   receiver.

   The RTP Metric Block exposes real time Application QoS/QoE metric
   information in the appropriate report block format to the management
   system (i.e., report collector) within the RTP monitoring
   architecture. Such information can be formulated as:

   o The direct metrics

   o or the composed metrics

or formulated as

o The Interval metrics

o or cumulative metrics

o or sampled metrics

Both the RTCP or RTCP XR can be extended to convey these metrics.
The details on transport protocols for metric blocks are described in
Section 3.2.

```
                    +------------------+
                    | RTP Sender       |       6      +----------+
                    |   +-----------+   ||----------->|Management|
          ------------->|   Monitor |----|     6      |  System  |
          |         |   |           |    |  | |---------->|        |
          |         |   +-----------+    |  |  -------->|          |
          |         |+----------------+| |  |      +-------/--+
          |         ||Application    || |  | -----------|   |
          |         ||-Streaming video|| |  | |  1      |  |6
          | |---------|-VOIP         || |  |  | +--------V------+
          | |        ||-Video conference|| |  | ---  Third Party |
          | |        ||-Telepresence || |  |  |   |   Monitor    |
          | |        ||-Ad insertion || |  6|   +---------------+
        5 |          |+----------------+| |  |
          | |        +------------------+ |  |
          | 1                             |  |
          | | +Intermediate------------+  |  | |-----------------------+
          | | | RTP System             |  |  | | RTP Receiver >--4-|   |
          | | |    +-----------         |  |  | |   +-----------+       |
          | | |    |       -----------|  -------|              | |     |
          | | |    |       |      |        |  | Monitor  |<--       |
          |----------- Monitor |<--------5------|----|         |<------|
            | |     |          | Report Block  |  +----/------+     ||
            | |     +----------+Transport Over |                    ||
            | |                 RTCP XR or RTCP |         |2         ||
            | | +-----------------+ extension   | +-------/---------+ ||
            | | |Application      |   |         | |Application      | ||
            | | |-Streaming video |   |         | |-Streaming video | ||
            | | |-VOIP            |   |    1    | |-VOIP            | 3|
            ----->-Video conference|--------------->|-Video conference  ||
              | |-Telepresence    |   |         | |-Telepresence    | ||
              | |-Ad insertion    |   |         | |-Ad insertion    | ||
              | +-----------------+   |         | +-----------------+ ||
              | +-----------------+   |         | +-----------------+ ||
              | |Transport        |   |         | |Transport        | ||
              | |-IP/UDP/RTP      |   |         | |-IP/UDP/RTP    >---||
              | |-IP/TCP/RTP      |   |         | |-IP/TCP/RTP      |  |
              | |-IP/TCP/RTSP/RTP |   |         | |-IP/TCP/RTSP/RTP |  |
              | +-----------------+   |         | +-----------------+  |
              +----------------------+          +----------------------+
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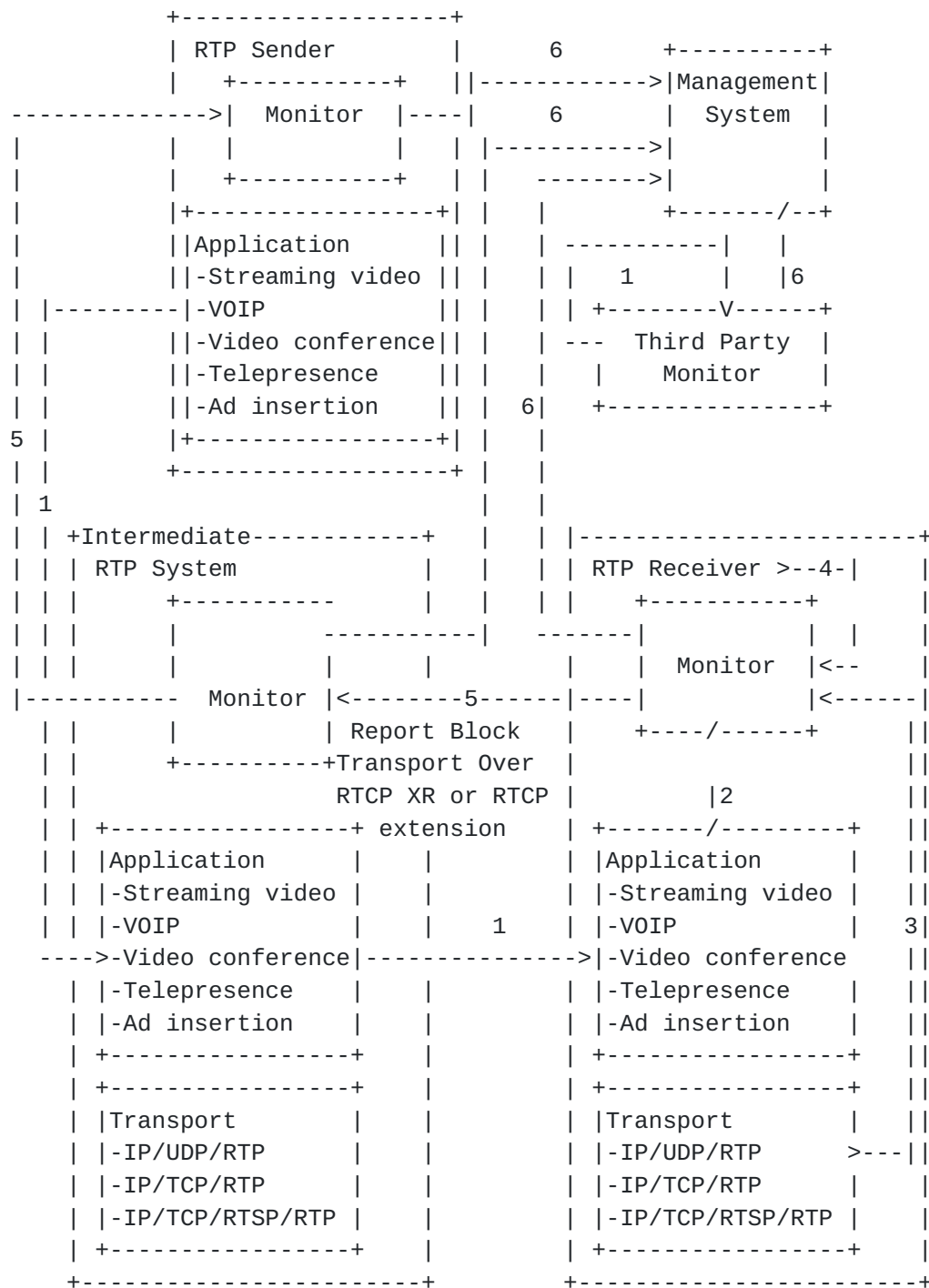
                  Figure 1: RTP Monitoring Architecture

   1. RTP communication between real time applications.

   2. Application level metrics collection.

   3. Transport level metrics collection.

   4. End System metrics collection.

   5. Metrics Reporting over the RTP/RTCP paths

   6. RTCP information Export to the network management system.

   RTP is used to multicast groups, both ASM and SSM. These groups can
   be monitored using RTCP. In the ASM case, the monitor is a member of
   the multicast group and listens to RTCP XR reports from all members
   of the ASM group. In the SSM case, there is a unicast feedback
   target that receives RTCP feedback from receivers and distributes it
   to other members of the SSM group (see figure 1 of RFC5760). The
   monitor will need to be co-located with the feedback target to
   receive all feedback from the receivers (this may also be an
   intermediate system). In both ASM and SSM scenarios, receivers can
   send RTCP XR reports to enhance the reception quality reporting.

3.2. RTCP Metric Block Report and associated parameters

   The basic RTCP Reception Report (RR) [RFC3550] conveys reception
   statistics (i.e., transport level statistics) in metric block report
   format for multiple RTP media streams including

   o the fraction of packet lost since the last report

   o the cumulative number of packets lost

   o the highest sequence number received

   o an estimate of the inter-arrival jitter

   o and information to allow senders to calculate the network round
      trip time.

   The RTCP XRs [RFC3611] supplement the existing RTCP packets and
   provide more detailed feedback on reception quality in several
   categories:

   o Loss and duplicate Run Length Encoding (RLE) reports

   o Packet-receipt times reports

   o Round-trip time reports

   o Statistics Summary Reports

There are also various other scenarios in which it is desirable to
send RTCP Metric reports more frequently. For example, the Audio/
Video Profile with Feedback [RFC4585] extends the standard Audio/
Video Profile [RFC3551] to allow RTCP reports to be sent early
provided RTCP bandwidth allocation is respected. The following are
four use cases but are not limited to:

o RTCP NACK is used to provide feedback on the RTP sequence numbers
   for a subset of the lost packets or all the currently lost packets
   [RFC4585].

o RTCP is extended to convey requests for full intra-coded frames or
   select the reference picture, and signal changes in the desired
   temporal/spatial trade-off and maximum media bit rate [RFC5104].

o RTCP or RTCP XR is extended to provide feedback on Explicit
   Congestion Notification (ECN) statistics information [ECN].

o RTCP XR is extended to provide feedback on multicast acquisition
   statistics information and parameters [RFC6332].

3.3. RTP Sender/Receiver entities located in network nodes

The location of the RTP Sender/Receiver entities may impact a set of
meaningful metrics. For instance, application level metrics for QoE
related performance parameters are under most conditions measured at
the user device that receives RTP data packets. However in some
cases, given the factors ("measurement point location", "measurement
model location", "awareness of content information", etc [P.NAMS])
taken into account, such metrics may be measured in a network node
instead of a user device.

4. **Issues with reporting metric block using RTCP XR extension**

   Issues that have come up in the past with reporting metric block
   using RTCP XR extensions include (but are probably not limited to)
   the following:

   o Using compound metrics block. A single report block
      (i.e.,compound metrics block) is designed to contain a large
      number of parameters in different classes for a specific
      application. For example, the RTCP Extended Reports (XRs)
      [RFC3611] defines seven report block formats for network
      management and quality monitoring. Some of these block types
      defined in the RTCP XRs [RFC3611] are only specifically designed
      for conveying multicast inference of network characteristics
      (MINC) or voice over IP (VoIP) monitoring. However different
      applications layered on RTP may have different monitoring
      requirements. Design compound metrics block only for specific
      applications may increase implementation cost and minimize
      interoperability.

   o Correlating RTCP XR with the non-RTP data. Canonical End-Point
      Identifier SDES Item (CNAME) defined in the RTP Protocol [RFC3550]
      is an example of existing tool that allows to bind an
      Synchronization source (SSRC) that may change to a fixed source
      name in one RTP session. It may be also fixed across multiple RTP
      sessions from the same source. However there may be situations
      where RTCP reports are sent to other participating endpoints using
      non-RTP protocol in a session. For example, as described in the
      SIP RTCP Summary Report Protocol [RFC6035], the data contained in
      RTCP XR VoIP metrics reports [RFC3611] are forwarded to a central
      collection server systems using SIP. In such case, there is a
      large portfolio of quality parameters that can be associated with
      real time application, e.g., VOIP application, but only a minimal
      number of parameters are included on the RTCP-XR reports.
      Therefore correlation between RTCP XR and non-RTP data should be
      concerned if administration or management systems need to rely on
      the mapping RTCP statistics to non-RTCP measurements to conducts
      data analysis and creates alerts to the users. Without such
      correlation, it is hard to provide accurate measures of real time
      application quality with a minimal number of parameters included
      on the RTCP-XR reports in such case.

   o Measurement Information duplication. Measurement information
      provides information relevant to a measurement reported in one or
      more other block types. For example we may set a metric interval
      for the session and monitor RTP packets within one or several
      consecutive metric interval. In such case, the extra measurement
      information (e.g., extended sequence number of 1st packet,

measurement period) may be expected. However if we put such extra
measurement information into each metric block, there may be
situations where an RTCP XR packet containing multiple metric
blocks, reports on the same streams from the same source. In
other words, duplicated data for the measurement is provided
multiple times, once in every metric block. Though this design
ensures immunity to packet loss, it may bring more packetization
complexity and the processing overhead is not completely trivial
in some cases. Therefore compromise between processing overhead
and reliability should be taken into account.

o Consumption of XR block code points. The RTCP XR block namespace
   is limited by the 8-bit block type field in the RTCP XR header.
   Space exhaustion may be a concern in the future. We therefore may
   need a way to extend the block type space, so that new
   specifications may continue to be developed.

5. Guideline for reporting metric block using RTCP XR

5.1. Using single metrics blocks

   Different applications using RTP for media transport certainly have
   differing requirements for metrics transported in RTCP to support
   their operation. For many applications, the basic metrics for
   transport impairments provided in RTCP SR and RR packets [RFC3550]
   (together with source identification provided in RTCP SDES packets)
   are sufficient. For other applications additional metrics may be
   required or at least sufficiently useful to justify the overheads,
   both of processing in endpoints and of increased session bandwidth.
   For example an IPTV application using Forward Error Correction (FEC)
   might use either a metric of post-repair loss or a metric giving
   detailed information about pre-repair loss bursts to optimise payload
   bandwidth and the strength of FEC required for changing network
   conditions. However there are many metrics available. It is likely
   that different applications or classes of applications will wish to
   use different metrics. Any one application is likely to require
   metrics for more than one parameter but if this is the case,
   different applications will almost certainly require different
   combinations of metrics. If larger blocks are defined containing
   multiple metrics to address the needs of each application, it becomes
   likely that many different such larger blocks are defined, which
   becomes a danger to interoperability.

   To avoid this pitfall, this memo proposes the use of single metrics
   blocks each containing a very small number of individual metrics
   characterizing only one parameter of interest to an application
   running over RTP. For example, at the RTP transport layer, the
   parameter of interest might be packet delay variation, and
   specifically the metric "IP Packet Delay Variation (IPDV)" defined by
   [Y1540]. See Section 6 for architectural considerations for a
   metrics block, using as an example a metrics block to report packet
   delay variation.

5.2. Correlating RTCP XR with the non-RTP data

   There may be situation where more than one media transport protocols
   are used by one application to interconnect to the same session in
   the gateway. For example, one RTCP XR Packet is sent to the
   participating endpoints using non-RTP-based media transport (e.g.,
   using SIP) in a VOIP session, one crucial factor lies in how to
   handle their different identities that are corresponding to different
   media transport.

   This memo proposes an approach to facilitate the correlation of the
   RTCP Session with other session-related non-RTP data. That is to say

if there is a need to correlate RTP sessions with non-RTP sessions,
then the correlation information needed should be conveyed in a new
RTCP Source Description (SDES) item, since such correlation
information describes the source, rather than providing a quality
report. An example use case is for a participant endpoint may convey
a call identifier or a global call identifier associated with the
SSRC of measured RTP stream. In such case, the participant endpoint
uses the SSRC of source to bind the call identifier using SDES item
in the SDES RTCP packet and send such correlation to the network
management system. A flow measurement tool that is configured with
the 5-tuple and not call-aware then forward the RTCP XR reports along
with the SSRC of the measured RTP stream which is included in the XR
Block header and 5-tuple to the network management system. Network
management system can then correlate this report using SSRC with
other diagnostic information such as call detail records.

5.3. Reducing Measurement information repetition

When multiple metric blocks are carried in one RTCP XR packet,
reporting on the same stream from the same source for the same time
period, RTCP should use the SSRC to identify and correlate the
multiple metric blocks between metric blocks. This memo proposes to
define a new XR Block that will be used to convey the common time
period and the number of packets sent during this period. If the
measurement interval for a metric is different from the RTCP
reporting interval, then this measurement duration in the Measurement
information block [MI] should be used to specify the interval. When
there may be multiple measurements information blocks with the same
SSRC in one RTCP XR compound packet, the measurement information
block should be put in order and followed by all the metric blocks
associated with this measurement information block. New RTCP XR
metric blocks that rely on the Measurement information block [MI]
must specify the response in case the new RTCP XR metric block is
received without an associated measurement information block. In
most cases, it is expected that the correct response is to discard
the received metric. In order to reduce measurement information
repetition in one RTCP XR compound packet containing multiple metric
blocks, the measurement information shall be sent before the related
metric blocks that are from the same reporting interval. Note that
for packet loss robustness if the report blocks for the same interval
span over more than one RTCP packet then each must have the
measurement identity information even if though they will be the
same.

5.4. Expanding the RTCP XR block namespace

The consumption of XR block code points isn't a major issue. However
if XR block codes points is really close to run out of space, it

might be desirable to define new fields in the XR report block or
define one XR block type for vendor-specific extensions, with an
enterprise number included to identify the vendor making the
extension.

6. **An example of a metric block**

   This section uses the example of an existing proposed metrics block
   to illustrate the application of the principles set out in
   Section 5.1.

   The example [PDV] is a block to convey information about packet delay
   variation (PDV) only, consistent with the principle that a metrics
   block should address only one parameter of interest. One simple
   metric of PDV is available in the RTCP RR packet as the "interarrival
   jitter" field. There are other PDV metrics with a certain similarity
   in metric structure which may be more useful to certain applications.
   Two such metrics are the IPDV metric ([Y1540], [RFC3393]) and the
   mean absolute packet delay variation 2 (MAPDV2) metric [G1020]. Use
   of these metrics is consistent with the principle in Section 5 of
   RTCP guideline [RFC5968] that metrics should usually be defined
   elsewhere, so that RTCP standards define only the transport of the
   metric rather than its nature. The purpose of this section is to
   illustrate the architecture using the example of [PDV] rather than to
   document the design of the PDV metrics block or to provide a tutorial
   on PDV in general.

   Given the availability of at least three metrics for PDV, there are
   design options for the allocation of metrics to RTCP XR blocks:

   o provide an RTCP XR block per metric

   o provide a single RTCP XR block which contains all three metrics

   o provide a single RTCP block to convey any one of the three
      metrics, together with a identifier to inform the receiving RTP
      system of the specific metric being conveyed

   In choosing between these options, extensibility is important,
   because additional metrics of PDV may well be standardized and
   require inclusion in this framework. The first option is extensible
   but only by use of additional RTCP XR blocks, which may consume the
   limited namespace for RTCP XR blocks at an unacceptable rate. The
   second option is not extensible, so could be rejected on that basis,
   but in any case a single application is quite unlikely to require
   transport of more than one metric for PDV. Hence the third option
   was chosen. This implies the creation of a subsidiary namespace to
   enumerate the PDV metrics which may be transported by this block, as
   discussed further in [PDV].

7. Application to RFC 5117 topologies

   The topologies specified in [RFC5117] fall into two categories. The
   first category relates to the RTP system model utilizing multicast
   and/or unicast. The topologies in this category are specifically
   Topo-Point-to-Point, Topo- Multicast, Topo-Translator (both variants,
   Topo-Trn-Translator and Topo-Media-Translator, and combinations of
   the two), and Topo-Mixer. These topologies use RTP end systems, RTP
   mixers and RTP translators defined in the RTP protocol [RFC3550].
   For purposes of reporting connection quality to other RTP systems,
   RTP mixers and RTP end systems are very similar. Mixers
   resynchronize packets and do not relay RTCP reports received from one
   cloud towards other cloud(s). Translators do not resynchronize
   packets and should forward certain RTCP reports between clouds. In
   this category, the RTP system (end system, mixer or translator) which
   originates, terminates or forwards RTCP XR blocks is expected to
   handle RTCP, including RTCP XR, according to the RTP protocol
   [RFC3550]. Provided this expectation is met, an RTP system using
   RTCP XR is architecturally no different from an RTP system of the
   same class (end system, mixer, or translator) which does not use RTCP
   XR. The second category relates to deployed system models used in
   many H.323 [H323] video conferences. The topologies in this category
   are Topo-Video-Switch-MCU and Topo-RTCP-terminating-MCU. Such
   topologies based on systems do not behave according to the RTP
   protocol [RFC3550].

   Considering the MCU and translator are two typical topologies in the
   two categories mentioned above, this document will take them as two
   typical examples to explain how RTCP XR report works in different
   RFC5117 topologies.

7.1. Applicability to MCU

   Topo-Video-Switch-MCU and Topo-RTCP-terminating-MCU, suffer from the
   difficulties described in [RFC5117]. These difficulties apply to
   systems sending, and expecting to receive, RTCP XR blocks as much as
   to systems using other RTCP packet types. For example, a participant
   RTP end system may send media to a video switch MCU. If the media
   stream is not selected for forwarding by the switch, neither RTCP RR
   packets nor RTCP XR blocks referring to the end system's generated
   stream will be received at the RTP end system. Strictly the RTP end
   system can only conclude that its RTP has been lost in the network,
   though an RTP end system complying with the robustness principle of
   [RFC1122] should survive with essential functions (i.e.,media
   distribution) unimpaired.

7.2. Applicability to Translators

Section 7.2 of the RTP protocol [RFC3550] describes processing of
RTCP by translators. RTCP XR is within the scope of the
recommendations of the RTP protocol [RFC3550]. Some RTCP XR metrics
blocks may usefully be measured at, and reported by, translators. As
described in the RTP protocol [RFC3550] this creates a requirement
for the translator to allocate an SSRC for the monitor collocated
with itself so that the monitor may populate the SSRC in the RTCP XR
packet header as packet sender SSRC and send it out(although the
translator is not a Synchronisation Source in the sense of
originating RTP media packets). It must also supply this SSRC and
the corresponding CNAME in RTCP SDES packets.

In RTP sessions where one or more translators generate any RTCP
traffic towards their next-neighbour RTP system, other translators in
the session have a choice as to whether they forward a translator's
RTCP packets. Forwarding may provide additional information to other
RTP systems in the connection but increases RTCP bandwidth and may in
some cases present a security risk. RTP translators may have
forwarding behaviour based on local policy, which might differ
between different interfaces of the same translator.

8. IANA Considerations

   There is no IANA action in this document.

9. Security Considerations

   This document focuses on the RTCP reporting extension using RTCP XR
   and should not give rise to any new security vulnerabilities beyond
   those described in RTCP XRs [RFC3611]. However it also describes the
   architectural framework to be used for monitoring at RTP layer. The
   security issues with monitoring needs to be considered.

   In RTP sessions, a RTP system may use its own SSRC to send its
   monitoring reports towards its next-neighbour RTP system. Other RTP
   system in the session may have a choice as to whether they forward
   this RTP system's RTCP packets. This present a security issue since
   the information in the report may be exposed by the other RTP system
   to any malicious node. Therefore if the information is considered as
   sensitive, the monitoring report should be encrypted.

   Also note that the third party monitors are not visible at the RTP
   layer since they do not send any RTCP packets. In order to prevent
   any sensitive information leakage, the monitoring from the third
   party monitors should be prohibited unless the security is in place
   to authenticate them.

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Appendix A. Change Log

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

A.1. draft-ietf-avtcore-monarch-00

   The following are the major changes compared to
   draft-hunt-avtcore-monarch-02:

   o Move Geoff Hunt and Philip Arden to acknowledgement section.

A.2. draft-ietf-avtcore-monarch-01

   The following are the major changes compared to 00:

   o Restructure the document by merging section 4 into section 3.

   o Remove section 4.1,section 5 that is out of scope of this
      document.

   o Remove the last bullet in section 6 and section 7.3 based on
      conclusion of last meeting.

   o Update figure 1 and related text in section 3 according to the
      monitor definition in RFC3550.

   o Revise section 9 to address monitor declaration issue.

   o Merge the first two bullet in section 6.

   o Add one new bullet to discuss metric block association in section
      6.

A.3. draft-ietf-avtcore-monarch-02

   The following are the major changes compared to 01:

   o Deleting first paragraph of Section 1.

   o Deleting Section 3.1, since the interaction with the management
      application is out of scope of this draft.

   o Separate identity information correlation from section 5.2 as new
      section 5.3.

   o Remove figure 2 and related text from section 5.2.

o Editorial changes in the section 4 and the first paragraph of
   section 7.

A.4. draft-ietf-avtcore-monarch-03

The following are the major changes compared to 02:

o Update bullet 2 in section 4 to explain the ill-effect of Identity
   Information duplication.

o Update bullet 3 in section 4 to explain why Correlating RTCP XR
   with the non-RTP data is needed.

o Update section 5.2 to focus on how to reduce the identity
   information repetition

o Update section 5.3 to explain how to correlate identity
   information with the non-RTP data

A.5. draft-ietf-avtcore-monarch-04

The following are the major changes compared to 03:

o Update section 5.2 to clarify using SDES packet to carry
   correlation information.

o Remove section 5.3 since additional identity information goes to
   SDES packet and using SSRC to identify each block is standard RTP
   feature.

o Swap the last two paragraphs in the section 4 since identity
   information duplication can not been 100% avoided.

o Other editorial changes.

A.6. draft-ietf-avtcore-monarch-05

The following are the major changes compared to 04:

o Replace "chunk" with "new SDES item".

o Add texts in security section to discussion potential security
   issues.

o Add new sub-section 5.3 to discuss Reducing Measurement
   information repetition.

o Other editorial changes.

A.7. draft-ietf-avtcore-monarch-06

   The following are the major changes compared to 05:

   o Some editorial changes.

A.8. draft-ietf-avtcore-monarch-07

   The following are the major changes compared to 06:

   o Clarify the XR block code points consumption issue in the section
      4 and new section 5.4.

   o Other editorial changes.

A.9. draft-ietf-avtcore-monarch-08

   The following are the major changes compared to 07:

   o Editorial change to the reference.

A.10. draft-ietf-avtcore-monarch-09

   The following are the major changes compared to 07:

   o Rephrase application level metric definition.

   o Add one new section to clarify where to measure QoE related
      parameters.

   o Add text in section 5.3 to clarify the failure case when
      measurement interval is not sent.

   o Add text in section 5.3 to clarify how to deal with multiple
      measurements information blocks carried in the same packet.

A.11. draft-ietf-avtcore-monarch-10

   The following are the major changes compared to 09:

   o Discuss what exist already for monitoring in section 3.1.

   o Provide benefit using RTCP XR based monitoring in section 3.1.

   o add one new paragraph in section 3.1 to describe how monitoring
      architecture is applied to ASM/SSM.

   o Other Editorial Changes.

A.12. draft-ietf-avtcore-monarch-11

   The following are the major changes compared to 10:

   o Editorial Changes.

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