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I. Johansson  
M. Westerlund  
Ericsson AB  
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**Support for non-compound RTCP, opportunities and consequences**  
**draft-ietf-avt-rtcp-non-compound**

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Abstract

This memo discusses benefits and issues that arise when allowing RTCP packets to be transmitted as non-compound packets, i.e not follow the rules of [RFC 3550](#). Based on that analysis this memo proposes changes to the rules to allow feedback messages to be sent as non-compound RTCP packets when using the RTP AVPF profile ([RFC 4585](#)) under certain conditions.

## 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

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## 1. Introduction

In RTP [[RFC3550](#)] it is currently mandatory to always use RTCP compound packets containing at least Sender Reports or Receiver reports, and a SDES packet containing at least the CNAME item. There are good reasons for this as discussed below (see [Section 2](#)). However this do result in that the minimal RTCP packets are quite large. The RTP profile AVPF [[RFC4585](#)] specifies new RTCP packet types for feedback messages. Some of these feedback messages would benefit from being transmitted with minimal delay and AVPF do provide some mechanism to enable this. However for environments with low-bitrate links this still consumes quite large amount of resources and introduce extra delay in the time it takes to completely send the compound packet in the network. There are also other benefits as discussed in [Section 3](#).

The use of non-compound packets is not without issues. This is discussed in [Section 4](#). These issues needs to be considered and is one motivation for this document.

In addition this document proposes how AVPF could be updated to allow the transmission of non-compound packets in a way that would not substantially affect the mechanisms that compound packets provide. The connection to AVPF is motivated by the fact that non-compound RTCP is mainly intended for event driven feedback purposes and that the AVPF early and immediate modes makes this possible.

## 2. RTCP Compound Packets

[Section 6.1 in RFC3550](#) [[RFC3550](#)] specifies that an RTCP packet must be sent in a compound packet consisting of at least two individual packets, first an Sender Report (SR) or Receiver Report (RR), followed by an SDES packet containing at least a CNAME Item for the transmitting source identifier (SSRC). Lets examine what these RTCP packet types are used for.

1. The sender and receiver reports (see [Section 6.4 of RFC 3550](#) [[RFC3550](#)]) provides the RTP session participant with the Sender Source Identifier (SSRC) of all RTCP senders. Having all participants send these packets periodically allows everyone to determine the current number of participants. This information is used in the transmission scheduling algorithm. Thus this is particularly important for new participants so that they quickly can establish a good estimate of the group size. Failure to do this would result in RTCP senders consuming to much bandwidth.



2. The sender and receiver reports contain some basic statistics usable for monitoring of the transport and thus enable adaptation. These reports become more useful if sent regularly as the receiver of a report can perform analysis to find trends between the individual reports. When used for media transmission adaptation the information become more useful the more frequently it is received, at least until one report per round-trip time (RTT) is achieved. Therefore there are most cases no reason to not include the sender or receiver report in all RTCP packets.
3. The CNAME SDES item (See [Section 6.5.1 of RFC 3550](#) [[RFC3550](#)]) exist to allow receivers to determine which media flows that should be synchronized with each other between different RTP sessions carrying different media types. Thus it is important to quickly receive this for each media sender in the session when joining an RTP session.
4. Sender Reports (SR) is used in combination with the above SDES CNAME mechanism to establish inter media synchronization. After having determined which media streams should be synchronized using the CNAME field, the receiver uses the Sender Report's NTP and RTP timestamp fields to establish synchronization.

Reviewing the above it is obvious that both SR/RR and the CNAME are very important for new session participants to be able to utilize any received media and to avoid flooding the network with RTCP reports. In addition, if not sent regularly the dynamic nature of the information provided would make it less and less useful.

### **3. Benefits with non-compound packets**

As mentioned in the introduction, most advantages of using non-compound packets exists in cases when the available RTCP bit-rate is limited. This because non-compound packets will be substantially smaller than a compound packet. A compound packet is forced to contain both an RR or an SR and the CNAME SDES item. The RR containing a report block for a single source is 32 bytes, an SR is 52 bytes. Both may be larger if they contain report blocks for multiple sources. The SDES packet containing a CNAME item will be 10 bytes plus the CNAME string length. Here it is reasonable that the CNAME string is at least 10 bytes to get a decent collision resistance. And if the recommended form of user@host is used, then most strings will be longer than 20 characters. Thus a non-compound packets can become at least 70-80 bytes smaller than the compound packet.

The following benefits exist for the smaller non-compound packets:



1. Shorter serialization time, i.e the time it takes the link to transmit the packet. For slower links this time can be substantial. For example transmitting 120 bytes over an link interface capable of 30 kbps takes 32 milliseconds (ms) assuming uniform transmission rate.
2. For links where the packet loss rate grows with the packet size, smaller packets will be less likely to be dropped. Example of such links are radio links. In the cellular world there exist links that are optimized to handle RTP packets with speech and these packets common sizes, the rationale behind this is to be able to increase the capacity and coverage for voice services. Compound RTCP packets commonly are 2-3 times the size of a RTP packet with compressed speech. If the speech packet over such a bearer have a packet loss probability of  $p$ , then the RTCP packet will experience  $1 - (1-p)^x$  where  $x$  is the number of fragments the compound packet will be split on the link layer, i.e. 2 or 3 commonly.
3. In fixed links there are also benefits with sending feedback in small non-compound RTCP. One such application is those that use RTCP AVPF in early or immediate mode to send frequent event driven feedback. Under these circumstances the use of non-compound RTCP minimizes the risk that the RTCP bandwidth becomes too high during periods of intense adaptation feedback signaling.
4. In cases when regular feedback is need, like in the profile under development for TCP friendly rate control (TFRC) for RTP [[I-D.ietf-avt-tfrc-profile](#)]. The size of compound RTCP can result in very high bandwidth requirements for the feedback in case the round trip time is short. For this particular application non-compound RTCP gives a very substantial improvement.

In cases when non-compound packets carry important and time sensitive feedback both shorter serialization time and the lower loss probability are important to enable the best possible functionality. Having a packet loss rate that is much higher for the feedback packets compared to media packets is not advantageous when for example trying to perform media adaptation to handle the e.g changed performance present at the cell border in cellular system.

For high bit-rate applications there is usually no problem of supplying RTCP with sufficient bit-rates. When using AVPF one can use the "trr-int" parameter to restrict the regular reporting interval to approximately once per RTT or less often. As in most cases there are no reasons to provide regular reports with higher density than this. Any additional bandwidth can then be used for





feedback messages. The benefit of non-compound packets in this case is limited, but exist. One typical example is video using generic NACK in cases where the RTT is low. Using non-compound packets would reduce the total amount of bits used for RTCP. This is primarily applicable if the number of non-compound packets is large. This would also result in lower processing delay and less complexity for the feedback packets as they do not need to query the RTCP database to construct the right messages.

#### **4. Issues with non-compound RTCP packets**

This section describes some of the known issues with non-compound RTCP packets

##### **4.1. Middle boxes**

Middle boxes in the network may discard RTCP packets that does not follow the rules outlined in [section 6.1 of RFC3550](#). The effect of this might for instance be that compound RTCP packets makes its way through while the non-compound feedback packets are lost.

##### **4.2. Packet Validation**

A non-compound packet will be discarded by the packet validation code in [Appendix A of RFC 3550](#) [[RFC3550](#)]. This has several impacts as described in the following sub sections.

###### **4.2.1. Old RTCP Receivers**

Any RTCP receiver without updated packet validation code will discard the non-compound packets. Thus these receivers will not see the feedback contained in the these non-compound packets. The effect of this depends on the type of feedback message and the role of the receiver. For example this may cause complete function loss in the case of attempting to use a non-compound NACK message (see [Section 6.2.1 of RFC 4585](#) [[RFC4585](#)]) to non updated media sender in a session using the retransmission scheme defined by [RFC 4588](#) [[RFC4588](#)].

This type of discarding would also effect the feedback suppression defined in AVPF. The result would be a partitioning of the receivers within the session between old ones only seeing the compound RTCP feedback messages and the newer ones seeing both. Where the old ones may send feedback messages for events already reported on in non-compound packets.



#### **4.2.2. Weakened Packet Validation**

The packet validation code needs to be rewritten to accept non-compound packets. One potential effect of this change is much weaker validation that received packets actually are RTCP packets, and not packets of some other type being wrongly delivered. Thus some consideration should be done to ensure the best possible validation is available. For example restricting non-compound packets to contain only some specific RTCP packet types, that is preferably signalled on a session basis. A solution to this is presented in [Section 6.2](#)

#### **4.2.3. Bandwidth consideration**

The discarding of non-compound RTCP packets would effect the RTCP transmission calculation in the following way; the `avg_rtcp_size` value would become larger than for RTP receivers that exclude the non-compound in this calculation (assuming that non-compound packets are smaller than compound ones). Therefore these senders would under-utilize the available bit-rate and send with a longer interval than updated receivers. For most sessions this would should not be an issue. However for sessions with a large portion of non-compound packets may result in that the updated receivers time out non-updated senders prematurely. A solution to this is presented in [Section 6.2](#).

#### **4.2.4. Computation of `avg_rtcp_size`**

Long intervals between compound RTCP packets and many non-compound RTCP packets in between may lead to a computation of the value `avg_rtcp_size` that varies greatly over time. A solution to this is presented in [Section 6.2](#).

#### **4.3. Header compression**

The classifiers for header compression algorithms such as RoHC [[RFC3095](#)] and its profiles must be aware of the fact that, with the proposed non-compound RTCP packets, the first RTCP packet type might differ from 200 or 201. Otherwise they may wrongly classify the packets as something else than RTCP. This may have impact on the compression efficiency.

#### **4.4. RTP and RTCP multiplex on the same port**

In applications that multiplexes RTP and RTCP on the same port, as defined in [[I-D.ietf-avt-rtp-and-rtcp-mux](#)], care must be taken to ensure that the de multiplexing is done properly even though RTCP packets are non-compound.



## **5. Use cases for non-compound RTCP**

Below are listed a few use cases for non-compound RTCP. It is worth notice here that the current use of non-compound RTCP and the applications is thoroughly specified in other standardization bodies and for services that have a meaning inside each standardization forum and is limited to a specific service such as PoC or 3GPP-MTSI. A general definition of the use of non-compound RTCP for e.g control plane or codec control signaling would probably need to be specified inside the IETF.

### **5.1. Control plane signaling**

Open Mobile Alliance (OMA) Push-to-talk over Cellular (PoC) [[OMA-PoC](#)] makes use of non-compound packets when transmitting certain events. The OMA POC service is primarily used over cellular links capable of IP transport, such as the GSM GPRS.

### **5.2. Codec control signaling**

Examples of codec control usage for non-compound RTCP is found in [[3GPP-MTSI](#)].

Another example that can be used with non-compound RTCP are e.g the TMMBR messages as specified in [[I-D.ietf-avt-avpf-ccm](#)] that signals a request for a change in codec bitrate. The benefit with transmitting these messages is that the likelihood that they are transmitted successfully in bad channel conditions can in some cases be considerably higher than if they are put in larger compound RTCP. This is critical as these messages predominantly occurs when channel conditions are poor.

### **5.3. Feedback**

The feedback scenario is best presented e.g as Video with generic NACK. In cases where the RTT is shorter than the receiver buffer depth, generic NACK can be used to request retransmission of missing information, thus improving play out quality considerably. If the generic NACK packets are transmitted non-compound the bandwidth requirement will be minimal, enabling more frequent feedback. Like in the Codec control case it is crucial that these packets can be transmitted as non-compound RTCP and also in some cases with as little delay as possible.

Another interesting use for non-compound RTCP is in cases when regular feedback is need, like in the profile under development for TCP friendly rate control (TFRC) for RTP [[I-D.ietf-avt-tfrc-profile](#)]. The size of compound RTCP can result in very high bandwidth



requirements for the feedback in case the round trip time is short. For this particular application non-compound RTCP may give a very substantial improvement.

#### **5.4. Status reports**

One idea that is discussed is to transmit small measurement or status reports in non-compound RTCP or to be able to split the parts of e.g. a minimum compound RTCP into its parts and transmit them separately. The status reports can be used either by the endpoints or by other network monitoring boxes in the network.

The benefit is that with some radio access technologies small packets are more robust to poor radio conditions than large packets. Additionally, with small (report) packets there is a smaller risk that the report packets affects the channel that it reports upon.

In principle it is perfectly OK to convey all sorts of information as non-compound RTCP by means of e.g. a new RTCP packet type with a new payload type. It is for instance possible to specify a number of measurement metrics in separate small non-compound RTCP. However a few issues need to be considered.

- o A risk exists that it opens up for a whole set of incompatible metrics and reports devised in various standardization fora leading to a potential interoperability problems.
- o Middle boxes or third party network monitoring equipment may fail to understand the new reports or even discard these new report types.
- o There may arise a need to verify that these "special" reports reach the intended recipient in case middle boxes in the network discards unknown reports.

#### **6. Rules and guidelines for non-compound packets in AVPF**

Based on the above analysis it seems feasible to allow transmission of non-compound RTCP under some restrictions. First of all it is important that compound packets are regularly sent to ensure the feedback reporting works. The tracking of session size and number of participants is also important as this ensures that the RTCP bandwidth remain bounded independent of the number of session participants. As the compound packets also are used to establish the synchronization, any newly joining participant in a session would need to receive a compound packet from the media sender. In summary the regular usage of compound packets must be maintained throughout





the complete session. Thus non-compound packets should be restricted to be used as extra feedback packets sent in cases when a regular compound packet would not have been sent.

The usage of non-compound RTCP packet SHALL only be done in RTP sessions operating in AVPF [[RFC4585](#)] Early RTCP or Immediate feedback mode. Non-compound packets SHALL NOT be sent until at least one compound packet has been sent. In Immediate feedback mode all feedback messages MAY be sent as non-compound packets. In early RTCP mode a feedback message scheduled for transmission as an Early RTCP packet, i.e not a Regular RTCP packet, MAY be sent as a non-compound packet.

### **6.1. Verifying the delivery of non-compound packets**

If an application is to use non-compound packets it is important to verify that they actually reaches the session participants. As outlined above in [Section 4.1](#) and [Section 4.2](#) packets may be discarded along the path or in the end-point. The end-points can be resolved by introducing signaling that informs if all session participants are capable of non-compound packets or not. The middle box issue is more difficult and here one will be required to use heuristics to determine if the non-compound packets are delivered or not. However in many cases the feedback messages sent using non-compound packets will result in either explicit or implicit indications that they have been received. Example of such are the RTP retransmission [[RFC4588](#)] that result from a NACK message [[RFC4585](#)], the Temporary Maximum Media Bit-rate Notification message resulting from a Temporary Maximum Media Bit-rate Request [[I-D.ietf-avt-avpf-ccm](#)], or the presence of a Decoder Refresh Point [[I-D.ietf-avt-avpf-ccm](#)] in the video media stream resulting from the Full Intra Request sent.

A proposed algorithm to detect consistent failure of delivery of non-compound packets needs to be written. The details of this algorithm is application dependent and therefore outside the scope of this document.

If the verification fails it is strongly recommended that only compound RTCP according to the rules outlined in [RFC3550](#) is transmitted.

### **6.2. Modified bandwidth computation**

In order to make the best possible use of the non-compound RTCP and also to enable a stable estimate of avg\_rtcp\_size it is necessary to modify the bandwidth computation in [Appendix A of RFC 3550](#) [[RFC3550](#)].



The concept behind the algorithm modifications is to treat small and large RTCP packets separately. There are a number of reasons to this

- o More stable estimate of avg\_rtcp\_size.
- o Easier to allocate bandwidth between small and large RTCP packets.

One question that arise is how to distinguish between small (non-compound) and large (compound) RTCP. A few alternatives:

- o Payload type: A non-compound RTCP may have a (first) PT number that differs from the PT numbers for SR or RR. This may be a weak alternative as some interest to be able to split minimum compound RTCP is expressed, see Status reports ([Section 5.4](#)). A possible problem here is also that this distinction does not actually tell the size of the RTCP.
- o Fixed size, set in specification. For instance one may base the distinction on the likely minimum size of a minimal compound RTCP. Assuming that such a packet will contain at least an SR (32 bytes) and a SDES CNAME (likely 16 bytes or more) one can conclude that 48 bytes (+IP/UDP overhead) is probably the smallest realistic size of a compound RTCP.
- o Fixed size, set in session setup : Some sessions may e.g use RTCP-XR or some other RTCP reporting on occasions that may give very large packet sizes, it may be desirable to adjust the threshold
- o Variable size: As non-compound RTCP is by definition RTCP that does not follow the rules for compound RTCP as they are specified in [RFC3550](#), the size can be determined "on the fly".

#### **6.2.1. Bandwidth allocation**

The distinction between compound and non-compound RTCP opens up for a possibility to allocate the available RTCP bandwidth between compound and non-compound RTCP. There are two alternatives how to solve this.

- o SDP attribute "trr-int": The combination of the total allocated RTCP bandwidth and the "trr-int" attribute allows non-compound RTCP to use the remaining RTCP bandwidth, thus a separate minimum transmit interval is computed for the non-compound RTCP.
- o ncp-share: A new attribute that tells how much of the total RTCP bandwidth should be allocated for non-compound RTCP.

It is possible to combine the two methods above.



### **6.2.2. Temporary immediate mode**

From the discussion about possible use cases in [Section 5](#), one can see two extreme scenarios for the use of non-compound RTCP.

1. Sparse transmission : For example generic NACK
2. Dense transmission : For example TFRC

In use case 2 the algorithm outline in [Section 6.2.1](#) gives optimal use of the available RTCP bandwidth. In use case 1 however the available RTCP bandwidth will be underutilized.

This opens up for the option to temporarily allow immediate transmission of non-compound RTCP as long as the used RTCP bandwidth stays under the allowed RTCP bandwidth measured over a given time span. The proposed algorithm outline below describes how immediate transmission in scenarios where non-compound RTCP is sparse can be allowed without a risk of over consuming RTCP bandwidth in scenarios where non-compound RTCP is dense.

- o Let `allow_immediate_ncp_ok` be a flag that signals that immediate transmission of non-compound RTCP is possible.
- o When a regular (compound) RTCP is transmitted.
  - \* Compute the bandwidth consumed by compound RTCP (`actual_rtcp_cp_bw`).
  - \* Compute the bandwidth consumed by non-compound RTCP (`actual_rtcp_ncp_bw`).
  - \* Compute the allowed number bytes for immediate non-compound RTCP (`max_immediate_bytes_TX_ncp`) as based on the total available RTCP bandwidth, `actual_rtcp_cp_bw`, `actual_rtcp_ncp_bw` and the time since the last regular RTCP
  - \* The variable `allow_immediate_ncp_ok` is set to true as long as the number of transmitted bytes belonging to non-compound RTCP (`immediate_bytes_TX_ncp`) is below the `max_immediate_bytes_TX_ncp`.
  - \* The variable `immediate_bytes_TX_ncp` is set to zero each time a regular RTCP is transmitted.

The proposed algorithm outline has the benefit that it allows for a large portion of immediate non-compound RTCP in scenarios where the non-compound RTCP is sparse while the allowed portion is



almost zero when non-compound RTCP is dense. This gives an algorithm that allows both for fast feedback and safe RTCP bandwidth utilization.

To conclude, the collection of modifications gives a few benefits.

- o More stable avg\_rtcp\_size as compound and non-compound RTCP are handled separately.
- o Shorter transmission interval for non-compound RTCP further leading to:
  - \* Fewer skipped non-compound RTCP. A non-compound RTCP can be skipped (or replaced) if it is still scheduled for transmission when a new non-compound RTCP of the same type is put on the queue. As the min transmission interval calculated with the proposed modification is lower (especially when transmission of non-compound RTCP is sparse) the risk of skipped non-compound RTCP is smaller.
- o Sensitive feedback can be transmitted with no transmission delay in cases when feedback is sparse. Unlike the AVPF immediate mode which does not concern about the bandwidth utilization and thus is not apt for larger groups, the proposed use of allow\_immediate\_ncp allows for immediate transmission of feedback (non-compound RTCP) as long as the bandwidth utilization stays below the designated limit.
- o The algorithm does not impose any requirement that other clients in a session implements the modifications.

### **6.2.3. Open issues**

The proposed algorithm has been verified with Matlab simulations and the results look promising. There are however a few open issues that needs to be addressed.

- o Varying RTCP size: Especially compound RTCP may vary quite a lot. So far a fixed size for non-compound and compound RTCP has been considered.
- o Number of members in session might vary: This may affect the bandwidth estimation algorithms in a negative way.
- o Very high bitrates: So far only relatively small RTCP bandwidths are tested.





- o Feedback suppression: For large groups the proposed use of `allow_immediate_ncp_ok` may lead to a feedback implosion. The dithering rules in [RFC4585](#) may be applicable here.
- o Feedback flooding: The proposed algorithm outline does not prevent the application from sending feedback at a very high rate as long as `allow_immediate_ncp_ok` is true, this may affect the media stream negatively, this is related to the feedback suppression issue.
- o A general mapping to the rules and function in [RFC4585](#) is missing.

### **6.3. SDP Signalling Attribute**

We request to define the a "a=ncp" [[RFC4566](#)] attribute to indicate if the session participant is capable of supporting non-compound packets. It is required that a participant that proposes the use of non-compound RTCP itself supports the reception of non-compound RTCP. Also it is possible that we request to define the "a=ncp-share" attribute.

## **7. IANA Considerations**

IANA will be required to register the SDP signalling attribute defined in [Section 6.3](#).

## **8. Security Considerations**

The security considerations of RTP [[RFC3550](#)] and AVPF [[RFC4585](#)] will apply also to non-compound packets. The reduction in validation strength for received packets on the RTCP port may result in a higher degree of acceptance of spurious data as real RTCP packets. This vulnerability can mostly be addressed by usage of an security mechanism that provide authentication, e.g. SRTP[RFC3711].

## **9. Acknowledgements**

The authors would like to thank all the people who gave feedback on this document.

This document also contain some text copied from [RFC 4585](#) [[RFC4585](#)] and we take the opportunity to thank the author of said document.

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#### Authors' Addresses

Ingemar Johansson  
Ericsson AB  
Laboratoriegrand 11  
SE-971 28 Lulea  
SWEDEN

Phone: +46 73 0783289  
Email: [ingemar.s.johansson \(AT\) ericsson.com](mailto:ingemar.s.johansson@ericsson.com)

Magnus Westerlund  
Ericsson AB  
Torshamnsgatan 21-23  
SE-164 83 Stockholm  
SWEDEN

Phone: +46 8 7190000  
Email: [magnus.westerlund \(AT\) ericsson.com](mailto:magnus.westerlund@ericsson.com)



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