RMCAT Feedback Requirements

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Feedback Requirements of NADA

- Information needed in NADA feedback:
  - Recommended rate adaptation mode (rmode)
  - Aggregated congestion signal (x_curr)
  - Recently measured receiving rate (r_recv)
- Recommended form of representation

Field	# of Bits	Unit	Range of Value
rmode	1	N/A	{0, 1}
x_curr	15	100us	0 – 32,767
r_recv*	16	100bps	0 – 65,535

* Error in current draft: draft-ietf-rmcat-nada-02

NADA Recommended Feedback Interval

- Design tradeoff between protocol overhead and responsiveness in rate adaptation
- Range of feedback intervals:
  - Minimum at 20ms: ~ 8% overhead for feedback message size 200 bytes and flow rate @ 1Mbps
  - Maximum value depends on path propagation delay and steady-state flow rate; can typically stretch to 400ms
- Recommended feedback interval: 100ms

GCC – What we need

- Start-up phase:
  - Send time, arrival time and size of each packet to estimate bandwidth.
  - Congestion controller knowledge about the sender's intent is useful (e.g., if packets are sent in a pattern on purpose, etc.). This is easier to achieve at the sender.
- Congestion control phase:
  - Ability to determine packet groups based on both send time and arrival time of packets.
  - Send time, arrival time and size of each group to compute inter-group delay variations.
  - Packet loss.
- One instance operates on all BUNDLEd streams.
  - Need to identify and compare packets from these streams.

GCC – Suggested feedback

- Per-packet feedback from receiver to sender:
  - Packet identifier (e.g., new sequence number or {ssrc, rtp seq num} tuple).
  - Packet send time.
  - Packet arrival time.
  - Packet size.
- More frequent is better.
  - Current choice is to send feedback every 50 ms.
  - Increasing to 100 ms would be possible, the cost would be delayed actuation, possibly leading to increased queuing.
  - Cost of high feedback frequency results in fewer ACKs per RTCP, leading to (assuming) :
    - Reduced ability to compress the feedback.
    - More packet overhead per ACK (limited by RFC 5506).

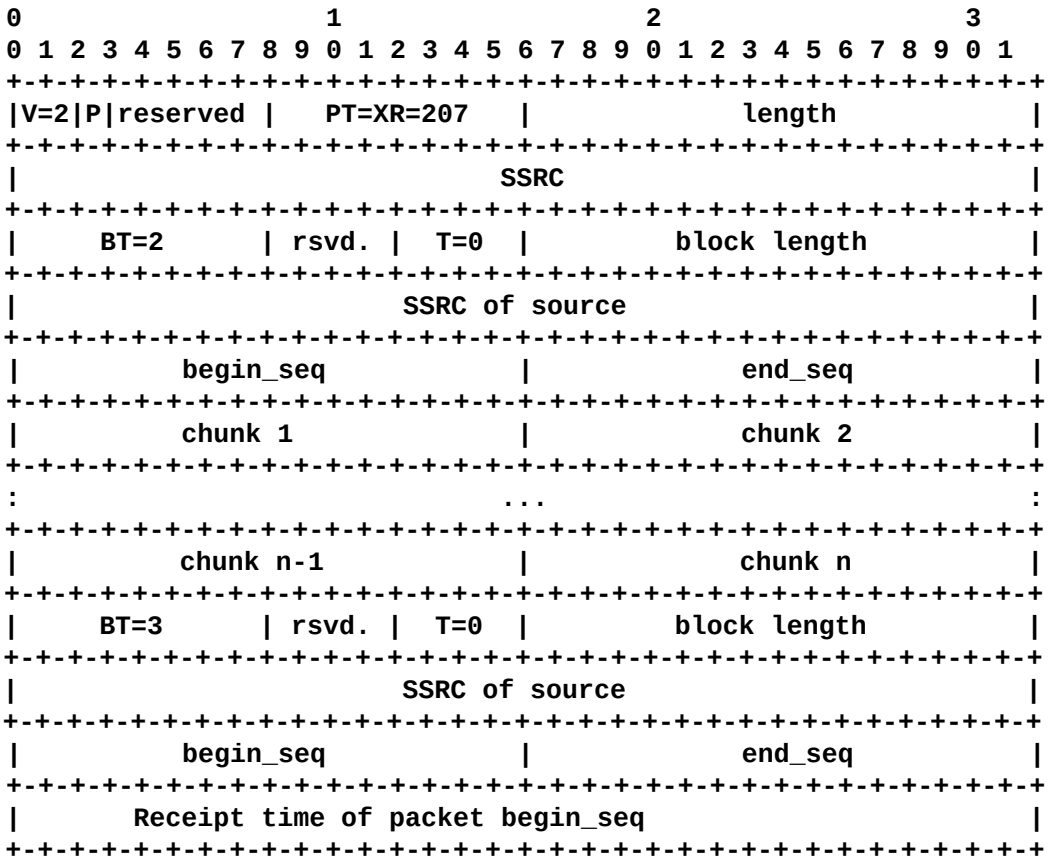
SCReAM feedback format

- Required for SCReAM functionality:
  - Arrival timestamp : Arrival timestamp of highest received RTP sequence number
    - 32 bits, timestamp clock equal to RTP media timestamp clock
  - List of received RTP packets :
- Optional , can enhance QoE:
  - ECN counter : ECN-CE counter value
  - Source quench bit, used to force sender to reduce sending rate

SCReAM feedback format

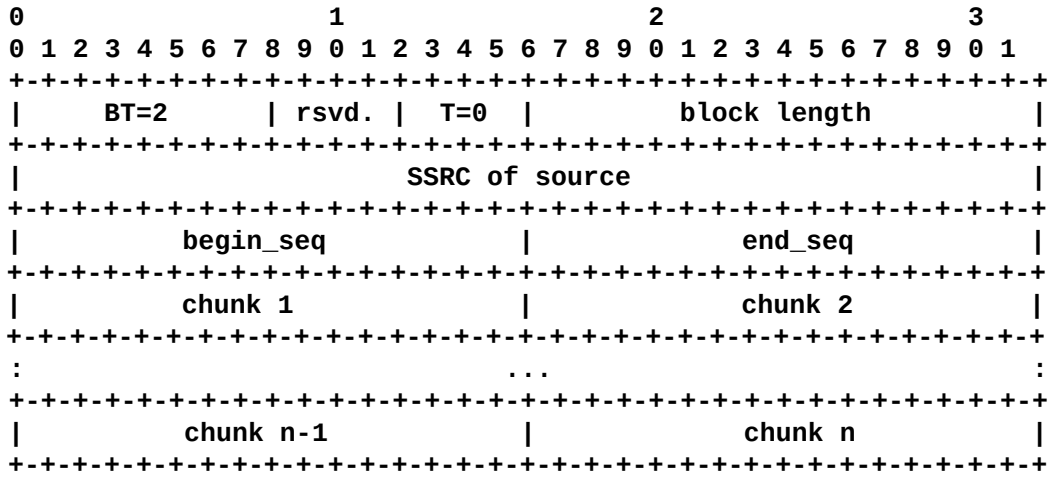
required, RFC3611 realization

- Required feedback can be implemented with RFC3611
  - Loss RLE report block
  - Packet Receipt Times block
- Feedback packet size : 44byte
  - assuming 4 RLE chunks
- Room for improvement
  - Fields are duplicated
  - Unnecessary headers



SCReAM feedback format
required, loss RLE report block, RFC3611

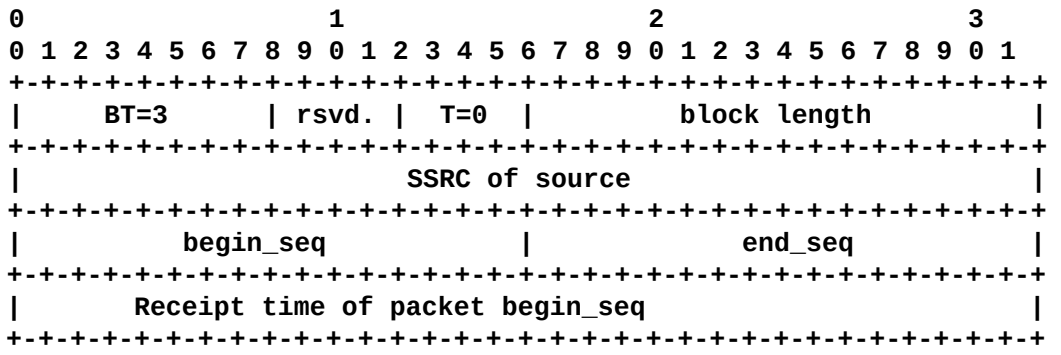
- Loss RLE report block spans from begin_seq to end_seg
- 4 chunks should be sufficient



SCReAM feedback format

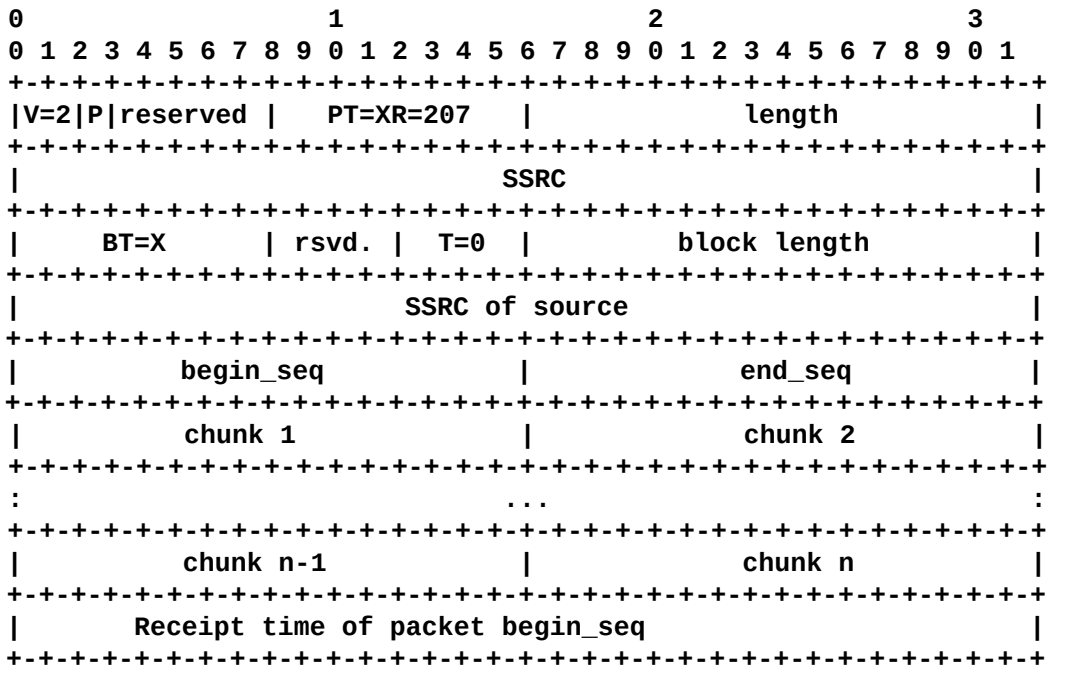
required, Packet receipt times block, RFC3611

- end_seq = (begin_seq+1) % 65536
- Receipt time stamp clock according to RFC3611 = Media RTP timestamp



SCReAM feedback format
compressed

- A compressed feedback packet with the same amount of information requires 32 bytes (assuming 4 RLE chunks)



SCReAM – False Loss detection

- Loss RLE block may not cover all received packets since last received feedback
  - Too low feedback rate
  - Feedback is lost
- Can lead to false loss detection
  - Should be a rare case but cannot be ignored

- Solution : Regular compound RTCP packets are expected to be transmitted at regular intervals (500ms), interval given by RFC4585 trr-int
  - cumulative number of packets lost : Can be used to undo a false loss detection

SCReAM – ECN and source quench

Optional

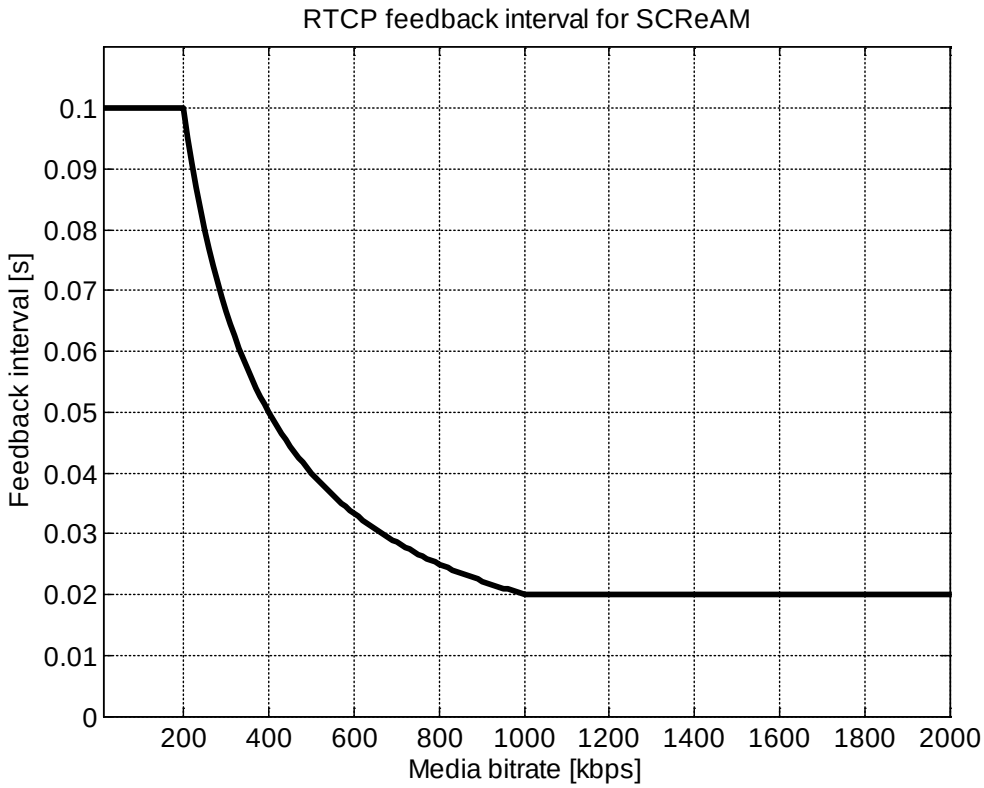
- ECN feedback can be implemented with RFC6679 XR report block
  - Adds 24 bytes to RTCP feedback packet
- Source quench: No known existing RTCP feedback
  - RTP packets can be signaled as lost in Loss RLE report block, will give a behavior similar to the desired source quench behavior
  - Possible unwanted side effects
    - Sender can base RTP retransmission on Loss RLE report block
    - Future ConEx functionality becomes more problematic but “cumulative number of packets lost” in RFC3550 can be used for disambiguation.

SCReAM – Considerations for a future format

- Detailed packet receipt times
  - Not required by SCReAM today but if GCC algorithm for initial rate estimation works well it can be of interest to include that in SCReAM as well
- RFC3611 + RFC6679 gives unnecessary extra overhead due to duplication of fields
  - A future RMCAT feedback can be more compact
  - A good start : http://tools.ietf.org/id/draft-holmer-rmcat-transport-wide-cc-extensions-01.txt

SCReAM Signaling

- RFC4585 regular mode is sufficient
  - Early mode may be used for application layer signaling (ReTx, FIR..)
- Reduced size RTCP highly recommended
  - Regular Compound RTCP transmission given by trr-int
- Signaling rate dependent on bitrate
  - From 100-200ms at low bitrates to 10-20ms at high bitrates
  - Based on empirical data from experiments and simulation
- Expressed as a simple equation




```
fb_int = 1.0/min(50,max(10,rate_media/20000))
```

SCReAM Conclusions

- SCReAM feedback can be realized with RFC3611 for basic functionality
  - RFC6679 for ECN
- A future feedback format can however be useful
- Signaling interval ranges from 100-200ms at low media rates to 10-20ms at high bitrates
- Reduced size RTCP (RFC5506) is highly recommended.
  - Full compound RTCP transmission controlled by trr-int.
- RFC4585 regular mode is OK

SBD Feedback Requirements

- The mechanism needs to:
  a) Compute summary statistics based on accurate and precise per packet relative One Way Delay (OWD) measurements.
  b) Determine shared bottlenecks based on summary statistics.
- Three scenarios:
  1. Summary statistic calculations and SBD performed on senders.
  2. Summary statistic calculations performed on receivers, SBD on senders.
  3. Calculations and SBD performed on both senders and receivers (beyond current scope—allows cooperative detection of bottlenecks).

1. Calculations and SBD on Sender

Feedback requirements:

- Precise accurate OWD measurements for every packet.
  - does not require synchronised clocks, summary statistics remove the clock offset.
- Packet(s) containing a collection of every OWD packet measurement since the last feedback transmission. This feedback should be sent at least every T (currently 350 ms) to match the current decision frequency of the SBD algorithm. A higher frequency is fine. A lower frequency is possible if the decision frequency is correspondingly reduced.

2. Calculations on the receiver, SBD on the sender

- SBD initialisation identifying summary statistics to be collected.
- Regular transmission of the summary statistics from receivers to senders every T (currently 350 ms).

3. Calculations and SBD on both the sender and receiver

NB. This is beyond the current scope, and here only to prevent inadvertent disqualification of such a future mechanism by decisions made at this juncture.

- SBD initialisation identifying summary statistics to be collected.
- Regular transmission of the summary statistics between receivers and senders every T (currently 350 ms).
- Regular transmission of relevant bottleneck determinations between senders and receivers every T.

Feedback Requirements – Summary

Algorithm	Feedback
NADA	Recommended rate adaptation mode (rmode)
NADA	Aggregated congestion signal (x_curr)
NADA	Recently measured receiving rate (r_recv)
GCC	Packet identifier → **Packet loss**
GCC	Packet send time } **Bandwidth estimate**
GCC	Packet arrival time } **Bandwidth estimate**
GCC	Packet size } **Bandwidth estimate**
SCReAM	Arrival timestamp of highest received RTP sequence number
SCReAM	List of received RTP packets → **Packet loss**
SCReAM	ECN counter (optional)
SCReAM	Source quench bit (optional)
SBD (S1)	OWD measurements for every packet → **Or packet send and arrival time?**
SBD (S2, S3)	Summary statistics, initialisation of summary statistics to be collected
SBD (S3)	Bottleneck determinations

Feedback Interval – Summary

- Tradeoff between overhead and responsiveness

Algorithm	Indicated Range	Recommended / used
NADA	20 ms – 400 ms	100 ms
GCC	50 ms – 100 ms	50 ms
SCReAM	100-200 ms (low bitrates) 10-20 ms (high bitrates)	
SBD		350 ms