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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Gateway control protocol: Guidelines for resource management of 'IP Address & Port' resources for H.248 RTP terminations

ITU-T H-series Recommendations – Supplement 5

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Supplement 5 to ITU-T H-series Recommendations

Gateway control protocol: Guidelines for resource management of 'IP Address & Port' resources for H.248 RTP terminations

Summary

RTP crosstalk is a situation, when a RTP endpoint (R_A) is wrongly sending RTP packets to another RTP endpoint (R_D), in which R_D is part of an active communication session (e.g., a RTP session between R_D and R_C). R_A was typically a used resource in another communication session (e.g., a RTP session between R_A and R_B). Such a failure situation may be caused by a couple of reasons. This Supplement describes potential failure scenarios in detail and provides possible solution proposals for each scenario.

Source

Supplement 5 to ITU-T H-series Recommendations was agreed on 24 November 2006 by ITU-T Study Group 16 (2005-2008).

FOREWORD

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Supplement 5 to ITU-T H-series Recommendations

Gateway control protocol: Guidelines for resource management of 'IP Address & Port' resources for H.248 RTP terminations

1 Scope

RTP crosstalk is a situation, when a RTP endpoint (R_A) is wrongly sending RTP packets to another RTP endpoint (R_D), in which R_D is part of an active communication session (e.g., a RTP session between R_D and R_C).

R_A was typically a used resource in another communication session (e.g., a RTP session between R_A and R_B). Such a failure situation may be caused by the following reasons:

1) Hanging RTP resource (see clause 6.1).

2) Disconnected H.248 Voice-over-RTP MG (see clause 6.2).

3) Fast reuse of RTP resource (see clause 6.3).

The purpose of this Supplement is to describe solution proposals for such kind of scenarios.

1.1 Out of scope

It is obvious that the above failure situation only occurs when call/session control and the corresponding bearer control are either following a "loosely coupled" control model (e.g., no explicit use of a bearer control protocol), or encounter synchronization issues.

The first problem is relaxed in following NGN environments, where RTP session endpoints are to be controlled via the following control protocols:

- H.245 in H.323 VoRTP media gateways or terminals;
- Q.1970 in BICC CS2-controlled VoRTP media gateways;
- SIP/SDP in SIP VoRTP media gateways or terminals;
- RTSP; or
- others.

2 References

[ITU-T H.248.1] ITU-T Recommendation H.248.1 (2005), *Gateway control protocol: Version 3*.

3 Terms and definitions

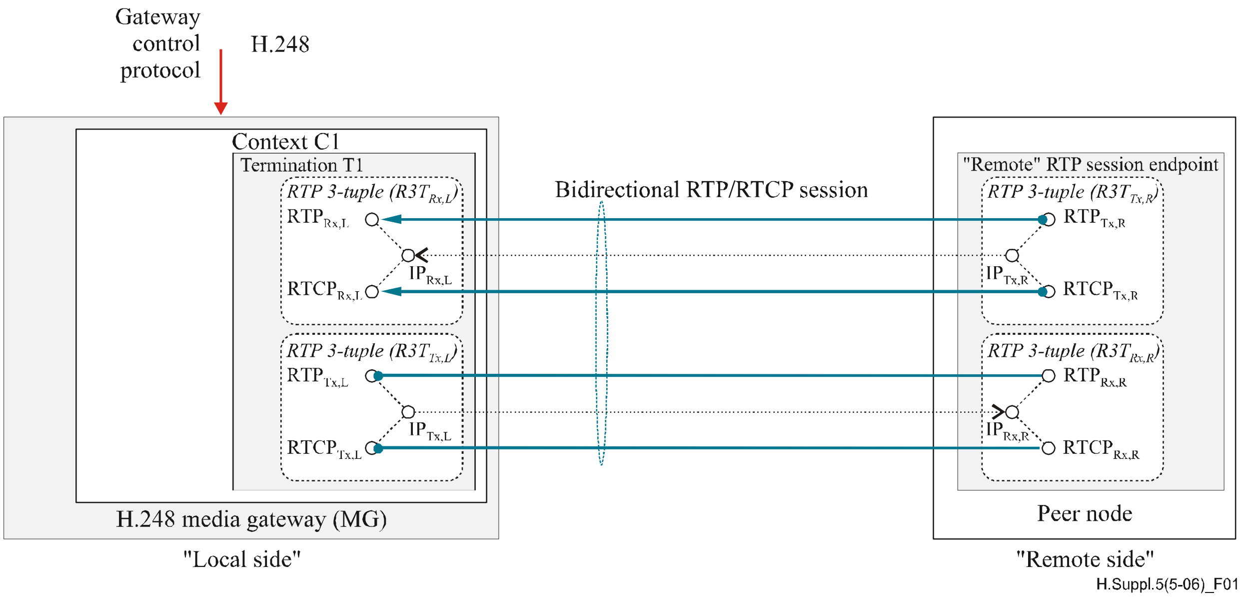
This Supplement uses the following terms and definitions:

3.1 5-tuple: The commonly used tuple <source address, source port, destination address, destination port, transport protocol> of IP protocol control information fields. A 5-tuple is a subset of an address tuple.

3.2 address tuple: It is defined in section 2.3.5/IETF RFC 3989.

3.3 RTP 3-tuple (R3T): The specifically used address tuple in this Supplement of <IP address, RTP port, RTCP port> for characterizing the main logical RTP endpoint resources.

NOTE – There are four RTP 3-tuples (abbreviated as $R3T_{Rx,L}$, $R3T_{Tx,L}$, $R3T_{Rx,R}$ and $R3T_{Tx,R}$) in a bidirectional RTP/RTCP Session from end-to-end perspective (Figure 1).



NOTE – "Local side" is H.248 media gateway in this example.

Figure 1 – RTP 3-tuples in a bidirectional RTP/RTCP session

3.4 symmetric RTP/RTCP: Identical values of address and ports in the two local RTP 3-tuples in case of a bidirectional RTP/RTCP session, i.e., $R3T_{Rx,L}$ equals to $R3T_{Tx,L}$.

NOTE – There is no condition of symmetry at remote side, i.e., remote RTP 3-tuples could be asymmetrical ($R3T_{Rx,R}$ not equal to $R3T_{Tx,R}$).

4 Abbreviations

This Supplement uses the following abbreviations:

BICC	Bearer Independent Call Control
C_AHT	Call Holding Time
C_OHT	Context Holding Time
CRD	Call Release Delay
CS2	Capability Set 2 (BICC)
CSD	Call Setup Delay
CSN	Circuit-Switched Network
DA	Destination Address (IP)
DP	Destination Port (IP)
IP_{Rx}	IP traffic in receive direction ("ingress traffic")
IP_{Tx}	IP traffic in transmit direction ("egress traffic")
IS	In-Service (H.248)
IT	Idle Time
LD	Local Descriptor (H.248)
MG	Media Gateway

MGC	Media Gateway Controller
NGN	Next Generation Network
OoS	Out-of-Service (H.248)
PSN	Packet Switched Network
R3T	RTP 3-Tuple
RCT	Resource Cycle Time
RD	Remote Descriptor (H.248)
RTCP	RTP Control Protocol
RTP	Real-time Transport Protocol
$RTP_{Rx,L}$	Local sink for RTP traffic
$RTP_{Rx,R}$	Remote sink for RTP traffic
$RTP_{Tx,L}$	Local source for RTP traffic
$RTP_{Tx,R}$	Remote source for RTP traffic
RTSP	Real-time Streaming Protocol
SA	Source Address (IP)
SC	ServiceChange (H.248)
SDP	Session Description Protocol
SIP	Session Initiation Protocol
SP	Source Port (IP)
VoRTP	Voice-over-RTP

5 Background: Still active RTP source of a released RTP session

The problem may be illustrated as follows. A point-to-point bidirectional RTP session is part of an end-to-end communication service, for instance, a speech telephony call between participants A and B in Figure 2.

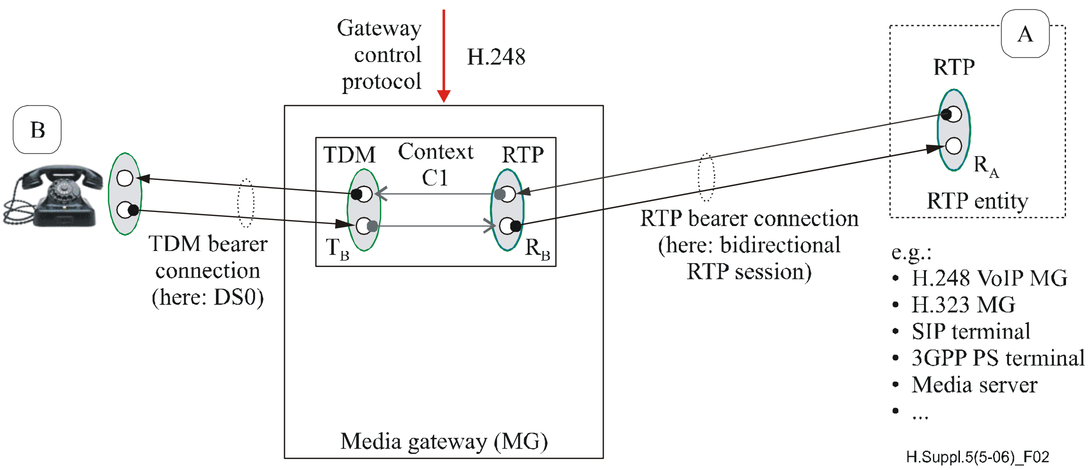


Figure 2 – First call A-B

The scope of this Supplement corresponds to the RTP endpoints located in H.248 entities, like VoIP media gateways (MG) or media servers (MS). Figure 2 shows such an example whereby H.248 termination 'R_B' represents one RTP endpoint. The peer RTP endpoint 'R_A' is located in a generic "RTP entity", which may be for instance again a H.248 MG or a SIP terminal. Both RTP endpoints are in state "sendreceive".

The resource 'RTP' is mainly characterized by different resource component types:

1) a transport connection endpoint given by the IP address and UDP port pair for RTP and RTCP (all three connection elements are also known as "RTP 3-tuple");
2) further RTP protocol control information fields (particularly the SSRC/CSRC and SDES (Note 1) fields for source description); and
3) transport capacity (bit rate reservations and allocations).

NOTE 1 – There are eight items defined by IETF RFC 3551 (see sections 6.4.1 to 6.4.8) to describe (and identify) an RTP source: CNAME, NAME, EMAIL, PHONE, LOC, TOOL, NOTE, PRIV. If the RTP source description information is used in an RTP session, then will be this kind of information exchanged via RTCP SDES packets.

The scope of this Supplement corresponds to the logical resource type of the first list item, the 3-tuple of IP address and the two ports for RTP and RTCP. The number of such 3-tuples is limited per H.248 MG (e.g., circuit-to-packet H.248 MGs like TDM-to-RTP or ALN-to-RTP for VoIP, or packet-to-packet H.248 MGs like IP-to-IP, UDP-to-UDP or RTP-to-RTP), defining its theoretical maximum capacity of parallel RTP sessions.

NOTE 2 – It is usually a theoretical maximum due to the 16-bit port range per IP address. The entire port range is typically not used in today's technique. If the required port capacity is very high, or even greater than the 16-bit range, then more than one IP address will be used. A physical IP interface for RTP traffic is then overloaded with multiple logical IP interfaces.

Call A-B shall then be released. Figure 3 shows the snapshot after the H.248 SUBTRACT command of R_B and release of Context C1. Send process or RTP R_B is then stopped and received RTP packets for R_B will be silently discarded.

Peer RTP endpoint R_A is not yet released, thus still transmitting RTP and RTCP packets towards R_B.

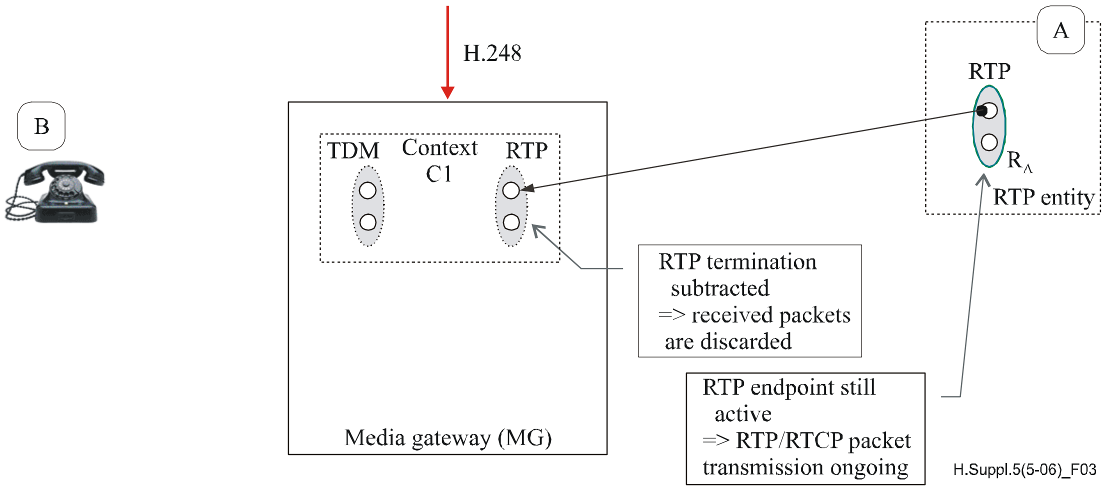


Figure 3 – Call legs/context release finished in MG

The H.248 MG then receives a new context request attempt (for new call C-D) by H.248 ADD commands for TDM and RTP resources for Context C2 (Figure 4).

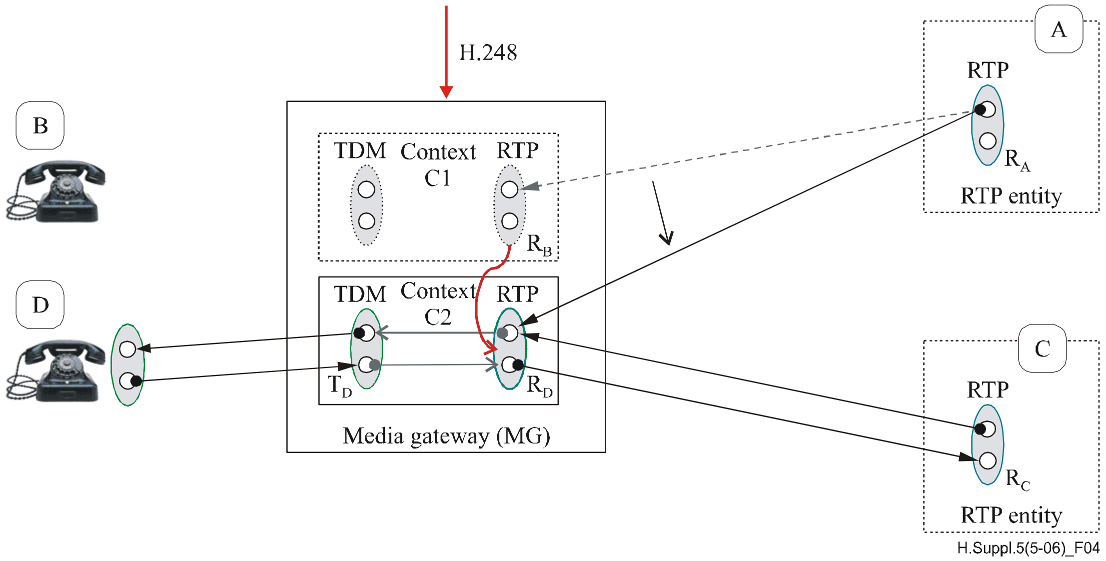


Figure 4 – MG allocates "R_B resources" for 'R_D' in next context

The MG allocates the previously deallocated resources ("3-tuple") of R_B to new H.248 termination R_D. This leads to an RTP crosstalk situation at RTP receiver R_D, as long as RTP endpoint R_A remains active (Figure 5).

RTP crosstalks are a serious issue because the communication in that direction may be completely disturbed (e.g., different codec types, packetization times, etc.). It is typically not straightforward for the RTP receiver process R_D to filter out and discard all received packets from source R_A. Such a filter process requires a correspondent policy rule (see clause 6.3.2.3.1, describing a possible rule).

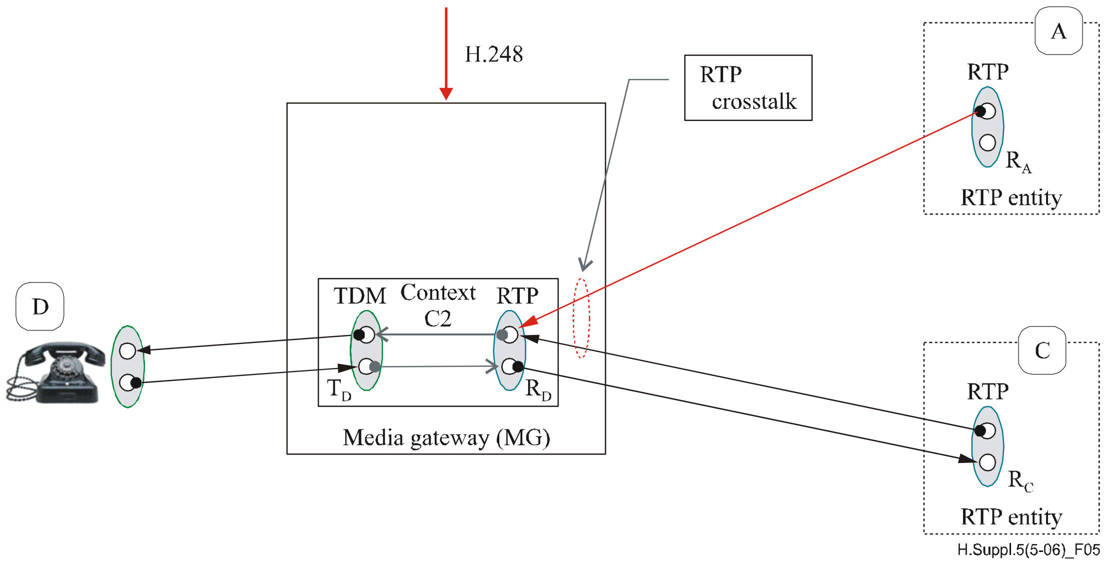


Figure 5 – RTP crosstalk situation at 'R_D' receiver

RTP crosstalk situations must be avoided or resolved as soon as detected.

6 Problems and solution proposals

There might be different reasons for RTP crosstalk situations.

6.1 Cause "Hanging termination"

6.1.1 Problem statement

A hanging H.248 termination is defined in clause 3.1/H.248.36. This is a failure situation, e.g., due to data synchronization issues between MGC and MG. Such data inconsistencies may be in principle on MGC and MG level. Relevant here is only the MG case because only a "hanging RTP termination on MG level" may generate RTP packets.

A hanging RTP termination should be a rather exceptional event because "successful bearer release" procedures are supposed: there is a positive acknowledgement by the MG with a SUBTRACT.reply on the SUBTRACT.request command from the MGC. The hanging RTP termination within the VoRTP MG is therefore caused by MG-internal synchronization issues here.

6.1.2 Solution: H.248.36 for "Hanging Termination"

Package H.248.36 is designed for hanging terminations. A timer resource will be additionally associated with the RTP resource. The MG notifies the MGC in case of timer expirations. ITU-T Rec. H.248.36 recommends timer configuration in the range "of a multiple of the typical context lifetime" (see clause 5.2.1.1.1/H.248.36).

A detected hanging H.248 termination may not be autonomously released by the MG, this action is still under the responsibility of the MGC.

6.2 Cause "Disconnected VoRTP media gateway"

6.2.1 Problem statement

A MG may be temporarily disconnected from his MGC, either by an interrupted H.248 transport connection, or an out-of-service MGC. The MG then tries to reconnect to the primary or a secondary MGC by the corresponding ServiceChange procedures (see Annex F of [ITU-T H.248.1]).

The states of established contexts and terminations in the MG are unaffected in this situation: during the period of disconnection, H.248 contexts will be all active and their allocated termination will remain in-service. RTP terminations, enabled for send, will consequently continue to transmit RTP packets.

Disconnection is typically only a very short-term period (Note 1) in networks designed for very high service availability. The H.248 model (Note 2) itself assumes that a disconnected MG will be shortly reconnected to an MGC.

NOTE 1 – For example, disconnect period << mean C_AHT (call holding time).

NOTE 2 – MG modes for "stand-alone operation" are not yet defined because they are basically out of scope of H.248. An operational gateway is realized by an MGC-MG pair, in which both H.248 entities are in-service state.

Nevertheless, long-lasting MGC-MG disconnect periods (Note 3) may lead to loss of call associations, normal call terminations by subscriber on-hooks, release of peer RTP endpoint resources, etc.

NOTE 3 – For example, disconnect period > mean C_AHT.

A worst-case situation is the case, when the *k* RTP Terminations of a disconnected MG, with correspondent *k* active Phy-to-RTP Contexts (Note 4), will continue RTP packet generation, whereas the *k* peer RTP endpoints are already released.

NOTE 4 – Or *k*/2 active RTP-to-RTP Contexts as another example.

6.2.2 Solution

There are not any specific solutions defined so far (because of the "short-term disconnect" assumption).

6.3 Cause "Fast reuse of RTP termination"

6.3.1 Problem statement

This relates to the case pointed out in clause 5. Such situations may occur due to the "loose synchronization" of quasi-parallel RTP endpoint release actions for an RTP session, despite the fact of successful call release and bearer release procedures.

The probability of such events primarily is related to the MG's resource management strategy, the engineered MG capacity for RTP sessions, the rate of RTP ADD.request commands (Note), and the operation of the IP network ("MG's IP interfaces for RTP traffic").

NOTE – Related to call attempt rate and context attempt rate (see also Supplement 6 to ITU-T H-series Recommendations).

Any MG "RTP resource" is either "busy" or "idle". The "busy time" is typically related to the Context holding time (C_OHT). The "idle time" is related to the probability of crosstalk events.

6.3.2 Solution(s)

6.3.2.1 Minimum idle time (Waiting period)

The problem may be solved by sufficient idle time (IT), or an explicit waiting period elapses between the end of an RTP termination and the reuse of the same (3-tuple) RTP resource in a new context.

The cycle of busy and idle phase may be characterized by parameter resource cycle time (RCT_{RTP}). The expected mean idle time IT may be then estimated by RCT_{RTP} minus C_OHT.

It is then recommended that a VoRTP MG implementation guarantee a minimum idle time $IT_{RTP,min}$. Such a guarantee may be achieved by following design rules. It should be noted that the design rules listed in clause 6.3.2.2 are only exemplary and non-exhaustive.

The minimum idle time $IT_{RTP,min}$ should be correlated with performance parameter end-to-end connection release delay (CRD_{E2E}) due to assumed cause of the crosstalk problem here. The following qualitative rule may be then stated:

$$IT_{RTP,min} >> CRD_{E2E}$$

NOTE – Provisional values for CRD_{E2E} may be for instance derived from ITU-T Recs Y.1530 or I.352, or Telcordia GR-3059-CORE. A value of approximately 10 seconds for $IT_{RTP,min}$ may be for instance a sufficient estimate (when considering quantiles of CRD).

6.3.2.2 Some design rules

6.3.2.2.1 Resource management policy

The pool of idle RTP "3-tuple" resources must not be accessed randomly, because such a policy does not allow any idle time guarantees. A "first-in, first-out" policy maximizes the idle time.

6.3.2.2.2 Theoretical maximum of RTP "3-tuples"

Every IP interface provides a theoretical space of 32K port pairs for RTP/RTCP sessions ("32.768 3-tuples per IP interface"). Multiple IP addresses may be assigned to a physical IP interface. There are then multiple logical IP addresses per physical IP interface. Assignment of additional IP addresses may be used to multiply the number of available RTP "3-tuple" resources.

NOTE – An IP interface in a VoIP MG may be either used for RTP traffic only, i.e., complete space of 32K port pairs is usable, or operated as general-purpose IP interface, i.e., the available space is then reduced by well-known ports, reserved ports, etc.

6.3.2.3 Filter rules

6.3.2.3.1 Source filtering in general

Figure 6 recalls again the H.248 process for configuration of the IP DA for incoming RTP traffic via the H.248 LD, and the IP DA for outgoing RTP traffic via the H.248 RD of a H.248 RTP Termination.

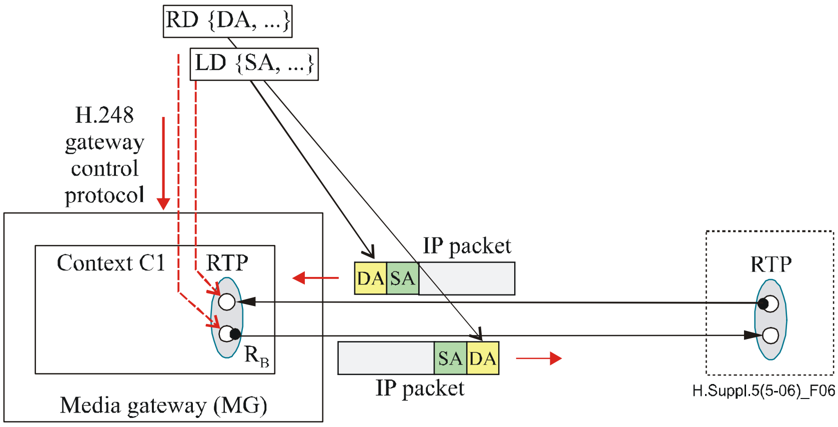


Figure 6 – H.248 LD & RD for configuration of IP DA & SA

From the H.248 perspective, the IP DA and SA, of either an outgoing or incoming RTP packet, are not correlated (Note). This concept allows the design of H.248 MG architectures which may support different (logical) IP interfaces for incoming and outgoing traffic.

NOTE – The LD and RD are basically disjoint in [ITU-T H.248.1]. There is one exception to this rule, see clause 7.1.8 of [ITU-T H.248.1]: "*The MG chooses the first alternative in Local for which it is able to support at least one alternative in Remote.*" This rule is only applicable for the codepoint combination of ""*ReserveGroup is "False" and ReserveValue is "False"*"" in the LocalControl Descriptor.

Figure 7 shows a specific implementation scenario by correlating:

{A1} the H.248 LD "SA" with the IP_{Tx} "SA" besides the IP_{Rx} "DA"; and

{A2} the H.248 RD "DA" with the IP_{Rx} "SA" besides the IP_{Tx} "DA".

Such a correlation may be the natural consequence of a single (physical or logical) IP interface.

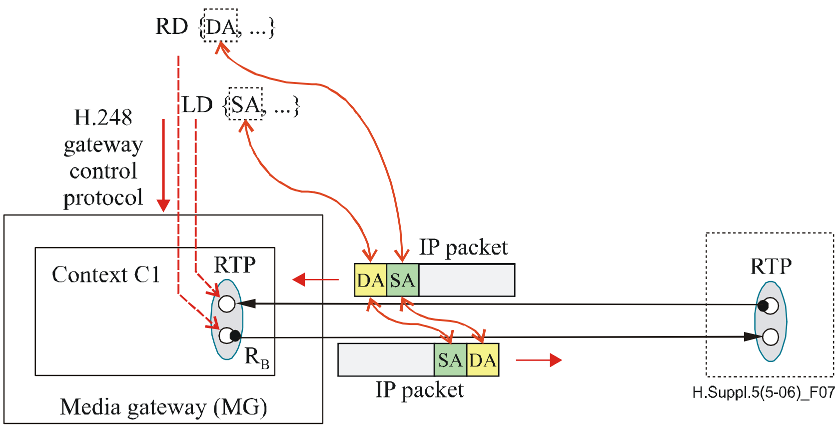


Figure 7 – Correlation between IP DA & SA of ingress and egress RTP/UDP/IP packets and H.248 LD & RD

Source (port) filtering may then be a policy rule, based on assumption {A2}. Source port filtering in the H.248 MG will reject/discard any incoming RTP packet with source address/port not equal to that received as the H.248 RD.

6.3.2.3.2 Source port filtering during establishment phase of H.248 RTP termination

The establishment of an RTP termination in a H.248 context may be principally based on either:

- a single ADD.request providing LD and RD in one command; or
- two separate commands by first ADD.request with LD and a subsequent MODIFY.request with RD,

due to the (potential) asymmetry of RTP session establishment. The worst case is the second scenario from an RTP crosstalk point of view. The period between the two H.248 commands does not allow source port filtering, or more general, source port filtering may not start until the availability of the complete specified RD in the MG.

There are two possible extensions of the filter rule concerning handling of incoming RTP traffic during this transition period:

1) promiscuous receipt of RTP and RTCP packets irrespective of the source RTP 3-tuple; or
2) rejection of all RTP and RTCP packets until IP_{Egress} "DA" is available via H.248 RD in MG.

It is recommended to follow the first rule extension, primarily due to the exceptional character of RTP crosstalk, short-term nature of transition period, consistency with H.248.1 (see also next subclause) and potential VoRTP services with "early media".

NOTE – The above transition period is typically in a time range much smaller than 100 ms when considering CRD_{E2E} performance objectives (and for calls in the 95%-quantile of CSD).

6.3.2.3.3 Applicability statements for source port filtering

Source port filtering may not be applied in general. The following aspects may limit the applicability:

- dedicated StreamMode settings (e.g., 'RecvOnly') in LocalControl descriptor of RTP termination;
- specific topology descriptor settings;
- RTP traffic passing NAT/FW device(s);

- H.248.37 enabled IP terminations ("ingress traffic required for latching"); or
- others.

6.3.2.3.4 Explicit support of source port filtering

Explicit support of source port filtering capability is within the scope of dedicated H.248 packages for gate management. The gm package defines corresponding H.248 properties. The gm-controlled source port filtering is an explicit mechanism in H.248 profiles for packet-to-packet MGs (e.g., ETSI TS 102 333, ETSI ES 283 018).

6.3.2.3.5 Explicit indication of source filtering via SDP source-filter attribute

IETF RFC 4570 defines an SDP extension for a dedicated attribute with regard to source filtering. This attribute must correlate with an existing <connection-field> value in the session description. Syntax and semantics of the SDP source-filter attribute are defined in section 3/RFC 4570, as well as applicability limitations.

The usage of this SDP attribute at H.248 interfaces may be described in H.248 profile specifications. There are not specific guidelines provided by this Supplement due to the flexibility of this SDP protocol element.

6.3.2.3.6 Others

For further study.

6.3.2.4 Symmetric RTP and RTCP

There are concepts of symmetric RTP and symmetric RTCP in IETF. The "symmetry aspect" is related to IP header fields (see below) at the receive and transmit direction of a local RTP/RTCP endpoint. Used RTP 3-tuple allocations (by the MG) at the local endpoint are not relevant for "remote source filtering".

The "symmetry" covers IP port and address.

NOTE – Assumption {A2} in clause 6.3.2.3.1 is on "symmetric IP" because initial considerations are IP addresses only. Symmetric RTP/RTCP extends symmetry to transport layer as well.

Symmetric RTP/RTCP supposes bidirectional RTP media streams.

6.3.2.4.1 Filter rule based on symmetric RTP/RTCP

The local filter rule would assume symmetric RTP/RTCP behaviour of the peer side. The two filter conditions are then:

Condition 1: $IP_{Rx,L}$ "SA" (= IP Address of interface $IP_{Tx,R}$ in Figure 1) must be equal to $IP_{Tx,L}$ "DA" (= IP Address of interface $IP_{Rx,R}$ in Figure 1);

AND

Condition 2: $IP_{Rx,L}$ "SP" (= IP Port of interface $IP_{Tx,R}$ in Figure 1) must be equal to $IP_{Tx,L}$ "DP" (= IP Port of interface $IP_{Rx,R}$ in Figure 1);

for RTP (and correspondingly RTCP).

6.3.2.4.2 Applicability statements for symmetric RTP/RTCP

The allocation of resources with regard to symmetrical RTP 3-tuples is possible in many cases, but cannot be guaranteed in the general case. The concept of H.248 LD and RD design does not inherently lead to symmetrical resource selections for IP interfaces at H.248 MGs. The MG is free in deciding the IP interface (address and port) behind the H.248 RD.

Whether a corresponding filter could be applied is therefore unambiguously known by a MG after successful establishment phase of an H.248 RTP termination.

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