Video Services Forum (VSF)
Technical Recommendation TR-02

Using RTCP for In Band Signaling of Media Flow Status

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Executive Summary

In the event that multiple RTP-based flows of the same media content exist on an IP network, it can be useful from an operational standpoint to be able to signal to a media receiver which flow is deemed to be active or On Line versus a flow that is functioning as a standby (Off Line). This VSF Technical Recommendation (TR) defines an interoperable configuration of RTCP for signaling On Line and Off Line status of any given RTP datagram flow. The process defined includes signaling of both the intended status of the sender, as well as the current condition of the receiver.

While the focus of this TR is for On Line vs. Off Line signaling, this TR provides for the addition of future signaling options when the need is identified.

Objectives:

- Utilize existing industry standards, constraining them when necessary, to create a VSF Technical Recommendation that provides in band signaling of media flow status and other possible relevant descriptors of media flows transported over IP networks.
- Enable interoperability between products from different equipment manufacturers.

Table of Contents

1. Introduction (informative)

RTCP Activity Group goal: To utilize existing industry standards, constraining them when necessary, to create a VSF Technical Recommendation that provides in band signaling of media flow status and other descriptors of media flows transported over IP networks.

In order to create this TR, the Video Services Forum, Inc. (VSF) authorized Activity Group No. 2014-3, titled "RTCP Signaling", in May 2014.

Recognizing that feedback from interoperability testing and actual use in the field may warrant clarification or improvement of this document, the VSF is committed to a program of maintenance for its technical recommendations, including periodic reviews of its technical recommendations. The first review of this document is planned for approximately one year after its initial publication date.

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1.2 About the Video Services Forum

The Video Services Forum, Inc. (www.videoservicesforum.org) is an international association dedicated to video transport technologies, interoperability, quality metrics and education. The VSF is composed of service providers, users and manufacturers. The organization's activities include:

- providing forums to identify issues involving the development, engineering, installation, testing and maintenance of audio and video services;
- exchanging non-proprietary information to promote the development of video transport service technology and to foster resolution of issues common to the video services industry;
- identification of video services applications and educational services utilizing video transport services;

- promoting interoperability and encouraging technical standards for national and international standards bodies.

The VSF is an association incorporated under the Not For Profit Corporation Law of the State of New York. Membership is open to businesses, public sector organizations and individuals worldwide. For more information on the Video Services Forum, contact Bob Ruhl, Operations Manager, Video Services Forum, +1 609 410 6767, bob.ruhl1@verizon.net.

2. Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; followed by formal languages; then figures; and then any other language forms.

3. Normative References

[1] IETF RFC 3550: "RTP: A Transport Protocol for Real-Time Applications"

4. Acronyms

IP	Internet Protocol
RTP	Real-time Transport Protocol
RTCP	Real Time Control Protocol
TR	Video Services Forum Technical Recommendation[1]
UDP	User Datagram Protocol
VSF	Video Services Forum

5. Definitions

Active	A device is Active when it is fully functional and available for use.
Content Consumer	The intended destination of the signal being delivered. Depending on the application, this could be a downstream network, a home viewer, or any other entity making use of the essence being transported.
Inactive	A device is Inactive when it is not available for use. This device may or may not be sending or processing a signal.
In Band Signaling	A companion data flow containing descriptive data travelling in the network using the same signal infrastructure and traffic management as its associated data flow.
Interoperability	An end user or service provider can transport a signal using devices from different manufacturers that meet the requirements of this Technical Recommendation with the expectation that they will successfully achieve their business objective.
Media Flow	A packetized data stream that contains media essence.
Off Line	Device or signal that is not an element of the signal flow providing service to the Content Consumer. If it is a device, it may or may not be sending or processing a signal.

[1] Note that the term Technical Recommendation is also used by other organizations such as the European Telecommunications Standards Institute (ETSI).

On Line	Device or signal that is an element of the signal flow providing service to the Content Consumer.
Optional	Device or signal to be selected if the Preferred device or signal is not available.
Preferred	Device or signal intended as the best option for On Line selection.
Receiver	Device that receives an RTP Media Flow from an IP network
Sender	Device that generates an RTP Media Flow and sends the flow into an IP network.

6. System Overview (Informative)

An end-user or service provider of broadcast transmission services can utilize devices that implement this Technical Recommendation (TR) for unidirectional transport of various media signals over IP.

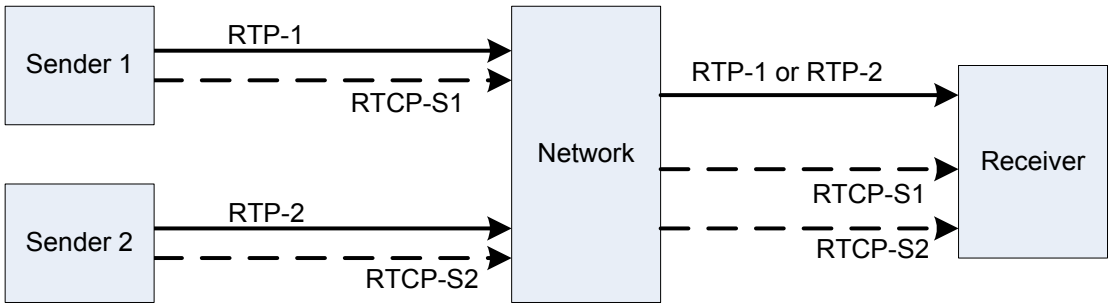

Figure 1: Example System for RTCP Redundancy Signaling

As shown in Figure 1 above, one or more Senders can produce an IP Media Flow using RTP encapsulation. A companion flow with status information regarding the content or function of the RTP datagram flow can also be produced by the Sender.

It is desirable for a Receiver that is presented with two or more signal flows to know which flow is deemed to be the Preferred flow. The Receiver may use this status to make a flow selection. While the status of an incoming RTP Media Flow could be signaled through an external control system, in large facilities, systems designed to monitor and signal the status of thousands of devices become complex and expensive. The mechanism described in this TR provides a simple and autonomous way to signal the

status of any number of devices independently without the use of an external control system. Furthermore, this method allows decisions to be made at the individual link level and not at a macro system level.

Users may find it beneficial for a Receiver to report which flow it has selected to be On Line. This information might also be useful for monitoring applications. The methods defined in this TR provide for either positive verification of the Preferred selection or notification that the Preferred selection is not selected by the Receiver.

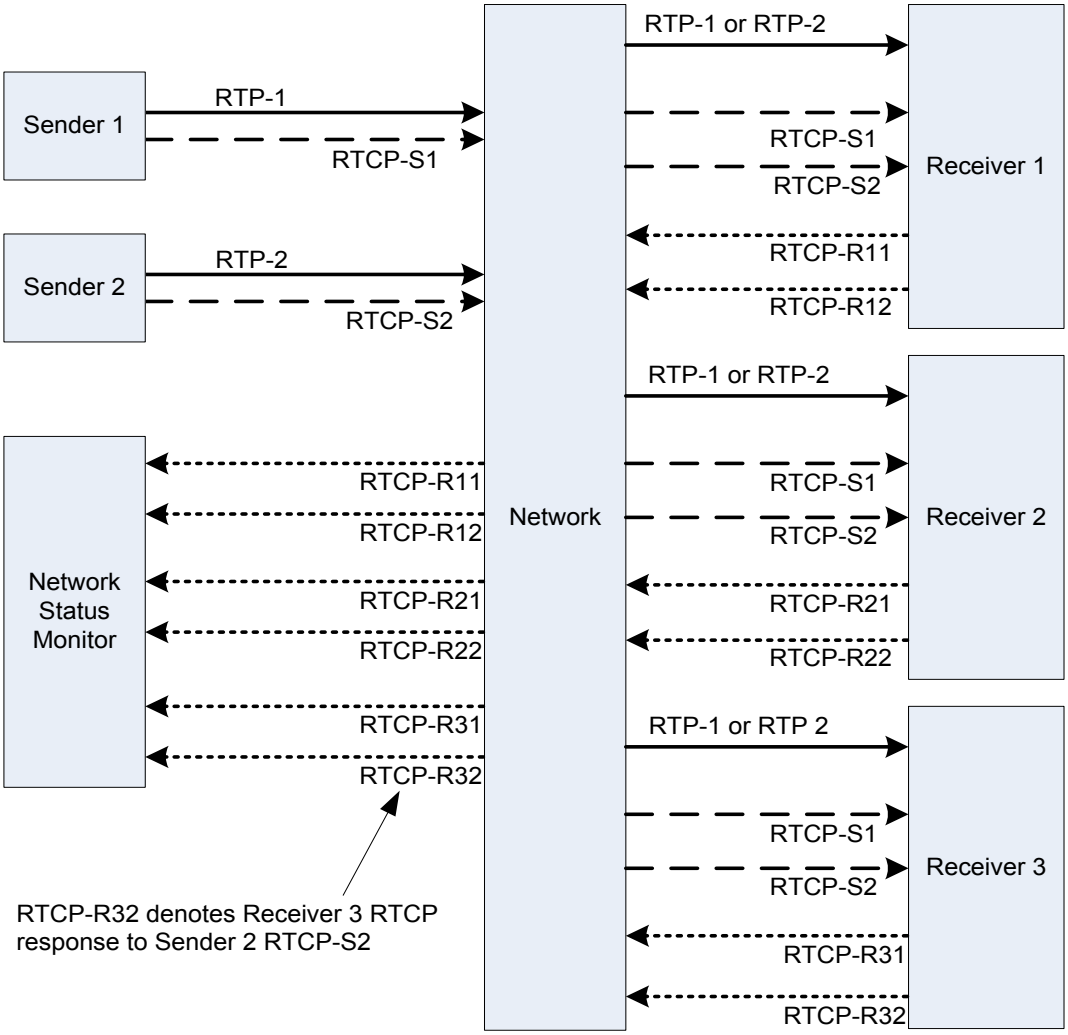

Figure 2: Example System for RTCP Receiver Selection Signaling

Figure 2 above illustrates a case where a network status monitor receives information about the On Line selections made by a number of Receivers in a system.

Many IP Media Flows use RTP for media signal encapsulation. RFC 3550, which defines RTP, contains a provision for a companion control flow called the Real Time

Control Protocol (RTCP). The RTCP flow is linked to a specific RTP Media Flow by using the same unicast IP address or multicast group address as the RTP Media Flow but a different UDP port number. This allows the Receiver to join both flows at the same address, but process one UDP port as a Media Flow and the other UDP port as control or status data.

As originally written, RTCP was intended to provide a protocol for a Receiver to signal the reliability of packet reception to a Sender. In the case of this TR, RTCP is being used to allow the Receiver to ascertain the status (or intended status) of the RTP Media Flow being emitted by Senders. In this TR, RTCP may also be used by the Receiver to report which of several Senders' Media Flows it has selected.
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7. RTCP Syntax for Redundancy Signaling Interoperability

This TR is divided into two parts, Part A and Part B,

Part A defines a method to be used to signal, using a corresponding RTCP flow, that a specific RTP Media Flow is the Preferred selection for On Line use by a Receiver meeting the requirements of this TR. Part A also defines the expected behavior of a Receiver upon receipt of a change in the status of a Sender

Both the Sender and Receiver need to meet the conformance requirements of Part A for both to be interoperable. Section 7.2.2 specifies the RTCP syntax and semantics to be used by the Sender.

Part B defines a method to be used to signal whether a Receiver has selected a particular RTP Media Flow for On Line use. Section 7.3.2 specifies the RTCP syntax and semantics to be used by a Receiver.

Note: This TR does not define where or how a Part B RTCP flow is to be used. Implementers of devices that consume the RTCP flow from a Part B compliant Receiver can rely on those Receivers emitting a flow that complies with Section 7.3.2 of this document.

This TR does not limit the number of Receivers emitting an RTCP flow that are allowed in any given system. Any device capable of consuming Part B compliant RTCP flows should define the maximum number of RTCP data flows it can accept and process.

Part A and Part B are completely independent. Compliance with either part is not dependant on compliance with the other part.

7.1 RTCP APP Packet

This TR makes use of RTCP APP packets as defined in RFC 3550. Two different APP packet formats are described in sections 7.2 and 7.3 for Part A and Part B compliance respectively. Compliance with either Part A or Part B requires that all aspects of RTCP APP packet defined in RFC 3550 be met with the following settings and additions.

The "application-dependant data" field in the RTCP APP packet layout in Figure 3 below shall be used for signaling content by Part A and Part B compliant devices. The format and parameters of this field are defined in sections 7.2 and 7.3.

Implementers should note that this TR does not make use of Sender or Receiver packets as defined in RFC 3550.

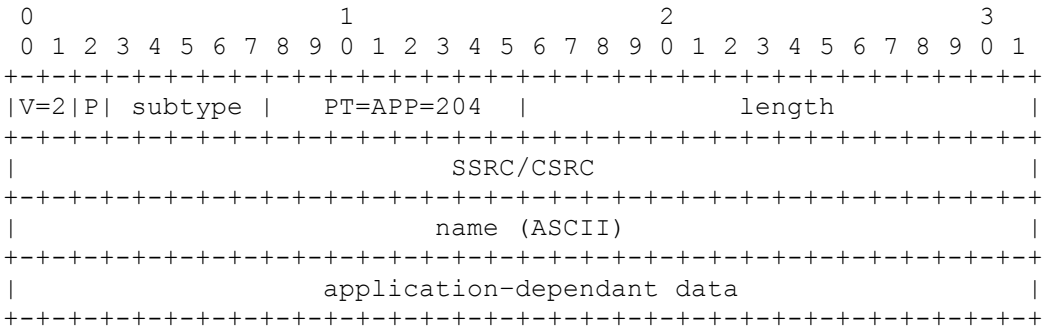

Figure 3: RTCP APP Packet Structure for Use in this TR

Version V = 2

Padding P = 0

Subtype = 0

PT – APP =204

Length = 3

SSRC/CSRC - As defined in RFC 3550

Name = Unique name of packet application as defined in Section 7.2.2 and Section 7.3.2

Application-dependant data - This 32 bit field is defined in RFC 3550 for application specific data. Senders and Receivers shall use this field as defined in Sections 7.2.2 and 7.3.2 below.

7.2 Part A

7.2.1 Part A Compliance

Note: in the text below, use of the word "join" refers to receiving either a multicast or unicast flow.

A compliant Part A Sender shall emit an RTCP data flow for each RTP Media Flow it generates. The RTCP data flow shall conform to RFC 3550 and shall meet the RTCP structure and syntax defined in Section 7.2.2 of this document.

A compliant Part A Receiver shall be capable of reading and processing the RTCP data fields as defined in Section 7.2.2 of this document.

An RTCP data flow noting a change in the status parameter of its associated RTP Media Flow shall be emitted by a Sender no later than two seconds after any status change has been noted by a Sender.

In any case an RTCP data flow shall be emitted by a Sender at least every 60 seconds but no more frequently than every 5 seconds. (Note: 5 seconds is the recommended fixed minimum interval in RFC 3550)

A compliant Part A Receiver shall be able to join multiple RTCP flows. A Part A compliant Receiver shall be capable of joining no less than two RTCP data flows simultaneously.

A compliant Part A Receiver shall make RTP Media Flow selection decisions based on the Redundancy field parameters provided in the RTCP flow.

A Part A compliant Receiver shall join the RTP media flow corresponding to the RTCP data flow containing the Redundancy field parameter set to "Preferred".

This TR does not specify whether the "Preferred" RTP Media Flow is the only flow joined by the Receiver, or both "Preferred" and "Optional" RTP Media Flows are joined by the Receiver. In the event that both "Preferred" and "Optional" RTP Media Flows are being simultaneously received by the receiver, a Part A compliant Receiver shall internally select the RTP Media Flow corresponding to the RTCP flow containing the Redundancy field that is set to "Preferred".

In the event that more than one RTCP data flow Redundancy field is set to "Preferred", a Part A compliant Receiver may select any of the RTP Media Flows corresponding to the RTCP data flows containing the Redundancy field that is set to "Preferred".

In the event that the RTP Media Flow corresponding to the RTCP data flow containing the Redundancy field that is set to "Preferred" is either missing or unavailable, a Part A compliant Receiver may join any RTP Media Flow associated with an RTCP status flow

where the RTCP Redundancy field is set to “Optional” and the Active field is set to “Active”.

A compliant Part A Receiver may provide a default input assignment to define a definitive source selection when no RTCP Flows contain “R” and “A” fields settings as defined above.

Table 1: Receiver Input Selection Actions

Condition	R	A	Receiver Input Selection Action
One RTCP Flow =	01	01	Select RTP Media Flow corresponding to the RTCP Flow with these settings
More than one RTCP Flow =	01	01	Select either of the RTP Media Flows corresponding to the RTCP Flows with these settings
None of the RTCP Flows =	01	01	Select any RTP Media Flow corresponding to RTCP Flow with settings R=10 and A=01
Any other RTCP Flow R & A conditions			Select any RTP Media Flow or Select default RTP Media Flow if Receiver is provisioned with a default selection

A Part A compliant Receiver shall complete an RTP Media Flow selection action no later than 2 seconds after it has received an RTCP packet with a change in the Redundancy field.

7.2.2 Part A Parameters and Settings

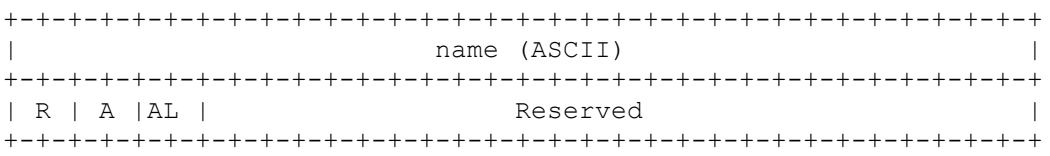

Figure 4: Application-dependant Data Field Parameters for Sender RTCP APP Packet Structure

Name – 32 bits – PrtA (ASCII)

Redundancy – “R” – 2 bits – defines On Line and Off Line status

Table 2: Redundancy Field Assignments

Bits	Description
00	Not Used
01	Preferred
10	Optional
11	Not used

Active – "A" – 2 bits – defines Active and Inactive status

Table 3: Active Field Assignments

Bits	Description
00	Not Used
01	Active
10	Inactive
11	Not used

Alarm – "AL" – 2 bits – defines Part A device alarm level as reported by Sender

Table 4: Alarm Type Field Assignments

Bits	Description
00	No Alarm
01	Minor Alarm
10	Major Alarm
11	Critical Alarm

Reserved – 26 bits – This space is reserved for other status parameters, to be defined in the future.

7.2.3 Part A Option 1

A manufacturer may choose to provide optional functionality, described in this section as Option 1. A Part A Option 1 compliant Receiver may select an input based on the alarm status of the incoming signals as designated in the "AL" field as shown in Table 4.

Note: In the text below a Preferred RTP Media Flow is an RTP Media Flow associated with the RTCP data flow with the redundancy field set to "Preferred", and an Optional RTP Media Flow is an RTP Media Flow associated with the RTCP data flow with the redundancy field set to "Optional".

Assuming that a Part A Option 1 compliant Receiver has selected an RTP Media Flow that has been designated as either a Preferred or Optional as identified in Table 2, the manufacturer of the Receiver shall provide the user with the option to select between at least the set of actions listed in Table 5, if an alarm condition for the Preferred or Optional RTP Media Flow is set to any alarm condition, according to Table 4.

Table 5: Option 1 Configuration Settings

Alarm Condition Switch Action
Do not switch based on alarm conditions
Switch to input with lowest priority alarm
Switch to input with lowest priority alarm only when existing signal selection has a critical alarm

Assuming that a Part A Option 1 compliant Receiver has selected an RTP Media Flow that is not identified in Table 2 as Preferred due to an alarm condition as identified according to Table 4 above, and if that alarm condition later changes to '00', indicating that there is now no alarm, the manufacturer of a Part A Option 1 compliant Receiver shall provide the user with the option to select between at least the set of actions listed in Table 6.

Table 6: Option 1 Reversion Switching Settings

Reversion Switch Action
Maintain current selection (do not revert)
Switch back to Preferred selection when alarm status of Preferred selection changes to No Alarm
Switch back to Preferred selection when alarm status of Preferred selection matches that of current selection
Switch back to Preferred selection when alarm status of Preferred selection has no critical alarms

A Part A Option 1 compliant Receiver shall not select any RTP Media Flow with an associated RTCP flow Active field "A" setting of "Inactive".

A Part A Option 1 compliant Receiver shall execute an RTP Media Flow selection action no later than 2 seconds after it has received an RTCP packet with a change of Alarm status requiring an "AL" Field selection action as defined in this section.

Note: Since the RTCP messaging mechanism defined in this TR is not deterministic, it is possible that conflicting information might be presented to a Receiver during rapidly changing alarm states perceived at a Sender. Implementers might choose to configure Senders to report alarms only after the alarm condition has been unchanged for a period of time.

7.3 Part B

7.3.1 Part B Compliance

Note: in the text below, use of the word "join" refers to either joining a multicast flow or receiving a unicast flow.

A compliant Part B receiver shall create and send a new RTCP data flow associated with each RTCP data flow it is receiving from a Sender. The RTCP data flow created by the Receiver shall conform to RFC 3550 and shall meet the RTCP structure and syntax defined in Section 7.3.2 of this document.

An RTCP data flow shall be sent no later than two seconds after any field has changed value in the status parameters of either the corresponding incoming RTCP data flow or the RTCP data flow being sent from the Receiver.

In any case, an RTCP data flow shall be emitted by a Receiver at least every 60 seconds but no more frequently than every 5 seconds.

The RTCP stream sent from the Part B receiver shall maintain a constant association with the incoming RTP Media Flow, as defined in RFC 3550.

Note: since multiple receivers can respond to the same RTP media flow, the APP packet SSRC field of the Part B Receiver sending the RTCP data flow shall be used as the unique identifier of that specific flow as specified below.

7.3.2 Part B Parameters and Settings

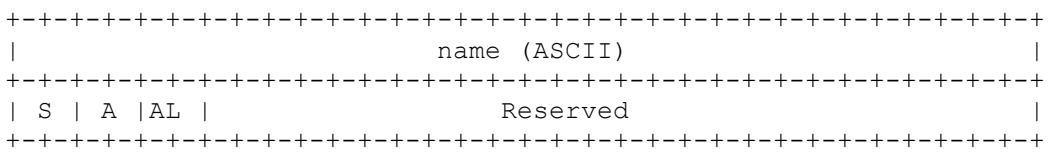

Figure 5: Application-dependant Data Field Parameters for Receiver RTCP APP Packet Structure

Name – 32 bits – PrtB (ASCII)

Selection – "S" – 2 bits – defines On Line (selected) and Off Line (not selected) status of associated RTP Media Flow

Table 7: Selection Field Assignments

Bits	Description
00	Not Used
01	On Line
10	Off Line
11	Not used

Available – "A" – 2 bits – defines Active and Inactive status of the Part B Receiver

Table 8: Available Field Assignments

Bits	Description
00	Not Used
01	Available
10	Not Available
11	Not used

Alarm – "AL" – 2 bits – defines device alarm level status of the Part B receiver

Table 9: Alarm Type Field Assignments

Bits	Description
00	No Alarm
01	Minor Alarm
10	Major Alarm
11	Critical Alarm

Reserved – 26 bits – This space is reserved for other status parameters, to be defined in the future.

7.4 Dual Compliance

Both a Sender and Receiver may be Dual Compliant.

7.4.1 Dual Compliant Sender

A Dual Compliant Sender shall join the RTCP flow response from one or more Part B compliant Receivers associated with its (the Senders) RTP Media Flow.

A Dual Compliant Sender shall provide either a local or remote indication of whether its RTP Media Flow has been selected as the On Line flow for any Receiver.

7.4.2 Dual Compliant Receiver

A Dual Compliant Receiver shall also be a Sender and meet all of the requirements defined in both Sections 7.2.2 and 7.3.2 of this document as well as the requirement for a Dual Complaint Sender as defined in Section 7.4.1.

A Dual Compliant Receiver shall provide a user configuration option which shall cause the "S" parameter in that device's Part B compliant RTCP data flow to provide a "Pass-through" option, as described below.

When the "Pass-through" option is selected, the Dual Compliant Receiver shall populate the "S" field in its Part B compliant RTCP flow with the "On Line" designation if any of the RTCP data flows from downstream receivers have designated the RTP Media Flow from this Dual Complaint Receiver as "On Line".

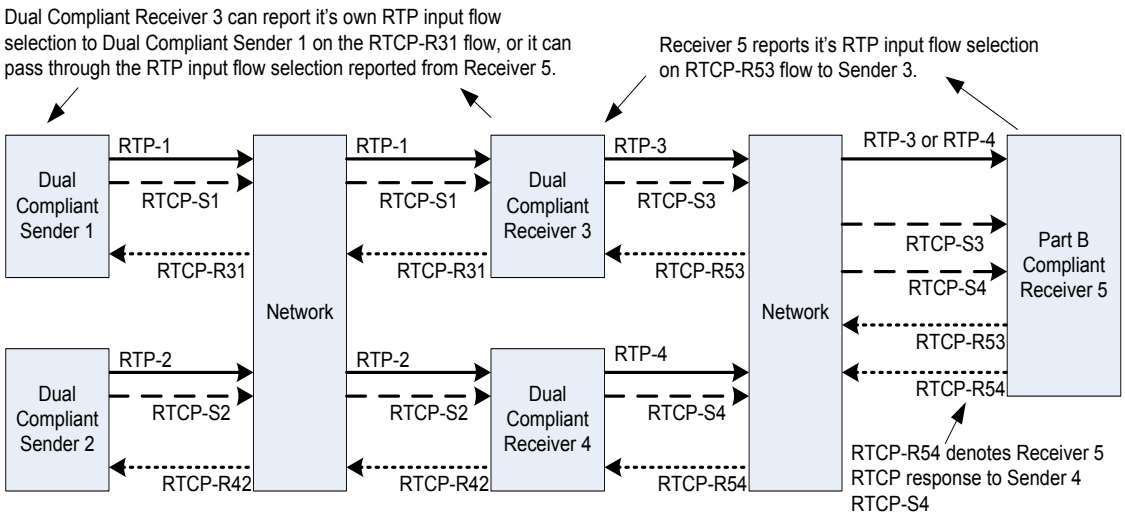

Figure 6: Example System for Dual Compliant Devices

If none of the RTCP data flows from downstream Receivers report this Dual Compliant Receiver as On Line, the "S" field shall be populated with the "Off Line" designation.

When the "Pass-through" option is selected, the Dual Compliant Receiver shall join the Part B RTCP flow from the downstream Receiver as defined above in Section 7.4.1 for a Dual Complaint Sender.

When the "Pass-through" option is not selected, a Dual Compliant Receiver shall populate all fields of the RTCP flow it generates as defined in Section 7.3.2 of this document.

Note: A Receiver may be both Part A and Part B compliant without being Dual Compliant, because a Dual Compliant Receiver also acts as a Sender.

8. Appendix – Compliance Matrix (Informative)

The following matrix is informative and is presented to give a visual comparison between the functions required of various elements of this TR. It is not intended to be used in place of the normative text presented above to define the requirements for the different elements in this TR.

In the following Compliance Matrix the columns are labeled as follows:

AS – Part A Compliant Sender
AR – Part A Compliant Receiver
A1R – Part A Option 1 Compliant Receiver
BR – Part B Compliant Receiver
DS – Dual Compliant Sender
DR – Dual Compliant Receiver

	Section	AS	AR	A1R	BR	DS	DR
Send an RTCP Data Flow with input preference	7.2.1	X				X	X
Send an RTCP Data Flow with input selection	7.3.1				X		X
Join RTCP data flow with input preference	7.2.1		X	X	X	X	X
Join RTCP data flow with input selection	7.3.1					X	X
Select RTP media flow input based on RTCP	7.2.1		X	X	X		X
Select RTP media flow input based on Alarm	7.2.3			X			
Conform to Syntax in Section 7.2.2	7.2.1	X	X	X		X	X
Conform to Syntax in Section 7.3.2	7.3.1				X	X	X
Switch input based on Table 5 Settings	7.2.3			X			
Restore original input selection based on Table 6	7.2.3			X			
Allow Pass-through of downstream selection status	7.4.2						X