Preamble to Video Services Forum (VSF) Technical Recommendation TR-06-4 Part 5

October 17, 2023

The Reliable Internet Stream Transport (RIST) project was initiated as an Activity Group under the auspices of the Video Services Forum in 2017. The RIST Protocol is defined by TR-06-1 (RIST Simple Profile, published in 2018 and updated in 2020), TR-06-2 (RIST Main Profile, published in 2020 and updated in 2021 and 2022), and TR-06-3 (RIST Advanced Profile, published in 2021 and updated in 2022).

The TR-06-4 series of recommendations define ancillary features for the RIST protocol that are applicable to multiple profiles. TR-06-4 Part 1 (Source Adaptation, published in 2022), TR-06-4 Part 2 (Use of Wireguard VPN in RIST Devices, published in 2023) and TR-06-4 Part 3 (RIST Relay, published in 2023) are part of this series. This document is TR-06-4 Part 5, RIST Multicast Discovery. RIST devices have the capability of sending and receiving multicast streams, possibly encapsulated over a unicast transport. In some cases, it may be useful for a RIST sender to avoid sending a multicast to a receiver that is not interested in that multicast to save bandwidth. While this can be accomplished using a traditional multicast routing protocol, this Specification provides a simplified mechanism for providing such functionality for the most common use cases.

Work continues within the group towards developing additional RIST specifications that include additional features. As the Activity Group develops and reaches consensus on new functions and capabilities, these documents will also be released in support of the RIST effort. For additional information about the RIST Activity group, or to find out about participating in the development of future specifications, please visit http://vsf.tv/RIST.shtml.

Video Services Forum (VSF)
Technical Recommendation TR-06-4
Part 5

Reliable Internet Stream Transport (RIST)
RIST Multicast Discovery

Approved October 17, 2023

© 2023 Video Services Forum

This work is licensed under the Creative Commons Attribution-NoDerivatives 4.0 International License. To view a copy of this license, visit https://creativecommons.org/licenses/by-nd/4.0/

or send a letter to Creative Commons, PO Box 1866, Mountain View, CA 94042, USA.

INTELLECTUAL PROPERTY RIGHTS

THIS RECOMMENDATION IS BEING OFFERED WITHOUT ANY WARRANTY WHATSOEVER, AND IN PARTICULAR, ANY WARRANTY OF NONINFRINGEMENT IS EXPRESSLY DISCLAIMED. ANY USE OF THIS RECOMMENDATION SHALL BE MADE ENTIRELY AT THE IMPLEMENTER'S OWN RISK, AND NEITHER THE FORUM, NOR ANY OF ITS MEMBERS OR SUBMITTERS, SHALL HAVE ANY LIABILITY WHATSOEVER TO ANY MPLEMENTER OR THIRD PARTY FOR ANY DAMAGES OF ANY NATURE WHATSOEVER, DIRECTLY OR INDIRECTLY, ARISING FROM THE USE OF THIS RECOMMENDATION.

LIMITATION OF LIABILITY

VSF SHALL NOT BE LIABLE FOR ANY AND ALL DAMAGES, DIRECT OR INDIRECT, ARISING FROM OR RELATING TO ANY USE OF THE CONTENTS CONTAINED HEREIN, INCLUDING WITHOUT LIMITATION ANY AND ALL INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES (INCLUDING DAMAGES FOR LOSS OF BUSINESS, LOSS OF PROFITS, LITIGATION, OR THE LIKE), WHETHER BASED UPON BREACH OF CONTRACT, BREACH OF WARRANTY, TORT (INCLUDING NEGLIGENCE), PRODUCT LIABILITY OR OTHERWISE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THE FOREGOING NEGATION OF DAMAGES IS A FUNDAMENTAL ELEMENT OF THE USE OF THE CONTENTS HEREOF, AND THESE CONTENTS WOULD NOT BE PUBLISHED BY VSF WITHOUT SUCH LIMITATIONS.

BY-ND

Executive Summary

RIST devices have the capability of sending and receiving multicast streams, including the capability of encapsulating such traffic over Main Profile (TR-06-2), Advanced Profile (TR-06-3), or Wireguard (TR-06-4 Part 2). In some situations, it may be useful for a RIST sender to avoid sending a multicast to a receiver that is not interested in that multicast, to save bandwidth. This Specification defines a method by which this functionality can be implemented, using existing IETF RFCs.

Recipients of this document are invited to submit technical comments. The VSF also requests that recipients notify us of any relevant patent claims or other intellectual property rights of which they may be aware, that might be infringed by any implementation of the Recommendation set forth in this document, and to provide supporting documentation.

CC BY-ND

Table of Contents

CC BY-ND

1 Introduction (Informative)

As broadcasters and others increasingly utilize unconditioned Internet circuits to transport high-quality video, the demand grows for systems that can compensate for the packet losses and delay variation that often affect these streams. A variety of solutions are currently available on the market; however, incompatibilities exist between devices from different suppliers.

The Reliable Internet Stream Transport (RIST) project was launched specifically to address the lack of compatibility between devices, and to define a set of interoperability points using existing or new standards and recommendations.

RIST Simple Profile (TR-06-1) includes support for IP Multicast operation. RIST Main Profile (TR-06-2), RIST Advanced Profile (TR-06-3), and Wireguard (TR-06-4 Part 2) can encapsulate IP Multicast packets into a unicast flow suitable for transmission over the Internet or any network without multicast support. In some situations, bandwidth savings can be achieved if a RIST sender can avoid sending a multicast to a receiver that is not interested in receiving it. This Specification describes mechanisms to provide this functionality, based on the Internet Group Management Protocol (IGMP) for IPv4, and the Multicast Listener Discovery Protocol (MLD) for IPv6. The techniques described in this Specification are general and can be applied to any type of multicast-capable VPN, tunnel, or network.

1.1 Contributors

The following individuals participated in the Video Services Forum RIST working group that developed this technical recommendation.

Merrick Ackermans (CBS/Paramount)	Sergio Ammirata (SipRadius/AMMUX)	Paul Atwell (Media Transport Solutions)
Eric Fankhauser (Evertz)	Ronald Fellman (QVidium)	Oded Gants (Zixi)
Brian Keane (Net Insight)	Holger Klaas (Nevion)	Ciro Noronha (Cobalt Digital)
Adi Rozenberg (AlvaLinks)	Wes Simpson (LearnIPVideo)	

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;

CC BY-ND

- 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 or this document, please call +1 929-279-1995 or e-mail opsmgr@videoservicesforum.org.

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 and 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.

BY-ND

3 References

VSF TR-06-1:2020, Reliable Internet Stream Transport (RIST) Protocol Specification – Simple Profile

VSF TR-06-2:2023, Reliable Internet Stream Transport (RIST) Protocol Specification – Main Profile

VSF TR-06-3:2022, Reliable Internet Stream Transport (RIST) Protocol Specification – Advanced Profile

VSF TR-06-3:2023, Reliable Internet Stream Transport (RIST) – Advanced Profile Levels Annex

VSF TR-06-4 Part 2, Use of Wireguard VPN in RIST Devices

IETF RFC 2236, Internet Group Management Protocol, Version 2

IETF RFC 2710, Multicast Listener Discovery (MLD) for IPv6

IETF RFC 3376, Internet Group Management Protocol, Version 3

IETF RFC 3810, Multicast Listener Discovery Version 2 (MLDv2) for IPv6

IETF RFC 4604, Using Internet Group Management Protocol Version 3 (IGMPv3) and Multicast Listener Discovery Protocol Version 2 (MLDv2) for Source-Specific Multicast

Any mention of references throughout the rest of this document refers to the versions described here, unless explicitly stated otherwise.

4 Architecture (Informative)

When referring to multicast group management protocols, this document follows the nomenclature used in RFC 4604, as follows:

- The term “Group Management Protocol” or “GMP” is used to refer to both IGMPv2 (RFC 2236) and MLD (RFC 2710).
- The term “Source Filtering GMP” or “SFGMP” is used to refer to both IGMPv3 (RFC 3376) and MLDv2 (RFC 3810), with the updates from RFC 4604.

All RIST Specifications include explicit support for both IPv4 and IPv6. RIST devices may implement either one or both protocols. For VPN-like operation (where one packet is encapsulated in another, as in TR-06-2, TR-06-3 and TR-06-4 Part 2), support may be at the inner (encapsulated) packet, and/or the outer packet. In all cases, the terms “GMP” and

CC BY-ND

"SFGMP" refer to the corresponding group management protocol appropriate for the IP version in use.

The following sections illustrate the use cases for this Specification.

4.1 Point-to-Point Case

Figure 1 shows the point-to-point case, using a multicast-capable transport between a RIST Multicast Sender and a RIST Multicast Receiver.

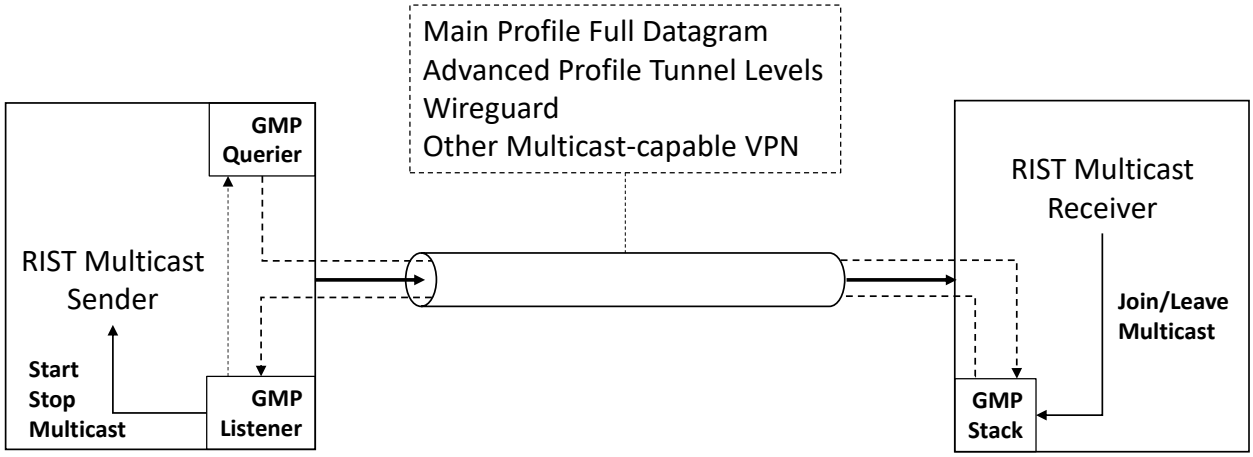

Figure 1: Point-to-Point Case

The RIST Multicast Sender includes a GMP Querier to send periodic group membership queries, and a GMP Listener, to listen and process responses. The RIST Multicast Receiver includes a standard GMP stack to process the queries and answer them appropriately.

4.2 Gateway Case

Figure 2 shows a gateway case. This is similar to Figure 1, but in this case the receiver does not consume the streams – it forwards them into another network, where other nodes may consume them.

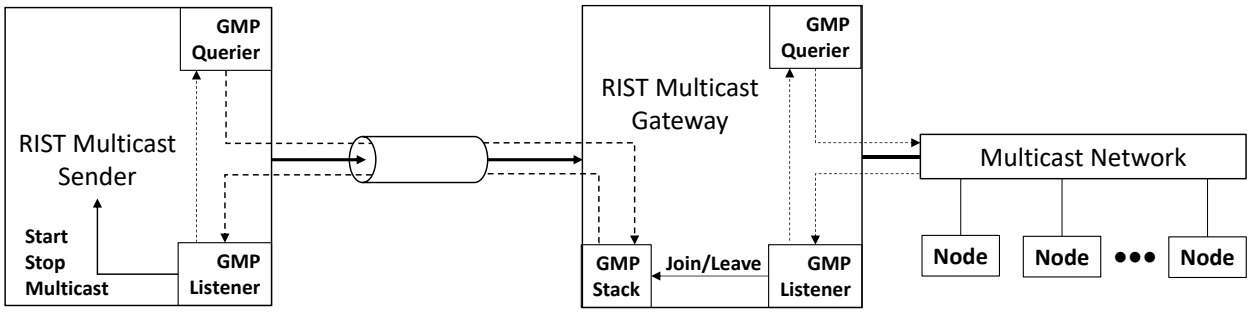

Figure 2: Gateway Case

In the case depicted in Figure 2, the RIST Multicast Gateway implements the GMP Querier to discover which multicasts are of interest to nodes in the multicast network and will only request

BY-ND

these multicasts from the RIST Multicast Sender – using standard multicast leave and join operations.

The architecture shown in Figure 2 can be replicated into subsequent hops.

5 Implementation Requirements

Implementation of the functionality described in this Specification by a RIST device is optional. If a RIST device implements the Multicast Discovery functionality, it shall comply with this Specification and it shall offer the user the ability to disable it. A device implementing the Multicast Discovery functionality shall support either IPv4 or IPv6. The device may support both.

The diagrams in Section 4 identify the following components:

1. The **GMP Querier**, responsible for sending group membership queries through the link at the sender side.
2. The **GMP Listener**, responsible for receiving and processing group membership responses at the sender side.
3. The **GMP Stack**, responsible for processing and responding to group membership queries at the receiver side.

The following sections describe the operation of these components.

5.1 GMP Querier Requirements

The GMP Querier is responsible for periodically sending the appropriate group membership queries. It shall comply with RFC 2236 (IGMPv2) and/or RFC 2710 (MLD). It may offer SFGMP querying; if it does so, it shall comply with RFC 3376 (IGMPv3) and/or RFC 3810 (MLDv2), with the updates from RFC 4604.

The RIST Sender shall encapsulate the GMP queries in the same manner as the streams in the output link. For example, if the link uses RIST Main Profile in Full Datagram mode (which uses GRE over UDP), the GMP queries are also encapsulated using GRE over UDP.

Note: The GMP Querier is not independent from the GMP Listener described in Section 5.2. For example, if RIST device implements IGMPv2, RFC 2236 compliance requires the transmission of a Group Specific Query when a Leave Group message is received.

5.2 GMP Listener Requirements

The GMP Listener is responsible for processing the group membership reports, deciding whether there RIST device at the other side of the link no longer needs the multicast, and stopping said multicast. It shall comply with RFC 2236 (IGMPv2) and/or RFC 2710 (MLD). It may offer SFGMP support; if it does so, it shall comply with RFC 3376 (IGMPv3) and/or RFC 3810 (MLDv2), with the updates from RFC 4604.

CC BY-ND

If the GMP Listener resides in a RIST Sender as shown in Figure 1, the RIST Sender shall stop sending the multicast when the GMP Listener determines that there are no more group members at the remote end of the link.

If the GMP Listener resides in a RIST Multicast Gateway as shown in Figure 2, the RIST Multicast Gateway shall issue a GMP Leave Group when the GMP Listener determines that there are no more group members in the local multicast network, so that the RIST Sender at the other end of the link will stop its transmission.

The RIST Sender shall accept the GMP responses in the same manner as the streams in the output link. For example, if the link uses RIST Main Profile in Full Datagram mode (which uses GRE over UDP), the GMP responses are also expected to be encapsulated using GRE over UDP.

5.3 GMP Stack Requirements

The GMP Stack at the RIST device receiving the multicast shall be a full implementation of the corresponding host side GMP. It shall comply with RFC 2236 (IGMPv2) and/or RFC 2710 (MLD). It may offer SFGMP support; if it does so, it shall comply with RFC 3376 (IGMPv3) and/or RFC 3810 (MLDv2), with the updates from RFC 4604.

Note: Standard built-in OS multicast stack implementations are considered suitable for the purposes of this Specification.

The RIST device shall encapsulate the GMP messages in the same manner as the streams in the input link. For example, if the link uses RIST Main Profile in Full Datagram mode (which uses GRE over UDP), the GMP messages are also encapsulated using GRE over UDP.

6 Interaction with Multicast Routing Protocols and Devices

6.1 Interaction with IGMP Snooping Layer 2 Switches (Informative)

In the gateway case shown in Figure 2, the "Multicast Network" can include multicast-enabled switches with GMP snooping. Such switches may filter GMP responses. Modern switches, however, automatically classify ports where GMP queries originate as "router ports" and will forward all GMP packets (and all multicasts) to these ports. These modern switches are automatically compatible with this Specification. However, manual configuration of older devices may be required to make the GMP responses available to the RIST device.

6.2 Operation in Mesh Networks

The techniques described in this Specification implement a simplified multicast routing protocol, unsuitable for multi-hop mesh operation. This case is depicted in Figure 3.

In the case of Figure 3, the multicast routing protocols are already performing the optimization function which is the primary purpose of this Specification. In such networks, RIST devices

CC BY-ND

should not implement this Specification and should behave as standard multicast-enabled IP hosts.

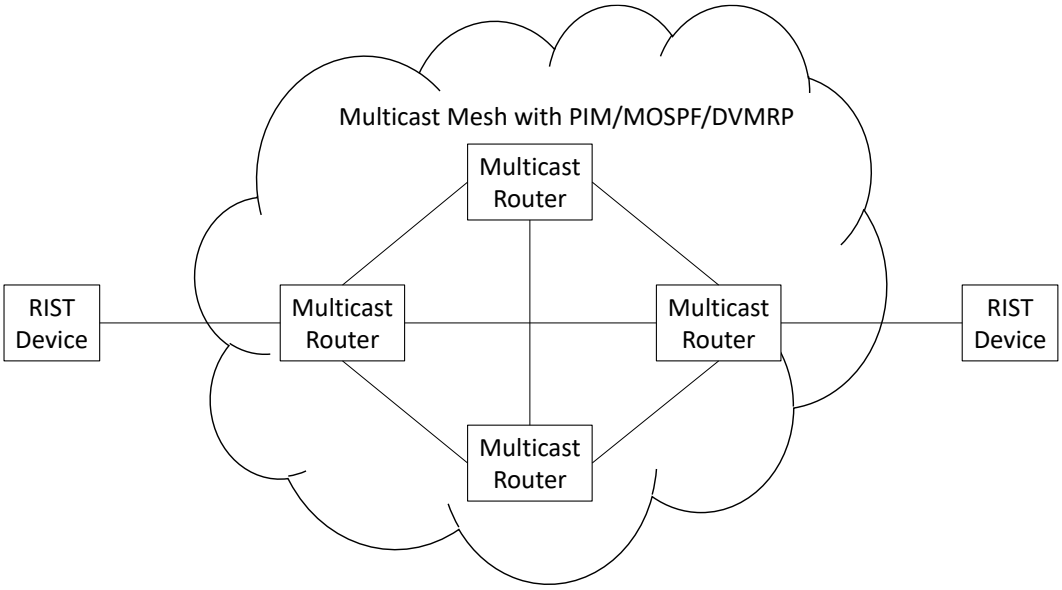

Figure 3: Multicast Mesh Network

In the situation depicted in Figure 4, a RIST Gateway or Device has more than one incoming RIST-encapsulated tunnel. If the device in the figure requests a multicast (either because one of the nodes served by it has requested this multicast, or because it will consume the multicast), this Specification has no mechanisms for the device to define to which incoming link(s) the request will be sent.

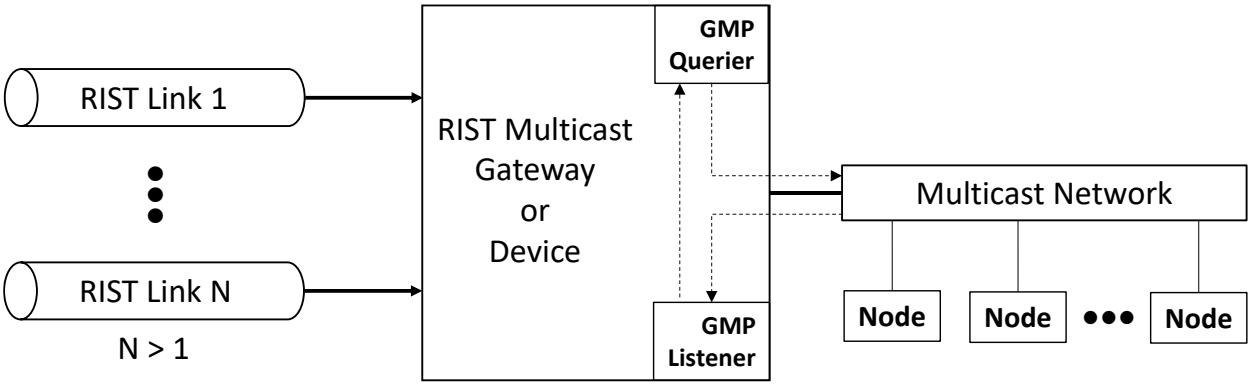

Figure 4: RIST Gateway with Multiple Links

Requesting the multicast on more than one link may result in a multicast storm if the network topology has loops. Therefore, RIST devices compliant with this Specification shall only request any given multicast over one single link at a time. Selection of which link to use, and the criteria to possibly switch from one link to another, are outside the scope of this Specification. In cases such as the one depicted in Figure 4, the use of a traditional multicast routing protocol in the

BY-ND

RIST Multicast Gateway or Device will provide better results, and the protocol messages can be encapsulated using RIST.

CC BY-ND