Preamble to Video Services Forum (VSF) Technical Recommendation TR-06-4 Part 7

July 23, 2025

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. This series includes:

- 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.
- TR-06-4 Part 3, RIST Relay, published in 2023.
- TR-06-4 Part 4, RIST Decoder Synchronization, published in 2024
- TR-06-4 Part 5, RIST Multicast Discovery, published in 2023.
- TR-06-4 Part 6, RIST Transport Stream Program Selection, published in 2024.

This document is TR-06-4 Part 7, RIST Satellite-Hybrid: In-Band Method. Satellite is the ideal way to distribute content to many geographically distinct locations. However, typical geo satellite distribution methods are unidirectional, and, depending on frequency used, may be subject to interference or rain fade. This Technical Recommendation describes a method to use the satellite (or any unidirectional transmission method based on MPEG-2 transport streams) as the primary distribution channel, while using RIST to recover any data that is corrupted or lost in transit. The method is backward-compatible with existing legacy receivers and requires the addition of synchronization data to the transport stream. It is called "in-band" due to this additional data.

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 7

Reliable Internet Stream Transport (RIST) Satellite-Hybrid: In-Band Method

Approved July 22, 2025

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Executive Summary

Satellite distribution is the ideal way to send the same content to many locations that are geographically distributed. However, typical geo satellite distribution methods are unidirectional, and, depending on the frequency, may be subject to interference or rain fade.

This Technical Recommendation describes a method to use the satellite (or any similar unidirectional one-way transmission method employing MPEG-2 Transport Streams, such as DVB-T) as the main distribution channel, with RIST as a backup to recover data that is lost or corrupted in the space segment. The method is backward-compatible with existing legacy receivers and requires the addition of data to the transport stream sent to the satellite. It is called "in-band" due to this additional data.

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.

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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, incompatibility exists 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.

Satellite distribution is the ideal way to send the same content to many locations that are geographically distributed. However, satellite transmission may be subject to localized degradation due to rain fade, interference, and other factors. Additionally, in many geo distribution cases, the satellite link is unidirectional, from one source to a multitude of receivers – no return channel exists. One possible approach to solving this content delivery problem is to augment satellite delivery using the Internet. The basic idea is to use the satellite for the "heavy lifting" (transmitting as much data as viable), with the Internet to "fill in the gaps". In other words, any data that is corrupted or lost in transit is retransmitted over the Internet using RIST, and only to the locations that need it. If there is a complete satellite fade (e.g., due to rain), the Internet can be temporarily used to deliver the complete signal. This way, if a region is experiencing any sort of fade or interference, only the receivers in that region need to use the Internet.

A requirement for the solution to this problem is that it must co-exist with current receivers to allow for gradual deployment. Such receivers expect a traditional MPEG-2 Transport Stream. The signal transmitted to the satellite either cannot change, or any changes to it must be backward compatible with existing legacy receivers. Broadcasters utilizing this solution can then gradually deploy the solution as needed, with high-priority sites being upgraded first.

This Technical Recommendation describes a method to use the satellite forward path in a way that is compatible with legacy receivers, and RIST to correct any lost data. It is called "in-band" because additional data is added to the satellite path. This solution is not limited to satellite; it can also be used to augment any large-scale point-to-multipoint network that uses a transport stream without an IP layer.

1.1 Contributors

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

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1.2 About the Video Services Forum

The Video Services Forum, Inc. (www.vsf.tv) 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;
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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.

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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 References

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

VSF TR-06-2:2024, Reliable Internet Stream Transport (RIST) Protocol Specification – Main Profile

VSF TR-06-3:2024, Reliable Internet Stream Transport (RIST) Protocol Specification – Advanced Profile

VSF TR-06-4 Part 2:2023, Reliable Internet Stream Transport (RIST) – Use of Wireguard VPN in RIST Devices

VSF TR-06-4 Part 3:2023, Reliable Internet Stream Transport (RIST) – RIST Relay

VSF TR-06-4 Part 5:2023, Reliable Internet Stream Transport (RIST) – RIST Multicast Discovery

VSF TR-06-4 Part 6:2024, Reliable Internet Stream Transport (RIST) – Transport Stream Program Selection

ISO/IEC 13818-1:2023, Generic coding of moving pictures and associated audio information, Part 1: Systems

SMPTE 2022-2-2007, Unidirectional Transport of Constant Bit Rate MPEG-2 Transport Streams on IP Networks

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

4 Solution Requirements (Informative)

Satellites are the ideal solution to the problem of simultaneously distributing the same content to many geographically distributed receivers. Content is uplinked only once and retransmitted by satellite to all receivers at the same time. Adding a new receiver only requires putting up an antenna and pointing it; there is no additional burden or extra capacity required on the system.

However, satellite systems can suffer from degraded operation due to factors such as rain fade, interference, and similar issues.

For a broadcaster delivering signals to affiliates, occasional interference and outages are obviously not acceptable. Therefore, additional measures need to be taken to ensure reliable delivery.

The solution considered in this Specification is to augment the traditional satellite delivery with the Internet. Use the satellite for the "heavy lifting" bulk delivery, and "fix any remaining problems" with the Internet. If a site is suffering from interference or rain fade, send a recovery stream to that site only, and include in this recovery stream only the blocks of data that were lost or corrupted.

A diagram of the solution is shown in Figure 1. The solution is required to comply with the following requirements:

1. Satellite is the primary distribution method.
2. The satellite channel is unidirectional; there is no return channel.
3. The Internet is used only to recover dropped or corrupted data.
4. Data recovery is seamless with no glitches.
5. The solution needs to be capable of delivering a complete feed in case of satellite outage.
6. The satellite signal is compatible with legacy receivers. More specifically, this means:
    a. The signal sent to the satellite is a traditional Transport Stream with one or more programs.
    b. Any information that is added to the Transport Stream is backward compatible with legacy receivers.

The following are specific requirements:

1. In many applications, the signal going to the modulator has been encrypted. Therefore, the solution cannot rely on specific fields in the transport stream payload.
2. Satellite modulators typically add or delete NULL packets for rate matching, and re-stamp PCRs to keep compliance. The solution cannot rely on the number and/or distribution of NULL packets, nor should it rely on the PCR values.

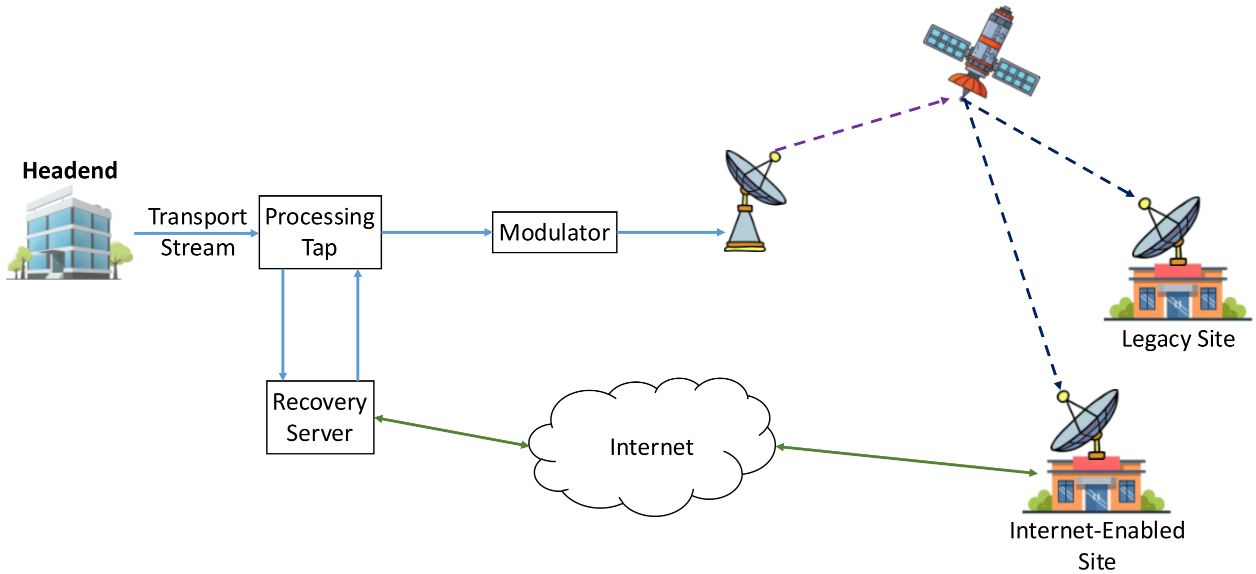

Figure 1: Solution Overview

5 Solution Architecture

The basic solution architecture is shown in Figure 2. The operational flow shall be as follows:

1. The original Transport Stream is transmitted to the Recovery Server.
2. The Recovery Server shall create and buffer an RTP stream, as if it were sending the Transport Stream over RIST, using RIST Simple or Advanced Profiles. The Recovery Server shall use 7 transport stream packets per RTP packet, as indicated in SMPTE 2022-7.
   Note: the buffer at the recovery server needs to be large enough to accommodate the satellite round-trip latency, plus the worst-case Internet latency to all the receivers. This buffer size typically will be on the order of several seconds.
3. The Recovery Server shall create additional metadata that correlates the transport packets in the original Transport Stream from the headend with corresponding RTP sequence numbers. This metadata allows an Internet-connected receiver to identify the RTP sequence number corresponding to lost or corrupted packets in the satellite stream. The metadata shall be formatted as per Section 6.
4. The metadata shall be multiplexed back into the transport stream in a compliant manner and shall be transmitted in-band over the satellite.
5. Internet-connected receivers shall synchronize the incoming satellite stream with the metadata. This synchronization yields the RTP sequence numbers required to request any lost or damaged data.
6. Lost packets shall be requested by Internet-connected receivers using the standard ARQ method in RIST Simple Profile or RIST Advanced Profile. Internet-enabled sites may keep a connection to the Recovery Server using RIST Main Profile or RIST Advanced Profile tunnels.

7. Optionally, Internet-connected receivers may use TR-06-4 Part 6 to select only a subset of programs they require, avoiding retransmission of unnecessary data.

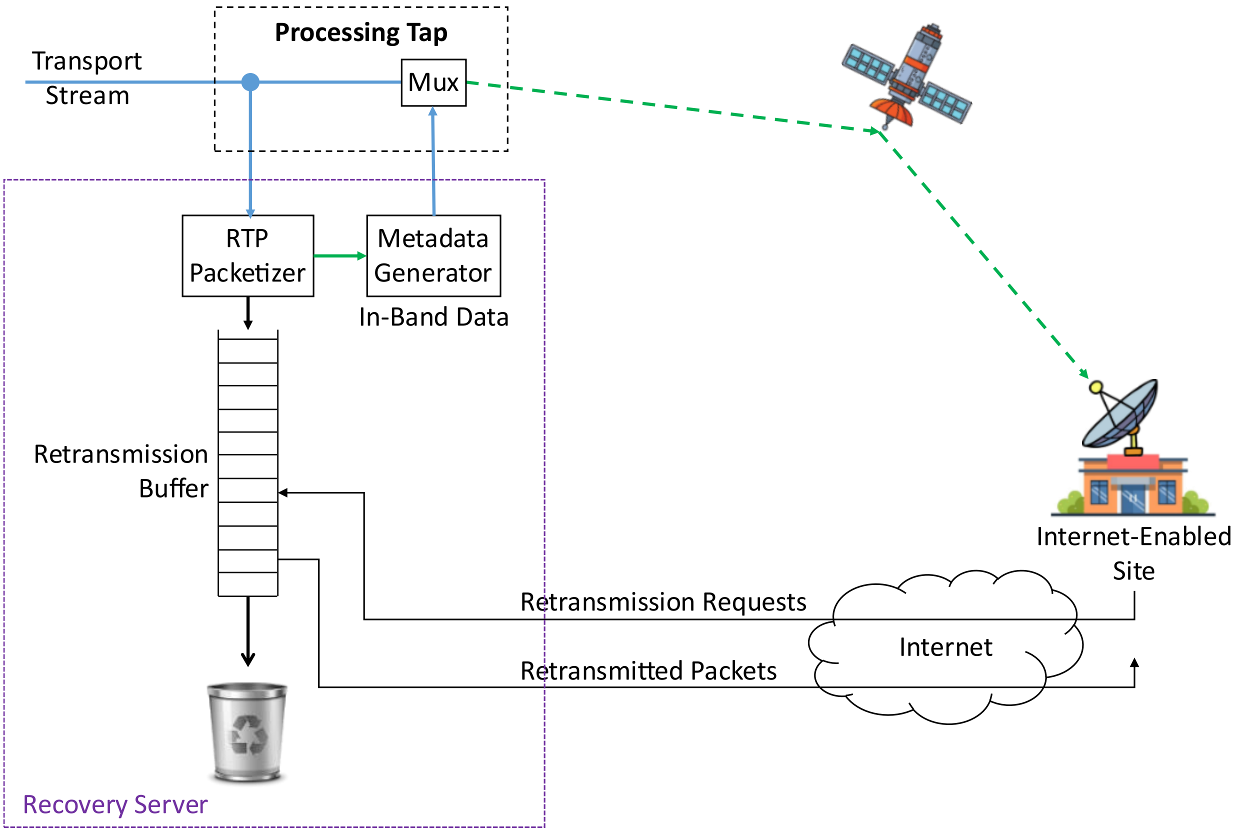

Figure 2: Solution Architecture

6 Metadata Creation Method

6.1 General Description

The in-band method described in this Specification relies on inserting metadata markers in the Transport Stream. The information contained in the markers allows the receiver to identify if any data is missing in the block delimited by the markers, and what RTP sequence number(s) it needs to request from the Recovery server to replace any missing data. If missing data is detected, the whole block between markers is requested.

Metadata markers shall be inserted at RTP payload boundaries; the number of payload boundaries between markers represents a tradeoff between overhead and retransmission traffic. As indicated in Section 5, RTP payloads shall consist of 7 transport packets. The data in the markers shall contain the following information:

- Number of non-NULL packets since the last marker.
- Number of NULL packets since the last marker (to aid in PCR restamping).
- RTP sequence number of the first RTP payload in the block between markers.
- RTP sequence number for the first RTP payload in the next block.
- A marker sequence number.
- The SSRC of the RTP recovery stream in the server.

The method is illustrated in Figure 3.

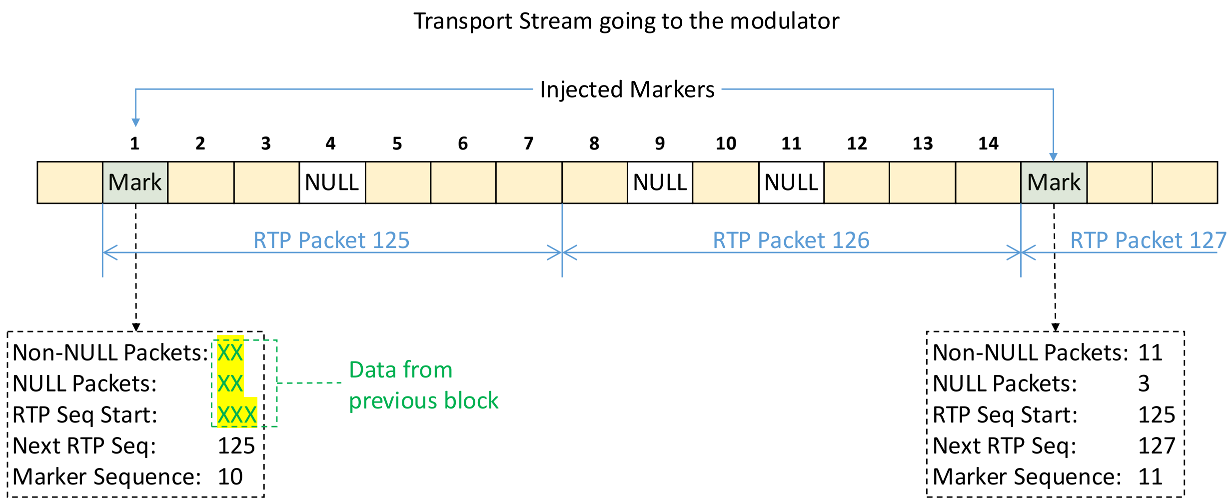

Figure 3: Metadata Insertion

In the example of Figure 3, markers are inserted every two RTP payloads. Upon reception of marker sequence 11, the Internet-enabled site shall compare the number of received non-NULL transport packets with the number reported in the marker (11). If the number is different, retransmission of the whole block (RTP packets 125 and 126) is requested.

6.2 Metadata Marker Format

The metadata marker shall use the **private_section()** syntax defined in ISO/IEC 13818-1, with **section_syntax_indicator** set to “0” (zero). The format for the private section is shown in Figure 4. The highlighted part is the private section header defined in ISO/IEC 13818-1.

Syntax	No. of Bits
private_section() {	
table_id	**8**
section_syntax_indicator	**1**
private_indicator	**1**
reserved	**2**
private_section_length	**12**
marker_sequence_number	**32**
non_null_count	**16**
null_count	**16**
rtp_sequence_start_msb	**16**
rtp_sequence_start_lsb	**16**
rtp_sequence_next_msb	**16**
rtp_sequence_next_lsb	**16**
source_ssrc	**32**
CRC_32	**32**
}	

Figure 4: Metadata Marker Format

The fields in Figure 4 shall be defined as follows:

- **table_id (8 bits):** this field shall be set to 0xBF (user-defined, outside of the ISO, ETSI and ATSC ranges).
- **section_syntax_indicator (1 bit):** this field shall be set to "0".
- **private_indicator (1 bit):** this field shall be set to "0".
- **private_section_length (12 bits):** this field shall contain the number of remaining bytes in the private section, immediately following the field. Since all metadata marker private sections are of the same size, this field shall be always set to "20".
- **marker_sequence_number (32 bits):** this field shall be incremented by one at every metadata marker section transmitted. The Recovery Server may arbitrarily select the starting value.
- **non_null_count (16 bits):** this field shall contain the number of non-NULL packets in the previous block, including the metadata marker at the beginning of the block, and excluding the current metadata marker.
- **null_count (16 bits):** this field shall contain the number of NULL packets in the previous block, after insertion of the markers.
- **rtp_sequence_start_msb (16 bits):** if 32-bit sequence numbers are in use, this field shall be set to the 16-bit MSB of the sequence number for the first RTP packet in the previous block. If 32-bit sequence numbers are not in use, this field shall be set to zero.
- **rtp_sequence_start_lsb (16 bits):** This field shall be set to the 16-bit RTP sequence number of the first RTP packet in the previous block.
- **rtp_sequence_next_msb (16 bits):** if 32-bit sequence numbers are in use, this field shall be set to the 16-bit MSB of the sequence number for the first RTP packet in the block

starting at this marker. If 32-bit sequence numbers are not in use, this field shall be set to zero.

- **rtp_sequence_next_lsb (16 bits):** This field shall be set to the 16-bit RTP sequence number of the first RTP packet in the block starting at this marker.
- **source_ssrc (32 bits):** This field shall be set to the SSRC used in the RTP packets for this transport stream.
- **CRC_32 (32 bits):** This field shall contain the CRC value that gives a zero output in the CRC decoder after processing the whole private section, using the algorithm specified in Appendix A of ISO/IEC 13818-1.

Metadata marker private sections are encapsulated in transport packets. Since the metadata marker is a small section (27 bytes total size, plus one additional byte for the **pointer_field**), it will always fit in a single transport packet.

The metadata marker PID should be set to PID 0x1FF0. Different PIDs may be used, and the value may be manually configured.

The metadata marker PID shall not be referenced in any of the PMTs in the transport stream.

6.3 Multiplexing the Metadata Marker in the Transport Stream (Informative)

Since the metadata marker needs to be inserted in very specific locations in the transport stream, the insertion cannot be achieved by simple NULL packet replacement. However, if the transport has enough available bandwidth in the form of NULL packets, the following simple algorithm can be used:

1. Define N as the "number of pending insertions so far". The starting value for N is zero.
2. The value of N is inspected as each transport packet is forwarded in the Processing Tap of Figure 2. The following actions are taken:
   a. If the transport packet is a NULL packet:
      i. If N is nonzero, the NULL packet is dropped and N is decremented by 1.
      ii. If N is zero, the NULL packet is forwarded.
   b. If the transport packet is not a NULL packet:
      i. If the transport packet does not have a PCR, it is forwarded.
      ii. If the transport packet has a PCR, the PCR value is re-stamped using equation (1) below, and the packet is forwarded.
3. Any time a metadata marker packet is inserted, N is incremented by one.

The PCR restamping equation is:

R: Transport stream bit rate, in bits/second.

N: Number of pending insertions defined above.

P_i: Incoming PCR.

P_R: Restamped PCR.

$$P_R = P_i + \frac{1504N}{R} \times 27{,}000{,}000 \qquad (1)$$

In a transport stream with enough NULL packet bandwidth to accommodate for the metadata marker insertion, the value of *N* is expected to be small or zero most of the time. If *N* increments without bound, it is an indication that there is not enough NULL packet bandwidth to accommodate the markers. A calculation of the required marker bandwidth can be found in Appendix A.

7 RIST Message Extensions

One limitation with the method described in Section 6 is that a receiver that is turned on during a complete fade event does not have an initial RTP sequence number to request retransmissions using the RIST NACK messages. Additionally, if the satellite signal disappears completely, the receiver needs to have a mechanism to switch to the Internet feed. This section describes the following extensions of the RIST messages, created to address this situation:

- An extension for the receiver to ask the server to start transmitting a complete copy of the stream until otherwise turned off.
- An extension for the receiver to ask the server to stop transmitting a complete copy of the stream.

7.1 RIST Simple Profile Full Stream Request Messages

RIST Simple and Main Profiles use several Application-Defined RTCP messages, with different subtypes. The Full Stream Request Messages use two new subtypes, as shown in Table 1.

Table 1: RIST APP Subtypes

Subtype	Message	Specification
0	Range NACK Message	TR-06-1 Section 5.3.2.2
1	Sequence Number Extension Message	TR-06-2 Section 8.4
2	RTT Echo Request	TR-06-1 Section 5.2.6
3	RTT Echo Response	TR-06-1 Section 5.2.6
4	Reserved	
5	**Full Stream Request Enable**	**TR-06-4 Part 7 Section 7.1**
6	**Full Stream Request Disable**	**TR-06-4 Part 7 Section 7.1**

The format for the Full Stream Request messages is shown in Figure 5.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|V=2|P| Subtype |   PT=APP=204  |             length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  SSRC of media source                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         name (ASCII)                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 5: RIST Simple Profile Full Stream Request Message

The fields shall be set as follows:

version (V): 2 bits

Identifies the version of RTP, which is the same in RTCP packets as in RTP data packets. RIST Full Stream Request packets shall have V=2.

padding (P): 1 bit

Indicates whether there is padding at the end of the packet. RIST Full Stream Request Packets shall have P=0.

Subtype: 5 bits

This field identifies the type of message. The following codes shall be used:
5: Enable Full Stream Transmission.
6: Disable Full Stream Transmission.

Payload type (PT): 8 bits

This is the RTCP packet type that identifies the packet as being an Application-defined Message. This field shall be set to 204.

Length: 16 bits

The length of this packet, expressed in 32-bit words minus one, including the header and any padding. This field shall be set to the value of **2**, since the size of Full Stream Request Message is three 32-bit words.

SSRC of media source: 32 bits

This field is normally set to the SSRC of the media source being requested. If the receiver does not know this value (e.g., at startup), it shall set to **0 (zero)**. Once the value is known, the receiver shall set this value to the actual SSRC of the media source.

Name (ASCII): 32 bits

This field identifies the application. For RIST packets, it shall have the value 0x52495354, the ASCII codes for “RIST”.

RIST Simple Profile requires that the least significant bit of the SSRC in the RTP packets be set to zero for original packets, and one for retransmissions. RTP packets sent in response to the Full Stream Request Message defined in this section shall have the last bit of the SSRC set to zero. Any retransmissions of such packets (in case they are lost in transit over the Internet) shall be set to one.

A receiver requesting the full stream shall send a Full Stream Request message with Subtype=5 every 30 seconds as a keep-alive method.

Once the full stream is no longer needed by the receiver, it shall send a Full Stream Request Message with Subtype=6 every 5 seconds until the server stops transmitting the full stream.

The server shall stop sending the full stream if it receives a Full Stream Request message with Subtype=6, or if no Full Stream Request messages with Subytpe=5 are received for a period of two minutes.

If the server supports program selection (TR-06-4 Part 6), only the requested programs shall be transmitted in response to a Full Stream Request message.

7.2 RIST Advanced Profile Full Stream Request Messages

For TR-06-3 Advanced Profile, two new tunnel control messages (see Section 5.3) are defined. These two new tunnel control messages are indicated in Table 2.

Table 2: RIST Advanced Profile Control Index Values

Control Index	Message Type	Mandatory
0x0000	NACK Bitmask	
0x0001	NACK Range	
0x0002-0x0003	TR-06-4 Part 1 Link Quality Reports	
0x0004	TR-06-4 Part 4 Sender Synchronization Message	
0x0005	**Full Stream Request Enable**	
0x0006	**Full Stream Request Disable**	
0x0007-0x000F	Reserved for future NACK messages	
0x0010	RTT Echo Request	
0x0011	RTT Echo Response	Yes
0x0012-0x001F	Reserved for future RTT messages	
0x0020	ST 2022-5 FEC Row Packet	
0x0021	ST 2022-5 FEC Column Packet	
0x0022	ST 2022-1 FEC Row Packet	
0x0023	ST 2022-1 FEC Column Packet	
0x0024-0x002F	Reserved for future FEC messages	
0x0030-0x77FF	Reserved for future control messages	
0x7800-0x7FFF	Reserved for private vendor use	
0x8000	RIST Main Profile Keep-Alive message	Yes
0x8001	Flow Attribute message	
0x8002-0x800F	Reserved for future tunnel messages	
0x8010	Advanced Profile SRP authentication for PSK sessions	
0x8011	PSK Future Nonce Announcement Message	
0x8012-0x801F	Reserved for future authentication messages	
0x8020	Control Message Unsupported Response	
0x8021-0x802F	Reserved for future error messages	
0x8030-0x804F	TR-06-4 Part 3 RIST Relay Messages	
0x8050-0xF7FF	Reserved for future control messages	
0xF800-0xFFFF	Reserved for private vendor use	

The format for the two new control messages from Table 2 is shown in Figure 6.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Control Index = 0x0005/0006  |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      SSRC of Media Source                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 6: Full Stream Request Control Messages

The fields for the message in Figure 6 shall be set as follows:

Control Index: 16 bits

This field identifies the type of message. The following codes shall be used:
0x0005: Enable Full Stream Transmission.
0x0006: Disable Full Stream Transmission.

Length: 16 bits

Senders shall use this field to indicate the size of the Advanced Profile Control Message following the Length field, in bytes. This field shall be set to the value of **4**.

SSRC of media source: 32 bits

This field is normally set to the SSRC of the media source being requested. If the receiver does not know this value (e.g., at startup), it shall set to **0 (zero)**. Once the value is known, the receiver shall set this value to the actual SSRC of the media source.

RIST Advanced Profile requires that the R flag (see Section 52.3) be set to zero for original packets, and to one for retransmitted packets. Packets sent in response to the Full Stream Request Message defined in this section shall have the R flag set to zero. Any retransmissions of such packets (in case they are lost in transit over the Internet) shall have the R flag set to 1.

A receiver requesting the full stream shall send a Full Stream Request message with Control Index set to 0x0005 every 30 seconds as a keep-alive method.

Once the full stream is no longer needed by the receiver, it shall send a Full Stream Request Message with Control Index set to 0x0006 every 5 seconds until the server stops transmitting the full stream.

The server shall stop sending the full stream if it receives a Full Stream Request message with Control Index set to 0x0006, or if no Full Stream Request messages with Control Index set to 0x0005 are received for a period of two minutes.

If the server supports program selection (TR-06-4 Part 6), only the requested programs shall be transmitted in response to a Full Stream Request message.

Appendix A Bandwidth Overhead (Informative)

The in-band method adds one transport packet every K RTP packets, and each RTP payload carries 7 transport packets. The required data rate for metadata markers is:

R: Transport stream bit rate.
K: Number of RTP packets between the markers.
D: Required marker metadata.

$$D = R\frac{1}{7K} \qquad (2)$$

A reasonable choice for K is 5, which yields an overhead of $1/35 = 2.86\%$. Note, however, that insertion of the markers can be done by NULL packet replacement; therefore, if the transport stream has at least that percentage of NULL packets, there is no additional required bandwidth in the satellite segment.

For the Internet connections, it is expected that the receiving sites will use RIST Main Profile tunnels to the Recovery Server, and the baseline overhead is simply the Main Profile Keep-Alive messages. These require only around 1.5 kb/s regardless of the bit rate.

Appendix B Receiver Configuration (Informative)

B.1 Receiver Buffer Sizing

Satellite links have relatively high latency, especially with geostationary satellites. This latency is typically higher than the round-trip latency through the Internet. For a receiver to be capable of seamlessly switching between an Internet stream and the satellite stream, while still being able to recover lost data, its buffer needs to be configured to be at least the satellite latency, plus a multiple of the Internet round-trip delay. This is especially important for sites that start up during a fade with an Internet stream; if they do not account for the satellite latency, they will not be able to switch to the satellite stream when it comes back, as it has more delay than the Internet version.

B.2 Receiver Connection Configuration

The configuration requirements depend on the RIST profile being used.

If the receivers are using RIST Simple Profile, then the configuration requirements are as follows:

1. The only configuration needed at the receiver site is the pair of UDP ports used to receive RTP and RTCP traffic.
2. If there is a firewall at the receiver site, it needs to be configured to expose the selected UDP ports.
3. The Recovery Server will need to be configured with a list of receive sites and their UDP ports.

An option to avoid having to configure the firewall is to use a Wireguard VPN as per TR-06-4 Part 2 and run RIST Simple Profile on the VPN. However, this does not change the requirement that the Recovery Server needs to be configured with a list of endpoints to send to. A possible alternative to configuring the server with a list of endpoints would be to select a multicast IP address and UDP port for the RTCP traffic and configure the server with that. Receivers send the RTCP packets to this multicast address and port; the server directs the return traffic to the source IP address of the RTCP packet, thus removing the need for a priori configuration.

If the receivers are using RIST Main or Advanced Profiles, the Recovery Server can be configured as a tunnel server, and the receivers all connect to it. This removes the need for firewall configuration at the receiver side and removes the need for the Recovery Server to be pre-configured with knowledge of all the receiver sites. The same mechanism suggested for Wireguard operation could also be used.

One option for scalability is to use the RIST Relay, described in TR-06-4 Part 3. In this case, the RIST Relay needs to be in Full Proxy mode (see TR-06-4 Part 3 Section 6.1) and needs to implement the NACK messages from Section 7.2. The receivers will connect to the RIST Relay instead of the Recover Server, and the Recover Server will simply send the full satellite feed to one or more RIST Relays.

If the Recovery Server is using a VPN that supports multicast, the multicast discovery method described in TR-06-4 Part 5 can be used as an alternative to the message extensions in Section 7.