Hybrid Satellite/Internet Delivery: An Overview of TR-06-4 Part 7

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Agenda

- RIST TR Status
- Problem Definition
- Technical Discussion
- Roadmap
- NAB NY Demo

RIST TR Status

- TR-06-1: RIST Simple Profile (last updated in 2020)
- TR-06-2: RIST Main Profile (last updated in 2024)
- TR-06-3: RIST Advanced Profile (last updated in 2024)
- TR-06-4: RIST Ancillary features
    - TR-06-4 Part 1: Source Adaptation (published in 2022)
    - TR-06-4 Part 2: Use of Wireguard in RIST (published 2023)
    - TR-06-4 Part 3: RIST Relay (published 2023)
    - TR-06-4 Part 4: Decoder Synchronization (published 2024)
    - TR-06-4 Part 5: Multicast Discovery (published 2023)
    - TR-06-4 Part 6: Transport Stream Program Selection (published July 2024)
   - TR-06-4 Part 7: Satellite Hybrid: In-Band Method (published July 2025)

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Problem Definition

- Satellite is an excellent solution for sending the **same content simultaneously** to a **large number of recipients that are geographically distributed**
  - Except when it doesn't work:
    - Rain Fade for Ku-Band
    - 5G interference for C-Band
- We now have the Internet and use it to distribute content.
- Can we combine the Internet and the satellite:
  - Primary distribution is via satellite (one way transmission)
  - Internet is used to "fix" problems (resend lost data)
  - RIST already has the mechanisms to resend lost data

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Can we just use the Internet?

- Yes, but:
  - The Internet is unicast. You need to send one individual copy to each destination.
  - For each destination added, there is an ongoing OPEX cost.
  - You can pay a CDN to do this for you, but it can get quite expensive for a very large number of sites.
  - If you are doing satellite now, you will have to retrofit **all** your sites before you can do Internet distribution.
- Internet distribution may or may not make financial sense, it will depend on the number of destinations

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Satellite Solution Architecture
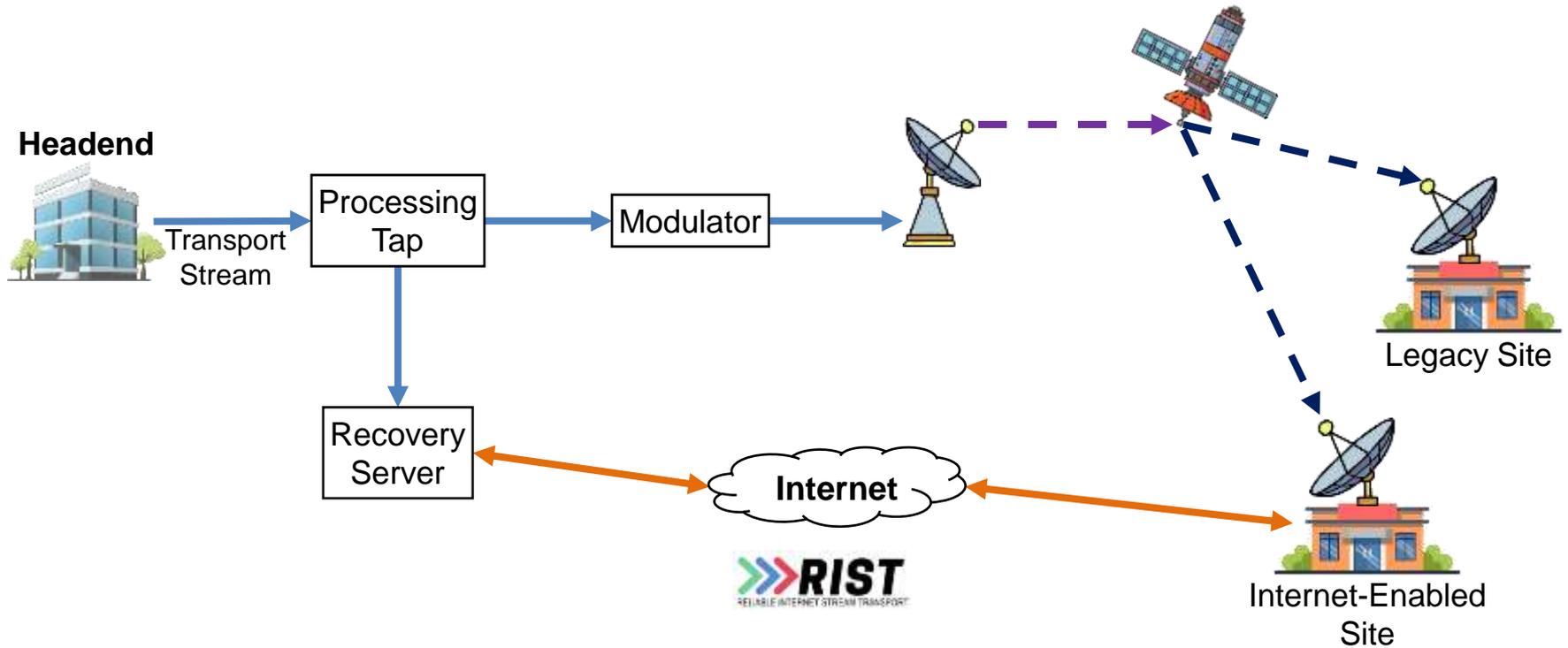
General Architecture

- Transport stream is sent through satellite to all receivers

- Transport stream is cached in a recovery server to retransmit over the Internet in case of corrupted or dropped data

- Metadata is included in the transport stream to allow Internet-enabled receivers to allow them to identify **what to request** from the recovery server in case of corrupted or dropped data

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General Solution Requirements

1. Satellite is the primary distribution method

2. A satellite return channel must not be assumed

3. The Internet must be used to recover dropped or corrupted data

4. The Internet must be able to deliver a complete feed in case of outage

5. The satellite signal must be compatible with legacy receivers
   - The signal to the satellite must be a transport stream
   - Any information added to the stream must be backward-compatible

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Additional Solution Requirements

6. The signal to the modulator may be encrypted
    - The solution must not rely on any information contained in the payload of transport packets

7. Satellite modulators typically add or remove NULL packets, and re-stamp the PCRs to match
    - The solution must not rely on the distribution of NULL packets
    - The solution must not rely on the PCR values

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Detailed Solution Architecture
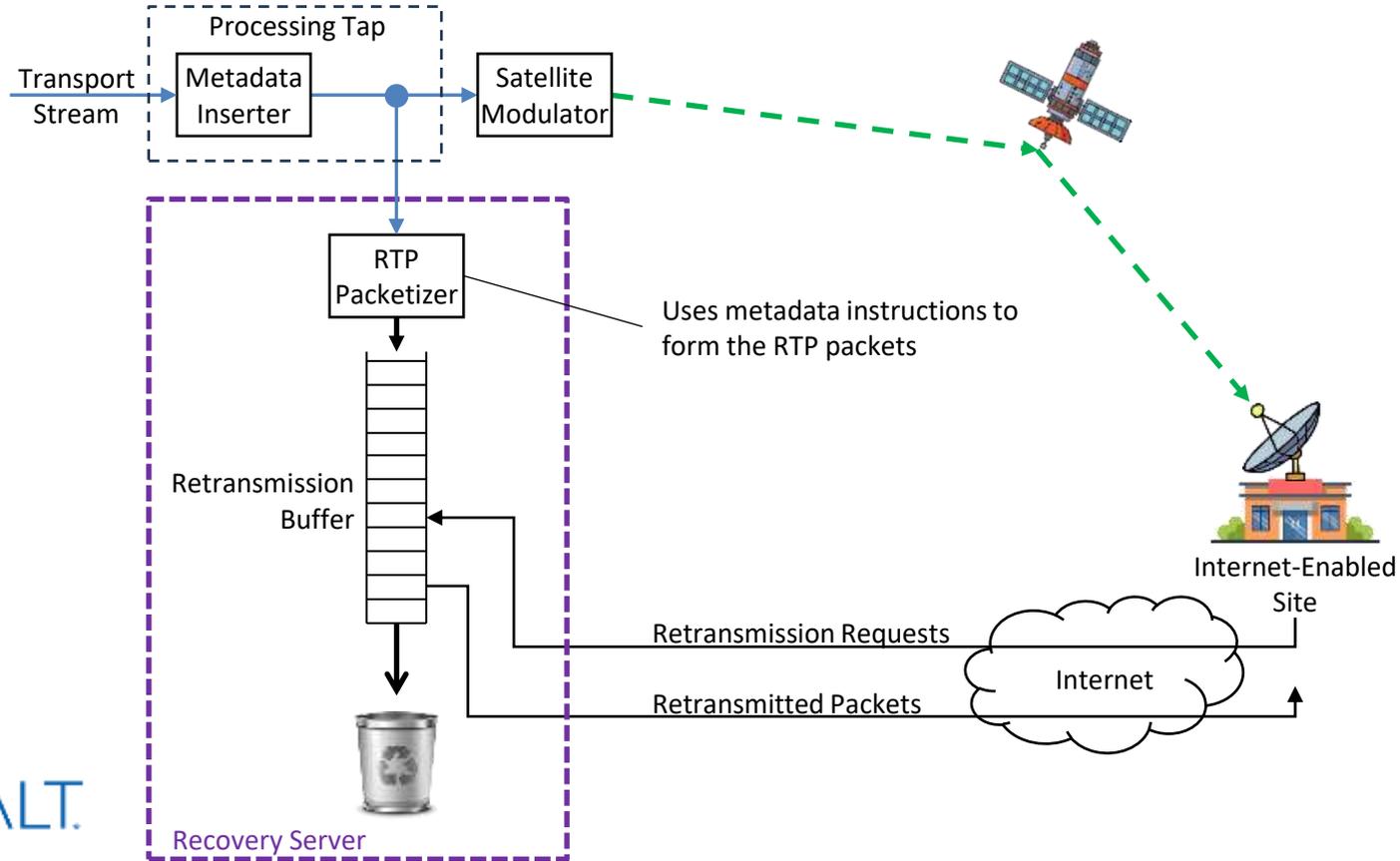
Detailed Description

- From the original transport stream, the Recovery Server creates and buffers an RTP stream, as if it were sending it using RIST Simple Profile.

- The Recovery Server creates metadata that correlates transport packets with RTP sequence numbers

- Receivers synchronize incoming transport stream with RTP sequence numbers using the metadata.

- In case of loss, data is recovered using retransmissions, requested using standard RIST NACK messages.

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Metadata Details

- Metadata markers are inserted in the transport stream at RTP packet boundaries, on a separate non-NULL PID.

- Metadata markers include:
  - Number of non-NULL packets since last marker
  - Number of NULL packets since last marker
  - RTP sequence numbers of:
    - First RTP packet in this block
    - First packet in the previous block
  - Marker sequence number
  - Stream SSRC

- New full stream request enable/disable messages have been added to deal with outages.
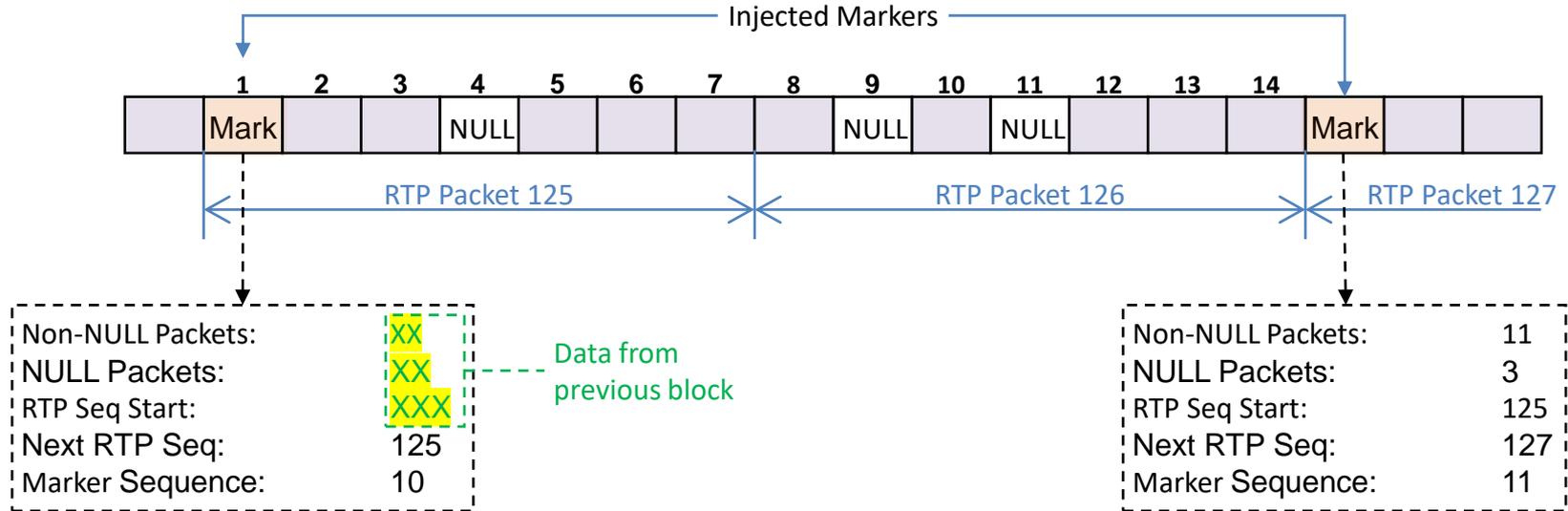
Metadata Marker Format

Syntax	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
}	

- ISO/IEC 13818-1 private section
- Table id: 0xBF
  - User-defined, outside of the ISO, ETSI and ATSC ranges
- Total Size: 27 bytes + pointer
  - Fits in one transport packet
- Fixed default PID 0x1FF0
  - Can be changed by manual configuration
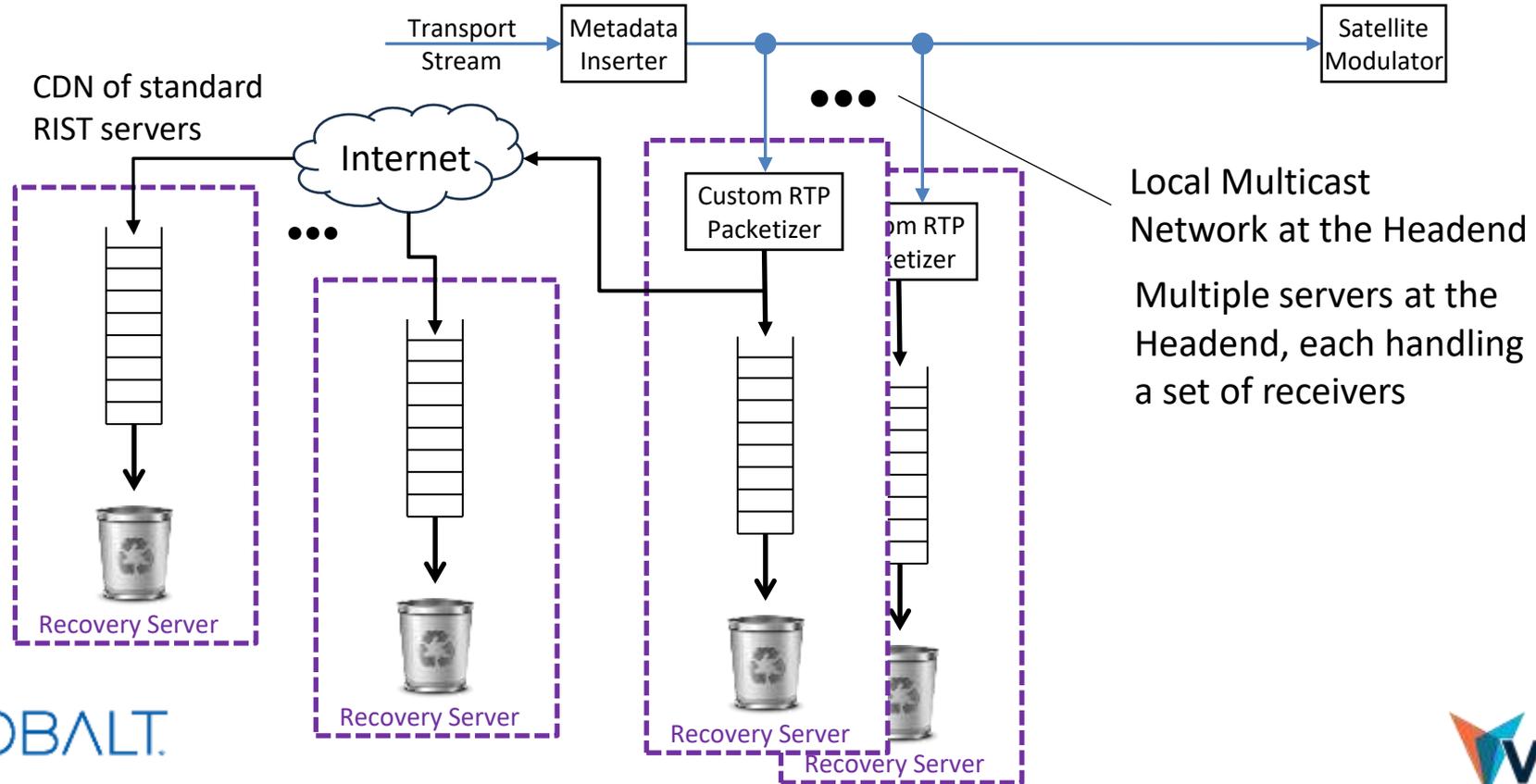 - No signaling (no PAT/PMT entry)

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Metadata Insertion Example

Transport Stream going to the modulator

Injected Markers

1	2	3	4	5	6	7	8	9	10	11	12	13	14		
Mark			NULL					NULL		NULL				Mark	

RTP Packet 125   RTP Packet 126   RTP Packet 127

Non-NULL Packets:	XX
NULL Packets:	XX
RTP Seq Start:	XXX
Next RTP Seq:	125
Marker Sequence:	10

Data from previous block

Non-NULL Packets:	11
NULL Packets:	3
RTP Seq Start:	125
Next RTP Seq:	127
Marker Sequence:	11

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Bandwidth Overhead

- One marker packet is sent every K RTP packets; the satellite segment overhead is $1/7K$
  - For K=7, the overhead is **2.04%** of the transport rate
  - This bandwidth can be reclaimed from NULL packets with proper PCR restamping (TR-06-4 Part 7 includes a suggested algorithm)
  - In case of loss, the receiver will request the whole block of K packets
  - Tradeoff between overhead and retransmission efficiency
- The overhead on the Internet link from headend to receivers is simply the periodic RTCP SR packets plus the Main Profile Keep-Alive, if used – on the order of a **few kb/s** per destination.

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Retransmission Server Scaling Options

Transport Stream → Metadata Inserter → ● ● ● → Satellite Modulator

CDN of standard RIST servers

Internet

Custom RTP Packetizer

...om RTP ...ketizer

Local Multicast Network at the Headend

Multiple servers at the Headend, each handling a set of receivers

Recovery Server

Recovery Server

Recovery Server

Recovery Server

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Roadmap

- The following TRs are being worked on:
  - An out-of-band method that does not require any changes in the transport stream going to the modulator
    - Easier to deploy – more reliable
    - Much lower overhead
    - Design is complete, on the "writing queue"
  - A method to use the same scheme for packet-based RF links
    - Usable with DVB-S2 and ATSC 3.0 ("Hybrid OTA")
    - Much simpler implementation
    - On the "writing queue"

NAB NY Interop Demo
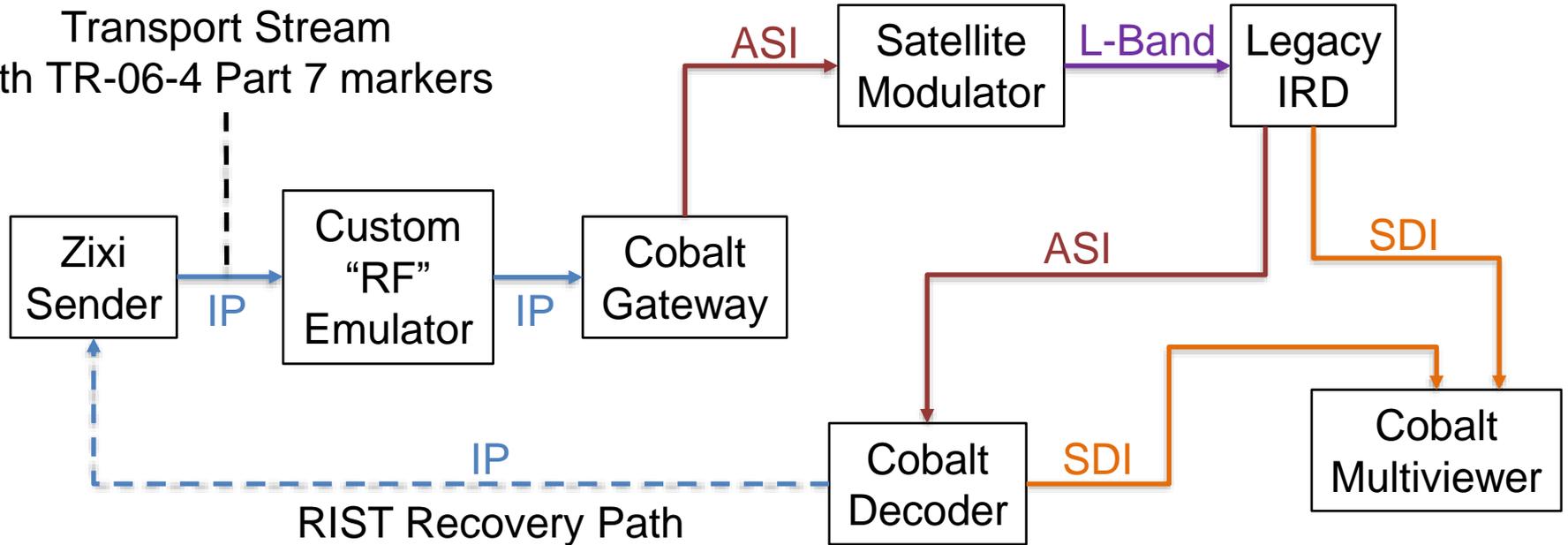
Q&A

- Questions?
- Thanks!

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