Telemetry Re-radiation System Upgrades

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Outline

- Purpose
- Generic Telemetry Re-radiation (Re-rad) System
- Current RTAS-2000 Re-rad System Configuration
- New Requirements that Drove Upgrade
- LDPC Basics
- Proposed RTAS-2000-5 New Capabilities
  - Higher Receiver and Transmitter Baseband Capability – 40 Mbps
  - LDPC Capability: LDPC decoding in receiver; LDPC encoding in transmitter
- Conclusion

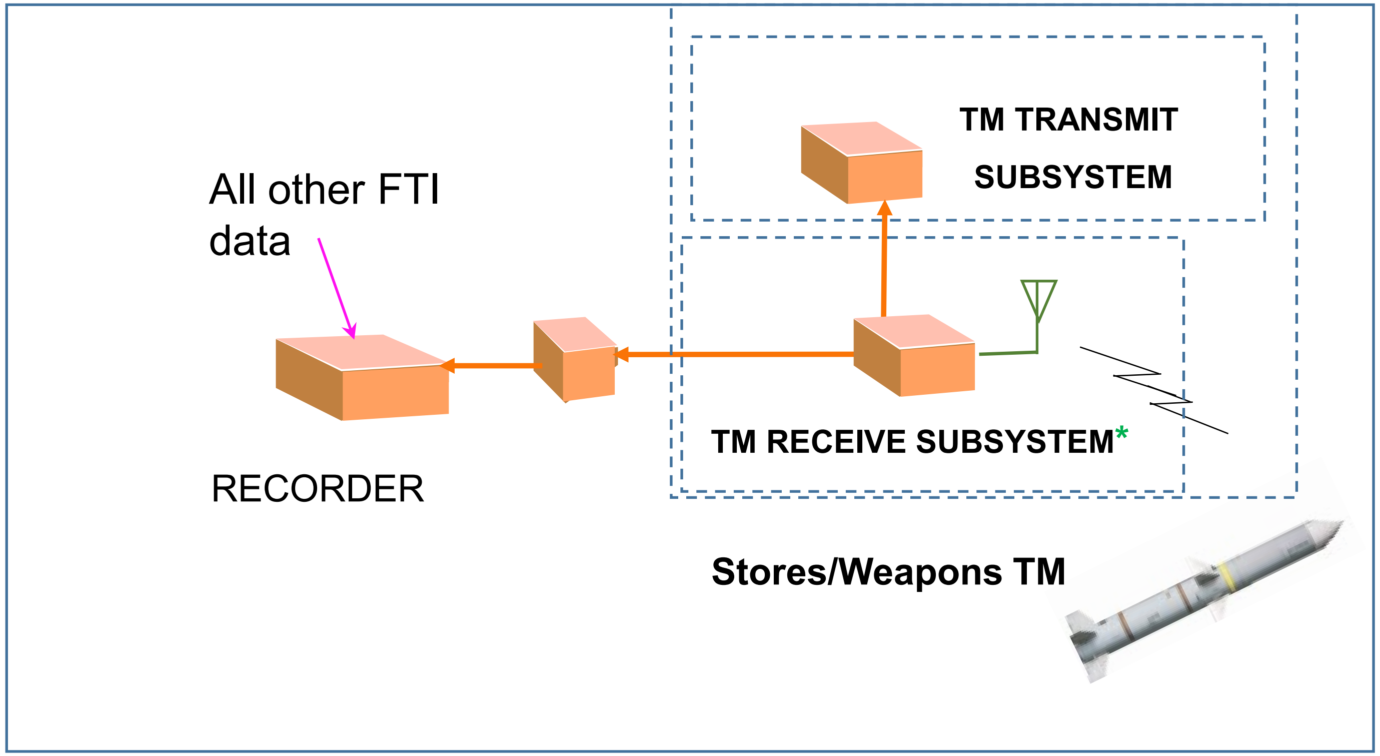
Purpose

- The purpose of this presentation is to provide the audience with information on the generic telemetry re-rad systems that are currently employed to support flight testing. Detailed information will be presented to discuss the current RTAS-2000 re-rad systems being used. Additional information will be provided on RTAS-2000 upgrades that are being implemented to meet new test project requirements, and the new capabilities that will be garnered, along with the resulting improvements and impacts of using these upgraded systems.

Generic Re-rad Systems

- Most re-rad systems used for flight testing are driven by requirements to monitor stores or weapons telemetry prior to drop or launch, for range safety purposes and confirmation of test article health
- Test aircraft, with weapons bays, may not allow enough telemetry power to escape the bay to enable this monitoring and validation of health, thus re-rad systems are employed
  - Telemetry (TM) data are received in the weapons bay by TM receiver(s), and the baseband signals are split and sent to an onboard recorder and also sent to re-rad transmitter(s) that normally operate in a different frequency bands than that of the actual store/weapon’s TM
    - Use of a separate TM frequency aids in TM auto-tracking when the drop or launch occurs
    - Use of a separate TM frequency doubles the spectrum required to support the test
    - Separate apertures are normally installed for re-rad, usually because it uses a different TM band

Typical Re-rad System

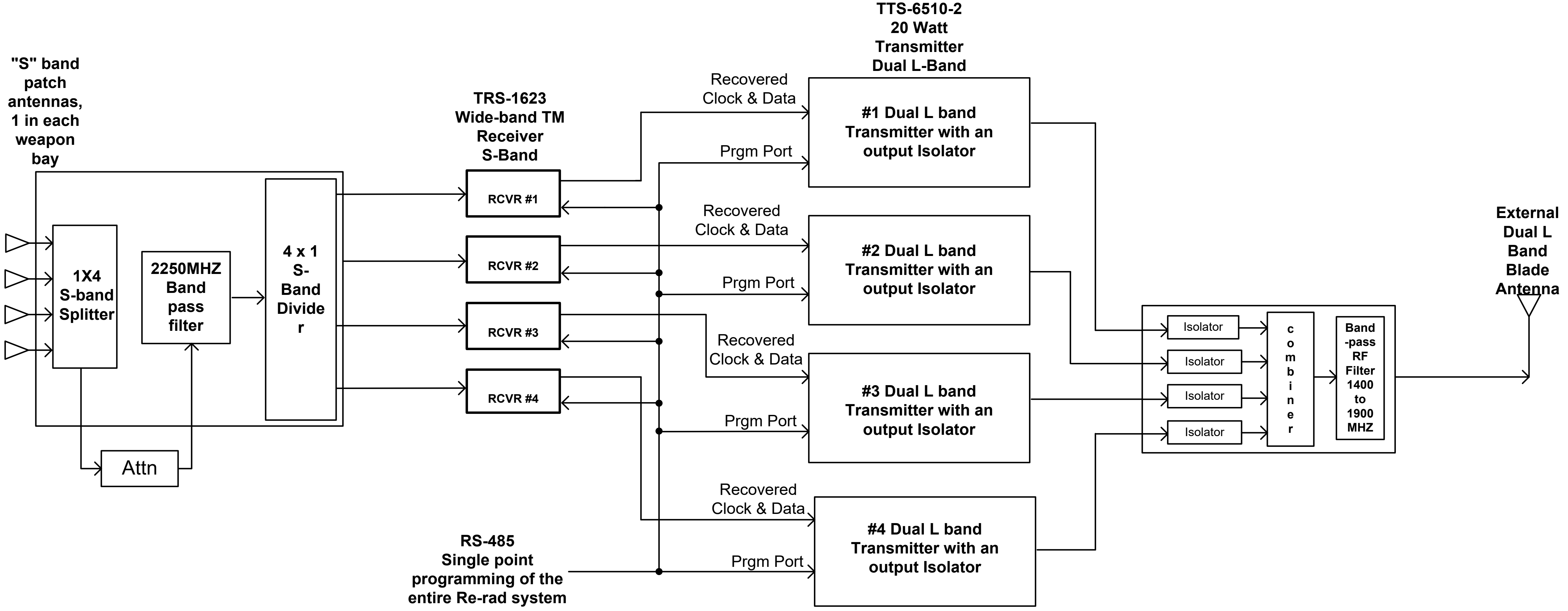


*Normally in the weapons bay(s)

RTAS-2000 Salient Characteristics

- Four channel receive/transmit
- 20 Mbps receive and transmit
- Programmable with TTC software
- PCM/FM or SOQPSK-TG receive or transmit
- S-band (2200-2290 MHz; 2360-2395 MHz) reception
- L-band (1435 MHz-1525 MHz; 1700 MHz-1850 MHz) transmission

Notional RTAS-2000 Block Diagram



Upgrade replaces TRS-1623 with TRS-1623-5 wideband receivers; replaces TTS-6510-2 with TTS-9689-3 transmitters; 40 Mbps capable; LDPC capable

New Requirements Drove Upgrade

- Testing for new projects required increase in slant range from ground TM acquisition sites to test area (thus test article)
  - Project chose to instrument the test article with a TM transmitter capable of Low Density Parity Check (LDPC) encoding (per RCC Document IRIG-106, Appendix 2-D)
    - Depending on code rate and block size, a 6-9 dB increase in link margin can be achieved
    - Depending on code rate and block size, a significant increase in transmitted bit rate (e.g. 20 Mbps increases to 31.25 Mbps (block size 1024 or 4096, code rate 4/5)
- Higher bit rate and the requirement to decode LDPC and re-encode it for transmission, required new receivers and transmitters be integrated into the RTAS
  - LDPC decoding in the RTAS receivers, enables on board recording at a lower bit rate, and facilitates playback, as LDPC decoding is not readily available except in TM receivers.

LDPC Basics

The LDPC code is a linear block code with options for $\{n,k\}$, where n is the length of the codeblock and k is the length of the information block. An LDPC code can be entirely defined by its parity check matrix, **H**. The k X n generator matrix that is used to encode a linear block code can be derived from the parity check matrix through linear operations.

Code rates, r, chosen for this AMT application are 1/2, 2/3, and 4/5. Information block sizes (k) are 1024 and 4096 bits. Given the code rate and information block sizes, codeword block sizes are calculated using $n = k/r$.

Table D-1. Codeblock Length per Information Block Size

Information Block Length, k	Codeblock Length, n		
	Rate 1/2	Rate 2/3	Rate 4/5
1024	2048	1536	1280
4096	8192	6144	5120

Table D-11. Bandwidth Expansion Factor

Information Block Length, k	Bandwidth Expansion Factor		
	Rate 1/2	Rate 2/3	Rate 4/5
1024	33/16	25/16	21/16
4096	33/16	25/16	21/16

Required RTAS-2000-5 New Capabilities

- Receive Subsystem
  - Expanded IF bandwidth (BW) to accept increased TM BW
  - 40 Mbps capability
  - LDPC decoding of received store's/weapon's TM
- Transmit Subsystem
  - 40 Mbps capability
  - LDPC encoding of received store's/weapon's TM
- Configuration software updated to enable programming of new capabilities

Conclusion

- RTAS-2000-5 is in development at Teletronics Technology Corporation (a Curtiss Wright company)
- Preliminary results in test range simulations predict a 9 dB improvement in link margin, which translates to more than double the previously useable range from the test article to the TM acquisition site, and provides the desired data quality at these ranges
- Although increased spectrum requirements result from employing LDPC encoding, gaining the additional link margin required to close the link, to yield the required data quality, is very valuable capability for the test community