A COMPARISON OF FOUR METHODS OF HIGH BIT RATE DATA RELAY

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Abstract

A number of methods exist for the transmission of digital telemetry data. This paper explores four separate methods of transmitting and receiving high bit rate telemetry data (13 megabit/sec). Since choices may need to be made in terms of performance and cost, these are the areas that are explored in some detail. Costs may also include considerations of existing equipment which can be somewhat intangible. Performance can be limited to transmitted and received signal levels in order to quantify the ability of the equipment to handle received signal levels. Although the results may indicate rather clear cut "winners" in both cost and performance, other factors may provide the deciding influence for the purchase of such a system.

Introduction

Ref.: "NAWCWPNS Point Mugu Analysis of SM-2 PTR 2.0 Telemetry Performance Anomaly, June 7, 1993." As a result of multi-path generated in the Standard Missile Vertical Launch System, VLS, Canister at the Navy Desert Ship, at White Sands Missile Range, a re-radiation system was configured by WSMR, i.e. "RERAD". The system would tap off the canister with "parasitic probe" antennae, demodulate the project TM and re-radiate the TM using different RF frequencies to J56, WSMR tracking and relay station, for pre-launch validation. This system worked well for the 2.4 Mbs. telemeters and has successfully supported several tests. Additionally, the WSMR RERAD actively supports the SEA SPARROW prior to test at the Desert Ship. As the Standard Missile program develops to the Block IV-A version, telemeters with data rates of 13 Mbs. will be used. Due to bandwidth restrictions generated by inter-modulation products of all the RF frequencies being used by the missile, target and RERAD, the concern was to review all available options of data transport from the Desert Ship to J56. This paper will review four suggested methods of data transport and provide a comparison of the tests with emphasis on performance and cost. The four methods reviewed were: 1. Translated RF System, 2. RF Fiber System, 3. Video Fiber System, 4. DS-3 Fiber System. The tests were

performed between the WSMR RERAD and Desert Ship communications room for Transmit and J56 for Receive.

Performance Comparison

Note from the preceding diagrams that each system relied on the same signal generating system. This is also noted as TX POWER at the RERAD van on the results chart that follows. At some point in each system there is a divergence from commonality. In the translated RF system the signal was routed to an horn antenna. In the RF fiber driver system the signal was routed to an RF fiber driver. In both the video fiber driver and the multiplexed fiber driver system the RF signal was delivered to a receiving and conditioning system before being routed to the appropriate fiber driver system. At the point where the data is recovered from the RF carrier and becomes an NRZ-L data stream the performance considerations become mute, as the determining factor in the transport system performance is the RF system performance.

PARAMETER	TRANSLATED RF SYSTEM	RF FIBER SYSTEM	VIDEO FIBER SYSTEM	MUXED SYSTEM
TX POWER	25.33 dBm	25.33 dBm	25.33 dBm	25.33dBm
ATTENUATION	36 dB	54 dB	60 dB	60 dB
ERP	4.9 dBm	-38.67 dBm	-30.37 dBm	-30.37 dBm
BER threshold RX 1 RX2	17.5 dB S.A.N. 18.1 dB S.A.N.	19.13 dB S.A.N 20 dB S.A.N.	15 dB S.A.N. 16 dB S.A.N.	15 dB S.A.N. 15 dB S.A.N.

S.A.N.- Signal above noise floor

It must be kept in mind that certain devices require a minimum level to operate. The robustness of a system would also consider the total dynamic range of a device. For example it would be easy to radiate multiple watts into an antenna thereby boosting the range of this particular system. Just as obviously you could not do this with the RF fiber system as its maximum input level is limited to about +10 dBm. These kinds of considerations were not taken into account in this comparison as the tests for BERT took place on the low end of the power budget.

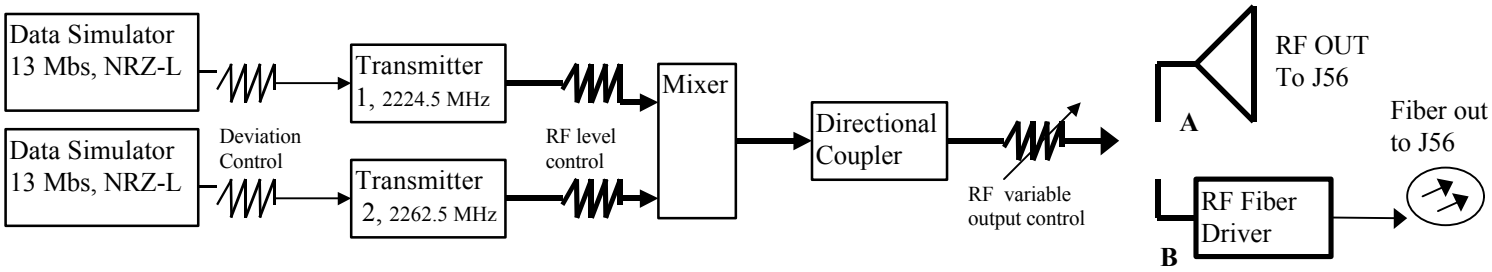

Figure 1: RERAD configuration for **A: Translated RF System Test**, **B: RF Fiber System Test**

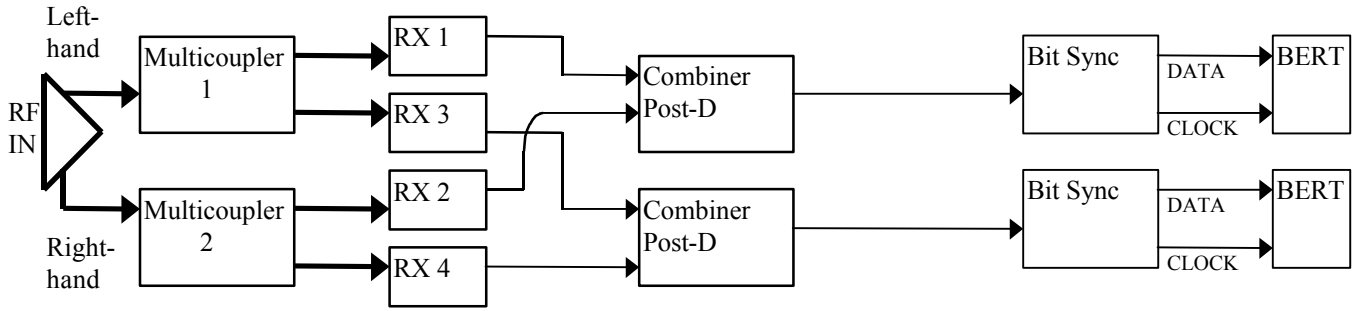

Figure 2: J56 configuration for **A: Translated RF System Test**

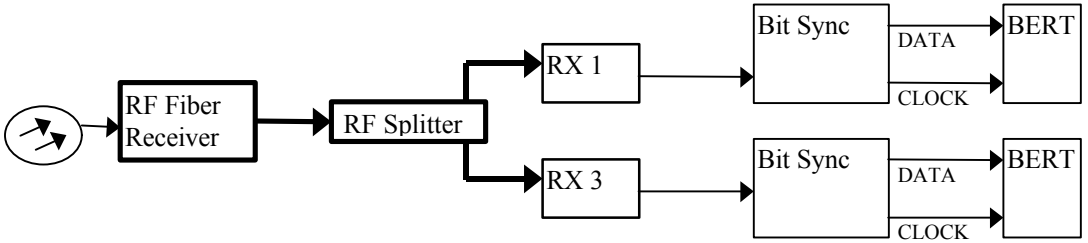

Figure 3: J56 configuration for **B: RF Fiber System Test**

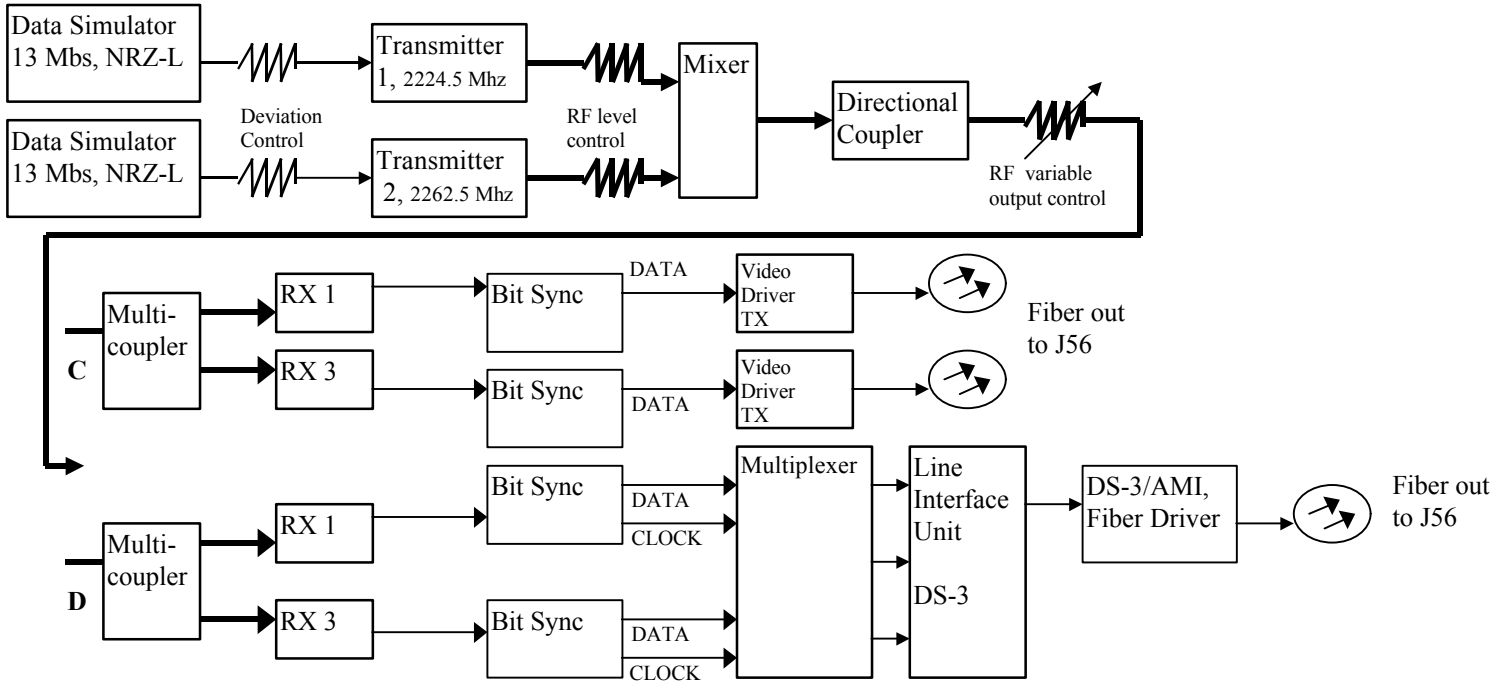

Figure 4: RERAD configuration for **C: Video Fiber System Test**, **D:DS-3 Fiber System Test**

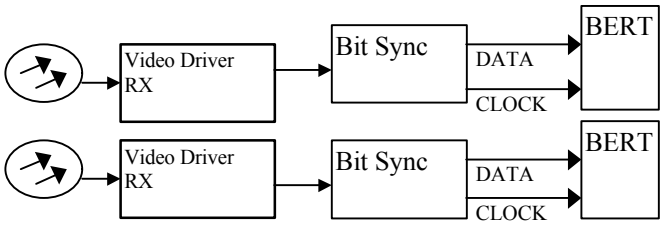

Figure 5: J56 configuration for **C: Video Fiber System Test**

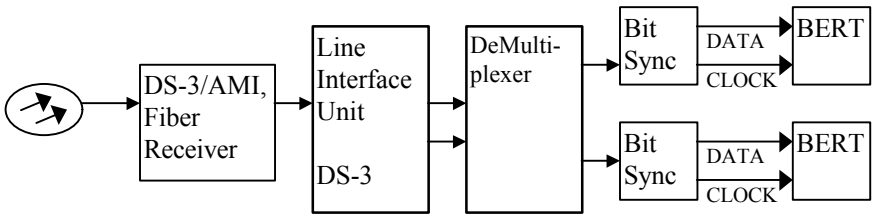

Figure 6: J56 configuration for **D:DS-3 Fiber System Test**

Cost Comparison

Review of costs associated with the selection of a data transport system is an important consideration. The following table was constructed based on the major items that might have to be purchased to implement a particular system. In our test cases most of the equipment was existing somewhere within our telemetry equipment inventory. The method that we used to transmit and receive data over the air can also be performed in a number of different (and less costly) ways using off the shelf microwave systems. The collection of RF and stripping of data is carried out in a "standard method" for White Sands. Because of the constraints for the type of test we are preparing for some of the setups may look overdone or not as $ efficient as they might have been.

RECEIVE SYSTEM

TRANSLATED RF SYSTEM		RF FIBER SYSTEM		VIDEO FIBER SYSTEM		DS-3 FIBER SYSTEM	
ITEM	**COST/EA**	**ITEM**	**COST/EA**	**ITEM**	**COST/EA**	**ITEM**	**COST/EA**
Antenna System	125000.00	Fiber Rx	3500.00	Video Rx (2)	3500.00	Fiber Rx	3500.00
Rcvr (4) TM	50000.00	Rcvr (2) TM	50000.00			LIU	6000.00
Combiner (2)	25000.00					DS-3 DMUX	10000.00
Bit Sync (2)	32000.00	Bit Sync (2)	32000.00	Bit Sync (2)	32000.00	Bit Sync (2)	32000.00

The totals expressed above include the transmitting and receiving system. The dollar amounts are for comparison purposes only and do not include cabling, multicouplers, installation, and other miscellaneous parts. Note that if a more efficient way of transmitting and receiving the translated RF (via multiplexed links) were used, it's costs would be very much in line with the others. This still leaves the RF fiber system as the cost winner. It is unlikely that cost would be the only consideration in selecting such a system.

TRANSMIT SYSTEM

TRANSLATED RF SYSTEM		RF FIBER SYSTEM		VIDEO FIBER SYSTEM		DS-3 FIBER SYSTEM	
ITEM	**COST/EA**	**ITEM**	**COST/EA**	**ITEM**	**COST/EA**	**ITEM**	**COST/EA**
Transmit set (1)	12000.00	RF fiber driver	3500. 00	Video TX (2)	3500.00	DS-3 fiber driver	3500.00
Antenna (1)	1000.00						
Rcvr (2) TM	50000.00			Rcvr (2) TM	50000.00	Rcvr (2) TM	50000.00
Bit sync (2)	32000.00			Bit Sync (2)	32000.00	Bit Sync (2)	32000.00
		Optic Cable	100000.00	Optic Cable	100000.00	Optic Cable	100000.00
						LIU	6000.00
						DS-3 MUX	8000.00
TOTAL	**616000.00**		**271000.00**		**335000.00**		**365000.00**

Conclusion

Each system performed adequately in terms of performance at threshold. Costs varied greatly depending on what pre-existing equipment is available and if fibers exist between the transmitting and receiving source. One major stand-out among the four is that the DS-3 Fiber System allows for expansion to more than two RF sources and the addition of other types of data to be multiplexed to J56 and the WSMR Telemetry Data Center. Additionally, the MUX/DEMUX units may be upgraded to transmit data to and from J56 and the Desert Ship.

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