EMBEDDED MIL-STD 1553 DATA FROM A SYSTEM PERSPECTIVE

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ABSTRACT

The recently delivered Telemetry Data Handling System (TDHS) was designed to support the current and future needs of a multi-purpose realtime range system at White Sands Missile Range. The system provides for data acquisition, processing, and archival of PCM, PAM, and FM data. The addition of support for MIL-STD 1553 data input as presented in the SRAM II data format is currently in process by Loral Data Systems.

The SRAM II format includes MIL-STD 1553 messages embedded in a traditional PCM mutiplex. These embedded 1553 messages must be extracted and processed in addition to standard processing of the PCM data.

This paper discusses a general purpose solution to the handling of embedded 1553 data including:

- Configuring the system components
- Extracting the embedded messages
- Processing the MIL-STD 1553 data
- Testing the system

INTRODUCTION

The Telemetry Data Handling System (TDHS) was designed in a modular fashion to facilitate upgrading the total system to meet new or unique requirements during the TDHS lifetime. The first requirement to put this concept to the test occurred before the first half of the TDHS had been delivered

With the addition of Chapter 8 to IRIG 106-86, real-time processing of 1553 as a telemetry stream became possible. A new program, SRAM II, took advantage of this development when designing the telemetry package for their program. This put a requirement on White Sands Missile Range (WSMR) to develop the capability of real-time 1553 support.

As the design of the modification evolved, the following goals were defined:

- No interruption of mission support
- Minimum of special single purpose hardware
- Dual use of equipment when possible, i.e., through software loading, a module would support either 1553 or standard telemetry data
- Ability to simulate 1553 data to aid software development and checkout
- ModifIcation of both TDHS-A and TDHS-B

Since available funding is never as much as is desired, it was important that these goals be met in order to get the best value for the money. Funding for the 1553 capability was dual sourced. As part of its continuing program of improvement and modernization of support equipment, WSMR funded the TDHS. Since the 1553 requirement was unique to their program, SRAM II provided the funding for TDHS modification.

This paper discusses the modifications implemented to meet the new system requirements.

CONFIGURING THE SYSTEM COMPONENTS

Decommutation Subsystem Modifications

Since the MIL-STD 1553 data is embedded in a standard PCM data link, an Asynchronous Format Synchronizer (AFS) will be added into an existing EMR 8330 Decommutator chassis to extract the 1553 messages, creating a MIL-STD 1553 data stream in addition to the PCM data stream. The AFS card can be inserted directly into the EMR 8330 chassis eliminating the need for additional rack space. The resultant data link may be used for PCM with embedded asynchronous data or MIL-STD 1553 data interchangeably.

Preprocessing Subsystem Modifications

The EMR 8715 Preprocessor will support up to 60 cards housed in up to three chassis. The original WSMR unit includes 27 cards spread across two chassis with ample space for necessary card additions as follows:

A Data Input Module (DIM) is required for each additional 1553 input stream to support actual data entry and clocking into the unit.

A Data Decoder Module (DDM - physically identical to a Distributed Procssing Unit) is required to establish an internal tag used to map the incoming 1553 date

Data Selector Module (DSM) is required to assign the processing path for the incoming data based on the tag assigned in the DDM.

The addition of Distributed Processing Units (DPU) is optional. These units perform the actual data processing functions and are included based on processing and speed criteria. Up to eight of these cards may be included in a configuration and may be defined as a pooled resource for processing or as part of a 1553 data path.

No additional Programmable Output Modules (POM) are required. The seven existing POMs output data to the host computer (into a current value array and logging buffers for data archival), DACs, discretes, and external computers.

The preprocessor card set is mode up of input, data identification/routing, processing, and output cards. The card set to be used, for a given application, is defined via operator interaction with a configuration utility package. This package allows the operator to customize the unit to meet the needs of a particular test by defining the card set and the operational characteristics of the various cards.

EXTRACTING THE EMBEDDED MESSAGES

MIL-STD 1553 Data Overview

The MIL-STD 1553 bus data is carried in a message format which utilizes command, data, status, error, and time words, each of which is identified by a

four bit identifier. A bus controller directs bus traffic by issuing specific commands to remote terminals (codes) or directs the remote terminal to send or receive measured data values. The remote terminals respond by transmitting or receiving the requested data along with status words denoting the results of the communication. Time values are included in the messages to time tag the command words and optionally to identify the response time of the data bus

Data Identification

The telemetry preprocessor supports a variety of hardware configurations and data formats including on EMR 8330 Asynchronous Format Synchronizer input carrying MIL-STD 1553 data.

Each MIL-STD 1553 message is initiated by a command word generated by one of eight bus controllers. The preprocessor evaluates the command word and identifies the message type as either a data transfer message or a ‘mode’ message. The command for a data transfer message contains the following elements:

Remote terminal to send or receive data
Transmit/receive flag denoting whether the remote terminal is to send or receive data Message identifier (also known as subaddress)
Transmission word count

The remainder of the message, specifically, data, status, and time, can be identified based on the interpretation of the command. As each data word occurs in the input stream, it is recognized, tagged, and passed to the data processing unit (DPU) for specialized processing as defined by the user in the parameter data base. The command for a ‘mode’ message contains the to following elements:

Remote terminal to receive the mode code
Transmit/receive flag
Flag indicating that this is a mode message
Specific mode code (ranging from 0 to 31)

The remainder of the message, specifically, an optional data word, status, and time, can be identified based on the interpretation of the command.

PROCESSING THE MIL-STD 1553 DATA

Data Base Interface

The processing of the incoming data by the Telemetry Data Handling System is controlled by entries in a Parameter Data Base. A data base entry is created for each parameter of interest in the incoming data stream(s). Each Parameter Data Base entry contains the information required to identify a measurand, such as multiplex location for PCM data. The elements required to identify a MIL-STD 1553 parameter include bus identifier, remote terminal address, transmit/ receive bit, subaddress, and word number (within the message for data words).

In addition to identifying the parameter, the specific preprocessing to be performed on a given parameter is maintained in the data base. The processing is defined by associating the parameter with processing ‘chains’. A processing chain is created by the user to perform any set of up to 100 algorithms in a user specified sequence. A different chain, tailored to the particular destination, may be assigned for each of the seven output ports provided on TDHS. A typical chain might include:

Compression algorithm(s)	(In/Out of Limits, Bit/No Bit Change, N-Sequential, etc.)
Engineering units conversion	(First Fifth Order Polynomial, Table Look up)
Limit violation detection	(Upper/lower Limit Check)
Data output	(to the assigned destination)

Data Acquisition

The TDHS data acquisition functions include initiating the independent, asynchronous execution of the various realtime processes and turning on the data channels for input into a current value array and logging buffers. The current value array is a global common area which may be accessed by the realtime processes as required.

Realtime Processing

The realtime processes initiated during data acquisition provide for data routing from the host processor to any of six destinations: two line printers, the preprocessor, a video graphics system, and two external computers. In addition, the TDHS offers two forms of quick-look data presentations. An alpha-numeric display presents the current processed value for up to 32 selected

parameters and a second display presents up to six selected parameters on a scrolling strip chart style display.

Post Realtime Processing

The digitized telemetry data archived on disk or magnetic tape may be retrieved and displayed to the user in two different forms. The first is on alpha-numeric format in which the data for up to 32 parameters is presented in a formatted display with a variable update rate. The second is an X - Y graph format which plots selected parameters versus each other or versus time.

TESTING THE SYSTEM

Having created a telemetry system to process, acquire, store and provide quick look presentations of MIL-STD 1553 data, it became necessary to develop a data simulation capability for use in system) testing. The simulation facilities had to be easy to use and offer a realistic representation of the live data formats. The EMR 8336 Data Simulator (four of which ore included in the Telemetry Data Handling System) offers both PCM and PAM signal simulation. The decision was made to add 1553 message structures into the 8336 simulation set with special attention to the combination of PCM with embedded 1553 data.

The existing simulation subsystem provides menu style setup of the basic simulator features via the selections:

(1) General format definition
(2) Unique mainframe word definitions
(3) Unique supercom word definitions
(4) Subcom general format definition
(5) Unique recycle subcom word definitions
(6) Unique recycle supersubcom word definitions
(7) Waveform and function definitions
(8-15) User specified waveform definitions

A new selection titled “1553 message setup” has been added. This selection presents the user with the appropriate meus to create up to 256 different messages for each of eight MIL-STD 1553 busses. Messages are generated and maintained on a bus basis. A given message is defined on a single page by responding to a series of menu prompts.

The initial prompt allows the user to select the Message Format from the eight choices presented:

Receive
Transmit
Mode (Receive)
Mode (Transmit)
Mode (No Data)
Mode (Broadcast)
RT - RT
User Defined

The remaining fields prompt for the elements of the message such as:

Terminal address
Subaddress/Mode
Word count/Code
Microsecond time (to associate with the command word)
fill words preceding response
Response time word
Status word
fill words following message
Data words (1-32)

The user entries are used to construct the basic command, status, time, and data words. The Bus Identifier Definition, Identifier Label Definition, and parity bit, as defined in IRIG 106 Chapter 8, are appended and the message elements are placed in the appropriate sequence based on the specified message type.

When message setup for all busses is complete and the data simulator is loaded, the messages for all of the busses are interleaved and combined into a single data table thus creating a more accurate representation of actual MIL-STD 1553 bus traffic.

The MIL-STD 1553 messages are inserted into the simulated PCM stream by defining selected minor frame words as unique (1553) words As each of the selected words occurs in the simulated data stream, the next entry in the 1553 data table will be placed into the word slot. When the entire table has been

output (asynchronously to the PCM frame), the table pointer is reset and the sequence is repeated.

CONCLUSION

The upgrade to the Telemetry Data Handling System of White Sands Missile Range has succeeded in meeting the primary goal by providing support for embedded MIL-STD 1553 data with minimal system impact. The hardware modifications required in both the Decommutation and Preprocessor Subsystems have been accomplished by adding standard product cards into existing chassis limiting design and cabling costs. The preprocessor configuration utilities have been designed to allow for flexibility and growth and readily accommodated the additional cards and functionality. The MIL-STD 1553 message interpretation approach utilized, allows the data to be identified and taagged in the preprocessor and requires no special handling thereafter. And finally, a simple method for the simulation of embedded 1553 messages compliments the existing calibration and simulation philosophy.