Mission Integrated Decommutation and Analysis System (MIDAS): Extracting Data from Digital Tape Recordings on a PC

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ABSTRACT

This paper presents the Mission Integrated Decommutation and Analysis System (MIDAS), a multi-threaded, multi-processing application developed in Microsoft Visual C++ for Windows NT by the Air Force Development Test Center (AFDTC) Eglin AFB, Florida. The primary function of MIDAS is to support post-test processing of instrumentation data by decommutating, logging, and reporting MIL-STD-1553B or pulse code modulated (PCM) encoded data extracted from MARS-II digital tape recordings. MIDAS processes multiple data streams from a single recording, and can process multiple recordings in parallel. MIDAS also serves as a diagnostics tool for investigating data processing anomalies reported during normal production runs.

MIDAS is part of an integrated suite of applications developed to provide AFDTC development test and operational test customers with quickly delivered, high-quality data products. Software development is underway to support the processing of Digital Data Acquisition and On-Board Recording Standard (DDAS) packetized telemetry data. DDAS is derived from the Consultative Committee for Space Data Systems (CCSDS) standard.

[MARS-II is the digital acquisition and recording system supported by MIDAS. MARS-II was developed by DATATAPE, Incorporated, Pasadena, California. It records up to 20 gigabytes of mission data across as many as eight channels of MIL-STD-1553B or PCM encoded data. Digital recording technology provides an alternative to traditional analog-based telemetry ground systems.]

KEYWORDS

Common Airborne Processing System, Decommutation, MARS-II, Multichannel Telemetry Processing, MIL-STD-1553B, Pulse Code Modulated Encoded Data, CCSDS, DDAS.

INTRODUCTION

MIDAS decommutates, logs, and reports MIL-STD-1553B or pulse code modulated (PCM) encoded data extracted from digital tape recordings. MIDAS also facilitates the analysis of the blocking structure and resident data of these recordings. Thus, MIDAS is targeted for two primary groups of users: data reduction technicians and analysts/engineers. Little knowledge of Windows-based computing is assumed or necessary. User tasks within MIDAS are divided into *Project Setup* and *Project Execution* activities.

Project Setup is the activity of characterizing the resident data and prescribing processing activities against it for a set of project-related digital recordings. Stream specifications for both 1553 and PCM data can be created and loaded against one or more of the eight channels of the project. This task might be performed by a telemetry engineer. The recordings of individual missions can then be processed against the project by data technicians, who indicate which channels to process, the times of interest, and any special processing requirements. Project Setup information is presented hierarchically and manipulated graphically via point and click operations. For simplicity, data reduction tasks are separated from more advanced user tasks.

Project Execution is the activity of reading and processing a recording while optionally monitoring the diagnostic information sent to the screen. Several functions are provided during execution, giving the user interactive control of the speed and manner with which he or she progresses through the recording. The user may also define the times of interest on-the-fly. The modes of execution, *Batch Mode*, *Production Mode* and *Analysis Mode*, offer varying degrees of insight and control into the data reduction process. Batch Mode enables the user to process recordings in the background while continuing to interact with the application. Production Mode provides only basic status information in order to emphasize speed. Analysis Mode is presented to the user as a property sheet containing data views at the SuperBlock, SubBlock, PCM frame, and 1553 Message level.

DECOMMUTATION CAPABILITIES

MIDAS decommutates selected streams of data and outputs each to a separate Digital Data Standard (DDS) file for follow-on processing within the Common Airborne

Processing System (CAPS) or some like application. MIDAS is a multi-threaded application, using an architecture that leverages dual-processor machines by performing the decommutation of two or more recordings in parallel.

Each channel of 1553 data intended for output is affiliated with a 1553 Setup file. As shown in Figure 1, a 1553 Setup file lists the only commands the user wishes to use in analyzing and converting to the DDS format. When listing a command, the user may specify the command as individual bits, hex digits, or subfield values. Immediate feedback is generated as the user's validated input is quickly filtered throughout the entire dialog. Sampling rates are available to associate with the constructed command.

A PCM Setup file is used to characterize a stream of PCM data. Each channel of PCM data intended for output must be affiliated with a PCM Setup file. PCM setup is realized via a set of tabbed dialogs (Figure 2), where the user specifies the Sync Pattern, Sync Mask, Pattern Length, and Subframe Identifier.

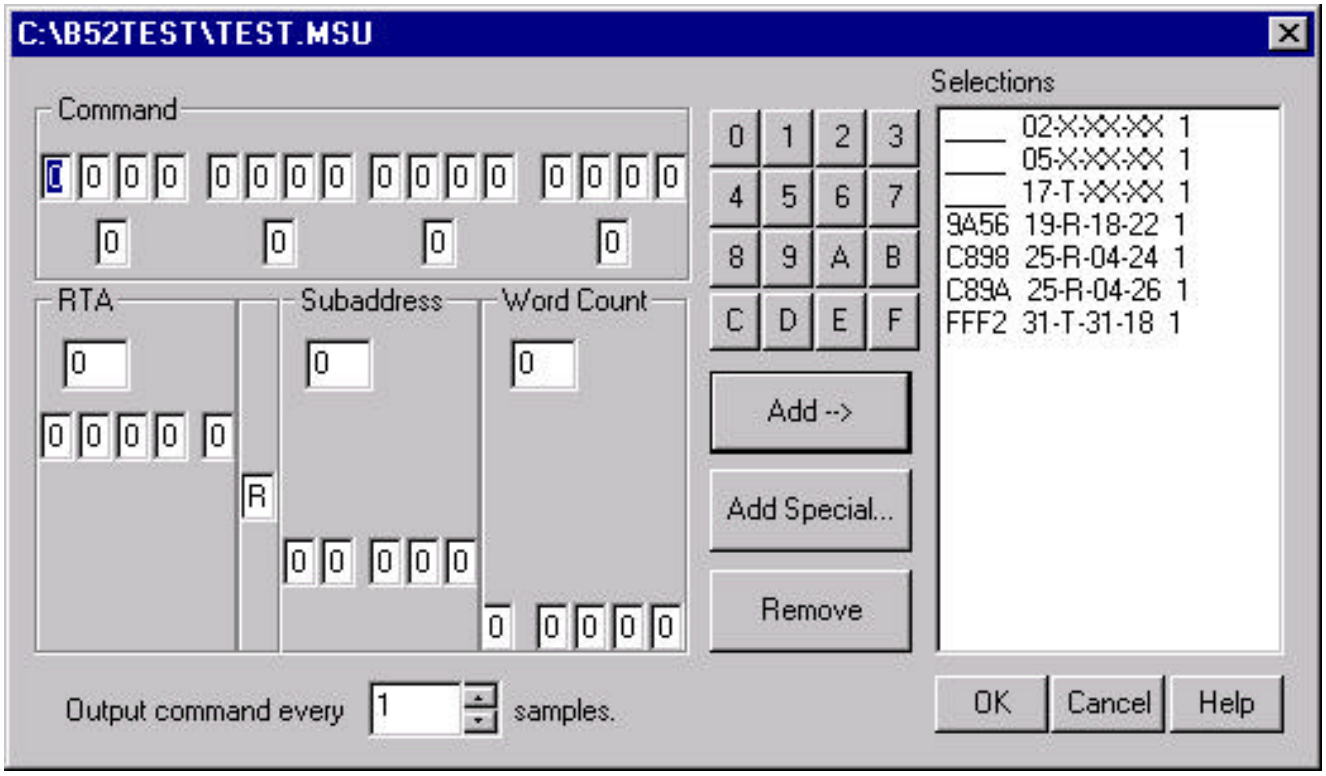


Figure 1 - 1553 Setup

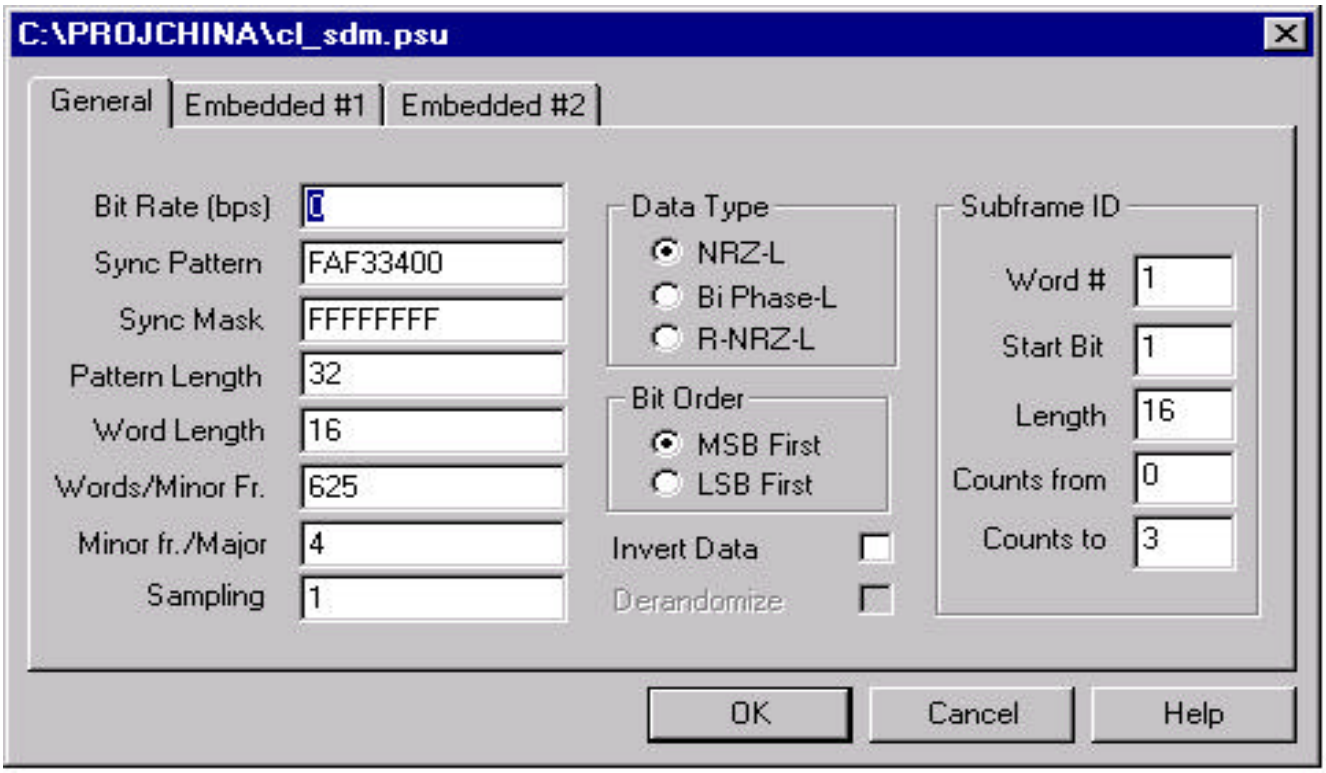


Figure 2 - PCM Channel Setup

Several options allow the user to tailor the decommutation process. For example, 1553 errors can be omitted from output. For rapid production, the streamlined Production Mode can be chosen.

The Executive Toolbar (Figure 4) provides buttons for all of the menu functions available during execution. From left to right, the functions are as follows: *Do Batch*, *Do Production*, *Do Analysis*, *Go*, *Step (to Next SuperBlock)*, *Pause*, *Step to Next Transfer*, *Go to Transfer*, *Skip Transfers*, *Go to Next Pass*, *Turn Output On*, *Turn Output Off*, *New Pass*, *Stop*. A Transfer is the unit of data transferred from the recording to the PC during a single read. It normally contains 63 SuperBlocks, each of which reserves a SubBlock for each active channel. Most tapes are processed by the continuously processing *Go* function in considerably less time than the actual time recorded on the tape. The *Skip Transfers* function provides extremely rapid access to any portion of the recording.

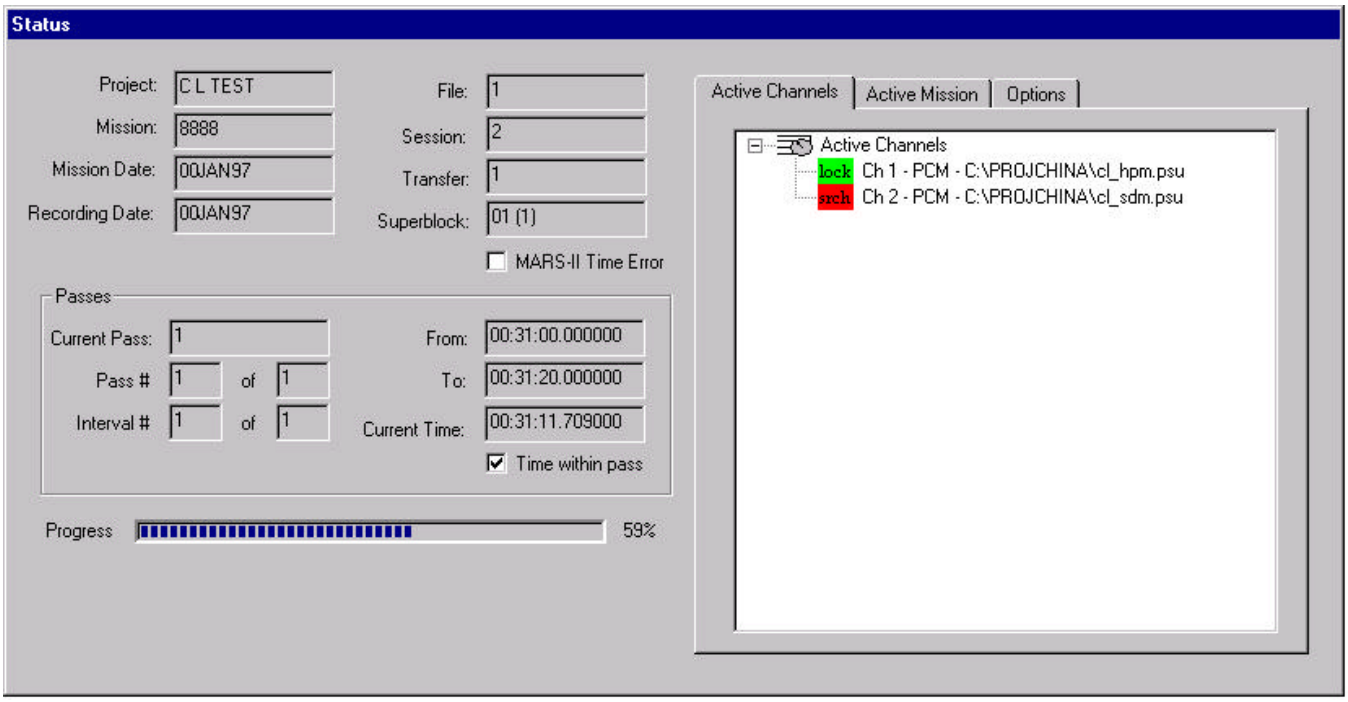


Figure 3 - Production Mode

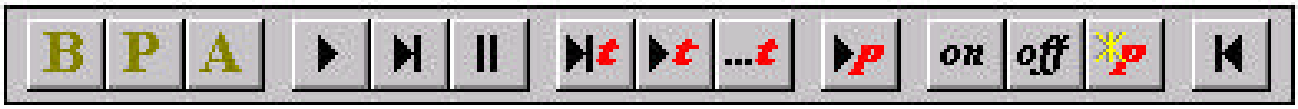


Figure 4 - Executive Toolbar

ANALYSIS CAPABILITIES

As stated above, the second capability of MIDAS is to serve as an instrumentation data troubleshooting tool for telemetry analysts and engineers. MIDAS provides information concerning the digital data format, as well as detailed stream-specific information for both 1553 and PCM. The Analysis Mode property sheet provides many different views of the data for each channel selected for output; the user may rapidly move among these various views and channels.

The SuperBlock Page (Figure 5) gives a complete analysis of the current SuperBlock. Header information is decoded and reported. A description of the time SubBlock and subblocking scheme for stream data is also included. Any channels of data identified for output are flagged by a checked box under *O/P*. The primary feature of the SuperBlock page, however, is a color-coded hexadecimal dump, from left to right, of all the data in the SuperBlock. Header data is shown with a grey background, time code and voice data are displayed in red, and subblock data alternates in blue and green.

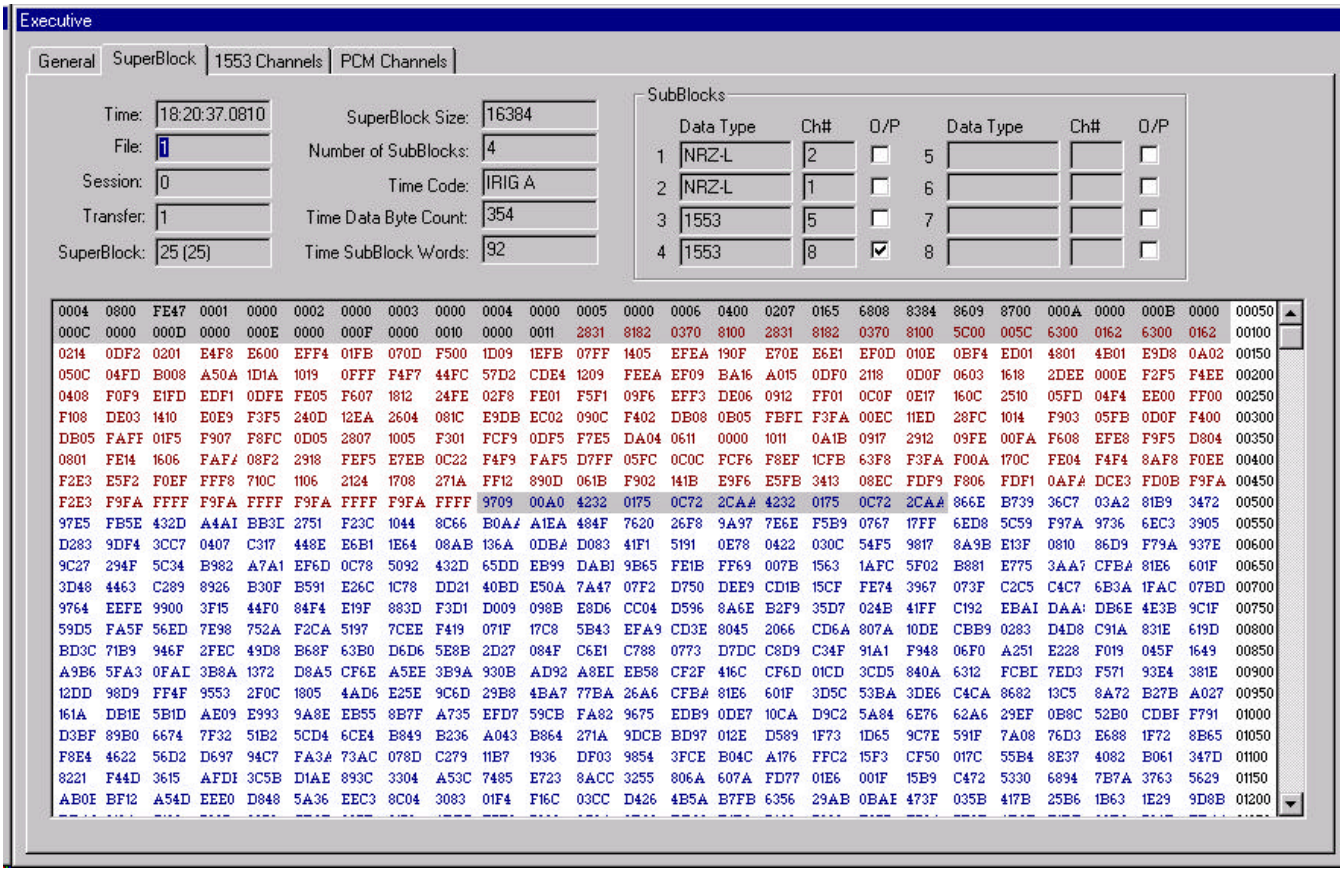


Figure 5 - SuperBlock Page

The SubBlock header is decoded and displayed in the SubBlock page (Figure 6), demonstrating typical values for the SubBlock number, the Data Type, and the various word and bit counts describing the SubBlock boundaries. Like the SuperBlock page, the SubBlock page provides a hexadecimal dump of all data in the current SubBlock. The data is presented in 20-bit words, the first 4 bits of which is the Identity Code, identifying the type of data that follows in the next 16 bits. Words are color coded based on the Identity Code: Channel A is shown in blue, Channel B in green, and Null data in gray. A popup dialog describes the selected 20-bit word.

The RTA Summary page in Figure 7 is a complete breakdown, summarized by remote terminal address, of message activity in the selected channel during times of interest. The *Toggle* button toggles between displaying RTAs 0-15 and 16-31. The *Tolerance* field determines the error level required to flag the checkboxes. In this example, it is clear that for RTA 26, the number of RT-RT messages with invalid responses exceeded 0.001% of the RTA's total message traffic.

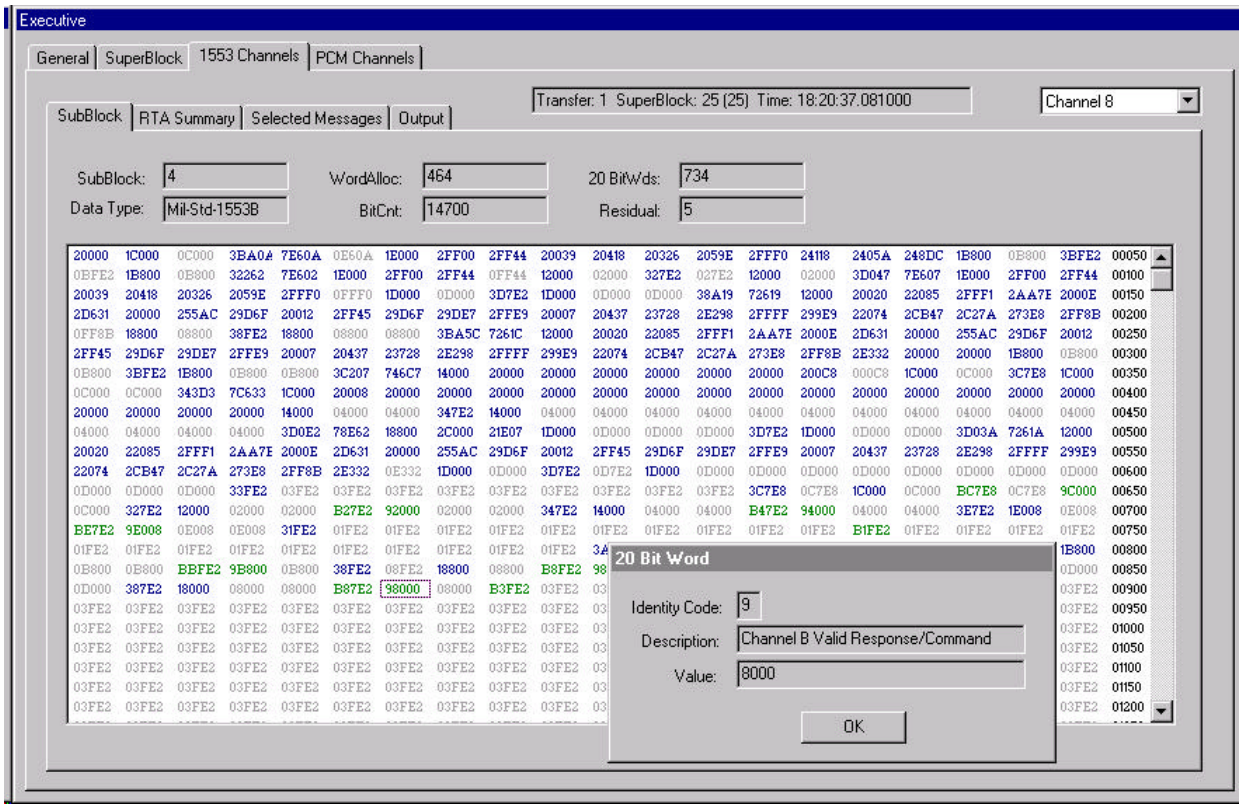


Figure 6 - SubBlock Page

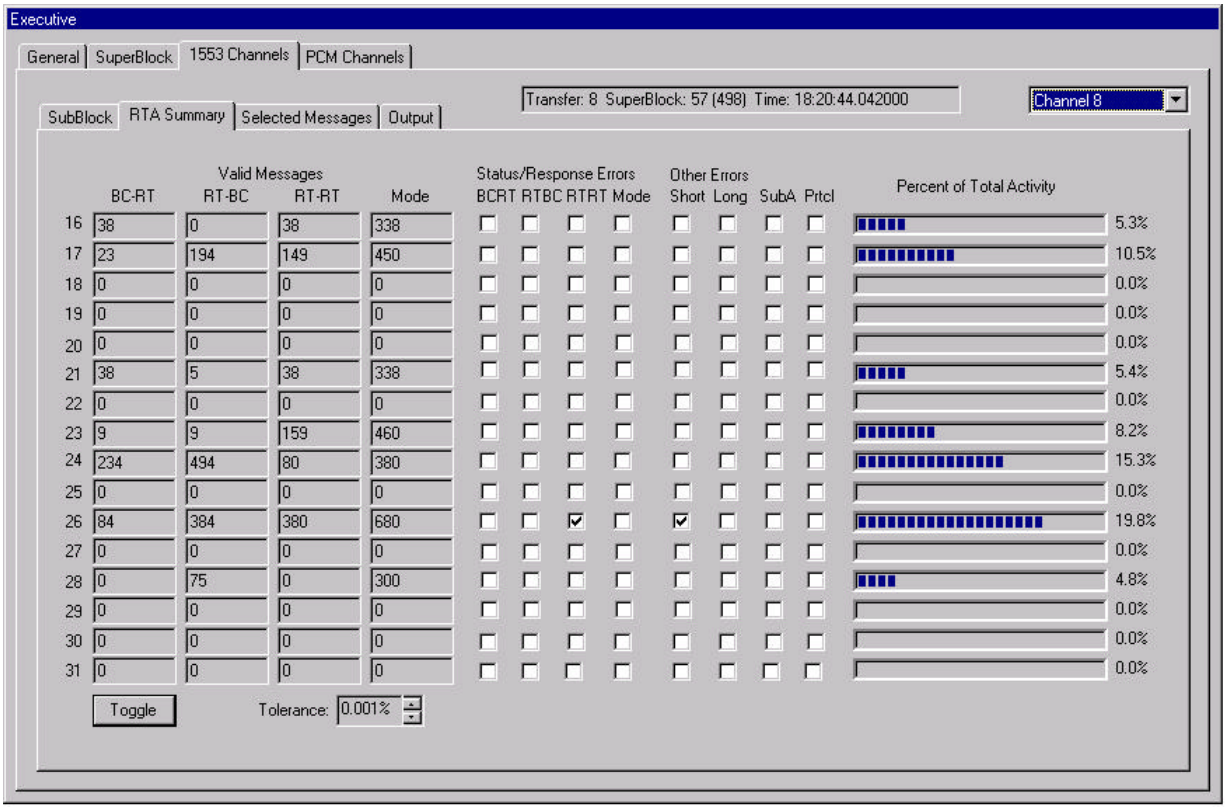
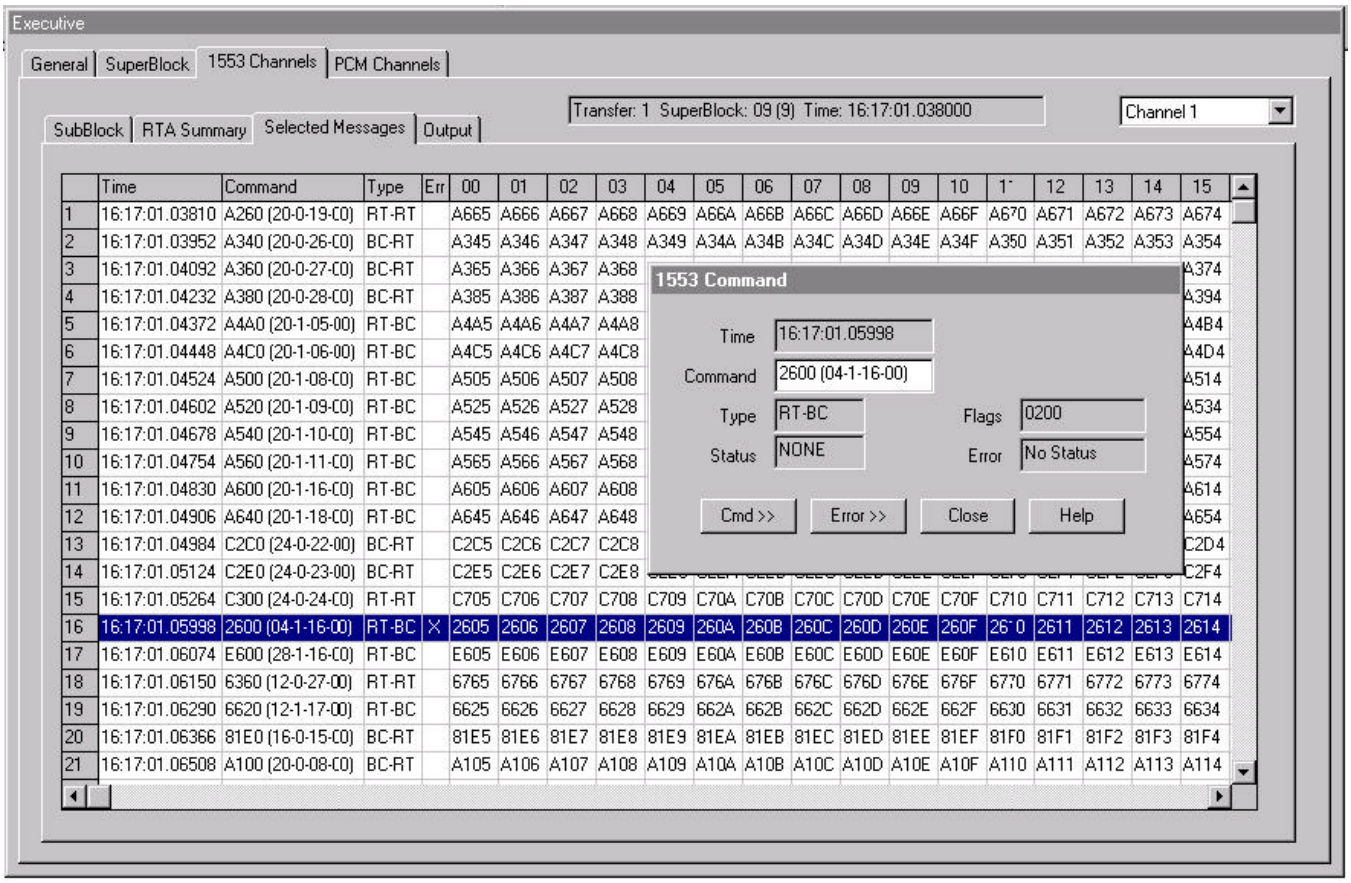


Figure 7 - RTA Summary

The Selected Messages page, displayed in Figure 8, lists selected 1553 messages in the current SubBlock of the selected channel. Messages are listed if they are included in the channel's setup file, regardless of the current time. As shown in the figure, the user may search for the next occurrence of an error or a particular command. Similarly, values of particular data words may also be monitored in a popup dialog.



	Time	Command	Type	Err	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
1	16:17:01.03810	A260 (20-0-19-C0)	RT-RT		A665	A666	A667	A668	A669	A66A	A66B	A66C	A66D	A66E	A66F	A670	A671	A672	A673	A674
2	16:17:01.03952	A340 (20-0-26-C0)	BC-RT		A345	A346	A347	A348	A349	A34A	A34B	A34C	A34D	A34E	A34F	A350	A351	A352	A353	A354
3	16:17:01.04092	A360 (20-0-27-C0)	BC-RT		A365	A366	A367	A368												A374
4	16:17:01.04232	A380 (20-0-28-C0)	BC-RT		A385	A386	A387	A388												A394
5	16:17:01.04372	A4A0 (20-1-05-00)	RT-BC		A4A5	A4A6	A4A7	A4A8												A4B4
6	16:17:01.04448	A4C0 (20-1-06-00)	RT-BC		A4C5	A4C6	A4C7	A4C8												A4D4
7	16:17:01.04524	A500 (20-1-08-C0)	RT-BC		A505	A506	A507	A508												A514
8	16:17:01.04602	A520 (20-1-09-C0)	RT-BC		A525	A526	A527	A528												A534
9	16:17:01.04678	A540 (20-1-10-C0)	RT-BC		A545	A546	A547	A548												A554
10	16:17:01.04754	A560 (20-1-11-C0)	RT-BC		A565	A566	A567	A568												A574
11	16:17:01.04830	A600 (20-1-16-C0)	RT-BC		A605	A606	A607	A608												A614
12	16:17:01.04906	A640 (20-1-18-C0)	RT-BC		A645	A646	A647	A648												A654
13	16:17:01.04984	C2C0 (24-0-22-00)	BC-RT		C2C5	C2C6	C2C7	C2C8												C2D4
14	16:17:01.05124	C2E0 (24-0-23-00)	BC-RT		C2E5	C2E6	C2E7	C2E8												C2F4
15	16:17:01.05264	C300 (24-0-24-C0)	RT-RT		C705	C706	C707	C708	C709	C70A	C70B	C70C	C70D	C70E	C70F	C710	C711	C712	C713	C714
16	16:17:01.05998	2600 (04-1-16-00)	RT-BC	X	2605	2606	2607	2608	2609	260A	260B	260C	260D	260E	260F	2610	2611	2612	2613	2614
17	16:17:01.06074	E600 (28-1-16-C0)	RT-BC		E605	E606	E607	E608	E609	E60A	E60B	E60C	E60D	E60E	E60F	E610	E611	E612	E613	E614
18	16:17:01.06150	6360 (12-0-27-00)	RT-RT		6765	6766	6767	6768	6769	676A	676B	676C	676D	676E	676F	6770	6771	6772	6773	6774
19	16:17:01.06290	6620 (12-1-17-00)	RT-BC		6625	6626	6627	6628	6629	662A	662B	662C	662D	662E	662F	6630	6631	6632	6633	6634
20	16:17:01.06366	81E0 (16-0-15-C0)	BC-RT		81E5	81E6	81E7	81E8	81E9	81EA	81EB	81EC	81ED	81EE	81EF	81F0	81F1	81F2	81F3	81F4
21	16:17:01.06508	A100 (20-0-08-C0)	BC-RT		A105	A106	A107	A108	A109	A10A	A10B	A10C	A10D	A10E	A10F	A110	A111	A112	A113	A114

Figure 8 - Selected Messages

The PCM Channels analysis page, shown in Figure 9, displays the subframe identifier (SFID), minor time frame, and data words of the minor frames of the most recent subblock of the selected data stream. The user may select for analysis any PCM channel designated for output, and may also select the range of words to be displayed. As with the 1553 Selected Messages page, the user may monitor the values of a particular data word within the frame; the PCM Watch dialog records a value of the selected data word for each occurrence of the corresponding subframe.

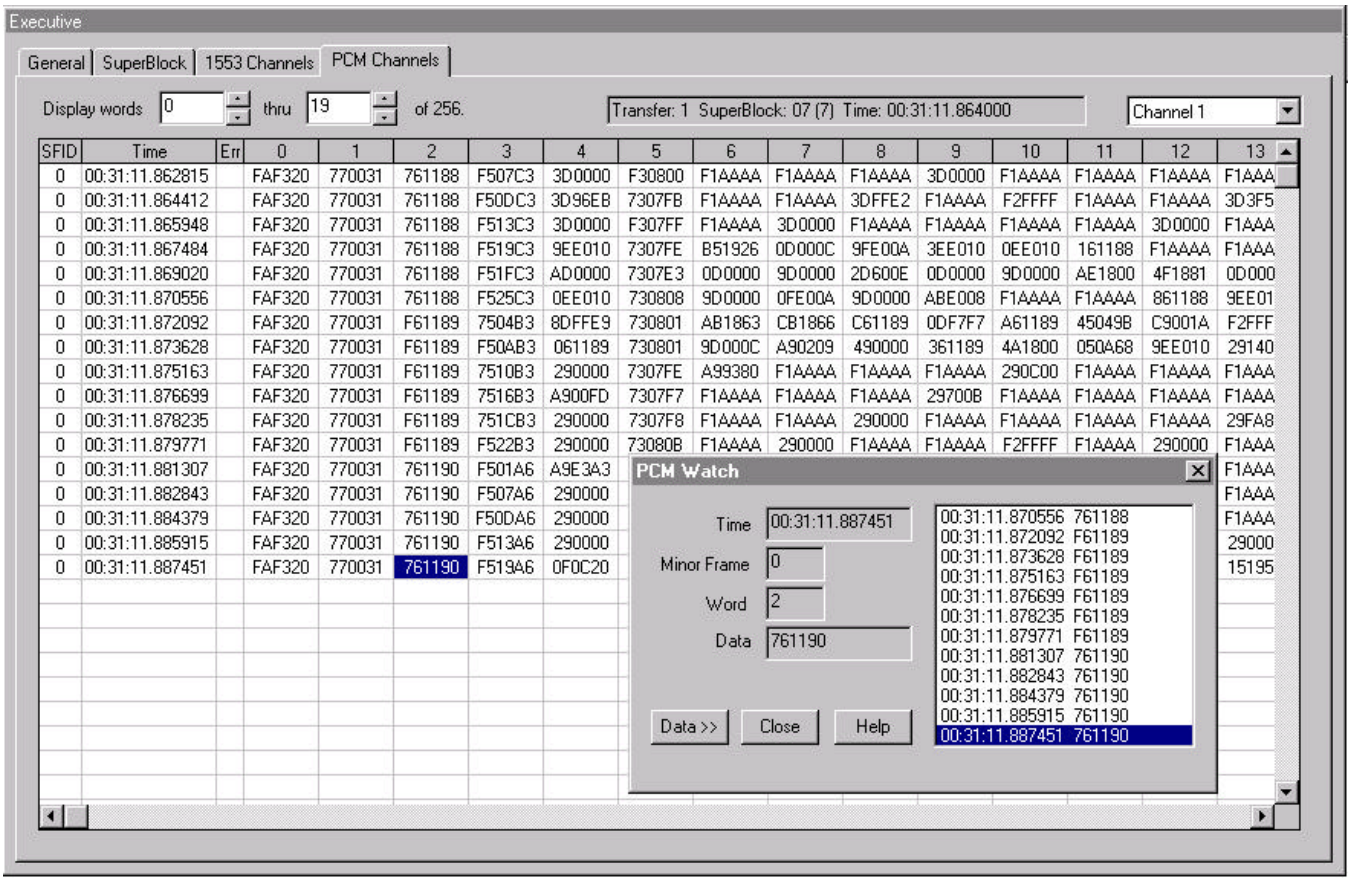


Figure 9 - PCM Analysis

REPORTING CAPABILITIES

During Production and Analysis Modes, MIDAS produces a DDS file for each selected channel of data. DDS files are directly transferable to the Common Airborne Processing System (CAPS), which provides a popular engineering unit conversion solution for varied customers and numerous data types. Simply put, the DDS file is the mechanism that links MIDAS to the processing power of pre-existing software, and helps to eliminate the need for expensive duplication of effort.

Various summary reports are also generated. Remote terminal address activity is summarized for 1553 channels, along with summaries for messages of interest, whereas synchronization errors are reported for PCM channels. Time Edits are reported for the detection of time backups and jumps.

CONCLUSION

MIDAS demonstrates the power and ease with which personal computers and workstations, when properly instrumented, can perform initial reduction of digitally recorded data. In concert with CAPS, MIDAS provides a robust system for data preparation and analysis on a single PC. To guarantee the widespread usefulness of MIDAS in future years, our development team plans to incorporate new and emerging digital recording formats into the application.