AUTOMATED DATA MANAGEMENT IN A HIGH-VOLUME TELEMETRY DATA PROCESSING ENVIRONMENT

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ABSTRACT

The vast amount of data telemetered from space probe experiments requires careful management and tracking from initial receipt through acquisition, archiving, and distribution. This paper presents the automated system used at the Phillips Laboratory, Geophysics Directorate, for tracking telemetry data from its receipt at the facility to its distribution on various media to the research community. Features of the system include computerized databases, automated generation of media labels, automated generation of reports, and automated archiving.

INTRODUCTION

The Geophysics Directorate of the Phillips Laboratory is a world leader in scientific research of the earth in its solar-terrestrial environment. The Directorate has a telemetry data processing laboratory dedicated to supporting geophysics research projects. The laboratory performs the tasks required to convert science data, collected on satellite, rocket, balloon, and space shuttle flights, into computer-compatible formats for easy input into analysis systems. Over thirty years of raw telemetry data is still maintained at the facility, because it is commonplace for Directorate researchers to re-process raw data to verify analysis findings, explain anomalies, or gather inputs for the design of next generation experiment sensors. Until recently, the only information available to the laboratory for recreating processing methods was contained on hand-written records. Significant advances in scientific instruments leading to higher volumes of raw data have challenged the laboratory to develop an automated data management system.

OVERVIEW OF AUTOMATED SYSTEM

The automated data management system contains an Analog Tape Database, Work Request Database, and Archive Database. The Analog Tape Database contains the owner, content, and format information about each analog tape. Each analog tape or tape set is assigned a unique ID. The Work Request Database documents requests to digitize analog data, generate strip charts, and duplicate analog tapes. The Work Request Database software assigns a unique ID to each Work Request. Each Work Request ID references a corresponding Analog Tape ID. The Archive Database contains a list of archived data files and their corresponding Analog Tape IDs and Work Request IDs.

The Analog Tape ID, Work Request ID, and Archive Media ID provide an efficient means of tracking the raw telemetry data from its receipt at the telemetry data processing laboratory, to its acquisition to digital media, distribution to researchers, and archive. These IDs are automatically printed on all media labels and all reports generated throughout the process.

REGISTERING AND LABELING ANALOG TAPES

As analog tapes arrive at the facility, an operator enters content and format information (such as program name, vehicle identification, point of contact, track content and format, and timing) into the Analog Tape Database through a series of menus. The Analog Tape Database software automatically assigns an Analog Tape ID in the form “Ayyxxx”, where “A” is for analog tape, “yy” is the year, and “xxx” is a consecutive number. An analog tape entry in the database may contain multiple volumes. Multiple volumes share the same general information but have unique beginning times, ending times, and volume descriptions.

The database software produces three hardcopy outputs to track the analog tapes: Analog Tape Labels, Analog Tape Reports, and Analog Tape Database Summaries. Each Analog Tape Label is a pre-printed, self-adhesive form perforated into three sections: one for the tape reel, one for the front of the tape carton, and one for the spine of the tape carton. Separate labels are printed for each volume in a tape set. The Analog Tape Report contains all of the database information and is printed on three-hole standard-size paper for storage in a three-ring binder. An operator may print an Analog Tape Database Summary listing all analog tapes in the database. This summary is placed at the beginning of the Analog Tape Database Binder as an index.

The Analog Tape Database also provides query functions to allow the operator to search for specific tapes by year, month, or project. Figure 1 presents a sample Analog Tape

Label, Figure 2 presents a sample Analog Tape Report, and Figure 3 presents a sample Analog Tape Database Summary.

REGISTERING AND PRINTING WORK REQUESTS

The laboratory tracks all requests for processing analog tapes through the Work Request Database. Work Requests are of three types: Digitize, Strip Chart, and Tape Duplication. Each Work Request references an Analog Tape ID, which is used to access the tape track assignment, format, and timing information. The Work Request Database software automatically assigns a Work Request ID in the form "Wyyxxx", where "W" is for Work Request, "yy" is the year of the request, and "xxx" is a consecutive number. The Work Request Database software prints a preliminary Work Request on three-hole paper for the Work Request Binder. Operators use the preliminary Work Request Report as a worksheet. This worksheet has sufficient space for the operator to record specific processing information as the Work Request is accomplished. Upon completion of the processing, an operator completes the worksheet, updates the database, and prints the final Work Request Report. Figure 5 presents a sample Work Request Report.

An operator may print a Work Request Database Summary listing all the Work Requests in the database. This summary is placed in the front of the Work Request Binder as an index. The Work Request Database also provides query functions, which allow the operator to search for Work Requests by year, month, Work Request type, data type (PCM, FM, or PAM), or Analog Tape ID. Figure 4 presents a sample Work Request Database Summary.

DIGITIZING RAW TELEMETRY DATA

Raw telemetry data is first decommutated and acquired to disk, then checked for anomalies and written to the output media. The data acquisition software prompts the operator for the Analog Tape ID and the Work Request ID. The operator uses the track assignment and format information contained in the Analog Tape Database to configure and setup the telemetry decommutation hardware. To allow the operator to correlate the digitized data file with the analog tape and reconstruct the hardware setup used to acquire the data, the Analog Tape ID, the Work Request ID, and the hardware setup parameters are stored in the header record of the disk file. The data acquisition software compiles statistics such as frames processed and dropouts detected. These statistics are written to the last record of the acquisition data file and printed on three-hole paper to accompany the Work Request Report.

CHECKING THE DIGITIZED DATA FOR ANOMALIES

The Quality Check software checks the digitized data for frame, subframe, and time anomalies. The Quality Check software reads the Analog Tape ID, the Work Request ID, and the telemetry format information from the header record of the acquisition file. The parameters which control the quality check process are derived directly from the telemetry format information. All anomalies are reported; in addition, illegal-length frames resulting from data dropouts are discarded and illegal IRIG times are corrected. The quality-checked data is written to disk or tape.

The Quality Check software rewrites information from the header record of the acquisition file to the header record of the quality-checked data file, along with the setup parameters for the Quality Check process. The software writes the Quality Check statistics to the last record of the quality-checked data file and prints the statistics on three-hole paper to accompany the Work Request Report and the Acquisition Report in the Work Request Binder. The laboratory provides the Quality Check statistics to the end-user. Figure 6 presents a sample Quality Check Report.

If the quality-checked data is written to tape, a Digital Tape Label is automatically printed for each volume produced. Figure 7 presents a sample Digital Tape Label.

ARCHIVING THE DIGITIZED DATA

The telemetry data processing laboratory archives all of the quality-checked data to 5-Gigabyte 8mm cassettes. Data from multiple analog tapes can be archived on one cassette. Once the telemetry data is archived the costly analog tapes are recycled. The Archive software allows an operator to write or restore quality checked data files to or from the 8mm cassettes and to search the Archive Database for specific Analog Tapes or Work Requests. It operates in a batch mode so it can be performed during off-hours. The Archive software automatically assigns an Archive Media ID in the form “Ryyxxx”, where “R” is for archive, “yy” is the year of the request, and “xxx” is a consecutive number. It obtains the name of the digitized datafiles and the corresponding Analog Tape and Work Request IDs and automatically prints an Archive Report on three-hole paper for storage in the Archive Binder. The Archive software also prints a label for the archive media similar to the Digital Tape Label. Figure 8 presents a sample Archive Report.

An operator may print an Archive Database Summary of archive media. This summary is placed in the front of the Archive Binder as an index. An operator may also query the Archive Database for specific Analog Tapes or Work Requests. Figure 9 presents a sample Archive Database Summary.

SUMMARY

The Analog Tape ID, Work Request ID, and Archive Media ID are used to track telemetry data through the process of registering analog tapes, registering work requests, acquiring raw telemetry data, quality checking the acquired data, and archiving the acquired data. During the process, the analog tape is correctly and legibly labeled and can be easily located using the index in the Analog Tape Database Binder or the query function of the Analog Tape Database Software. At the end of the process, the Work Request Database Binder contains a corresponding Work Request Report, a Data Acquisition Report, and a Quality Check Report. Together, these reports provide the operator with a legible hardcopy record of the entire acquisition process. An operator can locate a Work Request by using the index in the Work Request Binder or the query function in the Work Request Database. The digital media produced during the process is also correctly and legibly labeled and can be traced back to the analog tape through the Analog Tape ID or the Work Request ID on the Digital Tape Label. An operator can locate an archived data file by using the index in the Archive Binder or the query function in the Archive Database.

CONCLUSION

The automated data management system at the Geophysics Directorate provides the traceability that is essential to processing high volumes of science telemetry data. As a result, researchers can depend on ready access to a complete and accurate library of data to support scientific analysis and investigation.

TDPS TELEMETRY TAPE	TAPE ID: A92001	VOLUME: 01 OF 01	DATE RECORDED: 01-JAN-92
CUSTOMER TAPE ID: IOS5432.2-92-004	PROJECT NAME: STARION	TEST/VEHICLE NUMBER: STARION322	LAUNCH DATE: 05-NOV-91
STATION: SW AUST	PROJECT NUMBER: P182-4	TEST RANGE: MCGREGOR	LAUNCH TIME: 07:00:00

TRACK	FM	DIR	CONTENT	TRACK	FM	DIR	CONTENT
1		X	Mixer	8			
2		X	B/S #2, 256 kbps,BPM	9			
3		X	1.7 MHz Demod Out	10			
4		X	Servo Reference	11			
5	X		1.024 MHz Demod Out	12			
6	X		B/S #3, 16 Kbps, BPL	13			
7		X	IRIG-B Code 123	14			

MUX INFORMATION			TIMING INFORMATION			TAPE SPEED	POINT OF CONTACT
TRACK	VCO	DATA	TIME CODE	TRACK	VCO	30	
1	CH 13	GRARE AGC	IRIG-B	7		NUMBER OF TRACKS: 07	NAME: John Smith
1	CH 17	IH voice				BEGIN IRIG TIME: 001 08:30:00	OFFICE: PL/GPD Hanscom AFB
1	CH 18	IRIG-B, 123				END IRIG TIME: 001 10:15:00	TELEPHONE: (617) 377-3711

FM CENTER FREQ. (KHZ)	IRIG BAND	ORIGINAL TAPE (Y/N)	REWOUND (Y/N)	REMARKS
70000	WB II	Y	Y	Fifth day post-radiation experiments

TDPS TELEMETRY TAPE	DATE RECORDED: 01-JAN-92
TAPE ID: A92001	VOLUME: 01 OF 01
PROJECT NAME: STARION	TEST/VEHICLE NUMBER: STARION322

TRACK	FM	DIR	CONTENT	TRACK	FM	DIR	CONTENT
1		X	Mixer	8			
2		X	B/S #2, 256 kbps,BPM	9			
3		X	1.7 MHz Demod Out	10			
4		X	Servo Refe rence	11			
5	X		1.024 MHz Demod Out	12			
6	X		B/S #3, 16 Kbps, BPL	13			
7		X	IRIG-B Code 123	14			

TDPS TELEMETRY TAPE
TAPE ID: A92001
VOLUME: 01 OF 01
DATE RECORDED: 01-JAN-92
PROJECT NAME: STARION
TEST/VEHICLE NO.: STARION322

Figure 1 - Sample Analog Tape Label

ANALOG TAPE REPORT

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Customer ID:	IOS5432.2-92-004	Project Name:	STARION
Test Vehicle No.:	STARION322	Project No.:	P182-4
Test Range:	MCGREGOR	Station:	SW AUST
Date Recorded:	01-JAN-92	No. of Tracks:	07
Original or Copy:	ORIGINAL	Rewound:	YES
Tape Speed:	30	Launch Date:	05-NOV-91
Contact Name:	JOHN SMITH	Launch Time:	07:00:00
Contact Office:	PL/GPD		
Contact Phone:	123-456-7890		

Track Information

Track	Assignment	Mode
1	Station MUX	D
2	Bit Sync #2, 256KBps, BI0-L	D
3	1.7 MHz Demod Out	D
4	Servo Reference	D
5	1.024 MHz Demod Out	F
6	Bit Sync #3, 16 KBps, NRZ-L	D
7	IRIG-B Time Code	D

Timing Information

Track	Time Code	VCO
7	IRIG-B	CH17

Station MUX Information

Track	Assignment	VCO
1	Receiver #1 AGC	CH13
1	Voice	CH14
1	IRIG-B Time Code	CH18

FM Center Frequency	70KHz
IRIG Band (L=Low, I=INT, 1-WBI, 2=WBII)	2

PCM Information Track #2

Input Code:	BI0-L	Words per Minor Frame (w/o Sync):	253
Input Polarity:	Inverted	Bits per Frame (w/Sync):	2048
Data Stream Alignment:	MSB First	Frame Sync Pattern Length:	24
Bit Rate (bits per second):	2.56 E5	Frame Sync Pattern Base:	Hex
Bits per Word:	8	Frame Sync Pattern Value:	FAF320

Figure 2. Sample Analog Tape Report

ANALOG TAPE DATABASE SUMMARY

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For Month, Year: JAN, 92 Project Name: ALL

Tape ID	Volumes	Project Name	Date Recorded
A92001	02	STARION	01-JAN-92
A92002	01	BLUEBIRD	03-JAN-92
A92003	01	MASTEDON	17-JAN-92
A92004	01	IBX3	10-JAN-92

Figure 3 - Sample Analog Tape Database Summary

WORK REQUEST DATABASE SUMMARY

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Year: 92 Request Type:ALL Data Type:ALL Analog Tape ID:ALL

Work Req. ID	Data Type	Request Type	Analog Type ID	Description	Complete
W92001	PCM	D	A92001	STARION Pre-rad exp	Y
W92002	FM	S	A92001	STARION SOH	N
W92003	PCM	D	A92002	BLUEBIRD window	N
W02004	PCM	D	A92004	IBX3 pre-launch	N

Figure 4 - Sample Work Request Database Summary

WORK REQUEST REPORT

30-MAR-1992 Request ID: W92001 Page 1 of 1

Request Type:	D
Data Type:	PCM
Analog Tape ID:	A92001
Description:	STARION Pre-rad exp
Comments:	Requested product is 6250 BPI, 9-track. Expect noisy time code and data From 08:30 to 08:45
Requestor Name:	John Smith
Requestor Office:	PL/ABC
Requestor Telephone:	123-456-7890
Received Date:	14-FEB-92
Received By:	John Doe
Completed:	Y
Completed By:	John Doe

Hardware Configuration

Source Tape Drive:	ANAMODE 913, Unit 6
Dest. Tape Drive 1:	
Dest. Tape Drive 2:	
Time Code System:	TIMETRON 4810, Unit 1
Bit Synchronizer:	TELEM 8320, Unit 2
Decommutator:	TELEM 8330, Unit 3
Word Selector:	
Tuneable Discriminators:	
Fixed Discriminators:	
FM Acquisition Unit:	
Chart Recorder 1:	
Chart Recorder 2:	
Other:	

Input Specification

Analog Tape Track:	2
Process Data From:	100 08:30:00
Process Data To:	100 10:15:00

Digital Output Specification

Disk File:	1DIA3:[DATA]STAR01JAN92.DAT
Tape Density (BPI):	6250
# of Tapes Produced:	2

Figure 5. Sample Work Request Report

QUALITY CHECK REPORT

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Input File:	1DIA3:[DATA]STAR01JAN92.DAT
Output File:	TLMDP1$MUB0
Analog Tape ID:	A92001-01
Work Request Number:	W92001
Total Words Per Frame (including words merged):	131
Bits Per Frame (excluding words merged):	2048
Bit Rate (bits per second):	256000
Status Word Merged:	NO

Sync Word 1	Value:	FAF3	Index:	128
Mask Word 1	Value:	0000		
Sync Bit Errors Allowed:				0
Time Word 1 (Dayword)	Merged:	YES	Index:	129
Time Word 2 (Minword)	Merged:	YES	Index:	130
Time Word 3 (Fracword)	Merged:	YES	Index:	131
Time Format:				IRIG-B
Expected Delta Time Between Frames:				8.00000D-03
Allowed Delta Time Error:				2.40000D-03
Check SFID Enabled :				YES
Least Significant Bit First :				NO
SFID Index:				8
SFID Mask:				1111111111100000
Minimum SFID:				0
Maximum SFID:				31
SFID Count Direction:				INCREMENTS

Anomaly Type	Action Taken	Rec. Word	Current Value	Previous Value
SFID SEQ Error:	LOGGED	2 4494	16	11
Time Gap:	LOGGED	2 4615	001_08:15:25.840	001_08:15:25.532
Time Unchanged:	INC BY DELTA	2 4927	001_08:15:25.840	001_08:15:25.840

Processing Summary

Total Number of Input Records:			1456
Total Number of Output Records:			1456
Beginning IRIG Time in Data:			001_08:15:05.015
Ending IRIG Time in Data:			001_10:15:27.439
Total Resyncs:	0	Total Invalid Time Values:	0
Total Invalid Syncs:	0	Total Time Unchanged:	1
Total Frame Errors:	0	Total Time Decreasing:	0
Total Words Discarded:	0	Total Time Delta Insuff:	0
Total Invalid SFIDs:	0	Total Time Gaps:	1
Total SFID Sequence Errors:	1		

Figure 6. Sample Quality Check Report

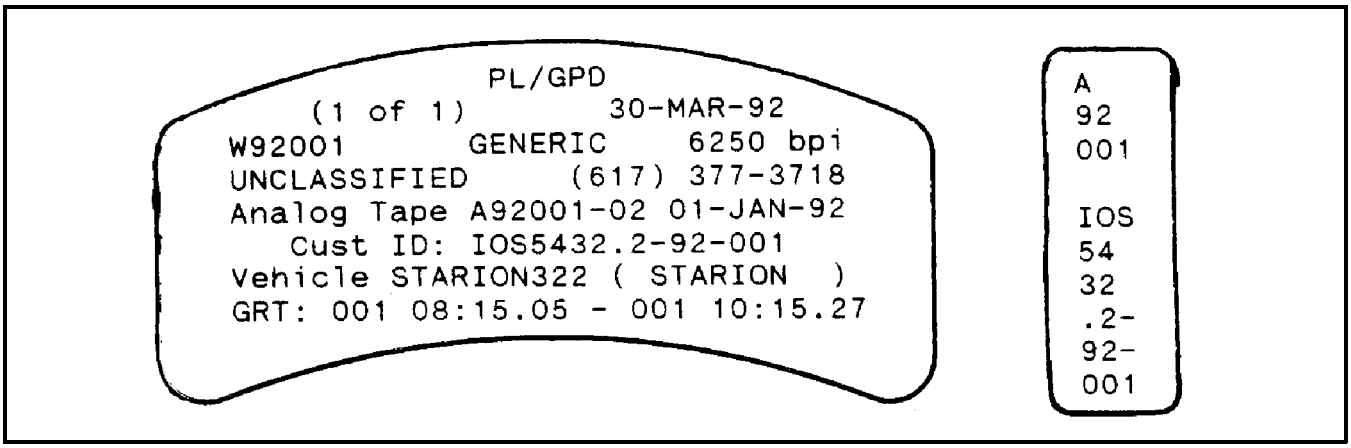

Figure 7 - Sample Digital Tape Label

ARCHIVE REPORT

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Archive ID:	R92002
Archive Description:	Data for STARION experiment 01-JAN-92 through 22-JAN-92
Classification:	UNCLASSIFIED
Media Type:	8 mm
Total Blocks:	401,568
Operation:	Backup

File	Blocks	Analog Tape	Work Request
1DIA3:[DATA]STAR01JAN92.DAT	46,592	A92001	W92001
1DIA3:[DATA]STAR02JAN92.DAT	128,480	A92007	W92002
1DIA3:[DATA]STAR03JAN92.DAT	97,984	A92008	W92003
1DIA3:[DATA]STAR04JAN92.DAT	54,976	A92009	W92004
1DIA3:[DATA]STAR05JAN92.DAT	73,536	A92010	W92005

ERRORS

none

Figure 8 - Sample Archive Report

ARCHIVE DATABASE SUMMARY

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ID	Date	Description
R92001	15-JAN-92	CASC Pre-flight Check
R92002	31-JAN-92	STARION experiment 01-JAN-92 to 22-JAN-92
R92003	10-FEB-92	CASC LEO

Figure 9 - Sample Archive Database Summary