TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 8.0
Ground System and the Payload Operations Centers (POCs) Interface Signature Page

TECHNICAL CONTENT APPROVAL (PAGE 1 OF 2)

D. Y. Kusnierkiewicz
TIMED Spacecraft System Engineer

B. Ogorzalek
GUVI System Engineer

K. J. Heffernan
TIMED Science Payload System Engineer

M. B. Weiss
GUVI Ground System Engineer

M. I. Chu
TIMED System Software Engineer

B. Crain (Aerospace)
GUVI Software Manager

E. H. Rodberg
TIMED Ground System Engineer

W. Roettker (LaRC)
SABER Instrument Manager

P. M. Lafferty
TIMED MDC Software Lead Engineer

S. Brown (SDL)
SABER System Engineer

L. L. Gordley
SABER Ground System Engineer

FSCM NO.	SIZE	DWG. NO.
88898	A	7363-9050 B
		04/07/05
SCALE	DO NOT SCALE PRINT	SHEET 8-1

TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 8.0
Ground System and the Payload Operations Centers (POCs) Interface
Signature Page

TECHNICAL CONTENT APPROVAL (PAGE 2 OF 2)

_____	_____
G. Ucker SEE System Engineer	
_____	_____
G. Tate SEE Ground System Engineer	
_____	_____
C. Edmonson TIDI System Engineer	
_____	_____
D. A. Gell TIDI Ground System Engineer	
_____	_____
_____	_____

TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 8.0
Ground System and the Payload Operations Centers (POCs) Interface

REVISION APPROVAL (PAGE 1 OF 5)

TIMED Spacecraft Approval Page

Rev #	Date	D. Kusnierkiewicz	K. Heffernan		
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

Rev #	Date	P. Lafferty	S. Nylund	W. Mitnick	
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

Rev #	Date	R. Nordeen	A. El-Dinary		
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

REVISION APPROVAL (PAGE 2 OF 5)

GUVI Instrument Approval Page

Rev #	Date	B. Ogorzalek	D. Mabry	M. Weiss	
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 8.0
Ground System and the Payload Operations Centers (POCs) Interface

REVISION APPROVAL (PAGE 3 OF 5)

SABER Instrument Approval Page

Rev #	Date	W. Roettker	S. Brown	L. Gordley	
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 8.0
Ground System and the Payload Operations Centers (POCs) Interface

REVISION APPROVAL (PAGE 4 OF 5)

SEE Instrument Approval Page

Rev #	Date	G. Ucker	G. Tate		
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 8.0
Ground System and the Payload Operations Centers (POCs) Interface

REVISION APPROVAL (PAGE 5 OF 5)

TIDI Instrument Approval Page

Rev #	Date	C. Edmonson	D. Gell		
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

Change History

Date of Change	Description of Change
1 December 1997	Version signed
1 December 2001	Revision B updated following sections: Signature Pages: Updated names to reflect changes in personnel. Add names of Ground Based Investigators Change History: Added Change History information. Section 8.1.2. Scope: Removed redundant wording “via the MDC.” in the 2nd paragraph. Replaced “contact plan’ with “timeline” as an example report. Section 8.1.3.1.2.1. Real-time Telemetry: Added 3rd type of requestable real-time telemetry, POC Telemetry Packets. Section 8.1.3.1.2.2. Dump Telemetry: Added 3rd type of requestable dump telemetry, POC Telemetry Packets. Section 8.1.3.2. TIMED Data Processing Overview: Added new paragraphs 2 through 6. Section 8.1.3.2.1. Planning Products: Removed contact schedules as an example of essential product for coordinating efforts. Section 8.1.4. Applicable Documentation: Removed Mission Data Center System Specification document. Updated dates of document versions. Figure 8.2.1-1. TIMED Ground System and POC Interfaces: Added Data Product Specification from interface of POC to MDC. Removed Contact Plan as interface from MDC to POC.

Section 8.2.2. Interface Requirements:
Removed reference to Appendix 8-D. Host Names and IP Addresses. which has been removed.

Table 8.2.2-1. Filenaming Conventions:
Changed length of APID from 4 to 3 characters.
Changed length of timeline identification from 5 to 2 characters.
Added PTP as a type of telemetry format datatype.
Added descriptor zzzz for spreadsheet indentifier.

Section 8.2.3.1. Command Messages:
Changed URL for source of information on PGP software to be the same as the source of the software in 4th paragraph.
Added information on duplicate names and command message files in 5th paragraph
Added "via a phone call" in 13th paragraph as the means of communication between the MOC and POC teams.

Table 8.2.3-1. Command Delivery Enable Time and Delivery Time-out Definitions:
Added "The command delivery delta time-out supersedes the command delivery time-out." to the third entry.

Table 8.2.3-6. Alarm Log File Format:
Added "32 char max" to Range of Item Alarm Mnemonic.

Table 8.2.3-8. Ad Hoc Housekeeping Log File Format:
Added "32 char max" to Range of Items Mnemonic 1 Column Heading and Mnemonic n Column Heading.

Section 8.2.4. MOC to POC Interfaces:
Removed "facility authentication checking" as MOC task for received command messages.

Section 8.2.4.1. Authentication Return Receipt:
Added timing information for Authentication Return Receipt and contact procedure for absence of ARR.

Table 8.2.4.1. Authentication Return Receipt File Format:
Changed range of Units for Item Success/Failure Flag from "0-6" to "0-999" and meaning of a value of 1 from "Decryption/Authentication Failure" to "Authentication Failure".

Section 8.2.4.2. Command Return Receipt:
Changed “spacecraft” to “instrument” as destination of POC command message.
Reworded describing actions by MOC regarding final disposition of the message.

Table 8.2.4-2. Command Return Receipt :
Defined or redefined values of Units 1 through 14 for Item Success/Failure.

Figure 8.2.5-1. Mission Data Center to Payload Operations Center Interfaces:
Altered list of products from MDC to POCs.

Section 8.2.5.1. Instrument Telemetry to POCs:
Reworded entire section.
Added Figure 8.2.5-2. Telemetry Stream Service
Altered Figure 8.2.5-3. TIMED Telemetry Frame and Telemetry Packet Definitions.
Added information to Table 8.2.5-1. POC HTTP Telemetry File Format

Section 8.2.5.2. Spacecraft Telemetry Definitions:
Reworded 2nd sentence of 1st paragraph.

Table 8.2.5-2. Spacecraft Telemetry Definitions File Format:
Changed Filename Convention field.
Reworded Availability.
Changed Format.
Extended the table by adding and altering information previously provided in Appendix E.

Section 8.2.5.3. Timelines:
Added an overview of timeline interfaces which introduces three new interfaces: Long Range Planning Report, As Flown Report and Planned/As Flown On-line Interactive Report.

Section 8.2.5.3.1. Planned and As Flown Timelines:
Relocated information previously given in the 1st two paragraphs of Section 8.2.6.2. Planned/As Flown timelines.

Table 8.2.5-3. Planned and As Flown Timeline File Format:
Relocated table previously given as Table 8.2.6-2.

Changed Filename Convention field.
Reworded Transfer Protocol and Availability fields.
Added two footnotes.

Section 8.2.5.3.2. Merged Timeline Reports:
Added this new section and accompanying Table 8.2.5-4. Long Range Planning Report File Format and Table 8.2.5-5. As Flown Report File Format.

Section 8.2.5.3.3. Valid Event and Anomaly Identifiers:
Relocated information previously given in the 3rd paragraph of Section 8.2.6.2. Planned/As Flown timelines.

Table 8.2.5-6. Valid Event, Anomaly and Mode Identifiers:
Relocated table previously given as Table 8.2.6-3. Valid Event and Anomaly Identifiers.
Expanded information to include mode identifiers.

Table 8.2.5-7. Valid Instrument Mode Parameter Identifiers:
Added a table on mode parameter identifiers.

Former Section 8.2.5.4. Contact Plans:
Removed this section and associated Table 8.2.5-4. Planned Monthly Contact Plan File Format, Table 8.2.5-5. Planned Weekly Contact Plan File Format and Table 8.2.5-6. Actual Daily Contact Plan File Format.

Section 8.2.5.4.1. Predicted Position, Velocity, Attitude, and Time (PVAT) Data:
Relocated information previously given in Section 8.2.5.5. Predicted Orbit Information.
Added that range, units and resolution for orbital elements are available from the TIMED web site.
Removed the note regarding revisiting accuracy estimates.
Added note at end of 4th paragraph that the use of flag items is important.

Table 8.2.5-8. Predicted Position, Velocity, Attitude, and Time NetCDF File Format:
Relocated table and consolidated information previously given as Table 8.2.5-7. Predicted Position, Velocity, Attitude, and Time NetCDF File Format and Table 8.2.5-8. Predicted Orbit ASCII File Format.

Changed Filename Convention field.
Added Items for Attitude Rates, Guidance and Control Solar Vector, three GPS-related items and MDC flags.
Changed bit offset from 790 to 789 for GPS Navigation System Validity Flags Item.
Redefined the information available for the 2-line orbit element set.
Added units for Position (Earth Centered, Earth Fixed).
Expanded units for Roll, Pitch and Yaw.
Added units to include bit definitions for several validity and warning flags.
Expanded units to include additional bit definitions for MDC flags.

Table 8.2.5-9. Predicted Orbit ASCII File Format:
Added rows containing Position (ECI), Velocity (EC), Velocity (ECI), Spacecraft Time and Time Vernier.

Section 8.2.5.4.2. Predicted Orbit Number File:
Added this new section and accompanying Table 8.2.5-10. Predicted Orbit Number File Format.

Section 8.2.5.5. File Change Notification Message:
Added this new section and accompanying Table 8.2.5-11. File Change Notification Message File Format.

Table 8.2.5-12. Telemetry Status Change Notification Definition:
Changed Filename Convention field.
Reworded Transfer Protocol and Format fields.

Section 8.2.5.7. Telemetry Data Status:
Changed this data product from a set of static files requiring updating to the dynamic output of the web site Archive Map Utility.

Table 8.2.5-13. Recommended Input to Archive Map Utility:
Added list of recommended input for Archive Map Utility.

Section 8.2.5-14. Current Good Telemetry Status File Output:
Replaced Table 8.2.5-11. Current Good Telemetry Status File Format. with Archive Map Utility output format.

Section 8.2.5.8.1. National Meteorological Center (NMC) Data:
Added that the NMC support product is provided daily for 1200 UTC data.

Table 8.2.5-13. NMC Data File Format:
Changed Filename Convention field.
Reworded Transfer Protocol field.
Added Item for Analysis Time.
Removed Items for Source file, Title, Create/revision history, Surface pressure and Surface height.
Corrected Units for Longitude and Latitude.
Changed the Resolution/Range set of values for Pressure Levels and single values for Temperature and Geopotential height.

Section 8.2.5.8.2. Solar and Geomagnetic Indices:
Expanded description of SGI support product.
Changed the A_p Data Type to Float 32.
Added that Item F10.7 is Observed value.

Table 8.2.5-14. Solar and Geomagnetic Indices File Format:
Changed Filename Convention field.
Removed Items for Time resolution, Kp Valid Time, Ap Valid time, Equatorial Dst and Rz (Zurich Sunspot Number).
Changed Items Kp to K_p and Ap to A_p.

Section 8.2.5.9.1. Actual Position, Velocity, Attitude, and Time Data:
Added that the coverage time period of the files is one day.
Added that range, units and resolution for orbital elements are available from the TIMED web site.

Table 8.2.5-17. Actual Position, Velocity, Attitude, and Time File Format:
Added that details of positional knowledge is to be found in GIIS Section 6.
Changed Filename Convention field.
Reworded Transfer Protocol field.
Added Items for Attitude Rates, Guidance and Control Solar Vector, three GPS-related items and MDC flags.
Changed bit offset from 790 to 789 for GPS Navigation System Validity Flags Item.
Added units for Position (Earth Centered, Earth Fixed).
Expanded units for Roll, Pitch and Yaw.
Added units to include bit definitions for several validity and warning flags.
Expanded units to include additional bit definitions for MDC flags.

Section 8.2.5.9.2. Actual Orbit Number File:
Renamed from former Section 8.2.5.2. Orbit Number File.
Added that file availability is from beginning of mission to the present day.
Changed description of file content.
Added the definitions for orbit start position numbering.

Table 8.2.5-18. Actual Orbit Number File Format:
Renamed from former Table 8.2.5-3. Orbit Number File Format.
Changed Filename Convention field.
Reworded Transfer Protocol field.
Expanded Units description for Orbit Number Item.
Removed Column 3 for Orbit Stop Time.

Former Section 8.2.5.6. Support Data Status:
Removed this section and associated Table 8.2.5-9. Support Data Status File Format.

Figure 8.2.6-1. Payload Operations Center to Mission Data Center Interfaces:
Added Data Product Specification from MDC to POC.

Former Section 8.2.6.1. Instrument Status Word Definitions:
Removed this section and associated Table 8.2.6-1. Instrument Status Word File Format.

Section 8.2.6.1. Planned/As Flown Timelines:
Added this section with a reference back to the main specification in Section 8.2.5.3.

Section 8.2.6.2. Product Availability Notice:
Renamed from former Section 8.2.6.3. POC Data Product Status.
Expanded the protocol for the use of this interface.

Table 8.2.6-1 Product Availability Notice File Format:
Renamed from former Table 8.2.6-4. POC Data Product Status File Format.
Changed Filename Convention field.
Extensively redesigned the file body contents.

Section 8.2.6.3. Science Data Producer's URL:
Renamed from former Section 8.2.6.4. POC Data Products URL.

	Changed the applicable facilities from POCs to science data producers. Table 8.2.6-2 Science Data Producer's URL File Format: Renamed from former Table 8.2.6-5. POC Data Products File Format. Changed Filename Convention field. Section 8.2.6.4. Data Product Specification Information: Added this section which defers to Reference 8-6, the Data Management Plan, for specific content. APPENDIX 8-A Acronyms and Abbreviations: Expanded list. APPENDIX 8-B Example Files: Marked as deleted. APPENDIX 8-C Ground Receipt Header Definitions: Changed this section which defers to Reference 8-14 for specific content. Table 8.2.6-3 Ground Receipt Header: Named from former unnamed table. Corrected Offset information. Altered numerous fields.
19 December 2002	Table 8.1.1-1. Valid Event, Anomaly and Mode Identifiers: Added new events, anomalies and modes for TIMED spacecraft. Table 8.1.1-16. Solar and Geomagnetic Indices File Format: Changed A_p from Integer 32 to Float 32. Changed F10.7 daily to F10.7 (Observed values). Table 8.1.1-1. Product Availability Notice File Format: Added Valid Values information for Data Product Filename. Table 8.2.5-8. Predicted Position, Velocity, Attitude, and Time NetCDF File Format: Changed to new Filename Convention with the addition of '_###' to represent the file version.

	Table 8.2.5-17. Actual Position, Velocity, Attitude, and Time NetCDF File Format: Changed to new Filename Convention with the addition of '_###' to represent the file version. Changed content of 6th and 7th LSB to contain flag information on out-of-spec state of attitude and attitude rate.
5 April 2005	Table 8.2.5-17. Actual Position, Velocity, Attitude, and Time File Format: Changed Guidance and Control Data Validity flags, Byte 1, 6th and 7th LSBs from Spare to IRU and AST flags of contributing to attitude rate determination, respectively. Changed Guidance and Control Warning flags, Byte 2, 1st and 2nd LSBs from Spare to AST 1 and 2 flags of health and providing data, respectively, and 3rd and 4th LSBs from Spare to IRU 1 and 2 flags of providing data, respectively.

Table of Contents

8. GROUND SYSTEM AND THE PAYLOAD OPERATIONS CENTERS (POCS) INTERFACE

8.1. INTRODUCTION

8.1.1. Purpose

This document describes the interfaces between the TIMED Ground System and the Payload Operations Centers (POCs) that are required to operate the individual instruments on board the TIMED spacecraft. This document also describes the interfaces required by the POCs and the Ground System to support instrument data processing and analysis of the individual instrument's telemetry.

8.1.2. Scope

The Ground System and Payload Operation Centers (POC) make up part of the TIMED Science Data System (SDS). The Ground System consists of the Ground Station, the Mission Operations Center, and the Mission Data Center. The Ground System to Payload Operation Centers interfaces include the Mission Operation Center (MOC) to/from POC communications and the Mission Data Center (MDC) to/from POC communications. There are no interfaces between the Ground Station and the POCs. This document describes the interfaces between the MOC and POC and the MDC and POC. These interfaces are defined by processes, data flow, stream service, file definitions, and file naming conventions.

Many products described here are supplied by the POCs to the MDC. These products support routine and ad hoc reports available to the general public and the POCs. MDC reports that directly support POC operations and planning are represented in this document, because the POCs are the primary users of these reports. Examples of these routine reports are the timelines and the support data file containing the National Meteorological Center data. MDC products that support general TIMED information are beyond the scope of this document but are described in **Reference 8-6. TIMED Program Data Management Plan, JHU/APL, 7363-9330.** The MDC also provides a data catalog that can be accessed by the POCs. The requirements and interface description for the catalog are both beyond the scope of this document.

Requirements for Mission Operations Center, Payload Operation Center, and Mission Data Center system availability are beyond the scope of this document but can be found in **Reference 8-6. TIMED Program Data Management Plan, JHU/APL, 7363-9330.**

8.1.3. Summary

This document is broken up into two main sections. The first section addresses the purpose, scope, and contents of the document itself. The second section defines the interfaces. The interface section presents the four interfaces: POC to MOC, MOC to POC, MDC to POC, and POC to MDC. The POC/MOC interfaces primarily address the uplinking of instrument commands in the TIMED system. The POC/MDC interfaces represent the downlink of instrument telemetry as well as TIMED Science Data System support required of the POCs and MDC. A high level diagram of these interfaces is presented in Figure 8.2.1-1. TIMED Ground System and Payload Operations Center Interfaces.

Appendices are provided for acronyms, file examples, ground receipt header definitions, and connection information such as host names and IP addresses.

The interface products described in this document can be summarized as falling into one of the following types of products: commanding, spacecraft and instrument telemetry, planning, status, and support products. The basic processing for each of these types of products is summarized below.

8.1.3.1. TIMED Command and Telemetry Overview

Figure 8.1.3-1. TIMED Command and Telemetry Overview depicts a high level overview of the command and telemetry flow through the TIMED system. The Payload Operation Centers (POCs) will issue instrument command messages to the Mission Operations Center (MOC). The MOC will forward validated spacecraft and instrument commands to the Ground Station (GS) for telemetering to the spacecraft. The MOC will also return command responses to the POCs indicating command delivery status as it can be determined. The POCs and MOC will be synchronized to Universal Time (UT). The POCs will need internet accessibility to connect to the MOC. This can be achieved via an internet provider, a modem or a PPP connection. The GUVI POC does not need internet service as it will be within the APL network firewalls.

The spacecraft will record on the solid-state recorder (SSR) housekeeping information indicating successful or failed command delivery to instruments and subsystems as well as pertinent engineering, position, and attitude data. The instruments that receive their commands will transmit data to the spacecraft indicating successful or failed command delivery and execution as well as instrument science data. The spacecraft will record this instrument housekeeping and science data on the SSR. During a scheduled contact with the Ground Station, the spacecraft will relay the contents of the SSR (Dump Telemetry) to the ground as well as any telemetry data currently being issued to the spacecraft from any of its subsystems and any of the instruments (Real-time Telemetry). The Ground Station will forward downlinked telemetry to both the MOC and the Mission Data Center (MDC). The MOC will use the spacecraft telemetry to monitor spacecraft health and command delivery status. The MDC will archive the telemetry

for playback to the instrument POCs. The POCs will retrieve instrument and spacecraft telemetry of interest from the MDC for instrument health monitoring and data processing, completing the circle of command and telemetry flow in the TIMED system. The POCs will need internet accessibility to connect to the MDC. This can be achieved via an internet provider, a modem or a PPP connection. The GUVI POC does not need internet service as it will be within the APL network firewalls.

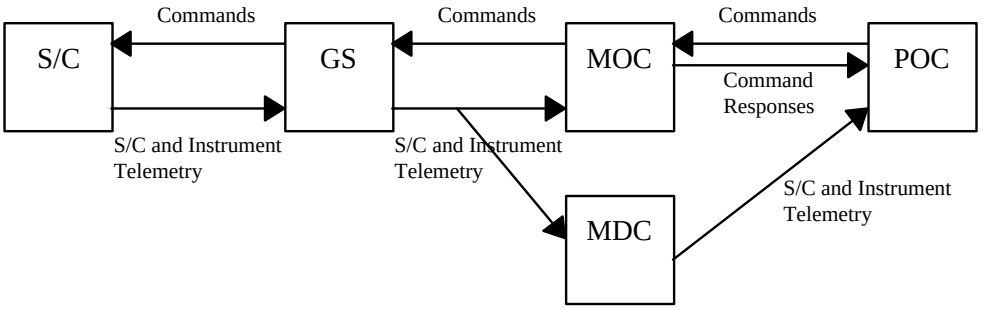

Figure 8.1.3-1. TIMED Command and Telemetry Overview

8.1.3.1.1. COMMANDING

The POCs will communicate commands to configure and manage each of their instruments by depositing command files at the MOC. When the commands pass decryption, authentication, and a minimal syntax check or if the command fails this initial vetting an Authentication Return Receipt will be forwarded to the POC facility indicating success or failure. After the initial verification, based on time-out information included in the command header, the MOC will forward the commands to the Ground Station, which then forwards them to the TIMED spacecraft. Finally, the Command and Data Handling (C&DH) process in the spacecraft will forward the commands on the 1553 bus for the instruments to retrieve. When the command is successfully delivered to the 1553 bus terminus at the instrument or if at any point the command fails delivery to the 1553 bus terminus, a Command Return Receipt will be issued to the POC indicating time and either successful delivery or the source of delivery failure. Actual command execution success or failure will be indicated in instrument telemetry telltales and the Instrument Status Words found in the spacecraft telemetry.

8.1.3.1.2. Spacecraft and Instrument Telemetry

8.1.3.1.2.1. Real-time Telemetry

Real-time telemetry is defined as any spacecraft or instrument telemetry that the spacecraft will send down to the Ground Station via Virtual Channel 7 (VC7) in real-time during

a contact. During the same contact, the Ground Station will forward the real-time telemetry to the MOC; the MOC will forward it to the MDC. The POCs can request it via stream service from the MDC. Note that the POCs can also request these data via stream service from the MOC during the contact if the MDC connections are unavailable. The MDC will perform the task of being a real-time telemetry server in the TIMED project as well as the real-time telemetry archives. The real-time telemetry data will not be cleaned and merged. It will be distributed by the MDC as received. After the contact, there will be two mechanisms for retrieving archived real-time telemetry from the MDC: stream playback via a socket connection or an HTTP file transfer. The real-time telemetry can be requested in three formats: CCSDS telemetry packets; Supplemented Telemetry Packets (STPs), which will contain ground receipt and transfer frame information as well as the CCSDS telemetry packets; or POC Telemetry Packets which will contain only the ground receipt header and the CCSDS telemetry packet.

8.1.3.1.2.2. Dump Telemetry

Dump telemetry is defined as any spacecraft or instrument telemetry from the SSR that the spacecraft will send down to the Ground Station via Virtual Channel 6 (VC6). The Ground Station will send the recorded spacecraft and instrument telemetry directly to the MDC. The MDC will again perform the task of being both the dump telemetry server in the TIMED project as well as the dump telemetry archives. The POCs can retrieve these data from the MDC via playback stream service or HTTP file transfer. Via the stream playback, dump telemetry will be made available for playback to the POCs as the MDC receives it from the Ground Station, but the telemetry won't be entirely cleaned and merged until one hour after receipt from the Ground Station. Similar to the real-time telemetry, the dump telemetry can also be requested in three formats: CCSDS telemetry packets, Supplemented Telemetry Packets (STPs) which will contain ground receipt and transfer frame information as well as the CCSDS telemetry packets; or POC Telemetry Packets, which will contain only the ground receipt header and the CCSDS telemetry packet.

8.1.3.2. TIMED Data Processing Overview

The instrument facilities will be responsible for coordinating their experiments with the TIMED project, other TIMED instrument facilities; and, in some cases, coordinating their experiments with projects outside of the TIMED project arena. The instrument facilities will also be responsible for producing their own data products. In order to assist the POCs in experiment planning and coordination and in data processing the TIMED project will provide planning products, status products, and support products. The MDC and POCs will both play a key role in archiving and distributing these products in the TIMED project Figure 8.1.3-2. TIMED Data Processing Overview provides a high level data flow for these products in the TIMED system. The MDC will be the archive and server of the merged planning, status and support products.

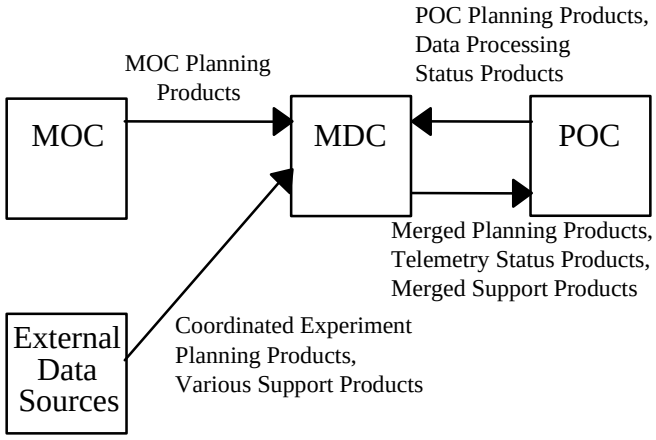

Figure 8.1.3-2. TIMED Data Processing Overview

The delivery of data products in the TIMED Science Data System is driven by both the contact time and time of data acquisition on the spacecraft. All planning products and command products are due based on time intervals prior to the contact date and time. All telemetry and routine data products such as as-flown timelines, and actual position, velocity, attitude, and time data are due based on time intervals after the data have been acquired on the spacecraft. The attached Nominal POC Data Processing Schedule shows the timeline for all currently identified products or sets of products in table form. Figure 8.1.3-3 Example TIMED Routine Product Schedule provides a timeline example of how this applies to some of the products.

The POCs will send preliminary planned timelines to the MDC 8 weeks prior to contact time. The POCs will send updates to the planned timelines to the MDC as needed. The MDC will produce the merged planned timeline products on a weekly basis. POC Command message files will be sent to the MOC at least 4 hours prior to the contact time. Authentication Return Receipts will be issued by the MOC to the POCs within seconds of receiving the command message file.

At the time of the contact for every command message file that is sent a Command Return Receipt will be issued to the appropriate POCs. Also, real-time telemetry will be available via socket stream from the MDC.

After the contact and within 36 hours of data acquisition on the spacecraft, playback telemetry will be available to the POCs via the MDC. The POCs will then have 24-hours to create their routine data products including the as-flown timelines and will make them available to the MDC for distribution.

The MDC will produce the initial as-flown timelines on a weekly basis. The operations week will be defined from Monday 000000Z thru Sunday 235959Z. The last data collection period for the operational week is Sunday. Therefore, adding up the previous time intervals of 36 hours to get Sunday's data down, plus 24 hours for the POCs to get their as-flown timelines, plus another 24 hours for the MDC to create the merged as-flown timelines based on inputs from the POCs, results in making the initial as-flown timelines available on Thursday 120000Z for the previous operational week.

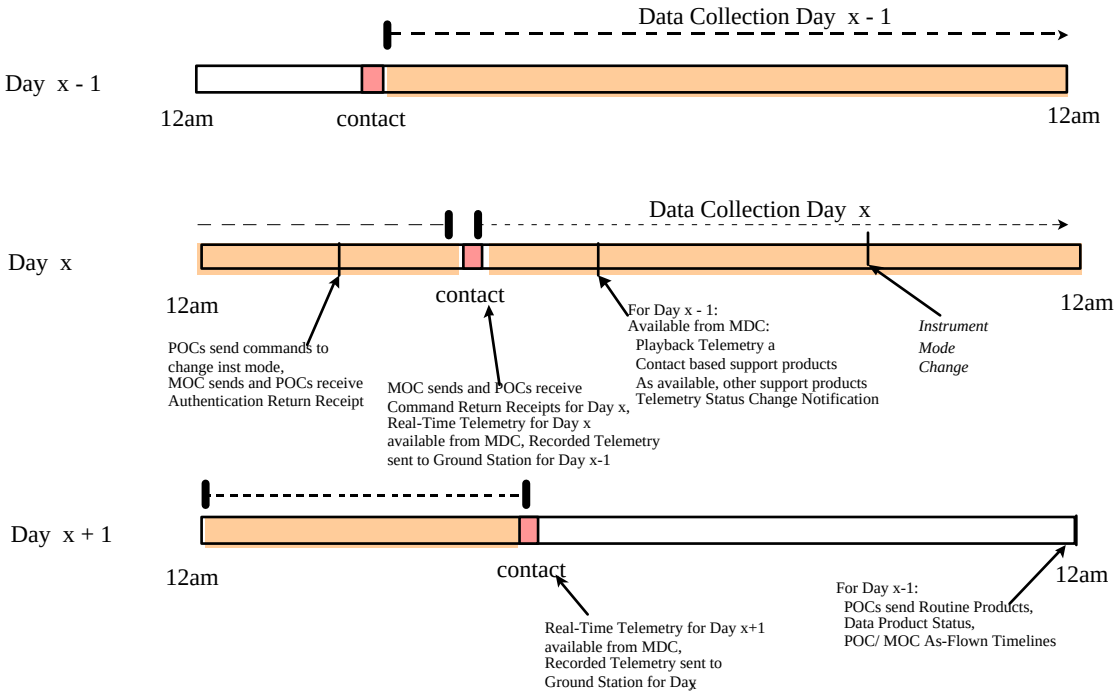

Figure 8.1.3-3. Example TIMED Routine Data Product Schedule

8.1.3.2.1. Planning Products

The TIMED spacecraft, subsystems, and instruments comprise a loosely coupled system. Each of the instruments will operate independently. In order to allow for coordinated efforts, some products will be essential, such as predicted orbit information, planned timelines, and as flown timelines. These will be general purpose planning products and are, therefore, covered in this interface document. The majority of these products will be interfaces between the MDC and the POCs. The MDC will use the POC supplied planning information and merge it with other TIMED data system products to produce routine and ad hoc reports. These MDC supplied reports are described in **Reference 8-6. TIMED Program Data Management Plan, JHU/APL, 7363-9330.**

8.1.3.2.2. Status Products

These data in the TIMED SDS will be highly distributed. Some data will be resident at the Ground System and some data will be resident at individual POCs. In order to trace the current status of the data products status information will be required. This will be in the form of product status, instrument product descriptions, and web distribution site locations. The majority of the status products will be interfaces between the MDC and the POCs. The MDC will use the POC supplied status information and merge it with other TIMED data system products to produce routine and ad hoc reports. These MDC supplied reports are described in **Reference 8-6. TIMED Program Data Management Plan, JHU/APL, 7363-9330.**

8.1.3.2.3. Support Products

The POC facilities have requested that the TIMED Science Data System provide a central location for retrieving and archiving specific supplemental environmental data, such as geomagnetic and solar indices, required by the POCs to perform data processing of their products. The MDC and POCs will be the main players in this interface.

8.1.4. Applicable Documentation

Reference 8-1. TIMED System Requirements Document, JHU/APL, 7363-9001, Rev B, Dec. 1997

Reference 8-2. GUVI Specific Instrument Interface Specification, JHU/APL, 7363-9046, May 1998.

Reference 8-3. SABER Specific Instrument Interface Specification, JHU/APL, 7363-9047, Jul. 1998.

Reference 8-4. SEE Specific Instrument Interface Specification, JHU/APL, 7363-9048, May 1998.

Reference 8-5. TIDI Specific Instrument Interface Specification, JHU/APL, 7363-9049, May 1998.

Reference 8-6. TIMED Program Data Management Plan, JHU/APL, 7363-9330, Oct 2001.

Reference 8-7. Mission Operations Requirements Document, JHU/APL, 7363-9021, Oct. 1996

Reference 8-8. TIMED Concept of Operations, JHU/APL, 7363-9037, March 1997

Reference 8-9. Consultative Committee for Space Data Systems, Blue Book, Telecommand, CCSDS 203.0-B-1, January 1987

Reference 8-10. Consultative Committee for Space Data Systems, Blue Book, Packet Telemetry, CCSDS 102.0-B-4, November 1995

Reference 8-11. TIMED End to End Data Systems Developers Guide, JHU/APL, 7363-9317, Draft

Reference 8-12. TIMED Spacecraft Integration Test Plan, JHU/APL, 7363-9020, Sept. 1997

Reference 8-13. NetCDF User's Guide, as of December, 2001, http://www.unidata.ucar.edu/packages/netcdf/docs.html

Reference 8-14. "TIMED Telemetry and Command Data Structures, Version d," P. J. Grunberger, SEA-99-0009a, 25 January 1999

8.2. INTERFACES

8.2.1. Interface Block Diagram

A high level interface diagram for interfaces, between the TIMED Ground System and the Payload Operations Centers, is depicted in Figure 8.2.1-1. TIMED Ground System and Payload Operations Center Interfaces.

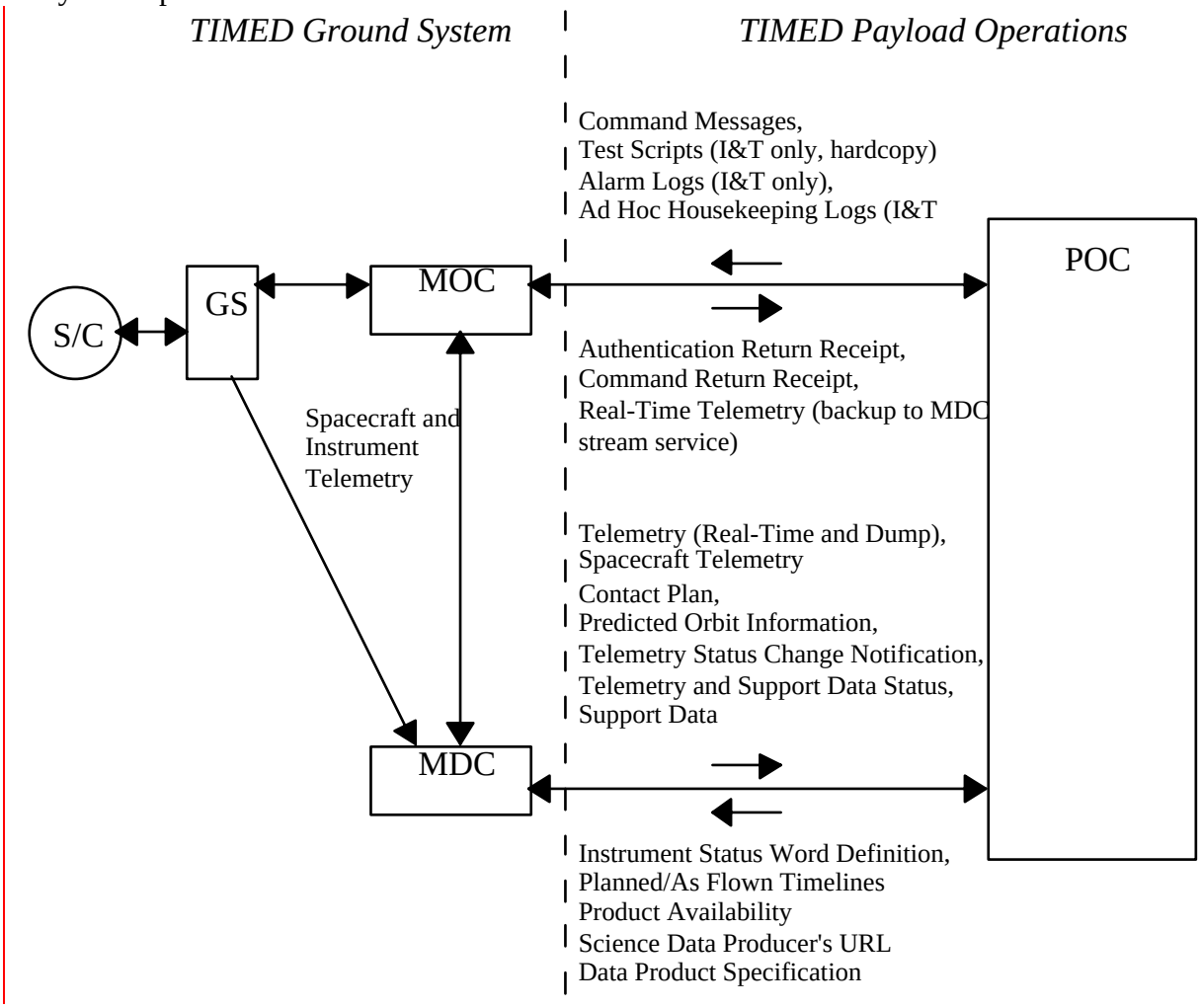

Figure 8.2.1-1. TIMED Ground System and Payload Operations Center Interfaces

8.2.2. Interface Requirements

The interfaces described in this document are defined by four characteristics: operations, format, content, and file naming convention where filenames are needed. The characteristics are unique to each interface and described in each of the following sections.

In order to specify the file naming convention it is helpful to specify the standard conventions that this document uses to describe a filename. These standards are specified in Table 8.2.2-1. Filenaming Conventions.

Table 8.2.2-1. Filenaming Conventions

Descriptor	Definition	Example(s)
inst	4 character instrument ID	GUVI, SABE,SEE_,TIDI
APID	3 character hexadecimal Application Process Identifier	
####, ###, ##, #	Padded 4 digit revision ID, padded 3 digit version ID, etc.	0001, 001
cc	2 characters describing which type of timeline is being provided (pl, af)	pl, af
datatype	2-3 characters describing the type of telemetry format	STP, TP, PTP (STP- Supplemented telemetry packet, TP- telemetry packet PTP- POC telemetry packet)
zzzz	4 character spreadsheet identifier	basi - basic, coef - coefficients, loca - locations, stat - states, calp - calibration pairs, alar - alarms, user - user defined
yyyy	UT Year	1999
doy	UT Day of year	030
hh	UT hour of day	12
mm	UT minutes of hour	06
ss	UT seconds of minute	59
starttime	UT yyyydoyhhmmss	1999211000000
stoptime	UT yyyydoyhhmmss	1999212000000

8.2.3. POC to MOC Interfaces

A high level diagram of the POC to MOC interfaces is depicted in Figure 8.2.3-1. Payload Operations Center to Mission Operations Center Interfaces below.

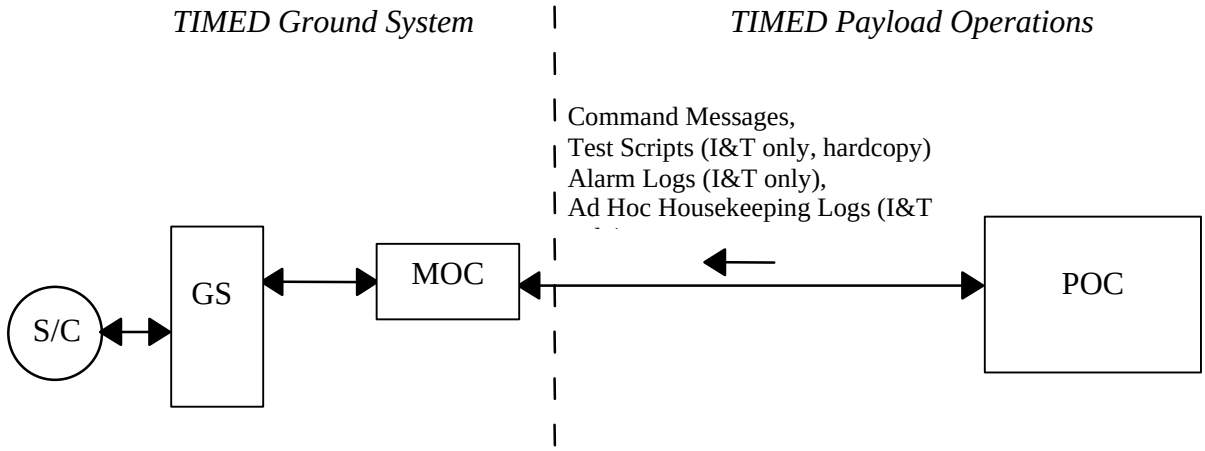

Figure 8.2.3-1. Payload Operations Center to Mission Operations Center Interfaces

8.2.3.1. Command Messages

The commands sent from the POCs to control their instruments will be sent via ftp to the Mission Operations Center (MOC) in TIMED command messages. The MOC processing of an instrument command message is presented in Figure 8.2.3-2. MOC Instrument Command Message Processing Flow. Each command message sent from the POCs will contain an ASCII header and a single CCSDS telecommand packet, see Figure 8.2.3-4. POC Signed and Encrypted Command Message File Block Diagram. Each CCSDS telecommand packet can have multiple instrument commands.

Once the command message is written to the command staging area (a MOC specified directory) and has been decrypted and authenticated the original encrypted and signed command message file is deleted. The decrypted and authenticated version is moved into a different directory.

The command message header will contain the authentication information, command enable time, command delivery time-outs, and a command description. For a detailed command message file definition see Table 8.2.3-3. Command Message File Format.

The command messages are encrypted with the MOC's public key and signed with the POC's private key at the POC facilities indicating the source of the command message. This will

be done using the Pretty Good Privacy (PGP) software package. More information on the PGP software can be found on the World Wide Web at HTTP://web.mit.edu/network/pgp.html, and the software can be downloaded from that site. The encrypted and signed command message file structure is depicted in Figure 8.2.3-3. Command Message File Format (after signature and encryption).

The MOC will check the command staging area at 1-second intervals for POC instrument command messages. It is okay for the POCs to send command message files with duplicate names but in using duplicate names the POC assumes the risk of duplicate Authentication Return Receipt and Command Return Receipt names. Duplicated command message files should not be sent to the MOC faster than the MOC queries the command message file directory which is once per second.

Upon finding a command message in the staging area, the MOC will authenticate the signature using the POC's public key and decrypt the message with the MOC's private key using the PGP software package. Then the MOC will verify that the source of the command is valid for the destination instrument identified by the Application Process Identifier (AP ID) in the CCSDS packet primary header. Minimal verification of CCSDS telecommand packet syntax will be performed by the MOC. Whether the file succeeds or fails decryption, authentication, syntax or source/destination verification, the MOC will issue the Authentication Return Receipt to the POC immediately indicating the success or failure.

Based on the command delivery enable time and the time-out information provided in the command message ASCII header the command packet will be issued from the Ground System to the spacecraft for delivery to the instrument. The definitions for the fields in the time block of the ASCII header can be found in Table 8.2.3-1. Command Delivery Enable Time and Delivery Time-out Definitions. The rules governing the usage of the command delivery enable time, command delivery time-out and command delivery delta time-out are listed in Table 8.2.3-2. Command Delivery Enable Time and Delivery Time-out Rules.

When the spacecraft Command and Data Handling (C&DH) system successfully deposits the command packet on the 1553 bus for the instrument it will issue a message to the Ground System indicating successful transmission. At this point a success status will be forwarded from the MOC to the POC via the Command Return Receipt message.

If a failure occurs anywhere in the system, for example, the C&DH could not deposit the packet on the 1553 bus or a COP-1 failure occurred, the Ground System will have the ability to continue to resend the command packet until either the command delivery time-out is reached or the command is flushed (removed from the queue) by the MOC. Manual flushing of commands from the queue will be done by the MOC controller in cases where the POC controller phones the MOC controller with a flush request or in cases where the MOC controller phones the POC controller with a request to flush the current commands in the POC's queue.

If the command delivery time-out is exceeded or if the command message is flushed by the MOC the MOC will indicate the delivery failure via the Command Return Receipt message sent to the POC. The types of command failure reasons are provided in the section 8.2.4.2 Command Return Receipt.

The maximum CCSDS Telecommand packet length allowed for TIMED will be 4006 bytes where 6 bytes will be the primary telecommand header and 4000 bytes will be allowed for the command data. It is recommended that the instrument teams provide an error checking field in their command data. The format recommendations for the CCSDS Telecommand can be found in **Reference 8-9. Consultative Committee for Space Data Systems, Blue Book, Telecommand, CCSDS 203.0-B-1, January 1987**.

If a POC cannot fit a command or sequence of commands into this packet length it will be up to the POC and instrument command processing to manage the sequence of its CCSDS command packets. Specifically, the Ground System and the C&DH system are not tracking the Sequence Count/packet name in the telecommand primary header. Therefore, all CCSDS command packets are considered to be stand-alone by the Ground System and the spacecraft.

During normal operations, each POC will be allowed to send up a maximum of 2 Kbytes of commands per day without MOC intervention. In some instances upload of flight software might be needed requiring more than the nominal case of 2 Kbytes/day. These situations will be handled on a case-by-case basis between the MOC and the POC teams via a phone call.

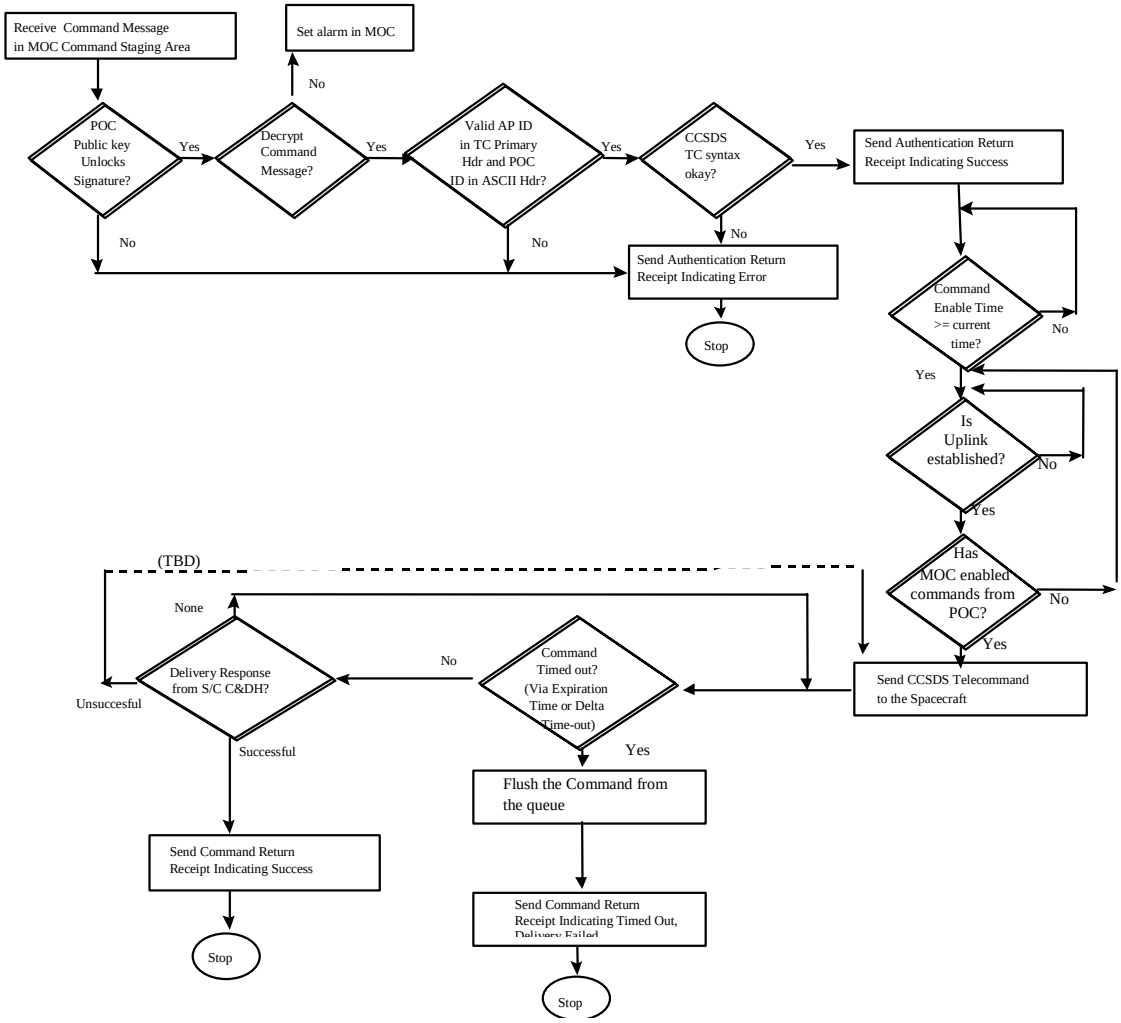

Figure 8.2.3-2. MOC Instrument Command Message Processing Flow without MOC/POC Controller Intervention

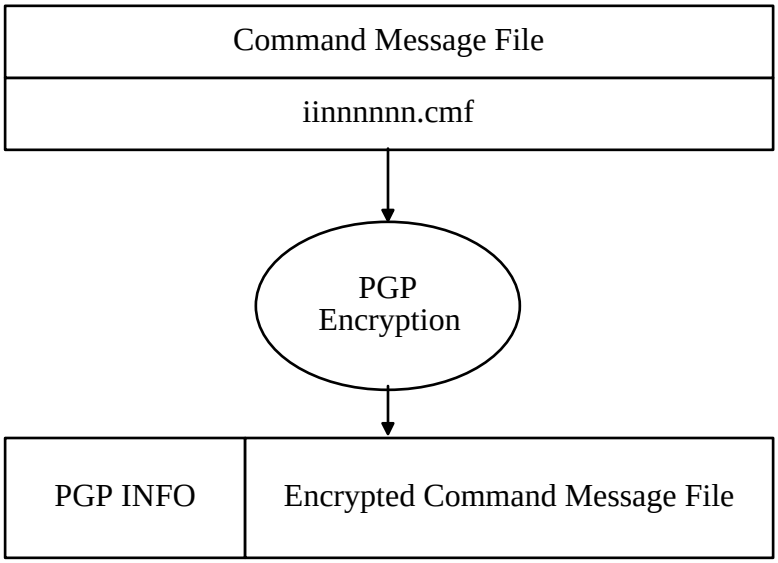

Figure 8.2.3-3. Command Message File Format (after signature and encryption)

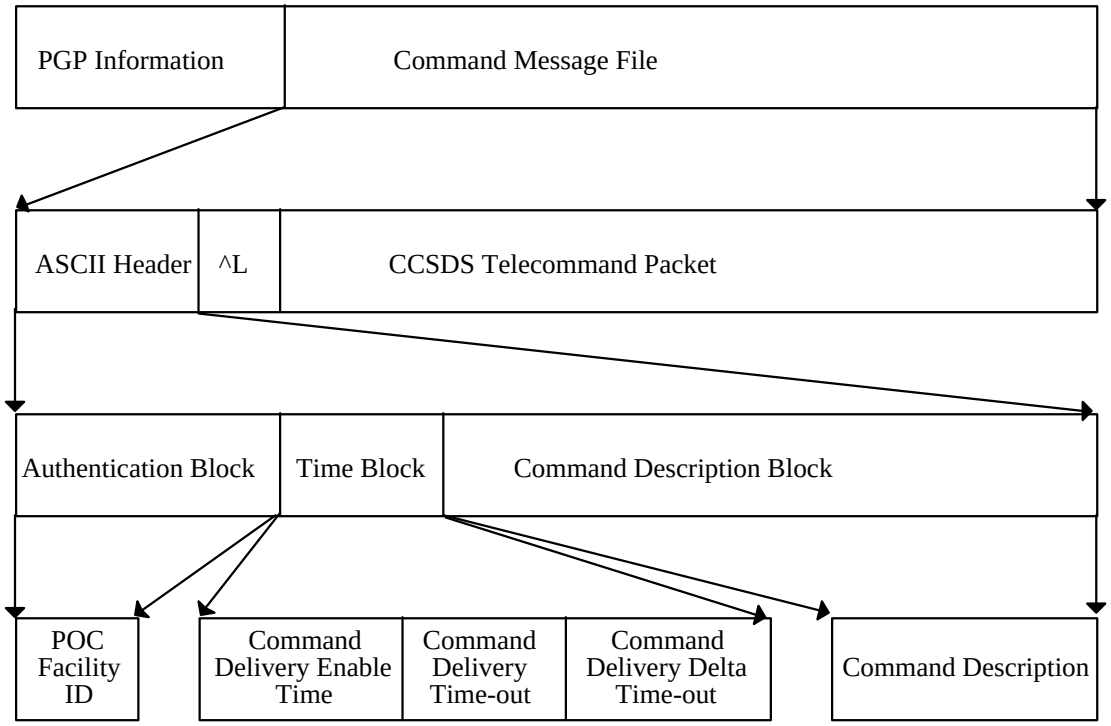

Figure 8.2.3-4. POC Signed and Encrypted Command Message File Block Diagram

FSCM NO.	SIZE	DWG. NO.
88898	A	7363-9050 B
		12/19/02
SCALE	DO NOT SCALE PRINT	SHEET 8-34

Table 8.2.3-1. Command Delivery Enable Time and Delivery Time-out Definitions	
1	The command delivery enable time indicates to the MOC the time in UT that MOC can start trying to send the POC command to the spacecraft.
2	The command delivery time-out indicates to the MOC the time in UT that MOC should stop trying to send the POC command to the spacecraft.
3	The command delivery delta time-out supersedes the command delivery time-out. The command delivery delta time-out is a duration in seconds that will be added to the command delivery enable time to compute the UT that the MOC should stop trying to send the POC command to the spacecraft after the command delivery enable time.

Table 8.2.3-2. Command Delivery Enable Time and Delivery Time-out Rules

Command Delivery Enable Time	Command Delivery Time-out	Command Delivery Delta Time-out	Rule
Blank	Blank	Blank	Enable time is MOC Receipt Time; time-out is infinite
Present	Blank	Blank	Enable time is Command Delivery Enable Time; time-out is infinite
Blank	Present	Blank	Enable time is MOC receipt time; time-out is Command Delivery Time-out
Present	Present	Blank	Enable time is Command Delivery Enable Time; time out is Command Delivery Time-out
Blank	Blank	Present	Enable time is MOC receipt time; time-out is receipt time + Command Delivery Delta Time-out
Blank	Present	Present	Enable time is MOC receipt time; time-out is receipt time + Command Delivery Delta Time-out
Present	Blank	Present	Enable time is Command Delivery Enable Time;

Table 8.2.3-2. Command Delivery Enable Time and Delivery Time-out Rules			
Command Delivery Enable Time	**Command Delivery Time-out**	**Command Delivery Delta Time-out**	**Rule**
			time-out is enable time + Command Delivery Delta Time-out
Present	Present	Present	Enable time is Command Delivery Enable Time; time-out is enable time + Command Delivery Delta Time-out

Table 8.2.3-3. Command Message File Format (Before signature and encryption)					
Filename Convention	**Prior to encryption:** iinnnnnn.cmf where ii denotes the first two characters of the instrument name and nnnnnn is a user-defined field.				
Transfer Protocol	The POCs will ftp the signed and encrypted command message files to the MOC.				
Availability	Under nominal circumstances the POCs will send the command messages to the MOC at least 4 hours prior to the primary contact. Currently, no maximum advance time limit exists. If a situation arises where a POC needs to issue commands in real-time or less than the 4-hour limit the POC team must coordinate the sending of these commands with the MOC team.				
Format	• ASCII Header Data • ^L (to delimit the end of the Header) • Binary CCSDS Telecommand Packet				
Contents					
Block	**Item**	**Size**	**Type**	**Units/Range**	**Delimiter****
Authentic-ation block	POC Facility ID	4	Alphanumeric	GUVI, SABE, SEE_, TIDI	CR, LF, or CR/LF
Time Block	Command Delivery Enable Time	0 or 13	Alphanumeric	UT in yyyydoyhhmmss	CR, LF, or CR/LF
	Command Delivery Time-out	0 or 13	Alphanumeric	UT in yyyydoyhhmmss	CR, LF, or CR/LF
	Command Delivery Delta Time-out	0 - 5	Alphanumeric	Delta seconds (Range: 0 - 86400)	CR, LF, or CR/LF
Command Description Block	Script Line Number*	4	Alphanumeric	NA	CR, LF, or CR/LF
	Script Version Number*	0 - 4	Alphanumeric	NA	CR, LF, or CR/LF
	Script Name*	Variable (0 - 132)	Alphanumeric	NA	CR, LF or CR/LF
	Command Description	Variable (0 - 132)	Alphanumeric	NA	NA
End of Header Indicator	End of ASCII Header Indicator	1	Alphanumeric	^L	NA
CCSDS Tele-command Block	CCSDS Telecommand	Variable (7- 4006)	Byte	NA	NA

*The test script fields are not required outside of Integration and Test; however, the delimiters for these fields are always required.

**Whenever the choice of delimiters is CR, LF, or CR/LF the same choice of delimiter must be used throughout the table.

8.2.3.2. Test Scripts

During spacecraft integration and test, the POCs will provide the MOC with hardcopy output of their test scripts. These scripts will be annotated with line numbers. They will be provided to the test conductor prior to test execution. For a complete description of integration and test please see **Reference 8-12. TIMED Spacecraft Integration Test Plan, JHU/APL, 7363-9020**.

8.2.3.3. Alarm Log

During spacecraft integration and test, the POCs will provide the MOC with alarm logs indicating any alarm that triggered during a test. These logs will be provided to the MOC after each test. The POCs will send blank alarm logs if no alarms were generated during the test. The test conductor will use these alarm logs to initiate problem resolutions. The detailed definition for the file is provided in Table 8.2.3-4. Alarm Log File Format. For a complete description of integration and test please see **Reference 8-12. TIMED Spacecraft Integration Test Plan, JHU/APL, 7363-9020**.

Table 8.2.3-4. Alarm Log File Format

Filename Convention	inst_test_yyyydoyhhmmss.alm		
Transfer Protocol	The POCs will ftp the alarm logs to the MOC after each test		
Availability	These alarm logs will only apply during integration and test. They will be FTP'd by the POCs to the MOC after each test.		
Format	ASCII		
Contents			
Standard Header	For contents of standard header see: APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.		
	For each alarm in the file		
Row #	**Item**	**Delimiter**	**Range**
1	Ground Receipt Time	tab	UT in yyyydoyhhmmss
1	Spacecraft Time	tab	UT in yyyydoyhhmmss
1	Alarm Mnemonic	tab	POC defined 32 char max
1	Value in Engineering Units	tab	POC defined
1	Condition	tab	Red_High, Red_Low, Yellow_High, Yellow_Low, Red, Yellow
…	…	…	CR, LF, CR/LF
N	Ground Receipt Time	tab	UT in yyyydoyhhmmss

Table 8.2.3-4. Alarm Log File Format			
N	Alarm Mnemonic	tab	POC defined 32 char max
N	Value in Engineering Units	tab	POC defined
N	Condition	tab	Red_High, Red_Low, Yellow_High, Yellow_Low, Red, Yellow

8.2.3.4. Ad Hoc Housekeeping Log

During spacecraft integration and test, the test conductor will be troubleshooting spacecraft and instrument problems. Occasionally, the test conductor will need to time-merge spacecraft and instrument housekeeping data to initiate problem resolutions. At these times the test conductor will call the POCs to request time ordered ASCII housekeeping log files. The test conductor will inform the POCs of what types of housekeeping items need to be included in the log file. Table 8.2.3-5. Ad Hoc Housekeeping Log File Format provides the detailed definition of this file. For a complete description of integration and test please see **Reference 8-12. TIMED Spacecraft Integration Test Plan, JHU/APL, 7363-9020**

NOTE: The Ad Hoc Housekeeping Logs may be used during mission operations as well to assist in troubleshooting anomalous scenarios.

Table 8.2.3-5. Ad Hoc Housekeeping Log File Format			
Filename Convention	inst_yyyydoyhhmmss.tlm		
Transfer Protocol	The POCs will ftp the Housekeeping Logs		
Availability	As requested		
Format	ASCII		
Contents			
Standard Header	For contents of standard header see APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.		
	Row 1 defines column headings, Rows 2..n define the time specified rows of housekeeping data items		
Row #	**Item**	**Delimiter**	**Range**
1	Ground Receipt Time Column Heading	tab	'GR_TIME'
1	Spacecraft Time Column Heading	tab	'SC_TIME'
1	Mnemonic 1 Column Heading	tab	POC defined 32 char max

Table 8.2.3-5. Ad Hoc Housekeeping Log File Format			
1	Mnemonic n Column Heading	tab	POC defined 32 char max
2	Ground Receipt Time	tab	UT in yyyydoyhhmmss
2	Spacecraft Time	tab	UT in yyyydoyhhmmss
2	Value 1 in Engineering Units	tab	POC defined
2	Value n in Engineering Units	tab	POC defined
…	…	…	CR, LF, CR/LF
N	Ground Receipt Time	tab	UT in yyyydoyhhmmss
N	Spacecraft Time	tab	UT in yyyydoyhhmmss
N	Value 1 in Engineering Units	tab	POC defined
N	Value n in Engineering Units	tab	POC defined

8.2.4. MOC to POC Interfaces

A high level diagram of the MOC to POC interfaces is depicted in Figure 8.2.4-1. Mission Operations Center to Payload Operations Center Interfaces below.

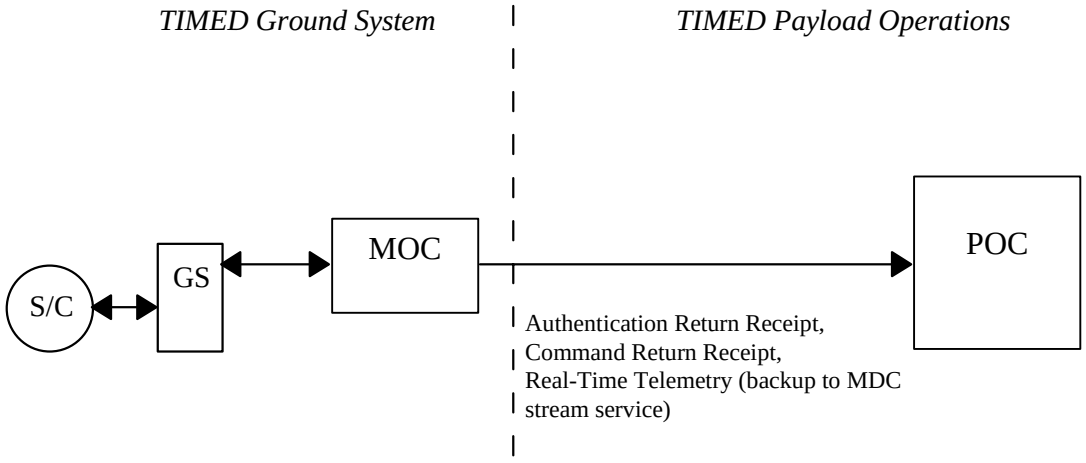

Figure 8.2.4-1. Mission Operations Center to Payload Operations Center Interfaces

8.2.4.1. Authentication Return Receipt

After the POCs send their command messages to the MOC, the MOC will perform decryption, valid source/destination checking, and some minimal syntax checking. When the command is authenticated and the source/destination pair is validated Authentication Return Receipt will be issued to the appropriate POC indicating success. If the command fails any step the Authentication Return Receipt will be issued indicating the source of the error. The POCs can expect an Authentication Return Receipt in response to their command message file within approximately 3-seconds + (2*time to FTP their command message file). If after an extended period of time a POC does not receive an ARR the POC operator should call the Mission Operations Center to determine if there is a problem.

The original command description block from the command message and CCSDS TC Primary header will be provided to assist in logging command status at the POCs. If the command message fails decryption/authentication the MOC will issue a failure ARR to the issuing POC. A graphical representation of this file is provided in Figure 8.2.4-2. Authentication Return Receipt Block Diagram. The detailed definition can be found in Table 8.2.4-1. Authentication Return Receipt File Format.

Table 8.2.4-1. Authentication Return Receipt File Format

Filename Convention	iinnnnnn.arr where ii denotes the first two characters of the instrument name and nnnnnn is user defined				
Transfer Protocol	The MOC will ftp the Authentication Return Receipt to the POC facility.				
Availability	As soon as authentication and source/destination validation is performed the MOC will issue the Authentication Return Receipt.				
Format	• ASCII Header Data • ^L (to delimit the end of the Header) • Binary CCSDS Telecommand Primary Header				
Contents					
Block	**Item**	**Size**	**Type**	**Units**	**Delimiter****
ASCII Header	Time of Acceptance or Failure	13	Alpha numeric	UT in yyyydoyhhmmss	CR, LF, or CR/LF
	Success/Failure Flag	Variable (max = 3 chars)	Alpha numeric, mutually exclusive	0-999 (0= success, 1= Authentication Failure, 2= Source/Destination Pair Invalid, 3= Syntax Error, 4= Enable time after expire, 5= Expire before MOC Receipt)	CR, LF, or CR/LF
	Command Description*	Variable (0 - 132)	Alpha numeric	NA	NA
	End of Header Indicator*	1	Alpha numeric	Control L (^L)	NA
CCSDS Primary TC Header	CCSDS Telecommand Primary Header*	6	Byte	NA	NA

* These fields will not be available when the Success/Failure Flag = 1 or 3; Authentication Failure or Syntax Error.

**Whenever the choice of delimiters is CR, LF, or CR/LF the same choice of delimiter must be used throughout the table.

8.2.4.2. Command Return Receipt

After successful authentication of a POC command message, the ground system stages the command for delivery to the instrument. A Command Return Receipt is returned to the originating POC to indicate the final disposition of the message. If the command message is successfully sent to the instrument a success CRR is returned. If the delivery time out is exceeded or if the MOC controller flushes the command, a failure receipt is returned. The original command description block from the command message and CCSDS Telecommand Primary Header will be provided to assist in logging command status at the POCs. A graphical representation of this file can be found below in Figure 8.2.4-3 Command Return Receipt Black Diagram. A detailed definition of the file can be found in Table 8.2.4-2. Command Return Receipt File Format. Note the differences between the ASCII headers in the Authentication Return Receipt and the Command Return Receipt.

ASCII Header	^L	CCSDS Telecommand Primary Header

Figure 8.2.4-2. Authentication Return Receipt Block Diagram

Table 8.2.4-2. Command Return Receipt File Format

Filename Convention	iinnnnnn.crr where ii denotes the first two characters of the instrument name and nnnnnn is user defined.				
Transfer Protocol	The MOC will ftp the Command Return Receipt to the POC facility.				
Availability	As soon as the command times out or is flushed by the controller or a successful delivery status from the C&DH is received at the MOC.				
Format	• ASCII Header Data • ^L (to delimit the end of the Header) • Binary CCSDS Telecommand Primary Header				
Contents					
Block	**Item**	**Size**	**Type**	**Units**	**Delimiter ***
ASCII Header	Time of Delivery to Instrument or Failure	13	Alphanumeric	UT in yyyydoyhhmmss	CR, LF, or CR/LF
	Success/Failure Field	3	Alphanumeric, mutually exclusive	0-999 (*currently 14 are defined where 1 through 11 are from the C&DH):* *0= Success,* *1= Spare,* *2= Spare,* *3= Spare,* *4= Spare,* *5= Spare,* *6= Spare,* *7= Spare,* *8= Spare,* *9= Spare,* *10=Spare,* *11=Timed out, Delivery Unknown** *12=Time-out, Delivery Failed* *, 13=Flushed By Controller, No Delivery* *14=Flushed by controller, Delivery Unknown** *"Delivery Unknown" means the command packet was in the verification queue, but it is not known whether delivery was completed.	CR, LF, or CR/LF
	Command Description	Vari	Alphanumeric	NA	NA

Table 8.2.4-2. Command Return Receipt File Format					
		able (0 - 132)			
	End of Header Indicator	1	Alphanumeric	Control L (^L)	NA
CCSDS Primary TC Header	CCSDS Telecommand Primary Header	6	Byte	NA	NA

*Whenever the choice of delimiters is CR, LF, or CR/LF the same choice of delimiter must be used throughout the table.

8.2.4.3. Real-Time Telemetry

The MOC will serve the real-time telemetry stream to the POCs as a backup to the MDC real-time telemetry stream service. With the exception of the IP address the interface is essentially the same as the MDC to POC real-time telemetry service detailed in Section 8.2.5.1.

8.2.5. MDC to POC Interfaces

A high level diagram of the MDC to POC interfaces is depicted in Figure 8.2.5-1. Mission Data Center to Payload Operations Center Interfaces below.

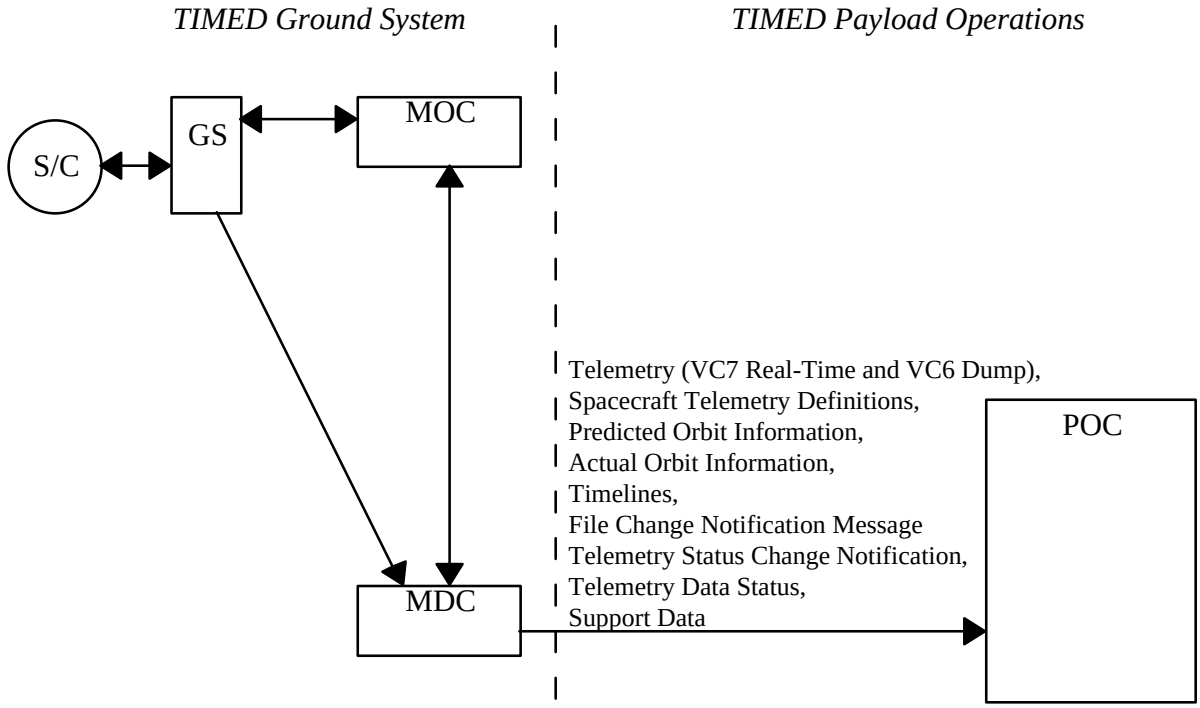

Figure 8.2.5-1. Mission Data Center to Payload Operations Center Interfaces

8.2.5.1. Instrument Telemetry to POCs

The POCs will receive telemetry stream service from the MDC using the process shown in Figure 8.2.5-2. Telemetry Stream Service. The directives used to initiate telemetry transfer while connected to the server are provided in APPENDIX 8-E: Real-Time and Playback Telemetry Service Directives.

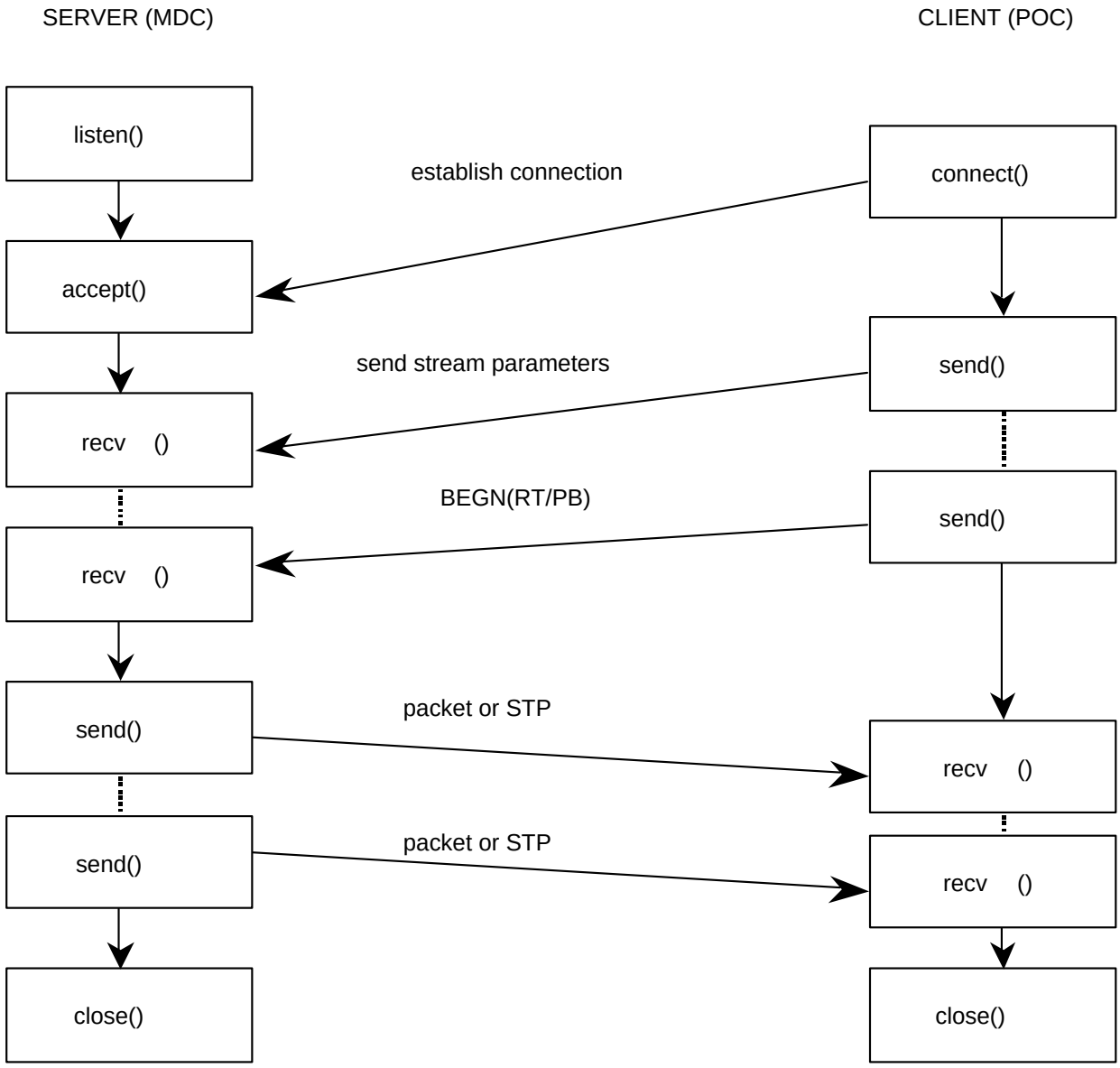

Figure 8.2.5-2. Telemetry Stream Service

FSCM NO.	SIZE	DWG. NO.
88898	A	7363-9050 B
		12/19/02
SCALE	DO NOT SCALE PRINT	SHEET 8-48

Real-time telemetry stream service will be available during the contact. It will be available by TCP/IP socket and will consist of a stream of CCSDS Telemetry Packets (TPs), Supplemented Telemetry Packets (STPs), or POC Telemetry Packets (PTPs) for one or more Application Process IDs (APIDs) as specified by the requester. The definition for the TPs can be found in Section 3.0 of this document. The definitions of the STPs and PTPs are shown in Figure 8.2.5-3. TIMED Telemetry Frame and Telemetry Packet Definitions. The TPs, STPs, and PTPs are obtained from Telemetry Frames(TFs) and Supplemented Telemetry Frames (STFs) which are also shown in Figure 8.2.5-3. The current definition of the Ground Receipt Header can be found in APPENDIX 8-C: Ground Receipt Header Definitions.

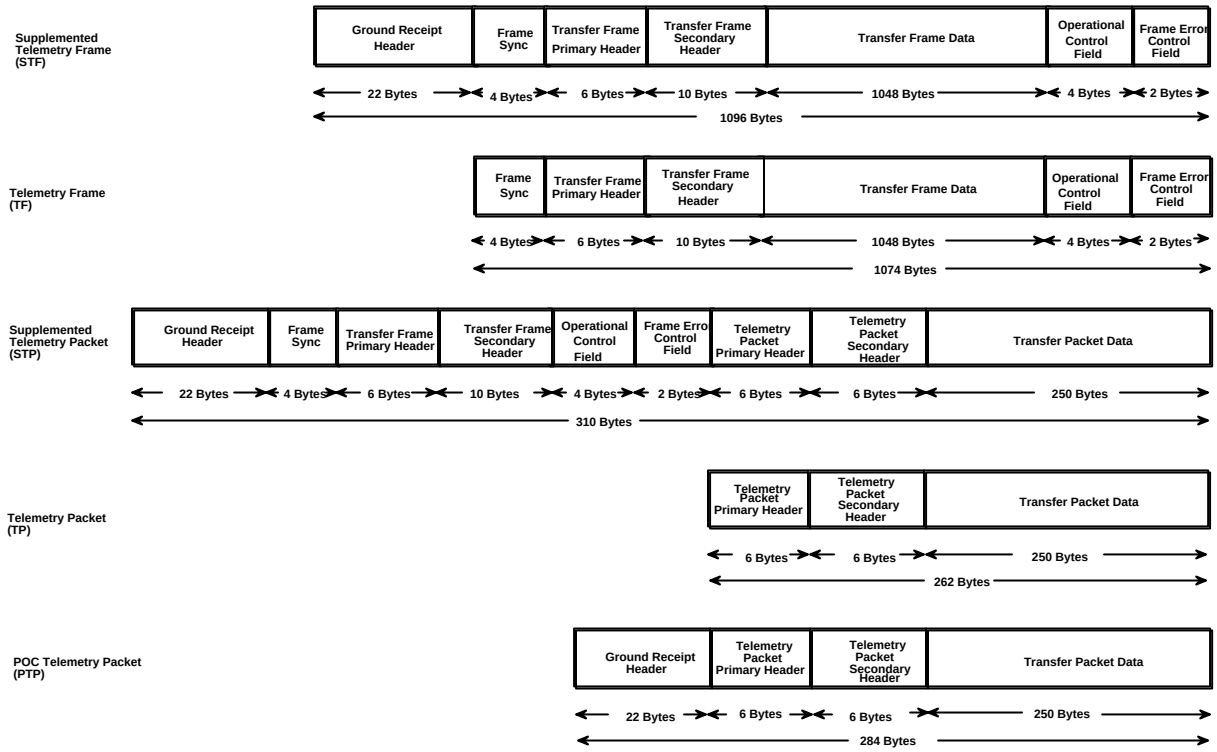

Figure 8.2.5-3. TIMED Telemetry Frame and Telemetry Packet Definitions

During the contact, real-time telemetry will be in ground receipt time order and will not be cleaned and merged. Since there is no system indication for the end of stream in real-time telemetry service the POCs will be expected to close the socket.

The real-time telemetry stream service rates, during a contact, will be at least 43.387 kbits/s. The bit rate is based on CCSDS packet streams. For users that want STPs or PTPs (which include additional header information), the rates will be raised so that the net packet data rates are the same as stated above. If the POC cannot keep up with the real-time data stream the

packets that it cannot pull are dropped. In total there will be 20 real-time sockets available to the POCs where each POC under nominal conditions will have access to 5 real-time sockets. Any attempt to open a real-time connection beyond the maximum number will result in failure to establish the new connection.

After contact, Virtual Channel Dump telemetry and Virtual Channel 7 real-time telemetry will be available by playback via TCP/IP socket stream service (and also by HTTP file transfer which will be covered later). Playback of telemetry can be requested in either ground receipt time or spacecraft time order with the selection of either Virtual Channel 6 (dump data), Virtual Channel 7 (real-time data), Virtual Channel 0 (fill data), or "ALL" virtual channels. If the POC cannot keep up with the playback data stream the process waits until the POC catches up. No packets will be dropped. When the stream is at the end of the requested data or at the end of the archive the POCs will receive a zero-filled STP, TP, or PTP indicating the end of the stream. After playing back data to the end of the archive, the telemetry server can be directed to wait for and playback new data by specifying a stop time beyond the end of the archive. The POCs are responsible for closing the socket connection after all requested data have been received.

Under nominal conditions the TIMED system will provide the playback of telemetry to the POCs within 36 hours of data acquisition on the spacecraft. Within the 36 hours after data acquisition on orbit it may take multiple solid-state recorder dumps to reconstruct the data stored on the solid-state recorder in the MDC. Telemetry from the solid-state recorder dumps will be available within 1 hour after the MDC receives data from the ground station after each pass. The POCs will have access to their telemetry as soon as the MDC receives the data; however, the telemetry may not be complete. It is expected that a complete set of data will be available 36 hours after acquisition on orbit. In total there will be 20 playback sockets available to the POCs where each POC under nominal conditions will have access to 5 playback sockets. The MDC telemetry service can be altered such that a POC may borrow a playback socket from another, but such borrowing is subject to the negotiated agreement with the other POC and the MDC. Any attempt to open a playback connection beyond the maximum number will result in failure to establish the new connection.

The bit rates provided below are based on CCSDS packet streams. For users that want STPs, which include additional header information, the rates will be raised so that the net packet data rates are the same as stated below. The playback server will provide the following minimum average data rates to each POC over any 12 hour period:

- SEE 7,671 bits/sec
- GUVI 26,099 bits/sec
- SABER 16,490 bits/sec
- TIDI 13,060 bits/sec

During mission operations, telemetry playback will be ordered by spacecraft time. During integration and test, spacecraft time may not be unique so the telemetry playback will be ordered by ground receipt time.

After contact telemetry data can also be obtained via HTTP file transfer. The use of the directives will be the same as with stream service with the exception that a stop time beyond the end of the archive will result in data only to the end of the current archive. With HTTP file transfer there will be no capability to wait for newly arriving data. The detailed definition of a telemetry file transferred via HTTP can be found in Table 8.2.5-1. POC HTTP Telemetry File Format.

When there is a need to view telemetry designated as having bad quality with either stream service or HTTP transfer the POCs can do so by requesting Telemetry Packets (TPs), Supplemented Telemetry Packets (STPs), or POC Telemetry Packets (PTPs) that contain packets marked as bad. Bad packets will be available only in ground receipt time order interleaved with the good packets.

Table 8.2.5-1. POC HTTP Telemetry File Format

Filename Convention	Filenaming convention is not applicable because the filenames are specified by the POC.
Transfer Protocol	◊ HTTP - VC6 Dump telemetry and VC7 Real-time telemetry will be available from the MDC via HTTP via the web. The files will consist of TPs STPs, or PTPs. (Note: Refer to the above paragraphs for the transfer protocol of stream service.)
Availability	◊ After the Contact - VC6 and VC7 data via HTTP transfer. Under nominal conditions: within 36-hours of data acquisition on the spacecraft. (Note: Refer to the above paragraphs for the availability of stream service.
Format	Binary
Content	Supplemented Telemetry Packets, CCSDS Telemetry Packets, or POC Telemetry Packets.

8.2.5.2. Spacecraft Telemetry Definitions

The spacecraft telemetry definitions will provide instrument facilities the capability to decommutate the spacecraft telemetry packets. There will be 7 files per APID – 1 for each spreadsheet type. The detailed definition of this file is provided in Table 8.2.5-2. Spacecraft Telemetry Definitions File Format.

Table 8.2.5-2. Spacecraft Telemetry Definitions File Format

Filename Convention	MOC_APID_yyyydoy_##_zzzz.def
Transfer Protocol	The MDC will make the files available via FTP and HTTP transfer via the web.
Availability	Initially as available and then as updates occur for the life of the mission
Format	Multiple Line, CSV (comma separated value) ASCII file
Contents	
Standard Header	For contents of standard header see: APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.

Column Name	Sheet	Description	# Of Chars	Comments*
				* defaults implemented by tlm_load
Mnemonic	All	unique id for telemetry point, 1st 3 characters reserved for subsystem id, e.g., "F1_" for subsystem Flight Computer #1. no blanks or special characters except underscore allowed. use uppercase.	15	
Description	Basic	description of telemetry point. no embedded double quotes or commas are allowed.	63	
Type	Basic	specifies how the SC value is interpreted:	15	defaults to UNSIGNED
		SIGNED for a two's complement binary number		
		UNSIGNED		
		FLOAT_IEEE		
		BYTE_ARRAY (for 32 bit times and for unsigned with > 32 bits)		
		RX2010		
		GPS_TIME		
Units	Basic	defines the units that will appear alongside the telemetry points in displays. note that some displays truncate this field to 2 characters.	7	optional
Conversion	Basic	defines the technique to be used in converting the raw value to engineering units and formatting the point for display:	7	defaults to DEC
		DEC display raw value in decimal, don't convert		
		HEX display raw value in hex, don't convert		
		FLOAT for floating point conversion		
		LINEAR for piecewise linear conversion		
		POLY for polynomial conversion		
		STATE displays state message		
		TIME for yyyyjjjhhmmss, works with byte array or gps_time type		
Subsystem	Basic	part of hierarchical system, subsystem structure;	15	

		supplied by MOT		
Invert_bit	Basic	called IB on spreadsheet: flips ones and zeros, i.e., one's complement	1	defaults to "N"
Reverse_BIt	Basic	called RB on the spreadsheet: bit-reverses the point, i.e., MSB on right instead of the left	1	defaults to "N"
Context_Point	Locations	if present, data are only extracted when the context_point assumes the value specified in the context value field (i.e. ,for subcommutation). called tlm_locations.context_mnemonic in the database.	15	optional defaults to "CC_APP_ID"
Context_Value	Locations	see description for context point	11	required if context point is used defaults to user input app id
Start Byte	Locations	the 0 based byte offset within the packet. for gse telemetry, the build tlm header is not considered to be a part of the packet. however, for gse telemetry, build tlm will create a 12 byte packet header, so gse telemetry starts at byte 12.	11	
Start Bit	Locations	0 based bit offset from the start byte. 0 is MSB.	11	
Data_Size	Locations	total size of telemetry point in bits called tlm_points.data_size and tlm_locations.num_bits in the database.	11	
Switch_Point	states, cal pairs, coefficients, and limits	context dependent point for state decoding, EU conversion, and limit checking. only one allowed per mnemonic. called tlm_points.context_mnemonic in the database.	15	optional
Switch_Conversion	states, cal pairs, coefficients, and limits	tells whether switch low and switch high limits are EU or RAW. called tlm_points.context_type in the database.	3	optional called "SC" on the spreadsheet
Switch_Low_Limit	states, cal pairs, coefficients, and limits	if a switch point is specified for the telemetry point, each STATE conversion, EU conversion, and limit check for this point may include one or more switch limits associated with the switch_point. however, switch_point ignored if switch limits not specified.	11	optional
Switch_High_Limit	states, cal pairs, coefficients, and limits	if a switch point is specified for the telemetry point, each STATE conversion, EU conversion, and limit check for this point may include one or more switch limits associated with the switch_point. however, switch_point ignored if switch limits are not specified.	11	optional
State_Low	states	for tlm points with STATE conversion, defines the low value	4	required if STATE conversion
State_High	states	for tlm points with STATE conversion, defines the high value	4	required if STATE conversion
State_Msg	states	for tlm points with STATE conversion, defines the associated text msg. the State_Msg is associated with the range between State_Low and State_High, inclusive. (only letters, numbers, period, and underscore allowed in State_Msg).	23	required if STATE conversion
Pair_Num	cal pairs	1-16, corresponding to pair raw and pair eng	2	required for each cal pair
Cal Pair Raw (1-16)	cal pairs	raw value for piecewise linear conversion	8	at least 2 pairs required if
Cal Pair Eng (1-16)	cal pairs	engineering value for piecewise linear conversion	8	conversion is linear
Coefficients (0-7)	coefficients	polynomial conversion constants e=C0 +C1*r + ...	11	required if conversion is poly if conversion is poly, all coeffs must be supplied
Yellow_Low_Limit	alarms	limit	11	required if any limits used
Yellow_High_LImit	alarms	limit	11	required if any limits used
Red_Low_Limit	alarms	limit	11	required if any limits used
Red_High_Limit	alarms	limit	11	required if any limits used
Range_Type	alarms	tells whether limits are inclusive or exclusive, normal or inverted. can be NORMAL INCLUSIVE,	20	defaults to "NORMAL_INCLUSIVE"

		NORMAL_EXCLUSIVE, INVERTED_INCLUSIVE, or INVERTED_EXCLUSIVE. Normal means green is between yellow_low and yellow_high. Inverted means green is less than yellow_low or greater than yellow_high. Inclusive means that a value equal to a limit is alarmed with the color of the alarm. Exclusive means that a value equal to a limit is not alarmed with the color of the alarm.		
Value_Type	alarms	tells whether limits for this telemetry point are raw or EU	8	required if any limits used called "VT" on the spreadsheet
User 1	user defined	field used by subsystem for reference, not used by MOC	20	optional
User 2	user defined	field used by subsystem for reference, not used by MOC	20	optional
User 3	user defined	field used by subsystem for reference, not used by MOC	20	optional
User 4	user defined	field used by subsystem for reference, not used by MOC	20	optional

8.2.5.3. Timelines

The MDC will make all the following TIMED timeline files available via the web to assist in POC command planning:

- Individual timelines generated by the POCs, MOC, and project scientist
  - Planned Timeline Files
  - As Flown Timeline Files
- Merged timelines generated by the MDC which include all sources of the timeline data
  - Long Range Planning Report
  - As Flown Report
  - Planned/As Flown On-line Interactive Report

The POCs will forward their individual timeline files to the MDC to be posted on the web by the MDC.

8.2.5.3.1. Planned and As Flown Timelines

The Planned and As Flown Timelines consist of time specified modes, events, and anomalies. These timelines are planning products that will assist the TIMED POC teams and scientists in coordinating experiments and data acquisition between TIMED instruments and ground-based experiments.

Modes are stable and mutually exclusive instrument configurations where there should be only a few mode changes per day. The mode changes should be meaningful to those doing data analyses. Understanding the modes should not require an in-depth knowledge of the instrument. Events are short duration occurrences from which standard data products are usually not generated such as calibration sequences, command uploads, etc. Anomalies are unplanned occurrences that may be important to those doing data analyses. Anomalies only apply to the as flown timelines. Examples include extended data dropouts, processor resets, temperature alarms, etc.

Planned Timelines shall cover a time period of either one week or 8 weeks. The choice of which is used shall be consistent for all Planned Timelines that are provided by any given POC, GBI, or MOC. The start and stop times in the header shall always be yyyydoy 00:00:00 Z Monday and yyyydoy 23:59:59 Z Sunday, respectively, and shall reflect either one week or eight weeks. Alternatively, the stop time may be identified 1 second later at the 00:00:00 boundary.

As Flown Timelines shall cover a time period of either one day or one week. The choice of which is used shall be consistent for all As Flown Timelines that are provided by any given POC, GBI, or MOC. For the case where the period is one day, the start and stop times in the header shall always be yyyydoy 00:00:00 Z and yyyydoy 23:59:59 Z, respectively, reflecting the operational day covered. For the case where the period is one week, the start and stop times in

the header shall always be yyyydoy 00:00:00 Z Monday and yyyydoy 23:59:59 Z Sunday, respectively, reflecting the operational week covered. Alternatively for either one-day or one-week timelines, the stop time may be identified 1 second later at the 00:00:00 boundary.

The start and stop times for each entry in Planned and As Flown Timelines shall follow either of two methods, and the timeline supplier shall pick one of these methods and use it consistently throughout the mission.

8.2.5.3.1.1. Method I for Timeline Entry Start and Stop Times

The start time for each entry in both Planned and As Flown Timelines shall be the real start time of the entry. If there is a need to submit an entry with a start time prior to the time range of the timeline currently being created, then a different timeline should be created and submitted that covers the start time of the entry and the entry should be included in that timeline.

The stop time of each entry in both Planned and As Flown Timelines shall be the real stop time of the entry with the following exception: If the actual stoppage of the entry has not yet occurred on the spacecraft or the stoppage is not yet planned, then the stop time shall be left blank.

8.2.5.3.1.2. Method II for Timeline Entry Start and Stop Times

Modes, events, and anomalies that span timeline boundaries should be split at the timeline's boundaries such that each entry is contained entirely within the boundaries of each timeline. In other words, if an entry in a timeline started before the time period covered in the timeline, the start time given to that entry in the timeline shall be the start time of the period covered in the timeline (000000Z of the earliest day of the time period reflected in the timeline header). The portion of the mode, event, or anomaly that occurred prior to this timeline would be included in the previous timeline with its stop time matching that timeline's stop time. (Note: To determine if an entry really started at exactly the starting time of the timeline or whether it was a carryover from a previous time period, one must refer to the timeline for the previous time period to see if there was a change in the entry or just a continuation.)

If an entry in a timeline continues past the time period covered in the timeline, the stop time for that entry shall be left blank or set to the stop time of the period covered in the timeline (235959Z of the latest day reflected in the timeline header).

For timelines that cover 1 day (a valid time-span choice for As Flown Timelines only), this day covered in the timeline shall be encoded in the filename as year and day of year in *yyyydoy* format. For timelines that cover 1 week (a valid time-span choice for As Flown or Planned Timelines), the Monday representing the start date of the 1-week period covered in the timeline shall be encoded in the filename in *yyyydoy* format. Similarly, for timelines that cover 8 weeks (a valid time-span choice for Planned Timelines only), the Monday representing the start

date of the 8-week period covered in the timeline shall be encoded in the filename in *yyyydoy* format.

The timeline file definition is provided in Table 8.2.5-3. Planned and As Flown Timeline File Format.

Table 8.2.5-3. Planned and As Flown Timeline File Format

Filename Convention	inst_yyyydoy_cc_##.tln where yyyydoy is the year and day of year of the start time of the interval covered; see Header item Start Time below. (The abbreviation for the project scientist, "PSCI", or the abbreviation for the MOC is used in place of the abbreviation for the instrument as appropriate.)				
Transfer Protocol	The POCs will FTP the timelines to the MDC, which will subsequently make them available via FTP and HTTP transfer via the web.				
Availability	The files will be provided to the MDC as soon as they are available from the POCs and subsequently, the MDC will make them available via the web. The timelines generated by the MOC and project scientist will also be available. The files may include data up to 8-weeks ahead of contact.				
Format	tab delimited ASCII file, EXCEL compatible				
Contents					
Standard Header	For contents of standard header see: APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.				
Block	**Item**	**Required/ Optional**	**Data Type**	**Delimiter***	**Range**
Header	Instrument Name	R	Alphanumeric (20 max)	tab	GUVI, SABER, SEE, or TIDI, MOC or PSCI (for Project Scientist)
	Date Generated	R	Alphanumeric (7)	tab	UT - yyyydoy
	Start Time	R	Alphanumeric (13)	tab	UT - yyyydoyhhmmss where doy is as used in Filename.
	End Time	R	Alphanumeric (13)	tab	UT- yyyydoyhhmmss
	Planned/ As Flown Flag	R	Alphanumeric (1)	tab	P or A
	New/Append/ Replace flag	R	Alphanumeric (1)	tab	N, A or R where: N: new timeline A: append this timeline information to that received previously for this time period.** R: replace previously received timeline information with this replacement information.***
	Header comment	O	Alphanumeric (0-255)	CR, LF, CR/LF	No tabs within comment text
Body	For each mode, event or anomaly entry, a line consisting of:				
	Entry Type	R	Alphanumeric(1)	tab	M, E, or A (mode, event, or anomaly)
	Entry ID	R	Alphanumeric (1-10)	tab	Mode, event or anomaly identifier
	Start time	R	Alphanumeric (13)	tab	S/C UT - yyyydoyhhmmss
	Stop time	O	Alphanumeric (13)	tab	S/C UT - yyyydoyhhmmss
	parameter id/value pairs	O	Alphanumeric	tab	parm id=value pairs appropriate for the mode given for this entry (multiple pairs are to be comma separated)
	Comments	O	Alphanumeric (512 max)	CR, LF, or CR/LF	no tabs within comment field

*Whenever the choice of delimiters is CR, LF, or CR/LF the same choice of delimiter must be used throughout the table. Tabs are required for optional fields that are not used.

**If there is an entry pre-existing in the catalog (the repository of timeline information) that has the same source, entry type, entry ID, Planned/As Flown flag and start time as the new entry in the "Append" timeline, it will be removed from the catalog and replace with the new entry from the "Append" timeline. This replacement will occur regardless of where the start time of the entry falls with respect to the time range in the timeline header.

***If an entry in the "New/Replace" timeline is a carryover from an earlier timeline (i.e. its start time falls before the timeline header time range and it has the same source, entry type, entry ID, Planned/As Flown flag and start time as an entry pre-existing in the catalog) the new entry from the "New/Replace" timeline will replace the pre-existing entry in the catalog. This allows the stop time and/or mode parameters to be changed for the carryover entry without sending a new timeline encompassing the start time of that entry. However, if the *start* time of the carryover entry needs to be changed, replacement timelines encompassing the old and new start times must be re-sent. This is because an entry in the catalog is uniquely identified by its source, entry type, entry ID, Planned/As Flown flag and start time. If a new start time for an entry is provided in the "New/Replace" timeline, the catalog has not knowledge of the original entry to which it refers and therefore does not know what to replace. This leads to the requirement for re-sending replacement timelines encompassing the old and new start times when an entry's start time needs to be changed.

8.2.5.3.2. Merged Timeline Reports

The Long-Range Planning Report will contain long-range planning data merged from the Planned Timeline Files from the MOC, POCs, and project scientist. The content of the report is sorted first by start time, then by instrument name. The details of the report are identified in Table 8.2.5-4. Long-Range Planning Report File Format.

Table 8.2.5-4. Long-Range Planning Report File Format

Filename Convention	MDC__yyyydoy_cc_##.rpt		
Transfer Protocol	The MDC will make the files available via FTP and HTTP transfer via the web.		
Availability	Every operational week a new report will be generated and will contain data for 8 weeks after the date of generation where an operational week is defined as 000000Z Monday to 235959Z Sunday. Each report will be available only until the next one is generated. These data available at time 000000Z Monday of an operational week will include data received prior to time 000000Z of the preceding Sunday.		
Format	Tab delimited ASCII file, EXCEL compatible.		
Contents			
Standard Header	For contents of standard header see APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions		
Column #			
1	Start time	R	
2	Instrument name	R	
3	Entry type	R	
4	Entry id	R	
5	Stop time	O	
6	Parameter id/value pairs	O	
7	Comments	O	

The As Flown Report will contain the as flown modes, events, and anomalies data merged from the As Flown Timeline files from the MOC, POCs, and project scientist. The content of the report is sorted first by start time, then by instrument name. The details of the report are identified in Table 8.2.5-5. As Flown Report File Format.

Table 8.2.5-5. As Flown Report File Format			
Filename Convention	MDC__yyyydoy_cc_##.rpt		
Transfer Protocol	The MDC will make the files available via FTP and HTTP transfer via the web.		
Availability	Every operational week a new report will be generated. The data will be available 120000Z Thursday for the previous operational week 000000Z Monday through 235959Z Sunday, and includes all data received by 120000Z Wednesday. The reports will be updated as needed and will be available on-line for the duration of the mission.		
Format	Tab delimited ASCII file, EXCEL compatible.		
Contents			
Standard Header	For contents of standard header see APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions		
Column #			
1	Start time	R	
2	Instrument name	R	
3	Entry type	R	
4	Entry id	R	
5	Stop time	O	
6	Parameter id/value pairs	O	
7	Comments	O	

In addition to the merged timeline files described above an additional on-line interactive report will be available via the web that will enable the MOC, POCs, and project scientist to specify a time range of the data, the source(s) of the timelines, and the type of the data -Planned or As Flown.

8.2.5.3.3. Valid Event and Anomaly Identifiers

The valid event and anomaly identifiers for all of the timeline files are provided in Table 8.2.5-6. Valid Event, Anomaly and Mode Identifiers; parameter identifiers are provided in Table 8.2.5-7. Valid Instrument Mode Parameter Identifiers. Mode identifiers and parameter are user defined and are limited to 10-characters.

Table 8.2.5-6. Valid Event, Anomaly and Mode Identifiers

Entry Type	Entry ID	Meaning
Event	CAL	Instrument calibration sequence (outside of nominal mode)
Event	PR CONTACT	Primary S/C contact
Event	BK CONTACT	Back-up S/C contact
Event	COOP	Cooperative measurement schedule during this timed (described in comments)
Event	HIGH PRIOR	The event is classified as having a high priority
Event	RT COMMAND	Real-time command
Event	USER	User defined event, type of event is described in the comment
Event	SW UPLOAD	Software upload
Event	YAW	TIMED special 180˚ yaw maneuver in progress
Event	SP ROTATE	Solar panel rotation in progress
Event	Dark	Non-solar pointing SEE experiment
Event	Dark_Field	Non-solar pointing, SEE EGS image generated with the lamp OFF
Event	Flat_Field	Non-solar pointing, SEE EGS image generated with the lamp ON
Event	Load_Cmds	Load Commands
Event	TIMER	Timer
Event	MOMNT DUMP	TIMED momentum dump in progress; event ends when torque rods have been powered down for 150 seconds.
Event	MANEUVER	TIMED maneuver other than YAW maneuver (described in comments)
Anomaly	SHUTDOWN	Instrument shutdown
Anomaly	DATA LOSS	Significant data loss
Anomaly	BAD CONFIG	Instrument was placed in an improper

Table 8.2.5-6. Valid Event, Anomaly and Mode Identifiers		
		configuration
Anomaly	REDLIMIT	Critical value exceeded that may effect data quality (describe in comments)
Anomaly	DATAWARN	Data during this period may be suspect (described in comments)
Anomaly	USER	User defined (described in comment)
Anomaly	SEE_Off	SEE Off
Anomaly	OutOfLimit	SEE telemetry point exceeded a limit
Anomaly	ODC_Missed	A SEE experiment was skipped
Anomaly	TidiAnomaly	TIDI Anomaly
Anomaly	Att/Rate	TIMED out of attitude or attitude rate specs
Anomaly	GAP	TIMED gap in SSR recorder
Mode	IMAGING	GUVI imaging mode
Mode	STAT IMAG	GUVI static imaging mode
Mode	SPECTRO	GUVI spectrograph mode
Mode	TEST	GUVI test mode
Mode	MAINT	GUVI maintenance mode
Mode	SHUTDOWN	SABER Shutdown
Mode	Calibrate	SEE Calibrate
Mode	Solar_Obs	SEE Solar Observation
Mode	POWERUP	SABER Power Up
Mode	STANDBY	SABER Standby
Mode	STABILIZATION	SABER Stabilization
Mode	CALIBRATE	SABER Calibrate
Mode	DATACOL	SABER Data Collection
Mode	MEMDUMP	SABER Memory Dump
Mode	DIAGNOSTIC	SABER Diagnostic
Mode	SAFE	SABER Safe
Mode	SAFE	TIMED Safe
Mode	ControlProgram	TIDI Control Program
Mode	SaveMode	TIDI Save Mode
Mode	OPER	TIMED Operational
Mode	NADIR	TIMED Nadir
Mode	AIU_BOOT	TIMED Attitude Interface Unit rebooting

Table 8.2.5-7. Valid Instrument Mode Parameter Identifiers		
Parameter ID	**Parameter Type**	**Source/Instrument**

Table 8.2.5-7. Valid Instrument Mode Parameter Identifiers		
DET_SEL	detector selection	GUVI
SLIT	slit position	GUVI
SCAN_MOTOR	scan motor position	GUVI
FORCE_CONV	forced convert option	GUVI
FAN	FAN	GUVI
XPS	XPS	SEE
EGS	EGS	SEE
ODC	ODC	SEE
MIRROR	MIRROR	SABER
COOLER	COOLER	SABER
AS	AS	SABER

8.2.5.4. Predicted Orbit Information

8.2.5.4.1. Predicted Position, Velocity, Attitude, and Time (PVAT) Data

The MDC will provide predicted PVAT orbit information for each day up to 8 weeks in advance in two different file formats: 1) a netCDF file containing position, velocity, attitude, time and a daily 2-line orbit element set; and 2) an ASCII file containing a daily 2-line orbit element set plus a seed position, velocity, time vector in both EC/EF and ECI coordinates. Considered a planning product the predicted orbit information will assist the POC teams in planning instrument modes, events, and experiments up to 8 weeks in the future. The range, units, and resolution for the orbital elements can be found in the product specification which is accessible from the TIMED web site.

The predicted orbit information will be based on data from the spacecraft GPS. These data from the GPS will be nominally downloaded daily providing better estimates on the orbit as time to the orbit decreases. The estimated accuracy for the orbit information for 4 days out will be 8 km cross track. The estimated accuracy for 8 weeks out will be approximately 150 km cross track based on a 10-minute along-track accuracy. Any changes will be reflected in a later version of this document.

The attitude data prediction will be based on perfect nadir pointing. This means that the predicted yaw in the file will not necessarily correspond to the exact time and position of a spacecraft yaw maneuver.

Each file will represent a day's worth of data. There will be a version number associated with each file so that as updates to the orbit information are provided an indication that the files have been updated will be maintained. The detailed definition of these files can be found in Table 8.2.5-8. Predicted Position, Velocity, Attitude, and Time NetCDF File Format and Table 8.2.5-9. Predicted Orbit ASCII File Format. Use of the flags items is important to ensure that data is valid and for the desired modes.

Table 8.2.5-8. Predicted Position, Velocity, Attitude, and Time NetCDF File Format

Filename Convention	MDC__yyyydoy_###_##.npo where the date in the file name corresponds to the date of the data in the file
Transfer Protocol	The POCs will FTP or HTTP the predicted p, v, t files from the MDC.
Availability	8 weeks in advance with daily updates
Format	netCDF
Resolution	PVAT data will be every minute; Leap seconds are 1-set per day; one 2-line orbit element set per day
Contents	

Table 8.2.5-8. Predicted Position, Velocity, Attitude, and Time NetCDF File Format

Global Attributes	For contents of global attributes see: APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.	
Item	**Units**	**Data Type**
Spacecraft time (applies only to Position, Attitude and Velocity data contained in the file)	seconds since 00:00:00 Jan. 6, 1980	Integer 32
Time Vernier for Position, Velocity Data	microseconds of second	Integer 32
Time Vernier for Attitude Data	microseconds of second	Integer 32
Position (Earth Centered Inertial referenced to ECI J2000)	x,y,z in km	Float 64
Position (Earth Centered, Earth Fixed)	x,y,z in km	Float 64
Position (Earth Centered, Earth Fixed)	latitude as –90-+90 degrees north, longitude as 0-360 degrees east, height in km	Float 64
Attitude Quaternion (Earth Centered Inertial to Spacecraft Coordinates)	Not Applicable	Float 64
Roll, Pitch and Yaw (Spacecraft Coordinates)	degrees where roll, pitch and yaw correspond to rotations about the x,y,z axes, respectively.	Float 64
Velocity (Earth Centered Inertial)	x,y,z vectors in km/sec	Float 64
Velocity (Earth Centered, Earth Fixed)	x,y,z vectors in km/sec	Float 64
Attitude Rates	Radians/sec	Float 64
Guidance and Control (G & C) Solar Vector (Spacecraft Coordinates)	x,y,z	Float 64
Guidance and Control Data Validity flags acquired from the High Priority House Keeping packet, bit offset 80 through 87	Byte 1: 1st LSB set indicates spacecraft is in Nadir Pointing mode; 0 indicates Operational mode. 2nd LSB set indicates spacecraft is in Safe mode; 0 indicates spacecraft is in either Nadir Pointing or Operational mode. 3rd LSB set indicates solar arrays are rotating. 4th LSB set indicates spacecraft in a yaw maneuver. 5th LSB set indicates ram direction is in +x direction. 6th LSB: Spare Warning flag 7th LSB: Spare Warning flag MSB: Spare Warning flag	Unsigned Integer 8
Guidance and Control Warning flags acquired from the High Priority House Keeping packet, bit offset 88 through 95	Byte 2: 1st LSB: Spare Validity indicator 2nd LSB: Spare Validity indicator 3rd LSB: Spare Validity indicator 4th LSB: Spare Validity indicator 5th LSB set indicates G & C data for Quaternion is valid. 6th LSB set indicates G & C data for	Unsigned Integer 8

Table 8.2.5-8. Predicted Position, Velocity, Attitude, and Time NetCDF File Format

	Sun vector is valid. 7th LSB set indicates G & C data for roll, pitch and yaw are valid. MSB set indicates G & C data for time and position are valid.	
GPS Navigation System (GNS)Validity Flags acquired from the High Priority House Keeping packet, bit offset 789 through 794, stored right justified in the byte and padded on the left with zeros.	1st LSB set indicates time jump in GPS data. 2nd LSB set indicates GNS data for Event Notification is valid. 3rd LSB set indicates GNS data for sun vector is valid. 4th LSB set indicates GNS data for time is valid. 5th LSB set indicates GNS data for velocity is valid. 6th LSB set indicates GNS data for position is valid. 7th LSB: Unused bit MSB: Unused bit	Unsigned Integer 8
GPS Navigation System Navigation Mode acquired from the Low Priority House Keeping packets #1 and 2, bit offset 1576 through 1581	Not Applicable	Unsigned Integer 8
GPS Navigation System Time Precision acquired from the Low Priority House Keeping packets #1 and 2, bit offset 1582 through 1583	Not Applicable	Unsigned Integer 8
MDC flags	1st LSB set means PVT and GNS data and flags absent. 2nd LSB set means Attitude and G&C data and flags absent. 3rd LSB set means roll, pitch, and yaw undetermined; unable to resolve quaternion. 4th LSB set means navigation mode absent; unable to determine if S/C in GPS tracking mode or element propagation mode. 5th LSB set means time precision absent; unknown if time is precise: this affects how well roll, pitch, and yaw can be known. 6th LSB: Unused bit 7th LSB: Unused bit MSB: Unused bit	Unsigned Integer 8
Per Day:		
Leap seconds	Number of leap seconds since 00:00:00 Jan. 6, 1980	Integer 16

Table 8.2.5-8. Predicted Position, Velocity, Attitude, and Time NetCDF File Format

2-line orbit element set:

The only valid characters in a 2-line element set are the numbers 0-9, the capital letters A-Z, the period, the space, and the plus and minus signs—no other characters are valid. Not all valid characters can be used in all character positions within the element set. The line representations below show what type of character is valid for each character position. Character positions with a space or period can have no other character. Character positions with an 'N' can have any number 0-9 or, in some cases, a space. Character positions with an 'A' can have any character A-Z or a space. The character position with a 'C' can only have a character representing the classification of the element set—normally either a 'U' for unclassified data or an 'S' for secret data (of course, only unclassified data are publicly available). Character positions with a '+' can have either a plus sign or a space and character positions with a '-' can have either a plus or minus sign.

Lines 1 and 2 representation:

```
1 NNNNNC NNNNNAAA NNNNN.NNNNNNNN +.NNNNNNNN +NNNNN-N +NNNNN-N N NNNNN
2 NNNNN NNN.NNNN NNN.NNNN NNNNNNN NNN.NNNN NNN.NNNN NN.NNNNNNNNNNNNN
```

Line Character Position	Field Name		
Line 1 which contains the following fields:			Character Array 69
01-01	Line Number of Element Data		
03-07	Satellite Number	NA	
10-11	International Designator (Last 2-digits of launch year)	NA	
12-14	International Designator (Launch number of year)	NA	
15-17	International Designator (Piece of Launch)	NA	
19-20	Epoch Year (Last 2-digits of year)	NA	
21-32	Epoch (Julian Day and fractional portion of the day)	NA	
34-43	First Time Derivative of the Mean Motion or Ballistic Coefficient (depending on ephemeris type)	NA	
45-52	Second Time Derivative of the Mean Motion (decimal point assumed; blank if N/A)	NA	
54-61	BSTAR drag term if GP4 general perturbation theory was used. Otherwise, radiation pressure coefficient. (decimal point assumed)	NA	
63-63	Ephemeris Type	NA	
65-68	Element Number	NA	
69-69	Checksum (modulo 10) (letters, blanks, periods, plus signs = 0; minus signs = 1)	NA	
Line 2 which contains the following fields:			Character Array 69
01-01	Line Number of Element Data	NA	
03-07	Satellite Number		
09-16	Inclination	Degrees	
18-25	Right Ascension of the Ascending Node	Degrees	
27-33	Eccentricity (Decimal point assumed)	NA	

Table 8.2.5-8. Predicted Position, Velocity, Attitude, and Time NetCDF File Format			
35-42	Argument of Perigee	Degrees	
44-51	Mean Anomaly	Degrees	
53-63	Mean Motion	Revs/day	
64-68	Revolution number at Epoch	Revs	
69-69	Checksum (modulo 10)	NA	

Table 8.2.5-9. Predicted Orbit ASCII File Format			
Filename Convention	MDC__yyyydoy_##.apo		
Transfer Protocol	The POCs will FTP or HTTP the predicted orbit files from the MDC.		
Availability	8 weeks in advance with daily updates		
Format	ASCII, 2-Line Orbit Element Set Format		
Contents			
Standard Header	For contents of standard header see: APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.		
Row #	**Item**	**Units**	**Data Type**
1	Line 1 of the 2-line orbit element set. (Refer to the above netCDF PVAT file format for a description.)	NA	Alphanumeric (69)
2	Line 2 of the 2-line orbit element set. (Refer to the above netCDF PVAT file format for a description.)	NA	Alphanumeric (69)
3	Position (Earth Centered Inertial referenced to ECI J2000)	x,y,z in km	Alphanumeric
4	Position (Earth Centered, Earth Fixed)	x,y,z in km	Alphanumeric
5	Velocity (Earth Centered Inertial)	x,y,z in km/sec	Alphanumeric
6	Velocity (Earth Centered, Earth Fixed)	x,y,z in km./sec	Alphanumeric
7	Spacecraft Time	Seconds since 00:00:00 Jan 6, 1980	Alphanumeric
8	Time Vernier	milliseconds of second	Alphanumeric

8.2.5.4.2. Predicted Orbit Number File

The MDC will make available a single file that contains the predicted orbit numbers and predicted start/stop times of the orbits for each day up to 8 weeks in advance. The information contained in the file will be obtained from the PVAT files described above and will be updated daily. An orbit is defined to start where the spacecraft crosses the equator in the ascending node. Orbit number 0 will occur for the period between separation from the launch vehicle to the first ascending node crossing. The format of this file is depicted in Table 8.2.5-10. Predicted Orbit Number File Format.

Table 8.2.5-10. Predicted Orbit Number File Format

Filename Convention	MDC__yyyydoy_ ##.pon, where the date represents the day of the earliest data in the file.		
Transfer Protocol	The POCs will FTP or HTTP the Predicted Orbit Number File from the MDC.		
Availability	Daily		
Format	Multiple line, tab-delimited ASCII file		
Contents			
Standard Header	For contents of standard header see: APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.		
	For each orbit in file:		
Column #	**Item**	**Delimiter***	**Units**
1	Orbit Number	tab	Whole number counter (5 digits max.)
2	Orbit Start Time	tab	UT in yyyydoyhhmmss

*Whenever the choice of delimiters is CR, LF, or CR/LF the same choice of delimiter must be used throughout the table.

8.2.5.5. File Change Notification Message

The MDC will generate File Change Notification Messages that will indicate the availability of new data products and all subsequent updates to the data products. There will be a separate File Change Notification Message for each creation or update of each data product. The data products for which the File Change Notification Message will be provided include Timelines, Spacecraft Telemetry Definition, Orbit Information, Solar and Geomagnetic Indices, and NMC. The details of the File Change Notification Message are presented in Table 8.2.5-11. File Change Notification Message File Format.

Table 8.2.5-11. File Change Notification Message File Format

Filename Convention	MDC__new-or-updated-data-product-filename_data-product-extension.fcn. For example, MDC__MDC__199912606_01_nmc.fcn would be the name of the File change Notification Message File for Revision 1 of the NMC file for Hour 6 of Day 126 of 1999. (The data product filename includes the data product creation date and revision number that provides the revision status of the data product. The creation date of the File Change Notification Message will indicate the date and time the File Change Notification Message was made available.)
Transfer Protocol	The MDC will make the files available via FTP or HTTP transfer via the web. The web listing of File Change Notification Messages will include the filename and creation date for each of the messages. The list of File Change Notification Messages will be viewable in its entirety or selectively by data product and date range.
Availability	Available upon MDC's receipt of new or updated data products and kept on-line throughout the life of the mission.
Format	Empty file (All information is in the filename.)
Contents	Empty file (All information is in the filename.)
Standard Header	Not included.

8.2.5.6. Telemetry Status Change Notification

In order to indicate to the POCs that a change in telemetry data status has occurred the MDC will issue a Telemetry Status Change Notification to the POCs. This notification will indicate which time ranges of data were updated in the MDC archive via application identifiers and start/stop times. The POCs can then go look at the appropriate telemetry status file. The telemetry status files are described in Section 8.2.5.7. The definition of the Telemetry Status Change Notification is provided in Table 8.2.5-12. Telemetry Status Change Notification Definition.

Table 8.2.5-12. Telemetry Status Change Notification Definition

Filename Convention	MDC__yyyydoy_##.scn where the date in the file name is the date the data are received		
Transfer Protocol	The MDC will make the files available via FTP or HTTP transfer via the web.		
Availability	The MDC will be updating telemetry status on an hourly basis as needed. If data are not updated in the archive then no notification will be issued.		
Format	Tab delimited, ASCII file, sorted primarily by AP ID and secondarily by start time of update		
Contents			
Standard Header	For contents of standard header see: APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.		
Row 1	**Item**	**Delimiter***	**Units**
1	Time of notification	CR,LF, CR/LF	UT in yyyydoyhhmmss
Row 2..N Column #	**for each application ID and each telemetry update**		
1	Application ID of updated telemetry	tab	hexadecimal
2	Start time of updated telemetry	tab	Spacecraft time in yyyydoyhhmmss
3	End time of updated telemetry	CR,LF, CR/LF	Spacecraft time in yyyydoyhhmmss

*Whenever the choice of delimiters is CR, LF, or CR/LF the same choice of delimiter must be used throughout the table.

8.2.5.7. Telemetry Data Status

A report of current good telemetry can be obtained by using the Archive Map Utility on the TIMED MDC/SDS web site, http://www.timed.jhuapl.edu/mdc/archivemap/mdc_archivemap.pl. The search criteria should be as specified in Table 8.2.5-13. Recommended Input to Archive Map Utility. The resulting report, depicted in Table 8.2.5-14. Archive Map Utility Output, will indicate the sequence number and start and end times of contiguous sets of good telemetry received by the ground system. Data gaps are derived by comparing start and end times of the contiguous sets of telemetry received. It is important to note that in the case where a gap occurs either at the beginning or ending of the day of interest, the items associated with start or stop values will be set to the boundary of this gap and not the requested start or stop times.

Table 8.2.5-13. Recommended Input to Archive Map Utility

Search Criteria	Recommended Input	Description	Comments
Include APID(s)	0x04, 0x84, Uncheck box for All	APID 0x04: High Priority House Keeping packets APID 0x84: Equivalent to 0x04 but from redundant C&DH system.	
Exclude APID(s)	0x7FF		
Subsystem(s)	<blank>, Uncheck box for All		
Source(s)	65, Uncheck box for All	Source 65: Spacecraft	
Front End(s)	All		
Virtual Channel(s)	All		
Dirty Data Wanted	No		
Start Time (yyyy doy hh:mm:ss)	*Year DOY* 00:00:00		Substitute desired values of interest for *Year* & *DOY*
End Time (yyyy doy hh:mm:ss)	*Year DOY* 23:59:59		Substitute desired values of interest for *Year* & *DOY*
Group by Sources	No		
Group by Front Ends	No		
Group by Virtual Channel	No		
Data Time Ordering	Space Craft Time		

Table 8.2.5-14. Archive Map Utility Output			
Column #	**Item**	**Delimiter**	**Units**
1	Application ID (APID)	spaces	Hexadecimal
2	Start packet sequence count from CCSDS telemetry packet primary header (SEQ START)	spaces	modulo counter (0 - 16383)
3	End packet sequence count from CCSDS telemetry packet primary header (SEQ STOP)	spaces	modulo counter (0 - 16383)
4	Start S/C Time (SC TIME START)	spaces	Spacecraft time in yyyydoyhhmmss
5	End S/C Time (SC TIME STOP)	spaces	Spacecraft time in yyyydoyhhmmss
6	Start Ground Receipt Time (GR TIME START)	spaces	UT in yyyydoyhhmmss
7	End Ground Receipt Time (GR TIME STOP)	spaces	UT in yyyydoyhhmmss
8	Total number of packets (TOTAL COUNT)	CR, LF, CR/LF	

8.2.5.8. Support Data

8.2.5.8.1. National Meteorological Center (NMC) Data

This product is considered to be a support product. It will be provided as a daily file, for 1200 UTC, to the POCs for use in instrument data processing. The file definition is provided in Table 8.2.5-15 NMC Data File Format.

Table 8.2.5-15. NMC Data File Format

Filename Convention	MDC__yyyydoyhh_##.cpc where the time is the valid analysis time for the data set
Transfer Protocol	The POCs can FTP or HTTP from the MDC
Availability	As soon as available
Format	netCDF
Contents	
Global Attributes	For contents of global attributes see: APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.

Item	**Units**	**Resolution/Range**	**Data Type**
Analysis Time	UT	yyyydoyhh	Char
Longitude	Degrees East	1 degree; 0 to 359	Float 32
Latitude	Degrees North	1 degree; 90 to -90	Float 32
Pressure Levels	Mb	1000, 850, 700, 500, 400, 300, 200, 150, 100, 70, 50, 30, 10, 5, 2, 1, 0.4	Float 32
Temperature	Degrees kelvin	IEEE floating point	Float 32
Geopotential height (altitude)	m	IEEE floating point	Float 32

8.2.5.8.2. Solar and Geomagnetic Indices

These index values are support products. They will be provided to the POCs for use in data processing. The file definition can be found in Table 8.2.5-16. Solar and Geomagnetic Indices File Format. The Solar and Geomagnetic Indices will be stored in 2 files. One file will contain values for A_p and K_p USAF indices from NOAA and F10.7. The other file will contain proxies for A_p and K_p USAF indices from NOAA with preliminary F10.7 taken at time 2000 for the time period from the latest non-proxy data through the current day. The file containing the

values for A_p and K_p USAF indices from NOAA and F10.7 is differentiated from the file containing the proxies for A_p and K_p USAF indices from NOAA with preliminary F10.7 by the start time and stop time in the file name.

Table 8.2.5-16. Solar and Geomagnetic Indices File Format

Filename Convention	MDC__starttime_stoptime_##.ind
Transfer Protocol	The POCs can FTP or HTTP from the MDC
Availability	As soon as available
Format	netCDF
Contents	
Global Attributes	For contents of global attributes see: APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.

Item	**Units**	**Resolution/Range**	**Data Type**
Date (yyyymmdd)	UT	day	Integer 32
A_p	nT	daily	Float 32
K_p (8 values)	NA	3 hours	Float 32
F10.7 (Observed values)	Solar Flux Units (10^{-22} $Js^{-1}m^{-2}Hz^{-1}$)	Daily	Float 32

8.2.5.9. Actual Orbit Information

8.2.5.9.1. Actual Position, Velocity, Attitude, and Time Data

The Actual Position, Velocity, Attitude, and Time files will be provided in netCDF format to support general POC usage. These data will be derived from the spacecraft GPS telemetry and will cover a time period of 1 day. If unexpected corrections to spacecraft position, velocity, and attitude data occur these files will be re-issued with the corrections. These files are considered to be support data. The file definition is provided in Table 8.2.5-17. Actual Position, Velocity, Attitude, and Time File Format. The range, units, and resolution for the orbital elements can be found in the product specification that is accessible from the TIMED web site. The details of positional knowledge including accuracies and uncertainties can be found in this document under Section 6. Navigation and Attitude Control.

Table 8.2.5-17. Actual Position, Velocity, Attitude, and Time File Format

Filename Convention	MDC__yyyydoy_###_##.pos where yyyydoy is the date of the set of data in the file.
Transfer	The POCs can FTP or HTTP from the MDC

Table 8.2.5-17. Actual Position, Velocity, Attitude, and Time File Format

Protocol	
Availability	As soon as available and within 12 hours of the MDC receiving dump data from the Ground Station
Format	netCDF
Resolution	PVAT is 1 second, Leap seconds are 1 set per day, variable number of 2-line orbit element sets needed per day
Contents	
Global Attributes	For contents of global attributes see: APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.

Item	**Units**	**Data Type**
Per Second:		
Spacecraft time	Seconds since 00:00:00 Jan. 6, 1980	Integer 32
Time Vernier for Position, Velocity Data	Microseconds of second	Integer 16
Time Vernier for Attitude Data	Microseconds of second	Integer 16
Position (Earth Centered Inertial referenced to ECI J2000)	x,y,z in km	Float 64
Position (Earth Centered, Earth Fixed)	x,y,z in km	Float 64
Position (Earth Centered, Earth Fixed)	latitude as –90-+90 degrees north, longitude as 0-360 degrees east, height in km	Float 64
Attitude Quaternion (Earth Centered Inertial to spacecraft)	Not Applicable	Float 64
Roll, Pitch and Yaw (Spacecraft Coordinates)	degrees where roll, pitch and yaw correspond to rotations about the x,y,z axes, respectively.	Float 64
Velocity (Earth Centered Inertial)	x,y,z vectors in km/sec	Float 64
Velocity (Earth Centered, Earth Fixed)	x,y,z vectors in km/sec	Float 64
Attitude Rates	Radians/sec	Float 64
Guidance and Control (G & C) Solar Vector (Spacecraft Coordinates)	x,y,z	Float 64
Guidance and Control Data Validity flags acquired from the High Priority House Keeping packet, bit offset 80 through 87	Byte 1: 1st LSB set indicates spacecraft is in Nadir Pointing mode; 0 indicates Operational mode. 2nd LSB set indicates spacecraft is in Safe mode; 0 indicates spacecraft is in either Nadir Pointing or Operational mode. 3rd LSB set indicates solar arrays are rotating. 4th LSB set indicates spacecraft in a yaw maneuver. 5th LSB set indicates ram	Unsigned Integer 8

Table 8.2.5-17. Actual Position, Velocity, Attitude, and Time File Format

	direction is in +x direction. 6th LSB set indicates one or both IRUs are contributing to attitude rate determination. Caution: Valid only for PVAT Data_Product_Version 013 and higher. 7th LSB set indicates one or both ASTs are contributing to attitude rate determination. Caution: Valid only for PVAT Data_Product_Version 013 and higher. MSB: Spare Warning flag	
Guidance and Control Warning flags acquired from the High Priority House Keeping packet, bit offset 88 through 95	Byte 2: 1st LSB set indicates AST #1 is healthy and providing data. Caution: Valid only for PVAT Data_Product_Version 013 and higher. 2nd LSB set indicates AST #2 is healthy and providing data. Caution: Valid only for PVAT Data_Product_Version 013 and higher. 3rd LSB set indicates IRU #1 is providing data. Caution: Valid only for PVAT Data_Product_Version 013 and higher. 4th LSB set indicates IRU #1 is providing data. Caution: Valid only for PVAT Data_Product_Version 013 and higher. 5th LSB set indicates G & C data for Quaternion is valid. 6th LSB set indicates G & C data for Sun vector is valid. 7th LSB set indicates G & C data for roll, pitch and yaw are valid. MSB set indicates G & C data for time and position are valid.	Unsigned Integer 8
GPS Navigation System (GNS)Validity Flags acquired from the High Priority House Keeping packet, bit offset 789 through 794, stored right justified in the byte and padded on the left with zeros.	1st LSB set indicates time jump in GPS data. 2nd LSB set indicates GNS data for Event Notification is valid. 3rd LSB set indicates GNS data	Unsigned Integer 8

Table 8.2.5-17. Actual Position, Velocity, Attitude, and Time File Format		
	for sun vector is valid. 4th LSB set indicates GNS data for time is valid. 5th LSB set indicates GNS data for velocity is valid. 6th LSB set indicates GNS data for position is valid. 7th LSB: Unused bit MSB: Unused bit	
GPS Navigation System Navigation Mode acquired from the Low Priority House Keeping packets #1 and 2, bit offset 1576 through 1581	Not Applicable	Unsigned Integer 8
GPS Navigation System Time Precision acquired from the Low Priority House Keeping packets #1 and 2, bit offset 1582 through 1583	Not Applicable	Unsigned Integer 8
MDC flags	1st LSB set means PVT and GNS data and flags absent. 2nd LSB set means Attitude and G&C data and flags absent. 3rd LSB set means roll, pitch, and yaw undetermined; unable to resolve quaternion. 4th LSB set means navigation mode absent; unable to determine if S/C in GPS tracking mode or element propagation mode. 5th LSB set means time precision absent; unknown if time is precise: this affects how well roll, pitch, and yaw can be known. 6th LSB set means attitude is out of specification. 7th LSB set means attitude rate is out of specification. MSB: Unused bit	Unsigned Integer 8
Per File:		
Leap seconds	Number of leap seconds since 00:00:00 Jan. 6, 1980	Integer 16
2-line orbit element sets (For a complete description of these fields refer to Table 8.2.5-8. Predicted Position, Velocity, Attitude, and Time NetCDF File Format)		

*Whenever the choice of delimiters is CR, LF, or CR/LF the same choice of delimiter must be used throughout the table.

8.2.5.9.2. Actual Orbit Number File

The MDC will make available a single file that contains the actual orbit numbers and start/stop times of the orbits for each day from the beginning of the mission to the present day. The information contained in the file will be obtained from the PVAT files described above and will be updated daily. An orbit is defined to start where the spacecraft crosses the equator in the ascending node. Orbit number 0 will occur for the period between separation from the launch vehicle to the first ascending node crossing. The format of this file is depicted in Table 8.2.5.18. Actual Orbit Number File Format. Table 8.2.5-10. Predicted Orbit Number File Format.

Table 8.2.5-18. Actual Orbit Number File Format

Filename Convention	MDC__yyyydoy_##.aon, where the date represents the day of the latest data in the file.		
Transfer Protocol	The POCs will FTP or HTTP the Actual Orbit Number File from the MDC.		
Availability	Daily		
Format	Multiple line, tab-delimited ASCII file		
Contents			
Standard Header	For contents of standard header see: APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.		
	For each orbit in file:		
Column #	**Item**	**Delimiter***	**Units**
1	Orbit Number	tab	whole number counter (5 digits max.)
2	Orbit Start Time	tab	UT in yyyydoyhhmmss

*Whenever the choice of delimiters is CR, LF, or CR/LF the same choice of delimiter must be used throughout the table.

8.2.6. POC to MDC Interfaces

A high level diagram of the POC to MDC interfaces is depicted in Figure 8.2.6-1. Payload Operations Center to Mission Data Center Interfaces below.

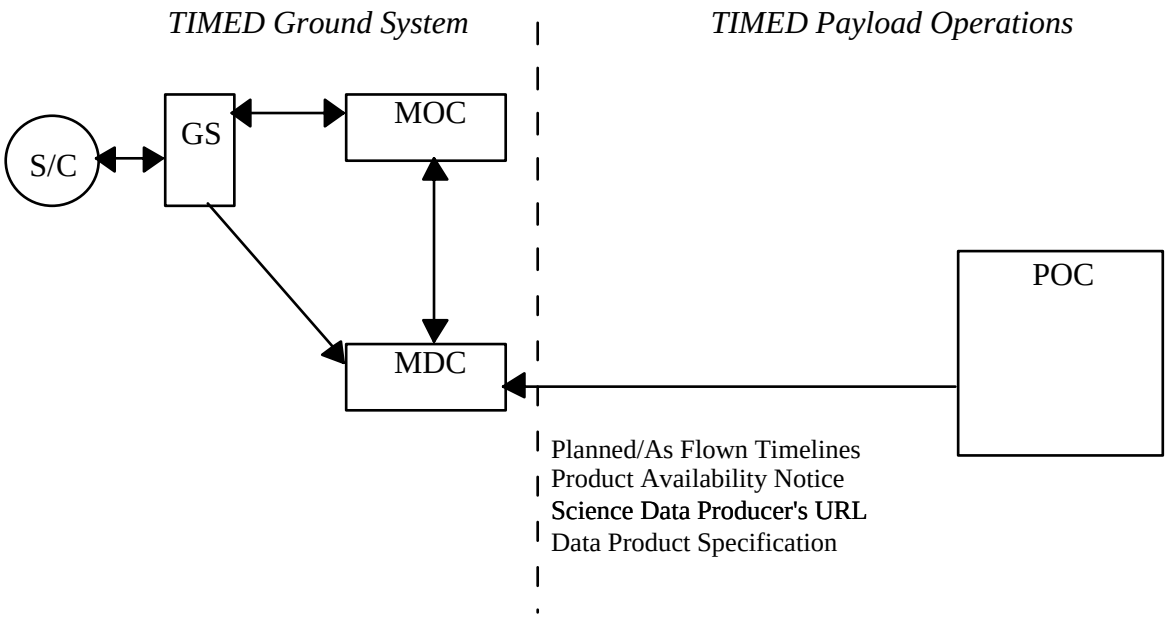

Figure 8.2.6-1. Payload Operations Center to Mission Data Center Interfaces

8.2.6.1. Planned/As Flown Timelines

The Planned and As Flown Timelines are planning products generated by the POCs (and also the MOC and project scientist) and transferred to the MDC via FTP. Since these timelines are also made available by the MDC after receipt from the POCs their detailed definitions are provided in sub-section Timelines (8.2.5.3) of the MDC to POC interfaces section.

8.2.6.2. Product Availability Notice

The Product Availability Notice (PAN) will be sent to the TIMED MDC Mission Data Cataloging and Distribution (MDC&D) subsystem to provide the metadata for a data product(s). This information will be stored in the Mission Data Catalog and will be used when the TIMED project and the general public request data products. The producers of the data products will send a PAN to the MDC to indicate the generation of a new data product the update to the metadata of an existing data product, or the deletion of an existing data product. If the producer is not responsible for storing the data product the producer will send a PAN indicating a new data product has been generated. Then the storing facility will send another PAN for the same data product with updated metadata that is the URL of the data product. A file definition is provided in Table 8.2.6-1. Product Availability Notice File Format. Some of these fields overlap with information that is required for the Data Product Specification Information described in **Reference 8-6. TIMED Program Data Management Plan, JHU/APL, 7363-9330.** Because each data product produced for the TIMED project requires either global attributes (netCDF files) or a standard header (ASCII Files), the majority of information contained in the Product Availability Notice can be pulled directly from these attributes or standard headers. A single PAN can be used to send metadata for multiple data products.

Table 8.2.6-1. Product Availability Notice File Format

Filename Convention	**inst_yyyydoyhhmmss_##.pan** where **inst** is the data product producer (e.g., GUVI, SABE, SEE_, TIDI, MDC_,) **yyyydoyhhmmss** is the PAN generation datetime stamp, **##** is the revision number of the PAN definition The revision number will be 01 initially and will be increased if the PAN definition changes.
Transfer Protocol	MDC will FTP the operation status file from a predefined POC location
Availability	This file should be available as soon as the data product has been created or revised.
Format	Tab delimited ASCII file, EXCEL compatible
Contents	
Standard Header	For contents of standard header see: APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.
	For each data product for which status is being reported:

Table 8.2.6-1. Product Availability Notice File Format

Column Name	Required or Optional	Comments	Valid Values	Delimiter*
Data Product Filename	R	The filename of the data product (unique id of a specific data product)	For PAF = D, valid filename or a filename that includes wildcard characters: - a "%" character for pattern matching any string of zero or more characters - an "_" character for pattern matching any single character	tab
PAN Action Flag (PAF)	R	A flag used to indicate the purpose of the PAN (i.e., New, Update, or Delete)	N = New Data Product U = Update Metadata D = Delete Data Product	tab
Data Product Type Name	R	The type of data product (e.g., SEE Level 2 Data)	See DMP Table 8	tab
Revision Number	R if PAF = N	The revision number of the data product.	Initial value of 01.	tab
Complete URL	O R from server	The product file WWW location		tab
Data Start Time	R if PAF = N	Start time of the data collection	UT in yyyydoyhhmmss	tab
Data End Time	R if PAF = N	End time of the data collection	UT in yyyydoyhhmmss	tab
Version Number	R if PAF = N	The version number of the data product.	Initial value of 001.	tab
Earth location of observation (GBI)	O	For mobile GBI to report location of instrument	Lat, Lon separated by a comma and a space with at most two digits of precision after the decimal point	tab**
Comments	O	Additional Comments		CR, LF, CR/LF

*Whenever the choice of delimiters is CR, LF, or CR/LF the same choice of delimiter must be used throughout the table.

**If there is no optional Comment entry, delimit with a CR, LF, or CR/LF, consistent with previous use in the table.

8.2.6.3. Science Data Producer's URL

There will be one Science Data Producer's URL file for each science data producer. These are considered to be support data that will be used by the MDC to provide links to the science data production facilities' web sites. The web site should contain product descriptions, instrument information, and such as outlined in **Reference 8-6. TIMED Program Data Management Plan, JHU/APL, 7363-9330.** The file is defined in Table 8.2.6-2. Science Data Producer's URL File Format.

Table 8.2.6-2. Science Data Producer's URL File Format

Filename Convention	inst_##.pur
Transfer Protocol	MDC will FTP the URL address file from a predefined POC location.
Availability	Launch
Format	ASCII
Contents	
Standard Header	For contents of standard header see: APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions.
Row #	**Item**
1	POC Product Page address (example: HTTP://guvi/data_products.htm)

8.2.6.4. Data Product Specification Information

There will be a Data Product Specification Information file for each version of a data product. These are considered to be support data that will be used by the MDC to update the TIMED MDC Mission Data Cataloging and Distribution (MDC&D) subsystem so as to provide the metadata for data products. They should contain data product descriptions as outlined in Table 11. Data Product Specification Information in Appendix B of **Reference 8-6. TIMED Program Data Management Plan, JHU/APL, 7363-9330.**

APPENDIX 8-A: Acronyms and Abbreviations

^L	Tab
AIU	Attitude Interface Unit
AOS	Acquisition of Signal
APID	Application Process ID
ASCII	American Standard Code for Information Interchange
C&DH	Command and Data Handling
CCSDS	Consultative Committee for Space Data Systems
EC/EF	Earth Centered, Earth Fixed
ECI	Earth Centered Inertial
FRNT	Front-end
FTP	File Transfer Protocol
G & C	Guidance & Control
GNS	GPS Navigation System
GPS	Global Positioning System
GS	Ground Station
GSE	Ground Support Equipment
GUVI	Global Ultraviolet Imager
kbits	kilobits
HTTP	Hypertext Transfer Protocol
JHU/APL	The Johns Hopkins University Applied Physics Laboratory
LaRC	Langley Research Center
LOS	Loss of Signal
MDC	Mission Data Center
MOC	Mission Operations Center
NMC	National Meteorological Center
nT	nanoTesla
PGP	Pretty Good Privacy
POC	Payload Operations Center
PPP	Point to Point Protocol
PTP	POC Telemetry Packet
PSCI	Project Scientist
PVAT	Position, Velocity, Attitude, and Time
SABER	Sounding of the Atmosphere using Broadband Emission Radiometry
SEE	Solar EUV Experiment
S/C	Spacecraft
SSR	Solid-State Recorder
STF	Supplemented Transfer Frame
STP	Supplemented Telemetry Packet
TF	Telemetry Frame

TIDI	TIMED Doppler Imager
TIMED	Thermosphere, Ionosphere, Mesosphere, Energetics, and Dynamics
tlm	Telemetry
TP	Telemetry Packet
URL	Uniform Resource Locator
UT	Universal Time
VCHN	Virtual Channel

APPENDIX 8-B: Example Files

Deleted

APPENDIX 8-C: Ground Receipt Header Definitions

The material in this appendix is extracted from Reference 8-14. It appears as Table 4 in the reference.

Table 8.2.6-3. Ground Receipt Header

Field	Offset(b)	Length(b)	Description
Size	0	16	Size of this object including headers in bytes, unsigned integer in MSB first order (max = 65535)
data type	16	*8*	type of data object, 1 = STF, 2 = STP, *3 = PTP*
spare bits	24	*8*	
GRH Version ID	32	6	version id associated with this GRH format. (Decimal number, where this version = 2)
spacecraft ID	38	10	CCSDS SCID assigned to TIMED (binary 000111100011, hex 1E3)
GR Time	48	32	Ground receipt time in elapsed seconds since 00:00:00 UTC January 6, 1980, in MSB first order
GR Time Vernier	80	32	Microsecond offset from GR Time, in MSB first order
Frame Source Type	112	4	0001 - Emulator/Mini-MOC 0010 - Simulator 0011 - Loop-Back 0100 - spacecraft 0101 - GSE 0110 - unused 0111 - unused 1000 - User-Defined 1001 - 1111 - unused
Frame Source Index	116	4	for frame source type 0001 (Emulator/Mini-MOC) 0001 GUVI Spacecraft Emulator 0010 SABER Spacecraft Emulator 0011 SEE Spacecraft Emulator 0100 TIDI Spacecraft Emulator 0101 GNS Mini-MOC 1 0110 GNS Mini-MOC 2 0111 G&C Mini-MOC 1 1000 G&C Mini-MOC 2 1001 IEM Mini-MOC 1 1010 IEM Mini-MOC 2 for frame source type 0010 (Simulator) 0001 TOPS 0010 Software Simulation for frame source type 0011 (Loop-Back) 0001 FE Hardware Simulation for frame source type 0100 (Spacecraft) 0001 Spacecraft for frame source type 0101 (GSE) 0001 GSE 0010 MPCF sc1_rt instance 0011 MPCF sc2_rt instance 0100 MPCF dev instance 0101 MPCF tops instance 0110 MPCF iem_mm1_rt instance

Table 8.2.6-3. Ground Receipt Header

			0111 MPCF iem_mm2_rt instance (where MPCF=MOC/POC Command filter, sc1_rt, sc2_rt, dev, tops, iem_mm1_rt, & iem_mm2_rt = EPOCH stream names) for frame source type 1000 (User-Defined) 0000-1111 - User-Defined
Path	120	4	other path information (0000 for now)
Front-end Identifier	124	4	0001 - FE1 (bench-testing) 0010 - FE2 (I&T) 0011 - FE3 (primary ground station) 0100 - FE4 (spare) 0101 - G&C 0110 - GPS 0111 - MOC 1000-1101 - LEO-T or other off-site 1110-1111 - unused
Reed-Solomon (R-S) decode Flag	128	1	0 = disabled 1 = enabled
R-S error status	129	1	0 = frame uncorrectable 1 = frame correct or corrected
R-S error count	130	7	0 = no error needed correction 1..80 count of corrected errors 81..127 unused
CRC Flag	137	1	0 = CRC disabled 1001 thru 1111 - unused
CRC Error Flag	138	1	0 = CRC failed 1 = CRC passed
Master Channel Sequence checked	139	1	0 = not checked/unknown 1 = sequence number checked
Master Channel Sequence Number Error	140	1	0 = sequence number increased by one 1 = sequence number increased by two or more
Frame Sync Mode	141	2	00 = search 01 = check 10 = lock 11 = flywheel
Frame Quality Flag	143	1	0 = data are suspect 1= data are correct (no Frame Error detected) used to determine if the frame quality is acceptable for output to client who requests only "good" data; No Frame Error Detected = No RS Error & No CRC Error & No SSR Playback Error
Frame Sync Pattern Errors	144	4	number of errors detected in Frame Sync pattern
Frame Sync bit slips	148	4	0000 = no slip 1001 = 1 bit late 1010 = 2 bits late 1011 = 3 bits late 1101 = 1 bit early 1110 = 2 bits early 1111 = 3 bits early
Archive Flag	152	1	0 = do not archive 1 = archive
SSR Playback Error	153	1	0 = no spacecraft Solid-State Recorder (SSR) playback error

Table 8.2.6-3. Ground Receipt Header			
			1 - SSR playback error
spares	154	22	undefined

APPENDIX 8-D: TIMED Global Attribute and Standard Header Conventions

This is the proposed set of conventions for global attributes of netCDF files and standard header for ASCII files created for the TIMED project. The global attributes and standard headers are required for each netCDF and ASCII file, respectively. In ASCII files these attributes should take the form of keyword/value pairs each on a separate line. *The specific format for these pairs is currently TBD.* The requirement for these global attributes and standard header can be found in **Reference 8-6. TIMED Program Data Management Plan, JHU/APL, 7363-9330.**

Attribute for NetCDF or Keyword for ASCII	Req/ Opt	Example NetCDF/ ASCII	Meaning
Title	R	Predicted Position, Velocity, Attitude, and Time/ Title=Predicted Position, Velocity, Attitude, and Time	Taken from netCDF manual. *A global attribute that is a character array providing a succinct description of what is in the data set.*
Data_Product_Type	R	Predicted PVAT/ Data_Product_Type=Predicted PVAT	This is the type that appears in the data product template that describes this file
Source	R	MDC/ Source=MDC	The person or facility that created this product
Mission	R	TIMED/ Mission=TIMED	Always TIMED
Data_Product_Version	R	001/ Data_Product_Version=001	Indicates how many times the content or format for date product type has changed
Product_Format_Version	R	001/ Product_Format_Version=001	Indicates how many times the format of the data type has changed
Software_Version	R	01.01/ Software_Version=01.01	Major.Minor Version number of the software that generated this product
Software_Name	R	OrbitProcessor	Name of the software that created this product
Input/Cal_Version	R	01.01/ Calibration_Version=01.01	Major.Minor Version of the input/calibration used to process these data

Description	O		
Comment_n	O		Optional comment lines where n is sequentially assigned
History	O		Taken from netCDF Manual. *A global attribute for an audit trail. This is a character array with a line for each invocation of a program that has modified the data set. Well-behaved generic netCDF applications should append a line containing: date, time of day, username, program name, and command arguments.*
Filename	R	MDC__yyyydoy_##.npo/ Filename=MDC__yyyydoy_##.npo	The name of this file
Date_Generated	R	yyyydoyhhmmss/ Date_Generated=yyyydoyhhmmss	Date that this data product was created
Standard Header Delimiter	R for ASCII	End_of_Header	For an ASCII file this string is required to appear on a single line after the last keyword/value pair of the standard header and before the beginning of the data in the file.

APPENDIX 8-E: Real-Time and Playback Telemetry Service Directives

This appendix contains the directives used to initiate and direct telemetry transfer while receiving telemetry stream service.

Real-time Service Directives

Directive	Parameters	Description	Defaults
APID	*Number in octal, hex or decimal*	Application Process ID from Packet Primary Header. You can request multiple APIDs, one per directive. You must specify at least one APID or SSYS to receive TP, STP, or PTP. For all APIDs use SSYS=ALL.	(none)
BEGN	RT	Start to Send Data	n/a
DRTY	(none)	Include data that has been marked as bad in the ground receipt header. Normally these data are not passed on.	n/a
EXAPID	*Number in octal, hex or decimal*	Exclude APID from stream. You can request multiple APIDs for exclusion.	(none)
FRNT	*decimal number*, "ALL", "BEST"	Front-end id from Ground Receipt Header. You can request multiple FRNTs, one per directive. You can get all of the front ends by using the keyword ALL. The ALL option will send duplicate streams for a source if there are multiple input streams from the same source. When BEST is specified the server will automatically switch which Front End the data comes from in an attempt to supply a continuous stream from a particular source.	(none)
SRCE	*decimal number, "ALL"*	Frame Source ID – Frame Source Type and Frame Source Index from the Ground Receipt Header. You can request multiple sources, one per directive. You can get all of the sources by specifying ALL.	(none)
SSYS	*decimal number*, "ALL"	Requests all APIDs that match the subsystem ID (4 most significant bits of the APID field in the Packet Primary Header). You can request multiple subsystems, one per directive. You must specify at least one APID or SSYS to receive TP,STP or PTP. SSYS=ALL will supply all APIDs.	(none)
TYPE	"TP", "STP", "TF", "STF", "PTP"	Specify whether to get Telemetry Packets, Supplemented Telemetry Packets, POC Telemetry Packets, Transfer Frames, or Supplemented Transfer Frames. Only 1 type may be specified.	(none)
VCHN	"0","6","7", "ALL"	Virtual channel ID from the Transfer Frame Primary Header. You can request multiple VCHNs, 1 per directive.	(none)
TLM_PORT	*decimal number*	Port number for remote connection of second socket (required if second socket requested)	(none)
TLM_HOST	*decimal number ddd.ddd.ddd.ddd*	Host IP number for remote connection of second socket - if not the same as first socket (host names not allowed)	same as IP of first socket connection

Playback Service Directives			
Directive	**Parameters**	**Description**	**Defaults**
APID	*Number in octal, hex or decimal*	Application Process ID from Packet Primary Header. You can request multiple APIDs, one per directive. You must specify at least one APID or SSYS to receive TP,STP,or PTP. For all APIDs use SSYS=ALL.	(none)
BEGN	PB	Start to send data	n/a
DRTY	(none) or “ONLY”	If directive not given them only good data are sent. If directive specified without parameter then stream will include both good and bad data. If DRTY=ONLY then only data marked as bad will be sent. Quality is defined by the Frame Quality Flag in the ground receipt header.	n/a
EXAPID	*Number in octal, hex or decimal*	Exclude APID from stream. You can request multiple APIDs for exclusion.	(none)
FRNT	*decimal number,* "ALL"	Front-end id from Ground Receipt Header. You can request multiple FRNTs, 1 per directive. Only meaningful for ORDR=GR. You can get all of the front ends by using the keyword ALL. The ALL option will send duplicate streams for a source if there are multiple input streams from the same source.	(none)
NOWAIT	*(none)*	Do not wait at end of archive data even if stop time not reached.	Off (see STOP)
ORDR	*"SC","GR"*	Spacecraft time or Ground Receipt time order. Prior to launch only ground receipt time ordering will be available.	GR
SRCE	*decimal number, "ALL"*	Frame Source ID – Frame Source Type and Frame Source Index from the Ground Receipt Header. You can request multiple SRCEs, 1 per directive. You can get all of the sources by specifying ALL.	(none)
SSYS	*decimal number,* "ALL"	Subsystem ID (4 most significant bits of the APID field in the Packet Primary Header). You can request multiple SSYSs, 1 per directive. You must specify at least 1 APID or SSYS to receive TP,STP or PTP. SSYS=ALL will supply all APIDs.	(none)
STRT	*yyyy ddd hh:mm:ss*	start time – must be before time of last data in archive	start of current utc day
STOP	*yyyy ddd hh:mm:ss*	end time - if end time exceeds the time of the last data in the archive the server will wait for new data to arrive	time of last data in archive
TYPE	"TP", "STP", "TF", "STF", "PTP"	Specify whether to get Telemetry Packets, Supplemented Telemetry Packets, POC Telemetry Packets, Transfer Frames, or Supplemented Transfer Frames. Only 1-type may be specified.	(none)

Playback Service Directives			
VCHN	"0","6","7", "ALL"	Virtual channel ID from the Transfer Frame Primary Header. You can request multiple VCHNs, 1-per directive.	(none)
TLM_PORT	*decimal number*	Port number for remote connection of second socket (required if second socket requested)	(none)
TLM_HOST	*decimal number ddd.ddd.ddd.ddd*	Host IP number for remote connection of second socket - if not the same as first socket (host names not allowed)	same as IP of first socket connection