SECTION 1. INTRODUCTION

1.1 PURPOSE AND SCOPE

This Interface Control Document (ICD) defines the interface between the Solar and Heliospheric Observatory (SOHO) Instrumenters and the Experimenters' Operations Facility (EOF) Core System (ECS). This interface supports three main data exchanges: instrument commanding data from the instrumenters, telemetry distribution to the instrumenters, and exchange of other mission related data.

The interface between the ECS and the SOHO instrumenters is described within the framework of the Open System Interconnection (OSI) model, a seven-layer reference model developed by the International Organization for Standardization (ISO). Section 2 of this ICD provides an overview of the interface between the ECS and the instrumenters. Section 3 defines the interface at the application layer level. Section 4 defines the lower levels of the OSI model: presentation layer, session layer, transport layer, network layer, data link layer and physical layer.

1.2 BACKGROUND

The SOHO mission is part of the International Solar-Terrestrial Physics (ISTP) program. The SOHO EOF is part of the NASA Goddard Space Flight Center (GSFC) ground system and serves as the focal point for instrument operations, mission planning, and science data analysis related to the operations.

The EOF is comprised of two main elements:

1) The ECS which includes hardware and software to support the three primary ECS functions described above. Two specialized workstations are part of the ECS: the Science Operations Coordinator (SOC) workstation and the Project Scientist workstation.

2) The Instrumenters WorkStations (IWS) which include hardware and software provided by the individual instrument teams and are dedicated to the operation of a given instrument and its science analysis for planning purpose.

The instrumenters may be located as follows:

1) The resident instrumenters are located at the EOF where they have data processing equipment, referred to as the IWSs.

2) The "remote" instrumenters are located outside of the EOF. They may have some support equipment at the EOF, or they may communicate with the ECS via another instrument's IWS or via a dedicated ECS workstation, namely, the SOC workstation. The remote instrumenters may also use the telephone or facsimile to communicate with the Flight Operations Team (FOT) or with an EOF resident team member and request changes in their instrument status.

3) Instrumenters may be located at the Analysis Facility at GSFC. At the present time, instrumenters at the Analysis Facility will have the same privileges as remote instrumenters. However, the EOF design does not preclude the fact that some of the equipment located at the Analysis Facility could be treated as resident IWSs, provided the following:
   - Security requirements are met: this includes having a dedicated line between the two facilities, and ensuring adequate physical security at the Analysis Facility.
   - ECS capacity: Telemetry could be distributed in real-time to workstations in the Analysis Facility provided this can be supported by the current ECS hardware/software architecture.

4) Instrumenters may also be located at the Multi-Experiment Data Operation Centre (MEDOC) in Orsay, France. The present document treats MEDOC as an IWS that would not have near-real-time commanding authority. Thus, MEDOC can receive real-time telemetry and archived telemetry files. If conditions change concerning the functionality of this interface, it will be described and defined in a separate document.

The ECS provides the communications between the instrumenters and other elements of the SOHO ground system as illustrated at a conceptual level in Figure 1.1. The physical configuration of the EOF is defined in section 4. ECS receives and stores telemetry data. ECS makes that telemetry data available to the instrumenters for processing on their own equipment and defining future instrument commands. The instrumenters use their interface with ECS to send these commands to their instruments both in real-time and on a delayed transmission basis. Near-real time commanding and reception of real-time telemetry is only available to the EOF resident instrumenters (i.e., IWSs).

1.3 <u>REFERENCES</u>

1. <u>Commanding at the SOHO Experiment Operations Facility</u>, Dr Van Ballegooijen, memorandum, Action Item from SOWG Splinter Meeting, November 1991.

2. <u>SOHO Science Operations Plan</u>, Issue 1.1, June 1993.

3. <u>SOHO Experimenters' Operations Facility (EOF) Core System (ECS) Functional Requirements Document</u>, NASA, April 1992.

4. <u>CCS External Interfaces Specification Document</u>, MATRA, July 1991.

5. <u>Telemetry and Telecommand Handbook</u>, MATRA, March 1991.

6. <u>CCS Protocol Implementation</u>, SS-AN-003-91, March 24, 1992.

7. <u>SOHO Experimenters' Operations Facility (EOF) Core System (ECS) System Requirements Document</u>, NASA 514-4SRD/0492, February 1993.

8. <u>Interface Control Document between the International Solar-Terrestrial Physics (ISTP) SOHO Command Management System (CMS) and the ECS</u>, NASA 514-4ICD/0293, July 1994.

9. <u>Interface Control Document between the Sensor Data Processing Facility (SDPF) and SOHO Consumers,</u> Revision 1, NASA 560-203.97, February 1995.

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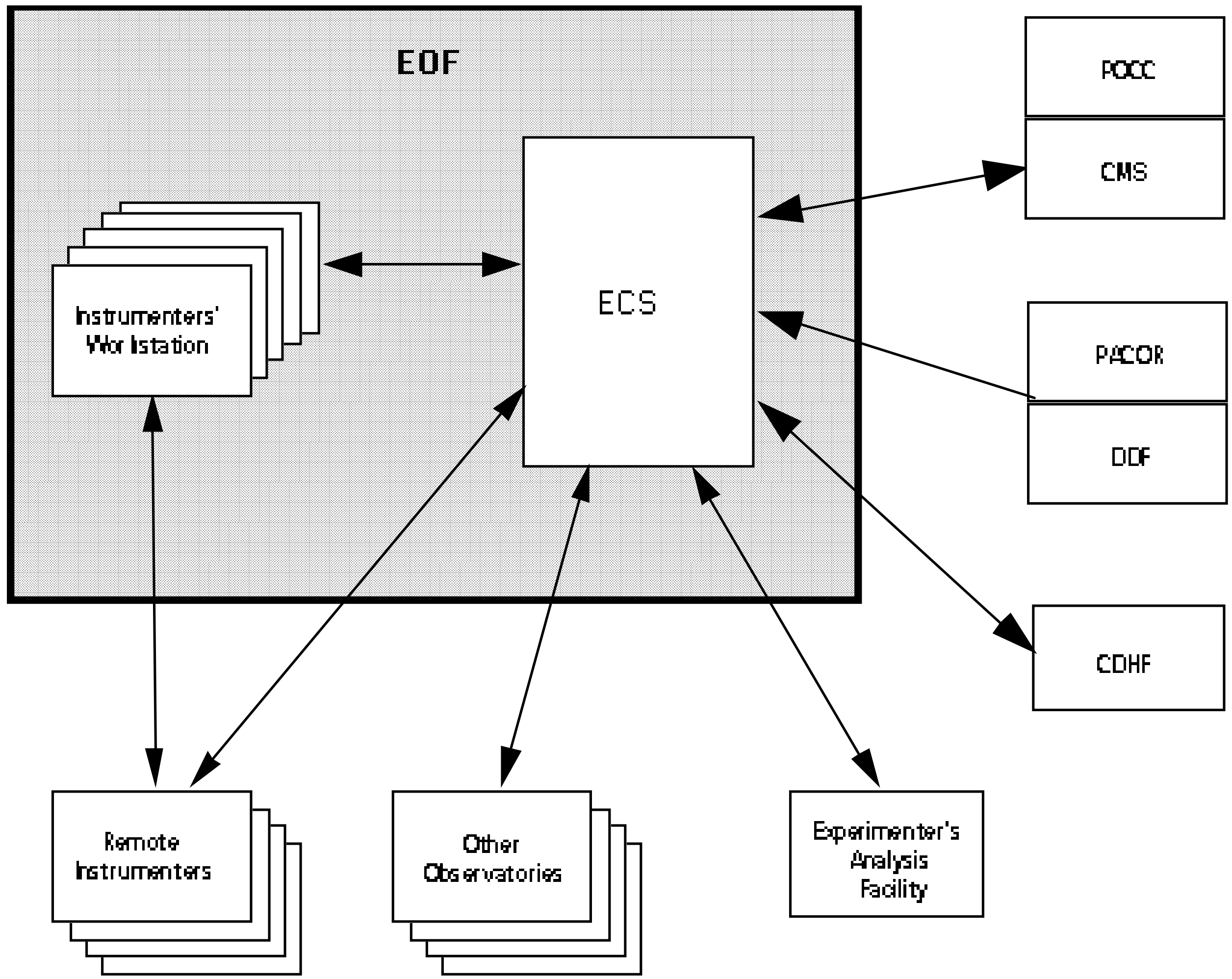

Figure 1.1 ECS/IWSs Context Diagram

11. Interface Control Document between the International Solar-Terrestrial Physics (ISTP) Program Central Data Handling Facility (CDHF) and the ISTP SOHO Experimenters' Operations Facility (EOF), NASA, 560-1ICD/1093, August 1994.

12. SOHO Experimenters' Operations Facility (EOF) Core System (ECS) Detailed Design Specification, NASA 514-4DDS/0293, Review Copy, June 1993.

13. SOHO Experimenters' Operations Facility (EOF) Core System (ECS) Software Users' Guide, NASA, April 1995.

14. Data Format Control Document for the International Solar-Terrestrial Physics (ISTP) Program SOHO Project Data Base, Revision 1, NASA, 511-4DFC/0292, September 1994.

1.4 GLOSSARY

As-Planned Database. Information provided by the instrumenters to the ECS describing the science activities scheduled for a given day or week. This information will be based on the template provided by the ECS Activity Plan (EAP) which shows Deep Space network (DSN) contact times, FOT-dedicated commanding times, and other related activities. The information provided by the instrumenters will be in the form of ASCII files and it will be electronically transferred to the ECS.

As-Run Database. Information provided by the instrumenters describing the science programs executed. The detailed format and content of the data provided by the instrumenters will be defined separately from this document. The design and implementation of the Database is the responsibility of a designated group of instrumenters. ECS is only responsible for providing the commercial Relational Database Management System package that will be used to support these functions and the hardware on which it will run. Information related to the As-Run data base will be provided to the ECS in an ASCII file format for inclusion into the Summary data files sent to the CDHF, for later distribution to the instrumenters' teams.

Critical Command. A command which is flagged as critical in the Project Database (PDB). Operationally, the uplink of a critical command requires the intervention of an FOT operator within the Payload Operations Control Center (POCC).

Delayed Commands. A group of commands originating from EOF-resident or remote instrumenters destined to be uplinked by the FOT within a specified time window during the next operational day or later.

Instrument Command. A command addressed to a given instrument. Most instruments have a processor which will act upon that command once it receives it. When an instrument command is received by the spacecraft, it is immediately routed to the instrument. The command may be an actual command to perform a specific function. That function may be executed as soon as received by the instrument processor or it may be stored within the instrument processor memory for execution at a later predefined time (this depends on the capabilities of the instrument processor itself). The command may also be data to be stored in the processor memory. Each instrument team is responsible for the management of their instrument processor memory. Note that the VIRGO instrument has a particular design and will require a special command handling.

Instrumenter WorkStation (IWS). Hardware and software provided by the individual instrument teams, physically located in the EOF. During real-time passes, they may support the commanding of a given set of instruments or perform their science analysis for planning purposes. The

commanding IWSs are the only authorized source of near-real-time commands. A given instrument may only be commanded by a single IWS at a given time.
Large Instrument Tables. Instrument command groups which do not need to be uplinked in a time critical manner. This includes large amounts of commanding data which could block the commanding channel for a long period of time. To avoid this, the instrumenters must package the commanding data into "chunks" no larger than 0.5 Kbytes, which corresponds approximately to 10 seconds of uplink time. These "chunks" will be uplinked using the CMS background queue.

Macros. The spacecraft has an on-board macro capability. However, this capability is not available for use by the instrumenters through the EOF.

Near-Real-time (NRT) Commands. A group of commands originating from an IWS that will be routed through the POCC for uplink and arrive at the spacecraft within 60 seconds. Near-real-time commanding is only available to the IWSs during the "throughput mode", that is when there is a contact with the spacecraft and near-real-time commanding is enabled by POCC, CMS and the ECS. Only instrument OBDH block commands are allowed in NRT. However, certain instrument OBDH block commands are not allowed to be sent by an IWS as an NRT command. The commands "not allowed in NRT" are identified as such in the Project Data Base. They include but are not limited to the critical commands. The commands "not allowed in NRT" can be used in RPRs and RCRs and in delayed command files.

On-line/off-line Availability. Within the EOF, "on-line" information may be accessed electronically, without human intervention. "Off-line" information is stored on a medium that requires human intervention before access, for example, mounting a tape or disk.

Operational Day and Operational Week. An operational day is the 24-hour period starting at 00:00 GMT. An operational week is the 7-day period starting on a fixed day of the week at 00:00 GMT.

Predefined Command Sequence (PCS). A list of command mnemonics resident in the POCC, identified by a unique name known to both the FOT and the instrumenters. It may contain instrument commands and/or approved spacecraft commands, but critical commands are not allowed. It contains no time-tags or delay factors. The definition and maintenance of a PCS takes place between the instrumenters and the FOT (possibly via E-mail) and does not involve the ECS.

Project Data Base (PDB). The PDB consists of a series of data sets defining commands, telemetry, page displays, procedures, etc... The FOT is responsible for its maintenance and redistribution. Changes to the PDB require approval by the Change Control Board and are implemented under the control of the FOT.

Quicklook Data. This term refers to data created expeditiously by PACOR, post-pass. In this document, it is primarily used to refer to files containing tape recorder dumps, forward-ordered, organized by APID and by time.

Real-time Telemetry. Telemetry data delivered to ECS by PACOR with minimal delay and immediately distributed to the instrumenters. It includes housekeeping (VC0), science (VC1), and MDI-M (VC2) packets.

Telemetry Archive Data. The telemetry data archived by ECS. It consists of all VC0, VC1 and VC2 packets received as real-time telemetry, tape recorder dumps quicklook data (VC4), or retransmission from PACOR of real-time telemetry in the case of a failure in the real-time transmission. The telemetry archive data is stored by ECS on-line for 7 days and off-line for 21 days. It can be retrieved by the instrumenters via file transfer.

Remote Command Request (RCR). Electronic request originating from a IWS and destined to the POCC. It is used to request the execution of a PCS which is already approved by the FOT and stored in the POCC. RCRs are primarily intended to allow the instrumenters to make use of spacecraft commands needed by the instrumenters.

Remote Instrumenter. This term refers to the hardware and software provided by individual instrument teams, physically located outside of the EOF. They are not allowed to perform near-real-time commanding from their remote sites and they cannot receive real-time telemetry.

Remote Procedure Request (RPR). Electronic request originating from a IWS and destined to the POCC, used to request that the FOT operator execute a Systems Test and Operations Language (STOL) procedure which is already approved and stored in the POCC under the control of the FOT. STOL is the high level interactive command language that will be used in the POCC. RPRs are primarily intended to allow the instrumenters to make use of spacecraft commands as well as critical commands.

Spacecraft Command. A command addressed to a spacecraft subsystem, not including the payload instruments. As a general rule, the FOT is responsible for all spacecraft commands and the instrumenters are not allowed to generate these commands. However, some spacecraft commands may affect an instrument operation or invoke functions in which associated instrument commands need to be sent. The following is a non-exhaustive list of such spacecraft commands, the execution of which will need to be coordinated with the FOT (see the RPR and RCR definitions):

Pulse commands,
On-Board Time (OBT) update commands,
Instrument power on/off,
Select primary/redundant electronics,
Non-operational heaters on/off,
Select mode of inter-instrument data exchange,
Program inter-instrument data exchange,
Select telemetry sub-mode, etc...

1.5 ACRONYMS

AIV	Assembly, Integration and Validation
APID	Application Process Identification
CCS	Central Checkout System
CDF	Common Data Format
CDHF	Central Data Handling Facility
CDS	Coronal Diagnostic Spectrometer
CELIAS	Charge, Element and Isotope Analysis System
CEPAC	COSTEP-ERNE Particle Analysis Collaboration
CMS	Command Management System
COSTEP	Comprehensive SupraThermal and Energetic Particle Analyzer
DDF	Data Distribution Facility
DFCD	Data Format Control Document
DSN	Deep Space Network
EAP	ECS Activity Plan
ECS	EOF Core System
EGSE	Experiment Ground Support Equipment
EIT	Extreme-ultraviolet Imaging Telescope

EOF	Experimenters' Operations Facility
ERNE	Energetic and Relativistic Nuclei and Electron experiment
ESA	European Space Agency
FDDI	Fiber Distributed Data Interface
FITS	Flexible Image Transport System
FOT	Flight Operations Team
FTP	File Transfer Protocol
GMT	Greenwich Mean Time
GOLF	Global Oscillations at Low Frequencies
GSFC	Goddard Space Flight Center
HK	Housekeeping
IAP	Instrumenter Input to the Activity Plan
ICD	Interface Control Document
IDL	Interactive Data Language
IP	Internet Protocol
IPD	Information Processing Division
ISO	International Organization for Standardization
ISTP	International Solar-Terrestrial Physics
IWS	Instrumenter WorkStation
LASCO	Large Angle Spectrometric Coronagraph
LOBT	Local On-Board Time
MDI-H	Michelson Doppler Imager-Helioseismology
MDI-M	Michelson Doppler Imager-Magnetogram
MEDOC	Multi-Experiment Data Operation Centre
MO&DSD	Mission Operations and Data Systems Directorate
MODNET	MO&DSD Operational Development Network
NASA	National Aeronautics and Space Administration
NRT	Near-Real-Time
NSI	NASA Science Internet
NTP	Network Time Protocol
OBDH	On-Board Data Handling
OBT	On-Board Time
ODB	Operational Data Base
OSI	Open System Interconnection
PACOR	Packet Processor
PCS	Predefined Command Sequence
PDB	Project Data Base
PI	Principal Investigator
POCC	Payload Operations Control Center
Q&A	Quality and Accounting
RCR	Remote Command Request
RDBMS	Relational DataBase Management System
RFC	Request for Comment
RPR	Remote Procedure Request
R-S	Reed-Solomon
S/C	Spacecraft
SDB	System Data Base
SDPF	Sensor Data Processing Facility
SFDU	Standard Formatted Data Unit
SMOCC	SOHO Mission Operations Control Center
SMTP	Simple Mail Transfer Protocol
SOC	Science Operations Coordinator

SOHO	Solar and Heliospheric Observatory
SOWG	Science Operations Working Group
STOL	Systems Test and Operations Language
SUMER	Solar Ultraviolet Measurements of Emitted Radiation
SWAN	Solar Wind Anisotropies
TCP	Transmission Control Protocol
TELNET	Remote Login over TCP/IP Network
TM	Telemetry
TPOCC	Transportable Payload Operations Control Center
UDP	User Datagram Protocol
UTC	Coordinated Universal Time
UVCS	Ultraviolet Coronagraph Spectrometer
VC	Virtual Channel
VIRGO	Variability of Solar Radiance and Gravity Oscillations